

**DEVELOPMENT OF A MANAGEMENT INFORMATION SYSTEM
FOR TRAFFIC DATA ON WV HIGHWAYS**

**West Virginia Department of Transportation
Division of Highways**

by

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TECHNICAL REPORT DOCUMENTATION

(Will be inserted here when binding the finalized project report)

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CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 Introduction

Monitoring and analysis of highway traffic characteristics are essential to the successful operation of any state department of transportation. Studies using traffic characteristic data may be helpful in numerous highway phases, which include, as examples, engineering, engineering economy, finance, legislation, planning, safety, statistics, and private sectors (Traffic monitoring guide, 1996). Examples of applications include assistance in design of highway geometry, pavement design, structural design, estimation of benefit of highway improvement, cost of vehicle operation, road revenue, highway cost allocation, selection of highway routes, location and design of highway systems, design of traffic control systems, location of service areas, and many more.

The West Virginia Division of Highways (WVDOH) has recently installed a \$2 million system of highway traffic data collection stations at 51 sites located throughout the state. Automated Traffic Recorders (ATR) at these stations collect data on traffic volume, speed, lane distribution, vehicle classification, and weights (weights only at selected stations.)

A large volume of data has been recorded by the West Virginia traffic data collection system, and subsequently archived by WVDOH personnel. Specifically, these data are first received from different stations; they are then read and stored onto magnetic storage areas. Programs for reading and storing the data were developed by PAT Equipment Corporation, Inc. (PAT), which stored the data in their final form in binary files. PAT also provided WVDOH with a program to read the data and produce the federal reporting files, in addition to some elementary statistics. Otherwise, the data, in their final format, could not be easily used to

produce meaningful statistics or other useful reports or files that may be needed by WVDOH for its own use and for compliance with Federal regulations and mandates. A strong need existed for the development of a computerized Management Information System (MIS) to organize the data and maintain them in a form conducive to the types of planning studies needed by WVDOH. In this MIS, computer software and procedures needed to be developed to perform all the necessary sorts, edits, updates, and merges of the data, produce files that are easy to work with, and generate reports that are needed by WVDOH.

In this report, details of a MIS that was developed to meet the needs of WVDOH personnel are presented.

1.2 Research Objectives

The research performed was aimed at the development of a computerized Management Information System to organize the data collected by WVDOH (at the data collection sites and using PAT equipment and software), and maintain them in a format that makes them easy to access and manipulate.

The specific objectives of the project included the following:

1. Development and testing of a MIS that can be used to manipulate the data, and keep them in a format that can be easily accessed and used for production of statistics, reports, etc. These statistics, reports, and other outputs that are produced by the system would be used by WVDOH for evaluation and planning purposes. The following objectives were considered in the development of the MIS:
 - a) Minimize storage requirements necessary to maintain the MIS.
 - b) Make maximum use of the existing WVDOH computer hardware.

- c) Incorporate and/or provide data interface with other types of collected traffic data.
2. Production o complete documentation about the use and maintenance of the MIS.
3. To demonstrate the final system to WVDOH personnel, and provide training for its implementation, maintenance, and future extensions.

1.3 Research Plan

In order to meet the project objectives, the following research plan was followed:

1. Identify all information, reports, etc. that pertain to the data collected by WVDOH (type, format, frequency, medium of storage, etc.)
2. Meet with WVDOH personnel (Transportation Planning Division) to identify all the information and statistics of interest that may be produced by the data.
3. Investigate and determine the most appropriate computer hardware that may be used in the manipulation of the data. Personal computers were to be given a higher priority unless the large volume of data involved inhibits their use. Selection of computer hardware had to meet the approval of WVDOH personnel and had to maximize the use of their existing equipment.
4. Develop a complete Management Information System. Computer software had to be developed and fully tested for the proper manipulation of the data. Procedures had also to be developed for use of the software and maintenance of the system. The MIS had to produce data files that can be easily accessed and used to produce statistics, reports, etc., which can be used as a decision making tool for evaluation and planning purposes. The development of the MIS had to follow, as much as possible, the “AASHTO Guidelines

for Traffic Data Programs”, along with its policies for the data collection process, editing of data, truth-in-data recommendations, etc.

5. Develop complete documentation of the MIS. This documentation would be very helpful to the WVDOH personnel in the use and maintenance of the MIS.
6. Demonstrate the system developed to WVDOH personnel, and provide them with a training seminar on the MIS implementation, maintenance, and future extensions.
7. Produce a final report.

1.4 Organization of this report

This report consists of six chapters. The first chapter contained an introduction, and the research objectives and plan. In the second chapter a brief summary of the results of literature review and the experience of neighboring states with traffic data management is given. The third chapter contains a brief overview of the Management Information System. A detailed “User’s Manual in given in the fourth chapter and is followed by the system’s manual in the fifth chapter.

The sixth chapter contains the conclusions and recommendations and is followed by the
appendices.

CHAPTER 2: LITERATURE REVIEW AND EXPERIENCE OF NEIGHBORING STATES

2.1 Literature Review

Transportation literature is rich with articles on traffic monitoring and analysis. However, very little can be found on the development or implementation of Management Information Systems for the manipulation of traffic data.

An excellent reference for traffic monitoring and uses of the data is the Traffic Monitoring Guide (TMG) (1996), which is updated and published by the U.S. Department of Transportation, Federal Highway Administration. This guide is the result of the effort of several committees, and includes recommendations based on previous research and on ideas of experts in the field. The TMG provides direction for improved traffic counting, vehicle classification, and truck weighing. It also provides ideas for updating these activities and statistical procedures to controlling them.

The use of Management Information Systems to manage traffic records may be found in a few articles. In 1982, Kutz and Zeiss published an article on improving highway program management through the use of “Integrated Information Systems”. They discussed in their paper the integrated use of five information system that were developed for the Pennsylvania Department of Transportation (Penn DOT). These systems are namely: the Project Management System (PMS), the Project Inventory (PI), the Consultant Agreement System (CAS), the Contract Management System (CMS), and the Structures Inventory Record System (SIRS). Each of the systems fulfilled a primary management need but, just as important, all five had the

capability of communicating with each other. A brief overview of each of the systems was presented in the paper, but no details were given.

Tobin (1984) followed with another article about his experience with managing traffic records systems for the Pennsylvania Department of Transportation through management information systems. Again no detailed description was given for the systems. In this article, Tobin did not cover traffic volumes or weights collected by traffic counters. Instead, he talked about managing traffic records for the following systems: Accident records, titles and vehicle registrations, driver licenses, registration renewals, driver license renewals. He concentrated on the statistical quality control aspects of the systems.

Hartgen and Lemmerman (1983) published an article on their experience with the New York Department of Transportation in streamlining the collection and processing of traffic count statistics and in reducing the costs involved. They presented a good discussion on how to manage the data collection effort for both continuous counter stations and seasonal control station, and how to use the data collected, but they did not address the computer management of the information.

Harper and Kopec (1984) presented a case study on the development , monitoring, and analysis of a Data Base Management System (DBMS) for a transportation improvement program for the Chicago Area Transportation Study (CATS). The article covered some of the technical details of the DBMS developed, but these details were pertinent to a transportation improvement program for a Metropolitan Planning Organization (MPO) rather than highway traffic counts.

In 1991, David Albright published an article on “Traffic Volume Summary Statistics”. In this article, Albright covered mainly the use of statistics to determine the location of permanent traffic counters. He did not address the management or the use of the information collected. He

then followed with another article (1993) on “Standards, Innovation, and the Future of Traffic Monitoring”, in which he presented guidelines for the integration of data systems, and for the transfer of data from traffic monitoring devices to application systems. He emphasized “Truth-in-Data” and “Base Data Integrity” as the way to improve our work now, and serve the interest of our successors.

2.2 Experience of Neighboring States

The states of Pennsylvania and Maryland were selected for a closer investigation of the management procedures they follow with the data collected from their automatic traffic counters. These two states were chosen because of their vicinity to West Virginia, and because of the good reputation of their departments of transportation as leaders in the field. Visits were made to the Pennsylvania Department of Transportation (Penn DOT) in Harrisburg, PA, and to the Maryland DOT in Baltimore, MD. A brief account of the results of the investigations is given below.

Penn DOT was visited during the summer of 1996. As of that time, Penn DOT was dealing mainly with traffic volume data and had sixty (60) Automated Traffic Recorder (ATR) stations strategically located throughout the state to count vehicles on an hourly basis for 24 hours per day, and 365 days per year. No serious effort was made for the collection of Weigh-in-Motion (WIM) data. Penn DOT had only one permanent WIM station that provides truck size and weigh data. Based on road functional classification, geographic location, and urban/rural characteristics, Penn DOT has categorized its individual traffic volume counts into one of ten Traffic Pattern Groups (TPGs) as shown in Table 2.1 below.

Table 2.1 Traffic Pattern Groups for Penn DOT

<u>TPG No.</u>	<u>Description</u>	<u>No. Of ATRs</u>
TPG 1 Urban	Interstate	6
TPG 2 Rural	Interstate	7
TPG 3 Urban	Principal Arterials	7
TPG 4 Rural	Principal Arterials	10
TPG 5 Urban	Minor Arterials or Collectors	6
TPG 6 North Rural	Minor Arterials	6
TPG 7 Central Rural	Minor Arterials	6
TPG 8 North Rural	Collectors	5
TPG 9 Central Rural	Collectors	6
TPG 10	Special Recreational	1

Each ATR is associated with one of the ten Traffic Pattern Groups (TPGs). The grouping of the data collected at the ATR sites provided a means to compute daily, monthly, and seasonal factors by road functional classification and geographic location. ATR data were also considered in the computing of yearly growth factors by TPG. Design hour factors (peak hour, 30th highest, and 50th highest hour) which are used for capacity analysis in the design of highways were also computed from the ATR data. Comparisons were also made of ATR data collected from consecutive years. Details of the Penn DOT system and reports produced can be found their “Traffic Data Collection and Factor development Report” (1994).

Maryland DOT was also visited during the summer of 1996. At that time Maryland DOT was just starting the development of a multi-million dollars, comprehensive “Automated Traffic

Monitoring Data System” (ATMDS) with the help of a consulting company (GIS/Trans Ltd.) Their system is not much different, in essence, than the system developed for West Virginia and presented in the following chapters, except that it is more comprehensive. It also includes the management of the temporary (portable) counters.

CHAPTER 3: OVERVIEW OF THE MANAGEMENT INFORMATION SYSTEM

The Management Information System (MIS) was developed for a PC environment with Windows-95 or Windows-NT. Minimum hardware requirements include a PC with 16 mega-bytes of RAM, and a hard disk with about one giga-byte of memory. A 100 mega-hertz Pentium or faster machine is recommended for faster manipulation of the large amount of data involved. A tape drive is highly recommended in order to easily take frequent back-ups of the system.

The MIS system was developed using a Delphi shell (version 2). It contains the following main features:

1. Data upload. The MIS reads the binary files produce by PAT software, performs some editing on the data, and upload it into the system files. Input information includes both volume (volume, speed, and classification) data, and WIM data.

2. Data edit. To maintain the integrity of the system, and the truth-in-data, the system does not allow the user to change the information read. However, the system gives the user the freedom to use the traffic counts recorded by the ATRs or override them with other values that he sees more appropriate or more correct.

3. Building summary tables. The important data are summarized into summary tables that can be easily and efficiently used in producing frequently needed reports.

4. Report production. Several standard reports are produced by the system, including the Federal reporting files. Some of these reports include comparisons of information for several years. Special reports may also be tailored and produced by the system, using the ReportSmith report writer provided by Delphi.

5. Archiving. At the end of each year the systems archives the summary tables of the old year, before it updates the system for the new year. These tables are used in producing some of the reports.

6. System control. The system allows the user to control many options provided to suit the user's preference.

Details of the system are given in the following two chapters. Chapter four contains the "User's Manual" which shows in more details the features of the system and how these features can be used. Chapter five contains the "System's Manual", which shows more technical details of the system, including all modules and files used in the system.

CHAPTER 4: WEST VIRGINIA DIVISION OF HIGHWAYS MANAGEMENT INFORMATION SYSTEM USERS MANUAL

Overview

The West Virginia Division of Highways Management Information System, or WVDOH MIS, is a data storage, analysis, and reporting tool developed by the West Virginia University (WVU) Industrial and Management Systems Engineering (IMSE) Department. WVDOH MIS was designed to provide the following primary capabilities:

- read and store data collected by PAT Equipment Corporation Automatic Traffic Recorder (ATR) models AVC100 and DAW100
- automate the creation of required Federal Highway Administration (FHWA) reports
- view, analyze, and edit traffic data for the current year

Additionally, WVDOH MIS supports the follow functions:

- management of ATR site reference data
- creation of user-defined vehicle classes that can be used to group and summarize traffic data
- ability to “filter” data through the application of user-defined traffic count rules
- summarization of data by day, month, day of week, site, hour, and time of day
- predefined reports that speed data analysis efforts

System Requirements

The WVDOH MIS was developed for the 32-bit environment using Borland's Delphi 2.0.

