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SPEED AND ACCIDENTS. VOLUME II

Research Triangle Institute
Durham, North Carolina

26 June 1970

RTI

RESEARCH TRIANGLE INSTITUTE

RTI PROJECT SU-409

SPEED AND ACCIDENTS
VOLUME II

RESEARCH TRIANGLE INSTITUTE

JUNE 26, 1970

FINAL REPORT

PREPARED FOR:

U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY SAFETY BUREAU
WASHINGTON, D.C. 20591

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FOREWORD

The Research Triangle Institute (RTI) and the Institute for Research in Public Safety of Indiana University have jointly performed a study to gather accident and speed information in order to better define the role that speed (primarily the speed deviation of accident-involved vehicles) plays as a contributing factor in vehicle accidents. This study was under contract number FH-11-6965 to the National Highway Safety Bureau (NHSB) of the Federal Highway Administration. Dr. Robert J. Taylor of the Mathematical Analysis Division under the direction of Mr. Donald Mela of the NHSB is the contract manager. The Research Triangle Institute is the prime contractor and the work is being performed in the Statistics Research Division (SRD) under the direction of Dr. A. L. Finkner. Dr. Herbert H. Hill is project leader and the following members have assisted in this study: S. B. White, Jr., J. W. Dunn, L. B. West, A. C. Nelson, Jr., R. L. Beadles, H. J. White, J. R. Batts, Mary J. Artz, and R. E. Kirk.

The Institute for Research in Public Safety is the subcontractor to RTI and has been primarily responsible for the data collection activity. This investigation has been under the direction of Dr. Kent B. Joscelyn and the following members have contributed to this report: G. H. Reinier, J. S. Merritt, T. H. Bryan, J. L. Shambach, S. P. Malak, J. R. Kinney, R. L. Chapman, R. G. Rockenbaugh, F. J. Connelly, R. N. Wolff, J. R. Treat, and K. J. Waymire.

The specific objectives of this study were to:

A. Gather more reliable accident data by using trained accident investigators rather than relying on the usual police and insurance accident reports,

B. Gather speed survey information over a selected representative sample of roadways in order to determine involvement rates in relation to miles traveled for different amounts of deviation from the average traffic speed, and

C. Determine the interaction between speed deviation and other factors precipitating accidents.

The authors wish to express their appreciation to Mrs. Patricia Daniel and Mrs. Linda Tingen for the typing of the tedious mathematical equations and tables, and to Mrs. Susan Bergeron for editorial assistance.

The report is contained in two volumes. Volume I is a summary report and contains the major results and conclusions along with examples of tables and figures from Volume II. Volume II contains the detailed information and analyses. In particular, the summary data for all of the accidents is contained in Volume II.

Many people have contributed to the success of this project. Immediate and accurate accident notification was furnished by the Bloomington Police Department, the Monroe County Sheriff's Department, and the Indiana State Police. Sheriff Clifford Thrasher and the deputies of the Monroe County Sheriff's Department deserve a special thanks for providing continuous communications support for the accident investigation teams. The excellent service provided by the staffs of Indiana Bell Telephone and Public Service of Indiana was particularly helpful during the implementation of the computer-sensor system. Finally, the Indiana State Highway Commission provided consistent support and, in particular, authorized the in-road installation of the detector hardware for the computer-sensor system.

ABSTRACT

In the last few years it has become the conviction of some investigators that, instead of blaming the absolute values of speeds for accidents, it may be more prudent to examine the extent to which accident-involved vehicles have deviated from the average speeds of surrounding traffic flow. The relationship between accident-involvement rate and the speed deviation of the accident-involved vehicle from the average of the surrounding traffic flow was investigated during this study. Accident and speed data were collected in Monroe County, Indiana by the Institute for Research in Public Safety of Indiana University. Based on these data it is concluded that a U-shaped relationship between involvement rate and speed deviation exists.

On approximately 20 miles of roadway magnetic loop vehicle detectors coupled on-line with a digital computer were used to record speed, effective length, and headway data for all detected vehicles on a full-time basis. The speeds of the accident-involved vehicles were estimated by means of accident investigation teams arriving at the scene of the accident as soon as is possible after notification of its occurrence and/or by speeds given by the computer-sensor system (CSS). The mean speed of the traffic in which the accident-involved vehicle was traveling was estimated by means of radar measurements taken both before and after the accident and under conditions as similar as possible to those surrounding the accident and/or by data from the CSS.

~~This~~ volume contains a detailed description of the data collection procedures, the methods used in analysis, and a tabulation of the results. A complete summary of all the information provided by the computer-sensor system would require many volumes and this information is being retained on tape by either RTI or the Institute for Research in Public Safety of Indiana University. The computer-sensor system is described in some detail in Appendix C. The summary data for all of the accidents are given in Section 6. A summary of the results is presented in Section 2 with convenient references to the section containing more detailed results.

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1. INTRODUCTION

1.1 Historical Background

For many years investigators have believed that speed has a direct correlation with highway traffic accidents. In principle this cannot be refuted because, obviously, if the speeds driven by all drivers were reduced by half, certainly the number of serious accidents would be reduced. However, such a drastic reduction in speeds is not acceptable to the motoring public in the interest of highway safety. Thus it appears that the ground transportation system involving motor vehicles is destined to be one of relatively high speeds and correspondingly high rates of accidents, with their attendant property damage, injuries, and fatalities.

In recent years it has been observed that it is possible for traffic to move in a relatively safe manner at high speeds on freeways and other roadways designed for high speed. It is now the conviction of some investigators that instead of "blaming" accidents on absolute speeds, it is more prudent to examine the extent to which speeds of vehicles involved in accidents deviate from the average speed of the surrounding traffic.

Speed difference is a very important concept and one which is very difficult to measure in the field. This difficulty is due, primarily, to the problems involved in determining a vehicle's speed immediately prior to its involvement in an accident. After an accident has occurred, such speed quantifications are, at best, subjective estimates and considerable variation in the estimates of speed is to be expected.

As substantiation of the significance of the correlation between accidents and speed differences it has been reported [1] that:

1. The accident-involvement rates were highest at very low speeds, lowest at about average speed, and increased at very high speeds (i.e., the greater the deviation in speed of any vehicle from the average speed of all traffic, the greater its chance of being involved in an accident).

2. Passenger-car drivers involved in two-car, rear-end collisions were much more likely to be traveling at larger speed differentials than the average. For example, one-third of accident-involved drivers had speed differences of 30 miles per hour or more, compared to only one percent of pairs of cars selected at random.

This study was based on 10,000 accidents covering more than 600 miles of highways. It is clear that there is no simple increasing monotone accident risk with speed. The issue is much more complex.

In another study [2], the relationship between accident involvement and a function of acceleration noise was investigated. The accident involvement rate increased as the mean number of 2 1/2 mph speed deviations increased. This study utilized six roads ranging in design and volume characteristics from a "farm to market" type to an expressway.

It appears that the key to a successful analysis of the role of speed differences as a causative factor in accidents is the ability to determine accurately the deviation in speed of each vehicle involved in an accident from the average speed of the surrounding traffic flow. Measurement errors and their effects on involvement rate are discussed in [3]. It was shown that errors in estimating the speed of the accident-involved vehicle (AIV) results in an overestimate of the involvement rate for large deviations (positive and negative) and an underestimate of the rate at deviations near zero. For this reason it was necessary to develop an automated and continuous device to identify vehicles and to estimate their speeds at selected points along particular roadways. It was hoped that such an automated and refined system would provide the speed accuracy required in this project. A description of the computer-sensor system that was developed is described in Appendix C.

1.2 Objectives

The major objective of this project was to gather and analyze accident and speed data that would quantitatively define the relationship between speed (primarily speed deviation of accident-involved vehicles) and the frequency of occurrence of corresponding motor vehicle accidents. In order to accomplish this objective it was necessary to:

1. Gather reliable accident data using trained accident investigators,
2. Estimate the speeds of vehicles involved in accidents at the time immediately before the collision sequence began,
3. Estimate the speed distribution of traffic flow at the time and location of the occurrence of each accident investigated,
4. Using the speed data as found in 2. and 3. above, quantify the correlation between speed deviation and accident rates, and to determine interactions, if any, between speed deviation and other factors precipitating accidents, and
5. Analyze other related factors which appear to be important in describing the mechanisms of accidents.

1.3 Plan of Research

The Research Triangle Institute (RTI), acting as prime contractor, and the Institute for Research in Public Safety (IRPS) (formerly the Research Division of the Department of Police Administration, Indiana University) for the Indiana University Foundation, serving as subcontractor to RTI, contracted with the National Highway Safety Bureau, Department of Transportation, to provide the personnel, facilities, and special equipment to fulfill the direct objectives enumerated in Section 1.2. The responsibility for data collection was given to the IRPS, while RTI was assigned the tasks of analysis and evaluation.

All state highways and all the county roads in Monroe County, Indiana, with a speed limit of 40 mph or over - or where the mean speed was 40 mph or greater -

were included in the study. This involved approximately 70 miles of state roads, on which two hundred (200) accident investigations were completed during the 13 months of active investigation.

During the initial phase of the project, accident investigators were trained for on-site and post-crash accident investigation. Based on the physical documented evidence, witness reports, and driver interviews, a subjective estimate of the pre-crash (sequence) speeds was determined. Subsequently, a panel of project research personnel reviewed each accident report and arrived at independent speed estimates. Whenever possible and appropriate, the data from the computer-sensor system were integrated into the pre-accident speed estimation processes.

During the second phase of the project, the decision was made to expand the computer-sensor system from eight to fourteen detector locations, each monitoring two lanes of traffic on State Route 37, North and South of the City of Bloomington. At the same time the decision was made to expand the computer-sensor system, the on-site investigation was discontinued in favor of a follow-up scheme in which the speed estimates were based on the computer-sensor system output, the accident report of the investigating law enforcement agency, and statements of witnesses.

Tasks of Data Collection

The data collection process used to satisfy the objectives of this investigation was essentially threefold: (1) radar speed sampling, (2) at-the-scene and follow-up accident investigation, and (3) a computer-sensor system for continuously monitoring traffic characteristics (i.e. speed, headway, length) at selected points. Brief descriptions of these three efforts are presented below:

(1) Radar Speed Sampling

The state roads were divided arbitrarily into one-mile segments. Within each segment 15-minute radar spot speed measurements were taken at various times under varying environmental conditions. This provided a data base for constructing volume-time relationships and speed profiles for the network of roads included in the study.

Radar speed readings were also collected at each accident site. Efforts were made to duplicate time of day, day of week, location and environmental conditions surrounding each accident. For each accident, speeds were observed for a minimum of 200 vehicles with at least 50 vehicles traveling in the same directions as the accident vehicles. Post-accident radar collection of data was conducted from January 6, 1969 through December 31, 1969. The complete description of the details of techniques utilized in radar sampling is given in Appendix A.

(2a) At-the-Scene Accident Investigation

On-scene accident investigation began December 7, 1968, and continued through July 31, 1969. Primary and back-up investigators were placed on-call 24 hours a day. Notifications of accidents were obtained through the cooperation of the Bloomington City Police Department, the Monroe County Sheriff's Department, and the Indiana State Police. Each of these has accident investigation jurisdiction within Monroe County. The on-site investigation was concluded with a formal, written report that included the regular police report, accident scene diagrams, photographs, and various computer-compatible report forms. Engineering analyses were included wherever appropriate. This report was then reviewed before the speed estimates were made. The complete details are given in Appendix B.

(2b) Follow-up Accident Investigation

The character, design, and intensity of the accident investigation process changed August 1, 1969. Only those accidents which occurred on State Route 37 within the computer-sensor system were investigated. On-site coverage of accidents was discontinued, and the accident investigation funds were used to extend the time of computer-sensor data collection in hopes of obtaining more information about speeds of AIV's. Consequently, accident data were obtained by reviewing the computer-sensor data, the police accident report, and statements made by the witnesses and drivers. A ten-hour accident investigation seminar was conducted by the research team and selected faculty for Monroe County Sheriff's deputies, to up-grade the quality of accident reports.

Forty-eight accidents were investigated between August 1, 1969, and December 31, 1969.

(3) Computer-Sensor System

The collection of speed and headway data from eight computer-sensor sites, North and South of the City of Bloomington, on State Route 37 began on May 7, 1969.

Each sensor site consisted of two induction loops laid in each lane, at certain "strategic" points, North and South of Bloomington. The passage of a vehicle through the radio-frequency field was "sensed" by the loop detector. The resulting signal was then transmitted to an IBM 1800 computer system at IRPS.

Two coded words were produced by the computer from the sensor signals. These words identified time, individual velocity, vehicle length, interval between vehicles, and direction of travel. Thus, data descriptive of vehicle length, speed, time of day, direction, site location, and time headway were noted and stored on magnetic tape during the 24-hour-a-day operation. Whenever possible, State Route 37 accident investigations utilized the information collected by the system for speed estimates, traffic flow profiles and, in some instances, vehicle identification.

2. SUMMARY

The results of this study are summarized below under the three major headings: A. Accidents, B. Traffic Flow, and C. Computer-Sensor System. The references given in parentheses following each summary statement indicate the sections in this report where the reader may find more detailed information.

A. Accidents

1. Over a thirteen month period, 200 accidents, involving 353 vehicles were investigated on the state roads of Monroe County, Indiana. In addition, 94 accidents which occurred on county roads were investigated. These accidents are listed in this report but are not included in the involvement rate analysis because of insufficient volume-time information on county roads. (Section 3)

2. The results of this study indicate a U-shaped relationship between involvement rate and speed deviation. The following table gives the numerical values of the involvement rate as a function of speed deviation for all state roads in Monroe County, Indiana. These rates were obtained after eliminating those accidents which involved a turning maneuver. (Section 3)

Speed Deviation Class Interval (mph)	Involvement Rate (No. Involvements per MVM)
< -15.5	9.8
-15.5 to - 5.5	0.8
- 5.5 to + 5.5	0.8
+ 5.5 to +15.5	1.3
> +15.5	9.8

3. These results confirm the hypothesis that slow driving as well as fast driving increases the likelihood of being involved in an accident. However, the curvature of this U-shaped relationship is not nearly as pronounced as that given by Solomon [1] in a previous study. (Section 3)

4. Forty-four percent of all accidents (and 56% of the involvements) involved at least one vehicle which was either in a turning maneuver or influenced by another vehicle which was in the process of turning. (Section 3)

5. Thirty-nine (39) out of 183 drivers, or 21 percent, having seat belts available were using them. (Section 3)

6. The number of involvements for the several age groups and speed deviation categories are tabulated below. As expected, there is a speed deviation and age interaction, that is, the distribution of speed deviations is not the same for all age groups. This tabulation does not include the turning involvements. (Section 3)

	Speed Deviation Category			
Age Category	$\Delta S_D < -15.5$	$-5.5 < \Delta S_D < 5.5$	$\Delta S_D > 15.5$	Totals
≤ 19	2	12	12	26
20 - 24	2	13	14	29
25 - 29	3	11	4	18
30 - 34	1	5	1	7
35 - 39	0	6	1	7
≥ 40	12	25	1	38
Totals	20	72	33	125

7. Another useful breakdown of the types of accidents and roads is given below.

	Single	Multiple			Totals
		Head-on	Rear-End	Side	
Highway 37 North	17	10	22	16	65
Highway 37 South	14	5	17	13	49
All Other State Roads	36	9	38	20	103
Totals	67	24	77	49	217

The major point to be made relative to this table is that the percentage of multiple (single) vehicle involvements decreases (increases) as the traffic volume decreases. Even though Highway 37 North appears to a driver to be a safer highway than 37 South, the likelihood of being involved is greater due to the multiple vehicle accidents. (Section 3)

B. Traffic Flow

Utilizing radar and the computer-sensor system data, traffic flow characteristics (mean speed, speed variability, and volume) were examined for each of the roads included in the study. For Highway No. 37, these characteristics have been examined with respect to changes over time. Some general conclusions resulting from these analyses are:

1. Large differences in mean speeds exist among the various roads included in the study. This was anticipated in view of differences in road geometry, surface, type, width, topography, concentration of population, etc., existing within the road network. (Section 6)
2. Mean speeds at night and especially the early morning hours are consistently higher than daytime mean speeds. (Section 6)
3. Mean speeds are generally higher for dry roads than for wet roads. There were stations where wet roads exhibited mean speeds equal to or even greater than dry roads; however, this could be a situation where rain had just ended and there was good visibility, but the road was still wet. (Section 6)

4. Speed variability is relatively stable over the entire road network system. (Section 6)

5. Speed variability is generally greater, but by only a small amount, during night driving as compared to daytime driving. (Section 6)

6. Three multiple linear regression models consisting of 3, 6, and 15 variables were examined to determine those variables which account most for the variation in hourly mean speeds. Of all the variables studied, volume of vehicles in same direction is the most important single factor. (Section 5)

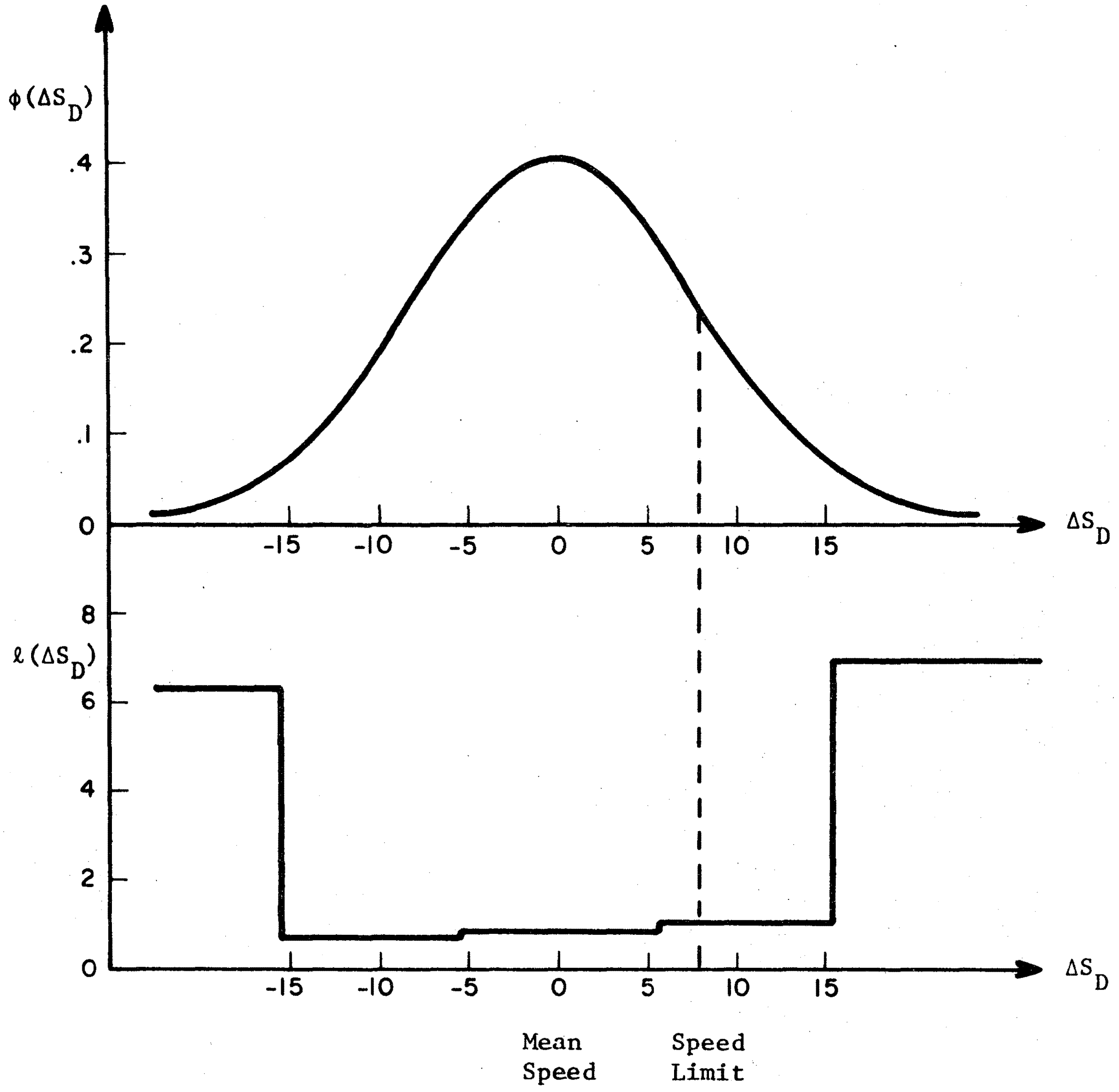
7. Speed distributions are adequately described by the normal distribution. (Section 5)

8. One approach for evaluating the effectiveness of countermeasures pertaining to speed deviations is described below. The step function describing the likelihood of being involved in an accident is nearly symmetrical and U-shaped, but is dependent on the road type. (See Section 3) For a symmetrical, U-shaped distribution, the overall likelihood of being involved in an accident can be reduced by:

  a. Reducing high speed deviations by one of many possible means,
  b. Enforcing minimum speeds, or
  c. Decreasing the likelihood of involvement over all speeds.

Given an estimate of the likelihood function $\ell(\Delta S_D)$ and the speed distribution, which is assumed to be normal, $\phi(\Delta S_D)$ say; one can estimate the portion of the overall likelihood L which is attributable to the high- and/or low-speed deviations. Consider the speed distribution and likelihood of involvement function given in Figure 2.1. For this example the values of $\ell(\Delta S_D)$ are taken from data in Table 3.1.3 for Highway No. 37 (see Section 3 of this volume). The speed distribution is assumed to be normal with a standard deviation of 8 mph. The calculation of L is made by summing the products of the likelihood of involvement by

Figure 2.1 Speed Distribution and Likelihood of Accident Involvement as a Function of Speed Deviation (ΔS_D)



the probability of a vehicle speed within the corresponding speed deviation interval, i.e.

$$L = 6.3[.026] + 0.7[.219] + 0.8[.510] + 1.0[.219] + 6.9[.026]$$
$$= 1.12.$$

Thus the portion of L attributable to each of the five speed deviation categories is given in the following table.

Total	$\Delta S_D \leq -15.5$	$-15.5 < \Delta S_D \leq -5.5$	$-5.5 \leq \Delta S_D \leq 5.5$	$5.5 < \Delta S_D \leq 15.5$	$\Delta S_D > 15.5$
$L = 1.12$	.164	.153	.408	.177	.179
Percent of L	14.6%	13.7%	36.4%	19.6%	16.0%
Maximum reduction of L possible in low- and high-speed deviation categories	.138 (12.3%)	- -	- -	- -	.153 (13.8%)

From the above results one can estimate the maximum reduction possible in overall likelihood (ignoring intersection-turning maneuver accidents) which can be achieved by particular countermeasure programs. The rates cannot be reduced to zero because any speed control, advisory, or enforcement program will only displace the driver-vehicle to another speed deviation category. In this example, the likelihood-involvement rate of unity is assumed for the minimum. This assumption yields 0.138 and 0.153, or about 12% and 14% respectively for the low- and high-speed deviation categories, as the estimated maximum reductions in L which can be attained. The effectiveness of a program to reduce the involvement rate must be considered relative to the maximum possible reduction, and then the potential value of a particular C/M program can be estimated. For example, if a program of law enforcement is able to reduce the number of speed deviations exceeding 15.5 mph by half its estimated magnitude, i.e. from 0.026 to 0.013, the savings will be approximately 7% of involvements. For this high-speed category a significant reduction in fatalities would result. The cost of additional enforcement to accomplish this magnitude of reduction would be expected to be very costly. (Section 3)

9. An additional conjecture relative to speed limits is given below. There were not sufficient data available to allow a full analysis but it appears that this study reinforces the setting of speed limits at the 85th percentile speed. The standard deviation of the speed distribution is approximately 8 mph. Approximately 85 percent of the drivers drive at speeds below the mean plus one standard deviation. The drivers having speeds between the mean and one standard deviation above the mean are definitely in a low involvement group. The region between one and two standard deviations above the mean speed encompasses approximately 10 percent of the drivers and does not have a significantly greater involvement rate than at mean speed. Speeds at two standard deviations above the mean correspond to approximately the tolerance level allowed by police agencies. Thus the higher level of enforcement occurs when the $\ell(\Delta S_D)$ function begins to increase significantly resulting in a more cost effective C/M.

If minimum speed limits are set, a similar argument would lead to the conclusion that the limit should be placed at about the 15th percentile speed with enforcement at about the 5th percentile.

C. Computer-Sensor System

1. The Computer-Sensor System (CSS) has provided data on speed, density, headways, and mix of vehicles on the roadway during the time of the accident in a very satisfactory manner. Data are now available that have not been previously collected regarding the overall traffic parameters in a traffic stream containing AIV's. (Section 4)

2. The CSS is capable of detecting either the AIV or the platoon of vehicles containing the AIV approximately 25 percent of the time with high confidence (Section 3). This capability is still dependent on some accident investigation which identifies the particular vehicles, location and time of the accident, and statements of witnesses concerning (unusual) speeds and relative positions of vehicles having extreme lengths (Section 4).

3. The standard deviations of the estimated vehicle speeds and lengths as recorded by the CSS are approximately 1 mph and 1 foot respectively. (Section 4)

4. The CSS has provided considerable data on vehicle speeds, lengths, and headways which can provide data for better understanding of traffic flow behavior. A detailed analysis of these data is costly and beyond the level of effort for this project. However, these data should be of value for future projects. To our knowledge no data on a two-lane road such as State Road No. 37 exists to the extent that they are available from this data collection effort. (Section 4)

5. For the 22 weeks beginning with June 23, 1969 through November 23, 1969, the weekly system availability ranged from about 57% to 96%, adjusting for scheduled maintenance of four hours per week. System availability is the proportion of up-time for the system to total time, in this case 164 hours per week. During this period of time considerable down-time was scheduled for system analysis, expansion, and improvements. During three weeks the availability exceeded 90% indicating that it is capable of high level performance.

3. ACCIDENT INVOLVEMENT RATE ANALYSIS

Contained in this section are the results of various analyses of speed and accident data which deal with the accident involvement rates observed on the network of state roads included in this study.

The results are grouped into five general areas of interest. These include:

Relationship Between Involvement Rate and Speed Deviation (Section 3.1)
Accident and Involvement Rates by Road and Time of Day (Section 3.2)
Estimating Vehicle Mileage (Section 3.3)
Tracking Vehicles Using the Computer-Sensor System (Section 3.4)
Classifications of Accidents (Section 3.5).

3.1 Relationship Between Involvement Rate and Speed Deviation

One of the primary objectives of this study is to determine the relationship between involvement rate and speed deviation from the mean traffic speed. The involvement rate, as used in this report, is a measure of the likelihood of being involved in an accident. Normally, this rate is expressed as the number of involvements per million vehicle miles.

The general concensus of opinion is that the involvement rate is a minimum at or near a speed deviation of zero. This means that both the slow and fast drivers are expected to experience a higher rate of involvement than those driving near the average traffic speed. Thus, it is not so much the absolute speed but rather the deviation from mean traffic speed that affects the probability of being involved in an accident. Of course, given that an accident has occurred, the severity of the injury is directly related to the absolute speed of the involved vehicle.

The relationship between the involvement rate and speed deviation may be empirically determined by dividing the speed deviation axis into arbitrary intervals and estimating the involvement rate within each interval. For this study, the involvement rate, on a per mile basis, for a given speed deviation interval, ΔS_D, for a specified time period, T, is estimated as follows:

$$I_{\Delta S_D, T} = \frac{n_{\Delta S_D, T}}{L \times V_T \times p_{\Delta S_D}}$$

where

$I_{\Delta S_D, T}$ = Involvement rate for the interval ΔS_D for time T.

$n_{\Delta S_D, T}$ = Number of involvements with speed deviations within the interval ΔS_D occurring over time, T.

L = Length of road (miles).

V_T = Total number of vehicles over time T.

$p_{\Delta S_D}$ = Proportion of vehicles traveling within the interval, ΔS_D.

For example, for ΔS_D between 0 and +5 mph, the involvement rate is calculated as: number of accident-involved vehicles whose speed differential is between 0 and +5 mph divided by the total mileage generated by all vehicles with speed differentials between 0 and +5 mph.

The numerator, $n_{\Delta S_D, T}$, is obtained by calculating, for each involvement, the difference between the estimated speed of the accident-involved vehicle and the estimated mean traffic speed, then counting the number of differences that lie within the interval ΔS_D. A discussion of the procedures employed in calculating the denominator, $L \times V_T \times p_{\Delta S_D}$, which represents the total mileage driven by all vehicles with speed differentials within the interval ΔS_D is given in Appendix D.

For Highway No. 37, other state roads, and all state roads combined, Table 3.1.1 shows the number of involvements, total vehicle mileage and the corresponding involvement rate (per MVM) for five arbitrarily selected speed deviation intervals. In all three cases the rate is highest for large negative deviations, decreases to a minimum at or near zero speed deviations, and then starts increasing for large

Table 3.1.1 Relationship Between Involvement Rate and Speed Deviation

Highway No. 37 (North and South)

Speed Deviation Class Interval (mph)	Number Involvements	Total Vehicle Mileage (MVM)	Rate (Involvements) per MVM)
< -15.5	80	1.890	42.3
-15.5 to - 5.5	37	16.243	2.3
- 5.5 to + 5.5	63	39.976	1.6
+ 5.5 to +15.5	20	16.243	1.2
> +15.5	16	1.890	8.5

Highway No.'s 46 (East and West),
45 (East and West)
and 48 (West)

Speed Deviation Class Interval (mph)	Number Involvements	Total Vehicle Mileage (MVM)	Rate (Involvements) per MVM)
< -15.5	52	.571	91.1
-15.5 to - 5.5	14	8.429	1.7
- 5.5 to + 5.5	37	23.621	1.6
+ 5.5 to +15.5	21	8.429	2.5
> +15.5	13	.571	22.8

Total (All State Roads In Monroe County)

Speed Deviation Class Interval (mph)	Number Involvements	Total Vehicle Mileage (MVM)	Rate (Involvements) per MVM)
< -15.5	132	2.461	53.6
-15.5 to - 5.5	51	24.672	2.1
- 5.5 to + 5.5	100	63.597	1.6
+ 5.5 to +15.5	41	24.672	1.7
> +15.5	29	2.461	11.8

positive speed deviations. The results are presented separately for Highway No. 37 (North and South) since the instrumentation of this road provided more complete and reliable vehicle speed and volume data on which the involvement rates are based. On the remaining state roads, radar was used to collect the necessary data.

The involvements occurring on Highway No. 37 totalled 216 and represented 114 accidents, for an average of 1.89 vehicles per accident. For the remaining state roads in Monroe County, there were 137 involvements in 86 accidents, for an average of 1.59 vehicles per accident. The average over all state roads was 1.77 vehicles per accident (200 accidents involving 353 vehicles).

Upon examining those involvements which exhibited large speed deviation (132 negative and 29 positive deviations) to determine perhaps some common factor or underlying mechanism, it became immediately apparent that many of the vehicles were either in the process of making some turning maneuver or influenced by another vehicle in the process of making a turn. The following table illustrates the degree to which this is present.

Table 3.1.2 Total Accidents and Number Associated with Turning Maneuver

			Associated With Turning Maneuver	
	Total No. Accidents	Total No. Involvements	Number Accidents	Number Involvements
Highway No. 37	114	216	56	132
Other State Roads	86	137	32	67
Total	200	353	88	199

From the above table, 44% (88 out of 200) of the total number of accidents had at least one vehicle directly involved in some turning maneuver or was directly influenced by another vehicle which was likewise involved in some turning maneuver. A similar statement can be made regarding 56% (199 out of 353) of the total involvement.

The use of involvements per million vehicle miles as a measure of risk is not applicable to intersections (or to any single point on the road) since the denominator of the involvement rate formula approaches zero as the length of the road, L, approaches zero. This problem is normally avoided by using involvements per volume of turning vehicles as a measure of risk at a given intersection. Data were not collected in this study to permit this type of analysis. Furthermore, it is extremely difficult to estimate the involvement rate over a finite length of road which encompasses an intersection because of the variation in the speed distribution parameters in the vicinity of the intersection. Hence, an adequate estimate of vehicle mileage in terms of speed deviation cannot be easily obtained.

In view of the above comments and the fact that such a large number of accidents occurred which possessed the common property of being associated with at least one vehicle involved in a turning maneuver, a decision was made to exclude these accidents in the involvement rate versus speed deviation analysis. By excluding these accidents, the resulting relationship between involvement rate and speed deviation is considered to be more valid. Table 3.1.3 shows the relationship between involvement rate and speed deviation for Highway No. 37, other state roads and for all state roads combined after eliminating all accidents involving at least one vehicle in a turning maneuver. It should be noted that in all cases the relationship is still U-shaped (involvement rate is a minimum near zero speed deviations and increases with deviation in speed regardless of sign). The involvement rates for large negative speed deviations are now comparable to the rates for large positive speed deviations which represents a significant change over the results previously given in Table 3.1.1. Based on the results from all the state roads in Monroe County, it appears that deviations in speed from the normal traffic flow by 15 mph in either direction increases the risk of being involved in an accident by an order of magnitude.

The elimination of accidents involving vehicles in turning maneuvers from the involvement rate versus speed deviation analysis does not, in any way, lessen the importance of these accidents and the valuable information they provide in the

Table 3.1.3 Relationship Between Involvement Rate and Speed Deviation (Adjusted*)

Speed Deviation Class Interval (mph)	Number Involvements	Total Vehicle Mileage (MVM)	Rate (Involvements per MVM)
Highway No. 37 (North and South)			
-15.5	12	1.890	6.3
-15.5 to - 5.5	11	16.243	.7
- 5.5 to + 5.5	32	39.976	.8
+ 5.5 to +15.5	16	16.243	1.0
> +15.5	13	1.890	6.9
Highway No.'s 46 (East and West), 45 (East and West) and 48 (West)			
< -15.5	12	.571	21.0
-15.5 to - 5.5	9	8.429	1.1
- 5.5 to + 5.5	22	23.621	.9
+ 5.5 to +15.5	16	8.429	1.9
> +15.5	11	.571	19.3
Total (All State Roads in Monroe County)			
< -15.5	24	2.461	9.8
-15.5 to - 5.5	20	24.672	.8
- 5.5 to + 5.5	54	63.597	.8
+ 5.5 to +15.5	32	24.672	1.3
> +15.5	24	2.461	9.8

---

*Accidents involving at least one vehicle in a turning maneuver or influenced by another vehicle involved in the process of making a turn have been excluded.

formulation of programs to increase highway safety. On the contrary, the occurrence of such a large number of these accidents in this study clearly demonstrates the danger areas and confirms the need for safety programs involving separate turn lanes, more limited access roads, more grade crossings, etc. (i.e. any action which reduces the need for stopping or drastic reduction in speed within the main stream of traffic).

3.2 Accident and Involvement Rates by Road and Time of Day

Table 3.2.1 gives the number of accidents, number of involvements, and the associated rates by time of day for each section of state road extending from Bloomington to the Monroe County line. It is recognized that over the time period of this study, daylight hours varied considerably. However, for convenience and also to eliminate any inconsistency in the data collection activity relative to the determination of day versus night, day is defined as the time period between 6:00 A.M. to 7:00 P.M.

Table 3.2.1 provides a more detailed breakdown of the data than the volume of data actually warrants (i.e. 200 accidents split into 14 classes). Hence, the amount of data in some of the classes is insufficient for drawing conclusions. Even for the case where a statistical test rejects the null hypothesis the Type II error is very large for small sample sizes; consequently, misleading results may be obtained.

For those situations where sufficient data are available for making comparative analyses, the chi-square statistic may be used in making tests of significance. The following example illustrates how this test may be carried out. Suppose we wish to determine whether the daytime involvement rate for Highway No. 37 North (3.3 involvements per MVM) is significantly higher than the daytime rate for Highway No. 37 South (1.9 involvements per MVM). Table 3.2.2 is then constructed:

Table 3.2.1 Number of Accidents, Number of Involvements and Associated Rates by Road by Time-of-Day*

Road	Time-of-Day	Number of Accidents	Number of Involvements	No. Acc. per MVM	No. Inv. per MVW
No. 46 East	Day	8	14	1.2	2.1
	Night	5	8	2.5	3.9
	Total	13	22	1.5	2.5
No. 46 West	Day	20	36	2.2	4.0
	Night	5	7	2.0	2.8
	Total	25	43	2.2	3.7
No. 45 East	Day	14	22	5.4	8.4
	Night	5	5	6.8	6.8
	Total	19	27	5.7	8.1
No. 45 West	Day	18	35	2.1	4.0
	Night	4	8	1.7	3.4
	Total	22	43	2.0	3.9
No. 48 West	Day	6	9	1.0	1.6
	Night	1	1	.8	.8
	Total	7	10	1.0	1.4
No. 37 North	Day	48	105	1.5	3.3
	Night	17	29	1.7	2.9
	Total	65	134	1.6	3.2
No. 37 South	Day	30	51	1.1	1.9
	Night	19	33	2.2	3.8
	Total	49	84	1.4	2.4

*For Highway No. 37 the time period covered is December 7, 1968 through December 31, 1969. For all other State Roads the time period is December 7, 1968 through July 31, 1969.

Day is defined as the time period 6:00 A.M. to 7:00 P.M.

Table 3.2.2 Observed and Expected Number of Daytime Involvement on Highway No. 37

	Observed No. Involvements (0)	Expected No. Involvements* (E)	$\frac{(0 - E)^2}{(E)}$
Highway No. 37 North	105	85	4.7
Highway No. 37 South	51	71	5.6
			χ^2 = 10.3

*Number of involvements expected under the null hypothesis that both roads have the same rate (i.e. rate averaged over both roads). The average rate times the vehicle mileage for a given road gives the expected number of involvements for that road.

Under the null hypothesis of no difference between the two involvement rates, a χ^2 value equal to or larger than $\chi^2 = 10.3$ would occur by chance less than one time in a hundred. Since our calculated value of $\chi^2 = 10.3$ represents an unlikely event, we reject the null hypothesis and conclude that the daytime involvement rate for Highway No. 37 North is greater than (or not equal to) that of Highway No. 37 South. In this case, our chance of being incorrect in drawing this conclusion is less than one in a hundred.

These two roads differ in many respects. For example, Highway No. 37 South as compared to the northern section is asphalt rather than concrete, contains more curves and grades, has lower speed limits, and shows a much higher degree of roadside development. In view of these differences, one may expect the daytime involvement rate to be higher on Highway No. 37 South, which is contrary to the results shown above. In this regard it is instructive to examine the accident rate for these two roads rather than the involvement rate, since multiple vehicle-accidents affect the latter rate but not the former. The following table provides the necessary data for comparing the daytime accident rates.

Table 3.2.3 Observed and Expected Number of Daytime Accidents on Highway No. 37

	Observed No. Accidents (O)	Expected No. Accidents (E)	$\frac{(O - E)^2}{(E)}$
Highway No. 37 North	48	42.5	0.71
Highway No. 37 South	30	35.5	0.85
			χ^2 = 1.56

This result (χ^2 = 1.56 with 1 degree of freedom) indicates there is no evidence of a significant difference in accident rates for the two roads. What happened in this situation was that more 3, 4, and 5 vehicle accidents occurred on Highway No. 37 North so as to increase the involvement rate to a significantly high level. Higher speeds on Highway No. 37 North may have been a contributing factor to the increase in the number of 3, 4, and 5 vehicle accidents.

These analyses merely serve to illustrate the types of considerations one must keep in mind in drawing conclusions from the results based on a particular comparison. In-depth analysis is required in all comparisons of interest.

3.3 Estimating Vehicle Mileage

Table 3.3.1 gives the estimated total vehicle mileage of the state roads in Monroe County, Indiana included in the study. For State Roads 45, 46, and 48, the time period covered by these mileage estimates is December 7, 1968 through July 31, 1969. Speed and volume count information obtained through radar spot speed measurements provided the source data for the mileage estimates for State Roads 45, 46, and 48. On the other hand, the computer-sensor system provided the source data (speeds and volume counts) for estimating vehicle mileage for Highway No. 37. Because of the differences in the source data, the procedures for estimating vehicle mileage for State Roads 45, 46, and 48 and State Road 37 are discussed separately in Appendix D.

Table 3.3.1 Estimated Vehicle Mileage* (in thousands of miles)

		Speed Deviation Interval (mph)					
Location		<-15.5	-15.5 to - 5.5	- 5.5 to 5.5	5.5 to 15.5	>15.5	Total
No. 46 (East)	Day**	77	1,332	3,786	1,332	77	6,604
	Night	19	402	1,191	402	19	2,033
	Total	96	1,734	4,977	1,734	96	8,637
No. 46 (West)	Day	111	1,780	5,263	1,780	111	9,045
	Night	70	547	1,231	547	70	2,465
	Total	181	2,327	6,494	2,327	181	11,510
No. 45 (East)	Day	19	480	1,614	480	19	2,612
	Night	5	144	437	144	5	735
	Total	24	624	2,051	624	24	3,347
No. 45 (West)	Day	127	1,841	4,781	1,841	127	8,717
	Night	46	522	1,206	522	46	2,342
	Total	173	2,363	5,987	2,363	173	11,059
No. 48 (West)	Day	74	1,105	3,378	1,105	75	5,736
	Night	23	276	734	276	23	1,332
	Total	97	1,381	4,112	1,381	97	7,068
No. 37 (North)	Day	839	6,739	16,360	6,739	839	31,516
	Night	332	2,184	4,838	2,184	332	9,870
	Total	1,171	8,923	21,198	8,923	1,171	41,386
No. 37 (South)	Day	511	5,473	14,313	5,473	511	26,281
	Night	208	1,847	4,465	1,847	208	8,575
	Total	719	7,320	18,778	7,320	719	34,856
All Roads	Day	1,758	18,750	49,495	18,750	1,758	90,511
	Night	703	5,922	14,102	5,922	703	27,352
Grand Total		2,461	24,672	63,597	24,672	2,461	117,863

[*] For Highway No. 37 the time period covered is December 7, 1968 through December 31, 1969. For all other State Roads the time period is December 7, 1968 through July 31, 1969.

[**] Day is defined as the time period 6:00 A.M. to 7:00 P.M.

3.4 Tracking Vehicles Using the Computer-Sensor System

The Computer-Sensor System provides two main functions in the Speed and Accident investigation. These are:

1. To provide traffic flow characteristics of the traffic stream on Highway No. 37 (Described in Section 5),
2. To identify accident-involved vehicles and to give an estimate of the speed(s) of these vehicle(s).

The latter function is the most important one relative to the primary objective of this study. There are several factors which can be used in the identification of accident-involved vehicles. Some of these factors are directly a function of the computer-sensor system and others are a function of post-accident investigations. Some factors which aid in identifying accident-involved vehicles from the computer printout are:

1. Sudden decrease in traffic speeds at a nearby sensor,
2. Gaps in the traffic stream,
3. Failure of a vehicle to cross the next sensor, and
4. Extreme length or speeds of the accident-involved vehicle.

   If the vehicle is of average length (17 to 19 feet), that of a passenger car, then its relative position to other vehicles in the traffic stream having extreme length and/or speeds is used in identifying the accident-involved vehicle.

The factors listed above are not always sufficient to identify accident-involved vehicles because very frequently accidents do not block the traffic lanes to a sufficient extent that the traffic flow pattern at the next sensor is disturbed. This is particularly true with the sensor sites located approximately 1 to 2 1/2 miles apart. Hence, it is necessary to use post-accident investigation to identify the time and position of the accident as accurately as is possible. Furthermore, the post-accident interview with the involved person(s) and/or witness(es) can aid in identifying the relative positions of vehicles in the traffic stream. The methodology for integrating the information from the CSS and the post-accident investigation is given in Appendix B.

A brief analysis of the capability of the system is presented below, along with a brief description of the computer program for tracking vehicles through the system, and the accompanying printout for a particular accident in which the probability of identification of the accident-involved vehicle(s) is extremely high. Table 3.4.1 presents a brief summary of the accident history for August 1, 1969 through December 31, 1969. The total number of accidents observed during this period was 48 and began with accident number 262.

Table 3.4.1 Accident History

Observed Information	Number of Cases
Total number of accidents -	48
Accidents within the Computer-Sensor System (CSS) -	36
Number of accidents for which the CSS speeds were used for at least 1 involved vehicle for estimating its speed -	23
Number of accidents in which AIV's were identified with high confidence (greater than 90% for the platoons containing the AIV's) -	14
1. Number of accidents subject to the above high confidence of identification and for which the estimated speeds given by the CSS are considered relevant	9
2. Other cases for which the speeds are not relevant because of the type of the accident (e.g., a rear-ender remote from the sensor)	5
The number of accidents within the "thick" CSS which was installed as of November 4, 1969 -	0
The number of accidents for which RTI has made a track of the AIV's -	5

In summary, the information given in the above table indicates that about 25% (9 out of 36) of the accidents within the Computer-Sensor System on Highway No. 37 can be tracked to the extent that an estimate of the speed of the accident-involved vehicle(s) is useful in this investigation; and furthermore, there is a high probability of identifying the accident-involved vehicle within a platoon of a few vehicles.

There is, however, the problem that the speed of an AIV at the last sensor site is not necessarily equal to its speed at the location of the accident due to the variation of the vehicle speeds from location to location as a function of the highway geometry, environment, and other factors. This variation is very clearly pointed out in the analysis of the traffic flow characteristics in Section 5.2 of this report. Hence, even with the Computer-Sensor System, one can estimate the speed of the accident-involved vehicle to within about six mph with 90% confidence.

Table 3.4.2 lists the accident numbers and the speeds as given by the computer-sensor system printout and the accident data sheet. It should be noted that the two speed estimates are nearly identical for many accidents, the only exceptions being the rear-end accidents and those accidents involving a passing maneuver in which a vehicle has speeded up after passing over the last sensor site. As of August 1, 1969 the accident investigation was purely a post-accident investigation of lesser depth than that used prior to August 1, 1969. Therefore, considerable dependence was placed upon the speed estimates obtained from the computer printout. Prior to August 1, 1969 the computer-sensor system was not yielding sufficiently precise and accurate data in order to attempt to track vehicles and compare the estimates of speeds with those given by an independent accident investigation. Thus, there is insufficient information to analyze the speeds provided by the accident investigation teams as compared with that of the computer-sensor system as the two estimates are not independent.

Utilization of the Several Sensors to Determine the Trajectory of a Vehicle Through the Test Section

The computer-sensor system provides output on a real-time basis which enables educated guesses to be made about vehicle trajectories. Each vehicle has speed and length computed from the sensor data.

A computer program was written which can, on a time increment basis, queue the vehicles by sensor into a time sequence. This sorted vehicle speed-length data is then printed with the time sequence down the page and the sensor distance spacing at

Table 3.4.2 Comparison of Speed Estimates

		Estimated Speeds of AIV's	
Accident No.	Vehicle No.	Computer Printout	Accident Data Sheet (Table 6.1)
263	1	57	40
264	1	57	55
265	1	61	75
268	1	31	26
	2	29	45
	3	28	45
	4	27	45
270	1	46	45
	2	50	50
275	1		
	2	59	59
279	1	54	55
	2	59	50
280	1	60	50
	2	40	40
282	1	40	40
290	1	41	41
291	1	55	55
297	1	64	75
303	1	51	50
305	1	-	-*
	2	(28 - 47)	45
307	1	65	65
308	1	74	72
	2	68	68
309	1	57	57
310	1	42	45
316	1	64	65
319	1	-	-*
	2	58	58
	3	60	60
327	1	58	58
332	1	-	-*
	2	-	-*
	3	61	61
335	1	-	-*
	2	-	-*
	3	57	57
340	1	39	40
342	1	-	-*
	2	45	40
	3	46	46
	4	49	49
344	1	34	34
	2	34	34
351	1	38	38
	2	21	21
352	1	42	42
355	1	-	-*

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*Computer estimated speeds not relevant.

a predetermined scale across the page. This method of output provides an overview of the traffic flow at each of the sensors.

Certain vehicles (longer or shorter, faster or slower) are easily found when they pass a sensor. A line may then be drawn which connects these vehicles at each sensor. These "different" vehicles effectively break the vehicle stream up into segments which contain groups of vehicles. Within these smaller groups several events are possible:

1. All vehicles remain on the road and no new vehicles enter.
2. Some vehicles leave the road and no new vehicles enter.
3. All vehicles remain on the road and new vehicles enter.
4. Some vehicles leave the road and new vehicles enter.
5. Vehicle order remains the same.
6. Vehicle order changes (passing).

Because of the multitude of possible events which can occur, at this point vehicle tracking is more of an art than a science. The usual process of vehicle tracking is as follows:

1. Locate a vehicle which has either unique speed or length characteristics at several sensor locations.
2. Connect the unique vehicle-sensor-time points with straight lines.
3. Examine the vehicles which are bounded by the vehicles located in Steps 1 and 2 for speed, headway, length, and platoon characteristics.
4. Repeat Step 2.

The basic sequence just outlined can usually be repeated within the groups defined in Step 1 until most vehicle trajectories can be traced.

The use of proportional spacing for the queue-sensor enables a visual study to be made of the traffic flow. A change in the slope of the trajectory line indicates a speed fluctuation between the sensors.

Example of Vehicle Tracking

Accident 280 has been selected as a positive example of the use of the computer-sensor system (CSS). This accident has three primary identification points which are not found in the average case; first, one accident-involved vehicle was followed by two-tractor semi-trailer trucks, second, the other vehicle was a tractor semi-trailer truck, and third, traffic was blocked (i.e. stopped) from the accident location through a sensor location. With these three facts in mind the apparent trajectories are easily found. See Figure 3.4.1 for tracking the vehicles in Accident 280.

Loops 12, 13, 14

At time 16.5579 the first of two trucks crossed Sensor 12, followed 5.4 seconds by the second, which in turn is followed 3.6 seconds later by a vehicle traveling 4 mph faster than the trucks ahead. This sub-platoon of three vehicles can be found at Sensor 13 at 16.5785. The next vehicle to cross 13 does so 36 seconds later at 34 mph (15 mph below the apparent mean speed at this time). Succeeding vehicles slow to a crawl and eventually traffic disappears from the sensor. Sensor 14 carries its normal traffic until the "point in time" at which the above vehicles should have arrived, then traffic almost disappears from it. The vehicle which was traveling 4 mph faster than the trucks is hypothesized to be the automobile involved.

Loops 10, 9, 8

Traffic disappearance is a major factor in tracking vehicles here. Traffic flows from Sensor 10 to 9 to 8. Around 16.5410 a platoon of three vehicles crosses Sensor 10, at 16.5789 they crossed 9, and at 16.6019 they crossed 8. Traffic following this platoon continues to cross Sensor 10 but disappears from Sensors 9 and 8. This platoon is followed on Sensor 10 by a 37 foot vehicle which never arrives at Sensor 9 or 8. This vehicle is hypothesized to be the tractor semi-tractor truck involved.

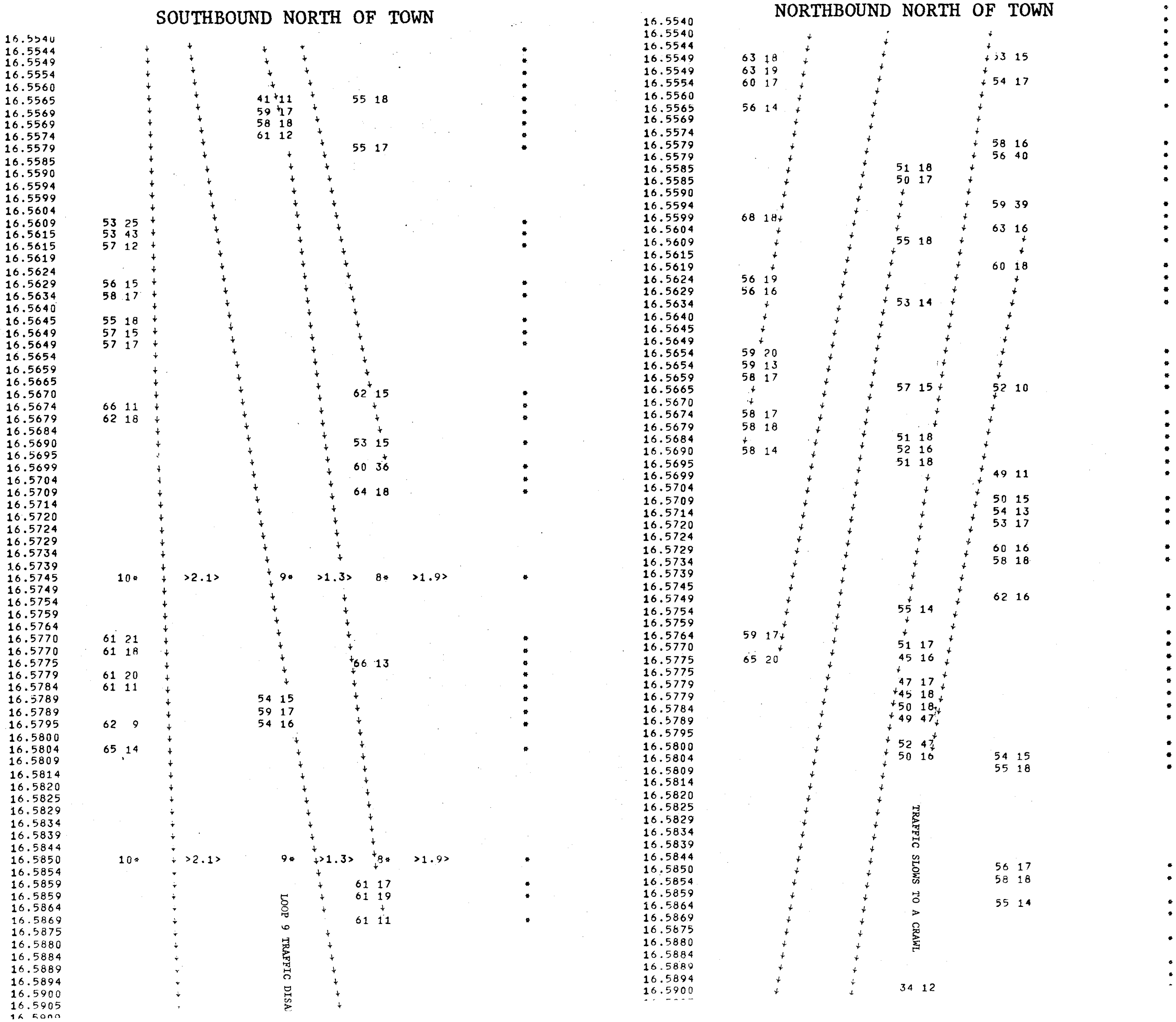
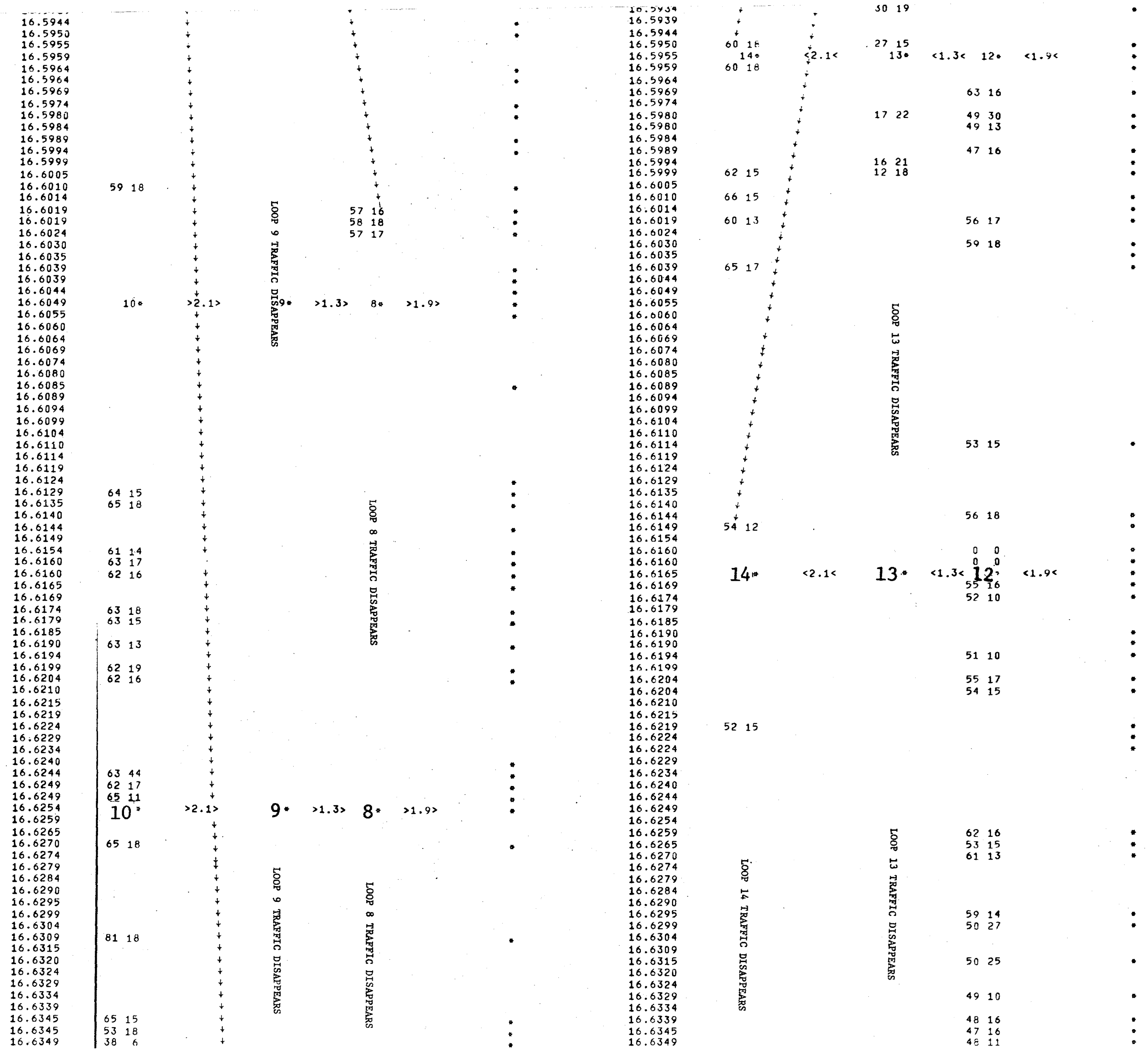


Figure 3.4.1 Example of Vehicle Tracking (Accident 280)



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16.5944                                                           *
16.5950                                                           *
16.5955
16.5959
16.5964                                                           *
16.5964                                                           *
16.5969
16.5974                                                           *
16.5980                                                           *
16.5984
16.5989                                                           *
16.5994                                                           *
16.5999
16.6005
16.6010     59 18                                                 *
16.6014
16.6019                                      57 16                *
16.6019                                      58 18                *
16.6024                                      57 17                *
16.6030
16.6035
16.6039                                                           *
16.6039                                                           *
16.6044                                                           *
16.6049       10*     >2.1>       9*   >1.3>   8*    >1.9>        *
16.6055                                                           *
16.6060
16.6064
16.6069
16.6074
16.6080
16.6085                                                           *
16.6089
16.6094
16.6099
16.6104
16.6110
16.6114
16.6119
16.6124                                                           *
16.6129     64 15                                                 *
16.6135     65 18                                                 *
16.6140
16.6144                                                           *
16.6149
16.6154     61 14                                                 *
16.6160     63 17                                                 *
16.6160     62 16                                                 *
16.6165                                                           *
16.6169
16.6174     63 18                                                 *
16.6179     63 15                                                 *
16.6185
16.6190     63 13                                                 *
16.6194
16.6199     62 19                                                 *
16.6204     62 16                                                 *
16.6210
16.6215
16.6219
16.6224
16.6229
16.6234
16.6240                                                           *
16.6244     63 44                                                 *
16.6249     62 17                                                 *
16.6249     65 11                                                 *
16.6254     10*       >2.1>       9*   >1.3>   8*    >1.9>        *
16.6259
16.6265
16.6270     65 18                                                 *
16.6274
16.6279
16.6284
16.6290
16.6295
16.6299
16.6304
16.6309     81 18                                                 *
16.6315
16.6320
16.6324
16.6329
16.6334
16.6339
16.6345     65 15                                                 *
16.6345     53 18                                                 *
16.6349     38  6                                                 *
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16.5934                        30 19                              *
16.5939
16.5944
16.5950     60 16              27 15                              *
16.5955       14*     <2.1<      13*   <1.3<  12*    <1.9<        *
16.5959     60 18                                                 *
16.5964
16.5969                                     63 16                 *
16.5974
16.5980                        17 22        49 30                 *
16.5980                                     49 13                 *
16.5984
16.5989                                     47 16                 *
16.5994                        16 21                              *
16.5999     62 15              12 18                              *
16.6005
16.6010     66 15                                                 *
16.6014                                                           *
16.6019     60 13                           56 17                 *
16.6024
16.6030                                     59 18                 *
16.6035                                                           *
16.6039     65 17                                                 *
16.6044
16.6049
16.6055
16.6060
16.6064
16.6069
16.6074
16.6080
16.6085
16.6089
16.6094
16.6099
16.6104
16.6110
16.6114                                     53 15                 *
16.6119
16.6124
16.6129
16.6135
16.6140
16.6144                                     56 18                 *
16.6149     54 12                                                 *
16.6154
16.6160                                      0  0                 *
16.6160                                      0  0                 *
16.6165     14*       <2.1<      13*   <1.3<  12*    <1.9<        *
16.6169                                     55 16                 *
16.6174                                     52 10                 *
16.6179
16.6185
16.6190                                                           *
16.6190                                                           *
16.6194                                     51 10                 *
16.6199
16.6204                                     55 17                 *
16.6204                                     54 15                 *
16.6210
16.6215
16.6219     52 15                                                 *
16.6224                                                           *
16.6224                                                           *
16.6229
16.6234
16.6240
16.6244
16.6249
16.6254
16.6259                                     62 16                 *
16.6265                                     53 15                 *
16.6270                                     61 13                 *
16.6274
16.6279
16.6284
16.6290
16.6295                                     59 14                 *
16.6299                                     50 27                 *
16.6304
16.6309
16.6315                                     50 25                 *
16.6320
16.6324
16.6329                                     49 10                 *
16.6334
16.6339                                     48 16                 *
16.6345                                     47 16                 *
16.6349                                     48 11                 *
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3.5 Classifications of Accidents

Included in Section 6 is a listing of each accident investigated along with certain accident data considered pertinent to this study. These accidents have been classified according to:

a) Type of accident

b) Location

c) Day of occurrence

d) Light conditions

e) Seat belt usage

f) Evidence of alcohol

g) Weather condition

h) Sex of driver

i) Age of driver

j) Year of vehicle.

