Traffic Operations as Related to Highway Illumination and Delineation

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Increasing construction of freeways has stimulated much discussion of highway illumination and its possible value in providing more comfortable night driving, in the possibility of increasing night usage of the highway, and in reducing traffic accidents. Because of lack of factual knowledge on the subject, the Connecticut State Highway Department in cooperation with the U.S. Bureau of Public Roads undertook a comprehensive study of illumination and delineation on the Connecticut Turnpike. Driver behavior data were recorded under nine different conditions of highway illumination and delineation at one onramp and one offramp on a mercury-illuminated section of the Connecticut Turnpike. Accident data were obtained on the 53-mi continuous illuminated section and on the 76-mi nonilluminated section.

For the various conditions of illumination and delineation, the results showed no significant differences with respect to average vehicle speeds, lateral placements, and clearances between vehicles. The manner of night use of speed change lanes, particularly the acceleration lane, improved with increased illumination. In general, it appears that some beneficial results of illumination in the deceleration area are derived when it is used at the full level and that even greater service is provided when illumination is combined with roadside delineation; and that illumination of the "interchange area only" does not appear to be advantageous insofar as the onramp site is concerned. The importance of delineation, with or without illumination, is demonstrated.

Analysis of the accident data for the lighted and unlighted sections of the Connecticut Turnpike did not provide conclusive results because of the extreme variance in traffic volumes and other characteristics.

●TRAFFIC AT night has always had accident rates which average about twice that of day rates. Awareness of the magnitude of this problem and increased efforts to develop remedial measures, stems not from any significant changes in this problem, but rather from the greater accident rates at night and from the rapid growth in annual vehicle-miles of travel. Night driving involves not only the problems of darkness, but hazards of fatigue, drowsiness, and other factors. The ultimate solution in avoiding darkness, of course, would be to illuminate the roadways at night to the same intensity as exists during daylight, but this is obviously an impractical approach. It remains to be determined, therefore, at what level of illumination would drivers operate their vehicles at night in the same manner as they do during daytime.

Although it is an accepted fact that good visibility is a prerequisite in good traffic operations, there have been no accredited warrants set forth for highway lighting. Similarly, there has been no correlation between the effects on traffic operations of delineation (reflector buttons) and illumination.

BACKGROUND

Increasing construction of freeways has increased the demand for highway lighting installations. Little is known on the effectiveness of highway lighting on freeways with respect to driver behavior, accidents, night use, and capacity. The subject of highway lighting and its effect on highway capacity, accidents, and driver behavior was discussed during the January 1958 Annual Meeting of the Highway Research Board by representatives of the U.S. Bureau of Public Roads, Connecticut State Highway Department and the Night Visibility Committee of the Board. It was generally agreed that there was a lack of data on the subject and that it would be desirable to conduct the needed research.

The importance of highway lighting is of such magnitude that the executive committee of the American Association of State Highway Officials assigned their committee on Planning and Design Policies to prepare a report on lighting controlled-access highways. This matter was discussed in detail during the October 1959 annual meeting of AASHO and their deliberations resulted in the distribution of a preliminary guide on highway lighting for use by the member States of the Association.

Construction of the 129-mi long Connecticut Turnpike with continuous highway lighting scheduled for 53 mi, presented an unusual opportunity to obtain factual data of the effects of illumination and delineation on traffic operations. The Connecticut State Highway Department in cooperation with the U.S. Bureau of Public Roads initiated such a study during the spring of 1958, and the results are described herein.

PURPOSE AND SCOPE

The purpose of this study was to evaluate the effectiveness of highway lighting per se, with roadside delineation, with pavement markings and with combinations of these under full, partial, and no illumination. The effects to be ascertained would be those manifested in accidents, and in drivers' actions, such as speeds, lateral placements, headways, lane use and utilization of acceleration and deceleration lanes. A total of some 183,000 vehicles were observed under nine principal study conditions. This multitude of data could not be treated by normal tabulating procedures and the data were processed by high-speed electronic equipment.

STUDY SITES

When first conceived, the study was to include tangent, curve, grade, bridge, on-ramp and offramp sections, both in fluorescent- and mercury-illuminated areas. However, time limitations later dictated that studies should be limited to a smaller number of locations.

The nine variable conditions selected for study at these sites were as follows:

No Illumination

1. Lane lines only.
2. Lane lines and edge lines.
3. Lane lines, edge lines and delineation.

Half Normal Illumination

4. Lane lines, edge lines and ½ normal illumination.
5. Lane lines, edge lines, delineation and ½ normal illumination.
6. Lane lines, edge lines, delineation and ½ normal illumination in interchange area only.

Full Illumination

7. Lane lines, edge lines, delineation and normal illumination in interchange area only.
8. Lane lines, edge lines and normal illumination.
9. Lane lines, edge lines, delineation and normal illumination.

The white reflectorized 6-in. wide lane lines were dashed, with both the dashes and spaces being 25 ft long. All edge lines were reflectorized, solid white to the left of the traffic stream and solid yellow to the right. Six-inch widths were used on the Turnpike proper, whereas 4-in. widths were used on the ramps.

Delineation consisted of acrylic plastic reflex reflectors, 3 in. in diameter mounted at a height of 4½ ft above the pavement, about 12 ft from the pavement edge on the shoulder side and about 5 ft on the median side, spaced at 200-ft intervals on the Turnpike and at reduced spacings on the ramps. Installations on the Turnpike consisted of single white reflectors on both sides of the roadways whereas dual amber reflectors were used on both sides of the ramps.

Highway lighting consisted of mercury luminaires throughout. Specific details of installation are shown later.

Conditions 1, 2 and 8 were observed during 1958 (Table 1). The analyses of the data for these three conditions, which were initiated immediately following the start of field observations, indicated the necessity for streamlining the program of studies so that a worthwhile report could be completed in a reasonable period of time. Accordingly, it was agreed to limit the study of all nine conditions to the onramp (site 4M) and offramp (site 5M) in one interchange with appreciable ramp volumes. This was accomplished during the summer of 1959. This concept evolved from the premise that of all the locations originally selected for study, these two sites would reveal the most significant effects evidenced by the nine conditions of the study.

The Connecticut Turnpike is a multilane freeway with full control of access which stretches from the New York State line in Greenwich easterly 129 mi to its intersection with US 6 at the Rhode Island State line in Killingly (Fig. 1). It serves primarily as an urban arterial in its westernmost 53 mi where the road way follows the general coastline and is comprised basically of three 12-ft portland cement concrete lanes either side of a median that varies in width from 4 ft to 30 ft. East of the 6-lane sec-

TABLE 1

TRAFFIC DISTRIBUTION BY LANES

Condition No.	Description	Day: Total Traffic (vph)	Day: Percent of Total Traffic in Ramp	Day: Lane 1	Day: Lane 2	Day: Lane 3	Night: Total Traffic (vph)	Night: Percent of Total Traffic in Ramp	Night: Lane 1	Night: Lane 2	Night: Lane 3
			(a) Site 4M								
1.	Lane lines only	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.	EM	672	51.0	22.6	21.3	5.1	313	48.4	29.5	18.4	3.7
3.	D-EM	1236	36.8	17.8	34.0	11.4	491	35.6	27.7	29.8	6.9
4.	EM-½ LTS	1219	42.4	19.1	27.6	10.9	519	35.2	23.1	27.0	14.7
5.	D-EM-½ LTS	1174	38.7	17.1	34.7	9.5	580	40.0	20.8	31.6	7.6
6.	D-EM-½ 1 LTS	1264	40.6	19.2	30.8	9.4	553	37.0	21.7	34.4	6.9
7.	D-EM-1 LTS	1096	40.5	20.0	30.3	9.2	533	38.5	23.1	30.4	8.0
8.	EM-LTS	798	52.0	21.6	21.2	5.2	376	28.5	47.0	20.0	4.5
9.	D-EM-LTS	1296	39.8	19.0	31.1	10.1	576	40.3	22.0	30.9	6.8
	Average	1094	42.7	19.6	28.9	18.8	494	37.9	26.9	27.8	7.4
			(b) Site 5M								
1.	Lane lines only	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.	EM	629	38.8	17.2	32.6	11.4	420	48.9	21.4	24.5	5.2
3.	D-EM	1503	47.2	10.7	26.0	16.1	666	44.2	20.8	27.9	7.1
4.	EM-½ LTS	1509	51.2	10.6	22.8	15.4	570	45.1	19.8	24.5	10.6
5.	D-EM-½ LTS	1488	48.6	10.7	24.5	16.2	656	49.2	14.8	26.9	9.1
6.	D-Em-½ 1 LTS	1478	48.4	11.7	25.4	14.5	563	47.0	22.0	24.4	6.6
7.	D-Em-1 LTS	1567	48.4	10.8	25.5	15.3	582	43.8	22.0	27.2	7.0
8.	Em-LTS	1401	46.5	10.7	27.1	15.7	810	59.8	18.4	17.5	4.3
9.	D-Em-LTS	1443	47.7	10.8	25.6	15.9	588	48.5	17.8	27.2	6.5
	Average	1377	47.1	11.6	26.2	15.1	607	48.3	19.6	25.0	7.1

Note: D = Roadside delineation.
E = Pavement edge markings.
LTS = Normal highway illumination.
⅛ LTS = ½ Normal highway illumination.
1 = Highway illumination in interchange area only.
NA = Not available.

tion, the Turnpike is a 4-lane divided arterial with a considerable mileage of bituminous concrete pavement. This section continues to follow the coastal line to its east intersection with US 1 and US 1A in the New London area where it turns to a northeasterly course.

The whole 53-mi section of the Turnpike west of Cherry Hill Road in Branford (about 8 mi east of New Haven), and all adjoining ramps were illuminated to a level of 0.8 foot-candle maintained on the mainline and onramps and a somewhat lower level on the offramps. East of this area illumination is confined to the more heavily traveled interchange areas.

It is of further interest to note that the western section of the Turnpike traverses the central or inner business districts of many cities and in some instances serves as a primary crosstown artery. The eastern section crosses the less densely populated areas although quite close, time-wise, to the central business districts.

The general area of study was the West Broad Street interchange in the Town of Stratford (Fig. 2). This location was selected because of the relatively high traffic volumes present and the relative ease in changing light intensities. Average daily traffic volumes on the Turnpike just west of this interchange are 17,000 vehicles in each direction. Close to 7,000 of the eastbound vehicles exit via the offramp to West Broad Street. Similarly, some 7,000 of the vehicles traveling in the opposite direction originate from the westbound access ramp. The 6-lane pavement is portland cement con-

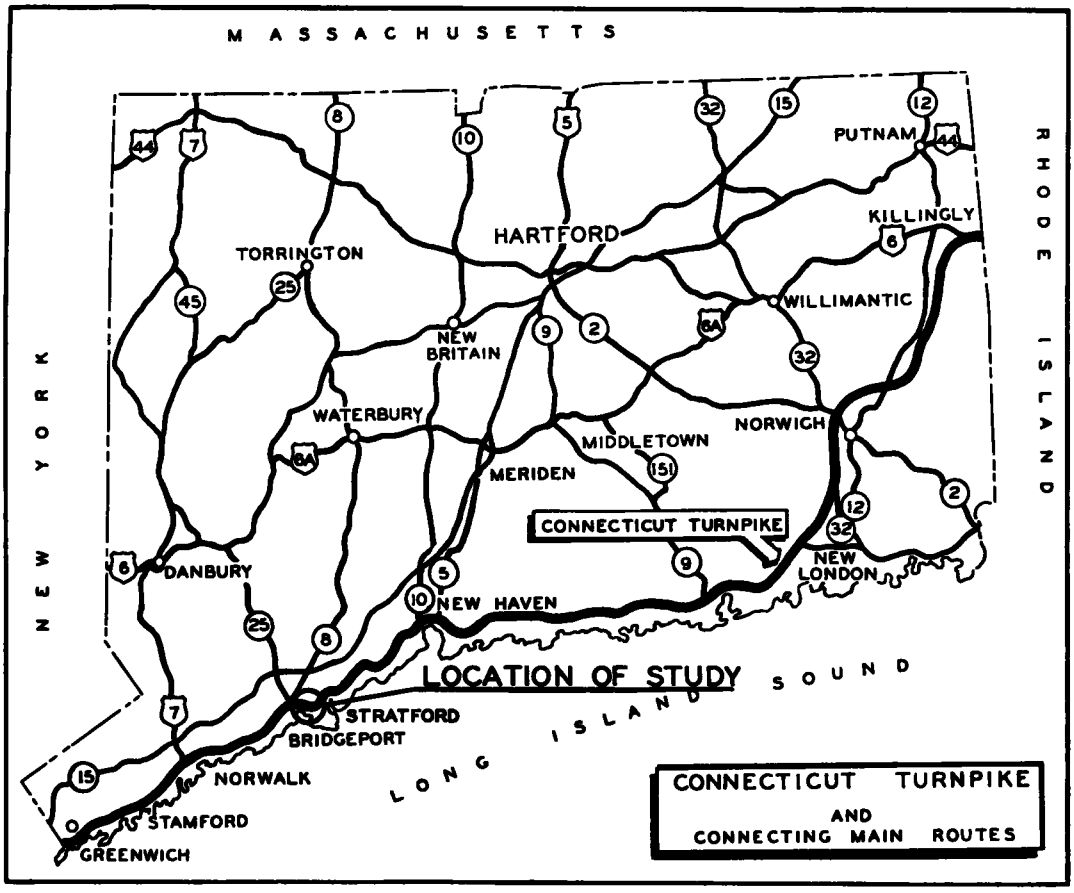


Figure 1. Location of study.

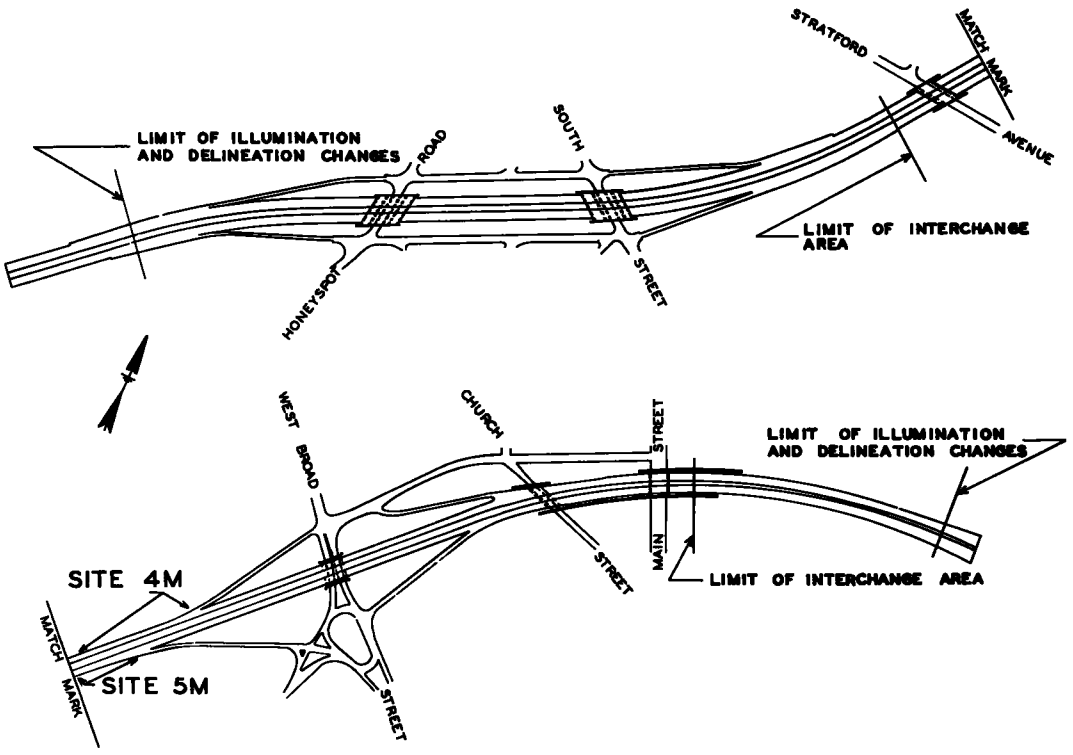


Figure 2. Plan of general study area.

crete with 2-ft wide bituminous concrete gutter strips and 10-ft wide bituminous concrete shoulders. The depressed grass median in this location averages 30 ft in width. An important item shown in Figure 2 is the limit of illumination and delineation changes and the limits of the interchange area. Lights were controlled within these limits.

Specific observations were obtained at both the westbound onramp and the eastbound offramp. Figure 3 shows the roadway geometry and details of the pavement markings, illumination, delineation, positions of the recording and detecting equipment, and the locations of the informatory and regulatory signs in the vicinity of the study sites. Figure 4 shows the view of the onramp site (4M) looking easterly on the westbound lanes. Figure 5 shows a similar view of the offramp site (5M) on the eastbound lanes.

The one-half normal level of illumination for conditions 4, 5 and 6 was achieved by changing lamps and ballasts as well as by using specially constructed lamps with the existing ballasts. The actual levels of illumination achieved were determined by the standard practice for measurement as recommended by the Illuminating Engineering Society. The actual values measured by the light meter and the calculated average foot-candles of illumination are shown in Figures 6 and 7. Generally, the ratio of the average to the minimum is 4 or 6 to 1. The different appearances of the highway under the two levels of illumination were readily discernible visually (Figure 8 shows normal illumination and Figure 9 shows half normal illumination).

FIELD OBSERVATIONS

The equipment utilized to record observed data was the Mobile Traffic Analyzer designed and constructed by the U.S. Bureau of Public Roads. During the field work, this vehicle was parked on specially constructed platforms located behind the wire rope railing (Fig. 10).

