
Methods for Economic Evaluation of Highways Investments and
Maintenance

HDM Manager Version 3.0:

User-friendly Shell Environment for the
Highway Design and Maintenance Standards Model (HDM)

June, 1995

Rodrigo Archondo-Callao
The World Bank



Transport Division, Transportation, Water &
Urban Development Department, the World Bank.

2 The HDM Manager Program

This report presents the HDM Manager developed by Rodrigo Archondo-Callao, The Transportation, Water & Urban Development Department, The World Bank.

Copyright © 1995
The International Bank for Reconstruction
and Development / The World Bank
1818 H Street, N.W.
Washington, DC 20433, U.S.A.

All rights reserved
Manufactured in the United States of America
First printing June 1995

HDM Manager is designed for use on 286, 386 or 486 personal computers. It requires a hard disk of 10 megabytes and minimum installed conventional memory of 640 Kb. The World Bank's Highway Design and Maintenance Standards Model (HDM), included in this package, is required to be used in conjunction with the HDM Manager.

The HDM Manager program was written to assist in the operational work of the World Bank. The author, the World Bank, the members of its Board of Executive Directors, and the countries they represent make no representations or warranty with respect to the HDM Manager program other than as specified in the User License Agreement. The User assumes all risk for the installation and use of, and results obtained from, the program. The author and The World Bank shall not be liable for any error contained in the program or in the supporting manual or documentation supplied with the program or for incidental or consequential damage resulting from furnishing, performance, or use of the program.

Although every effort has been made to test HDM Manager and ensure its accuracy, the World Bank is not in a position to provide user support.

HDM Manager Version 3.0

Contents

HDM MANAGER VERSION 3.0.....	3
CONTENTS.....	3
ACKNOWLEDGMENTS.....	5
THE HDM MANAGER PROGRAM.....	6
<i>Introducing HDM Manager</i>	6
<i>The 1995 HDM System</i>	7
<i>Installing 1995 HDM System</i>	7
<i>Starting the HDM Manager</i>	8
Using all the Defaults.....	8
Storing Work Files in Other Directories.....	8
Using Monochrome Monitors.....	8
<i>HDM Manager</i>	8
Using all the Defaults.....	8
Storing Work Files in Other Directories.....	8
Using Monochrome Monitors.....	8
<i>Working with the 1989 HDM Model</i>	9
<i>Working with Windows 3.1</i>	10
<i>The Main Menu</i>	10
<i>Learning the Basics</i>	11
<i>The Road Agency Strategies</i>	12
<i>Defining the Analysis Control</i>	13
<i>Defining Road Characteristics</i>	14
<i>Defining Vehicle Fleet Data</i>	15
<i>Working with Strategies</i>	17
Define Operations Unit Costs.....	18
Define Policies Data Bank.....	19
Define Strategies.....	23
<i>Running the HDM Model</i>	24
<i>Viewing the Road Deterioration</i>	25
<i>Viewing the User Impacts</i>	26
<i>Viewing the Cost Streams</i>	28
<i>Viewing the Economic Analysis</i>	29
<i>Working with Other Options</i>	30
<i>Perform Sensitivity Analysis</i>	31
<i>Produce Project Summary</i>	33
<i>Export Results</i>	33
<i>Manage HDM Output Files</i>	34
<i>Edit Congestion Parameters</i>	35
<i>Manage Data Set Files</i>	35
<i>Exiting the Program</i>	35
<i>The Data Set Files</i>	35

4 The HDM Manager Program

<i>HDM Manager and HDM</i>	35
THE HDM MANAGER INPUTS.....	37
<i>The Input Data</i>	37
<i>Analysis Control</i>	37
<i>Road Characteristics</i>	38
<i>Required Vehicle Characteristics</i>	45
<i>Optional Vehicle Characteristics</i>	48
<i>Operation Unit Costs</i>	51
<i>Definition of Strategies</i>	53
<i>Paved Maintenance Policies</i>	53
<i>Unpaved Maintenance Policies</i>	57
<i>Construction Policies</i>	59
<i>Exogenous Cst-Bnf Policies</i>	60
ANNEX 1 - PROJECT SUMMARY TABLE.....	i
ANNEX 2 - DETAILED LOTUS TABLE.....	II
ANNEX 3 - SUMMARY LOTUS TABLE.....	IV

Acknowledgments

The HDM Manager is a user-friendly shell environment for the Highway Design and Maintenance Standards Model (HDM). The core HDM model was developed by Thawat Watanatada, Clell Harral, William Paterson, Ashok Dhareshwar, Anil Bhandari, Koji Tsunokawa, Chris Hoban, and Rodrigo Archondo-Callao.

The development of the HDM Manager software and documentation benefited from comments of many individuals. Special thanks go to Chris Hoban, Gerard Liautaud, Cesar Queiroz, Roberto Armijo, Koji Tsunokawa, and Raymond Charles, who motivated and guided its development.

The HDM Manager Program

Introducing HDM Manager

The Highway Design and Maintenance Standard Model (HDM) is a computer program for analyzing the total transport costs of alternative road improvement and maintenance strategies through life-cycle economic evaluation. The program provides detailed modeling of pavement deterioration and maintenance effects, and calculates annual costs of road construction, maintenance, vehicle operation, and travel time. Accidents and other impacts can be added exogenously to the economic evaluation.

The first personal computer version of HDM, released by the World Bank in 1989, is widely used in the evaluation of specific road proposals, national or regional road investments analysis, and road maintenance policy assessment. The second personal computer version of HDM, released by the World Bank in 1995 in this package, maintains total compatibility with the previous HDM and addresses its significant limitation that it does not take account of traffic congestion, and its effects on traffic speeds, travel times and road user costs. That is, the 1995 HDM contains congestion analysis capabilities but maintains all the other characteristics of 1989 HDM.

The use of HDM was greatly simplified with the release by the World Bank of a user-friendly shell environment called HDM Manager in 1992. The HDM Manager stores the input data efficiently, creates all the required HDM input files, runs the HDM program, collects the results, and presents the results in a practical way. The first version of HDM Manager evaluated only paved roads maintenance projects and the second version was improved to evaluate maintenance and construction projects for paved and unpaved roads.

The HDM Manager being presented in this package is the third version. It is designed to manage the inputs and outputs of the current 1995 HDM and optionally the inputs and outputs of the previous HDM model. It also implements all the suggestions for improvements given by the HDM Manager 2.1 users, specially regarding the presentation of the results. While you can use the HDM Manager alone for demonstration purposes, it cannot analyze new options or save new data without the presence of the 1995 or 1989 HDM models. On the other hand, you could use the HDM models alone without the need for the HDM Manager. A procedure that is not recommended for new HDM users because of cumbersome process involved in using the HDM software.

The HDM Manager is a user-friendly shell environment for HDM. It is designed to evaluate a set of road agency strategies applied to paved and unpaved roads. The program computes, for each of the road agency strategies being evaluated, the road deterioration, the cost streams (agency costs, road user costs, and total society costs), and the economic indicators (net present value of net benefits and the internal rate of return) used to compare the set of road agency strategies. As a result, the user obtains the strategy that yields the highest benefits to society and if there is a budgetary constraint, the user obtains the optimal strategy as a function of the budget constraint.

HDM Manager incorporates most but not all the features of HDM. The main HDM features not included in this version are the following: i) division of roads to be evaluated (links) into sections and subdivision of sections into subsections, ii) use of alternative vehicle operating costs relationships, and iii) variable number of strategies to be evaluate in each run. To access

any of these features you would have to run the HDM model independently from the HDM Manager following its instructions.

The HDM Manager 3.0 is compatible with the HDM Manager 2.1. That is, the HDM Manager 3.0 reads data files created with the HDM Manager 2.1 and both produce the same results if the congestion analysis of the 1995 HDM model is disabled. The new features of HDM Manager 3.0 are: a) manages 1995 HDM (new congestion inputs), b) new user impacts output box, c) new cost-benefits policies option, d) new sensitivity analysis option, e) new economic analysis indicators, f) ADT of cars can be higher than 9999, g) improved graphics, h) new option for saving graphics, and i) use of extended memory if available.

The 1995 HDM System

The 1995 HDM system disk provided with this package contains the HDM Manager 3.0, the 1995 HDM, the new EBM-HS Model, and three HDM case studies. To run these programs you need a 80286 CPU or greater, DOS 3.1 or greater, 640 Kb of conventional memory, and a disk space of 10 Mb. Also make sure that 30 or more files are defined in the CONFIG.SYS file.

Installing 1995 HDM System

The steps needed to install the 1995 HDM system are the following:

- | | |
|--------|---------------------------------------|
| Step 1 | Insert the system disk in drive A: |
| Step 2 | At the DOS prompt, enter the command: |

A:INSTALL

The installation program expands the compressed files located on the system disk and copies them to the following directories:

HDM	where the 1995 HDM program is located
HDM-MAN	where the HDM Manager 3.0 and the HDM Manager 3.0 Utilities are located
HDMCASE1	where the Gravel Road Case Study is located
HDMCASE2	where the Paved Road Case Study is located
HDMCASE3	where the Congestion Case Study is located
EBM-HS	where the EBM-HS model is located

If any of the directories does not exist, the installation program will create it. If you have a previous version of the HDM, HDM Manager or EBM already installed on your computer, note the following: a) The 1995 HDM does not interfere with the 1989 HDM (they are composed of different and can be located on the same directory), b) If you have a previous version of the HDM Manager in a directory called HDM-MAN, the install program will overwrite it, and c) The EBM-HS program interferes with the previous EBM. Therefore, it is installed in a directory called EBM-HS.

For instructions regarding the EBM-HS model, refer to the EBM-HS documentation. To follow the HDM case studies, refer to their documentation. This document presents the HDM Manager software and the input data.

Starting the HDM Manager

The HDM Manager is a program written for DOS that can be executed from within the Windows 3.1 environment. This section and the following section present the procedures for starting the HDM Manager using DOS commands. For instructions on how to install and execute the HDM Manager on Windows 3.1, refer to the section titled "Working with Windows 3.1" that is given after the DOS instructions sections.

Using all the Defaults

To start the program using all the programs defaults, following the Steps below:

Step 1 Change to the HDM-MAN directory with the following DOS command:

CD\HDM-MAN

Step 2 Run the HDM Manager with the command:

HDM-MAN

Storing Work Files in Other Directories

The default setup of the HDM Manager is to store the input files and output files in the HDM-MAN directory (current directory). If you want to store all the input and output files in another disk drive or directory (work area directory) to avoid mixing the program files with the data files (procedure that is highly recommended), start the program as follow:

Step 1 Change to the HDM-MAN directory with the following DOS command:

CD\HDM-MAN

Step 2 Run the HDM Manager with the command:

HDM-MAN xxxxx

replace xxxxx with the work area directory. For example:

HDM-MAN c:\hdmcase1

Note that before starting the program in this manner, you should have created the work area directory. For example, using the DOS command:

MD\HDMCASE1

Using Monochrome Monitors

HDM Manager detects if you have a color or monochrome board and sets the screen colors accordingly. If you want to force HDM Manager to use the monochrome palette (for example on portable computers), start the program as follows:

Step 1 Change to the HDM-MAN directory with the following DOS command:

CD\HDM-MAN

Step 2 Run the HDM Manager with the command:

HDM-MAN xxxxx M

replace xxxxx with the work area directory. For example:

HDM-MAN c:\hdmcase1\ M

Working with the 1989 HDM Model

This HDM Manager version is designed mainly to be used with the 1995 HDM. The 1995 HDM has an option designed to disable the congestion analysis and if the congestion analysis is disabled, the model gives the same results as the 1989 HDM. Therefore, the use of the previous HDM model is not necessary or recommended. In case you want to use the HDM Manager with the previous HDM model, follow the steps below.

Install the 1989 HDM

Install 1989 HDM in a directory called HDM, following the instructions given by the HDM-PC manual.

Install the 1995 HDM System

Install the 1995 HDM System following the steps described in the previous section.

Start the HDM Manager

To start the HDM Manager and access the 1989 HDM program, change to the HDM-MAN directory with the following DOS command:

CD\HDM-MAN

and start the program with any of the following DOS commands:

a) To start the program with all the defaults:

HDM3-MAN

b) To store the data files in the directory xxxxx:

HDM3-MAN xxxxx

replace xxxxx with the work area directory

c) To store the data files in the directory xxxxx and to display the monochrome palette:

HDM3-MAN xxxxx M.

replace xxxxx with the work area directory

Working with Windows 3.1

The HDM Manager is a program written for DOS that can be executed from within the Windows 3.1 environment. To use the HDM Manager under Window, you first need to add an icon to Windows that when activated will execute the HDM Manager. To install the HDM Manager under Windows, follow the steps below.

- | | |
|--------|---|
| Step 1 | Select the <u>F</u> ile menu at the Windows Program Manager |
| Step 2 | Select the <u>N</u> ew option at the File menu |
| Step 3 | Select <u>P</u> rogram <u>I</u> tem at the New Program Object dialog box |
| Step 4 | Enter the following information at the Program Item Properties dialog box |

Description:	HDM Manager 3.0
Command Line:	HDM-MAN xxxx
Working Directory:	C:\HDM-MAN
Shortcut Key:	None

where xxxx should be replaced by the work area directory,

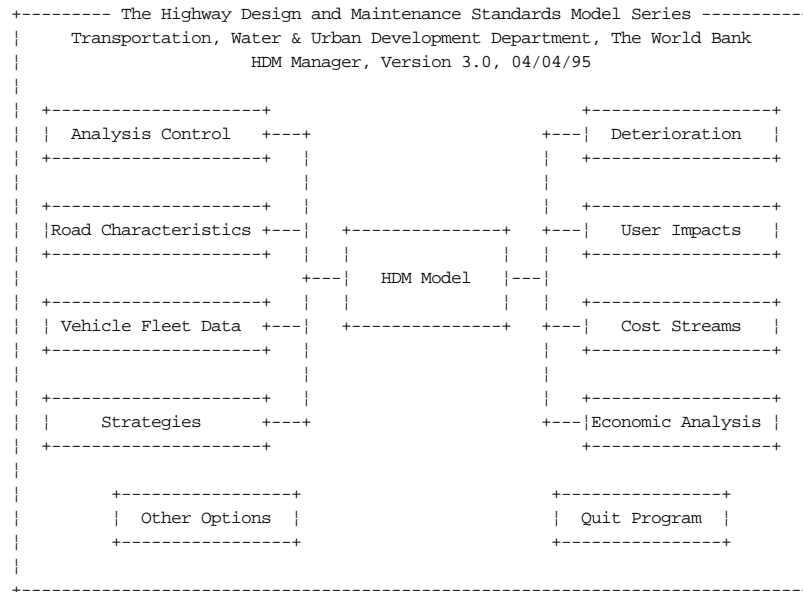
for example: HDM-MAN c:\hdmcase1\

Note that when you are defining an icon for the HDM Manager, you specify the work area directory that the HDM Manager will use to store the data files. Therefore, if you will be working with different work area directories (for example working with the case studies supplied in this package), you will need to add a separate icon for each work area directory that you will be working. Each icon that you add should have on the Command Line, at the Program Item Properties, the corresponding work area directory.

To start the HDM Manager under Windows, select the HDM Manager 3.0 icon. Windows executes the HDM Manager and after you define the input data, the HDM Manager executes the HDM program automatically and collects the results. Note that the HDM Manager is being executed under Windows but it is not a Windows program. Therefore, you can not use the mouse while working with the HDM Manager and you can not cut and paste information to and from the Windows clipboard.