The results of these categorizations are shown in Table 3.5.1, prepared primarily for informational purposes. It is difficult to draw conclusions from these data alone, since direct comparison of absolute numbers of accidents are, in most cases, invalid. Other information must be considered in making comparative analyses. For example, male drivers were involved in 368 accidents (73% of all involvements), whereas, female drivers were involved in 136 accidents (27% of all involvements). According to the 1960 U.S. Census data, the breakdown of the Monroe County driver-age population (ages 16-70) by sex shows an almost even split between males and females (50.4% and 49.6% respectively). If one is willing to assume that males and females drive an equal amount, then we could conclude from these data that males are more likely to be involved in an accident. However, the above assumption is invalid since the male population normally has greater exposure in terms of miles driven. Hence, information regarding miles driven by males and females is necessary in order to make a comparative analysis. As a second example, consider the breakdown of accidents by

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Table 3.5.1 Accidents Classified According to Type, Location, Environment, Driver and Vehicle Characteristics

(a) Type of Accident

Single		110
Multiple		184
Head-on	32	
Rear-end	81	
Side	71	

(b) Location

Highway #37 North	65
Highway #37 South	49
Highway #45 East	19
Highway #45 West	22
Highway #46 East	13
Highway #46 West	25
Highway #48 West	7
Other County Roads	94

(c) Day of Occurrence

Weekday	188
Weekend	106

(d) Light Conditions

Day	173
Night	103
Dusk	12
Dawn	6

(e) Seat Belt Usage

Used	39
Not Used	144
Not Installed	84
Use Unknown	254

(f) Evidence of Alcohol

Yes	40
No	438
Unknown	34

(g) Weather Conditions

Clear	174
Rain	59
Snow	13
Ice	6
Overcast	37
Fog	5

(h) Sex of Driver

Male	368
Female	136
Not Identified	8

(i) Age of Driver

≤ 19	102
20 - 24	119
25 - 29	59
30 - 34	46
35 - 39	28
≥ 40	147
Unknown	11

(j) Year of Vehicle

1970	1
1969	56
1968	67
1967	60
1966	60
1965	66
1964	50
1963	44
1962	37
1961	11
1960	12
< 1960	37
Unknown	11

year of vehicle. To illustrate how additional information may be utilized in making comparative analyses of model years the following table has been prepared.

Table 3.5.2 Observed and Expected Number of Accidents by Year

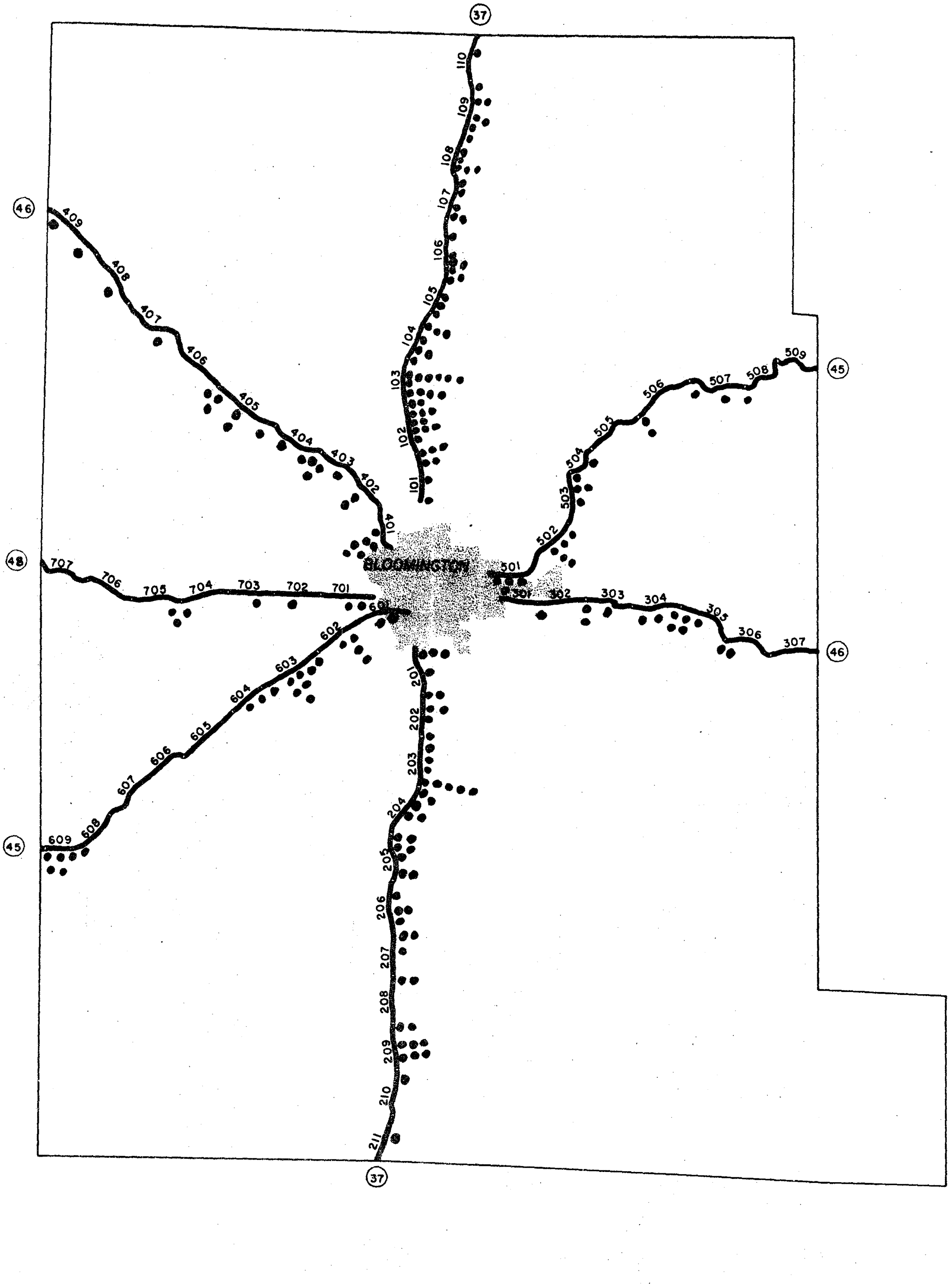
Year	Observed No. Accidents	Expected No. Accidents*
1969	56	45.4
1968	67	64.4
1967	60	63.4
1966	60	59.3
1965	66	52.8
1964	50	46.3
1963	44	42.1
1962	37	37.0
1961	11	29.2
1960	12	23.2

*The expected number of accidents was obtained by multiplying the proportion of vehicles for a given model year by the total number of accidents. Data on a national basis for proportion of vehicle by model year may be found in Automotive News 1969 Almanac.

A chi-square statistic may be used to determine whether the differences between the observed and expected number of accidents can be attributed to chance variation. In carrying out this statistical test, however, one must assume equal exposure for all model year vehicles which may not be completely valid. If data are available on exposure by model year then these should be used to obtain the expected number of accidents.

In addition, a map of the state highways in Monroe County is shown in Figure 3.5.1 with the locations of the accidents superimposed. Although the locations of accidents appear to be well dispersed throughout the county, there are indications of "danger" spots. Stations 102, 103, 203, 209, 305, 401, 603 and 609 appear to have experienced a proportionately high number of accidents. In analyzing Figure 3.5.1 one must recall that for Highway No. 37 the time period covered is December 7, 1968 through December 31, 1969. For the remaining State Roads the time period is December 7, 1968 through July 31, 1969.

Figure 3.5.1 Accident Locations - Monroe County



For each of the accidents on the state highways in Monroe County and involving at least one vehicle in the low-, medium-, and high-speed deviation categories, the most pertinent contributing factors were tabulated and the results are given in Table 3.5.3.

Table 3.5.3 Contributing Factors Versus Speed Deviation Category

	Speed Deviation Category			
Contributing Factors	$\Delta S_D < -15.5$		$-5.5<\Delta S_D<5.5$	$\Delta S_D > 15.5$
	No Turning Maneuver	Turning Maneuver		
1. Lost control	2	1	20	14
2. Too fast for road and weather conditions	1	0	8	10
3. Road surface slippery	5	6	21	8
4. Following too closely	5	14	21	3
5. Passing maneuver	2	9	8	3
6. Forced off road	0	1	6	2
7. Too slow for normal traffic flow	1	1	0	0
8. Vision obscurred	3	9	10	4
9. Narcolepsy	0	0	0	1
10. Mechanical defect	1	5	6	1
11. Interaction with turning maneuver	0	26	15	2
12. Alcohol*	0	1	6	6
13. Wrong side of road	3	2	15	9
14. Inattention	2	10	8	1
15. Failure to yield right of way (primary factor)	0	13	5	1

---

* Those instances of alcohol involvement reported reflect the driver status as noted on the investigating officer's report. Neither strict guidelines nor legal aids exist in Indiana to provide for the identification of the drunk driver. Except in the extreme case where a blood-alcohol test was administered, most reported incidences of alcohol were based on the subjective judgement of the investigating officer.

4. SYSTEMS ANALYSIS

At the inception of this project it was intended that the computer-sensor system be able to provide data in a real time system in two basic areas:

1. To record traffic parameters as a function of time and sensor position on Highway 37; in particular, this includes the speed, density, headways, and mix of vehicles on the roadway during the time of an accident.

2. Identification of the accident-involved vehicles (AIV's) such that their speeds over the last sensor before the accident site could be determined.

The computer-sensor system was able to provide data in Area 1 very satisfactorily. In this respect, data are now available which have not been previously collected regarding the specific overall traffic parameters in the stream of flow containing the AIV's. These data are very important in determining the mean speeds of surrounding traffic flow, which are really half the speed data required for determining speed deviations of the AIV. In this respect the computer-sensor system has been valuable.

One of the most difficult tasks (Area 2) of this project was to estimate accurately the speeds of the AIV's. In general, only a small number of AIV's were identified with this system, i.e., in approximately 25% of the accidents was it possible to identify the specific AIV <u>or</u> the platoon of vehicles containing the AIV as they passed over the last sensor before the accident site. The 25% figure may seem low at first reading; however, the following rationalization may help to explain the figure and also indicate the additional number of sensor sites necessary to increase the figure to a relatively high percentage. The first eight sensor sites were dispersed over a section of road approximately 11.2 miles in length (not including the sections beyond the outer loops) or about 12.2 miles allowing one-quarter mile on each end of the two instrumented sections of Highway 37 North and South. The "sight" distances

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vary from one loop site to another, but suppose that the area surrounding each site can be "observed" by an average distance of about one-quarter of a mile in each direction, then the eight sites "cover" approximately four miles or about 33% of the road. To yield a high percentage coverage would require two to three times as many loop sensors. They could be located so that the sight distance would be such that the occurrence of an accident anywhere on the road would result in an almost immediate disturbance in the traffic flow at one of the adjacent sensor sites. Since the additional sensor sites added in the later portion of this study are located within approximately this distance (i.e. six sites were added within the distance of two sites), it appears that data should become available to check the validity of these remarks.

Since the accuracy and precision of the computer-sensor system was assessed just prior to August 1, 1969, the intensive use of the CSS to provide the required speed data for each accident within the outer loops of the CSS began at that time. From this point until December 31, 1969, 36 accidents occurred on Highway 37 within the sensor system. Since, in approximately 9 cases the AIV's could be identified with a high degree of confidence, either as the individual vehicle or one member of a platoon, it appears that the cost per accident is quite high. In fact, if this were the only justification of theCSS the cost per accident exceeds that of a multidisciplinary accident investigation, the latter being about $2,000 to $2,500 per accident. If two to three times as many sensors could be added to the roadway and the additional cost increase by no more than 25% and if the percentage of detection of the AIV's could be increased to 90%, the cost could be reduced to about $1,400 per accident. This tradeoff of cost needs to be evaluated for the potential value of such data in future highway safety programs.

However, as mentioned previously, the CSS has provided for this study the necessary characteristics of the traffic flow surrounding that of the accident. Without improved measures of individual and mean traffic speeds, standard deviation of speeds, and volumes, the precisions of the estimates of the involvement rates as a function of speed deviation would have been reduced. Thus the use of the CSS as a means of providing pertinent traffic flow data is not easily converted to a cost figure for the primary purpose of this study.

4.1 System Availability

Individual observations of speed, length and headway for each vehicle crossing a pair of magnetic loop detectors are generated by the computer-sensor system and stored on magnetic tape. Through a series of data processing techniques, these individual observations are reduced to Hourly Summary Reports which, through various summary statistics, characterize the events of interest during one-hour periods at each loop site. The volume of traffic in each direction on Highway No. 37 is sufficiently high so as to insure that at least one vehicle per hour will cross each loop which is sufficient to generate an Hourly Summary Report. Hence, for each 24-hour day the complete system, composed of sixteen loops, should generate a total of 16 × 24 = 384 hourly reports. Based on the presence of these reports and the usability of data contained therein a system availability is calculated. System availability for a given time period is defined as the ratio of the number of hourly reports for the time period which contain usable data to the total possible hourly reports, expressed in percent. Four hours during each seven day period are normally scheduled for maintenance, thus the availability cannot exceed 100 × 164/168 = 97.6% unless the maintenance period is shorter than anticipated. The numerator of this ratio is affected by two factors. First, if the hourly report is missing then, naturally, the data for that report is not usable. Second, if the hourly report shows the bad car count (BCC) $\geq$ 5% then the data for that report is considered unusable. The 5% is an arbitrary value. Frequently, the computer-sensor system will sense the passage of a vehicle over the sensor; however, the speed and length is recorded as zero - this constitutes a bad car count. A BCC of 5% infers that 5% of the total activations had speed and length of zero. Several possible causes of this phenomena are given below.

1. Improper lane usage.

2. One of the two Vedets per loop set can fail locking the relay open or shut.

3. The field strength of one of the VeDets may be less than its pair loop so that one loop detects (or fails to detect) when the other loop does not. This often occurs with trailer trucks with the body some distance from the road surface.

4. Loops 11 and 15 and 10 and 14 were multiplexed using a single phone line. We believe, but have been unable to document because of the intermittency, that the multiplex circuit equipment malfunctions sending multipulse signals that cause misinterpretation by the computer.

During July 1969 the problem of VeDet sensitivity to deal with 3. above was studied. It was discovered in loops 8-15, which were located in the concrete portion of North 37, that the interaction between the wire loops and the iron reinforcing rods contained in the concrete was sufficient to greatly alter the field above the loops. This resulted in insufficient detection , particularly of trucks. In mid-August and throughout September the power input of the northern detectors was raised in order to increase the field strength over the wire loops. At the same time the relays utilized in the output were altered in all units. Increasing the field strength did reduce the BCC but it also increased the sensitivity of the unit requiring more frequent tuning and making it more temperature sensitive.

The data involving BCC's can be divided into two types:

1. Non-continuous failure where intermediate data are accurate and may be viewed as a sample. Volume count would be affected but in some cases can be corrected.

2. Continous failure where the data samples are not usable.

Normally, the change from type 1 to 2 is quite evident because usually the VeDet is either operational, accurate and missing only a relatively few vehicles or it is non-operational, missing almost all vehicles. If a detector were properly calibrated, it is expected that accurate speed data on the portion of vehicles counted would be provided even though BCC is as large as 15%. Situations have been observed where the BCC is almost 100% and the actual number of BCC recorded during an hour far exceeds the expected number of vehicles for that hour. Also, there is evidence that during these times the recorded speeds are grossly in error.

Beginning with June 23, 1969, weekly system availability percentages have been calculated for each of the loops and for all sixteen loops combined. Data are presented on paired loops because of the commonality in location and the similarity of the availability figures for loop pairs. The results are shown in Table 4.1.1 for the 22 week period from June 23, 1969 through November 23, 1969.

For the sixteen loops combined, the weekly system availability ranged from 54% to 93%. On a paired loop basis the weekly system availability ranged from 0% to 99%. With one exception (Loop No.'s 11 and 15) all paired loops had one or more weeks in which the system availability was 96% or higher. This alone demonstrates that the system is capable of high level performance. The overall level of performance measures the effects and interactions of many factors as listed above, for some of which an adequate solution may be simple, complex, expensive and/or time consuming. A detailed systems analysis is needed with regard to accuracy, repeatability, maintainability, the identification of problem areas (including causes and possible solutions), recommendations for improvement, and other areas of vital interest to potential users of such a system.

System availability as shown in Table 4.1.1 provides, on a weekly basis, an overall view of the system's operational characteristics. This does not, however, provide information to the detailed level required to attempt to identify or diagnose the underlying causes or problems. Some additional analyses have been made

Table 4.1.1 System Availability (%)*

	Time Period													
	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11	WEEK 12	WEEK 13	WEEK 14
Loop No.	6/23 – 6/29	6/30 – 7/6	7/7 – 7/13	7/14 – 7/20	7/21 – 7/27	7/28 – 8/3	8/4 – 8/10	8/11 – 8/17	8/18 – 8/24	8/25 – 8/31	9/1 – 9/7	9/8 – 9/14	9/15 – 9/21	9/22 – 9/28
	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0 & 4	70	96	88	92	94	97	94	86	90	96	93	82	42	80
1 & 5	75	96	87	93	95	99	95	88	82	99	95	84	74	86
2 & 6	76	92	88	94	86	98	95	86	83	96	96	86	74	90
3 & 7	75	98	90	90	96	99	89	79	84	99	98	86	76	90
8 & 12	76	96	70	72	96	92	93	84	87	95	89	74	49	70
9 & 13	18	45	44	86	96	90	95	87	91	98	93	70	54	81
10 & 14	36	65	42	54	77	93	94	85	91	99	88	82	73	85
11 & 15	15	25	16	42	69	79	60	64	62	0	27	46	8	0
TOTAL (16 Loops)	55	77	66	78	89	93	89	82	84	85	85	76	56	73

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*Scheduled maintenance time of four hours per week of 168 hours reduces the maximum value to 97.6%. Values exceeding 97.6% result from maintenance times shorter than anticipated.

Table 4.1.1 (Continued)

Time Period

Loop No.	WEEK 15 9/29 – 10/5	WEEK 16 10/6 – 10/12	WEEK 17 10/13 – 10/19	WEEK 18 10/20 – 10/26	WEEK 19 10/27 – 11/2	WEEK 20 11/3 – 11/9	WEEK 21 11/10 – 11/16	WEEK 22 11/17 – 11/23
	%	%	%	%	%	%	%	%
0 & 4	68	75	72	70	65	75	80	71
1 & 5	71	78	72	72	68	74	79	90
2 & 6	73	25	52	74	67	72	58	75
3 & 7	73	79	76	75	68	76	58	62
8 & 12	33	0	50	72	63	75	63	66
9 & 13	71	76	72	73	69	76	74	0
10 & 14	63	67	63	62	64	76	70	63
11 & 15	24	31	53	67	61	70	49	64
TOTAL (16 Loops)	60	54	64	71	66	74	66	61

for the four week period of September 1st to 28th, 1969. This time period is almost four months after the system became operational and one month before the system was expanded to include six additional sets or loop pairs. During the month of September, program development for the expanded system as well as hardware implementation was on-going. In particular the 1:00 to 4:00 P.M. time period and the 12:00 to 6:00 A.M. time period were chosen for system shut down. This was done to maximize the chances of collecting data at high accident times.

Figure 4.1.1 shows, by time of day, the percentage of missing hourly summary reports. For each hour over a four week period there should be 448 hourly reports (28 hourly reports for each of the 16 loops). Figure 4.1.1 shows, for example, that for the hour ending at 2:00 A.M., 25% of 112 of the 448 reports are missing. The percentage of missing reports is slightly higher during the early morning hour (midnight to 6:00 A.M.) than during the remainder of the day, with the exception of the period from 2-4:00 P.M. During this period the high percentage of missing reports reflects deliberate down time in conjunction with system upgrade. Thus the percentages at times other than 12 to 6:00 A.M. and 1 to 4:00 P.M. provide a reasonable estimate of system performance with regard to missing reports.

Figure 4.1.2 shows, by time of day, the percentage of hourly summary reports in which the bad car count (BCC) $\geq$ 5%. The 5% level is an arbitrary selection. The percentages of BCC during low volume hours (nighttime) are significantly higher than for the remaining hours. This would suggest that possibly trucks and improper lane usage represent problems to the system, since the percentage of trucks and improper lane usage is higher during low volume hours. These are system problem areas which should receive high priority in future research.

A comparison of the results in Figures 4.1.1 and 4.1.2 with those for November 1 to 24, 1969 indicates that no significant change in system performance with regard to missing reports but that the BCC's are reduced to about 4%.

Figure 4.1.1 Percentage of Missing Hourly Summaries by Time of Day
(Time Period 9/1/69 to 9/28/69)

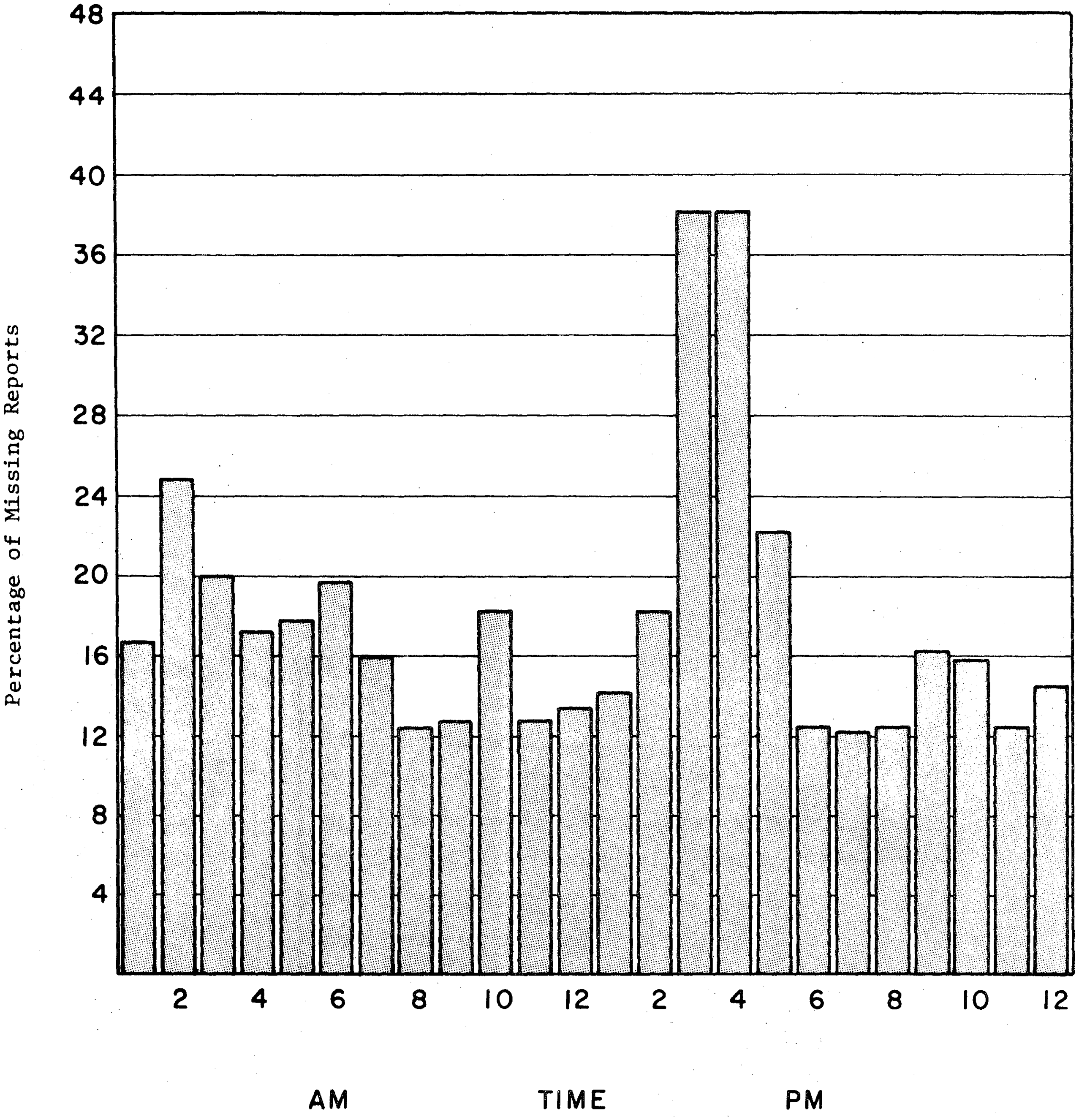
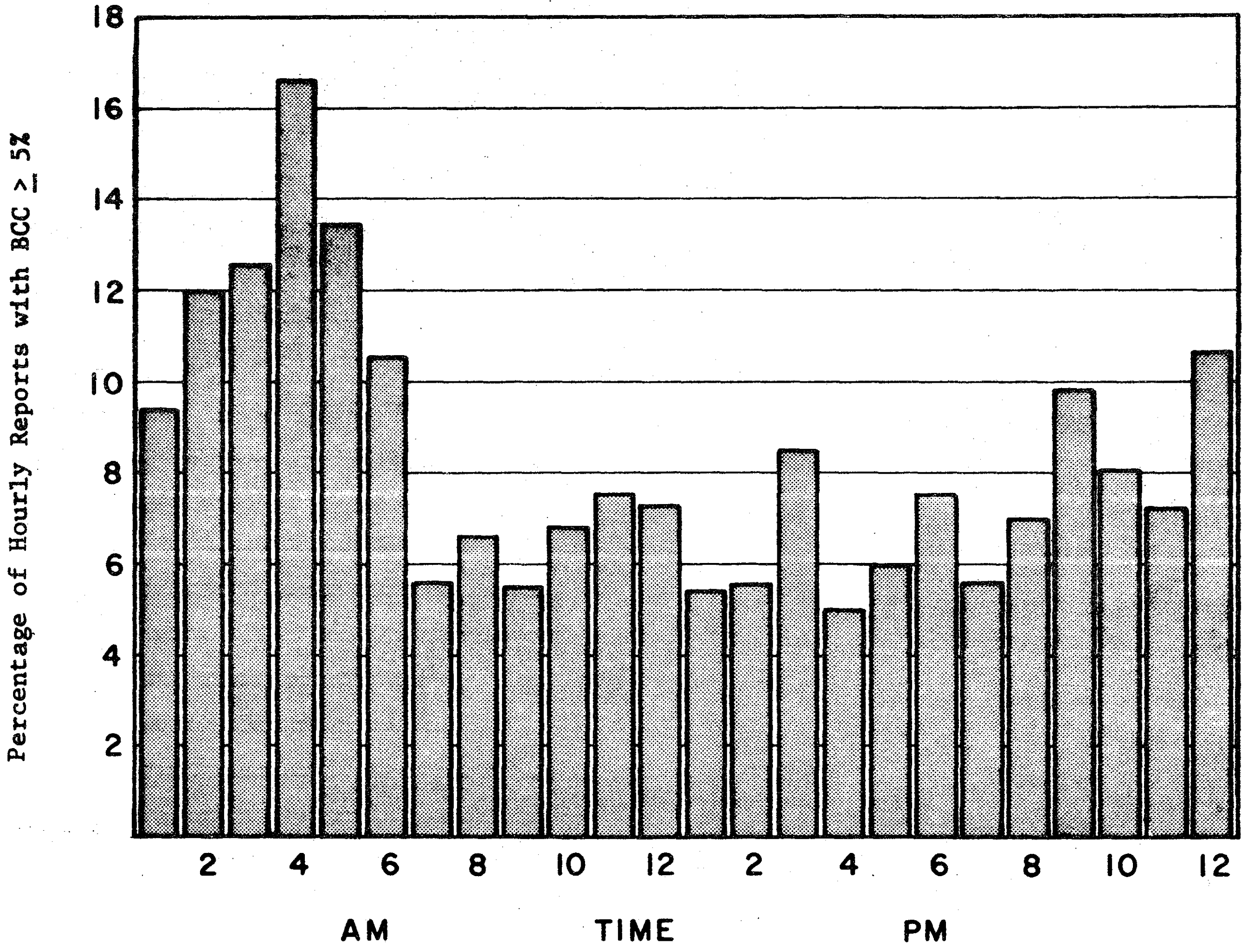


Figure 4.1.2 Percentage of Hourly Summaries with BCC $\geq$ 5% by Time of Day (Time Period 9/1/69 to 9/28/69)



The table below shows, by paired loops, the percentage of hourly summary reports in which the BCC $\geq$ 5% along with some comments pertaining to the values for BCC's. These results enable direct comparisons to be made among the loop sites. Both "good" and "bad" loop sites exist, as evidenced by Pairs 3 & 7 and 11 & 15 respectively.

Table 4.1.2 Percentage of Hourly Reports With BCC $\geq$ 5% Versus Loop Pair

Loop Pair		Percentage of Hourly Reports with BCC $\geq$ 5%	
0 - 4		5.7	← probably best site but high volume of improper lane usage at low traffic volumes
1 - 5		2.3	
2 - 6		2.1	
3 - 7	← very low improper lane usage due to road geometry	0.6	
8 - 12		18.0	
9 - 13		3.1	
10 - 14		5.9	
11 - 15		46.5	← high interacting with reinforcing rods

System availability reflects both missing data and data discarded due to BCC $\geq$ 5%. One may question the validity of discarding speed data for those cases where the BCC was $\geq$ 5%. However, a very large quantity of data are available and this decision should minimize the error of biased estimates while maintaining sufficient data for performing the desired analyses.

4.2 System Accuracy and Repeatability

About three months after the computer-sensor system became operational, a speed check of accuracy and repeatability was made on the entire system. Each of the sixteen pairs of magnetic loop detectors (identified as Loop No.'s 0, 1, ..., 15) was checked for accuracy and repeatability of vehicle speed through the use of an RTI-supplied speed measuring device consisting of pressure sensitive tapes coupled to an extremely accurate electronic timer. When a vehicle traversed a loop, simultaneous readings of its speed were obtained from the "timer" and the "computer-sensor system." Appendix G contains the speed data collected for each of the sixteen loops. As a result of the method employed in calculating speed (truncation), the computer is expected to read 0.5 mph below the timer speed. Hence, the expected difference is $\bar{d} = -.5$ when the bias is zero. Assuming the error associated with the timer is negligible, then s_d reflects the repeatability of the computer-sensor system.

From a total system standpoint, the computer-sensor system measures vehicle speed satisfactorily. Ten of the sixteen loops showed a bias less than .5 mph. The biases shown in the remaining six loops could be eliminated by "adjustments" to the computer programs. Loop 7 exhibited the largest bias, $\bar{d} = -4.6$ mph. From the standpoint of repeatability, only six of the sixteen loops showed standard deviations greater than 1.0 mph. These are:

Loop No.	Standard Deviation (s_d)
10	1.1
9	1.2
12	1.3
13	1.6
6	1.7
8	2.2.

A systems study should be made to determine how these loops differ from the remaining ten loops which showed standard deviations less than 1.0 mph. Also, it should be determined if there are economically justifiable ways of reducing the standard deviation to 1.0 mph or less.

All accuracy checks on these sixteen loops made prior to and subsequent to this test utilized radar as the standard or control.

4.3 Analysis of Estimated Vehicle Lengths

Several platoons of vehicles were followed through the Computer-Sensor System to determine the variation of the estimated lengths as given by the computer printout at various sites. As an example, the following data were selected from a printout for August 30, 1969 (Loops 6 and 7, SR 37 South).

TABLE 4.3.1 ESTIMATED LENGTHS (IN FEET)

Vehicle	Loop 7	Loop 6	Total
1	41	43	84
2	14	17	31
3	17	17	34
4	15	18	33
5	15	16	31
6	15	17	32
7	16	15	31
8	18	19	37
9	11	13	24
10	17	18	35
11	32	36	68
12	11	14	25
Total	222	243	465

An analysis of variance was performed on the above data to obtain the following information:

Source of Variation	Degrees of Freedom	Mean Square
Among Vehicles	11	164.01
Between Loops	1	18.37
Residual	11	1.01

The variation among vehicles is a function of the particular types passing through the sensor at the time of the study and is not of interest here. The variation between loops is a measure of the bias between the two sensors, that is Loop site 6 consistently gives results slightly greater than Loop site 7. The major value of this analysis is to estimate the residual variation in estimated lengths; that is, the capability of the system to yield consistent length measurements over the several loops. The variance estimate is approximately unity and the standard deviation in the estimated length is approximately one foot based on these results. The residual variation can be expressed as a measure of the inconsistency of the bias. That is, if one loop consistently measured lengths one foot greater than another loop, the residual variation would be zero and this bias could be made zero by appropriate changes in the computer software. However, the variation in this difference of length measurements (bias) can only be corrected through improved hardware. Several analyses of this type were performed yielding values for the residual standard deviation as follows.

Date	Loop Sets	Number of Vehicles	Residual Standard Deviation
8/30/69	0, 1	5	0.59
8/30/69	1, 2	9	1.64
8/30/69	1, 2, 3	7	0.62
8/27/69	8, 9	12	1.06
8/27/69	9, 10	10	0.88

The average residual standard deviation of the length measurement for a total of 43 vehicles is 1.08.

In a recent study [4], involving the calibration and correction of magnetic loop detectors it was pointed out that errors in excess of ten percent in speed and length are not uncommon. This study concludes that through computer logic alone there is no obvious solution to the problem of misreading the length of high ground clearance vehicles.

5. TRAFFIC FLOW CHARACTERISTICS AND ANALYSIS

The hourly volume of traffic for a given location on a road is expected to vary significantly from hour-to-hour over any consecutive 24-hour period. This variation is relatively consistent from day-to-day, especially during weekdays when the normal pattern shows peak hourly rates during the morning and afternoon rush hours, low hourly rates during early morning hours, and intermediate hourly rates elsewhere. The weekend (or holiday) hourly volume rates may differ appreciably from the weekday pattern, but again, the variation is relatively stable from day-to-day.

Also, the hourly volume of traffic at a given time is expected to vary significantly from one location on a road to another. This difference may be attributable to one or a combination of many factors such as locations of private industries, residential areas, schools, and other highways.

The volume-time relationships are described in Section 5.1. The relationships between mean speeds and traffic flow and environmental effects are considered in Section 5.2. Three models of increasing degree of complexity are fitted to the observed data by means of the method of least squares. The adequacy of these models to predict the mean speed is given.

Section 5.3 contains the mean speed and the standard deviation of speed as a function of location on the state roads (expressed as distance from Bloomington) and the environmental effects (night versus day and dry versus wet road conditions). The adequacy of the normal distribution for describing the variation in vehicle speeds is contained in Section 5.4.

5.1 Volume-Time Relationship

Volume-time relationships were developed for all the state roads in Monroe County, Indiana. These results are given in Appendix H. For Highway No. 37 (North and South), the computer-sensor system provided the source data for calculating the average hourly volume rates for Monday through Thursday, Friday, Saturday and Sunday for each of the sixteen loops. Small day-to-day differences were noted during each hour of the day. The hourly volume of vehicles on Friday morning followed very closely the observed rates for the other weekday mornings. However, beginning around noontime, Friday's rates begin to increase and are consistently higher than the other weekdays for the remainder of the day. Also, differences in ADT were noted for Saturday and Sunday. On Highway 37 North (Loops 8-15) the Sunday ADT is higher than Saturday, whereas on Highway 37 South the reverse is true. Volume count data generated by the computer-sensor system over the period June 23, 1969 through September 30, 1969, provided the source data for Appendix H. However, holiday periods surrounding July 4th, September 1st (Labor Day), and a football game day were excluded as being non-typical. Since the computer-sensor system downtime is unknown, the hourly volume count as given by the computer-sensor system cannot be used directly in calculating the volume-time relationship. Downtime causes the average hourly rate to be under-estimated. To avoid this bias, a minimum count for each hour, day-of-week, and loop was empirically established. Those hourly volume counts below the corresponding minimum counts were then discarded. In addition, hourly volume counts in which the bad car count (BCC) exceeded 50% were also excluded in the preparation of Appendix H. A listing of factors contributing to BCC's is given in Section 4.1. It is felt that when the bad car count reaches such a high level, the hourly volume count as given by the computer-sensor system is questionable.

Appendix H also gives the hourly volume rates for the remaining state highways in Monroe County. However, these rates were based on volume counts obtained from the 15-minute radar observation periods in which speed data were being recorded. Due to the manpower requirements, it was not economically feasible to obtain a sample hourly volume count for each direction of travel for each hour of the day, for each day of the week, at each station on these state highways in Monroe County. Based on the available speed survey data, it was necessary to ignore days of the week and direction of travel in order to have sufficient data for estimating hourly volume rates at most of the stations. On each highway, data from stations having similar average daily traffic (ADT) were combined into one volume-time curve. As expected, each highway had the highest ADT in the areas adjacent to the city of Bloomington, and as the distance from Bloomington increased, the ADT decreased. Many of the volume-time curves did not show the typical early morning high volume rate because of the manner in which the data were combined as described above.

5.2 Relationship Between Speed and Traffic Flow Characteristics

The computer-sensor system provides speed and volume information continuously, by direction of travel, at a given point on the highway. Data collected in this manner provides an opportunity to statistically analyze the effect of volume rate (vehicles per hour) on the speed characteristics, mean and variability. Multiple regression techniques were employed in the evaluation of how speeds are affected by such factors as vehicles per hour in same direction, vehicles per hour in opposing lane, number of trucks per hour (based on length measurements), day effect, hour-within-day effect, and so on. Three linear models were considered:

a) Model I: $\hat{Y} = b_0 + b_1X_1 + b_2X_2 + b_3X_3$

where $\hat{Y}$ = Predicted hourly mean speed (or standard deviation) (mph)

X_1 = Vehicles per hour in same direction (100's Veh.)

X_2 = Vehicles per hour in opposite direction (100's Veh.)

$X_3 = X_1X_2$.

Model I is the simplest of all models examined in that it uses only volume information in each direction and their interaction as independent variables. The results of fitting this model to actual speed characteristics at four locations on Highway 37 North (Loop Nos. 8, 10, 12, and 14) are given in Tables 5.2.1 and 5.2.2. The data used in fitting this model were collected during Saturday and Sunday daylight hours (7 A.M. - 7 P.M.). Weekends were selected because of the vehicle per hour rate which ranged from 100 to 1,200 (one direction). In addition to fitting the full model, consisting of three variables (X_1, X_2, and X_3), all possible regression equations involving these three variables were evaluated and the results are given in Tables 5.2.1 and 5.2.2. From this, the effects of the variables taken singly or in combinations can be easily ascertained from the R^2 values for each regression equation. R^2 is a measure of the goodness of fit of the regression in that it is the fraction of the total sum of squares of deviations of the observed Y (dependent variable) that is attributable to regression.

In Table 5.2.1, which treats hourly mean speed as the dependent variable, R^2 for Model I varies from .596 (Loop 14) to .842 (Loop 8). This says, in effect, that from approximately 60% to 84% of the hourly variation in speeds is attributable to variations in hourly volume counts. From the values of R^2 it is not necessary to include all of the variables X_1, X_2, and X_3 in the regression equation. For example, at Loop 8, R^2 for the full model is .842 whereas for the equation including only X_1, R^2 was .840. Figure 5.2.1 shows a plot of the hourly mean speeds at Loop 8 versus the hourly volume (same direction). In general, for these four locations X_1 considered alone or X_1 and X_2 combined will provide essentially the same information as when X_1, X_2, and X_3 are used. As expected, for all four locations the coefficients of X_1 and X_2 taken separately or together are negative and, also, the magnitude of the X_1 coefficient is larger.

Table 5.2.2 gives the results of fitting Model I to a new dependent variable Y (hourly standard deviations in speed). As evidenced by the R^2 values, variables X_1, X_2, and X_3 do not account for a very large portion of the changes in speed variation. Hourly standard deviations of speed are not affected by hourly volumes to the extent that mean speeds are affected by the same variables.

b) Model II: $\hat{Y} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6$

where $\hat{Y}$ = Predicted hourly mean speed (mph)

X_1 = Vehicles per hour in same direction (100's Veh.)

X_2 = Percent vehicles in same direction > 22' (%)

X_3 = Vehicles per hour in opposite direction (100's Veh.)

$X_4 = (X_1 - d)^2$

$X_5 = X_1X_3$

$X_6 = X_3X_4$

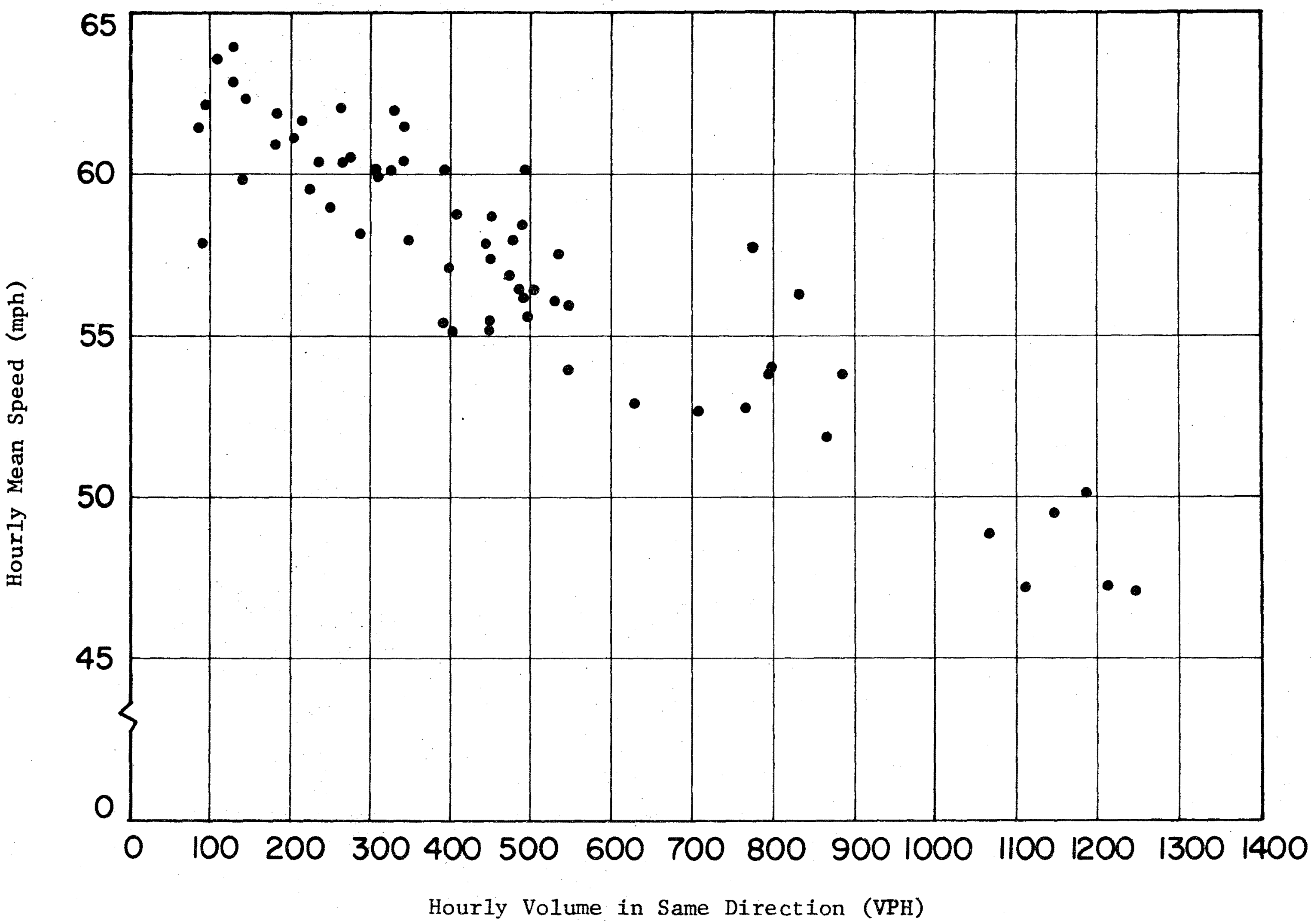
Table 5.2.1 Regression Equations and R^2 for Four Locations Using Model I with Hourly Mean Speed as the Dependent Variable

Location	Regression Equation	Independent Variables	R^2
Loop 8	$Y = 63.3 - 1.26X_1$	X_1	.840
	$Y = 57.9 - 0.17X_2$	X_2	.015
	$Y = 59.8 - 0.13X_3$	X_3	.274
	$Y = 63.4 - 1.25X_1 - 0.01X_2$	X_1, X_2	.840
	$Y = 63.4 - 1.23X_1 - 0.01X_3$	X_1, X_3	.841
	$Y = 58.4 + 1.28X_2 - 0.31X_3$	X_2, X_3	.556
	$Y = 63.1 - 1.17X_1 + 0.14X_2 - 0.04X_3$	X_1, X_2, X_3	.842
Loop 12	$Y = 56.4 - 0.65X_1$	X_1	.520
	$Y = 55.9 - 0.43X_2$	X_2	.233
	$Y = 56.4 - 0.13X_3$	X_3	.705
	$Y = 57.9 - 0.61X_1 - 0.36X_2$	X_1, X_2	.678
	$Y = 56.5 - 0.96X_1 - 0.12X_3$	X_1, X_3	.709
	$Y = 56.5 - 0.03X_2 - 0.13X_3$	X_2, X_3	.706
	$Y = 57.1 - 0.23X_1 - 0.14X_2 - 0.09X_3$	X_1, X_2, X_3	.719
Loop 10	$Y = 64.5 - 1.45X_1$	X_1	.644
	$Y = 58.7 - 0.26X_2$	X_2	.019
	$Y = 58.9 - 0.12X_3$	X_3	.130
	$Y = 65.0 - 1.44X_1 - 0.14X_2$	X_1, X_2	.650
	$Y = 64.4 - 1.47X_1 + 0.01X_3$	X_1, X_3	.645
	$Y = 59.0 + 0.78X_2 - 0.24X_3$	X_2, X_3	.193
	$Y = 66.2 - 1.75X_1 - 0.74X_2 + 0.14X_3$	X_1, X_2, X_3	.683
Loop 14	$Y = 60.8 - 0.64X_1$	X_1	.423
	$Y = 60.5 - 0.43X_2$	X_2	.207
	$Y = 60.7 - 0.13X_3$	X_3	.515
	$Y = 62.5 - 0.61X_1 - 0.38X_2$	X_1, X_2	.592
	$Y = 60.9 - 0.22X_1 - 0.10X_3$	X_1, X_3	.533
	$Y = 61.1 - 0.14X_2 - 0.12X_3$	X_2, X_3	.531
	$Y = 62.3 - 0.51X_1 - 0.33X_2 - 0.25X_3$	X_1, X_2, X_3	.596

Table 5.2.2 Regression Equations and R^2 for Two Locations Using Model I with Hourly Standard Deviation of Speed as the Dependent Variable

Location	Regression Equation	Independent Variables	R^2
Loop 8	$Y = 8.5 - 0.24X_1$	X_1	.143
	$Y = 6.0 + 0.34X_2$	X_2	.279
	$Y = 7.0 + 0.02X_3$	X_3	.029
	$Y = 7.3 - 0.28X_1 + 0.38X_2$	X_1, X_2	.477
	$Y = 8.2 - 0.42X_1 + 0.06X_3$	X_1, X_3	.342
	$Y = 6.2 + 0.75X_2 - 0.09X_3$	X_2, X_3	.483
	$Y = 6.8 - 0.15X_1 + 0.60X_2 - 0.05X_3$	X_1, X_2, X_3	.506
Loop 10	$Y = 5.9 + 0.11X_1$	X_1	.059
	$Y = 6.8 - 0.11X_2$	X_2	.051
	$Y = 6.8 - 0.02X_3$	X_3	.061
	$Y = 6.3 + 0.12X_1 - 0.12X_2$	X_1, X_2	.119
	$Y = 6.1 + 0.22X_1 - 0.04X_3$	X_1, X_3	.228
	$Y = 6.8 - 0.04X_2 - 0.02X_3$	X_2, X_3	.063
	$Y = 5.6 + 0.31X_1 + 0.22X_2 - 0.08X_3$	X_1, X_2, X_3	.278

Figure 5.2.1 Hourly Mean Speed Versus Hourly Volume For Loop 8



Model II is simply the extension of Model I by the addition of three variables. The new variables are: the percent trucks (or vehicles with length greater than 22 feet as obtained from the sensor system) in the traffic stream, a quadratic term involving the X_1 variable, i.e. $X_4 = (X_1 - d)^2$, and the interaction of volume of vehicles in opposite directions (X_3) with X_4. The quadratic term was added so as to make the model applicable over low hourly volumes (normally occurring at night) and high hourly volumes (daytime). Some preliminary analysis had indicated a need for a "squared" term. $X_4 = (X_1 - d)^2$ is used instead of $X_4 = X_1^2$ to avoid a high correlation between X_1 and X_1^2. This approach, along with the formula for estimating the quantity, d, is discussed by Daniel [5].

Hourly speed data obtained from the computer-sensor system at loop 0 were used to evaluate Model II. Specifically, speed, volume and truck information were obtained for the hours ending at 0200, 0500, 0800, ..., 2300 for each day of a one week period (Monday - Sunday), for a total of 8 × 7 = 56 observations. The full model (all six variables) accounted for 82% ($R^2 = .820$) of the variation in hourly mean speeds as shown in Table 5.2.3. It is informative to examine models involving subsets of these six variables since some of the variables may not be significant, i.e. some variables may be dropped from the model without a significant loss in information. There are various procedures that may be employed in this type of analysis, such as step-wise regression (forward and backward). We have used the technique developed by Lamotte and Hocking [6] for selecting the "best" subset in regression analysis. This utilizes the "standardized total squared error" concept as the selection criterion which was first suggested by Mallows [7]. In addition to the full six variable model, Table 5.2.3 identifies, and gives the R^2, for the "best" models of subsets of five variables, four variables, ..., one variable. All possible regression equations were not calculated for each subset size. For example, for subsets of three variables there are a total of $\binom{6}{3} = 20$ regression equations; however, only ten (the "best" ten) were calculated. It is apparent from Table 5.2.3 that a model with only X_1 and X_4 is almost as good a predictor of Y as

Table 5.2.3 R^2 for Selected Subsets of Regressions Using Model II with Hourly Mean Speed as the Dependent Variables

Subset	Independent Variables						R^2
Six Variables (Complete Model)	X_1	X_2	X_3	X_4	X_5	X_6	.820
Five Variables	X_1	X_2	X_3	X_4		X_6	.820
	X_1	X_2		X_4	X_5	X_6	.819
	X_1	X_2	X_3	X_4	X_5		.812
	X_1		X_3	X_4	X_5	X_6	.811
		X_2	X_3	X_4	X_5	X_6	.808
	X_1	X_2	X_3		X_5	X_6	.803
Four Variables	X_1	X_2		X_4		X_6	.819
	X_1			X_4	X_5	X_6	.811
	X_1		X_3	X_4		X_6	.811
	X_1	X_2	X_3	X_4			.808
		X_2		X_4	X_5	X_6	.800
	X_1	X_2		X_4	X_5		.800
	X_1	X_2	X_3		X_5		.800
			X_3	X_4	X_5	X_6	.799
	X_1		X_3	X_4	X_5		.795
	X_1	X_2	X_3			X_6	.786
Three Variables	X_1			X_4		X_6	.811
	X_1	X_2		X_4			.795
	X_1		X_3	X_4			.792
	X_1			X_4	X_5		.788
		X_2		X_4		X_6	.780
				X_4	X_5	X_6	.773
	X_1	X_2	X_3				.768
	X_1		X_3		X_5		.767
		X_2		X_4	X_5		.762
			X_3	X_4		X_6	.755

Table 5.2.3 (Continued)

Subset	Independent Variables						R^2
Two Variables	X_1			X_4			.786
				X_4		X_6	.754
	X_1					X_6	.707
	X_1		X_3				.706
				X_4	X_5		.701
	X_1	X_2					.697
		X_2			X_5		.692
		X_2	X_3				.687
	X_1				X_5		.647
					X_5	X_6	.598
One Variable	X_1						.644
					X_5		.563
			X_3				.455
		X_2					.438
				X_4			.140
						X_6	.127

the full model with six variables ($R^2 = .786$ as compared to $R^2 = .820$). Note X_1 is the volume of vehicles in the same direction and $X_4 = (S_1 - d)^2$ is the quadratic term discussed previously. Figure 5.2.2 shows the hourly mean speeds at loop 0 versus the hourly volume (same direction). It is evident from this plot that the relationship between speed and volume is nonlinear for the range of values considered.

The variable representing the percentage of trucks (or vehicle lengths greater than 22 feet) does not explain any additional variation in hourly mean speeds over that already accounted for by variables X_1 and X_4. This could be due to the relatively low percentage of trucks during high volume hours. The high percentage of trucks occurred during low volume hours and represented only a small volume in absolute numbers.

Model II was modified by defining X_2 as the number of trucks (vehicles with lengths greater than 22 feet) rather than percentage and a similar type analysis was conducted. The results were almost identical to those in Table 5.2.3 and are not included in this report. R^2 for the full model was .832.

c) Model III: $\hat{Y} = b_0 + b_1X_1 + \cdots + b_{15}X_{15}$

where $\hat{Y}$ = Predicted hourly mean speed (mph)

X_1 = Volume of vehicles per hour with length $\leq$ 22 feet

X_2 = Volume of vehicles per hour with length > 22 feet

X_3 = Volume of vehicles per hour in opposite directions

X_4 = Standard deviation of hourly mean speed

X_5 = Volume of vehicles per hour with headway < 7 seconds

X_6 = Volume of vehicles per hour with headway $\geq$ 30 seconds

X_7 = Day effect - linear

X_8 = Day effect - quadratic

X_9 = Day effect - cubic

X_{10} = Hour effect - linear

X_{11} = Hour effect - quadratic

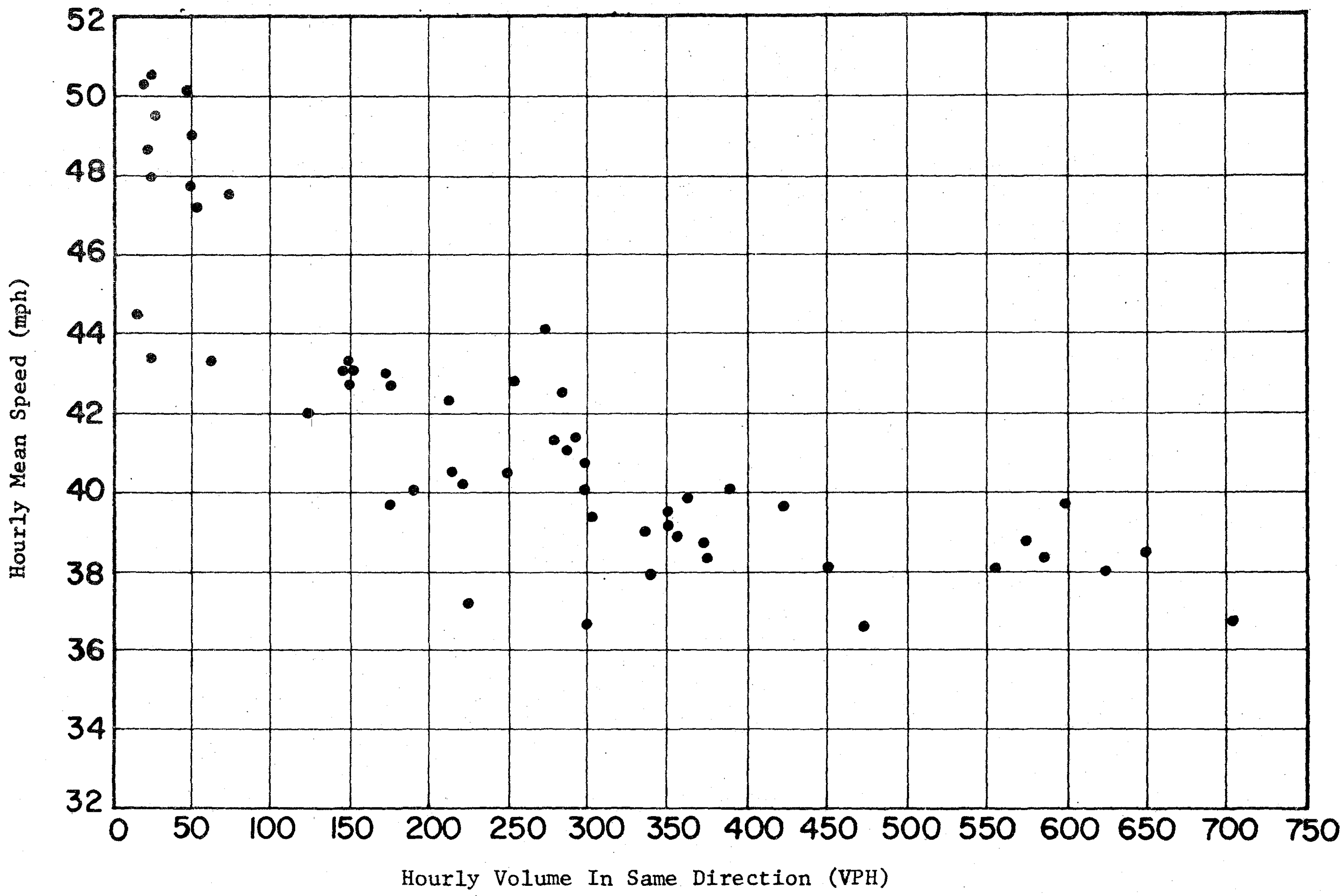
X_{12} = Hour effect - cubic

X_{13} = Hour effect - quartic

$X_{14} = X_8X_{11}$

$X_{15} = X_8X_{12}$

Figure 5.2.2 Hourly Mean Speed Versus Hourly Volume For Loop 0



Model III expresses $\hat{Y}$ (predicted hourly mean speed) as a linear function of fifteen variables which are identified above. The model was formulated in this manner primarily to examine the linear and higher order effects of days within week and similar effects of hours within days. Model III was fitted to the same set of data used for fitting Model II. This was discussed in the preceding section. R^2 for the full fifteen variable model is .809 as shown in Table 5.2.4. Actually, these fifteen variables accounted for slightly less variation in Y than did Model II where R^2 was .820. In addition to the full model, Table 5.2.4 gives the R^2 associated with the "best" models consisting of five variables, four variables, ..., one variable. It is apparent from Table 5.2.4 that there are subsets of four and five variables that do almost as well in explaining variations in Y as the fifteen term regression model. Also, of these four and five variable models, the variables involving day and hour-within-day effects occur so infrequently that one may conclude that these are relatively unimportant variables.