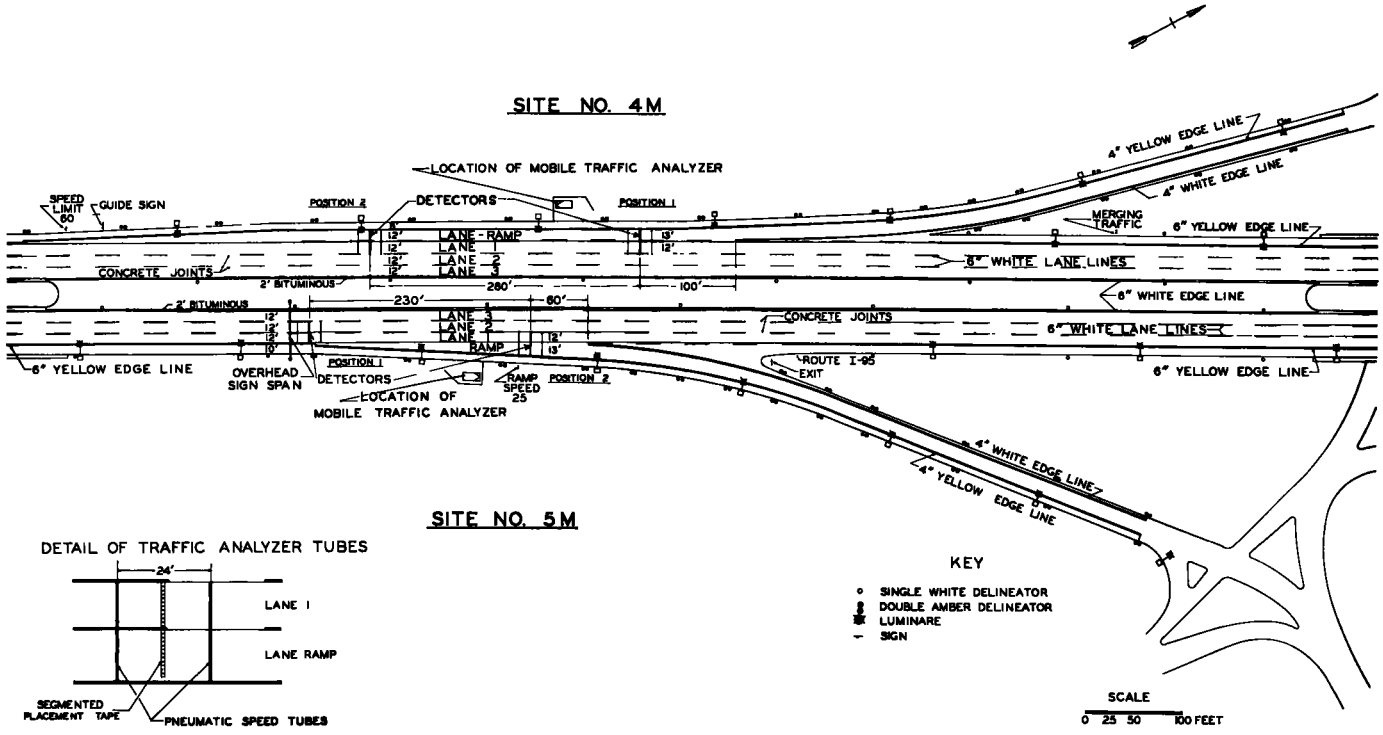


Figure 3. Plan of study sites.

Figure 4. Study site 4M.

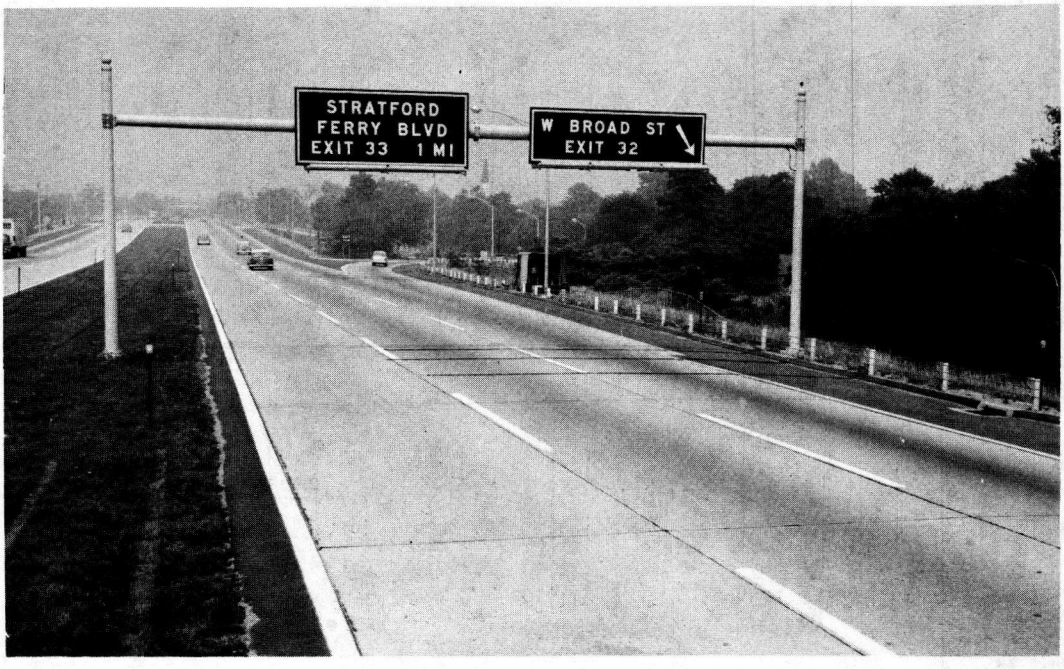
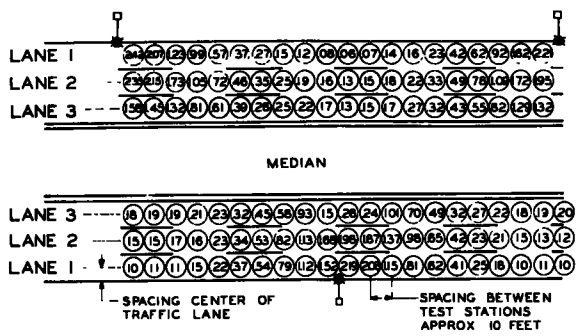
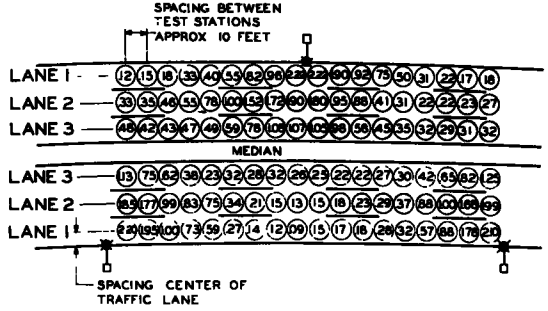


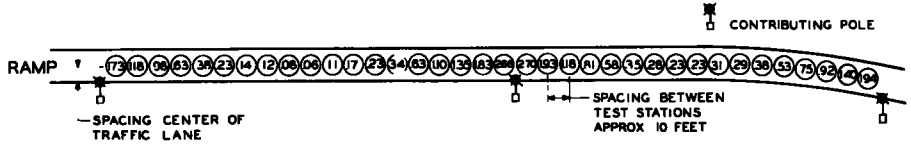
Figure 5. Study site 5M.



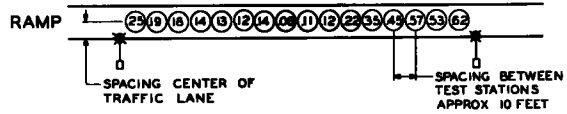
NORMAL TANGENT SECTION (30' MEDIAN)
AVERAGE FOOT CANDLES = 633



CURVE SECTION WITH NARROW MEDIAN
AVERAGE FOOT CANDLES = 68



TYPICAL ON RAMP
AVERAGE FOOT CANDLES = 802



TYPICAL OFF RAMP
AVERAGE FOOT CANDLES = 261
NOTE WHEELER L.L.B. UNITS WITH 15,000 LUMEN GOLD LAMP

NOTE GE FORM 400 UNITS WITH 20,000 LUMEN CLEAR LAMP.

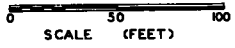


Figure 6. Measured illumination values, normal illumination.

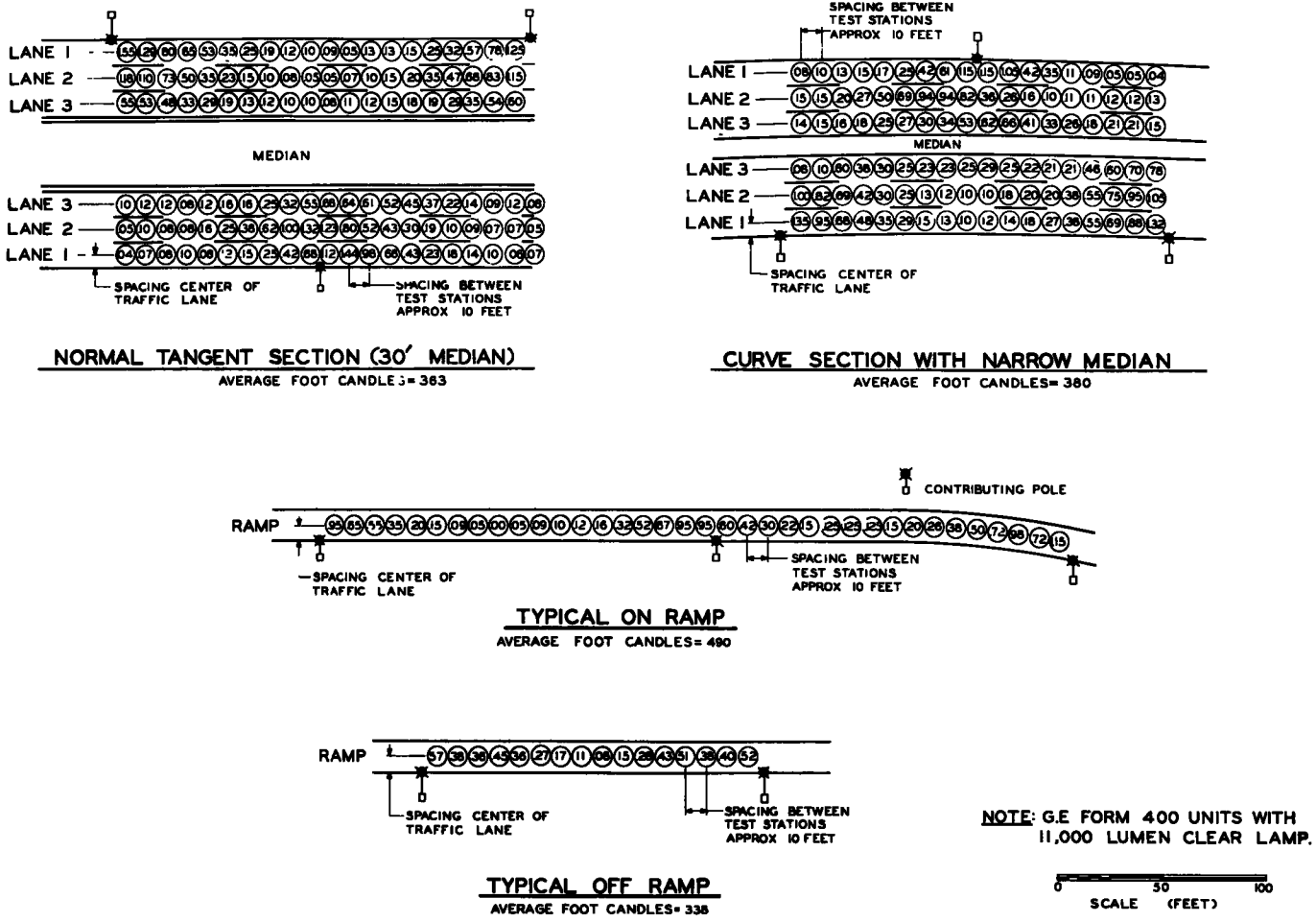


Figure 7. Measured illumination values, one-half normal illumination.

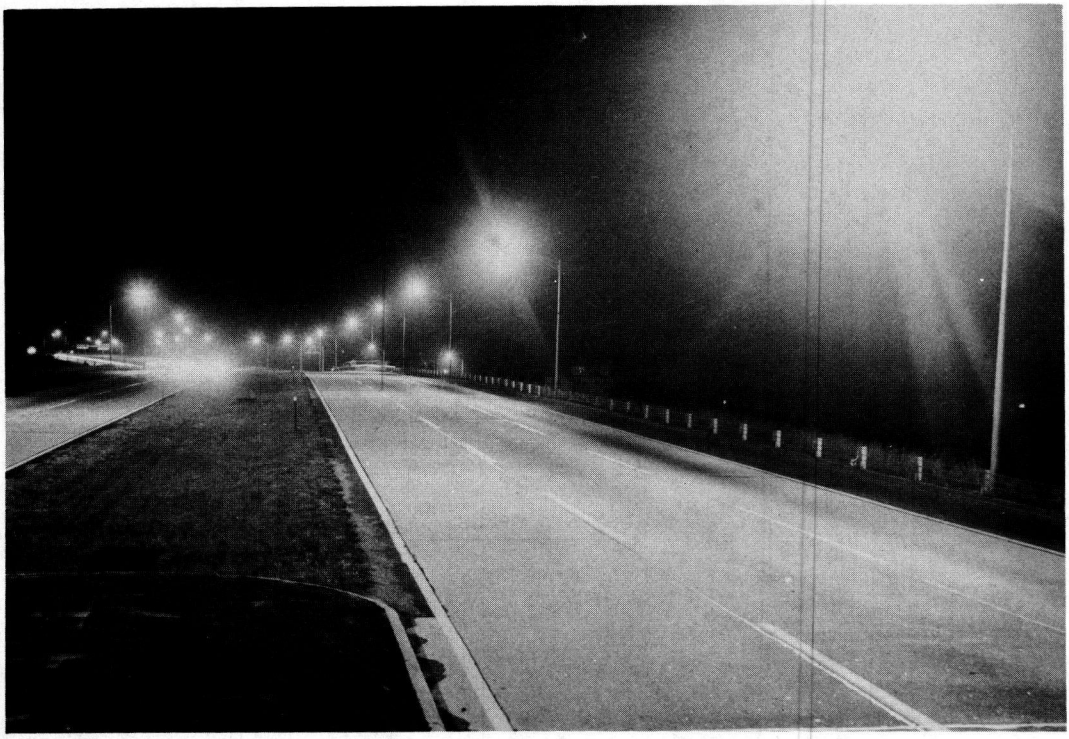


Figure 8. Normal illumination.

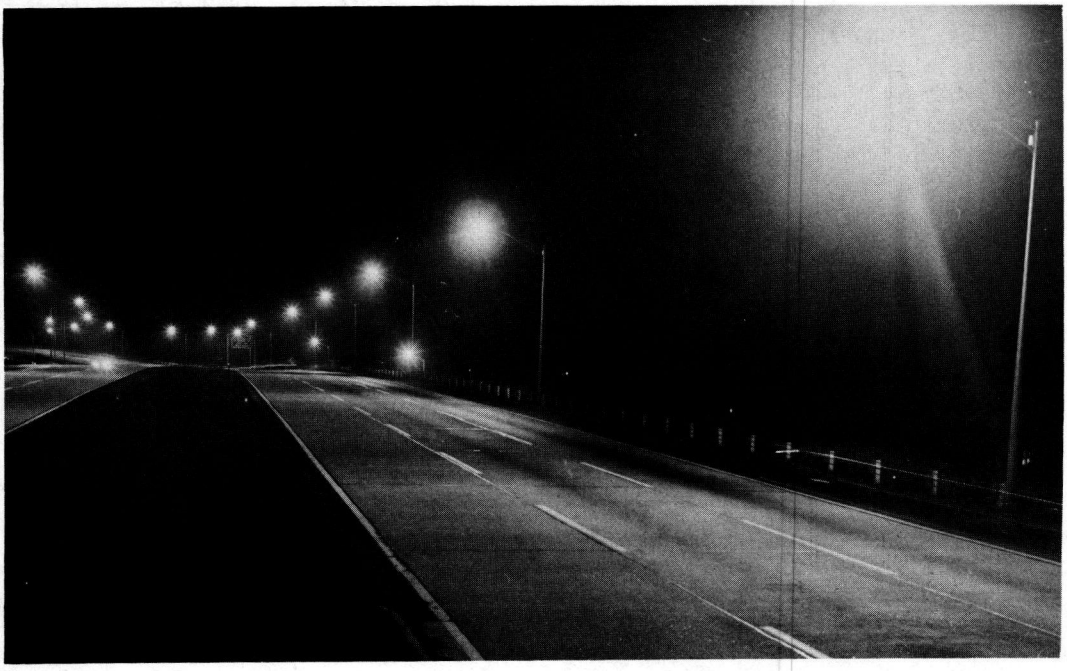


Figure 9. One-half normal illumination.

Figure 10. Mobile traffic analyzer—location at site 4M.

Specific equipment included four solenoid-operated adding machines, chronometer, telegraph keys, and other supporting equipment, all electronically interconnected and housed in a revamped delivery truck (Fig. 11). The major portion of the data was recorded by a crew of nine persons, four machine operators plus a supervisor located inside the vehicle and four others located outside, but in the immediate proximity of the vehicle. Electronic impulses were received via multiconductor cables which connected the recording apparatus to its detectors at the four locations in each site. Observations were made during both daylight and darkness for each day of the study and the number of observations for each traffic maneuver are given in Tables 7 and 8.

Data recorded automatically consisted of speed, lateral placement (from which lateral clearances between vehicles were calculated) and time of day to the nearest $^{1}/_{10,000}$th of an hour (from which traffic maneuvers and headways were calculated). The observers operated certain keys manually to introduce onto the recording tapes such items as vehicle classification and drivers' actions in the merging and diverging areas.

At both sites, complete data were recorded mechanically at each of four positions (Fig. 3); one set of road tubes was placed in lane 1 (curb lane) and on the onramp near both the beginning and end of the acceleration lane (site 4M); also, in lanes 1 (curb) and 2 (middle) near the beginning of the deceleration lane and in lane 1 and the offramp near the gore area (site 5M).

Simultaneously with the traffic analyzer, observers recorded the manner in which drivers utilized the acceleration and deceleration lanes including various driving actions such as use of brakes, sudden slowdown, etc. Volumes and lane changing were also recorded for those lanes not fitted with detector tubes.