The Main Menu

The main menu (shown below) shows you the basic structure of the program and gives you a series of options (Analysis Control, Deterioration, etc.). At this type of menu, select an option by using the cursor keys to highlight the option and pressing the Enter key or by pressing the first letter of the option selected.



Learning the Basics

To do a basic life-cycle economic evaluation of a set of road agency strategies applied to a paved or unpaved road, follow the Steps below:

- | | |
|--------|---|
| Step 1 | Define the <u>Analysis Control</u> . Enter the discount rate, the analysis period, the calendar year of the initial year, and the currency to be used. |
| Step 2 | Define the <u>Road Characteristics</u> . Enter the road geometry, road structure, road condition, environment, daily traffic, the traffic growth, and congestion parameters. |
| Step 3 | Define the <u>Vehicle Fleet Data</u> . Enter the vehicle fleet characteristics and the vehicle operation unit costs. |
| Step 4 | Define the <u>Strategies</u> . Enter the maintenance operations and construction unit costs, define a data bank of possible road agency maintenance and construction policies, and define the road agency strategies to be evaluated. |
| Step 5 | Execute the <u>HDM Model</u> . Run the HDM model from within the shell environment. Note that after the HDM run is completed, the HDM Manager collects the HDM results from the HDM output files. |
| Step 6 | View the <u>Deterioration</u> . Examine the road deterioration behavior (roughness progression, wide cracks progression, etc.) of each of the road agency strategies being evaluated. |
| Step 7 | View the <u>User Impacts</u> . Examine the user impacts (road user costs, speeds, etc.) of each of the road agency strategies being evaluated. |
| Step 8 | View the <u>Cost Streams</u> . Examine the financial and economic cost streams (agency costs, road user costs, exogenous costs-benefits, and |

total society costs) of the road agency strategies being evaluated.

- Step 9 View the Economic Analysis. Examine the economic comparison of the strategies being evaluated. The comparison is based on the net present value of benefits (NPV) of each strategy in relation to a base strategy.
- Step 10 Explore Other Options. For example: i) perform sensitivity analysis, ii) produce a project summary, iii) export the results to Lotus 1-2-2 or Dbase, iv) view or print the original HDM output files, v) edit the congestion setup tables, or vi) manage the data set files.

For each step described above, select the corresponding option at the main menu.

The Road Agency Strategies

The HDM Manager evaluates road agency strategies that are defined as sequence of actions performed by a road agency during a defined analysis period to maintain and/or improve a roadway. Some examples are given below:

- Example 1 Maintain an unpaved road for twenty year by doing routine maintenance, gravel resurfacing, and grading twice a year.
- Example 2 Maintain an unpaved road for two years doing routine maintenance and grading twice a year, and on the third year upgrade the road to a paved standard to be follow in subsequent years (next seventeen years) by routine maintenance, pothole patching and reseals activated when the surface distress area is greater than 10 percent.
- Example 3 Maintain a paved road by just doing routine maintenance for twenty years.
- Example 4 Maintain a paved road for twenty years by doing routine maintenance, patching all the potholes and by doing overlays every eight years.
- Example 5 Rehabilitate and widen the paved road in the first year to be follow in the next nineteen years by routine maintenance and overlays activated when the road roughness is greater than 4.5 IRI.

The actions performed by a road agency that can be included in the definition of a road agency strategy are the following:

- Routine maintenance
- Grading a gravel road
- Gravel resurfacing
- Spot regraveling
- Pothole patching
- Reseals
- Overlays
- Reconstructions
- New Constructions or Upgradings

The timing of these actions is in control of the user. That is, the user defines if an action takes place scheduled at a certain year or time interval, or if the action is activated in response to the condition of the road. The HDM model and the HDM Manager do not generate strategies for a given road. They perform a life-cycle economic evaluation of strategies defined by the user.

The next sections present the steps needed to setup the life-cycle economic evaluation and to define the strategies to be evaluated.

Defining the Analysis Control

Select the Analysis Control option at the main menu to enter the control data to be used in the HDM run. When you select this option, the Analysis Control screen (shown below) appears.

```

+----- Analysis Control -----+
| Description      Paving Gravel Road #1 |
| Run Date                Day 08  Month 08  Year 94 |
| Discount Rate (%)                12.0 |
| Analysis Period (years)                20 |
| Calendar Year of Initial Year        1995 |
| Input Currency Name                Dollars |
| Output Currency Name                Dollars |
| Output Currency Conversion Multiplier  1.0000000 |
|                                     |
|                                     |
+-----+

Edit          Print          Keep          Get          Save/Exit

```

The screen presents the current information stored in the memory of the system and a menu of options at the bottom of the screen. In this type of menu, you should select an option using the arrow keys and the Enter key or by pressing the first letter of the selected option.

To modify any of the inputs, use the Edit option. The HDM Manager has three types of inputs: i) required inputs, ii) optional inputs, and iii) lookup table inputs. The required inputs are displayed in Black and should be entered by the user. The optional inputs are displayed in Purple and in this case if the user wants the HDM model to estimate an optional input as a function of other inputs, the user can leave the input empty (not zero). The lookup table inputs are displayed in Brown and accept only a valid choice from a list of options. Press the F10 key, when the cursor is at the input field, to display the list of valid options and select an option with the Enter key. Note that you can not leave the lookup table inputs empty. They are required inputs.

The information displayed on this type of screen (Blue background) is what will be used by the HDM model to compute the results. The information on a screen is saved automatically in the memory of the system by HDM Manager each time you exit the screen with the Save/Exit option. That is, if you use the Save/Exit option to exit the screen and later you load the program and go back to the screen, the information previously on the screen will be there.

You also have the option of storing in a file (data set file) the information currently on the screen to create a library of information files that you can retrieve later. To store in a file the information currently on the screen, use the Keep option. This option prompts for the name of

the data set file to store the information. Enter a file name of up to six characters or digits. The HDM Manager will give a proper extension to the file.

To retrieve the information of a previously stored (using the Keep option) data set file, use the Get option. This option lists the available data sets. Highlight the data set you want and press the Enter key. The program will get the information from the data set file and present it on the screen. Remember that the HDM model uses the current information displayed on the screen (saved automatically with the Save/Exit option) to compute the results.

To print the current information, use the Print option and the program displays a list of valid printers. Select your printer by highlighting the printer and pressing the Enter key.

To return to the main menu use the Save/Exit option. If you press the Escape key, the program will return to the main menu but it will not save in the memory of the system the latest screen changes. Note that in the HDM Manager at any moment you can press the Escape key to cancel an operation or to go back to a previous menu.

Defining Road Characteristics

Select the Road Characteristics option at the main menu to enter the road information to be used in the HDM run. When you select this option, the Road Characteristics screen (shown below) appears.

```

+----- Road Characteristics -----+
|                                     | Page 1/3 |
| Description      Gravel Road #1 in North Region |
| Road Class (Paved/Unpaved)  U |
| GEOMETRY |
| Road Length (km)      100.0   Road Width (m)      6.0 |
| One Shoulder Width (m)  0.4   Effective Number of Lanes  . |
| Rise & Fall (m/km)     40.0   Curvature (deg/km)     100.0 |
| Superelevation (%)     0.0 |
| ENVIRONMENT |
| Altitude (m)          500   Rainfall (m/month)     0.0300 |
|                                     |
|                                     |
|                                     |
|                                     |
+-----+ Next Page ++
Edit          Print          Keep          Get          Save/Exit
    
```

The Road Characteristics menu is similar to the Analysis Control menu. Use the Edit option to edit the information, the Print option to print the information, the Keep option to store the information into a data set file for future use, the Get option to retrieve a data set information, and the Save/Exit option to save the current information and return to the main menu.

If you decide to store the current information (using the Keep option) in a data set file, you can give to the road characteristics data set file name the same data set file name given to an Analysis Control, Vehicle Fleet, Maintenance Unit Costs, Road Agency Policies, or a Road Agency Strategies data set. That is, the HDM Manager program considers each set of information (Analysis Control, Road Characteristics, Vehicle Fleet, Maintenance Unit Costs, Policies and Strategies) to be independent of each other, assigning to each one a different


```

+----- Vehicle Fleet Data - Required Parameters -----+
|                                                                 Page 1/2 |
| Description          Required Data for North Region      |
|                                                                 |
| BASIC CHARACTERISTICS          Car Pickup   Bus   Light Medium Heavy Artic. |
|                               Truck   Truck   Truck   Truck   Truck   |
| Gross Vehicle Weight (t)  1.200  1.800 10.900  5.600 11.300 20.800 27.000 |
| ESAL Factor per Veh.(E4)  0.000  0.010 0.500  0.100 1.000  3.000  5.000 |
| Number of Axles           2         2     2       2       2       3       5 |
| Number of Tires           4         4     6       6       6       10      18 |
| Number of Passengers       3.00    3.00 40.00   0.00   0.00   0.00   0.00 |
|                                                                 |
| VEHICLE UTILIZATION DATA |
|                                                                 |
| Service Life (yr)         10.0     8.0   8.0    8.0    8.0    8.0    8.0 |
| Hours Driven per Year     450     1300 2000   1300   2100   2000   1900 |
| Km Driven per Year        18000  30000 80000  50000  65000  67500  80000 |
| Depreciation Code        2         2     2       2       2       2       2 |
| Utilization Code         1         3     3       3       3       3       3 |
| Annual Interest Rate (%) 12.00   12.00 12.00  12.00  12.00  12.00  12.00 |
+-----+-----+-----+-----+-----+-----+-----+ Next Page +-+

```

Edit Print Keep Get Save/Exit

The Required Parameters menu is similar to the Analysis Control and Road Characteristics menus. Use the Edit option to edit the information, the Print option to print the information, the Keep option to store the information into a data set file for future use, the Get option to retrieve a data set information, and the Save/Exit option to save the current information and return to the main menu.

The Required Parameters are defined in two pages of information. Use the Next Page option to move among pages. Remember that the Edit option acts on the current page while the Print, Keep, and Get options act on all the pages.

The Required Parameters (all inputs in Black and Brown) option collects the basic vehicle characteristics, the vehicle utilization, and the vehicle unit costs data. The HDM model uses this information to compute the road user cost as a function of the road geometry and the road roughness.

When you select the Optional Parameters option at the Vehicle Fleet Data menu, the Vehicle Fleet Data - Optional Parameters screen (shown below) appears.

```

+----- Vehicle Fleet Data - Optional Parameters -----+
|                                                                 Page 1/2 |
| Description      Optional Data for Norht Region          |
|                                                                 |
| VEHICLE PARAMETERS      Car Pickup      Bus      Light Medium Heavy Artic. |
|                               Truck      Truck      Truck      Truck |
| Payload (Tons)           0.20    0.40    3.50    2.80    7.60    12.80    22.00 |
| Aerodynamic Drag Coeff.  .        .        .        .        .        .        . |
| Projected Frontal Area  .        .        .        .        .        .        . |
| Driving Power (Metric HP) .        .        .        .        .        .        . |
| Braking Power (Metric HP) .        .        .        .        .        .        . |
| Paved Desired Spd (km/h) 98.30   94.90   93.40   81.60   88.80   88.80   84.10 |
| Unpaved Desired Sp (km/h) 82.20   76.30   69.40   71.90   72.10   72.10   49.60 |
| Energy Efficiency Factor 0.85    0.95    0.95    0.95    0.95    0.95    0.95 |
| Hourly Utilization Ratio .        .        .        .        .        .        . |
| Calibrated Eng Spd (rpm) .        .        .        .        .        .        . |
| Weibull Shape Parameter .        .        .        .        .        .        . |
| Max Avg Rect Vel (mm/s) .        .        .        .        .        .        . |
| Width Parameter for Spd .        .        .        .        .        .        . |
| Fuel Adjustment Factor  .        .        .        .        .        .        . |
+-----+-----+-----+-----+-----+-----+-----+ Next Page ++

```

Edit Print Keep Get Save/Exit

The Optional Parameters menu is similar to the Analysis Control and Road Characteristics menus. Use the Edit option to edit the information, the Print option to print the information, the Keep option to store the information into a data set file for future use, the Get option to retrieve a data set information, and the Save/Exit option to save the current information and return to the main menu.

The Optional Parameters option (all inputs in Purple) is used to enter the data required to calibrate the vehicle operating costs model. Remember that if you want to change any of the default values supplied by the HDM model, you should enter the new values, otherwise leave the fields blank (not zero).

For detailed information on the information requested at the Vehicle Fleet Data option, refer to the HDM manuals. The HDM manuals describe each input item, the units used, and the valid range. This option contains the vehicle fleet characteristics required by HDM (series D in HDM).

The HDM Manager program adopts the Brazil vehicle operating costs relationships of HDM and defines seven types of vehicles. The number of vehicle types defined is fixed by the HDM Manager program. Therefore, while the full HDM program allows you to change the number of vehicle types and their names, these cannot be changed through the HDM Manager. The HDM Manager allows you to change the characteristics of each of the seven defined vehicle types and if in your analysis you don't want to include a particular vehicle type, enter 0 (zero) in the corresponding average daily traffic (ADT) field at the Road Characteristics option. Note also that the currency used to enter the unit costs is defined in the Analysis Control screen.

Working with Strategies

Select the Strategies option at the main menu to define the road agency strategies to be evaluated in the HDM run. This option displays the Strategies Menu screen (shown below). You have six options: i) enter the maintenance and construction operations unit costs, ii) define the road agency strategies, iii) define a library of paved road maintenance policies, iv) define a library of unpaved road maintenance policies, v) define a library of construction


```

+----- Strategies - Operations Unit Costs -----+
|
| Description      Operation Costs for North Region
|
|                                     Financial   Economic
| Operation                                     Unit Cost Unit Cost
|
| Grading (Currency per km of road graded)          100.0    85.0
| Spot Regravelling (Currency per cu m)             10.00    8.50
| Gravel Resurfacing (Currency per cu m)            20.00   17.00
| Unpaved Routine Maintenance (Currency per km per yr)  500     425
|
| Patching (Currency per sq m)                      10.00    8.50
| Resealing (Currency per sq m)                     2.70    2.30
| Overlay (Currency per sq m)                       10.81    9.19
| Reconstruction (Currency per sq m)                40.00   34.00
| Paved Routine Maintenance (Currency per km per yr) 1500   1275
|
| Construction (Thousands currency per km)          100.0    85.0
|
| Note: The input currency is defined in the Analysis Control Data
+-----+
|
| Edit          Print          Keep          Get          Save/Exit

```

Define Policies Data Bank

The HDM Manager evaluates road agency strategies that are composed of one or more than one paved maintenance policy, unpaved maintenance policy, construction policy, or exogenous costs-benefits policy. Therefore, you have to create a data bank of road agency policies before defining the strategies to be evaluated.

Some examples of policies and strategies are given below::

- Strategy X: Policy 1 - Grading every 90 days, plus gravel resurfacing (from 1995 to 2014)

- Strategy Y: Policy 1 - Reseals every 4 years (from 1995 to 2004)
- Policy 2 - Overlays every 8 years (from 2005 to 2011)

- Strategy Z: Policy 1 - Grading every 90 days (from 1995 to 1996)
- Policy 2 - Paving the road (in 1997)
- Policy 3 - Reseals when area of cracks > 15% (from 1998 to 2014)
- Policy 4 - Exogenous benefits activated after the paving

Note that strategies are the road agency alternatives being evaluated and that each strategy defines a set of future agency actions over the analysis period. Maintenance and construction policies within a strategy are not alternatives, but a sequence, with only one being applicable in a given year. Note also that a policy can include a number of operations which may be scheduled at a fixed time interval or activated in response to the condition of the road.

