APPENDIX A: COMPUTER SOFTWARE FOR TEST VEHICLE TECHNIQUES

This appendix contains documentation for test vehicle computer software that is used to collect travel times. Chapter 3 of the handbook describes the test vehicle methods of travel time collection that can utilize software for automating data collection and reduction. The appendix primarily documents 3 software packages that are used in conjunction with electronic distance measuring instruments (DMIs). At the time of publication, no commercially available software for global positioning system (GPS) equipment was deemed adequate for travel time data collection (although several developmental versions are in the public domain).

Software for Electronic DMI Equipment

Table A-1 summarizes commercially available electronic DMI software and hardware and the corresponding contact information. An attempt was made to evaluate all available hardware and software packages. The following sections provide the reader with an overview of the look, feel, and features of each software package. No recommendation is stated or should be implied. Notes on the ease of use and problems were observations of the drivers and opinions and experiences may vary.

Software for GPS Equipment

At the time of publication, no commercially available software for global positioning system (GPS) equipment was deemed adequate for inclusion in this appendix. However, several developmental or beta software programs do exist in the public domain. These packages have mostly been adapted to the preferences of individual users and their applications. Many GPS equipment vendors distribute proprietary data logging software with individual units, but this software does not have the flexibility to perform required travel time collection functions such as conversion to a GIS platform.

There are three primary software tasks that are required for performing GPS travel time data collection. Several vendors provide software that is capable of individually performing the GPS software tasks of logging, mapping, and analysis. However, it is still up to the practitioner to decide how to go about setting up the system with the several software tools and vendors available. For example, the data logging software is often proprietary for each GPS receiver vendor. This data must be compatible with the GIS mapping platform that is used (i.e., files must be either in the form acceptable by the GIS software or must be converted). Finally, the analysis package must be capable of analyzing the GPS data that is received. Many vendors provide software that can read the GPS data and compute travel time and speed of positional data along predetermined links. For probe vehicle applications using the GPS data, such analyses need to be performed and reported in real-time. Again, several vendors are currently available that can develop such analysis tools depending upon the needs of the practitioner.

There are also many additional considerations (e.g., the need to purchase an FM signal for differential GPS, the variety of available equipment from different vendors) that are inevitable in GPS travel time data collection. These considerations make it difficult to define a specific software or hardware specification that will be satisfactory for all practitioners. At the time of this publication, a fair amount of research is still required by the practitioner to determine the desirable software and hardware configurations.

Table A-1. Summary of Test Vehicle Software and Contact Information

Product	Hardware Requirements	Program Capabilities	Analyses/Reports	Contact Information
Computer Aided Transportation Software (CATS)	Laptop PC: 386 CPU, 4 MB RAM, 5 MB free hard drive Analysis PC: 486 DX2, 66 MHz or higher, 16 MB RAM 30 MB free hard drive space (for storage) Windows 95 or Windows 3.1 Microsoft Excel Version 5.0+ DMI equipped Vehicle,9-pin RS-232 serial port	Measures distances, speeds, and travel times. Provides access to raw data files. Offers an incident location and identification. System allows driver comments to be saved to run files. Provides an automatic file naming scheme.	Detailed statistical reports Project-level summaries Speed profiles	McTrans, Phone (352) 392-0378 http://www-t2.ce.ufl.edu/mctrans/mct.htm or PC-Trans, Phone (913) 864-5655 http://kuhub.cc.ukans.edu/~pctrans/index.html
PC-TRAVEL	Laptop or TDC-8 data collection board Analysis PC: DOS 2.2+, 512K RAM Hard disk 286 CPU class or higher Vehicle equipped with a transmission sensor	Measures speed, distance traveled, travel time, delay, fuel consumption, and emissions. Offers an incident location and identification system	Study summaries Individual & group run statistics Speed profiles HP LaserJet and PostScript output capabilities	Jamar Technologies Phone (800) 776-0940 or (215) 491-4899 151 Keith Valley Road Horsham, PA 19044
Traffic Analyzer 1988 (TA-88) Moving Vehicle Run Analysis Package (MVRAP)	Laptop PC: DOS 2.1+, 256K memory Parallel printer port Analysis PC: DOS 3.0+, 640K RAM Vehicle equipped with a DMI	TA-88 measures distance, travel time, speed, delay, stops, acceleration noise, and fuel consumption MVRAP analyzes the collected data	Average values of the measure of effectiveness for all travel time runs in a study, Speed profiles	McTrans, Phone (352) 392-0378 http://www-t2.ce.ufl.edu/mctrans/mct.htm
Nitestar Distance Measuring Instrument	not available	not applicable	not applicable	Nu-Metrics Phone (800) 346-2025 or (412) 438-8750 Box 518 University Drive Uniontown, PA 15401
Distance Measuring Instruments Microcomm Software	not available	not available	not available	Advanced Microsystems Phone (800) 628-0575 or (412) 438-7500 654 Pittsburgh Road Uniontown, PA 15401
Microfloat Software	not applicable	not available	not available	Fredric R. Harris Phone (703) 204-6395 Fairfax, VA

1 TA-88/MVRAP Speed and Delay Study Software

Traffic Analyzer 1988 (TA-88) data collection software and the Moving Vehicle Run Analysis Package (MVRAP) were developed by the University of Florida Transportation Research Center for "evaluating the performance of an arterial street in terms of travel speed, delay, fuel consumption, and driver comfort". TA-88 was accessed from within MVRAP in this report, but it can also be used independently.

1.1 Preparing to Use MVRAP

1.1.1 Equipment Required

- laptop computer with at least 256K memory, a disk drive, and a parallel printer port;
- computer for analysis with at least 640K memory, a hard disk, DOS 3.0, and a standard printer;
- vehicle equipped with a distance measuring instrument (DMI) such as the Nitestar by Nu-metrics that was used for this report; and
- cable to connect the printer port to the DMI unit.

1.1.2 Training

All personnel should be familiar with the software and hardware set-up procedure, use of the DMI, and the route being studied.

1.1.3 Configuring Files and Directories

1.1.3.1 Setting Up a Directory and Starting the Program

Set up a directory for the program files. Within this directory, type "MVRAP" at the DOS prompt. All collected data will be stored in the MVRAP directory. Follow on-screen instructions (if any) until the main menu appears (see Figure A-1).

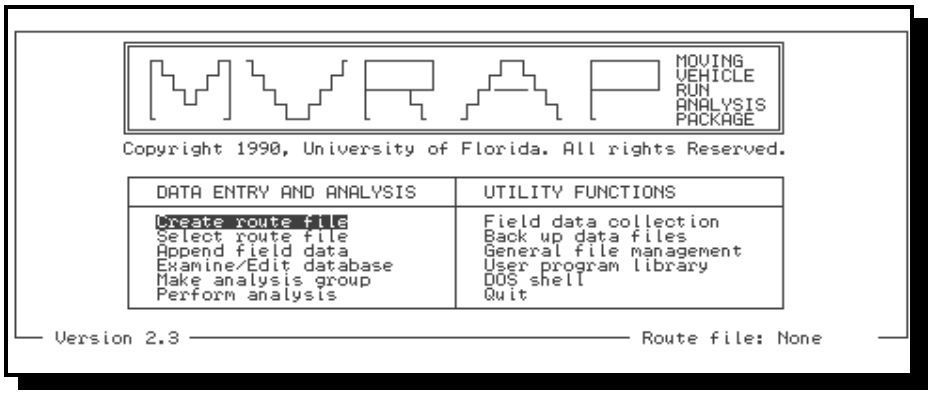


Figure A-1. MVRAP Main Menu

1.1.3.2 Creating a Route Map

Choose "Field Data Collection" from the main menu, using the arrow keys or the F key. Hit ENTER to reach the TA-88 control screen (see Figure A-2). Hit ESC to move from the *Run Description* section of the screen to the *Command List* section and type C for "Create New Route". Type in a name for the new route map. (Note: Route maps names are a reversible pair when they differ only by E and W (for East and West), N and S (for North and South), or 1 and 2.) Then enter the route name and its starting point.

Link lengths (in ft) are entered in the office, but they may also be measured directly in the field on the first data collection run. Link ending points *must* be entered in the office before any data is collected. A maximum of eighteen links is allowed per route. Type CTRL-S to save route data.

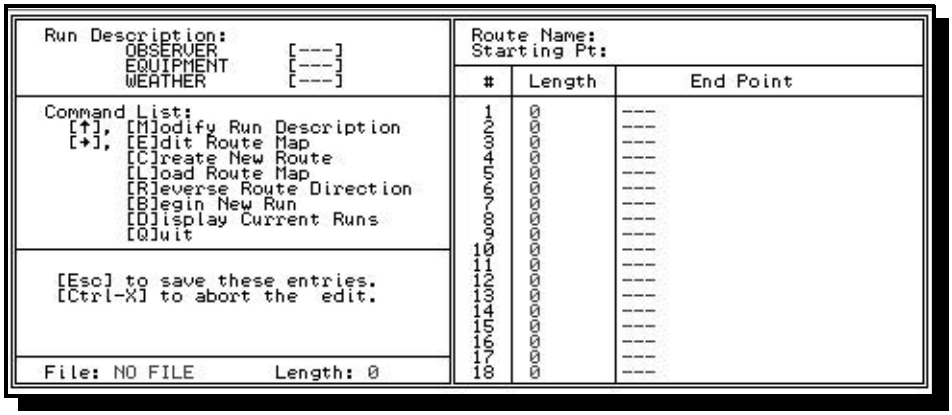


Figure A-2. TA-88 Control Screen

1.2 Collecting Field Data

1.2.1 Loading a Route Map

In the field, run MVRAP and choose "Field Data Collection". At the TA-88 control screen, fill in the observer, equipment, and weather fields with predefined three-letter codes and hit ESC. Type L for "Load Route Map" and select the proper route map. Then type B for "Begin New Route" and begin driving.

1.2.2 Starting the Run, Marking Checkpoints, and Ending the Run

When the vehicle reaches the starting point, hit any key. Hit the space bar at each subsequent link ending point. After marking the last ending point, hit ENTER to conclude the data collection run.

1.2.3 Notes on Data Collection

- If a link ending point is not marked, TA-88 may not save any data for that run;
- Ending points can be marked no more than two percent or sixty feet off the link lengths in the route map file;
- The computer will beep whenever zero distance is traveled in any one-second interval;
- There is nothing on the screen during data collection to indicate that the equipment and software are working correctly; and
- A route map is easily reversed for return trips (provided the naming convention mentioned earlier has been utilized) by choosing "Reverse Route Direction" from the TA-88 control screen.

