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Video Image Processing with the Mobilizer: An Analysis of Travel Time

Nancy L. Nihan, Professor of Civil Engineering

and Christa Crane

Department of Civil and Environmental Engineering
University of Washington
Seattle, Washington 98195

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Department **of** Civil Engineering
129 More Hall
University of Washington, Box 352700
Seattle, WA 98195-2700

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The primary objectives of this study are to determine the accuracy of collecting travel times with the Mobilizer, a video tracking technology, as well as to analyze the travel times for vehicles in the HOV lane along the designated segment of Interstate 5 in Seattle, WA. The data extracted in this study are subjected to two separate analyses: an examination of the accuracy of Mobilizer collected travel times and a general comparison of the travel times for the three separate lanes. The statistical validity of the travel time estimates resulting from Mobilizer analysis are examined by comparing them to the true population travel time results.

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LIST OF ABBREVIATIONS

AGC	Automated Gain Control
AVI	Automatic Vehicle Identification
AVL	Automatic Vehicle Location
CMS	Condition Monitoring Systems
DMI	Distance Measuring Instrument
FHWA	Federal Highway Administration
FOV	Field of View
GP	General Purpose
GPS	Global Positioning System
HOV	High Occupancy Vehicle
ID	Identification
ITS	Intelligent Transportation System
PSRC	Puget Sound Regional Council
SM	System Manager
TN	Track Node
TxDOT	Texas Department of Transportation
U.W.	University of Washington
WSDOT	Washington State Department of Transportation

CHAPTER 1: INTRODUCTION

The primary objectives of this study are to determine the accuracy of collecting travel times with the Mobilizer, a video tracking technology, as well as to analyze the travel times for vehicles in the HOV lane along the designated segment of Interstate 5 in Seattle, WA. The data extracted in this study are subjected to two separate analyses: an examination of the accuracy of Mobilizer collected travel times and a general comparison of the travel times for the three separate lanes. The statistical validity of the travel time estimates resulting from Mobilizer analysis are examined by comparing them to the true population travel time results.

The following chapters will review the current literature, outline the research approach, discuss the results, and offer conclusions and recommendations based upon this study of travel times and the Mobilizer. The literature review includes an overview of the various current strategies for travel time collection. Floating car surveys, license matching plate methods, probe vehicle surveys, inductive loop usage, and video image tracking systems have all been summarized within the literature review. The chapter explaining the research approach has been broken into a description of the data collection process, data analysis methods, and an explanation of the statistical approach applied. Following the outline of the testing procedure used to evaluate the Mobilizer are the results of the Mobilizer evaluation and the comparison of travel times in the three lanes studied. The final chapter consists of the recommendations and conclusions about the Mobilizer and the travel times being experienced along the northbound route of Interstate 5 in Seattle, WA.

CHAPTER 2: LITERATURE REVIEW

Statistics garnered from travel time surveys can be useful for planning, design, and operational studies, in addition to being able to assess alternative improvements. Travel times can also be used to analyze and assess various transportation problems and policies. Various methods and technologies exist for collecting travel times. Older methods include floating car surveys and manual collection of license plate information. More recent methods exist using Intelligent Transportation System (ITS) technologies as well as various forms of video imaging, such as the Mobilizer.

Various methods are currently in existence for measuring travel time data. The most encompassing studies on travel time collection methods have been done in three reports: "Advanced Techniques for Travel Time Data" (Turner), "Improved Method for Collecting Travel Time Information" (Rickman, Hallenbeck, and Schroeder), and the user's guide of "Quantifying Congestion" (Lomax, Turner, and Shunk). "Assessing Vehicle Detection Utilizing Video Image Processing Technology" (Hartmann, Middleton, and Morris) offers short summaries of current detection methods as well as background information about various video image processing systems. Also offering studies of video image processing systems are the Task A and Task F Reports, "Development of IVHS Traffic Parameter Specifications" and "Vehicle Detector Field Test Specifications and Field Test Plan" prepared by the Hughes Aircraft Company.

While it would be impractical to go into great detail about all methods of travel time collection available, an overview of travel time collection methods has been included in this study. The various methods of travel time collection chosen for summary include:

Floating car surveys:

Electronic Distance-Measuring Instruments (DMI's),

Global Positioning System (GPS) receivers;

License plate matching:

Manual Collection,

Lap Top computer;

Probe Vehicle:

Automatic Vehicle Identification,

Automatic Vehicle Location,

Cellular Phone Tracking;

Inductance Loop Sensors;

Video Image Traclung Systems.

FLOATING CAR SURVEYS

The floating car method requires the driver to "float" within the traffic stream, passing as many vehicles as it is passed by. During traffic conditions where counting the passing and passed vehicles is difficult, the vehicle is driven at a speed representative of the average speed of the traffic flow. The driving style and judgment of the driver will effect the recorded travel times (1). Distance Measuring Instruments (DMI's) and Global Positioning System (GPS) receivers are among the various technologies that can be used in conjunction with floating car surveys to increase data accuracy.

Once a test section has been identified, travel time is obtained by starting a stopwatch at the beginning station of the test section and stopping it at the final test

station. The time of travel across the test section is recorded and the test run can be repeated a number of times to determine the overall average travel time. Additional data can be collected by recording the times that the test vehicle passes pre-established checkpoints. Suggested checkpoint locations include: major interchanges, major intersections, jurisdictional boundaries, and transition points between different roadway cross sections or land uses (1). While the number and spacing between checkpoints will vary, mileage can be determined between various checkpoints by the odometer of the test vehicle or by scaling a map of the regional location. Precise locations of checkpoints must be determined to ensure consistent data collection. The same checkpoints should be used for every run of the floating car method to ensure consistent and comparable results.

The following are the advantages and disadvantages of the floating car sweys (1 & 2):

Advantages:

- no special equipment requirements,
- positively identified travel time measurements,
- easy to record travel times between intermediate roadway points,
- ability to record delays or incidents affecting travel time during collection process.

Disadvantages:

- extensive staffing necessary for driving and recording data for a large number of travel times,
- extensive staff time necessary for data transcription,
- cost due to staffing needs,
- difficulty in funding the necessary amount of data collected,

- accuracy problems associated with correctly recording times at checkpoints,
- accuracy of travel times dependent upon the judgment of the driver,
- vehicle characteristics can influence collected travel times.

ELECTRONIC DISTANCE MEASURING INSTRUMENTS (DMI'S)

Electronic distance-measuring instruments (DMI's) have been integrated into the floating car method. The equipment necessary to conduct a travel time survey using the DMI method include: driver, vehicle, electronic DMI, and data collection sheets for easy data recording. The DMI is an electronic instrument that when attached to the test vehicle's transmission receives a series of pulses from the transmission. The frequency of the pulse series transmitted is directly related to the distance being traveled by the test vehicle. The DMI translates the pulses into an equivalent distance. Distance measurements are much more accurate than an odometer with proper D M calibration **(3).** DMI's can provide instantaneous speeds that can be automatically downloaded to a portable computer. Turner found the following advantages and disadvantages with the electronic DMI's (3):

Advantages:

- improved cost effectiveness and safety,
- decreased time for data reduction and analysis from portable computer,
- detailed travel time and delay information,
- characteristics of acceleration and deceleration calculable.

Disadvantages:

- labor intensive,
- travel times only as accurate as driver's judgment.

GLOBAL POSITIONING SYSTEM (GPS) RECEIVERS

Global Positioning System (GPS) receivers can also be used in conjunction with the floating car technique to automatically collect travel time data. GPS for travel time collection requires a vehicle, a driver, a GPS receiver, a portable computer, and Geographic Information System software for automatically reducing and viewing the collected data (1). GPS uses a satellite system to continuously track the location of a specified vehicle. Receiving device-equipped vehicles can be visually tracked and monitored.

Advantages:

- travel time measurement is actual and not estimated.

Disadvantages:

- large number of probe vehicles required for accuracy,
- public wariness due to privacy issues.

LICENSE PLATE MATCHING

An advantage the license plate matching technique has over the floating car method is that it collects data from the real traffic stream rather than measuring travel time along an arbitrarily selected path at the driver's estimate of the average stream

speed. License plate matching data collection is accomplished by observers noting the license plates of passing vehicles along with the current time on paper, computer, or even into a tape recorder.

MANUAL COLLECTION

At least two people are required for collecting license plate samples. One located at the origin and one at the destination of the roadway under study. The recorders are required to note the passing license plates either into a voice recorder or onto a data sheet. Usually one person is required per lane per location for manual license plate collection studies. Manual license plate collection field data (data sheets or tape recorded results) get matched later in the office by hand or a computer algorithm that processes the collected data. A study by Donald Berry in 1952 determined that manual license plate collection methods require about twice as many hours in the field compared to the floating car method (4).

LAP TOP COMPUTER

To match license plates with the help of lap top computers, data collectors manually enter license plate characters into their computers. Only part of the license plate is entered (usually the first four characters) to decrease the number of incorrect entries as well as to aide the recorder in collecting a large number of plates quickly. This method of collecting travel times costs less than floating car surveys while providing a larger number of travel time runs and offering additional information regarding the traffic stream under observation, i.e. origin-destination information (2).

Advantages:

- large sample sizes per data collection period,

- representative estimate of travel times provided by random sampling,
- speed profiles for study sections available from collection of travel times at small time intervals,
- computer entry more cost effective per travel time run than the floating car technique,
- effective for small amounts of data as well as for very slow moving traffic.

Disadvantages:

- potential data inaccuracy from incorrectly read or matched plates,
- no stopped delay or incident information collected, only overall travel times,
- high initial cost of equipment,
- manual operations have been characterized by unacceptably high rates of error in data collection and processing (5),
- not terribly practical for high speed or extended roadway traffic without extensive through traffic volumes (6).

PROBE VEHICLE

The probe vehicle technique utilizes vehicles in the traffic stream to periodically report vehicle location or speed to a traffic information center. The speed and location can be reported using any of the following methods: automatic vehicle identification, automatic vehicle location, or cellular phone tracking. The probe vehicle technique provides large volumes of travel time information on a real-time basis.

AUTOMATIC VEHICLE IDENTIFICATION

Automatic Vehicle Identification (AVI) systems require an in-vehicle transponder, a roadside unit to identify the vehicle transponder, and a central processing computer system. After a vehicle with a transponder has passed a roadside unit, the information carried in the transponder is transferred to the roadside reading unit. Transponder information ranges from basic vehicle identification to trip information to toll account balances (6). Vehicle positions can only be reported at locations where a roadside detection device has been placed. AVI systems can provide very accurate travel time measurements from uniquely identified vehicles. Unfortunately, the accuracy and reliability of the travel time data is dependent upon the number of transponders in the tr c stream. If a bias exists in the vehicles carrying the majority of the transponders (i.e. commercial vehicles) then the travel times will subsequently carry that same bias.

An AVI study was conducted by the Texas Department of Transportation (TxDOT) to provide travel time information for a 120 mile stretch of freeway (7). affi TxDOT installed AVI systems on the freeway and HOV lane networks in Houston to monitor travel times at intervals 2 to 4 miles long. The information was to be used to evaluate alternative transportation routes and to encourage the use of the HOV and toll facilities in the area.

20-mile sections of various freeways leading into Houston were monitored by approximately 34 AVI reader stations. Electronic tags were distributed by the Harris County Toll Authority, TxDOT, and the Metro Transit Authority. Information on vehicle identification, location, and time were all collected by the roadside readers and then transmitted to the Central Control Facility via modems and telephone lines. The travel time information was formatted and distributed to the various real-time information users.

Advantages:

- real-time travel information collection and distribution by traffic information center,
- error associated with floating car eliminated,
- low operating cost after transponders have been distributed,
- little disruption to traffic during installation process,
- compatible with fleet management or toll collection technology.

Disadvantages:

- high initial equipment costs (readers, transponders, etc.),
- tag acquisition and display required by motorists,
- travel times limited to fixed routes and checkpoints.

AUTOMATIC VEHICLE LOCATION

Automatic Vehicle Location (AVL) permits the location of a vehicle to be known automatically by the use of transmitters carried within the vehicle. The transmitters can determine the vehicle's location at frequent intervals by comparing the location of the vehicle to the location of a fixed reference point, such as a sign post, satellite, or radio tower. Travel times can be calculated from corresponding vehicle location reports.

Various AVL technologies exist: signpost, ground based radio navigation, and global positioning AVL. Signpost AVL systems employ fixed location antennas for tracking specific vehicles along a fixed route. Ground based radio navigation AVL technology uses a radio frequency and receiving towers for position information transmission. GPS utilizes orbiting satellites for continuous location determination via

triangulation. Additionally, differential GPS uses local towers in conjunction with satellites to increase GPS accuracy.

Advantages:

- real time travel information collected at frequent intervals,
- human error eliminated,
- not limited to fixed routes or checkpoints,
- compatible technology with fleet management.

Disadvantages:

- high initial costs ($1000 - $4500 per vehicle),
- 5-10% error in exact vehicle location **(3).**

CELLULAR PHONE **TRACKING**

Cellular phones can be used for evaluating travel times through a geolocation/tracking technique. Geolocation processes locate vehicles using cellular phones within the desired traffic stream via a triangulation method using three or more cellular phone towers to locate the positions of the vehicles equipped with the cellular phones.

Two methods exist for monitoring the location, and therefore the time-difference-arrivals, of cellular phone vehicles. The first method requires cellular phone users to report their locations at designated checkpoints along their route of travel. The second relies on the geolocation system to poll and monitor all the locations of the

cellular phones in use and' disseminate and process all the collected information at a control center.

The Texas Department of Transportation (TxDOT) conducted a demonstration project designed to use cellular phones for traffic condition data collection (8). TxDOT recruited 200 commuters to report traffic conditions and traffic incidents affecting the traffic flow as well as to phone into the control center while passing the designated reporting stations. The operators at the control center recorded the time of day, vehicle identification, vehicle location and any additional information (incidents or accidents causing delay) into the travel time analysis database. Probes completing their commute to and from work were reporting at 3 to 4 mile intervals along a 20 mile corridor. A computer analysis program calculated the travel times and average speeds between the stations.

Advantages:

- minimal installation costs due to cellular phone popularity,
- incident and emergency calls receivable through cellular network and control centers.

Disadvantages:

- large investment to track phone calls at control center,
- tracking limited to cellular phone holders and cellular phone ranges,
- potential public disapproval for privacy concerns.

INDUCTANCE LOOP SENSORS

Wire loops placed in the roadway, acting as inductive units, send a signal to a controller when vehicles pass over them. A study conducted by the University of Washington investigated the methodology of converting raw binary loop data into travel time and speed data (9). Inductive loops are the most common traffic detectors (10). Loops provide data such as occupancy, traffic counts, and vehicle passage. Speed and travel time data can be obtained from dual-loop configurations.

Advantages:

- inductance loop detector popularity.

Disadvantages:

- relatively high loop detection rates (10%),
- installation and maintenance,
- necessity of adjacent loops.

LICENSE PLATE RECOGNITION

Video imaging for license plate recognition systems is more limited than regular surveillance systems. Surveillance systems can be used for multiple lanes and to detect incidents as well as performing volume and capacity counts. License plate recognition systems require one camera per lane. License plate recognition systems utilized for HOV enforcement may require up to three individual cameras per lane.

License plate recognition systems use video imaging to search for the license plate within the field of view (FOV). Detectors alert the recognition system of the presence of a vehicle. Once a vehicle has been detected the license plate recognition software searches the video image for the license plate. After the license plate has been

located, the image is "frozen" and saved. If the system is being used for enforcement, many times the license plate image is obtained before the violation is detected. Only the images associated with violations need to be kept for processing and the rest can be overwritten.

Until very recently, video imaging was a high cost means of monitoring traffic flows. However, the Federal Highway Administration (FHWA) funded a project to combine the television camera with the video processing technology of the time to identify and track vehicles. Like loop detectors, video imaging functions as a means to collect, analyze, and record various traffic parameters such as: density (vehicles per mile per lane), speed, volume, presence, and queue lengths. In addition to providing real-time measurements, video imaging also acts as a tool for monitoring congestion and as a means of incident management.

Comparatively, video imaging is able to provide more accurate data as well as more traffic flow parameters than inductive loops. Queue presence as well as density tend to be more qualitative descriptions of traffic behavior. Loop detectors provide only a quantitative measurement. Video captures data in real time footage that can either processed into quantitative measurements or viewed in a qualitative capacity Viewing a specific roadway can provide a more "gut reaction" sense of roadway description. "One picture is worth ten thousand words" (11). Many imaging systems are providing thousands of pictures per second.

In addition to the wider range of data supplied, video imaging is also less disruptive to install and maintain. Oakland County, Michigan found their Autoscope video vehicle detection system better than loops because "the freezing and thawing cycles destroy the road surfaces very quickly, especially with pouring raw salt from local salt-mines on the road. The survivability of long loops in this environment was in serious doubt, i.e. it was questionable that they would be able to last longer than a year at a time" (12).

Table 1 : Video Image Processors vs. Inductance Loops

Four Advantages of Video Image Processor over Inductive Loop Detector (13)	
1	Multilane coverage and potential installation and service advantages.
2	Detection Zones on the road are controlled by an operator at a computer terminal and can be changed at any time as dictated by the traffic flow.
3	The Detection Zone can be programmed to detect queues and turn patterns.
4	Additional traffic data (vehicle classification, tracking, incident prediction, visual accident confirmation.

VIDEO IMAGE TRACKING SYSTEMS

The Hughes Aircraft Corporation undertook a study in 1991 to investigate various detector technologies that could be incorporated into Intelligent Transportation Systems (ITS). The study compared current technologies and attempted to establish accuracy specifications for detector installations. Two examples of video image processors tested and summarized are the Autoscope and the Traffic Analysis System.

Advantages:

- potentially low operating costs compared to equipping probe vehicles,
- video usable to verify and respond to accidents/incidents.

Disadvantages:

- technology has not been extensively tested,
- video quality limited by conditions such as fog, rain, snow, darkness, shadows, etc.,
- public disapproval due to privacy issues.

Autoscope collects data such as volume, lane occupancy, headway, single vehicle speeds, and average speeds of all the vehicles over a given length of time. Additionally, Autoscope can report the classification of a single vehicle detection based upon the class of the vehicle length (14). Autoscope reliability is dependent upon camera placement. As with the majority of video image processing systems, the ideal camera location for maximum accuracy is immediately above or adjacent to the roadway under study.

The Tr c Analysis System marketed by Computer Recognition Systems is designed to report the overall mean speeds of vehicles, vehicle lengths, vehicle areas, total number of vehicles surveyed, vehicle density, and vehicle occupancy. The Traffic Analysis System also offers data on a per lane basis such as average speeds, densities, occupancies, and number of vehicles.

MOBILIZER

The Mobilizer is composed of two subsystems: a Track Node (TN) which interfaces with the camera at the roadside, and the System Manager (SM) which processes the TN inputs from one or more cameras. The TN detects vehicles in the camera video and sends the time and location of each vehicle detection (object sighting message) to the SM for processing along with a snapshot for visual verification of freeway conditions (15). Once the detections have been received by SM, they are combined into vehicle tracks by linking the object sighting messages for each vehicle together. The SM calculates each individual vehicle's flow characterization from its track and into output data. Output data is calculated by lane and by aggregation time intervals. Currently, Mobilizer can provide the following data for freeways: speed, density, occupancy, volume, headways, vehicle classification, and acceleration.

When more than one camera location is monitored by the SM, the Mobilizer has been designed to estimate travel times from one camera location to another. At each camera station, vehicles are tracked within the field of view. The Mobilizer gathers its information by taking as many "looks" at each vehicle as possible within the field of view. The information gathered from these "looks" is used to extract details from the physical characteristics of the vehicles being tracked and to create a vehicle "fingerprint" (16). Each vehicle tracked is also given a unique track identification number. The System Manager (SM) compares the vehicle fingerprints from the two locations and will estimate the travel times between them for every match that is found.

HIGH OCCUPANCY VEHICLE (HOV) LANES

Two documents have been used to evaluate the effectiveness of the HOV lane within the study. The first, by Charles A. Fuhs in "High-Occupancy Vehicle Facilities," offers a comprehensive survey of current HOV design, operation, and planning practices. The primary guidelines for HOV lane viability are congestion, travel time savings, person throughput, vehicle throughput, capacity improvement, local and public support, enforceability, cost effectiveness, and physical feasibility (17). Fuhs reports that travel time savings for HOV lane users should be approximately one minute per mile from origin to destination. Five minutes is considered to be the minimum of overall savings. A time savings of eight minutes between the origin and destination is desirable (17).

The "Washington State Freeway HOV System Policy" takes the stance that HOV lanes should offer reliable speeds and travel time advantages to HOV users. The existing policy for the HOV Speed and Reliability Standard is as follows:

> "HOV lane vehicles should maintain or exceed an average speed of 45 mph or greater at least 90% of the times they use that lane during peak hour" (18).

Unfortunately, the WSDOT policy does not specify whether the travelers are to be exceeding 45 mph for at least 90% of their trip, the entire system is supposed to be exceeding 45 mph 90% of the time, or whether any segment of the roadway is supposed to perform at 45 mph 90% of the time during peak hour.