Accident data were obtained by close liaison with the Connecticut State Police with specific information coming from accident reports submitted by their investigating troopers. This information was compiled for both illuminated and nonilluminated areas. The only period of Turnpike accidents considered for comparative analyses was the first eight months of 1959. Data prior to this date on the Turnpike are not considered too indicative because of the partial openings to traffic in 1958. The accident information for the Merritt Parkway and for all state highways combined, was obtained from the last full year of accident tabulations available from motor vehicle reports at the present time.

ANALYSES AND DISCUSSION OF DATA

In the analyses of speeds and lateral placements, the vehicles were grouped into two main categories: passenger cars and commercial vehicles. Each of these were then classified as to their proximity to other vehicles on the roadway. These consisted of the following: (1) free moving, (2) adjacent and not trailing, (3) adjacent and trailing, (4) trailing and not adjacent, and (5) all others.

Free-moving vehicles are those whose longitudinal spacing to the nearest vehicle (ahead or behind) in any lane is more than 7 sec.

Adjacent vehicles are those whose longitudinal spacing to the nearest vehicle in an adjoining lane is 1.4 sec or less.

Trailing vehicles are those whose longitudinal spacing to the preceding vehicle in the same lane is 3 sec or less.

Volumes

The volumes passing through the study sites and their distribution by lanes are given in Table 1. It will be noted that for nearly all conditions of study, the ramp carried more traffic than any other single lane and that lane 3 (the median lane) generally carried the least amount of traffic. Lane 2 (middle lane) carried about twice as many vehicles as did lane 1 (curb lane). It appears, therefore, that the selection of these ramps as study sites were appropriate.

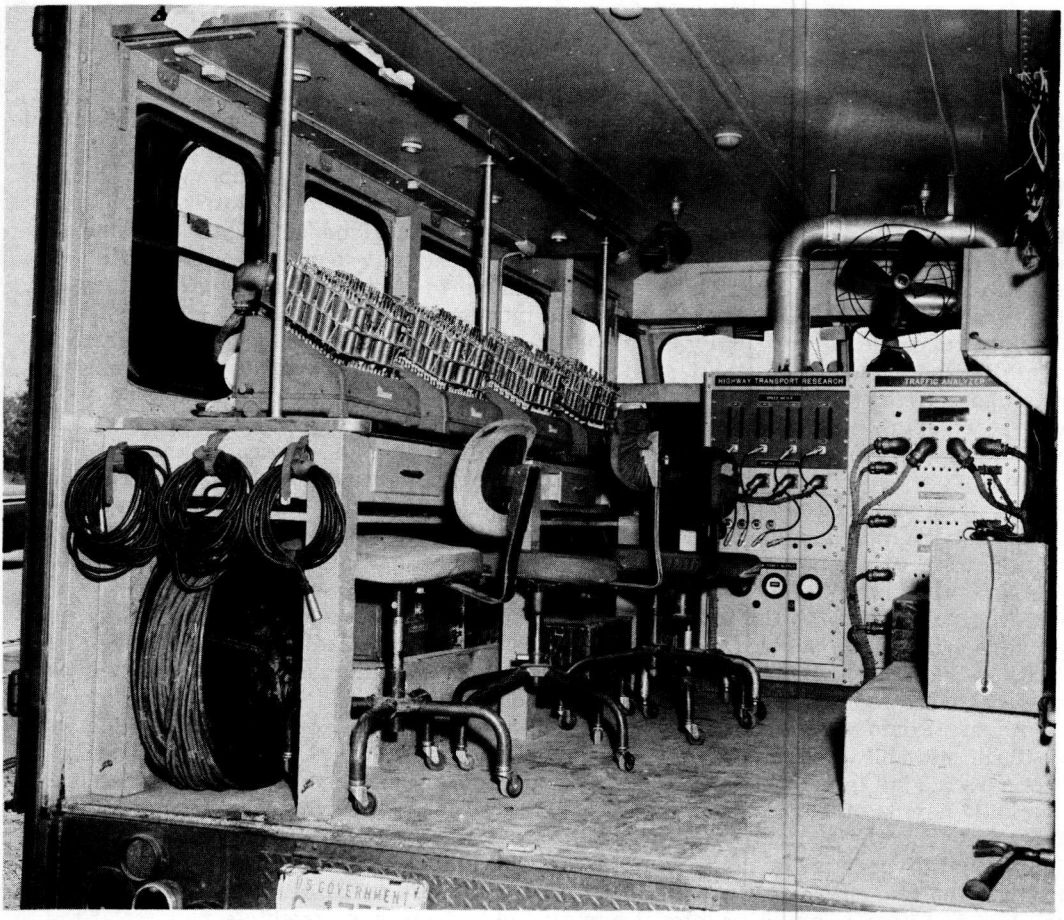


Figure 11. Mobile traffic analyzer—interior view.

Daytime volumes observed were greater than those at night mainly because of the normal distribution at the time of the year studied. This was further accentuated because the daytime observations embraced the late afternoon peak hour.

TABLE 2

COMMERCIAL TRAFFIC[1]

Condition	Site 4M		Site 5M	
	Day	Night	Day	Night
Lane lines only	22	23	12	17
EM	16	17	10	13
D-EM	10	15	7	12
EM-½ LTS	11	15	7	13
D-EM-½ LTS	16	13	9	10
D-EM-½ 1 LTS	11	11	9	13
D-EM 1 LTS	11	11	5	8
EM LTS	14	12	10	15
D-EM-LTS	9	12	8	8
Average	12.4	12.6	8.6	12.1

[1]Percent of total volumes.

Table 2 indicates that commercial traffic accounted for an average of some 12 percent of the total vehicles passing through site 4M and 10 percent through site 5M. The values ranged from 9 to 23 percent at site 4M and 5 to 17 percent at site 5M. From an analysis of data not given in tables, it was found that the through traffic streams carried a higher percentage of commercial vehicles. The smaller percentage and lesser amount of commercial vehicles passing through the offramp site (5M) is due in part to the location of a toll plaza easterly of this area and in part to the fact that the preceding exit ramp leads more directly to US 1 in Stratford.

Speeds

There does not appear to be any significant relation between vehicle speeds and the nine conditions of this study. The summary data are shown in Figures 12 and 13 and Table 3. Variations among daytime speeds were as great or greater than between day and night of a particular day, or for that matter, between night observations on different dates (Tables 9 and 10). These analyses hold true for passenger cars as well as commercial vehicles and for the various categories of traffic maneuvers such as free-moving, trailing, adjacent, etc.

The difference between the average speeds for the nine conditions rarely exceeded 3 mph, and was usually 1 mph, for any single combination of site, location, lane and light condition. Table 3 gives these comparisons for through passenger cars. These vehicles were observed in the curb lane for the onramp site and the middle lane for offramp site, because these lanes carried the greatest proportion of through vehicles.

A review of the distributions of observed speeds indicated that the percentage of through passenger cars traveling below 40 mph might provide a good index for comparing the relative advantages of the several conditions of study. The index derived for each condition of study was the variation (expressed in percent) of the percentage of nighttime vehicles traveling below 40 mph from the percentage of the total daytime vehicles observed at the same site traveling below 40 mph during the average day. For example, if 35 percent of the vehicles traveled below 40 mph during the "average day" and 30 percent of the vehicles traveled below 40 mph at night for a given condition, the percent variation was -14 percent. If the nighttime percentage of vehicles traveling below 40 mph is lower than the daytime figure, then the variation is minus. In the converse case, the variation would be plus. The seemingly large values that appear for some conditions in Figures 14 and 15 result usually from the fact that during the

daytime the average percent of observed speeds below 40 mph is quite low. Figure 14 shows the results for the onramp, site 4M. The least percent variation occurred for conditions of normal illumination with and without delineation, half level of illumination with delineation, and no illumination with delineation. Illumination in the interchange area only with delineation for both conditions resulted in greater variances. It appears that at this site, roadside delineation exhibits strong influence toward maintaining

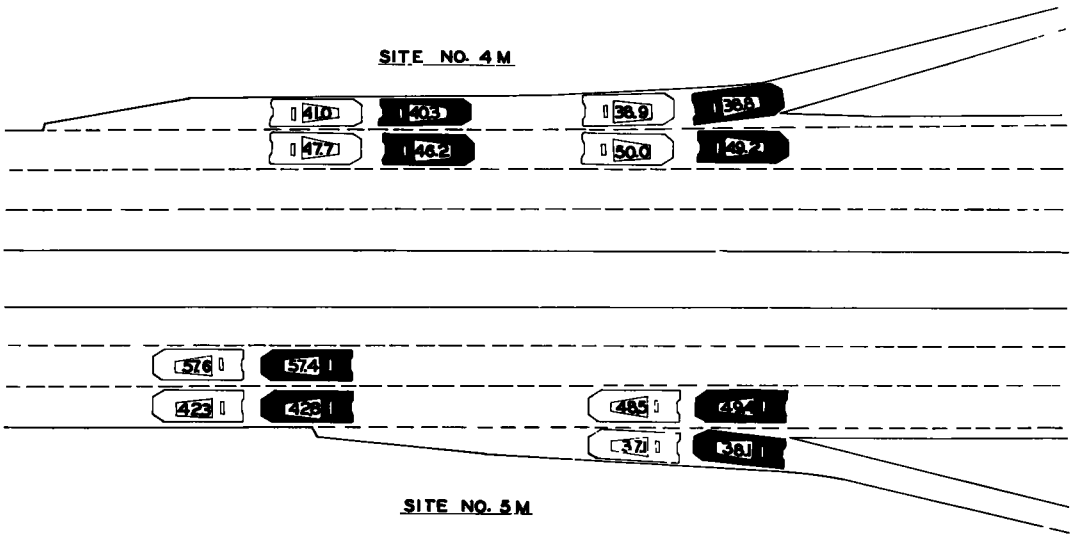


Figure 12. Average speeds for passenger cars (mph, day and night).

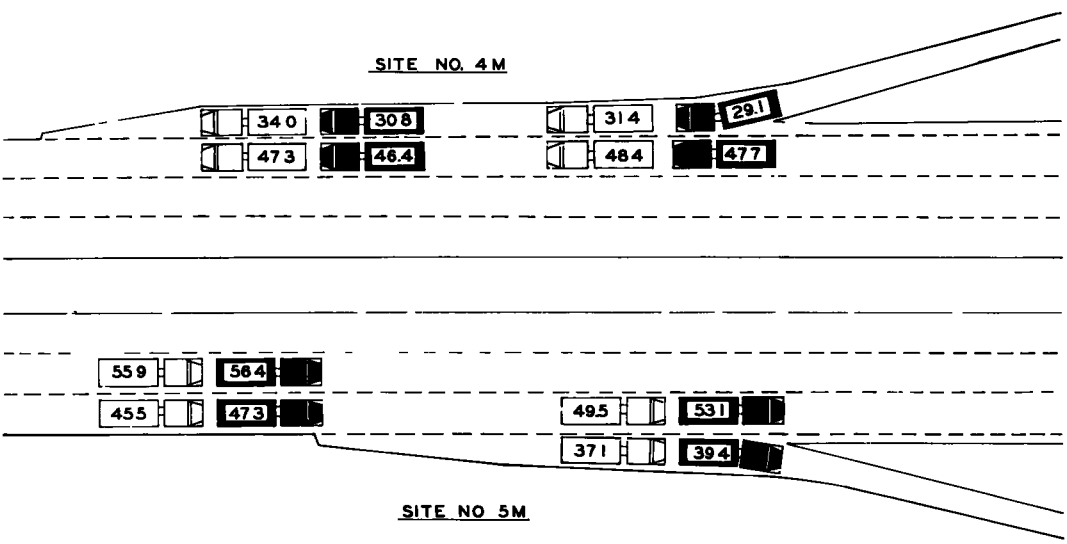


Figure 13. Average speeds for commercial vehicles (mph, day and night).

TABLE 3

SUMMARY OF AVERAGE SPEEDS, PLACEMENTS AND CLEARANCES FOR THROUGH PASSENGER CARS ONLY

Conditions of Study[1]	Near the Onramp(Site 4M)						Near the Offramp(Site 5M)					
	Speed		Placement[2]		Clearance[3]		Speed		Placement[2]		Clearance[3]	
	Day (mph)	Night (mph)	Day (ft)	Night (ft)	Day (ft)	Night (ft)	Day (mph)	Night (mph)	Day (ft)	Night (ft)	Day (ft)	Night (ft)
1. Lane lines only	49.8	47.0	6.6	6.1	6.9	6.2	55.9	57.2	6.4	6.0	8.6	8.0
2. Edge markings	51.3	48.1	6.7	6.8	7.4	6.8	56.8	56.5	6.7	6.5	8.0	7.3
3. Edge markings and delineation	49.2	47.2	6.7	6.4	7.4	7.0	58.5	57.7	6.8	7.2	8.3	8.3
4. Edge markings and ½ illumination	50.3	51.2	6.9	6.4	7.4	6.2	57.5	58.4	6.8	6.9	8.4	8.0
5. Edge markings, delineation and ½ illumination	50.8	50.0	6.5	6.5	7.1	7.8	56.9	55.5	6.6	6.7	8.1	8.5
6. Same as 5, but ½ illumination in interchange area only	49.8	50.5	6.6	6.6	7.2	6.8	57.4	56.7	6.8	6.6	8.1	7.9
7. Same as 6, but full illumination in interchange area only	48.8	49.7	6.5	6.6	7.1	7.6	58.9	58.3	7.1	6.7	8.4	8.2
8. Edge markings and full illumination	51.0	49.0	6.9	6.5	8.3	7.6	59.1	58.5	6.9	6.9	8.2	8.4
9. Edge markings, delineation and full illumination	49.5	49.8	6.7	7.0	7.6	7.3	57.8	57.5	7.2	6.8	8.4	7.9
Average	50.0	49.2	6.7	6.5	7.4	7.0	57.6	57.4	6.8	6.7	8.3	8.1

[1]Lane lines were present for all conditions.
[2]Distance in feet center of car to right edge of lane.
[3]Clearance in feet between bodies of adjacent cars.

minimum speed differentials. Continuous illumination of the lower level exhibits no improvement over "no illumination."

The data for the offramp (site 5M) shown in Figure 15 revealed entirely different trends. It is found that a smaller percentage of "through passenger cars" traveled below 40 mph during nighttime than during daytime for all conditions except with edge and lane lines and half illumination. One possible explanation for the exception is that the reduced illumination in the area of heavy diverging maneuvers resulted in a loss of confidence and subsequent lowering of speed. Cumulative speed curves for each condition were compared to the similar curve for the "average day" at the pertinent site. The trends noted support the results in Figures 14 and 15.

Placements

The summaries of all placement data given in Tables 3, 11 and 12 indicate that the lateral placements of vehicles were not significantly different for the nine conditions of the study. There are certain trends indicated by the average day-night placements shown in Figures 16 and 17, but there was none that could be used as a criteria in evaluating the study conditions. Figure 16 shows the placements of passenger cars averaged for all nine conditions. The values shown are distances that centers of cars were from the right edge of lane at the specific points of study. The darkened silhouettes are for night observations. Figure 17 shows similar data for commerical vehicles. Interesting observations of the placement data are as follows:

1. All vehicles in the ramps at both sites generally traveled closer to the through lanes at night.
2. All vehicles in the lane nearest the ramp at both sites generally traveled closer to the right edge of pavement at night.
3. For passenger cars at the start of the offramp and near the end of the onramp, there was considerable difference between the average placements in the outer lane and the inner lane for both day and night observations.

Headways

It would be reasonable to suppose that the manner in which motorists select their

position on the highway with relation to the preceding vehicle in the same lane would be a good measure of their confidence of operating conditions. The percent of the headways below 1.4 sec was selected as a criteria in evaluating the conditions of study because 1.4 sec is the approximate time equivalent of the recommended safe distance between vehicles traveling in the same lane at the posted speed of 60 mph. The percent of headways below 1.4 sec, between 1.4 and 2.8 sec, and over 2.8 sec are given in Table 13. A review of these data indicated no definite relation between the headway distributions and the various study conditions.

Clearances

The term "clearance" as used in this report relates to the lateral distance in feet between adjacent vehicles. Clearance measurements for through passenger cars are given in Table 3. The average clearances for all lanes are summarized in Table 14. Average clearances for the offramp (site 5M) were generally higher than those at the onramp (site 4M). As in the case of speeds, placements and headways, analyses of the average clearance for each study condition showed that they followed no set pattern and that the differences in clearances for the nine study conditions were small in magnitude.

Lane Use

The most significant findings of this study related to the way in which the motorists made use of the acceleration and deceleration lanes. Data for this phase of the analyses were obtained by manual counts. For this purpose the ramps were divided into

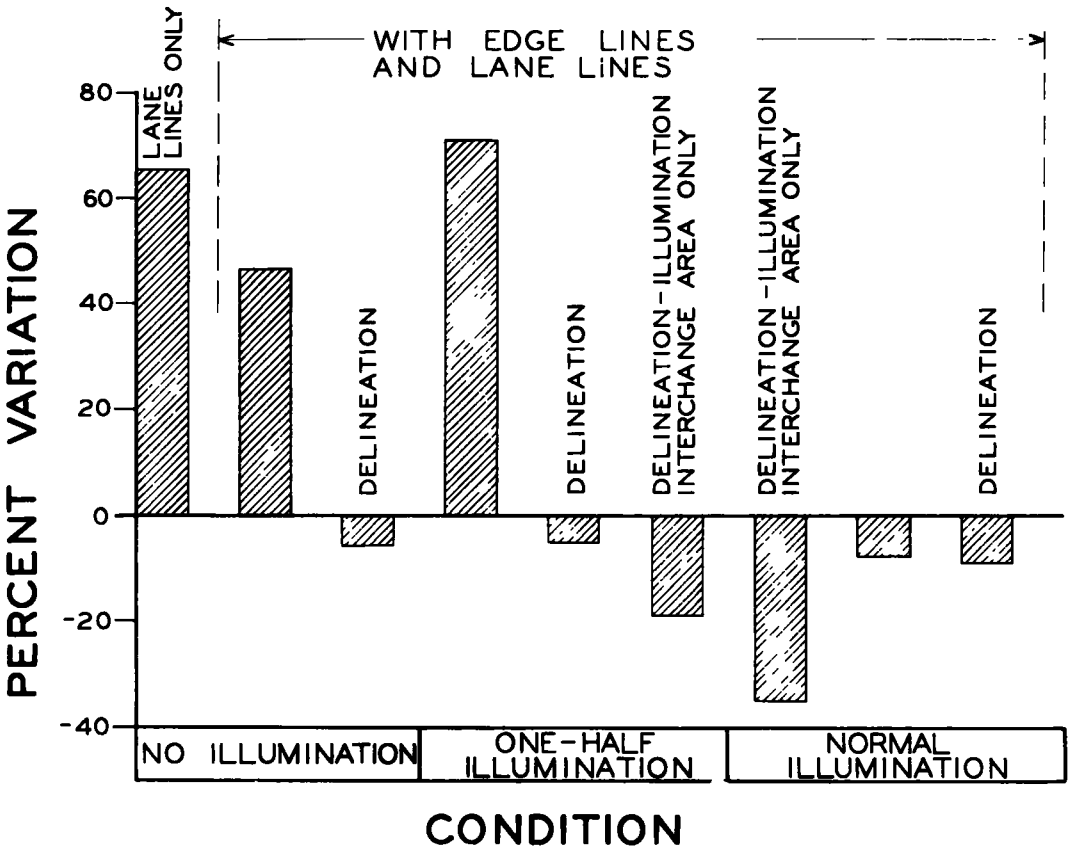


Figure 14. Site 4M near onramp—variation in percentages of speeds below 40 mph for through passenger cars only in the right lane (night from average day).