You define the paved maintenance policies, unpaved maintenance policies, construction policies, and exogenous costs-benefits policies that should belong to your policies data bank. These policies are stored in data set files with unique file names and should have unique and clear descriptions to identify the policies at the Definition of Strategies phase.

Paved Maintenance Policies

When you select the Paved Maintenance Policies option at the Strategies menu, the screen below appears.

```

+----- Data Bank - Paved Maintenance Policies -----+
|                                                                 |
| Description                                                    | Page 1/3 |
|                                                                 |
| Yes/No                                                         |
| Y  ROUTINE MAINTENANCE                                         |
|   Features:  Cost factor      1.00                             |
|                                                                 |
| N  PATCHING  (Scheduled or Responsive) R                       |
|   Scheduled: Area to be patched (m2/km/y)                      | 0.0 |
|   Responsive: Percent of pothole area to be patched           | 0.0 |
|                 Maximum applicable area (m2/km/y)              | .   |
|   Features:  Cost factor                                       | 1.00 |
|                 Last applicable year                           |
|                 Maximum applicable roughness (IRI)              | .   |
|                                                                 |
| N  RESEALING (Scheduled or Responsive) R                       |
|   Scheduled: Resealing interval (y)                            | 0   |
|   Responsive: Maximum allowable total damaged area (%)        | 0.0 |
|                 Minimum applicable resealing interval (y)      |
|                 Maximum applicable resealing interval (y)      |
|-----+-----| Next Page +-+
|
| Edit          Print          Save          Retrieve          Exit

```

The Paved Maintenance Policies menu is different from the Analysis Control menu or the other previous input data menus described so far. To indicate that, the screen background is Green while at the previous input data screens the backgrounds are Blue. On the Blue input screens, after you select the Save/Exit option, the program saves and retains in memory the information displayed on the screen. This information is then used by the HDM program. The Green input screens are managing a Data Bank of policies stored on files. Therefore, the information is not retained in memory when you select the Exit option. To save the information related to a policy, you have to explicitly use the Save option and supply a file name.

Use the Edit option to edit the information, the Print option to print the information, the Save option to save the information in a file, the Retrieve option to retrieve previously saved information for editing or viewing purposes, and the Exit option to return to the previous menu.

Remember that in this Step you are not deciding which policies to include in the strategies to be evaluated. You are managing a series of road agency policies stored in files that could or could not be used by the HDM model. You define the policies to be included in each strategy and the timing of these policies in the Definition of Strategies phase.

The Paved Maintenance Policies information is composed of three screen "pages". In these pages, you define the maintenance operations included in the policy and the characteristics of the operations. A paved maintenance policy is composed of Routine Maintenance and if wanted other maintenance operations (Patching, Reseal, Overlay or Reconstruction). Each maintenance operation can be scheduled at a certain time interval or activated in response to the condition of the road. Note that the Routine Maintenance operation is always included and that you can have more than one operation in a policy.

To show that a certain operation should be included on the policy being defined, enter a "Y"

at the left column of the screen at the corresponding operation. Otherwise, enter "N" or leave it blank. To select the type of operation (Scheduled or Responsive) place an "R" or "S" at right of the "Scheduled or Responsive" line. If you select the Scheduled option, enter the information at the Scheduled line (lines) and disregard the information on the Responsive line (lines). If you select the Responsive option, enter the information at the Responsive line (lines), and disregard the Scheduled line (lines). In both cases, Scheduled or Responsive options, you should define the Features of the operation.

Unpaved Maintenance Policies

When you select the Unpaved Maintenance Policies option at the Strategies menu, the screen below appears.

The Unpaved Maintenance Policies menu is equal to the Paved Maintenance Policies menu. Use the Edit option to edit the information, the Print option to print the information, the Save option to save the information in a file, the Retrieve option to retrieve previously saved information for editing or viewing purposes, and the Exit option to return to the previous menu. When you use the Save option, you are requested to enter a six digit/character file name and when you use the Retrieve option, the program displays a list of the previously saved policies.

```

+----- Data Bank - Unpaved Maintenance Policies -----+
|                                                                 |
| Description                                                    | Page 1/2 |
|                                                                 |
| Yes/No                                                         |
| Y  ROUTINE MAINTENANCE                                         |
|   Features:  Cost factor    1.00                               |
|                                                                 |
| N  GRADING (Scheduled or Responsive) R                         |
|   Scheduled: Time interval between gradings (d)                | 0 |
|   Responsive: Traffic interval between grading (vet)          | 0 |
|                 Minimum applicable time interval (d)           |
|                 Maximum applicable time interval (d)           |
|   Features:  Cost factor    1.00                               |
|                                                                 |
| N  SPOT REGRAVELLING (Scheduled or Responsive) R              |
|   Scheduled:  Gravel volume (m3/km/y)                          | 0.0 |
|   Responsive: Percent annual material loss replaced (%)        | 0 |
|                 Maximum applicable gravel volume (m3/km/y)     | . |
|   Features:  Cost factor    1.00                               |
|                                                                 |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Next Page +-+

```

Edit Print Save Retrieve Exit

Remember that the inputs in Black are required inputs, the inputs in Purple are optional (you can leave them blank, not zero, to be estimated by HDM), and the inputs in Brown are obtained from a list of valid options (press F10).

The Unpaved Maintenance Policies structure is similar to the Paved Maintenance Policies structure. The only difference is the type of operations included (Grading, Spot Regravelling, and Gravel Resurfacing). Remember that you select an operations by placing a "Y" at the left of the operation line, you decide between a Scheduled or Responsive operation by placing an "R" or "S" at the right of the corresponding line, and that you should enter the features of the operation.

Construction Policies

When you select the Construction Policies option at the Strategy menu, the screen below appears. The Construction Policies menu is equal to the Paved Maintenance Policies and Unpaved Maintenance Policies menus.

Use the Edit option to edit the information, the Print option to print the information, the Save option to save the information in a file, the Retrieve option to retrieve previously saved information for editing or viewing purposes, and the Exit option to return to the previous menu. When you use the Save option, you are requested to enter a six digit/character file name and when you use the Retrieve option, the program displays a list of previously saved policies.

Remember that each policy should have a unique file name and a unique description. While defining the strategies, you will identify the policies that are part of a strategy through the policy description.

The Construction Policies option requests the characteristics of a construction policy. That is, the construction duration and costs, the new road characteristics, and an optional generated traffic to be activated at the end of the construction.

```

+----- Data Bank - Construction Policies -----+
|                                                                 |
| Description                                                    | Page 1/3 |
|                                                                 |
| CONSTRUCTION                                                  |
|   Construction Duration (y)                                   1 |
|   Annual Cost Stream (% of total cost):  Construction Year 1  0.0 |
|                                                                 | Construction Year 2  0.0 |
|                                                                 | Construction Year 3  0.0 |
|                                                                 | Construction Year 4  0.0 |
|                                                                 | Construction Year 5  0.0 |
|   Salvage Value (% of total cost)  0.0 |
|   Cost Factor                       1.00 |
|                                                                 |
| GEOMETRY                                                       |
|   Road Class (Paved/Unpaved)  P |
|   Road Length (km)            1.0 | Road Width (m)          2.5 |
|   One Shoulder Width (m)      0.0 | Effective Number of Lanes . |
|   Rise & Fall (m/km)          0.0 | Curvature (deg/km)      0.0 |
|   Superelevation (%)          . |
|                                                                 |
+-----+-----+-----+-----+-----+-----+-----+-----+
| Next Page ++

```

Edit Print Save Retrieve Exit

Exogenous Costs-Benefits Policies

When you select the Exogenous Costs-Benefits Policies option at the Strategy menu, the screen below appears. The Exogenous Costs-Benefits Policies menu is equal to the Paved Maintenance Policies and Unpaved Maintenance Policies menus.

Use the Edit option to edit the information, the Print option to print the information, the Save option to save the information in a file, the Retrieve option to retrieve previously saved information for editing or viewing purposes, and the Exit option to return to the previous menu. When you use the Save option, you are requested to enter a six digit/character file name and when you use the Retrieve option, the program displays a list of previously saved policies.

```

+----- Data Bank - Exogenous Cst-Bnf Policies -----+
|
| Description
|
| Year  Costs (+) or Benefits (-)      Year  Costs (+) or Benefits (-)
|      (Million Currency)              (Million Currency)
|
|  1      0.00                          14      0.00
|  2      0.00                          15      0.00
|  3      0.00                          16      0.00
|  4      0.00                          17      0.00
|  5      0.00                          18      0.00
|  6      0.00                          19      0.00
|  7      0.00                          20      0.00
|  8      0.00                          21      0.00
|  9      0.00                          22      0.00
| 10      0.00                          23      0.00
| 11      0.00                          24      0.00
| 12      0.00                          25      0.00
| 13      0.00
|
| Note: The input currency is defined in the Analysis Control Data
+-----+
|
| Edit          Print          Save          Retrieve          Exit

```

The Exogenous Costs-Benefits Policies option defines a stream of extra costs or benefits to be activated when the policy is activated in the definition of strategies phase. The years in these policies are relative years. That is, year one represents the year the policy is activated, year two the following year and so on. Note that to assign extra benefits to a strategy you should enter negative values and to assign extra costs you should enter positive values.

Define Strategies

The HDM Manager evaluates and compares five road agency strategies at a time. Each strategy is composed of one or more than one road agency policy that is valid for a certain period. The program always analyzes five strategies. Therefore, you always have to define five strategies even if you are interested in the results of only one or two strategies. You could use the other strategies to do some sensitivity analysis. Of the five strategies being defined, the first strategy is the base strategy for comparison (the do minimum case). That is, the program computes the net benefits of the remaining strategies in relation to the first strategy.

When you select the Define Strategies option, the screen below appears. The Definition of Strategies menu is similar to the Analysis Control menu. Use the Edit option to edit the information, the Print option to print the information, the Keep option to store the information into a data set file for future use, the Get option to retrieve a data set information, and the Save/Exit option to save the current information and return to the previous menu.

To define the strategies enter the description of the set of five strategies and for each strategy define the policies (or policy) that compose the strategy. For each strategy, define at least the following information:

- The description of the strategy
- The starting year of the first maintenance policy
- The description of the first maintenance policy

```

+----- Strategies - Definition of Strategies -----+
|                                                                 | Page 1/2 |
| Description      Paving Gravel Road #1 / Run C                |
| STRATEGY 1:      Grade Every 120 Days                        |
|   Start in Year: 1995 Policy: Grading (120 days), Regravelling (Unp:G120_R)|
|                                                                 | (      )|
|                                                                 | (      )|
|                                                                 | (      )|
| STRATEGY 2:      Pave the Road in 1995                       |
|   Start in Year: 1995 Policy: Wait for Paving                 (Unp:WAIT )|
|                                                                 |          |
|                   1995      Paving Gravel Road #1           (Con:PAV_01)|
|                   1996      Reseal (12mm,20%), Patching     (Pav:SST_20)|
|                                                                 | (      )|
|                                                                 |          |
| Note: Strategy 1 is the base strategy for the economic analysis |
+-----+-----+-----+-----+-----+-----+-----+ Next Page ++
Edit          Print          Keep          Get          Save/Exit

```

Each strategy should have at least one maintenance policy and the first policy should start at the calendar year of the beginning of the analysis period. Each strategy can have a maximum of four policies. For example:

	Starting in year	Policy Description
STRATEGY 1	1995	Grading every 90 days
STRATEGY 2	1995	Grading every 90 days
	1996	Paving the road
	1997	Reseal when damage > 15%
	2005	Overlays when IRI > 4.5

A maintenance policy will be active from the starting year up to the end of the analysis period, unless a new policy starts. If a new maintenance policy starts, the previous policy will be stopped. The construction policies are active from the starting year and for the duration of the construction. The exogenous costs-benefits policies are active from the starting year to the end of the analysis period.

Enter the starting calendar year for each policy and on the right side enter the policy description. To enter a policy description, press the F10 key while the cursor is positioned at the description field. When you press the F10 key, at a policy description field, the program lists all the available policies (in your policies data bank stored in your work area directory). Select a policy by highlighting it and pressing the enter key.

Note that the first strategy is the strategy defined by the HDM Manager as the base strategy (do minimum case). That is, the HDM Manager computes the economic benefits of implementing the other strategies in relation to implementing the first strategy.

Running the HDM Model

After defining all the input data, run the HDM model using the HDM Model option. This option creates all the input data files required by HDM, runs the HDM model automatically, and after the HDM run is completed, collects the HDM results. Note that you need 3.5 Mb of

empty hard disk to store the temporary files created by the HDM model. These temporary files are erased automatically when you exit the HDM Manager.

If there is an input data or system error detected by the HDM model, the HDM model will not generate the results. The HDM Manager program indicates this fact by giving you a error message. If there is an input data error, you should locate it by viewing the output HDM scan files. Use the Other Options option at the main menu and select "Manage HDM Output Files". View the SCAN 1 file to locate errors on the Analysis Control and Road Characteristics Data. View the SCAN 2 file to locate errors on the Vehicle Fleet Data and Road Agency Policies. View the SCAN 3 file to locate errors on the Road Agency Strategies and the structure of the run and to obtain a summary table of errors and warnings. View the SCAN 4 file to locate execution errors. After locating the errors, you should fix them and run the HDM model again. Note that if the HDM model is not installed on your hard disk, the HDM Manager presents an error message and doesn't compute the results.