CHAPTER 3: RESEARCH APPROACH

DATA COLLECTION

Data collection occurred on the afternoon of Thursday, April 30, 1998 during afternoon peak period travel times. The day was chosen for its perfect weather conditions: sunny with light winds. The Mobilizer is still being tested for dependability in inclement weather and less-than-ideal visibility situations such as fog, rain, snow, dawn, and dusk.

Although an hour of data was collected, only the fifteen minute period between 5:18 and 5:33 p.m. will be discussed. The sites chosen for data collection of travel times were two overpasses overlooking the northbound lanes of Interstate 5 in Seattle, WA at 130'' and 145th streets. The site location overpasses cross the interstate at right angles and offer a direct view of the lanes below while being inconspicuous to the traffic under observation. Figure 1 shows the map location of the test sites. Figures 2 and 3 show the freeway sections as seen from the camera fields of view. The section of freeway has five northbound lanes: four general purpose lanes and one HOV lane. Only the three outermost lanes were chosen to be studied due to the field of view restrictions of the camera.

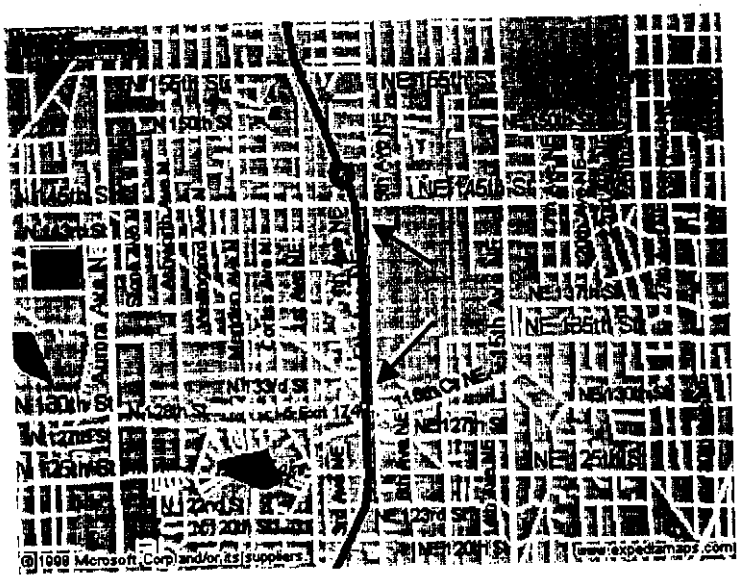

Figure 1: Study Site Location

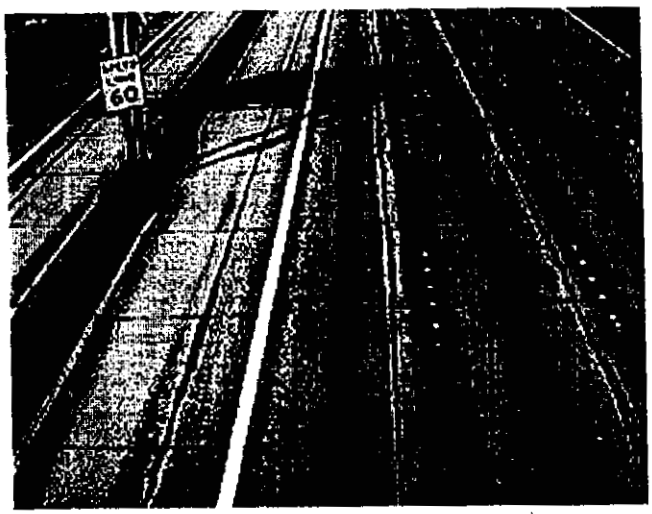

Figure 2: Field of View at 130th St. Location

Figure 3: Field of View at 145th St. Location

The sites were chosen for the following attributes:

- HOV lanes,
- calibration marks on the roadway,
- overpass at approximately 90 degree angle with sidewalks,
- unimpeded view of roadway below overpass,
- adjacent overpass sites.

Calibration Marks

One of the notable features about the two camera locations were the pavement section joints within the camera fields of view (FOV's) below the overpasses. These dark lines showed up on the digitized images and provided an excellent calibration reference. The distances between the lines were determined for a previous study and the measurements were retained and reused (16). The calibration lines provide an essential component for the Mobilizer analysis since length is one of the most important vehicle characteristics. Mobilizer gathers the most information during the initial "looks," therefore having closely spaced calibration marks at the beginning of a field of view is recommended. For this reason the raised pavement markers within the roadway were used as well as the pavement section joints for improved data accuracy.

Automated Gain Control (AGC) Region

The desired feature that is missing from the collection sites is an Automated Gain Control (AGC) region. An AGC region compensates for both sudden changes in background conditions and general shifts in gain. Sudden shifts in background conditions are caused by changes in the general lighting conditions, usually due to moving cloud cover and shifting shadows. Cameras utilize gain shift when a big, dark or light vehicle saturates the dynamic range of the camera. Without gain shifts all

that would remain in the scene would be large dark or light spots with the rest of the scene completely washed out.

Ideal ACG regions would consist of signs tilted slightly upward, extending above the highest vehicle. These signs could also double as registration points in case the camera needs to be automatically re-positioned by the system. Temporary AGC regions need to ensure that some small portion within the camera's field of view is free from both vehicles and their shadows. Although AGC region placement was attempted for the sites, the AGC regions turned out to cause more problems than they solved and were removed. AGC regions would be necessary for any extended video-imaging usage.

Data were collected using video cameras located at particular vantage points. Video cameras were set up strategically over the center of the three lanes being studied at the overpass locations. The video operators "stamped" the video segments by recording the time of day onto the video via walkie-talkies. Due to difficulties in the accuracy of starting both cameras simultaneously in two different locations, the time stamps allow the time codes on the video segments to be translated into the real collection times during the data processing stage. However, if real time data were desired and the proper equipment already in place, simultaneous real time collection would easily be viable.

The camera was set to record on a manual mode with a shutter speed of 112000. The manual camera mode was chosen instead of an automatic mode to override automatic camera features such as zoom and focus. The manual mode was necessary to keep the focus and gain control constant during the data collection process. The fast shutter speed was appropriate considering the speed of the vehicles being recorded. Because the Mobilizer analysis is based upon the number of "looks" taken of distinct vehicles, the images collected by the video camera needed to be as sharp as possible. A

microphone was included in the camera equipment for recording the audio time stamps relayed by the walkie-talkies between the data collectors in the field.

Radar guns were also used during the data collection to confirm the accuracy of both the collected travel times from the video and from the Mobilizer in all three lanes being studied. During the video taping the radar gun was used to "shoot" speeds of specific vehicles. The speeds and vehicle descriptions were recorded onto the videotape with the microphone. Later on, the vehicle speeds were converted into estimated travel times. The estimated travel times were compared with the true travel times collected.

An hour of video was collected simultaneously from the 130" and 145" street overpasses. A fifteen minute segment taped between 5:18 p.m. and 5:33 p.m. was chosen for the data processing and Mobilizer comparison. The time period included a wide range of flow conditions. The fifteen minute segment was also chosen because it had the least number of buses interfering with the automatic gain control (AGC) region. A restricted amount of memory on the computer being used to run the data limited the data collection to fifteen minutes of video per location.

Only three of the five northbound lanes were studied. Three lanes offer the best field of view for the Mobilizer. The HOV lane was necessary for the study. The two innermost lanes were excluded from the study because of their absence within the field of view as well as the increased likelihood of lane-changing vehicles. The Mobilizer is unable to follow vehicles changing lanes. The two innermost lanes, being closest to the freeway on and off ramps, have the most potential for vehicles changing lanes.

The three lanes studied are referred to as the "right," "middle," and "HOV" lanes, as defined within Figure 4.. The HOV lane is the outermost lane on the left side of the roadway that has been separated from the rest of the general purpose lanes by a wide white stripe. The "middle" lane for the analyses is the lane directly adjacent to the HOV lane. The "right" lane is the third lane from the right, adjacent to the "middle"

lane and two lanes from the HOV lane. Although the roadway is composed of five lanes, only three of the lanes were studied.

Figure 4: "HOV," "Middle," and "**Right**" Lanes

DATA EXTRACTION

Two methods were used to extract the data from the video segments collected. The first was a manual extraction and the second was an automatic extraction

using Mobilizer. The manual method determined the true travel times against which the Mobilizer results were evaluated for accuracy.

MANUAL EXTRACTION

A time code was included on both of the video records to assist in the manual data extraction. An observer watched the fifteen minutes of tape and recorded the times and lanes of all the vehicles within the fifteen minute segments of the tapes. Distinctive marks were chosen on the images of 130' and 145' (the pole and the maintenance hole cover, respectively). Each time a vehicle in any of the three lanes being studied passed the mark, the time was noted. The observer then had to find the same vehicle in the other video segment and record its location and time. The whole process required extensive effort and was extremely time consuming. It was necessary for the viewer to toggle back and forth between the images of both the origin and destination videos. All of the vehicles within the three lanes studied had to be found and matched within the alternate video. It took approximately 24 hours to match the cars in the fifteen minute video segments at their origins and destinations along the 0.625 mile stretch of interstate.

The roadway characteristics were useful for data collection. There is only one northbound off-ramp located right before the 145'' overpass, see Figure 5. Every vehicle that passed through the 130th FOV did not necessarily continue on to the 145' FOV. However, every vehicle that was seen within the 145'' FOV had to pass through the FOV at 130'' Street. All of the vehicles within the 145'' FOV were matched with the same vehicle within the 130'' FOV.

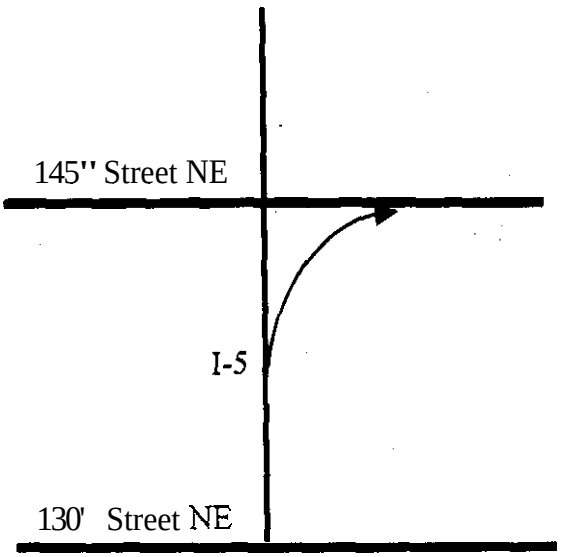

Figure 5: Off-ramp Between 130th and 145th

MOBILIZER EXTRACTION

Two proprietary software diagnostic tools for link time performance analysis were loaned by Condition Monitoring Systems (CMS) to the University of Washington (U.W.) for the duration of this study. The first tool, a non-real-time version of the SM, processes inputs only from a digitized file stored on disk. This tool provides supplementary data in the Mobilizer log files in addition to the output produced during normal system operation with a videotape or camera input. Therefore, for the matching performance analysis, it was necessary to digitize the videotape segments to be studied prior to processing them with the non-real-time SM (20).

As the digitized images are processed, the diagnostic SM tool provides travel time output data and the normal operator displays the outputs. In addition, the log file contains the following information for the matching performance analysis: the unique

track identification (ID) number for each vehicle in both the origin and destination images; the frame number for both the origin and destination image files for the vehicle and its match; and the lane number for both the origin and destination image files for the vehicle and its match. The image files for both the origin and destination are then "browsed" with a second software tool which overlays the track ID number on each tracked vehicle's image. These vehicle images are then checked against the track ID numbers for the origin/destination matches listed in the log files. The matches can be manually checked to determine whether the destination vehicle has been correctly matched with the origin vehicle.

The travel time analysis for the two video segments considered each lane separately. Mobilizer tracks all lane changes and does not include matches for any vehicles that have changed lanes between the origin and destination locations. The system derives a "pure" travel time for each individual lane to allow a comparison of travel times between the various lanes. If the Mobilizer did not consider each lane independently, a vehicle that spent part of its travel time in the HOV lane, for instance, and then part of its travel time in the center lane would confuse the data for both of the lanes.

Another reason for analyzing one lane at a time for this segment of video with the Mobilizer was due to the large variability of travel times at the beginning of the video segment. All three lanes were running at widely varying travel times and the travel times within each lane changed rapidly at the beginning of the segment. The isolation of each lane provided the Mobilizer with start up conditions closer to a steady state.

To begin the travel time estimation process the Mobilizer must derive an initial starting condition for the travel time for each lane at start up. It assumes a steady state and similar flows in each lane for the initial travel time estimation process. Steady state refers to conditions with all vehicles traveling at a constant speed. There is no

stopping and re-starting in any lanes during steady state conditions and differences in vehicle acceleration and deceleration are minute. **A** steady state start up provides several minutes of free flowing data during the initialization process. During steady state conditions the Mobilizer can most effectively begin processing data and can establish the vehicle dynamics before the flow becomes discontinuous. The steady state must last at least as long as it takes for the first vehicles in each lane to travel between the origin and destination. After the system finds the first vehicle match for each lane it can begin to correct the initial estimates, converging on the correct travel time. If the initial conditions are very close to a steady state, the convergence happens quickly. When the initial estimates are far from correct, the estimation process takes a long time to find enough matches to converge; potentially taking longer to converge than the digitized video segment under analysis. Once the system converges, it constantly updates the vehicle dynamics by using previously collected information about the road dynamics.

Due to long convergence times in the segment studied, the start-up error was optimized by analyzing each lane individually. The Mobilizer has not been designed to analyze the travel times of short congested scenes but was designed to operate in real time over long periods of time. Instead of waiting for the Mobilizer to converge on its own, it was found to be more efficient to modify the implementation of the setup parameters within the link time estimation process. Due to the proprietary nature of the Mobilizer, specific parameter descriptions cannot be disclosed. However, the parameter modification gave more flexibility in analyzing the short segments of congested video and did not affect any other system operations (19).

STATISTICAL APPROACH

Reliability of travel time estimates is relative to sample size, the sample's population variance, the statistical confidence level desired, and the error allowed within

the sample (1). A simple random sampling formula was used to test the accuracy of the travel times estimated by the Mobilizer. The formula assumes a normal distribution within the sample size of a known population: the 100% sample obtained from the manually matched video data. The standard deviation of the known, true population was calculated and used to determine reliable estimates of the error within the Mobilizer samples and the accuracy of the travel time data. The Mobilizer was tested for a 95% level of confidence with the following formula (20):

$$N = \left(s \frac{z}{e} \right)^2 \qquad \text{[Equation 1]}$$

Where:

N = sample size needed for the given level of confidence,

s = standard deviation from the tested sample,

z = test statistic constant corresponding to the given level of confidence

(z=1.96 for a 95% level of confidence),

e =permissible error (precision) of the estimate of the true mean.

Additional descriptions of the statistical approach and hypothesis testing have been described in detail within the analysis of the results.

CHAPTER 4: RESULTS

The primary objectives of the study were to examine the accuracy of the Mobilizer for travel time collection as well as to compare the travel times of vehicles in the HOV lane with the general purpose lanes between 130'' and 145th streets. The data extracted in this study were subjected to two separate analyses: an examination of the accuracy of the Mobilizer in matching the travel times for the various lanes and a general comparison of the travel times for the three separate lanes. The statistical validity of the travel time estimates resulting from the Mobilizer analysis was examined by comparing the true population results obtained manually with the Mobilizer analysis of the 15 minutes of traffic observed between 5:18 p.m. and 5:33 p.m.

Three distinct data samples were collected to evaluate the accuracy of the Mobilizer (see Figure 6). The first sample set consists of the true population. The true population travel times were determined by comparing the video segments and manually matching all the vehicles within the camera FOV at the origin and destinations. The second set of data are the original Mobilizer sample matches. The Mobilizer data contains both ''correct'' matches and reasonable matches and are the entire sample produced by the video tracking device. The final set of data is a subset of the Mobilizer output: the ''correct'' matches (again, obtained manually from the video) in the entire batch of Mobilizer matches. The "correct" Mobilizer matches are matches with the identical vehicle within the FOV at the origin and the destination. Excluded from the ''correct'' match sample are the Mobilizer matches with reasonable travel times but that match the origin vehicle with the vehicle preceding or following the match-vehicle at the destination FOV.

The accuracy of the Mobilizer depends upon two assumptions being true: first, that the mean of all the Mobilizer matches are a valid representation of the mean

travel time of the true population; and second, that the mean travel time of the Mobilizer matches are representative of the "correct" Mobilizer match population. For the Mobilizer to be reliable, it is necessary that the Mobilizer data be consistent with the correct-match population. Mobilizer accuracy is based upon the correct Mobilizer matches being a viable subset of all the Mobilizer matches and the Mobilizer matches, in turn, being a reliable subset of the true population. Two steps were used to determine the accuracy of Mobilizer-collected travel times. The first step involved determining whether the overall Mobilizer results mirror the true population travel times. The second step determined the accuracy of the overall Mobilizer match results by comparing them with the subset of "correct" Mobilizer match results.

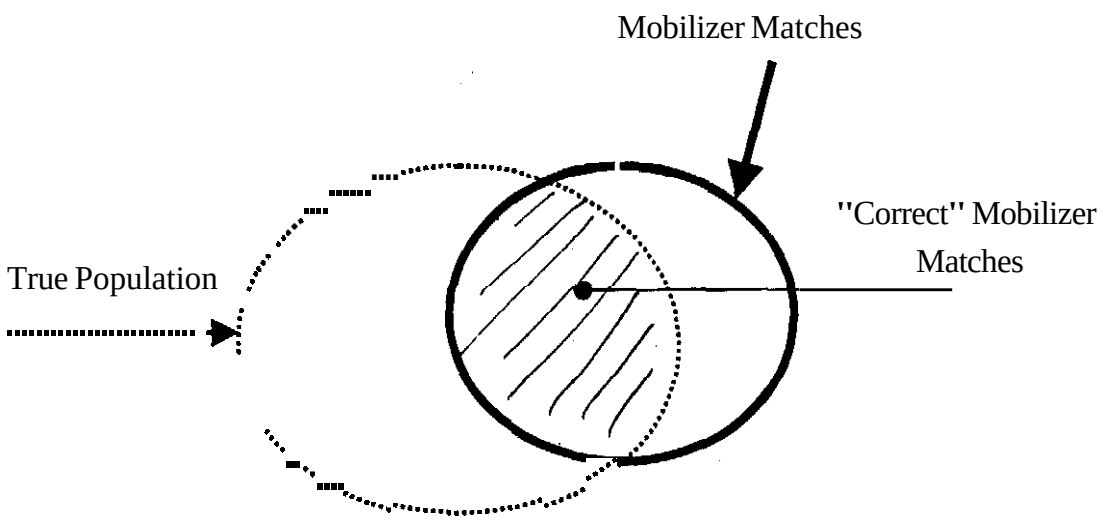

Figure 6: Sample Groups

The first assumption focuses on showing that the Mobilizer matches are an accurate, unbiased subset of the true population. The travel time values of the two populations (Mobilizer and true population) were compared statistically to determine whether the Mobilizer can be used to determine travel time estimates in lieu of having to collect an entire population sample. Table 2 compares the sample sizes of the true population with the Mobilizer travel time sample size. In all, Mobilizer "matched" 278 of the 1159 vehicles within the true population. The Mobilizer is unable to match lane-changing vehicles. The fifty vehicles that moved from the right lane to the middle lane (and vice versa) were not included within the true populations of the right and middle lanes to eliminate counting their travel times twice. However, the vehicles that do move between the middle and right lanes are represented in the total general purpose (GP) lane heading. The GP lanes are the combination of the middle and right lane travel times plus the travel times of the vehicles changing lanes between the middle and right lane.

Table 2 : Comparison of the True Population with the Mobilizer

	Right Lane	**Middle Lane**	**GP Lanes (Right and Middle)**	**HOV Lane**
True Population	328	370	748	411
# of Vehicles Matched by Mobilizer	55	121	176	102

To determine a 95% confidence level in the Mobilizer correct matches, the following statistical equation was used:

$$N = \left(s \frac{z}{e} \right)^2 \qquad \text{[Equation 1]}$$

Where:

N = sample size needed for the given level of confidence,

s = standard deviation from the tested sample,

z = test statistic constant corresponding to the given level of co dence (z=1.96 for a 95% level of confidence),

e = permissible error @recision) of the estimate of the true mean.

A significant test of the true population and Mobilizer data is the statistical validity of the travel time estimates from their respective analyses. The results of the mean travel times for the fifteen minute period from both the true population and the Mobilizer analysis are summarized in Table 3. Presented are the mean travel times, respective standard deviations, sample sizes, test statistics, p-values, and an estimation of error (based on a 95% confidence level), and the sample size necessary for a 95% level of confidence with an allowable error of 2 seconds in the HOV lane and 5 seconds in the remaining lanes associated with each sample. The mean travel times and standard deviations given in Table 3 under the true population heading are derived from a very large sample of observations that constitute the majority of the total population of vehicles travelling between 130" and 145" streets during the period of observation. Therefore, the statistics may be taken as a reasonable, unbiased estimate of the true population that can be used to compare the equivalent estimates provided by the Mobilizer.