The following PC specifications are required for WVDOH MIS:

- IBM PC or compatible
- Microsoft Windows 95 or Windows NT
- 12 Mb of RAM (16 Mb or more recommended)
- 750 Mb hard disk storage space (1.2 GB recommended)

Flow of Operation

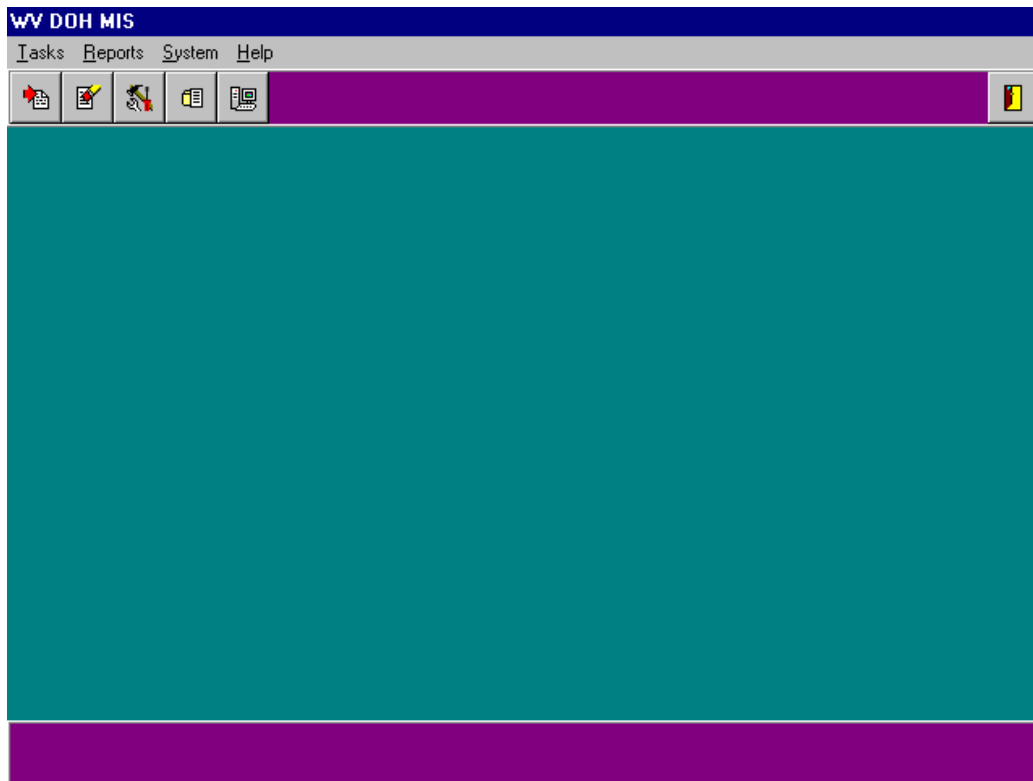
The flow of operation for the use of WVDOH MIS is as follows:

1. Upload data collected from the ATRs to the WVDOH MIS
2. Rebuild the summary tables used by WVDOH MIS for analysis and reporting functions
3. Edit traffic data stored in the Edit File (See **Rebuild Summary Tables**) as necessary
4. Create reports using the standard reports provided by WVDOH MIS or ReportSmith 3.0

In addition to these major operations, there are several auxiliary operations that can be performed (See **System Administration**).

Starting the Program

When you start the WVDOH MIS, the following screen will appear:



You can use the application menus to access the functions of the MIS, or you can use the speed buttons located in the toolbar.

To exit the application at any time, click the Exit speed button on the far right of the toolbar. Note: you cannot have any other windows of the WVDOH MIS open when you try to exit.

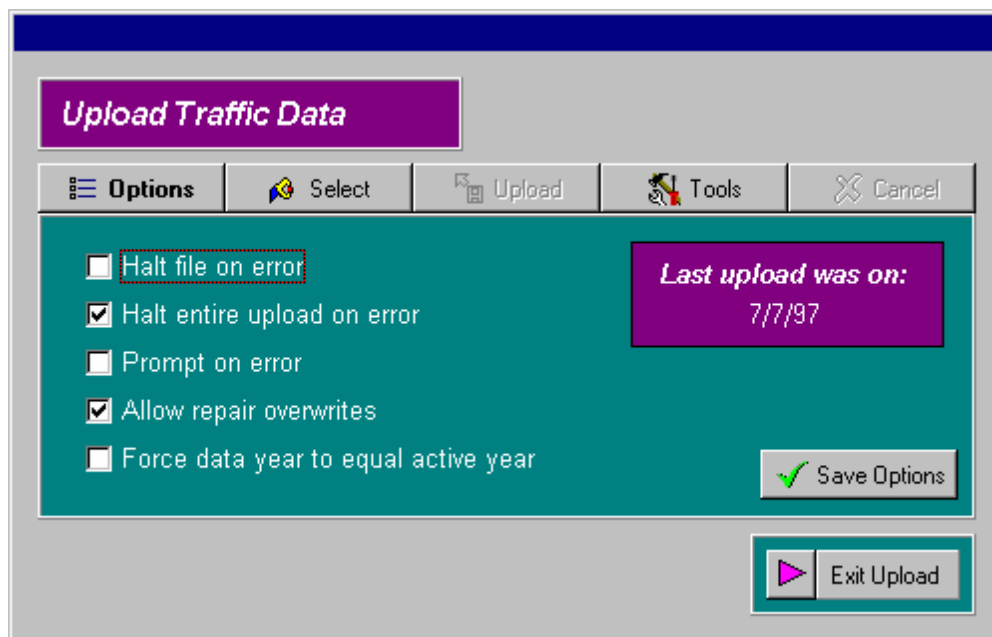


Upload Traffic Data

To begin to use the WVDOH MIS, you must first upload data from the raw binary files to the traffic database. WVDOH MIS 1.0 can read data from PAT Equipment Corporation counter models AVC100 (vehicle counts only) and DAW100/Bending Plate (vehicle weights and counts).

To upload data into the traffic database:

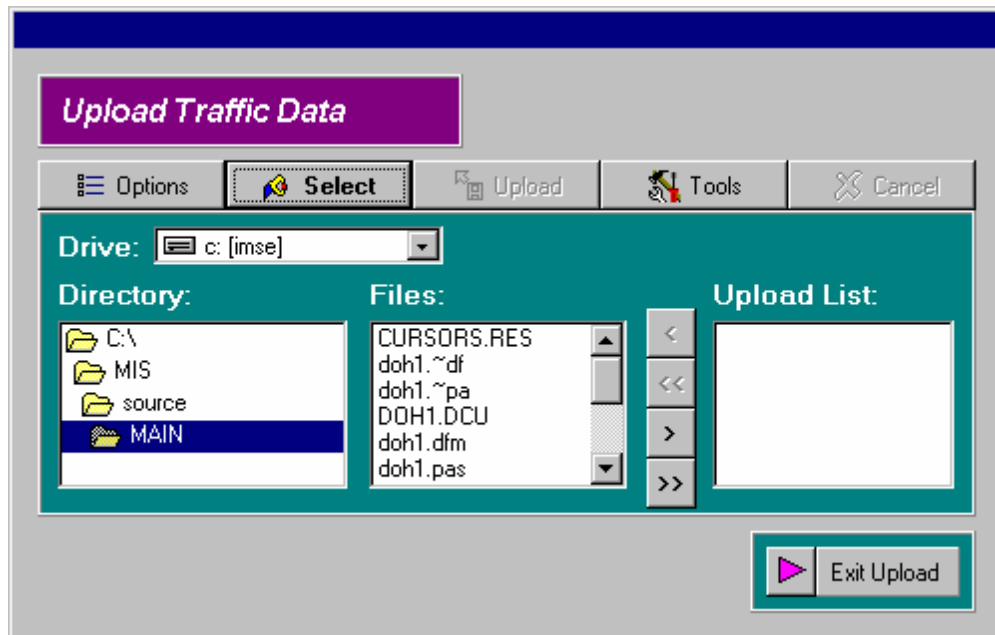
1. Select *Upload Traffic Data* from the menu, or click the *Upload* speed button. You will see the following screen:



The *Options* button is in bold face because it is the current selection. The date of the last upload attempt is shown in the upper right corner of the dialog box. The user can change any of the upload settings on this screen, and the user can save these settings by clicking the *Save Options* button. The following upload options are supported:

- ***Halt File on Error*** : Select this option to cause the upload procedure to stop the upload of the current file only if an error is encountered.
- ***Halt Entire Upload on Error*** : Select this option to cause the upload procedure to stop the upload of all files, including the current file.
- ***Prompt on Error*** : Select this option to cause the upload procedure to ask whether it should continue when an error occurs.
- ***Allow Repair Overwrites*** : Select this option to cause the upload procedure to allow the upload of corrected versions of files with previous upload attempts that resulted in one or more errors.
- ***Force Data Year to Equal Active Year*** : Select this option to automatically correct a problem found with PAT Equipment, Inc., ATRs in which the counter sometimes erroneously reports the incorrect year.

To begin an upload procedure, click the ***Select*** button. The following screen appears:



Once the user selects the drive and directory location of the files to be uploaded, all files in that location are displayed in the *Files* box. Files can be selected using the following buttons:

 **Add Selected File**

You can add a single file to the upload list by selecting the file name in the *Files* list and clicking the *Add Selected File* button. You can also add a single file to the upload list by double-clicking the file name.

 **Add All Files**

You can add all of the files in the current path to the file list by clicking the *Add All Files* button.

 **Remove Selected File**

You can remove a file from the Upload List by selecting that file name in the Upload List and clicking the *Remove Selected File* button.

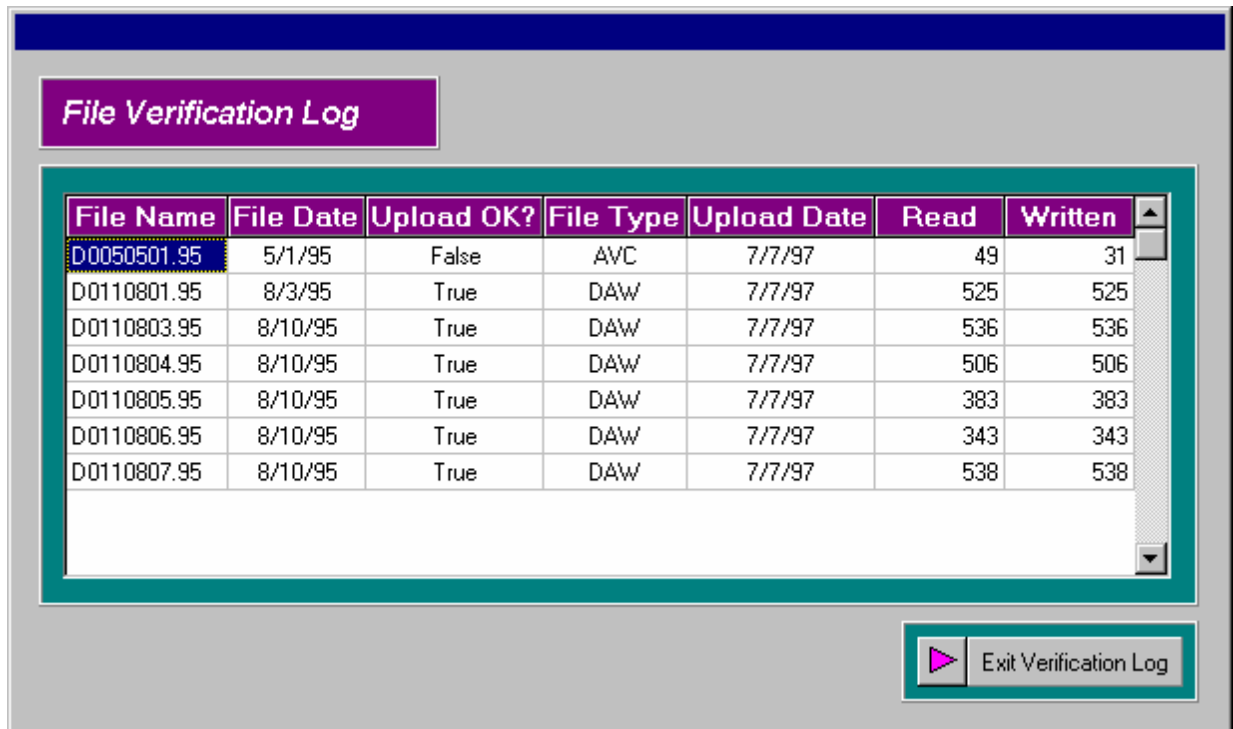
 **Remove All Files**

You can remove all files from the Upload List by clicking the *Remove All Files* button.

The selection can be cleared at any time by clicking the *Cancel* button. Once the selection is complete, the upload procedure can be initiated by clicking the *Upload* button. The caption of the *Upload* button will change to *Confirm* after it is clicked. At this point, the user must click the button again to verify the desire to upload the selected files.