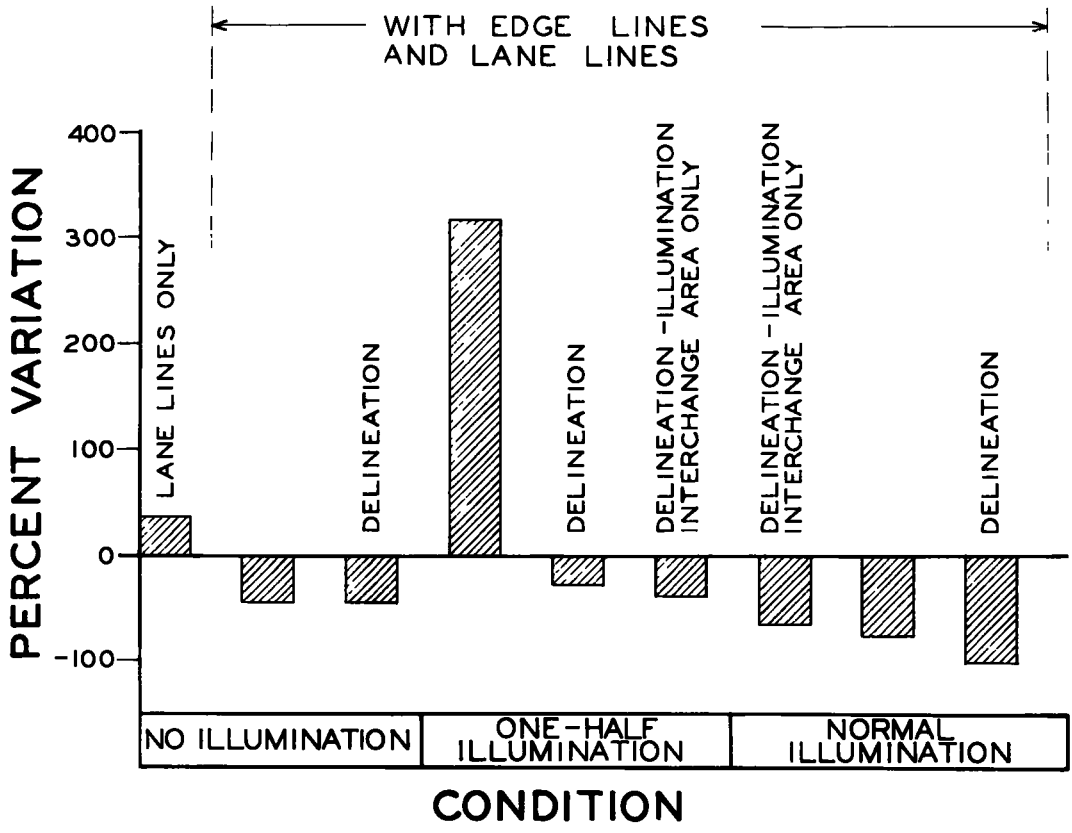


Figure 15. Site 5M near offramp—variation in percentages of speeds below 40 mph for through passenger cars only in the middle lane (night from average day).

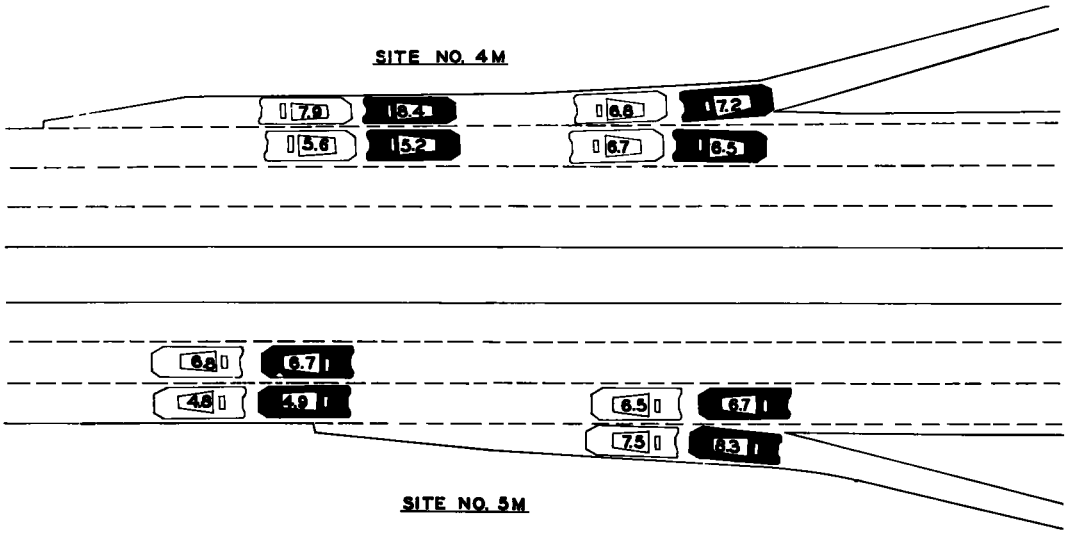


Figure 16. Average placements for passenger cars (feet, night and day).

three equal parts. Observers noted the number of vehicles using the onramp and the proportion of the length of the acceleration lane which was traversed by each vehicle before crossing to lane 1. The opposite movement was recorded at the offramp.

The percentage of the total vehicles crossing in each third of the lane for each condition at night was then paired with the similar figures for the "average day." The difference between each pair of percentages was then expressed as a percent of the "average day," and the percentages for the 3 sections of the speed change lanes were averaged. The averages of the three percent variations from the "average day" as thus determined are plotted in Figures 18 and 19 for each condition of study. The average percent variation is another measure of how close night operation approaches daytime operation.

For the onramp (site 4M), Figure 18 (data for condition 1 not available), it was found that under same conditions of delineation, drivers' use of the acceleration lane at night was directly related to the level of illumination. As the amount of illumination increased, night use of the acceleration lane more nearly approached daytime use.

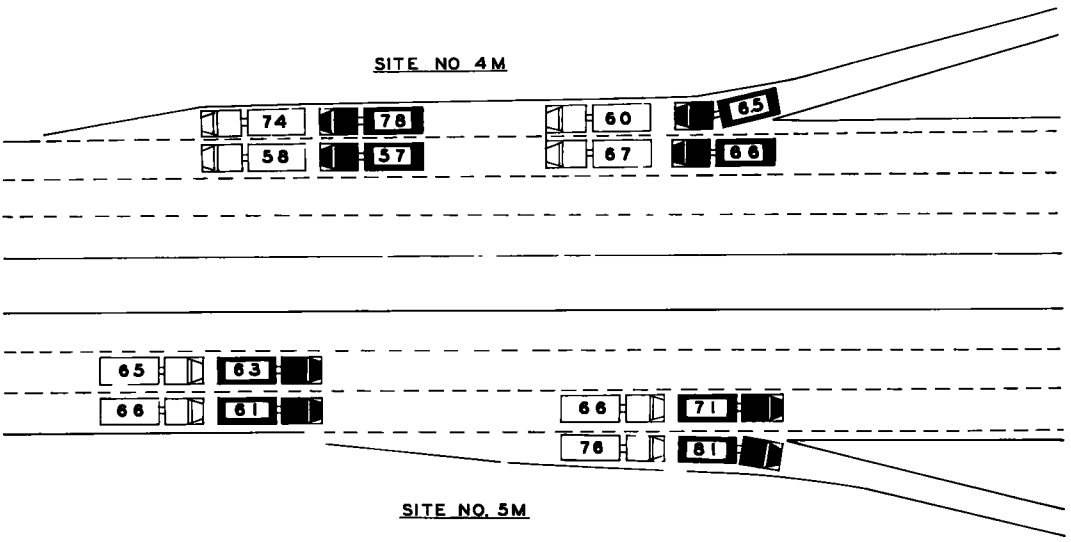


Figure 17. Average placements for commercial vehicles (feet, day and night).

For example, with delineation and no illumination night use was 37 percent different from the average day; with one-half illumination this variation dropped to 23 percent, and with full illumination the variation was about 17 percent.

In case of the deceleration lane (offramp site 5M), Figure 19 (data for condition 1 not available), shows that full illumination yielded the best results. One-half illumination on the average produced slightly larger variations from daytime operations than no illumination. The importance of delineation is again demonstrated.

The other maneuvers considered in relation to the manner in which the motorists made use of the acceleration and deceleration lanes were "use of brakes," "sudden deceleration," "cutting over," and "changing lanes." All observations in these categories revealed nothing of importance. There was more "sudden slowing" and use of "brake lights" at the offramp site 5M for the condition of only lane and edge lines than the others during hours of darkness. During daylight hours, there was an even higher total of such maneuvers at both study sites.

ACCIDENTS

Correlation of traffic operations with accidents was rather inconclusive because of the limitations of the data available at the time the study was concluded. Traffic vol-

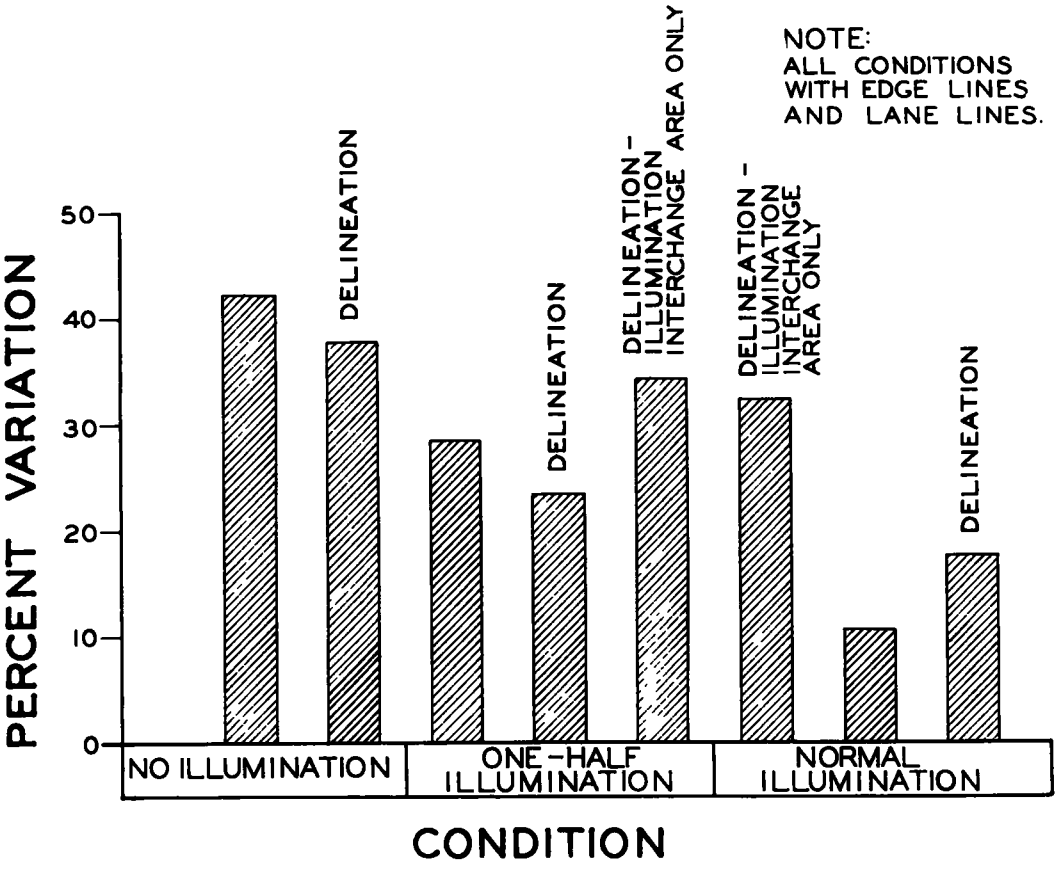


Figure 18. Site 4M—variation in percentages of use of acceleration lane (night from average day).

umes and other highway characteristics were different for the illuminated and non-illuminated section of the Turnpike. Incomplete roadway openings, general construction cleanup, etc., made it necessary to limit the surveillance of Turnpike accidents to the first eight months of 1959.

A summary of the general accident statistics for the "illuminated" and "nonilluminated" sections of the Turnpike are given in Table 4 along with similar data for the nonilluminated Merritt Parkway and all state highways.

The accident rates for both day and night travel on the Turnpike are considerably lower than either of the other facilities. This is to be expected because of the higher standard of design of this limited-access facility and its traffic appurtenances.

Analyses of the dark vs illuminated sections of the Turnpike reveal a slightly higher rate for the illuminated section during day and an appreciable higher rate for the illuminated section during night. On the illuminated area the night rate is 1.71 times that of the day rate; on the nonilluminated area the night rate is 1.36 times that of the day rate. The difference between the accident rates did not prove to be statistically significant. Also, they must be evaluated with respect to the wide variation in volumes and other characteristics between the dark and illuminated sections.

Analysis was then conducted of the relative exposure to accidents. This basically involved a comparison of the traffic volumes, frequency of ramp intersections, and general roadway features. Immediately it appeared that conditions in the illuminated section were considerably more conducive to accidents than in the nonilluminated sec-

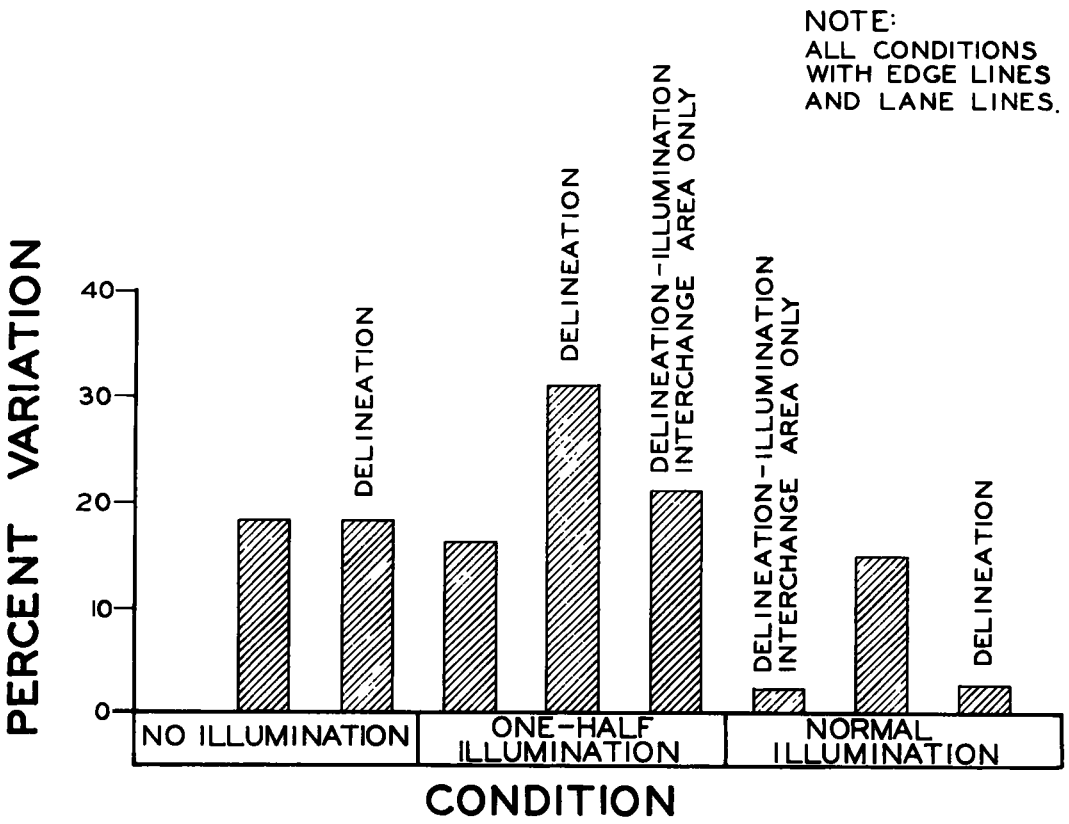


Figure 19. Site 5M—variation in percentages of use of deceleration lane (night from average day).

TABLE 4

ACCIDENT SUMMARY

CONNECTICUT TURNPIKE VS OTHER FACILITIES

	Length	Vehicle-Miles (10^8)		No. of Accidents		Accident Rate (per 10^8 veh-mi)	
		Day	Night	Day	Night	Day	Night
Connecticut Turnpike							
1/1/59 to 8/31/59 incl.							
Illuminated area	53.0	2.40	1.29	177	168	74	130
Non-illuminated area	75.69	0.99	0.53	71	52	72	98
Total	128.69	3.39	1.82	248	220	73	121
Merritt Parkway							
1/1/57 to 12/31/57 incl. (Non-illuminated)	37.46	3.45	0.97	493	402	142.9	414.4
All state highways							
1/1/57 to 12/31/57 incl.	3224.66	39.07	16.75	8736	6117	223.6	365.2

tion. Whereas the general roadway design standards in the two sections were the same for maximum curvature, maximum gradient, and ramp intersections, special note was made of the following:

1. The average daily traffic volume on the illuminated section was approximately 3.6 times that on the nonilluminated section.
2. There are twice as many ramp intersections per mile on the average along the mainline in the illuminated area.
3. The illuminated section follows a more undulating course than the nonilluminated section.