Table 3 : Comparison of True Population and Mobilizer Statistics

	True Population					Mobilizer			
	Right	Middle	GP	HOV		Right	Middle	GP	HOV
Mean Travel Time (sec)	116.07	128.99	122.76	72.03		118.07	128.10	124.97	72.59
Standard Deviation (sec)	15.17	21.25	19.74	9.77		17.29	24.81	23.15	3.84
Sample Size	328	370	748	411		55	121	176	102
test statistic, z						0.98	-0.46	1.49	0.58
P-values						0.33	0.65	0.14	0.56
At a 95% Confidence Level (z=1.96)									
Error (sec)						4.57	4.42	3.42	0.75
Sample Size*						46	95	83	15
* sample sizes based on an allowable error of 2 seconds for the HOV lane, and an allowable error of 5 seconds for the Right, Middle, and GP lanes.									

The data in Table 3 show that the Mobilizer mean travel times are nearly identical to the mean travel times of the true population. For example, the mean travel time of the HOV lane Mobilizer matches was 72.59 seconds while the mean travel time from the HOV lane true population was 72.03 seconds; a difference of 0.56 seconds. Considering the travel time is approximately 72 seconds, half of a second is negligible. In the two general purpose lanes the Mobilizer mean travel time is 124.97 and the true population travel time is 122.76; again, for a 120 second travel time 2 seconds are inconsequential. The mean travel times of the true population and the Mobilizer sample have an average difference of 1.45 seconds. The smallest mean difference in the calculated means of the Mobilizer and true population was 0.59 seconds (in the HOV lane) and the largest difference in the means was 2.21 seconds (both general purpose lanes).

P-values, sometimes referred to as observed significance levels, illustrate the probability of observing a value of the test statistic "that is at least as contradictory to the null hypothesis, and supportive of the alternative hypothesis" (20). The null

hypothesis will be rejected only when the p-value is less than the chosen significance level, α. The p-values within Table 3 are all greater than 0.05, showing the Mobilizer mean travel times are not significantly different from the means of the true population for all of the lanes studied. P-values are determined by first calculating a test statistic, z (see Equation 2). The p-value is then determined from the normal distribution curve and is directly associated with the computed test statistic, z (see Figure 7).

$$z = \frac{\bar{y} - \mu}{\sigma / \sqrt{n}} \qquad \text{[Equation 2]}$$

Where:

z = test statistic,

$\bar{y}$ = mean of the sample,

μ = true population mean,

σ = standard deviation of the true population,

n = sample size.

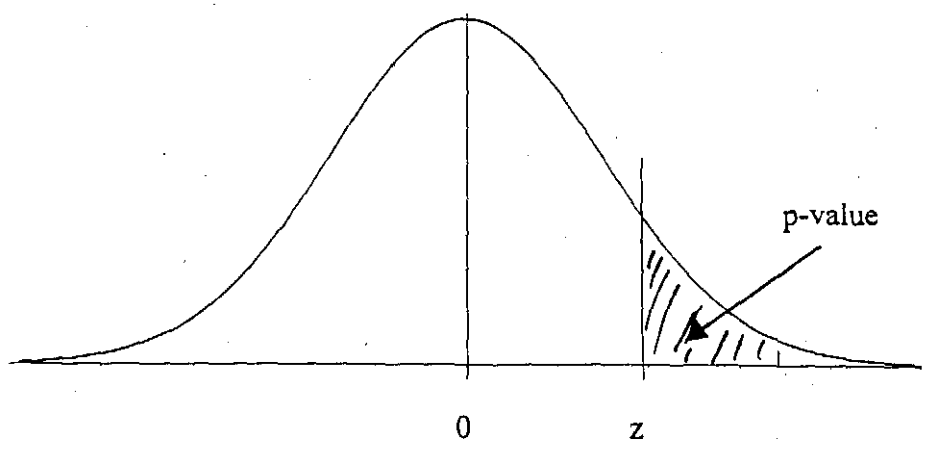

Figure 7: Normal Distribution Curve — p-value and z relationship

To further demonstrate the accuracy of the Mobilizer travel time data the error associated with the Mobilizer sample has been determined at a 95% level of confidence. At a 95% level of confidence there is a 95% certainty in the Mobilizer estimation of the true travel time. A five second or less error at 95% confidence assures the use of the Mobilizer to be a reasonable tool for travel time collection. The largest error, 4.57 seconds, of the Mobilizer matches occurred within the analysis of the right lane (Table 3). Therefore, at a 95% level of confidence, the error is approximately 5 seconds. Five seconds of error correspond to 4% of the 118 second mean travel time, a negligible amount. Statistically the Mobilizer analysis of the video-taped vehicles produce accurate and precise estimates of the mean travel times.

The necessary sample sizes of Mobilizer matches were calculated to determine whether or not the match rate of the Mobilizer was adequate for determining the true travel times at a 95% level of confidence. Equation 1 was used with the standard deviation from the Mobilizer sample along with a z of 1.96 for a 95% co dence level. The error, e, used was 5 seconds for the middle, right, and general purpose lanes. An error of 2 seconds was used for the HOV lane. For all cases, the sample size of the Mobilizer exceeded the sample size necessary to have a 95 % confidence that the average travel time was within an acceptable proximity to the true average travel time. For example, the sample size required for 95% confidence level and 5 seconds allowable error for the right lane results was 46; the actual sample size of 55 matches exceeded the necessary 46 matches. 95 % confidence and 2 seconds of allowable error required 15 matches in the HOV lane, a great deal fewer than the 102 matched HOV lane vehicles.

After concluding that the Mobilizer sample results are consistent with the true population, it was necessary to establish that the Mobilizer results themselves are consistent with the subset of "correct" Mobilizer match data. All of the matches that the

Mobilizer reports are not "correct" matches. "Correct" matches consist of the same vehicle being identified by the Mobilizer at both the origin and the destination. Oftentimes the Mobilizer will match a vehicle at one location with the vehicle preceding or following the "correct" match vehicle. However, even when the Mobilizer does not "correctly" match a vehicle, the travel times gathered are still consistent with the travel times of the traffic stream. Additionally, the Mobilizer needs all of the matches to update the road dynamics. Table 4 compares the Mobilizer travel time population with the "correct" Mobilizer match population. There were 19, 26, and 39 correct Mobilizer matches out of the right, middle, and HOV lanes, respectively. In all, Mobilizer "correctly" matched 84 of the 278 vehicles in the total Mobilizer match sample.

Table 4 : Population Comparison Between Mobilizer and "Correct" Mobilizer Matches

	Right Lane	**Middle** Lane	HOV Lane
All Mobilizer Matches	55	121	102
"Correct" Mobilizer Matches	19	26	39

The second assumption to be proven was that the mean travel times of the Mobilizer matches are representative of the "correct" Mobilizer match population. The Mobilizer data provides an overview of the travel times of the traffic stream. It would be both time-consuming and impractical to rely only upon the "correct" Mobilizer matches. The identification process of the "correct" matches within the Mobilizer results requires extensive manpower and produces small sample sizes. Therefore, it is necessary to identify whether or not the "correct" matches provide the same mean results as the entire Mobilizer sample.

To determine that the "correct" Mobilizer matches themselves were accurate, the "correctly" matched vehicles were compared with the same vehicles within the true population. Appendix **A** compares the Mobilizer vehicle travel times with the identical vehicles within the true population. If travel times computed by the Mobilizer for "correct" match vehicles differed greatly from the travel times of identical vehicles within the true population, the accuracy of the Mobilizer would be questionable. However, as shown in Appendix A, the travel times of "correct" Mobilizer match vehicles are nearly identical to the travel times of their counterparts within the true population.

As in the comparison of the true population to the Mobilizer sample, the mean travel times, standard deviations, test statistics, p-values, errors, and necessary sample sizes were calculated and are presented in Table 5. Again, the mean travel times of the "correct" matches were nearly identical to the mean travel times of the Mobilizer sample. The HOV lane "correct" match mean travel time was 72.63 seconds. The HOV lane Mobilizer mean travel time was 72.59 seconds.

Table 5 : "Correct" vs. Mobilizer Match Sample Sizes and Errors

	All Mobilizer Matches				"Correct" Mobilizer Matches		
	Right	Middle	HOV		Right	Middle	HOV
mean travel time (sec)	118.07	128.10	72.59		118.91	128.19	72.63
std. dev., s	17.29	24.81	3.84		14.92	20.06	3.77
sample size, n	55	121	102		19	26	39
test statistic, z					0.21	0.02	0.07
p-values					0.83	0.98	0.94
At a 95% Confidence Level (z=1.96)							
Error, e (sec)					6.71	7.71	1.18
Sample Size*					34.21	61.83	13.65
* sample size based on an allowable error of 2 seconds for the HOV lane, and an allowable error 5 seconds for the Right, Middle, and GP lanes.							

The HOV lane Mobilizer matches experience the smallest amount of error in travel time due to the lack of stop-and-go traffic within the HOV lane. At a 95% confidence level, the HOV lane error is 2 seconds or less during the period of evaluation. The greatest error occurred in the middle lane and was only 7.71 seconds. Compared to the mean travel time of 128.19 seconds in the middle lane the error represents an error of 6%. The higher errors are consistent with the need for larger sample sizes than were available for a 95% confidence level with an allowable error of 5 and 2 seconds for the general purpose lanes and the HOV lane, respectively. However, the p-values show high confidence in the "correct" Mobilizer match travel times, but a larger sample size of "correct" matches would be desirable and would possibly reduce the amount of error at the 95 % level of confidence.

The HOV Lane

The second portion of the analysis focuses on a comparison of the travel times for the three separate lanes. The general comparison of travel times within the three lanes will focus on the performance differences between the HOV lane and the general purpose lanes. The statistical data of the true population are shown in Table 11 for the fifteen minute period studied:

Table *6* : True Population Comparison Statistics

True Population	All 3 Lanes	HOV	Middle	Right	GP
Mean (sec)	104.44	72.03	128.99	116.07	122.76
Mean Speed (mph)	21.54	31.24	17.44	19.38	18.32
Std. Var. (sec)	29.22	9.77	21.24	15.17	19.74
Minimum	54	54	86	89	86
Maximum	167	99	167	153	167
Sample Size	1231	411	370	328	748

Figures 8, 9, and 10 graphically demonstrate the variations in vehicle travel times. The HOV lane, as expected, has the best performance. The mean HOV lane travel times are 70% lower than the mean of the adjacent general purpose lanes:

$$\frac{TT_{HOV} - TT_{GP}}{TT_{HOV}} * 100 = 70.43\%$$

According to the Puget Sound Regional Council, the average trip length from work to home in the Puget Sound region is ten miles long (21). Using this assumption and rounding the HOV lane and GP lanes average speeds to 30 mph and 20 mph, respectively, the calculated travel time savings for the HOV lane users is 10 minutes. A ten minute travel time savings for a 10 mile trip fits the recommendations of Fuhs.

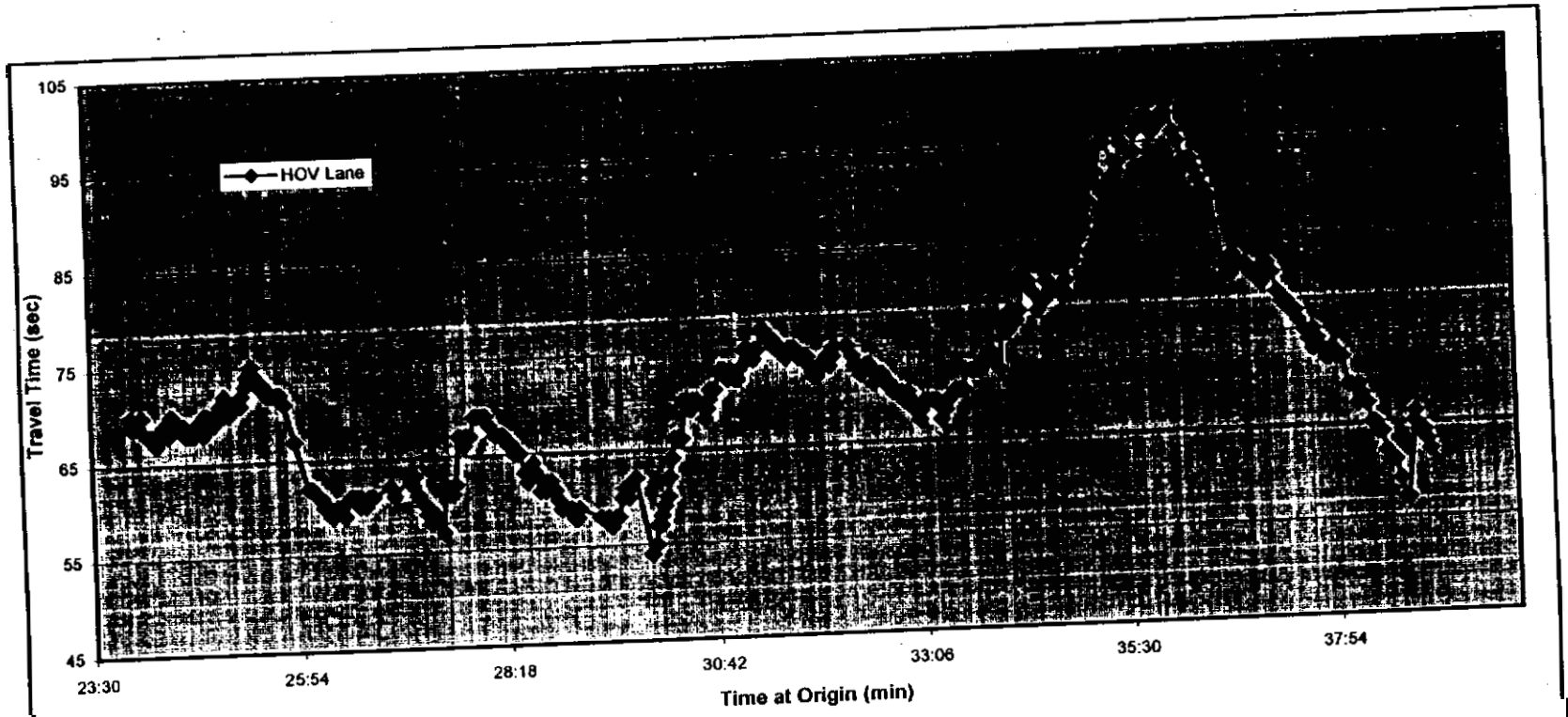

Figure 8: HOV Lane Travel Times

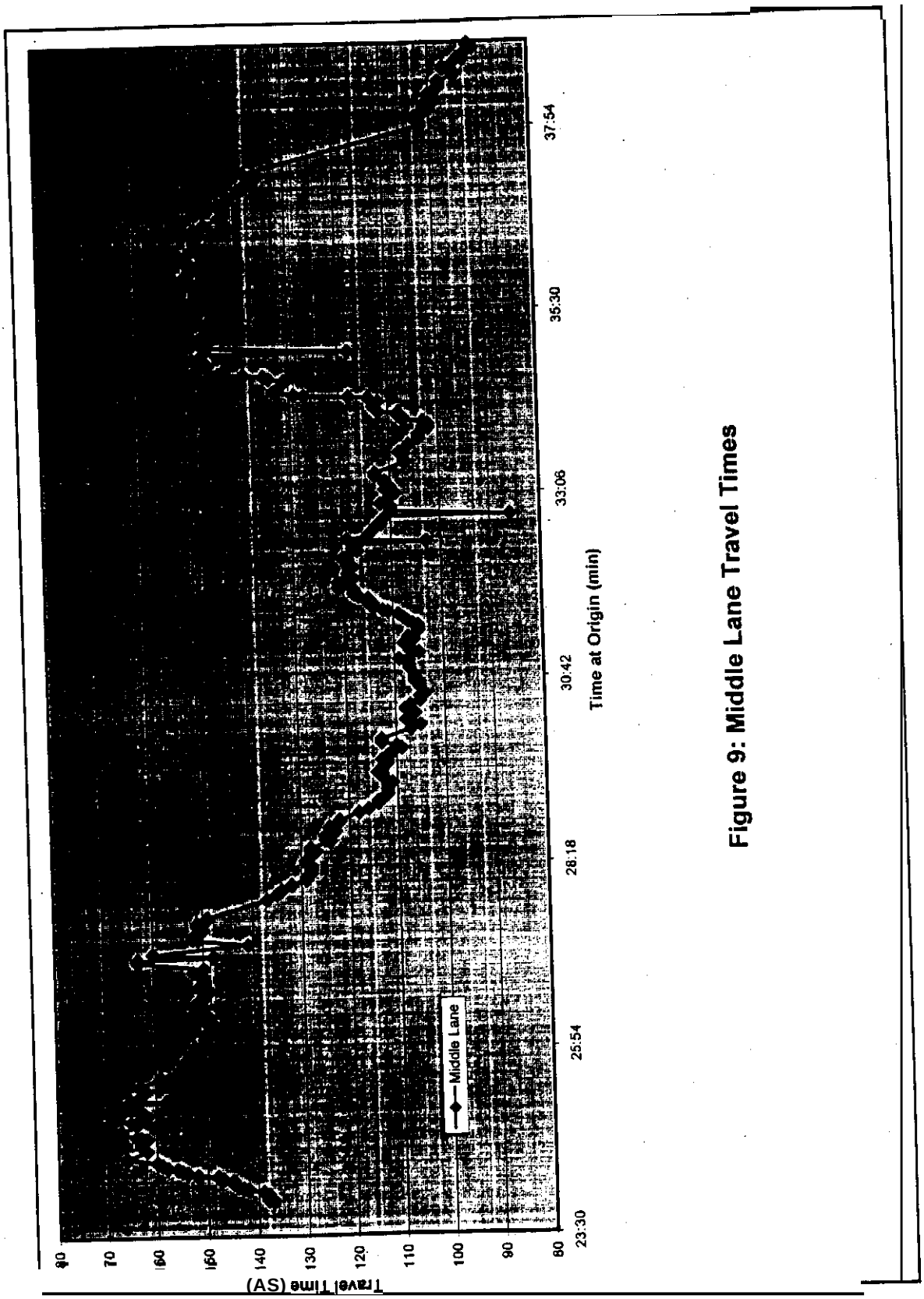

Figure 9: Middle Lane Travel Times

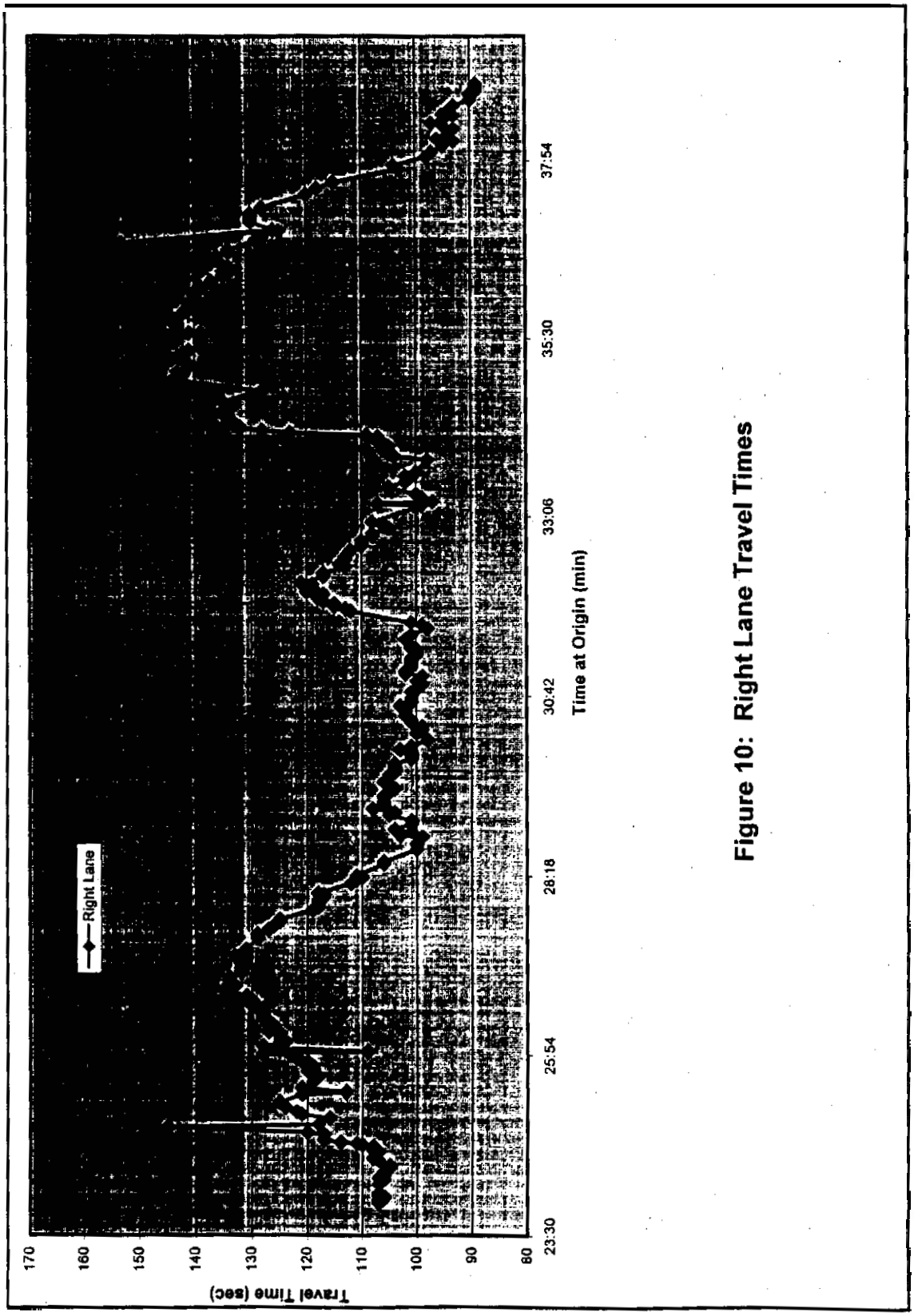

Figure 10: Right Lane Travel Times

HOV Lane:

10 miles @ 30 mph = 20 minute travel time

General Purpose Lanes:

10 miles @ 20 mph = 30 minute travel time

However, comparing the travel times of this particular section to the Washington State Department of Transportation (WSDOT) policy, the HOV lane is not achieving speeds of 45 mph or more for at least 90% of the peak hour (18). The results obtained by converting average travel time between origin and destination to average speed are illustrated by Figure 11. None of the vehicles, let alone 90%, achieve the 45 mph goal set by the WSDOT policy. Although this is a particularly short segment of the entire HOV system, the speeds along it are consistent with the speeds along the rest of the facility during the afternoon peak period.

