



COMMONWEALTH OF KENTUCKY

DEPARTMENT OF HIGHWAYS

FRANKFORT, KENTUCKY 40601

April 5, 1972

ADDRESS REPLY TO:
DEPARTMENT OF HIGHWAYS
DIVISION OF RESEARCH
533 SOUTH LIMESTONE STREET
LEXINGTON, KENTUCKY 40508
TELEPHONE 606-254-4475

H.3.36

Memorandum to: C. G. Grayson
Assistant State Highway Engineer
Planning and Programming

Subject: The I 64, I 65, I 71 Route Junction, Louisville

References: 1) Research Division memo to E. B. Gaither, November 19, 1971.
2) Your memo to J. T. Anderson, December 29, 1971.

In response to your memo of November 11, 1971, we agreed to conduct a preliminary study of the prevailing conditions at the Kennedy Bridge Route Junction in Louisville. The brief report, submitted herewith, may suffice as a basis for revisions needed there to relieve a severe, peak-hour bottleneck at Ramps 3 and 4.

All accident reports for calendar year 1971 were obtained and analyzed. Each loop and leg in the interchange was filmed; conflict movements at the juncture of Ramps 3 and 4 were filmed. These latter films show the collapse of Ramp 3 to a Level of Service F during peak hours. Skid tests were made throughout.

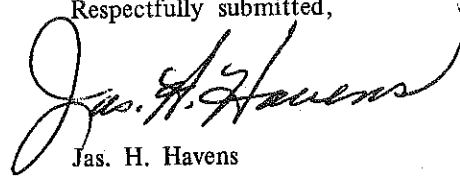
The film is a supplemental but necessary part of this report.

It was not our duty in this instance to present conclusions or recommendations. Originally, we had intended to monitor and film each bifurcation and merging site; however, the terminus of Ramp 3 commanded our full attention. All other points were deferred in order to bring the most obvious problem into more timely consideration.

Our report on "...Lane Drops," October 1971, may have some bearing on the problem at Louisville. The addition of a lane to carry Ramp 3 traffic forward, as has already been discussed and proposed by others, would surely allow Ramp 3 traffic to enter the weaving zone downstream. However, the existing 2-lane weaving zone would become a 3-lane weaving zone. Considering the short length, a 3-lane weaving situation would seem frightening. On the other hand, if lane assignments (destination) were made at the entrance to Ramp 4 (2 lanes), the leftward-bound traffic could proceed without further weaving. The center lane would necessarily branch rightward and leftward -- that is to say, the 3-lane

section would have to split into two 2-lane roadways ahead. Thus, the rightward-bound traffic off of Ramp 3 would merely merge into the center lane. No other weaving movements would seem necessary.

Respectfully submitted,



Jas. H. Havens
Director of Research

JHH:dw

Attachment

cc's: J. R. Harbison
W. B. Drake
J. T. Anderson
E. B. Gaither
J. W. Fehr
G. Ethington
A. R. Romine



Research Report
326

**AN OPERATIONAL ANALYSIS OF THE
I 64, I 65, I 71 ROUTE JUNCTION IN LOUISVILLE**

KYP-72-36

by

Jerry G. Pigman
Research Engineer

William M. Seymour
Research Engineer

Kenneth R. Agent
Research Engineer Associate

and

Don L. Cornette
Research Engineer Associate

Division of Research
DEPARTMENT OF HIGHWAYS
Commonwealth of Kentucky

April 1972

INTRODUCTION

The Kennedy Interchange in Louisville is the most geometrically complicated of any in Kentucky; it is the junction of three interstate routes, I 64, I 65, and I 71. The many diverging, weaving, and merging movements demand a driver's attention. One merging situation collapses into an impasse during peak-hour traffic. This study is responsive to certain inquiries by the Department concerning safety and possible discovery of design deficiencies at this interchange. It was not intended to be an in-depth study but rather an exploratory identification of problems and their locations; more comprehensive studies, by others, would ensue if needed. The specific objectives were to discover conflicts and erratic movements and to locate and analyze high-frequency accident sites.

METHODS

All accident records were obtained for the entire interchange for calendar year 1971. Accidents were summarized, coded, and then plotted on aerial photographs of the interchange. Accident summaries are presented in APPENDIX A, and the collision diagrams in APPENDIX B. Coded information placed on the photograph included type of accident, severity, time and date, weather, and pavement conditions. To further define the pavement conditions, skid tests were conducted with a skid trailer, and the resulting friction measurements were noted on the aerial photographs.

The second phase involved photologging all loops and legs of the interchange. A 16-mm movie camera was mounted on a tripod in the front seat of an automobile, and the driver's view of the roadway was recorded while traveling at the speed of the traffic stream. In order to cover the entire interchange, fourteen separate filming excursions were made. All of these sections of film were spliced together and titled to comprise a twenty-minute film.

In the third phase, the highest accident-frequency location was monitored visually and with the camera during a peak-hour period. This location was the merging point of two lanes from I 65 northbound to I 71 - I 64 eastbound, and the single lane ramp from I 65 southbound leading to I 71 - I 64 eastbound. Data were collected on March 2, 1972, for 35 minutes between 4:00 and 5:00 p.m. A 16-mm Bolex movie camera with a zoom lens was positioned so that the merging of these lanes of traffic could be photographed. Visual monitoring of the location supplemented the filmed data. Included in this visual monitoring phase were traffic counts and observations of brakelight applications and erratic movements. Erratic movements were categorized as "crowded weave", "swerve", "slowed drastically", and "stopped". Erratic movement definitions are listed in APPENDIX C.