Importance of these items is evidenced by the fact that within the illuminated area alone, some 43 percent of the accidents occurred in only 27 percent (14.3 mi) of the total 53 mi of roadway involved. The average daily traffic volumes in this specific area ranged from 30,000 to 40,000. A portion of this 14.3-mi section, 6.9 mi with the highest volume, was also subjected to a comprehensive examination, and the results are given in Table 5.

TABLE 5

CONNECTICUT TURNPIKE – ACCIDENT SUMMARY

HIGH VOLUME AREAS IN THE ILLUMINATED SECTION							
		Vehicle-Miles (10^6)		No. of Accidents		Accident Rate (per 10^8 veh-mi)	
	Length	Day	Night	Day	Night	Day	Night
High volume areas							
Total	14.3	0.85	0.45	80	70	94	156
6.9-mi section	6.9	0.44	0.23	50	31	114	135
Total illuminated area	53.0	2.40	1.29	177	168	74	130

Several important facts are evident from the accident summary contained in Table 5. In connection with these findings it should be noted that the average daily traffic volume on the 6.9-mi section was about 1.6 times that for the total 53 mi.

1. The day accident rate on the 6.9-mi section was 114 per 100 million vehicle-miles or 1.54 times the day rate (74) for the entire 53 mi of illuminated roadway.
2. The night accident rate on the 6.9-mi section was 135 per 100 million vehicle-miles or 1.18 times that of the day rate and only 1.04 times the average night rate for the 53 mi.

The day accident rate increased with the traffic volumes whereas the night rate remained substantially the same and was then only slightly greater than the day rate on the same section. It must be realized that in the areas under discussion the traffic volumes during the day are about double those during the night.

It would appear from the study of accident rates for the illuminated sections of varying volumes that highway illumination may have a beneficial effect on accident experience. However, it was most evident that the value of accident experience in establishing criteria for highway illumination would require considerably more data than were available, if statistically significant results were to be obtained.

CONCLUSIONS

The conclusions drawn from the analyses of the data included in this report would naturally apply to a freeway similar in design and traffic volumes to that of the Connecticut Turnpike. However, it is believed that the results obtained here can be generally used with confidence because the interchange studied is typical of freeways both from the standpoint of geometrics and traffic volumes.

The more important results evolved from this study are as follows:

1. Neither average speed, placement, headway, nor lateral clearance showed any

consistent change between day and night conditions by virtue of highway illumination or delineation.

2. Nighttime use of the acceleration lane approached daytime use as the level of illumination increased. A similar pattern existed at the deceleration lane, although it was more variable.

3. In general, it appears that beneficial results of illumination in the deceleration area are derived when it is used at the full level and that even greater services are derived when illumination is combined with roadside delineation, and that illumination of the "interchange area only" does not appear to be desirable insofar as the onramp site is concerned.

4. Analysis of the accident data for the lighted and unlighted sections of the Connecticut Turnpike does not provide conclusive results because of the extreme variance in traffic volumes and other characteristics.

It is ironical that the extensive analysis with a high-speed computer of the tremendous volume of data does not reveal such positive trends that definite warrants for highway lighting can be formed. However, the results do point up the value of roadside delineation with or without illumination and the need for using adequate intensity of illumination if highway lighting is to be provided. Above all, the experience gained will be most helpful in the planning and conducting of future highway lighting research. It appears that criteria other than those used in this report must be studied to evaluate properly the effect of highway lighting on traffic operations. The conclusions reached in this report are gleaned from studies of a modern facility operating well below its practical capacity, and may not be applicable to a similar facility carrying a heavier volume of traffic.

Appendix

TABLE 6

SCHEDULE OF FIELD OPERATIONS

Site	Date	Hours of Operation (p.m.)	Condition No.	Description of Condition[1]
4M (Onramp)	3-11-58	2:00- 5:30 6:30-10:00	1	No illumination and without delineation
5M (Offramp)	3-12-58	2:00- 5:30 6:30-10:00		
4M	5-20-58	3:30- 7:00 8:00-11:00	2	With edge markings, no illumination and without delineation
5M	5-21-58	4:00- 7:30 8:30-11:00		
4M	7-13-59	3:00- 7:00 9:00-12:00	3	With edge markings, no illumination and with delineation
5M	7-16-59	3:00- 7:00 9:00-12:00		
4M	6-23-59	3:00- 6:30 9:30-12:00	4	With edge markings, ⅓ normal illumination and without delineation
5M	6-29-59	3:00- 7:00 9:00-12:00		
4M	7- 1-59	3:00- 7:00 9:00-12:00	5	With edge markings, ⅓ normal illumination and with delineation
5M	6-30-59	3:00- 7:00 9:00-12:00		
4M	7- 8-59	3:30- 7:00 9:00-12:00	6	With edge markings with delineation and ⅓ normal illumination in interchange area only
5M	7- 7-59	3:00- 7:00 9:00-12:00		
4M	7-22-59	3:00- 7:00 9:00-12:00	7	With edge markings, with delineation and normal illumination in interchange area only
5M	7-17-59	3:00- 7:00 9:00-12:00		
4M	9-30-58	2:30- 6:30 7:30- 9:30	8	With edge markings, normal illumination and without delineation
5M	10- 2-58	2:30- 6:30 7:30-10:30		
4M	7-21-59	3:30- 7:00 9:00-12:00	9	With edge markings, normal illumination and with delineation
5M	7-23-59	3:00- 7:00 9:00-12:00		

[1]Lane lines were present for all conditions.

TABLE 7

SAMPLE SIZE

(FOR PASSENGER CARS ONLY FOR EACH CONDITION BY TRAFFIC MANEUVER)

	Site 4M								Site 5M							
	Day				Night				Day				Night			
Condition	Ramp Loc 1	Lane 1 Loc 1	Ramp Loc 2	Lane 1 Loc 2	Ramp Loc 1	Lane 1 Loc 1	Ramp Loc 2	Lane 1 Loc 2	Lane 1 Loc 1	Lane 2 Loc 1	Ramp Loc 2	Lane 1 Loc 2	Lane 1 Loc 1	Lane 2 Loc. 1	Ramp Loc 2	Lane 1 Loc 2
Free-moving vehicles																
Lane lines only	336	67	168	127	304	52	138	232	134	25	13	44	319	91	225	78
EM	355	95	241	191	245	70	136	175	248	80	338	50	242	47	238	65
D-EM	217	79	170	141	208	112	135	163	125	47	320	55	214	73	280	86
EM-½ LTS	236	80	155	162	187	70	118	136	122	43	277	42	271	87	297	79
D-EM-½ LTS	211	60	154	107	281	61	162	184	163	36	382	44	254	70	343	48
D-EM-½ 1 LTS	239	97	178	148	246	72	139	184	146	41	305	35	232	59	260	73
D-EM 1 LTS	218	79	163	129	245	76	138	197	96	34	300	67	159	122	290	73
EM LTS	356	133	243	200	325	150	190	218	214	60	338	57	286	56	385	154
D-EM LTS	245	84	169	148	277	80	167	194	112	34	213	48	202	71	276	91
Adjacent and not trailing																
Pass car vs pass car																
Lane lines only	23	38	41	45	21	25	25	19	50	165	16	65	34	54	7	6
EM	64	88	79	79	18	20	26	28	77	149	16	67	15	22	7	12
D-EM	67	129	110	126	18	19	17	16	143	343	28	99	58	102	10	24
EM-½ LTS	69	109	120	111	15	14	16	21	96	318	25	131	39	64	9	13
D-EM-½ LTS	49	79	74	98	21	27	29	71	122	280	33	117	66	101	17	21
D-EM-½ 1 LTS	65	121	106	110	23	25	25	23	128	388	44	148	44	78	13	17
D-EM 1 LTS	77	105	100	115	26	26	26	22	164	373	35	141	106	131	19	27
EM LTS	78	127	89	96	19	09	33	27	90	242	46	121	47	86	18	30
D-EM LTS	79	128	101	125	23	27	28	24	82	317	30	94	41	63	13	17
Pass car vs comm veh																
Lane lines only	15	6	10	5	7	5	4	3	7	10	3	1	8	3	4	1
EM	23	8	23	3	9	0	5	0	6	15	10	1	10	2	7	0
D-EM	36	7	24	7	12	0	4	1	15	17	6	1	19	12	7	0
EM-½ LTS	40	9	21	8	8	2	3	0	10	25	14	1	17	15	8	0
D-EM-½ LTS	28	1	16	5	23	0	11	0	17	18	9	1	13	5	3	0
D-EM-½ 1 LTS	36	8	28	10	15	0	7	1	17	17	8	1	9	8	4	0
D-EM 1 LTS	28	10	25	6	20	1	5	1	16	23	7	1	14	13	0	0
EM LTS	19	0	36	0	8	0	33	0	1	94	4	6	0	28	0	0
D-EM LTS	27	7	24	10	14	0	12	0	10	22	5	0	16	8	8	0
Adjacent and trailing																
Pass car vs pass car																
Lane lines only	21	4	21	13	9	8	5	6	256	72	65	9	19	9	0	1
EM	39	14	26	24	6	4	5	1	150	50	35	4	13	4	6	1
D-EM	98	26	92	42	3	3	4	0	879	295	106	34	74	31	9	0
EM-½ LTS	97	30	72	60	2	1	3	1	619	235	128	28	31	13	0	1
D-EM-½ LTS	66	18	60	31	7	3	9	7	535	188	123	17	53	18	4	1
D-EM-½ 1 LTS	100	37	90	62	4	2	5	4	894	280	138	30	42	14	0	3
D-EM 1 LTS	70	30	68	41	6	4	2	7	977	537	122	22	82	64	11	2
EM LTS	55	13	32	27	32	24	22	24	312	100	93	21	67	18	8	1
D-EM LTS	103	39	81	57	11	8	5	8	408	146	71	4	49	20	5	1
Pass car vs comm veh																
Lane lines only	2	2	2	2	0	0	0	0	33	5	11	0	6	1	0	0
EM	15	0	8	6	1	0	1	0	22	3	2	0	5	0	1	0
D-EM	29	2	14	7	5	0	1	0	81	14	17	0	17	3	4	0
EM-½ LTS	27	6	14	9	3	1	1	0	94	9	13	0	11	2	2	0
D-EM-½ LTS	28	0	12	2	8	0	2	0	108	6	18	0	20	2	3	0
D-EM-½ 1 LTS	32	2	20	6	1	0	0	0	88	16	16	0	12	2	1	0
D-EM 1 LTS	30	1	13	8	2	0	0	0	75	25	12	1	7	4	5	0
EM LTS	24	0	17	0	16	0	11	0	0	62	40	0	0	9	0	0
D-EM LTS	43	2	16	9	2	0	2	0	71	8	10	1	19	2	3	0
Trailing not adjacent																
Lane lines only	190	25	81	63	108	6	34	54	842	36	855	18	180	20	117	13
EM	375	38	192	96	56	11	17	45	889	60	781	19	152	12	100	0
D-EM	818	62	302	168	89	18	38	49	1294	194	1507	36	329	54	272	21
EM-½ LTS	682	56	304	213	67	9	23	28	1463	142	1658	31	287	21	197	15
D-EM-½ LTS	521	46	206	167	134	17	44	56	1383	110	1478	36	346	28	293	15
D-EM-½ 1 LTS	666	63	300	212	97	6	33	52	1385	158	1548	39	337	39	178	16
D-EM 1 LTS	538	43	282	142	122	16	34	72	1255	331	1727	50	342	121	181	24
EM LTS	527	42	218	102	322	42	99	154	899	75	1316	27	313	16	361	24
D-EM LTS	646	56	318	157	149	17	52	65	877	99	986	22	226	24	282	9
All others																
Lane lines only	237	84	177	143	151	33	82	108	461	234	486	143	230	96	189	74
EM	350	141	318	250	116	44	80	63	517	268	446	143	280	89	136	45
D-EM	538	233	461	364	172	61	107	119	802	990	752	255	381	224	296	110
EM-½ LTS	558	213	446	363	136	37	90	61	773	485	713	216	317	146	254	72
D-EM-½ LTS	424	187	364	284	201	60	156	127	781	413	781	217	372	146	301	68
D-EM-½ 1 LTS	607	262	494	442	161	70	97	112	640	841	770	261	278	115	225	70
D-EM 1 LTS	486	221	413	347	189	82	109	150	906	817	799	244	322	318	251	122
EM LTS	567	282	517	329	333	205	223	232	614	384	699	277	316	123	289	116
D-EM LTS	554	280	499	376	201	71	131	118	528	339	514	144	279	135	199	55
Totals																
Lane line only	724	226	500	397	600	127	278	412	1785	539	1590	280	776	274	642	173
EM	1221	370	940	648	451	148	270	312	1809	617	1636	284	155	196	488	130
D-EM	1824	558	1173	875	507	211	306	373	3130	1470	2781	470	1082	499	878	241
EM-½ LTS	1699	499	1134	926	418	134	254	247	3167	1257	2823	443	973	347	765	181
D-EM-½ LTS	1325	383	912	704	623	168	413	367	3073	1092	2705	436	1123	371	864	190
D-EM-½ 1 LTS	1745	580	1314	981	549	175	306	376	3279	1395	2830	525	854	305	685	180
D-EM 1 LTS	1450	489	1072	787	610	205	314	449	3481	2140	2982	526	1013	773	757	248
EM LTS	1658	587	1152	754	1006	480	531	655	2130	1017	2536	538	1019	337	1044	325
D-EM LTS	1687	575	1208	883	677	201	397	399	2086	885	1819	313	832	321	797	133

Note For definitions see footnotes (Table 1)

TABLE 8

SAMPLE SIZE

(FOR COMMERCIAL VEHICLES ONLY FOR EACH CONDITION BY TRAFFIC MANEUVER)

	Site 4M								Site 5M							
	Day				Night				Day				Night			
Condition	Ramp Loc 1	Lane 1 Loc 1	Ramp Loc. 2	Lane 1 Loc 2	Ramp Loc. 1	Lane 1 Loc. 1	Ramp Loc. 2	Lane 1 Loc. 2	Lane 1 Loc 1	Lane 2 Loc. 1	Ramp Loc. 2	Lane 1 Loc 2	Lane 1 Loc 1	Lane 2 Loc 1	Ramp Loc 2	Lane 1 Loc. 2
Free-moving vehicles																
Lane lines only	19	33	28	43	10	77	15	82	29	3	172	20	76	15	25	66
EM	16	50	12	65	2	72	1	85	34	3	12	33	60	6	11	55
D-EM	13	51	9	56	4	104	2	118	20	2	4	28	52	5	6	66
EM-½ LTS	9	61	9	56	0	66	4	86	12	3	6	18	57	2	4	70
D-EM-½ LTS	16	36	10	49	2	74	4	93	27	4	11	27	46	5	4	55
D-EM-½ 1 LTS	8	36	12	48	3	75	1	81	19	2	6	25	54	4	3	67
D-EM 1 LTS	9	53	8	71	4	84	2	92	9	2	6	31	39	2	6	67
EM LTS	0	3	0	18	0	3	0	70	41	0	5	6	74	0	1	2
D-EM LTS	8	48	8	50	0	86	0	84	14	3	9	18	51	7	4	49
Adjacent and not trailing																
Comm veh vs pass car																
Lane lines only	5	16	7	10	4	5	3	3	7	25	1	15	5	11	1	5
EM	5	30	5	20	0	10	0	5	6	16	0	10	2	13	0	8
D-EM	3	60	6	30	0	15	1	4	14	33	1	22	11	25	0	11
EM-½ LTS	6	61	16	34	2	10	1	5	10	45	0	21	12	26	0	7
D-EM-½ LTS	3	51	8	23	0	23	0	10	7	49	0	30	2	26	0	9
D-EM-½ 1 LTS	7	58	9	34	0	17	1	6	13	32	1	25	5	17	0	9
D-EM 1 LTS	6	55	11	33	1	20	1	4	21	26	1	21	9	17	0	5
EM LTS	0	44	0	46	0	16	0	23	27	0	0	29	14	0	0	0
D-EM LTS	4	57	15	30	0	14	0	11	9	35	0	16	5	28	0	12
Comm veh vs comm veh																
Lane lines only	2	2	1	1	0	0	0	0	2	1	0	0	10	6	0	0
EM	2	2	0	0	0	0	0	0	0	0	0	0	4	7	0	0
D-EM	2	3	4	2	0	0	0	0	3	2	0	0	6	9	0	0
EM-½ LTS	1	3	3	2	0	0	0	0	0	1	0	0	3	4	0	0
D-EM-½ LTS	1	0	1	1	0	0	0	0	1	3	1	2	5	7	0	0
D-EM-½ 1 LTS	1	0	2	1	0	0	0	0	1	3	1	1	2	2	0	0
D-EM 1 LTS	1	1	1	0	0	0	0	0	1	2	0	1	7	9	0	0
EM LTS	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
D-EM LTS	1	3	1	1	0	0	0	0	2	2	0	0	2	5	0	0
Adjacent and trailing																
Comm veh vs pass car																
Lane lines only	1	1	0	0	0	0	0	0	11	7	1	2	1	4	0	1
EM	1	5	2	7	0	0	0	0	6	9	1	2	0	0	0	0
D-EM	3	4	3	6	0	2	0	0	27	29	2	3	3	10	0	1
EM-½ LTS	4	9	1	7	0	0	0	0	19	27	1	4	7	6	0	0
D-EM-½ LTS	1	7	0	6	0	3	0	2	20	35	0	1	2	6	0	1
D-EM-½ 1 LTS	6	9	6	10	0	1	0	1	17	28	2	3	1	6	0	1
D-EM 1 LTS	5	3	3	6	0	1	0	1	41	47	0	1	7	8	0	0
EM LTS	0	12	0	14	0	6	0	21	200	1	5	3	20	0	0	0
D-EM LTS	2	9	4	8	0	4	0	1	12	20	1	1	1	6	0	1
Comm veh vs comm veh																
Lane lines only	0	0	0	0	0	0	0	0	4	1	1	0	0	1	0	0
EM	0	0	0	0	0	0	0	0	1	0	0	0	4	1	0	0
D-EM	0	0	0	1	0	0	0	0	5	2	0	0	3	0	0	0
EM-½ LTS	3	0	0	0	0	0	0	0	3	2	0	0	1	1	0	0
D-EM-½ LTS	0	0	0	0	0	0	0	0	6	0	1	0	1	0	0	0
D-EM-½ 1 LTS	0	0	0	0	0	0	0	0	2	2	0	0	2	1	0	0
D-EM 1 LTS	1	2	0	1	0	0	0	0	1	1	1	0	3	4	0	0
EM LTS	0	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0
D-EM LTS	1	0	1	0	0	0	0	0	6	3	0	0	3	0	0	0
Trailing not adjacent																
Lane lines only	7	6	4	5	1	8	1	13	50	3	19	7	27	2	12	8
EM	4	14	1	23	0	3	0	1	33	4	14	7	18	3	6	3
D-EM	9	20	3	32	1	13	0	25	62	22	14	19	28	3	0	20
EM-½ LTS	6	32	8	45	0	10	0	14	65	14	15	13	36	5	1	13
D-EM-½ LTS	5	17	4	28	0	10	1	13	62	11	16	13	26	5	2	11
D-EM-½ 1 LTS	7	26	3	40	0	13	0	19	54	9	11	14	22	7	0	14
D-EM 1 LTS	8	14	7	25	0	8	0	12	48	16	17	16	33	10	1	18
EM LTS	1	6	0	72	0	1	0	93	541	1	48	1	158	0	0	0
D-EM LTS	16	15	6	24	1	7	0	12	56	6	17	8	29	3	0	9
All others																
Lane lines only	19	55	15	44	12	51	5	34	59	32	12	66	47	22	8	34
EM	18	91	21	72	2	43	1	38	45	37	12	41	131	23	8	29
D-EM	29	119	29	123	1	54	0	45	75	85	9	87	76	31	0	76
EM-½ LTS	38	127	31	121	0	54	1	47	80	55	10	91	59	29	1	68
D-EM-½ LTS	11	109	14	103	0	83	3	79	82	62	15	100	54	35	0	65
D-EM-½ 1 LTS	20	142	19	140	0	43	0	35	82	46	12	100	57	24	0	50
D-EM 1 LTS	28	130	26	109	1	52	2	46	83	62	15	85	54	26	2	46
EM LTS	0	27	1	117	0	15	0	121	212	2	12	23	98	0	1	2
D-EM LTS	24	128	17	130	1	68	2	55	89	43	10	66	49	34	1	58
Totals																
Lane lines only	63	113	55	103	27	141	24	132	162	72	47	110	186	61	46	114
EM	46	192	41	187	4	128	2	129	125	69	39	93	43	53	25	95
D-EM	59	257	54	252	6	188	3	192	206	175	30	159	179	83	6	174
EM-½ LTS	67	293	68	265	2	142	6	152	189	147	32	147	175	73	6	158
D-EM-½ LTS	37	220	37	210	2	193	8	197	205	164	44	173	136	84	6	141
D-EM-½ 1 LTS	49	271	51	273	3	149	2	142	188	122	33	168	143	61	3	141
D-EM 1 LTS	58	258	56	245	6	165	5	155	204	156	40	155	152	76	9	136
EM-LTS	1	92	1	297	0	41	0	328	1027	7	7	62	364	0	2	4
D-EM LTS	56	260	52	243	2	179	2	163	768	112	37	109	140	83	5	129