Although the WSDOT policy is not being met, the travel time savings are consistent with, and even exceed Fuhs' recommendation. It may not be feasible for the HOV lanes to reach speeds in excess of 45 mph during peak periods. Policy statements could better focus on travel time savings to HOV users. Another policy option would be to establish comparisons of speed within each lane by percentage rather than a constant 45 mph. It is very unlikely that speeds over 45 mph will be reached on Interstate 5 during the peak period travel times.

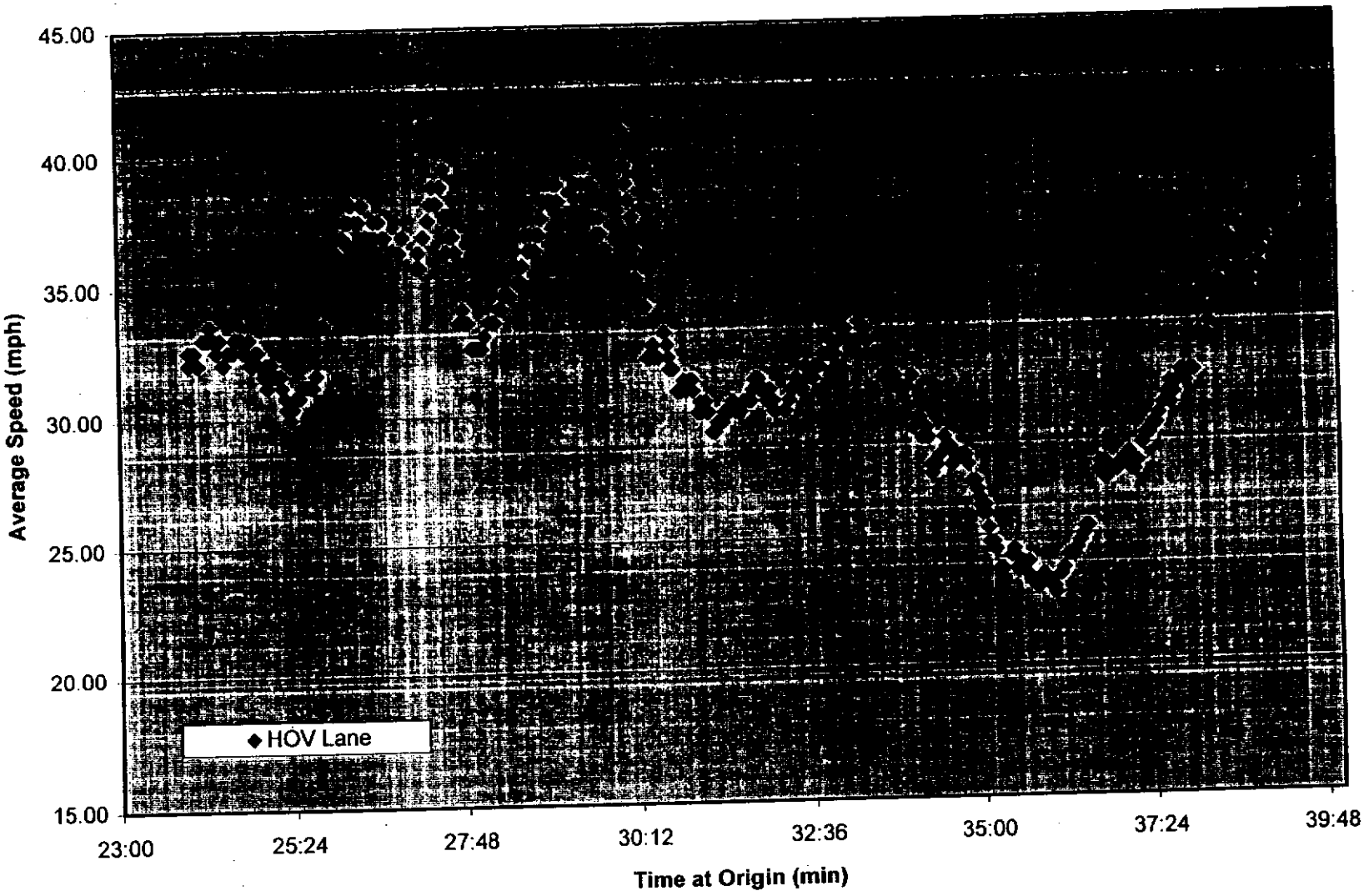

Figure 11: HOV Lane Speeds

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

A two part study was undertaken for the travel time data of vehicles using Interstate 5 between 130th and 145th streets in Seattle, Washington. The first part of the study evaluated the accuracy of travel times collected and reported by the Mobilizer. The second part of the study focused on the travel times of the HOV lane compared to the general purpose lanes.

The travel time accuracy of the Mobilizer was determined at a 95% level of confidence by first comparing the entire sample of Mobilizer matches with the true population. The Mobilizer reported mean travel times with accuracy within 1 second for the HOV lane. Within the general purpose lanes the Mobilizer is able to collect mean travel time data that differs from the true population mean travel time by a mere 4%. The Mobilizer data closely matches the data collected from the true population.

The travel time accuracy of the Mobilizer was investigated further by comparing the entire Mobilizer results with the subset of the "correct" Mobilizer matches. Although not all of the matches produced by the Mobilizer are matches of identical vehicles, all of the matches involve vehicles travelling within the vicinity of the correct match vehicle. The Mobilizer matches all have travel times that are similar to the vehicle dynamics within the tr c stream. One of the goals was to determine if the Mobilizer matches were a good representation of the "correct" matches. The correct matches reported travel times with accuracy within 2 seconds of the entire Mobilizer sample for

the HOV lane. Within the general purpose lanes the correct match travel time data differs from the Mobilizer mean travel time by ***6%.*** The Mobilizer data is statistically accurate to the correct matches.

By establishing the statistical accuracy of the Mobilizer with the true population and the correct matches with the Mobilizer matches, the accuracy of the Mobilizer for travel time data has been verified.

The second part of the study focused on the comparison of the travel times of vehicles within the HOV lane with the travel times within the general purpose lanes. On average, the HOV lane is moving approximately 10 mph faster than the general purpose lanes. A lane speed difference of 10 mph corresponds to 70% faster travel times in the HOV lane for the segment during peak period afternoon travel. While the HOV lane is not fulfilling the WSDOT HOV lane policy, the HOV lane is fulfilling other criteria. The HOV lane is providing, on average, 10 minute travel time savings to the users of the HOV lane. According to Charles Fuhs, the HOV lane is fulfilling its purpose.

RECOMMENDATIONS

The results in the previous chapter illustrate the usefulness of the Mobilizer technology for determining travel times. However, there is still a need for further testing in many situations where the Mobilizer could be used. The Mobilizer could be further tested and evaluated for the following: system modifications, varying flow conditions, origin-destination studies, designated AGC region, and usage in inclement conditions.

System modifications could be made on the Mobilizer to include more input parameters useful for research purposes. Implementation of setup parameters for

the link time estimation process for non-real-time Mobilizer usage could give more flexibility in short video segment analysis. Suggested parameter changes include changing the start up setup to allow different initial travel times to be entered for each lane. The entry of initial travel times unique to each lane would allow the Mobilizer to be started and used in a greater variety of flow conditions.

The Mobilizer should further be tested to determine data accuracy in a variety of flow conditions—from free flow to start and stop conditions. A longer video segment that begins at a steady state and deteriorates into start and stop conditions would demonstrate the full range of Mobilizer capabilities. Such a study would be best approached with a computer designated to the Mobilizer study to ensure memory capacity to store the digitized video files and to run the Mobilizer. A 10 gigabyte hard drive designated to the Mobilizer would eliminate file transfers between computers and could hold an hour of video beginning with free flow conditions and progressing to start and stop conditions.

Further studies of the Mobilizer could include origin-destination studies. The Mobilizer is able to provide accurate travel times by vehicle matching. However, the Mobilizer travel times are sometimes calculated from a match vehicle and the vehicle either preceding or following the match-vehicle. "Correct" matches are absolutely essential for reliable origin-destination studies. Further testing could be done to show whether or not origin-destination data could be another application of the Mobilizer technology.

A designated AGC region is recommended to either be established or found naturally at the Mobilizer sites. AGC regions compensate for shadows and eliminate mis-matching due to the presence of distinct shadows on the roadway. If a natural AGC region cannot be found adjacent to the roadway, temporary AGC regions need to be installed to ensure that some small portion within the camera's field of view is

free from both vehicles and their shadows. Ideal ACG regions would consist of signs tilted slightly upward, extending above the highest vehicle.

Additionally, testing of the Mobilizer in inclement weather conditions, such as heavy rain or fog, as well as transitional lighting occurring at dawn and dusk, would develop a greater certainty of the adaptability and usefulness of the Mobilizer technology.

Finally, as for HOV lane usage, the WSDOT policy could be re-evaluated and rewritten to focus on travel time savings within the HOV lane rather than requiring a set speed that may not be achievable during peak period travel times.

ENDNOTES

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APPENDIX **A:** MOBILIZER MATCH ACCURACY

The Mobilizer matches include vehicles that are "correct" matches as well as matches that are close to the correct vehicle match but that match the car preceding or following the correct match vehicle. Though the matches are not all "correct," all of the Mobilizer matches are providing travel times close to the true travel times of the traffic stream under study. "Incorrect" Mobilizer matches are unavoidable and can be ignored because although the vehicle matches are incorrect, the travel times are close to the correct travel times.

However, to verify that the Mobilizer matches do indeed closely mirror the matches within the true population at a 95% level of confidence; the following section compares the "correct" Mobilizer vehicle matches with the matches of the same vehicles within the true population. Table 7 compares the "correct" match population with the identical vehicle matches within the true population. Included in the comparison are values of the mean travel times, standard deviations, minimum and maximum observed travel times, and error estimates based upon a 95% confidence level. The mean travel times calculated by the Mobilizer were nearly identical to the mean travel times of the true population matches for the same vehicles. The errors estimated show negligible travel time error at a 95% confidence level. The middle lane demonstrated the greatest

error, 7.71 seconds. 7.71 seconds, compared to a mean travel time in the middle lane of 127.94 seconds is only a *6%* error.

Table 7: Comparison of "Correct" Matches with True Matches

	"Correct" Mobilizer Matches				True Population Matches		
	Right	Middle	HOV		Right	Middle	HOV
Mean	117.90	127.94	72.63		117.32	129.64	72.82
Standard Deviation	14.92	20.06	3.77		14.54	20.08	3.98
Minimum	100.25	102.5	64.7		99	102	65
Maximum	144	162.25	81.5		144	163	86
Count	19	26	39		19	26	39
Error, e (sec)	6.71	7.71	1.18				

Tables 8, 9, and 10 have broken down the Mobilizer statistical data into five minute spans within the fifteen minutes of collected data for each of the three lanes studied. The five minute segments are studied to show the Mobilizer results with smaller ranges of travel times. Smaller spreads of travel time help to establish at which speeds breakdown of the Mobilizer occurs. These tables compare the correctly matched Mobilizer travel times with the corresponding true population travel times. Tables 8 and 9 illustrate the break down that occurs in the Mobilizer results during periods of high travel times resulting from stop and go traffic. The periods of high travel times correlate with the higher statistical standard deviations. Figures 12, 13, and 14 plot the travel times of the true population and the Mobilizer travel times collected for each of the three lanes: right, middle, and HOV, respectively. Again, with the error terms based on a 95% level of confidence, the largest errors are occumng during the intervals with the highest travel times. When speeds are in excess of 120 mph in the middle lane and 130 mph in the right lane the Mobilizer results show greater travel time errors.

Table 8: Right Lane Mobilizer vs. Match Statistics in 5 min. periods

Right Lane	"Correct" Mobilizer Matches				True Population Matches		
	24:00-28:59	29:00-33:59	34:00-38:59		24:00-28:59	29:00-33:59	34:00-38:59
Mean Travel Time	110.75	107.71	131.86		110.69	107.21	132.71
Standard Deviation	5.91	9.14	11.77		4.85	6.47	12.36
Sample Size	4	8	7		4	8	7
Error, e (sec)	5.79	6.33	8.72				

Table 9: Middle Lane -- Mobilizer vs. Match Statistics in 5 min. periods

Middle Lane	"Correct" Mobilizer Matches				True Population Matches		
	24:00-28:59	29:00-33:59	34:00-38:59		24:00-28:59	29:00-33:59	34:00-38:59
Mean Travel Time	143.3	109.91	149.33		142.75	109.88	150.83
Standard Deviation	13.46	5.32	0.58		13.67	5.13	1.66
Sample Size	10	13	3		10	13	3
Error, e (sec)	8.34	2.89	0.65				

Table 10 : HOV Lane Mobilizer vs. Match Statistics

HOV Lane	"Correct" Mobilizer Matches				True Population Matches		
	24:00-28:59	29:00-33:59	34:00-38:59		24:00-28:59	29:00-33:59	34:00-38:59
Mean Travel Time	70.43	72.18	78.38		70.48	71.94	77.86
Standard Deviation	2.93	2.07	3.54		3.50	1.77	2.36
Sample Size	14	17	8		14	17	8
Error, e (sec)	1.53	0.98	2.45				

Further study is needed to determine whether the high errors are associated to the slower travel times or some other factor. The small sample sizes hinder the effectiveness of determining whether there truly is a breakdown at these slower speeds. However, the inverse is also true. If the Mobilizer cannot get enough "looks" at the vehicles within the track then it is harder to develop specific fingerprints for each vehicle. There must be an optimum ranger of speeds between steady state and stop and go where

the Mobilizer can get enough "looks" but not experience the breakdown that results from stop and go traffic conditions.