FINDINGS

Accident Summary

The accident statistics for the calendar year 1971 are presented in APPENDIX A. There were 134 accidents during the year. The summary indicated there was no predominant day or month in which accidents occurred. Most accidents occurred on Mondays and Fridays and in October and November. The erratic vehicle in the great majority of accidents was a passenger car, and the erratic driver was most frequently male and under thirty. The driver's residence in most cases was Jefferson County, but a large number of the drivers resided in Indiana.

Of the 134 accidents, 103 involved property damage. There were 42 nonfatal injuries and one fatal injury involved in the remainder of the accidents.

The majority of accidents occurred during dry roadway conditions during daylight hours. Only six accidents occurred during darkness outside the lighted area of the interchange. Although the majority of accidents occurred during dry roadway conditions, a significant portion (34 percent) occurred during wet or icy roadway conditions.

A predominance of rear-end and multiple rear-end accidents (66) indicates a high degree of congestion. There were also several fixed-object accidents (32) and oblique or sideswipe accidents (28).

The contributing circumstances listed in most of the accident reports was a statement that the vehicle was not under proper control. Therefore, the majority of the accidents were placed in the "other" category of contributing circumstances. Other main items listed were failure to yield right of way and inattention of the driver. In a few cases, the driver was following too closely and (or) speeding.

HIGH ACCIDENT LOCATIONS

From the collision diagrams (APPENDIX B), the five highest accident locations were isolated. A brief summary of the number and type of accidents at each location follows. The locations are in the order of highest-to-lowest number of accidents.

1. **The merge of the ramp from I 65 southbound to I 64 - I 71 eastbound with the ramp from I 65 northbound to I 64 - I 71 eastbound.**

There were 18 accidents at this location during the study period. Of these 18 accidents, 13 were rear-end type, and 3 were multiple rear-end collisions. There was also one oblique accident and one fixed-object-type accident. Of the 18 accidents, 17 involved property damage, and there was only one injury reported. Friction measurements on the ramp from I 65 southbound and from I 65 northbound were 34 and 40, respectively. These compare with a recommended minimum friction value of 37 as presented in National Cooperative Highway Research Program Report 37. This

minimum value corresponds to that required for normal driving needs at a mean speed of 50 mph. The speed limit for this section of the interchange is 50 mph. Normal needs encompass all driving, cornering, and braking maneuvers by the majority of drivers under normal traffic conditions. Report 37 further states that the friction level should be higher whenever it is economically or technically feasible. The friction measurements at the four other high accident locations can also be compared with the minimum friction value. It is interesting to note that only one of the rear-end collisions occurred during wet weather conditions. Of the 16 rear-end collisions at this site, 14 occurred on the ramp from I 65 southbound. This indicates that this ramp is the source of the accident problem. It should also be noted that the majority of those accidents occurred during the evening rush hour, which points to congestion as the probable cause of accidents. Another possible contributing factor is the short acceleration lane of the ramp from I 65 southbound.

2. **I 65 southbound, just south of the Kennedy Bridge, at the ramp to Third Street and I 64 - I 71 eastbound.**

There were 14 accidents at this location during the study period. Of these, five were the rear-end type, four were with fixed objects, three were sideswipes, and two were combination rear-end and sidewise encounters (involving three vehicles). These accidents were generally spread throughout the day, but several occurred during the evening rush hour. Eleven of the accidents involved property damage; three caused injuries (four persons). There, 10 of the 14 accidents occurred during wet weather. This tends to indicate that pavement conditions might have played a significant role in these accidents. Friction measurements for the outer and inner lanes were 34 and 36, respectively. There are three southbound lanes crossing the Kennedy Bridge; the outside-lane traffic must turn right; the middle lane is optional with respect to I 65, south, or I 64 and I 71, east; traffic in the innermost lane must continue on I 65. Apparently, conflicts arise when unwary drivers desiring to exit toward 3rd Street find themselves in the innermost lane and when those trapped in the outermost lane desire to continue southward on I 65. A possible remedy might be to improve the advance signing (north of bridge) to emphasize lane assignments.

3. **I 64, westbound, between Story Avenue and the I 71 overpass.**

A total of 13 accidents occurred on this 0.2-mile section during the study period. Of these, six involved fixed objects, four were rear-end collisions, and three were sideswipes. Eight caused property damage, and five resulted in 11 personal

injuries. Five occurred in wet weather; three of the six fixed-object accidents were during wet weather conditions. Three of the four rear-end accidents occurred during the morning rush hour when traffic was backed up on the expressway. Two of the three sideswipes involved vehicles which were merging into traffic from the Story Avenue ramp. The friction measurements in the outer and inner lanes were 31 and 33, respectively.

4. **Ramp from I 64 westbound to I 65 southbound.**

Nine accidents occurred on this 0.2-mile section of road during the study period. Six involved fixed objects, two were sideswipes, and one was a rear-end collision. Only two occurred during wet weather; they were sideswipes. Friction measurements in the outer and inner lanes were 40 and 44, respectively. The problem at this location is caused by the sharp curvature of this ramp, which was the probable cause of the fixed-object accidents. There are dual-mounted warning signs advising motorists to reduce speed to 35 mph and there are two sets of rumble strips; however, drivers continue to lose control.

5. **I 65, northbound, at the exit ramp to Third Street and I 64 - I 71 eastbound.**

Eight accidents occurred at this location during the study period. Three were rear-end collisions, three were sideswipes, and two involved fixed objects. Three of the accidents occurred during wet weather. The friction measurements in the outer and inner lanes were 33 and 39, respectively. The accidents did not occur at any particular time of the day. No pattern could be found from accident reports.