Viewing the Road Deterioration

Select the Deterioration option at the main menu to view the road deterioration under the five standards being evaluated. When you select this option, the periodic operations table appears and if you select the Next Table option, the following roughness deterioration table appears.

```

+----- Roughness (IRI m/km) -----+
|                                     |
|                                     |
|      First   Second   Third   Fourth   Fifth   |
|      Year   Strategy Strategy Strategy Strategy Strategy |
+-----+-----+-----+-----+-----+
| 1 1995 |      11.2   12.4   12.4   12.4   12.4 |
| 2 1996 |      12.0   3.2   13.9   13.9   13.9 |
| 3 1997 |      12.2   3.3   3.2   14.3   14.3 |
| 4 1998 |      12.4   3.4   3.3   3.2   14.5 |
| 5 1999 |      10.8   3.4   3.4   3.3   3.2 |
| 6 2000 |      11.0   3.5   3.4   3.4   3.3 |
| 7 2001 |      11.2   3.6   3.5   3.4   3.4 |
| 8 2002 |      11.4   3.7   3.6   3.5   3.5 |
| 9 2003 |      11.6   3.8   3.7   3.6   3.5 |
|10 2004 |      11.4   3.9   3.8   3.7   3.6 |
|11 2005 |      11.9   4.0   3.9   3.8   3.7 |
|12 2006 |      12.1   4.1   4.0   3.9   3.8 |
|13 2007 |      12.2   4.2   4.1   4.0   3.9 |
|14 2008 |      11.9   4.3   4.2   4.1   4.0 |
|15 2009 |      12.6   4.4   4.3   4.2   4.1 |
+-----+-----+-----+-----+-----+
Next Table  Prev. Table  Select Table  Graph Table  Output Table  Exit
    
```

The Roughness table presents the roughness progression for all five strategies and it is only one of the following available tables:

- Capital Operations
- Roughness (IRI m/km)
- All Cracks Area (%)
- Wide Cracks Area (%)
- Area Ravelled (%)
- Pothole Area (%)
- Rut Depth (mm)
- SD Rut Depth (mm)

- Modified Structural Number
- Surface Type
- Gravel Thickness
- Two-Way Average Daily Traffic
- Two-Way Annual Equivalent Standard Axles ('000)
- First Strategy Deterioration
- Second Strategy Deterioration
- Third Strategy Deterioration
- Fourth Strategy Deterioration
- Fifth Strategy Deterioration

The tables display the first 15 years. To display the next years (years 16 to 25), press the Page Down key, and to display again years 1 to 15, press the Page Up key. To display the next table, select the Next Table option and to display a previous table, select the Previous Table option. To display a particular table, use the Select Table option. Note that the last five tables present all the deterioration characteristics for each strategy (see example below).

```

+----- First Strategy - Grade Every 120 Days -----+
|
|      Oper Rough All Wide Rave Potho Rut      Gra      Annual
|      atio ness Crck Crck lled les Dpth Mod Sur vel 2-Way 2-Way
|      Year ns IRI % % % % mm SN face mm ADT ESA 000
+-----+-----+-----+-----+-----+-----+-----+
| 1 1995 |      11.2 |          |          |          |          |          |          |          |          |          |
| 2 1996 |      12.0 |          |          |          |          |          |          |          |          |          |
| 3 1997 |      12.2 |          |          |          |          |          |          |          |          |          |
| 4 1998 | RESU 12.4 |          |          |          |          |          |          |          |          |          |
| 5 1999 |      10.8 |          |          |          |          |          |          |          |          |          |
| 6 2000 |      11.0 |          |          |          |          |          |          |          |          |          |
| 7 2001 |      11.2 |          |          |          |          |          |          |          |          |          |
| 8 2002 |      11.4 |          |          |          |          |          |          |          |          |          |
| 9 2003 | RESU 11.6 |          |          |          |          |          |          |          |          |          |
|10 2004 |      11.4 |          |          |          |          |          |          |          |          |          |
|11 2005 |      11.9 |          |          |          |          |          |          |          |          |          |
|12 2006 |      12.1 |          |          |          |          |          |          |          |          |          |
|13 2007 | RESU 12.2 |          |          |          |          |          |          |          |          |          |
|14 2008 |      11.9 |          |          |          |          |          |          |          |          |          |
|15 2009 |      12.6 |          |          |          |          |          |          |          |          |          |
+-----+-----+-----+-----+-----+-----+-----+
Next Table  Prev. Table  Select Table  Graph Table  Output Table  Exit

```

To print, save into an ASCII file or export to Lotus 1-2-3 a particular table, select the Output Table option. If you save or export a table, the program asks for a filename. Enter a legitimate DOS filename including a path and extension if necessary.

To graph a particular table, select the Graph Table option. To print a graph you have the following options: a) to produce a screen dump to an Epson printer, IBM Proprinter, or HP LaserJet printer, press the F7 key while displaying a graph, and b) to print a high quality graph in a HP LaserJet printer, press the F9 key while displaying a graph. To save the graph in a .PCX format, press the F4 key while displaying the graph. You can then retrieve the .PCX file into a graphics program and print it on any printer supported by the graphics program.

Viewing the User Impacts

Select the User Impacts option at the main menu to view the user impacts for the five strategies being evaluated. When you select this option, the following unit road user costs table appears.

the vehicle selected.

To print a graph you have the following options: a) to produce a screen dump to an Epson printer, IBM Proprinter, or HP LaserJet printer, press the F7 key while displaying a graph, and b) to print a high quality graph in a HP LaserJet printer, press the F9 key while displaying a graph. To save the graph in a .PCX format, press the F4 key while displaying the graph. You can then retrieve the .PCX file into a graphics program and print it on any printer supported by the graphics program.

Viewing the Cost Streams

Select the Cost Streams option at the main menu to view the cost streams for the five strategies being evaluated. When you select this option, the following financial agency capital costs table appears.

```

+----- Financial Agency Capital Costs (Million Dollars) -----+
|
|
|      First   Second   Third   Fourth   Fifth
|      Year   Strategy Strategy Strategy Strategy Strategy
|-----|-----|-----|-----|-----|
| 1 1995 |      0.000  10.000   0.000   0.000   0.000
| 2 1996 |      0.000   0.000  10.000   0.000   0.000
| 3 1997 |      0.000   0.000   0.000  10.000   0.000
| 4 1998 |      1.920   0.000   0.000   0.000  10.000
| 5 1999 |      0.000   0.000   0.000   0.000   0.000
| 6 2000 |      0.000   0.000   0.000   0.000   0.000
| 7 2001 |      0.000   0.000   0.000   0.000   0.000
| 8 2002 |      0.000   0.000   0.000   0.000   0.000
| 9 2003 |      1.920   0.000   0.000   0.000   0.000
|10 2004 |      0.000   0.000   0.000   0.000   0.000
|11 2005 |      0.000   0.000   0.000   0.000   0.000
|12 2006 |      0.000   0.000   0.000   0.000   0.000
|13 2007 |      1.920   0.000   0.000   0.000   0.000
|14 2008 |      0.000   1.998   0.000   0.000   0.000
|15 2009 |      0.000   0.000   1.998   0.000   0.000
|-----|-----|-----|-----|-----|
|
|
| Next Table  Prev. Table  Select Table  Graph Table  Output Table  Exit

```

This table is only one of the following available tables:

- Financial Agency Capital Costs
- Financial Agency Recurrent Costs
- Economic Agency Capital Costs
- Economic Agency Recurrent Costs
- Economic Road User Costs
- Economic Travel Time Costs
- Economic Exogenous Costs-Benefits
- Economic Total Society Costs
- Net Economic Benefits
- First Strategy Economic Costs
- Second Strategy Economic Costs
- Third Strategy Economic Costs
- Fourth Strategy Economic Costs
- Fifth Strategy Economic Costs

The tables display the first 15 years. To display the next years (years 16 to 25), press the Page Down key, and to display again years 1 to 15, press the Page Up key. To display the next table

select, the Next Table option and to display a previous table select the Previous Table option. To display a particular table, use the Select Table option. Note that the last five tables present all the cost streams for each strategy.

To print, save into an ASCII file or export to Lotus 1-2-3 a particular table, select the Output Table option. If you save or export a table, the program asks for a filename. Enter a legitimate DOS filename including a path and extension if necessary.

To graph a particular table, select the Graph Table option. If you are displaying a table that compares the five strategies, the program displays a bar chart comparing the strategies. If you are displaying a table that presents the costs for a single strategy, the program produces a stacked bar chart with the costs of the strategy.

To print a graph you have the following options: a) to produce a screen dump to an Epson printer, IBM Proprinter, or HP LaserJet printer, press the F7 key while displaying a graph, and b) to print a high quality graph in a HP LaserJet printer, press the F9 key while displaying a graph. To save the graph in a .PCX format, press the F4 key while displaying the graph. You can then retrieve the .PCX file into a graphics program and print it on any printer supported by the graphics program.

Note that HDM Manager divides the total society costs into the following components:

$$\begin{aligned} \text{Total Society Costs} = & \text{Road Agency Costs} \\ & + \text{Road User Costs} \\ & + \text{Exogenous Costs-Benefits} \end{aligned}$$

$$\text{and Road Agency Costs} = \begin{aligned} & \text{Capital Costs} \\ & + \text{Recurrent Costs} \end{aligned}$$

$$\text{and Road User Costs} = \begin{aligned} & \text{Vehicle Operation} \\ & + \text{Travel Time} \end{aligned}$$

The road agency capital costs are the costs related to new construction, reconstruction, overlays, reseals, and gravel resurfacing. The road agency recurrent costs are costs related to routine maintenance, pothole patching, gradings, and sport regraveling. The vehicle operation costs are related to the fuel consumption, lubricants consumption, tire wear, maintenance parts, maintenance labor, depreciation, interest lost, and crew time. The travel time costs are related to the passenger time and cargo holding time. The exogenous costs-benefits costs are specified by the user.

Viewing the Economic Analysis

Select the Economic Analysis option at the main menu to view the economic analysis performed by the HDM model. When you select this option, the following table appears.

```

+----- Present Values and Internal Rate of Return -----+
|
| -Present Values at | First   Second   Third   Fourth   Fifth
| 12.0% Discount Rate| Strategy Strategy Strategy Strategy Strategy
| (Million           |-----|
| Dollars)           |
|
| Society            | 37.20  32.85  33.21  33.61  34.04
| Agency             | 3.08   9.79   8.77   7.87   7.06
|  Capital           | 2.51   8.79   7.84   6.99   6.23
|  Recurrent         | 0.57   1.00   0.94   0.88   0.84
| Road Users        | 34.13  23.06  24.43  25.74  26.98
|  Vehicle Operation| 24.53  16.28  17.30  18.28  19.20
|  Travel Time      | 9.60   6.78   7.13   7.46   7.77
|  Exogenous Cst-Bnf| 0.00   0.00   0.00   0.00   0.00
|
| Net Present Value  | 0.00   4.35   4.00   3.59   3.16
| (Net Benefits)    |
|
| -Rate of Return (%)|      NA   18.9   19.2   19.3   19.3
|
+-----+

```

Next Table Prev. Table Select Table Graph Table Output Table Exit

The table presents the discounted cost streams present values, the discounted net present value of benefits (NPV), and the internal rate of return. Note that if the core HDM model finds many rates of return for a given strategy, the HDM Manager computes the various rates of return and displays one of them along with the warning "(MANY)". In this case, the rate of return displayed is the first rate of return higher than the discount rate if the net present value is positive, and the first rate of return lower than the discount rate if the net present value is negative.

The following five tables are available in the Economic Analysis option:

- Present Values and Internal Rate of Return
- Equivalent Annual Values and Average Roughness
- Benefit Cost Ratios and Incremental Benefit Cost Ratios
- Net Present Value per Initial Capital Investment
- Financial Agency Costs
- Quality of Service Indicators

To display the next table, select the Next Table option or press the Page Down key and to display the previous table select the Previous Table option or press the PgUp key. To print, save into an ASCII file or export the table to Lotus 1-2-3, select the Output Table option. If you save or export the table, the program asks for a filename. Enter a legitimate DOS filename including a path and extension if necessary.

Select the Graph Table option to graph the table. There are different graph options for each table being displayed. To print a graph you have the following options: a) to produce a screen dump to an Epson printer, IBM Proprinter, or HP LaserJet printer, press the F7 key while displaying a graph, and b) to print a high quality graph in a HP LaserJet printer, press the F9 key while displaying a graph. To save the graph in a .PCX format, press the F4 key while displaying the graph. You can then retrieve the .PCX file into a graphics program and print it on any printer supported by the graphics program.

Working

Select the Other Options option at the main menu to perform any of the tasks listed in the Other Options menu (shown below).


```

+----- Second Strategy - Pave the Road in 1995 -----+
|
|           Study 1  Study 2  Study 3  Study 4  Study 5  Study 6 |
| Discount Rate (%)      12.00  12.00  12.00  12.00  12.00  12.00 |
| Multiplicative Factors |
| For Net Benefits      |
| Agency Capital         1.00   1.20   1.00   1.20   1.30   1.40 |
| Agency Recurrent       1.00   1.20   1.00   1.20   1.30   1.40 |
| Vehicle Operation      1.00   1.00   0.80   0.80   0.70   0.60 |
| Travel Time            1.00   1.00   0.80   0.80   0.70   0.60 |
| Exogenous Cst-Bnf     1.00   1.00   0.80   0.80   0.70   0.60 |
|
|-----|-----|-----|-----|-----|-----|
| Net Present Value      4.36   3.02   2.14   0.80  -0.98  -2.75 |
| Rate of Return (%)    18.90  16.10  15.50  13.10  10.70   8.40 |
|
+-----+-----+-----+-----+-----+-----+
Edit Factors           Graph Table   Output Table   Exit

```

The sensitivity analysis screen shows the net present value and the internal rate of return for six case studies. For each case study, the discount rate and the multiplicative factors for net benefits used in the calculations are also shown. For a given strategy, the HDM model computes the net present value and the internal rate of return from a stream of total net benefits and the discount rate. The stream of total net benefits represents the benefits of implementing the strategy in relation to implementing the base strategy (first strategy). The stream of total benefits is the sum of the following streams:

- Net benefits related to savings in agency capital costs
- Net benefits related to saving in agency recurrent costs
- Net benefits related to savings in vehicle operation costs
- Net benefits related to savings in travel time costs
- Net benefits related to savings in exogenous costs-benefits costs

Note that the net benefits streams contain positive and negative values. Positive values indicate benefits (savings) and negative values indicate negative benefits (increases) in relation to the base strategy.

For each case study, the sensitivity analysis option computes the net present value and the internal rate of return by multiplying the streams of net benefits by user-specified factors and the given discount rate. For example, a vehicle operation factor of 0.8 represents taking in to account only 80 percent of the benefits related to vehicle operation.

The sensitivity analysis option computes the results with the multiplicative factors and discount rate that are currently stored on the memory of the system. To change these parameters, use the Edit Factors option. Once you change these parameters, the program computes again the results and presents them on the screen. The new parameters will be saved on the memory of the system and will be used the next time you use this option.

To print, save into an ASCII file or export the table to Lotus 1-2-3, select the Output Table option. If you save or export the table, the program asks for a filename. Enter a legitimate DOS filename including a path and extension if necessary. Select the Graph Table option to graph the table. To print a graph you have the following options: a) to produce a screen

dump to an Epson printer, IBM Proprinter, or HP LaserJet printer, press the F7 key while displaying a graph, and b) to print a high quality graph in a HP LaserJet printer, press the F9 key while displaying a graph. To save the graph in a .PCX format, press the F4 key while displaying the graph. You can then retrieve the .PCX file into a graphics program and print it on any printer supported by the graphics program.

Produce Project Summary

The produce project summary option allows you to produce a one page summary report of the results of the economic evaluation of a given strategy. Select the Project Summary option to view, print, or export a summary report for your selected project (see Annex 1). Your selected project should be one of the four strategies being analyzed (second strategy to fifth strategy). Remember that the first strategy is the base strategy (without project case) used to compute the benefits of implementing the other strategies. After you select the project, the program asks if you want to view, print, save (ASCII) or export (Lotus 1-2-3) the summary report.

The summary report presents for the without project case (first strategy) and for the selected project the following information:

- Roughness Progression
- Average Daily Traffic
- Periodic Maintenance Actions
- Economic Road Agency Costs
- Economic Road User Costs
- Economic Total Society Costs

It also presents the following economic comparison indicators:

- Decrease in Agency Costs Stream
- Decrease in User Costs Stream
- Net Economic Benefits Stream
- Project Net Present Value
- Project Internal Rate of Return

The economic road agency costs are the sum of the capital and recurrent costs. The economic road user costs are, in this table, the sum of the vehicle operation, travel time costs and exogenous costs-benefits. Note that if you export the summary report to Lotus 1-2-3, it will also present the financial agency costs of the project.