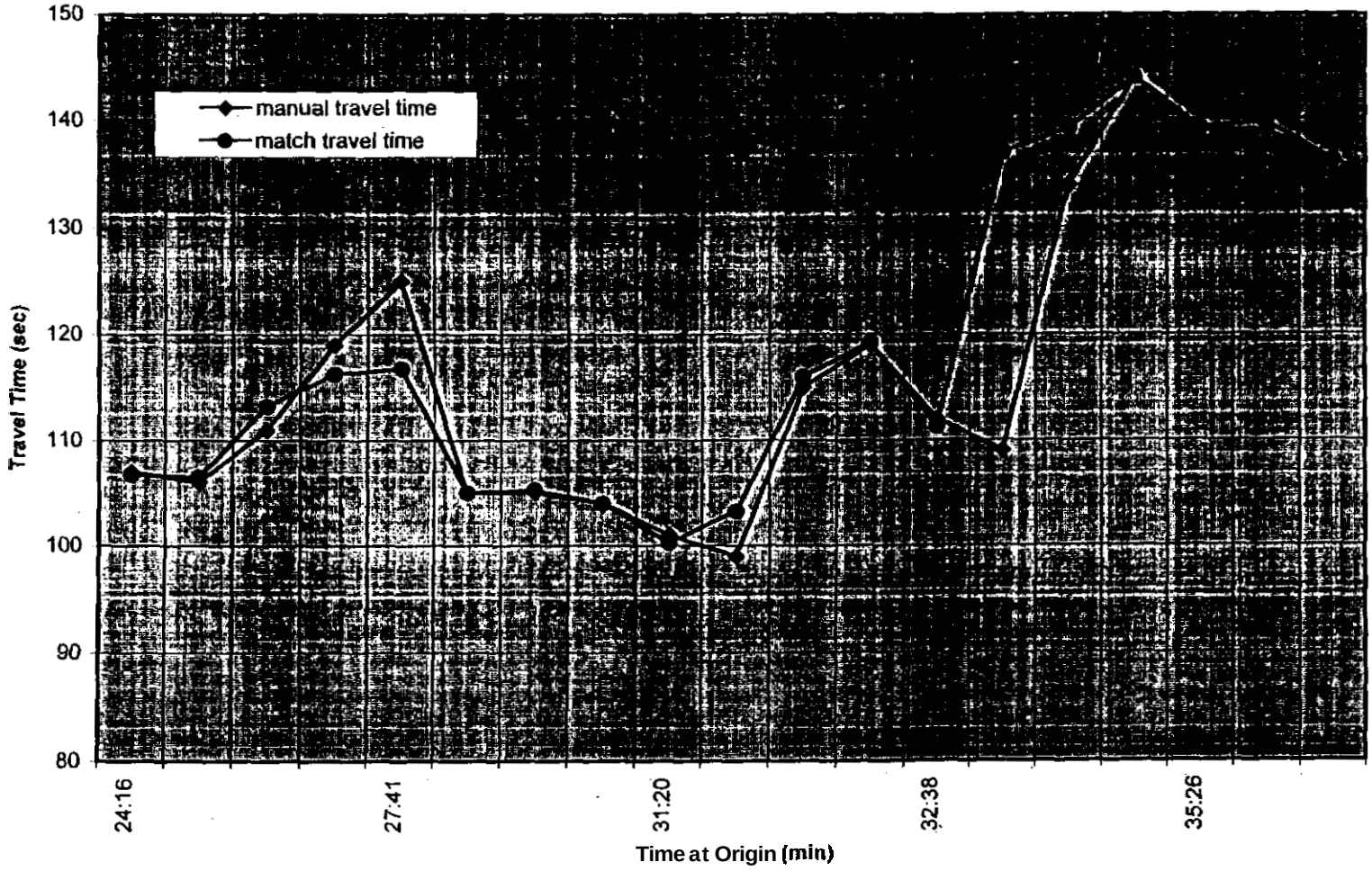

Figure 12: Right Lane -- Mobilizer Travel Time vs. True Population

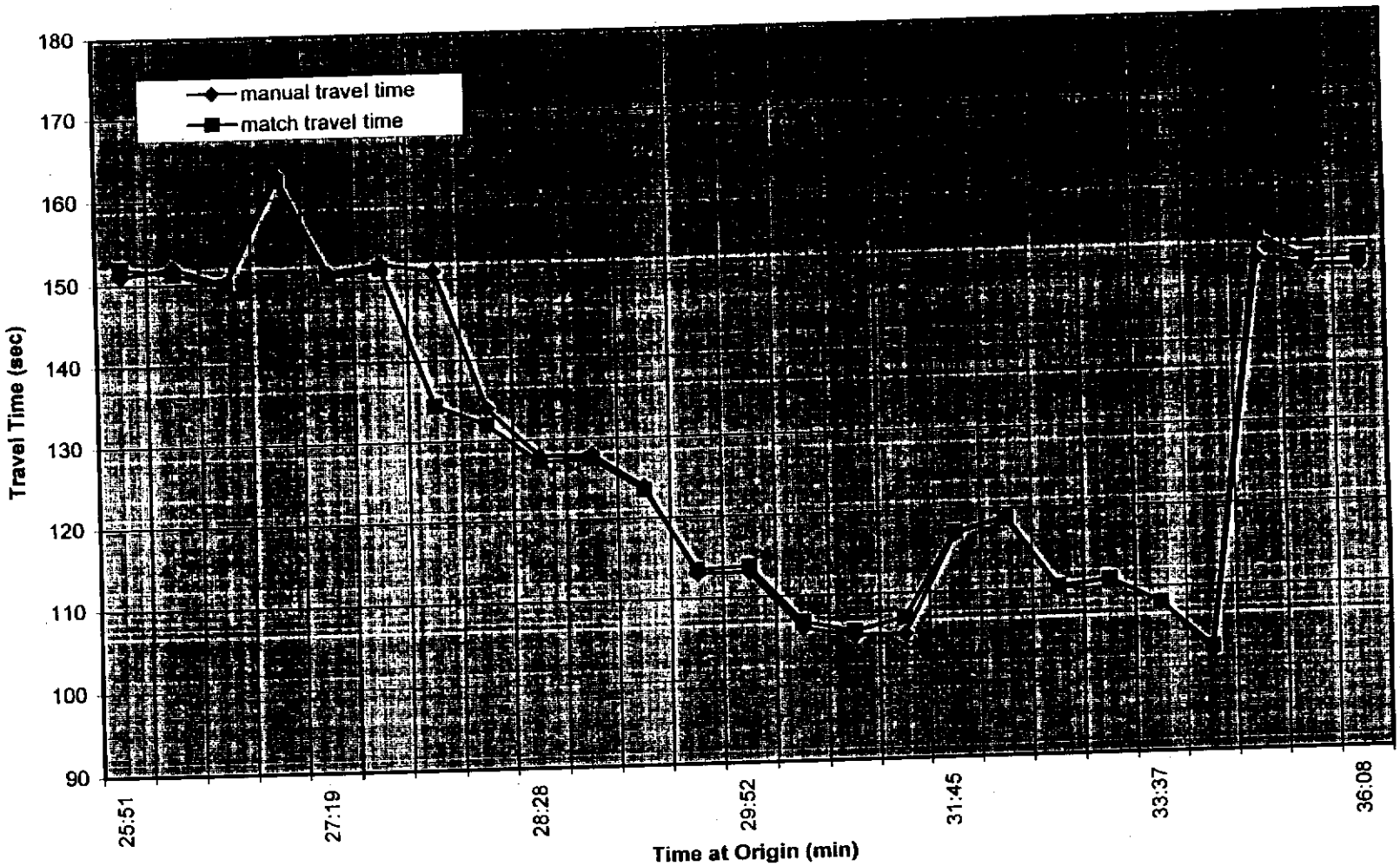

Figure 13: Middle Lane -- Mobilizer Travel Time vs. True Population

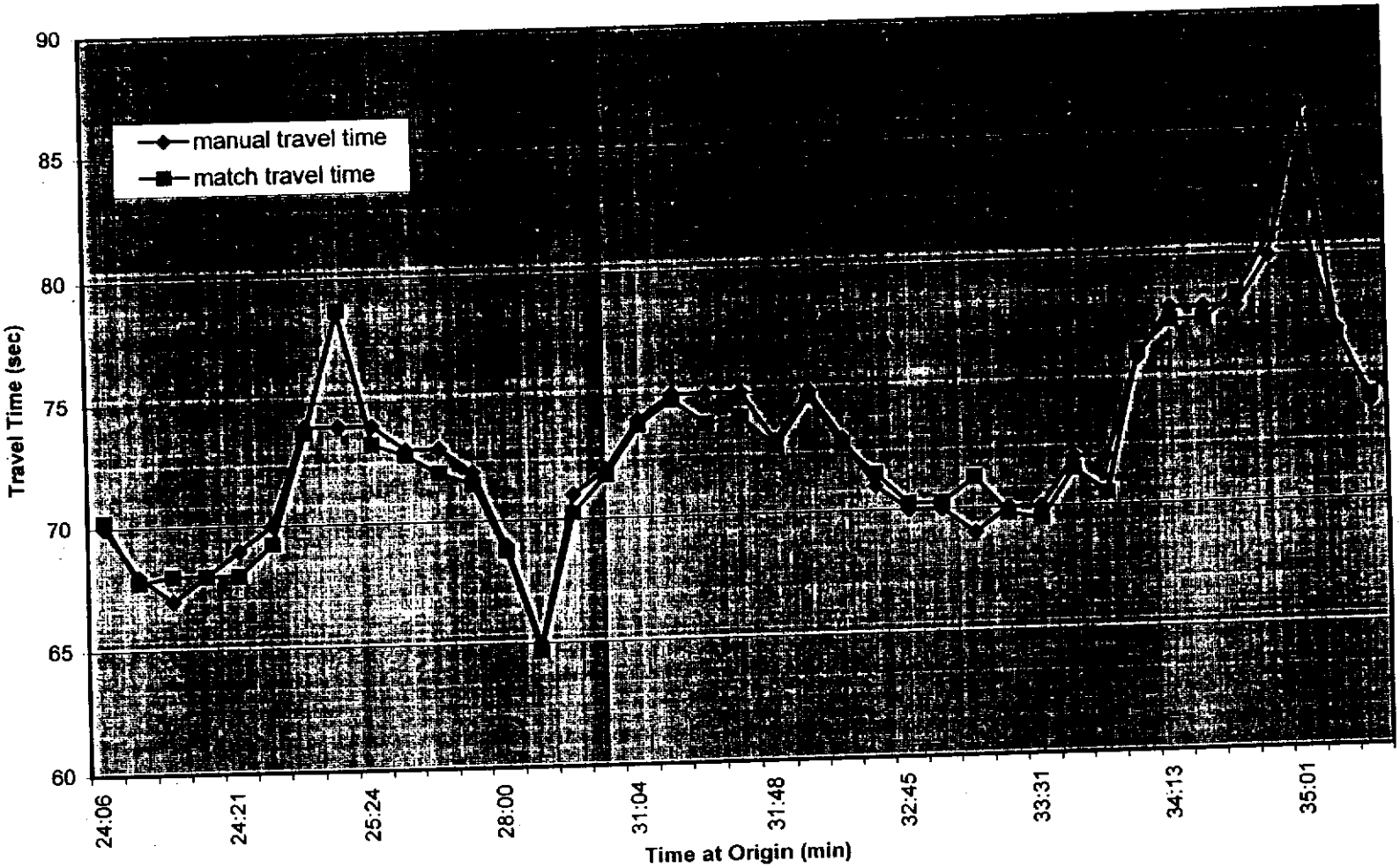

Figure 14: HOV Lane Mobilizer Travel Time vs. True Population

APPENDIX B: TRUE POPULATION DATA

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
23:56	3	25:42	3	Black passenger	107
23:56	2	26:12	2	Black passenger	137
23:57	2	26:14	2	White passenger	138
23:58	1	25:06	1	Blue passenger	69
23:58	3	25:44	3	Purple passenger	107
23:58	1	25:07	1	motorcycle	70
24:00	3	25:45	3	Maroon sedan	106
24:00	1	25:08	1	Gray passenger	69
24:00	2	26:17	2	Jeep	138
24:01	2	26:18	2	Black SUV	138
24:01	3	25:46	3	gray van	106
24:02	1	25:10	1	gray sedan	69
24:02	3	25:48	3	Black sedan	107
24:03	2	26:21	2	red pickup	139
24:03	1	25:11	1	Blue w/ sunroof	69
24:04	3	25:50	3	black pickup	107
24:05	2	26:26	2	white sedan	142
24:05	1	25:14	1	Black SUV	70
24:06	2	26:28	2	white pickup	143
24:06	1	25:15	1	Blue passenger	70
24:07	2	26:30	2	blue pickup (bedcover)	144
24:10	1	25:17	1	blue wagon	68
24:10	2	26:34	2	white pickup	145
24:12	2	26:36	2	light purple sedan	145
24:11	3	25:57	3	black sedan	107
24:12	1	25:19	1	Maroon pass.	68
24:12	3	25:58	3	Black pass. w/sunroof	107
24:13	2	26:39	2	Gray passenger	147
24:14	1	25:21	1	White passenger	68
24:15	2	26:42	2	truck and canopy	148
24:15	3	26:00	3	Black passenger	106

Note: Actual Travel times are one second more than the difference between the time the vehicle was seen at the origin and the time the vehicle was seen at the destination due to camera start time difference of one second.

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
24:16	1	25:22	1	motorcycle	67
24:16	2	26:47	2	white w/ sunroof	152
24:16	3	26:02	3	blue hatchback	107
24:18	3	26:03	3	red cherokee	106
24:18	2	26:51	2	red sedan	154
24:18	1	25:25	1	silver SUV	68
24:19	2	26:53	2	white truck/canopy	155
24:20	3	26:05	3	Black pass. w/sunroof	106
24:20	1	25:27	1	Red SUV	68
24:21	3	26:06	3	red pass.	106
24:21	2	26:56	2	Black pass.	156
24:21	1	25:29	1	blue sedan	69
24:22	2	26:59	2	White passenger	158
24:23	3	25:56	4	White delivery truck	94
24:24	1	25:31	1	black truck/canopy	68
24:24	3	26:08	3	red hatchback	105
24:24	2	27:02	2	silver truck/canopy	159
24:26	1	25:35	1	red minivan	70
24:26	2	27:05	2	gray pass w/ sunroof	160
24:26	3	26:10	3	White passenger	105
24:27	2	27:10	2	black pass w/ sunroof	164
24:27	1	25:36	1	gray pass.	70
24:28	3	26:00	5	big white car (time est.)	93
24:29	2	27:14	2	White SUV	166
24:30	3	26:16	3	Tan sedan w/ sunroof	107
24:30	1	25:38	1	Black pass. w/sunroof	69
24:30	2	27:03	3	White jeep w/ tire	154
24:31	1	25:39	1	gray sedan	69
24:32	3	26:19	3	tanker truck	108
24:33	1	25:41	1	Blue passenger	69
24:34	3	26:06	5	red truck/canopy (est.)	93
24:35	1	25:43	1	black van	69
24:35	2	27:16	2	black convertible	162
24:36	1	25:43	1	White passenger	68
24:37	3	26:23	3	maroon sporty	107
24:38	1	25:45	1	black van	68
24:38	2	27:20	2	black pickup	163
24:38	3	26:25	3	black station wagon	108
24:40	3	26:27	3	Blue passenger	108
24:40	1	25:47	1	motorcycle	68
24:40	2	27:22	2	white/orange van	163
24:41	1	25:48	1	red pickup	68
24:41	3	26:27	4	White passenger	107

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
24:42	1	25:49	1	black pass.	68
24:42	3	26:29	3	black truck/canopy	108
24:43	3	26:32	3	red convertible	110
24:43	1	25:51	1	White van with ladder	69
24:44	3	26:34	3	White van with ladder	111
24:44	1	25:52	1	motorcycle	69
24:44	2	27:25	2	red pickup w/ canopy	162
24:45	3	26:38	3	White passenger	114
24:45	1	25:53	1	maroon SUV	69
24:45	2	27:27	2	red pickup w/tan canopy	163
24:46	2	27:29	2	dark blue passenger	164
24:47	3	26:43	3	Black passenger	117
24:48	1	25:55	1	silver minivan	68
24:48	3	27:31	2	Black passenger	164
24:49	2	27:35	2	white van	167
24:49	1	25:58	1	Black passenger	70
24:49	3	26:55	4	Black passenger	127
24:50	2	27:36	2	light brown pickup	167
24:51	1	26:00	1	red pass.	70
24:51	3	26:47	3	oranger/brown van	117
24:53	3	26:52	3	white wagon	120
24:53	1	26:01	1	black SUV	69
24:55	1	26:03	1	white pass. w/ sunroof	69
24:55	2	27:38	2	white van	164
24:56	1	26:05	1	blue gray pass.	70
24:57	3	27:21	3	white pass. w/ sunroof	145
24:57	2	27:41	2	PU w/yellow box	165
24:59	2	27:12	3	Lt. Brown pass.	134
24:59	3	26:56	3	white pass. w/ sunroof	118
25:00	1	26:10	1	black SUV	71
25:01	2	27:43	2	Black pass. w/sunroof	163
25:01	3	27:04	4	Maroon pass.	124
25:02	1	26:11	1	black SUV	70
25:02	2	27:43	2	white convertible	162
25:03	3	27:07	1	white van	125
25:03	1	26:14	1	white pass. w/ sunroof	72
25:04	2	27:46	2	bronze pass.	163
25:04	3	26:59	3	blue SUV	116
25:06	2	27:48	2	maroon wagon	163
25:06	1	26:15	1	white SUV	70
25:07	3	27:07	3	blue convertible	121
25:07	2	27:51	2	silver SUV	165
25:08	2	27:53	2	blue pass. W/sunroof	166

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
25:08	1	26:18	1	white minivan	71
25:09	3	27:10	3	Black pass. w/sunroof	122
25:10	1	26:20	1	white pass. Brown roof	71
25:10	2	27:56	2	red pass.	167
25:11	1	26:21	1	gray minivan	71
25:13	2	27:50	2	white pass.	158
25:13	1	26:23	1	white pass.	71
25:13	3	27:16	3	white van	124
25:14	1	26:24	1	brown pass.	71
25:14	2	27:58	2	gray PU	165
25:15	1	26:26	1	maroon SUV	72
25:16	2	28:00	3	red pass. W/sunroof	165
25:17	3	27:21	3	black truck w/pipe	125
25:18	1	26:30	1	black suv	73
25:18	2	28:00	2	red pu	163
25:18	3	26:57	5	yellow bug	100
25:19	1	26:32	1	black pass.	74
25:20	1	26:33	1	silver pu	74
25:21	2	28:02	2	black jeep	162
25:22	1	26:36	1	black pu	75
25:23	3	27:23	3	red van w/pipes	121
25:23	2	28:05	2	black pu w/white canopy	163
25:24	1	26:37	1	lt. Blue suv	74
25:25	3	27:17	3	white pass. w/ sunroof	113
25:25	2	28:07	2	white pu w/canopy	163
25:26	1	26:38	1	black pu	73
25:28	1	26:40	1	white pass.	73
25:28	3	27:28	3	big moving truck	121
25:30	1	26:42	1	red suv	73
25:32	2	28:10	2	blue sedan	159
25:32	1	26:43	1	red pass.	72
25:33	3	27:31	3	white pass. w/ sunroof	119
25:34	1	26:45	1	black sedan	72
25:36	1	26:47	1	white pass	72
25:37	3	27:34	3	white black suv	118
25:38	2	28:12	2	black suv	155
25:39	1	26:50	1	white pass.	72
25:39	3	27:37	3	maroon pass.	119
25:41	3	27:40	3	black pass.	120
25:41	1	26:52	1	lt blue pass.	72
25:42	2	28:15	2	black pass.	154
25:43	3	27:41	3	dark gray pass.	119
25:44	1	26:54	1	white pass. w/ sunroof	71

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
25:44	2	28:17	2	maroon pass.	154
25:45	3	27:43	3	white van	119
25:47	2	28:19	2	black pass.	153
25:49	3	27:48	3	blue wagon	120
25:49	2	28:21	2	blue pu	153
25:49	3	27:49	3	white suv	121
25:50	1	26:56	1	gray sedan w/ sunroof	67
25:51	2	28:21	2	white pass.	151
25:52	3	27:53	3	red pu	122
25:54	2	28:25	2	maroon el camino	152
25:54	3	27:56	3	gray sedan	123
25:55	3	28:02	3	white suv	128
25:56	2	28:27	2	red pass.	152
25:57	3	27:45	3	silver sedan	109
25:59	1	27:00	1	black pass.	62
25:59	3	28:04	3	black w/ ladder	126
26:00	2	28:29	2	black pu	150
26:00	1	27:01	1	blue pass. W/sunroof	62
26:01	3	28:08	3	black pass.	128
26:02	1	27:03	1	white suv	62
26:02	2	28:31	2	maroon chevy truck	150
26:04	3	28:07	3	blue pass. W/sunroof	124
26:05	3	28:09	3	red pass.	125
26:05	2	28:34	2	silver black van	150
26:07	3	28:11	3	maroon pass.	125
26:07	1	27:07	1	white van	61
26:07	2	27:19	1	gray t-top	73
26:08	1	27:08	1	black jeep	61
26:10	3	28:14	3	long bed truck w/ cont.	125
26:10	2	28:37	2	red pass.	148
26:10	1	27:09	1	silver suv	60
26:11	3	28:15	3	black pass.	125
26:11	1	27:10	1	black pass.	60
26:12	2	28:39	2	black pass.	148
26:12	3	28:18	3	black pu	127
26:13	1	27:12	1	silver pass.	60
26:13	3	28:19	3	tan pass.	127
26:14	2	28:42	2	silver pass.	149
26:15	1	27:13	1	lt blue suv	59
26:16	2	28:45	2	blue pass. W/sunroof	150
26:17	3	28:22	3	gray pass	126
26:18	2	28:46	2	black pass	149
26:18	3	28:24	3	black pu	127

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
26:18	1	27:17	1	black gray minivan	60
26:19	2	28:48	2	gray pass	150
26:19	3	28:25	3	maroon pass	127
26:20	2	28:50	2	blue pass.	151
26:21	3	28:27	3	white suv	127
26:21	1	27:20	1	blue pass	60
26:22	2	28:53	2	black pass	152
26:22	3	28:31	4	white pass	130
26:23	1	27:21	1	white van	59
26:23	2	28:38	4	silver pass.	136
26:24	3	28:31	3	blue suv	128
26:24	1	27:22	1	black minivan	59
26:26	2	28:55	2	tan pass. W/ sunroof	150
26:26	3	28:33	3	red silver pu	128
26:28	3	28:35	3	gray pass.	128
26:28	1	27:28	1	silver pass.	61
26:28	2	28:59	2	blue minivan	152
26:30	1	27:30	1	red pass.	61
26:31	3	28:38	3	black sedan	128
26:32	3	28:40	3	silver pass.	129
26:32	2	29:02	2	black pass.	151
26:32	1	27:32	1	black conv.	61
26:33	3	28:42	3	jeep	130
26:34	2	29:03	2	black pass	150
26:34	1	27:33	1	maroon pass.	60
26:35	1	27:35	1	white pass.	61
26:37	2	29:06	2	red pass.	150
26:37	3	28:46	3	truck/trailer	130
26:38	1	27:37	1	black wagon	60
26:39	2	29:07	2	black pass w/ sunroof	149
26:41	3	28:51	3	black suv	131
26:41	1	27:41	1	white suv	61
26:42	2	29:12	2	gray pass w/ sunroof	151
26:43	1	27:43	1	tan sedan	61
26:44	3	28:57	3	black jeep	134
26:45	2	29:14	2	white pass	150
26:46	3	29:00	3	green pass	135
26:47	2	29:16	2	black pass	150
26:49	3	29:01	3	maroon pass	133
26:50	2	29:19	2	black pu	150
26:50	3	29:03	3	blue hatchback	134
26:52	2	29:22	2	maroon pass	151
26:53	3	29:06	3	white pu	134

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
26:54	2	29:25	2	black pass	152
26:54	3	29:07	3	maroon pass	134
26:55	1	27:56	1	white pass	62
26:56	3	29:09	3	dk gray pass	134
26:57	2	29:26	2	blue van	150
26:58	1	27:58	1	black van	61
26:58	3	29:10	2	blue pass	133
27:00	3	29:11	3	red pass.	132
27:01	3	29:12	3	dark gray pass	132
27:02	2	29:44	2	dump truck and trailer	163
27:03	3	29:14	3	black suv	132
27:04	2	29:46	2	white pu/canopy	163
27:04	3	29:09	2	silver suv	126
27:06	2	29:33	2	gray pass w/ sunroof	148
27:06	3	29:16	3	maroon sedan	131
27:07	3	29:18	3	black suv	132
27:08	2	29:47	2	black pass.	160
27:09	3	29:20	3	white pass	132
27:09	1	28:11	1	white van	63
27:11	1	28:12	1	maroon pass	62
27:12	3	29:22	3	red silver suv	131
27:12	1	28:14	1	white pass w/sunroof	63
27:13	2	29:31	3	red pu/canopy	139
27:13	3	29:25	3	red pass w/ sunroof	133
27:13	1	28:48	4	maroon suv	96
27:15	2	29:35	2	blue pass	141
27:15	3	29:26	3	blue pass w/ sunroof	132
27:15	1	28:15	1	gray hatchback	61
27:17	3	29:27	3	gray sedan w/ sunroof	131
27:18	3	29:28	2	bluck suv	131
27:19	1	28:18	1	silver minivan	60
27:19	2	29:49	2	white pu	151
27:19	3	29:29	3	tan pass w/ brown top	131
27:20	2	29:51	2	maroon pass w/ sun.	152
27:21	3	29:33	4	maroon pass w/ sun.	133
27:21	1	28:19	1	black pass	59
27:22	2	29:53	2	black pass	152
27:23	1	28:20	1	blue pass	58
27:23	3	29:31	2	white van w/ ladder	129
27:24	2	29:54	2	gray pass	151
27:25	1	28:23	1	motorcycle	59
27:26	1	28:24	1	motorcycle	59
27:27	2	29:56	2	gray wagon	150

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
27:28	3	29:36	3	blue hatchback	129
27:29	1	28:26	1	black minivan	58
27:30	2	30:00	2	blue white pass	151
27:31	3	29:39	3	dark blue suv	129
27:32	1	28:28	1	black minivan	57
27:32	2	30:02	2	lt blue pass	151
27:33	3	29:40	2	black suv	128
27:34	1	28:35	1	black pass w/ sunroof	62
27:35	3	29:41	3	red pass w/ sunroof	127
27:36	2	30:04	2	maroon pass w/ sun.	149
27:37	1	28:37	1	red van	61
27:38	3	29:43	3	yellow pass	126
27:38	1	28:38	1	black van	61
27:39	1	28:39	1	lt blue van	61
27:41	3	29:45	3	blue pass	125
27:41	1	28:42	1	jeep	62
27:43	3	29:47	3	maroon pass w/ sun.	125
27:44	1	28:50	1	black pass	67
27:47	1	28:52	1	dark blue pass	66
27:48	1	28:54	1	white minivan	67
27:48	3	29:57	2	gray pass	130
27:49	1	28:55	1	black pass	67
27:50	2	30:06	2	maroon pass	137
27:51	3	29:49	3	tan pass w/ brown top	119
27:51	1	28:57	1	black pass	67
27:53	3	29:50	3	silver pass	118
27:54	1	29:02	1	gray pass w/ sunroof	69
27:54	2	30:08	2	red pass	135
27:55	3	29:52	3	lt blue minivan	118
27:56	1	29:04	1	silver pass	69
27:57	2	30:10	2	gold suv	134
27:57	3	29:54	3	black pu	118
27:58	1	29:06	1	blue pass	69
27:59	3	29:56	3	white pass	118
28:00	1	29:08	1	yellow taxi	69
28:01	2	30:12	2	white pass	132
28:01	3	29:57	3	black suv	117
28:02	1	29:10	1	red pass w/ sunroof	69
28:03	3	29:59	3	blue pass	117
28:04	3	30:01	3	maroon pass	118
28:05	2	30:13	2	black jeep	129
28:05	1	29:12	1	blue pass	68
28:07	2	30:15	2	black pass w/ sunroof	129