ERRATIC MOVEMENT STUDY AT THE HIGHEST ACCIDENT-FREQUENCY LOCATION

The merging of the ramp from I 65, southbound, to I 64 - I 71, eastbound, with the ramp from I 65, northbound, to I 64 - I 71, eastbound, was identified from the collision diagrams as being the highest accident frequency location in the Kennedy Interchange. Therefore, it was felt that this would be an appropriate location for both camera monitoring and an erratic movement study.

On March 2, between 4:00 - 5:00 p.m. (a peak hour), this site was monitored with a tripod-mounted 16 mm movie camera. Brakelight applications and volumes were recorded for both ramps. Erratic movements, classified as "crowded weave", "swerve", "slowed drastically", and "stopped", were recorded for the ramp from I 65, southbound, to I 64 - I 71, eastbound. The periods of observation of erratic movements coincided with periods of filming. These periods were 4:10 to 4:25 p.m., 4:33 to 4:43 p.m., and 4:52 to 5:02 p.m. This 15-minute period and the two-10 minute periods coincided with the amount of time

required to expose three, 100-foot rolls of film. An average of 13 percent of the vehicles issuing from I 65, southbound, into I 64 - I 71, eastbound, committed a "crowded weave", 2.5 percent committed a "swerve", 16 percent "slowed drastically", and 33 percent "stopped". These percentages indicate the magnitude of the problem at this location. It is important to note that the erratic movement classifications of "slowed drastically" and "stopped" were mutually exclusive of each other, as were "crowded weave" and "swerve". In other words, if a vehicle had "stopped" or committed a "crowded weave", it was never classified as having "slowed drastically" nor counted as having "swerved", and vice-versa. However, a vehicle which "slowed drastically" could also have been recorded as having committed a "crowded weave" or a "swerve", but not both. Erratic movements and brakelight applications are tabulated in APPENDIX C, as both numbers and rates. Volumes and erratic movement definitions may also be found in APPENDIX C. Each of the high accident sites is shown in Figures 1 through 5, respectively. An aerial view encompassing most of the study area and nearby environs is presented in APPENDIX D.



Figure 2. I 65 Southbound just South of the Kennedy Bridge at the Ramp to Third Street and I 64 - I 71 Eastbound.



Figure 1. Merge of the Ramp from I 65 Southbound to I 64 - I 71 Eastbound with the Ramp from I 65 Northbound to I 64 - I 71 Eastbound.



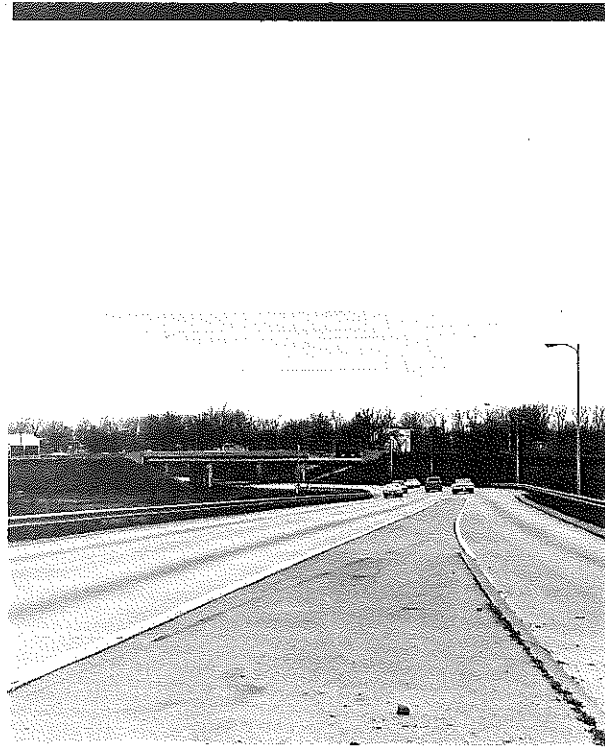


Figure 3. I 64 Westbound between Story Avenue and the I 71 Overpass.

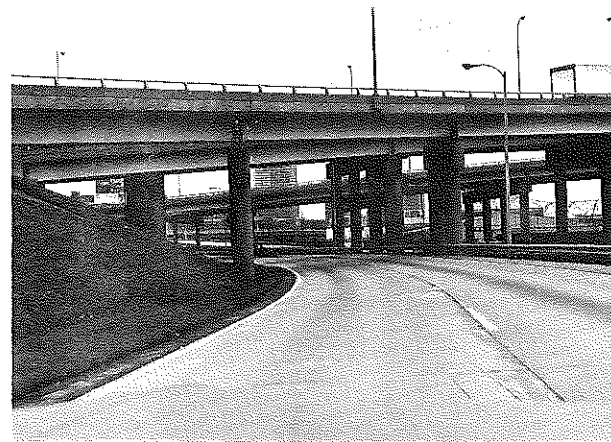
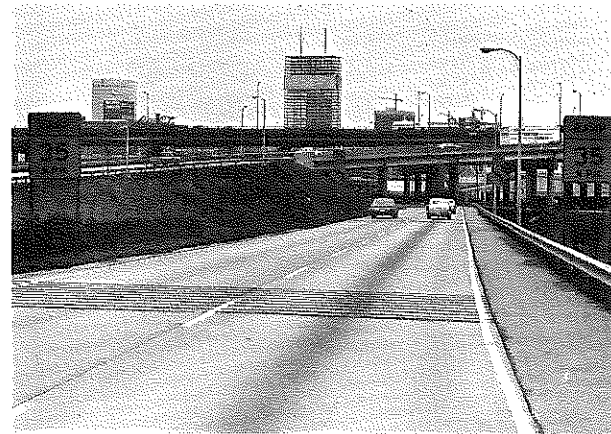


Figure 4. Ramp from I 64 Westbound to I 65 Southbound.