In summary, a series of multiple linear regression models were examined to determine those variables or factors which help to explain hourly changes in mean speeds. Of all the variables studied, volume (same direction) appears to be the most important single factor. Over low and high volume conditions (i.e. nighttime and daytime) it is necessary to include a second degree term involving volume in the model. As evidenced by the results at several locations on Highway 37, mathematical models can be constructed which will account for 60% to 84% of the hourly variation in mean speeds. This wide range probably reflects to some degree road geometry differences which should be included in the model.

Table 5.2.4 R^2 for Selected Subsets of Regressions Using Model III With Hourly Mean Speed as the Dependent Variable

Subset	Independent Variables															R^2
Fifteen Variables (Complete Model)	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	.809
Five Variables	X_1		X_3	X_4	X_5					X_{10}						.795
	X_1		X_3	X_4	X_5							X_{12}				.793
	X_1		X_3	X_4	X_5									X_{14}		.792
	X_1		X_3	X_4	X_5										X_{15}	.791
	X_1		X_3	X_4	X_5						X_{11}					.790
	X_1		X_3	X_4	X_5				X_9							.789
Four Variables	X_1		X_3	X_4	X_5											.787
	X_1		X_3	X_4						X_{10}						.777
			X_3	X_4	X_5					X_{10}						.762
	X_1		X_3	X_4		X_6										.757
	X_1		X_3	X_4							X_{11}					.746
	X_1		X_3	X_4								X_{12}				.741
Three Variables	X_1			X_4	X_5											.758
	X_1		X_3		X_5											.733
	X_1		X_3	X_4												.730
	X_1				X_5									X_{14}		.716
	X_1			X_4		X_6										.715
	X_1				X_5	X_6										.711
Two Variables	X_1				X_5											.706
	X_1		X_3													.677
	X_1					X_6										.674
	X_1			X_4												.656
	X_1									X_{10}						.624
			X_3		X_5											.622
One Variable	X_1															.608
					X_5											.494
			X_3													.453
										X_{10}						.332
		X_2														.126
											X_{11}					.109

5.3 Speed Profiles

Speed profiles are given in this section for the network of state roads included in this study. The profiles are for specified conditions and consist of mean speed and speed variability (standard deviation) plotted by sensor location and/or road segment.

Figure 5.3.1 shows the speed profile for Highway No. 37 (North and South) during the time periods 0-600, 0600-1900, and 1900-2400 hours. These curves are based on one full week of speed data (August 16-27) as obtained from the computer-sensor system. As expected, mean speeds were highest at all sensor sites during the early morning (0-0600 A.M.). Little differences exist between the periods 0600-1900 and 1900-2400. On Highway No. 37 South, the mean speeds increase with distance from Bloomington. This confirms what was anticipated. Highway No. 37 North exhibited higher mean speeds and less differences were noted between sensor sites. It is believed that speeds at Loops 11 and 15 as shown on Figure 5.3.1 are perhaps low, since these loops have shown some erratic behavior throughout the study period. Standard deviations throughout each period of the day and over all sensor sites appeared to be stable. The notable exception was the increase over Highway No. 37 North during the 0-0600 time period. Again, the value for Loops 11 and 15 may not be reliable.

Figures 5.3.2 - 5.3.8 provide speed profiles for all the state roads used in the study. Radar spot speed measurements provided the source data rather than the computer-sensor system. Two profiles were plotted on the same graph so that a visual comparison of the two conditions could be made directly. For example, a comparison of day and night mean speeds on Highway No. 46 East for vehicles traveling East during week-days on dry roads can be made through a visual inspection of the plots in Figure 5.3.6. Figures 5.3.9 and 5.3.10 show mean speeds for various state roads plotted as a function of the distance (in miles) from Bloomington. The conditions under which these data were collected are shown on the graphs. It is obvious that large differences in mean speed exist over the network of roads included in the study. Figure 5.3.11 shows the posted speed limits over the network of state roads included in the study.

Figure 5.3.1 Speed Profile - Highway No. 37

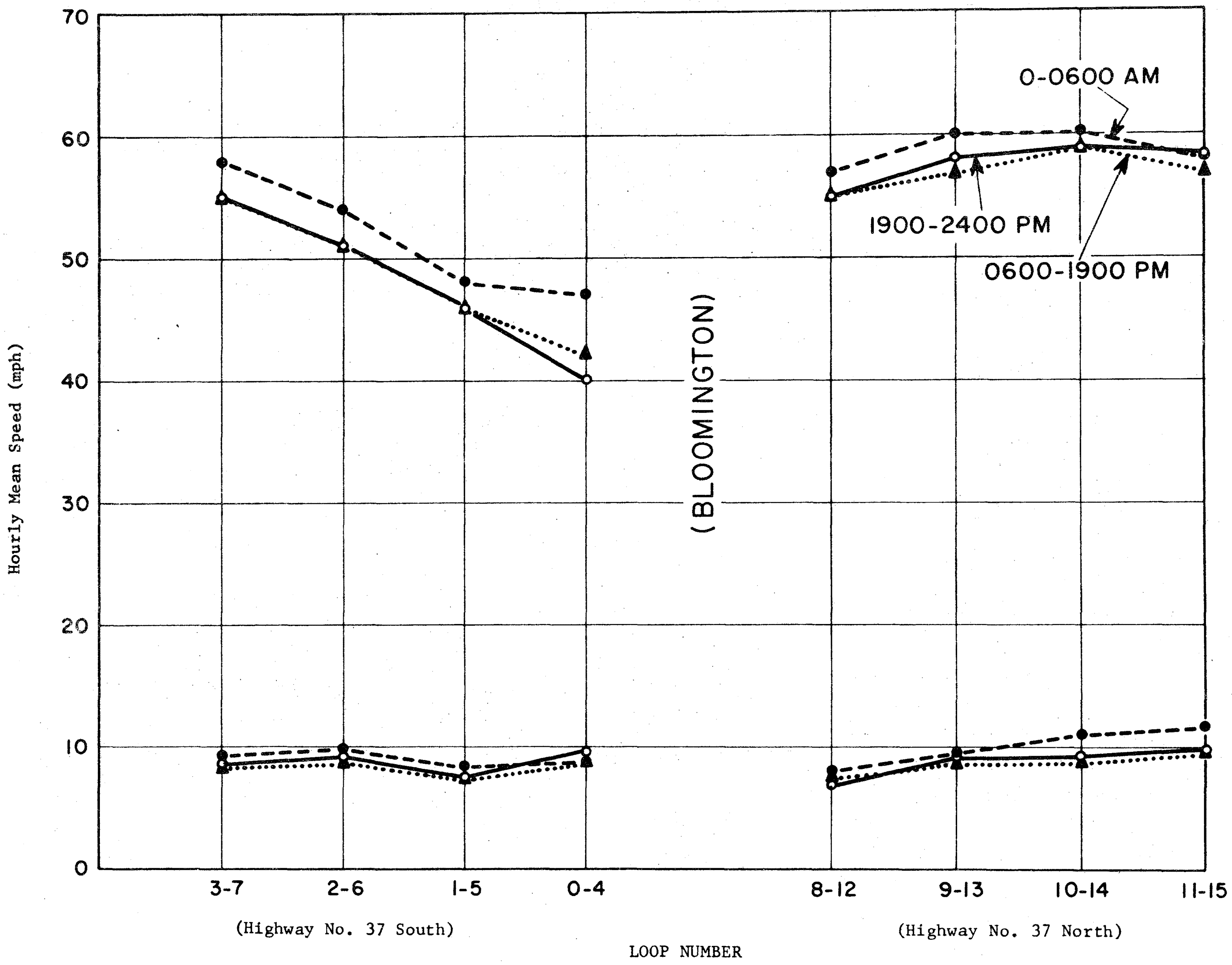
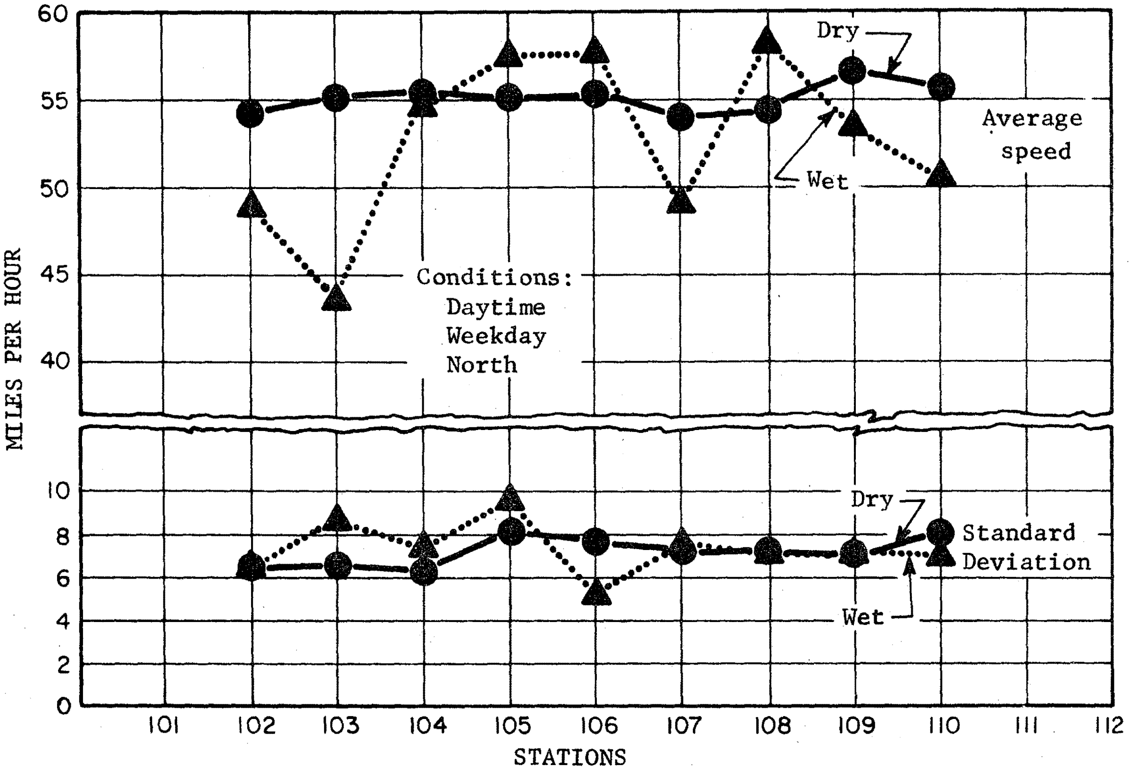


Figure 5.3.2 Speed Profiles - Highway No. 37 North



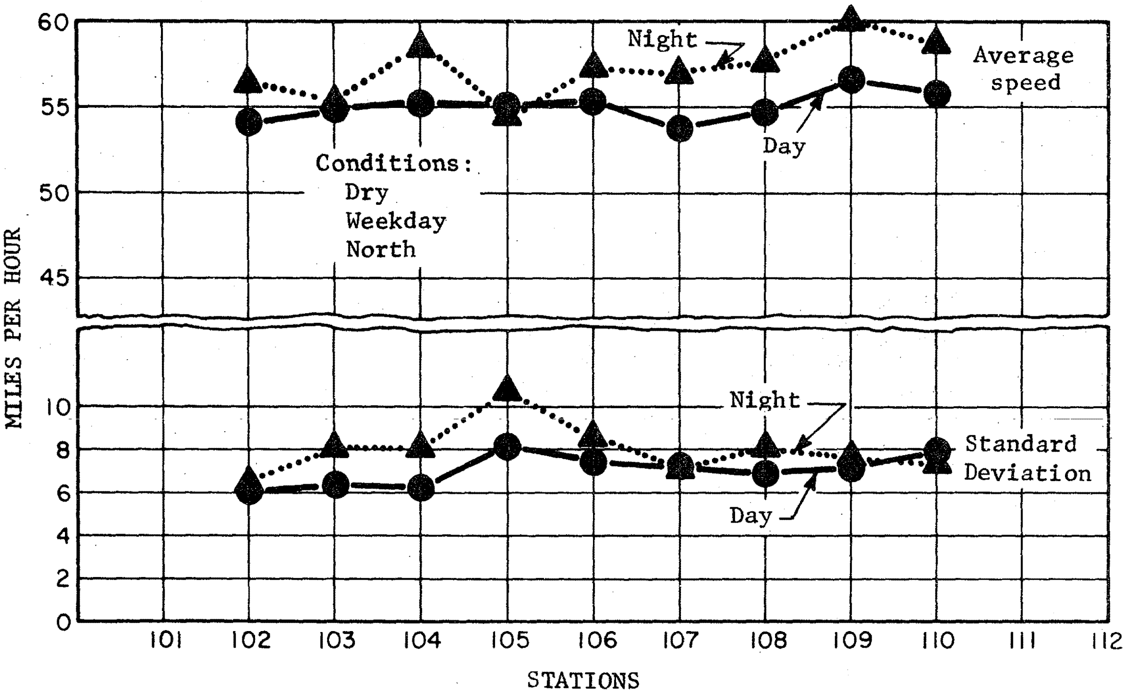


Figure 5.3.3 Speed Profiles - Highway No. 37 South

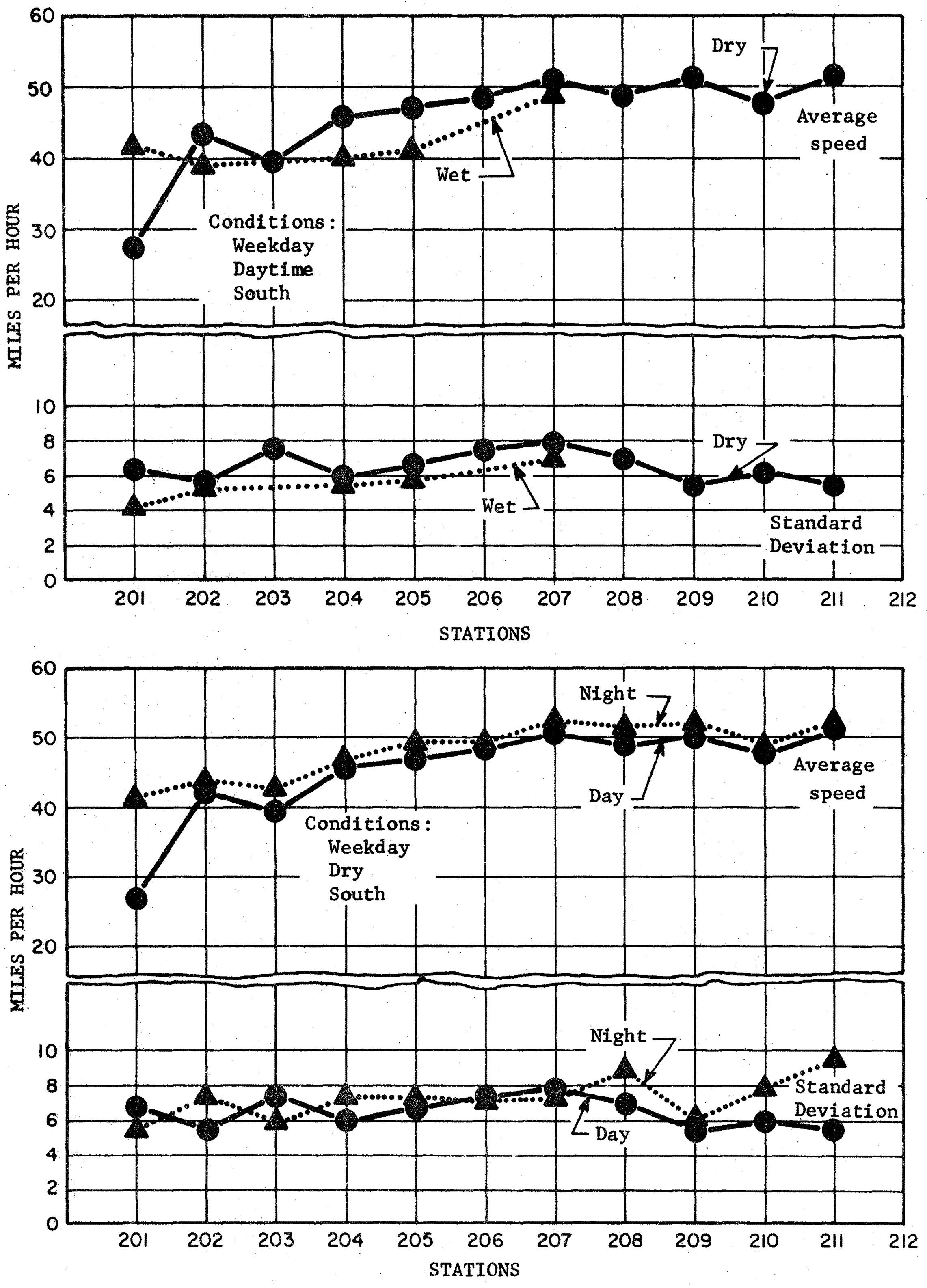


Figure 5.3.4 Speed Profiles - Highway No. 46 East

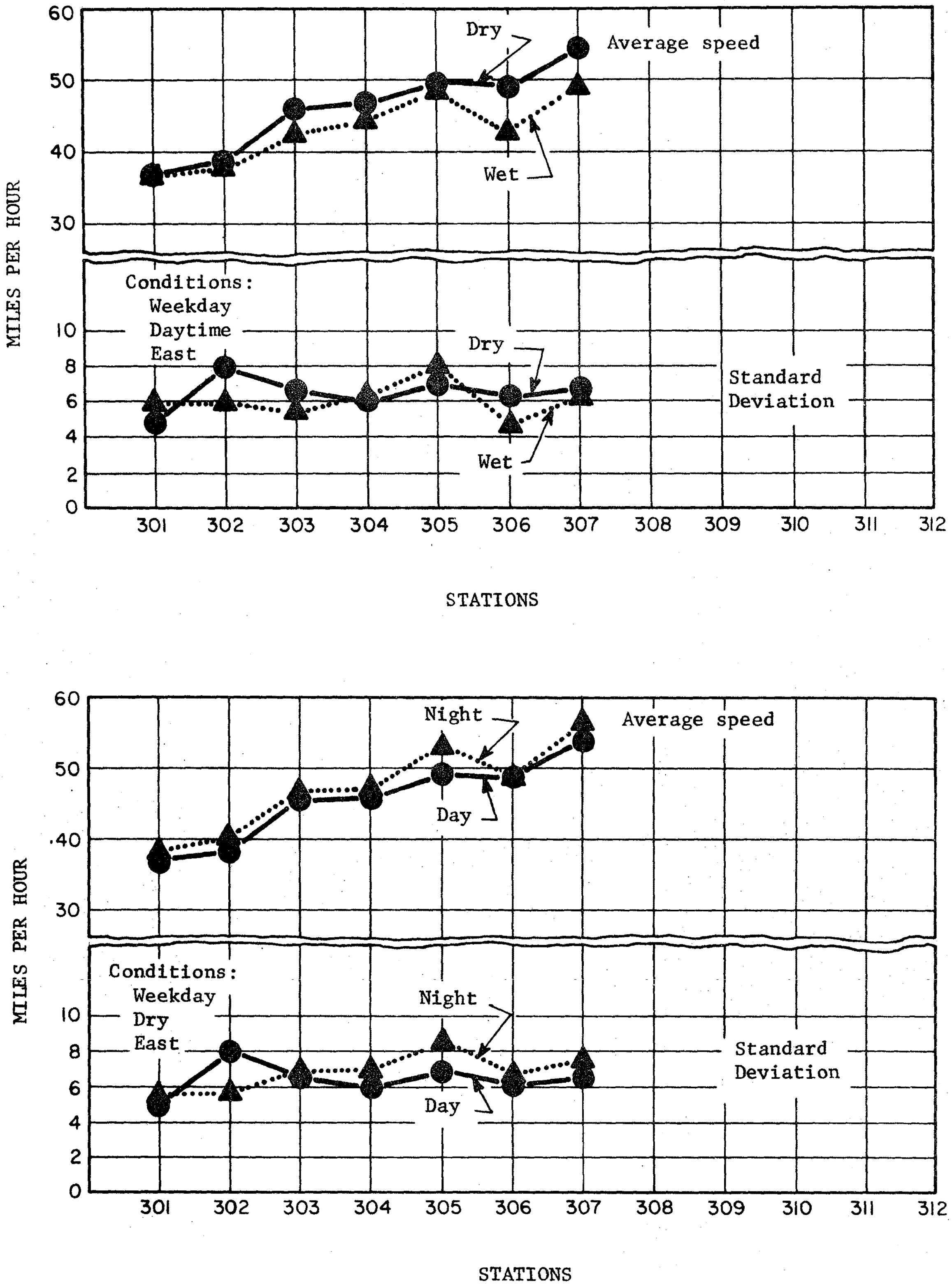
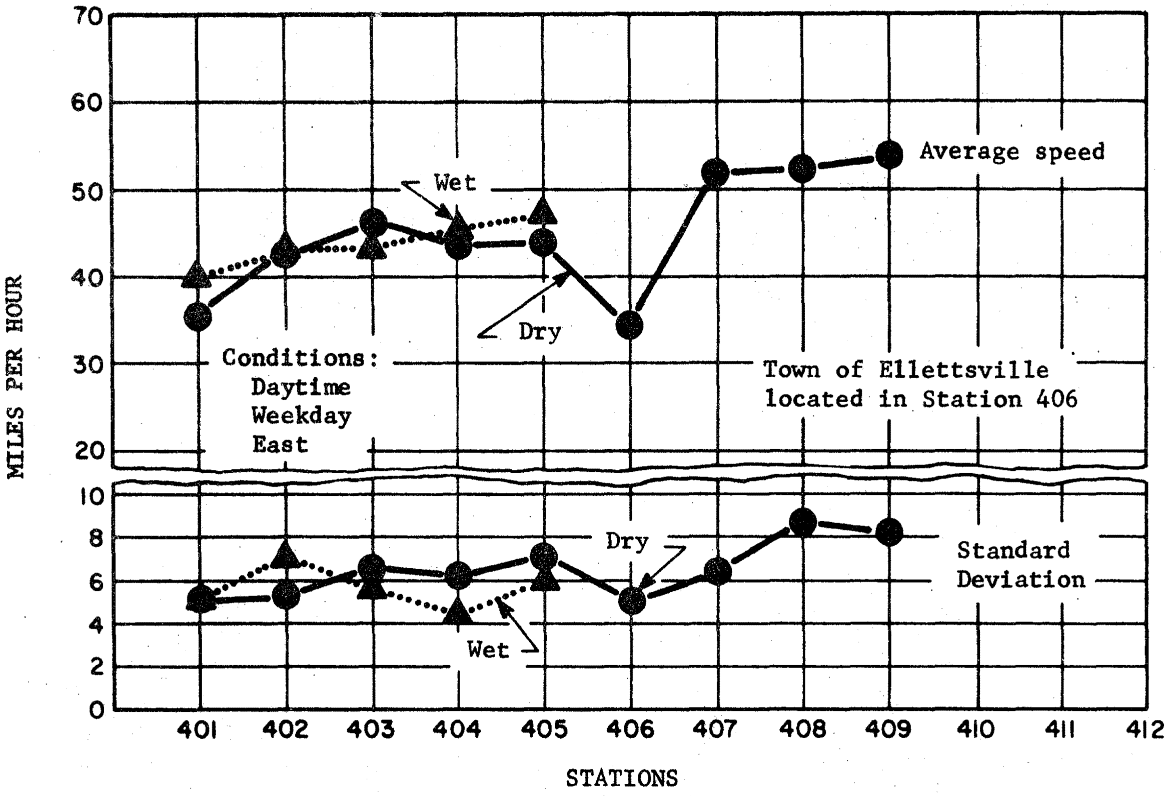


Figure 5.3.5 Speed Profiles - Highway No. 46 West



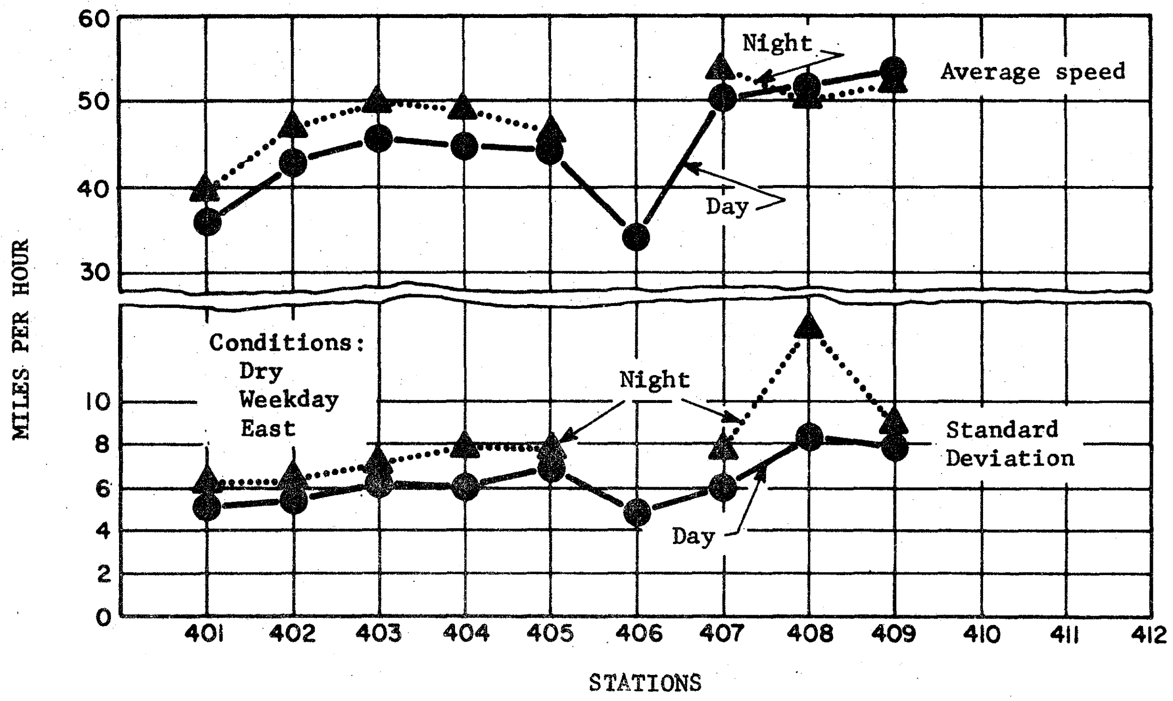


Figure 5.3.6 Speed Profiles - Highway No. 45 East

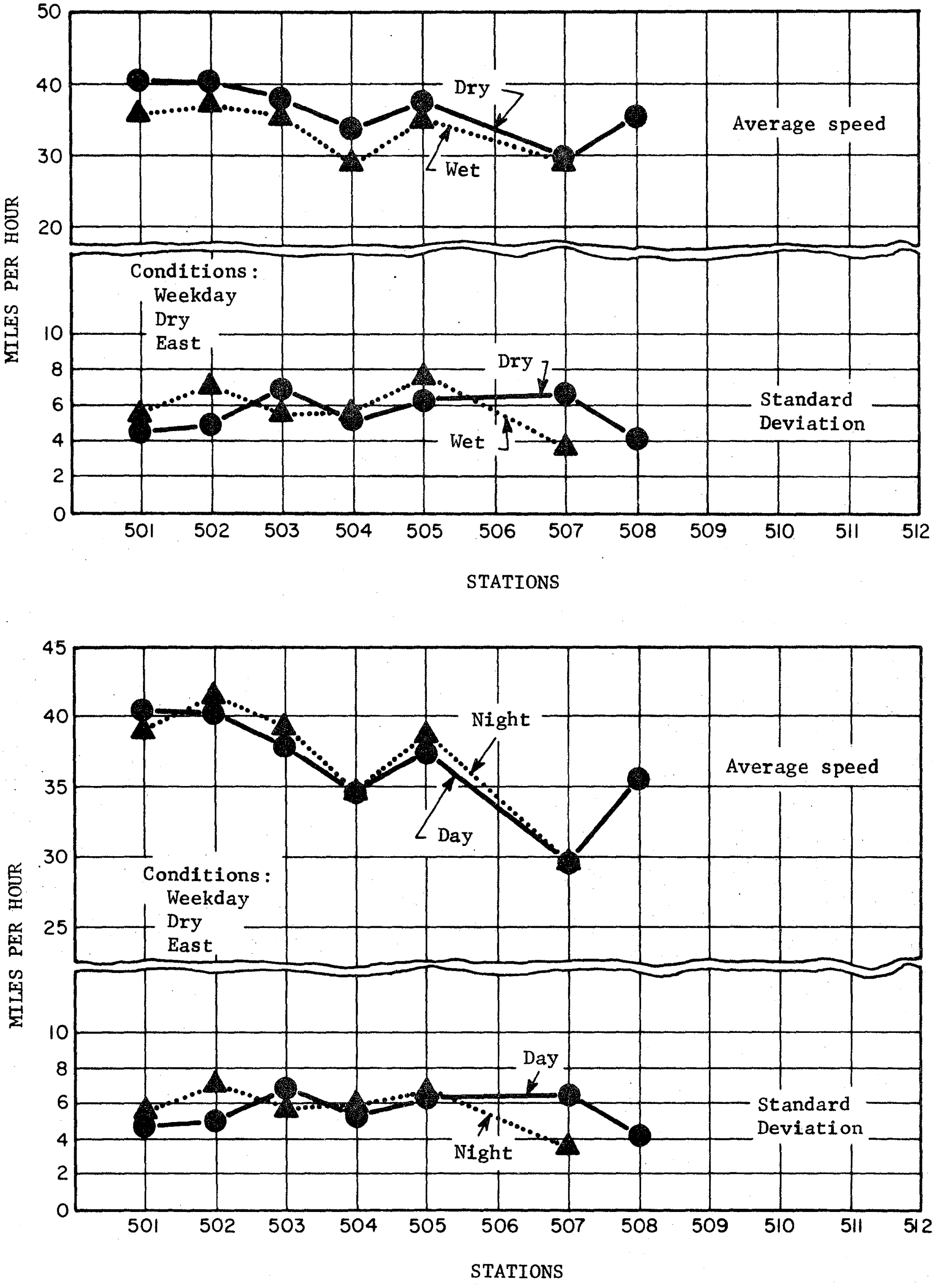


Figure 5.3.7 Speed Profiles - Highway No. 45 West

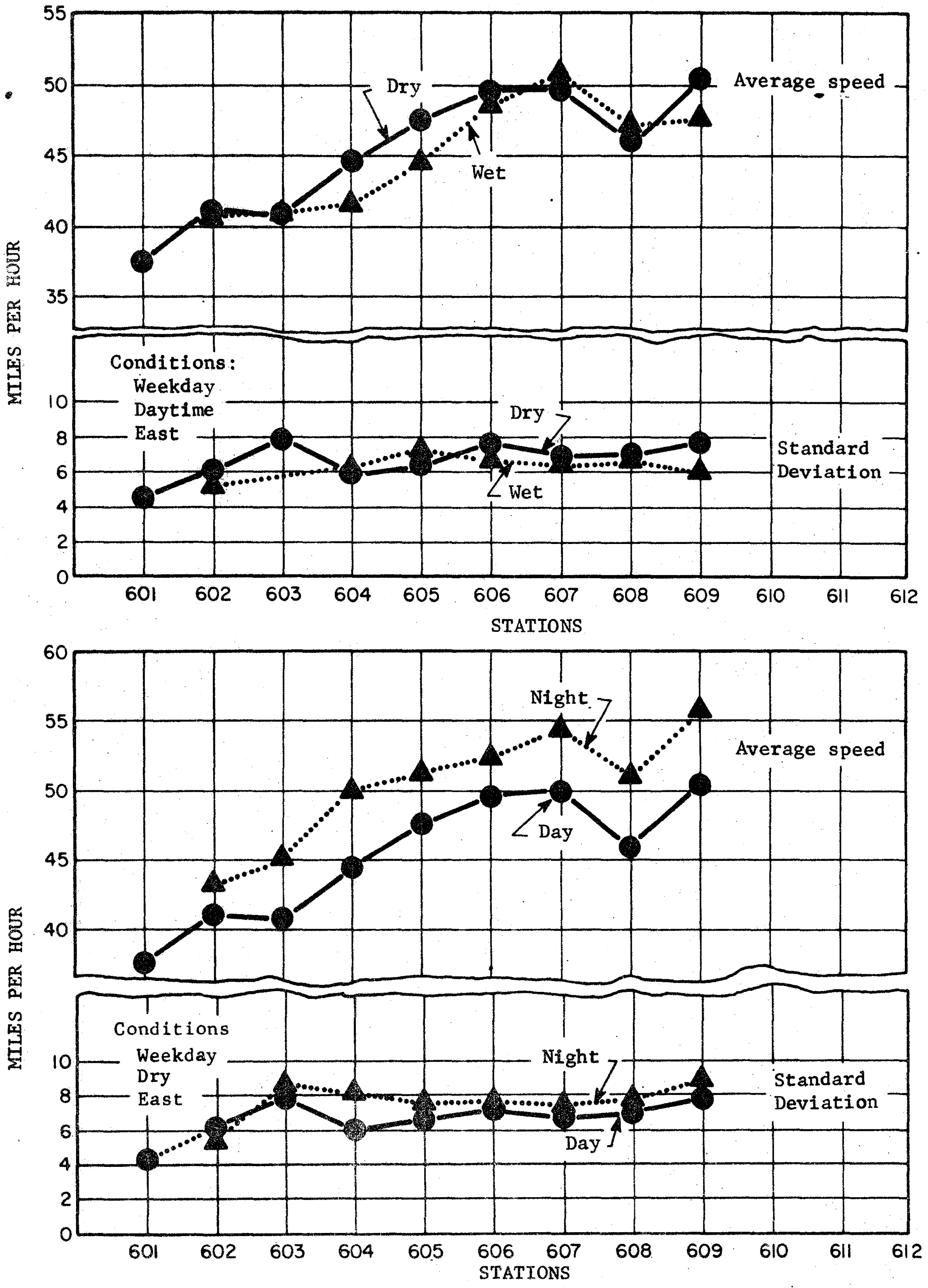


Figure 5.3.8 Speed Profiles - Highway No. 48 West

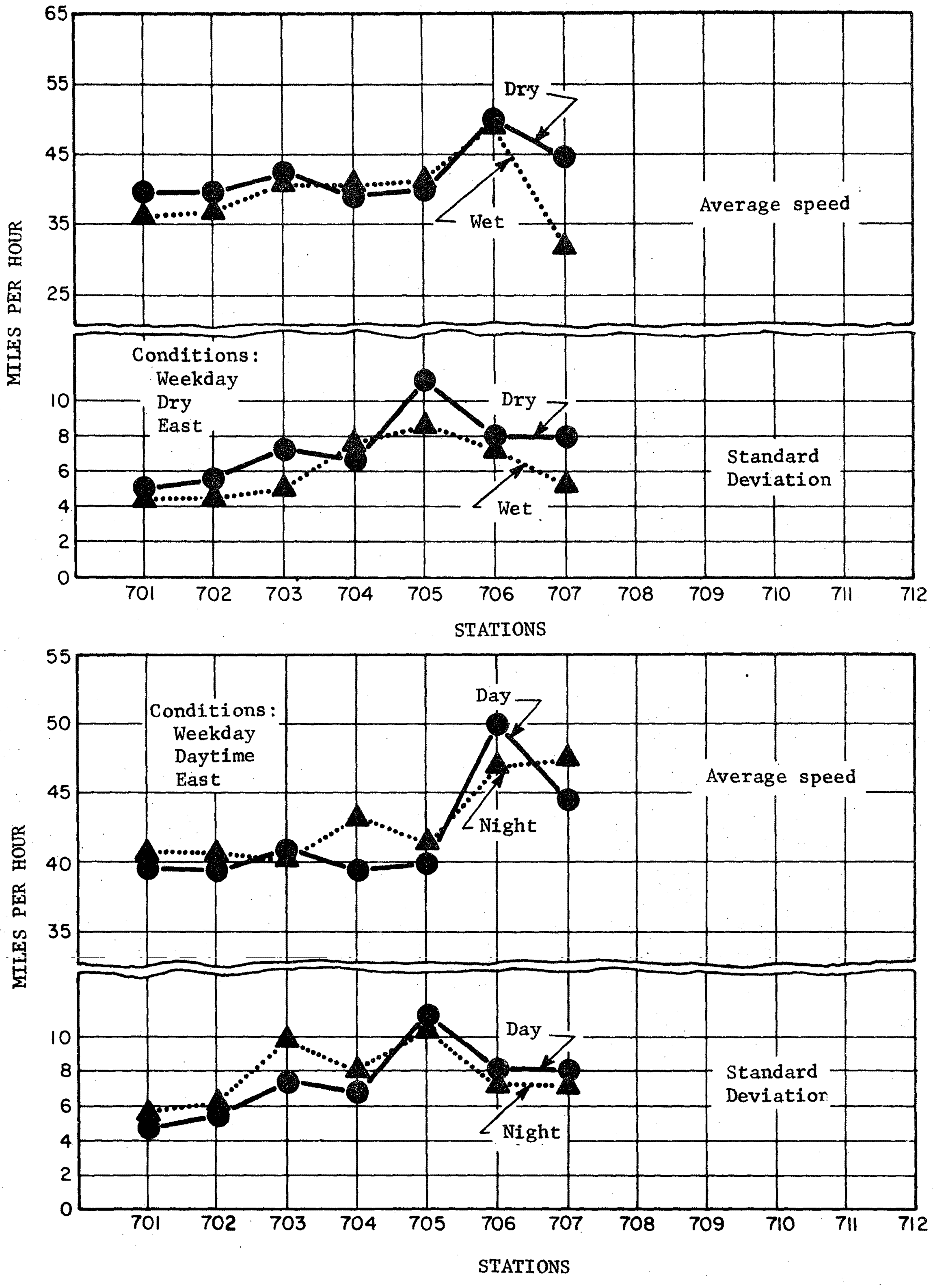


Figure 5.3.9 Speed Profiles

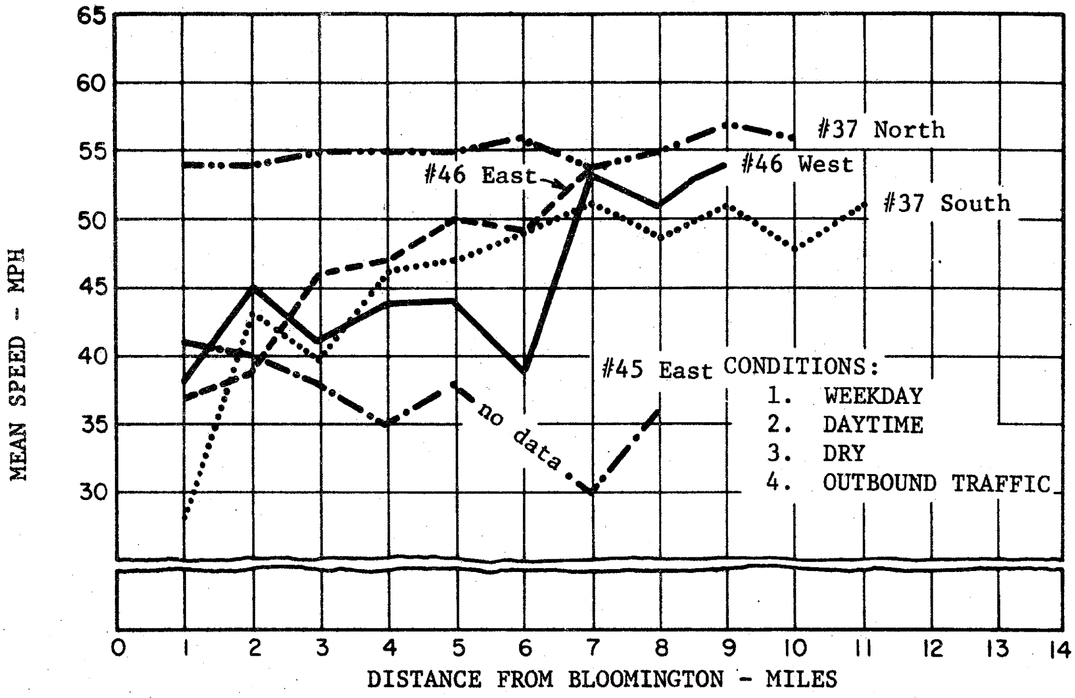


Figure 5.3.10 Speed Profiles

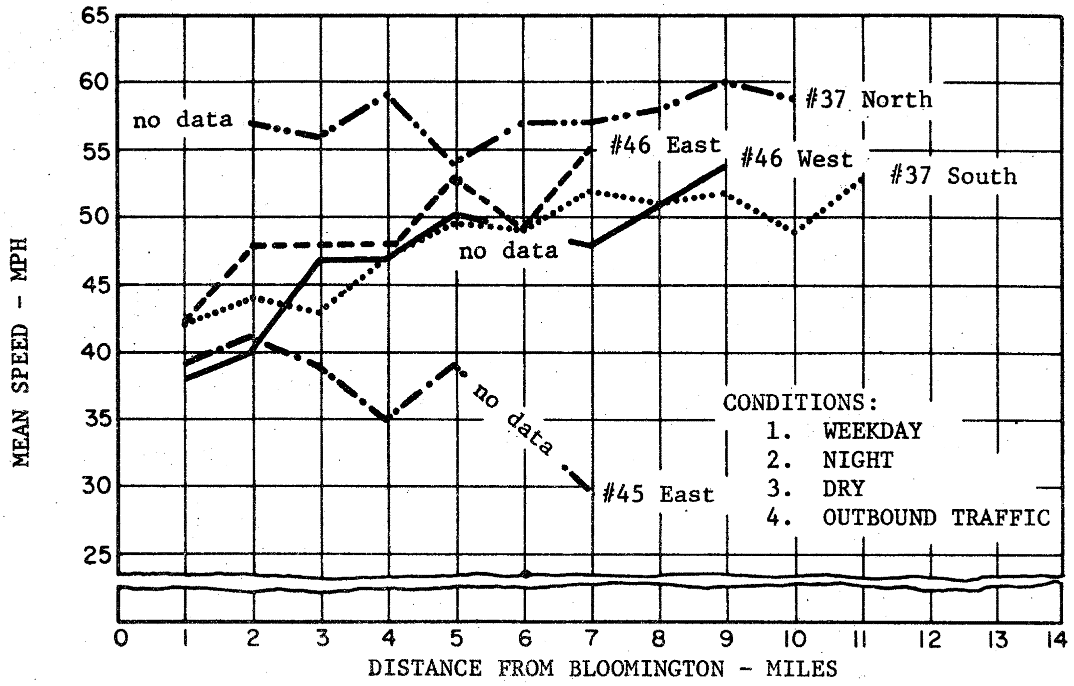
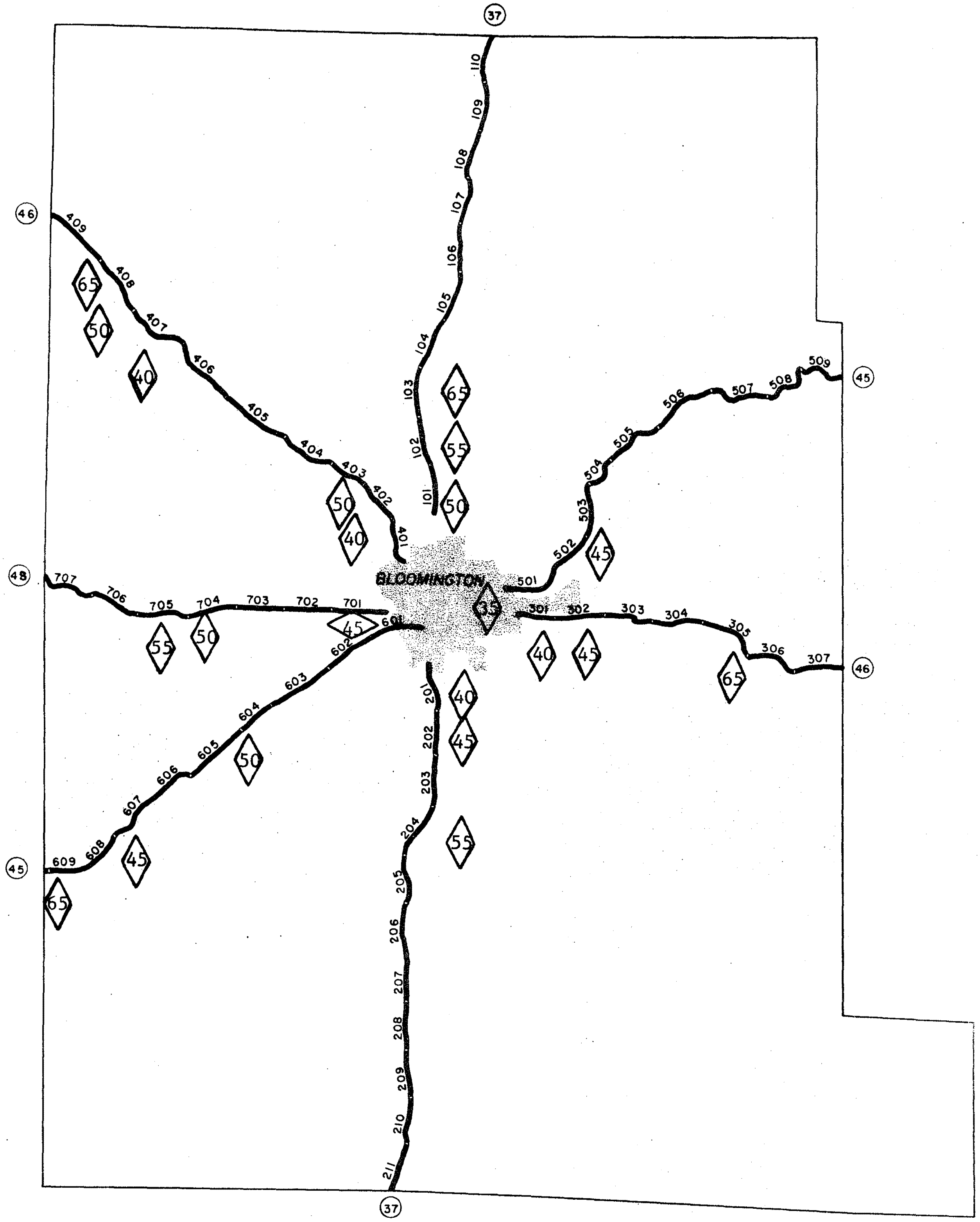


Figure 5.3.11 Posted Speeds (mph) Shown In ◇ For Monroe County State Roads



A review of these profiles resulted in the following general observations or conclusions:

1) Large differences in mean speeds exist among the various roads included in the study. This was anticipated in view of differences in road geometry, surface, type, width, topography, concentration of population, etc., existing within the road network.
2) Mean speeds at night and especially the early morning hours are consistently higher than daytime mean speeds.
3) Mean speeds are generally higher for dry roads than for wet roads.
4) Mean speeds, for any given condition, tend to increase as the distance from Bloomington increases. The one exception was Highway No. 45 East, where speeds tended to decrease - due to road geometry.
5) Speed variability is relatively stable over the entire road network system.
6) Speed variability is generally greater, but by only a small amount, during night driving as compared to daytime driving.

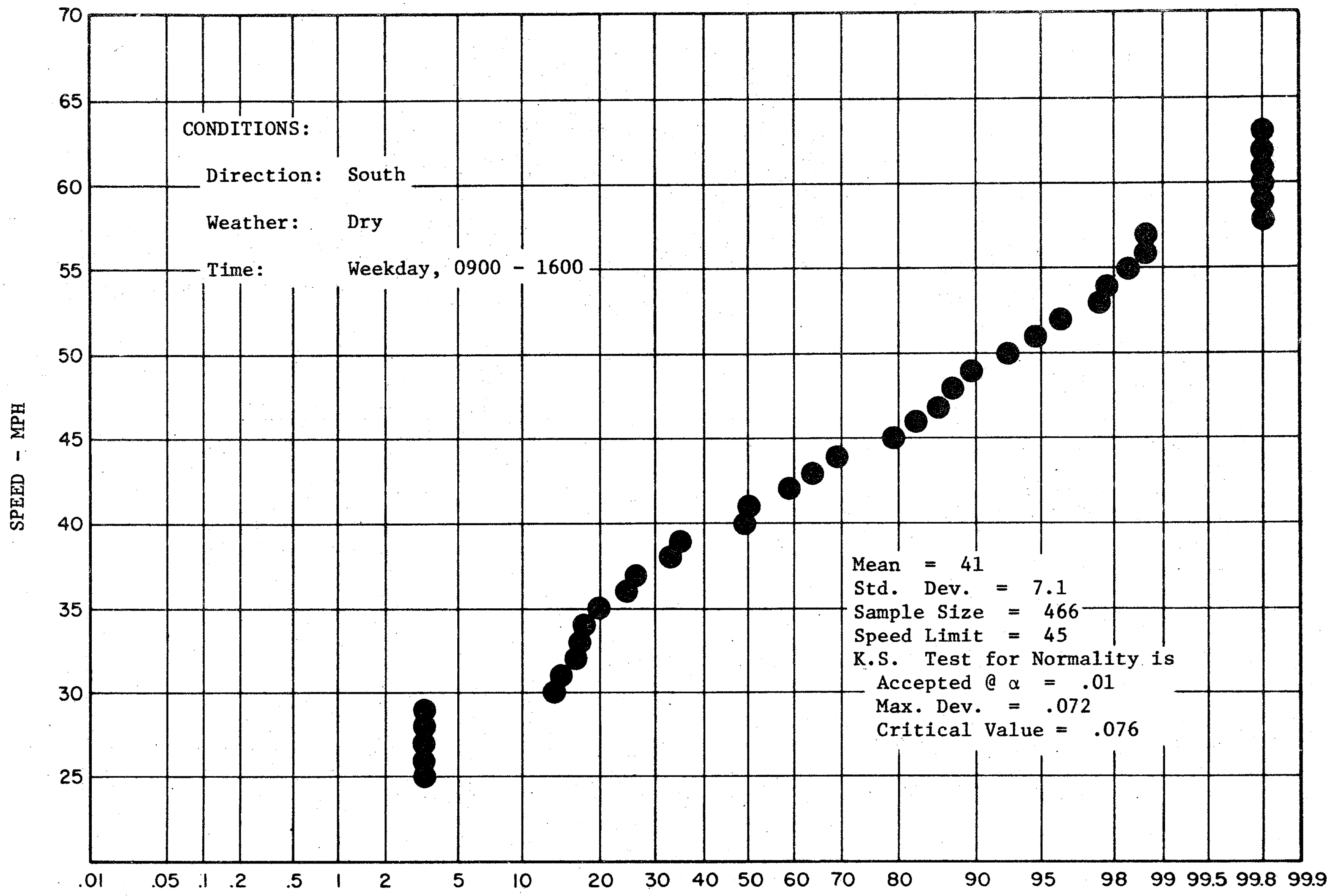
5.4 Speed Distributions

Many of the statistical techniques routinely used in the analysis of speed data require some assumption regarding the underlying distribution. More specifically, the assumption of a normal distribution is necessary to validate certain statistical tests applied to the observed or transformed observations. In order to verify the validity of the normality assumption, some sample speed distributions were examined and a statistical test for normality was applied.

Speed distributions on each of the seven state highways coming into Bloomington were examined. The cumulative speed distribution was calculated and then plotted on normal probability paper. The Kolmogorov-Smirnov (K.S.) test was applied to the cumulative distribution function to determine the acceptance or rejection of normality. The results of these analyses are given in [8]. Figure 5.4.1 illustrates the format with which the results are reported. In addition to the plot of the cumulative distribution function (which will plot as a straight line if the distribution is normal), each distribution is identified as to the location where the speed data were recorded, conditions under which the data were recorded, mean speed, standard deviation, sample size, speed limit, and results of the K.S. test.

Nine of the fourteen speed distributions examined were "accepted" by the K.S. test for normality (@ α = .01). One of the remaining five was a borderline case with regard to acceptance or rejection by the K.S. test, and all five involved large sample sizes (ranging from 333 to 971). These results would indicate that the assumption of normality is probably "safe", especially in applying the t- and F-test for testing significance among mean speeds.

Figure 5.4.1 Speed Distribution - Station 203



CONDITIONS:

Direction: South

Weather: Dry

Time: Weekday, 0900 - 1600

Mean = 41
Std. Dev. = 7.1
Sample Size = 466
Speed Limit = 45
K.S. Test for Normality is
Accepted @ α = .01
Max. Dev. = .072
Critical Value = .076

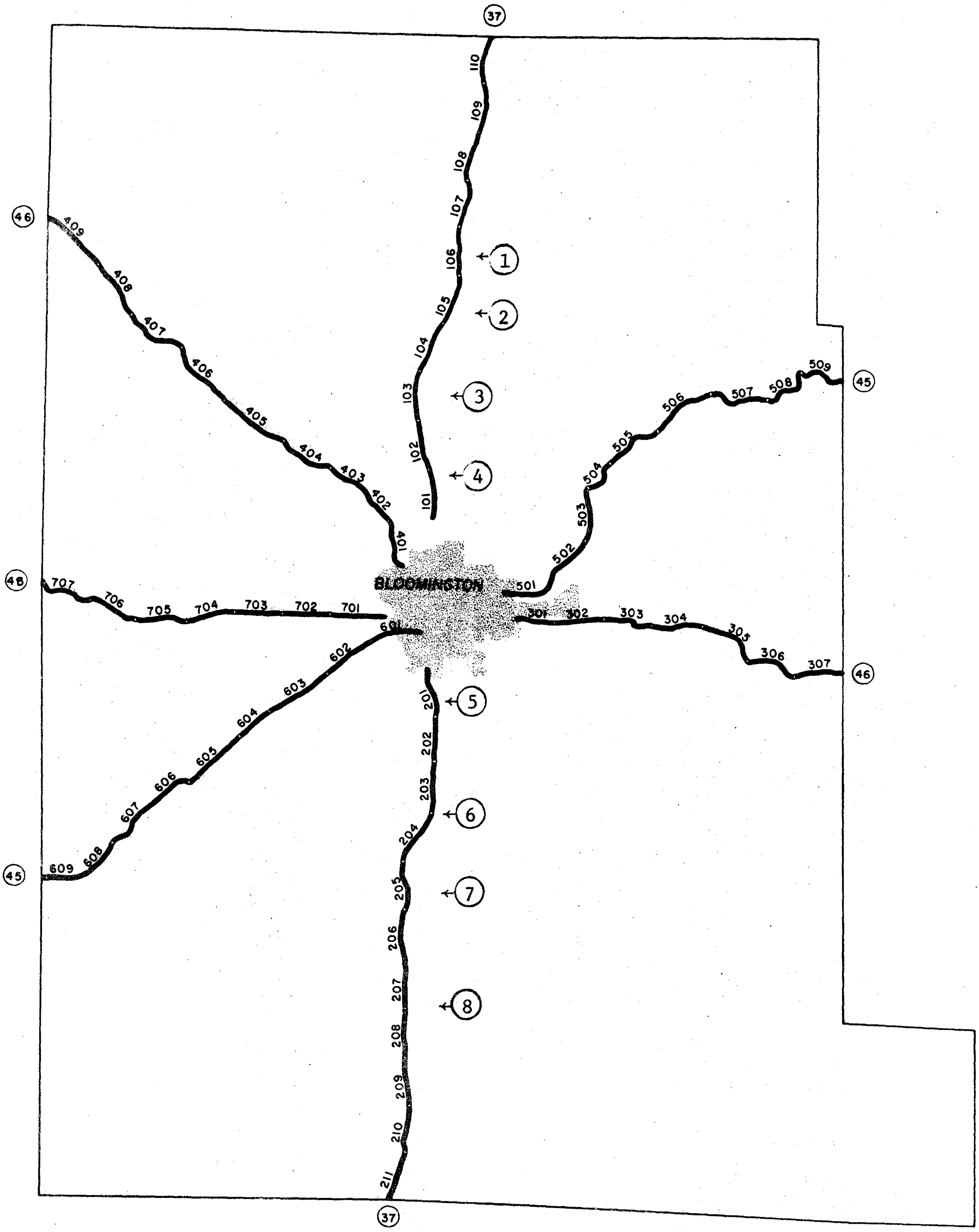
6. SPEED CHARACTERISTICS AND ACCIDENT DATA

Included in this section are the accident data, speed data collected by radar, and speed data collected by the computer-sensor system. It is necessary to present these data in a reduced form because of the voluminous amount of raw data. For example, the number of actual speed observations collected via radar exceeds 100,000, and the complete file on any one of the 294 accidents investigated would cover several pages. The computer-sensor system continuously monitored the speed, length and headway of each vehicle at sixteen points on Highway No. 37 for more than six months, hence, literally hundreds of thousands of observations were collected. In the event it is necessary to check these raw data, individual speed observations collected by both the radar and loop detectors have been stored on magnetic tape. On an hourly basis, the data generated by the computer-sensor system were summarized for each pair of loop detectors. These hourly summaries are also available on magnetic tape. The complete file on each accident investigated is available from the Institute for Research in Public Safety, Indiana University.