Export Results

This option allows you to export the results to Lotus 1-2-3, Dbase and EBM formats. You can create a Detailed Lotus 1-2-3 Table (see Annex 2), a Summary Lotus 1-2-3 Table (see Annex 3), a Dbase Table, or an EBM input file. When you select a Lotus 1-2-3 table, the program asks for a filename. Enter a legitimate DOS filename including a path if necessary. Note that you don't have to include the .WK1 extension in the filename. The Lotus 1-2-3 tables can be used to prepare plots or charts, or perform further analysis of the results.

When you select the Dbase Results Table the following input screen appears:

```

+---+| Create Dbase Results Table +-----+
|  |
|  |          FILE TO
|  |          BE CREATED
|  |
|  |
|  | DOS filename   : \MANAGER3\GRAV.DBF
|  | Road code      : GRAV
|  | Strategy 1 code : GRAD
|  | Strategy 2 code : PAVI
|  | Strategy 3 code : PAVI
|  | Strategy 4 code : PAVI
|  | Strategy 5 code : PAVI
|  |
|  |
|  | -----
|  | Road Name   : Gravel Road 1 in North Region
|  | Strategy 1  : Grading every 90 days + Regrav.
+---+ Strategy 2  : Paving in 1993 + Reseal at 20%
|  | Strategy 3  : Paving in 1994 + Reseal at 20%
|  | Strategy 4  : Paving in 1995 + Reseal at 20%
|  | Strategy 5  : Paving in 1996 + Reseal at 20%
|  |
+-----+

```

You should enter the DOS filename, including a path if necessary, and the road and strategy codes. The Dbase tables created from different runs can be merged to store the results of different roads into a single Dbase table for further analysis at a network level. For this purpose, when creating the Dbase Results Table, you should give to each road and to each strategy a four character identification code. The default road code is the first four characters of the road description and the default strategy codes are the first four characters of the strategies descriptions.

When you select to create an EBM Input File, the program presents an input screen similar to the Dbase Results Table input screen (shown above). You should enter the DOS filename, including a path if necessary, and the road and strategy codes. Although it is not mandatory, an extension of .EBM is recommended. Each EBM file to be created needs a four character identification code for the road and the strategies being evaluated. The default road code is the first four characters of the road description and the default strategy codes are the first four characters of the strategies descriptions. Note that if you enter a filename that already exists, the program asks if you want to overwrite the file or append to the existing file.

Manage HDM Output Files

This option allows you to view, print, and keep the output files created by the HDM model. The HDM model produces 10 output files that contain all the inputs, error messages and warnings, and all the results. Select the "View the HDM Output Files" option to view the output files created by HDM model or any text (ASCII) file. When you select this option and the file to view, the file you selected is displayed on the screen. Use the arrow keys to move through the file and press the ESC key to return to the menu.

Select the "Print the HDM Output Files" option to print the output files created by HDM model. When you select this option, you have to select the file you want to print and a printer from a list of available printers. Note that the HDM output files contain 132 characters per line.

Select the "Keep HDM Output Files" option to store the HDM output files. Each time you run the HDM Manager, the previous HDM output files created by the previous HDM run are overwritten. Therefore, use this option to make a copy of these output files for future use before they are overwritten. When you select the file you want to keep, the program asks for the filename (include path and extension) to copy the file.

Edit Congestion Parameters

This option allows you to modify the congestion lookup tables after the congestion calibration process. Use the "Edit Road Types" option to edit the road types lookup tables. You have the option of editing road types, adding road types and deleting road types. Use the "Edit Road Uses" option to edit the road uses lookup tables. You have the option of editing road uses, adding road uses and deleting road uses.

Manage Data Set Files

This option allows you to delete and copy the Data Set files. Select the "Delete a Data Set" option to delete a data set of a particular input module (Analysis Control, Road Characteristics, Vehicle Fleet Data, etc.). Select the "Copy a Data Set" option to copy a data set of a particular input module (Analysis Control, Road Characteristics, Vehicle Fleet Data, etc.) to a different drive or directory. Select the "Copy all Data Set" option to copy all data sets to a different drive or directory. When you select the "Delete" or "Copy" options, the program enters into a loop that allows you to delete or copy many Data Sets quicker. To exit the loop, select the "Return to Main Menu" option.

Exiting the Program

Select the Quit Program option at the main menu to exit the program and return to DOS.

The Data Set Files

All Data Set files created by the HDM Manager are Dbase files. The filenames start with the character "_" and the second character indicates the type of data the file contains. We have the following:

_A	Run Control Data
_B	Reserved for Future Use
_C	Road Characteristics
_D	Reserved for Future Use
_E	Required Vehicle Parameters
_F	Optional Vehicle Parameters
_G	Maintenance Unit Costs
_H	Definition of Standards
_I	Paved Maintenance Policies
_J	Unpaved Maintenance Policies
_K	Construction Policies
_L	Exogenous Cst-Bnf Policies

HDM Manager and HDM

The HDM Model reads a series of input files (ASCII text files) and after it computes the results, it creates another series of output text files. The HDM Manager program stores the input data and the results in Dbase files. Therefore, the HDM input files you created with your word processor or with the HDM Input Data Facility are not compatible with HDM Manager. That means that you cannot import the data stored in HDM input files into the HDM Manager.

The HDM Manager creates all the required HDM input files before it runs the HDM model. These files are named HDMDATA.*. That is, HDMDATA.RUN, HDMDATA.AAA, HDMDATA.BBB, etc. You can view and modify these files with a word processor or the HDM Input Data Facility to run the HDM model directly.

The HDM Manager Inputs

This section describes the input data used by the HDM Manager. Refer to the following World Bank publications for additional information regarding the HDM Manager inputs and HDM relationships:

Watanatada, T. and others. The Highway Design and Maintenance Standards Model, Volume 1, Description of the HDM-III Model. Washington, D.C.: Transportation Department, World Bank, 1987.

Watanatada, T. and others. The Highway Design and Maintenance Standards Model, Volume 2, User's Manual for the HDM-III Model. Washington, D.C.: Transportation Department, World Bank, 1987.

Chris Hoban and others. Economic Analysis of Road Projects with Congested Traffic. Washington, D.C.: Infrastructure Department, World Bank, 1995.

The Input Data

The HDM Manager has the following three types of inputs:

Required	The required inputs are displayed in Black. You should enter these inputs.
Optional	The optional inputs are displayed in Purple. You can leave these inputs blank (not zero), if you want the HDM Model to estimate these inputs as a function of other inputs or collect default values.
Lookup Table	The lookup table inputs are displayed in Brown. These inputs accept only a valid choice from a list of options. To display the lookup table, press the F10 key, when the cursor is at the input field.

Analysis Control

Description	Description of the run. This description appears in all the reports produced by the HDM Manager and when you use the Get option to retrieve information stored in data files.
Run Date	Calendar day, month and year of the run. This information appears on all the reports produced by the HDM Manager.
Discount Rate	Discount rate used to compute the present value of the costs and benefits streams, in percent. For developing countries, the discount rate generally adopted is 12 percent.
Analysis Period	Number of years to be included in the life-cycle economic evaluation, in years. That is, the time over which benefits and costs are compared. You options are between 10, 15, 20, or 25 years. An analysis period between 15 to 20 years is recommended.
Initial Calendar Year	Calendar year of first year in the analysis period. Note that all the strategies to be defined for the run should have a maintenance policy that starts in this calendar year.
Input Currency	Name of the currency being used to enter the unit vehicle operation,

maintenance , construction, and exogenous costs. The program can accept any currency, but you should use a currency that will fit on the input fields. If a currency does not fit, you can use a multiplier of the currency (for example: millions of pesos).

Output Currency Name of the currency to be use to present the results. If the results do not fit in the output fields, select a different output currency. Note that the name you enter here will appear in all the reports produced by the HDM Manager.

Conversion Multiplier Factor to convert from input currency to output currency. The output currency will be the input currency multiplied by the output currency conversion multiplier.

Road Characteristics

Description Description of the road. This description appears in all the reports produced by the HDM Manager and when you use the Get option to retrieve information stored in data files. If you plan to a create the EBM input file, the first four characters of the description should be the road code (project code) needed by the EBM program to identify the road.

Road Type Code to identify the road type. Enter P to specify a paved road or U to specify an unpaved road. Note that the second page of the road characteristics inputs changes as a function of the road type.

PAVED AND UNPAVED ROADS

GEOMETRY

Road Length Road length, in kilometers. Note that the minimum length possible is 1 kilometer.

Road Width Carriageway width, in meters.

One Shoulder Width Width of one shoulder, in meters.

Effective Number of Lanes Effective number of lanes. If value is not specified, the program estimates the effective number of lanes as a function of the road width. Estimated values:

1.0 if width < 4.5 m
 1.5 if 4.5 m < width < 6.0 m
 2.0 if 6.5 m < width < 8.0 m
 3.0 if 8.0 m < width < 11.0 m
 4.0 if 11.0 > width

Rise Plus Fall Aggregate measure of the vertical gradient of a road in, m/km. It is defined as the sum of the absolute values, in meters, of all ascents and all descents along a road, divided by the length of the road in kilometers. Suggested values:

Flat terrain 0
 Level terrain 10
 Rolling terrain 20

	Hilly terrain	50
	Mountainous terrain	80
Curvature	Aggregate of the horizontal curvature of the roadway, in degrees/km. It is defined as the sum of the absolute values of angular deviations (in degrees) of successive tangent lines of the road alignment when traveling in one direction, divided by the road length in km. Suggested values:	
	Flat terrain	0
	Level terrain	50
	Rolling terrain	150
	Hilly terrain	300
	Mountainous terrain	500
Superelevation	Average superelevation is defined as the weighted average of the superelevations of the curvy sections of the road, the weights being the proportion of the lengths of curvy sections. (dimensionless). The superelevation of a curvy section is the vertical distance between the heights of the inner and outer edges of the road divided by the road width. If value is not specified, the program estimates the superelevation as a function of the road curvature. Note that this value has no significant effect on the results.	

ENVIRONMENT

Altitude	Mean elevation of the road section above the mean sea level, in meters. Note that this value has no significant effect on the results.	
Rainfall	Mean monthly precipitation, in m/month. Suggested values:	
	Arid environment	0.002
	Semiarid environment	0.020
	Subhumid environment	0.080
	Humid environment	0.150

PAVED ROADS**SURFACE**

Surface Type	Code that indicates the surface type. The seven surface type codes are:	
	<u>1</u> for surface treatment (ST) roads	
	<u>2</u> for asphalt Concrete (AC) roads	
	<u>3</u> for slurry on surface treatment (SSST) roads	
	<u>4</u> for reseal on surface treatment (RSST) roads	
	<u>5</u> for reseal on asphalt concrete (RSAC) roads	
	<u>6</u> for open graded cold mix on surface treatment (OCMS) roads	
	<u>7</u> for asphalt overlay or slurry seal on asphalt concrete, and asphalt overlay on surface treatment (OVSA) roads	
	Two of the surface types, surface treatment and asphalt concrete, apply to original, new or reconstructed pavements. The other types	

define surfaces after a full-width maintenance treatment or rehabilitation of an existing pavement.

- New Layers Thickness Total thickness of the most recent surfacing layers (or layer), in mm.
- Old Layers Thickness Total thickness of previous, underlying surfacing layers (or layer), in mm. If a road was constructed 20 years ago and an overlay was applied 5 years ago, the layers (or layer) of the construction period are the “old” layers and the layers (or layer) of the overlay are the “new” layers. Note that when a pavement surface is applied to a road it can be applied in one single layer or in more than one layer.

BASE/SUBGRADE

Base Type Code that indicates the base type. The three base type codes are:

- 1 for granular bases
- 2 for cement stabilized bases
- 3 bituminous bases

Subgrade CBR The California Bearing Ratio of the subgrade, in percent. It is determined at the equilibrium in situ conditions of moisture content and density. Suggested values:

Poor roadbed soil	2
Fair roadbed soil	5
Good roadbed soil	10

Base Layers Thickness Thickness of base layers in the original pavement, in mm. Note that this input is only required if the base is cement stabilized.

Resilient Modulus Resilient modulus of soil cement, in Gpa. Note that this input is only required if the base is cement stabilized.

STRENGTH

Structural Number Measure of pavement strength that summarize the complex interactions between material types and stiffness. The structural number (AASHTO) is defined as a linear combination of layer strength coefficients and thicknesses of the individual layers above the subgrade. Typical values:

Surface treatment (12 mm) road	1.0
Surface treatment (25 mm) road	1.5
Asphalt Concrete (5 cm) road	2.0
Asphalt Concrete (8 cm) road	3.0
Asphalt Concrete (10 cm) road	4.0
Asphalt Concrete (15 cm) road	5.5

Note that the roads described above are classified only by the surface thickness with the assumption of having proper base layers. In the computation of the structural number, the thicknesses of all layers above the subgrade should be taken into account.

Benkelman Deflection The mean Benkelman Beam rebound deflection of the surfacing in both wheelpaths under 80 kN standard axle load, 520 kPa tire pressure, and 30 C average asphalt temperature, in mm.

Note that you can enter both the structural number and the Benkelman Bean deflection or you can enter only one of these values. If you enter only one of these values, the other will be estimated by the HDM Model as a function of the supplied value. If you have both values, it is recommended that you enter both values because the current relationship between the modified structural number and Benkelman deflection is somewhat weak.

CONDITION

Roughness Deviation of a surface from a true planar surface with characteristic dimensions that affect vehicle dynamics, ride quality, dynamic loads and drainage (ASTM E-867-82A) - typically in ranges of 0.1 to 100 m wavelengths and 1 to 100 mm amplitudes , in IRI. IRI is the International Roughness Index, the reference measure expressing roughness as a dimensionless average rectified slope statistic of the longitudinal profile and defined in Sayer, Gillespie, and Paterson (1987), in m/km. Suggested values based on a qualitative evaluation of the ride quality of the road:

Smooth paved road	2
Reasonably smooth paved road	4
Medium rough paved road	6
Rough paved road	8
Very rough paved road	10

If you have roughness in QI units (roughness measured by a quarter-car index scale), convert it into IRI units using the formula:

$$\text{IRI} = \text{QI} / 13$$

If you have roughness in BI units (roughness measured by Bump Integrator trailer at 32 km/h), convert it into IRI units using the formula:

$$\text{IRI} = \text{BI} / 715$$

If you have roughness in other units, convert it into IRI units using an appropriate conversion method. Refer to the following publication for more information about the International Roughness Index and its relationship to other roughness units. Sayers, M.W., T.D. Gillespie and W.D.O. Paterson. Guidelines for Conducting and Calibrating Road Roughness Measurements. Technical Paper No. 46, The World Bank. Washington, DC, 1986.

Construction Fault Code indicating the construction quality. The options are:

- 0 if the surfacing has not construction faults
- 1 if the surfacing has construction faults

Wide Cracks Area Total area of wide cracking, comprising the area of the interconnected or line cracks of 3 mm crack width or greater, with spalling (equivalent

to AASHTO Class 4), in percent of the total carriageway area.

All Cracks Area	Total area of all cracking, comprising wide and narrow cracking, in percent of the total carriageway area. Note that narrow cracks area is the area of the interconnected or line cracks of 1-3 mm crack width (equivalent to AASHTO Class 2).
Ravelling Area	Area of loss of material from wearing surface., in percent of the total carriageway area.
Pothole Area	Area of open cavities in road surface with at least 150 mm diameter and at least 25 mm depth, in percent of the total carriageway area. Note that a road in poor condition, with a series of potholes, will have around 1.0 (one) percent of pothole area.