ERRATIC MOVEMENT DEFINITIONS

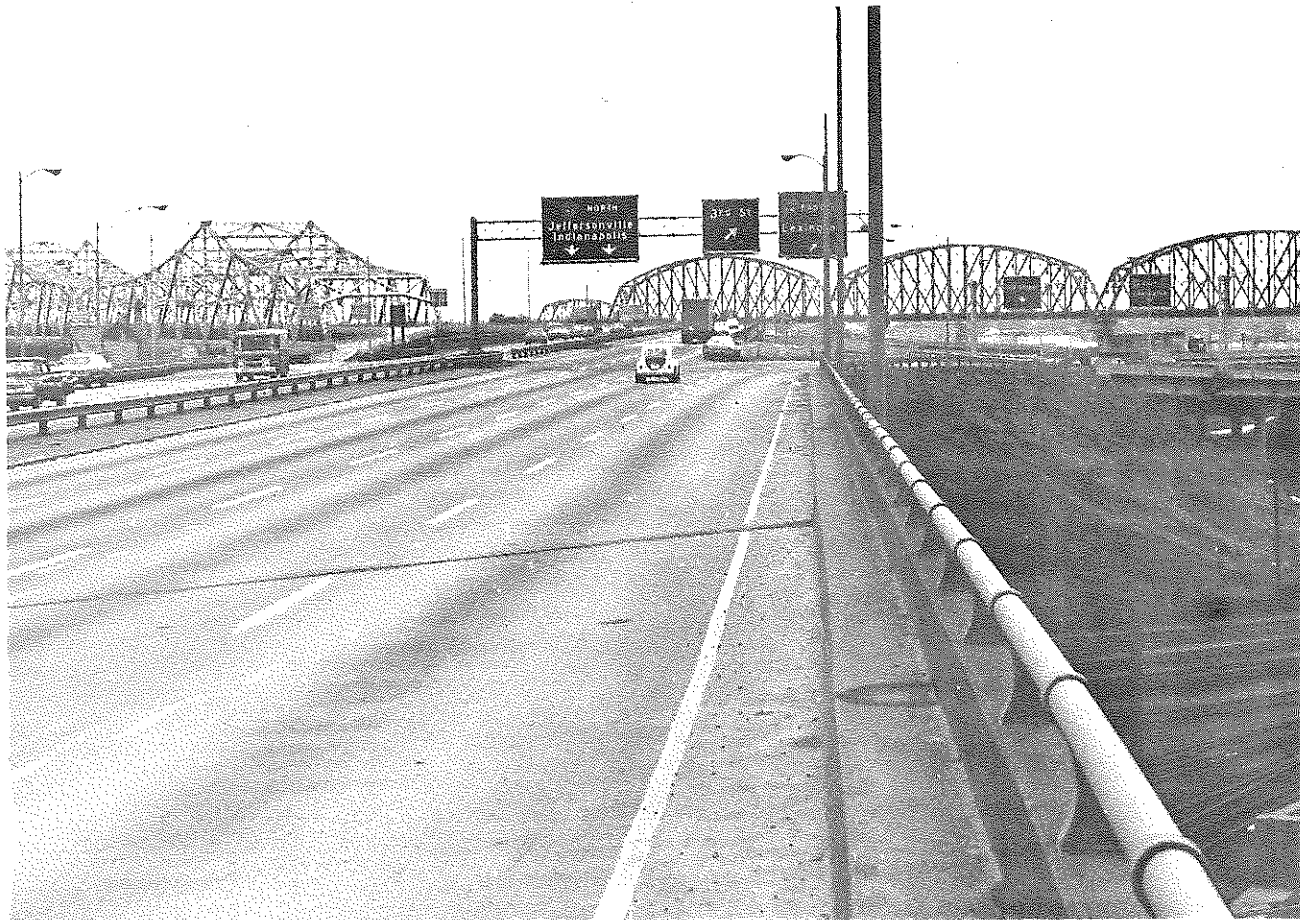
CROWDED WEAVE -- A vehicle changes lanes directly in front of a following vehicle, causing the following vehicle to apply its brakes. This type of erratic movement always directly involves at least two vehicles.

SWERVE -- A vehicle abruptly veers from its straight ahead course. A swerve may or may not consist of a change of lanes for the erratic vehicle. This type of erratic movement always involves only one vehicle.

SLOWED DRASTICALLY -- A very rapid deceleration, causing "dipping" of the front end or tire squealing.

COMPLETE STOP -- Vehicle comes to a complete stop.

Figure 5. I 65 Northbound at the Exit Ramp to Third Street and I 64 - I 71 Eastbound.