Figure 6.1 shows the network system of state highways in Monroe County, Indiana which are included in this study. Each road has been divided into approximately one-mile segments and given a station number which identifies the location of the segment. The station identification numbers are also shown in Figure 6.1. Within each one-mile segment, a one-tenth mile code is used to further pinpoint on a highway the exact location of some event such as an accident or place where radar spot speeds were observed. For example, if an accident occurred on Highway 37 South about halfway within the segment identified as Station 204, the location of the accident would be identified as 204.5. Both the accident investigation teams and radar operators use this method of identifying the location where data are being collected. The locations of the magnetic loop detectors on Highway No. 37 (North and South) are also shown in Figure 6.1.

The accident investigation teams started operating officially on December 7, 1968. Accident investigation activity was not limited to the network of state

Figure 6.1 State Roads in Monroe County, Indiana Showing Location of Sensor Sites and Road Segment Station Identification



highways shown in Figure 6.1. Certain portions of Monroe County roads were included in the study (those roads or sections of roads where speeds of 40 mph or greater were anticipated). Accidents on these county roads were also investigated. However, insufficient volume-time data were available to warrant the inclusion of those accidents occurring outside the state road system in the calculation of accident or involvement rates.

In-depth investigation of accidents on all state and selected county roads continued until July 31, 1969. At this time, a decision was made to discontinue accident investigation on all roads except Highway No. 37 (North and South) where speeds were being monitored via magnetic loop detectors. This reduction in effort was used in extending the utilization of the computer-sensor system.

Table 6.1 provides a tabulation of data pertinent to this study for each of the 294 accidents. With the exception of the two columns identified as traffic characteristics, data in Table 6.1 were extracted directly from the accident files.

Traffic characteristics (mean speed and standard deviation) in Table 6.1 are estimates of the characteristics of all traffic at the time and location of the accident. This estimation of traffic flow conditions at the time and location of the accident utilized three sources of information: (1) post-accident speed data, (2) data in the speed survey master file which were collected by radar close to the scene of the accident and under conditions similar to those at the time of the accident, and (3) computer-sensor speed data at the nearest sensor site at the time of the accident.

During the course of the study some general guidelines or procedures for the collection of post-accident speed data were developed. These procedures evolved after reviewing some of the speed characteristics of the roads included in the study. The procedures are necessarily flexible to allow for maximum efficiency of radar operators' time under the constraint of a limited number of man-hours available per week. In general, the guidelines call for the collection of 200 speed readings at the accident site (including both directions of travel). Every effort was made to obtain speed readings at the accident site under the same conditions as those present at the time of the accident (i.e. time-of-day, day-of-week, and environmental conditions). In order to maintain similar environmental conditions, it became necessary sometimes to vary time-of-day and/or day-of-week.

Within each one-mile segment of the complete network system, 15-minute radar spot speed measurements were made at varying times under varying environmental conditions. The radar spot speed data were collected during the period August 1968 through February 1969. Specifically, these data have been classified according to the following factors and factor levels.

(1) Day of week - weekday, weekend

(2) Light condition - day, night

(3) Weather - dry, wet, ice & snow, fog

(4) Direction of travel - north, south (or east, west).

These are 2 × 2 × 4 × 2 = 32 classes or combinations of the above factor levels. For each combination at each station, the mean speed and standard deviation (of individual speed observations) have been calculated. These statistics along with the sample sizes on which they were based are given in Table 6.2. There are many combinations for which speed data are not available. Most of these involve inclement weather conditions. In addition, it is difficult, and in some cases physically impossible, to obtain spot speeds at each station under adverse weather conditions.

As indicated previously, the computer-sensor system continuously monitored the speed, length and headway of each vehicle at sixteen points on Highway No. 37 for more than six months. For two months, twelve additional sites were being monitored. The raw data (individual observations), as collected by the system, have been stored on magnetic tape. In addition, hourly summaries for each sensor site have been prepared and are also available on magnetic tape. Further data reduction was made by combining hourly summaries into daily summaries. Programs have been written to reduce the data even further by generating weekly summaries for each sensor site.

Because of the voluminous amount of data produced by the system even in the reduced form, a complete presentation of the results, either in tabular or graphical form, cannot be given in this report. However, a sample of the results given in the daily summary reports is graphically portrayed in Figure 6.2. Daily mean speeds and standard deviations for 0600-1900 time period are given in Figure 6.2 for Loops 0 and 12 covering a three month period. Loop 0 is the first sensor site South of Bloomington and Loop 12 is the first sensor site North of Bloomington. In both cases the sensors are monitoring outbound traffic. The daily mean speeds at Loop 0 are quite stable at 40 mph, whereas, the mean speeds at Loop 12 are averaging about 55 mph and are more variable. Most likely, some of the variation at Loop 12 can be attributed to equipment performance and calibration adjustments.

Also shown on Figure 6.2 are the daily standard deviations in speed for Loops 0 and 12. As evidenced by the curves, speed variability is stable over time; however, there are consistent differences in speed variability between the two sites. Loop 0 shows a higher but more stable pattern of standard deviation. These standard deviations are inflated by hour-to-hour variation in speeds, hence, the values are somewhat higher than the within-hour speed variability mentioned elsewhere in the report.

Similar type data are available on each of the sixteen sensor sites (0000-0600) and late evening time periods (1900-2400).

TABLE 6.1. ACCIDENT DATA

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Charac-teristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
001	304.9	12/7/68	0850	Rain	Day	Single	N.D.	65	V-1	E	N/A	N/A	Unk	Unk	Unk	Unk	M	1	Ramb	Unk	Unk	No	Decreased Visibility
002	305.2	12/7/68	0850	Rain	Day	Single	N.D.	65	V-1	E	N/A	N/A	Unk	Unk	Unk	Unk	M	1	Semi	Unk	Unk	No	Due to 001 off road braking--jacknife
003	305.4	12/7/68	1000	Rain	Day	Head-on	P.D.	65	V-1 V-2	E W	48 47	6.2 6.0	0 30	0 25	0 35	55 51	M M	1 2	Ford Ford	66 65	N.U. N.U.	No No	V-2 lost control Driving left of center
004	108.7	12/7/68	1005	Rain	Day	Single	P.D.	65	V-1	S	55	8.1	45	40	50	19	F	2	Ford	67	N.U.	No	Lost control on ice
005	1900 blk. of Curry Pike 2 mi. w. of city	12/7/68	1625	Clear	Day	Side Coll.	P.D.	30	V-1 V-2	N S	N/A	N/A	50 05	45 03	55 08	22 51	M M	1 1	Pont Int. Dump	64 65	U. N.I.	No No	Speed V-1 V-2 turning
006	209.1	12/8/68	1750	Clear	Nite	Rear End	P.I.	55	V-1 V-2	N N	51 51	5.9 5.9	0 70	0 65	0 75	27 19	M M	2 2	Merc Chev	65 55	N.U. N.U.	No No	V-1 stopped to turn V-2 too fast to stop
007	207.2	12/7/68	1902	Clear	Nite	Rear End	P.I.	55	V-1 V-2	N N	50 50	5.5 5.5	0 35	0 31	0 38	18 72	M M	1 11	Merc Chev	66 55	N.U. N.I.	No No	V-2 faulty brakes V-1 turning
008	507.5	12/11/68	1311	Clear	Day	Head-on	P.I.	35	V-1 V-2	E W	30 29	5.8 6.2	40 30	35 25	45 35	19 19	M F	1 1	Ford Merc	64 60	N.U. U.U.	No No	V-1 driving left of center
009	Tapp & Leonard Springs Road	12/12/68	1300	Clear	Day	Side Coll.	P.D.	20	V-1 V-2	S W	N/A	N/A	05 0	03 0	08 0	38 17	M F	1 1	Chev Trk Olds	68 67	U.U. U.U.	No No	V-1 turned too sharply
010	201.1	12/12/68	2200	Rain	Nite	Side Coll.	P.D.	40	V-1 V-2	E N	40 40	5.1 5.1	0† 30	0† 25	0† 35	46 22	M F	1 2	Chev Chev	65 68	N.U. N.U.	No No	V-1 failed to yield right-of-way
011	204.3	12/14/68	0845	Snow	Day	Rear End	P.D.	55	V-1 V-2	N N	43 43	4.0 4.0	50 08	40 05	50 15	51 30	M F	1 1	Chev Ford	59 66	U.U. U.U.	No No	V-2 turning left V-1 saw no indicator signal, use unknown
012	603.1	12/17/68	2250	Clear	Nite	Single	P.D.	45	V-1	E	45	8.8	70	64	76	19	M	1	Dodge	68	U.U.	No	Speed--lost control on grade descent
013	107.1	12/17/68	1405	Over cast	Day	Side Coll.	P.D.	65	V-1 V-2	N S	55 55	8.0 7.8	70 55	68 50	78 60	46 62	M M	1 1	Olds Fd. Trk.	62 65	N.I. N.I.	Yes No	V-1 lost control excess speed

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
014	205.3	12/22/68	1245	Rain	Day	Single	P.D.	55	V-1	S	44	5.6	65	60	70	34	M	1	Merc	69	N.U.	No	Lost control in pass
015	Vernal Pike at woodyard	12/22/68	2230	Over cast	Nite	Single	P.D.	35	V-1	E	N/A	N/A	40	35	45	20	M	1	Ply	68	U.U.	Yes	Driver falling asleep
016	3420 Leonard Springs Road	12/24/68	0930	Clear	Day	Side Coll.	P.I.	40	V-1 V-2	E S	N/A	N/A	35 02	30 01	35 03	40 50	F M	2 1	Ply Merc	63 60	N.U. N.U.	No Unk	V-2 failed to yield right-of-way
017	446-3696' S.	12/24/68	1600	Clear	Day	Single	P.D.	40	V-1	S	N/A	N/A	70	65	75	35	M	1	Pont	64	U.U.	Yes	Pass at excessive speed, lost control
018	109.8	12/24/68	1956	Clear	Nite	Side-swipe	P.D.	65	V-1 V-2	N S	61 58	7.4 7.7	55 65	53 Unk	60 Unk	53 Unk	M Unk	2 Unk	Ford Unk	59 Unk	N.I. U.U.	No Unk	V-2 driving left of center
019	304.5	12/24/68	2010	Over cast	Nite	Single	P.D.	45	V-1	E	46	6.7	50	45	55	54	M	1	Crys	58	N.I.	Yes	Failure to negotiate curve
020	Leonard Sprgs. & Tapp Road	12/25/68	1500	Clear	Day	Side Coll.	P.D.	20	V-1 V-2	S N	N/A	N/A	05 60	03 54	10 60	18 30	M M	2 3	Ford Chev	58 62	N.I. N.I.	No No	V-1 did not see speeding V-2
021	Leonard Sprgs. 111' S. of Farington Dr.	12/26/68	1130	Freez-ing Rain	Day	Single	P.D.	20	V-1	S	N/A	N/A	25	25	35	58	M	1	Ramb	66	U.U.	No	Lost control on ice when brakes applied
022	107.6	12/26/68	1212	Snow Rain	Day	Single	P.I.	65	V-1	S	57	7.6	45	42	47	46	F	1	Ply	62	N.U.	No	Lost control on ice
023	208.1	12/28/68	2345	Clear	Nite	Single	P.D.	55	V-1	N	48	6.7	45	40	55	26	M	1	FdTk	67	U.U.	Yes	Lost control
024	603.4	12/29/68	0920	Clear	Day	Side Coll.	P.D.	45	V-1 V-2	E W	42 46	6.3 6.1	08 55	05 40	12 60	24 57	F M	1 1	Buick Chev	68 68	U.U. U.U.	No No	Failure V-2 to observe V-1
025	202.3	12/30/68	1423	Clear	Day	Rear End	P.D.	40	V-1 V-2	N N	42 42	5.1 5.1	10 35	05 35	15 40	30 46	F M	2 1	Ford Olds	65 67	N.U. N.U.	No No	Failure V-2 to observe V-1
026	104.2	12/30/68	1530	Sleet	Day	Single	P.D.	65	V-1	N	38	5.7	65	60	70	29	M	1	Ramb	67	U.	No	Slippery Road
027	102.4	12/30/68	1635	Rain Snow	Day	Single	P.D.	65	V-1	N	49	6.7	60	55	65	24	M	1	V.W.	68	U.	No	Slippery Road

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
028	Delap Rd. 1 1/4 mi W. of Union Valley	12/30/68	1955	Rain	Nite	Single	P.I.	not post-ed	V-1	E	N/A	N/A	30	25	35	29	F	1	Chev	59	N.U.	No	Slippery Road
029	404.7	12/31/68	1800	Clear	Nite	Forced Off Road	P.D.	50	V-1 V-2	W W	47 47	4.3 4.3	55 15	45 15	58 15	24 Unk	M Unk	2 Unk	Ford Unk	65 Unk	N.U. Unk	No Unk	V-2 signaled right then turned left
030	Old 37, .35 m. N. of Bethel L	1/1/69	0220	Clear	Nite	Single	P.I.	40	V-1	NE	N/A	N/A	85	80	100	19	M	1	Buick	63	N.I.	Yes	Excessive speed
031	202.3	1/1/69	2029	Over cast	Nite	Single	P.I.	45	V-1	S	43	5.0	70	65	75	24	M	1	Olds	57	N.I.	No	Lost control, speeding
032	S. Rogers & Hays Drive	1/6/69	1530	Clear	Dusk	Single	P.D.	Not Post-ed	V-1	S	N/A	N/A	60	56	65	16	F	1	Chev	69	N.U.	No	Lost control due to rise in roadway
033	102.5	1/5/69	1720	Over cast	Dusk	Rear End Multiple	P.D.	65	V-1 V-2 V-3 V-4 V-5	S S S S S	54 54 54 54 54	6.8 6.8 6.8 6.8 6.8	N/A 18 45 33 45	N/A 15 43 30 43	N/A 20 47 35 47	20 21 30 20 18	F M M M M	1 1 1 1 1	Olds Chev Chev Buick Olds	67 66 63 69 63	U.U. U.U. U.U. U.U. U.U.	No No No No No	V-1 slowing down for turning vehicle; other vehicles following too close
034	102.7	1/5/69	1725	Over cast	Dusk	Rear End Multiple	P.D.	65	V-1 V-2 V-3 V-4	S S S S	54 54 54 54	6.8 6.8 6.8 6.8	N/A N/A 40 50	N/A N/A 38 45	N/A N/A 42 53	19 18 18 54	M F F M	1 1 1 1	Chev Ford Ply Cadi	68 67 66 67	U.U. U.U. U.U. U.U.	No No No No	Acc#033-caused V-1 & V-2 to stop V-3 & V-4 following too close
035	104.1	1/5/69	1756	Over cast	Nite	Rear End	P.D.	65	V-1 V-2	S S	56 56	6.7 6.7	0 35	0 30	0 37	20 17	F M	1 2	Ford Chev	59 63	U.U. N.U.	No No	Faulty brakes V-2
036	105.1	1/5/69	1810	Clear	Nite	Rear End	P.D.	65	V-1 V-2 V-3	S S S	56 56 56	6.7 6.7 6.7	0 20 35	0 15 30	0 30 45	20 20 21	M F M	1 4 3	Chev Chev Ford	64 64 69	U.U. U.U. U.U.	No No No	Following too close
037	5700 block of S. Rogers	1/5/69	2115	Clear	Nite	Single	P.D.	30	V-1	N	N/A	N/A	80	75	85	19	M	1	Chev	63	N.U.	No	Speed

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
038	101.5	1/6/69	0929	Snow	Day	Side Coll.	P.I.	50	V-1 V-2	S N	45 47	6.6 7.7	40 40	35 35	45 45	44 60	F F	1 1	Ford Chev	47 61	U.U. U.U.	No No	Snow surface--V-2 lost control
039	102.6	1/6/69	0945	Snow	Day	Single	P.D.	65	V-1	S	49	6.7	45	40	50	27	F	1	Chev	66	U.	No	Lost control slick surface
040	609.8	1/6/69	1026	Snow	Day	Single	P.I.	65	V-1	W	44	4.9	45	40	47	20	F	1	Volvo	67	U.	No	Lost control passing on slick surface
041	Handy Ridge Rd .7 m S.Moffet	1/6/69	1519	Snow	Day	Head-on	P.D.	30	V-1 V-2	E W	N/A	N/A	15 15	12 10	17 20	39 26	M F	1 1	Ford P/U Chev	65 58	N.U. N.I.	No No	Slick surface
042	2729 S.Rogers	1/6/69	1616	Clear	Day	Rear End	P.D.	30	V-1 V-2	N N	N/A	N/A	05 25	03 20	07 27	23 25	F M	1 1	Chev Pont	64 66	N.I. N.U.	No No	Slick surface
043	504.8	1/7/69	0900	Clear	Day	Single	P.D.	45	V-1	E	35	5.4	45	40	47	41	M	1	Ford	66	U.U.	No	Faulty brakes
044	Hart Straight Rd. .1 m SE of 46W	1/8/69	0320	Clear	Nite	Single	P.D.	30	V-1	NW	N/A	N/A	30	25	35	18	M	1	Pont	67	N.U.	No	Lost control
045	103.1	1/8/69	1600	Rain	Dusk	Off Road	P.D.	65	V-1 V-2	N S	41 41	6.9 6.9	55 57	55 55	60 60	20 28	M M	1 1	Opel Chev P/U	68 68	U.U. U.	No No	V-1 pulled out in front of V-2
046	401.3	1/12/69	1800	Clear	Dusk	Rear End	P.I.	40	V-1 V-2	W W	42 42	7.6 7.6	45 0	40 0	50 0	23 26	F M	1 2	Buick Chev	62 68	U.U. N.U.	No No	V-2 stopped for turn
047	406.1	1/9/69	0918	Clear	Day	Side Coll.	Fatal	40	V-1 V-2	E N	*	*	40 35	35 30	42 40	51 62	M M	1 2	Ford Locomotive	65	N.I.	No	V-1 thru crossing (no gates) against signal (sun in eyes?)
048	701.1	1/10/69	1612	Clear	Day	Rear End	P.D.	45	V-1 V-2	E E	40 40	5.0 5.0	35 35	33 33	38 40	22 38	M M	1 1	Dodge Ford	67 64	U.U. U.U.	No No	V-2 following too close

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Conditions	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
049	Moores Pike 1/2 mi. W. of Smith Road	1/8/69	1830	Clear	Dusk	Rear End	P.D.	35	V-1 V-2 V-3	E E W	N/A	N/A	0 20 Unk	0 20 Unk	0 30 Unk	20 17 Unk	M M Unk	2 1 Unk	Pont Ramb Unk	67 62 Unk	N.U. N.I. Unk	No No Unk	Illegally parked V-1 projecting on roadway V-2 struck V-1
050	2314 N. Walnut	1/10/69	1802	Clear	Nite	Rear End & Head-on	P.I.	40	V-1 V-2 V-3	S N N	N/A	N/A	30 0 30	35 0 35	25 0 25	16 31 22	F M F	1 1 1	Ford Ford Olds	65 66 67	U.U. U.U. U.U.	No No No	V-2 stopped; V-1 not aware of condition
051	Moores Pike 520' W. Smith Road	1/10/69	1851	Clear	Nite	Head-on	P.I.	40	V-1 V-2	E W	N/A	N/A	35 30	30 27	40 35	28 49	F M	1 1	Chev Int. Scout	64 65	U.U. U.U.	No No	Ice on roadway; V-1 lost control
052	Bethel Lane 4000' S. of Hinnle Road	1/10/69	1945	Clear	Nite	Single	P.D.	40	V-1	E	N/A	N/A	35	25	40	17	M	1	Dodge	66	N.U.	No	Lost control
053	304.9	1/12/69	0115	Clear	Nite	Rear End	P.D.	45	V-1 V-2	W W	47 47	7.7 7.7	20 45	Unk Unk	Unk Unk	17 19	M M	1 1	Chev Ford	57 69	U.U. U.U.	Unk Unk	V-1 too slow
054	404.3	1/14/69	1510	Clear	Day	Single	P.D.	50	V-1	E	43	6.1	50	Unk	Unk	44	M	1	Buick	67	U.U.	Unk	Lost consciousness
055	704.9	1/14/69	2250	Clear	Nite	Single	P.I.	50	V-1	W	46	7.7	75	60	85	21	F	2	Chev	64	N.I.	Yes	Lost control on curve
056	409.9	1/15/69	0654	Over cast	Nite	Single	P.I.	65	V-1	E	52	8.0	60	55	65	20	M	5	Nash	60	N.I.	No	Mech. (steering)
057	306.5' E. of SR275 on SR46 By-pass	1/15/69	2055	Clear	Nite	Rear End	P.I.	45	V-1 V-2	E E	N/A	N/A	0 35	0 30	0 40	48 27	M M	1 1	Olds Ply	64 68	U.U. U.U.	No Yes	Intoxication V-2
058	603.5	1/16/69	0710	Over cast	Day	Side Coll.	P.I.	45	V-1 V-2	E E	37 37	6.0 6.0	07 20	05 18	09 25	62 40	M M	1 1	Ford Trk. Olds	68 62	U.U. U.U.	No No	V-1 did not observe V-2
059	403.9	1/16/69	1600	Rain	Day	Rear End Multiple	P.I.	50	V-1 V-2 V-3 V-4	E E E E	46 46 46 46	5.3 5.3 5.3 5.3	N/A N/A 13 42	N/A N/A 10 40	N/A N/A 15 47	22 27 55 18	F F F M	2 1 1 1	Chev Ford Chev Chev	65 66 66 65	N.U./U. U. N.U. N.U.	No No No No	Rain decreased visibility vehicle travel too fast for conditions

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
060	Airport Rd. 632.4' W. of Kirby Road	1/17/69	2106	Rain	Nite	Rear End	P.D.	30	V-1	W	N/A	N/A	27	25	30	29	F	1	Buick	66	U.U.	No	Wet, slippery pavement V-2 skid into V-1
									V-2	W			27	25	30	25	M	2	Opel	68	U.U.	No	
061	Moores Pike .2 mi.E.of Smith Road	1/18/69	2340	Over cast	Nite	Single	P.D.	30	V-1	E	N/A	N/A	60	55	65	17	M	3	Merc	65	N.U.	No	Lost control in avoiding slower car
062	507.2	1/20/69	0724	Icing	Nite	Single	P.D.	30	V-1	W	32	7.3	45	35	45	29	M	1	Merc	68	N.U.	No	Lost control on ice patch
063	401.5	1/21/69	1545	Wet	Day	Rear End	P.D.	40	V-1	S	**	**	05	03	07	33	M	2	Mac Trk.	65	U.U.	No	Failure to watch when backing
									V-2	N	**	**	05	05	10	19	F	1	Ford	66	N.U.	No	
064	603.5	1/22/69	0715	Rain Fog	Nite	Rear End	P.D.	40	V-1	E	42	5.3	0	0	0	26	M	1	Pont	65	N.U.	No	V-2 following too close
									V-2	E	42	5.3	40	35	45	44	M	1	Ford	67	N.U.	No	
065	102.1	1/23/69	1909	Rain	Nite	Rear End	P.D.	65	V-1	N	52	7.4	0	0	0	27	M	1	Chev Trk.	68	N.U.	No	V-1 & V-2 (wrecker w/car) stopped--V-3 obscured vision
									V-2	N	N/A	N/A	0	0	0	(being towed)			Chev	67			
									V-3	N	52	7.4	45	40	50	19	M	2	Chev	65	U.U.	No	
066	401.3	1/23/69	1925	Rain Fog	Nite	Single	P.D.	40	V-1	W	36	4.5	20	20	25	Unk	F	1	Pont	64	U.	No	Heavy rain & fog--unfamiliarity w/road
067	408.4	1/23/69	2216	Rain Fog	Nite	Single	P.I.	65	V-1	W	45	6.7	55	50	60	35	M	1	V.W.	68	U.U.	No	Lost control on flooded roadway
068	401.3	1/25/69	0746	Clear	Day	Single	P.D.	50	V-1	W	43	6.2	55	50	60	33	M	1	V.W.	64	U.U.	Unk	Lost control on curve
069	401.3	1/25/69	1618	Clear	Day	Head-on	P.I.	40	V-1	E	44	4.7	40	38	45	50	M	1	Chev Trk.	60	U.U.	No	Sun blinded V-2
									V-2	W	43	5.6	08	05	10	23	M	2	V.W.	68	U.U.	No	
070	201.4	1/25/69	1802	Clear	Nite	Head-on	P.D.	45	V-1	S	41	4.9	40	35	45	44	M	1	Ford Trk.	64	U.U.	No	V-2 left of center
									V-2	N	43	5.6	20	18	25	26	M	1	Buick	63	U.U.	Yes	

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
071	109.7	12/24/69	1956	Clear	Nite	Rear End	P.I.	65	V-1	S	58	7.5	25	25	25	48	M	1	Diam. T.Trk.	68	N.I.	No	V-2 eyes off traffic rear ended slow V-1 climbing grade
									V-2	S	58	7.5	65	63	67	19	M	2	Ford	64	N.I.	No	
072	INSUFFICIENT DATA																						
073	609.8	1/30/69	0717	Rain	Dawn	Single	P.I.	65	V-1	E	48	6.1	68	65	70	40	F	3	Chev	67	N.U.	No	Excessive speed for conditions
074	609.9	2/1/69	0231	Rain	Nite	Single	P.D.	50	V-1	W	48	10.5	35	25	40	32	M	2	Int P/U	Unk	N.I.	Unk	Driver blinded by headlights
075	209.5	2/1/69	1622	Over cast	Day	Single	P.I.	55	V-1	S	52	3.8	55	50	60	46	M	1	Dodge	65	N.U.	No	Forced off road at lane change 1-2
076	306.0	2/2/69	0023	Icing	Nite	Single	P.I.	65	V-1	E	42	4.4	65	60	70	20	M	2	Ramb	63	U.U.	No	Lost control due to ice on roadway
077	603.7	2/3/69	0700	Clear	Day	Rear End	P.D.	45	V-1	W	46	7.2	0	0	0	17	F	1	Buick	65	U.U.	Unk	V-1 illegally parked protruding into roadway
									V-2	W	46	7.2	25	30	35	34	M	1	Ford	68	U.	Unk	
									V-3	W	46	7.2	35	35	40	20	M	1	Merc	61	N.U.	Unk	
078	601.2	2/3/69	0822	Clear	Day	Head-on	P.D.	45	V-1	E	36	5.7	30	30	40	25	M	1	Chev	66	N.U.	Unk	Soft shoulder--wheel off--lost control
									V-2	W	40	7.0	40	40	50	66	F	1	V.W.	64	N.U.	No	
079	1000' N. of Woodyrd on Smith Pike	2/3/69	0944	Ice	Day	Single	P.I.	35	V-1	N	N/A	N/A	40	30	45	17	M	1	Chev	59	N.U.	No	Ice on roadway
080	107.7	2/5/69	0716	Clear	Dawn	Rear End	P.I.	65	V-1	N	54	7.1	0	0	0	28	F	3	Ford	67	N.U.	No	V-1 stopped for school bus V-2 rear ended V-1
									V-2	N	54	7.1	55	53	58	69	M	4	Chev	69	N.U.	No	
081	405.6	2/5/69	1545	Clear	Day	Rear End	P.D.	50	V-1	E	45	7.4	0	0	0	53	F	1	Cadi	63	N.I.	No	V-1 stopped to turn
									V-2	E	45	7.4	50	45	56	49	F	1	Chev	65	N.U.	No	
082	446 (.5 mi S. of Moores Pke)	2/8/69	1745	Mist	Dusk	Single	P.I.	40	V-1	W	N/A	N/A	40	35	45	21	F	1	Ramb	58	N.U.	No	Too fast for curve
083	INSUFFICIENT DATA																						

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
084	203.9	2/8/69	2100	Snow	Nite	Side Coll.	P.I.	45	V-1 V-2	S N	40 40	5.1 5.7	05 25	03 20	07 30	19 18	M M	1 3	Ford V.W.	66 62	N.U. N.I.	No No	V-1 turned in front of V-2
085	502.6	2/8/69	2122	Ice	Nite	Single	P.D.	45	V-1	E	33	4.4	35	33	38	37	F	1	Chev	67	U.U.	No	Icy road surface
086	202.9	2/10/69	1859	Clear	Nite	Side Coll.	P.D.	45	V-1 V-2	N W	47 47	6.8 6.8	50 0†	30 0†	50 0†	46 26	F M	2 2	Olds Ford Trk.	65 50	N.U. N.I.	No Unk	V-2 not yielding right of way
087	205.2	2/10/69	1840	Over cast	Nite	Rear End	P.D.	55	V-1 V-2	S S	48 48	6.9 6.9	50 50	48 48	52 52	20 25	F M	1 1	Chev Int. Trk.	63 68	U.U. U.U.	No. No	V-2 following too closely
088	204.0	2/11/69	1514	Clear	Day	Rear End	P.D.	55	V-1 V-2	N N	45 45	7.0 7.0	50 50	46 47	53 54	49 73	M M	1 1	Ford Chev	67 64	N.U. N.U.	No Unk	V-2 following too closely
089	506.1	2/11/69	2034	Over cast	Nite	Single	P.D.	45	V-1	E	38	7.3	50	48	54	19	M	1	V.W.	59	N.I.	No	Lost control due to speed and vehicle leaving road
090	701.2	2/13/69	0931	Clear	Day	Single	P.I.	45	V-1	E	42	5.9	45	42	48	22	M	1	Chev Dump	64	N.U.	No	Mech--Brakes failed
091	602.2	2/14/69	0736	Clear	Day	Side Coll.	P.I.	45	V-1 V-2	W S	42 42	6.5 6.5	40 0†	35 0†	45 0†	21 25	F M	1 2	Ply Ford	64 69	U.U. U.U.	No No	V-2 not seeing V-1
092	Old 37 @ No. Dunn	2/14/69	1525	Clear	Day	Single	P.I.	30	V-1	E	N/A	N/A	35	30	40	28	M	1	Ford	62	U.U.	Yes	Lost control
093	S. Rogers at Monon Trks	2/15/69	1203	Clear	Day	Single	P.D.	30	V-1	S	N/A	N/A	30	25	35	72	M	1	Chev Trk.	64	N.I.	No	Wheel off road; lost control
094	S. Rogers & Country Club	2/18/69	1605	Clear	Day	Side Coll.	P.I.	30	V-1 V-2	N E	N/A	N/A	30 08	27 06	35 10	17 36	M M	1 2	Chev Trk. Ply	50 65	N.I. N.U.	No No	V-2 failed to yield right of way
095	501.1	2/20/69	0823	Clear	Day	Side Coll.	P.D.	45	V-1 V-2	S E	39 39	5.5 5.5	0† 05	0† 05	0† 08	48 22	F M	1 1	Chev Ply	68 65	U. U.U.	No No	Failure V-2 to yield

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
096	S. Rogers & That Rd.	2/20/69	1520	Clear	Day	Side Coll.	P.D.	35	V-1 V-2	N E	N/A	N/A	30 0	25 0	30 0	52 66	M M	1 1	Chev Chev	65 64	N.U. N.U.	No No	Improper turn by V-2
097	208.1	2/20/69	1625	Clear	Day	Rear End	P.I.	55	V-1 V-2	S S	49 49	5.7 5.7	10 55	05 55	15 60	42 42	F F	2 3	Ford Ford	66 69	U.U. N.U.	No No	V-1 attempting improper right pass on Berm
098	603.2	2/20/69	1630	Clear	Day	Side Coll.	P.D.	45	V-1 V-2	E N	36 36	6.4 6.4	40 0†	38 0†	43 0†	72 32	F F	2 1	Cadi Olds	68 60	N.U. N.U.	No No	V-1 sun blinded
099	Rockport at Graham Drug	2/22/69	0230	Clear	Nite	Single	P.I.	30	V-1	N	N/A	N/A	30	25	35	17	F	1	Stude	61	N.U.	No	Mech (power steering failed)
100	105.7	2/22/69	2000	Rain	Nite	Side Coll.	P.D.	65	V-1 V-2	S N	50 49	7.8 4.8	50 65	45 65	55 70	25 21	M M	1 1	Chev V.W.	69 62	U.U. U.U.	No No	V-2 left of center
101	46 bypass at 10th Street	2/23/69	1346	Clear	Day	Single	P.D.	45	V-1	S	N/A	N/A	30	30	35	34	F	1	Pont	65	U.	No	Mech. (Brakes)
102	203.9	2/23/69	1500	Clear	Day	Side Coll.	P.I.	45	V-1 V-2	E S	42 42	5.0 5.0	0† 15	0† 10	0† 18	47 50	M M	1 1	Pont V.W.	66 62	N.U. N.U.	No No	V-1 not yielding intersection right of way
103	108.2	2/25/69	1756	Over cast	Day	Rear End	P.D.	65	V-1 V-2	N N	54 54	7.4 7.4	0 45	0 43	0 48	52 18	M M	1 1	Chev Chev	69 65	U.U. U.U.	No No	V-2 following too close
104	Moores Pike 145'E of Valley Forge	2/26/69	0940	Clear	Nite	Side Swipe	P.I.	20	V-1 V-2	E W	N/A	N/A	40 60	35 55	45 65	44 25	M M	1 1	Ford Ford	65 67	U.U. U.U.	Unk Unk	V-1 & V-2 left of center
105	INSUFFICIENT	DATA																					
106	110.6	2/27/69	1800	Clear	Dusk	Side Coll. Head-on	P.I.	65	V-1 V-2 V-3	N S S	57 58 58	6.3 6.0 6.0	70 65 60	65 60 55	75 70 65	44 18 36	M M M	1 2 1	Dodge Ford Chev Trk	66 63 64	U.U. N.I. N.U.	No No No	V-2 improper pass of V-3, V-1 speed

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
107	105.3	3/1/69	1240	Clear	Day	Rear End	P.D.	65	V-1 V-2	N N	49 49	6.9 6.9	15 10	10 5	20 15	31 19	M M	2 4	Olds Buick	62 63	UU NI	No No	V-1 attempting pass, pulled back into lane too soon.
108	504.1	3/4/69	2250	Clear	Nite	Single	P.D.	45	V-1	E	33	7.0	45	40	50	40	M	1	Chev	66	UU	Yes	Wheel off road - lost control
109	No Police Report																						
110	Harrodsburg Rd -Strain Ridge Rd.	3/5/69	1835	Clear	Dusk	Single	P.I.	30	V-1	N	N/A	N/A	30	25	30	20	F	1	Merc	64	NU	No	Lost control
111	No Police Report																						
112	604.5	3/6/69	1733	Clear	Day	Rear End	P.I.	50	V-1 V-2	W W	42 42	6.9 6.9	35 65	25 60	40 70	17 28	F M	3 1	Merc Mack	61 62	NI NI	No No	V-1 slowed; V-2 could not
113	303.1	3/7/69	1455	Clear	Day	Side	P.D.	45	V-1 V-2	W E	44 44	4.7 5.1	30 0	25 0	35 0	22 31	M M	1 1	M.G. Dodge	65 48	UU NI	No Yes	V-2 turned in front of V-1
114	201.9	3/7/69	1720	Clear	Day	Rear End	P.D.	45	V-1 V-2	S S	39 39	3.8 3.8	60 05	50 03	65 07	17 36	M F	1 1	Olds Ford	63 66	NI U	Yes No	V-2 slowing & making left turn; V-1 struck V-2 on right rear
115	Shuffle Gr. Rd 2000's South Shore Dr.	3/7/69	1900	Clear	Nite	Single	P.D.	30	V-1	N	N/A	N/A	65	60	70	49	M	1	Olds	69	UU	Yes	Lost control due to on-coming vehicle on his side of road
116	101.9	3/8/69	1245	Over cast Wet	Day	Rear End Side	P.I.	50	V-1 V-2 V-3	S W E	46 46 46	8.7 8.7 8.7	45 $0^{\dagger}$ $0^{\dagger}$	40 $0^{\dagger}$ $0^{\dagger}$	50 $0^{\dagger}$ $0^{\dagger}$	30 27 33	M M F	7 3 1	MCI Bus Chev Tr. Dodge	68 68 68	UU UU U	No No No	V-2 turning; V-1 unable to stop; V-2 knocked in front of V-3

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
117	46 By-pass 20' South of SR 45	3/8/69	1550	Wet	Day	Rear End	P.I.	30	V-1 V-2 V-3	S S S	N/A	N/A	0 0 5	0 0 0	0 0 5	51 31 20	F M F	4 4 2	Chev Ford Ford	68 68 68	U N.U. U.U.	No No No	V-4 unable to stop.
118	405.6	3/20/69	0750	Wet	Day	Rear End Side	P.I.	50	V-1 V-2 V-3	S W E	47 47 50	6.1 6.1 5.7	0+ 25 0	0+ 20 0	0+ 40 0	22 22 33	F M M	1 1 1	Chev Chev IntTk	63 68 58	N.U. N.U. N.I.	No Unk Unk	V-1 on priv. dr., brakes failed; struck by V-2, impact forced V-1 into V-3.
119	110.9	3/8/69	2210	Rain Fog	Nite	Side	P.I.	65	V-1 V-2	N S	54 50	6.5 8.7	50 10	45 7	55 12	17 56	M M	2 3	VW Chev	67 62	N.U. N.U.	Unk Unk	V-2 turned in front of V-1.
120	Old 37 N. 52' South of Chambers	3/5/69	0810	Clear	Day	Single	P.D.	45	V-1	N	N/A	N/A	40	30	45	63	M	1	Nash	58	N.I.	No	Vehicle 1 left road in order to miss Vehicle X.
121	Insufficient Data																						
122	306.5	3/16/69	0100	Clear	Nite	Side	P.I.	65	V-1 V-2	W E	47 50	6.6 7.0	55 45	50 45	60 50	19 18	M M	1 5	TR-3 Ramb	60 64	N.U. N.U.	Yes No	Vehicle 1 lost control. Bump on road.

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
123	106.3	3/16/69	1450	Clear	Day	Rear End	P.I.	65	V-1 V-2	N N	43 43	9.5 9.5	0 55	0 50	0 60	19 28	M M	2 4	Pont Ford P.U.	65 62	U N.I.	No No	Improper passing by V-2
124	102.5	3/20/69	0930	Clear	Day	Head-on Side	P.I.	65	V-1 V-2 V-3	S N S	56 55 56	5.0 6.2 5.0	65 15 55	55 10 50	70 20 60	21 21 25	M M M	1 1 1	Pont Chev Semi	66 66 66	Unk N.U. U.U.	No Yes Unk	Failure to yield right of way by V-2
125	Rockport Road 3000' South of Country Club Road	3/21/69	1605	Clear	Day Dust Observed Complete	Head-on	P.D.	30	V-1 V-2	S N	 N/A	 N/A	15 15	10 10	20 20	18 34	M M	2 2	Olds Dodge	64 51	N.U. N.I.	No No	100% obscured vision by lime dust.
126	No Police Report																						
127	SR 446 1 1/3 South of SR 46	3/22/69	0111	Over Cast	Nite	Single	P.I.	40	V-1	E	N/A	N/A	50	45	55	19	M	2	Chev	62	N.U.	No	Lost control in middle of curve when tried to avoid left of center - on-coming vehicle
128	Vernal Pike 3500' West of Curry Pike	3/23/69	0120	Clear	Nite	Single	P.I.	65	V-1	N	N/A	N/A	55	50	60	18	M	2	Ford	67	U	No	Too fast in curve
129	College Mall & Rd. & Corenanter Drive	3/24/69	1925	Rain	Nite	Fatal Side swipe	F	65	V-1	N	N/A	N/A	40	35	45	16	M	1	Chev	63	U.U.	No	Pedestrian changing tire on roadway
130	702.5	3/26/69	1630	Over cast	Day	Rear End	P.D.	45	V-1 V-2	W W	37 37	4.3 4.3	0 40	0 38	0 42	37 37	M M	2 1	Cry Ford	66 62	N.U. N.I.	No No	V-1 turning right, V-2 ran into rear
131	103.8	3/28/69	1235	Clear	Day	Multi-Rear End	P.I.	65	V-1 V-2 V-3	N N N	45 45 45	8.8 8.8 8.8	0 45 45	0 42 42	0 48 48	45 22 22	F M M	6 1 5	Ramb Ford Chev	66 68 67	N.U. U N.U.	No No No	V-1 stopped W/O sig. V-2 rear-ended V-1; V-3 rear-ended V-2

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
132	108.2	3/29/69	0255	Light Rain	Nite	Side	P.I.	65	V-1 V-2	S N	59 56	5.8 6.5	55 10	50 8	65 13	44 32	F M	1 1	VW Chev	66 65	N.U. N.U.	Unk Unk	V-2 turned in front of V-1
133	101.9	3/29/69	1958	Clear	Nite	Side	P.I.	55	V-1 V-2	W S	52 52	7.4 7.4	0† 55	0† 50	0† 60	21 16	M M	2 1	Olds Ford	69 65	N.U. U.U.	No No	V-1 turned in front of V-2
134	506.1	4/4/69	1405	Over cast	Day	Head-on	P.I.	45	V-1 V-2	E W	37 36	6.1 5.5	35 25	30 20	40 30	17 21	M M	1 2	Ford P.U. Motor cycle Tri-umph	65 68	U.U. N.I.	No No	V-1 crested hill left of center
135	405.6	4/4/69	1730	Rain	Day	Rear End	P.I.	50	V-1 V-2	W W	42 42	4.6 4.0	0 45	0 40	0 50	21 16	F F	2 1	Chev P.U. Buick	65 64	N.I. N.I.	No No	V-1 stopped to make turn; V-2 rear-ended
136	SR 446, 2640' North of Knight Ridge Road	4/6/69	0130	Clear	Nite	Single	P.I.	40	V-1	S	N/A	N/A	40	35	45	19	M	2	Ford	63	N.I.	No	V-1 states that mule ran onto road in front of him. V-1 struck mule
137	102.6	4/6/69	1740	Clear	Day	Rear End	P.D.	65	V-1 V-2 V-3	S S S	56 56 56	4.4 4.4 4.4	N/A 0 35	N/A 0 30	N/A 0 40	21 22 19	M M M	2 3 3	Olds Chev Chry	66 69 66	U N.U. N.U.	No No No	V-1 & V-2 stopped; V-3 following too close - didn't stop
138	109.3	4/6/69	2330	Clear	Nite	Head-on	F	65	V-1 V-2	N S	58 57	5.4 5.6	55 65	50 55	60 70	26 24	M M	1 2	White Tk. Ford	69 62	U.U. N.I.	No No	V-2 forced off road by V-X; then lost control & hit V-1.
139	609.8	4/8/69	2030	Over cast	Nite	Side-swiped	P.I.	65	V-1 V-2	W W	50 50	8.7 8.4	25 60	20 57	30 65	16 24	F M	1 1	Chev Chev	68 67	U.U. U.U.	No No	V-1 slowing & making left turn; V-2 passed & struck V-1
140	409.3	4/9/69	1215	Over cast	Day	Rear End	P.D.	40	V-1 V-2	E E	47 47	6.1 6.1	0 30	0 28	0 33	75 23	M M	1 2	Ford Pont	69 68	N.U. U	No No	V-2 following too close

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
141	705.1	4/10/69	1420	Clear	Day	Single	P.I.	55	V-1	E	47	8.5	60	55	65	22	M	1	Buick	61	N.U.	No	Ran off road; lost control
142	405.9	4/11/69	0122	Fog	Nite	Single	P.I.	40	V-1	W	37	7.1	60	55	65	32	M	1	Pont	69	N.U.	Yes	Fell asleep
143	446 at 1846' South of Moores Pike	4/14/69	1955	Rain	Nite	Single	P.I.	40	V-1	N	N/A	N/A	45	40	48	27	M	2	Chry	60	N.I.	Yes	Lost control on wet curve
144	Country Club at Monon R.R.	4/17/69	1217	Clear	Day	Single	P.I.	30	V-1	E	N/A	N/A	30	25	35	18	M	1	Yamaha	65	N.I.	No	Lost control on R.R. tracks
145	402.5	4/18/69	2345	Over cast	Nite	Side	P.D.	40	V-1 V-2	E S	43 43	6.7 6.7	45 0†	40 0†	50 0†	22 18	M M	1 1	Chev Buick	69 66	U.U. U.U.	Yes No	V-2 backed onto road; V-1 could not stop
146	508.1	4/19/69	0307	Rain	Nite	Single	P.I.	45	V-1	W	22	4.2	45	40	50	26	M	2	Ply	67	U.U.	No	Fell asleep
147	446 at 1 mile N. Moores Pike	4/19/69	0915	Clear	Day	Single	F	45	V-1	S	N/A	N/A	65	50	70	39	M	1	GMC P.U.	66	N.I.	Yes	Drunk; drove off road and struck tree
148	402.5	4/19/69	1300	Clear	Day	Rear End	P.D.	50	V-1 V-2	W W	41 41	4.8 4.8	25 25	20 20	30 35	41 17	F F	3 1	Chev Pont	66 65	U N.U.	No No	V-2 following too close
149	46 By-pass 300' S. SR45	4/19/69	1301	Clear	Day	Rear End	P.I.	45	V-1 V-2 V-3	S S S	N/A	N/A	0 0 35	0 0 30	0 0 40	34 20 50	F M M	3 1 2	Chev Ford Int.Tk	62 65 69	N.I. U N.U.	No No No	V-1 & V-2 stopped; V-3 didn't
150	Mt. Tabor Rd. 2,000 ' North of Maple Grove Rd.	4/19/69	2238	Clear	Nite	Rear End	P.I.	35	V-1 V-2	N P	N/A	N/A	60 0	50 0	65 0	20 -	M -	1 0	Ford Chev	64 63	N.I.	Yes	Lost control due to speed; V-2 was parked.
151	603.4	4/22/69	0715	Clear	Day	Side	P.D.	45	V-1 V-2	E W	32 34	4.1 3.9	18 65	10 55	20 70	31 25	M M	1 1	VW Ply	67 69	N.U. U	No No	V-1 failed to see V-2 because of sun

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
152	503.8	4/25/69	1700	Clear	Day	Single	P.I.	35	V-1	W	33	4.8	60	58	61	19	M	3	Chev	60	U.U.	No	Lost control on curve
153	103.1	4/26/69	0525	Clear	Dawn	Head-on	P.I.	65	V-1 V-2	S N	59 56	8.0 9.8	80 65	75 60	85 70	18 18	M M	1 1	Pont Ford	67 66	U.U. U.U.	Yes No	V-1 reckless driving left of center
154	Winslow Rd. at SR 37 S.	4/26/69	1250	Clear	Day	Rear End	P.D.	30	V-1 V-2	W W	N/A	N/A	0 5	0 3	0 7	26 54	M F	1 1	VW Chev	66 63	U.U. U.U.	No No	V-2 following too close
155	104.3	4/26/69	1740	Clear	Day	Single	P.D.	65	V-1	S	54	6.2	60	55	65	29	M	1	VW	63	U	No	Aborted pass - over-steered - rolled
156	502.9	4/27/69	1140	Clear	Day	Head-on	P.I.	45	V-1 V-2	E W	34 34	5.7 7.6	70 5	65 0	75 10	17 69	M M	2 1	Chev Chev	69 62	U.U. N.I.	No No	Excessive speed for road condition
157	207.4	4/30/69	0925	Clear	Day	Head-on	P.I.	55	V-1 V-2	N S	50 52	6.7 6.9	10 55	7 50	15 60	27 33	F M	3 1	Pont Int.Tr	59 65	N.I. U.U.	No No	Foot feed of V-1 stuck
158	446: 1000' S. of Duke Road	4/30/69	1640	Clear	Day	Single	P.I.	40	V-1	W	N/A	N/A	45	40	50	16	M	1	Chev P.U.	69	N.U.	No	Speed too fast for curve
159	Old 37, 528' S. of Myers Rd.	5/1/69	0230	Clear	Nite	Single	P.I.	40	V-1	S	N/A	N/A	45	42	50	35	M	1	Chev	64	N.U.	Yes	Struck bridge in order to avoid another vehicle
160	No Police Report																						
161	109.9	5/2/69	1906	Clear	Day	Rear End	P.D.	55	V-1 V-2	N N	50 50	8.3 8.3	0 40	0 40	0 45	27 20	F M	1 3	Ford Chev	63 66	N.U. N.U.	No No	V-2 failed to see V-1 stopped for left turn
162	109.3	5/2/69	2325	Clear	Nite	Single	P.I.	65	V-1	S	60	7.0	65	60	70	42	F	2	Chev	61	N.I.	Yes	Drunk; drive off rd.
163	303.0	5/5/69	2330	Clear	Nite	Side	P.I.	45	V-1 V-2	E W	46 42	7.7 6.4	10 60	8 50	15 65	47 19	M F	1 2	Dodge SAAB	68 67	U.U. U.U.	No No	V-1 failed to yield right-of-way while turning left; V-2 speeding.

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
164	109.2	5/9/69	1400	Rain	Day	Rear End	P.I.	65	V-1	N	56	7.0	55	40	60	43	M	1	Ford P.U.	69	U.U.	No	V-1 speed too fast for conditions and following too close. V-1 struck V-2; V-2 struck V-3, and V-3 struck V-4.
									V-2	N	56	7.0	10	5	15	43	M	2	Chry	68	U.U.	No	
									V-3	N	56	7.0	0	0	0	20	F	1	Olds	63	U.U.	No	
									V-4	N	56	7.0	0	0	0	58	M	1	Chev	67	U.U.	No	
165	209.1	5/8/69	1800	Over cast	Dusk	Head-on	P.D.	55	V-1	N	50	4.8	45	40	50	21	M	1	Olds	69	U	No	V-1 driving left of center
									V-2	S	47	5.6	45	40	50	19	M	1	Ford	67	N.U.	No	
166	S. Rogers St. 1/10 mile S. of Rock Post Rd.	5/9/69	0709	Over cast	Dawn	Rear End	P.D.	30	V-1	N	N/A	N/A	10	5	15	52	F	2	Chev	64	N.I.	No	V-1 slowed; V-2 couldn't due to gravel on road & wet pavement.
									V-2	N			35	30	40	26	M	1	Olds	67	U.U.	No	
167	Curry Pike at Beasley Drive	5/9/69	0400	Rain	Nite	Single	P.I.	30	V-1	N	N/A	N/A	77	65	85	30	M	1	Ford	67	N.U.	Yes	Excessive speed & alcohol
168	Old SR 37 N. of Dunn St.	5/16/69	1910	Rain	Day	Head-on	P.I.	45	V-1	N	N/A	N/A	30	30	40	33	F	1	Ford	63	U	No	V-2 left of center in curve.
									V-2	S			40	40	50	17	F	3	Ramb	67	U.U.	No	
169	SR 46 By-pass at 17th St.	5/16/69	2200	Clear	Nite	Rear End	P.I.	45	V-1	N	N/A	N/A	0	0	0	16	M	2	VW	62	N.I.	No	Brake failure on V-2
									V-2	N			30	25	35	21	M	2	Saab	60	N.I.	No	
170	Curry Pike at Midland	5/17/69	0308	Rain	Nite	Single	P.D.	30	V-1	N	N/A	N/A	55	45	60	24	M	1	Ford	65	U.U.	Yes	Excessive speed & alcohol.
171	209.4	5/17/69	1000	Rain	Day	Single	P.I.	55	V-1	N	48	6.6	65	45	70	23	F	2	Olds	64	N.I.	No	Lost control due to poor traction & excessive speed
172	Bethel Lane at Hinkle Rd.	5/11/69	2345	Clear	Nite	Side	P.I.	30	V-1	N	N/A	N/A	0†	0†	0†	18	M	4	Pont	66	N.U.	Yes	V-1 failed to yield right of way to V-2
									V-2	E			40	35	45	22	M	3	Buick	67	N.U.	No	
173	Fairfax Rd. E. of SR 37	5/12/69	1240	Clear	Day	Single	P.I.	30	V-1	E	N/A	N/A	30	25	35	NA	F	1	Chev	61	N.I.	No	Leaned down to pick up purse & lost control

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
174	609.5	5/13/69	1435	Clear	Day	Side Swipe	P.D.	65	V-1 V-2 V-3	E E E	55 55 55	9.3 9.3 9.3	45 55 65	42 50 63	48 55 70	42 41 56	F M F	1 1 1	Ply ChevTk Ply	66 67 65	N.U. N.U. N.U.	No No No	Improper pass by V-3 Tried to pass V-2 while V-2 was Passing V-1.
175	SR 43 at SR 48 Intersection	5/13/69	1720	Rain	Day	Rear End	P.D.	55	V-1 V-2	W W	N/A	N/A	40 0	35 0	45 0	18 45	M M	1 1	Ford Ford	63 62	N.I. N.I.	No No	Traffic lane obstructed by Road Closed sign visible at max. 280 ft.
176	705.1	5/14/69	1850	Clear	Day	Single	P.D.	50	V-1	W	47	11.1	60	55	65	19	M	3	Chev	50	N.I.	No	V-1 lost control while avoiding Veh. in front of him that was turning left.
177	46 By-pass 176' East of 17th Street	5/15/69	1530	Clear	Day	Rear End	P.D.	45	V-1 V-2	E E	N/A	N/A	0 40	0 35	0 45	43 53	F M	2 1	Chev Ford	66 68	U U	No No	V-1 stopped; V-2 didn't.
178	204.5	5/17/69	1545	Over cast	Day	Side	P.D.	55	V-1 V-2	N N	47 47	5.2 5.2	20 40	15 35	20 50	31 43	M F	2 3	Pont Chev	67 56	N.U. N.I.	No No	V-2 was passing V-1. V-1 turned left (improper passing).
179	46 By-pass at Fee Lane	5/17/69	2350	Rain	Nite	Single	P.D.	45	V-1	W	N/A	N/A	40	35	45	21	M	2	Volvo	63	N.I.	No	V-1 forced off rd. by unknown veh.
180	303.5	5/18/69	1315	Rain	Day	Rear End	P.D.	45	V-1 V-2 V-3	W W W	46 46 46	5.9 5.9 5.9	5 25 30	3 20 25	8 30 35	50 21 27	M M M	1 5 2	Ramb Ply Merc	68 69 64	U U.U. U.U.	No No No	V-1 slowed for traffic; V-2 following too close struck V-1; V-3 Also too close - struck V-2.
181	101.1	5/18/69	1340	Rain	Day	Side	P.D.	40	V-1 V-2 V-3	E W N	49 49 49	7.9 7.9 7.9	10 0 40	5 0 30	15 0 45	21 35 47	F M M	1 1 3	Buick VW Chev P.U.	68 63 64	U U N.I.	No No No	Sbound V1 turned **lt.** on yel. lite., Nbound V3 hit V1 broadside, swung V1 180° into & on top of V2 stopped at intersection.

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
182	Anderson Rd. 1.3 miles E. of Shilo	5/19/69	0005	Clear	Nite	Single	P.I.	65	V-1	E	N/A	N/A	45	30	50	22	M	1	Camaro	68	N.U.	No	Too fast for conditions - patches of water.
183	703.4	5/20/69	1700	Over cast	Day	Side	P.D.	45	V-1 V-2	W W	45 45	5.6 5.6	10 40	Unk 40	Unk 45	32 38	M M	2 3	Pont Ramb	64 66	N.U. N.U.	No No	V-1 slowed to make rt. turn; V-2 not able to stop; tried to pass on right.
184	Vernal Pike 224' N. of Adam	5/21/69	2340	Clear	Nite	Single	P.I.	30	V-1	S	N/A	N/A	40	35	45	40	M	1	Chry	67	N.U.	Yes	Speeding; lost control crossing RR tracks.
185	That Rd. 1000' W. of Rogers	5/22/69	0645	Rain	Dawn	Single	P.I.	30	V-1	W	N/A	N/A	30	25	35	62	M	1	Chev	61	N.I.	No	Lost control avoiding another veh.
186	609.1	5/22/69	0700	Rain	Dawn	Single	P.D.	45	V-1	E	51	7.8	45	45	50	42	F	1	Ford	67	N.U.	No	Lost control due to wet pavement.
187	502.4	5/22/69	1845	Clear	Nite	Single	P.D.	20	V-1	W	38	5.0	55	50	60	Unk	M	1	Chev	65	U.U.	Unk	Speed too fast for curve.
188	502.5	5/23/69	1550	Over cast	Day	Head-on	P.I.	45	V-1 V-2	E W	40 40	6.0 5.3	40 50	35 45	45 55	57 18	M M	1 1	Pont Pont	64 63	N.I. N.I.	No No	V-2 locked brakes to avoid other Veh., then lost control.
189	Rohner Rd. 2/10 mi. E. of SR 37	5/23/69	1710	Clear	Day	Side	P.I.	35	V-1 V-2	E E	N/A	N/A	7 40	5 36	10 44	34 20	F M	1 2	Dodge Honda	64 66	N.U. N.I.	No No	V-1 turning left & V-2 attempted to pass on left.
190	601.2	5/24/69	1200	Clear	Day	Rear End	P.D.	45	V-1 V-2	W W	37 37	6.2 6.2	10 50	Unk 45	Unk 55	42 22	M M	1 1	Ply Ford	68 65	N.U. U	No No	V-1 slowed to turn rt; V-2 didn't stop.
191	Curry Pike 5/10 mi. S. of Woodyard Rd.	5/19/69	1345	Over cast	Day	Single	P.I.	30	V-1	N	N/A	N/A	64	50	70	19	M	2	Chev	68	N.U.	No	Rt. front wheel left rd.; lost control.

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
193	102.8	6/1/69	1500	Clear	Day	Rear End	P.I.	65	V-1 V-2	S S	57 57	8.0 8.0	50 80	Unk Unk	Unk Unk	23 Unk	M Unk	Unk Unk	Cycle Unk	62 Unk	N.A. Unk	Unk Unk	Hit & Run. V-2 struck V-1 then left
197	602.2	5/20/69	1920	Clear	Day	Rear End	P.D.	45	V-1 V-2	E E	40 40	6.8 6.8	15 35	10 22	20 40	23 24	M M	3 1	Ford VW	65 62	U N.U.	No Yes	V-1 slowed; V-2 did not.
198	Weimer Rd. at Camp Rd.	5/30/69	1625	Clear	Day	Head-on	P.D.	65	V-1 V-2	S N	N/A	N/A	30 30	25 25	35 35	24 20	M M	5 1	Ford Chev	67 64	N.U. N.U.	No No	Unknown Veh. Crossed rd. forcing V-2 left of center.
199	305.1	6/1/69	1555	Clear	Day	Single	P.D.	45	V-1	E	46	6.3	35	30	40	45	F	2	Dodge	66	U.U.	No	Lost control of trailer due to wind.
200	306.1	6/1/69	1859	Rain	Day	Rear End	P.D.	55	V-1 V-2	W W	41 41	7.6 7.6	20 40	Unk 35	Unk 45	44 62	M M	2 4	Chev Ford	65 68	U.U. U.U.	No No	V-1 slowed to turn; V-2 following another veh. which avoided V-1, but V-2 struck.
201	Old 37 N. at Bethel Lane	6/3/69	0830	Clear	Day	Side	P.I.	30	V-1 V-2	E N	N/A	N/A	30 0†	25 0†	35 0†	17 26	F M	1 1	Pont Chev	67 64	U.U. U.U.	No No	V-2 failed to yield right-of-way.
202	Oard Rd. 3/10 mi. E. Vernal Pike	6/2/69	1509	Over cast	Day	Single	P.D.	35	V-1	W	N/A	N/A	35	30	40	49	M	3	Buick	53	N.I.	Yes	"Faulty Brake" claim
203	Hartstraight Rd. 2/10 mi. Elletsville	5/26/69	1135	Clear	Day	Side	P.D.	35	V-1 V-2	N S	N/A	N/A	35 40	30 35	40 45	34 18	M M	1 1	Ford Dodge	64 63	U N.U.	No No	V-2 driving left of center; V-1 pulled left to avoid
204	Winslow Rd. 432' W. of High Street	6/8/69	0225	Clear	Nite	Single	P.I.	30	V-1	W	N/A	N/A	50	45	55	32	M	1	Dodge	65	N.I.	Yes	Driver intoxicated
205	Rockport Rd. 3.3 Mi. S. of Rogers	6/9/69	0700	Over cast	Day	Head-on	P.I.	30	V-1 V-2	N S	N/A	N/A	45 35	40 30	50 40	17 60	F F	1 1	Chev Chev	66 67	U.U. U.U.	No No	V-1 topped hill lt. of center.