Note that the area of any distress (cracks, ravelling, and potholes) is the sum of rectangular areas circumscribing the manifest distress and that for line cracks a width dimension of 0.5 m is assigned. The distresses are expressed as percentage of the total carriageway area.

Suggested values for surface distress:

Asphalt Concrete Roads

	No Surface Distress	Medium Surface Distress	High Surface Distress
Wide Cracks Area (%)	0	15	60
All Cracks Area (%)	0	25	75
Ravelling Area (%)	0	0	0
Pothole Area (%)	0	0.01	1.0

Surface Treatment Roads

	No Surface Distress	Medium Surface Distress	High Surface Distress
Wide Cracks Area (%)	0	15	60
All Cracks Area (%)	0	25	75
Ravelling Area (%)	0	50	15
Pothole Area (%)	0	0.01	1.0

Rut Depth Average of the measures of maximum depth under a 1.2 m straightedge placed transversely across a wheelpath, in mm.

Rut Depth STD Standard deviation of rut depth measures (across both wheel paths), in mm.

Suggested values for rut depth and standard deviation of rut depth measures:

	Low Rut Depth	High Rut Depth
Rut Depth (mm)	5	15
Rut Depth STD (mm)	2	6

HISTORY

Surfacing Age	Number of years elapsed since latest reseal, overlay, pavement reconstruction, or new construction, in years.
Construction Age	Number of years elapsed since latest overlay, pavement reconstruction, or new construction, in years.
Previous Wide Cracks	Area of wide cracks before the latest reseal or overlay, in percent of the total carriageway area. Note that this information is required only if there are old surfacing layers.

DETERIORATION FACTORS

Roughness-Age	Environmental roughness-age term in the roughness prediction model. Suggested values for different environments:
	Arid / Tropical / Nonfreezing 0.220
	Arid / Subtropical / Nonfreezing 0.440
	Arid / Temperate / Freezing 1.090
	Semiarid / Tropical / Nonfreezing 0.440
	Semiarid / Subtropical / Nonfreezing 0.700
	Semiarid / Temperate / Freezing 1.520
	Subhumid / Tropical / Nonfreezing 1.000
	Subhumid / Subtropical / Nonfreezing 1.300
	Subhumid / Temperate / Freezing 2.170
	Humid / Tropical / Nonfreezing 1.300
	Humid / Subtropical / Nonfreezing 1.740
	Humid / Temperate / Freezing 3.040
Cracking Initiation	Linear multiplier of the prediction of cracking initiation.
Cracking Progression	Linear multiplier of the prediction of cracking progression.
Ravelling Initiation	Linear multiplier of the prediction of ravelling initiation.
Pothole Progression	Linear multiplier of the prediction of pothole progression.
Roughness Progression	Linear multiplier of the prediction of roughness progression.
Rut Depth Progression	Linear multiplier of the prediction of rut depth progression.

UNPAVED ROADSCONDITION

Gravel Thickness	Current gravel thickness, in mm. If the current gravel thickness is 0 (zero), the road will be treated as an earth road. That is, the surface information will be disregarded and the model will compute the road roughness given the subgrade properties.
Gravel Age	Time in years since last regravelling or construction, in years.
Road Roughness	Roughness of the unpaved road, in IRI. Suggested values based on a

qualitative evaluation of the ride quality of the road:

Smooth unpaved road	4	
Reasonably smooth unpaved road	8	
Medium rough unpaved road	12	
Rough unpaved road		15
Very rough unpaved road	20	

Compaction Code Code that indicate if mechanical compaction was used during construction or rehabilitation. A code equal to 1 indicates with mechanical compaction, and a code equal to 0 indicates without mechanical compaction.

SURFACE

Minimum Roughness Minimum roughness of unpaved road surfacing material, in IRI.

Maximum Roughness Maximum roughness of unpaved road surfacing material, in IRI.

Maximum Particle Size Maximum particle size of the material, defined as the equivalent sieve opening through which 95 percent of material passes, in mm.

Plasticity Index Plasticity index of the material, in percent.

Passing 2.0 mm Sieve Amount of material passing the 2.0 mm sieve (or ASTM No. 10 sieve), in percent by mass.

Passing 0.425 mm Sieve Amount of material passing the 0.525 mm sieve (or ASTM No. 40 sieve), in percent by mass.

Passing 0.0075 mm Sieve Amount of material passing the 0.075 mm sieve (or ASTM No. 200 sieve), in percent by mass.

SUBGRADE

Minimum Roughness Minimum roughness of unpaved road subgrade material, in IRI.

Maximum Roughness Maximum roughness of unpaved road subgrade material, in IRI.

Maximum Particle Size Maximum particle size of the material, defined as the equivalent sieve opening through which 95 percent of material passes, in mm.

Plasticity Index Plasticity index of the material, in percent.

Passing 2.0 mm Sieve Amount of material passing the 2.0 mm sieve (or ASTM No. 10 sieve), in percent by mass.

Passing 0.425 mm Sieve Amount of material passing the 0.525 mm sieve (or ASTM No. 40 sieve), in percent by mass.

Passing 0.0075 mm Sieve Amount of material passing the 0.075 mm sieve (or ASTM No. 200 sieve), in percent by mass.

PAVED AND UNPAVED ROADS

TRAFFIC

Average Daily Traffic Current average daily vehicular traffic in both directions for each vehicle class, in vehicles/day.

Traffic Growth Rate Average daily traffic growth rate for each vehicle class, in percent increase per year.

Note that if you do not want to use a particular vehicle class in the analysis, you should enter zero in the corresponding average daily traffic.

Change in Growth You can specify a change in the traffic growth rates in a future year. Enter the year when the growth rate will change or leave this field blank to maintain the same growth rate over the analysis period.

New Traffic Growth Enter the new traffic growth rates, in percent, if you had entered the year when these new rates will be activated.

CONGESTION

Include Congestion? Enter Y to include the congestion effects calculated by 1995 HDM. Enter N or leave the field blank to not include the congestion analysis of 1995 HDM to obtain the same results as 1989 HDM.

Road Type Select the road type category. The road type defines the road capacity and speed parameters.

Road Use Select the road use category. The road use defines the characteristics of the yearly flow periods.

Roadside Friction “Friction” factor to account for slow moving vehicles and roadside activities, which reduces speeds.

**Required
Vehicle
Characteristics**

Description Description of the required vehicle characteristics. This description appears when you use the Get option to retrieve information stored in data files.

BASIC CHARACTERISTICS

Gross Vehicle Weight Gross vehicle weight, in tons. Defined as the sum of the tare weight and the payload. Note that you should not enter the gross vehicle weight of a fully loaded vehicle. Enter the gross vehicle weight of a representative vehicle of the vehicle class. Suggested range for gross vehicle weights:

Cars	0.8 to 2.0
Pickups	1.1 to 2.5
Buses	7.5 to 12.0
Light trucks	3.0 to 6.5

Medium trucks	5.0 to 16.0
Heavy trucks	6.0 to 22.0
Articulated trucks	13.0 to 45.0

ESA Factor per Veh. Equivalent 80 kN standard axle load factor based on the equivalency exponent of 4.0, in ESA per vehicle. The equivalent standard axle (ESA) is defined as the number of applications of a standard 80 kN dual-wheel single axle load which would cause the same amount of damage to a road as one application of the axle load being considered. Suggested values:

Cars	0
Pickups	0 to 0.01
Buses	0.4 to 0.8
Light trucks	0.01 to 1.0
Medium trucks	1.0 to 2.0
Heavy trucks	2.0 to 4.0
Articulated trucks	4.0 to 8.0

Number of Axles Number of axles per vehicle. Suggested values:

Cars	2
Pickups	2
Buses	2
Light trucks	2
Medium trucks	2
Heavy trucks	3
Articulated trucks	5

Number of Tires Number of tires per vehicle. Suggested values:

Cars	4
Pickups	4
Buses	6
Light trucks	6
Medium trucks	6
Heavy trucks	10
Articulated trucks	18

Number of Passengers Number of passengers per vehicle. Suggested values:

Cars	3
Pickups	3
Buses	40
Light trucks	0
Medium trucks	0
Heavy trucks	0
Articulated trucks	0

VEHICLE UTILIZATION

Service Life	The baseline average vehicle service life, in years
Hours Driven per Year	Baseline average number of hours driven per vehicle per year, in hours per year.
Km Driven per Year	Baseline average number of kilometers driven per vehicle per year, in kilometers per year.
Depreciation Code	Code that indicates depreciation method to be used. Enter <u>1</u> for de Weille's varying vehicle life method. Enter <u>2</u> for constant vehicle life method. The de Weille's varying vehicle life method assumes that the vehicle service life decreases somewhat as the vehicle speed increases. The constant vehicle life method assumes the vehicle life to be constant irrespective of the vehicle speed and equal to the user-specified baseline value.
Utilization Code	Code that indicates the utilization method to be used. Enter <u>1</u> for constant annual kilometerage method. Enter <u>2</u> for constant annual hourly utilization method. Enter <u>3</u> for adjusted utilization method. The constant annual kilometerage method assumes that for each vehicle class the average annual kilometerage driven per vehicle is constant and equal to the user-specified baseline km driven per year. The constant annual hourly utilization method assumes that the average annual number of hours driven per vehicle is constant. Thus the average annual kilometerage driven per vehicle is computed as the product of the user-specified average number of hours driven per vehicle per year and the speed. The adjusted utilization method assumes the annual kilometerage driven per year to be a function of the user-specified baseline km and hours driven per year, the vehicle speed and the hourly utilization ratio defined as the ratio of the annual number of hours driven to the number of hours available for operation. The constant annual kilometerage method is recommended for cars while the adjusted utilization method is recommended for the other vehicle classes.
Annual Interest Rate	Annual real interest charge on the purchase of a new vehicle, in percent.

ECONOMIC UNIT COSTS

New Vehicle Price	Cost per new vehicle.
New Tire Price	Cost per new tire.
Maintenance Labor	Cost per labor-hour of vehicle repairs and maintenance.
Crew Cost	Cost per crew-hour of vehicle operation.
Passenger Time	Passenger time cost per passenger-hour delayed.
Cargo Time	Cargo time cost per vehicle-hour delayed.
Gas/Petrol Price	Gasoline/Petrol cost per liter.

Diesel Price	Diesel cost per liter.
Lubricants Price	Lubricants cost per liter.

Note that the program request economic unit costs not the financial unit costs in order to compute the total vehicle fleet vehicle operation and travel time costs in economic terms. Financial costs represent the actual costs incurred by transport operators in owning and operating the vehicles over the road. Economic costs represent the real costs to the economy of that ownership and operation, where adjustments are made to allow for market price distortions such as taxes, foreign exchange restrictions, labor wage laws, etc.

Optional Vehicle Characteristics

Description Description of the optional vehicle characteristics. This description appears when you use the Get option to retrieve information stored in data files.

Note that all the following inputs are optional. If you leave them blank (not zero), the model will adopt the default values obtained in the Brazil HDM study.

Payload Vehicle payload, in tons. Suggested range values for payloads:

Car	0 to 0.4
Pickups	0 to 1.4
Buses	0 to 4.5
Light trucks	0 to 3.5
Medium trucks	0 to 11.0
Heavy trucks	0 to 16.0
Articulated trucks	0 to 32.0

Aerodyn. Drag Coeff. Aerodynamic drag coefficient (dimensionless). Suggested range values for aerodynamic drag coefficients:

Cars & Pickups	0.3 to 0.6
Buses	0.6 to 0.7
Trucks	0.8 to 1.0

Projected Frontal Area Projected frontal area of the vehicle, in m2. Suggested range values for frontal areas:

Car	1.5 to 2.4
Pickups	2.3 to 3.2
Buses	6.0 to 7.0
Light trucks	3.0 to 5.0
Medium trucks	5.0 to 8.0
Heavy trucks	5.0 to 8.0
Articulated trucks	5.5 to 10.0

Driving Power Maximum used driving power, in metric hp. Suggested range values for driving powers:

Car	25 to 100
Pickups	35 to 100
Buses	80 to 120

Light trucks	50 to 100
Medium trucks	80 to 120
Heavy trucks	80 to 120
Articulated trucks	180 to 230

You can estimate the maximum driving power (HPDRIVE) from the maximum rated power of a vehicle, that is available from the vehicle manufacturer (HPRATED). Based on the test vehicles data from the Brazil study, separate relationships were developed for gasoline and diesel vehicles:

For gasoline vehicles:

$$\text{HPDRIVE} = 2.0 \text{ HPRATED}^{0.7}$$

For diesel vehicles:

$$\text{HPDRIVE} = 0.7 \text{ HPRATED}$$

where HPRATED is the SAE maximum rated power of the vehicle. Note that since HPRATED is usually quoted under standard atmospheric conditions, the value of HPRATED should be adjusted where the operating atmospheric conditions depart from the standard conditions (e.g., in high-altitude driving or driving in severely cold weather).

Braking Power

Maximum used braking power, in metric hp. Suggested range values for braking powers:

Car	15 to 30
Pickups	20 to 35
Buses	140 to 180
Light trucks	90 to 120
Medium trucks	230 to 270
Heavy trucks	230 to 270
Articulated trucks	460 to 540

You can estimate the maximum braking power (HPBRAKE) from the manufacturer's rated gross vehicle weight (GVWRATED). Based on the test vehicles data from the Brazil study, use one of the following simple formulas:

$$\text{HPBRAKE} = 14 \text{ GVWRATED or } 15 \text{ GVWRATED}$$

where GVWRATED is the manufacture's rated gross vehicle weight. This formula is based on the assumption that vehicle designers strive to match the vehicle's braking capacity with its design weight.

Paved Desired Speed

The desired speed for paved roads, in km/h. The desired speed is the desired vehicle speed without the effect of road severity factors. On a straight, flat and smooth road, although the driving, braking, curve and ride severity speed constraints do not exist, the vehicle still does not normally travel at the speed afforded by its own maximum or even used power. Rather, its speed is usually governed by subjective considerations of such factors as fuel economy, vehicle wear, safety or

blanket speed limits. Since it was not possible to separate these effects in the study data, they were combined in the parameter "desired speed".

Unpaved Desired Speed The desired speed for unpaved roads, in km/h.

Energy Efficiency Factor Fuel efficiency factor (dimensionless). The sample of test vehicles for the Brazil study was chosen before the two major oil crises, in the early and late seventies, that stimulated an unprecedented change in vehicle technology to improve fuel economy. You can incorporate changes in vehicle technology through the energy efficiency factor. This factor has a default value of 1.0 for makes and models close to the ones employed in the Brazil study. You may specify lower values for newer, more fuel-efficient makes and models. Some typical values are given below:

Cars	0.85
Pickups	0.95
Buses	0.95
Light trucks	0.95
Medium trucks	0.95
Heavy trucks	0.95
Articulated trucks	0.80

Hourly Utilization Ratio Hourly utilization ratio (dimensionless). The hourly utilization ratio is the ratio of the annual number of hours driven to the number of hours available for operation.

Calibrated Eng Spd. Calibrated engine speed, in revolutions per minute. You can estimate the calibrated engine speed (CRPM) from the maximum rated engine speed (MRPM), that is available from the vehicle manufacturer using the formula:

$$\text{CRPM} = 0.75 \text{ MRPM}$$

where MRPM is the maximum rated engine speed, in rpm.

Weibull Shape Parameter Weibull shape parameter for speed distribution (dimensionless).