Note: For definitions see footnotes (Table 1).

TABLE 9

AVERAGE SPEEDS
(FOR PASSENGER CARS ONLY FOR EACH CONDITION BY TRAFFIC MANEUVER)

Condition	Site 4M								Site 5M							
	Day				Night				Day				Night			
	Ramp Loc. 1	Lane 1 Loc 1	Ramp Loc 2	Lane 1 Loc 2	Ramp Loc. 1	Lane 1 Loc 1	Ramp Loc 2	Lane 1 Loc. 2	Lane 1 Loc. 1	Lane 2 Loc 1	Ramp Loc. 2	Lane 1 Loc. 2	Lane 1 Loc. 1	Lane 2 Loc 1	Ramp Loc. 2	Lane 1 Loc. 2
Free-moving vehicles																
Lane lines only	39.5	52.6	40.1	47.4	40.8	49.6	41.6	45.7	46.1	59.8	39.8	53.2	45 0	59.2	40.2	50.2
EM	40.5	55.0	41.3	49.4	39.2	50.6	41.9	47.8	46.0	58.1	40.7	53.0	45.5	56.0	40.0	51.3
D-EM	38.5	53 3	41.5	48 6	36 3	47 7	36.8	43.8	44.7	59.8	39 8	52.2	45 7	61.7	38.4	50.9
EM-½ LTS	40.2	52 9	40.9	49.6	39.5	53.2	40.6	48.4	44 4	56.0	39.6	50.7	42.4	59.4	37.1	45.3
D-EM-½ LTS	39.7	52.3	37.7	48.8	39.7	52.3	42.8	48.5	45.5	59.1	40.7	50.6	42.5	56.5	36.6	48.9
D-EM-½ 1 LTS	40.7	52.8	42.7	50.3	40.4	53.4	39.8	46.6	46.2	58.9	40.4	51.4	43.1	57.8	38.0	49.5
D-EM 1 LTS	39.6	50.8	41.1	47.8	39.5	50.3	41.8	46.0	47.1	59.8	40 6	52.8	43.6	58.7	37.9	50.1
EM LTS	40 4	52 8	42.2	50 3	38.2	49 5	40 5	48.7	48.5	61.0	42.8	53.9	45 6	58.0	40.3	53.3
D-EM LTS	39.1	53.7	42.6	49.6	38.7	51.5	40.5	46.3	45.2	58.7	37 5	47.1	43.9	58.3	38.5	51.0
Adjacent and not trailing																
Pass car vs pass car																
Lane lines only	37 7	45.6	37.8	45.4	35.6	45.3	38 1	42.0	43.6	55.5	38.8	47.3	44.6	55.0	42.8	50.5
EM	37.7	47.2	39.4	48.4	37.4	43.5	39.2	46.6	43.9	55.7	41.4	44.8	46.1	56.5	42.0	51.0
D-EM	37.5	47.4	39.1	46.1	32 4	43 7	34 8	38 1	43 0	58 1	39.0	44.0	45 2	57 5	37 5	45.8
EM-½ LTS	40.5	49.4	41 4	47.0	35.1	49.1	38.3	45.6	45.3	57.2	39.7	42.5	42.8	58.4	36.2	45.8
D-EM -½ LTS	39 3	47.7	36.0	46.0	38 4	46.5	36 9	44 7	44 4	56 7	38.5	44.0	41.7	54.7	34.5	42.0
D-EM-½ 1 LTS	39.7	47.5	39.2	45.6	38 7	46.9	38.4	45.0	45.0	57.4	41.9	45.5	44.3	56.0	35.9	50.4
D-EM 1 LTS	37.6	48.2	40 0	46.1	38.9	47.0	39.8	46 4	46.5	58.3	41.4	46.1	44.8	58.0	38.1	45.2
EM LTS	39 4	50.2	40.8	50.8	37 4	48.5	40 4	47.3	46 5	59.8	41.5	47.8	43.4	58.6	42.3	50.6
D-EM LTS	37.8	47.5	39.6	45.4	37 9	48.5	37.6	45.3	44.3	57.8	39.5	45.1	45 7	56.7	38.5	44 4
Pass car vs comm veh																
Lane lines only	38.2	39.6	38.8	42 0	38.3	36.7	41.3	46.0	42.8	49.1	38.1	-	45.1	57.9	41.1	63.0
EM	38.8	44.7	40 3	34 3	39.0	-	45.7	-	41.4	57.1	41.6	49.2	41.4	63.8	44.1	-
D-EM	39.3	35.3	41.1	40.3	35.5	-	35.0	37.2	45.4	59.6	43.8	54.0	41.4	56.3	42.2	-
EM-½ LTS	39.8	43.6	41.7	43.5	38.6	42.8	35.4	-	42.2	58.4	40 5	44.0	41 1	61.8	40.3	-
D-EM-¾ LTS	39 3	34.2	36.7	43.4	37.4	-	36.5	-	45.2	58.3	40.9	55.8	39.3	56.5	40.0	-
D-EM-½ 1 LTS	41.2	45.1	40 7	46.7	37.9	-	43 7	55.8	43.2	58.0	43.4	54.0	41.2	56.9	39.1	-
D-EM 1 LTS	38 5	46.1	41.7	43.3	39.0	45.2	43.9	49.2	41 2	59.3	40.3	42.9	46.0	57.5	-	-
EM LTS	34.1	-	37.3	-	34.7	-	38 0	-	55.8	57.7	37 3	46 5	-	57.9	-	-
D-EM LTS	37.5	45.5	39.9	42.3	39.3	-	38 1	-	43 9	59.3	34.3	-	43.6	54.1	40.4	-
Adjacent and trailing																
Pass car vs pass car																
Lane lines only	35.4	44 4	35 7	47.3	36 0	42.9	38.5	43 5	41 6	55.0	36.3	44.2	44.4	56.3	-	40.8
EM	38 1	48.7	39 9	49.1	33 4	41.5	35.8	50.7	39.7	56.2	34 7	44.2	47.7	53.7	37.4	45.2
D-EM	35 4	44.0	38.8	43.7	38.8	53.4	35.2	-	40 1	58.4	32.4	41.3	39.1	56.0	39.4	-
EM-½ LTS	37.1	46.0	39 8	45.9	35 2	59.8	36 4	29.2	38 5	56.2	30.3	32.7	40.9	58.0	-	47 2
D-EM-½ LTS	37 1	47.5	36 2	43.4	37.4	38.8	39.4	46 2	39.9	55.3	35.7	42.8	38.5	53.2	34.9	46.5
D-EM-½ 1 LTS	36.9	45.5	39 5	46.5	39.1	42.3	34.1	43.0	39.7	56 5	34 5	43 9	41.6	56 6	39.2	42.7
D-EM 1 LTS	36 9	45.4	39.5	46.5	39.1	42 3	34.1	43 0	39.9	58 1	33.6	42.9	42.8	57.5	34.8	44.0
EM LTS	37.9	51.7	41 3	48.6	37.5	50 8	39 7	45.1	43.3	57.1	38 5	47 2	41.3	58 7	37 4	46.5
D-EM LTS	36 5	43.9	39 8	44.8	38 1	47 4	39 0	42 8	39.8	56 5	36 7	49 0	39.6	55.6	29.4	45.2
Pass car vs comm veh																
Lane lines only	36 1	44.0	46.5	40.3	-	-	-	-	39.2	57 7	31.5	-	49.2	52.3	-	-
EM	38 7	-	39.9	40.2	36 4	-	31 7	-	40 5	58.6	39.6	-	36.6	-	39.8	-
D-EM	35 0	48.4	36 9	44 3	36 6	-	42 9	-	42.7	58 8	35.0	-	38.3	56.9	34.4	-
EM-½ LTS	37 2	42.7	34.7	45.0	38.2	38.9	37.2	-	39.0	56.3	38.6	-	45.5	56.7	36 9	-
D-EM-½ LTS	36 3	-	35.2	40.5	36 3	-	31 3	-	39.3	56.4	36.8	-	39.5	55.8	35.6	-
D-EM-½ 1 LTS	38 8	39.6	40.9	47.0	38.1	-	-	-	41.3	56.5	37.0	-	43.2	55.8	34.2	-
D-EM 1 LTS	39 7	37.2	40.3	40.9	42.4	-	-	-	39.9	59.2	34.7	49.2	46.5	60.4	40.2	-
EM LTS	36.8	-	41.6	-	35.1	-	41.1	-	-	58.1	36.3	-	-	57 5	-	-
D-EM LTS	37 5	38 2	39.0	46.1	33.2	-	34.2	-	37.6	59.1	34 7	38 9	40.8	54 0	38.1	-
Trailing not adjacent																
Lane lines only	39.4	48 7	40.3	47 2	40.3	42 9	41.7	43 9	40.5	56.4	36.1	48.3	43.7	59 2	38 1	51.2
EM	39 4	51.5	40.4	48 8	37 9	44 2	37.6	46.5	42.1	57.7	36.3	51.1	43.0	56.2	39.1	49.6
D-EM	37 0	48 0	40.0	48 5	35.0	48 6	37.8	42.3	41.8	58 9	33.8	45.0	39.7	58.2	35.8	50.8
EM-½ LTS	38.9	49.1	41.1	47.4	38.1	48.4	39.1	46.4	39 2	56.4	32.9	47.8	40.5	55.4	34.8	43.4
D-EM-½ LTS	38 0	51 4	36.5	46 4	38 9	48 1	41.1	46.1	40.9	57.4	35.6	48.1	40.4	56.1	34.6	45.8
D-EM-½ 1 LTS	38.9	49 4	41.0	47.7	38.6	47.7	38.6	44.0	40.9	57.8	35.3	48 0	43.4	56.6	36.5	52.1
D-EM 1 LTS	37.5	49 1	40.4	45 7	37 3	49.4	39.7	42.8	40 1	58.9	34.4	48.0	42.4	58.9	35.5	46.2
EM LTS	39.6	51.5	41.2	48.7	38.1	49.2	39.7	47.5	44.4	60.0	38.7	50.4	42 7	58.0	37.9	54.6
D-EM LTS	37 5	48.5	40.8	46.7	38 1	47 9	40.2	45 7	40.3	58.2	34.1	46.2	41.5	57.6	35.0	52.0
All others																
Lane lines only	40 5	50 8	40.7	45.5	41 5	47.0	41.8	44.4	43.4	56.4	39.6	49.1	45.3	56.3	40.9	49.9
EM	40.1	52.0	41.7	49.0	39.9	47.9	41.9	45.8	44 4	57 0	40.2	50.7	44.8	56.9	41.3	49.4
D-EM	38 1	50.2	41.3	47 7	36 7	48 8	38 8	43.1	43.7	58.0	38.9	47.9	44.4	58.4	39.3	48.5
EM-½ LTS	39.8	51.2	42.1	48.2	39.0	49.5	41.6	45 4	43 9	58.7	39.1	47.3	41.7	57.9	37.5	47.8
D-EM-½ LTS	39 4	51.9	36.9	47.6	38.8	50.2	40.5	46.4	44.4	57 3	40.0	49.4	41 5	55.6	37.7	46.1
D-EM-½ 1 LTS	40.3	50 9	42.1	48.0	40.6	49.3	40.6	47.7	44.7	57.6	40.3	50.5	43 4	56.6	38.8	48.4
D-EM 1 LTS	38 2	48.9	41.3	47 2	39.1	50.1	41.6	44.6	45.2	59.2	39.8	50.7	44.5	58.3	39.3	48.8
EM LTS	39.5	50.4	41.0	49.5	38 2	48.6	39.9	48.9	47.7	59.2	42.9	52.8	45.0	58.9	40.4	51.3
D-EM LTS	38.9	50.3	41.7	47.4	39.3	49.0	41.2	45.2	44.8	58 1	38.7	49.0	43.2	58.0	39 0	48.6
Totals																
Lane lines only	39.6	49.6	40.0	46.4	40.6	47.0	41 3	45.0	41 9	55 9	37.6	48 5	44 8	57.2	40.0	50.2
EM	39.8	51.3	41.0	48.9	39 1	48.1	41.3	47.1	43.3	56.8	38.3	50.0	44.6	56.5	40.2	50.5
D-EM	37.5	49.2	40.5	47.1	36.1	47.2	37 5	43 1	43 1	58 5	35.9	47.1	41.2	57.7	37.9	49.3
EM-½ LTS	39.3	50.3	41.3	47.9	38 9	51.2	40.5	47.2	40.6	57 5	35.1	45.6	41.6	58.4	36.6	46.2
D-EM-½ LTS	38.7	50.8	36.8	47.0	39.1	50.0	41.1	47 1	41.9	56.9	37.5	47.8	41.2	55.5	36.3	48.6
D-EM-½ 1 LTS	39.6	49 8	41.4	47 9	40.0	50.5	38.9	48.4	42 0	57.4	37.3	48.7	43.2	56.7	37.8	49.3
D-EM 1 LTS	38.1	48.8	40.8	46.6	38 9	49.7	41.2	45 0	41.8	58.9	36.5	49.1	43.7	58.3	37.8	48.7
EM LTS	39 5	51.0	42.2	49.7	38.0	49.0	40.0	48.3	45.7	59.1	40 4	51.5	44.2	58.5	39.5	52.4
D-EM LTS	38.1	49.5	41.2	47.1	38 7	49.8	40.4	45.7	41.7	57.8	36.0	47.3	42.8	57.5	37.6	49.2

Notes For definitions see footnotes (Table 1)

TABLE 10

AVERAGE SPEEDS
(FOR COMMERCIAL VEHICLES ONLY FOR EACH CONDITION BY TRAFFIC MANEUVER)