1.3 Data Analysis

MVRAP will organize all data collection run text files (*.txt) in its database structure. After new data is collected, it must be appended to an existing route database file (*.rdf) or stored in a new one by choosing "Select Route File" or "Create Route File" from the MVRAP main menu. (If a new *.rdf file is created, it must then be selected using "Select Route File".)

- "Append Field Data" must then be selected in order to officially attach new data to the route database file.

- "Examine/Edit Database" allows the analyst to see route map information and a summary of collected run data, with the option to print hard copies of this information. The summary includes travel time, delay, number of stops, fuel consumption, and acceleration noise for each link in the route. (Travel speed is calculated elsewhere.)

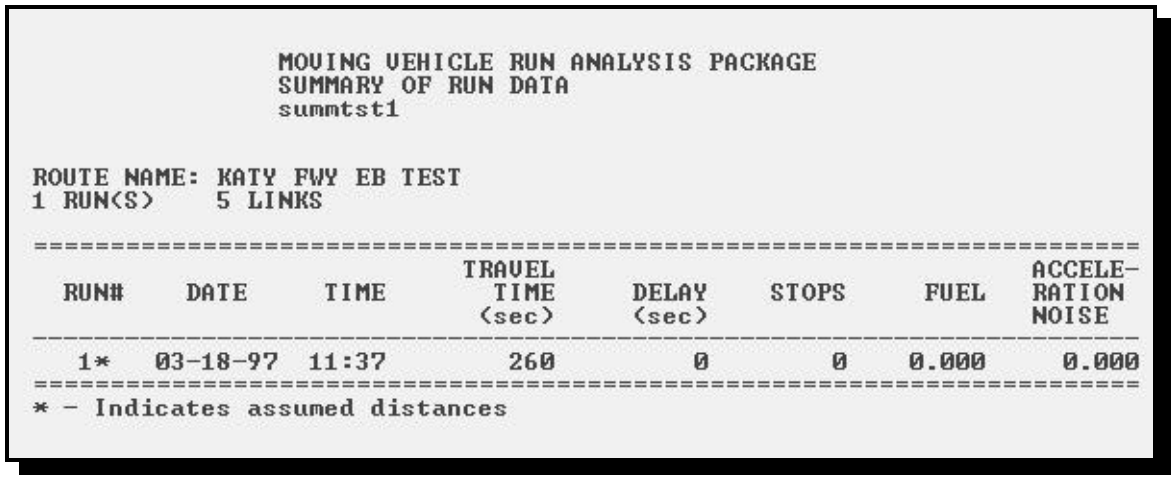
- "Make Analysis Group" allows the analyst to select specific runs from the route database file for different time and date ranges. (Note: To choose all runs in the route database file, press ENTER and move through all the time and date fields. Pressing ESC will not select all the runs.)

- "Perform Analysis" will produce three types of output, printed either to a single file or to the printer:

    - "Summary of Run Data" table with travel time, speed, delay, number of stops, fuel consumption, and acceleration noise data averaged over each run (see Figure A-3);

    - "Evaluation Summary (By Link)" table with the same information as above except that the data is averaged over each link in each run (see Figure A-4); and

    - "Travel Speed Profile" plot of speed vs distance (see Figure A-5).



MOVING VEHICLE RUN ANALYSIS PACKAGE
SUMMARY OF RUN DATA
summtst1

ROUTE NAME: KATY FWY EB TEST
1 RUN(S) 5 LINKS

RUN#	DATE	TIME	TRAVEL TIME (sec)	DELAY (sec)	STOPS	FUEL	ACCELE-RATION NOISE
1*	03-18-97	11:37	260	0	0	0.000	0.000

* - Indicates assumed distances

Figure A-3. Example of "Summary of Run Data" Report

MOVING VEHICLE RUN ANALYSIS PACKAGE
ARTERIAL SYSTEM PERFORMANCE EVALUATION
summtst2

ROUTE NAME: KATY FWY EB TEST
STARTING AT GESSNER AVL
1 RUN(S) 5 LINKS

END POINT	LINK LENGTH (ft)	TRAVEL TIME (sec)	DELAY (sec)	STOPS	ACCELE-RATION NOISE	SPEED (MPH) AVG.	SPEED (MPH) RUN.
BUNKER HILL	1584	30.0	0.0	0.0	0.00	36.0	36.0
BLALOCK	3326	46.0	0.0	0.0	0.00	49.3	49.3
BINGLE	7181	93.0	0.0	0.0	0.00	52.6	52.6
WIRT	4330	54.0	0.0	0.0	0.00	54.6	54.6
ANTOINE	3010	37.0	0.0	0.0	0.00	55.4	55.4
TOTAL	19431	260.0	0.0	0.0	0.00	50.9	50.9

Figure A-4. Example of "Evaluation Summary (By Link)" Report

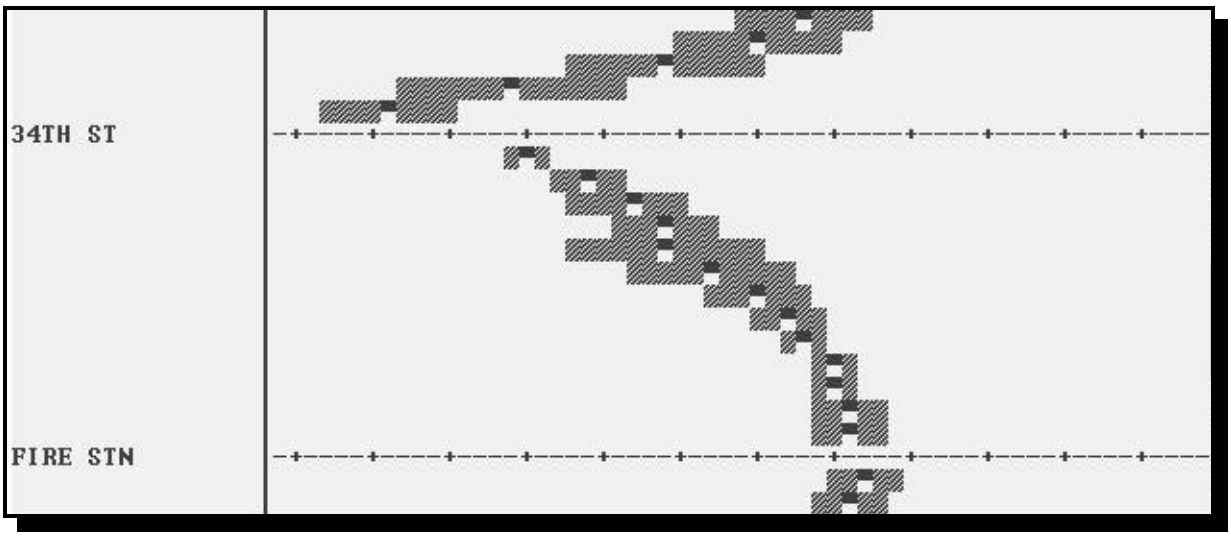


Figure A-5. Example Section of "Travel Speed Profile" Report

1.4 Comments on the Analysis

- All output reports are printed to a *single* file. For separate report files, they must be viewed in a text editor and saved separately there;
- Configuration of screen layout and report layout is extremely limited;
- The program is set up to work with dot matrix printers, although a laser printer was used for this report;
- A limited help file is found only within the analysis portion of the MVRAP program;
- Deleting a file within MVRAP renames it with a .old extension;
- The travel speed profile is plotted at 100-foot increments when the route length is less than 30,000 feet, at 200-foot increments when the route length is between 30,000 and 60,000 feet, and increases proportionally past 60,000 feet. Shading around the plot of average speeds is the 95 percent confidence interval;
- Fuel consumption is estimated from the travel speed profile;
- Acceleration noise is used to measure driver comfort;
- It is possible to tie in a user program library, access a DOS shell, and manage files from within MVRAP; and
- Run adjustments are also possible, in order to better fit run lengths to route data or take into consideration variations in DMI units.

2 PC-TRAVEL

PC-TRAVEL 2.0 is a "computerized travel time and delay analysis" software package developed by Jamar Technologies, Inc., to acquire and analyze speed and travel time data. It also provides "a completely flexible data presentation system," and operation is "simple and intuitive." Both fixed-route and chase car studies can be accommodated.

Jamar's TDC-8 traffic data collection board was used in this report, but a laptop computer may be substituted in the field as noted throughout.

2.1 Preparing to Use PC-TRAVEL

2.1.1 Equipment Required

- IBM-compatible computer for analysis, with at least 512 KB RAM and a hard disk (a four-hour run will require about 30 KB of memory);
- Epson or other IBM-compatible printer (designed originally for dot matrix, but Hewlett Packard LaserJet and PostScript output are possibilities with this version of PC-TRAVEL);
- TDC-8 collection board or a laptop computer;
- Vehicle equipped with transmission/speedometer sensor; and
- PC-TRAVEL (software and hardware such as cables and connections included).

2.1.2 Training

All personnel should be familiar with the software and hardware setup procedure and the route being studied.

2.1.3 Setting Up Files and Equipment

2.1.3.1 Naming Conventions

Set up a naming convention for data files beforehand. It is very difficult to change file names later on, since analysis files refer to specific data files and will not be able to find these data files if their names are changed. The PC-TRAVEL manual describes one possible naming scheme.

2.1.3.2 Incident Descriptions (Optional)

PC-TRAVEL can record incident type and location information. Assign incident descriptions to the sixteen buttons on the TDC-8. (Sixteen more are available when using the BANK 1 key in conjunction with the numbered buttons.) If using the laptop for data collection, only ten incident keys (the number keys) are available.

The templates provided with the TDC-8 can be used as a model to assist the driver in remembering which buttons/keys correspond to which incidents.

2.1.3.3 Setting Up the Equipment

In the office, run "trsetup.exe" in DOS on the analysis computer to configure ports, printer options, display options, fuel and emissions constants, and mouse setup. Type "trav" to run PC-TRAVEL and reach the main menu (see Figure A-6).