Max Avg Rect Vel. Maximum allowable average rectified velocity of suspension motion of the standard Opala-Maysmeter vehicle in response to roughness, in mm/s.

Width Parameter Width parameter for adjusting the desired speed (dimensionless).

Fuel Adjustment Factor Fuel consumption adjustment factor for operating conditions (dimensionless). The fuel consumption data employed in the development and validation of the fuel consumption prediction model was obtained under rather idealized controlled conditions in favor of fuel efficiency. Predictions by the model were found to be generally lower than values experienced by vehicle operators in the same geographic region but under actual conditions. Therefore, an adjustment factor was developed to bring the predictions closer to vehicle operators' values. The default values of the adjustment factor

were obtained from calibrating the mechanistic fuel prediction model to the road user cost survey data in Brazil. They are 1.16 for cars and utilities, and 1.15 for trucks and large buses.

FRATIO0 (Paved)	Perceived friction ratio for paved roads (dimensionless).
FRATIO0 (Unpaved)	Perceived friction ratio for unpaved roads (dimensionless).
FRATIO1 (Paved)	Load parameter for adjusting perceived friction ratio for paved roads, in tons-1.
FRATIO1 (Unpaved)	Load parameter for adjusting perceived friction ratio for unpaved roads, in tons-1
Recap Cost Ratio	Cost ratio of a retreading to a new tire, in percent.
Tire Rubber Vol	Wearable rubber volume per tire, in dm ³ .
Number of Retreads	Base number of recaps (dimensionless)
Tread Wear, COTC	Constant term of the tire tread wear model, in dm ³ .
Tread Wear, CTCTE	Wear coefficient of the tire tread wear model, in dm ³ /J-M (scale 10 ⁻²).
Spare Parts, C0SP	Constant term of the parts consumption model (dimensionless) (scale 10 ⁻⁶).
Spare Parts, CSPQI	Roughness exponent of the parts consumption model, per QI (scale 10 ⁻³).
Spare Parts, QIOSP	Transition roughness value, in QI.
Labor Hours, COLH	Constant term of the maintenance labor model (dimensionless).
Labor Hours, CLHPC	Parts exponent of the maintenance labor model (dimensionless).
Labor Hours, CLHQI	Roughness coefficient of the maintenance labor model, per QI.

Operation Unit Costs

Description	Description of the operation unit costs. This description appears when you use the Get option to retrieve information stored in data files.
Financial & Economic	The program requests the financial operations unit costs and the economic operations unit costs in order to compute the road agency costs in financial and economic terms. Financial costs represent the actual costs incurred by the agency in maintaining and investing in the road infrastructure. Economic costs represent the real costs to the economy of that maintenance and investments, where adjustments are made to allow for market price distortions such as taxes, foreign exchange restrictions, labor wage laws, etc.
Inflation	Inflation should not be accounted for in the evaluation because we are

assuming that the cost components considered in the economic evaluation are subjected to the same inflation rate over the analysis period,. Constant prices, as applicable to the first calendar year of the analysis period, should be used.

UNPAVED ROADS

Grading	Grading cost per km of road graded.
Spot Regraveling	Spot regravelling cost per cubic meter. Spot regravelling provides repair to areas of severe depression (gravel loss, rutting, etc.).
Gravel Resurfacing	Gravel resurfacing costs per cubic meter.
Unp. Routine Maint.	Unpaved routine maintenance cost per kilometer per year. This includes drainage maintenance, vegetation control, shoulder maintenance, safety installations, and other items which are not modelled as affecting the ride quality of the pavement. A lump sum cost per year is used as the basis for costing routine maintenance.

PAVED ROADS

Patching	Patching cost per square meter. This includes mainly surface patching and repair of surfacing distress. Included are skin patches of binder and stone or slurry seal on cracked or ravelled areas, the replacement of the surfacing in small severely-cracked areas, and the filling of potholes. The unit cost of patching must be provided whenever a resealing operation is included in any maintenance policy, whether or not patching is included as an operation.
Resealing	Resealing cost per square meter. It comprises two thin resurfacing operations which repair surface distress but cause little change to the roughness or structural strength of the pavement; these operations are surface treatment (i.e., chip seal) and slurry seal. Although resealing usually implies also preparatory patching, the unit cost of resealing should not include the patching cost; the two are computed separately as appropriate by the model.
Overlay	Overlay cost per square meter. It applies to bituminous overlays placed by mechanical paver-finisher in a single-layer. Double-layer asphaltic overlays of less than 125 mm thickness may be specified under this operation by regarding the two layers as one compound layer.
Reconstruction	Reconstruction cost per square meter. It applies in the model to all works that require re-specification of the surfacing and base types, and pavement thicknesses and strength parameters. The cost should include the costs of scarification, stripping, base repair, recompaction, and resurfacing for an average rehabilitation operation.
Paved Routine Maint.	Paved routine maintenance cost per kilometer per year. This includes drainage maintenance, vegetation control, shoulder maintenance, safety installations, and other items which are not modelled as affecting the ride quality of the pavement. A lump sum cost per year is

used as the basis for costing routine maintenance.

Note that the cost of the operations described above are entered in the currency specified in the Analysis Control. If your costs do not fit the input fields, you should change the input currency at the Analysis Control. For example, instead of using pesos you could use “thousands of pesos” as your input currency.

Construction Construction cost per kilometer. It includes new construction, widening, realignment, or some other form of upgrading. Note that the cost for this operation is entered in thousands of the currency defined in the Analysis Control.

Note that the unit costs entered are the costs for a particular (user defined) operation. For example the financial unit cost for an overlay could be set to 8.00 \$/m², the thickness and the material being defined by the user. This cost, for example, may be based on a 40 mm asphalt concrete overlay, but these details are not shown in the input screen. The cost for a particular operation can be adjusted by a cost factor to consider variations on the defined operation (for example to consider different thicknesses or materials) in the definition of maintenance and construction policies.

Definition of Strategies

Description Description of the of set of five strategies. This description appears when you use the Get option to retrieve information stored in data files.

The Manager requires that you define the five strategies to be evaluated. For each strategy, you have to enter the following information.

Description Description of the strategy. This description appears in all the reports produced by the HDM Manager. If you plan to create the EBM input file, the first four characters of the description should be the strategy code (alternative code) needed by the EBM program to identify the strategy.

Each strategy is composed of one ore more than one policy. For each policy (a line in the definition of strategies) to be included in the strategy, enter the following information.

Starting Year The starting calendar year of the policy to be part of the strategy.

Policy Description of the policy to be activated in the specified starting calendar year. To obtain a list of valid policies, press the F10 key when the cursor is placed in the corresponding policy input field. Note that the HDM Manager displays all the policies stored in the work area directory. That is, the directory that was specified when you started the HDM Manager. If you can not locate your previously defined policies, make sure that you starting the program properly.

Paved Maintenance Policies

Description Description of the paved maintenance policy. This description appears when you use the Retrieve option to retrieve information stored in data files. Note that the data regarding a paved maintenance policy is stored in a data set file located in the hard disk and is accessed through its description. Therefore, each policy should have an unique file name and description.

The following inputs describe a paved maintenance policy. Each policy is composed of one or

more than one maintenance operation. You define what maintenance operations should be included in the policy by placing a “Y” at the left side of the name of the operation to be included. After you include an operation, you have to decide if the operation would be scheduled at a certain time interval or if it would be activated in response to the condition of the road. You make this decision by placing a “S” (Scheduled) or “R” (Condition Responsive) at the right side of the operation name. Finally, you have to enter the time interval or trigger point and the features of the operation being defined.

One operation feature that is present in all operations is the cost factor. Whenever a maintenance operation is carried out in the simulation, its cost will be the multiplication of the unit cost data (defined in the Operation Unit Costs screen) by the cost factor. This allows for the definition of variations of the operation. For example, to consider different thicknesses, materials, or other characteristics.

ROUTINE MAINTENANCE

(Y/N) Input to indicate if routine maintenance should be included in the policy. Note that routine maintenance is always included in a paved maintenance policy. Therefore, you can not change this input.

Cost Factor Routine maintenance cost factor.

PATCHING

(Y/N) Input to indicate if patching should be included in the policy. Enter “Y” to include patching. If you entered “Y”, you should enter the following information.

(S/R) Input to indicate if patching should be scheduled or condition responsive. Enter “S” for scheduled and “R” for condition responsive.

Area to Patch Area to be patched, in m²/km/y. Required only if patching is scheduled.

Pothole Area to Patch Pothole area to be patched per year, in percent. Required only if patching is condition responsive.

Max. Applicable Area Maximum applicable area to patch per year independently of the percent of pothole area to be patched per year, in m²/km/y. Required only if patching is condition responsive.

Cost Factor Patching cost factor.

Last Applicable Year Last applicable year, in number of years starting from the first year in the analysis period. If this is specified, the operation will not be carried out after that year.

Max. Appl. Roughness Maximum applicable roughness, in IRI. If this is specified, the operation will not be carried out after the roughness passes this threshold roughness level.

RESEALING

(Y/N) Input to indicate if resealing should be included in the policy. Enter

“Y” to include resealing. If you entered “Y”, you should enter the following information.

(S/R)	Input to indicate if resealing should be scheduled or condition responsive. Enter “S” for scheduled and “R” for condition responsive.
Interval	Resealing interval, in years. Required only if resealing is scheduled.
Max. Damaged Area	Maximum allowable total damaged area, in percent. The damaged area is defined as the sum of the all cracks area, ravelled area, and pothole area. If this is specified, the reseal will be carried out after the damaged area passes this threshold level. Required only if resealing is condition responsive.
Min. Interval	Minimum applicable resealing interval, in years. Required only if resealing is condition responsive.
Max. Interval	Maximum applicable resealing interval, in years. Required only if resealing is condition responsive.
Cost factor	Resealing cost factor.
Resealing Type	Resealing type. The options are: i) <u>1</u> for surface treatment, ii) <u>2</u> for slurry seal, and iii) <u>3</u> for reseal with shape correction.
Resealing Strength	Resealing strength coefficient (dimensionless). A suggested value is 0.25.
Resealing Thickness	Resealing thickness, in mm.
Last Applicable Year	Last applicable year, in number of years starting from the first year in the analysis period. If this is specified, the operation will not be carried out after that year.
Max. Appl. Roughness	Maximum applicable roughness, in IRI. If this is specified, the operation will not be carried out after the roughness passes this threshold roughness level.

OVERLAY

(Y/N)	Input to indicate if overlays should be included in the policy. Enter “Y” to include overlays. If you entered “Y”, you should enter the following information.
(S/R)	Input to indicate if overlays should be scheduled or condition responsive. Enter “S” for scheduled and “R” for condition responsive.
Interval	Overlays interval, in years. Required only if overlays are scheduled.
Max. roughness	Maximum allowable roughness, in IRI. If this is specified, the overlay will be carried out after the roughness passes this threshold roughness level. Required only if overlays are condition responsive.
Min. Interval	Minimum applicable overlay interval, in years. Required only if

	overlays are condition responsive.
Max. Interval	Maximum applicable overlay interval, in years. Required only if overlays are condition responsive.
Cost Factor	Overlay cost factor.
Overlay Type	Overlay type. The options are: i) 1 for open-graded cold-mix asphalt with regular or manual leveling control, ii) 2 for hot-mix asphalt concrete with regular or manual leveling control, and iii) 3 for hot-mix asphalt concrete with long-base automatic leveling control (base longer than 5m)
Overlay Strength	Overlay strength coefficient (dimensionless). A suggested value is 0.40.
Overlay Thickness	Overlay thickness, in mm.
Last Applicable Year	Last applicable year, in number of years starting from the first year in the analysis period. If this is specified, the operation will not be carried out after that year.
Roughness After Overlay	Road roughness after the overlay is applied, in IRI. If this is specified, you will overwrite the roughness after overlay value estimated by the model.

RECONSTRUCTION

(Y/N)	Input to indicate if reconstructions should be included in the policy. Enter "Y" to include reconstructions. If you entered "Y", you should enter the following information.
(S/R)	Input to indicate if reconstructions should be scheduled or condition responsive. Enter "S" for scheduled and "R" for condition responsive.
Interval	Reconstruction interval, in years. Required only if reconstructions are scheduled.
Max. Roughness	Maximum allowable roughness, in IRI. If this is specified, the reconstruction will be carried out after the roughness passes this threshold roughness level. Required only if reconstructions are condition responsive.
Min. Interval	Minimum applicable reconstruction interval, in years.
Max. Interval	Maximum applicable reconstruction interval, in years.
Cost Factor	Reconstruction cost factor.
New Structural Number	Structural number after reconstruction (dimensionless).
Surface Type	Surface type after reconstruction. The options are: i) 1 for surface treatment (ST) roads, ii) 2 for asphalt Concrete (AC) roads, iii) 3 for slurry on surface treatment (SSST) roads, and iv) 6 for open graded

cold mix on surface treatment (OCMS) roads.

New Layers Thickness	Total new surfacing layer thickness after reconstruction, in mm.
Base Type	Base type after reconstruction. The options are: i) <u>1</u> for granular, ii) <u>2</u> for cement-stabilized, and iii) <u>3</u> for bituminous.
Base Layer Thickness	Base layer thickness, in mm. This is required only if the base is cement stabilized.
Resilient Modulus	Resilient modulus of soil cement, in GPA. This is required only if the base is cement stabilized.
Construction Fault	Construction fault code. The options are: i) <u>0</u> for good construction and ii) <u>1</u> for faulty construction.
Last Applicable Year	Last applicable year, in number of years starting from the first year in the analysis period. If this is specified, the operation will not be carried out after that year.
New Roughness	Roughness after reconstruction, in IRI.

Unpaved Maintenance Policies

Description	Description of the unpaved maintenance policies set of inputs. This description appears when you use the Retrieve option to retrieve information stored in data files. Note that the data regarding an unpaved maintenance policy is stored in a data set file located in the hard disk and is accessed through its description. Therefore, each policy should have a unique file name and description.
-------------	---

The following inputs describe an unpaved maintenance policy. Each policy is composed of one or more than one maintenance operation. You define what maintenance operations should be included in the policy by placing a “Y” at the left side of the name of the operation to be included. After you include an operation, you have to decide if the operation would be scheduled at a certain time interval or if it would be activated in response to the condition of the road. You make this decision by placing a “S” (Scheduled) or “R” (Condition Responsive) at the right side of the operation name. Finally, you have to enter the time interval or trigger point and the features of the operation being defined.

One operation feature that is present in all operations is the cost factor. Whenever a maintenance operation is carried out in the simulation, its cost will be the multiplication of the unit cost data (defined in the Operation Unit Costs screen) by the cost factor. This allows for the definition of variations of the operation. For example, to consider different thicknesses, materials, or other characteristics.

ROUTINE MAINTENANCE

(Y/N)	Input to indicate if routine maintenance should be included in the policy. Note that routine maintenance is always included in an unpaved maintenance policy. Therefore, you can not change this input.
Cost Factor	Routine maintenance cost factor.

GRADING

(Y/N)	Input to indicate if gradings should be included in the policy. Enter “Y” to include gradings. If you entered “Y”, you should enter the following information.
(S/R)	Input to indicate if gradings should be scheduled or condition responsive. Enter “S” for scheduled and “R” for condition responsive.
Time Interval	Time interval between gradings, in days. Required only if gradings are scheduled.
Traffic Interval	Traffic interval between gradings, in vehicles. Required only if gradings are condition responsive.
Min. Interval	Minimum applicable time interval between gradings, in days. Required only if gradings are condition responsive.
Max. Interval	Maximum applicable time interval between gradings, in days. Required only if gradings are condition responsive.
Cost Factor	Gradings cost factor.