Condition	Site 4M								Site 5M							
	Day				Night				Day				Night			
	Ramp Loc. 1	Lane 1 Loc. 1	Ramp Loc. 2	Lane 1 Loc. 2	Ramp Loc. 1	Lane 1 Loc. 1	Ramp Loc. 2	Lane 1 Loc. 2	Lane 1 Loc 1	Lane 2 Loc. 1	Ramp Loc. 2	Lane 1 Loc. 2	Lane 1 Loc. 1	Lane 2 Loc. 1	Ramp Loc. 2	Lane 1 Loc. 2
Free-moving vehicles																
Lane lines only	29.7	46.4	31.5	43.0	27.2	46.4	30.1	45.6	46.0	51.5	43 3	45.2	48.7	54.7	40.2	52.7
EM	31.2	48.6	34.1	46.6	39.6	45.6	34.9	46.6	46.8	60.6	40 1	52.2	51.8	49.3	41.9	53 8
D-EM	31.2	49.5	32.0	47 0	28.7	44 9	24.3	44 1	51 7	59.0	37 2	50.0	50.3	53.2	34.4	54 5
EM-½ LTS	29.5	49.3	33.7	49.0	-	50.6	34.9	49.3	46.6	47.6	36.4	50.3	47.7	51.5	40.9	51.4
D-EM-½ LTS	32.4	48.2	30.8	47.3	24.9	49 0	31.0	48.2	48 8	58.7	37.2	51.6	50.5	52.5	35.4	53.6
D-EM-½ 1 LTS	32.4	51.7	35.5	51.2	37.1	49.0	30.0	48.5	51.2	57.1	48.3	53.1	50.0	52.9	35 8	52.6
D-EM 1 LTS	30.1	48.3	35.5	46.6	31.1	47 7	33.6	48.0	53.7	63.2	34.3	53.5	53.1	48.8	38 6	55.0
EM LTS	-	44.9	-	47.0	-	47.4	-	44.7	47 3	-	34.7	46.9	44.3	-	23.3	65.4
D-EM LTS	29.6	47.6	37.2	48 1	-	49.0	-	48.0	46.4	56.5	38.5	47.1	51.6	58.1	39.9	54.0
Adjacent and not trailing																
Comm veh vs pass car																
Lane lines only	24.3	45.6	30 6	44.3	23 7	48.4	30.6	47.8	42.9	50 6	44.0	44.6	48.7	56.9	47.8	50.9
EM	28 2	46.9	28.3	47.5	-	44.9	-	50.9	48.9	54 6	-	44.4	44.8	55.4	-	51.6
D-EM	28.8	47.6	32.8	46.8	-	47.1	33 6	41.1	49.6	56.8	45.2	47.7	47 9	58.0	-	47 2
EM-½ LTS	29.2	48.5	30.7	45 8	29.0	49.4	25.6	48.2	48 7	55.3	-	46.9	48.9	53.4	-	53.3
D-EM-½ LTS	34.8	50.6	32.0	46 7	-	48.5	-	42.3	38.1	55.9	-	49.7	51.6	55.8	-	51.9
D-EM-½ 1 LTS	31.0	47.0	33.4	48 7	-	47.2	36.4	44.8	48.2	55 6	49.2	49.3	48 4	57.1	-	46.8
D-EM 1 LTS	28.7	27.5	30.9	47.0	23.6	48.5	24.9	46.7	46.4	55.6	39.8	49.4	51.2	56.7	-	62.0
EM LTS	-	43.8	-	44.8	-	43.1	-	46 1	44.6	-	-	44.6	39.6	-	-	-
D-EM LTS	27.2	48.7	31.2	48 0	-	49.3	-	47.0	48 8	56.3	-	52.1	49.0	55 7	-	52.8
Comm veh vs comm veh																
Lane lines only	26 9	31.6	33 6	37.2	-	-	-	-	47 1	52 3	-	-	50.9	58.7	-	-
EM	28.6	46.5	-	-	-	-	-	-	-	-	-	-	49.0	54.6	-	-
D-EM	31.1	46.3	39.9	46.6	-	-	-	-	49 0	55.7	-	-	36.2	55.0	-	-
EM-½ LTS	36.4	45.9	31.0	44.8	-	-	-	-	-	49.2	-	-	51.5	56.8	-	-
D-EM-½ LTS	29.5	-	31.1	46.5	-	-	-	-	38.9	58.7	34.2	40.8	50.2	58.3	-	-
D-EM-½ 1 LTS	37.2	-	35.8	57.7	-	-	-	-	42.9	61.3	34 2	42.9	50.5	58.7	-	-
D-EM 1 LTS	36 4	50.7	34.2	-	-	-	-	-	44.0	60.9	-	46.5	52.3	58.2	-	-
EM LTS	-	-	-	-	-	-	-	-	-	54.9	-	-	-	-	-	-
D-EM LTS	34 9	47.6	28.6	50 7	-	-	-	-	49 2	59.9	-	-	56 7	57.9	-	-
Adjacent and trailing																
Comm veh vs pass car																
Lane lines only	22.7	38.9	-	-	-	-	-	-	40.5	46.8	-	42.5	49.2	55.9	-	44 0
EM	28.6	50.9	32.1	49.2	-	-	-	-	47.9	50.0	39.8	56.7	-	-	-	-
D-EM	31.1	52.8	35.4	49.3	-	44.1	-	-	49.6	57.9	35.9	48.0	44.8	56.1	-	59.8
EM-½ LTS	31 1	47.3	45 2	46.5	-	-	-	-	45.0	55.0	34.2	47.7	49.6	51.3	-	-
D-EM-½ LTS	32.9	53.0	-	49.4	-	48.3	-	48 5	46.7	56.6	-	54.0	44.1	54.3	-	44.0
D-EM-½ 1 LTS	31.3	47.9	31 8	47.6	-	55.8	-	38.9	45.3	56.8	33.8	53.0	50.7	54.1	-	47.8
D-EM 1 LTS	29.7	48.2	34.7	48.8	-	50.7	-	46.5	44.2	56.3	-	42.9	46.4	58.2	-	-
EM LTS	-	41.6	-	43.1	-	40.7	-	43.8	41.3	55.8	25.6	46.9	41.1	-	-	-
D-EM LTS	31.7	47.3	37.3	43 9	-	52.3	-	55 8	41.9	55.7	35.7	38.1	49.2	57.3	-	59.8
Comm veh vs comm veh																
Lane lines only	-	-	-	-	-	-	-	-	38.8	62 0	30.6	-	-	62.0	-	-
EM	-	-	-	-	-	-	-	-	35.7	-	-	-	48.6	59.8	-	-
D-EM	-	-	-	39 8	-	-	-	-	48 8	-	-	-	44.7	54.9	-	-
EM-½ LTS	34.3	-	-	-	-	-	-	-	42.7	43.2	-	-	39.8	64.4	-	-
D-EM-½ LTS	-	-	-	-	-	-	-	-	46 1	-	-	-	44.0	-	-	-
D-EM-½ 1 LTS	-	-	-	-	-	-	-	-	42.1	57.7	-	-	49 9	54.0	-	-
D-EM 1 LTS	27.7	42.8	-	38.9	-	-	-	-	54.0	47.8	24.2	-	49.4	54.9	-	-
EM LTS	-	-	-	-	-	-	-	-	41 7	47.8	-	-	-	-	-	-
D-EM LTS	32.9	-	34.7	-	-	-	-	-	40.8	59.7	-	-	47 8	-	-	-
Trailing not adjacent																
Lane lines only	31.8	51.8	35.3	48 6	23.9	48.7	30.6	48 1	43.3	49.3	34.1	46.4	48.9	55 6	40.1	52.4
EM	35.7	48.6	36 4	48 8	-	44.9	-	37.2	46 1	49.1	34.9	51.4	52.8	56.0	38.8	56.6
D-EM	35.0	50.2	38.9	47.7	27.2	45.7	-	45 1	51 4	63.6	32.6	50.0	47.2	58 2	-	54.7
EM-½ LTS	35 3	49.8	38 3	48 2	-	50.0	-	50.5	49.9	50.9	33.1	49.5	49.2	51.6	38.4	50.9
D-EM-½ LTS	37.6	49 1	37 6	46.4	-	48.1	38.1	46.5	47.6	54.7	38.4	51.9	50.2	60 0	31.0	48.4
D-EM-½ 1 LTS	32.3	53.1	30 4	49.3	-	50.5	-	49.0	48.7	56.7	34.2	51.3	50.2	54.4	-	52.5
D-EM 1 LTS	34.6	49.3	39 5	47.0	-	49.1	-	48.3	48 1	58.5	32.0	53.7	53.0	62.0	29.5	54 7
EM LTS	-	45.7	-	46.1	-	40.8	-	44.7	41.6	54.0	32.3	50.7	41 0	-	-	-
D-EM LTS	32.1	48.6	38.7	47.0	24 6	52.2	-	51 6	47 2	60.9	34.3	51.4	52.3	57.7	-	55.0
All others																
Lane lines only	31.4	47.4	31 4	45.8	29.8	47.6	32.5	45.4	44.2	55.3	41 8	47.4	50.2	55.8	43.0	52.4
EM	32.6	48.4	35.7	47.2	25.7	45.7	29.0	46.1	48.3	53.5	39.6	50.9	51.5	57.0	44.1	54.5
D-EM	30.7	48.1	35.6	47.1	26.4	45.8	-	43.5	53.4	56.9	38.9	48.5	47.8	58.4	-	53.1
EM-½ LTS	31.6	49.3	35.3	47.4	-	49.4	34.2	49.7	45.5	56.8	40.2	48.0	41.7	55.0	41.8	51 1
D-EM-½ LTS	33.2	49.8	31.5	47.7	-	47.9	26.9	47.0	47.4	55.7	37.5	50.6	51.4	56.9	-	52.8
D-EM-½ 1 LTS	31.0	49.3	35.3	48.4	-	49.6	-	47.3	47.7	55.3	40.5	50.2	51.2	58.6	-	52.3
D-EM 1 LTS	31.1	47.9	35.3	47.3	38.9	48.7	27.9	49.1	47 7	56.9	37.6	50.2	53.3	57 6	34.4	55.6
EM LTS	-	42.7	44.0	46.5	-	44.1	-	43 6	45.7	52.7	33.9	49.3	43.3	-	30.0	45.6
D-EM LTS	33.6	49.1	35.8	48.7	35.7	48.2	31.2	48.2	47.8	58.3	39.9	49.9	51.8	55.7	31.7	53.1
Total																
Lane lines only	29.8	46.7	31.7	44.5	27.7	47.0	30.7	45.8	43 8	52.5	38.8	46.2	49.3	56.1	40.8	52.4
EM	31.7	48.3	34.1	47.3	32.7	45.6	32.0	46.5	47.2	53.4	38.1	50.8	51.5	55 5	42.0	53.9
D-EM	31.4	48.5	35.2	47.2	28.0	45.4	27.4	44.0	52 1	57.2	35.2	48 8	47.2	57.7	34.4	53.5
EM-½ LTS	31.6	49.1	34.3	47.6	29.0	50.0	33.3	49.5	45.8	55.0	36.0	48.5	41.6	54.0	40.3	51.3
D-EM-½ LTS	32.6	49.7	32.1	47.4	24.9	48.4	30.4	47 3	47 2	56.0	37.7	50.7	50.7	56 3	33.9	52.7
D-EM-½ 1 LTS	31.5	49.6	34.3	49 0	37.1	49.1	33.2	48.1	48.1	56.0	39.9	50.6	50.5	56.8	35.8	52 1
D-EM 1 LTS	31.4	48.0	34.7	47.0	31.2	48 2	29.6	48.3	47.2	56.8	35.5	51.0	52.6	58.2	36.6	55 4
EM LTS	-	43.3	44.0	45.7	-	43.4	-	43.3	42.7	53.2	32.2	47.5	42.2	-	26.7	55.5
D-EM LTS	32.1	48.6	35.0	48.2	30.1	49 0	31.2	48.4	46.9	57.4	36.9	49.8	51.7	56.3	38.2	53.6

Note For definitions see footnotes (Table 1).

TABLE 11

AVERAGE PLACEMENTS
(FOR PASSENGER CARS ONLY FOR EACH CONDITION BY TRAFFIC MANEUVER)

	Site 4M								Site 5M							
	Day				Night				Day				Night			
Condition	Ramp Loc 1	Lane 1 Loc. 1	Ramp Loc. 2	Lane 1 Loc. 2	Ramp Loc 1	Lane 1 Loc 1	Ramp Loc. 2	Lane 1 Loc. 2	Lane 1 Loc. 1	Lane 2 Loc. 1	Ramp Loc. 2	Lane 1 Loc. 2	Lane 1 Loc. 1	Lane 2 Loc 1	Ramp Loc. 2	Lane 1 Loc. 2
Free-moving vehicles																
Lane lines only	6 9	6.7	8 2	5.2	8.5	6 0	8.4	5 1	4.7	5 9	7.3	6 5	4.6	6.0	8.0	6.3
EM	6 4	6 5	7.6	4 9	7.0	7.0	7.5	5 0	5.2	6 4	8.1	6.7	5.3	6.6	8.5	6.7
D-EM	6 7	6 9	7.6	5 4	6.8	6.3	8.2	5.3	5.4	6 5	8.5	6.5	5.4	7 1	8.7	5.9
EM-½ LTS	7 2	6 9	7 9	5 2	7.5	6 6	8.7	5.1	5.1	6 6	7.7	6.8	5.4	6.8	8 8	6.3
D-EM-½ LTS	6 5	6.1	8.1	5.1	7.0	6.5	8 7	4 8	4 9	6.6	7.7	6.5	5.0	6.4	8.7	7 0
D-EM-½ 1 LTS	6.8	6 8	8.1	5.1	7.4	6.9	8.5	4 9	4 9	6.5	7.7	6 4	5 2	6.5	8.4	7.2
D-EM 1 LTS	7 1	6.9	7.9	5 1	7 5	6.6	8 8	4 9	5.7	6.9	8.1	6.7	4 9	6.3	8 1	6 8
EM LTS	6 6	6 6	7 8	5 7	7 3	6.4	8 8	6.0	5.5	6.3	7.9	6.6	5.3	6.5	8.2	6.9
D-EM LTS	7 2	6.7	7 7	5.2	7 1	7.0	8 7	5 0	5 2	6.7	7.9	6.8	5 2	6.5	8.3	6 9
Adjacent and not trailing																
Pass car vs pass car																
Lane lines only	6 8	6.5	8 1	6.9	6 9	6.0	7 9	6.3	4.4	6.6	6.7	6.9	3.9	5.6	8 6	5 9
EM	5.6	6.4	7 6	6.6	6 4	6.8	6 9	6.4	4.8	6.8	7.7	6.5	4.6	6.2	6.9	6.8
D-EM	6 4	7.1	7 4	6.5	6 2	6.4	8.0	6.0	5 0	7.3	7.7	6.3	5.2	7.4	8.1	5.9
EM-½ LTS	6.5	6.9	7 8	5.9	7.0	5 7	7.5	6.2	4 6	6.9	7.4	6.6	5.1	7.3	8 9	7 6
D-EM-½ LTS	6 4	6.6	7 7	6.7	5.7	6 5	8.3	6.1	4.6	6 6	7.1	6.1	4.6	6.9	7.5	5.9
D-EM-½ 1 LTS	6.2	6.5	7.7	6.3	6 2	6 0	8.3	5.6	5.0	6.9	7.4	6.7	4.8	6.7	8.7	7.2
D-EM 1 LTS	6.3	6.7	7 4	6.2	6 9	7.2	7.8	6.6	5.0	7.3	7.9	7 1	4.6	7.1	7.4	7.6
EM LTS	6.0	7 5	7 3	7 1	7.0	7 0	8.5	6.7	5.3	7 2	7.5	6.5	5.0	7 3	7 9	7.0
D-EM LTS	6.5	6.9	7.5	6.5	6 9	7.7	7.7	6.9	5.0	7.1	7.6	6.8	4.9	6 9	7.5	7.0
Pass car vs comm veh																
Lane lines only	5.8	7 1	7 7	6.7	8.0	6 9	8.5	7.5	5.2	6.9	6.2	5.0	4.6	8.0	7.8	10.0
EM	5.0	5.5	7 0	6.2	7 6	-	6.5	-	4.7	7 4	7.5	7.0	5.9	6.7	7.4	-
D-EM	6 3	6.6	7 4	8 0	5.4	-	8.0	-	4.5	7.5	8.2	7.0	4.8	7.1	7.9	-
EM-½ LTS	6.0	6 4	8.0	5 8	6.5	6.0	6.9	-	5.1	7.2	7.5	-	4.7	7.7	9 5	-
D-EM-½ LTS	6 3	6.0	8 3	7 8	6.0	-	8.7	-	4.3	7 0	7.2	7.0	4.0	6 9	9.3	-
D-EM-½ 1 LTS	5 6	4 9	7.1	8.6	7.3	-	7.2	8 0	5 2	7.4	7 5	8.3	4.1	6 9	5 4	-
D-EM 1 LTS	6 3	7 1	7.4	7.0	6 4	11 0	10.6	10.0	4.6	7.6	7.6	7 3	6.0	7.9	-	-
EM LTS	6.1	-	7 1	-	6.5	-	8.1	-	5.7	7.1	7.7	7 1	-	6.5	-	-
D-EM LTS	5.8	8 2	7.2	7 5	6 0	-	7.7	-	5.2	7.2	6.4	-	4.2	6.5	7.1	-
Adjacent and trailing																
Pass car vs pass car																
Lane lines only	6 7	4.0	7.8	6 8	6.6	5.8	9 3	7.9	3.9	6 8	6.5	6.5	4.2	6.7	-	1.0
EM	6.5	5.5	7.1	5.8	7 3	5.8	6.8	4.5	4.8	7.0	6.7	6.4	5.2	6.1	8.2	6.5
D-EM	6.6	4.9	7 2	5.8	5.7	6.7	6.9	-	4.4	7 1	8.2	6.5	4.8	7 3	8.1	-
EM-½ LTS	6.8	7.1	7.6	5.9	8.7	8.0	7.2	12.0	4.4	7.0	7.4	5 9	4.7	6.9	-	9.0
D-EM-½ LTS	6.8	6.4	7.8	6.1	5.9	6.0	7.9	6 3	4.6	6.8	7.5	6 8	4.4	7.5	9.2	-
D-EM-½ 1 LTS	6 3	6.5	7 4	6.9	8.5	6.0	6.8	6.2	4.7	7.0	7 5	6.6	4.5	7 7	6 5	6.6
D-EM 1 LTS	6 9	6.6	7.9	5.9	7 1	5.8	10 2	7 1	4 7	7.2	7.3	6.8	4.9	6.8	7.7	3.8
EM LTS	6 2	6.3	7.4	6.9	6.9	7.2	7.4	5.2	4 5	7.1	6.5	5.8	4 9	6 9	7 1	7.0
D-EM LTS	6 4	6.9	7 6	5 8	7 4	5 6	7.4	8.2	4.7	7.6	7.7	7.7	5.3	7 3	9.3	8.0
Pass car vs comm veh																
Lane lines only	8.5	7 2	4.5	10 1	-	-	-	-	3.8	5.2	5.7	-	5 0	9.0	-	-
EM	6.5	-	8 7	7.2	3.7	-	8.0	-	4.5	7 3	7.1	-	3.2	-	10.3	-
D-EM	6.1	7.0	7.5	7.6	7 2	-	9.3	-	4 7	7.2	8.0	-	4.9	8.3	10.5	-
EM-½ LTS	6.6	5.0	8 0	6.8	6 2	12.0	6.3	-	4.0	6.9	6.6	-	4.6	7.7	9.0	-
D-EM-½ LTS	6 2	-	7.2	6 5	6 8	-	5.5	-	4.8	6.4	6.7	-	4.2	10.5	7.4	-
D-EM-½ 1 LTS	6.6	2.2	7 5	8.0	-	-	-	-	4.3	6.4	6 9	-	4.6	8.8	4.0	-
D-EM 1 LTS	5.9	2.3	5.9	7.2	6.5	-	-	-	4.0	7.6	7.9	9.0	4.7	7.1	7.6	-
EM LTS	6.4	-	7.1	-	6.8	-	7 3	-	-	6 9	6.7	-	-	6 2	-	-
D-EM LTS	6 3	6 6	7 3	6.9	5 8	-	8 1	-	4 5	8 6	8.5	2.3	4.1	10.5	6.8	-
Trailing not adjacent																
Lane lines only	7 6	6.7	8 5	5.8	8.5	6.3	8.5	4.6	4.0	5.8	7 0	6.5	4 5	6.5	7 8	7.3
EM	7.0	6.8	7.5	5.6	7.1	6.6	7.0	5.1	5.0	6 7	7 8	6.5	4 8	6.9	8.1	7.3
D-EM	7 1	6 7	7.7	4.9	7 2	5.9	8.0	5.1	4.8	6.8	8.5	6.6	5.1	6.5	8.1	7.4
EM-½ LTS	7 0	6 8	7.9	4 9	7 0	6.1	8 5	5.2	4.6	6 6	7.9	6.4	4.9	6.7	8.7	6.2
D-EM-½ LTS	6.9	6 4	7.6	5.1	7.2	6.7	8 5	5 0	4.7	6.3	7.8	6.6	4.7	6.4	8.2	7.4
D-EM-½ 1 LTS	7 1	6.5	8.0	5.4	7.0	6.9	9.8	5.5	4.8	6.5	7.6	6.1	4.8	6.5	7.8	7 0
D-EM 1 LTS	7.1	6.1	7.9	5 2	7.4	6.1	8 2	5.0	4.8	6.8	7 8	6.7	4.9	6.8	7.5	6 9
EM LTS	7 2	6.8	7.6	6.0	7 3	6.3	8 5	5.4	4.7	6.6	7.3	5.9	4.8	7.0	7.8	6.3
D-EM LTS	7.0	6.3	7 8	5.6	7 2	6.8	8.5	5.1	5.0	7.0	8.1	6.8	5.0	6.7	7.8	7 6
All others																
Lane lines only	6.8	6.7	8 2	5.0	8.4	6 3	8.4	4.9	4.2	6 2	7.4	6.4	4.8	6.0	8 0	6.5
EM	6.2	6.4	7.7	5 0	7 0	6.7	7.6	4.6	5.0	6.5	8.0	6 6	5.0	6.5	8 3	6.9
D-EM	6.8	6.6	7.8	5.5	6.8	6 5	8 5	4 8	5.1	6.7	8.5	6.2	5.5	7.1	8.4	6.5
EM-½ LTS	6.8	6.9	7 9	5.6	7 0	6 1	8.3	5 0	4.7	6.6	7 9	6.4	5.4	6.7	8.7	7.1
D-EM-½ LTS	6 4	6 7	7 8	5 4	6.7	6.4	8.6	5 3	4 8	6.6	7 9	6.5	4.7	6.6	8 5	6.5
D-EM-½ 1 LTS	6.8	6.7	7 9	5 5	7 4	6.8	8.5	5.3	4.9	6.7	7.7	6.5	4.8	6.5	8.0	6.9
D-EM 1 LTS	6.8	6.6	7 8	5.6	7.2	6.4	9.0	4.6	5.1	7 1	8.0	6.7	5 0	6.6	8.1	6.9
EM LTS	6.5	6.9	7 6	5.9	7 1	6.5	8.7	5 7	5.2	6.9	7.7	6.6	5.2	6.7	8.3	6 8
D-EM LTS	6.8	6.6	7 5	5.3	7 4	6.7	8.9	5 2	5.2	7.1	8 0	6.7	4.9	6.8	8.4	6 7
Totals																
Lane lines only	7.0	6 6	8.2	5 5	8.4	6 1	8 4	5.1	4.1	6 4	7.1	6.6	4.6	6.0	7.9	6.4
EM	6.5	6.7	7 6	5 3	7.0	6.8	7.4	5 0	5.0	6 7	7.9	6 6	5.1	6.5	8.3	6.8
D-EM	6.8	6 7	7 7	5.6	6.8	6.4	8.3	5.2	5.0	6 8	8.5	6.3	5.1	7 2	8.4	6.3
EM-½ LTS	6 9	6.9	7.9	5.5	7.2	6.4	8.5	5 2	4.6	6.8	7 8	6.5	5 2	6.9	8.8	6.7
D-EM-½ LTS	6 6	6 5	7.8	5.5	6.8	6 5	8 6	5.1	4.7	6.6	7 8	6.4	4 7	6.7	8 5	6.7
D-EM-½ 1 LTS	6.8	6.6	7.9	5.7	7.3	6.6	8 4	5.2	4.8	6.8	7 6	6.5	4.8	6.6	8.1	7.1
D-EM 1 LTS	6 9	6.5	7.8	5 6	7.3	6.6	8 7	4.9	4.9	7.1	7 9	6.8	4.9	6.7	7.9	6.9
EM LTS	6 7	6 9	7 6	6.0	7.2	6 5	8.5	5 8	4.9	6 9	7.5	6.5	5.1	6.9	8 1	6.8
D-EM LTS	6.9	6 7	7.6	5.6	7 2	7 0	8.6	5 3	5.0	7.2	8.0	6.8	5.0	6.8	8.2	6.9