By clicking the **Tools** button, the user can access any of the following tools provided to facilitate the upload procedure:

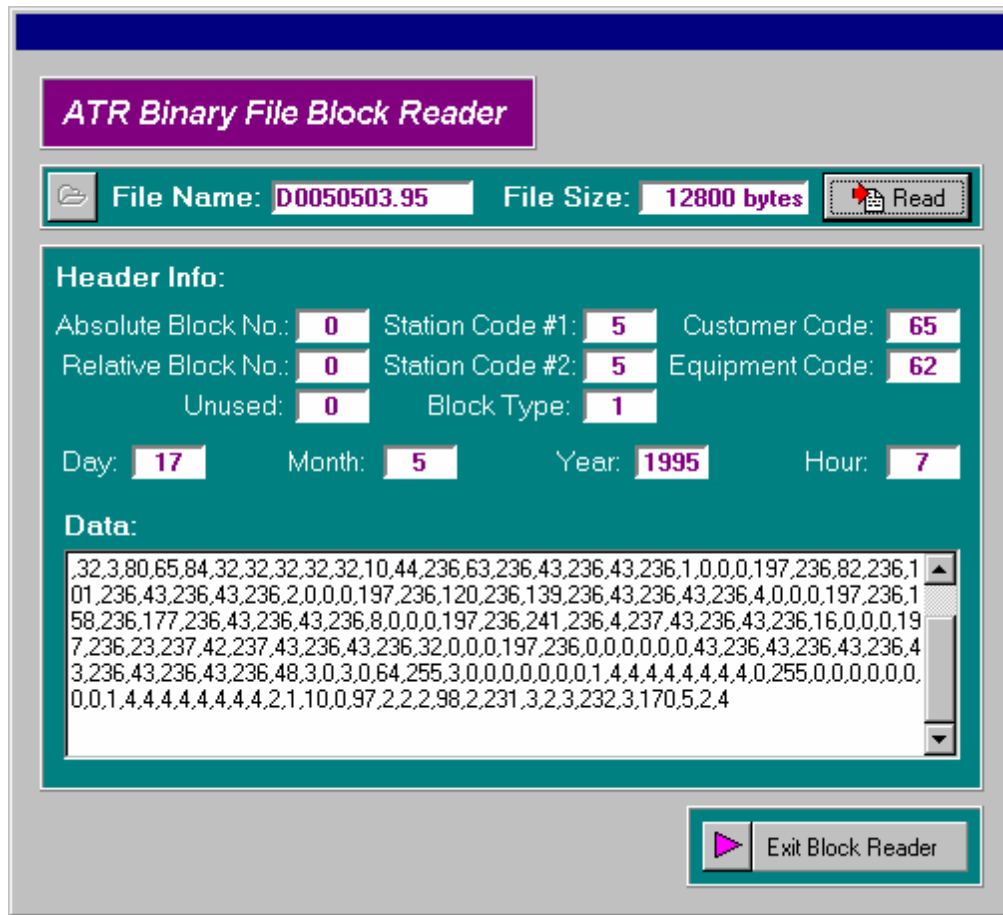
- **File Verification Log** : The File Verification Log shows all files that have ever had an upload attempt, the file date, the result, the type of file, the date of the upload attempt, the number of data blocks read and the number of data blocks written (see below).



File Name	File Date	Upload OK?	File Type	Upload Date	Read	Written
D0050501.95	5/1/95	False	AVC	7/7/97	49	31
D0110801.95	8/3/95	True	DAW	7/7/97	525	525
D0110803.95	8/10/95	True	DAW	7/7/97	536	536
D0110804.95	8/10/95	True	DAW	7/7/97	506	506
D0110805.95	8/10/95	True	DAW	7/7/97	383	383
D0110806.95	8/10/95	True	DAW	7/7/97	343	343
D0110807.95	8/10/95	True	DAW	7/7/97	538	538

- **Upload Log** : The Upload Log contains a record of the events that occur (particularly errors, if they occur) during upload procedures. See **View Log Files** below for more information on the Upload Log.
- **Block Reader** : The Block Reader is a tool used to view the binary data files generated by the PAT Equipment, Inc., ATRs. The user can load a file and view the

recorded data block by block as it is read by the MIS. This tool is very useful for isolating problems with erroneous data files.



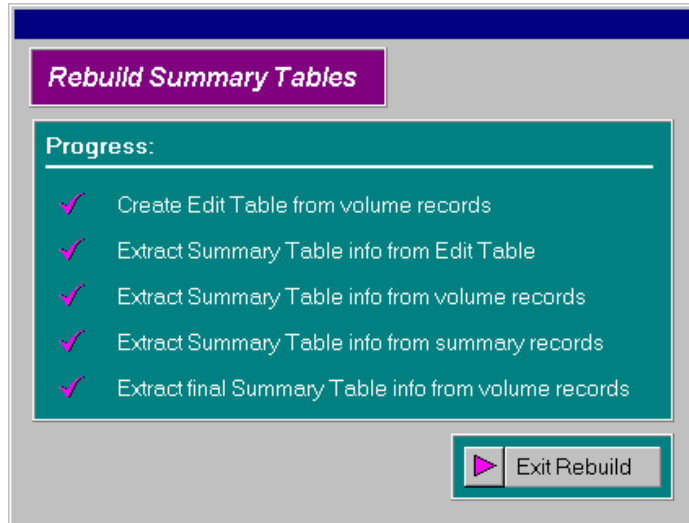
Rebuild Summary Tables

After the traffic data has been uploaded to the WVDOH MIS, it is necessary to rebuild the summary tables used for analysis and reporting purposes. The rebuild can be accomplished off-line, by way of the Standby Mode (See **Standby Mode**), or can be performed manually.

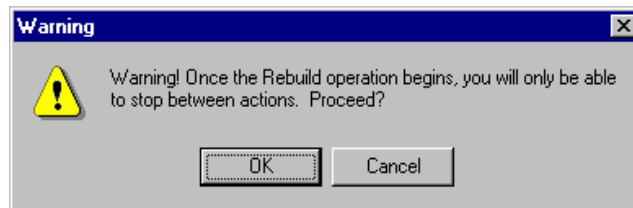
For a complete description of the database tables used by WVDOH MIS, please see Appendix A.

To manually rebuild the summary tables:

1. Select **Rebuild Summary Tables** from the menu, or click the **Rebuild** speed button. The following screen will appear:



2. A dialog box will appear to ask if you would like to continue with the next phase of the rebuild operation. Click **OK** to continue, or **Cancel** to abort the operation.



3. The next phase of the rebuild operation will take place in the background, with the progress visible in the foreground.
4. Steps (3) and (4) will continue until all phases of the rebuild operation are complete.

The following is a list of the rebuild operation phases and a brief description of each:

- ***Create Edit Table from volume records*** -- The daily traffic count information for each site is copied into the Edit File, a database table that holds the data that can be edited by the user. Please note that this is the *only* traffic data that can be edited by the user.
- ***Extract Summary Table info from Edit Table*** -- The site-by-day information is extracted from the Edit File.
- ***Extract Summary Table info from volume records*** -- Site-by-hour and other Summary Table information is created from data found in the Volume Table.
- ***Extract Summary Table info from summary records*** -- Additional Summary Table information is compiled from data already in the Summary Table.
- ***Extract final Summary Table info from volume records*** -- Information from the Volume Table is combined with Summary Table information to produce the final Summary Table Information.

The rebuild operation can also be performed automatically through the use of the Standby Mode. The same rebuild phases occur during the automatic processing as do in the manual processing, only no confirmation dialog boxes are generated. See **Standby Mode** for more details.

WARNING! As the traffic database gets larger, rebuild operations will take longer. Manual rebuild operations are cautioned since they could take a considerable amount of time, thereby keeping the machine tied up for the duration.

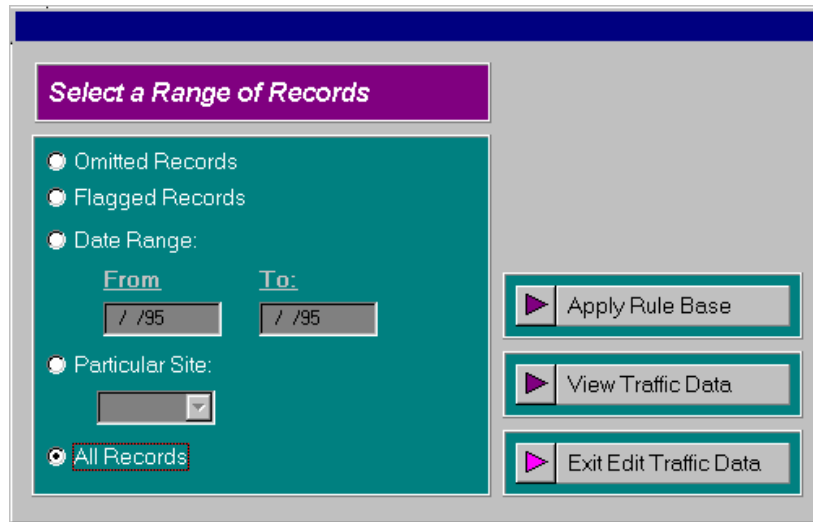


Edit Traffic Data

After the summary table rebuild operation (See **Rebuild Summary Tables**) has been completed, a wide variety of editing can be performed on the Edit Table.

To edit the data in the Edit Table:

1. Select *Edit Traffic Database* from the menu or click the *Edit* speed button. The following screen will appear:



2. Select a range of records from the following options:
 - *All Records*. This option will select every record current in the Edit Table.
 - *Particular Site*. You can select an individual site from the drop-down list box to limit the selection to records from that site only.
 - *Date Range*. You can select a starting and ending date to limit the selection to records from that time period only.
 - *Flagged Records*. You can select only those records that were flagged the last time the rule base was applied (See **Apply Rule Base**) .
 - *Omitted Records*. You can select only those records that have been marked as omitted during a previous edit operation.

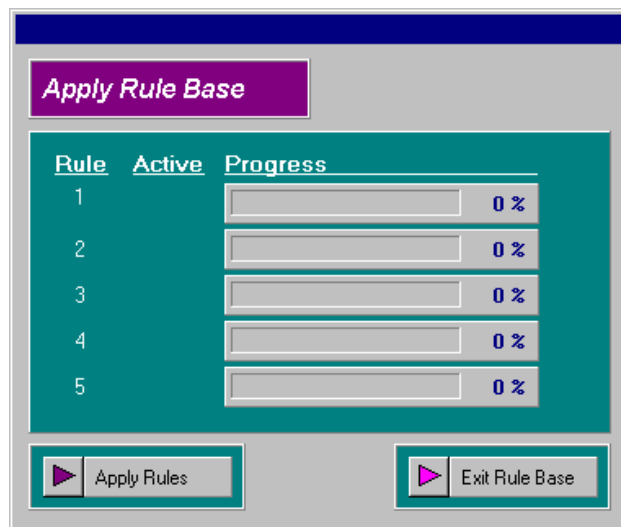
3. Once you have identified the set of records for the edit operation, you can either (a) apply the rule base to this set of records, or (b) view these traffic records.

Apply Rule Base

The WVDOH MIS has the ability to “flag,” or filter, records in the Edit File through the application of some user-defined rules.

To apply the rule base to a selection of Edit File records:

- a. From the *Select Range of Records* screen, select a range of records as described above.
- b. Click the *Apply Rule Base* button. The following screen will appear:



- c. To apply the rules to the selected records, click the *Apply Rules* button. The WVDOH MIS will check each rule in turn (if it is active) and apply it to the selected records. The progress for each rule as it is being processed is shown by individual progress bars. When the rule has been checked, a check mark will appear in the *Active* column.

View Traffic Data

The WVDOH MIS allows direct interaction with the data stored in the Edit File. The traffic counts for individual records can be modified or excluded from reporting through the Edit File Viewer.

To view or modify data stored in the Edit File:

- a. From the *Select Range of Records* screen, select a range of records as described above.
- b. Click the *View Traffic Data* button. The following screen will appear:

The screenshot displays the 'Edit File Viewer' interface. It features a data grid on the left and control panels on the right and bottom.

Record	Date	Site	Source	Count	Omit?	Flagged?
1	5/1/95	5	Actual	12200		Yes
2	5/2/95	5	Actual	12022		Yes
3	5/3/95	5	Actual	12334		Yes
4	5/4/95	5	Actual	14095		Yes
5	5/5/95	5	Actual	16670		Yes
6	5/6/95	5	Actual	12849		Yes
7	5/7/95	5	Estimated	12714		Yes
8	5/8/95	5	Actual	12884		Yes
9	5/9/95	5	Actual	12015		Yes
10	5/10/95	5	Actual	12642		Yes

Site Description: I-79, 0.8 MI. N. OF US 19

Actual Count: 12200

Estimated Count: 12714

Previous Year

Peer Avg.

Monthly Site Avg.

User Defined Count: 8000 ✓

Navigation buttons: Previous, Next, Edit Count, Edit Status, Exit Edit File Viewer.

The data for the records included in the selection criteria are shown in the *data grid*. The data grid has the following columns:

- **Record**. This number identifies the record's position in the current selection, not in the database itself. It is provided to aid navigation within the selection.

- **Date**. The date on which the data was recorded is shown in this field.
- **Site**. The site number, as reported by the ATR, corresponding to the collection location is given in this field.
- **Source**. The source of the traffic count used for reporting purposes (see below) is shown here.
- **Count**. The traffic count used for reporting purposes (see below) is given in this field.
- **Omit?**. This field shows whether or not this particular record is marked for omission for reporting purposes. This field has no effect on standard reports, but could be used for custom reports (see below).
- **Flagged?**. This field shows whether or not this particular record was flagged by the last execution of the rule base. This field has no effect on standard reports, but could be used for custom reports (see below).

Before continuing the descriptions and purposes of the Edit File Viewer features, a brief word about reporting is in order. When the user exits the Edit File Viewer, the Edit File data is copied back into the Summary Table for the site-by-day information. The traffic count used for this operation is the value specified in the Count column of the data grid described above. This copy operation only affects the predefined Distribution Reports. The Omit? and Flagged? columns of the data grid are not used by any of the standard reports, but could be very useful in the generation of Ad Hoc reports (See **Ad Hoc Reports**).

The *info box* holds the following information about the current record selected in the data grid:

→ **Site Description.** This field gives a description of the site in question, taken from the Site Reference File (See Appendix A).

→ **Actual.** The actual count recorded by the ATR is shown in this field. The user may select this count as that used for reporting purposes, but the user cannot change this value.

→ **Estimated.** Instead of using the actual traffic count for reports, the user may opt to use one of the estimated values. These estimated values come from the following sources:

Previous Year. If a value for this site and day combination exists in the archive, then this value will appear here. Otherwise, this value will be zero.