APPENDIX A
ACCIDENT SUMMARY

SUMMARY OF ACCIDENTS


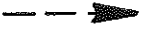








**Kennedy Interchange
Calendar Year 1971**

1. Total Number of Accidents (1-1-71 through 12-1-71)				134
2. a) Day of Week	Monday	29		
	Tuesday	17		
	Wednesday	17		
	Thursday	14		
	Friday	26		
	Saturday	14		
	Sunday	17		
b) Month of Year	January	12		
	February	3		
	March	14		
	April	7		
	May	13		
	June	6		
	July	13		
	August	5		
	September	9		
	October	21		
	November	20		
	December	11		
3. Type of Erratic Vehicle	Passenger Car		117	
	Four-Tired Truck		1	
	Truck (six or more tires)		14	
	Bus		1	
	Motorcycle		1	
4. Sex of Erratic Driver	Male	102		
	Female	28		
	Unknown	4		
5. Age of Erratic Driver	16 - 20	19	46 - 50	12
	21 - 25	39	51 - 55	3
	26 - 30	18	56 - 60	5
	31 - 35	10	61 - 65	2
	36 - 40	7	Over 65	4
	41 - 45	10	Unknown	5
6. Accident Involvement Rate by Residence of Erratic Driver	In County Where Accident Occurred			71
	In Other County in State			11
	Out of State			50
	Unknown			2

7. Seriousness of Injury Among Car Occupants		
A - Visible signs of injury, as bleeding, distorted member, or had to be carried from the scene of the accident.		17
B - Other visible injury, as bruises, abrasions, swelling, limping, etc.		10
C - No visible injury but complaint of pain or momentary unconsciousness.		15
O - No indication of injury.		103
K - Fatal		1
8. Road Surface Condition	Dry	88
	Wet	35
	Snowy or Icy	11
9. Light Condition	Daylight	89
	Darkness	6
	Dawn or Dusk	3
	Darkness- Highway Lighted	36
10. Weather Conditions	Clear	74
	Raining	23
	Snowing	9
	Fog	0
	Unknown	0
	Cloudy	28
11. Type of Accident	Rear End	55
	Right Angle	1
	Oblique or Sideswipe	28
	Fixed Object	32
	Single Vehicle	7
	Head On	0
	Multiple Rear End	11
	Other	0
12. Contributing Circumstances	Drinking	0
	Speeding	10
	Failed to Yield Right of Way	23
	Ran Stop Sign	0
	Disregard Traffic Signal	0
	Followed Too Closely	13
	Improper Passing	0
	Improper Turn	0
	Inattentive	37
	Failed to Signal	0
	Other	57
	Backing on Ramp	1

APPENDIX B
COLLISION DIAGRAMS

COLLISION DIAGRAM LEGEND

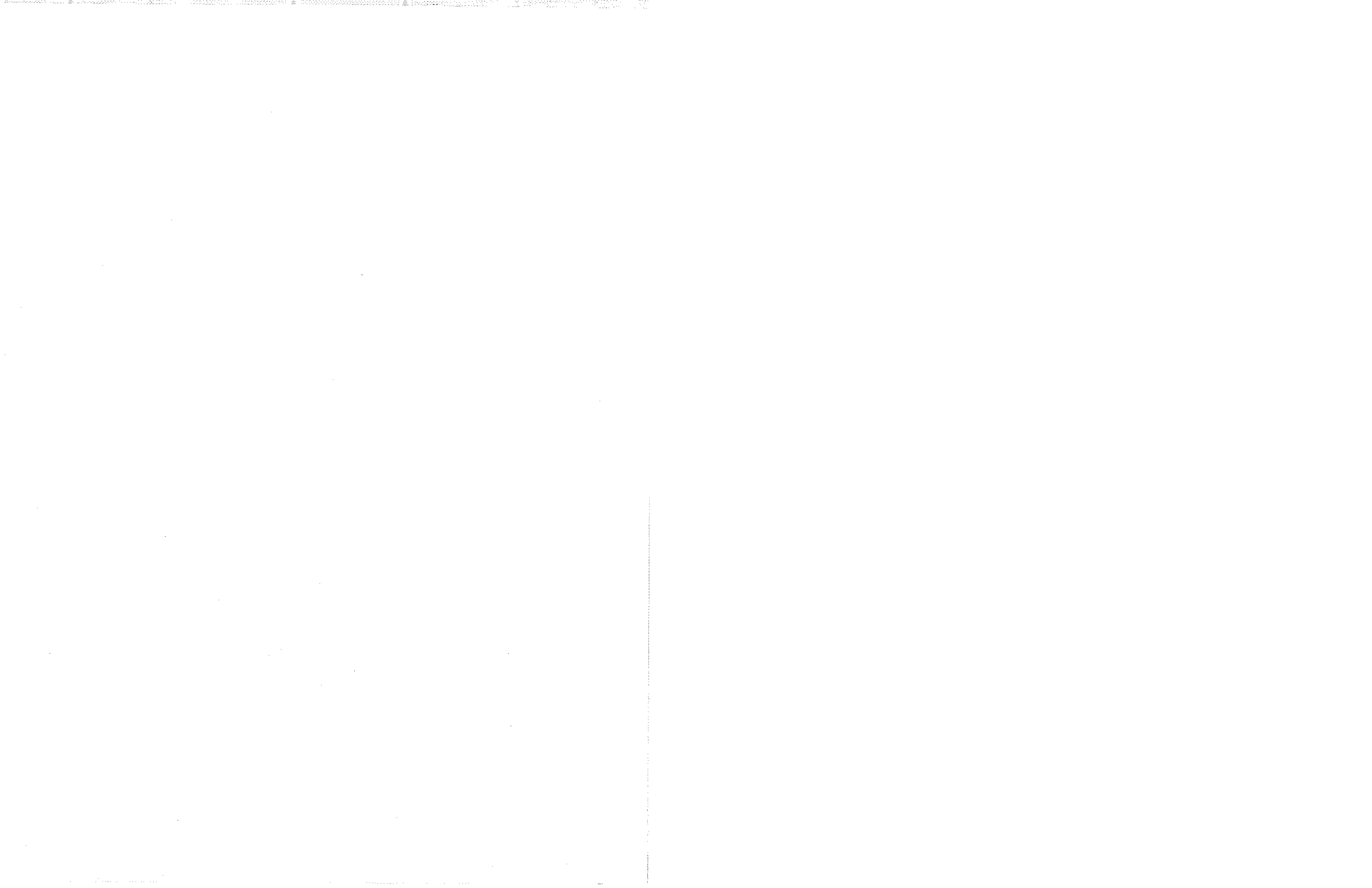
Path of moving motor vehicles	
Pedestrian path	
Fatal injury	
Non-fatal injury	
Rear-end collision	
Collision with parked vehicle	
Collision with fixed object	
Overtaken	
Out of control	
Sideswipe	