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
207	Woodyard Rd. 112' W. Vernal Pike	6/11/69	2359	Clear	Nite	Single	P.D.	35	V-1	W	N/A	N/A	35	30	40	34	M	1	Chev PU	69	U.U.	Yes	Lost control in curve.
208	405.9	6/11/69	2245	Clear	Nite	Rear End	P.D.	55	V-1 V-2	W W	44 44	8.4 8.4	40 05	35 02	40 05	43 22	M M	5 2	Renault Buick	64 63	N.U. N.I.	No Yes	V-2 slowed to make left turn; V-1 didn't see in time to stop.
209	Curry Pike 6/10 mi. N. of 48	6/12/69	1400	Over cast	Day	Rear End	P.D.	30	V-1 V-2	N N	N/A	N/A	30 30	25 25	35 35	20 30	F F	1 1	Merc Chev	65 64	N.U. N.I.	No No	V-2 didn't see V-1 in time to stop.
210	Old 37 4/10 mi. N. of Bethel	6/12/69	1434	Rain	Day	Single	P.I.	40	V-1	S	N/A	N/A	45	35	50	20	F	1	Ford	63	U.U.	No	Failed to adjust speed to weather conditions.
211	501.2	6/12/69	1511	Rain	Day	Side	P.I.	45	V-1 V-2 V-3	W E S	41 39 41	7.6 5.0 7.6	40 40 0	35 35 0	45 45 0	41 43 23	F F F	1 2 2	Ford Buick Pont	65 66 63	U.U. U.U. U.U.	No No No	V-3 stopped at jct. with car in Wbound lane; V-1 pulled left of center to avoid V-3.
212	Hartstraight Rd. 4/10 mi. S. SR 46	6/12/69	1432	Rain	Day	Side	P.D.	35	V-1 V-2	N N	N/A	N/A	20 25	Unk 20	Unk 30	33 24	F M	1 1	Olds Chev	66 65	U.U. U.U.	No No	V-1 was making left turn; V-2 was not able to stop & turned with her.
213	504.1	6/13/69	1600	Over cast	Day	Rear End	P.D.	45	V-1 V-2	W W	28 28	5.8 5.8	30 30	25 25	30 30	41 55	F M	1 2	Ford Buick	67 69	N.U. U	No No	V-2 following too close.
214	202.9	6/14/69	1120	Over cast	Day	Side	P.D.	45	V-1 V-2	N N	36 36	7.6 7.6	35 15	30 Unk	40 Unk	16 49	M M	1 1	Chev Buick	55 66	N.I. U.U.	No No	V-2 turned left while V-1 passing on left.

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Charac- teristics		Speed of Accident- Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
215	209.6	6/14/69	1240	Rain	Day	Single	P.D.	55	V-1	N	52	5.2	55	50	60	22	F	1	Olds	68	N.U.	No	Lost control on rainslick curve.
216	Ahorer Rd. at Harrell Rd.	6/14/69	1643	Over cast	Day	Rear End	P.D.	35	V-1 V-2	W P	N/A	N/A	25 0	30 0	30 0	16 N/A	F N/A	6 -	Ply Olds	62 69	N.U. N.A.	No NA	V-2 parked with part of car on rd; V-1 crested rise & hit V-2.
217	602.2	6/15/69	1523	Clear	Day	Side	P.I.	45	V-1 V-2	E W	42 44	4.2 5.0	0 40	0 35	5 45	43 19	M M	1 1	Ford Honda	69 69	N.U. N.I.	Yes No	V-1 turned in front of V-2.
218	105.4	6/16/69	1850	Clear	Day	Single	P.I.	65	V-1	N	59	6.0	70	65	75	24	F	1	VW	64	N.U.	Yes	V-1 left rd & lost control.
219	404.1	6/17/69	0848	Clear	Day	Rear End	P.I.	50	V-1 V-2 V-3	W W W	42 42 42	11.0 11.0 11.0	N/A 0 50	N/A 0 45	N/A 0 55	69 31 31	M M F	2 1 1	Olds FordPU Chev	63 68 69	U.U. U.U. U.U.	No No No	V-1 & 2 stopped; V-3 didn't.
220	502.4	6/18/69	0826	Rain	Day	Single	P.I.	45	V-1	W	43	6.6	45	40	50	20	F	2	VW	65	N.U.	No	Lost control due to braking.
221	Mt. Tabor Rd, at Maple Grove Rd.	6/19/69	0702	Over cast	Day	Side	P.I.	35	V-1 V-2	E S	N/A	N/A	$0^{\dagger}$ 35	$0^{\dagger}$ 30	$0^{\dagger}$ 40	44 41	M M	1 1	Ford Chev P.U.	65 48	N.U. N.I.	No No	V-1 pulled into intersection & was hit by V2; No stop signs.
222	Tapp Rd. 374' W. of Rockport	6/21/69	1645	Clear	Day	Single	P.D.	40	V-1	W	N/A	N/A	40	35	45	44	M	1	Olds	66	N.U.	No	Lost control avoidg. on-coming traffic.
223	Union Valley Rd. 1 mi. N. of SR 46	6/21/69	2345	Clear	Nite	Single	P.D.	35	V-1	N	N/A	N/A	50	45	55	16	M	2	Chev	69	N.U.	No	Left ft. wheel locked.
224	103.7	6/22/69	1150	Rain	Day	Rear End	P.D.	65	V-1 V-2 V-3	N N N	54 54 54	8.6 8.6 8.6	8 15 40	5 12 35	10 18 45	44 49 33	F M M	4 4 2	Ford Cad. FordPU	68 67 68	Unk U.U. U.U.	No No No	V-1 making left turn V-2&3 unable to stop
225	46 By-pass at Jordan Ave.	6/22/69	1720	Rain	Day	Single	P.I.	35	V-1	S	N/A	N/A	45	40	50	20	M	2	Olds	63	N.U.	No	Lost control due to water on road.

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
226	46 By-pass at Jordan Ave.	6/22/69	1045	Rain	Day	Rear End	P.D.	45	V-1 V-2	E E	N/A	N/A	10 35	8 30	12 40	26 35	M M	1 3	Ford Chev	65 69	U.U. U.U.	No No	V-1 turning; V-2 pulling boat unable to stop.
227	209.5	6/25/69	0720	Rain	Day	Single	P.D.	55	V-1	N	42	8.9	55	50	60	21	F	1	Pont	64	N.I.	No	Lost control on wet pavement.
228	446 on Causeway at Monroe Reservoir	6/25/69	2215	Over cast	Nite	Rear End	P.D.	40	V-1 V-2	N N	N/A	N/A	45 0	40 0	50 0	67 38	M M	1 2	Chry Jeep Tk.	67 67	N.U. U.U.	No No	V-2 stopped on rd. with no lites on; V-1 did not see.
229	Country Club Rd. & South Rogers St.	6/22/69	0825	Clear	Day	Side	P.D.	35	V-1 V-2	E N	N/A	N/A	35 0†	30 0†	40 0†	29 31	M M	1 1	Dodge Tk. Olds	67 69	U N.U.	No No	V-2 failed to stop for stop sign.
230	46 By-pass at N. Dunn	6/27/69	1835	Clear	Day	Single	P.D.	45	V-1	E	N/A	N/A	45	40	50	18	M	1	Pont	69	N.U.	No	V-1 passing; Veh. in front turned left.
231	404.1	6/30/69	1400	Clear	Day	Side	P.I.	50	V-1 V-2	E W	40 44	9.7 5.5	30 50	25 45	35 55	54 28	M M	1 1	IntTk IntTk	68 63	N.U. U.U.	No No	V-2 braked to avoid another veh; brakes pulled him into V-1.
233	603.5	7/1/69	1720	Clear	Day	Head-on	P.I.	45	V-1 V-2	E W	44 32	5.1 11.5	30 10	25 5	35 15	23 22	M F	1 2	Triump Buick	68 67	N.I. U.U.	No No	V-2 failed to yield right-of-way to V-1
234	S. Rogers 3/10 mi. S. of Gordon P. La.	7/4/69	0332	Clear	Nite	Rear End	P.D.	30	V-1 V-2	N N	N/A	N/A	60 25	55 20	65 30	20 21	M M	2 3	Chev Chev	68 64	N.U. N.U.	No No	V-1 speeding & improper overtaking.
235	207.1	7/6/69	1345	Rain	Day	Single	P.I.	55	V-1	S	48	7.8	40	35	45	42	F	1	Merc	63	N.U.	Unk	V-1 hit puddle of water & lost contl.
236	403.2	7/7/69	1000	Clear	Day	Single	P.D.	55	V-1	E	41	9.0	45	40	50	76	M	1	Stude	62	N.I.	No	Pulling trailer; no previous exp; braked hard; trailer j-knif
238	Rockport at Tapp Rd.	7/9/69	1645	Over cast	Day	Side	P.D.	40 30	V-1 V-2	E N	N/A	N/A	35 0†	30 0†	40 0†	28 19	M F	1 3	Ford Olds	65 53	N.U. N.I.	No No	V-2 didn't yield ROW to V-1.

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
239	Old 37 1/2 mi. N. of Bethel	7/10/69	0844	Rain	Day	Side	P.D.	40	V-1 V-2	S N	N/A	N/A	35 35	30 30	40 40	49 39	F M	3 1	Merc FordPU	58 68	N.I. U.U.	No No	V-2 lost control rounding curve & struck V-1 broadside
240	405.2	7/11/69	1813	Over cast	Day	Side Swipe	P.D.	55	V-1 V-2	W W	45 45	9.2 9.2	10 30	8 25	15 35	18 36	M F	2 1	Chev Olds	68 64	U.U. U.U.	No No	V-2 improper pass on rt; V-1 signaled lt - turned right.
241	Old 37 2/10 mi. N. of Bethel Lane	7/13/69	2205	Dry	Nite	Side	P.I.	35	V-1 V-2	S N	N/A	N/A	40 55	35 50	45 60	25 23	M M	1 1	Fiat Chev	67 69	U.U. U.U.	No No	V-2 crossed center line & struck V-1
242	407.2	7/14/69	1900	Clear	Day	Single	P.I.	50	V-1	E	46	6.1	50	45	55	22	F	3	VW	63	U.U.	No	Took eyes off rd. too long - left rd. and lost control.
243	501.6	7/19/69	1330	Clear	Day	Single	P.I.	45	V-1	E	37	4.6	35	30	40	18	M	1	Honda	69	N.I.	No	Forced off rd. by tk
244	103.2	7/19/60	1747	Clear	Day	Head-on	F	65	V-1 V-2	N S	54 57	6.8 4.9	70 55	65 55	75 60	18 40	M M	3 2	Olds FordPU	59 67	N.I. U/NU	No No	V-1 left of center in passing; struck V-2 head-on.
245	That Rd .5 mi Wofclew Crk.	7/20/69	1045	Rain	Day	Single	P.D.	35	V-1	E	N/A	N/A	35	30	40	19	F	1	Chev	69	N.U.	No	Tried to avoid a dog lost control.
246	3110' S. of Leonard Spgs	7/20/69	1330	Rain	Day	Rear End	P.D.	30	V-1 V-2	S S	N/A	N/A	25 20	20 15	30 25	28 30	M M	5 5	Buick Chev	61 64	N.I. U/NU	No No	V-2 slowed for water on rd; V-1 struck in rear.
247	Old 37 2/10 mi. N. of Whisnand	7/20/69	1911	Over cast & wet	Day	Side	P.D.	35	V-1 V-2	S N	N/A	N/A	35 35	30 30	40 40	UNKNOWN NO POLICE REPORT							V-2 driving left of center & struck V-1.
248	401.4	7/22/69	1731	Clear	Day	Rear End	P.I.	40	V-1 V-2	W W	45 45	10.1 10.1	0 40	0 35	0 40	21 60	F M	1 1	Olds Ford	62 69	N.U. N.U.	No No	V-1 stopped to make left turn;
250	503.5	7/26/69	1304	Clear	Day	Single	P.I.	45	V-1	W	38	4.7	45	40	50	21	M	2	Renault	65	U.U.	No	Wheel off rd; lost control & rolled over

TABLE 6.1. Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
251	Airport Rd. 50' W. of End Wright	7/27/69	0810	Rain	Day	Head-on	P.I.	40	V-1 V-2	E W	N/A	N/A	40 45	35 40	45 50	20 30	F M	1 1	Dodge Ford	63 61	U.U. U.U.	No No	Both Veh. left of center.
252	Union Valley Rd. 1000' N. of Maple Gr.	7/27/69	1355	Clear	Day	Head-on	P.I.	65	V-1 V-2	N S	N/A	N/A	30 5	25 5	35 10	22 7	M M	1 1	Ford Bicycle	58 -	N.I. -	No No	V-1 crested hill; V-2 left of center.
253	SR 46 By-pass at Dunn	7/25/69	1415	Clear	Day	Side	P.I.	30 45	V-1 V-2	N W	N/A	N/A	0† 45	0† 40	0† 45	14 21	M F	1 1	Soapbox Derby Car Ramb	- 59	N.A. N.I.	No No	V-1 disregarded stop & hit V-2.
254	2614 Leonard Springs	7/29/69	2200	Clear	Nite	Single	P.I.	20	V-1	S	N/A	N/A	35	30	40	33	M	1	FordTk	64	N.I.	No	Forced off rd. by on-coming vehicle.
255	501.3	7/31/69	2340	Clear	Nite	Single	P.I.	35	V-1	W	36	6.8	60	55	65	17	M	1	Chev	55	N.I.	No	Forced off rd. by on-coming vehicle - lost control.
257	102.1	7/4/69	0215	Clear	Nite	Single	P.I.	55	V-1	S	57	5.6	45	40	50	18	M	2	Volvo	69	U.U.	Yes	Drunk - lost control
258	210.2	7/7/69	2345	Clear	Nite	Rear End	P.D.	55	V-1 V-2	S S	47 47	5.2 5.2	0 5	0 3	0 7	27 67	M M	1 1	Merc Ford	69 61	U.U. U.U.	No Yes	V-1 stopped behind V-2; V-2 backed into V-1.
259	SR 46 By-pass at Dunn St.	7/11/69	2220	Clear	Nite	Side	P.D.	45 30	V-1 V-2 V-3	W N S	N/A	N/A	35 0† 0	30 0† 0	40 0† 0	20 16 44	M M M	1 1 1	Chev Ramb VW Bus	66 66 65	U.U. U.U. U.U.	No No No	V-2 failed to yield ROW; hit by V-1 & forced into V-3.
260	602.4	7/16/69	1145	Clear	Day	Rear End	P.D.	30	V-1 V-2	W W	39 39	6.3 6.3	20 20	15 15	25 25	51 19	M M	1 1	FordTk Chev	67 60	U.U. U.U.	No No	V-2 following too close; hit V1 in rear rear.

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
261	604.1	7/16/69	1645	Clear	Day	Side	P.D.	45	V-1 V-2	E W	43 44	10.6 7.9	5 0	3 0	7 0	46 N/A	M N/A	1 0	IntTk Pont.	68 67	U.U. -	No -	V-1(Trac./Trail) turned too sharply.
262	103.2	8/1/69	1630	Clear	Day	Side	P.I.	65	V-1 V-2	S S	51 51	6.4 6.4	60 05	55 03	65 07	59 25	F M	Unk Unk	Buick Dodge	63 64	U.U. U.U.	No No	V-2 turned left in front of V-1.
263	203.9	8/2/69	0015	Glear	Nite	Side	P.I.	45	V-1 V-2	N S	39 41	7.4 8.0	08 40	05 35	11 45	24 19	M M	Unk Unk	Ford VW	66 69	U.U. U.U.	No No	V-1 making left turn; turned in front of V-2.
264	211.5	8/7/69	0750	Light Rain	Day	Single	P.I.	55	V-1	S	53	7.0	55	50	60	21	M	Unk	IHC	66	U.U.	No	Lost control on curve.
265	205.1	8/12/69	0120	Clear	Nite	Single	F	55	V-1	S	47	6.0	75	65	80	23	M	1	Chev	68	N.U.	Yes	Lost control; hit tree.
267	203.5	8/7/69	1115	Clear	Day	Rear End	P.D.	45	V-1 V-2	S S	39 38	6.5 5.5	10 0	8 0	12 0	57 22	M F	Unk Unk	Chev Olds	62 62	U.U. U.U.	No No	V-2 slowed for 2 veh. turning in ft. of him; V1 unable to stop.
268	103.7	8/9/69	1445	Clear	Day	Rear End	P.I.	65	V-1 V-2 V-3 V-4	N N N N	51 51 51 51	5.4 5.4 5.4 5.4	26 45 45 45	Unk 40 40 40	Unk 50 50 50	35 35 42 44	M M F M	Unk Unk Unk Unk	Dodge Chev Dodge Ford	69 68 65 69	U.U. U.U. U.U. U.U.	No No No No	V-1 was making lt. turn; Other veh. were unable to stop.
269	203.9	8/19/69	2020	Clear	Nite	Side	P.D.	45	V-1 V-2	N W	38 38	5.6 5.6	25 0†	20 0†	30 0†	22 43	M F	Unk Unk	Buick Ford	66 65	U.U. U.U.	No No	V-2 failed to yield ROW at intersection.
270	204.9	8/22/69	2230	Clear	Nite	Rear End	P.D.	55	V-1 V-2	S S	47 47	6.1 6.1	45 0	40 0	50 0	32 28	M F	Unk Unk	Ford Chev.	67 61	U.U. U.U.	No No	V-2 stopped to make left turn; V1 crested hill & was unable to stop.
271	302.1	6/11/69	1300	Clear	Day	Side	P.I.	45	V-1 V-2	E E	47 47	6.4 6.4	35 5	35 5	40 5	19 54	M F	1 1	VW Chev	66 62	N.U. N.U.	No No	V-2 stopped to make lt. turn; V1 about 5 cars back attempted to pass on left.

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
272	S. Rogers at That Rd.	6/11/69	1550	Clear	Day	Side	P.D.	30	V-1	S	N/A	N/A	70	60	75	16	M	Unk	Ply	64	U.U.	No	V-2 pulled out of That Rd. in prep. for turn onto Rogers, V-1 unable to stop.
									V-2	E			00	00	03	68	M	1	Ford	62	U.U.	No	
273	205.8	8/27/69	2213	Clear	Nite	Side	P.D.	55	V-1	N	53	5.2	40	35	45	45	M	Unk	ChevTk	60	U.U.	No	V-1 lost wheel; Wheel then hit V-2.
									V-2	S	49	4.8	50	48	52	24	M	Unk	Ford	67	U.U.	No	
274	107.3	8/27/69	1445	Clear	Day	Side	P.D.	65	V-1	W	56	6.8	0†	0†	0†	26	M	Unk	Chev	60	U.U.	No	V-1 pulled out in front of V-2.
									V-2	S	56	6.8	45	35	50	18	M	Unk	Ford	69	U.U.	No	
275	103.2	8/27/69	1015	Clear	Day	Rear End	P.D.	65	V-1	N	56	8.3	0	0	0	61	F	2	Cad.	68	N.U.	No	V-1 stopping for flagman.
									V-2	N	56	8.3	59	Unk	Unk	69	F	2	Volvo	68	U.U.	No	
276	103.2	8/28/69	1840	Clear	Day	Side	P.I.	65	V-1	S	57	5.6	30	20	50	76	M	Unk	Chev	66	U.U.	No	V-1 turning; V-2 attempted to pass.
									V-2	S	57	5.6	50	40	60	29	M	Unk	Olds	68	U.U.	No	
277	203.2	8/30/69	0234	Fog	Nite	Rear End	P.I.	45	V-1	P	43	6.0	0	0	0	No Driver			Semi	60	N/A	N/A	V-1 parked; V-2 hit by V3; V2 then hit V1; V4 unable to stop hit V-3.
									V-2	S	43	6.0	20	15	30	38	M	1	FordTk	Unk	U.U.	No	
									V-3	S	43	6.0	70	60	75	22	M	1	Chev	69	U.U.	No	
									V-4	S	43	6.0	48	43	53	29	M	Unk	IntTk	68	U.U.	No	
279	106.1	9/2/69	1920	Rain	Nite	Side	P.D.	65	V-1	N	56	8.2	55	50	60	26	M	Unk	Chev	65	U.U.	No	PU in front of V-2 stopping to turn; V-2 unable to stop - lost control.
									V-2	S	61	6.2	50	45	55	65	M	Unk	Olds	68	U.U.	No	
280	103.8	9/10/69	1735	Clear	Day	Head-on	P.D.	65	V-1	N	56	7.2	60	55	65	24	F	Unk	Pont	62	U.U.	No	V-1 unable to stop in time to avoid veh stopped in ft; entered on-coming lane & was struck head-on by V-2.
									V-2	S	54	7.8	53	50	55	38	M	Unk	IntTk	63	U.U.	No	
281	204.1	8/30/69	1905	Clear	Day	Head-on	P.I.	55	V-1	S	44	5.1	46	40	55	39	M	Unk	Ford Van	69	U.U.	No	V-1 lost control on curve; crossed center & struck V-2.
									V-2	N	46	5.4	40	40	55	25	M	Unk	Chev	67	U.U.	No	

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
282	201.9	9/14/69	1248	Clear	Day	Side	P.D.	45	V-1 V-2	S E	42 42	5.0 5.0	40 0†	38 0†	42 0†	30 35	M M	Unk Unk	Chev Ply	64 62	U.U. U.U.	No No	V-2 entered the intersection in ft. of V-1; V-1 had ROW.
284	206.6	9/17/69	0300	Rain	Nite	Single	P.I.	45	V-1	S	48	6.2	70	60	80	22	M	Unk	Chev	69	U.U.	Unk	Lost control; Veh left road.
287	206.8	9/19/69	1605	Clear	Day	Rear End	P.D.	55	V-1 V-2	S S	48 48	10.4 10.4	0 45	0 35	0 55	19 49	F F	Unk Unk	Ply Chev	63 63	U.U. U.U.	No No	V-1 stopped for schoolbus; V-2 did not see V-1 in time to stop.
288	203.7	9/24/69	1910	Clear	Day	Rear End	P.D.	45	V-1 V-2	N N	40 40	4.9 4.9	7 50	5 35	10 65	26 21	M M	Unk Unk	Volvo Ply	58 69	N.I. U.U.	No No	V-1 slowed to turn left; V-2 unable to stop.
290	202.1	9/27/69	0026	Clear	Nite	Side	P.I.	45 35	V-1 V-2	S E	44 44	5.2 5.2	41 0†	39 0†	42 0†	22 23	M M	Unk Unk	Dodge Dodge	68 67	U.U. U.U.	No No	V-2 failed to stop at intersection & struck V-1.
291	204.4	10/4/69	0207	Clear	Nite	Single	P.D.	55	V-1	N	48	5.0	55	55	55	21	M	Unk	Merc	64	U.U.	No	D-1 fell asleep & ran off highway.
296	108.1	10/12/69	1015	Dry	Day	Rear End	P.D.	65	V-1 V-2 V-3	N N N	60 60 60	5.6 5.6 5.6	0 0 65	0 0 59	0 0 71	31 45 18	M M M	Unk Unk Unk	Pont Ford Ford	67 68 65	U.U. U.U. U.U.	No No NO	V-1&2 stopped for a turning Veh; V3 did not notice V-1&2 in time to stop.
297	104.5	10/14/69	1543	Clear	Day	Side	F	65	V-1 V-2	S S	60 60	7.2 7.2	75 40	65 36	82 44	53 58	M M	Unk 2	Pont VW	62 66	U.U. U.U.	No No	V-1 passing V-2; saw on-coming traf. (V-3) - pulls back into his lane & hit V-2.
303	106.7	10/12/69	2207	Rain	Nite	Single	P.D.	65	V-1	N	55	7.2	51	50	58	42	F	Unk	Ramb	69	U.U.	No	Deer ran in ft. of V-1 & was hit by V-1

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min	Max.	Age	Sex		Make	Year			
305	203.9	10/24/69	0717	Clear	Nite	Side	P.I.	45	V-1 V-2	W S	44 44	5.4 5.4	0+ 45	0+ 28	0+ 47	50 22	M M	Unk Unk	Buick Chev	66 67	U.U. U.U.	No No	V-1 pulled out in front of V-2 at an intersection.
307	106.1	10/25/69	0510	Dry	Nite	Single	P.I.	65	V-1	N	48	15.8	65	60	70	23	M	Unk	Ford	68	U.U.	Yes	V-1 left road & struck garage
308	103.8	10/25/69	0714	Dry	Nite	Side	P.D.	65	V-1 V-2	S N	56 55	6.6 6.7	72 68	70 65	74 68	Hit and Run - Old School Bus 20	 M	 Unk	 Olds	 69	 U.U.	 No	V-1 crossed center line & side-swiped V-2.
309	102.9	10/26/69	1845	Clear	Nite	Single	P.D.	65	V-1	N	54	6.1	57	40	60	55	F	Unk	Merc	65	Unk	No	Left front ball joint broken; D-1 lost control.
310	205.4	10/28/69	2230	Clear	Nite	Single	P.I.	55	V-1	S	48	7.2	45	45	65	16	M	Unk	VW	65	Unk	No	V-1 started to skid; D-1 lost control.
315	206.7	10/31/69	1730	Rain	Nite	Single	P.I.	55	V-1	S	47	7.6	45	40	50	23	M	Unk	Pont	65	Unk	No	D-1 stated that a truck forced him off road.
316	201.1	11/2/69	0247	Clear	Nite	Single	P.D.	45	V-1	N	38	5.4	65	60	70	22	M	Unk	Ford	65	Unk	Yes	D-1 lost control while passing other vehicle.
319	102.9	10/26/69	1845	Clear	Nite	Rear End	P.D.	65	V-1 V-2 V-3	N N N	58 58 58	6.9 6.9 6.9	10 58 60	Unk 40 40	Unk 63 65	20 36 46	M M F	Unk Unk Unk	Pont Olds Olds	62 67 68	Unk Unk Unk	No No No	V1 slowed for accident #309; V2 & 3 could not react in time to avoid rear-ending.
327	104.8	11/15/69	1325	Clear	Day	Single	P.I.	65	V-1	N	57	7.0	58	53	60	18	M	Unk	Dodge	59	Unk	No	V1 run off rd by oncoming vehicle.

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
329	107.1	11/18/69	0157	Rain	Nite	Single	P.I.	65	V-1	N	58	6.9	55	49	61	38	M	1	Merc	69	U	No	Deer ran in ft. of V-1.
331	202.4	11/19/69	1815	Wet	Day	Rear End	P.I.	45	V-1	S	33	6.8	0	0	0	20	M	Unk	Chev	69	U.U.	No	V1 stopped to make left turn; V2 unable to stop.
									V-2	S	33	6.8	35	30	40	17	F	Unk	Ford	63	U.U.	No	
332	104.8	11/8/69	1000	Fog	Day	Rear End	P.D.	65	V-1	S	57	6.4	0	0	0	53	M	Unk	Merc	69	U.U.	No	V-1&2 stopped; V3 unable to stop.
									V-2	S	57	6.4	0	0	0	21	F	Unk	Ford	69	U.U.	No	
									V-3	S	57	6.4	61	59	63	19	F	Unk	Merc	68	U.U.	No	
333	104.8	11/8/69	1005	Fog	Day	Single	P.D.	65	V-1	S	56	6.5	Unk	Unk	Unk	50	M	Unk	Ford	64	U.U.	No	Traffic stopped for accident 332; V-1 unable to stop & took evasive action to the right.
335	108.2	11/24/69	1710	Clear	Day	Rear End & Head-on	P.D.	65	V-1	N	55	8.2	N/A	N/A	N/A	53	M	Unk	Olds	66	Unk	No	V-1&2 stopped; V3 unable to stop; attempted to pass but struck V4 in the process.
									V-2	N	55	8.2	5	0	10	23	M	Unk	Chev	63	Unk	No	
									V-3	N	55	8.2	57	49	70	26	M	Unk	Dodge Tk.	66	Unk	No	
									V-4	S	57	8.7	50	45	55	35	M	Unk	IHC	69	Unk	No	
340	205.9	12/8/69	0818	Clear	Day	Single	P.D.	55	V-1	S	47	6.6	40	40	45	35	M	Unk	VW	58	Unk	No	D-1 fell asleep & lost control.
341	209.5	12/14/69	1535	Clear	Day	Head-on	P.I.	55	V-1	S	51	6.5	55	49	61	36	F	Unk	Ford	62	Unk	Unk	V-2 turned in front of V-1 & was hit by V-1.
									V-2	N	51	7.0	10	9	11	41	F	Unk	Buick	65	Unk	Unk	
342	103.6	12/18/69	1407	Mist	Day	Rear End	P.I.	65	V-1	N	53	7.5	5	0	10	55	M	Unk	Linc	68	Unk	No	V-1 slowed for turning veh. V2,3,&4 unable to avoid hit each other; V5 enroute opp. dir. hit V-3 as 3 crossed center of road.
									V-2	N	53	7.5	40	36	40	23	F	Unk	Ford	70	Unk	No	
									V-3	N	53	7.5	46	40	49	18	M	Unk	Chev	65	Unk	No	
									V-4	N	53	7.5	49	40	49	19	M	Unk	Ply	69	Unk	No	
									V-5	S	50	7.5	53	50	60	19	F	Unk	Buick	65	Unk	No	

TABLE 6.1. (Continued)

Accident Number	Location	Date	Time	Weather	Light Condition	Type	Damage	Speed Limit	Vehicle Identification	Direction	Traffic Characteristics		Speed of Accident-Involved Veh.			Driver		No. Occupants	Vehicle		Seat Belts	Alcohol	Contrib. Circum.
											Mean Speed	Std. Dev.	Est.	Min.	Max.	Age	Sex		Make	Year			
344	103.6	12/21/69	1650	Snow	Dusk	Head-on	P.D.	65	V-1	N	35	3.5	34	30	35	33	F	Unk	Ford	63	U.U.	No	D-1 lost control of his veh. due to snow; V-1 crossed over center line & struck V-2.
									V-2	S	39	5.7	34	30	40	52	M	Unk	Ford	65	U.U.	No	
346	102.1	12/21/69	2030	Snow	Nite	Side	P.D.	65	V-1	N	33	3.5	12	10	20	63	M	Unk	IntTk	67	Unk	No	V-2 lost control on snow & slid into highway truck.
									V-2	S	39	5.7	14	14	25	61	M	Unk	Buick	66	Unk	No	
348	108.9	12/21/69	1640	Snow	Day	Head-on	P.I.	65	V-1	S	33	6.1	30	27	33	58	M	Unk	Chev	67	Unk	No	V-1 crossed center line to avoid a veh stopped in his lane; V-1 hit by V2.
									V-2	N	40	4.7	30	27	33	36	M	Unk	Desoto	60	Unk	No	
351	105.9	12/23/69	1030	Snow	Day	Side	P.D.	65	V-1	S	40	4.7	38	30	40	30	M	Unk	Ford	63	Unk	No	D-1 lost control on snow; crossed center line; hit V2.
									V-2	N	33	6.1	21	20	25	26	M	Unk	Chev	62	Unk	No	
352	105.9	12/23/69	1106	Snow	Day	Single	P.D.	65	V-1	S	40	4.7	42	40	45	52	F	Unk	Ford	62	Unk	No	V-1 lost control due to snow.
355	206.7	12/30/69	1330	Clear	Day	Rear End	P.I.	55	V-1	N	48	6.5	10	5	15	33	F	Unk	Stude	65	U.U.	No	V-1 making right turn; V-2 (tractor/trailer) unable to slow in time.
									V-2	N	48	6.5	35	35	57	57	M	Unk	Dodge	68	U.U.	No	

N/A - Traffic characteristic not available or data not applicable due to secondary accident. (A secondary accident is defined as one in which the striking vehicle has just previously been involved in an accident.)

† - Vehicle was crossing the stream of traffic of interest, hence speed is assumed to be 0 mph.

* - Accident #47 not included in involvement rate calculation since traffic speed is zero given that a train is crossing the highway.

** - Accident #63 not included in involvement rate calculation since both vehicles were crossing the stream of traffic of interest.

NOTE: In the "Accident Number" Column, missing numbers refer to reported accidents which were assigned a number but for one of several reasons were voided at a later date.

TABLE 6.2. SPEED SURVEY DATA SUMMARY

	WEEKDAY																WEEKEND															
	DAY								NIGHT								DAY								NIGHT							
	DRY		WET		ICE		FOG		DRY		WET		ICE		FOG		DRY		WET		ICE		FOG		DRY		WET		ICE		FOG	
Station	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S
												MEAN SPEED																				
101	54								*	*	*	53																				
102	54	55	49						57	57	53	52	48	52			54	51					63	56	53	56						
103	55	54	44						56	55	55	51	44	48			54	55					54	55	54	58						
104	55	55	55	35		38			59	58	55	53	*	53			54	56					60	57	56	59						
105	55	55	58						54	54	53	53					55	55					57	55	56	59						
106	56	56	58	56					57	60	56	55	47	45			55	56					54	52		51						
107	54	56	49	52					57	56	51	56					55	60					58	53	55	59						
108	55	57	58	55					58	57	*	61						59							59	58						
109	57	56	54	56					60	57	*	54						56							60	59						
110	56	57	51	57					59	59	*	58						57					54	57	56	60						
												STANDARD DEVIATION																				
101	6.3								*	*	*	7.2																				
102	6.6	6.2	6.7						6.8	7.3	6.0	6.8	4.6	12.4			6.2	14.3					7.2	6.7	6.8	7.3						
103	6.6	6.6	8.7						8.3	6.8	7.8	6.6	5.3	7.8			6.5	6.0					7.0	5.1	6.8	4.0						
104	6.4	7.0	7.5	4.5		5.7			8.2	7.6	7.9	6.8	*	8.7			6.4	5.7					12.2	6.2	7.4	7.0						
105	8.3	6.6	9.6						10.8	7.9	7.4	8.5					7.4	6.2					5.6	6.5	5.3	5.8						
106	7.8	6.6	5.3	4.2					8.6	8.1	8.5	7.5	6.7	5.4			10.8	7.9					9.0	6.0		5.4						
107	7.6	7.1	7.8	7.4					7.6	7.7	9.2	6.6					7.9	5.4					5.6	6.9	7.2	7.8						
108	7.2	7.6	6.9	8.1					8.1	7.6	*	6.8						6.1							3.7	7.5						
109	7.2	6.7	7.6	5.8					7.7	8.3	*	7.3						5.9							7.0	7.6						
110	8.1	6.6	7.0	6.3					7.6	7.2	*	9.1						6.8					5.5	5.6	5.9	8.8						
												SAMPLE SIZE																				
101	57								5	2	1	13																				
102	1212	823	66						162	152	87	118	21	17			427	477					43	75	161	93						
103	1521	1010	622						201	308	59	64	22	18			632	167					87	102	183	36						
104	952	1370	69	84		44			235	308	62	120	5	16			357	382					31	42	122	38						
105	1110	992	57						299	389	63	79					436	132					51	68	22	26						
106	774	959	113	31					208	211	47	71	17	21			475	203					67	54		65						
107	1076	1058	165	115					247	437	24	38					286	208					12	27	104	44						
108	1106	951	68	62					258	420	6	15						162							15	34						
109	856	644	95	145					262	266	9	18						195							45	40						
110	692	867	132	178					231	265	8	17						223					67	69	122	101						

TABLE 6.2. Continued

	WEEKDAY														WEEKEND										
	DAY							NIGHT							DAY						NIGHT				
	DRY		WET		ICE		FOG	DRY		WET		ICE	FOG		DRY		WET		ICE	FOG	DRY		WET	ICE	FOG
	N	S	N	S	N	S	N S	N	S	N	S	N S	N	S	N	S	N	S	N S	N S	N	S	N S	N S	N S
												MEAN SPEED													
201		28	38	42	40	39		40	42						41	43		36							
202	43	43	42	39	41	42		44	44	41	40				44	42	45	44			42	42			
203	40	40			40	40		41	43	*	41				40	44					40	43			
204	46	46	43	41	46	42		48	47	47	43				47	46	43	44			46	46			
205	51	47	48	41	48	46		52	50						53	50	44				48	50			
206	49	49			47	47		49	49						52	52		44							
207	48	51	51	49				52	52	*	*				50	53	50	50			51	51			
208	51	49						48	51				50	51	51	50	47	48			47	47			
209	49	51						47	52						50	52	50	52			50	50			
210	49	48						49	49	*	*				49	48	51	48			46	44			
211	53	51						53	53	*	50		*	*	54	51	53	46			54	53			
												STANDARD DEVIATION													
201		6.6	6.0	4.3	3.7	4.1		6:5	5.6						4.6	3.8		4.3							
202	5.1	5.7	5.1	5.4	4.4	4.0		6.1	7.4	4.9	5.2				4.7	4.6	3.7	4.1			6.8	7.3			
203	7.2	7.6			5.7	5.1		10.5	5.9	*	7.4				7.4	6.7					5.6	5.3			
204	6.4	6.0	5.6	5.3	4.3	5.0		6.5	7.5	8.4	7.1				5.2	5.8	4.4	3.5			4.7	6.2			
205	5.6	6.7	5.5	5.7	5.1	4.9		7.9	7.5						5.6	4.8	6.2				5.8	6.3			
206	6.5	7.4			5.9	5.2		7.5	7.1						6.7	6.7		5.6							
207	7.1	7.9	7.5	7.0				7.1	7.5	*	*				6.0	6.5	5.0	4.6			5.4	7.2			
208	6.8	7.0						8.2	8.9				10.7	8.4	5.9	8.3	4.1	5.2			7.2	11.5			
209	6.6	5.5						10.4	5.8						6.7	6.2	5.6	4.9			4.8	5.3			
210	6.0	6.2						10.0	8.1	*	*				6.7	8.0	4.2	3.7			8.7	9.2			
211	6.4	5.6						7.6	9.7	*	5.5		*	*	6.0	7.2	5.4	5.0			8.0	6.9			
												SAMPLE SIZE													
201		110	67	71	80	80		67	135						191	156		174							
202	829	876	59	89	73	68		233	295	34	112				247	220	47	51			66	47			
203	919	855			125	98		233	276	6	19				1313	403					113	65			
204	527	606	78	59	42	65		240	331	22	18				238	165	54	39			47	44			
205	532	523	24	28	48	53		168	289						110	741	54				34	40			
206	534	558			50	40		204	255						171	176		60							
207	891	579	16	15				143	205	4	3				239	237	51	38			66	80			
208	507	619						90	165				10	18	268	296	51	41			101	55			
209	412	563						90	100						300	328	98	80			110	90			
210	387	537						78	78	1	5				275	235	42	42			130	105			
211	306	611						53	43	4	20		2	1	221	176	42	27			128	117			

TABLE 6.2. Continued

	WEEKDAY																WEEKEND															
	DAY								NIGHT								DAY								NIGHT							
	DRY		WET		ICE		FOG		DRY		WET		ICE		FOG		DRY		WET		ICE		FOG		DRY		WET		ICE		FOG	
	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W
MEAN SPEED																																
301	37	36	37	34					38	36	39	35					37	37	37	35					40	42						
302	39	40	38	38		40			40	41	40	40					41	42	37	41			38	38	43	44	36	40				
303	46	45	43	44					47	47	47	*					45	43	*	45					49	48	42	41				
304	47	46	45	43					47	47	*	*					46	46	44	45	*	*			46	44	44	42				
305	50	49	49	48					53	52	*	*					49	43	47	46	*	*			49	48	43	43				
306	49	50	43	41					49	51	*	*					49	47	45	47	39	43			51	52	42	41				
307	54	54	49	49					55	55	*						55	56	50	49	50	*			55	53	44	41				
STANDARD DEVIATION																																
301	5.0	4.8	6.0	6.4					5.5	5.3	5.9	5.8					5.7	4.6	4.8	3.6					6.0	7.2						
302	8.2	6.3	5.9	7.0		6.6			5.6	6.0	5.5	5.9					7.7	6.0	4.7	5.1			4.2	4.0	7.7	7.0	5.1	5.8				
303	6.8	6.7	5.5	6.7					6.9	6.6	4.9	*					4.8	5.9	*	6.4					8.4	7.1	7.2	4.2				
304	6.1	5.9	6.3	5.7					6.9	5.8	*	*					5.8	6.1	5.3	6.5	*	*			6.1	5.7	6.6	5.4				
305	7.0	7.2	8.1	7.6					8.4	7.9	*	*					3.5	6.6	6.3	5.7	*	*			6.8	7.1	4.1	6.9				
306	6.2	7.2	4.6	7.6					6.7	6.2	*	*					4.4	6.6	6.0	7.4	4.1	3.2			6.9	5.4	4.8	5.6				
307	6.5	7.3	6.2	5.4					7.6	7.0	*						6.8	7.2	7.5	6.6	6.9	*			7.5	7.6	5.0	8.1				
SAMPLE SIZE																																
301	1184	982	331	436					651	368	114	114					173	329	40	298					92	76						
302	468	457	549	371		45			358	207	86	87					142	553	98	61			42	56	89	99	55	24				
303	396	372	264	201					132	106	15	5					627	665	6	16					32	39	72	44				
304	203	238	203	206					108	110	1	2					736	106	23	49	6	2			62	78	21	17				
305	479	467	53	66					115	73	3	2					45	541	69	84	7	9			70	80	36	22				
306	434	413	21	40					76	50	1	2					63	76	76	61	18	12			61	69	15	22				
307	389	377	34	72					78	62	2						111	134	89	62	14	8			55	70	20	27				

TABLE 6.2. Continued

	WEEKDAY																WEEKEND															
	DAY								NIGHT								DAY								NIGHT							
	DRY		WET		ICE		FOG		DRY		WET		ICE		FOG		DRY		WET		ICE		FOG		DRY		WET		ICE		FOG	
	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W
MEAN SPEED																																
401	36	37	39	36					39	42	35	37					40	43							38	35						
402	43	45	43	46					47	48							45	48		45					50	45	44	44				
403	46	41	43	43					50	48							50	46							48	44	41	40				
404	45	44	45	46					49	48	41	43					46	48							46	49						
405	45	44	47	47					46	50	41	39					47	46							47	44						
406	34	39																														
407	51	53							54	48	44	44					52	50							47	47						
408	52	51	51	55					50	51	45	45			45	45	52	52							54	55						
409	54	54							51	54	49	47			44	38	54	53							54	50						
STANDARD DEVIATION																																
401	5.0	4.9	5.0	5.6					6.3	5.7	4.5	4.8					5.8	5.6							5.7	6.4						
402	5.3	4.9	7.1	4.5					6.3	6.5							6.0	7.9		4.8					8.8	6.0	6.0	5.5				
403	6.4	7.6	5.7	4.9					7.2	7.2							5.9	5.8							5.9	7.6	6.5	4.2				
404	6.1	6.3	4.2	5.5					8.1	6.1	8.4	6.6					6.0	6.1							7.5	6.2						
405	7.1	6.5	6.1	4.7					7.5	6.9	5.2	4.9					6.0	5.6							7.4	6.7						
406	4.9	4.6																														
407	6.2	7.5							7.7	8.8	5.1	7.2					6.6	7.5							7.8	8.0						
408	8.4	6.8	6.8	6.0					14.0	13.1	6.4	6.5			6.8	6.7	8.3	7.8							8.0	8.0						
409	8.0	6.6							8.7	9.4	7.0	8.5			13.8	9.7	7.9	7.6							7.9	9.2						
SAMPLE SIZE																																
401	726	888	58	218					124	138	143	120					229	172							55	82						
402	509	614	113	48					159	163							193	58		539					33	49	62	84				
403	720	633	226	279					119	163							206	157							24	29	83	79				
404	1118	687	98	118					84	128	138	121					779	210							31	79						
405	593	471	69	54					88	110	78	104					198	298							72	100						
406	36	70																														
407	486	526							56	69	54	54					190	163							47	78						
408	550	629	22	21					23	39	45	45			18	44	176	143							14	19						
409	290	249							44	52	28	28			38	43	245	277							48	53						

TABLE 6.2. Continued

	WEEKDAY													WEEKEND											
	DAY							NIGHT						DAY							NIGHT				
	DRY		WET		ICE		FOG	DRY		WET		ICE	FOG	DRY		WET		ICE		FOG	DRY		WET	ICE	FOG
	E	W	E	W	E	W	E W	E	W	E	W	E W	E W	E	W	E	W	E	W	E W	E	W	E W	E W	E W
MEAN SPEED																									
501	41	40	36	35				39	39	*	*			39	38	38	37	27	29		38	37			
502	40	41	37	38	32	33		41	41	38	36			42	42	40	40	33	32		48	47			
503	38	37	36	33	36	36		39	37	32	29			38	37						*	41			
504	35	35	29	29				35	37	*	*			33	34	31	27	23	23		33	33			
505	38	39	36	35	28	28		39	37	39	31			35	38	30	*	*	29		43	39			
506																									
507	30	30	29	28		*		30	33	30	30			31	29						*	*			
508	36	33	*	*	*	*		*	*	*	*			29	*						*	*			
509	*	36	*	*				*	*	*	*			30	35						*	*			
STANDARD DEVIATION																									
501	4.5	5.8	5.6	4.6				5.2	6.2	*	*			5.4	4.9	5.0	5.6	4.9	6.3		6.8	5.4			
502	5.0	6.5	7.2	6.3	5.9	6.3		6.6	6.2	5.9	3.5			6.7	7.2	5.6	7.5	4.3	4.5		10.4	6.1			
503	7.1	6.8	5.8	5.7	8.6	4.2		6.7	4.4	3.7	4.7			5.2	4.8						*	6.4			
504	5.4	4.3	5.8	5.4				5.9	7.0	*	*			5.2	5.0	3.6	3.3	4.4	4.4		6.0	4.6			
505	6.4	6.7	6.9	6.2	4.6	5.6		7.3	6.1	4.8	8.1			7.1	6.9	6.3	*	*	5.4		8.4	7.6			
506																									
507	6.7	6.7	3.8	4.7		*		7.0	5.1	5.2	4.1			6.1	7.6						*	*			
508	4.2	4.4	*	*	*	*		*	*	*	*			5.0	*						*	*			
509	*	9.5	*	*				*	*	*	*			6.7	5.3						*	*			
SAMPLE SIZE																									
501	256	169	130	141				207	117	8	2			161	209	61	59	10	29		21	13			
502	151	88	85	99	30	34		72	49	36	17			99	178	22	22	34	72		18	21			
503	119	91	87	90	16	15		86	70	20	15			93	119						9	12			
504	107	55	32	40				74	41	8	6			99	137	29	42	18	50		26	23			
505	126	98	12	14	14	15		68	55	20	11			113	124	13	3	6	16		12	15			
506																									
507	39	58	23	24		3		11	16	13	10			44	49						1	1			
508	17	14	1	3	4	4		8	2	2	3			13	9						2	2			
509	7	13	9	5				3	2	2	3			18	27						1	2			

TABLE 6.2. Continued

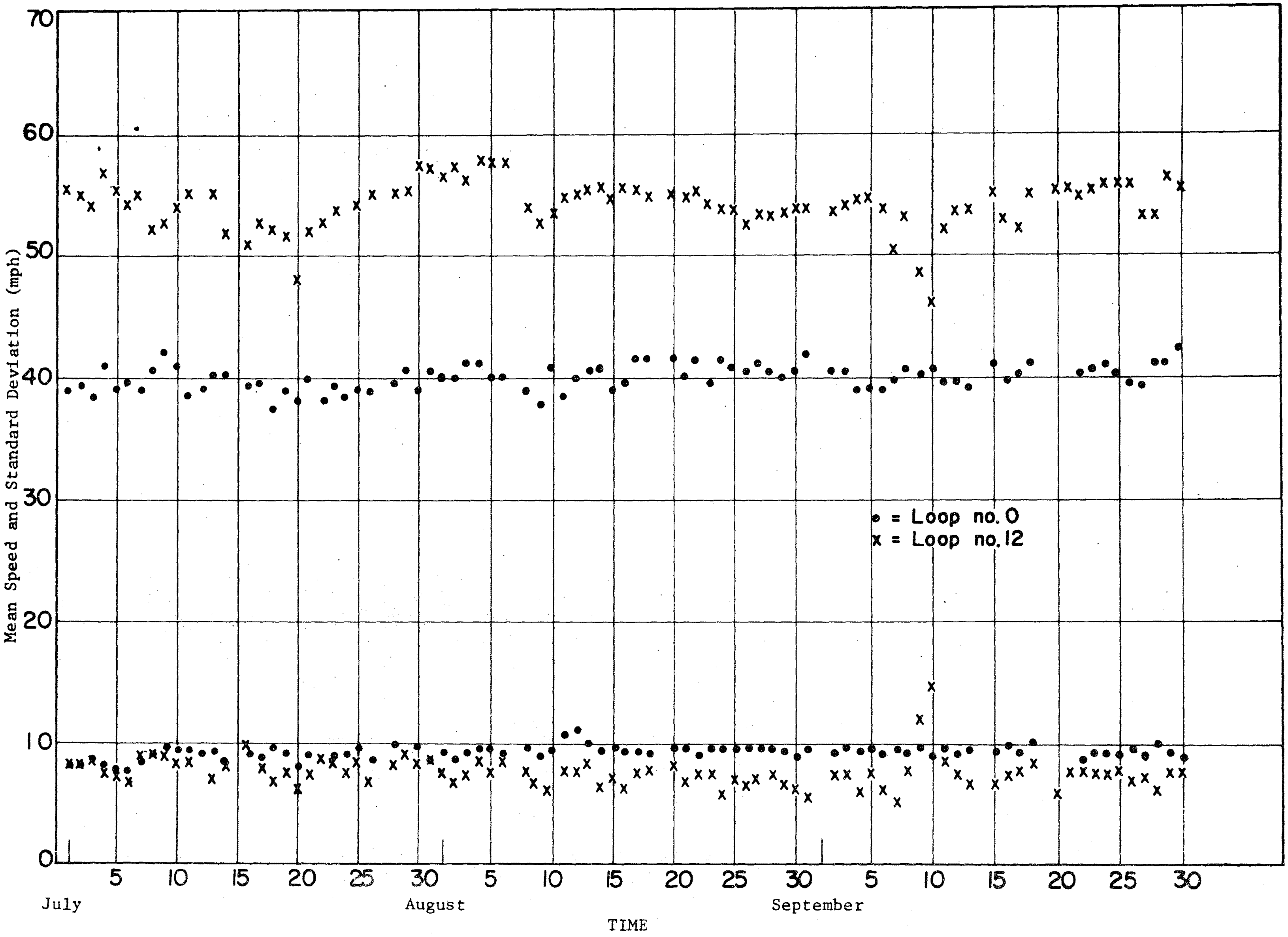
	WEEKDAY																WEEKEND															
	DAY								NIGHT								DAY								NIGHT							
	DRY		WET		ICE		FOG		DRY		WET		ICE		FOG		DRY		WET		ICE		FOG		DRY		WET		ICE		FOG	
	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W
MEAN SPEED																																
601	38	32																														
602	41	42	41	42	38	43	40	45	43	46	42	43					43	44							43	47						
603	41	43			30	33			45	44	44	40	*	*			45	46							46	46	*	*				
604	45	45	42	42					50	46	46	43					48	47							47	44	*	45				
605	48	47	44	44	48	44			51	50	47	45					48	47							53	50		51				
606	49	49	49	42					52	52	52	*					49	49							52	49	*	*				
607	50	50	51	48	46	46			54	54	51	50					54	54														
608	46	48	47	45	45	43	46	52	51	51	46	47					51	49							42	47						
609	50	47	48	47			41	44	56	52	48	51													54	50						
STANDARD DEVIATION																																
601	4.3	6.0																														
602	6.0	6.7	5.6	6.5	4.6	4.0	4.4	5.1	5.4	6.8	5.4	4.1					5.5	6.4							7.0	6.2						
603	8.0	6.7			5.9	6.3			8.5	6.6	6.0	5.9	*	*			7.1	6.4							7.8	6.6	*	*				
604	6.1	7.1	6.2	8.0					8.3	7.8	4.6	4.8					6.9	6.2							3.8	5.4	*	5.9				
605	6.8	5.7	7.2	7.7	5.9	4.6			7.9	7.2	8.6	4.6					6.5	6.4							9.0	6.7		12.9				
606	7.4	7.1	6.8	7.3					7.6	6.5	7.4	*					8.3	7.1							9.8	7.2	*	*				
607	6.8	7.2	6.3	5.9	4.8	3.9			7.5	7.5	6.8	6.2					6.0	5.4														
608	7.1	7.9	6.7	8.2	6.1	5.9	6.0	6.6	7.6	7.8	5.5	9.2					5.9	6.1							9.9	7.7						
609	7.8	8.3	6.0	7.7			10.1	6.4	8.9	7.6	6.3	6.5													7.7	10.1						
SAMPLE SIZE																																
601	109	75																														
602	619	885	169	270	50	30	37	20	100	153	97	184					127	55							47	64						
603	833	707			50	19			95	159	34	56	6	9			199	133							36	87	7	9				
604	663	527	53	168					91	206	26	80					168	148							14	17	5	11				
605	386	681	429	234	87	28			107	180	33	31					240	123							24	43		29				
606	545	525	98	160					95	133	10	3					211	110							25	58	2	5				
607	477	455	55	103	38	59			61	73	39	68					91	82														
608	432	447	35	71	29	39	18	13	57	83	39	66					52	56							32	46						
609	403	359	99	125			18	15	42	54	14	35													30	49						

TABLE 6.2. Continued

	WEEKDAY																WEEKEND															
	DAY								NIGHT								DAY								NIGHT							
	DRY		WET		ICE		FOG		DRY		WET		ICE		FOG		DRY		WET		ICE		FOG		DRY		WET		ICE		FOG	
	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W
MEAN SPEED																																
701	40	37	36	35					41	38	*	*					40	38		33			39	37	42	39						
702	39	40	37	40					41	41	38	39					38	40	34	37			36	38	43	41						
703	42	42	41	42					40	42	38	37					42	43	37	37			47	40	42	40	*	40				
704	39	43	41	43					43	47	*	*					42	42					*		41	42	46	*				
705	40	42	41	40					41	46	*	45					40	41	42	51			36	44	42	46		*			*	*
706	50	48	49	46					47	48	*	*					48	46	49	*				*	52	50	*	48				
707	45	46	32	*					47	46	33	31					40	42					*	*			*	*			*	*
STANDARD DEVIATION																																
701	4.9	5.6	4.5	5.6					5.7	5.8	*	*					4.8	5.1		5.5			4.8	4.7	7.7	5.5						
702	5.6	5.4	4.5	5.1					6.1	6.1	8.7	4.2					5.5	5.2	6.5	5.0			5.6	5.8	5.8	5.3						
703	7.6	6.8	4.9	3.7					9.8	11.3	5.3	6.0					8.4	7.1	6.8	7.9			7.6	8.0	12.1	9.9	*	5.6				
704	6.9	6.8	7.5	6.5					8.0	6.8	*	*					5.9	6.3					*		7.4	7.4	6.9	*				
705	11.2	8.8	8.6	6.8					10.7	8.3	*	8.0					8.3	7.6	9.1	6.2			8.4	8.2	9.0	8.8		*			*	*
706	8.2	7.0	7.2	8.1					7.8	7.1	*	*					6.3	6.3	3.7	*				*	7.4	9.0	*	5.8				
707	8.0	7.9	5.0	*					7.2	6.2	8.1	12.1					5.6	7.3					*	*			*	*			*	*
SAMPLE SIZE																																
701	1610	1549	58	165					242	433	6	5					160	184		14			120	85	38	52						
702	805	1100	518	332					312	399	47	49					317	286	101	64			65	46	16	34						
703	607	525	50	34					77	119	16	18					247	271	25	25			19	17	32	34	7	18				
704	517	541	137	72					61	94	3	4					138	171					6		30	40	12	5				
705	359	389	48	11					64	134	5	12					118	114	24	12			30	15	11	21		4			5	4
706	245	290	36	11					73	127	2	7					99	89	12	8				1	10	17	4	24				
707	155	238	22	4					60	74	11	15					196	97					1	2			2	2			1	1

* Samples sizes are 9 or less.

Figure 6.2 Daytime (0600-1900) Mean Speed and Standard Deviation Versus Time



7. REFERENCES

[1] Solomon, David, (1964) "Accidents on Main Rural Highways Related to Speed, Driver, and Vehicle," Bureau of Public Roads, July, 44pp.

[2] Heimbach, C. L., (1968) "Developing Traffic Indices for the Detection of High Accident Potential Highways in North Carolina," Project ERD-110-67-6 - Part 1, January, 95pp.

[3] White, S. B., Jr. and Nelson, A. C., Jr., (1970) "Some Effects of Measurement Errors in Estimating Involvement Rate as a Function of Deviation from Mean Traffic Speed," Accepted for publication in June issue of Journal of Safety Research.

[4] Gazis, D. C. and Foote, R. S., (1969) "Calibration and Correction of Magnetic Loop Detectors," IBM Research, RC 2520 (#12140), Computer Applications, June 25, 1969, 9pp.

[5] Daniel, C., et al, (1969) "Fitting Equations to Industrial Data with the Aid of a Computer," Unpublished book.

[6] LaMotte, L. R. and Hocking, R. R., (1970) "Computational Efficiency in the Selection of Regression Variables," Technometrics, Vol. 12, No. 1, February, 1970, pp. 83-93.

[7] Mallows, C. L., (1966) "Choosing a Subset Regression," Presented at the Joint Statistical Meeting, Los Angeles, California.

[8] RTI and IRPS Staff Members, (1969) "Speed and Accidents - Phase I," Interim Report prepared for the National Highway Safety Bureau under Contract Number FH-11-6965, July 11, 1969, 138pp.

Appendix A

RADAR SPEED SAMPLING

A. RADAR DATA COLLECTION

This section deals with the problem areas and the general conduction of the radar collection effort as performed by the Institute for Research in Public Safety under conditions of the present study. The radar collection was undertaken to supply quantitative speed data which might be used in constructing a "Traffic Flow Profile". This profile is a data-set of the characteristics of speed, volume, types of vehicles, and groupings of vehicles for a given segment of highway during a specified time interval under specified weather conditions. Additionally, radar operations were utilized to supply post-accident information with regard to speed and density for a given time and date in order to facilitate the reconstruction of the conditions which existed at the time of the accident.

A.1 Traffic Flow Profile

This section discusses the process of development of the profile; it covers description, procedures, problem areas, and evaluation of effectiveness of the radar collection process itself.

Sample Size and Location

It was believed that a minimum of 400 accidents would be required for confident statistical predictions. An analysis of the accidents of Monroe County for 1966 and 1967 showed that it would be desirable to use all accidents on state highways within the county, plus those accidents which occurred on county highways on which vehicles would normally travel 40 mph or faster. The 40 mph determination is based upon the original RFP stipulation that the study should be pertinent to typical federal and state highways.

The state highways were arbitrarily divided into one-mile segments. Segments of this size were chosen initially because there was no way of knowing whether the profile of any one-mile segment would be sufficiently like that of the adjoining segment. The use of larger segments could not be made with confidence until readings of smaller segments had been made. It was also estimated that a fifteen minute reading would be sufficient to establish the characteristics for any given hour (25 percent sample size).