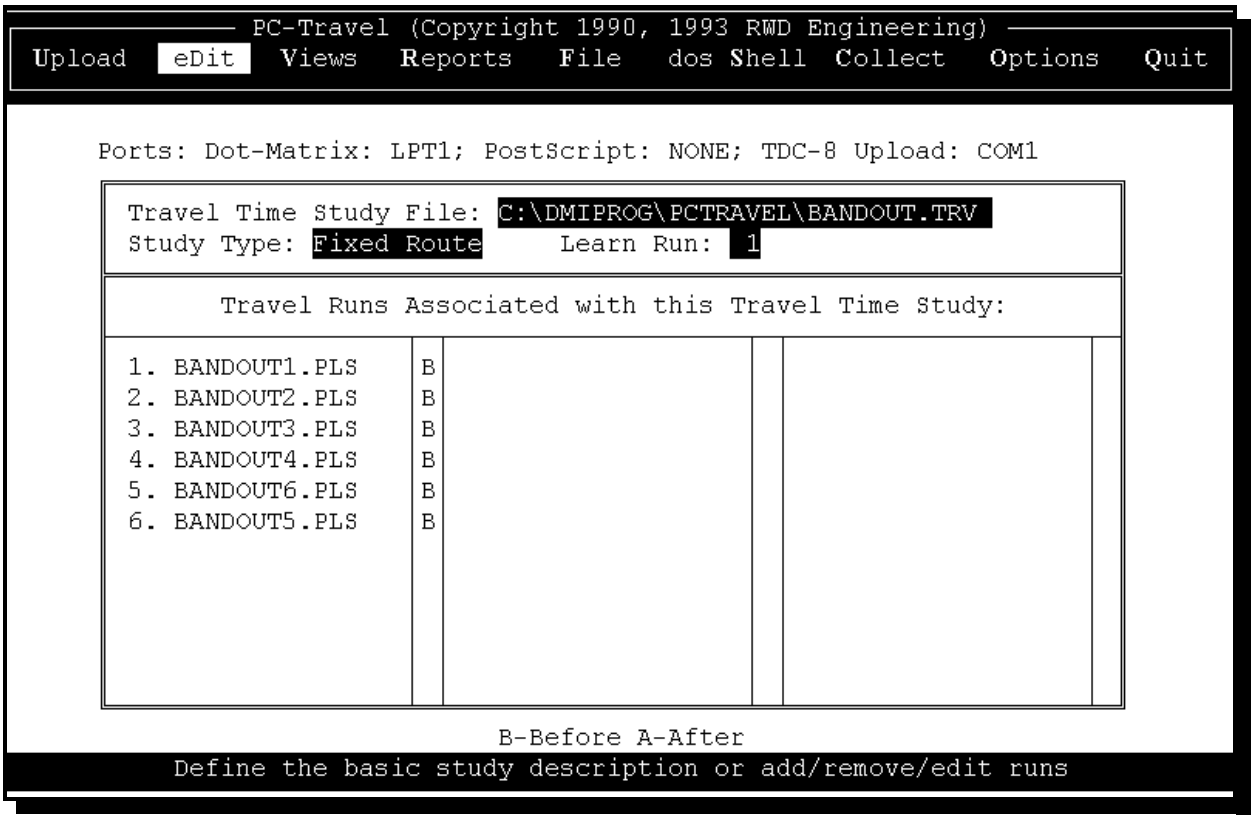


Figure A-6. PC-TRAVEL Main Menu

In the field, connect the TDC-8 (see Figure A-7) or laptop to the vehicle's transmission sensor using the appropriate Jamar cable. If using the TDC-8, connect the push-button switch to "Bank 2" on the side of the TDC-8 to provide an alternate method of marking new links in the study. The AC adaptor that comes with the software package can be used in lieu of the four AA batteries that power the TDC-8.

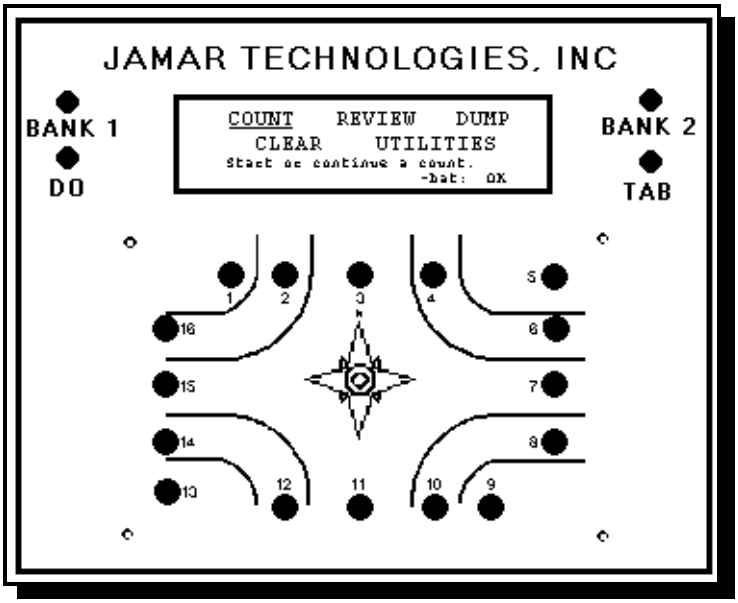


Figure A-7. Diagram of TDC-8

There is no need to predefine a route on either the TDC-8 or laptop. Collected data will be stored in the TDC-8 until manually cleared or (somewhere) in the laptop.

2.1.4 Using the Equipment

2.1.4.1 The TDC-8

The DO button is used to select entries from the display screen menu. The TAB button is used to move from one menu item to another. Pressing buttons 1 through 9 will enter those numbers as digits, and button 10 acts as a zero. The BANK 1 button is equivalent to the SHIFT key.

2.1.4.2 The Laptop

In later sections of this report, to use the laptop in place of the TDC-8, PC-TRAVEL must be running on the laptop. During data collection, utilize the following key/button equivalencies:

- DO on the TDC-8 is equivalent to ENTER on the laptop;

- "New Link" or BANK 2 on the TDC-8 is equivalent to the space bar on the laptop; and

- The numbered buttons on the TDC-8 are equivalent to the number keys on the laptop.

2.2 Collecting Field Data

2.2.1 Running the Program

Turn on the TDC-8. If using the TDC-8 with the AC adaptor, the on/off switch will not work, and the unit will have to be unplugged to turn it off later.

2.2.1.1 Calibration

To calibrate the data collection system, select COUNT, then NEW, then TT (for Travel Time Study), and then CALIBRATE from the TDC-8 menu. Enter a known constant by selecting EDIT or measure a new one by selecting MEASURE.

2.2.1.2 Collecting Data

Select COUNT, then NEW, then TT, and then TRAVEL. Choose to enter a site code (maximum of eight digits) or an alpha-numeric site description.

Begin driving. At the start of the first link, hit DO. At the start of each subsequent link, hit BANK 2 or press the push-button switch to indicate "New Link". 32 links are allowed. Press DO again at the end of the last link to end the run. Throughout, press the numbered buttons to mark incidents.

To start another run, press DO at its first checkpoint and repeat the process above.

2.2.2 Notes and Observations on Collecting Field Data

- If calibrating with the laptop instead of with the TDC-8, select *Collect* from the main menu and then "Calibrate System". Follow on-screen instructions, which are similar to those used in calibrating with the TDC-8.

- If collecting data with the laptop, choose *Collect* and then "Run Data Collection" from the main menu. Press ENTER to start the run, use the number keys as incident markers, use the space bar to mark the start of new links, and press ENTER again at the end of the run. Choose "Run Data Collection" again to start a new run.

- Entering a site code or site description is required with the TDC-8. The alpha-numeric site description is very awkward to enter.

- To run different routes out in the field, the site code must be changed before starting each one. The only way to do this is to turn off TDC-8 and restart the run setup from the beginning. "Before" and "After" designations make it unnecessary to enter a new site code before making a return trip, though. These designations can be set under "Edit Run Headers".

- Jamar recommends including "dummy" links at the start and end of each route to minimize the distance errors inherent in using a device that records all data at the *end* of the current second. These can be ignored in the analysis.

- Jamar recommends that links be long enough that it takes more than two seconds to traverse them. This helps to reduce the distance errors mentioned above.

- The TDC-8 indicates remaining battery power and available memory.

- Run length is limited only by available memory.

- The TDC-8 can store up to 4.25 hours of data.

- All measures are in feet and mph.

- To exit from calibration or data collection routines, you must turn off the TDC-8. There is no other way to exit or cancel. This is awkward when using the AC adaptor.

- On-screen instructions are helpful and make the TDC-8 very easy to use.

- Context-sensitive help is available by pressing F1.

2.3 Data Analysis

2.3.1 Organizing Collected Data

2.3.1.1 TDC-8 Data

Connect the TDC-8 to the analysis computer using the provided cable. Turn on both devices. Run PC-TRAVEL on the analysis computer by typing "trav" at the DOS prompt. Select *Upload* from the main menu and follow on-screen instructions.

On the TDC-8, choose "Dump" and "Local" to send data directly to the copy of PC-TRAVEL running on the analysis computer. The data may also be sent via modem.

After the transfer begins, pressing ESC on the analysis computer will abort the upload.

When the transfer is complete, PC-TRAVEL will ask for file names and header information. The file name must be entered correctly now because it will be very difficult to change it later without invalidating current analyses.

All information will remain stored in the TDC-8 until specifically cleared, so the data can be uploaded again if necessary.

2.3.1.2 Laptop Data

In the directory that PC-TRAVEL is run from on the laptop, up to 32 temporary run files can be created. Before these files can be used, their data must be "finalized" by selecting *Collect* and then "Finalize Field Data" on the main menu.

2.3.2 Creating and Modifying a Study

A "study" is a collection of data files for a particular project. Select *File* and "Get Study" from the main menu. If a new study is being created, type in the new study name. Otherwise search for an existing study. Study files are merely lists of run file names, and they have a *.trv extension.

Under the *Edit* menu, select runs to add to the study. These will have a *.hdr extension. There are options to delete the run data, edit run headers, edit link lengths and names, and change the study type between fixed-route and chase car.

Under "Edit Run Headers" (see Figure A-8), selecting one run in a study as the "primary" run will use its link lengths as the basis of comparison in all the other runs. Type in incident marker button descriptions and the three speed threshold values for the primary run and they will apply to all other runs as well. Alternatively, select the option for user-defined lengths after link names are typed in under "Section Names and Lengths" (see Figure A-9). These will apply to all runs in the study.