Three-Day Average. For the particular site in question, the actual counts for the day prior to, the day after, and the current day in question are summed and the average is taken. This value is shown here.

Month Site Average. This field contains the average count for the current site for the month that corresponds to the collection date.

→ **User Defined.** If the actual and estimated traffic counts are found to be unsatisfactory, the user may enter the desired value here. When the value has been entered, click the check mark to the right of the edit box to save the value in the data table.

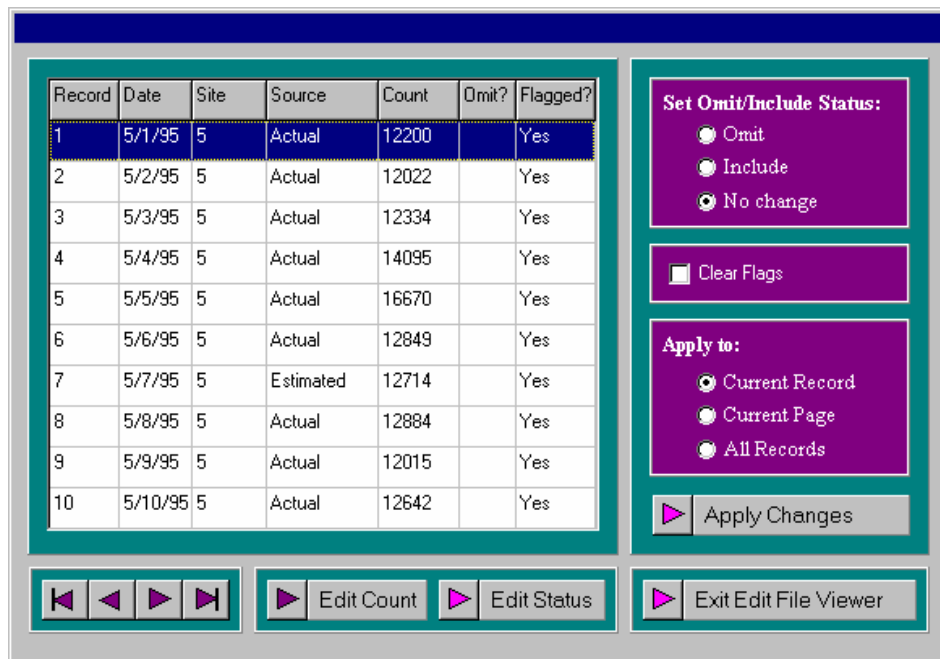


The *navigator bar* is used to move between selected records. The user can move to the top of the selection (the first record), to the previous page of records, to the next page of records, or to the end of the selection (the last record).



When the user enters the Edit File Viewer, the **Edit Count** button will be lit. This signifies that the info box contains traffic count information, i.e., the actual, estimated, and user-defined counts. If the user clicks the **Edit Status** button, the info box will contain the following status information:

- **Omit/Include.** The user can specify if the *target records* should be omitted (the Omit? field will be set to true), included (the Omit? field will be set to false), or not changed from its current value.
- **Clear Flags.** The user can specify if the target records should have any set flags cleared, i.e., all Flagged? field entries will be set to false.
- **Apply To.** The user can choose the records to which the specified status changes will apply: the current record only, the current page of records only, or the entire Edit File.



Once the user has selected the desired status changes and identified the target records, the changes are made simply by clicking the *Apply Changes* button.

The contents of the data grid can be printed or saved in a Comma Separated Values (CSV) formatted file. To access these functions, click the right mouse button anywhere inside the data grid.

The user can leave the Edit File Viewer by clicking the *Exit* button.



Reports

The WVDOH MIS has several predefined, or *standard*, reports that are very flexible and easy to use for analyzing data. In addition, ReportSmith can be used to develop nearly any custom report.

The WVDOH MIS provides the following standard reports:

- ***Distributions of Data.*** You can analyze the traffic count data from any of the following tables: speed table, vehicle classification table, weight file speed table, or the main summary table. You can select the entire active year or a range of dates, and you can select either an individual site or all sites combined.
- ***Peak Hour Report.*** The Peak Hour Report lists the first, thirtieth, and fiftieth highest volume hours for each site. The Peak Hour Report is only available *after* the traffic database has been archived (See **Archive Database**).
- ***Class Reports.*** The following class reports are available for either the Traffic Monitoring Guide (TMG) classes or the user-defined classes:

Membership. This report lists every site and its site classification.

Volume-By-Class. The Volume-By-Class Report displays each class and the total volume for all sites belonging to each class.

- ***Day-By-Hour Report.*** The Day-By-Hour Report lists ...
- ***FHWA Reports.*** The following FHWA Reports can be generated automatically (as per the TMG Version xxx format) by the WVDOH MIS:

#3 Cards. This report is an ASCII output in the prescribed format of the hourly volume data for each site.

#4 Cards. This report is an ASCII output in the prescribed format of the vehicle classification data for each site.

#7 Cards. This report is an ASCII output in the prescribed format of the truck weight data for each Weigh-In-Motion (WIM) site.

The TMG formats for each the FHWA reports is listed in Appendix B.\

- **Ad Hoc Reports.** In addition to the standard reports provided by WVDOH MIS, the user can use ReportSmith to develop custom reports based on any table in the system.

To create either a standard report or a custom report:

- Select the Reports menu and further refine your selection through the menu choices until you have reached the desired report option.

OR

- Click the Reports speed button to bring the Report Menu:

You can get any of the reports listed simply by clicking the corresponding button. If you select the Class Reports button, the following selection screen will appear:

Report Menu

Report Type: <input checked="" type="radio"/> Membership Report <input type="radio"/> Volume By Class Report	Site Class Reference: <input checked="" type="radio"/> TMG Classes <input type="radio"/> User Defined Classes
<input type="button" value="◀ Cancel Selection"/>	<input type="button" value="▶ Select Report"/>
<input type="button" value="▶ Exit Edit Report Menu"/>	

Simply choose whether you would like a Membership Report or a Volume-By-Class Report, then select whether you would like the report to be based on the TMG Class reference or the User Defined Class reference. When the desired options have been selected, click the Select Report button to view the report.



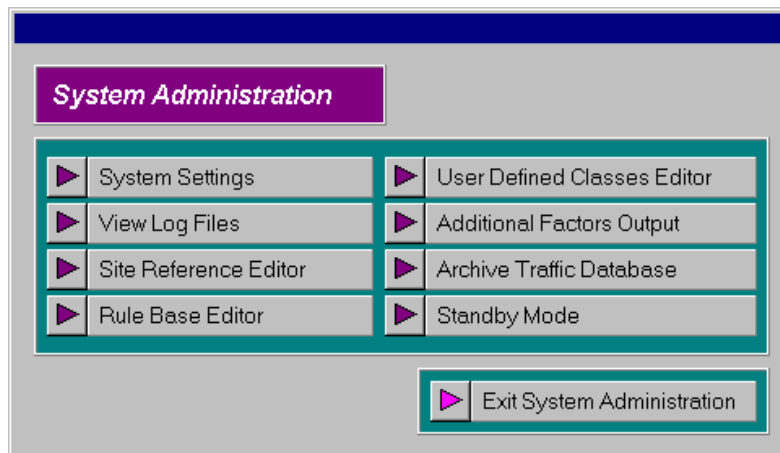
System Administration

In addition to the primary functions of the WVDOH MIS, there are several administrative functions that must be managed to ensure the proper working of the system. The system administration functions can be accessed in either of two ways:

- Select the *System* menu and refine your selection through the menu choices until you have reached the desired system option.

OR

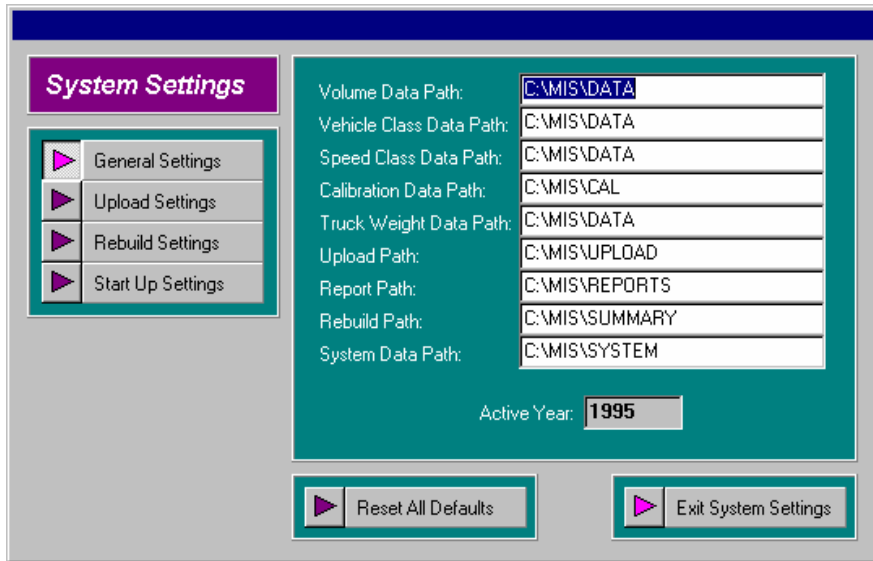
- Click the *System* button to bring up the *System Menu* screen:



System Settings

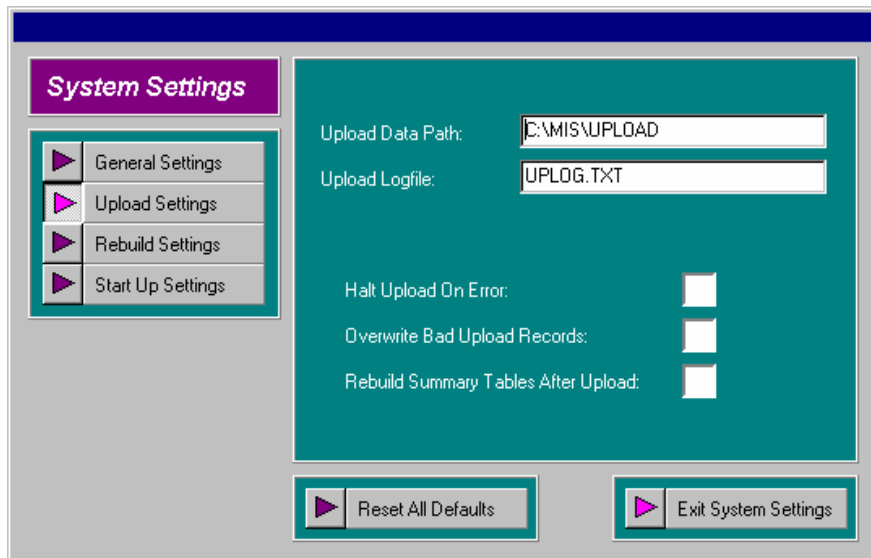
There are four categories of system settings applicable to WVDOH MIS. They are:

- *General*. The general settings consist of the file paths for the various system data files and the Active Year for the current data:



Note: the Active Year cannot be edited.

- **Upload Settings.** The upload settings consist of the file path for uploads, the upload log file name, and several settings applicable to the upload operation:

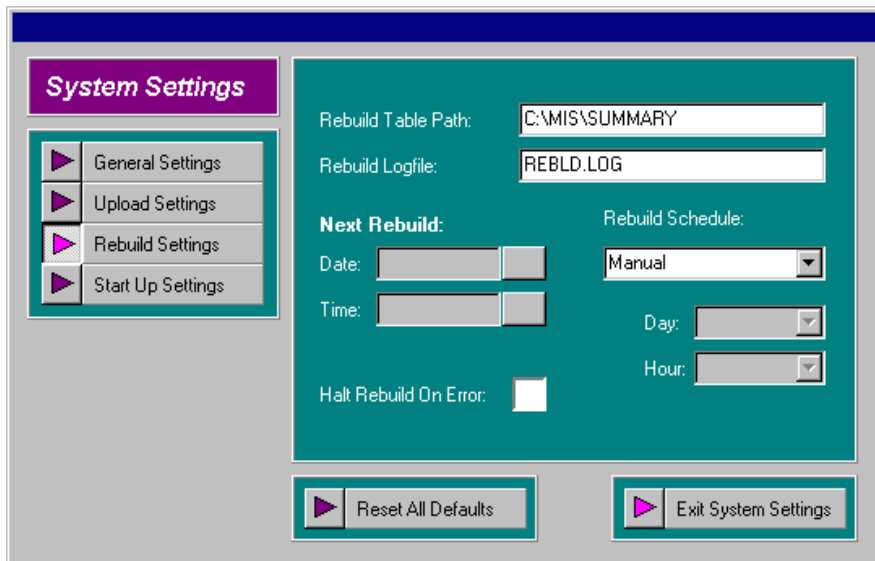


Halt On Error. If this is set to true, then WVDOH MIS will cease an upload operation if it encounters an error. If it is false, only the file exhibiting the error will be abandoned.

Overwrite Bad Upload Records. Before a file is uploaded, the File Verify Log is checked to make sure that this file has not been previously uploaded. The File Verify Log contains the name, upload attempt date, and status for every file for which an upload operation is attempted. If the overwrite option is set to true, files that were recorded as failed upload attempts can be attempted again. If this option is false, once the file has been identified as bad, it can never be attempted again.

Rebuild Summary Table After Upload. If this option is set to true, a rebuild operation will be executed immediately following each upload operation.