A.2 Post-Accident Radar

This section directs itself to the process of development of the post-accident radar collection system.

Objectives

While the purpose of the Traffic Flow Profile was to establish a data base by which the speed estimates of the accident-involved vehicles might be compared, the purpose of the Post-Accident Radar operation was to refine this established base.

Not all the roadways under study were subjected to the profile activity; therefore, for those roads which were not under study, the post-accident activity formed the only normal-flow data available. Actual accident conditions were duplicated as much as was possible in the follow-up surveys. Platooning characteristics were also noted, so that a complete re-representation might be obtained.

Description

The purpose of post-accident radar collection was to reproduce, or simulate as closely as possible, the conditions surrounding the time of the accident. Post-accident radar data was collected for conditions as similar as possible to those existing at the time of the accident.

Since statistical significance is dependent on adequate samples, a minimum of 200 vehicles were recorded, with at least 50 vehicles traveling in the same direction(s) as the accident-involved vehicles. At least two visits to each accident site were required, to average out any unusual conditions influencing traffic on the collection day. Volume was read in both directions whenever possible.

When the accidents occurred during a low-volume time, adjustments in the collection methodology became necessary. The times for site visitation were adjusted to move towards higher volume-times, so that the 200 vehicles versus 2 hours criteria could be met. All other parameters were kept constant, particularly, the day-night dichotomy. When the environmental conditions were difficult to duplicate (rain, ice or snow), the day of week was varied as necessary to match the accident's weather condition.

Vehicles were recorded as to type, direction of travel and speed, with a distinction being made between vehicles in a platoon and those traveling in a free flow condition.

Appendix B

ACCIDENT INVESTIGATION PROCEDURES

PHASE I AND PHASE II

B. ACCIDENT INVESTIGATION

B.1 Objectives and Format

Two different methodologies characterized the accident investigation activity. During Phase I, the accident investigation was conducted to estimate the speed(s) of accident-involved vehicle(s) in all accidents occurring in the state highways within Monroe County, as well as those occurring on county highways on which the normal rate of speed was 40 mph or greater. Factors from which the speed of the accident-involved vehicles could be determined were gathered by trained investigators who went to the scene as soon as possible after the accident had occurred.

In Phase II, follow-up investigations were made only of those accidents occurring on State Route 37. I.U. Institute personnel addressed their inquiries to the investigation officer and made use of his report and the data which were supplied by the computer-sensor system.

B.2 Accident Investigation: Phase I

The Phase I activity covered the period December 7, 1968, through July 31, 1969, and resulted in 250 accident reports. Following is a description of the activity in detail.

Procedures

The equipment used by the investigators was designed to assure their safety, as well as to expedite the gathering of the required data.

The investigators each had prior traffic accident investigation experience. Their experience was supplemented by training given by members of the Department of Forensic Studies (formerly the Department of Police Administration), Indiana University, covering such areas as the recognition, collection and preservation of physical evidence, scale drawing, the use of the traffic template, and skid mark measurements.

The definition of accidents to be investigated was based on Baker's "Traffic Accident Investigation Manual for Police" (page 10, paragraph 11.130, Motor-Vehicle-Accident). This defines a motor vehicle accident as any event that results in unintended injury or property damage attributable directly or indirectly to the motion of a motor vehicle or its load. For the purpose of the present study, the definition was expanded to include any situation in which a vehicle has deviated unintentionally from the normal traffic pattern.

To facilitate immediate notification of an accident, a prime investigator and a stand-by investigator were available 24 hours a day. In addition, third and fourth backup investigators were available when the volume of accidents was greater than that which could be handled by the first two. These situations generally occurred when ice and snow were present or when there was an extremely large volume of traffic.

Notification was accomplished by a special phone system that enabled the police agencies to call a single phone number at any time of the day or night. During the day, the phone was answered by the investigators in the office; during nights and weekends, it was answered by the Indiana University Safety Division. When the investigator was not on duty at the office, the I.U. Safety Division contacted him.

The investigators' cars were equipped with two-way radios which enabled them to be contacted directly through the Sheriff's Department. In addition, the investigators monitored the sheriff's radio on the fixed location receivers.

The investigation was conducted at the scene to permit the investigators to collect transitory or short term evidence, which included photographs of damaged vehicles, skid marks and other pertinent information as well as statements from involved parties and witnesses. Follow-up interviews were sometimes necessary when the information could not be obtained at the scene.

Two mechanical engineers were assigned to the investigators to assist in developing the accident data.

Reporting

The investigators engaged in two types of reporting. The first concerned their activities and the second concerned events. Activity reporting consisted of a daily report submitted by each investigator which outlined his activities during the previous 24-hour period.

Event reporting was accomplished by means of a series of forms developed for use by the investigators, both at the scene and for final data reporting. These forms are: (1) dispatch form, (2) letter of introduction, (3) field data collection guide, (4) interview guide, (5) accident summary, (6) conclusion sheet, and (7) data sheets.

The prime emphasis in the reporting process was to secure information on skid marks, vehicle damage and faults, road configuration, weather conditions, and the driver's condition. Subjective information was secured through statements from involved persons concerning his actions and the actions of other vehicles. A copy of one of the accident reports is included in this report as Appendix E.

Review

When the investigator had concluded the data gathering process and had prepared the report, it was submitted for review. The investigator was expected to draw conclusions regarding the elements contributing to the accident. The function of the review board was first to determine the consistency of the reports and secondly to independently examine the accident reports and supporting data, without reference to conclusions of investigators or other reviewers, and then form conclusions about the speed and contributing elements.

Engineering Analysis

As mentioned previously the engineers worked jointly with the accident investigators in the determinations of speeds of vehicles. To accomplish this, it was necessary to use formulas and concepts which had been developed in the field of traffic and vehicle engineering for reconstruction of the sequence of events and assignment of velocities within the sequence.

Approximately three months were utilized for the purpose of literature search, derivation of appropriate formulas, and documentation.

B.3 Accident Investigation: Phase II

Phase II transferred the investigation emphasis from the on-site scheme used in Phase I to a computer-sensor system follow-up approach. A late July meeting of Research Triangle Institute, National Highway Safety Bureau, and Institute for Research in Public Safety (IRPS) representatives reviewed the capability of the computer-sensor system to estimate the speeds of accident-involved vehicles. It was decided to reduce the accident investigation function to a follow-up approach and make use of the computer-sensor system to estimate speeds. With additional road sensors, and police officer accident investigation training, the accident study could continue without the expensive services of a project investigation team. Instead, IRPS personnel would address their inquiries to the investigation officer, his report, and use the data supplied by the computer-sensor system. This restricted the activity to within the boundaries defined by the sensor sites on State Road 37. This activity, which continued from August 1, 1969 through December 31, 1969, produced 48 accident reports. Following is a description of the activity in detail.

Preliminary Activity

As a preliminary to the full implementation of Phase II of the research effort, a five-session training seminar in accident investigation was held by I.U. Institute personnel for the deputy investigators of the Monroe County Sheriff's Department. Subjects of study included traffic and hazard control, scene preservation, photography, driver and witness interviewing, and speed estimation. Indiana State Police records personnel conducted a session on completing the accident report form. One two-hour session was devoted to skid tests and measurements, with each attendee receiving instructions in the use of the Northwestern Traffic Template.

The computer-sensor system was expanded from 8 to 14 sensor-sites in order that the data base for speed comparisons could be increased, along with the probability of accident-involved vehicle identification.

Accident Notification and/or Accident Selection

Before an accident became the subject of a Phase II report, several preliminary qualifications had to be satisfied. Institute personnel had daily contact with all three law enforcement agencies in the county. Each previous 24-hour radio-dispatch log was reviewed for traffic investigation communications, with the approximate locations being noted. All State Route 37 accidents were assigned an accident report number. These files were reported to project management and were held until some decision could be made concerning the accident's Phase II usability.

Each week, a research person of the IRPS visited the three agencies and obtained copies of all the accident reports which had been received since the last survey was made. A record of the resulting reports, as well as the reports themselves, was maintained by the Institute. This file was examined concerning the report numbers assigned from the daily contact.

Each report was examined as to whether the accident location fell within the confines of the computer-sensor system. If it did, a printout of vehicle speeds and lengths at all relevant computer-sensor system locations was obtained. At the same time, a statement of time, day of week, weather conditions and location was given to the field radar operator for post-accident radar scheduling for the accident site.

Computer-Sensor System Printout Analysis

When an accident report for a usable accident was received, the time of the accident was noted and checked for consistency with the time of notification and the time of arrival at accident scene. The times were then compared with the entries made in the dispatcher's logbook and with any statements which were available from witnesses.

The police report provided the precise location at which the accident occurred, and from this the loop pairs bracketing the accident site were identified. Data were obtained from the computer printout for these two pairs of sensors for a period of one-half hour prior to the accident to one-half hour after the accident. The computer printout of data for both loops was placed juxtaposition on a page to allow a more thorough examination of the data. This matching was generally accomplished by picking a distinctive occurrence; i.e., a large semi-truck or large headway passing the first loop, then aligning it with the same sequential event at the second loop.

Once this was done, the traffic was examined at the first and second loops to identify any changes in the traffic flow. Of particular interest were large time gaps or cessations of traffic at the second loop, while traffic at the first loop continued in a normal manner. This was sometimes evidenced by a gap in the flow followed by a large platoon which was not present in the traffic at the prior loop.

Depending upon the distance of the accident site from either the first or second sensor, a large reduction in vehicle speeds is often observed, indicating a traffic slowdown and/or eventual stoppage behind the accident at the first loop.

The reports of witnesses often are quite helpful in locating the accident-involved vehicle (AIV) within the traffic flow. The characteristics of the AIV as listed on the police report (make, year, type, estimated prior speed) were also of great value, especially if any of the vehicles were unusually small or large.

Any vehicle which was suspected to be an AIV was then marked at the first loop. Using the speed at this loop and assuming constant speed was maintained, the time of arrival at the second loop could then be predicted. The vehicle which thus was identified at the second loop was then checked, using the average of the speeds from first and second sensors to validate elapsed time between loops. The vehicle length and position within the traffic pattern (headways in front of and behind vehicle, length of adjacent vehicles) were examined for further correlation and verification.

All vehicles, including suspected AIV's, could be traced through the sensor system in this way. Normally, the AIV was seen to disappear from the system between the two loops. Once such a vehicle(s) was found, it was possible to project the time of arrival at the accident site by using the speed at the first loop and the distance from that loop to the accident site. Using this time and the average speed for the flow of the traffic in the opposing direction, an estimate could be made for the time of arrival at the first loop for any AIV(s) traveling in the opposite direction of the first vehicle(s) identified.

All vehicles crossing the first loop for the opposing direction within an interval around this estimated time were examined. The AIV from this opposing direction also failed to cross the second loop as expected. The suspected AIV in this direction was then verified using the police report, witness statements, and physical characteristics of the vehicle.

Once the AIV(s) had been identified by means of the sensor system data, speed estimates were made for these vehicles to show both speed prior to accident and speed at impact.

The estimate of speed prior to the accident was made using the following data and considerations: (1) depending upon the proximity of the accident site to the sensor location, the sensor data was considered, (2) the prior speeds as given by the police report, when available, were considered valid within ±10 percent, (3) witness statements were used to strengthen the estimate if they correlated with the other data, (4) the characteristics of the roadway - condition, type, grade, speed limit, etc., and (5) weather and general traffic conditions.

The impact speed was derived in basically the same manner, with a few additional considerations such as skid marks, rest position relative to impact, statements of witnesses, and vehicle characteristics. A sample Phase II accident report appears in Appendix E.

Fifteen-Minute Summary

For the Phase II accidents, the standard deviation and mean of the speeds and headways for the fifteen minutes preceeding the accident were retrieved from the raw data tape. The vehicle count and the eighty-fifth percentile (a common speed limit determination parameter) were also included.

Appendix C

COMPUTER-SENSOR SYSTEM

C. THE COMPUTER-SENSOR SYSTEM

One of the difficulties with the traffic measuring devices in common use is the influence the device exerts on the very thing it is measuring. Obtrusive methods such as radar and speed tapes tend to interject bias into the data because of their visibility to the driver.

As an integral portion of the present study, the Institute for Research in Public Safety undertook the development of an unobtrusive traffic measuring system in which loop detectors were connected via telephone lines to a process control computer.

Eight locations along State Route 37, North and South of the City of Bloomington, Indiana, were monitored 24 hours a day during Phase I of the study. This number was expanded to fourteen during Phase II.

The unobtrusive instrumentation at each site relayed two signals which were interpreted by the IBM 1800 computer to yield the vehicle's speed, length, location, lane of travel, direction, headway (the time differential between the preceeding vehicle and the vehicle being monitored), and time of transit.

One of the chief attributes of the computer-sensor system is its ability to collect, array, and store data without outside intervention. No human judgment (or error) became a factor in the data assimilated by the system. Other than the weekly calibration and a replacement of magnetic tape on a five day cycle, no personnel are involved in the system operation.

C.1 The Computer

The computer system developed for the present project has as its core an IBM 1800 system. An IBM traffic control system program was modified by project personnel to the special needs called for when measuring vehicle velocities data. The requirements of the project contemplated the use of the computer as a portion of an information system which would provide data for decision-making purposes.

The decision-making process contemplated in these projects was more analytical in nature; however, the system could also be adapted for tactical decision-making.

Hardware

During Phase I, the IBM 1800 system was composed of the following components:

(1) 1802 Central Processing Unit (16K, 4mics.)

(2) 2401 Magnetic Tape Unit

(3) 1442 Card Read Punch

(4) 1810 Disk Storage (250,000 words)

(5) 1826 Data Adaptor

(6) 1816 Printer Keyboard

(7) 1802 Process Controller.

Twelve interrupt levels are necessary for a minimal system. The system also has a 1053 character printer which is used for data retrieval, while the other printer (1816) maintains a printed record of system status. In order to receive the vehicle information from the highway, four digital input strips with sixteen points each are mounted in the computer interfacing.

System Software

The basic system software used in the system design is IBM's 1800 O.S. Time Sharing Executive (TSX), Version 3, Modification Level 7. Through a series of programmed interrupts, queued programs and non-process programs, as well as optimizing alterations in the systems director, the facility has been adapted to the specific requirements of traffic study. Non-process programs can be run during low traffic volume periods without disturbing data collection.

Program PILOP, an incore subroutine, scans the digital input points every 5 milliseconds to check the status of each vehicle detector. A shift in voltage caused by a vehicle passing over a magnetic loop detector will be recorded along with the time as indicated on a 30.000 second clock. This, and the return to normalcy which accompanies the passage of the vehicle, are recorded for two wire loops, as both are necessary to calculate the vehicle's velocity, length, direction, headway and time of passage. PILOP senses these times, and stores them in the appropriate buffer in INSKEL COMMON.

Program IR001, an interrupt core load, checks the INSKEL COMMON buffers for each loop set and dumps any full buffers to the appropriate disk files. Two 25 vehicle buffers are allotted for each loop set, so that one may be storing data while the other is being written to disk. If IR001 senses that a disk file is full, it queues up PC002.

Program PC002, a queued program, checks the disk files and dumps the full files to magnetic tape. The disk files are then reset, and the magnetic tape is checked to see if it is almost full. In this fashion, the system monitors traffic 24 hours a day without operator intervention.

Many non-process operations may be conducted utilizing the collected data, and other computer analysis functions may be performed while the system is monitoring traffic. A series of non-process programs have been developed to allow the users to care for the collection activity while engaged in other activity. Many of these programs provide for the maintenance of the computer-sensor system files and its calibration. The time-sharing capability of the IBM 1800 TSX provides for seemingly coincidental data collection and analysis activity.

Program NC003 establishes the disk files, initializes the tape and allows for parameter entry. When the loop sets are calibrated (by radar), adjustments in velocity and length are accomplished by means of modification in one of the conversion factors within the program which calculated these items from the four times provided by PILOP.

Programs NC004, NC005, and NC006 allow the operator to turn the loop sets on and off, and to enter the Data Input (interface) time sense base, day of week, weather and special conditions. The traffic at a given site may be examined on a real time basis if desired.

Program NC007 writes all the disk files onto magnetic tape. In this fashion, the disk unit may continue to collect and store vehicle data for a period of three to four hours (depending on traffic density) before requiring a tape backup. During this time, previously completed tapes may be re-examined for retrieval of old data (Program NC012), analysis or any other task which may require the assistance of a magnetic tape unit.

Program NC011 replaces the tape removed by NC007. To regain the computer for any analysis requiring the tape unit, the NC007-NC011 sequence may be rerun as often as necessary, up until midnight when Program ENDDAY computes the daily totals and reinintializes the system with the new date.

From the signals received from each loop set, vehicle speed, length, direction and lane of travel are calculated. Also recorded is the time of day and the time between the vehicle in the set and the previous vehicle. In this manner, the system yields lane usage information as well as speed relationship data.

C.2 Sensor System and Interface Equipment

The sensor consists of an RCA Vehicle Detector Unit which is connected to a loop of wire placed into the roadway. The vehicle detector senses the presence of a vehicle in the loop and closes a relay in the detector amplifier. The relay is connected to a phone line which terminates in an interface system specially developed for this project by Indiana University Institute for Research in Public Safety personnel. The interface system interrogates the relay by means of an electrical signal and reports the relay state to the computer in digital input form.

By combining the sensors in groups of four, it is possible to monitor traffic in two directions and to determine the speed and length of each vehicle passing through the loop set. Inasmuch as the events are time related, traffic densities as well as information on traffic flow composition may also be determined.

Description of Loop Installation

At each site, four loop detectors are installed in the configuration shown in Figure C.1. The cuts are 1/8 inch wide, and originally 2 inches deep for the loop wires. The wire depth, and the loop dimensions have been subject to some minor variance in order to optimize response. After the cutting operation, the wire (19 strand, 14 gauge TW) is placed in the cuts, making three turns per loop, and all leads are brought out to the edge of the road. When the wire installation is completed, the cuts are filled with a quick-setting hydraulic cement.

At the edge of the roadway, each pair of loop wires is spliced to a pre-twisted shielded cable, which is buried up to a service pole.

The Service Pole

Mounted on each telephone pole is an equipment cabinet and an electric power meter. The cables from the loops come up the pole in a piece of conduit and into the equipment cabinet, where they terminate on a terminal strip. On this strip the loops are connected to the detector amplifiers and the detector output (relay closure) is connected to the telephone lines, which in turn run to the computer room of the Institute (Figure C.2). 115V service is provided to the pole by Public Service of Indiana for the operation of the Vehicle Detectors.

The Vehicle Detector

The RCA Multi-Pak Vehicle Detector was designed primarily as an intersection traffic control device. Its solid state circuitry detects a phase shift in the loop impedance whenever a metallic vehicle crosses the wire loops embedded in the roadway. Since each loop at the site requires its own circuitry and relay, the standard package contains a power supply and four detector modules, grouped together in a 4-Pak configuration.

To adapt the Ve-Det to the special usages demanded by the research activity, several modifications were required. The original relays were replaced by faster mercury wetted relays, and at some sites, the tuning board gain has been increased by changing two resistors. This may become necessary where the cuts are deep or the roadway has steel reinforcing. At some installations, the loop inductance was so great as to require the addition of external capacitance (0.012 mf, in parallel with the loop) to achieve a tuning peak within the range of the Ve-Det's variable capacitance. Occasional tuning is required, as the loop sensitivity experiences minor fluctuations with time and weather.

The Computer Interface Circuit

An IBM 1800 Computer with digital voltage input has two input conditions:

Voltage at input	Computer reads
-1 to +30 volts	1
-6 to -30 volts	0
-1 to - 6 volts	indeterminant .

The Detector returns a -25 volts signal (sent to the site via one telephone wire) to the computer digital input point when no car is in the loop. When a vehicle enters the loops, the relay change at the Detector causes the digital input point to be connected to the computer ground (zero volts). With this information the computer is able to compute vehicle speed, length, number of vehicles per hour, and so forth.

The interface connections system used is of nominal cost ($200) and replaces a system now in general use, which requires mechanical relays and costs in excess of $2,500.

Sensor Sites: Phase I

Each sensor site has two loop "sets" - so called because a set of two wire loops is required in each lane to gather the necessary information. Two lanes are monitored at each site, and this configuration is named a loop "pair". During Phase I, sixteen loop sets were being monitored on North and South State Route 37, for a total of eight locations, i.e., two lanes of travel at eight spots. For reasons of programming, these sets are numbered from zero through fifteen. The additional sites created for Phase II will be discussed in the following section.

Loop sets 0-7 are located on State Route 37 South, with sets zero through three monitoring southbound traffic, and sets four through seven monitoring northbound traffic. The sequence of numbering is such that ascending numbers move away from Bloomington.

Pair 0-4 is located in a 45 mph zone, on a blacktop section of Highway 37. It is approximately 75 feet North of an intersection with a stop street. For southbound traffic, there is a negative slope of -5.2%. This is a main artery leading into Bloomington, and some rather high rush hour traffic may be experienced (rate of 900+/hour). Loop set zero monitors southbound traffic, and loop set four monitors northbound traffic.

Pair 1-5 is located in a 55 mph zone, enough South of the speed change from 45 mph to 55 mph to be unaffected by the former speed limit. The site is in the middle of a short straight stretch which acts as the connector for two curves in a general "S" configuration. The road is 22' blacktop, and the site is in a no passing zone. Set one monitors southbound; five monitors northbound.

Pair 2-6 is located in a 55 mph zone, in a 22' blacktop section of Highway 37. Traffic from the North has good visibility to the site, and its path is straight and effectively level. 130' South of the site, traffic experiences a gradual curve to the right. Set two monitors southbound traffic; six monitors northbound traffic.

Pair 3-7, the southernmost site, is located just beyond the bottom of a long hill, with good straight visibility in both directions. The road is 22' blacktop, and the speed limit is 55 mph. Set three monitors southbound and set seven monitors northbound traffic.

Loop sets eight through fifteen were installed on State Route 37 North, with sets of eight through eleven monitoring southbound traffic, and sets twelve through fifteen monitoring northbound traffic.

Pair 8-12 is located in a 65 mph zone, approximately 0.2 miles North of a flat curve with a speed limit of 55 mph. The geometry is such that speed would be expected to have normalized to the 65 mph zone by the time northbound vehicles arrive at the site. Southbound vehicles have been in a 65 mph zone for over 15 miles. The road is concrete, 24' wide. Set eight monitors southbound traffic, and set twelve monitors northbound traffic.

Pair 9-13 is located at the northern end of the straight-away from Pair 8-12, in a long flat curve. The full expanse of the South straight-away is not fully visible at this site. The speed limit on this concrete, 24' wide portion of the roadway is 65 mph. Seven hundred feet to the North lies a small bridge on the same curve. Set nine monitors southbound traffic; set thirteen monitors northbound traffic.

Pair 10-14 borders the northern end of a long straight uphill section (for northbound traffic) which contains a passing zone for northbound traffic. It lies midway through a long curve which terminated in the hill section just mentioned. The road is 24' concrete, and the speed limit is 65 mph. Set ten monitors southbound traffic; set 14 monitors northbound traffic.

Pair 11-15 borders the northern end of a long level straight-away, and the southern end of a long level curve. The road is concrete, and the speed limit is 65 mph. Set eleven monitors southbound traffic and set fifteen monitors northbound traffic.

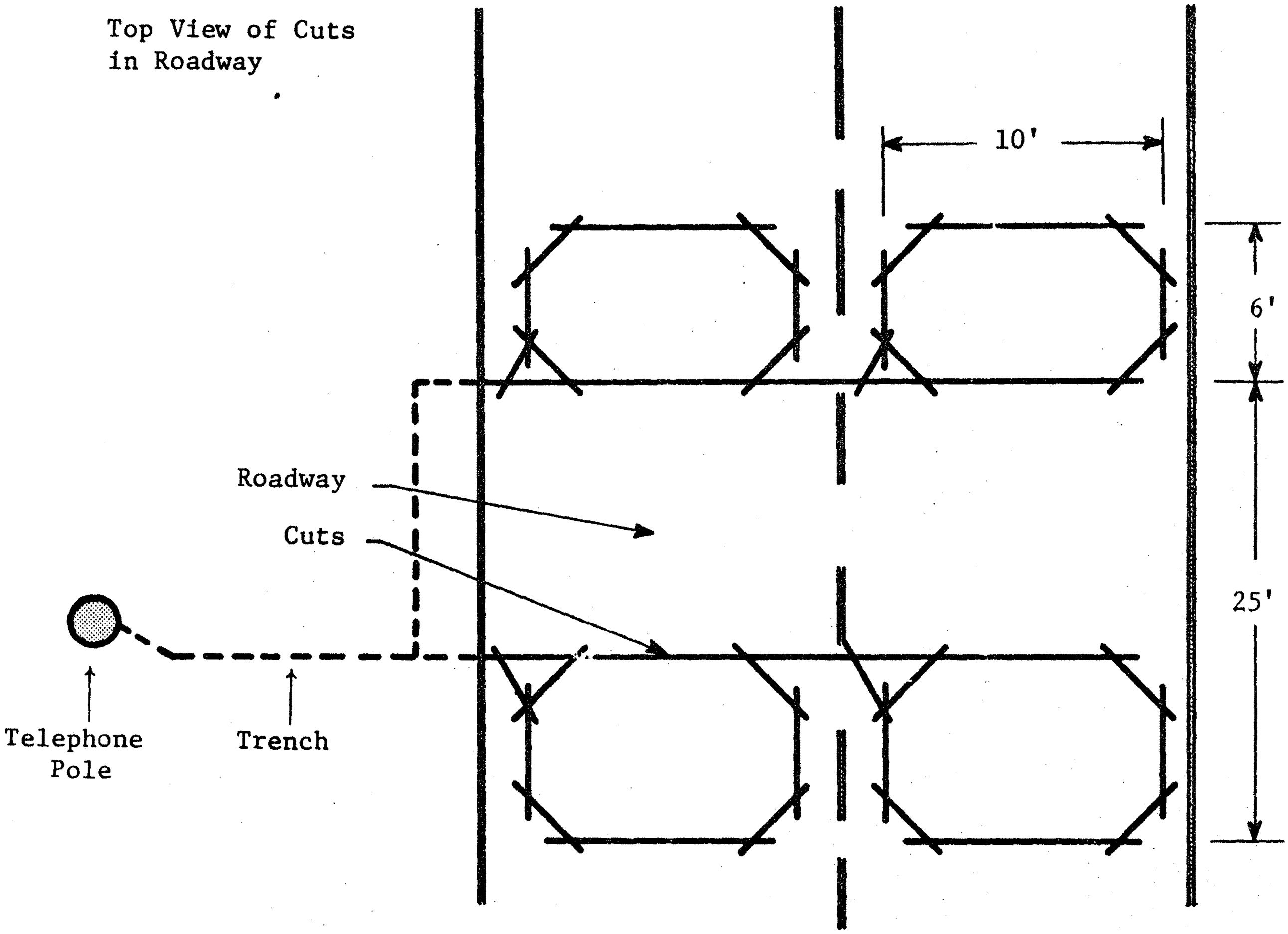
Roadway Diagrams - Sensor Sites: Phase I

Figure C.3 shows the location of the sensor sites on State Highway 37. Figures C.4 through C.11 show plan views of the roadway along Route 37 North and South which contain the above described sensor sites. Included in these sketches are vertical profiles and curvature information as indicated.

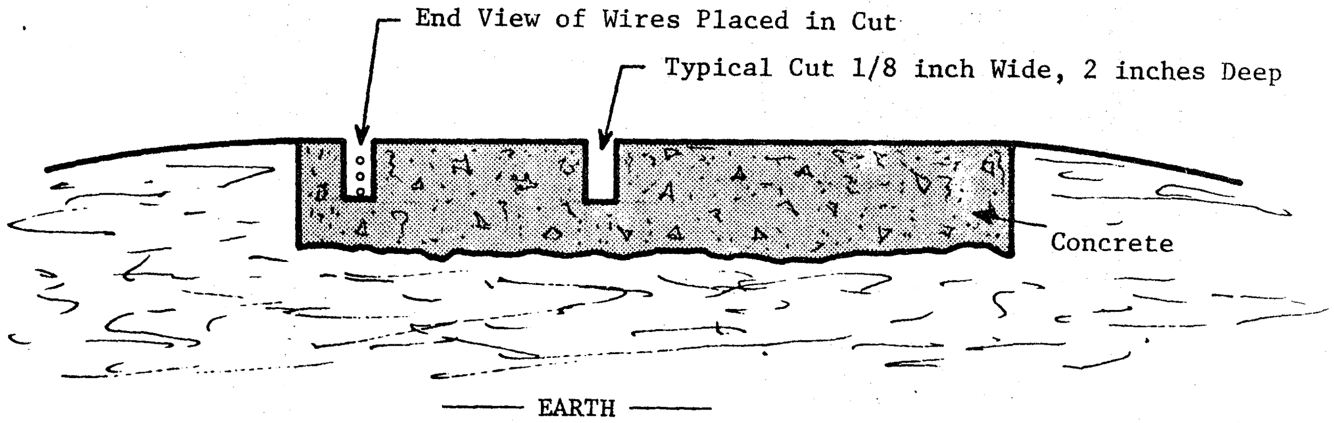
System Expansion: Phase II

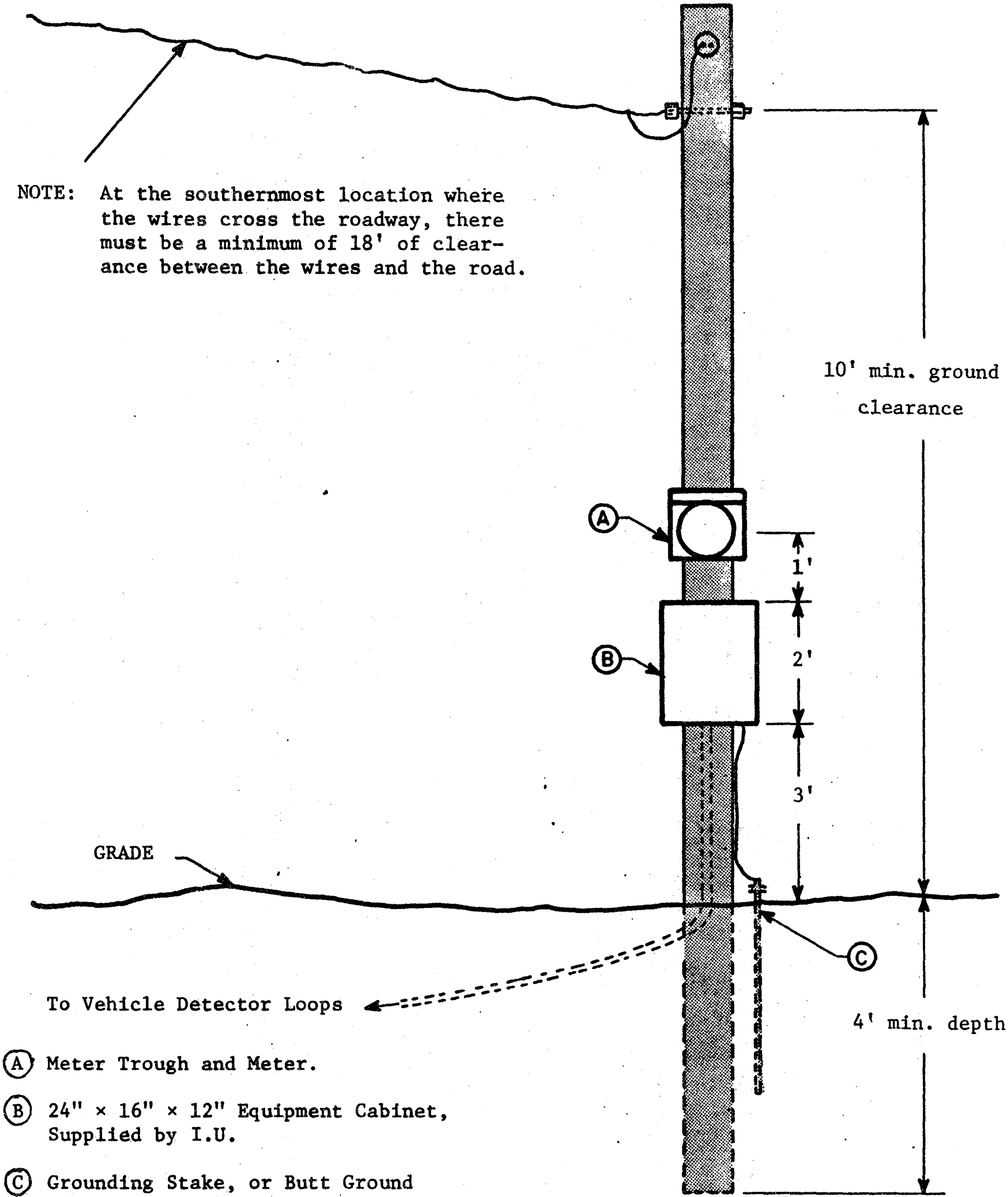
In late July, 1969, a meeting of project officials, including those from the National Highway Safety Bureau, the Research Triangle Institute, and the Institute for Research in Public Safety, reviewed the system's capability as an instrument of traffic data collection. At that time, the system had a demonstrated capability of speed measurements to within ±1.0 mph and length measurements to within ±2.0 feet.

Top View of Cuts
in Roadway



Cross-sectional View
of Roadway





NOTE: At the southernmost location where the wires cross the roadway, there must be a minimum of 18' of clearance between the wires and the road.

Ⓐ Meter Trough and Meter.

Ⓑ 24" × 16" × 12" Equipment Cabinet, Supplied by I.U.

Ⓒ Grounding Stake, or Butt Ground at Bottom of Pole May be Used.

Figure C.3 Location of Sensor Sites on State Highway 37

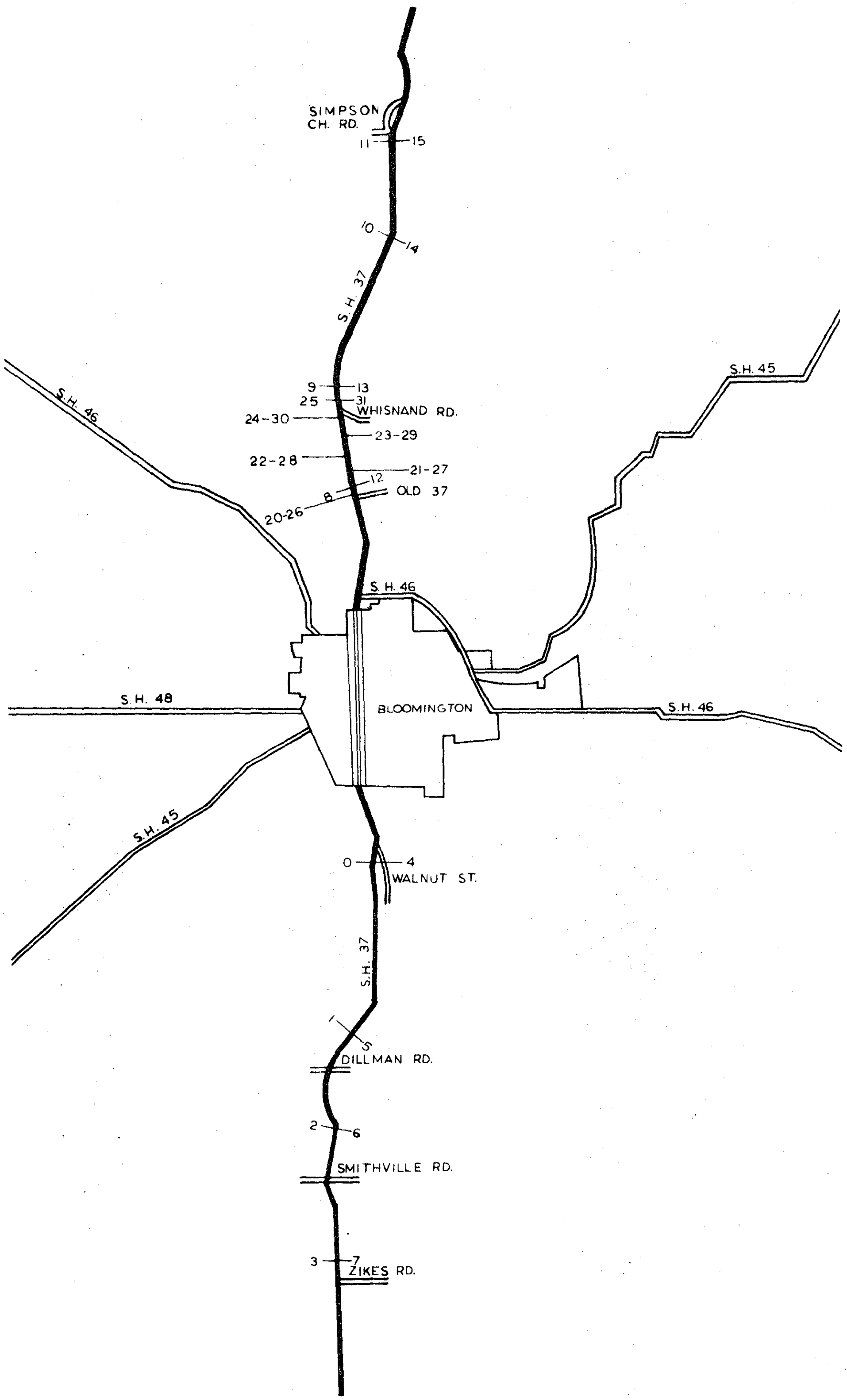


Figure C.4 Plan View of Roadway Section for Site 0-4

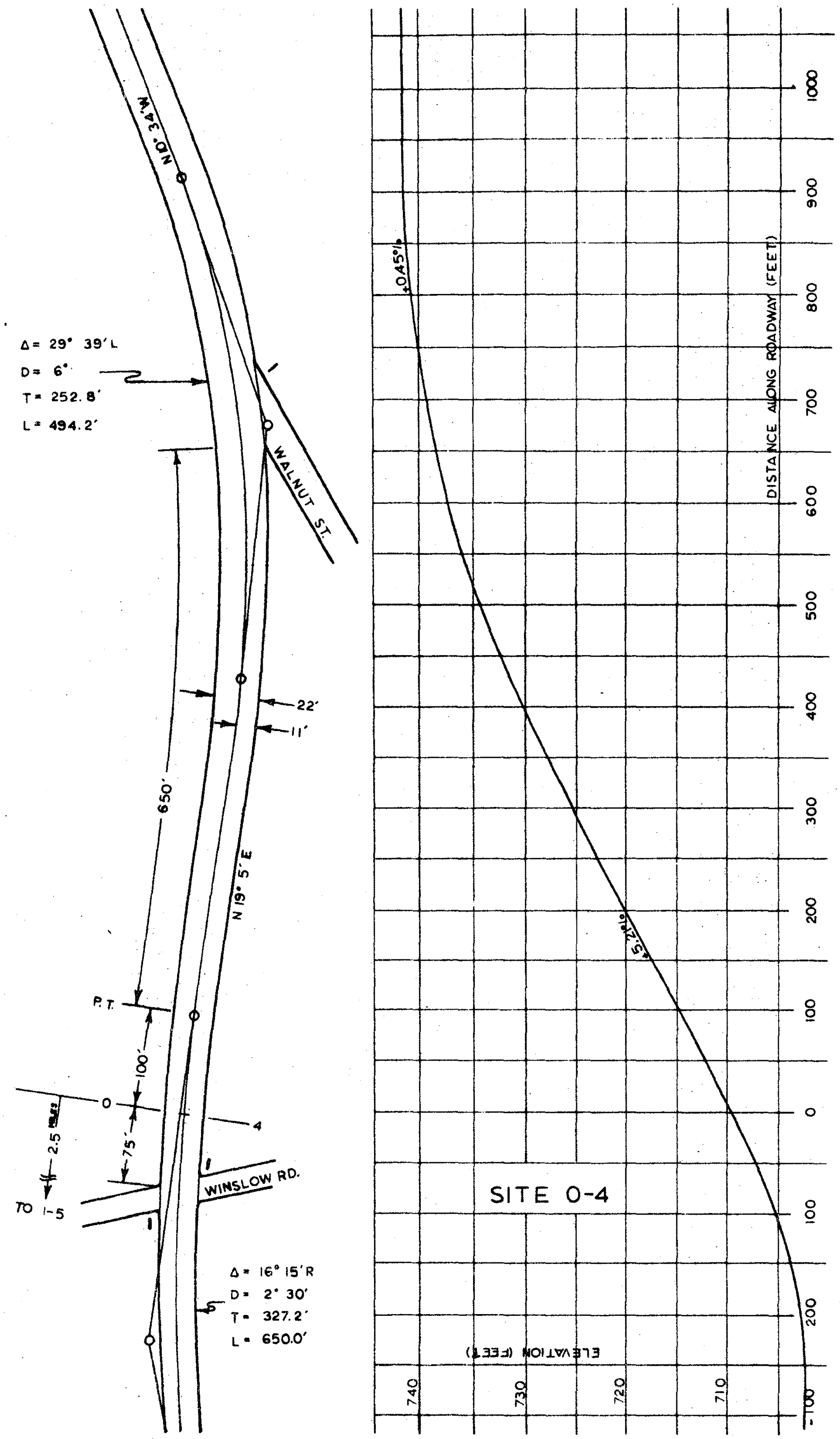


Figure C.5 Plan View of Roadway Section for Site 1-5

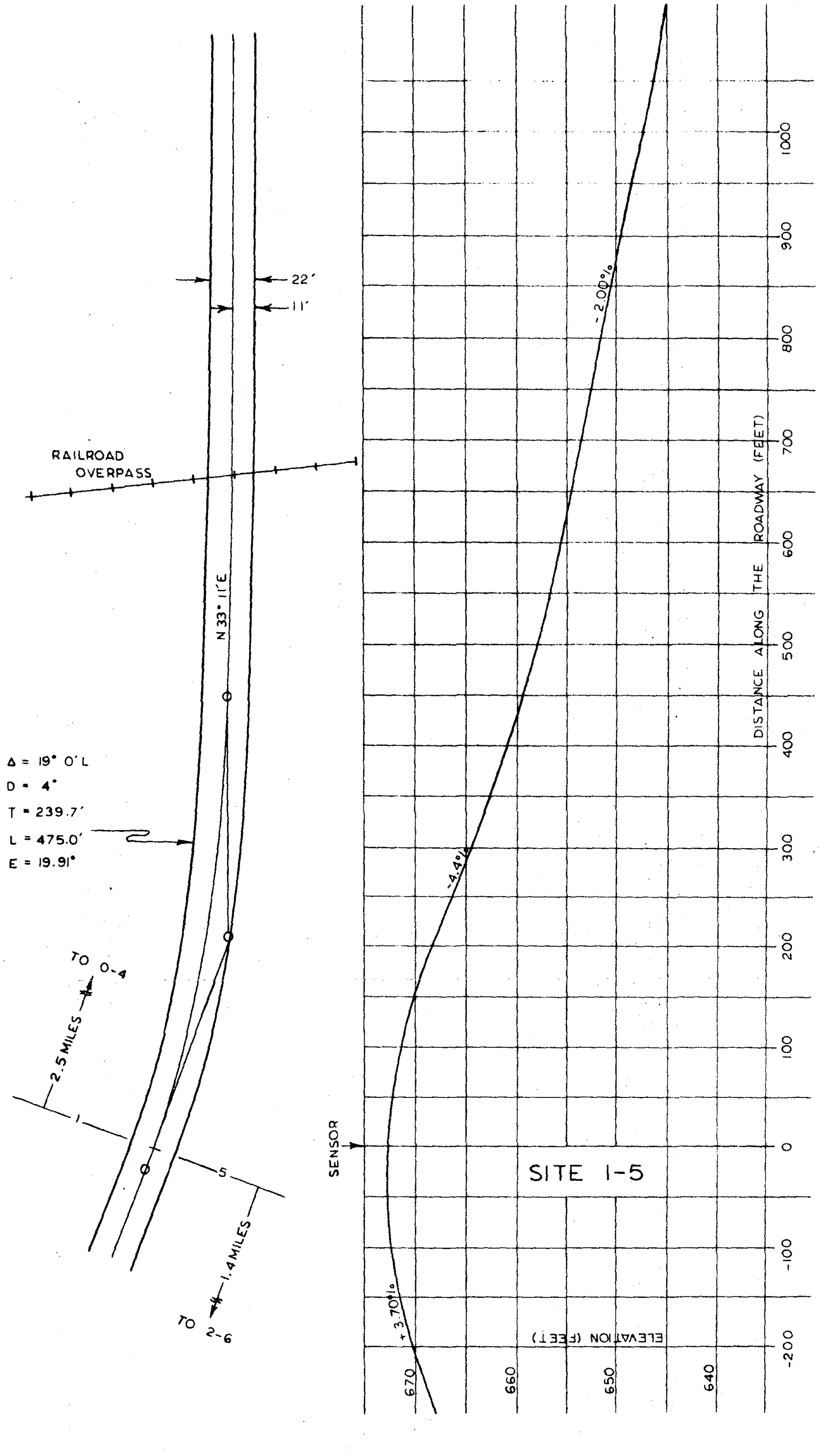


Figure C.6 Plan View of Roadway Section for Site 2-6

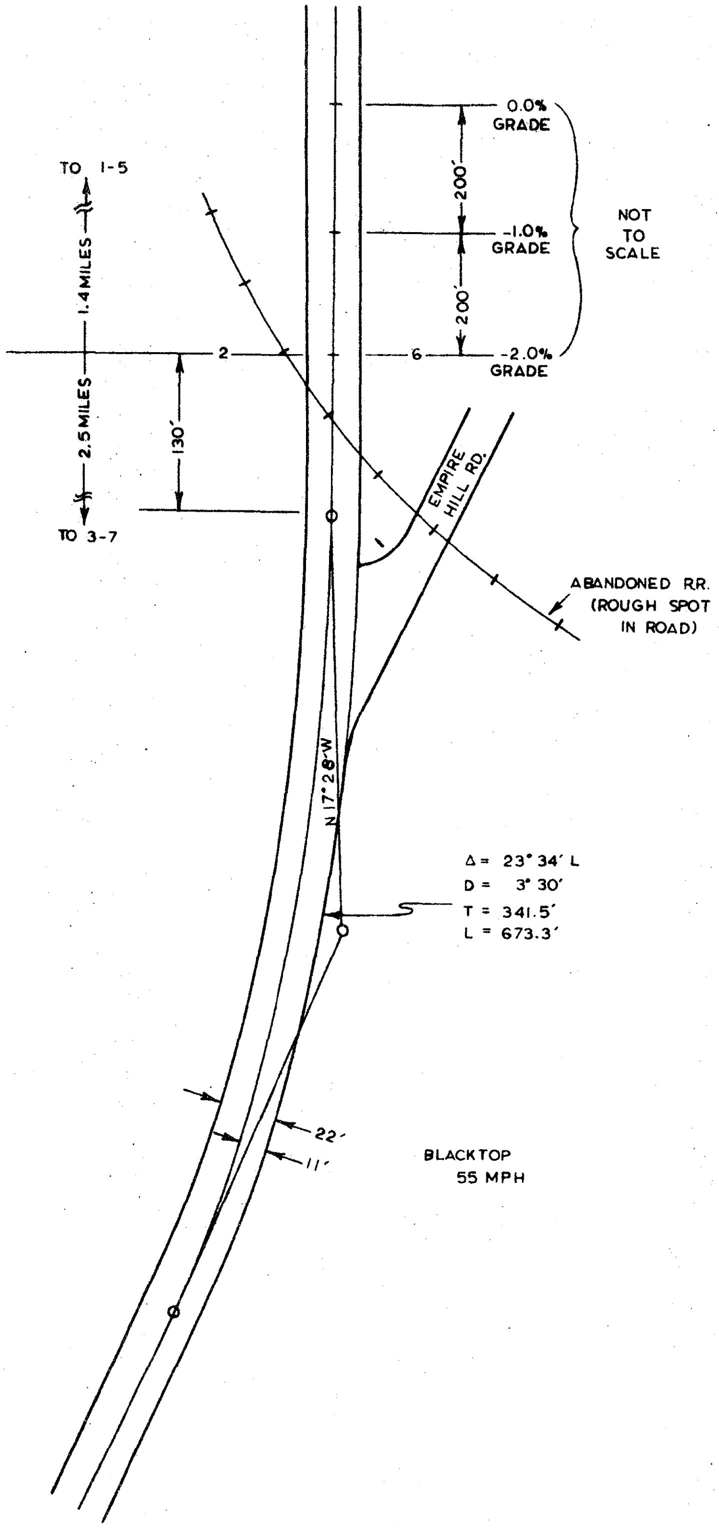


Figure C.7 Plan View of Roadway Section for Site 3-7

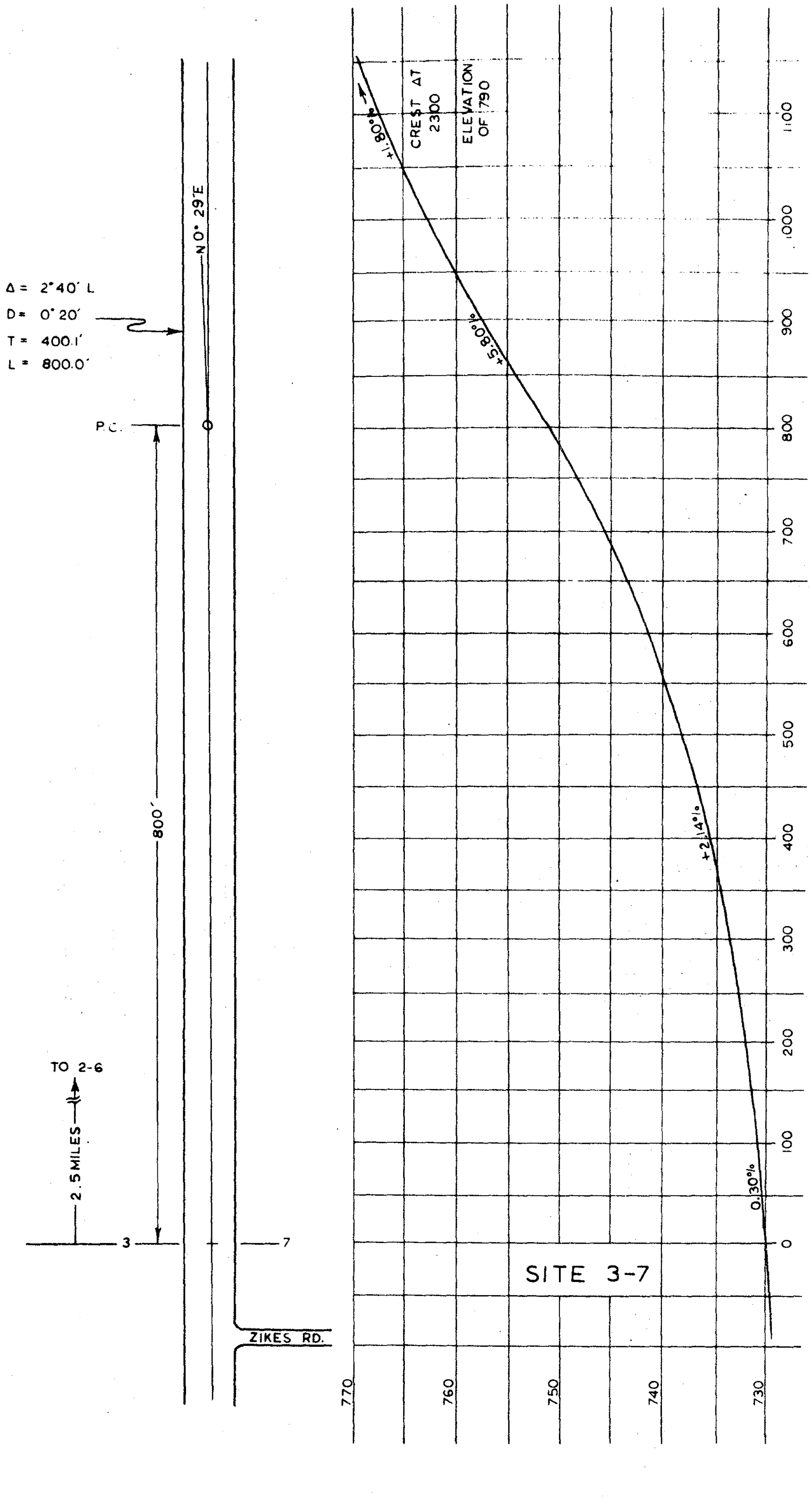


Figure C.8 Plan View of Roadway Section for Site 8-12

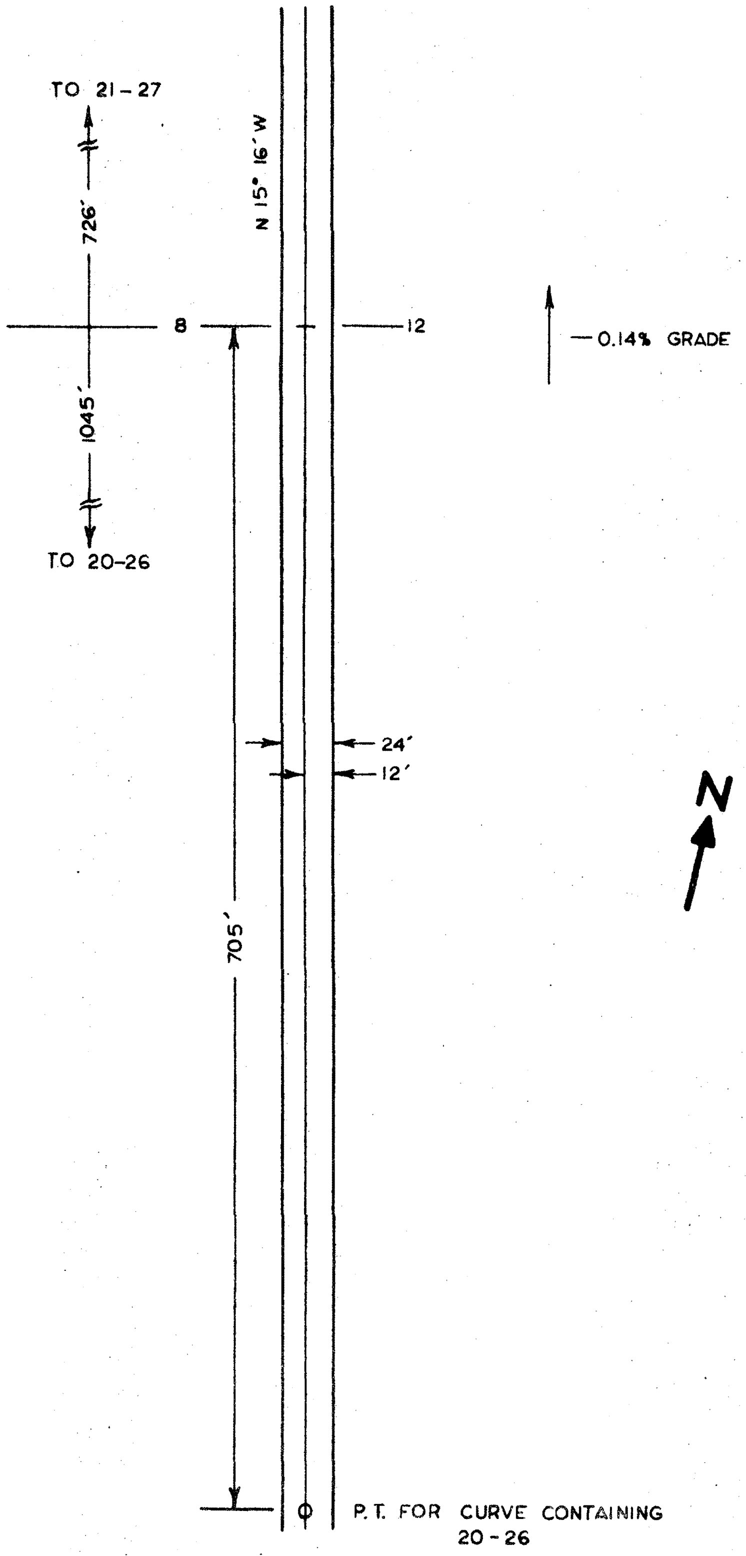


Figure C.9 Plan View of Roadway Section for Site 9-13

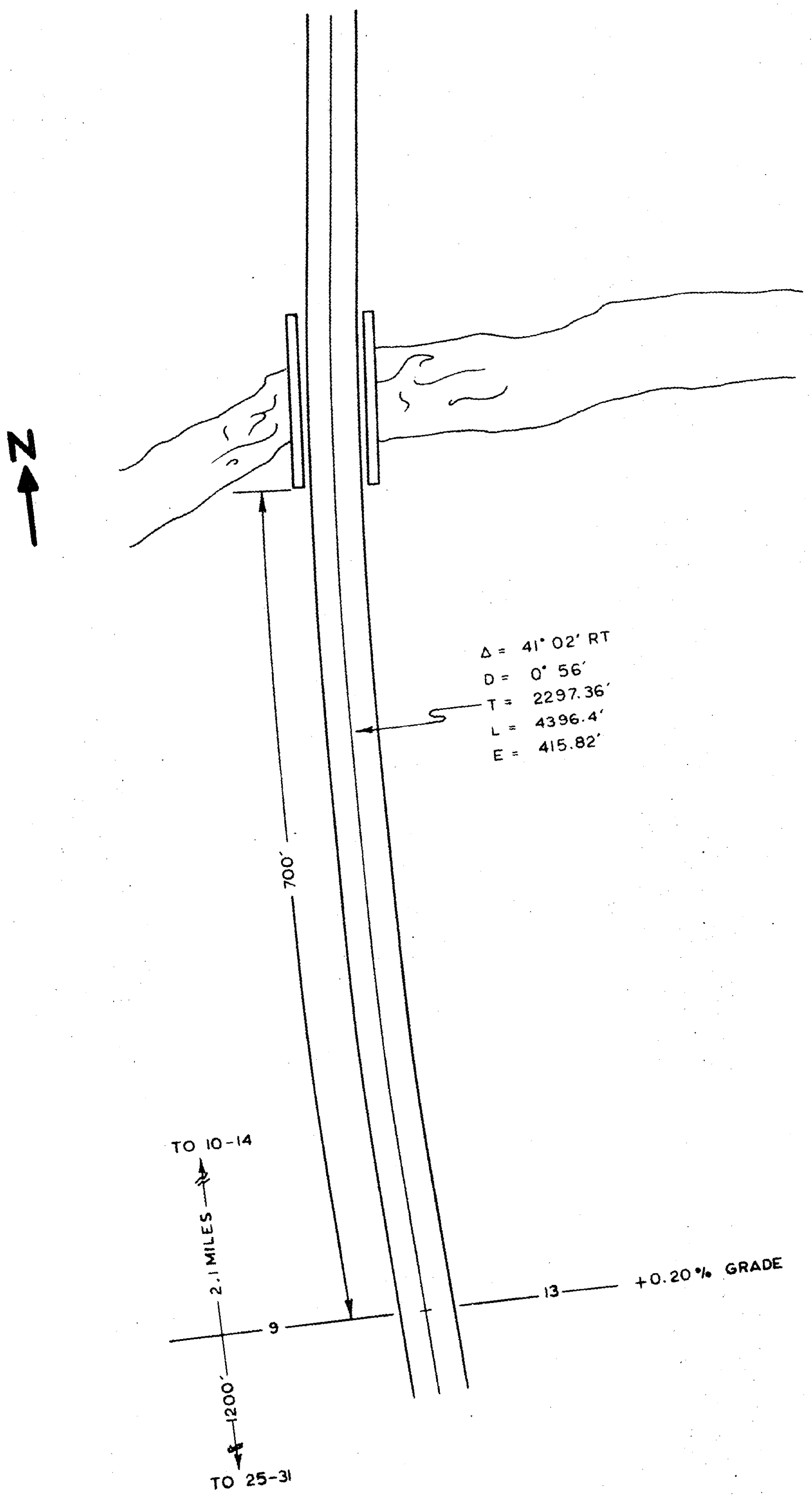


Figure C.10 Plan View of Roadway Section for Site 10-14

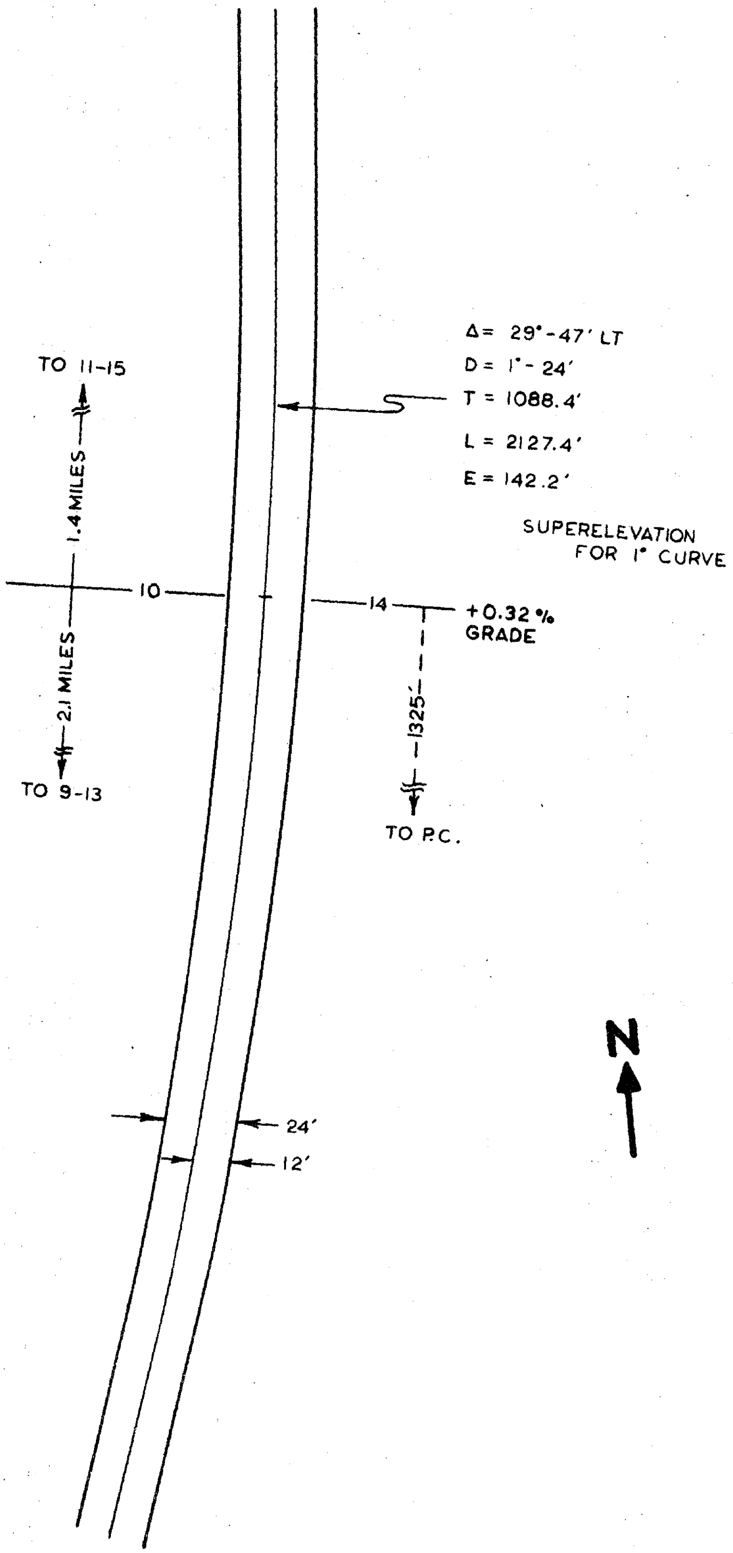
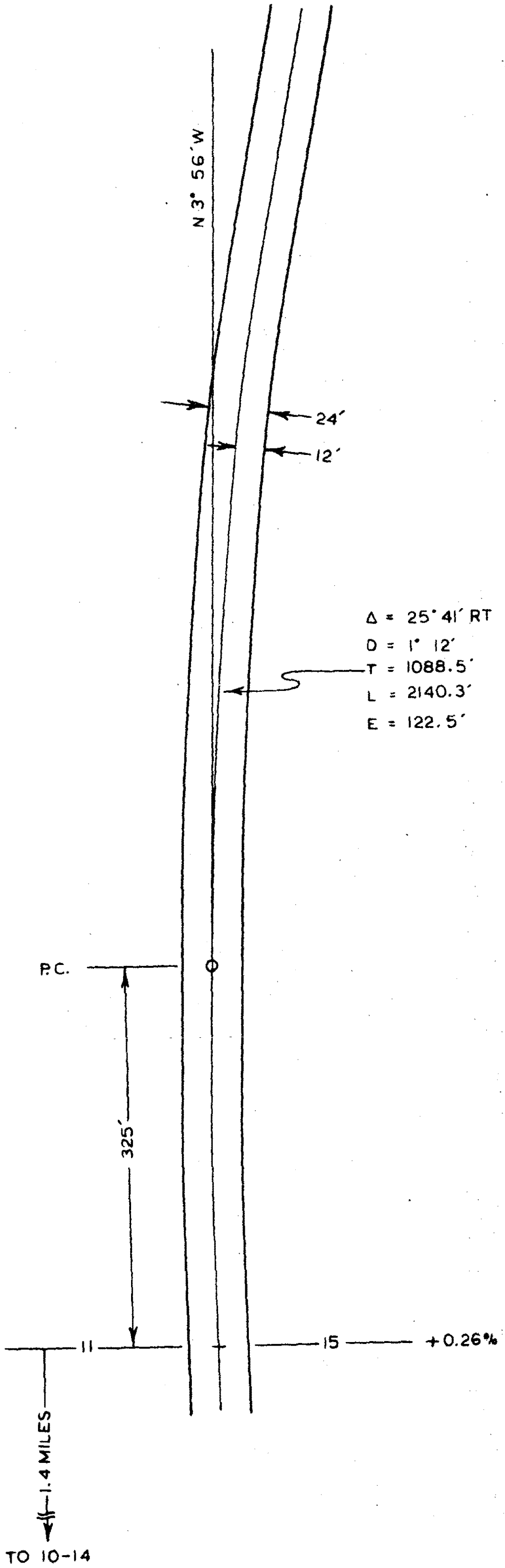


Figure C.11 Plan View of Roadway Section for Site 11-15



Phase II called for post-accident follow-up and the use of the system as the accident data collection approach. To aid in this data collection and system evaluation, the system was expanded. Six additional sensor sites were located on State Route 37 North, with the computer software being rewritten to monitor these new sites. The installation and the computer software were completed November 4, 1969. These changes are discussed below.