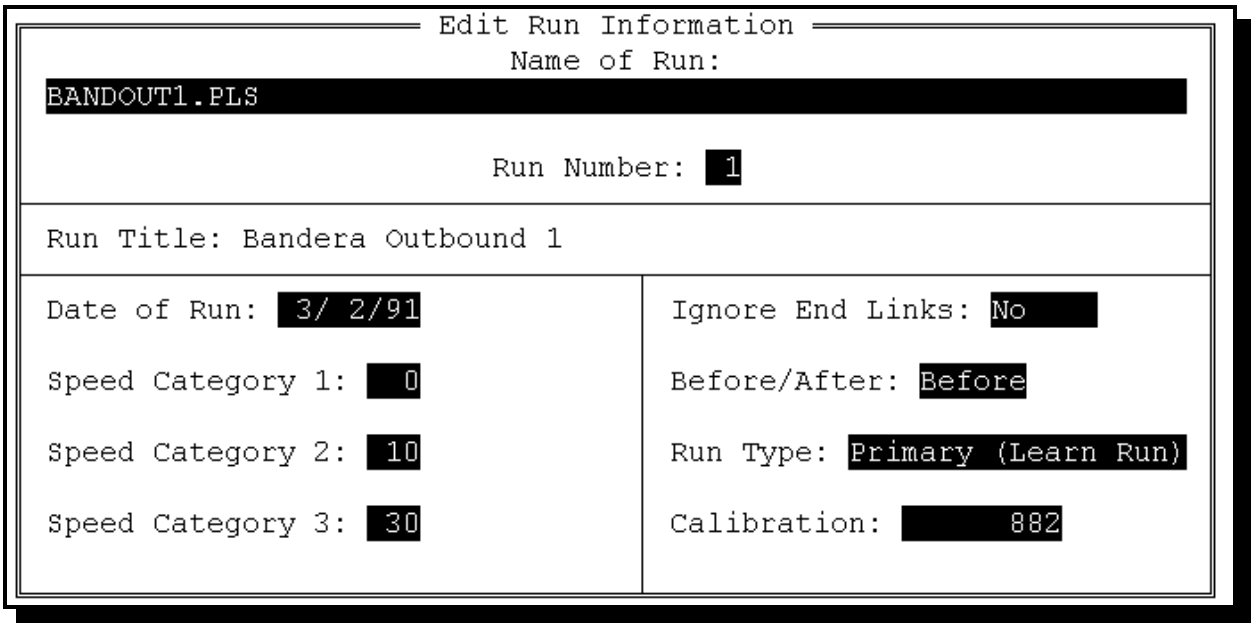


Figure A-8. "Edit Run Headers" Screen

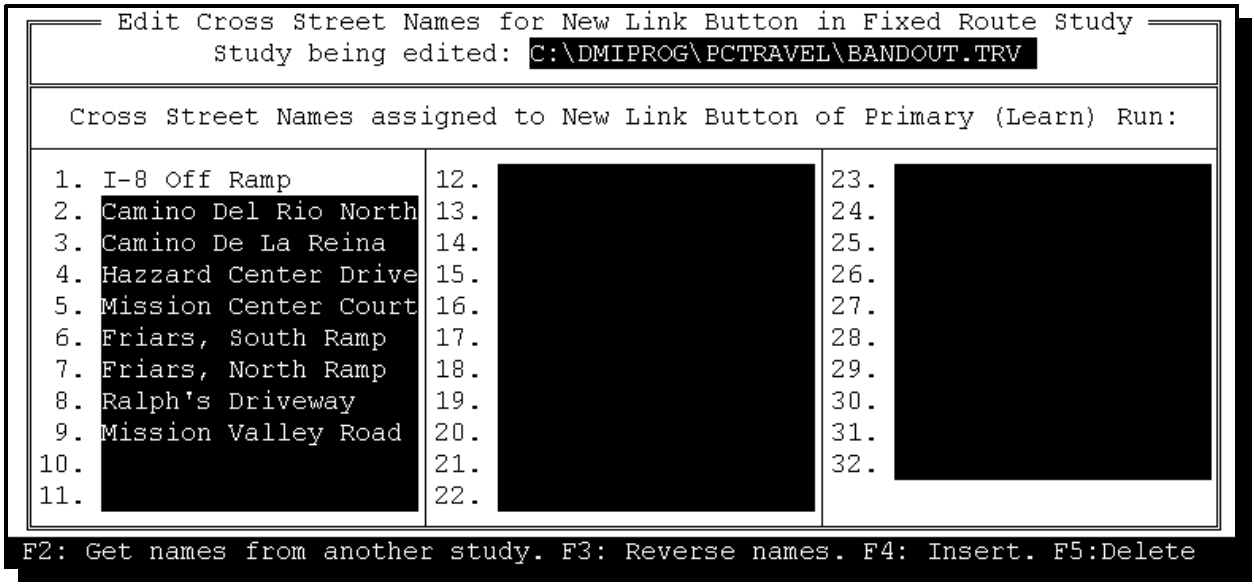


Figure A-9. "Section Names and Length" Entry Screen

2.3.3 Analyzing the Data

2.3.3.1 Available Analyses Under the Views Menu

These are all viewed on the screen:

- Quick Summary (which provides a summary of travel time, stops, speed, and time below the three threshold speeds for all runs; see Figure A-10);
- Speed Profile (which is a plot of speed in mph vs. distance in feet for each run in the study; see Figure A-11); and
- Run Statistics (which is a report like the quick summary, but for a single run; see Figure A-12).

Summary of Study

Travel Study File: C:\DMIPROG\PCTRAVEL\BANDOUT.TRV

Section #	1	2	3	4	5	6	7	8	9	10	11
BEFORE Number of Before Runs: 6											
Travel Time	14.3	40.3	64.5	46.0	33.8	0.0	0.0	0.0	0.0	0.0	0.0
Stops	0.0	0.5	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Speed	38.1	27.9	27.5	37.4	45.8	0.0	0.0	0.0	0.0	0.0	0.0
Time Below:											
Speed 1	0.0	4.3	10.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Speed 2	0.0	8.0	14.3	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Speed 3	2.0	19.3	25.5	6.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
AFTER Number of After Runs: 0											
Travel Time	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stops	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Speed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Time Below:											
Speed 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Speed 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Speed 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PgUp/PgDn/Esc

Look at a short summary of the travel study

Figure A-10. Partial "Quick Summary"

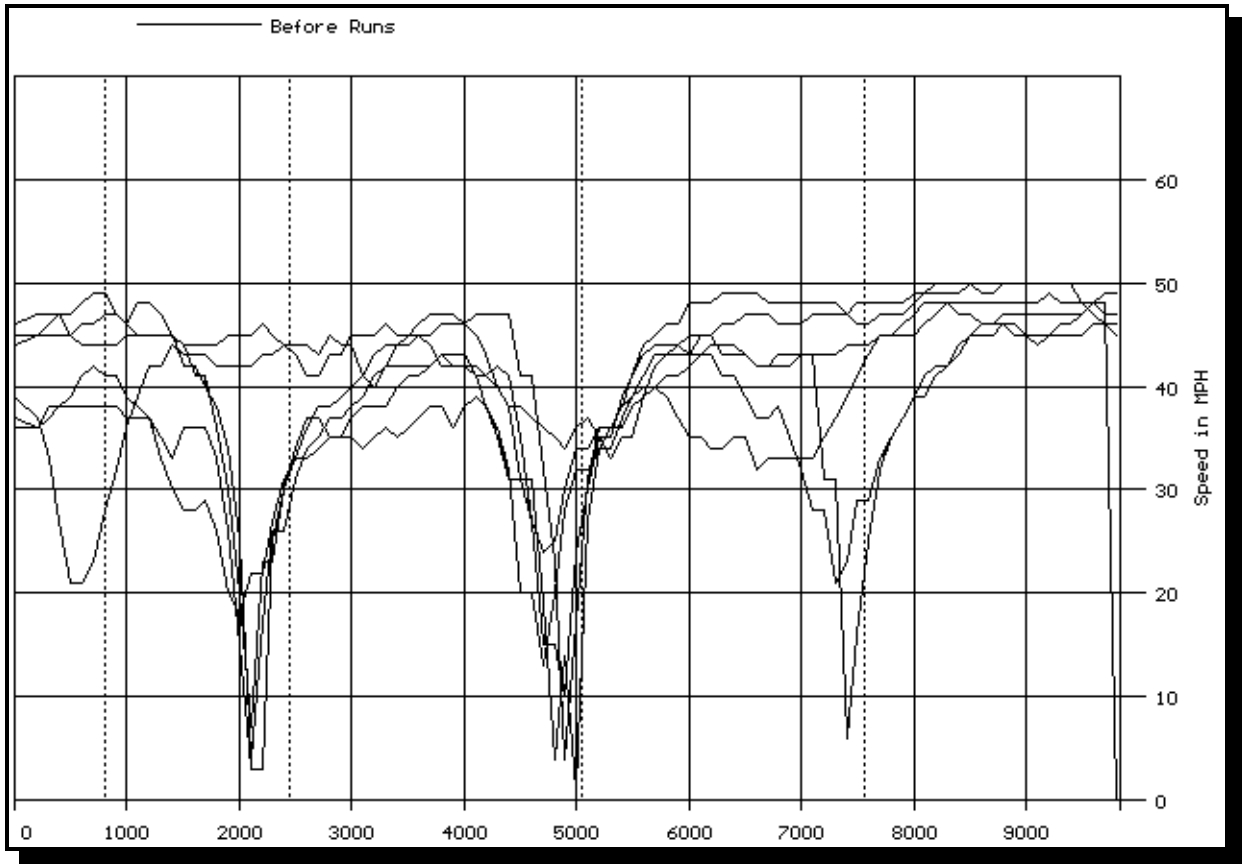


Figure A-11. "Speed Profile"