- **Rebuild Settings.** The rebuild settings consist of the file path for the Summary Table, the rebuild log file, and the following rebuild options and information:



Rebuild Schedule. Rebuild operations can be performed manually, or they can be set to occur off-line. The user can select any of these three schedule types:

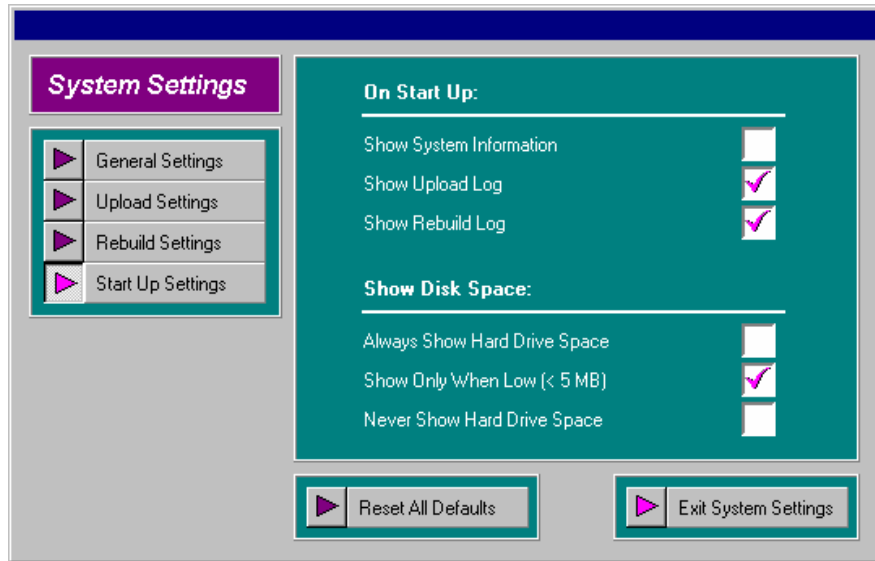
Manual. Select this option if you choose to perform the rebuild operations manually. It is also important to note that the rebuild schedule is reset to manual automatically after the rebuild operation is complete if the current schedule type is not weekly. (See **Standby Mode**).

Specific Date and Time. Select this option for a one-time rebuild on a particular date at a particular time. The Date and Time fields under Next Rebuild will activate when this option is selected.

Weekly. Select this option if you would like the rebuild to occur on a weekly basis. The Day and Hour fields will activate when this option is selected.

Halt Rebuild On Error. If this option is set to true, the rebuild operation will cease when it encounters an error. If this option is false, the section in which the error is encountered will be abandoned, but the rebuild will continue.

- **Start Up Settings.** The start up settings consist of options for information shown when the application starts:



Show System Information. If this option is set to true, then...

Show Upload Log. If the Show System Information is set to true, then this option can be used to specify if the upload log file will be shown as well.

Show Rebuild Log. If the Show System Information is set to true, then this option can be used to specify if the rebuild log file will be shown as well.

Show Disk Space. As the WVDOH MIS maintains database files that can reach considerable sizes, it is important for the user to know the current amount of hard disk space. This option will allow the user to specify whether this information is shown always, only when the remaining space is under five megabytes (5 Mb), or not shown. Note: Disk space is only shown if Show System Information is set to true.

View Log File

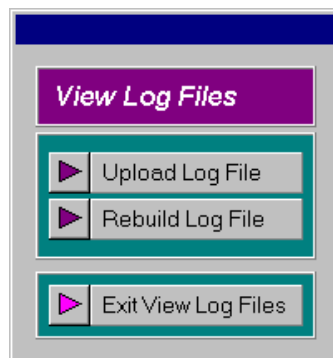
The WVDOH MIS has two log files that are important to its operation: the Upload Log and the Rebuild Log. The Upload Log stores the status information recorded during upload operations. Errors encountered during the operation are written to this file. Similarly, the Rebuild Log contains the status information recorded during rebuild operations.

To view either the Upload Log or the Rebuild Log:

- From the System Menu, select View Log File, then select the desired log file to view.

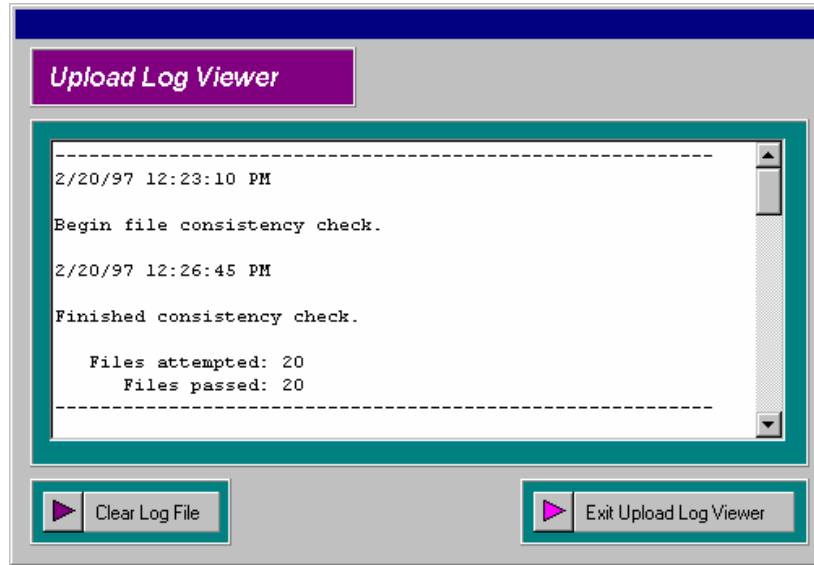
OR

- Click the *System* button. The Next click the *View Log File* button. The following log file menu will appear:



Select the desired log file from this menu.

The Log File Viewer will appear:



The display area in the Log File Viewer is read only. You cannot change the information in a log file. You may clear the contents of the log file by clicking the *Clear Log File* button.

When the Log File Viewer is loaded, if the selected log file is too large, the file will be split into several files, until a size is reached that can be handled by the viewer. The oldest data will not be accessible through the Log File Viewer. However, a dialog box will appear to inform the user of the required file splitting and the file name(s) that were used. The split files will always be found in the file path corresponding to the log file, i.e., any files split from the Upload Log will be found in the file path specified in the Upload Settings as the Upload Data Path, and similarly for the Rebuild Log File.

Site Reference Editor

You can view or edit ATR site data or add data for a new ATR site with the WVDOH MIS Site Reference Editor.

To view, edit, or add ATR site information:

1. Select *Site Reference Editor* from the *System* menu, or click the *System* speed button and then select *Site Reference Editor* from the selection dialog. The following screen will appear:

Site ID:	Station:	Location:	Year:	Active?
001	000001	I-64, 1.0 MI. W. OF WV 20	94	True

FIPS Code:	54	System Direction:	5 South	Number of Lanes:	4
Route Number:	06400	Route Category:	2 U.S. Route	TMG Lanes:	123456
County Station ID:	549901	ESAL:	R 12	Lane Type:	CCCCXX
County Code:	025	ESAL Processing Code:	A	Lane Direction:	337700

Weighing Equipment:	3 Static (platform or pit)	HPMS Info:	0640013838
Vehicle Classification:	6 Portable AVC in some lanes	Enforcement:	2 Separate

TMG Class:	09 Rural, Local System	User Defined Class:	1 Default
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Navigation icons: Home, Back, Forward, Next, Refresh, Add, Edit, Delete, Print, Close. Exit Site Reference Editor button.



The *navigator bar* allows you to move to the beginning of the file (first record), to the previous record, to the next record, or to the end of the file (last record).



Sometimes the full length descriptions that correspond to the numeric codes will disappear after certain edit operations. Click the ***Refresh*** button on the navigator bar to update the screen with the current data.



The data on the screen can only be modified if the ***Edit*** button is down. If the ***Edit*** button is up and you make changes, these changes will appear on screen but will not be written to the database. After making the desired changes to the current record (with the edit button down), you can either write the changes to the database by clicking the ***Keep*** button, or abandon these changes with the ***Discard*** button.



To add a new site record to the database, click the ***Add*** button. All fields will be cleared (except those with read-only default values) and then you can enter in the data as required.



To delete the current site record from the database, click the ***Delete*** button.

WARNING! Though it is possible to delete a site reference record, it is recommended that you **only** do so with extreme caution. If you incorrectly add a site and wish to delete it, then deleting the site record will not have any adverse effect on the system. **If you delete a site record for which there is traffic data recorded, the database will be corrupt and the system will crash.**

Deleting records for existing sites with data will orphan the data. If the WVDOH MIS encounters orphaned data, **it will crash**.

The following is a description of the fields in the Site Reference Editor:

Site ID. This field identifies the particular ATR by an identification number as reported by the ATR.

Station. The *Station* field is an additional identification field for the ATR site.

Location. The *Location* field gives a brief description of the physical location of the ATR.

Year. This is the year that the ATR was installed.

Active. The *Active* field denotes whether or not the ATR is currently in use. WVDOH MIS will continue to upload data that references an inactive site; this field is for custom reporting purposes.

FIPS Code. The *FIPS Code* is the Federal Information Processing Standards code used to identify the state in which the ATR site is located. The FIPS code for West Virginia is 54. Since this field will never change, it is read-only, as denoted by the grey color.

System Direction. The general direction of the highway on which the ATR site is located is given in this field. The coded values come from the following table:

<u>Code</u>	<u>Direction</u>
1	North
2	Northeast
3	East
4	Southeast
5	South
6	Southwest
7	West
8	Northwest
9	North-South or Northeast-Southwest combination
0	East-West or Northwest-Southeast combination

Route Number. This is the route number of the principal route on which the ATR site is located.

Route Category. The *Route Category* field takes its values from the following table:

<u>Code</u>	<u>Category</u>
1	Interstate
2	U. S. Route
3	State Route
4	County Route
0	Other

County Station ID. This field is another identification number for the ATR site.

County Code. The *County Code* field contains the three-digit FIPS code for the county.

ESAL. The *ESAL* field holds the Equivalent Single Axle Load for the ATR site.

Number of Lanes. This field gives the number of lanes at this site for which the ATR collects data,

TMG Lanes. The TMG Lanes field gives the TMG lane numbering scheme (starting from the rightmost lane).

Lane Type. If the ATR in a particular lane collects vehicle volume and classification data only, a 'C' will be in the column that corresponds to the lane. If the ATR in this lane also collects weight data, then a 'W' will be in listed in the column. Unused columns will have an 'X.'

Lane Direction. The direction of each lane at the ATR site is given in this field. The direction codes conform to the table given above for *System Direction*.

Weighing Equipment. This field gives the type of weighing equipment found at this ATR site according to the following table (note: codes 1-4 are for historical purposes only as they are no longer used):

<u>Code</u>	<u>Equipment Type</u>
0	None
1	Static (portable scales)
2	Static (chassis-mounted, towed)
3	Static (platform or pit)
4	Weigh-In-Motion (WIM)
5	Portable WIM in all lanes
6	Portable WIM in some lanes
7	Permanent WIM in all lanes
8	Permanent WIM in some lanes

Vehicle Classification. This field gives the method of vehicle classification employed at this ATR site according to the following table (note: codes 1 and 2 are for historical purposes only as they are no longer used):

<u>Code</u>	<u>Method</u>
0	None
1	Manual vehicle classification (VC)
2	Automated VC
3	Manual VC in all lanes
4	Manual VC in some lanes
5	Portable VC in all lanes
6	Portable VC in some lanes
7	Permanent VC in all lanes
8	Permanent VC in some lanes

HPMS Info. This information is pertinent to sites that are on sections of highway that have been identified as HPMS sample sections. Coding instructions for this field must be obtained from an HPMS source of information.

Law Enforcement. This field describes the level of cooperation with law enforcement activities in regard to the data collected at this site, according to the following table:

<u>Code</u>	<u>Enforcement</u>
1	Planning and enforcement activities are performed simultaneously at this site
2	Planning and enforcement activities are performed separately at this site

TMG Class. The following is a list of site functional classifications from the Traffic Monitoring Guide (TMG):

Rural

- 01 Principal Arterial - Interstate
- 02 Principal Arterial - Other
- 06 Minor Arterial
- 07 Major Collector
- 08 Minor Collector
- 09 Local System

Urban

- 11 Principal Arterial - Interstate
- 12 Principal Arterial - Other Freeways
- 14 Principal Arterial - Other
- 16 Minor Arterial
- 17 Collector
- 19 Local System

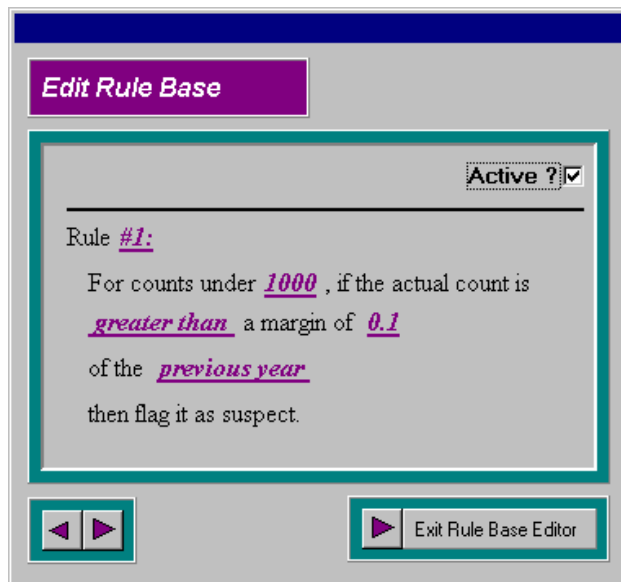
User Class. The *User Class* field has the current user-defined class assignment for each ATR site record. This field is usually set to **Default**, but may be changed for any grouping desired.