Six loop pairs were added; five were placed in between Loops Pairs 8-12, and 9-13 and one (Set 20-26) was placed 0.2 miles South of 8-12. Sets 20 through 25 are monitoring southbound traffic, and Sets 26-31 are monitoring northbound traffic. (See diagrams at the end of this section for spacing and locations of these new sites.)

The same basic computer hardware which monitored 16 loop sets was utilized for the expanded system. The only addition came in the interfacing, with four digital input strips being utilized, instead of two. The 16K of core did prove to be sufficient after modification of the system software. Also, while the overall logic remained the same, interrupt levels and core allocations were reduced to accomodate the load levied on the system by the additional input. IBM-furnished TSX up-dates arrived out of sequence, causing some delay until the system could be built up under Version 3, Modification level 7, but the expanded system came on-line on November 4, 1969.

In order that the 1800 could monitor the almost twice as many loops as before, core work areas were preserved. Whereas in Phase I each loop set had two 50-vehicle in-core buffers to store vehicle data until it could be written to disk, in Phase II each was reassigned to two 25-vehicle buffers. Addresses, previously stored in core, in Phase II were calculated by program PILOP. Also, without requiring a rewiring operation, all unnecessary interrupt levels were stripped of their in-core work areas, saving 100 words for each of the four deleted levels. The retained interrupt levels were pared down to their absolute minimum necessary work areas. Some of these core-saving measures resulted in longer execution times, but the basic five millisecond interrupt was undisturbed. All fifty-six digital input points were still scanned every five milliseconds.

Roadway Diagrams - Added Sensor Sites: Phase II

Figure C.12 shows the location of the six additional sensor sites on Highway 37 North. The loop sets are numbered 20 through 31 inclusive. Figures C.13 through C.18 show plan views of the roadway sections along Route 37 North which contain the six additional sensor sites. Pertinent roadway geometry is indicated on each figure as required.

Figure C.12 Location of Additional Sensor Sites on State Highway 37 North

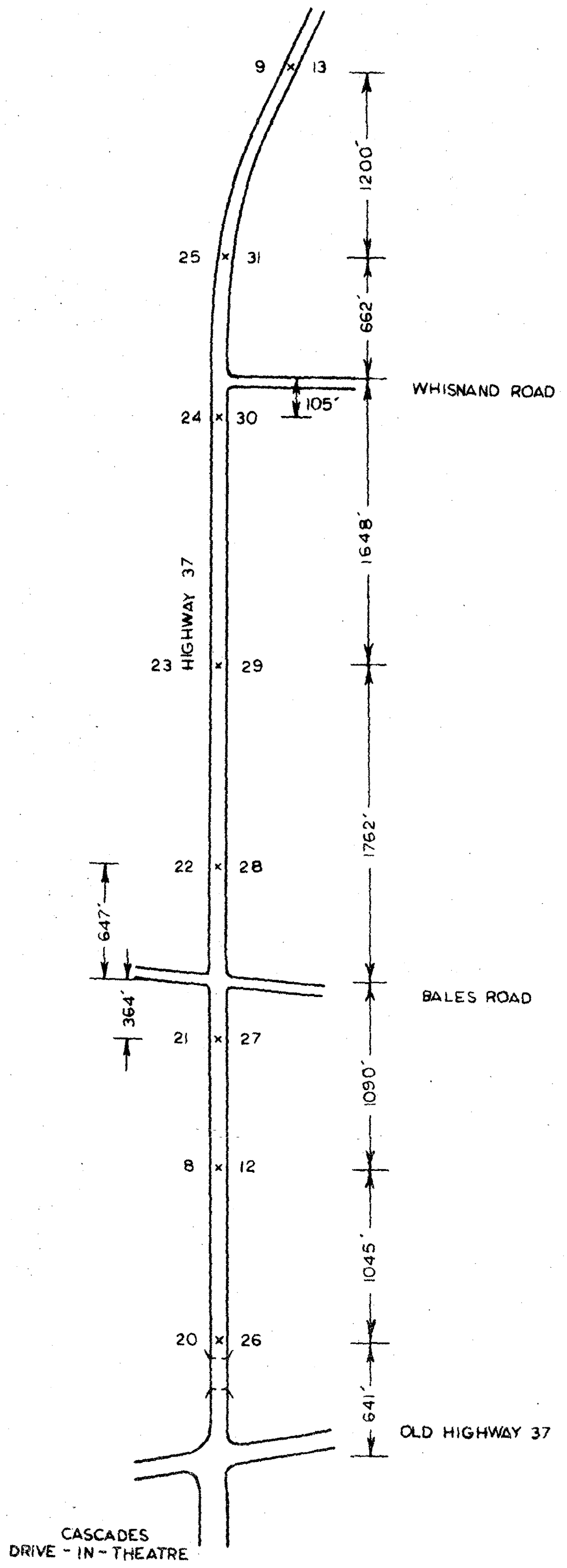


Figure C.13 Plan View of Roadway Section for Site 20-26

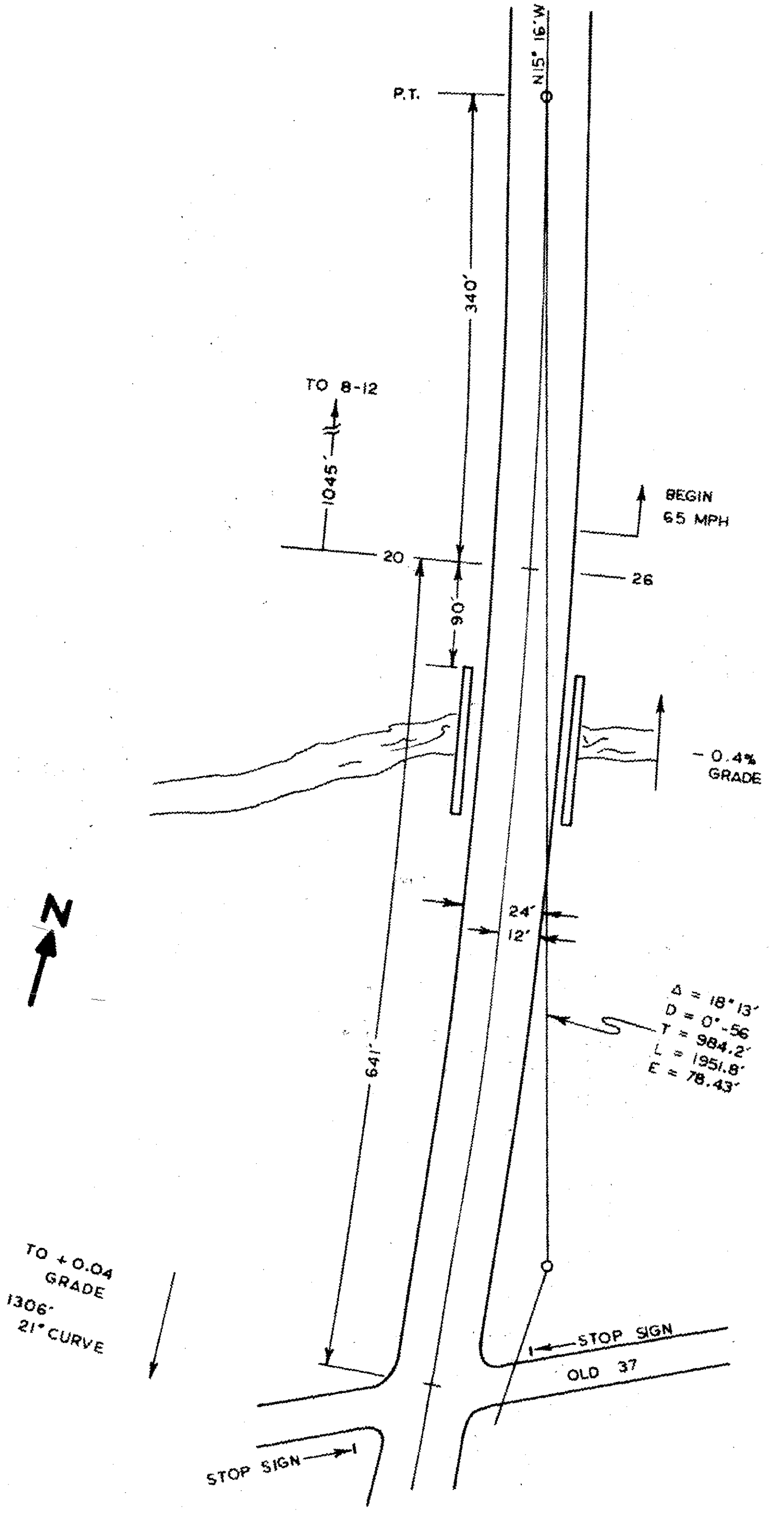


Figure C.14 Plan View of Roadway Section for Site 21-27

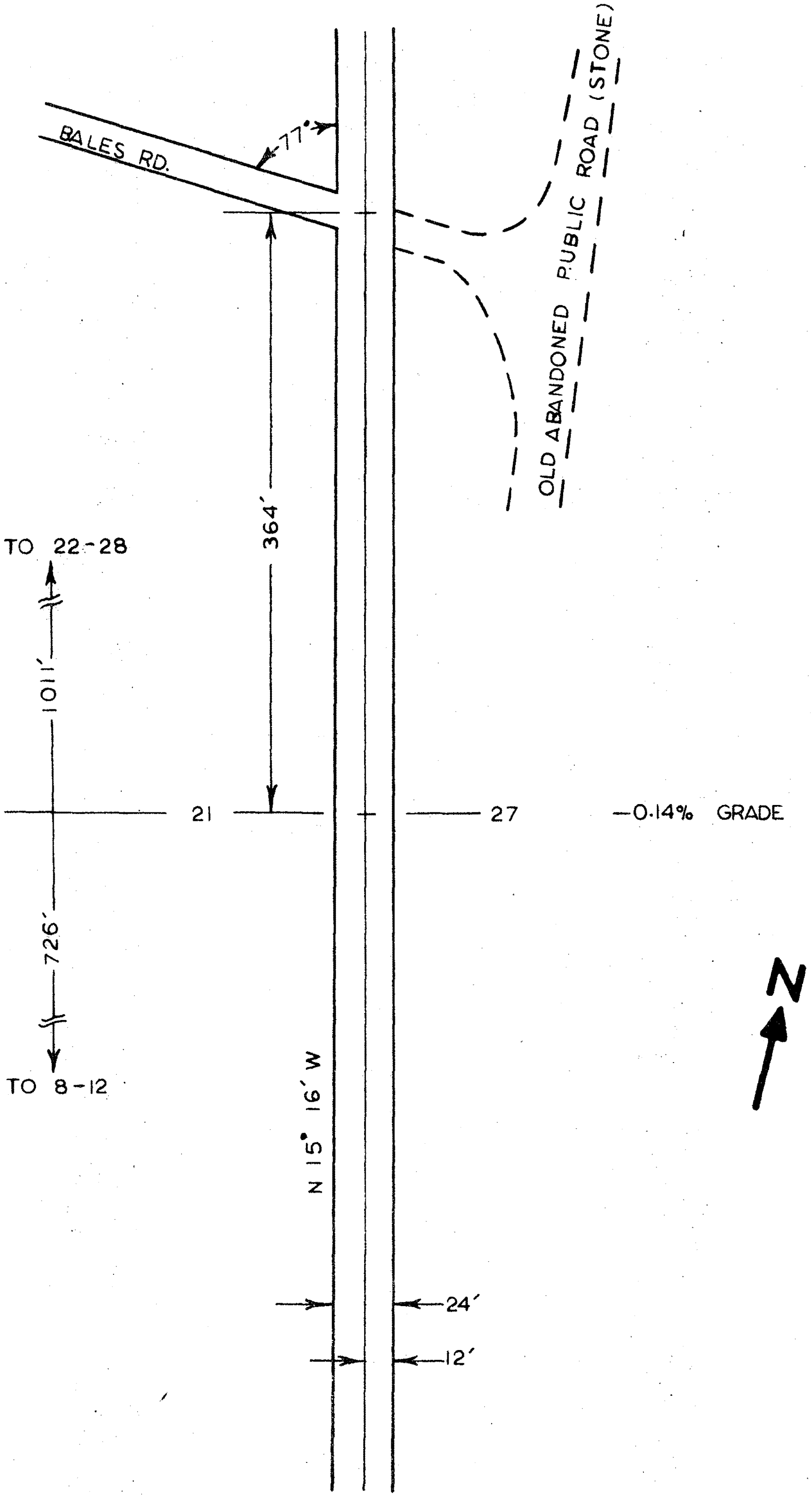


Figure C.15 Plan View of Roadway Section for Site 22-28

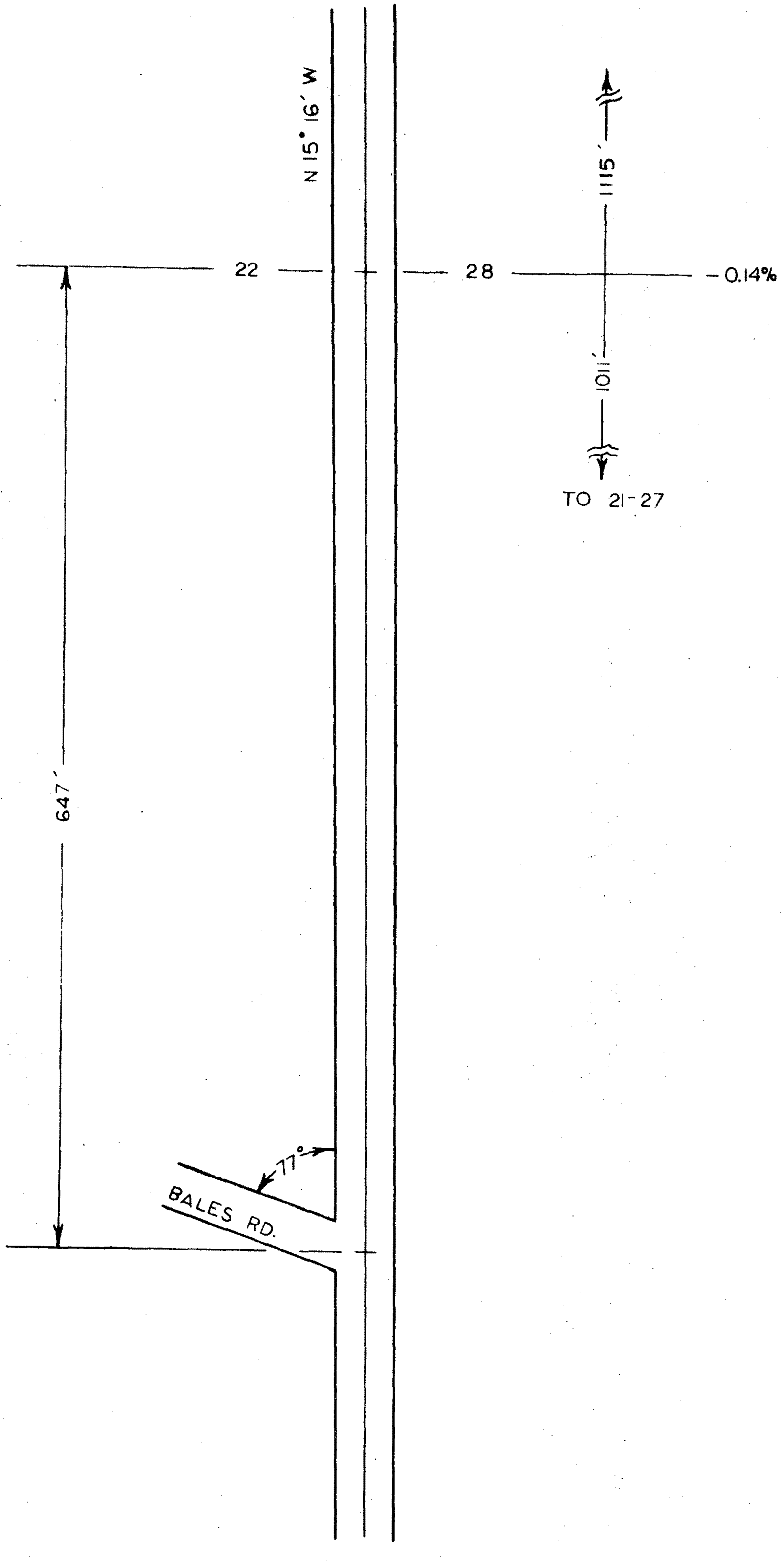


Figure C.16 Plan View of Roadway Section for Site 23-29

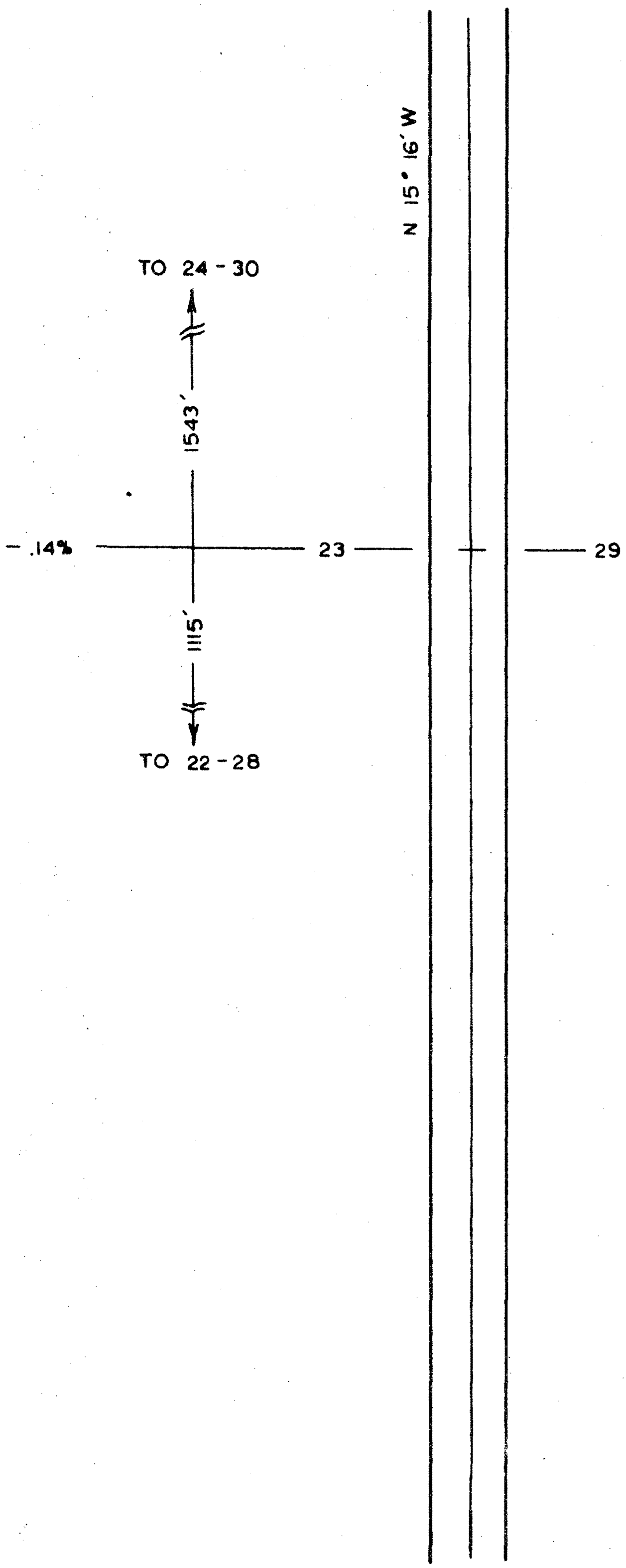


Figure C.17 Plan View of Roadway Section for Site 24-30

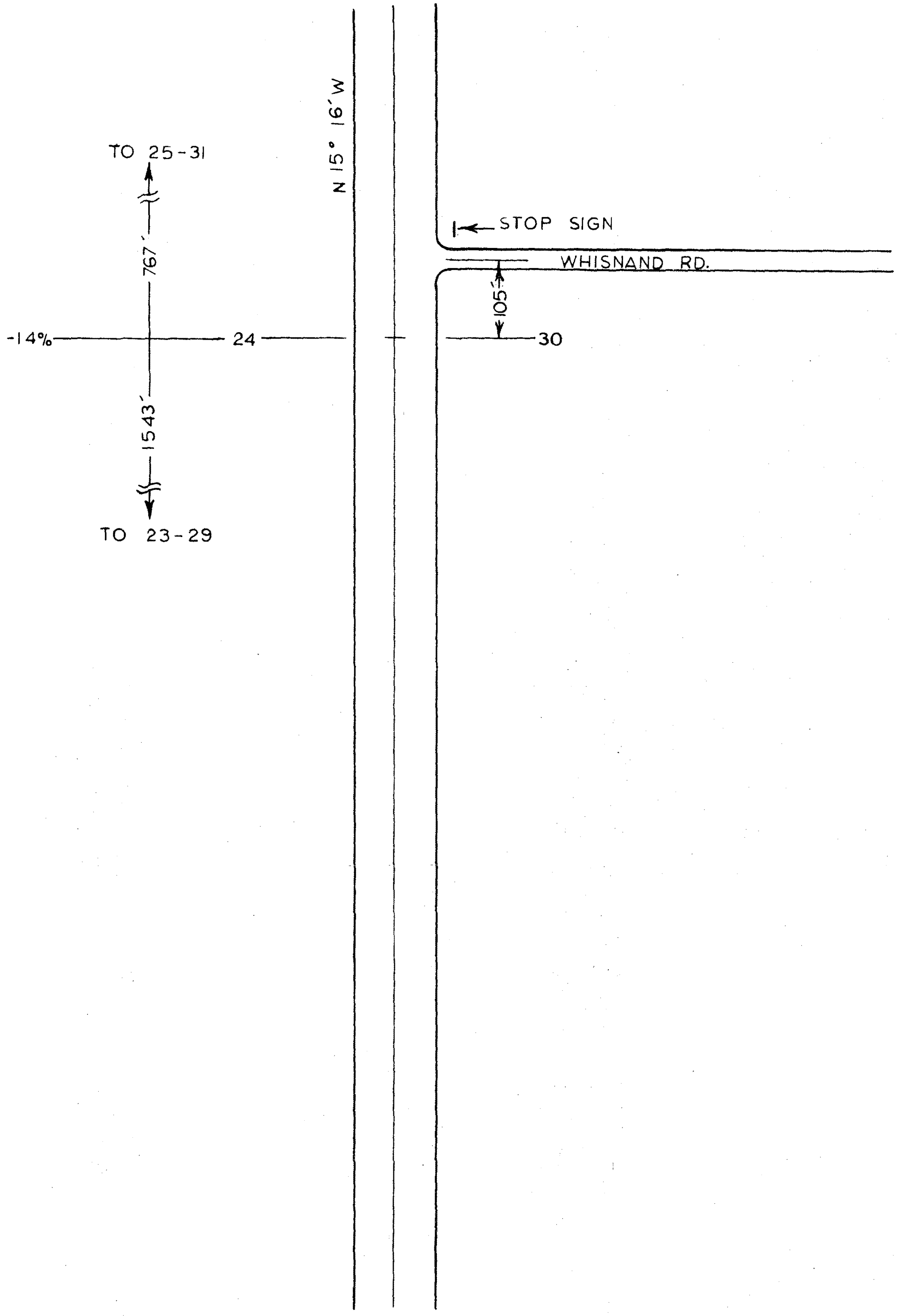
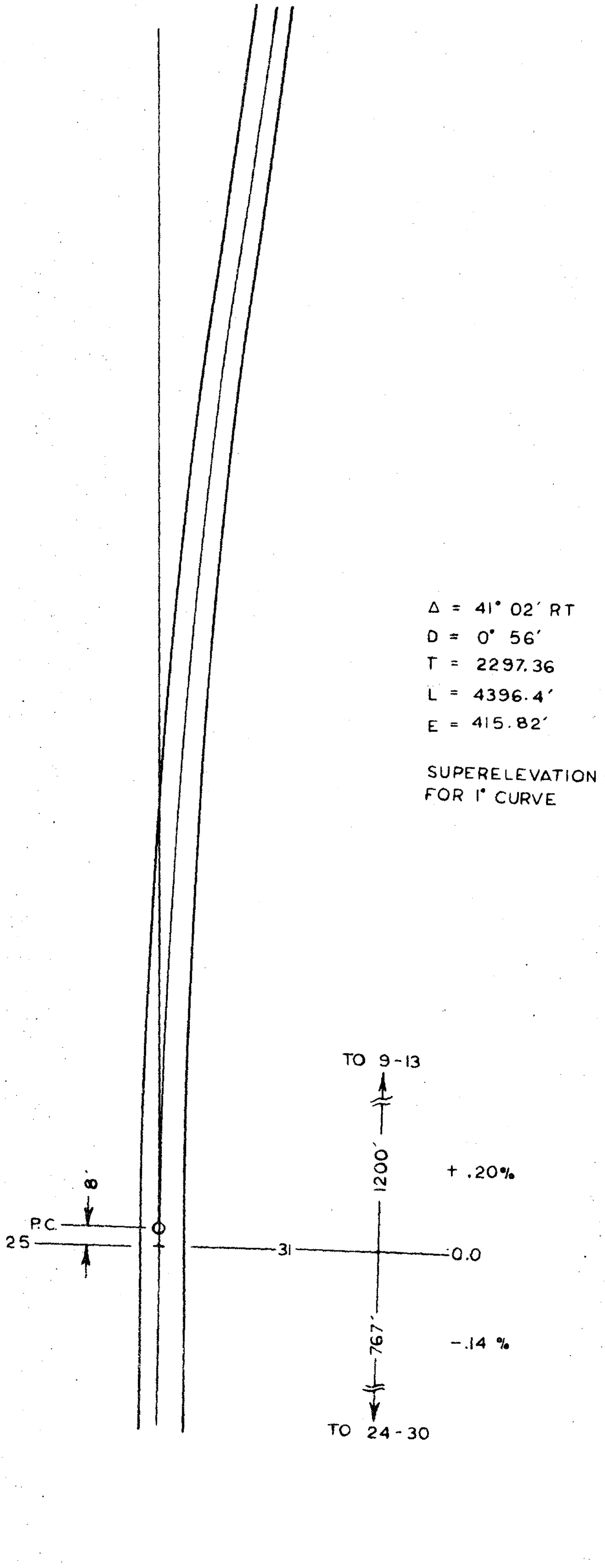


Figure C.18 Plan View of Roadway Section for Site 25-31



Appendix D

ESTIMATING VEHICLE MILEAGE

D. ESTIMATING VEHICLE MILEAGE

State Roads 45, 46, and 48

Step 1

Each road was divided into approximately one-mile segments and each segment given a station number (see Figure 6.1 of Section 6). Nighttime and daytime volumes were calculated for each station from the volume-time curves given in Appendix H. Because of insufficient data, these volume-time curves cover both directions of travel seven days a week.

Step 2

Using the information on speed variability given in Table 6.2 of Section 6. standard deviations for nighttime speeds and daytime speeds were calculated for each station. These standard deviations were obtained from variances in speeds observed during weekdays on dry roads averaged for both directions of travel. A more precise approach would have required separate standard deviations calculated for each station for weekday and weekend speeds (day and night); however, this would have required weekday and weekend volume-time curves which are not available. In view of the general stability of the speed variances, the use of weekday, dry road speed variances, pooled over both directions of travel, appears adequate for estimating total vehicle mileage.

Step 3

Using the daytime standard deviation calculated in Step 2 and assuming a normal distribution of speeds, the proportions of vehicles within the various speed deviation intervals of interest were calculated for each station. Similar calculations were made using nighttime standard deviations.

Step 4

For each speed deviation interval, the daytime volume for a given station, as found in Step 1, was multiplied by the daytime proportion calculated in Step 3 for that station. The product is the daytime miles for one day for each of the speed deviation intervals. The mileage for one day is then multiplied by the number of days in the time period covered by the study (i.e., December 7, 1968 through July 31, 1969). Similar calculations are made using nighttime volumes and proportions.

Step 5

The daytime and nighttime totals calculated in Step 4 are summed to give the total mileage for each speed deivation for each station for the entire study period. These totals are then summed over all stations on a given road to give the total mileage for each speed deviation interval for that road.

Highway No. 37

The general procedure for estimating vehicle mileage on Highway No. 37 follows closely the procedure previously outlined for the other state roads. However, since the computer-sensor system monitors the traffic characteristics continuously, more refined techniques were utilized to obtain more accurate mileage estimates. For example, separate volume-time curves were developed for Monday through Thursday, Friday, Saturday, and Sunday for each direction of travel.

Step 1

Each lane of Highway No. 37 was divided into segments of varying lengths. Each segment contained one pair of magnetic loop detectors located, as nearly as possible, in the center of the segment. Nighttime and daytime volumes, by days of the week, were calculated for each segment from the volume-time data given in Section for that loop which represented a given segment.

Step 2

Standard deviations for nighttime and daytime speeds for Monday through Thursday, Friday, Saturday, and Sunday were calculated for each loop. These standard deviations represent the average within-one-hour standard deviations in speeds for nighttime and daytime driving. As such these standard deviations are not affected by hour-to-hour changes in mean traffic speed.

Step 3

Using the standard deviation calculated in Step 2 and assuming a normal distribution of speeds, the proportions of vehicles within the various speed deviation intervals of interest were calculated for each segment.

Step 4

The product of the volume of vehicles obtained in Step 1 and the proportion, for a given speed deviation interval, corresponding to the same segment, day-of-week and time period within-a-day, obtained in Step 3 times the length of the segment gives the daily vehicle mileage for that segment for the particular speed deviation interval. The mileage for one day is then multiplied by the number of days in the time period covered by the study (i.e., December 7, 1968 through December 31, 1969). This type of calculation was made for all speed deviation intervals for each segment.

Step 5

Total vehicle mileage for some given condition is obtained by summing over the appropriate mileage values calculated in Step 4. For example, the total mileage for a particular speed deviation interval is obtained by summing the mileage for a particular speed deviation interval is obtained by summing the mileage for the given interval over all segments.

Appendix E

TYPICAL ON-SITE ACCIDENT REPORT

E. TYPICAL ON-SITE ACCIDENT REPORT

Accident Report No. 073-B
PI 1/30/69 0717 Thursday

Investigator arrived at the scene at 0740 about 20 minutes after the accident had occurred. Monroe County Sheriff's Department was on the scene until arrival.

V-1 (vehicle number 1) was on its top in a ravine on the South side of the highway for eastbound traffic and was a distance of 26.4 feet South of the traveled portion of the roadway. There were three injuries involved in the accident.

D-1 (driver of vehicle 1) was interviewed at the Bloomington Hospital by the investigation officer from the Sheriff's Department. D-1 stated at that time that she was eastbound on SR 45 at a speed of 55 to 60 mph. As she rounded the curve to the right, she was temporarily blinded by the headlights from westbound vehicles and misjudged the curvature of the roadway. She left the roadway and dropped over an embankment and struck a tree on the South side of the roadway.

Physical evidence consists of tracks on the right shoulder for eastbound traffic, 27.0 feet in length. At this point, the vehicle become air-borne and traveled over an embankment where it struck a tree located 26.4 feet South of the traveled portion of the roadway. The vehicle struck the tree 4.8 feet above ground level. The vehicle then proceeded 15.3 feet where it struck a second tree, uprooting it. The vehicle then ricocheted off of the second tree and struck the embankment 10.2 feet beyond the second tree, at which time the vehicle flipped onto its top and came to rest 15.3 feet from the second tree. The front of the vehicle came to rest 26.4 feet from the traveled portion of the roadway and the rear of the vehicle was 32.4 feet South of the roadway. The distance traveled by the vehicle after it became air-borne on the South shoulder to the point where it impacted with the first tree was a distance of 52.8 feet. Engineers' calculations based on the trajectory of the vehicle using the vehicle weight and the distance that it dropped in 52.8 feet estimates the speed of the vehicle when it left the roadway to be 67 mph.

Vehicle damage consisted of the front of the vehicle in its entirety, windshield, left front door, right front door, left rear fender, top, frame, undercarriage. The transmission, differential, and motor were all ripped from the vehicle.

All three occupants in the vehicle received injuries in the accident. D-1 was thrown from the vehicle on impact with the first tree and received bruises on the right leg and hip. P-2 (passenger) received cuts and abrasions and a broken clavical. P-5 received severe cuts and abrasions and a broken back.

P-2 stated to the investigating deputy that she believed the vehicle was traveling approximately 65 mph when it left the roadway.

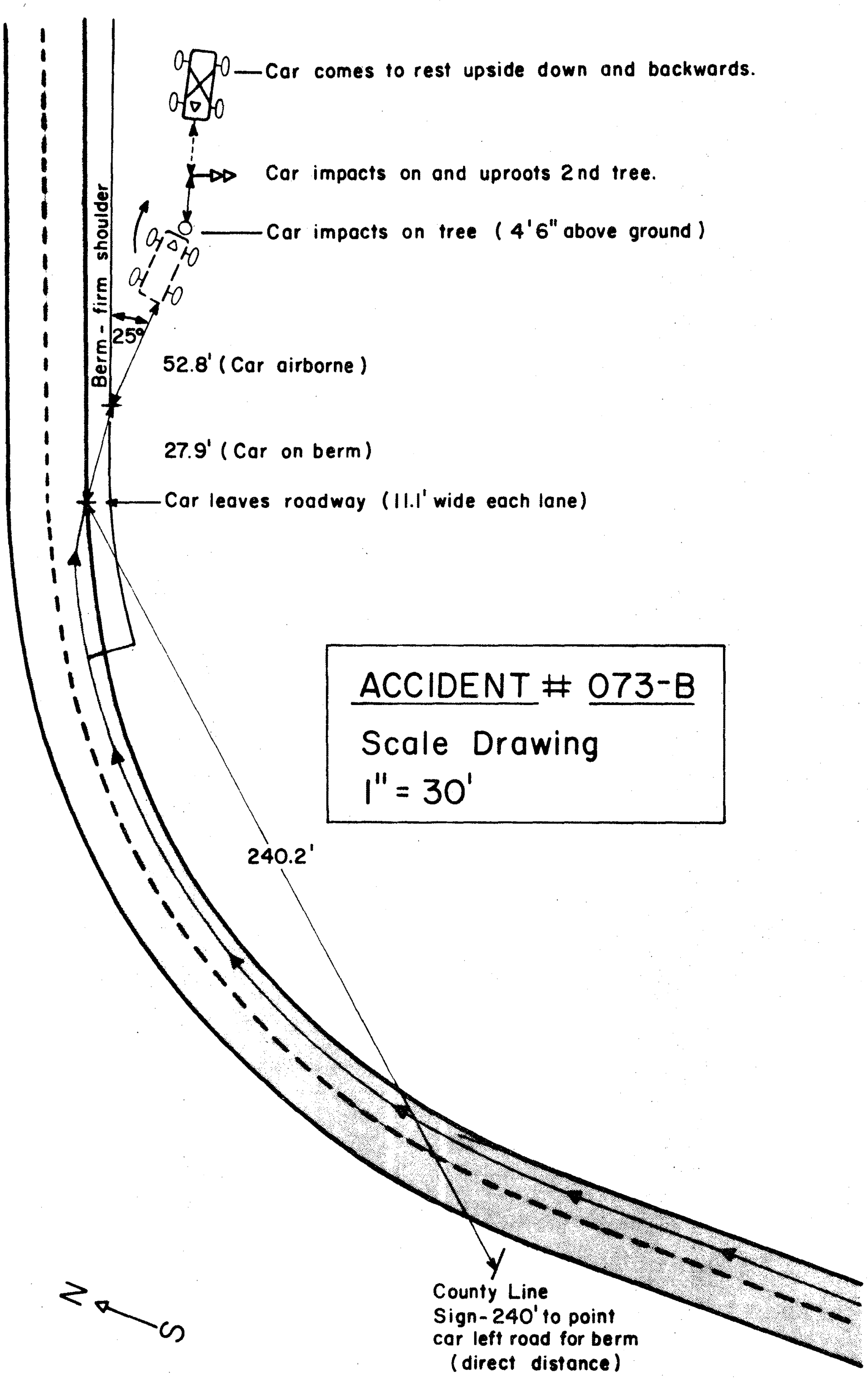
P-5 also stated to the investigating deputy that he believed the vehicle was traveling approximately 65 mph when it left the roadway.

Investigator drove to the scene at 55 to 60 mph with no difficulty and other traffic on the roadway seemed to be moving at a normal pace. The accident occurred at dawn; visibility was somewhat limited due to extremely heavy rain. Roadway was wet; temperature was slightly above freezing; there was no icing on the roadway. Both Monroe County Sheriff's Department Deputy and Bloomington Police Ambulance responded to the call with red lights and sirens and indicated no difficulty at speeds of 65 mph.

Traffic flow count was not obtained.

Seat belts were not used by any of the occupants.

Cause of the accident is attributable to the fact that the roadway was wet; vision was somewhat obscured by rain on the windshield and the drivers' ability to see the roadway was impaired by blinding headlights of on-coming traffic.


Car comes to rest upside down and backwards.
Car impacts on and uproots 2nd tree.
Car impacts on tree (4'6" above ground)
Berm - firm shoulder
25°
52.8' (Car airborne)
27.9' (Car on berm)
Car leaves roadway (11.1' wide each lane)
ACCIDENT # 073-B
Scale Drawing
1" = 30'
240.2'
County Line
Sign-240' to point
car left road for berm
(direct distance)
N
S

MONROE COUNTY ACCIDENT STUDY
ACCIDENT REPORT

Accident Number: 073-B Type PT

Date/Time/Group: 30 January 1969 0717 Thursday

AGENCY: Reporting S/0 Investigating S/0 Other

Location S.R. 45 West, 240.2 Ft. from Green Co. Line

ROAD DESCRIPTION

Type Blacktop, 2 lane

Speed limit 65 MPH

Weather Raining (hard), temperature in high 30's, Roadway wet.

Time: Dawn

Visibility Poor due to heavy rain and dawn

Volume Not taken at time of accident. Reading 0705-0720, Thursday, 13 February was 83 Eastbound @ average of 47.253 MPH and

Flow Speed 28 Westbound @ 48.607 MPH

INVOLVED VEHICLES	Type
V-1	1967 Chevrolet Station Wagon
V-2	
V-3	
V-4	

Parties	Location	Injury
1-D	Driver V-1	Bruise on R. Hip
1-P2	R.F. V-1	Broken Clavical
1-P5	R.R. V-1	Broken Back

Summary:

V-1 was eastbound on S.R. 45, 240.2 ft. east of the Monroe-Green Co. Line. V-1 left the road on the right side, went air-borne and struck a tree 4'8" above the ground. V-1 then proceeded to a second tree and uprooted this tree and then came to rest on its top.

FORM 107

Accident No.		Driver / Owner (Last) (First) (Middle)	Sex	Age	Veh. No.
0 7 3 B	X Driver X Owner		F M	40 Dob 1/9/29	0 1

Address	City	State
	Springville	Indiana
	Springville	Indiana

Drivers License ☒ Yes ☐ No Type op.

State Ind. Number C516-29049

Vehicle Make	Year	Type	State Lic. No.	State	Year	Trailer Lic. No.—State—Year
Chevrolet	67	S/W	28A3720	Ind.	68	

	Azimuth	Roadway:	Odometer	Speedometer (If Jammed)
☒ Moving ☐ Stopped ☐ Parked	0 7 0 °	S.R. #45 240.2' E. of Green Co. Ln.	40130	

Identification No.—(or any other factor)	Towed To: By:	Posted Speed Limit	Estimate of Vehicle Speed
	Cy Gyger - Wrecker	65	67

Vehicle Defects

☐ Yes

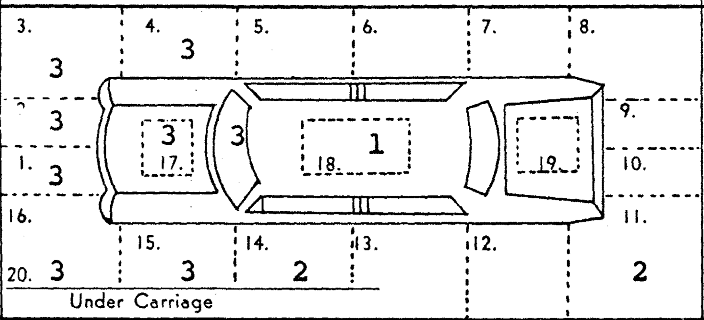
☒ No

☐ Undeterminable

☐ See Narrative

Type

Body Damage Severity



Severity Code

1. Slight or Minor
2. Moderate
3. Severe or Extreme
4. Fire Damage

I—Induced Damage

C—Contact Damage

→ Arrow Length Depth of Severity (Drawn into Diagram)

Driver Had Been Drinking

☐ Yes ☒ No ☐ Other (Drugs)

Police Determinate of Influence

☐ Minor

☐ Moderate

☐ Major

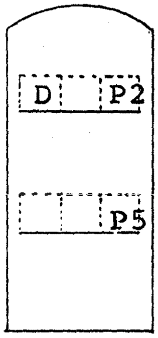
Test Results

Citation or Arrest Charge:

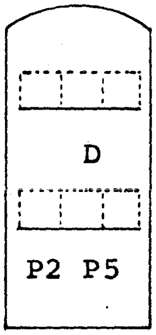
None

Occupants Positions Prior and After Accident

PRIOR



AFTER (Post)



Pass. Position (WT)

D=Driver

P1=CF

P2=RF

P3=LR

P4=CR

P5=RR

If 3 Seated Use

P6=LC

P7=CC

P8=RC

Skid Marks

Right Front

Left Front

Right Rear

Left Rear

Not Distinguishable

Total 0

Tread Depth

Recap

☐ Yes ☐ No RF

☐ Yes ☐ No LF

☐ Yes ☐ No RR

☐ Yes ☐ No LR

Seat Belts	Oper(D)	P1	P2	P3	P4	P5
Lap Belt	NU		NU			NU
Diagonal Belt	NU		NU			NU
Combination	NU		NU			NU
Child Restrainter	NU		NU			NU
Other	NU		NU			NU

Code

U=Used

NU=Not Used

NI=Not Installed

F=Failure

UU=Use Unknown

Gear Shift Position

Radio/Stereo 4☐ 3☐

1. ON
2. OFF
3. NI
4. UU

Motorcyclist:

Req. Equip. Used

☐ All—Items Not Used—

Light Switch Position ☐ HB ☒ LB ☐ Pk.

☒ On ☐ Off

1-4 Acc# 0 7 3B

5-10 Date Day | Week 0 1 3 0 9 5

11-14 Time 0 7 1 7

15 Acc involved:
1 Two or more M.V.
☒ One M.V. (Non-col)
3 Veh / Ped
4 Veh / Obj
5 Other

Tot Veh 16-17: 0 1
Tot Inj 18-19: 0 3
Tot Dead 20-21: 0 0

22-33 Location Matrix

34-36 Temp +54

Din 37-39 Vel. Wind

40 Weather
1 Clear & Bright
2 Overcast
3 Light Rain
4 Heavy
☒ Rrain
5 Light Snow
6 Heavy Snow
7 Sleet
8 Fog
9 Smoke
0 Other

41 Light
1 Day
2 Night
☒ Dawn
4 Dusk
5 Moon-light

42 County ☒ 2

43-44 Twp 0 6

Refrence (Milepost/Inters)

Dist & Dir

45 Other Damage
1 Yes
2 No

Obj Struck & extent of damage

Owner (Names & Add)

46-48 Rd #1 Ref No

ROADWAY OF VEHICLE S.R. #45 240.2' E. of Green Co. Ln.

62-64 Rd #2 Ref No

ROADWAY OF VEHICLE

49 Condition
1 Holes, ruts, bumps
2 Loose surface
3 Obj. on road
4 Soft shoulder
5 Const/repair

50 Type/Surface
1 Concrete
☒ Blacktop
3
4
5

51 Rd #1 Curvature
1 None
2 222'
3
4
5
6
7
8
9
0 Max.

65 Condition
1 Holes, ruts, bumps
2 Loose surface
3 Obj. on road
4 Soft shoulder
5 Const/repair

66 Type/Surface
1 Concrete
2 Blacktop
3
4
5

67 Rd #2 Curvature
1 None
2
3
4
5
6
7
8
9
0 Max.

52 Weather Surface—Rd #1
1 Dry
☒ Wet
3 Loose snow(<6")
4 Loose snow(>6")
5 Packed snow
6 Ice
7 Flooded
8 Other

53 Grade—Rd #1
1 None
2 -.01
3
4
5
6
7
8 Max.

68 Weather Surface—Rd #2
1 Dry
2 Wet
3 Loose snow(<6")
4 Loose snow(>6")
5 Packed snow
6 Ice
7 Flooded
8 Other

69 Grade—Rd #2
1 None
2
3
4
5
6
7
8 Max.

54 Obstructed Vision Rd #1
1 Yes
☒ No

55 Temp. Change in Flow Dir. Rd #1
1 Yes
☒ No

56 Temp. Change in # of Lanes Rd #1
1 Reduction in # of Lanes
2 Reduction in Lane Width
3 Increase in # of Lanes
4 Increase in Lane Width

70 Obstructed Vision Rd #2
1 Yes
2 No

71 Temp. Change in Flow Dir. Rd #2
1 Yes
2 No

72 Temp. Change in # of Lanes Rd #2
1 Reduction in # of Lanes
2 Reduction in Lane Width
3 Increase in # of Lanes
4 Increase in Lane Width

57 Traffic Controls Rd #1
☒ None
2 Stop Sign
3 Yield
4 Red Blinker
5 Yellow Blinker
6 Red
7 Green
8 Yellow
9 Unknown
0 Manual

58 # of Lanes Rd #1
1 (1)
☒ (2)
3 (1)/(2)
4 (2)/(1)
5 (2)/(2)
6 (3)/(2)
7 (2)/(3)
8 (3)/(3)
9 Other

59-61 Direction of Travel (Azimuth) 7 0

73 Traffic Controls Rd #2
1 None
2 Stop Sign
3 Yield
4 Red Blinker
5 Yellow Blinker
6 Red
7 Green
8 Yellow
9 Unknown
0

74 # of Lanes Rd #2
1 (1)
2 (2)
3 (1)/(2)
4 (2)/(1)
5 (2)/(2)
6 (3)/(2)
7 (2)/(3)
8 (3)/(3)
9 Other

75-77 Direction Travel (Azimuth) Rd # 2

78 Photos
2 Police
☒ Research
3 Both ☐

Number of Research Pictures
Polaroid 6
Instamatic ☐
Specify Type Other 16 35 mm.

Agencies Notified By Police
Name
Reason for Notification
Name
Reason for Notification

Police Agency Investigating
Agency Monroe Co. Sheriff's Dept.
Unit No. and Name
Agency Accident Report No.

DRIVER/PASSENGER

Accident No. 0 7 3 B	1=Bleeding Wound, Distorted Members, or Victim carried away 2=Bruises, Abrasions, Swelling 3=Complaint of Pain, No Visible Sign or Momentary Unconsciousness

Name (Last) (First) (Middle)	Sex F	Age 40	Vehicle No. 01
Address (Street) (City) (State) Springville, Indiana		Tele.No.	x Driver _ Passenger _ Pedestrian
If Passenger Position Class.	_ Fatal _ 1 x 2 Non-Fatal _ 3		☐ No Injury
First Aid: ☒ Given By: Bloomington ☐ Refused: Police Dept.	Taken To: Bloomington Hospital		By: Police Ambulance
Nature of Injuries: Bruise on right hip			

Name (Last) (First) (Middle)	Sex F	Age 59	Vehicle No. 01
Address (Street) (City) (State) Springville, Indiana		Tele.No.	_ Driver x Passenger _ Pedestrian
If Passenger Position Class. P2	_ Fatal x 1 _ 2 Non-Fatal 3		☐ No Injury
First Aid: ☒ Given By: Bloomington ☐ Refused: Police Dept.	Taken To: Bloomington Hospital		By: Police Ambulance
Nature of Injuries: Abrasion and broken clavical			

Name (Last) (First) (Middle)	Sex M	Age 21	Vehicle No. 01
Address (Street) (City) (State) Springville, Indiana		Tele.No.	_ Driver x Passenger _ Pedestrian
If Passenger Position Class. P5	_ Fatal x 1 _ 2 Non-Fatal 3		☐ No Injury
First Aid: ☒ Given By: Bloomington ☐ Refused: Police Dept.	Taken To: Bloomington Hospital		By: Police Ambulance
Nature of Injuries: Abrasions - cuts and broken back			

INVESTIGATORS CONCLUSION

TRAFFIC FLOW BEHAVIOR

VOLUME EB-83, WB-28

SPEED (EB) Average 47.3 (WB) Average 48.6 MPH Speed limit 65 MPH

ACCIDENT INVOLVED VEHICLES

SPEED PRIOR	V-1	EST 65	MIN 60	MAX 67
	V-2	EST	MIN	MAX
	V-3	EST	MIN	MAX
	V-4	EST	MIN	MAX
SPEED IMPACT	V-1	EST 60	MIN 58	MAX 63
	V-2	EST	MIN	MAX
	V-3	EST	MIN	MAX
	V-4	EST	MIN	MAX

SPEED A FACTOR IN ACCIDENT (YES OR NO) NO

COMMENTS:

The trajectory calculations indicate that the vehicle was traveling at about speed limit. In the opinion of the investigator, the accident would have occurred even if the vehicle had been traveling up to 15 mph slower. The condition of being blinded by oncoming traffic during heavy rain was independent of the speed deviance from the average as indicated above.

DO NOT CIRCULATE

Appendix F

SPEED ESTIMATION OF AIV USING DATA FROM COMPUTER SENSOR SYSTEM

MONROE COUNTY ACCIDENT STUDY
ACCIDENT REPORT

Accident Number: 280-J Type PD

Date/Time/Group: 10 Sept. 1969 1735 Wednesday

AGENCY: Reporting ISP Investigating ISP Other

Location SR 37N (300 ft. south of Kinser Pike)

ROAD DESCRIPTION

Type 2 Lane - 1 SB, 1 NB, Concrete

Speed limit 65 mph

Weather Clear, Dry pavement, daylight

Visibility unobscured

Volume SB 16.328 - 107; NB 16.327 - 159

Flow Speed SB - 56 NB - 55

INVOLVED VEHICLES	Type
V-1	1962 Pontiac 4 dr. sedan
V-2	1963 International truck (semi)
V-3	
V-4	

Parties	Location	Injury
V-1-D	LF	None
V-2-D	LF	None

Summary:

FORM 107

Accident 280
Date: September 10, 1969
Time: 1735 hours
Location: SR 37 N, 300 feet south of Kinser Pike
Weather: Clear and dry

V-1, a 1962 Pontiac, was enroute north on SR 37N at 1735 hours on Wednesday, 10 September, 1969. D-1 noticed several vehicles stopped in the northbound lane at Kinser Pike and braked sharply to avoid a rear-end collision with these stopped vehicles. V-1 skidded across the centerline and into the southbound lane of SR 37N. V-1 was struck head-on by V-2, a southbound 1963 International combination truck (tractor and trailer). Both vehicles came to rest against the side railing of an iron bridge in the northbound lane of SR 37N.

The accident site is bracketed by loop pair 9-13 on the south and 10-14 on the north. Loops 13 and 14 monitor northbound traffic in sequential order while loops 10 and 9 monitor southbound traffic. The distance between these loop pairs is 2.3 miles. The accident occurred approximately .2 miles north of loop pair 9-13. (The data for these loops between 1600 hours and 1730 hours was retrieved from computer tape storage. A portion of this data has been reproduced on the following pages.)

From the police report it is determined that V-1 was a northbound, 1962 Pontiac 4-door sedan, traveling at approximately 65 mph. Witness statements further indicate that V-1 was followed by two consecutive semitrucks.

By examining the data for loop 13 two items are immediately noticed: (1) at 16.590 traffic begins to slow and eventually stops at 16.683 and (2) two semitrucks (A & B) pass thru loop 13 in succession at 16.579. Using the witness reports, the vehicle preceding the trucks is tentatively identified as V-1. At a constant speed of 50 mph, this vehicle should have arrived at loop 14, 151 seconds later or 16.620. At the time that V-1 should arrive at loop 14 an eight minute gap occurs in the traffic flow and V-1 has disappeared from the system. The length of this vehicle is 18 feet which is as expected for V-1.