Time: A = AM P = PM

Pavement Conditions: D = Dry I = Icy W = Wet

Weather Conditions: C = Clear CL = Cloudy
R = Rain F = Fog
S = Snow

COLLISION DIAGRAMS





6-20 DC 12-8 DC
7:40 A
4:35 P

10-5 DC
5:12 P

36

36

10-15 WR
4:29 P

39

11-6 WR
12:1 P

40

3-28 DC
2:24 A

39

9-7 WR
2:30 P

40

4-23 WR
3:38 P

36

10-23 DC
6:42 A 5-7 WR
6:59 P

36

32

7-12 DC
9:30 A

32

5-5 WCL
6:50 P

32

7-12 DC
9:47 A

32

9-23 DC
8:17 A

32

4-19 DC
8:20 A

32

5-30 DC
6:50 P

32

9-20 WR
8:45 A

32

7-12 DC
9:47 A

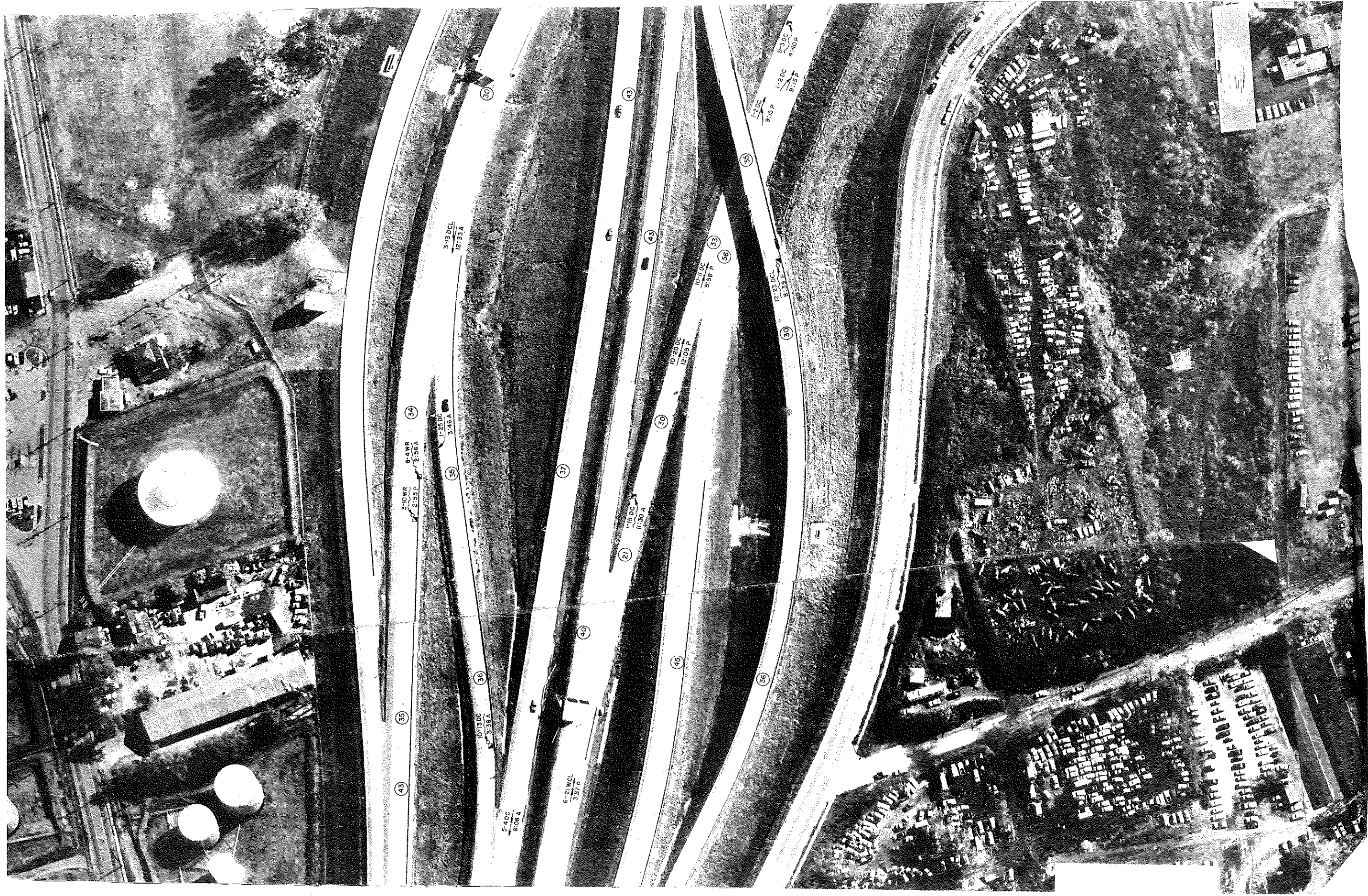
32

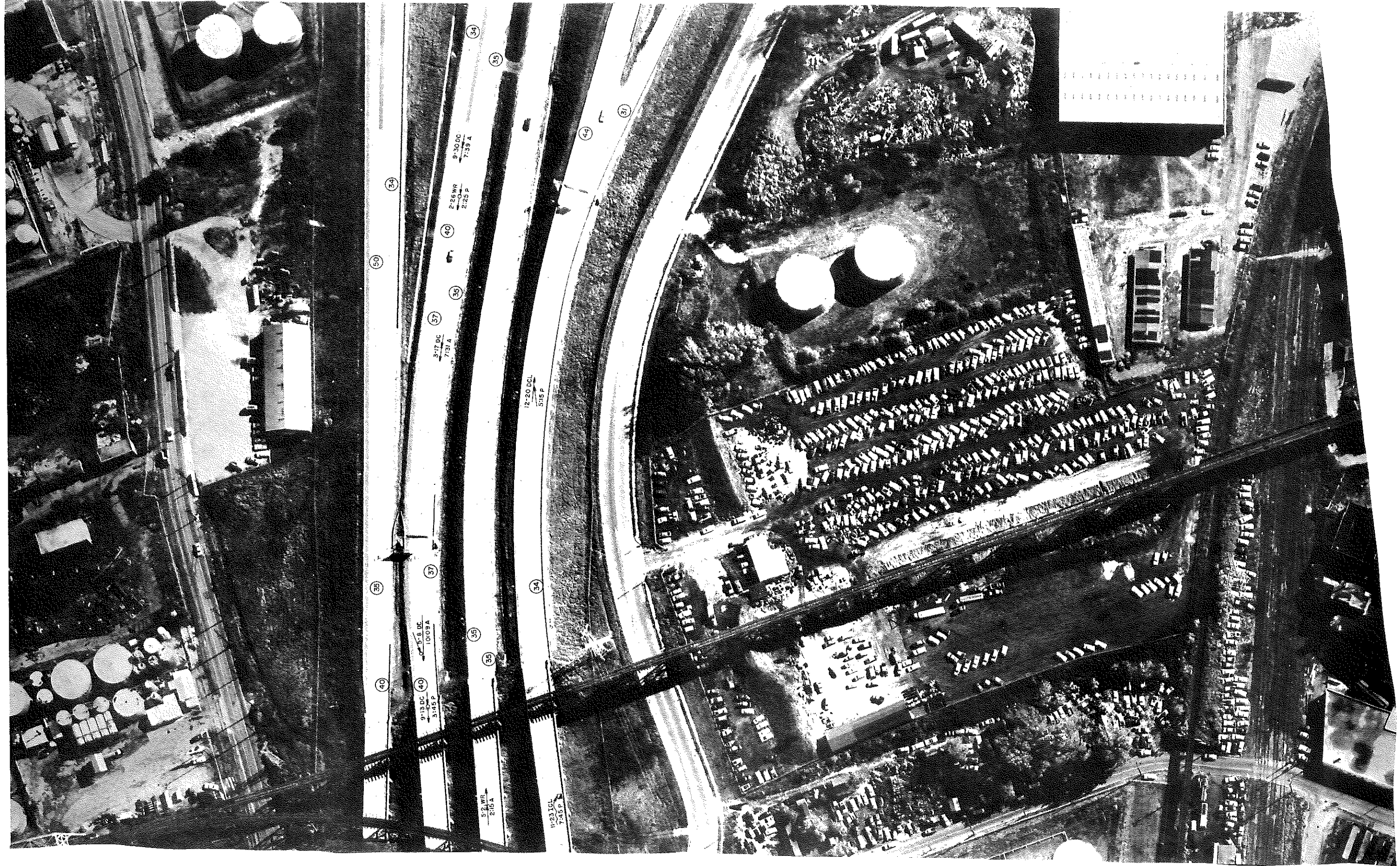
43

10-15 WCL
4:09 P

43



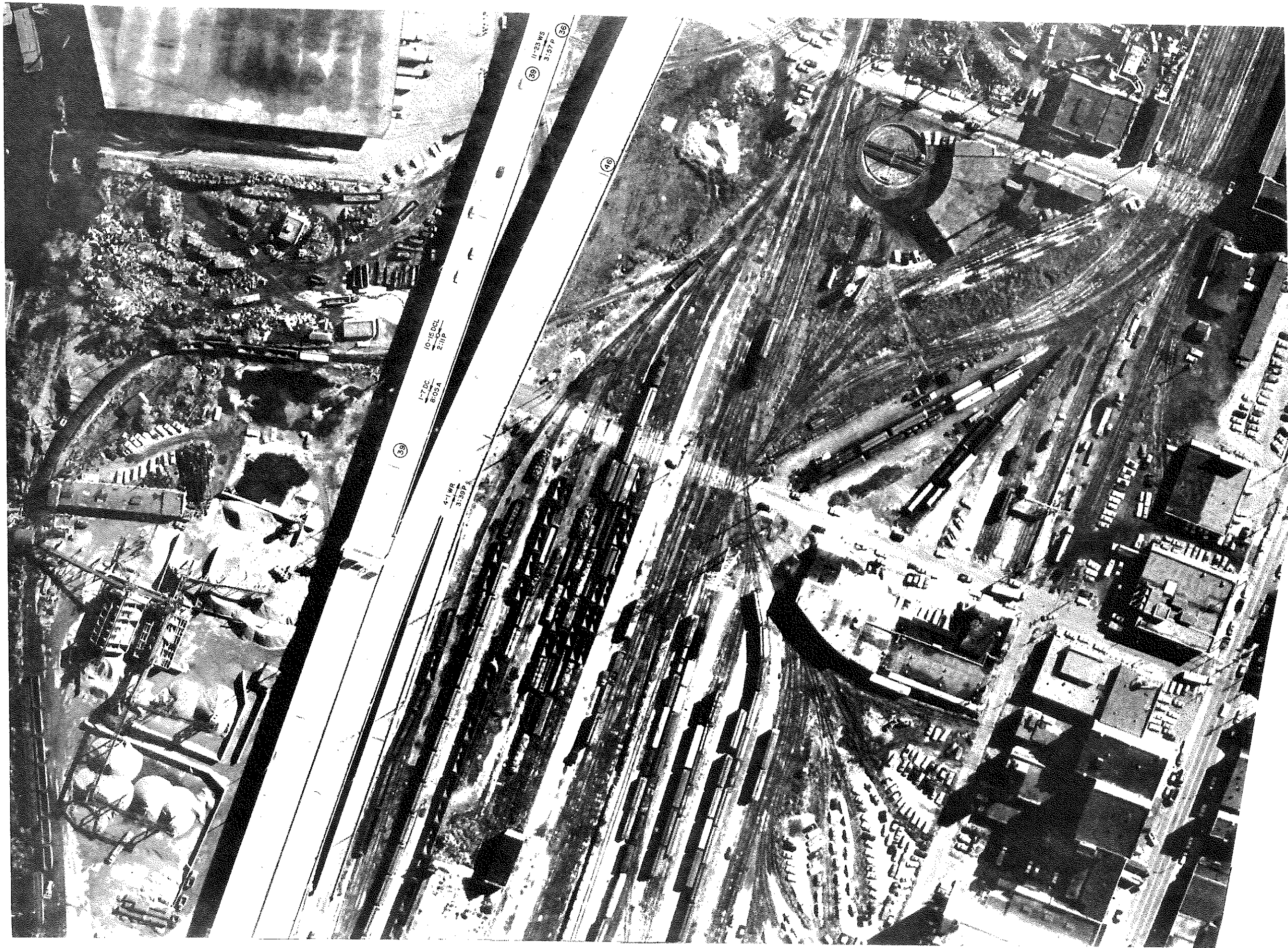














APPENDIX C

**ERRATIC MOVEMENTS, BRAKELIGHT APPLICATIONS, AND LANE
VOLUMES AT THE MERGE OF RAMP FROM I 65 SOUTHBOUND TO
I 64-I 71 EASTBOUND WITH RAMP FROM I 65 NORTHBOUND TO
I 64-I 71 EASTBOUND**

TABLE C-1. NUMBERS OF ERRATIC MOVEMENTS, BRAKELIGHT APPLICATIONS, AND LANE VOLUMES.