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
28:07	1	29:13	1	black pass	67
28:09	1	29:15	1	gray pass	67
28:10	2	30:17	2	black wagon	128
28:12	1	29:18	1	gold pass	67
28:12	2	30:19	2	white pass	128
28:12	3	30:03	3	red pu/canopy	112
28:13	2	30:20	2	black pass	128
28:14	1	29:20	1	gray pass w/ sunroof	67
28:15	2	30:22	2	blue pass	128
28:15	3	30:05	3	gray pass	111
28:16	2	30:23	2	jeep	128
28:17	3	30:06	3	white suv	110
28:18	1	29:23	1	red minivan	66
28:18	2	30:26	2	blue pass	129
28:18	3	30:08	3	blue pass	111
28:20	2	30:28	2	white wagon	129
28:20	1	29:25	1	blue suv	66
28:21	2	30:10	3	black suv	110
28:22	1	29:26	1	black pu	65
28:23	2	30:30	2	blue pass	128
28:24	1	29:28	1	maroon pass	65
28:25	2	30:32	2	white pass	128
28:26	1	29:30	1	gray pass	65
28:27	2	30:33	2	white wagon	127
28:28	3	30:13	3	truck trailer semi	106
28:28	2	30:35	2	white pu	128
28:29	1	29:31	1	maroon pu/canopy	63
28:30	2	30:37	2	blue hatchback	128
28:30	3	30:15	3	blue convertible	106
28:31	1	29:32	1	red pass	62
28:32	1	29:34	1	black gray suburban	63
28:32	3	30:11	4	gray van	100
28:34	2	30:36	3	red jeep	123
28:35	1	29:38	1	black wagon	64
28:35	2	30:38	2	white pass	124
28:36	3	30:15	4	maroon pass	100
28:36	2	30:40	2	blue pu/canopy	125
28:37	1	29:39	1	white pass	63
28:39	2	30:43	2	silver minivan	125
28:40	3	30:19	3	red pu/canopy	100
28:40	1	29:40	1	black suv	61
28:42	1	29:43	1	black pass	62
28:42	2	30:44	2	black jeep	123

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
28:43	2	30:45	2	gray pass	123
28:44	3	30:23	3	silver pu	100
28:44	1	29:44	1	white delivery truck	61
28:45	1	29:46	1	red pass	62
28:45	3	30:24	3	blue pass	100
28:45	2	30:48	2	gray pass	124
28:46	2	30:49	2	maroon pass	124
28:47	3	30:23	4	black pass	97
28:48	1	29:49	1	white wagon	62
28:48	3	30:25	4	gray blue pass	98
28:49	1	29:49	1	black pass	61
28:50	3	30:28	3	white van	99
28:50	2	30:51	2	black suv	122
28:51	2	30:52	2	black pass	122
28:51	1	29:51	1	gray pass	61
28:51	3	30:33	3	black pu	103
28:53	1	29:52	1	white pu	60
28:54	2	30:47	3	blue pu/canopy	114
28:54	3	30:34	3	black pass	101
28:55	1	29:53	1	gray pass	59
28:55	2	30:49	3	red pu/canopy	115
28:56	3	30:39	3	white hatchback	104
28:57	2	30:54	2	white pass w/ sunroof	118
28:58	2	30:45	3	maroon pass	108
28:59	1	29:57	1	black pass	59
29:00	3	30:40	3	gray suv	101
29:00	2	30:55	2	white van	116
29:01	1	29:59	1	black pass	59
29:01	2	30:41	3	blue pass	101
29:02	1	30:00	1	blue minivan	59
29:03	3	30:43	3	white red suv	101
29:04	1	30:01	1	green pass	58
29:04	2	30:57	2	red pass	114
29:06	1	30:03	1	maroon pass	58
29:06	3	30:49	4	red suv	104
29:06	2	30:59	2	black van	114
29:07	1	30:05	1	black pass	59
29:07	3	30:51	3	silver van	105
29:08	2	31:00	2	gray pu/canopy	113
29:09	3	30:52	3	red pass	104
29:10	3	30:54	3	maroon pass	105
29:10	1	30:08	1	dark gray pass	59
29:11	2	31:02	2	white minivan	112

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
29:12	3	30:59	3	black suv	108
29:12	1	30:10	1	white pu	59
29:14	3	31:00	4	blue pass w/ black top	107
29:14	2	31:05	2	maroon sedan	112
29:14	1	30:11	1	black pass	58
29:15	2	31:06	2	white blue pu	112
29:16	3	31:01	3	maroon suv	106
29:17	1	30:16	1	silver pu	60
29:18	3	31:03	3	white suv	106
29:18	2	31:09	2	white flatbed	112
29:20	3	31:06	4	silver minivan	107
29:20	2	31:10	2	black pass	111
29:20	1	30:18	1	white wagon	59
29:21	3	31:06	3	black pu	106
29:21	2	31:12	2	maroon pass	112
29:22	1	30:19	1	maroon pass	58
29:22	3	31:07	3	blue pass	106
29:24	2	31:16	2	black hatchback	113
29:25	3	31:09	3	blue pu/canopy	105
29:25	2	31:17	2	black pass w/ sunroof	113
29:27	2	31:19	2	black pu/canopy	113
29:27	1	30:24	1	black suv	58
29:28	3	31:11	3	white pu	104
29:28	2	31:21	2	blue pass	114
29:28	3	31:12	3	dark gray pass w/ sun.	105
29:29	1	30:25	1	black minivan	57
29:29	3	31:13	3	red pass	105
29:30	2	31:22	2	white pu/canopy	113
29:31	3	31:15	3	silver wagon	105
29:32	1	30:29	1	white pu	58
29:32	2	31:24	2	black pass	113
29:33	3	31:18	3	red pass	106
29:34	1	30:31	1	silver hatchback	58
29:35	2	31:26	2	maroon pass	112
29:35	3	31:22	4	blue pass	108
29:37	1	30:36	1	blue vw van	60
29:37	2	31:28	2	red pass	112
29:37	3	31:21	3	blue pass	105
29:38	2	31:30	2	black pu	113
29:39	3	31:23	3	black pu/canopy	105
29:39	1	30:39	1	blue hatchback	61
29:41	1	30:40	1	silver pu/canopy	60
29:41	3	31:24	3	red pass w/sunroof	104

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
29:41	2	31:32	2	maroon pass	112
29:42	1	30:42	1	black suv	61
29:43	2	31:33	2	gray pass	111
29:43	3	31:26	3	gray pass w/ sunroof	104
29:44	2	31:34	2	maroon pass	111
29:45	3	31:28	3	yellow pass	104
29:46	1	30:47	1	gray pass w/ sunroof	62
29:47	3	31:30	3	brown hatchback	104
29:47	2	31:35	2	red pu	109
29:48	2	31:37	2	blue pass	110
29:48	3	31:31	3	white pass w/ sunroof	104
29:49	2	31:38	2	black pu	110
29:50	3	31:41	2	gray/black suv	112
29:51	2	31:43	2	black pass	113
29:52	2	31:44	2	dark blue w/ sunroof	113
29:52	3	31:32	3	blue pass	101
29:54	2	31:46	2	white pass w/ sunroof	113
29:55	3	31:35	3	black pass	101
29:56	1	30:49	1	white pass w/ sunroof	54
29:56	2	31:43	5	bus	108
29:56	3	31:36	3	black suv	101
29:58	2	31:48	3	white pass w/ sunroof	111
29:58	3	31:38	3	bronze pass w/ sunroof	101
29:59	1	30:53	1	brown/tan suv	55
29:59	2	31:45	3	red suv	107
29:59	3	31:41	3	red pu	103
30:00	1	30:56	1	white minivan	57
30:02	2	31:48	2	maroon pass	107
30:02	1	30:58	1	silver suv	57
30:02	3	31:42	3	black minivan	101
30:03	1	31:00	1	bronze suv	58
30:04	3	31:28	1	gray suv	85
30:05	1	31:03	1	gold wagon	59
30:05	2	31:49	2	gray pu/canopy	105
30:06	3	31:50	2	maroon pu	105
30:07	3	31:44	3	black pass	98
30:08	1	31:07	1	black convertible	60
30:08	2	31:54	2	gray van	107
30:09	1	31:10	1	silver hatchback	62
30:09	2	31:56	2	maroon pass	108
30:11	1	31:14	1	red pass	64
30:12	3	31:51	3	dump truck	100
30:13	1	31:18	1	gray pu	66

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
30:14	2	31:59	2	blue hatchback	106
30:15	3	31:53	3	black pass	99
30:15	1	31:20	1	gray pass	66
30:16	1	31:21	1	red pass	66
30:16	3	31:55	3	black pass	100
30:17	2	32:04	2	white van	108
30:17	1	31:22	1	red suv	66
30:18	3	31:56	3	blue hatchback	99
30:18	2	32:05	2	white pass w/ sunroof	108
30:18	1	31:23	1	black suv	66
30:19	2	32:04	3	red pu/canopy	106
30:20	1	31:29	1	blue gray van	70
30:21	2	32:07	2	red pass	107
30:21	3	32:01	3	truck trailer semi	101
30:22	3	32:01	2	white pu	100
30:22	1	31:31	1	black suv	70
30:22	2	32:07	4	white pu/canopy	106
30:23	3	32:03	3	blue/gray pass w/ sun.	101
30:24	1	31:32	1	white toyata w/ canopy	69
30:24	2	32:08	2	white pass	105
30:25	1	31:33	1	maroon pass	69
30:26	3	32:07	3	white delivery truck	102
30:26	1	31:35	1	silver minivan	70
30:27	2	32:11	2	gray pass w/ sunroof	105
30:29	2	32:12	2	gray pass w/ sunroof	104
30:29	1	31:38	1	silver pass	70
30:30	3	32:11	3	truck trailer semi	102
30:33	3	32:14	3	red minivan	102
30:34	1	31:41	1	CT bus	68
30:34	2	32:18	2	black/silver pu/canopy	105
30:34	3	32:16	3	gray hatchback	103
30:36	2	32:20	2	green van w/ ladders	105
30:36	1	31:44	1	motorcycle	69
30:37	1	31:46	1	black pass	70
30:37	3	32:17	3	silver truck	101
30:38	2	32:22	2	maroon pass	105
30:38	1	31:48	1	red pass	71
30:39	2	32:24	2	black pu	106
30:40	3	32:20	3	red pass	101
30:40	1	31:50	1	black pass	71
30:41	1	31:51	1	motorcycle	71
30:41	2	32:26	2	black el camino	106
30:42	3	32:21	4	blue van	100

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
30:43	2	32:28	2	white pu	106
30:44	3	32:31	2	maroon pass	108
30:44	2	32:29	2	black pass	106
30:45	1	31:57	1	CT bus	73
30:45	3	32:25	3	black pass w/ sunroof	101
30:46	1	31:58	1	black pass	73
30:47	3	32:26	3	gray pass	100
30:48	1	32:00	1	red pass	73
30:49	2	32:35	2	blue gray pass	107
30:50	2	32:37	3	white minivan	108
30:50	1	32:01	1	gold suv	72
30:51	3	32:29	3	white pass	99
30:51	2	32:37	2	gold wagon	107
30:52	3	32:30	3	tan pass	99
30:52	1	32:04	1	blue pass	73
30:54	3	32:33	3	black pass	100
30:55	2	32:41	2	blue pass	107
30:55	1	32:06	1	tan van	72
30:56	2	32:44	2	black pass	109
30:57	1	32:08	1	white pass	72
30:58	2	32:11	1	gray pass	74
30:58	3	32:36	3	black pu	99
30:58	1	32:10	1	red pass	73
31:00	3	32:41	3	silver pass	102
31:01	2	32:45	2	black pass	105
31:01	1	32:16	2	white pu w/ trailer	76
31:02	2	32:47	2	black pu/canopy	106
31:02	3	32:43	3	black pass	102
31:02	1	32:16	1	gray pass	75
31:03	2	32:49	2	brown pu	107
31:04	1	32:17	1	jeep	74
31:05	3	32:45	3	white pass	101
31:05	2	32:51	2	gray hatchback	107
31:05	1	32:19	1	maroon pass	75
31:07	2	32:53	2	blue pu/canopy	107
31:07	3	32:47	3	blue w/ sunroof	101
31:08	1	32:21	1	gray minivan	74
31:08	3	32:48	3	gray pass	101
31:08	2	32:55	2	gray pass	108
31:09	1	32:23	1	blue pass w/ sunroof	75
31:10	3	32:50	3	black pu	101
31:10	1	32:24	1	maroon pass	75
31:11	1	32:25	1	black suv	75

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
31:11	2	32:56	2	gray w/ sun.	106
31:12	3	32:52	3	dark blue suv	101
31:12	1	32:33	2	white pass	82
31:13	2	32:59	2	gray pass w/ sunroof	107
31:14	1	32:30	1	blue pass	77
31:15	3	32:54	3	white truck with junk	100
31:16	1	32:32	1	silver van	77
31:17	3	32:56	3	maroon hatchback	100
31:18	1	32:33	1	red minivan	76
31:18	2	33:02	2	white pu	105
31:19	3	32:58	3	silver pass	100
31:20	2	33:04	2	gray pass w/ sunroof	105
31:20	1	32:35	1	white pass	76
31:20	3	33:00	3	red pu	101
31:22	3	33:02	3	red pu/canopy	101
31:22	2	33:06	2	blue pass	105
31:22	1	32:37	1	blue pass	76
31:23	2	33:08	2	black wagon	106
31:24	1	32:38	1	white minivan	75
31:25	1	32:39	1	motorcycle	75
31:25	2	33:11	2	white suv	107
31:26	1	32:40	1	motorcycle	75
31:27		33:08	3	semi	102
31:28	2	33:15	2	black suv	108
31:28	1	32:42	1	black suv	75
31:31	2	33:19	2	white pu	109
31:31	1	32:44	1	black wagon	74
31:31	3	33:11	3	black suv	101
31:33	2	33:23	2	white pass	111
31:33	1	32:47	1	gray pass	75
31:34	3	33:09	4	red/white pu/canopy	96
31:34	2	33:25	2	black suv	112
31:35	1	32:49	1	black hatchback	75
31:36	3	33:13	3	gray pass	98
31:36	2	33:29	2	white pass	114
31:37	1	32:51	1	red pu	75
31:39	2	33:32	2	red suv	114
31:39	3	33:17	3	maroon/silver pu	99
31:40	1	32:53	1	black suburban	74
31:40	2	33:34	2	black pass	115
31:41	3	33:21	3	black suv	101
31:42	1	32:55	1	gray pass w/ sunroof	74
31:43	2	33:37	2	blue pass	115

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
31:44	1	32:57	1	black pass	74
31:44	3	33:24	5	red pass	101
31:45	2	33:41	2	silver suburban	117
31:46	1	32:59	1	blue pass	74
31:47	2	33:44	2	white pu/canopy	118
31:48	1	33:00	1	maroon suv	73
31:50	1	33:01	1	white van	72
31:50	2	33:47	2	gray pass	118
31:50	3	33:41	3	truck trailer w/ lumber	112
31:51	2	33:51	2	red hatchback	121
31:52	1	33:03	1	red pass w/ sunroof	72
31:52	3	33:44	3	red pass	113
31:53	1	33:05	1	black suv	73
31:53	2	33:52	2	white/blue van	120
31:54	3	33:48	3	maroon pass	115
31:55	2	33:55	2	white hatchback	121
31:55	1	33:07	1	black pu	73
31:56	3	33:50	3	black pass	115
31:57	1	33:09	1	black minivan	73
31:58	2	33:55	2	dark blue pass	118
31:58	3	33:54	3	black pass	117
31:59	2	33:57	2	black pass	119
31:59	1	33:12	1	white pipe truck	74
32:00	3	33:57	3	gray pass	118
32:00	2	33:58	2	red pass	119
32:01	1	33:13	1	white minivan	73
32:02	2	34:00	2	silver pu	119
32:03	3	33:59	3	black pass	117
32:04	1	33:17	1	black minivan	74
32:04	3	34:01	3	gray pass	118
32:05	1	33:19	1	black pass	75
32:05	3	34:04	3	white suv	120
32:07	2	34:04	2	white pu	118
32:07	3	34:05	3	red pass w/ sunroof	119
32:09	3	34:08	3	black pass w/ sunroof	120
32:09	2	34:07	2	silver pass	119
32:11	3	34:09	3	gray hatchback	119
32:12	3	34:12	3	blue pass	121
32:13	1	33:27	1	CT bus	75
32:13	2	34:11	2	maroon pass	119
32:14	3	34:15	4	black minivan	122
32:14	1	33:28	1	black pass	75
32:14	2	34:13	2	gray pass	120

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
32:16	3	34:05	4	black pass	110
32:16	2	34:14	2	gray pass	119
32:17	1	33:30	1	white van	74
32:17	3	34:13	3	white pass w/ sunroof	117
32:19	1	33:31	1	white pass	73
32:20	2	34:16	2	black pu/canopy	117
32:20	3	34:16	3	white pass w/ sunroof	117
32:21	1	33:33	1	black pu/canopy	73
32:22	2	34:19	2	maroon suv	118
32:23	1	33:34	1	black pass w/ sunroof	72
32:24	2	34:20	2	maroon suv	117
32:25	3	34:17	3	black pass	113
32:25	2	34:22	2	black pass w/ sunroof	118
32:26	1	33:38	1	gray van	73
32:27	2	34:09	2	gray pass w/ sunroof	103
32:27	3	34:20	3	black pu/canopy	114
32:28	1	33:40	1	white pass	73
32:29	2	34:27	2	white pass	119
32:31	1	33:41	1	black pass w/ sunroof	71
32:31	2	34:25	2	white minivan	115
32:31	3	34:23	3	flatbed truck	113
32:32	1	33:43	1	black minivan	72
32:33	3	34:25	3	white pass	113
32:35	1	33:46	1	white pu/canopy	72
32:35	2	34:28	2	gray pass	114
32:36	3	34:17	4	white pass w/ sunroof	102
32:37	1	33:48	1	blue pass	72
32:38	3	34:29	3	red convertible	112
32:39	2	34:31	2	black jeep	113
32:39	1	33:49	1	gray minivan	71
32:40	1	33:50	1	black pass	71
32:41	2	34:32	2	blue pass	112
32:42	3	34:31	3	black pass w/ sunroof	110
32:42	1	33:52	1	red pass	71
32:43	2	34:34	2	cream pass	112
32:44	3	34:33	3	gray pass	110
32:45	2	34:35	1	gray pass w/ sunroof	111
32:45	1	33:54	1	black pass w/ sunroof	70
32:46	3	34:35	3	white van	110
32:47	2	34:37	2	maroon pu	111
32:47	1	33:56	1	red hatchback	70
32:48	2	34:13	2	white pass	86
32:49	1	33:58	1	red jeep	70

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
32:50	3	34:37	3	gray van	108
32:51	1	34:00	1	black pass	70
32:51	2	34:40	2	red pu/canopy	110
32:52	3	34:39	3	black pass	108
32:53	1	34:01	1	black van	69
32:53	2	34:42	2	red pass w/ sunroof	110
32:55	2	34:44	2	maroon pass w/ sunroof	110
32:55	1	34:04	1	black pu	70
32:56	3	34:40	3	white wagon	105
32:57	2	34:48	2	white pass	112
32:58	1	34:06	1	tan pass	69
32:58	3	34:43	3	maroon ford pu	106
32:59	2	34:49	2	white suburban	111
33:00	1	34:07	1	black minivan	68
33:00	3	34:45	3	black pass	106
33:01	1	34:08	1	white pu	68
33:01	3	34:48	3	blue wagon	108
33:02	2	34:51	2	brown van	110
33:03	1	34:09	1	red pass	67
33:03	3	34:15	5	brown/tan pu/canopy	73
33:04	1	34:11	1	black minivan	68
33:04	3	34:26	5	red suv	83
33:05	2	34:53	2	silver pass	109
33:06	3	34:54	2	red/silver pu	109
33:06	1	34:14	1	dark gray pass	69
33:07	2	34:56	2	gray pass	110
33:08	2	34:58	2	pu w/ white canopy	111
33:08	1	34:16	1	blue minivan	69
33:09	1	34:17	1	blue pass	69
33:09	3	34:50	4	maroon convertible	102
33:10	2	34:59	2	gray pass w/ sunroof	110
33:12	1	34:20	1	silver minivan	69
33:13	1	34:21	1	gold pass	69
33:13	2	35:03	2	white junk truck	111
33:13	3	34:52	3	red pass	100
33:15	3	34:53	3	gray/blue van	99
33:15	1	34:23	1	black pass	69
33:15	2	35:05	2	black pass	111
33:16	3	35:02	3	white pass w/ sunroof	107
33:18	3	34:54	3	silver pass w/ sunroof	97
33:18	1	34:24	1	gray pass	67
33:19	1	34:26	1	gray pass	68
33:19	2	35:11	2	tanker truck	113