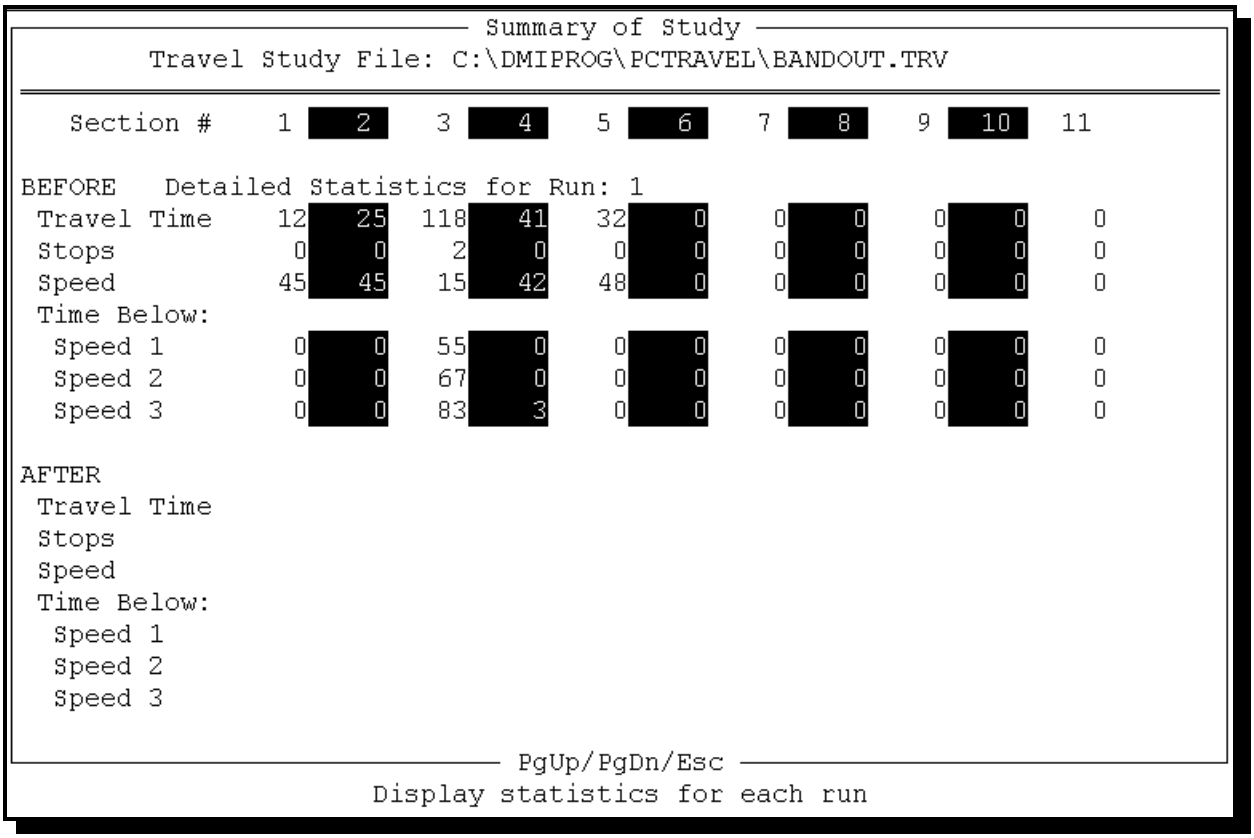


Figure A-12. Partial "Run Statistics" Report

2.3.3.2 Available Analyses Under the Reports *Menu*

The first four reports are printed directly to the printer configured in "trsetup.exe". (This version of PC-TRAVEL will print to an HP LaserJet where the menu options describe dot matrix output.) The fifth report prints to a comma-delimited .txt file with the same name as the study. The printing options are:

- Quick Dot Matrix (which is the Quick Summary from the *Views* menu);
- Complete Dot Matrix (which includes the Quick Summary, Speed Profiles, and individual Run Statistics from the *Views* menu);
- Quick PostScript;
- Complete PostScript; and

- Spreadsheet Output (which contains summary statistics for the complete study and each run).

2.3.4 Notes and Observations on Data Analysis

- Raw (second-by-second) data can be accessed only by capturing TDC-8 uploads with a communications program.
- Report and view layouts cannot be reconfigured by the user.
- It is possible to add a run to a study multiple times. Be careful not to duplicate data in this way.
- One run *must* be designated as the primary run in order to assign incident description labels to the data, set speed thresholds, and choose whether or not end links should be ignored in analysis.
- Calibration numbers can be edited with run headers.
- "Delay" is actual travel time minus ideal travel time (the time a run would have taken at the desired speed). The desired speed is set under *Options*.
- Moving about the screen is not always completely intuitive, though it is still fairly easy. Sometimes the name of a run must be selected and sometimes only its number is necessary, the TAB and arrow keys *increment* some fields instead of moving the cursor between them, and some program features are buried within menus and not quick to access.
- Section names and links are reversible.
- Some incorrect entries can force the program to close. If a study has not been saved, it will be lost.

3 CATS

Computer Aided Transportation Software (CATS) was developed by the Texas Transportation Institute to "assist the transportation professional with all phases of corridor-level travel time and speed studies". The software records distances, speeds, and travel times, provides easy access to raw data files, offers an incident location and identification system and a file naming scheme, generates detailed statistical reports, and maintains project-level summaries and output tables.

3.1 Preparing to Use CATS

3.1.1 Equipment Required

- Laptop computer with 386 CPU class or higher, at least 4 MB RAM, and at least 5 MB free hard drive space;
- Analysis computer with 486 DX2 CPU running at 66 MHz or higher, at least 16 MB RAM, and at least 30 MB free hard drive space (large enough to store collected data);
- Windows 95 or Windows 3.1, Microsoft Excel Version 5.0 or higher;
- Vehicle equipped with a distance measuring instrument (DMI) such as the Nitestar by Nu-metrics that was used for this report; and
- Cable for 9-pin RS232 serial port.

3.1.2 Training

All personnel should be familiar with the software and hardware setup procedure, use of the DMI, and the route being studied.

3.1.3 Configuring Files, Directories, and the Program

CATS is made up of two separate program modules: the DMI_READ data collection module and the DMI_ANALYZE analysis module.

3.1.3.1 Setting Up a Project

A project can include up to twenty different roadways. The number of projects that can be set up is limited only by available computer memory.

To set up a project, run CATS from Windows. From the CATS main menu (see Figure A-13), choose **Set Up a Project**. Select *Define Project Parameters* and type in the project name, a directory name, and the path via which project files will be saved.

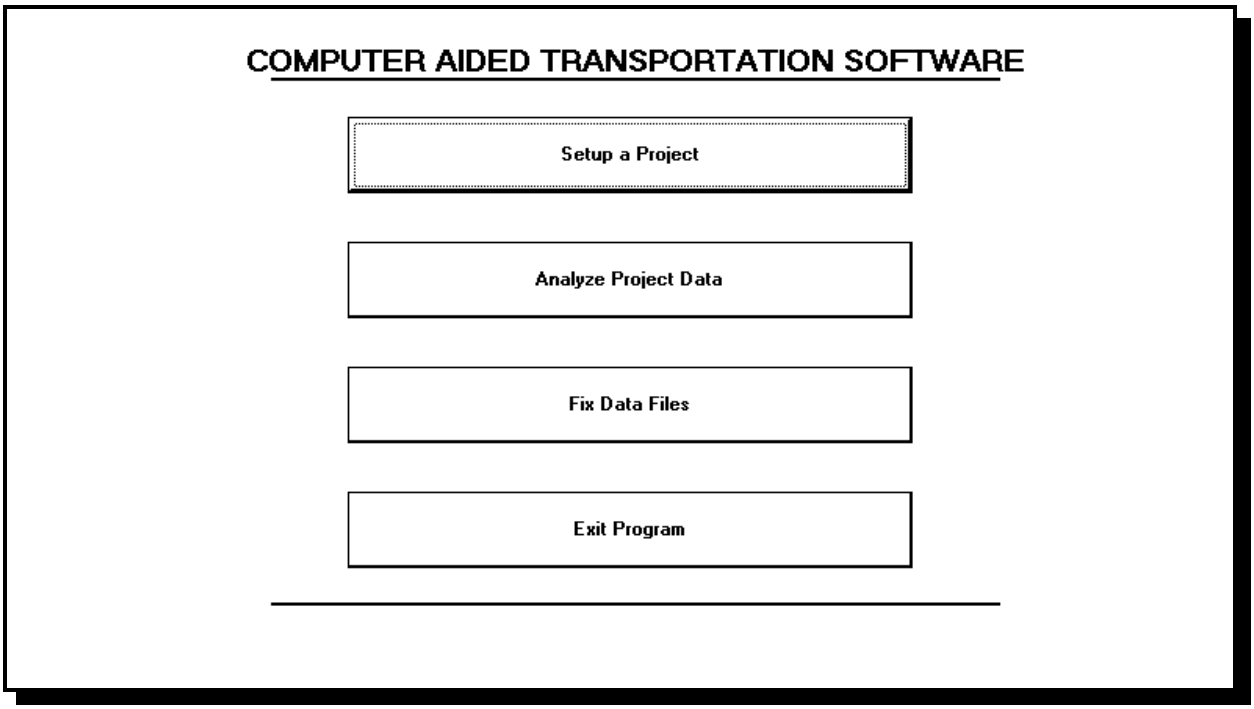


Figure A-13. CATS Main Menu

Then select *Configure DMI_READ Menus* and "Facility Menu Setup Wizard" (see Figure A-14) and type in the roadways that will be a part of the study. Each must have a unique two-character code (for the naming scheme) and an eight-character abbreviation (for a directory name). Valid travel directions must also be entered for each roadway.