TIME	ERRATIC MOVEMENTS				BRAKELIGHT APPLICATIONS			VOLUMES		
	CROWDED WEAVE	SWERVE	SLOWED DRASTICALLY	STOPPED	RAMP A	RAMP B		RAMP A	RAMP B	
						MEDIAN LANE	SHOULDER LANE		MEDIAN LANE	SHOULDER LANE
4:10-4:25	13	7	34	36	149	51	34	238	219	350
4:33-4:43	30	4	20	87	100	53	49	198	264	324
4:52-5:02	40	5	50	83	146	86	28	210	250	300
								1,100*	1,260*	1,680*

* Hourly volumes extrapolated from the short-term volumes shown.

TABLE C-2. 1) ERRATIC MOVEMENTS EXPRESSED AS A PERCENTAGE OF THE RAMP A VOLUME.
2) BRAKELIGHT APPLICATIONS EXPRESSED AS A PERCENTAGE OF THE RESPECTIVE LANE VOLUMES.

TIME	ERRATIC MOVEMENTS				BRAKELIGHT APPLICATIONS		
	CROWDED WEAVE	SWERVE	SLOWED DRASTICALLY	STOPPED	RAMP A	RAMP B	
						MEDIAN LANE	SHOULDER LANE
4:10-4:25							
4:33-4:43	15	2	10	44	51	20	15
4:52-5:02	19	2	24	40	70	34	9
AVERAGES	13	2.5	16	33	61	26	11

APPENDIX D

**AERIAL VIEW OF THE I 64, I 65, I 71
ROUTE JUNCTION AND SURROUNDING AREA**



The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry should be supported by a valid receipt or invoice. This ensures transparency and allows for easy verification of the data.

In the second section, the author outlines the various methods used to collect and analyze the data. This includes both primary and secondary data collection techniques. The primary data was gathered through direct observation and interviews with key stakeholders. Secondary data was obtained from existing reports and databases.

The third section details the results of the data analysis. It shows a clear upward trend in the number of transactions over the period studied. This increase is attributed to several factors, including improved marketing strategies and a growing customer base.

Finally, the document concludes with a series of recommendations for future actions. It suggests that the organization should continue to invest in data collection and analysis to stay ahead of the competition. Additionally, it recommends regular audits to ensure the accuracy of the records.