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
33:21	1	34:28	1	red pass	68
33:21	3	34:59	3	white van	99
33:21	2	35:13	2	black wagon	113
33:22	1	34:30	1	white van	69
33:23	1	34:31	1	blue suv	69
33:23	3	35:02	3	white pass w/ sunroof	100
33:24	3	35:03	3	white pu	100
33:28	1	34:37	1	CT bus	70
33:28	2	35:05	3	brown pass	98
33:29	1	34:38	1	white pass	70
33:29	3	35:13	3	truck trailer w/ red box	105
33:29	2	35:15	2	white pass	107
33:30	3	35:14	3	black pass	105
33:31	1	34:40	1	maroon minivan	70
33:31	2	35:17	2	maroon suv	107
33:32	1	34:41	1	sick brown pass	70
33:32	3	35:19	2	white pu	108
33:33	2	35:07	3	red wagon	95
33:34	3	35:15	3	black pass	102
33:34	1	34:43	1	gray pass	70
33:35	3	35:00	5	white pu	86
33:35	1	34:46	1	black pu	72
33:36	2	35:22	2	black pass	107
33:36	3	35:13	4	black suv	98
33:37	2	35:24	2	maroon pu	108
33:38	3	35:18	3	black pass w/ sunroof	101
33:39	2	35:25	2	gray van	107
33:39	1	34:50	1	art. CT bus (5824)	72
33:39	3	35:20	3	black suv	102
33:41	2	35:23	3	white pass w/ sunroof	103
33:41	1	34:52	1	red pass	72
33:42	3	35:21	3	dark blue pass	100
33:43	2	35:28	2	brown pass	106
33:44	1	34:55	1	white pass	72
33:44	2	34:53	1	silver pu/canopy	70
33:45	1	34:56	1	blue minivan	72
33:45	2	35:23	1	red pass w/ sunroof	99
33:46	1	34:57	1	black hatchback	72
33:47	1	34:59	1	maroon pass	73
33:48	2	35:31	2	red pu	104
33:49	1	35:01	1	white pu/canopy	73
33:49	2	35:25	3	red pass w/ sunroof	97
33:50	1	35:02	1	silver pu/canopy	73

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
33:50	2	35:33	2	red hatchback	104
33:51	2	35:34	2	black pass w/ sunroof	104
33:52	3	35:29	3	white wagon	98
33:52	1	35:04	1	gray pass	73
33:53	2	35:08	1	maroon pass	76
33:53	1	35:06	1	tan pu	74
33:55	1	35:07	1	white pass	73
33:55	3	35:38	3	truck trailer	104
33:56	2	35:37	2	black pu	102
33:56	1	35:08	1	maroon pass	73
33:57	3	35:41	3	maroon pu/canopy	105
33:57	2	35:39	2	blue/silver pu	103
33:59	3	35:43	3	white pu toyota	105
33:59	2	35:40	2	white pass	102
34:00	1	35:11	1	black conv. w/ gray top	72
34:00	3	35:45	3	white pass w/ sunroof	106
34:01	1	35:17	1	flatbed pipe truck	77
34:01	2	35:43	2	maroon pass	103
34:02	3	35:47	2	maroon/silver pu	106
34:03	2	35:49	2	black pass	107
34:03	3	35:47	3	red minivan	105
34:04	2	35:50	2	black minivan	107
34:04	1	35:19	1	blue pass	76
34:06	3	35:51	3	black suv	106
34:06	1	35:21	1	black minivan	76
34:06	2	35:53	2	black pass	108
34:07	3	35:53	3	gray pass	107
34:08	2	35:55	2	silver pass	108
34:08	1	35:25	1	maroon pass	78
34:09	2	36:00	2	blue w/ whitetop	112
34:09	3	35:49	5	red pass	101
34:10	3	35:40	5	red suv	91
34:10	1	35:27	1	brown pass	78
34:10	2	36:32	4	white minivan	143
34:11	3	35:57	3	black pass	107
34:12	1	35:28	1	black pass	77
34:12	3	36:00	3	black w/ sunroof	109
34:13	2	36:05	2	white pu	113
34:13	1	35:30	1	blue pass	78
34:14	3	36:16	3	gray pu/canopy	123
34:14	1	35:31	1	black suv	78
34:15	2	35:32	1	black pass	78
34:16	3	36:23	3	black wagon	128

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
34:16	1	35:36	1	blue w/ sunroof	81
34:17	2	36:08	2	white van	112
34:17	1	35:38	1	gray pu/canopy	82
34:17	3	36:28	3	black pu	132
34:19	1	35:39	1	red suv	81
34:19	3	36:30	3	silver pass	132
34:20	2	36:13	2	green pass	114
34:20	3	36:32	3	tan pass	133
34:21	2	36:18	2	gray pass	118
34:21	1	35:41	1	black pass w/ sunroof	81
34:22	2	36:28	2	black pu	127
34:22	3	36:34	3	black suv	133
34:23	1	35:42	1	black wagon	80
34:23	2	36:31	2	blue pass	129
34:24	1	35:41	2	black pass	78
34:25	3	35:53	5	maroon pu/canopy	89
34:26	2	36:38	2	semi cab...no trailer	133
34:26	3	36:39	3	white van	134
34:27	1	35:44	1	white pass	78
34:28	3	36:41	3	gray pu	134
34:29	3	36:43	3	gray suv	135
34:29	1	35:47	1	white pass w/ sunroof	79
34:29	2	36:40	2	red hatchback	132
34:30	3	36:34	2	white suv	125
34:30	1	35:48	1	motorcycle	79
34:31	3	36:45	3	red pass	135
34:32	1	35:50	1	blue pass	79
34:33	2	36:43	2	gray pass	131
34:33	1	35:53	1	black pass	81
34:34	2	36:44	2	silver pass w/ sunroof	131
34:34	3	36:46	2	tan pu	133
34:34	1	35:54	1	red pass	81
34:35	3	36:50	2	white hatchback	136
34:36	2	36:49	2	gray pu/canopy	134
34:36	3	36:48	3	gray pass w/ sunroof	133
34:36	1	35:55	1	blue suv	80
34:38	3	36:50	3	red pass w/ sunroof	133
34:38	2	36:52	2	gray pass	135
34:38	1	35:57	1	gold/red van	80
34:39	2	36:57	2	white pass	139
34:39	3	36:53	3	black pass	135
34:40	1	35:59	1	black pu	80
34:40	2	37:03	2	gray hatchback	144

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
34:41	1	36:00	1	black jeep	80
34:42	2	37:04	2	black pu/canopy	143
34:42	3	37:00	2	red pu/canopy	139
34:43	1	36:02	1	black suv	80
34:44	2	37:11	2	white pass	148
34:45	3	37:07	2	blue pass	143
34:45	1	36:04	1	black pass	80
34:47	1	36:07	1	white hatchback	81
34:47	2	37:12	2	orange pu	146
34:48	3	36:55	3	gray minivan	128
34:48	2	36:52	3	black pass w/ sunroof	125
34:50	2	37:16	2	white pass	147
34:50	1	36:12	1	white pass	83
34:51	2	37:17	2	white pu	147
34:52	2	37:20	2	red convertible	149
34:53	1	36:15	1	gray pass	83
34:54	2	36:59	3	gray minivan	126
34:55	1	36:18	1	white pass	84
34:56	1	36:20	1	black jeep	85
34:56	2	37:22	2	black pass w/ sunroof	147
34:56	3	37:19	3	truck/trailer	144
34:57	2	36:54	2	white van	118
34:57	1	36:22	1	white convert.	86
34:59	1	36:25	1	gray pass	87
34:59	2	37:09	1	blue minivan	131
35:00	3	37:25	2	white suv	146
35:01	2	37:26	2	black suv	146
35:01	1	36:26	1	black jeep	86
35:01	3	37:22	3	gray pass w/ sunroof	142
35:02	2	37:28	2	black suv	147
35:02	1	36:28	1	black pass	87
35:03	3	37:25	3	black pass	143
35:04	1	36:32	1	black suv	89
35:05	2	37:30	2	black pass	146
35:05	3	37:26	4	lt blue pas	142
35:05	1	36:35	1	white wagon	91
35:07	1	36:37	1	gray pass w/ sunroof	91
35:07	2	37:33	2	black jeep	147
35:07	3	37:27	3	blue wagon	141
35:08	1	36:38	1	red pass	91
35:09	3	37:29	3	white pu/canopy	141
35:09	2	37:35	2	black pass	147
35:10	2	37:36	2	red/brown wagon	147

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
35:10	1	36:41	1	red suv	92
35:11	2	36:44	1	maroon van	94
35:12	3	37:33	3	black pass	142
35:13	1	36:47	1	gray pass	95
35:13	3	37:36	3	red pu	144
35:14	2	37:38	2	cream pass	145
35:14	1	36:48	1	gray pu	95
35:15	2	37:40	2	black pu	146
35:15	3	37:37	3	black pass	143
35:16	1	36:50	1	dark blue pass	95
35:18	3	37:39	3	white pu	142
35:20	2	37:45	2	black wagon	146
35:20	3	37:40	3	black pu/canopy	141
35:20	2	37:47	2	white van	148
35:22	2	37:49	2	black suv	148
35:23	3	37:41	3	blue pass	139
35:23	1	36:55	1	brown pass	93
35:24	2	37:51	2	blue pass	148
35:25	1	36:56	1	black pass	92
35:26	3	37:44	3	maroon suv	139
35:26	2	37:53	2	black pu	148
35:26	1	36:58	1	black pass	93
35:27	1	37:01	1	white pass	95
35:27	2	37:54	2	maroon suv	148
35:28	3	37:46	3	black hatchback	139
35:29	1	37:03	1	black pass	95
35:29	2	37:56	2	black hatchback	148
35:29	3	37:47	3	white pass	139
35:31	3	37:49	3	brown truck	139
35:31	2	37:58	2	tan pass	148
35:33	1	37:06	1	black pass	94
35:34	3	37:52	3	gray pass	139
35:34	2	38:01	2	green /white pu/canopy	148
35:34	3	37:54	3	blue hatchback	141
35:35	1	37:31	3	metro little bus	117
35:36	2	38:03	2	maroon pu	148
35:36	3	37:58	3	red pu/canopy	143
35:37	1	37:10	1	tan pu/canopy	94
35:37	2	38:05	2	gray pass	149
35:37	1	37:12	1	maroon pass w/ sunroof	96
35:39	1	37:15	1	gray pass	97
35:39	3	38:01	3	maroon pass	143
35:40	2	37:56	5	blue minivan	137

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
35:41	3	38:03	3	black pass	143
35:41	2	38:07	2	gray hatchback	147
35:42	1	37:18	1	black pass	97
35:42	2	38:08	2	black pass	147
35:43	2	38:10	2	maroon pass	148
35:43	3	38:06	3	black pass	144
35:43	1	37:19	1	gray pass	97
35:44	2	38:11	2	black pass w/ sunroof	148
35:45	1	37:22	1	gray hatchback	98
35:46	3	38:09	3	gray pass	144
35:46	2	38:13	2	black suv	148
35:49	1	37:24	1	gold minivan	96
35:49	2	38:16	2	gray wagon	148
35:49	3	38:17	2	yellow van	149
35:50	1	37:25	1	black pass	96
35:50	3	38:11	3	black hatchback	142
35:51	2	38:19	2	black pass	149
35:52	1	37:28	1	white minvan	97
35:52	2	38:21	2	black pass	150
35:53	3	38:13	3	white convert.	141
35:54	2	38:22	2	red pass	149
35:54	3	38:14	3	brown pass	141
35:54	1	37:30	1	blue pass	97
35:54	2	38:24	2	maroon pass	151
35:55	2	38:26	2	black hatchback	152
35:56	3	38:15	3	blue pass	140
35:56	1	37:32	1	white pu	97
35:57	1	37:34	1	black pass	98
35:57	3	38:17	3	gray wagon	141
35:58	2	38:27	2	white truck	150
35:59	1	37:36	1	red pass	98
36:00	1	37:38	1	black pass	99
36:01	2	38:29	2	gray pu/canopy	149
36:01	3	38:20	3	black pass w/ sunroof	140
36:03	2	38:31	2	blue pu	149
36:04	3	38:23	3	blue pass	140
36:04	1	37:39	1	blue suv	96
36:05	2	38:33	2	black pass w/ sunroof	149
36:06	3	38:25	3	tan pass w/ sunroof	140
36:06	2	38:34	2	maroon truck/canopy	149
36:07	2	38:35	2	white pass	149
36:07	1	37:41	1	gray pass	95
36:08	2	38:36	2	black pass	149

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
36:09	2	38:38	2	white pass	150
36:09	3	38:27	3	black pu/canopy	139
36:11	1	37:43	1	brown pass	93
36:11	3	38:29	3	maroon wagon	139
36:11	2	38:40	2	gray pass w/ sunroof	150
36:12	1	37:44	1	maroon hatchback	93
36:13	2	38:42	2	black suv	150
36:14	1	37:46	1	motorcycle	93
36:14	2	38:44	2	blue pass	151
36:15	3	38:31	3	tan pass	137
36:16	1	37:48	1	black suv	93
36:17	2	38:45	2	gray pass	149
36:18	1	37:49	1	maroon suv	92
36:19	3	38:07	5	black pu/canopy	109
36:20	2	38:47	2	black pass	148
36:20	3	38:34	3	gray suv	135
36:21	1	37:51	1	whtie pass	91
36:21	2	38:48	2	tan pass	148
36:22	3	38:35	3	black pass	134
36:23	3	38:37	3	blue convertible	135
36:24	2	38:51	2	gray minivan	148
36:24	1	37:53	1	white pu	90
36:25	3	38:38	3	white t-top	134
36:25	2	38:52	2	blue/green pass	148
36:26	1	37:54	1	maroon pass	89
36:27	3	38:40	3	blue w/ black top	134
36:27	2	38:33	5	gray pass	127
36:28	3	38:42	3	black pass	135
36:28	1	37:56	1	blue pass	89
36:29	2	38:56	2	gray pass w/ sunroof	148
36:30	3	38:46	3	black suv	137
36:31	2	38:57	2	blue pass	147
36:31	2	38:59	2	white pass	149
36:32	3	38:48	3	maroon pass	137
36:33	2	39:00	2	lt brown pass	148
36:34	2	39:01	3	white pass	148
36:35	2	39:02	2	gray conv.	148
36:35	3	38:50	3	red pass	136
36:37	1	37:58	1	maroon suv	82
36:38	3	38:51	3	red/silver pu	134
36:39	2	39:04	2	black suv	146
36:39	1	37:59	1	white suv	81
36:40	3	38:53	3	truck and camper	134

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
36:41	3	38:54	2	brown/red pass	134
36:42	1	38:02	1	silver pass	81
36:43	3	38:48	5	black/silver pu	126
36:43	1	38:05	1	black pass	83
36:44	2	39:06	2	black pass	143
36:46	2	39:07	2	maroon minivan	142
36:46	1	38:07	1	silver hatchback	82
36:48	2	39:09	2	black hatchback	142
36:48	1	38:09	1	white pass w/ sunroof	82
36:48	3	38:56	3	tan pass	129
36:49	3	38:57	3	black jeep	129
36:50	2	39:11	2	white minivan	142
36:50	1	38:11	1	black wagon	82
36:51	3	38:58	3	black pass w/ sunroof	128
36:52	2	39:13	2	white pass	142
36:52	1	38:13	1	blue pu	82
36:53	2	39:15	2	brown/red pass	143
36:55	2	39:17	2	black suv	143
36:56	1	38:16	1	motorcycle	81
36:56	3	39:00	3	white pass	125
36:46	3	39:18	3	white suv	153
36:57	3	39:02	3	silver pu/canopy	126
36:58	2	39:18	2	blue pass	141
36:58	1	38:18	1	white pu	81
36:59	1	38:19	1	black pu	81
37:00	2	39:20	2	black pass	141
37:01	1	38:21	1	black pass	81
37:03	3	39:12	3	maroon minivan	130
37:03	1	38:22	1	silver hatchback	80
37:04	2	39:22	2	black hatchback	139
37:05	1	38:26	1	white pass w/ sunroof	82
37:06	3	39:15	3	tan pass	130
37:06	1	38:27	1	black jeep	82
37:06	2	39:24	2	white minivan	139
37:07	1	38:28	1	black wagon	82
37:08	2	39:29	4	black pass w/ sunroof	142
37:08	3	39:17	3	white pass	130
37:09	1	38:29	1	blue pu	81
37:09	2	39:26	2	brown/red pass	138
37:10	3	39:19	3	black suv	130
37:10	1	38:30	1	motorcycle	81
37:11	2	39:27	2	white pass	137
37:12	3	39:17	4	white suv	126

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
37:14	3	39:21	3	silver pu/canopy	128
37:14	2	39:29	2	blue pass	136
37:14	1	38:32	1	white pu	79
37:15	3	39:22	3	black pu	128
37:17	2	39:31	2	red pu	135
37:17	1	38:34	1	gray pass	78
37:19	1	38:36	1	white van	78
37:19	2	39:36	2	gray hatchback	138
37:19	3	39:17	5	white pass w/ sunroof	119
37:20	1	38:37	1	black hatchback	78
37:21	3	39:15	4	gray pass	115
37:23	1	38:39	1	maroon suv	77
37:25	1	38:41	1	black pass	77
37:26	3	39:25	3	white pass	120
37:26	1	38:42	1	black pass	77
37:28	1	38:43	1	white van	76
37:31	3	39:28	3	red hatchback	118
37:32	1	38:46	1	gray pass	75
37:35	1	38:48	1	red convertible	74
37:36	3	39:30	3	blue minivan	115
37:38	1	38:50	1	black pu w/ ladder	73
37:38	1	38:52	1	black pass w/ sunroof	75
37:41	1	38:54	1	gray pass w/ sunroof	74
37:43	1	38:55	1	black pass	73
37:44	1	38:56	1	lt blue pass	73
37:47	3	39:29	3	black pass	103
37:47	1	38:58	1	red pass	72
37:49	1	39:00	1	tan van	72
37:50	3	39:33	3	gray suv	104
37:51	1	39:03	1	black minivan	73
37:52	3	39:25	5	black pass	94
37:54	2	39:35	2	black pu/canopy	102
37:54	1	39:05	1	red pass	72
37:56	1	39:07	1	red pass	72
37:57	2	39:38	2	black pass	102
37:57	3	39:34	3	red pu w/ trailer	98
37:58	1	39:09	1	gray pass	72
37:59	2	39:41	2	black pass	103
37:59	3	39:40	2	black suv	102
38:01	2	39:43	2	gray pass	103
38:01	3	39:37	3	blue pass w/ sunroof	97
38:02	1	39:10	1	white utility truck	69
38:03	2	39:44	2	black pu	102

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
38:04	1	39:12	1	maroon pass	69
38:05	2	39:45	2	white pass	101
38:06	3	39:40	3	gray pass	95
38:07	2	39:46	2	black pass	100
38:08	1	39:14	1	gray pass	67
38:09	2	39:49	2	maroon pass w/ sunroof	101
38:09	1	39:17	1	maroon pass	69
38:10	3	39:42	3	maroon pass	93
38:11	1	39:18	1	blue wagon	68
38:11	2	39:51	2	white pass	101
38:12	3	39:47	3	brown jeep	96
38:13	2	39:51	2	silver pass	99
38:14	1	39:20	1	black pass	67
38:14	3	39:48	2	gray pass	95
38:14	2	39:52	2	tan van	99
38:15	1	39:21	1	red pu	67
38:16	2	39:54	2	black pass	99
38:16	3	39:49	3	silver minivan	94
38:17	2	39:56	2	red pu	100
38:18	3	39:51	3	gray wagon	94
38:18	1	39:22	1	black pass	65
38:19	2	39:58	2	maroon pass	100
38:20	3	39:52	3	tan minivan	93
38:20	1	39:24	1	gray pass	65
38:21	2	39:59	2	black pass	99
38:22	2	39:54	3	black convertible	93
38:22	1	39:25	1	black minivan	64
38:23	3	39:57	3	bronze minivan	95
38:24	1	39:27	1	white hatchback	64
38:24	2	40:01	2	gray suv	98
38:25	3	40:01	3	black pass	97
38:25	1	39:28	1	blue pass	64
38:25	2	40:02	2	black jeep	98
38:26	3	39:57	5	blue pass	92
38:27	3	40:01	3	red pass	95
38:28	2	40:05	2	black pass	98
38:28	1	39:29	1	black pu	62
38:29	3	40:03	2	red pu	95
38:29	2	40:06	2	black pass w/ sunroof	98
38:30	1	39:30	1	black suv	61
38:31	3	40:03	3	gray pass	93
38:32	1	39:32	1	black pass	61
38:32	3	40:06	3	blue van	95