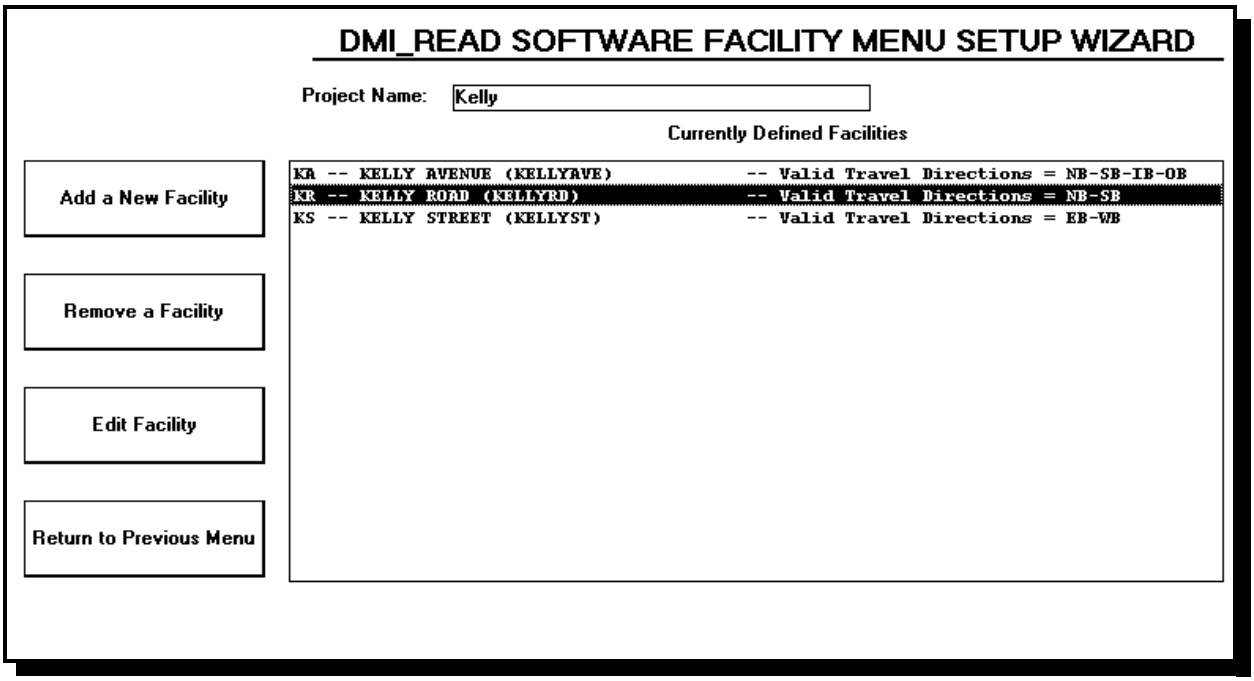


Figure A-14. DMI_READ Facility Menu Setup Wizard

One optional program feature is the ability to assign function keys to the types of incidents (such as stalled vehicles or debris) that might be encountered during the travel time run. Up to 48 incident types can be defined using the function keys, CTRL, ALT, and SHIFT. Incident descriptions are limited to 80 characters (see Figure A-15).

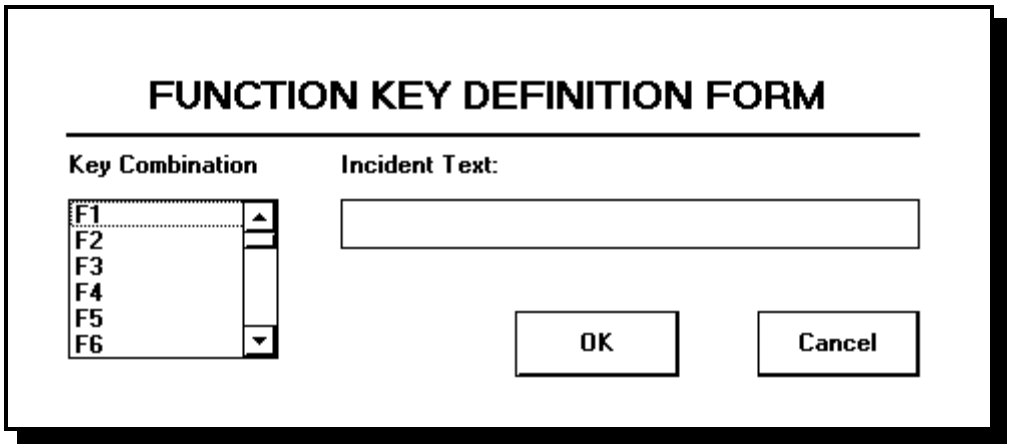


Figure A-15. Function Key Definition Form

A second optional program feature is the ability to include end-of-run questions for the driver to answer. An unlimited number of questions may be asked, but each can be no longer than 80 characters.

A final setup option is the creation of an installation diskette which can be used to install DMI_READ on the laptop used for data collection.

Another required setup element under **Set Up a Project** is *Make DMI_ANALYZE Yardstick Files* (see Figure A-16). Yardstick files contain the segment names and lengths (bounded by "checkpoints") and are compared with collected data in analysis. Up to 55 segments may be defined for a project. The yardstick file may be printed out in the form of a data collection sheet that can be taken into the field to assist the driver in locating checkpoints. This sheet lists the facility name, checkpoint names, identification landmarks, and cumulative distances between checkpoints, and it is printed automatically through Microsoft Excel.

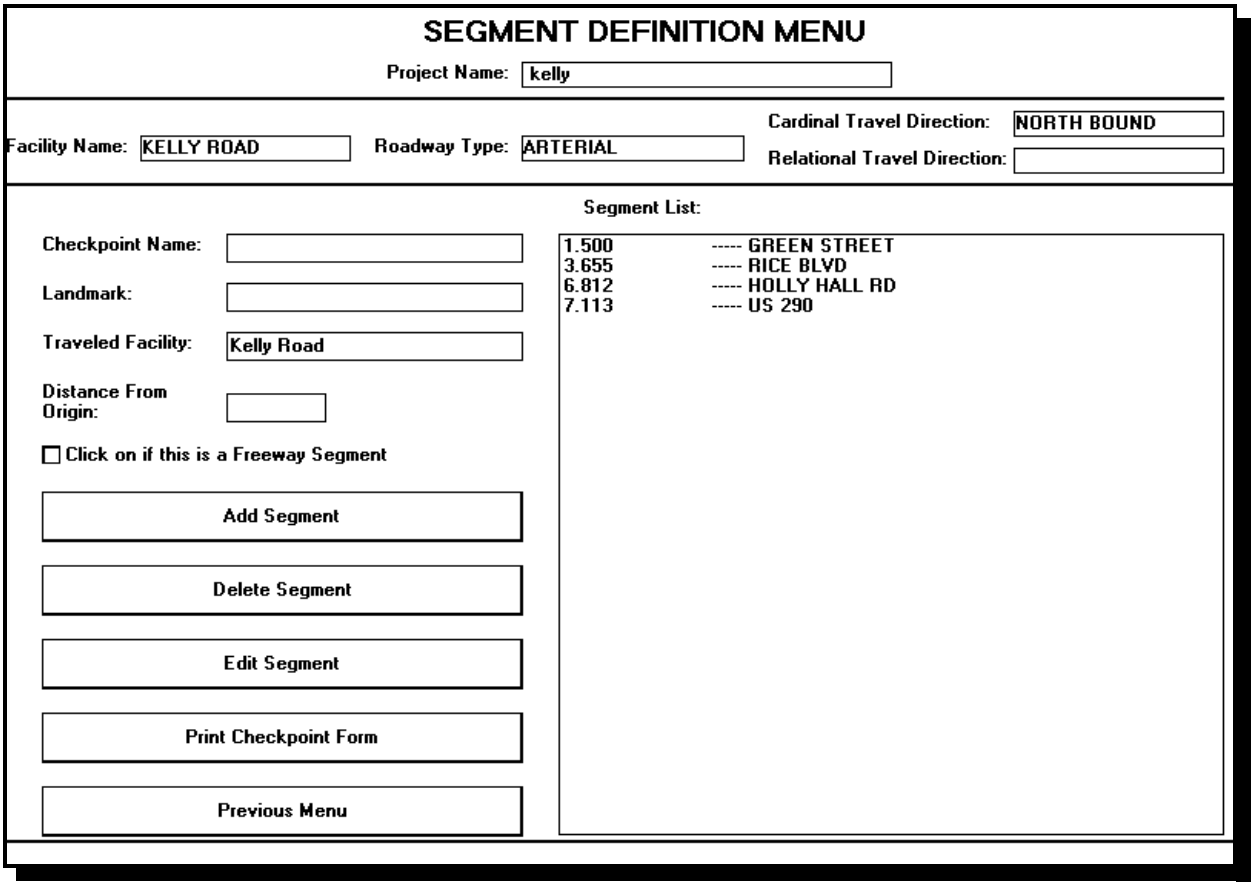


Figure A-16. Segment Definition Menu Under "Make DMI_ANALYZE Yardstick Files"

3.1.3.2 *Notes and Observations on Setting Up a Project*

- Interface is very easy to understand.
- Some input errors, such as entering an incorrect path name, will exit CATS without providing a chance to correct the error.
- The CATS setup routine operates smoothly when it is completed in one sitting. If re-entering the program at a later time to complete the setup of a project, defining the same project parameters will access the previously-entered information. However, CATS tries to create a *new* project whenever project parameters are entered and will say that the file already exists. Exit this screen--the correct project information will be still be accessed.
- Avoid assigning incident types to combinations of function keys and CTRL, ALT, and SHIFT unless absolutely necessary. It is unsafe for a driver to try to use such combinations while driving, so limit incident markers to the 12 function keys individually.
- Space for answers to the optional questions is limited to 80 characters.

3.2 Collecting Field Data

3.2.1 The CATS Main Menu

From the DOS prompt, type “dmi”, or choose the DMI icon in Windows. Follow on-screen instructions to reach the DMI_READ main menu (see Figure A-17).

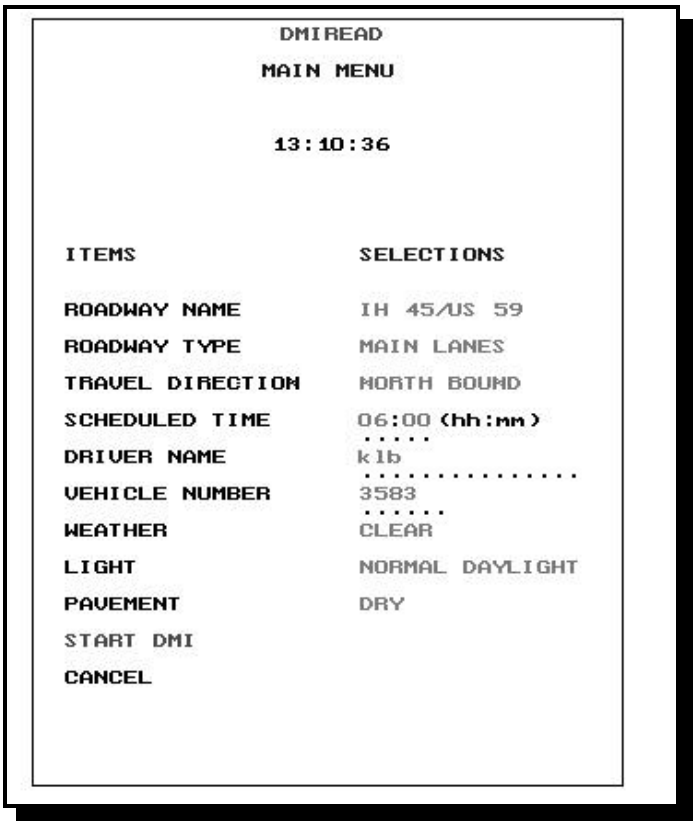


Figure A-17. DMI_READ Main Menu

3.2.2 Starting the Run, Marking Checkpoints, and Ending the Run

Select a user-defined roadway name, roadway type, and travel direction. Type in driver name and vehicle number, and then select preconfigured weather, lighting, pavement condition descriptions. To start the data collection process, highlight "Start DMI" and press ENTER. Data will begin scrolling on the screen in half-second increments, if equipment is set up properly (see Figure A-18).