Rule Base Editor

The WVDOH MIS allows the user to flag records in the Edit File if they meet certain user-specified criteria. Users can create up to five “rules” for filtering, and can activate and deactivate each of them at any time.

To edit the rules in the Rule Base:

1. Run the Rule Base Editor through the System Menu or through the System speed button. The following screen will appear:



The first rule in the Rule Base will be shown when the Rule Base Editor comes up. You can change any of the fields in the rule (shown in purple and underlined italics) or activate/deactivate the rule. When you move the mouse pointer over a field that can be changed, the cursor will change from an arrow to a pointing finger.

Active?. The *Active?* check box designates whether or not the rule will be used the next time the rule base is applied. This value can be changed simply by clicking inside the box.

Rule #n. Clicking the number listed after “Rule” will cause the next rule to be displayed (if the fifth rule is currently displayed, then the first rule will be shown). You can also navigate between rules by using the arrows in the lower left corner.

under xxxx. This value determines the range of traffic counts for which this rule will apply (see below).

count is xxxx. You can select if the rule will flag counts that are *greater than* the reference value, *less than* the reference value, or both (see below).

margin of xxxx. This value is a fraction that describes the allowed deviation from the reference. Variation beyond this amount will cause the record to be flagged (see below).

of the xxxx. The reference value used for applying the rule is identified here. You can select the *previous year* count, the *three-day average* count, or the *monthly average for this site* to be the reference value. For a complete description of these values, see **Edit Traffic Data**.

You can exit at any time by clicking the **Exit** button.

Figures 1 and 2 show how the rules work. Figure 1 shows a traffic count that successfully passes the given rule. It is within the amount specified by the *margin*, so it is not flagged.

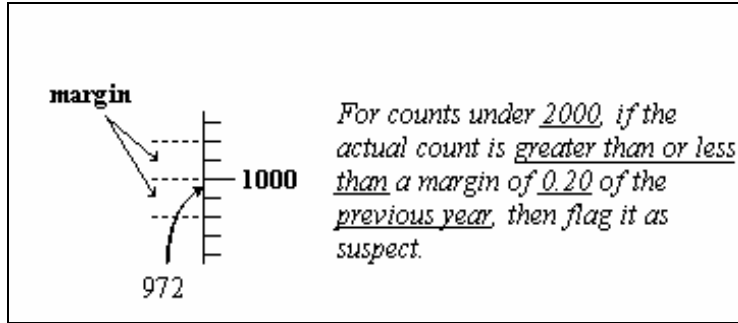


Figure 1. Traffic count passing a two-sided rule.

Figure 2 shows a different rule (this one is a one-sided rule) and a traffic count that is not successful. Since this count is outside of the margin, it is flagged.

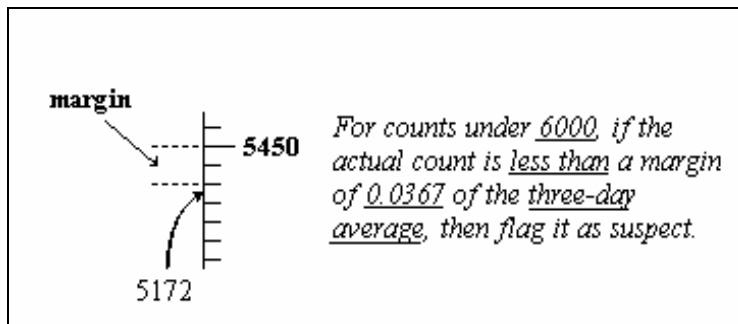


Figure 2. Traffic count failing a one-sided rule.

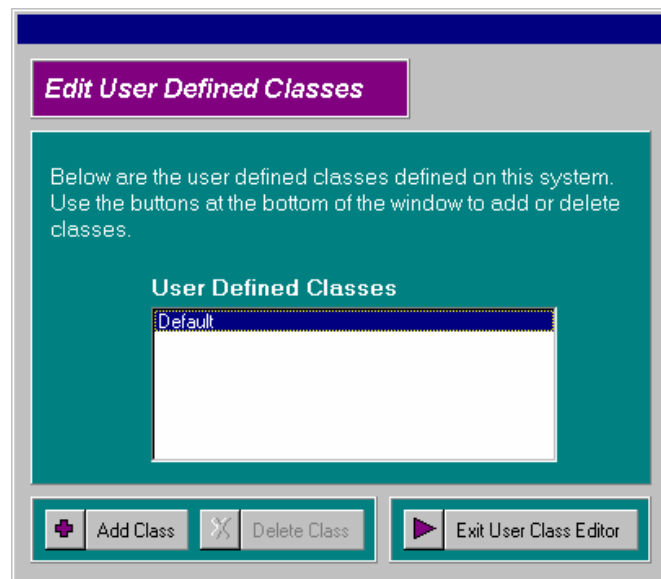
The Rule Base can only be used effectively to filter traffic counts if the rules themselves are well planned. Take care in selecting the proper reference value and margin.

User-Defined Class Editor

The WVDOH MIS allows the you to create up to xx user-defined classes for organizing the ATR sites. The user-defined classes can then be used in developing powerful reports for analyzing the traffic count data.

To create a user-defined class:

1. Run the User-Defined Class Editor either through the System Menu or by clicking the System button. The following screen will appear:



You can add a class to the list (up to a limit of 15) by clicking the **Add** button. A dialog will appear to ask you the name of the new class:

With the exception of the *Default* class, user-defined classes can be deleted from the list by first selecting the class you would like to delete by clicking on it, then clicking the **Delete** button.

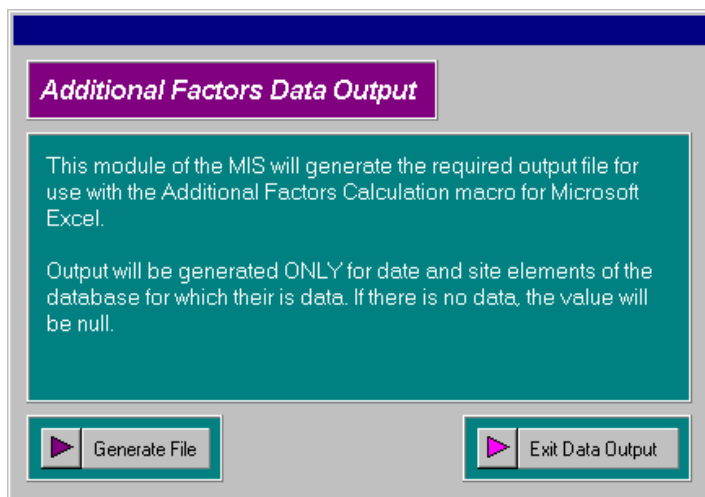
You can exit at any time by clicking on the *Exit* button.

Output Additional Factors Data

The WVDOH MIS can also output the data necessary to update the Microsoft Excel Macro developed by the WVU IMSE Department for Additional Factors analysis purposes.

To generate the Additional Factors information:

1. Select Output Additional Factors Data through the System Menu, or by clicking the System button. The following screen will appear:



1. Click the Generate button to create the data file.
2. Click the Exit button and then close the WVDOH MIS.
3. Run Microsoft Excel and load the WVU IMSE Additional Factors Macro.
4. Follow the instructions that accompany the macro.

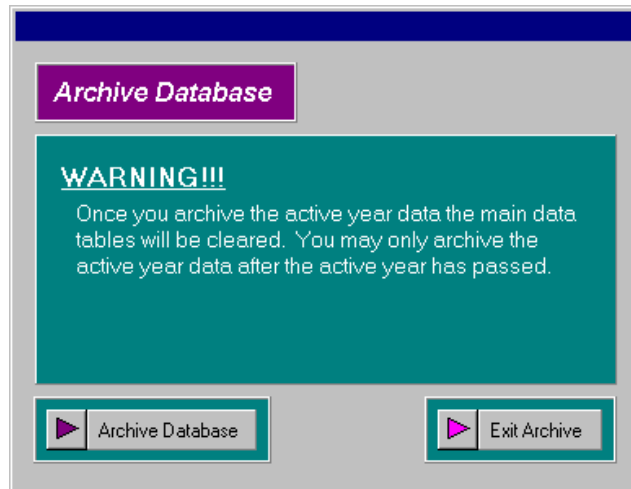
Archive Traffic Database

After the final reports for the active year have been submitted, it is necessary to archive the current data so that new data can be uploaded. During a database archive operation, the following events occur:

- The Peak Hour Table, the Total Count Archive, and the xxx tables are updated.
- The actual counts from the Edit Table are archived into the xxx table.
- The Active Year is incremented.
- All other data tables are cleared of data (reference tables are left in tact). For this reason it is **vitaly important** that great care is taken whenever the system is archived. This operation **cannot be undone** once it has occurred.

To archive the traffic database:

1. Select Archive Traffic Database either through the System Menu or by clicking the System button and then the Archive Traffic Database button. The following screen will appear:



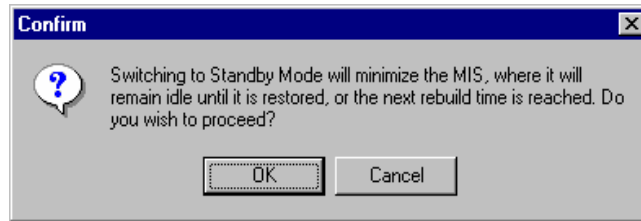
2. Click the Archive button **only** after you are sure that this is what you would like to do. A confirmation dialog will come up to ensure that this is not an accidental choice. If you are **sure** you want to archive the system, click OK.

Standby Mode

In order for the WVDOH MIS to be able to perform its rebuild operations off-line, not only do you have to make the appropriate selections in the Rebuild Settings (See **System Settings**), but you also have to place the PC in Standby Mode just prior to the rebuild time.

To place the PC in Standby Mode:

1. Select ***Standby Mode*** either through the ***System*** menu or by clicking the ***System*** button, then clicking the ***Standby Mode*** button.
2. A dialog will ask you if you are sure you want to do this, as it minimizes the WVDOH MIS until time to perform the operation. Click OK.



3. The WVDOH MIS will then minimize until either the rebuild is complete, or the application is restored. When the WVDOH MIS has completed the rebuild operation, it will close itself as well.

As an illustration, suppose the next off-line rebuild is scheduled for today at 8:00 p.m. When you leave work for the day, 5:30 p.m. for example, place the PC in Standby Mode before leaving. Note: You **must** leave the PC **on** for the off-line rebuild to occur, and you **must** have the PC in Standby Mode.

CHAPTER 5: WEST VIRGINIA DIVISION OF HIGHWAYS MANAGEMENT INFORMATION SYSTEM SYSTEM MANUAL

How To Use This Manual

The WV DOH MIS System's manual is divided into five main sections. The **Overview of Operations** gives a general description of the objectives of the MIS, its information storage, manipulation, and analysis capabilities, and an introduction to the data flow model of the system. A detailed description of the expected data inputs, what the MIS does with those inputs, and what outputs can be expected are explained in the **Data Flow of the WV DOH MIS**. The **Database Structure of the WV DOH MIS**, including the table types, database aliases, and table definitions, are given to provide maximum insight into the data management of the MIS. The **WV DOH MIS Output**, such as reports and data files, are also described. The manual wraps up with an in-depth view into the organization and function of **The WV DOH MIS Program Organization** itself.

I. Overview of Operations

WV DOH MIS Objectives

The WV DOH MIS is a data storage, analysis, and reporting tool designed by research staff from West Virginia University's Industrial and Management Systems Engineering (IMSE) department in cooperation with personnel from the West Virginia Division of Highways. The primary objectives of the MIS are:

- read and store data collected by PAT Equipment Corporation Automatic Traffic Recorder (ATR) models AVC100 and DAW100
- automate the creation of required Federal Highway Administration (FHWA) reports
- edit and analyze traffic data for the current year

WV DOH MIS Capabilities

In addition to the design objectives, the WV DOH MIS also supports the following data management capabilities:

- management of ATR site reference data
- creation of user-defined vehicle classes that can be used to group and summarize traffic data
- ability to "filter" data through the application of user-defined traffic count rules
- summarization of data by day, month, day of week, site, hour, and time of day
- predefined reports that speed data analysis efforts

Order of Operations

Since the WV DOH MIS is a multipurpose tool, there is no rigid order of operations for its use.

However, some general guidelines do apply:

- *if the purpose of the session is to upload data*, be sure to rebuild the tables afterwards so that the summary tables will have the most current information
- *if the purpose of the session is to modify data*, be sure to rebuild the tables afterwards so that the summary tables will have the most current information

- *if the purpose of the session is to view reports*, be sure to rebuild the tables prior to viewing so that you will have the most current information
- *if the purpose of the session is to modify any other portion of the system*, be sure to notify other users, as they may not always check the settings prior to use and might become alarmed if the system behaves differently than expected

In order to understand how the MIS meets these design objectives and provides these data management capabilities, let us look at the typical data flow for the MIS.

II. Data Flow of the WV DOH MIS

The data flow of the MIS revolves around the upload of an ATR data file. The ATR files can be loaded from the MIS host computer or any external location (network, floppy, etc.) that is visible to the Windows 95/Windows NT file management system. By visible we mean any drive-path-filename combination that can be located by the operating system's file management services. For example, floppy drives are (usually) visible; network drives may not be visible if there is no current network connection or valid drive mapping. To see if the desired location is visible, simply try to view it in Windows Explorer. If you can view it with the Explorer, then it is visible to the MIS.