Using this vehicle's time of crossing loop 13 as a base the time of accident may now be predicted. At 50 mph, V-1 would have reached the accident site at 16.582. The average speed for southbound traffic between 1600 and 1730 hours is 52 mph. Using this speed we then project back from the accident site to loop 10. To arrive at the accident site at 16.582 traveling at 52 mph a vehicle would have to have crossed loop 10 at 16.546, 130 seconds earlier.

Examining the data for loop 10 at 16.546 a large vehicle is observed traveling south at a speed of 53 mph. The two vehicles immediately preceding this truck (C & D) cross loop 9 as expected at 16.579 but the truck fails to cross loop 9. Instead there appears a three minute and 50 second gap in the flow which was not apparent at loop 10. This vehicle is then identified as V-2. Its speed coincides with the police report estimate and its length lends additional credence to the identification.

Now that the vehicles have been identified a speed estimate may be made. The posted speed limit is 65 mph. The police report gives 65 mph and 50 mph as the prior speed estimates for V-1 and V-2 respectively. These may be considered valid within ±10%. The printout indicates a speed of 53 mph for V-2 lending support to the police estimates; however, V-1 printout speed is only 50 mph. Since the accident occurred only .2 miles north of the sensor this speed would normally be given greater consideration in making the estimate; however, in an interview at the accident scene with the investigating officer it was learned that V-1 was accelerating. D-1 was anticipating passing the vehicle preceding him after they crossed the bridge on which the accident occurred. The accident diagram indicates that V-1 skidded 110 feet and V-2 125 feet prior to impact. This data can be used to estimate the impact speeds for V-1 and V-2 as 41 mph and 15 mph respectively using prior speeds of 60 mph and 53 mph respectively.

	PRIOR			IMPACT		
	MIN	EST	MAX	MIN	EST	MAX
V-1	50	60	65	15	41	45
V-2	53	53	55	10	15	15

```
THIS LISTING IS FOR LOOPS 13  14 BETWEEN 16000 AND 17500 ON 9/  10

                  LOOP 13                                          LOOP 14

    DIR    SPEED   LEN    HEADWAY     TIME          DIR    SPEED    LEN     HEADWAY    TIME

     0      60     17      19084      16550   *      0       65      20        3733     16577
     0      62     18       1160      16550   *      0       60      18           0     16595
     0      51     18      28673      16558   *      0       60      18        4205     16596
     0      50     17        905      16558   *      0       62      15       14825     16600
     0      55     18       8892      16561   *      0       66      15        3410     16601
     0      53     14       9247      16563   *      0       60      13        3442     16602
     0      57     15      10298      16566   *      0       65      17        8220     16604
     0      51     18       7293      16568   *      0       54      12           0     16615
     0      52     16        807      16569   *      0       52      15       26247     16622
     0      51     18       2054      16569   *      0       74      17           0     16756
     0      55     14      21636      16575   *      0       67      16           0     16785
     0      51     17       5209      16577   *      0       54      14           0     16825
     0      45     16       1949      16577   *      0       57      13        1652     16825
     0      47     17       2076      16578   *      0       45      17           0     16839
     0      45     18        898      16578   *      1       71      21           0     16890
     0 V-I  50     18       2043      16578   *      0       51      12           0     16927
     0  A   49     47       1224      16579   *      0       64      12           0     16950
     0  B   52     47       2796      16580   *      0       62      17        9465     16952
     0      50     16       1628      16580   *      0       17      25           0     16964
     0      34     12          0      16590   *      0       47      13           0     16982
     0      30     19      14346      16593   *      0       65      18           0     17010
     0      27     15       5433      16595   *      0       56      13           0     17023
     0      17     22      10570      16598   *      0       64      15        2643     17023
     0      16     21       3969      16599   *      0       68      15        1106     17024
     0      12     18       3399      16600   *      0       64      17        7231     17026
     0       3     28          0      16660   *      0       49      38       11753     17029
     0       8     20          0      16680   *      0       49      39        1964     17029
     0       8     19       5468      16681   *      0       51      17        2192     17030
     0       9     21       7257      16683   *      0       49      17        1873     17030
     0       0      0          0      16836   *      0       48      15        2237     17031
     0       3     21          0      16847   *      0       58      26           0     17041
     0       0      0          0      16903   *      0       59      17        9167     17043
     0       6     45        873      16903   *      0       65      15        2238     17044
     0       9     38          0      16924   *      0       65      18        1968     17044
     0       7     22      12004      16927   *      0       59      13        3497     17045
     0       0      0          0      16949   *      0       60      15        2444     17046
     0       0      0       4347      16950   *      0       62      17        1492     17046
     0       2     33          0      16961   *      0       63      17        2536     17047
     0       0      0      15821      16965   *      0       66      13        1818     17047
     0       0      0       6941      16967   *      0       66      16        1493     17048
     0       0      0          0      16983   *      0       63      17        2199     17049
```

```
LISTING IS FOR LOOPS 9   10 BETWEEN 16000 AND 17500 ON  9/  10

                  LOOP 9                                           LOOP 10

   DIR   SPEED    LEN   HEADWAY     TIME          DIR     SPEED   LEN      HEADWAY   TIME

    0      62      12      2417     16471  *       0        66     36          0     16521
    0      92      14     11477     16474  *       0        75     19       2638     16521
    0      79      17         0     16492  *       0        60     17          0     16531
    0      76      18      1905     16492  *       0        57     17        988     16531
    0      57      19     17381     16497  *       0        59     12       2918     16532
    0      61      19     13760     16501  *       0        54     13          0     16541
    0      60      18      2082     16501  *       0   C    64     16       3685     16542
    0      60      18       846     16501  *       0   D    68     15       3501     16542
    0      62      19      3155     16502  *       0 V-2    53     37      14246     16546
    0      61      15      2244     16503  *       0        55      8       1155     16547
    0      61      11      3158     16504  *       0        56     17       1193     16547
    0      54      16     10442     16507  *       0        53     17       1020     16547
    0      71      17     11158     16510  *       0        53     11       1490     16548
    0      64      19     24371     16517  *       0        61     16       1777     16548
    0      65      16      1494     16517  *       0        60     11       2500     16549
    0      53      13     18923     16522  *       0        58     17       4839     16550
    0      55      11      3655     16523  *       0        53     25          0     16561
    0      59      16      1573     16524  *       0        53     43       2399     16561
    0      59      18      1660     16524  *       0        57     12       1017     16561
    0      53      16      1950     16525  *       0        56     15       4690     16563
    0      49      14      1165     16525  *       0        58     17       2419     16563
    0      49      17      2442     16526  *       0        55     18       3118     16564
    0      50      17      2050     16526  *       0        57     15        939     16565
    0      48      15      4138     16527  *       0        57     17       1338     16565
    0      50      16      3128     16528  *       0        66     11       7536     16567
    0      48      16     12800     16532  *       0        62     18       2306     16568
    0      58      18     12992     16536  *       0        61     21          0     16577
    0      42      12     20910     16541  *       0        61     18       1468     16577
    0      74      37         0     16551  *       0        61     20       2317     16578
    0      76      18      6161     16552  *       0        61     11       2182     16578
    0      41      11     14792     16556  *       0        62      9       3154     16579
    0      59      17       456     16557  *       0        65     14       2272     16580
    0      58      18       915     16557  *       0        73     19          0     16592
    0      61      12      1550     16557  *       0        59     18          0     16601
    0      54      15         0     16579  *       0        64     15          0     16613
    0  C   59      17      1513     16579  *       0        65     18       1965     16613
    0  D   54      16      1017     16579  *       0        61     14       7986     16615
    0      10      12         0     16643  *       0        63     17       1280     16616
    0       0       0         0     16658  *       0        62     16       1075     16616
    0       0       0      1581     16658  *       0        63     18       4664     16617
    0      15      12     17147     16663  *       0        63     15       1933     16618
    0      18       8         0     16675  *       0        63     13       2829     16619
    1       5       5     21482     16680  *       0        62     19       4067     16620
    0      11      14      7731     16683  *       0        62     16       1554     16620
    0      30      16         0     16713  *       0        63     44      15571     16624
    0      36      15     11892     16716  *       0        62     17       1228     16625
```

Accident No. 2 8 0

Driver (Last) (First) (Middle)

Owner Same

Sex F

Age 24

Dob 12/28/44

Veh. No. 0 1

Address

City Indianapolis

State Ind.

Drivers License ☒ Yes ☐ No Type OP

State Ind. Number G-550-44508

Vehicle Make	Year	Type	State Lic. No.	State	Year	Trailer Lic. No.—State—Year
Pontiac	62	4 Dr. Sed	71F 5387	Ind.	69	

X Moving

Stopped

Parked

Azimuth North

Roadway: S.R. #37 North

Odometer

Speedometer (If Jammed)

Identification No.—(or any other factor)

Towed To: By: Hay's Gulf

Posted Speed Limit 65

Estimate of Vehicle Speed

Vehicle Defects

☐ Yes

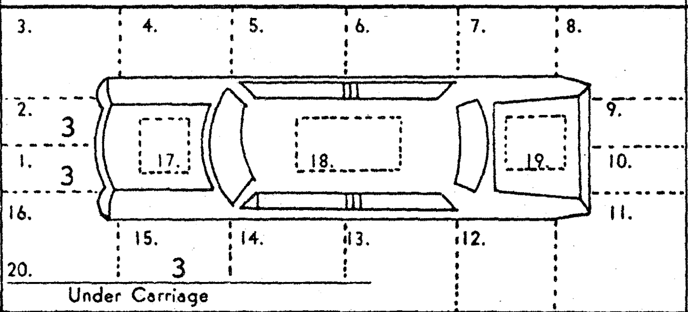
☐ No

☐ Undeterminable

☐ See Narrative

Type

Body Damage Severity



Severity Code ·

1. Slight or Minor
2. Moderate
3. Severe or Extreme
4. Fire Damage

I—Induced Damage

C—Contact Damage

→ Arrow Length Depth of Severity (Drawn into Diagram)

Driver Had Been Drinking ☐ Yes ☒ No ☐ Other (Drugs)

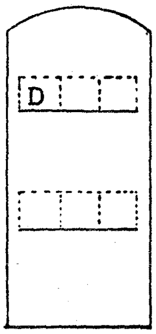
Police Determinate of Influence ☐ Minor ☐ Moderate ☐ Major

Test Results

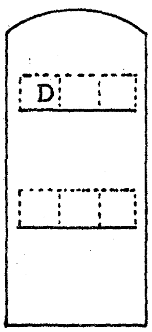
Citation or Arrest Charge:

Occupants Positions Prior and After Accident

PRIOR



AFTER (Post)



Pass. Position (WT)

D=Driver ....

P_1=CF ....

P_2=RF ....

P_3=LR ....

P_4=CR ....

P_5=RR ....

If 3 Seated Use

P_6=LC ....

P_7=CC ....

P_8=RC ....

Skid Marks

Right Front ....

Left Front ....

Right Rear ....

Left Rear ....

Not Distinguishable ....

Total 110'

Tread Depth

Recap

☐ Yes ☐ No..........RF ....

☐ Yes ☐ No..........LF ....

☐ Yes ☐ No..........RR ....

☐ Yes ☐ No..........LR ....

Gear Shift Position

Seat Belts	Oper(D)	P_1	P_2	P_3	P_4	P_5
Lap Belt	U.U.					
Diagonal Belt						
Combination						
Child Restrainter						
Other						

Code

U=Used

NU=Not Used

NI=Not Installed

F=Failure

UU=Use Unknown

Radio/Stereo ☐ ☐

1. ON
2. OFF
3. NI
4. UU

Motorcyclist:
Req. Equip. Used
☐ All—Items Not Used—

Light Switch Position ☐ HB ☐ LB ☐ Pk. ☐ On ☐ Off

1-4 Acc # 2810

5-10 Date Day | Week 091094

11-14 Time 1735

15 Acc involved:
X Two or more M.V.
2 One M.V. (Non-col)

3 Veh / Ped
4 Veh / Obj
5 Other

16-17 Tot Veh 02

18-19 Tot Inj 00

20-21 Tot Dead 00

22-33 Location Matrix

34-36 Temp

37-39 Dir Vel. Wind

40 Weather
X Clear & Bright
2 Overcast
3 Light Rain
4 Heavy Rrain
5 Light Snow
6 Heavy Snow
7 Sleet
8 Fog
9 Smoke
0 Other

41 Light
X Day
2 Night
3 Dawn
4 Dusk
5 Moon-light

42
X
2

43-44 County 1 0

Twp 5

Refrence (Milepost/Inters) S.R. 37 N. (300 Ft. South of Kinser Pike)

Dist & Dir

45 Other Damage
1 Yes
X No

Obj Struck & extent of damage

Owner (Names & Add)

46-48 Rd #1 Ref No

ROADWAY OF VEHICLE 1 S.R. 37 North

62-64 Rd #2 Ref No

ROADWAY OF VEHICLE 2 S.R. 37 North

49 Condition
1 Holes, ruts, bumps
2 Loose surface
3 Obj. on road
4 Soft shoulder
5 Const/repair

50 Type/Surface
X Concrete
2 Blacktop
3
4
5

51 Rd #1 Curvature
X None
2
3
4
5
6
7
8
9
0 Max.

65 Condition
1 Holes, ruts, bumps
2 Loose surface
3 Obj. on road
4 Soft shoulder
5 Const/repair

66 Type/Surface
X Concrete
2 Blacktop
3
4
5

67 Rd #2 Curvature
X None
2
3
4
5
6
7
8
9
0 Max.

52 Weather Surface—Rd #1
X Dry
2 Wet
3 Loose snow(<6")
4 Loose snow(>6")
5 Packed snow
6 Ice
7 Flooded
8 Other

53 Grade—Rd #1
X None
2
3
4
5
6
7
8 Max.

68 Weather Surface—Rd #2
X Dry
2 Wet
3 Loose snow(<6")
4 Loose snow(>6")
5 Packed snow
6 Ice
7 Flooded
8 Other

69 Grade—Rd #2
X None
2
3
4
5
6
7
8 Max.

54 Obstructed Vision Rd #1
1 Yes
X No

55 Temp. Change in Flow Dir. Rd #1
1 Yes
X No

56 Temp. Change in # of Lanes Rd #1
1 Reduction in # of Lanes
2 Reduction in Lane Width
3 Increase in # of Lanes
4 Increase in Lane Width

70 Obstructed Vision Rd #2
1 Yes
X No

71 Temp. Change in Flow Dir. Rd #2
1 Yes
X No

72 Temp. Change in # of Lanes Rd #2
1 Reduction in # of Lanes
2 Reduction in Lane Width
3 Increase in # of Lanes
4 Increase in Lane Width

57 Traffic Controls Rd #1
X None
2 Stop Sign
3 Yield
4 Red Blinker
5 Yellow Blinker
6 Red
7 Green
8 Yellow
9 Unknown
0 Manual

58 # of Lanes Rd #1
1 (1)
X (2)
3 (1)/(2)
4 (2)/(1)
5 (2)/(2)
6 (3)/(2)
7 (2)/(3)
8 (3)/(3)
9 Other

59-61 Direction of Travel (Azimuth) Northbound

73 Traffic Controls Rd #2
X None
2 Stop Sign
3 Yield
4 Red Blinker
5 Yellow Blinker
6 Red
7 Green
8 Yellow
9 Unknown
0

74 # of Lanes Rd #2
1 (1)
X (2)
3 (1)/(2)
4 (2)/(1)
5 (2)/(2)
6 (3)/(2)
7 (2)/(3)
8 (3)/(3)
9 Other

75-77 Direction Travel (Azimuth) Rd # 2 Southbound

78 Photos
2 Police
1 Research
3 Both ☐

Number of Research Pictures
Polaroid ☐
Instamatic ☐
Other ☐
Specify Type ....

Agencies Notified By Police

Name

Reason for Notification

Name

Reason for Notification

Police Agency Investigating

Agency ISP

Unit No. and Name Patrick

Agency Accident Report No.

Accident No. 2 8 0

Driver (Last) (First) (Middle)

Owner

Sex M

Age 38

Dob 11/19/30

Veh. No. 0 2

Address

City Indianapolis, State Ind.

Indianapolis, Ind.

Drivers License ☒ Yes ☐ No Type Chaf.

State Ind. Number 5-240-30459

Vehicle Make	Year	Type	State Lic. No.	State	Year	Trailer Lic. No.—State—Year
International	63	Truck (tractor)	2887 L	Ind.	69	

☒ Moving
☐ Stopped
☐ Parked

Azimuth South

Roadway: S.R. 37 North

Odometer

Speedometer (If Jammed)

Identification No.—(or any other factor)

Towed To: By: Drive Away

Posted Speed Limit 65

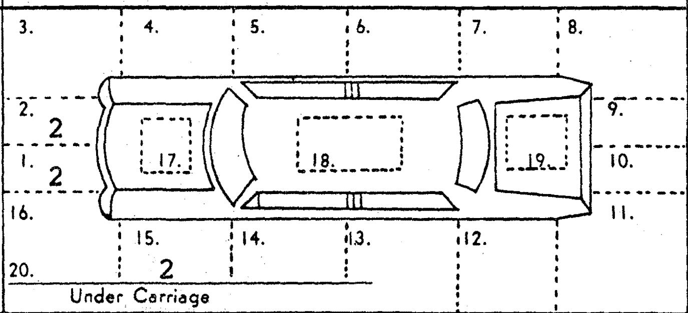
Estimate of Vehicle Speed

Vehicle Defects

☐ Yes
☒ No
☐ Undeterminable
☐ See Narrative

Type

Body Damage Severity



Severity Code

1. Slight or Minor
2. Moderate
3. Severe or Extreme
4. Fire Damage

I—Induced Damage

C—Contact Damage

→ Arrow Length Depth of Severity (Drawn into Diagram)

Driver Had Been Drinking

☐ Yes ☒ No ☐ Other (Drugs)

Police Determinate of Influence

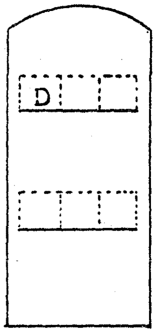
☐ Minor
☐ Moderate
☐ Major

Test Results

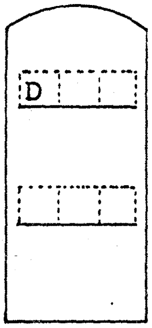
Citation or Arrest Charge: None

Occupants Positions Prior and After Accident

PRIOR



AFTER (Post)



Pass. Position (WT)

D=Driver
P_1=CF
P_2=RF
P_3=LR
P_4=CR
P_5=RR

If 3 Seated Use

P_6=LC
P_7=CC
P_8=RC

Skid Marks

Right Front
Left Front
Right Rear
Left Rear
Not Distinguishable
Total 125'

Tread Depth

Recap

☐ Yes ☐ No RF
☐ Yes ☐ No LF
☐ Yes ☐ No RR
☐ Yes ☐ No LR

Seat Belts	Oper(D)	P_1	P_2	P_3	P_4	P_5
Lap Belt	U.U.					
Diagonal Belt						
Combination						
Child Restrainter						
Other						

Code

U=Used
NU=Not Used
NI=Not Installed
F=Failure
UU=Use Unknown

Gear Shift Position

Radio/Stereo ☐ ☐

1. ON
2. OFF
3. NI
4. UU

Motorcyclist: Req. Equip. Used
☐ All—Items Not Used—

Light Switch Position ☐ HB ☐ LB ☐ Pk.
☐ On ☐ Off

Mail Report To: DIANA STATE POLICE, IN... IANA 46204

(8) TYPE ______ (9) SOURCE ______ (10-11) ANALYSIS ______ (12-13-14-15) LOSS ______ (16) LOCATION ______ (2-3-4-5-6-7) ACCIDENT NO. 280

TIME

(17-18) (19-20) (21) DATE OF ACCIDENT September 10, 1969 (Month Day Year)

(22) ☐ DAY OF WEEK Wednesday

(23-24) ☐☐ TIME OF DAY ______ AM 5:35 PM

LOCATION

PLACE WHERE ACCIDENT OCCURRED:
If accident occurred outside of city limits, indicate distance from nearest city or town limits, using two directions, if necessary.

______ Occurred within corporate limits.

______ Occurred outside corporate limits.

(25-26) ☐☐ COUNTY Monroe

(27) ☐ (28-29) ☐☐ CITY OR TOWN ______

(30-31) ☐☐ TOWNSHIP Bloomington

½ MILES NORTH. ______ MILES SOUTH. ______ MILES EAST. ______ MILES WEST OF.

LIMITS OF Bloomington, (City or Town)

(32-33-34) ROAD ON WHICH ACCIDENT OCCURRED SR.#37 (Name of Street or No. of Highway (US or STATE). If no No., use name.)

(35-36) ☐☐ AT IT S INTERSECTION WITH ______ (37-38-39-40) (Name or Number of Intersecting Street or Highway.)

IF NOT AT INTERSECTION 300 FEET (____N X S ____E ____W) OF Kinser Pike (Show nearest intersection, house number, or other identifying landmark.)

VEHICLES

Total Number of Vehicles Involved 2

VEHICLE NUMBER 1:	VEHICLE NUMBER 2:
YEAR 62 MAKE Pontiac (41) ☐ TYPE 4 dr. Sed. (42-43) ☐☐ (Sedan, Truck, Bus, etc.)	YEAR 63 MAKE International (41) ☐ TYPE Truck (42-43) ☐☐ (Sedan, Truck, Bus, etc.)
(44) ☐ LICENSE PLATE 71F 5387 Ind. 1969 (Number State Year)	(44) ☐ LICENSE PLATE 2887 L Ind. 1969 (Number State Year)
DRIVER ______ (Print) Last Name First Middle	DRIVER ______ (Print) Last Name First Middle
ADDRESS ______ (Print) Street or R.F.D.	ADDRESS ______ (Print) Street or R.F.D.
Indianapolis, Indiana (City and State) (45-46) BIRTH DATE 12-23-44 AGE 24 (47) ☐ SEX F	Indianapolis, Indiana (City and State) (45-46) BIRTH DATE 11-19-30 AGE 38 (47) ☐ SEX
(48) ☐ DRIVER'S LICENSE S 550-44566 Ind. OP. (Number State Type)	(48) ☐ DRIVER'S LICENSE S 240-30459 Ind. Chauff. (Number State Type)
(49) ☐ OWNER Same as above (Last Name First Middle)	(49) ☐ OWNER ______ (Last Name First Middle)
ADDRESS ______ (Street or R.F.D. City State)	ADDRESS Indianapolis, Ind. (Street or R.F.D. City State)
PARTS OF VEHICLE DAMAGED TOTAL--front end, motor, frame	PARTS OF VEHICLE DAMAGED front bumper, left front of tractor
ESTIMATE OF REPAIR $ 1100.00	ESTIMATE OF REPAIR $ 300.00
VEHICLE REMOVED TO Hay's Gulf BY Wrecker	VEHICLE REMOVED TO Driven BY Driver

INJURED

Total Number Killed (50) 0

Injured (51) 0

(52)

(53-54) (55) ☐ NAME ______ (Print) Last Name First Middle AGE ____ SEX ____	(53-54) (55) ☐ NAME ______ (Print) Last Name First Middle AGE ____ SEX ____
ADDRESS ______ (56) ☐ Street or R.F.D. City (57) ☐ State	ADDRESS ______ (56) ☐ Street or R.F.D. City (57) ☐ State
DRIVER ____ PASSENGER ____ IN VEHICLE NUMBER ____	DRIVER ____ PASSENGER ____ IN VEHICLE NUMBER ____
PEDESTRIAN ____ Other (EXPLAIN) ____	PEDESTRIAN ____ Other (EXPLAIN) ____
NATURE AND EXTENT OF INJURIES ____	NATURE AND EXTENT OF INJURIES ____

Mark First One That Applies

1. ____	2. ____	3. ____	4. ____	1. ____	2. ____	3. ____	4. ____
Died as result of accident.	Visible signs of injury, as bleeding wound, distorted limb or had to be carried away.	Other visible injuries, as bruises, swelling, abrasions, limping, etc.	No visible injuries, but complaint of pain or momentary unconsciousness.	Died as result of accident.	Visible signs of injury, as bleeding wound, distorted limb or had to be carried away.	Other visible injuries, as bruises, swelling, abrasions, limping, etc.	No visible injuries, but complaint of pain or momentary unconsciousness.

DO NOT MARK IN BOXES

DAMAGE TO OTHER PROPERTY NONE (Name of Object (s) Owner's Name and Address Nature of Damages)

ESTIMATE OF REPAIR $ ______

302 This form is approved by the Superintendent, Indiana State Police, pursuant to Burns Indiana Statutes 47-1918, Acts 1939, Ch. 48.

Driver Ped. (Check one)
1 2
0 X X ___ No test offered.
1 ___ ___ ___ Test offered but refused.
2 ___ ___ ___ Breath test given.
3 ___ ___ ___ Blood test given.
4 ___ ___ ___ Urine test given.

(80) ARREST—(Check one)
Driver
1 2
0 X X Not arrested.
1 ___ ___ Arrested for D. U. I.
2 ___ ___ Arrested for other violation.

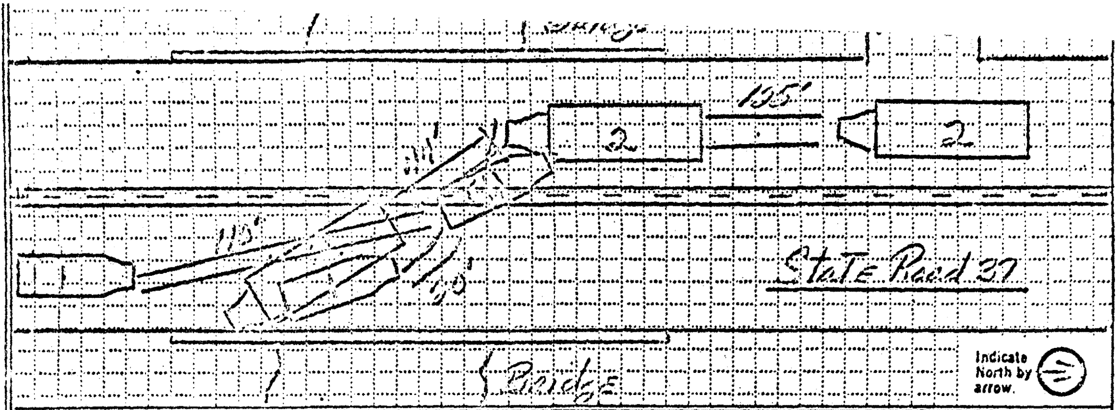
(81) SPEED LIMIT 65 MPH

(82) SPEED BEFORE ACCIDENT
Veh. 1 65 MPH Veh. 2 50 MPH

(83) CONTRIBUTING CIRCUMSTANCES INDICATED
Driver
1 2
1 ___ ___ Speed too fast.
2 ___ ___ Failed to yield right-of-way.
3 X ___ Drove left of center.
4 ___ ___ Improper overtaking.
5 ___ ___ Passed stop sign.
6 ___ ___ Disregarded traffic signal.
7 ___ ___ Followed too closely.
8 ___ ___ Made improper turn.
9 ___ ___ Other improper driving.
10 ___ ___ Inadequate brakes.
11 ___ ___ Improper lights.
12 ___ ___ Had been drinking.

(84) VEHICLE DEFECTS
Driver
1 2
0 X X No defects.
1 ___ ___ Brakes defective.
2 ___ ___ Lights defective.
3 ___ ___ Defective steering.
4 ___ ___ Puncture or blowout.
8 ___ ___ Other defects.

(85) VISION OBSCURED
Driver
1 2
0 X X Not obscured.
1 ___ ___ By building/s.
2 ___ ___ By embankment.
3 ___ ___ By signboard.
4 ___ ___ Trees, crops, etc.
5 ___ ___ By hillcrest.
8 ___ ___ ___
(Specify other)



DESCRIBE WHAT HAPPENED: Refer to vehicle by number: Veh.1 enroute north on SR37 was coming into an ifon bridge approaching Kinser Pike when suddenly traffic in front slowed for a veh. that was turning off of SR37 onto Kinser Pike. Veh.1 braked sharply and skidded approx. 110 ft. and went across the center line to avoid a rear end collision & was hit headon by veh.2 as it was southbound on SR37. Veh.2 skidded 125 ft. before impact in the south bound lane & after impact went antoher 44 ft. into the bridge on the east side of the road. Veh.1 was wedged under the tractor trailer at this time. Opinion: cause of acc. was veh.1 being left of center with other traffic present & not having veh. under control to avoid a collisi

WHAT DRIVERS WERE GOING TO DO BEFORE ACCIDENT:
(C3)
Driver No. 1 was headed X N ___ S ___ E ___ W on SR#37 (Name or number of street or highway.)
Driver No. 2 was headed ___ N X S ___ E ___ W on SR#37 (Name or number of street or highway.)

(Check applicable items for each driver.)
Driver
1 2
0 ___ ___ Passing.
1 ___ ___ Turn right.
1 ___ ___ Turn left.
1 ___ ___ Make U turn.
2 ___ ___ Backing.
3 ___ ___ Slow or stop.
4 X X Going straight ahead.
5 ___ ___ Start in traffic lane.
5 ___ ___ Start from parked position.
6 ___ ___ Avoiding veh., obj., ped.
7 ___ ___ Skidded before applying brakes.
8 X X Skidded after applying brakes.
9 ___ ___ Parked.

CONDITION OF DRIVERS AND PEDESTRIANS
(Check one)
(C3) (70)
Driver Ped.
1 2
0 X X ___ Had NOT been drinking.
1 ___ ___ ___ Obviously drunk.
2 ___ ___ ___ Ability impaired.
3 ___ ___ ___ Ability not impaired.
4 ___ ___ ___ Unknown if impaired.
(C3) (71)
11 X X ___ Apparently normal.
0 ___ ___ ___ Eyesight defective.
1 ___ ___ ___ Hearing defective.
2 ___ ___ ___ Other defects.
3 ___ ___ ___ Illness.
4 ___ ___ ___ Fatigued.
5 ___ ___ ___ Apparently asleep.
6 ___ ___ ___ Attention diverted.
7 ___ ___ ___ Advanced senility.
8 ___ ___ ___ Other handicaps.
(Specify other handicaps)

WHAT PEDESTRIAN WAS DOING BEFORE ACCIDENT
(C7)
Pedestrian was going ___ N ___ S ___ E ___ W ___ along ___ across or into ___ Street or Highway
From ___ to ___ (N. E. corner to S. E. corner or from West side to East side, etc.)
(Check one)
0 ___ Not in roadway.
1 ___ Walking in roadway with traffic.
2 ___ Walking in roadway against traffic.
3 ___ Pushing or working on vehicle.
4 ___ Getting on or off vehicle.
5 ___ Standing in roadway.
6 ___ Other working in roadway.
7 ___ Playing in roadway.
8 ___ Other ___ (Specify actions)
11 ___ Crossing or entering not at intersection.
12 ___ Crossing or entering at intersection.

ROAD

(72) TRAFFIC CONTROL
Driver
1 2
0 ___ ___ Police officer.
1 ___ ___ Automatic signal.
2 ___ ___ Yield right-of-way sign
3 X X Center line marked.
4 ___ ___ Other lane markings.
5 ___ ___ Stop sign.
6 ___ ___ Warning sign or signal.
7 X X No passing zone.
8 ___ ___ All others.

(73) CHARACTER (74) (Check two)
1 X Straight.
2 ___ Curve.
1 X Level.
2 ___ On grade.
3 ___ Hillcrest.

(75) SURFACE (Check one)
1 X Concrete.
2 ___ Blacktop.
3 ___ Sand or dirt.
4 ___ Gravel.
8 ___ Other

(76) CONDITION (Check one)
1 X Dry.
2 ___ Wet.
3 ___ Snow/ice
8 ___ Other

(77) WEATHER (Check one)
1 X Clear.
2 ___ Raining.
3 ___ Snowing.
4 ___ Fog.
8 ___ Other

(78) LIGHT (Check one)
1 X Daylight.
2 ___ Dark.
3 ___ Dawn or dusk.

(79) KIND OF LOCALITY (Check one to show that area adjacent to roadway for 300' was primarily:)
1 ___ School or playground.
2 ___ Industrial or business.
3 ___ Residential.
4 X Open country.

(80) ROAD DEFECTS
1 ___ Foreign material on surface.
2 ___ Loose sand, gravel, etc.
3 ___ Holes, ruts, dips, bumps, etc.
4 ___ Defective shoulders.
5 ___ Obstruction not lighted or signaled.
6 ___ Standing water, landslide, etc.
7 ___ Obstructed by previous acc.
8 ___ All other defects.

WITNESSES
Name [redacted] Address [redacted]-Indpls. Location northbound on 3
Name [redacted] Address [redacted]-Indpls. Location northbound on 3

POLICE ACTION
ARRESTS: Name ___ Charge ___
Name ___ Charge ___

INVESTIGATION: Time notified of accident ___ AM 5:40 PM Time of arrival at the scene ___ AM 5:45 PM
Where else was investigation made? ___ Is investigation complete? X Yes ___ No
Were photographs taken? ___ Yes X No Driver report form furnished to X driver No. 1 X driver No. 2
*SIGNATURE Gary B. Ostrich PE1240 Department ISP Post 7A Date of report 9-10-69

ARS-2 Investigator's Report Rev. 60

F.10

Appendix G

COMPUTER-SENSOR ACCURACY AND REPEATABILITY TEST DATA

G. COMPUTER-SENSOR ACCURACY AND REPEATABILITY TEST DATA

The first column of data within a given loop number gives the speed (mph) of the vehicle as recorded by the "timer." The second column gives the speed for the same vehicle as recorded by the "computer." The third column is the difference, d, in speeds, calculated as (computer speed-timer speed). The average difference, $\bar{d}$, and the standard deviation of the difference, s_d, are given at the bottom of the third column. $\bar{d}$ represents the bias associated with the computer-sensor system.

Loop No. 0

Timer a	Computer b	Diff. d=b-a
43.6	44	.4
40.8	40	- .8
27.9	28	.1
45.6	46	.4
42.6	42	- .6
40.9	40	- .9
43.6	43	- .6
29.6	29	- .6
39.5	39	- .5
45.0	45	0
42.1	42	- .1
43.3	43	- .3
40.6	41	.4
41.1	40	-1.1
38.1	38	- .1
42.6	43	.4
43.6	43	- .6
37.4	36	-1.4
34.2	34	- .2
47.4	48	.6
48.4	48	- .4
29.7	30	- .3
38.0	37	-1.0
45.6	46	.4
42.7	43	.3
43.9	44	.1
48.0	48	0
25.2	25	- .2
42.6	42	- .6
46.4	46	- .4

$\overline{d} = -0.3$

$s_d = 0.5$

Loop No. 1

Timer a	Computer b	Diff. d=b-a
46.6	44	-2.6
44.1	42	-2.1
45.2	43	-2.2
47.6	46	-1.6
46.8	45	-1.8
46.8	44	-2.8
49.0	47	-2.0
43.6	41	-2.6
44.6	42	-2.6
47.2	44	-3.2
47.7	46	-1.7
47.6	45	-2.6
41.4	39	-2.4
29.9	27	-2.9
27.6	25	-2.6
35.2	33	-2.2
46.6	43	-3.6
38.6	36	-2.6
46.9	44	-2.9
47.0	45	-2.0
47.6	45	-2.6
40.0	37	-3.0
43.4	41	-2.4
37.0	35	-2.0
32.2	30	-2.2
40.2	38	-2.2
39.0	37	-2.0
50.2	48	-2.2
48.8	46	-2.8

$\overline{d} = -2.4$

$s_d = 0.5$

Loop No. 2

Timer a	Computer b	Diff. d=b-a
47.1	47	- .1
44.5	44	- .5
47.0	46	-1.0
45.8	45	- .8
41.2	40	-1.2
37.2	36	-1.2
50.1	49	-1.1
41.0	40	-1.0
42.3	42	- .3
41.3	40	-1.3
35.1	34	-1.1
53.6	52	-1.6
44.8	45	.2
41.6	40	-1.6
50.1	49	-1.1
51.8	51	- .8
41.9	41	- .9
36.6	36	- .6
43.2	42	-1.2
36.9	36	- .9
40.1	40	- .1
33.8	33	- .8
46.1	46	- .1
44.0	44	0
45.5	44	-1.5
48.0	47	-1.0
46.0	45	-1.0
47.6	47	- .6
47.6	46	-1.6
41.7	41	- .7
49.1	48	-1.1

$\overline{d} = -0.9$

$s_d = 0.5$

Loop No. 3

Timer a	Computer b	Diff. d=b-a
54.7	54	- .7
33.8	34	.2
62.4	62	- .4
62.0	62	0
51.9	52	.1
58.6	58	- .6
53.4	54	.6
50.3	50	- .3
45.3	45	- .3
56.9	56	- .9
53.9	54	- .1
51.4	51	- .4
56.6	55	-1.6
54.0	54	0
51.5	52	.5
56.9	56	- .9
60.7	60	- .7
49.4	50	.6
47.3	47	- .3
62.4	62	- .4
48.5	48	- .5
63.5	63	- .5
55.0	54	-1.0
52.5	53	.5
51.7	51	- .7
31.1	31	- .1
54.8	55	.2
50.6	50	- .6
69.1	68	-1.1
67.0	68	1.0

$\overline{d} = -0.3$

$s_d = 0.6$

Loop No. 4

Timer a	Computer b	Diff. d=b-a
38.5	39	.5
23.6	24	.4
41.6	42	.4
42.4	43	.6
37.4	38	.6
35.4	36	.6
36.8	38	1.2
37.1	38	.9
49.2	50	.8
40.8	42	1.2
44.6	45	.4
39.9	40	.1
39.8	40	.2
39.9	41	1.1
22.7	23	.3
40.6	42	1.4
51.6	52	.4
21.4	22	.6
35.0	36	1.0
27.5	28	.5
36.5	38	1.5
40.0	41	1.0
42.6	44	1.4
40.6	41	.4
44.2	45	.8
47.1	48	.9
17.1	17	- .1
37.1	37	- .1
41.7	43	1.3
42.6	44	1.4
39.4	40	.6

$\overline{d} = 0.7$

$s_d = 0.5$

Loop No. 5

Timer a	Computer b	Diff. d=b-a
49.5	48	-1.5
42.3	41	-1.3
50.0	49	-1.0
50.4	51	.6
47.3	46	-1.3
43.3	42	-1.3
38.4	36	-2.4
44.1	43	-1.1
47.1	46	-1.1
53.3	55	1.7
46.2	45	-1.2
48.0	47	-1.0
43.2	42	-1.2
44.0	44	0
40.4	39	-1.4
38.5	37	-1.5
46.9	35	-1.9
41.2	40	-1.2
38.7	37	-1.7
45.0	44	-1.0
43.1	41	-2.1
39.9	38	-1.9
45.2	44	-1.2
48.4	47	-1.4
43.4	43	- .4
46.1	45	-1.1
43.7	43	- .7
54.7	55	.3
47.0	47	0
42.4	41	-1.4

$\overline{d} = -1.0$

$s_d = 0.8$

Loop No. 6

Timer a	Computer b	Diff. d=b-a
40.3	38	-2.3
44.0	43	-1.0
34.5	31	-3.5
36.6	34	-2.6
37.6	35	-2.6
35.0	32	-3.0
42.2	40	-2.2
51.1	52	.9
44.0	44	0
42.5	42	- .5
43.5	42	-1.5
40.8	39	-1.8
52.2	51	-1.2
51.6	51	- .6
48.4	48	- .4
43.5	42	-1.5
56.1	57	.9
54.7	56	1.3
52.5	53	.5
60.0	64	4.0
54.2	53	-1.2
52.3	53	.7
54.2	56	1.8
54.5	56	1.5
46.9	46	- .9
46.4	45	-1.4
42.9	41	-1.9

$\overline{d} = -0.7$

$s_d = 1.7$

Loop No. 7

Timer a	Computer b	Diff. d=b-a
47.9	44	-3.9
55.4	50	-5.4
58.4	53	-5.4
52.5	48	-4.5
57.4	52	-5.4
59.5	54	-5.5
52.3	48	-4.3
65.1	60	-5.1
59.1	54	-5.1
49.1	44	-5.1
47.8	44	-3.8
46.9	43	-3.9
52.1	47	-5.1
50.9	46	-4.9
27.8	25	-2.8
42.3	38	-4.3
42.6	39	-3.6
46.9	42	-4.9
56.3	52	-4.3
56.6	52	-4.6
58.3	54	-4.3
48.8	44	-4.8
53.5	48	-5.5
51.9	48	-3.9
49.4	45	-4.4
46.9	42	-4.9
44.3	40	-4.3
53.9	49	-4.9
53.6	49	-4.6
52.3	48	-4.3

$\overline{d} = -4.6$

$s_d = 0.6$

Loop No. 8

Timer a	Computer b	Diff. d=b-a
57.7	56	-1.7
54.4	53	-1.4
58.7	57	-1.7
62.2	58	-4.2
63.5	60	-3.5
56.6	54	-2.6
54.0	54	0
50.4	50	- .4
51.7	51	- .7
53.0	52	-1.0
55.1	54	-1.1
43.9	44	.1
38.2	41	2.8
53.0	53	0
52.3	52	- .3
60.3	57	-3.3
55.3	53	- .3
58.8	57	-1.8
52.0	53	1.0
59.4	58	-1.4
48.4	49	.6
57.0	56	-1.0
64.0	61	-3.0
61.9	58	-3.9
60.7	57	-3.7
62.0	60	-2.0
41.1	43	1.9
33.0	36	3.0
60.5	55	5.5

$\overline{d} = -0.8$

$s_d = 2.2$

Loop No. 9

Timer a	Computer b	Diff. d=b-a
52.2	52	- .2
52.5	52	- .5
55.0	56	1.0
48.5	46	-2.5
49.6	50	.4
44.5	44	- .5
47.9	46	-1.9
56.2	55	-1.2
52.2	50	-2.2
46.5	46	- .5
51.4	50	-1.4
53.5	53	- .5
54.5	54	- .5
57.5	59	1.5
52.1	52	- .1
53.0	53	0
58.1	58	- .1
59.2	59	- .2
36.6	34	-2.6
61.0	61	0
44.3	41	-3.3
51.0	50	-1.0
51.9	53	1.1
59.4	59	- .4
56.4	57	.6
43.4	41	-2.4
53.4	53	- .4
53.1	53	- .1

$\overline{d} = -0.6$

$s_d = 1.2$

Loop No. 10

Timer a	Computer b	Diff. d=b-a
45.2	48	2.8
47.6	50	2.4
50.2	52	1.8
51.6	53	1.4
65.6	64	-1.6
55.6	58	2.4
56.2	59	2.8
61.1	63	1.9
58.8	61	2.2
70.7	71	.3
48.0	50	2.0
63.8	64	.2
57.0	54	3.0
54.0	56	2.0
49.0	51	2.0
58.4	60	1.6
56.6	58	1.4
54.2	56	1.8
63.0	64	1.0
54.4	57	2.6
47.6	48	.4
45.0	48	3.0
47.5	48	.5

$\overline{d} = 1.6$

$s_d = 1.1$

Loop No. 11

Timer a	Computer b	Diff. d=b-a
17.6	15	-2.6
41.7	39	-2.7
40.0	37	-3.0
50.0	46	-4.0
55.2	53	-2.2
33.6	30	-3.6
46.0	43	-3.0
52.3	49	-3.3
49.1	47	-2.1
50.6	47	-3.6
63.5	63	- .5
62.7	61	-1.7
51.1	47	-4.1
55.6	54	-1.6
59.7	56	-3.7
53.6	51	-2.6
54.7	52	-2.7
56.7	54	-2.7
51.6	49	-2.6
51.1	48	-3.1
45.9	43	-2.9
49.0	47	-2.0
56.1	54	-2.1
56.6	54	-2.6
50.0	47	-3.0
50.0	46	-4.0
49.1	46	-3.1
48.0	45	-3.0
46.6	44	-2.6
46.6	44	-2.6
57.6	55	-2.6
59.4	58	-1.4
56.1	53	-3.1

$\overline{d} = -2.7$

$s_d = 0.8$

Loop No. 12

Timer a	Computer b	Diff. d=b-a
43.6	44	.4
42.1	43	.9
48.4	48	- .4
44.8	46	1.2
43.2	44	.8
50.8	51	.2
50.8	50	- .8
50.0	50	0
60.4	59	-1.4
57.9	57	- .9
46.0	47	1.0
53.6	54	.4
39.1	40	.9
51.1	50	-1.1
56.0	55	-1.0
40.3	43	2.7
44.1	46	1.9
51.9	52	.1
53.4	51	-2.4
50.6	51	.4
58.6	55	-3.6
56.4	55	-1.4
43.6	45	1.4
56.6	56	- .6
58.0	57	-1.0
39.4	41	1.6
55.7	55	- .7
56.5	55	- .5
55.8	55	- .8
47.5	48	.5

$\bar{d} = -0.1$

$s_d = 1.3$

Loop No. 13

Timer a	Computer b	Diff. d=b-a
52.0	55	3.0
53.3	51	-2.3
55.3	51	-4.3
46.3	46	- .3
50.0	49	-1.0
57.3	54	-3.3
62.1	58	-4.1
45.3	45	- .3
49.6	49	- .6
43.2	43	- .2
56.4	54	-2.4
44.7	44	- .7
38.3	39	.7
49.7	47	-2.7
50.5	49	- .5
49.6	49	- .6
51.0	49	-2.0
54.1	53	-1.1
53.5	51	-2.5
52.7	61	-1.7
51.5	50	-1.5
52.2	51	-1.2
43.4	43	- .4
50.4	48	-2.4
52.2	51	-1.2
60.3	58	-2.3
60.4	56	-4.4
58.0	56	-2.0

$\bar{d} = -1.5$

$s_d = 1.6$

Loop No. 14

Timer a	Computer b	Diff. d=b-a
58.4	58	- .4
59.8	58	-1.8
54.2	53	-1.2
55.1	55	- .1
64.8	63	-1.8
57.1	58	.9
62.6	63	.4
59.4	58	-1.4
57.6	56	-1.6
52.3	52	- .3
52.8	51	-1.8
55.7	55	- .7
50.6	51	.4
59.5	59	- .5
60.5	60	- .5
49.3	49	- .3
43.6	42	-1.6
57.3	55	-2.3
60.8	60	- .8
60.4	59	-1.4
64.0	64	0
65.1	63	-2.1
50.5	50	- .5
41.0	40	-1.0
51.1	50	-1.1

$\overline{d} = -0.9$

$s_d = 0.8$

Loop No. 15

Timer a	Computer b	Diff. d=b-a
46.0	45	-1.0
50.6	51	.4
56.6	56	- .6
62.0	62	0
55.7	54	-1.7
56.1	56	0
44.0	42	-2.0
57.0	58	1.0
55.2	53	-2.2
45.4	44	-1.4
43.4	41	-2.4
43.4	43	- .4
33.0	32	-1.0
44.0	43	-1.0

$\overline{d} = -0.9$

$s_d = 1.0$

Appendix H

VOLUME-TIME RELATIONSHIP - HIGHWAY NO. 37

ALSO INCLUDES STATE ROADS 45, 46, 48

Table H.1 Volume-Time Relationship - Highway No. 37

	LOOP #0					LOOP #1			
Hour Ending	Mon.-Thur.	Fri.	Sat.	Sun.		Mon.-Thur.	Fri.	Sat.	Sun.
1	75	92	172	194		39	46	98	94
2	48	54	112	137		26	32	61	60
3	44	54	98	81		27	36	60	39
4	20	27	51	48		11	15	34	29
5	21	24	38	34		12	13	23	19
6	31	35	48	26		18	18	26	14
7	117	116	74	41		89	88	46	20
8	199	204	153	72		123	127	84	43
9	211	205	208	113		123	110	128	79
10	247	257	327	212		151	152	200	165
11	293	305	418	280		177	178	240	203
12	334	345	508	379		177	180	286	250
13	370	390	557	415		193	198	311	282
14	336	365	492	386		179	204	299	283
15	349	399	454	379		208	233	285	284
16	418	471	463	387		244	260	286	281
17	594	651	473	388		407	421	291	288
18	575	662	458	393		329	405	274	270
19	351	493	384	363		205	298	248	242
20	309	476	371	337		167	280	233	220
21	308	490	385	315		157	292	226	203
22	304	448	387	249		148	273	216	133
23	206	312	282	188		89	177	135	89
24	111	192	235	103		48	93	102	55
Total ADT	5,871	7,067	7,148	5,520		3,347	4,129	4,192	3,645

Table H.1 (Continued)

	LOOP #2					LOOP #3			
Hour Ending	Mon.-Thur.	Fri.	Sat.	Sun.		Mon.-Thur.	Fri.	Sat.	Sun.
1	59	71	126	106		54	62	117	101
2	29	35	69	69		26	34	67	70
3	40	51	78	43		36	43	68	41
4	14	17	36	31		12	16	31	26
5	17	18	28	20		15	16	24	18
6	24	25	33	16		23	23	30	14
7	95	94	52	22		98	96	51	21
8	126	133	87	45		117	119	80	41
9	131	122	130	84		120	115	126	81
10	153	159	198	180		148	148	188	181
11	179	170	231	220		167	169	219	210
12	177	192	300	268		167	183	260	249
13	194	206	331	308		174	181	287	276
14	186	212	314	308		170	193	268	283
15	217	242	300	300		190	218	252	275
16	277	320	318	315		261	307	272	286
17	568	614	332	320		517	543	295	298
18	365	448	299	305		312	389	257	285
19	230	315	274	277		199	298	238	256
20	185	307	269	259		159	279	230	231
21	176	331	277	221		137	240	179	176
22	167	287	253	171		122	199	150	130
23	110	203	160	109		89	174	127	96
24	56	119	120	57		48	97	109	56
Total ADT	3,775	4,691	4,615	4,054		3,361	4,142	3,925	3,701

Table H.1 (Continued)

	LOOP #4					LOOP #5			
Hour Ending	Mon.-Thur.	Fri.	Sat.	Sun.		Mon.-Thur.	Fri.	Sat.	Sun.
1	54	60	118	153		34	38	65	90
2	41	45	112	138		28	32	63	88
3	20	22	61	86		14	12	25	35
4	24	24	40	43		15	14	17	15
5	39	34	36	24		29	23	21	12
6	88	82	62	29		59	49	37	15
7	335	338	151	52		216	218	89	32
8	597	573	250	81		336	335	141	47
9	376	383	325	111		209	204	174	64
10	323	327	422	233		178	180	216	124
11	310	321	490	282		173	181	262	177
12	337	368	496	339		168	182	245	235
13	340	375	410	376		172	186	219	263
14	336	363	410	381		177	198	231	268
15	331	351	394	401		189	184	233	298
16	362	418	407	447		213	230	244	333
17	392	437	423	507		232	252	241	387
18	343	428	405	522		193	228	231	375
19	341	420	412	507		176	242	238	360
20	330	399	417	469		161	241	234	306
21	270	358	378	383		124	184	206	244
22	235	292	336	281		107	134	172	176
23	163	247	249	205		74	112	136	134
24	88	169	182	108		44	83	95	62
Total ADT	6,075	6,834	6,986	6,158		3,321	3,742	3,835	4,140

Table H.1 (Continued)

	LOOP #6				LOOP #7			
Hour Ending	Mon.-Thur.	Fri.	Sat.	Sun.	Mon.-Thur.	Fri.	Sat.	Sun.
1	39	42	72	111	28	32	51	70
2	31	37	73	106	17	17	33	44
3	15	15	32	44	13	11	22	28
4	16	15	19	17	15	15	17	16
5	34	28	26	14	33	26	24	13
6	66	58	43	18	60	53	39	16
7	435	426	130	39	437	430	117	34
8	467	452	162	50	392	381	135	44
9	216	200	179	70	185	180	153	62
10	182	182	225	149	162	160	194	127
11	174	190	263	192	159	178	224	180
12	175	182	248	251	154	159	214	233
13	171	184	222	290	157	166	201	272
14	183	201	234	285	170	178	207	264
15	209	223	250	315	195	209	221	307
16	237	249	263	368	205	233	227	350
17	247	267	251	418	220	250	219	388
18	205	255	252	418	188	225	225	397
19	188	258	251	400	168	233	226	362
20	168	247	247	343	142	226	222	316
21	132	189	220	270	115	172	203	257
22	119	148	192	203	104	129	169	183
23	86	126	159	149	75	100	128	140
24	47	91	109	75	39	57	81	53
Total ADT	3,842	4,265	4,122	4,595	3,433	3,820	3,552	4,156

Table H.1 (Continued)

	LOOP #8				LOOP #9			
Hour Ending	Mon.-Thur.	Fri.	Sat.	Sun.	Mon.-Thur.	Fri.	Sat.	Sun.
1	68	72	128	158	67	70	123	154
2	48	46	103	101	47	45	104	98
3	27	28	66	57	26	27	64	56
4	23	23	48	37	23	21	47	37
5	24	24	44	31	23	24	43	30
6	41	41	81	39	39	40	83	38
7	207	202	128	65	207	201	123	58
8	334	307	177	87	329	311	173	86
9	318	285	292	143	314	274	271	147
10	321	273	381	257	313	266	365	252
11	319	288	418	353	303	278	412	350
12	306	291	456	471	301	287	438	478
13	301	302	413	506	293	288	404	497
14	294	313	408	504	284	297	386	490
15	289	316	387	488	282	296	383	467
16	303	349	403	441	286	323	380	416
17	338	379	401	437	325	368	390	416
18	368	484	381	440	359	466	366	410
19	311	484	364	422	299	470	338	389
20	230	470	330	385	228	455	308	359
21	180	382	272	338	175	376	262	323
22	155	281	227	287	149	276	215	274
23	122	235	170	222	122	227	161	212
24	80	156	139	144	80	150	157	132
Total ADT	5,007	6,031	6,217	6,413	4,874	5,836	5,996	6,229

Table H.1 (Continued)

	Loop #10					LOOP #11			
Hour Ending	Mon.-Thur.	Fri.	Sat.	Sun.		Mon.-Thur.	Fri.	Sat.	Sun.
1	59	58	113	138		61	58	116	150
2	40	39	85	90		42	43	87	91
3	23	21	57	49		23	21	56	50
4	20	18	46	33		21	20	44	35
5	21	23	39	28		21	25	44	29
6	35	36	79	40		35	35	80	39
7	191	182	110	61		190	184	108	59
8	277	257	157	79		275	246	157	80
9	264	236	243	132		268	226	245	133
10	276	228	326	235		279	232	328	227
11	276	249	346	328		262	224	365	328
12	262	259	408	435		266	277	409	472
13	260	248	360	470		280	233	361	477
14	253	277	369	452		276	295	393	492
15	263	278	354	445		281	310	375	408
16	268	306	352	410		266	312	380	437
17	297	310	356	401		297	342	387	412
18	333	418	341	392		336	437	370	395
19	267	474	335	380		266	433	356	380
20	189	422	294	346		192	399	296	338
21	148	357	226	310		147	325	238	301
22	139	255	194	265		128	242	193	253
23	106	212	144	203		107	192	145	210
24	71	132	130	124		73	138	138	128
Total ADT	4,062	5,295	5,464	5,846		4,392	5,249	5,671	5,924

Table H.1 (Continued)

	LOOP #12					LOOP #13			
Hour Ending	Mon.- Thur.	Fri.	Sat.	Sun.		Mon.- Thur.	Fri.	Sat.	Sun.
1	57	59	99	116		57	59	102	116
2	37	38	57	76		38	38	57	77
3	28	32	45	49		29	32	45	50
4	24	25	33	30		24	24	34	30
5	36	32	32	23		35	34	32	23
6	84	75	58	25		83	74	56	25
7	200	192	108	50		205	195	108	47
8	258	243	125	72		252	235	128	70
9	233	225	182	114		233	231	179	114
10	243	240	261	205		237	243	258	206
11	247	258	318	275		248	256	320	274
12	269	319	338	333		265	311	344	334
13	291	380	383	386		290	380	378	391
14	310	411	403	448		311	417	406	445
15	323	395	369	473		327	372	364	491
16	342	415	378	550		335	428	382	582
17	423	493	365	652		433	451	374	679
18	364	457	373	665		371	477	366	691
19	239	320	350	632		242	325	341	651
20	182	251	317	538		181	255	328	562
21	167	236	290	446		166	236	280	453
22	157	217	238	328		157	215	238	326
23	126	160	202	226		126	161	200	231
24	72	110	155	114		73	113	161	117
Total ADT	4,712	5,583	5,479	6,726		4,718	5,562	5,481	6,985

Table H.1 (Continued)

	LOOP #14					LOOP #15			
Hour Ending	Mon.- Thur.	Fri.	Sat.	Sun.		Mon.- Thur.	Fri.	Sat.	Sun.
1	51	51	94	106		52	57	100	98
2	34	34	49	69		35	34	56	68
3	27	29	40	44		26	25	40	42
4	21	24	32	27		20	24	31	25
5	32	29	30	20		32	28	29	21
6	78	67	52	23		79	73	53	22
7	191	181	99	44		197	182	103	52
8	204	194	121	67		204	195	124	71
9	209	202	166	100		206	202	169	101
10	214	216	236	193		213	215	237	197
11	224	234	297	253		224	245	279	255
12	236	273	338	325		247	293	310	309
13	250	330	373	372		261	361	345	360
14	269	370	389	429		280	411	362	406
15	304	356	351	448		294	378	335	469
16	299	368	365	548		292	399	349	537
17	395	400	357	611		379	407	327	650
18	314	423	327	646		321	412	333	606
19	222	271	270	544		219	301	311	625
20	155	224	302	533		160	222	316	559
21	150	227	271	437		141	223	270	437
22	144	200	226	321		134	197	227	336
23	114	148	183	225		114	142	178	234
24	62	113	133	100		70	112	142	124
Total ADT	4,199	4,964	5,101	6,485		3,806	5,138	5,026	6,604

Table H.2 Volume-Time Relationship for Other State Roads

	No. 46 East		No. 46 West		No. 45 East		No. 45 West		No. 48 West		
Time Period	301-302	303-307	401-405	406-409	501-504	505-509	601-603	604-609	701-702	703-704	705-707
1 A.M.	252	37	117	69	56	17	126	98	114	34	32
2	42	56	36	48	21	11	127	42	67	24	14
3	72	42	58	32	17	4	44	56	20	24	21
4	102	18	24	19	12	6	46	19	44	10	10
5	65	15	31	21	7	8	22	23	56	10	9
6	28	25	53	15	16	6	56	53	86	16	8
7	168	96	229	148	48	21	560	368	174	254	24
8	518	142	339	91	107	23	460	238	622	204	81
9	539	204	248	128	104	38	396	161	342	172	60
10	505	188	296	156	125	30	262	199	588	146	59
11	526	195	324	231	164	29	332	174	425	148	61
12	457	256	376	216	137	45	309	176	706	151	76
1 P.M.	528	225	489	204	197	73	343	177	712	159	75
2	564	226	394	210	167	41	347	229	595	154	71
3	505	206	431	206	151	50	315	261	618	174	76
4	638	208	535	282	168	60	532	338	960	212	129
5	884	268	636	405	239	103	764	420	1,046	236	142
6	758	314	688	287	315	100	526	362	924	154	116
7	532	197	400	252	170	52	402	254	480	164	84
8	466	139	343	138	140	32	346	147	465	111	79
9	331	132	257	148	92	36	220	141	333	76	53
10	415	133	233	134	121	10	224	132	320	84	51
11	406	95	204	83	72	12	170	114	189	59	42
12	245	56	118	51	61	21	131	66	126	18	33
Total	9,540	3,473	6,859	3,574	2,707	828	7,060	4,248	10,012	2,794	1,406