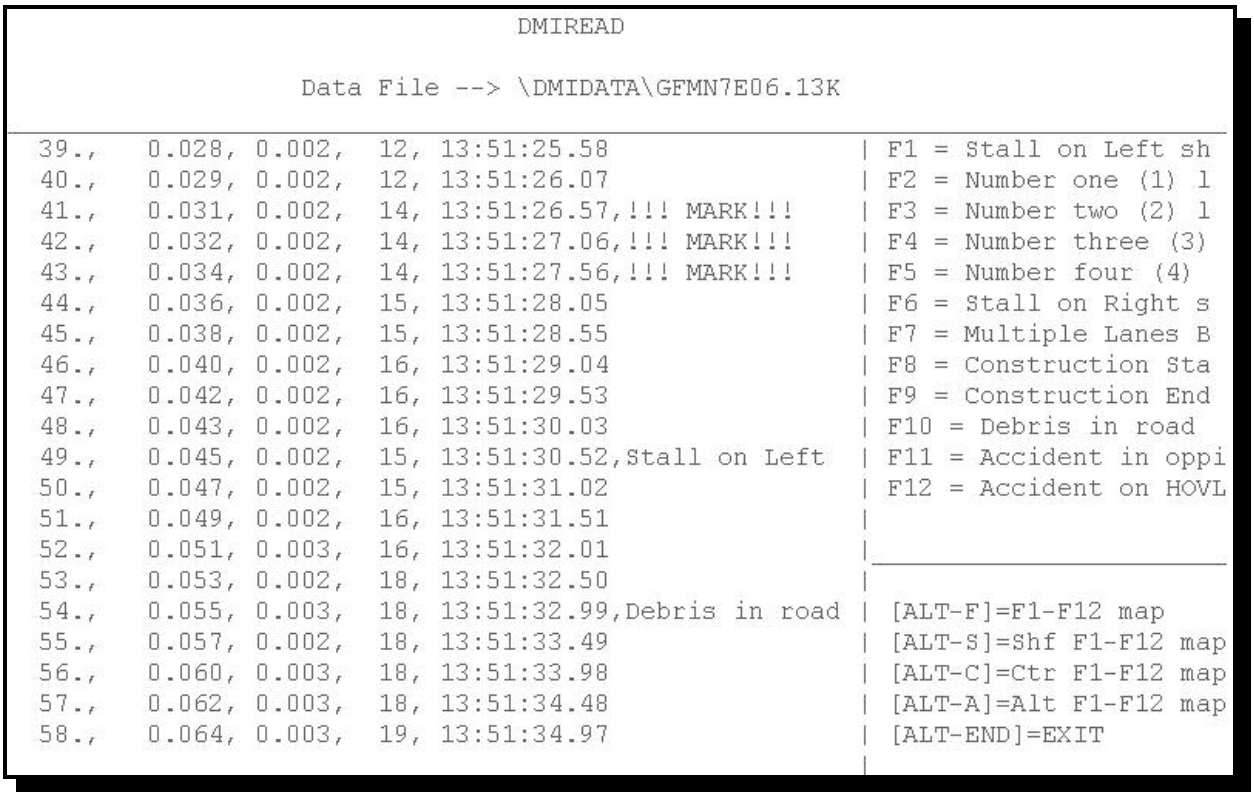


Figure A-18. CATS Display Screen

Hit any key (except function keys) three times when passing the first checkpoint. "!!!MARK!!!" will appear three times in a row on the screen. Hit any key once at each subsequent checkpoint, and choose the appropriate function key to indicate any incidents passed.

To end the run, hit ALT-END. A series of preconfigured questions about the data collection run will follow (see Figure A-19). After answering the final question and hitting ENTER, the program will terminate. Repeat this process for additional runs.

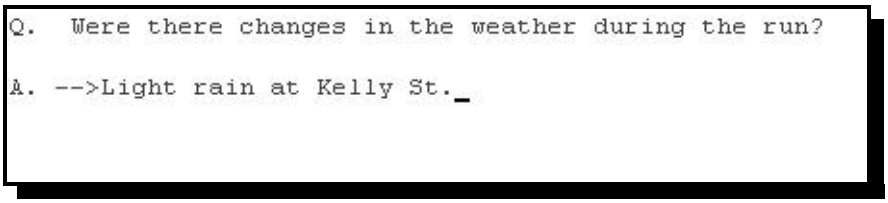


Figure A-19. Example of CATS Comment Questions

3.2.3 Notes and Observations on Data Collection

- The data entered on the DMI_READ menu are used to define unique run file names.
- Constantly scrolling data makes it easy to check that the DMI-reported speeds match those of the speedometer and that the correct function keys have been pressed.
- Ford vehicles traveling at speeds less than eight mph do not send pulses to the DMI, and so stop and delay data may not be correct.
- The roadway names on the data collection sheets printed out from the Segment Definition Menu will exactly match those listed in the DMI_READ main menu to help the driver select the proper project roadway in the field

3.3 Data Analysis

3.3.1 Performing the Analysis

First, all data files must be moved from a subdirectory called DMIDATA on the laptop to the DATA subdirectory under the appropriate project directory on the analysis computer. The raw data is in ASCII format, and an example is shown in Figure A-20.

Run CATS on the analysis computer and choose **Analyze Project Data** from the CATS main menu. This will bring up the DMI_ANALYZE screen (see Figure A-21).

Select one or more of the available analysis options, type in the path to the project directory, and click on "Process Data!!!" to analyze the data. The available analysis options are:

- Convert From Feet to Miles;
- Update Executive Summary (which stores only segment travel time and speed data in the project's EXEC_SUM subdirectory; see Figure A-22);
- Archive Analyzed Data (which stores statistical reports of each file in the OUTPUT subdirectory);
- Plot Speed Profiles (which prints a graph of instantaneous speed vs. distance traveled for each file; see Figure A-23);
- Print Driver Comments; and
- Print Statistical Reports.

After the analyses are finished, completed files are moved to a subdirectory called COMPLETE if the analysis identified no problems or to a subdirectory called PROBLEMS if there was an analysis error. These analysis errors might include incorrect DMI calibration or failure to mark the first checkpoint.

3.3.2 Notes and Observations on Data Analysis

- If any files other than raw data files are in the DATA subdirectory, the analysis will fail.

- Excel is opened and closed automatically by CATS, so close any running copies of Excel before running CATS.

- Other program capabilities include the ability to change calibration numbers and convert units.

```
ROADWAY NAME      : ,EAST LOOP TO I-10
ROADWAY TYPE      : ,MAIN LANES
ROADWAY DIRECTION : ,NORTH BOUND
DATE TODAY        : ,11/21/1996
SCHEDULED TIME    : ,17:30
WEATHER CONDITION : ,OVERCAST
LIGHT CONDITION   : ,DARK OR TWILIGHT
PAVEMENT CONDITION : ,DRY
DRIVER            : ,klb
MILE START        : ,3582
START TIME        : ,17:28:03.64

 79.,  0.396, 0.008,  55  ,17:28:42.26
 80.,  0.403, 0.008,  55  ,17:28:42.75
 81.,  0.411, 0.008,  55  ,17:28:43.24 ,!!! MARK!!!
 82.,  0.419, 0.008,  56  ,17:28:43.74 ,!!! MARK!!!
 83.,  0.426, 0.008,  56  ,17:28:44.23 ,!!! MARK!!!
 84.,  0.434, 0.008,  56  ,17:28:44.73
 85.,  0.442, 0.008,  56  ,17:28:45.22
 86.,  0.449, 0.008,  56  ,17:28:45.72
 87.,  0.457, 0.008,  56  ,17:28:46.21
 88.,  0.465, 0.008,  56  ,17:28:46.70
 89.,  0.472, 0.008,  56  ,17:28:47.20
 90.,  0.480, 0.008,  56  ,17:28:47.69 ,Stall on Right shoulder
 91.,  0.488, 0.008,  56  ,17:28:48.19
 92.,  0.496, 0.008,  56  ,17:28:48.68
 93.,  0.504, 0.009,  58  ,17:28:49.18
 94.,  0.512, 0.008,  58  ,17:28:49.67
 95.,  0.520, 0.009,  58  ,17:28:50.16
 96.,  0.528, 0.008,  58  ,17:28:50.66
 97.,  0.536, 0.009,  59  ,17:28:51.15
 98.,  0.544, 0.008,  59  ,17:28:51.65
 99.,  0.552, 0.009,  58  ,17:28:52.14 ,!!! MARK!!!
100.,  0.560, 0.008,  58  ,17:28:52.64
101.,  0.568, 0.009,  58  ,17:28:53.13
102.,  0.576, 0.008,  58  ,17:28:53.63
<many data points deleted for this example>
3488., 21.718, 0.000,   0  ,17:56:48.91
3489., 21.718, 0.000,   0  ,17:56:49.40 ,!!! MARK!!!
3490., 21.718, 0.000,   0  ,17:56:49.90
3491., 21.718, 0.000,   0  ,17:56:50.39
3492., 21.718, 0.000,   0  ,17:56:50.88
3493., 21.718, 0.000,   0  ,17:56:51.38

Q. ,Were any incidents, stalls etc. observed?
A. ,"yes"

Q. ,Were there changes in the weather during the run?
A. ,"no"

Q. ,Did you observe any major queue build up during the run?  If so at what locations?
A. ,"yes--before cavalcade"

Q. ,Did you need to take any detours?
A. ,"no"

Q. ,Any other comments?
A. ,"construction at I-45/I-610.  construction at main in right lane."
```

Figure A-20.
Example of CATS Raw Data File (Greatly Abbreviated)