SPOT REGRAVELLING

(Y/N)	Input to indicate if spot regravelling should be included in the policy. Enter “Y” to include spot regravellings. If you entered “Y”, you should enter the following information.
(S/R)	Input to indicate if spot regravellings should be scheduled or condition responsive. Enter “S” for scheduled and “R” for condition responsive.
Gravel Volume	Gravel volume, in m ³ /km/y. Required only if spot regravelling is scheduled.
Percent Replaced	Percent annual material loss replaced, in percent. Required only if spot regravelling is condition responsive.
Max. Gravel Volume	Maximum applicable gravel volume, in m ³ /km/y. Required only if spot regravelling is condition responsive.
Cost Factor	Spot regravelling cost factor.

RESURFACING

(Y/N)	Input to indicate if gravel resurfacings should be included in the policy. Enter “Y” to include gravel resurfacings. If you entered “Y”, you should enter the following information.
(S/R)	Input to indicate if gravel resurfacings should be scheduled or condition responsive. Enter “S” for scheduled and “R” for condition responsive.

Interval	Resurfacing interval, in years. Required only if gravel resurfacings are scheduled.
Min. Thickness	Minimum allowable thickness, in mm. Required only if gravel resurfacings are condition responsive.
Min. Interval	Minimum applicable resurfacing interval, in years. Required only if gravel resurfacings are condition responsive.
Max. Interval	Maximum applicable resurfacing interval, in years. Required only if gravel resurfacings are condition responsive.
Cost Factor	Gravel resurfacings cost factor.
Gravel Increase	Increase in gravel thickness, in mm.
Last Applicable Year	Last applicable year, in number of years starting from the first year in the analysis period. If this is specified, the operation will not be carried out after that year.
Initial Roughness	Roughness after the gravel resurfacing, in IRI.
Compaction Code	Code that indicate if mechanical compaction was used during the gravel resurfacing. A code equal to <u>1</u> indicates with mechanical compaction, and a code equal to <u>0</u> indicates without mechanical compaction.
Maximum Particle Size	Maximum particle size of the material, defined as the equivalent sieve opening through which 95 percent of material passes, in mm.
Passing 2.00 mm Sieve	Amount of material passing the 2.0 mm sieve (or ASTM No. 10 sieve), in percent by mass.
Passing 0.425 mm Sieve	Amount of material passing the 0.525 mm sieve (or ASTM No. 40 sieve), in percent by mass.
Passing 0.075 mm Sieve	Amount of material passing the 0.075 mm sieve (or ASTM No. 200 sieve), in percent by mass.
Plasticity Index	Plasticity index of the material, in percent.
Minimum Roughness	Minimum roughness of unpaved road surfacing material, in IRI.
Maximum Roughness	Maximum roughness of unpaved road surfacing material, in IRI.

Construction Policies

Description	Description of the construction policy. This description appears when you use the Retrieve option to retrieve information stored in data files. Note that the data regarding a construction policy is stored in a data set file located in the hard disk and is accessed through its description. Therefore, each policy should have an unique file name and description.
Duration	Construction duration, in years. The duration of a construction

can be from one to five years.

Cost Streams	Annual cost stream, in percent of total costs. Proportion of the total construction costs used in each of the construction years. Note that the sum of this stream should be equal to 100 percent.
Salvage Value	Construction salvage value, in percent of total construction cost.
Cost Factor	Construction cost factor.
Road Characteristics	Refer to the road characteristics section of this chapter for a detailed explanation of these inputs.
Generated Traffic	Traffic generated due to the construction. This traffic is activated when the construction is terminated.

Exogenous Cst-Bnf Policies

Description	Description of the exogenous costs-benefits policy. This description appears when you use the Retrieve option to retrieve information stored in data files. Note that the data regarding an exogenous costs-benefits policy is stored in a data set file located in the hard disk and is accessed through its description. Therefore, each policy should have a unique file name and description.
Costs-Benefits Stream	Stream of exogenous costs of benefits. Costs are entered as positive values and benefits as negative values. The years are relative years to the year the policy will be activated in the definition of strategies phase.

Annex 1 - Project Summary Table

HDM Manager - Project Summary

=====

Run Name: Paving Gravel Road #1

Run Date: 08/08/94

Road Name: Gravel Road #1 in North Region

Road Length: 100.0 km

Currency: Million Dollars

YEAR	WITHOUT PROJECT CASE					WITH PROJECT CASE					ECONOMIC COMPARISON				
	ADT	OPER	IRI	ECONOMIC AGENCY COSTS	ECONOMIC USER COSTS	ECONOMIC TOTAL COSTS	ADT	OPER	IRI	ECONOMIC AGENCY COSTS	ECONOMIC USER COSTS	ECONOMIC TOTAL COSTS	DECREASE AGENCY COSTS	DECREASE USER COSTS	ECONOMIC NET BENEFITS
	Grade Every 120 Days					Pave the Road in 1995									
1995	200		11.2	0.07	3.18	3.25	200		12.4	8.56	3.36	11.92	-8.49	-0.17	-8.66
1996	207		12.0	0.07	3.41	3.48	207	CONS	3.2	0.13	2.12	2.24	-0.06	1.29	1.23
1997	215		12.2	0.07	3.56	3.63	215		3.3	0.13	2.20	2.33	-0.06	1.36	1.30
1998	223	RESU	12.4	1.70	3.71	5.41	223		3.4	0.13	2.28	2.41	1.57	1.43	3.01
1999	231		10.8	0.07	3.58	3.65	231		3.4	0.13	2.37	2.49	-0.06	1.21	1.15
2000	239		11.0	0.07	3.75	3.81	239		3.5	0.13	2.45	2.58	-0.06	1.29	1.23
2001	248		11.2	0.07	3.91	3.97	248		3.6	0.13	2.55	2.67	-0.06	1.36	1.30
2002	258		11.4	0.07	4.07	4.14	258		3.7	0.13	2.64	2.77	-0.06	1.43	1.37
2003	267	RESU	11.6	1.70	4.24	5.94	267		3.8	0.13	2.74	2.87	1.57	1.50	3.07
2004	277		11.4	0.07	4.35	4.42	277		3.9	0.13	2.84	2.97	-0.06	1.51	1.45
2005	287		11.9	0.07	4.60	4.67	287		4.0	0.13	2.95	3.08	-0.06	1.65	1.59
2006	298		12.1	0.07	4.80	4.87	298		4.1	0.13	3.06	3.19	-0.06	1.74	1.68
2007	309	RESU	12.2	1.70	5.01	6.71	309		4.2	0.13	3.18	3.31	1.57	1.82	3.40
2008	321		11.9	0.07	5.11	5.17	321	RESE	4.3	1.83	3.30	5.13	-1.76	1.80	0.04
2009	333		12.6	0.07	5.44	5.50	333		4.4	0.13	3.43	3.56	-0.06	2.01	1.95
2010	345		12.8	0.07	5.67	5.74	345		4.5	0.13	3.56	3.69	-0.06	2.11	2.05
2011	358	RESU	12.9	1.70	5.91	7.61	358		4.6	0.13	3.70	3.83	1.57	2.21	3.78
2012	371		12.5	0.07	6.00	6.07	371		4.7	0.13	3.84	3.97	-0.06	2.15	2.09
2013	385		13.3	0.07	6.42	6.49	385		4.8	0.13	3.99	4.12	-0.06	2.42	2.36
2014	400		13.4	0.07	6.69	6.76	400		5.0	-0.72	4.15	3.43	0.79	2.54	3.33
Average			12.0						4.4						
Total (undiscounted)				7.89	93.40	101.30				11.83	60.73	72.57	-3.94	32.66	28.73
Total (at 12.0 %)				3.08	34.13	37.20				9.79	23.06	32.85	-6.71	11.06	4.35

Project NPV at 12.0 % Discount Rate: 4.35

Project Internal Rate of Return (%): 18.9

Annex 2 - Detailed Lotus Table

HDM Manager - Detailed Table (SAMPLE)

Run Name: Paving Gravel Road #1
 Run Date: 08/08/94
 Road Name: Gravel Road #1 in North Region
 Road Length (km): 100.0

Economic Net Strategy Benefits	Year	2-Way	Roughness	Capital	Gravel	(million Dollars)			Economic	Economic
		Daily Traff	IRI	Operation	Thickness	Financial	Financial	Economic	Vehicle	Society
		(vpd)	(m/km)	Applied	(mm)	Agency	Agency	Agency	Operation	Total
1 - Grade Every 120 Days	1995	200.0	11.2		121.9	0.000	0.080	0.000	2.285	3.252
0.000	1996	207.0	12.0		93.2	0.000	0.080	0.000	2.454	3.478
0.000	1997	215.0	12.2		64.0	0.000	0.080	0.000	2.566	3.631
0.000	1998	223.0	12.4	RESU	184.2	1.920	0.080	1.632	2.675	5.414
0.000	1999	231.0	10.8		153.5	0.000	0.080	0.000	2.562	3.646
0.000	2000	239.0	11.0		122.1	0.000	0.080	0.000	2.685	3.814
0.000	2001	248.0	11.2		90.1	0.000	0.080	0.000	2.801	3.973
0.000	2002	258.0	11.4		57.4	0.000	0.080	0.000	2.920	4.137
0.000	2003	267.0	11.6	RESU	174.0	1.920	0.080	1.632	3.045	5.941
0.000	2004	277.0	11.4		139.8	0.000	0.080	0.000	3.124	4.422
0.000	2005	287.0	11.9		104.9	0.000	0.080	0.000	3.308	4.672
0.000	2006	298.0	12.1		69.2	0.000	0.080	0.000	3.452	4.870
0.000	2007	309.0	12.2	RESU	182.7	1.920	0.080	1.632	3.600	6.706
2 - Pave the Road in 1995	1995	200.0	12.4		121.9	10.000	0.070	8.500	2.419	11.916
8.665	1996	207.0	3.2	CONS	0.0	0.000	0.150	0.000	1.480	2.244
1.234	1997	215.0	3.3		0.0	0.000	0.150	0.000	1.540	2.326
1.304	1998	223.0	3.4		0.0	0.000	0.150	0.000	1.598	2.408
3.006	1999	231.0	3.4		0.0	0.000	0.150	0.000	1.659	2.493
1.152	2000	239.0	3.5		0.0	0.000	0.150	0.000	1.722	2.582
1.232	2001	248.0	3.6		0.0	0.000	0.150	0.000	1.788	2.674
1.299	2002	258.0	3.7		0.0	0.000	0.150	0.000	1.857	2.769
1.368	2003	267.0	3.8		0.0	0.000	0.150	0.000	1.928	2.869
3.072	2004	277.0	3.9		0.0	0.000	0.150	0.000	2.002	2.972
1.450	2005	287.0	4.0		0.0	0.000	0.150	0.000	2.080	3.080
1.592	2006	298.0	4.1		0.0	0.000	0.150	0.000	2.160	3.192
1.678	2007	309.0	4.2		0.0	0.000	0.150	0.000	2.245	3.309
3.396										

Economic Analysis

	First Strategy	Second Strategy	Third Strategy	Fourth Strategy	Fifth Strategy
-Present Values at 12.0% Discount Rate (Million Dollars)					
Society	37.20	32.85	33.21	33.61	34.04
Agency	3.08	9.79	8.77	7.87	7.06
Capital	2.51	8.79	7.84	6.99	6.23
Recurrent	0.57	1.00	0.94	0.88	0.84
Road Users	34.13	23.06	24.43	25.74	26.98
Vehicle Operation	24.53	16.28	17.30	18.28	19.20
Travel Time	9.60	6.78	7.13	7.46	7.77
Exogenous Cst-Bnf	0.00	0.00	0.00	0.00	0.00
Net Present Value (Net Benefits)	0.00	4.35	4.00	3.59	3.16

-Equivalent Annual Values per km (Dollars per km)					
Society	44472	39266	39691	40180	40693
Agency	3676	11699	10488	9409	8444
Capital	2996	10508	9370	8353	7446
Recurrent	680	1189	1119	1054	998
Road Users	40791	27563	29198	30771	32247
Vehicle Operation	29316	19454	20676	21851	22954
Travel Time	11475	8109	8520	8920	9293
Exogenous Cst-Bnf	0	0	0	0	0
Net Benefits	0	5202	4779	4291	3776
-Rate of Return (%)	NA	18.9	19.2	19.3	19.3

Annex 3 - Summary Lotus Table

HDM Manager - Summary Table (SAMPLE)

Run Name: Paving Gravel Road #1
 Run Date: 08/08/94
 Road Name: Gravel Road #1 in North Region
 Currency: Million Dollars
 Initial Length (km): 100.0
 Initial Roughness (IRI): 2.00
 Initial All Cracks (%): 0.0
 Initial Modified Structural No.: 0.7
 Initial Surface Age (yr): 0

Strategies	1995 Roughness (IRI)	2014 Roughness (IRI)	1995 All Cracks (%)	2014 All Cracks (%)	1995 Modified Structural No.	2014 Modified Structural No.	1995 Daily Traffic (ADT)	2014 Daily Traffic (ADT)
1 - Grade Every 120 Days	11.20	13.40	0.0	0.0	0.0	0.0	200	400
2 - Pave the Road in 1995	12.40	5.00	0.0	0.0	0.0	2.8	200	400
3 - Pave the Road in 1996	12.40	4.90	0.0	0.0	0.0	2.8	200	400
4 - Pave the Road in 1997	12.40	4.70	0.0	0.0	0.0	2.8	200	400
5 - Pave the Road in 1998	12.40	4.60	0.0	0.0	0.0	2.8	200	400

Operations

1 - Grade Every 120 Days: 1998RESU, 2003RESU, 2007RESU, 2011RESU
 2 - Pave the Road in 1995: 1996CONS, 2008RESE
 3 - Pave the Road in 1996: 1997CONS, 2009RESE
 4 - Pave the Road in 1997: 1998CONS, 2010RESE
 5 - Pave the Road in 1998: 1999CONS, 2011RESE

	Financial Agency Capital 0.0%	Financial Agency Recurrent 0.0%	Financial Agency Capital 12.0%	Financial Agency Recurrent 12.0%	Economic Agency Recurrent 12.0%	Economic Vehicle Operation 12.0%	Economic Society Total 12.0%	Net Present Value 12.0%	Internal Rate of Return (%)	Average Roughness (IRI)
1 - Grade Every 120 Days	7.68	1.60	2.95	0.67	0.57	24.53	37.20	0.00	NONE	12.04
2 - Pave the Road in 1995	11.00	2.92	10.34	1.18	1.00	16.28	32.85	4.35	18.9	4.44
3 - Pave the Road in 1996	11.00	2.84	9.22	1.10	0.94	17.30	33.21	4.00	19.2	4.89
4 - Pave the Road in 1997	11.00	2.76	8.22	1.04	0.88	18.28	33.61	3.59	19.3	5.36
5 - Pave the Road in 1998	11.00	2.68	7.33	0.98	0.84	19.20	34.04	3.16	19.3	5.86

Rodrigo Archondo-Callao
 C:\MAN DOC\HDM Manager Documentation.doc
 August 23, 2002 9:52 AM