130th time (min:sec)	lane	145th time (min:sec)	lane	Vehicle Description	travel time (sec)
38:33	2	40:07	2	gray van	95
38:34	2	40:08	2	silver pass	95
38:34	1	39:34	1	black suv	61
38:35	3	40:08	3	gray pass	94
38:36	2	40:10	2	brown pu	95
38:38	1	39:36	1	black pass w/ sunroof	59
38:38	2	40:14	2	blue minivan	97
38:39	3	40:11	3	white pass	93
38:40	3	39:41	1	white van	62
38:40	2	40:16	2	red pass	97
38:41	1	39:37	1	black pass	57
38:41	3	40:04	5	white van	84
38:43	1	39:39	1	maroon pass	57
38:43	2	40:17	2	gray pass w/ sunroof	95
38:44	3	40:13	3	white suv	90
38:44	2	40:14	3	gray pass	91
38:45	3	40:06	5	white pass w/ sunroof	82
38:46	2	40:18	2	black suv	93
38:47	2	40:20	2	blak pass	94
38:48	1	39:52	1	CT bus	65
38:48	3	40:17	3	black pass	90
38:49	1	39:54	1	black pass	66
38:49	3	40:18	3	white pass	90
38:50	2	40:22	2	blue pass	93
38:51	1	39:54	1	black pass w/ sunroof	64
38:51	2	40:13	1	blue minivan	83
38:51	3	40:19	3	white pass w/ sunroof	89
38:52	1	39:55	1	red pu/canopy	64
38:53	3	40:21	3	brown/tan vw van	89
38:53	2	40:24	2	black pass	92
38:54	1	39:57	1	maroon/silver pu	64
38:55	2	40:25	2	blue pass w/ sunroof	91
38:55	1	39:58	1	black pass	64
38:55	3	40:23	3	red pass	89
38:57	1	39:59	1	gray pass	63
38:57	2	40:28	2	yellow bug	92
38:57	3	40:25	3	maroon pass	89
38:59	2	40:30	2	white pass	92
38:59	1	40:00	1	white van	62

APPENDIX C: MOBILIZER DATA – RIGHT LANE

Destination time	id	Origin time	id	travel time
106.25	10048	2.50	1	103.75
115.00	10053	20.75	15	94.25
117.75	10054	8.25	7	109.50
119.00	10055	20.75	15	98.25
122.75	10058	16.00	12	106.75
124.25	10059	17.75	13	106.50
126.00	10060	20.75	15	105.25
129.00	10062	20.75	15	108.25
145.25	10069	48.00	37	97.25
146.75	10070	48.00	37	98.75
157.00	10075	43.75	33	113.25
268.75	10100	102.50	70	116.25
221.25	10101	102.50	70	118.75
289.50	10136	182.25	131	107.25
312.00	10148	199.00	146	113.00
319.75	10152	199.00	146	120.75
346.75	10171	230.00	159	116.75
422.50	10216	312.00	222	110.50
434.50	10226	329.50	234	105.00
436.00	10227	330.75	236	105.25
439.00	10230	337.75	240	101.25
440.75	10232	337.75	240	103.00
449.00	10238	345.00	246	104.00
456.00	10246	337.75	240	118.25
463.75	10251	359.50	255	104.25
467.00	10254	364.75	257	102.25
474.75	10258	378.25	267	96.50
476.50	10259	387.50	271	89.00
533.75	10289	430.50	301	103.25
540.00	10294	425.25	297	114.75
541.50	10295	441.25	307	100.25
563.75	10303	460.50	318	103.25

Highlighted Vehicles Are Also Mobilizer Matches

Destination		Origin		
time	id	time	id	travel time
593.25	10308	477.25	331	116.00
601.50	10313	491.75	340	109.75
611.00	10318	491.75	340	119.25
630.75	10331	519.50	364	111.25
632.50	10332	509.75	358	122.75
649.75	10341	519.50	364	130.25
653.75	10342	519.50	364	134.25
668.00	10350	531.50	373	136.50
680.00	10356	535.25	377	144.75
681.25	10357	550.00	389	131.25
682.50	10358	550.00	389	132.50
687.25	10360	550.00	389	137.25
750.25	10376	613.25	436	137.00
767.25	10388	628.00	452	139.25
817.50	10410	673.50	479	144.00
819.00	10411	688.00	489	131.00
822.25	10413	672.25	478	150.00
825.50	10416	686.25	487	139.25
831.25	10421	691.50	492	139.75
851.00	10431	703.75	504	147.25
856.25	10434	703.75	504	152.50
889.00	10454	732.50	526	156.50
891.50	10456	755.25	543	136.25

APPENDIX D: MOBILIZER DATA—MIDDLE LANE

Destination		Origin		
time	id	time	id	travel time
82.75	10041	7.00	2	75.75
96.00	10049	11.50	4	84.50
107.00	10057	12.75	5	94.25
108.25	10058	12.75	5	95.50
113.50	10059	40.25	18	73.25
126.00	10066	60.50	23	65.50
131.50	10069	64.00	25	67.50
138.50	10072	60.50	23	78.00
144.75	10074	65.75	26	79.00
176.00	10088	84.50	34	91.50
199.50	10100	119.00	45	80.50
206.75	10104	103.20	37	103.55
218.00	10110	105.50	38	112.50
223.00	10113	110.50	41	112.50
230.00	10117	108.25	40	121.75
232.75	10118	105.50	38	127.25
237.25	10120	103.25	37	134.00
241.75	10123	110.50	41	131.25
256.50	10128	110.50	41	146.00
259.00	10129	119.00	45	140.00
261.00	10131	119.00	45	142.00
264.25	10133	112.25	42	152.00
266.50	10134	103.25	37	163.25
270.50	10136	108.25	40	162.25
281.00	10139	119.00	45	162.00
283.50	10141	140.50	57	143.00
286.25	10143	119.00	45	167.25
287.75	10144	119.00	45	168.75
289.50	10145	119.00	45	170.50
294.25	10148	149.25	62	145.00
300.50	10150	149.25	62	151.25
303.25	10151	139.50	56	163.75

Highlighted Vehicles are Mobilizer Matches

Destination		Origin		
time	id	time	id	travel time
309.25	10154	139.50	56	169.75
311.50	10156	139.50	56	172.00
313.50	10157	139.50	56	174.00
317.00	10160	139.50	56	177.50
320.50	10161	170.75	73	149.75
332.00	10166	177.75	76	154.25
334.25	10168	163.50	70	170.75
347.00	10171	184.75	79	162.25
350.50	10174	200.00	86	150.50
352.25	10175	200.75	87	151.50
363.75	10182	229.25	92	134.50
371.00	10186	239.00	96	132.00
374.75	10188	229.25	92	145.50
376.25	10189	233.75	94	142.50
387.00	10195	233.75	94	153.25
389.25	10196	252.50	102	136.75
391.50	10197	233.75	94	157.75
394.50	10199	252.50	102	142.00
396.25	10200	269.00	113	127.25
398.00	10201	270.50	114	127.50
405.50	10206	283.25	122	122.25
406.75	10207	285.50	124	121.25
409.00	10208	285.50	124	123.50
410.00	10209	301.75	133	108.25
413.50	10211	283.25	122	130.25
433.75	10221	301.75	133	132.00
454.50	10235	327.75	145	126.75
455.50	10237	346.75	151	108.75
459.25	10241	351.25	153	108.00
464.75	10243	351.25	153	113.50
466.00	10244	352.25	154	113.75
468.75	10246	352.25	154	116.50
470.25	10247	346.75	151	123.50
475.25	10250	346.75	151	128.50
477.25	10251	351.25	153	126.00
480.75	10254	374.00	162	106.75
486.50	10258	384.25	166	102.25
488.00	10259	389.25	168	98.75
495.50	10263	391.25	169	104.25
499.50	10266	402.00	175	97.50
502.00	10267	396.50	171	105.50
511.00	10272	389.25	168	121.75

Destination time	id	Origin time	id	(travel time
517.25	10275	387.75	167	129.50
519.00	10276	387.75	167	131.25
531.50	10284	402.00	175	129.50
538.25	10288	431.00	193	107.25
546.50	10291	439.50	200	107.00
549.50	10293	421.50	185	128.00
568.50	10300	459.50	215	109.00
574.75	10304	461.25	216	113.50
583.25	10308	466.00	219	117.25
600.00	10316	490.00	232	110.00
601.50	10317	482.75	230	118.75
614.75	10324	481.25	228	133.50
618.25	10326	502.75	238	115.50
620.25	10328	497.00	235	123.25
635.25	10337	525.50	249	109.75
657.75	10346	547.50	260	110.25
659.50	10347	548.50	261	111.00
661.00	10348	544.50	258	116.50
685.50	10356	577.50	272	108.00
694.25	10361	577.50	272	116.75
696.25	10362	583.75	274	112.50
698.75	10363	584.75	275	114.00
702.00	10366	599.50	281	102.50
710.75	10370	591.75	278	119.00
712.25	10371	584.75	275	127.50
737.25	10379	609.25	287	128.00
745.50	10380	609.25	287	136.25
765.00	10388	638.00	297	127.00
768.00	10390	638.00	297	130.00
774.50	10393	638.00	297	136.50
778.25	10396	644.75	301	133.50
781.25	10397	642.25	300	139.00
827.25	10421	709.50	332	117.75
834.75	10425	703.25	330	131.50
838.25	10427	703.25	330	135.00
845.00	10430	728.25	338	116.75
848.75	10432	709.50	332	139.25
850.00	10433	709.50	332	140.50
858.25	10437	703.25	330	155.00
864.50	10441	709.50	332	155.00
866.00	10442	709.50	332	156.50
867.50	10443	703.25	330	164.25

Destination time	id	Origin time	id	(travel time
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
871.00	10445	418.25	334	152.75
874.75	10448	703.25	330	171.50
876.00	10449	726.25	337	149.75
878.25	10452	728.25	338	150.00
889.00	10459	751.25	350	137.75

APPENDIX E: MOBILIZER DATA—HOV LANE

Destination		Origin		
time	id	time	id	(traveltime
67.50	10027	2.75	2	64.75
70.75	10029	4.50	3	66.25
74.75	10031	4.50	3	70.25
81.50	10035	13.75	4	67.75
83.25	10036	15.25	5	68.00
87.50	10038	19.50	10	68.00
89.50	10039	21.50	11	68.00
91.50	10040	19.50	10	72.00
95.25	10041	26.00	14	69.25
98.50	10043	23.75	13	74.75
100.00	10044	27.25	15	72.75
105.25	10048	27.25	15	78.00
114.00	10054	41.75	25	72.25
131.00	10062	52.75	32	78.25
132.25	10063	52.75	32	79.50
153.00	10073	79.25	47	73.75
154.50	10074	75.75	45	78.75
156.75	10075	82.75	49	74.00
158.00	10076	84.75	50	73.25
159.50	10077	86.75	51	72.75
163.25	10079	91.25	53	72.00
164.25	10080	92.75	54	71.50
166.00	10082	91.25	53	74.75
189.00	10093	120.00	63	69.00
197.75	10098	128.25	66	69.50
211.00	10104	141.25	73	69.75
214.00	10106	140.00	72	74.00
266.50	10122	198.50	96	68.00
279.25	10126	214.75	103	64.50
296.25	10133	231.75	112	64.50
297.50	10134	227.00	109	70.50
309.50	10138	240.75	116	68.75

Highlighted Vehicles Are Mobilizer Matches

Destination time	id	(Origin (time	id	(traveltime
314.50	10141	245.75	118	68.75
329.20	10148	264.50	126	64.70
338.75	10154	271.25	130	67.50
358.25	10166	289.50	141	68.75
360.50	10168	288.00	140	72.50
361.75	10169	289.50	141	72.25
363.50	10170	289.50	141	74.00
365.75	10171	289.50	141	76.25
403.00	10185	326.75	157	76.25
413.75	10188	340.75	164	73.00
443.00	10199	363.75	174	79.25
444.00	10200	368.00	176	76.00
471.00	10212	400.75	195	70.25
479.00	10215	409.00	199	70.00
481.25	10216	412.50	201	68.75
487.50	10220	415.75	202	71.75
491.50	10222	424.75	208	66.75
498.50	10225	424.75	208	73.75
500.00	10226	431.00	212	69.00
502.00	10227	431.00	212	71.00
510.75	10231	434.75	216	76.00
519.50	10236	444.75	221	74.75
523.00	10239	449.25	224	73.75
525.00	10240	449.25	224	75.75
532.00	10243	458.00	228	74.00
538.25	10246	466.75	232	71.50
541.25	10248	468.50	233	72.75
546.50	10251	476.25	238	70.25
550.25	10254	476.25	238	74.00
569.75	10260	495.00	245	74.75
574.00	10263	503.50	249	70.50
579.25	10265	506.50	250	72.75
582.75	10267	511.25	252	71.50
584.50	10268	512.75	253	71.75
587.75	10270	519.50	256	68.25
596.00	10275	525.75	259	70.25
599.75	10277	529.50	261	70.25

Destination		Origin		
time	id	time	id	travel time
602.75	10279	529.50	261	73.25
605.25	10280	536.25	264	69.00
608.25	10283	532.00	262	76.25
618.25	10288	547.00	270	71.25
639.75	10299	570.00	282	69.75
642.00	10300	571.50	283	70.50
653.25	10306	581.75	288	71.50
658.50	10310	588.00	291	70.50
660.00	10311	588.00	291	72.00
665.50	10314	594.00	296	71.50
682.75	10324	606.50	303	76.25
686.25	10326	616.50	309	69.75
690.00	10328	615.00	308	75.00
691.50	10329	614.00	307	77.50
692.50	10330	615.00	308	77.50
694.00	10331	621.75	312	72.25
702.50	10336	630.75	317	71.75
706.25	10338	627.75	315	78.50
724.00	10346	640.25	323	80.75
766.00	10366	689.25	352	76.75
777.50	10371	705.75	360	71.75
779.50	10372	705.75	360	73.75
797.25	10379	721.00	369	76.25
799.50	10380	721.00	369	78.50
830.00	10397	746.75	379	83.25
840.00	10403	765.00	385	75.00
851.25	10408	776.50	390	74.75
861.50	10413	787.25	396	74.25
868.75	10417	787.25	396	81.50
881.00	10425	804.25	407	76.75
890.00	10430	815.75	413	74.25
894.00	10432	815.75	413	78.25
912.00	10441	839.25	432	72.75

RIGHT									
Mobilizer "Correct" Matches						True Population			
destination		origin		travel		origin	destination	adjusted	
time	id	time	id	time		time	time	travel time	description
122.75	10058	16.00	12	106.75		24:16	26:02	107	blue hatchback
124.25	10059	17.75	13	106.50		24:18	26:03	106	red cherokee
157.00	10075	43.75	33	113.25		24:44	26:34	111	White van with ladder
218.75	10100	102.50	70	116.25		25:39	27:37	119	maroon pass.
346.75	10171	230.00	159	116.75		27:41	29:45	125	blue pass
434.50	10226	329.50	234	105.00		29:29	31:13	105	red pass
436.00	10227	330.75	236	105.25		29:31	31:15	105	silver wagon
449.00	10238	345.00	246	104.00		29:45	31:28	104	yellow pass
541.50	10295	441.25	307	100.25		31:20	33:00	101	red pu
563.75	10303	460.50	318	103.25		31:39	33:17	99	maroon/silver pu
593.25	10308	477.25	331	116.00		31:56	33:50	115	black pass
611.00	10318	491.75	340	119.25		32:11	34:09	119	gray hatchback
630.75	10331	519.50	364	111.25		32:38	34:29	112	red convertible
750.25	10376	613.25	435	137.00		34:12	36:00	109	black w/ sunroof
767.25	10388	628.00	452	139.25		34:28	36:41	134	gray pu
817.50	10410	673.50	479	144.00		35:13	37:36	144	red pu
825.50	10416	686.25	487	139.25		35:26	37:44	139	maroon suv
831.25	10421	691.50	492	139.75		35:31	37:49	139	brown truck
891.50	10456	755.25	543	136.25		36:35	38:50	136	red pass

MIDDLE

Mobilizer "Correct" Matches					True Population			
destination		origin		travel	origin	destination	adjusted	
time	id	time	id	travel	time	time	travel time	description
264.25	10133	112.25	42	152.00	25:51	28:21	151	white pass.
300.50	10150	149.25	62	151.25	26:28	28:59	152	blue minivan
320.50	10161	170.75	73	149.75	26:50	29:19	150	black pu
347.00	10171	184.75	79	162.25	27:04	29:46	163	white pu/canopy
350.50	10174	200.00	86	150.50	27:19	29:49	151	white pu
352.25	10175	200.75	87	151.50	27:20	29:51	152	maroon pass w/ sun.
363.75	10182	229.25	92	134.50	27:32	30:02	151	lt blue pass
371.00	10186	239.00	96	132.00	27:57	30:10	134	gold suv
396.25	10200	269.00	113	127.25	28:28	30:35	128	white pu
398.00	10201	270.50	114	127.50	28:30	30:37	128	blue hatchback
409.00	10208	285.50	124	123.50	28:45	30:48	124	gray pass
464.75	10243	351.25	153	113.50	29:51	31:43	113	black pass
466.00	10244	352.25	154	113.75	29:52	31:44	113	dark blue w/ sunroof
480.75	10254	374.00	162	106.75	30:14	31:59	106	blue hatchback
502.00	10267	396.50	171	105.50	30:36	32:20	105	green van w/ ladders
546.50	10291	439.50	200	107.00	31:18	33:02	105	white pu
583.25	10308	466.00	219	117.25	31:45	33:41	117	silver suburban
601.50	10317	482.75	230	118.75	32:02	34:00	119	silver pu
657.75	10346	547.50	260	110.25	33:07	34:56	110	gray pass
659.50	10347	548.50	261	111.00	33:08	34:58	111	pu w/ white canopy
685.50	10356	577.50	272	108.00	33:37	35:24	108	maroon pu
702.00	10366	599.50	281	102.50	33:59	35:40	102	white pass
871.00	10445	718.25	334	152.75	35:58	38:27	150	white truck
876.00	10449	726.25	337	149.75	36:06	38:34	149	maroon truck/canopy
878.25	10452	728.25	338	150.00	36:08	38:36	149	black pass

HOV

Mobilizer "Correct" Matches					True Population			
destination		origin		travel	origin	destination	adjusted	
time	id	time	id	travel	time	time	travel time	description
74.75	10031	4.50	3	70.25	24:06	25:15	70	Blue passenger
81.50	10035	13.75	7	67.75	24:14	25:21	68	White passenger
83.25	10036	15.25	8	68.00	24:16	25:22	67	motorcycle
87.50	10038	19.50	10	68.00	24:20	25:27	68	Red SUV
89.50	10039	21.50	11	68.00	24:21	25:29	69	blue sedan
95.25	10041	26.00	14	69.25	24:26	25:35	70	red minivan
153.00	10073	79.25	47	73.75	25:19	26:32	74	black pass.
154.50	10074	75.75	45	78.75	25:20	26:33	74	silver pu
158.00	10076	84.75	50	73.25	25:24	26:37	74	lt. Blue suv
159.50	10077	86.75	51	72.75	25:26	26:38	73	black pu
163.25	10079	91.25	53	72.00	25:30	26:42	73	red suv
164.25	10080	92.75	54	71.50	25:32	26:43	72	red pass.
309.50	10138	240.75	116	68.75	28:00	29:08	69	yellow taxi
329.20	10148	264.50	126	64.70	28:24	29:28	65	maroon pass
471.00	10212	400.75	195	70.25	30:40	31:50	71	black pass
487.50	10220	415.75	202	71.75	30:55	32:06	72	tan van
498.50	10225	424.75	208	73.75	31:04	32:17	74	jeep
519.50	10236	444.75	221	74.75	31:24	32:38	75	white minivan
523.00	10239	449.25	224	73.75	31:28	32:42	75	black suv
532.00	10243	458.00	228	74.00	31:37	32:51	75	red pu
541.25	10248	468.50	233	72.75	31:48	33:00	73	maroon suv
569.75	10260	495.00	245	74.75	32:14	33:28	75	black pass
579.25	10265	506.50	250	72.75	32:26	33:38	73	gray van
582.75	10267	511.25	252	71.50	32:31	33:41	71	black pass w/ sunroof
596.00	10275	525.75	259	70.25	32:45	33:54	70	black pass w/ sunroof

599.75	10277	529.50	261	70.25		32:49	33:58	70	red jeep
618.25	10288	547.00	270	71.25		33:06	34:14	69	dark gray pass
639.75	10299	570.00	282	69.75		33:29	34:38	70	white pass
641.00	10300	571.50	283	69.50		33:31	34:40	70	maroon minivan
653.25	10306	581.75	288	71.50		33:41	34:52	72	red pass
658.50	10310	588.00	291	70.50		33:46	34:57	72	black hatchback
662.75	10324	606.50	303	76.25		34:06	35:21	76	black minivan
691.50	10329	614.00	307	77.50		34:13	35:30	78	blue pass
692.50	10330	615.00	308	77.50		34:14	35:31	78	black suv
706.25	10338	627.75	315	78.50		34:27	35:44	78	white pass
721.00	10346	640.25	323	80.75		34:40	35:59	80	black pu
868.75	10417	787.25	396	81.50		35:01	36:26	86	black jeep
881.00	10425	804.25	407	76.75		37.23	38:39	77	maroon suv
690.00	10430	815.75	413	74.25		37:35	38:48	74	red convertible