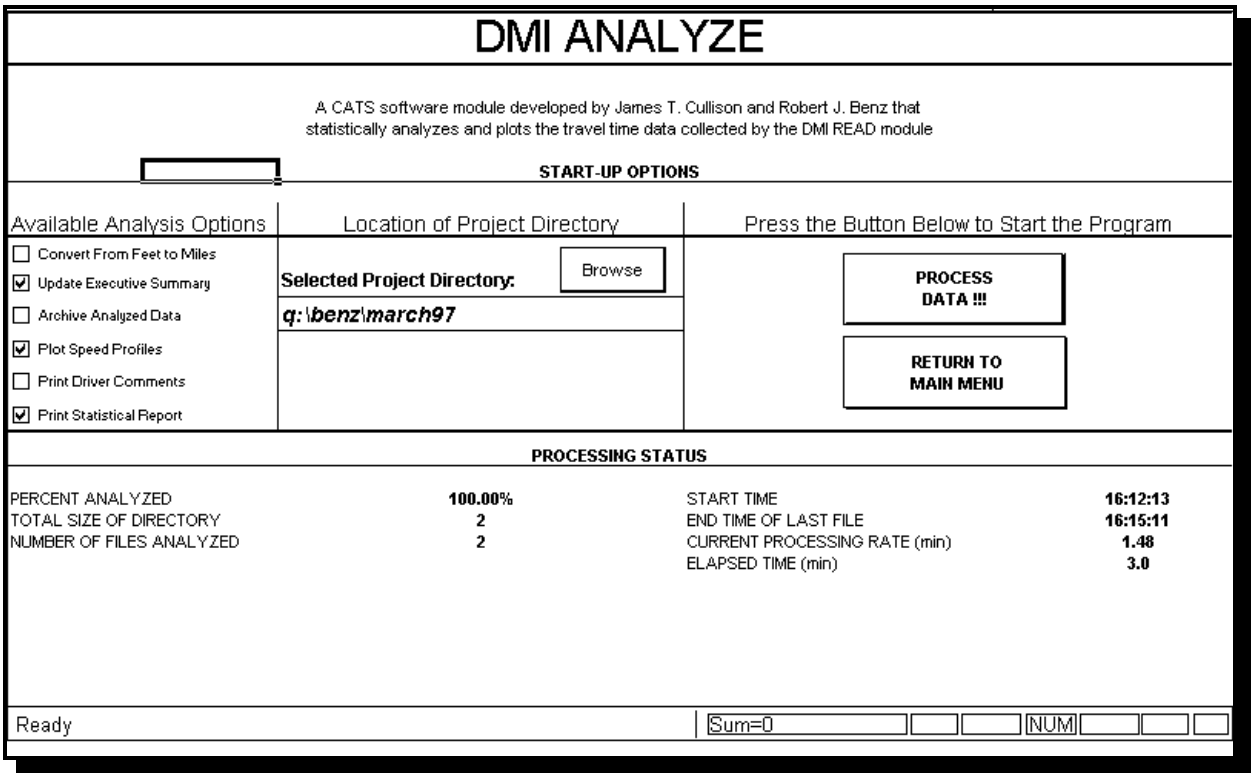


Figure A-21. DMI_ANALYZE Screen

EFME7C18.06L

FACILITY NAME	EAST FREEWAY
TRAVEL DIRECTION	EAST BOUND
TTR DATE	3/18/97
WEATHER	OVERCAST
PAVEMENT	DRY
LIGHT CONDITION	NORMAL DAYLIGHT
SCHEDULED TIME	7:00
START TIME	06:55

CHECKPOINT	INT DIST (miles)	CUMM DIST (miles)	INT TIME (min)	CUMM TIME (min)	STDEV SPEED (mph)	AVG SPEED (mph)	PERCENT TIME UNDER 5 mph	BETWEEN 5-35 mph	BETWEEN 35-50 mph	OVER 50 mph	LEVEL OF SERVICE
MCKINNEY	0.000	0.000	0.00	0.00	-----	-----	-----	-----	-----	-----	-----
TEXAS	0.250	0.250	1.28	1.28	11.49	11.72	46.2%	53.8%	0.0%	0.0%	-----
COLLINS/ROTHWELL	0.610	0.860	1.95	3.23	13.13	18.75	29.0%	67.6%	3.4%	0.0%	-----
EASTEX	0.950	1.810	2.38	5.62	22.45	23.91	36.6%	31.7%	17.6%	14.1%	-----
WACO	1.070	2.880	1.08	6.70	1.93	59.33	0.0%	0.0%	0.0%	100.0%	A
LOCKWOOD	0.670	3.550	0.68	7.37	0.47	59.50	0.0%	0.0%	0.0%	100.0%	A
KRESS	0.480	4.030	0.49	7.86	0.52	59.26	0.0%	0.0%	0.0%	100.0%	A
LATHROP	0.380	4.410	0.38	8.24	0.31	60.16	0.0%	0.0%	0.0%	100.0%	A
WAYSIDE	0.620	5.030	0.62	8.86	0.81	60.19	0.0%	0.0%	0.0%	100.0%	A
MCCARTY	0.460	5.490	0.46	9.32	1.43	59.83	0.0%	0.0%	0.0%	100.0%	A
EAST LOOP	1.210	6.700	1.21	10.53	0.69	59.81	0.0%	0.0%	0.0%	100.0%	A
MERCURY	1.010	7.710	1.01	11.54	1.60	60.29	0.0%	0.0%	0.0%	100.0%	A
HOLLAND	0.880	8.590	0.83	12.37	1.45	63.45	0.0%	0.0%	0.0%	100.0%	A
FEDERAL	1.180	9.770	1.18	13.55	0.61	59.96	0.0%	0.0%	0.0%	100.0%	A
UVALDE	1.670	11.440	1.68	15.23	0.80	59.62	0.0%	0.0%	0.0%	100.0%	A
FREEPORT	0.480	11.920	0.48	15.71	0.89	60.27	0.0%	0.0%	0.0%	100.0%	A
BELTWAY 8	1.480	13.400	1.44	17.15	4.05	61.47	0.0%	0.0%	0.0%	100.0%	A
SHELDON	1.800	15.200	1.55	18.70	0.68	69.73	0.0%	0.0%	0.0%	94.7%	A
CEDAR LANE	1.180	16.380	1.02	19.73	2.18	69.12	0.0%	0.0%	0.0%	95.2%	A
MAGNOLIA DRIVE	1.090	17.470	0.97	20.70	3.52	67.27	0.0%	0.0%	0.0%	81.5%	A
CROSBY LYNCHBERG	2.050	19.520	2.02	22.72	3.88	60.85	0.0%	0.0%	0.0%	100.0%	A
RUN AVERAGES						**51.55**	**8.9%**	**12.2%**	**2.1%**	**75.4%**	

Figure A-22. Executive Summary

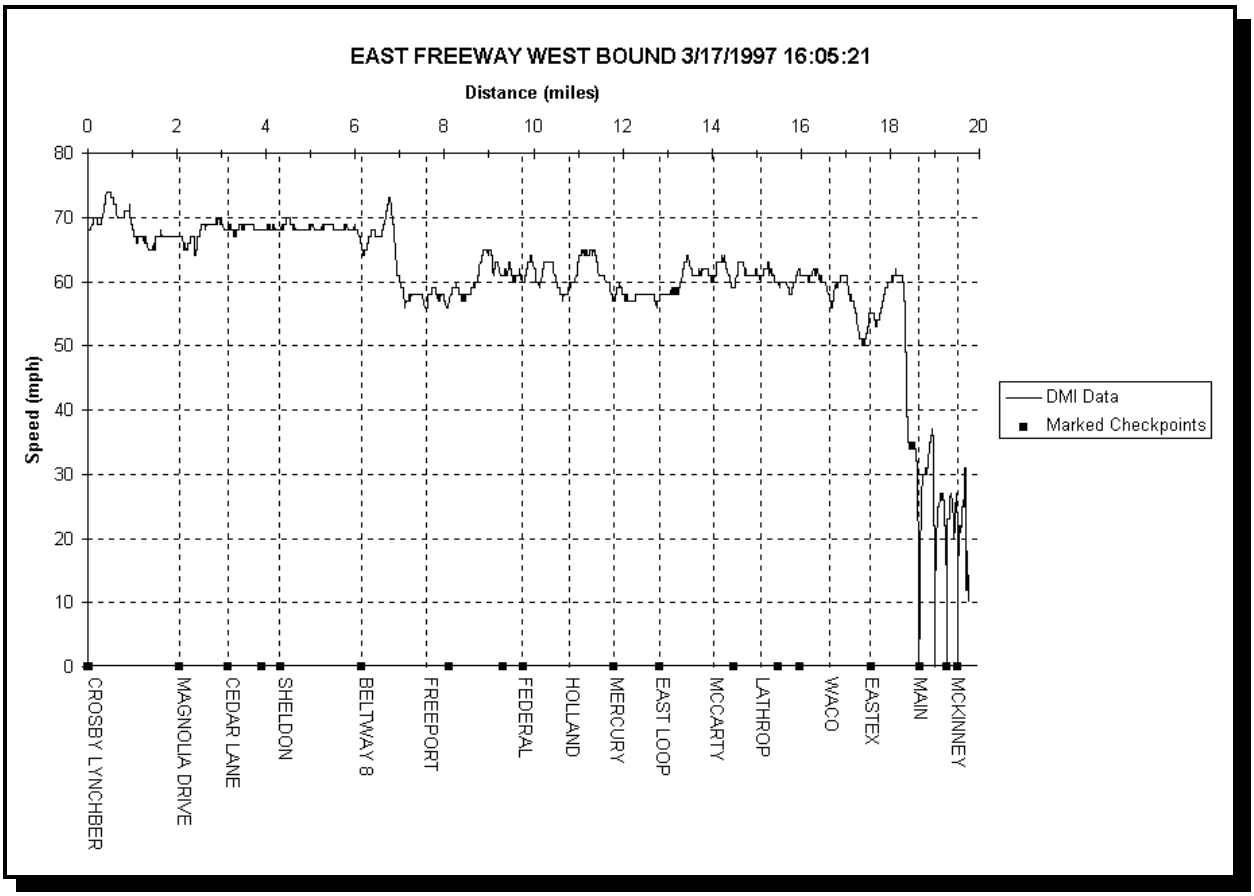


Figure A-23. Speed Profile