Any number of files can be uploaded to the MIS at one time. However, it is not recommended to select more than one hundred (100) files at a time for two reasons. First of all, since the upload process is the most vulnerable of the MIS operations, it is important that it be supervised. Uploading one hundred files could take well over an hour, depending on the system, ATR file

type, and file source. Second, the program would likely crash due to memory errors if the file limit were exceeded.

Figure 1 shows a typical ATR file and the subsequent data that are extracted from it. All of these data are readily accessible to the user, either through the MIS itself or through external reporting tools. The Calibration data are kept in external text files, as the format of the calibration records within the ATR file itself is proprietary and could not be obtained for the development of this MIS.

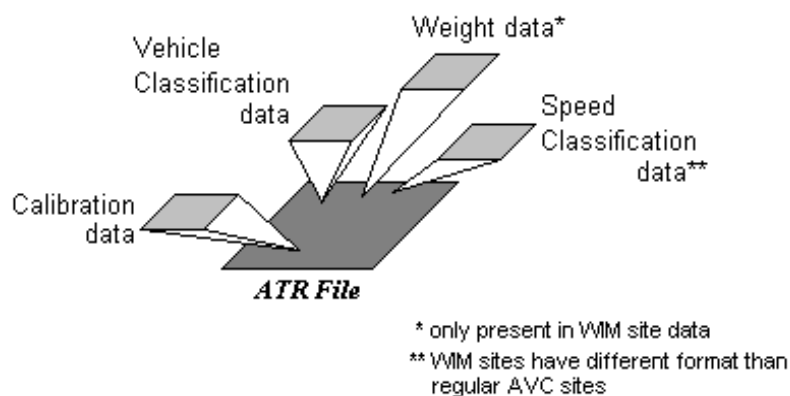


Figure 1. Data extracted from ATR files.

The actual process of an upload procedure is as follows:

- the user reviews the current Upload Settings and alters them, if desired
- the user selects the files that are to be uploaded
- starting with the first file in the selection list, the MIS performs the following:
 - check for a previous upload of the current file (1)
 - try to read the first block of 256 bytes (2)

- if this is a calibration block, then write it to the appropriate calibration file; otherwise, this is an unknown file type, so generate an error (3)
- read each of the remaining blocks of 256 bytes and process them based on block type:
 - AVC blocks contain vehicle class, volume, and speed information
 - WIM blocks contain weight information from WIM ATR sites
- report any errors encountered during the reading, conversion, and writing of the data blocks (4)
- continue with each file in the selection list until all files have had an upload attempt (5)

Some of these concepts may seem confusing, particularly the items cited by number in the above procedure. These items are clarified more below (for a listing of errors generated during upload, see Appendix C):

- (1) The first level of data protection is the File Verification Log. If a previous attempt to upload a file was successful, then the File Verification Log will prevent the overwrite of this particular file. If a previous attempt to upload a file was not successful, then one of two things can occur. If the option "*Allow repair overwrites*" is selected, the File Verification Log will allow another attempt to upload the file. If this option is not selected, the File Verification Log will prevent the overwrite of this file.
- (2) If an ATR file is physically missing some data, the byte counts of the file will not be evenly divisible by 256 (this is the size of an ATR block record). The MIS will report an error if it tries to read a block of 256 bytes and reaches End Of File (EOF) before it reads a full block.

- (3) The first block of every ATR file is the calibration block. If the first block cannot be correctly identified as a calibration block, then this file is not recognized as an ATR file, and the MIS will report an error.
- (4) When a block is read, it is first converted from a stream of bytes into a block record. If the conversion is unsuccessful, the MIS will report an error. If the year reported by the block record does not match the Active Year identified by the system, the MIS will report an error unless the "*Force data year to equal active year*" option is not selected. If this option is selected, then the year reported by the block record is automatically changed to be the Active Year. This feature was included in the upload procedure to correct a problem in which the ATR counters occasionally report the year of data collection incorrectly.
- (5) If the option "*Halt file on error*" is selected, any error that is encountered while attempting to upload a file will cause the MIS to abandon the attempt for that file. If the option "*Halt upload on error*" is selected, any error that is encountered will cause the MIS to abandon the entire upload procedure.

When an ATR file is uploaded, the data are routed to several different tables within the MIS database structure. The MIS database structure is described in the following section.

III. Database Structure of the WV DOH MIS

The MIS database structure is shown conceptually in Figure 2. The files are held in the Upload Bin until they are ready to be incorporated into the Active Data Tables. The Active Data Tables are those tables that hold the raw data as read from the ATR files (refer to Figure 1). The Active

Summary Tables are derived from the Active Data Tables and are used to speed querying the database by providing common summaries of the Active Data Tables. The Archive Data Tables hold summaries of Active Data after it has been turned over through the archive process. The System Tables are used for housekeeping by the MIS.

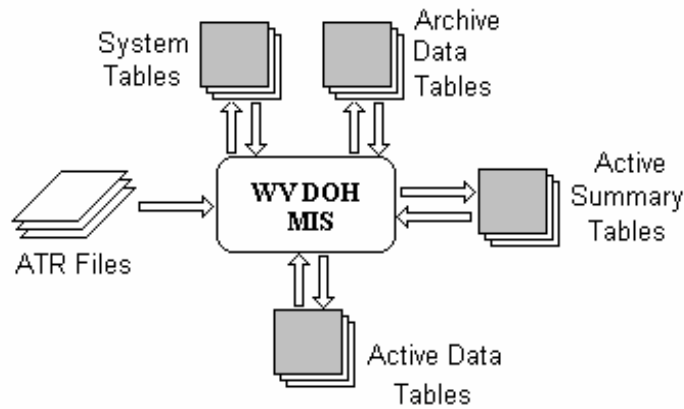


Figure 2. WV DOH MIS database structure.

Database Aliases

The MIS database structure was developed using the Borland Database Desktop v.7.0 that ships with Borland's Delphi v.2.0. The tables were created in Paradox 7.0 format. The Database Desktop (and also Delphi) allows you to specify aliases for the actual drive and directory locations of the database tables so that you can change them external to the code. What that means is you can move the databases without having to rewrite the program (providing you maintain the aliases). The aliases used by the MIS are given below:

- DOH
- DOHSUM
- DOHARCH

- DOHSYS

The DOH Alias

The DOH alias points to the Active Data Tables and the temporary tables used to create them. These tables and their use are listed below. For a listing of the fields and field types for each table, see Appendix A:

- ***Class***. The Class table holds the Automatic Vehicle Classification (AVC) data extracted from the ATR files, sorted by date, hour, site, and lane.
- ***Volume***. The Volume table holds the total traffic counts extracted from the ATR files, sorted by date, hour, site, and lane.
- ***Speed***. The Speed table holds the speed classification information for non-WIM sites only, as extracted from the ATR files and sorted by date, hour, site, and lane.
- ***WTSpeed***. The WTSpeed table holds the speed classification information for the WIM sites. This information is stored in ATR files differently than it is for non-WIM sites, so a different table must be maintained. This table is sorted by date, hour, site, and lane.
- ***Weight***. The Weight table holds the WIM weight data for each weighed vehicle. The Weight table is sorted by date and site.

The DOHSUM Alias

The DOHSUM alias points to the Active Summary Tables. These tables are used by the MIS to categorize and summarize the raw data found in the Active Data Tables to speed data analysis and query. Some of the Archive Data Tables are also found in this directory. These tables and their use are described below:

- **MainSum.** One of the primary Active Summary Tables, the MainSum table holds summaries of the Volume table by month, date, day-of-week, time-of-day (i.e., morning, etc.), and hour of day (see Appendix A for details). The MainSum table is used by the MIS for some standard reports (such as distributions) but is also available for use with external reporting tools.
- **DesignHr.** The DesignHr table is used to archive traffic count data for the highest, 30th highest, and 50th highest volume counts of the year for each site. This table is only updated when the system is archived.
- **EditFile.** The EditFile is one of the primary Active Summary Tables. This table holds daily traffic volume counts that the user can modify or even change to whatever is desired. However, the actual ATR data cannot be modified through the MIS.
- **TCArchive.** The TCArchive table holds the total traffic count for each site for each year archived and the number of hours of data that were recorded. The Average Annual Daily Traffic (AADT) can easily be calculated from these data. This table is only updated when the system is archived.
- **TempSum.** The TempSum table is used by the MIS during the rebuild operation. As it is a system file, it is erased often and should not be used as a source of data.
- **SumArch.** The SumArch table holds a list of the names of the archived MainSum tables. The actual archived tables are found under the DOHARCH alias. This table is only updated when the system is archived.

The DOHARCH Alias

The DOHARCH alias is used by the MIS to point to the archived versions of MainSum tables for previous years. These tables, in addition to the Archive Data Tables found in the DOHSUM alias, are updated only when the system is archived. When an archive operation is performed, these Archive Data Tables are created from the Active Summary Tables. The MIS then empties all data from the Active Data and Summary Tables to prepare for the new active year.

The DOHSYS Alias

The DOHSYS Alias points to the data tables used internally by the system to make the MIS work. These tables should NEVER be directly modified or else the MIS may cease to function.

The system tables and their use are listed below:

- **VerLog.** As ATR files are uploaded to the system, their filename and date of upload attempt are written to the File Verification Log (VerLog). The status of the upload is also recorded, to identify whether or not the file is in repair status.
- **DAWAVC.** The DAWAVC table is used by the MIS to interpret the data blocks read from the ATR file. The data blocks differ depending upon the type of ATR (AVC100 or DAW100) that collected the data, and this table is used to process the blocks according to ATR type. This table should NEVER be altered, or else the system WILL NOT be able to upload ATR files.
- **ClrList.** The ClrList table holds the names of the tables that the MIS will empty when the archive operation is complete. This table should NEVER be altered, or else the MIS will be unable to archive the data properly.
- **Rules.** The Rules table holds the parameters for the user-defined rules that can be used to filter data, either with the MIS itself or with an external reporting tool.

- ***TMGClass***. The Traffic Monitoring Guide (TMG) functional classes are stored in the TMGClass table. These classes can be used to categorize data for reporting purposes.
- ***UsrClass***. The UsrClass table holds the user-defined site classifications for the MIS (as created in the User Defined Classes Editor).
- ***SiteRef***. The SiteRef table holds the site reference information (as shown in the Site Reference Editor).
- ***AVC100***. The AVC100 table holds the calibration header information: date, site, hour, and name of text file holding the calibration data extracted from the ATR file for non-WIM sites. The calibration data are generated by the ATR itself once per month, so only the first calibration block encountered for that site in that month will be stored; the remaining headers for that particular month will point to the same file.
- ***DAW100***. The DAW100 table holds the calibration header information: date, site, hour, and name of text file holding the calibration data extracted from the ATR file for WIM sites. The calibration data are generated by the ATR itself once per month, so only the first calibration block encountered for that site in that month will be stored; the remaining headers for that particular month will point to the same file.
- ***AVCTemp***. The AVCTemp table is used by the MIS during certain upload and query operations. This is a system file and should not be used.
- ***UpdSet***. The UpdSet table holds the upload settings for the MIS.
- ***GenSet***. The GenSet table holds the general system settings for the MIS.
- ***RebSet***. The RebSet table holds the rebuild operation settings for the MIS.
- ***StUpSet***. The StUpSet table holds the start up settings for the MIS.

- **TOD.** The MIS organizes the summary data by four times of day: morning, afternoon, evening, night. The TOD table contains the starting and ending hours (numbered 0-23) for these divisions.
- **FHWA.** The FHWA table records when the most recent FHWA #3 card, #4 card, and #7 card reports were generated.
- **FCFields.** The FCFields table is also used by the MIS to interpret data blocks read from ATR files and should NEVER be altered, or else the MIS WILL NOT be able to upload ATR files.
- **AVC100Tmp.** The MIS uses AVC100Tmp to create the AVC100 table. It is a system file and should not be used.
- **DAW100Tmp.** The MIS uses DAW100Tmp to create the DAW100 table. It is a system file and should not be used.

IV. WV DOH MIS Output

In addition to the database structure maintained by the MIS, several text outputs are generated as well. The majority of these text files are in simple ASCII format. Some are in what is called Comma Separated Values (CSV) format so they can be easily imported into other database or spreadsheet applications. Additionally, the histograms produced by the Distribution reports are saved as Windows Bitmap files (BMP). The output files can be organized into five groups: log files, FHWA reports, standard reports, editor reports and additional factors data.

Log Files

The MIS produces log files for each of the major operations of the system: upload and rebuild. The log files catalog the progress of each operation, including successes and errors. New log information is always appended to the files, so when the files become too large, the MIS divides the log file into smaller files. The division begins with the earliest text and continues through the most recent, with each file being given a filename that begins with a two letter designator for the applicable type of log ("UP" for Upload Log, "RB" for the Rebuild Log), some numbers to ensure uniqueness of filename, and an extension that indicates the file division (for example, "002" for the second division of the log file). The appropriate log files are stored in the Upload and Rebuild path locations specified in the system settings. The log files can be viewed by the MIS itself, through the Upload and Rebuild Log Viewers, or through any text editor, such as Windows Notepad or the DOS Editor.

FHWA Reports

The MIS produces FHWA #3, #4, and #7 card reports as per the Traffic Monitoring Guide. See Appendix B for the complete format of each of these reports. The report files are stored in the Report path location as specified in the system settings. Each report is given a name with the following format:

- the first two characters correspond to the postal abbreviation of the state (e. g. "WV")
- the next two characters correspond to the year of collection of the data (e. g. "96")
- the extension describes the type of report ("VOL" for the #3 cards, "CLA" for #4 cards, and "WGT" for #7 cards)

The reports can be generated for a date range specified by the user, or they can be created for the entire year. Please note that these reports could take considerable time to generate, so generate them only as needed. If an error occurs during the generation of any of these reports the MIS will create an error log file to describe the problem. The log files are located in the Report path and have filenames that begin with "FHWA," followed by the type of report ("#3," "#4," or "#7") and an extension of "ERR." The report files themselves will most probably be too large to view with small text editors, such as Windows Notepad, but can be viewed with Windows WordPad or Microsoft Word. The error files are small and can be viewed by any text editor.

Standard Reports

The WV DOH MIS provides the following standard reports:

- ***Distributions of Data:*** vehicle class, speed, and volume data can be compiled into distributions of varying bases
- ***Peak Hour Report:*** for each site, the hours of the given data year in which the highest, 30th highest, and 50th highest volume counts were recorded

- ***Class Reports:***
 - ***Membership By Class:*** a listing of each ATR site and its site classification; the user can select the Traffic Monitoring Guide (TMG) class or the user defined class as the basis
 - ***Volume By Class:*** breaks down total vehicle counts recorded by class membership; the user can select the TMG class or the user defined class as the basis
- ***Day By Hour Report:*** total volume data for each ATR is broken down by day of week and by hour of day

For now, let us consider all of the standard reports excluding the Distribution reports. All of these standard reports can be saved (the save option is in a pop-up menu activated by clicking the right mouse button) in CSV, or Comma Separated Values, format. In CSV format, each value in the table is enclosed in double quotes and separated by commas, and individual rows of the table are on separate lines. These files can be imported into any database or spreadsheet application that supports the CSV format, such as Microsoft Excel.

The Distribution reports have two sections: a histogram that appears at the top of the form and a table that appears at the bottom of the form. The histogram can be saved (again, via the pop-up menu called by the right mouse button) as a BMP file that can be viewed in any graphics editor, such as Windows Paint. From the graphics editor it can be copied and inserted into any word processing application that supports pasting of bitmap images, such as Microsoft Word. The data in the table can be saved in CSV format and then imported as described previously.

Both types of reports are saved in the directory pointed to by the Report path location found in the General Settings.

Editor Reports

The MIS Edit File Viewer can create CSV formatted reports of any data that can be shown in the viewer. The save option (via right mouse click) will create the CSV file and store it in the Report path location.

Additional Factors Data

The MIS can generate the data used by the WV DOH Additional Factors Microsoft Excel Macro developed by the WVU IMSE department. The data file is created in the Report path location. Its filename begins with "AFF" followed by the two-digit active year and ending with the "CSV" extension. The file can be imported directly into the macro itself, with no intervention on the behalf of the user.

Ad Hoc Reports

Additionally, the MIS provides the capability of creating custom reports with ReportSmith 3.0. These reports can be run from within the MIS program, giving quick access to user defined views of the traffic data. However, ad hoc reports should be created by running ReportSmith from outside of the MIS program, as the runtime version used by the MIS program is limited in capability.

V. WV DOH MIS Program Organization

The WV DOH MIS program is comprised of a main form and several child forms. The main form is responsible for showing the appropriate child forms based on the user's input. The user's input is received through the speed buttons and through the menu choices of the main form. Each child form is shown in *modal* state. The modal state prevents the user from clicking on anything outside of the current active form until it is closed. The modal state was used to control user navigation and protect the sensitive database operations.

The entire program is compiled into an executable with the filename "WVDOH1.EXE" in the "MIS\SOURCE\MAIN" sub-directory. A description of each form and its unit file is given below. The source code for each of the unit files described below can be found in the "MIS\SOURCE" sub-directory.

CAUTION: It is VERY important to make a backup copy of any source file before accessing it directly; otherwise, future revisions may be hindered, or even impossible.

WV DOH MIS Unit Files

The code for each form is contained in what is called a *unit file*. The WV DOH MIS program is actually comprised of 30 unit files, each controlling a different aspect of the program. A general description of each unit file is given below. Please note that some of the unit file names have a numeric suffix, which was used during development to identify the latest revision. Only the latest revision of each unit is described here. For example, the description of *SOMEUNIT3*

below does not mean that the descriptions for *SOMEUNIT1* and *SOMEUNIT2* were omitted; rather, *SOMEUNIT3* is the latest revision and replaces both of these earlier versions.

The *ABORT1* Unit

The *ABORT1* unit file contains the code associated with the printer Abort dialog box. It is called by every form that has a print capability.

The *ABOUT1* Unit

The *ABOUT1* unit file contains the code associated with the About box shown when the user selects the About item in the Help menu.

The *ADDFAC1* Unit

The *ADDFAC1* unit file generates the additional factors data file to be used with the WV DOH Additional Factors Microsoft Excel Macro.

The *ADHOC1* Unit

The run-time version of Borland's ReportSmith is called from the *ADHOC1* unit file. The run-time version is best used to access previously created reports, as the full functionality of ReportSmith is not available with this version.

The *ARCHIVE1* Unit

The archive operation is accomplished by the *ARCHIVE1* unit file. Specifically, the unit file does the following:

- adds the appropriate data to the DesignHr table
- adds the appropriate data to the TCArchive table
- creates an archive of the MainSum summary table
- empties the tables specified in the ClrList table
- advances the active year

The *DISTSEL1* Unit

The *DISTSEL1* unit file processes the user selection of data distribution for display. The unit file then calls the *DISTVIEW* unit to display the distribution data.

The *DISTVIEW* Unit

Once the user has selected the desired parameters for the data distribution, the *DISTSEL1* unit calls the *DISTVIEW* unit file to actually perform the database query, create the histogram, and populate the data table. This unit allows the user to save either portion of the distribution data (histogram or table), or print the entire form.

The *DOHI* Unit

The main form is contained in the *DOHI* unit file. When the user runs the MIS application, this unit file is called as the main unit. The main unit does the following upon start up:

- loads the Start Up, Upload, and Rebuild settings (in that order)
- spaces the speed buttons on the toolbar
- checks to see if the start up information should be displayed
- checks to see if the rebuild reminder should be displayed

If the user has checked the start up setting "*Report system information on start up?*" the MIS will call the *STARTUPI* unit to show the information. If the options for showing the respective log files are checked, they will be showed automatically after the system information form is shown. If they are not checked, the user can still view the Log Files by clicking a button on the start up information form.

The Rebuild Reminder is displayed when a rebuild has been scheduled in the Rebuild settings. The Rebuild Reminder is shown in blue if the rebuild is scheduled for another day and red if it is for the current day. If it is less than an hour away, it is shown in red and blinking. If the rebuild has been missed, the reminder is shown in gray. The reminder is shown only for ten seconds, then it is removed.

The *EDIT2* Unit

The *EDIT2* unit file allows the user to select a range of records from the Edit File. The user can then either apply the current rule base to these records or view them with the Edit File Viewer. If there are no records found in the range, the user is notified with a message box. If the range is

valid, the unit file marks all of the applicable records and then passes control to either *EDVIEWI* or *RULES1*, depending upon the user's choice of action.

The *EDVIEWI* Unit

The *EDVIEWI* unit file encapsulates the code for the functionality of the Edit File Viewer. When the user exits the Viewer, the GenSet table is notified that the Edit File has been modified.

The *GGCOMMON* Unit

The *GGCOMMON* unit contains the code for common functions used throughout the remainder of the MIS code; namely functions created to copy files and log messages to arbitrary log files.

The *GGSETS* Unit

The *GGSETS* unit contains the constructs for containing the system settings. Each type of systems setting -- general, upload, rebuild, and start up -- has its own type of container defined here so the MIS code can process these settings as a whole, rather than as individual items.

The *LOGMENU1* Unit

The *LOGMENU1* unit file simply provides the menu form shown when the user selects View Log Files from the System Menu.

The *LOGVIEW1* Unit

The code for displaying the Upload Log is contained in the *LOGVIEW1* unit file. This unit is called from both the main form and the Upload Options form.

The *LOGVIEW2* Unit

The Rebuild Log Viewer is encapsulated by the *LOGVIEW2* unit file. It is identical to the *LOGVIEW1* unit file except that it accesses the Rebuild Log rather than the Upload Log.

The *NUMFOUR1* Unit

The form that allows the user to select a range and then generate the FHWA #4 cards is contained in the *NUMFOUR1* unit file.

The *NUMSEVI* Unit

The *NUMSEVI* unit file is identical to the *NUMFOUR1* unit file except that it is used to generate the FHWA #7 card reports instead.

The *NUMTHRI* Unit

The *NUMTHRI* unit file is identical to the *NUMFOUR1* unit file except that it is used to generate the FHWA #3 card reports instead.

The *REBUILD1* Unit

The rebuild operation is accomplished through the *REBUILD1* unit file. The unit file processes the following steps when a rebuild operation occurs:

- load the path information from system settings
- extract the Edit File data from the Volume table
- extract the initial summary information from the Volume table
- build the additional summary information from the MainSum table itself
- build the final summary information
- copy all summary information from the temporary table to the MainSum table
- inform the GenSet table that the tables are up to date (no table modifications)

If the rebuild is in automatic mode, this unit will proceed without prompt from the user. If it is invoked by the user explicitly, or if it is invoked immediately succeeding an upload, the user is asked if this is the correct course of action.

The *REPMENU1* Unit

The *REPMENU1* unit file contains the code for the Report Menu form. The user can select any of the reports that are available through the Reports menu options.

The *RULES1* Unit

The Rule Base Editor is encapsulated in the *RULES1* unit file. The user can edit and activate/deactivate any of the rules with the Rule Base Editor. The rules are then applied by clicking the Edit Traffic Data speed button or selecting the same option in the Tasks menu.

The *RULES2* Unit

The *RULES2* unit file contains the code that actually flags the data according to the user defined rules in the rule base. The progress is updated on the screen as the rules are processed. The user must use the Edit File Viewer to see the results of the rule base application.

The *SITEREF1* Unit

The Site Reference Editor is encapsulated in the *SITEREF1* unit file. The user can modify or view any of the ATR site information with the Site Reference Editor. The Editor is called by selecting the Site Reference Editor option from the System menu.

The *STARTUP1* Unit

The start up information is collected and shown in the start up form by the *STARTUP1* unit file. If the user has specified in the Start Up settings that the Upload and Rebuild Log files should be shown at this time, then the *LOGVIEW1* and *LOGVIEW2* unit files are called.

The *STDSEL1* Unit

The *STDSEL1* unit file contains the code that actually processes the database query and shows the results for the standard reports other than the distribution reports. The *STDSEL1* unit file is called from either the main form, through the Reports menu selections, or through the Report Menu form, with parameters set to reflect the user's choices.

The *SYSMENU1* Unit

The System Menu form code is contained in the *SYSMENU1* unit file. From here the user can select any of the items available in the Systems menu. The System Menu form is called by clicking the System speed button in the toolbar.

The *SYSSET1* Unit

The *SYSSET1* unit file contains the code for the System Settings editor. The System Settings editor allows the user to modify the system settings -- general, upload, rebuild, and start up settings -- at any time. The appropriate system tables are updated when the user exits the form and the rest of the MIS is updated.

The *UPLD2* Unit

The *UPLD2* encapsulates the code for the Upload Traffic Data form. This form allows the user to: change the upload settings, if desired; select a group of files for upload; start and confirm the upload procedure; and access the File Verification Log, Upload Log, or Block Reader.

The *USERC1* Unit

The User Defined Classes Editor code is found in the *USERC1* unit file. The User Defined Classes Editor can be invoked through the System Menu or from the System Menu form that is shown after the System speed button is clicked.

The *VERLOG1* Unit

The *VERLOGI* Unit contains the code used to display the File Verification Log. This unit is called from the Upload Options form.

CHAPTER 6. CONCLUSIONS AND RECOMMENDATIONS

Traffic data form an integral component of WDDOH's decision making process and may be utilized primarily for such purposes as engineering, highway geometry, planning (location and design of highway systems), research (methods of improving highway usage efficiency), safety (design of traffic control systems and accident rates), and statistics (average annual daily traffic). WVDOH has installed ATRs at 51 stations located throughout the state. These ATRs collect traffic volume data (volume, speed, and classification), with some ATRs also collecting WIM data. All data collected are stored in binary format and could only be used to produce the Federal reporting files using software developed by PAT Equipment Corporation, Inc.

A Management Information System (MIS) was developed to easily manipulate and maintain the traffic data so that they can be easily used by WVDOH. Details of the MIS developed were presented in this report.

Several visits were made to the WVDOH offices in Charleston, WV, and several meetings were held with WVDOH personnel to identify details of all the data collected by the ATRs, all information, reports, and statistics to be produced by the system, and the main characteristics desired in the system. A literature review was performed on the subject, and the DOTs of the states of Pennsylvania and Maryland were visited to gain insight on their status of handling the management of traffic data, and the kind of reports they do or like to produce. After the ground work was completed, a complete design of the MIS system was developed and discussed in details with WVDOH personnel before obtaining their approval. The actual development of the system then took place, with close interaction with WVDOH personnel, and was followed by the development of the MIS documentation in the form of a "User's Manual"

and a “System’s Manual, and the implementation of the system in Charleston. Several meetings were held with WVDOH to provide them with proper training, and to modify the system to better meet their needs and to correct it from any “bugs” that were encountered.

The research team recommends the continuation of this effort with the development of another Management Information System to manage the information related to the short term (portable) ATR’s. This information includes location and timing of data collection as well as the data actually collected by these ATRs.

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APPENDICES