Note For definitions see footnotes (Table 1).

TABLE 12

AVERAGE PLACEMENTS
(FOR COMMERCIAL VEHICLES ONLY FOR EACH CONDITION BY TRAFFIC MANEUVER)

	Site 4M								Site 5M							
	Day				Night				Day				Night			
Condition	Ramp Loc. 1	Lane 1 Loc. 1	Ramp Loc 2	Lane 1 Loc. 2	Ramp Loc. 1	Lane 1 Loc 1	Ramp Loc. 2	Lane 1 Loc. 2	Lane 1 Loc 1	Lane 2 Loc 1	Ramp Loc 2	Lane 1 Loc. 2	Lane 1 Loc. 1	Lane 2 Loc. 1	Ramp Loc. 2	Lane 1 Loc. 2
Free-moving vehicles																
Lane lines only	6.4	6.3	8.0	6.1	7 1	7.2	7.8	7 0	5 9	8.3	6.8	7.0	6.3	4 7	8 1	6 4
EM	5.6	6 1	7.4	5.4	5.7	6 5	10.3	5.8	6 4	6.7	7 2	6.5	7.1	5.3	8.7	7.2
D-EM	5.6	6.0	7 4	5 4	6.5	6.2	9 0	5.8	6.8	6.0	9 5	7.1	7.2	3 7	8 4	6 9
EM-½ LTS	6.7	6.3	8.0	5 8	-	6.5	7 7	5.9	5.7	7.7	8.0	6.1	6.9	5.5	7.8	7.3
D-EM-½ LTS	6 6	6.0	6.9	5.3	6 0	6.3	7.4	5 8	6.0	5.9	6.2	6.3	6.4	4.8	8.6	7.1
D-EM-⅛ 1 LTS	5.8	5.9	8.1	5.6	6 2	6 4	7.0	5.9	6.1	4 4	7 4	6.3	6 7	6.5	7.7	7 0
D-EM 1 LTS	6.2	6.2	7.3	5.6	7.9	6.3	6 7	6 0	6.7	4.7	8.4	6.5	7.0	2 7	9.2	7.0
EM LTS	-	4 9	-	4.1	-	7.2	-	3 4	4 9	-	8.0	4 0	4.7	-	9.0	5.5
D-EM LTS	7.8	6.2	7 9	5.7	-	6 7	-	6.0	5.8	6 3	8.7	6.7	7 0	6.1	8 4	7 2
Adjacent and not trailing																
Comm veh vs pass car																
Lane lines only	5.2	8.2	8 0	7.0	5.3	7 8	6 4	6 6	5.7	5.6	5 0	6 5	4.2	6 1	5 5	5.7
EM	5.3	7.0	8.3	7 3	-	7 2	-	7.7	6.6	5 6	-	7.0	3 2	6.4	-	7 8
D-EM	5.0	6.8	6 6	6.4	-	7.2	10.3	7.4	5.0	6 8	9.3	7.7	6.8	7 3	-	7 0
EM-½ LTS	5.1	7.7	6 6	7 0	5.0	7.8	6.3	8 6	5.5	6.6	-	6.9	6.6	6 4	-	7.2
D-EM-½ LTS	3 9	7 4	7 9	7.7	-	7 6	-	6.9	5 0	6 4	-	6.8	5.0	6.9	-	8.5
D-EM-½ 1 LTS	6.4	7 2	7 3	7.2	-	7.2	7.5	6 4	6 0	6.0	5.5	6.6	6 4	7 1	-	6 9
D-EM 1 LTS	5.1	7 4	6.9	7 1	4.0	7.7	6 5	7.5	6 1	7 1	10.3	7.6	6.2	7 6	-	7 9
EM LTS	-	4.8	-	5 9	-	4.9	-	5.4	3 9	-	-	4.9	3.4	-	-	-
D-EM LTS	5.4	7.4	6.4	7 2	-	7 5	-	7.5	5 9	6.6	-	7 4	5.5	6.8	-	7 6
Comm veh vs comm veh																
Lane lines only	5 7	3 3	9.7	4 7	-	-	-	-	2 9	6.5	-	-	6.7	5.2	-	-
EM	5 0	9 1	-	-	-	-	-	-	-	-	-	-	4.8	5.7	-	-
D-EM	5.5	8.2	9.7	4.5	-	-	-	-	6.0	6.8	-	-	6 7	9.1	-	-
EM-⅛ LTS	6.0	7.9	6.6	7.5	-	-	-	-	-	7.0	-	-	6.1	7 9	-	-
D-EM-⅛ LTS	4.3	-	6.0	3.0	-	-	-	-	2.5	7 3	4.7	6.7	6.7	6.1	-	-
D-EM-⅛ 1 LTS	1.0	-	4.0	7.0	-	-	-	-	2.3	6.9	8.5	6.7	6 0	7.1	-	-
D-EM 1 LTS	5.7	8 7	9.0	-	-	-	-	-	6 0	8 5	-	7.0	6.0	5 8	-	-
EM LTS	-	-	-	-	-	-	-	-	-	4.5	-	-	-	-	-	-
D-EM LTS	5.7	7.7	5.7	8.0	-	-	-	-	6 4	5 3	-	-	5.9	5.6	-	-
Adjacent and trailing																
Comm veh vs pass car																
Lane lines only	5.0	5.5	-	-	-	-	-	-	4 6	5.6	-	7.1	8 0	7.3	-	3.0
EM	4.7	6.0	8 5	7.3	-	-	-	-	3.9	7.2	5 5	8.7	-	-	-	-
D-EM	5.1	7.6	7.9	7.4	-	9.2	-	-	6.6	7 5	4.8	6.5	6.2	6.9	-	7 5
EM-½ LTS	4.4	7.9	6.3	7.1	-	-	-	-	6.1	6 5	9.0	7 1	7.1	6.9	-	-
D-EM-½ LTS	7.0	8.6	-	8.6	-	8.1	-	7.5	6.1	6.5	-	4.5	5.6	6.7	-	6.0
D-EM-½ 1 LTS	7.4	7 7	7.3	6.7	-	7.5	-	6.0	5.8	7.0	6.0	7.2	6.5	6.9	-	6 5
D-EM 1 LTS	5.4	6 7	7.7	7 0	-	4.0	-	9.5	5.6	6 7	-	5.5	6.8	6.9	-	-
EM LTS	-	5.2	-	5.6	-	5.1	-	3 9	4 2	8.0	6.1	0.1	4.4	-	-	-
D-EM LTS	9 1	7 9	6.9	7 1	-	6.7	-	5 7	5 3	7.7	10 5	6.0	3.5	6.7	-	8.0
Comm veh vs comm veh																
Lane lines only	-	-	-	-	-	-	-	-	4.4	7.0	4 3	-	-	0.5	-	-
EM	-	-	-	-	-	-	-	-	3 5	-	-	-	6.8	10.7	-	-
D-EM	-	-	-	5.0	-	-	-	-	7.6	-	-	-	5.4	7.9	-	-
EM-⅛ LTS	3.4	-	-	-	-	-	-	-	6.6	8 0	-	-	3 0	8 0	-	-
D-EM-⅛ LTS	-	-	-	-	-	-	-	-	5.4	-	4.7	-	5 5	-	-	-
D-EM-⅛ 1 LTS	-	-	-	-	-	-	-	-	5.5	6.6	-	-	6 3	7 5	-	-
D-EM 1 LTS	6.7	7.3	-	4.5	-	-	-	-	9.0	7 5	5.0	-	6 2	6 5	-	-
EM LTS	-	-	-	-	-	-	-	-	4.5	11.0	-	-	-	-	-	-
D-EM LTS	4.3	-	6.9	-	-	-	-	-	5 2	6 5	-	-	7 6	-	-	-
Trailing not adjacent																
Lane lines only	5.6	6 0	7 9	5 4	8.3	6.6	6.5	5.6	5.1	6 2	6.3	6 3	5 8	5 8	7 9	6 6
EM	5.7	6.2	7.5	6.0	-	7.4	-	5.7	6.4	5 9	8.3	6 3	6 9	5 4	7.3	6 5
D-EM	7.0	6.4	7 7	5.5	8.0	6.3	-	5 9	6 8	7.7	7.9	7 4	6 9	6 5	-	7 2
EM-½ LTS	6.1	6.9	7.8	6.3	-	6.2	-	6.0	6.1	5 3	8.1	6.1	7 0	6 7	7 5	6.8
D-EM-½ LTS	5.7	6 5	6.1	6.1	-	6.6	10.0	6.7	6 2	6.2	7.5	6 7	7 6	5 8	7 5	7.9
D-EM-½ 1 LTS	5.1	7 1	6.5	6.2	-	6.9	-	6.4	6.8	6 5	7.7	6.1	7.2	6 2	-	6 9
D-EM 1 LTS	6.3	6.7	6.7	6.4	-	6.4	-	5 7	6.5	6.5	6 9	6 7	7 1	4 3	5 5	6 7
EM LTS	-	3.7	-	4.3	-	4.0	-	4.6	4 2	3.5	7 5	6 0	4.3	-	-	-
D-EM LTS	6.1	6.7	7.8	5.8	4.5	6.0	-	6.4	6.2	5.1	8 0	6.5	7.5	5 6	-	8.2
All others																
Lane lines only	5.7	6.6	8 0	6.3	6 4	7 7	7 5	6.5	5.8	5.8	7 7	6 7	6.4	6.5	8 0	7.2
EM	4.7	6 4	7.4	6.0	8 5	6 8	9 5	6.0	6.2	6.4	7.4	6.6	7.0	5 3	9 0	7 7
D-EM	6 8	6.2	8.7	5.7	8.0	6.4	-	5.8	6 6	6 4	8 9	7 0	6 7	6 6	-	7.1
EM-½ LTS	6.2	7.0	7.8	5.8	-	6 6	8 3	6 2	5.8	6 2	7.5	6 5	6.8	6.1	11.0	7.3
D-EM-½ LTS	6 0	6.4	7.3	6.0	-	6 6	8.0	6.3	6.2	6 1	7 5	6.5	6 8	6 1	-	7 3
D-EM-½ 1 LTS	5.8	6.5	7.5	6.0	-	6.8	-	6.4	6.1	6.1	7.6	6.5	6 3	6 3	-	6 8
D-EM 1 LTS	6.1	6.5	7.1	5.7	6.0	6.8	8.6	6.3	5.9	6 4	7 3	6.3	6.5	5 8	5 9	6 8
EM LTS	-	5.2	6.0	4.1	-	4.9	-	4.2	4 3	5.3	6 7	5.8	4.4	-	7 0	3 8
D-EM LTS	5.9	6.5	7.0	5.9	7.0	6.9	6 2	6.5	6 2	7.3	8 2	6.9	6.9	5.9	6.0	7 3
Totals																
Lane lines only	6.0	6.7	8.0	6.2	6.5	7 4	7 5	6.7	5 5	5 9	6 7	6 7	6.2	5.8	7 9	6 6
EM	5.2	6.4	7.4	6.0	6.7	6 6	9.9	5.9	6.2	6.3	7.6	6.6	6 9	5.7	8 4	7 4
D-EM	6.8	6.4	7.2	5.7	7.0	6 4	9.6	5 9	6 6	6 8	8 2	7.1	6.7	6.8	8 5	7.0
EM-½ LTS	5.9	7.0	7.4	6 1	5.0	6 6	8.5	6 1	6.0	6.3	8 0	6 5	6.8	6.4	8 3	7 2
D-EM-½ LTS	6.0	6 6	7 4	6.1	6.0	6.6	7 4	6 1	6 1	6.3	7 5	6.5	6.8	6.3	8 2	7 3
D-EM-½ 1 LTS	5.9	6.7	7.4	6.2	6.2	6 6	7.2	6 1	6 2	6.3	7 5	6.4	6.6	6 7	7.7	6.9
D-EM 1 LTS	6.0	6.6	7 1	6.0	6.9	6.6	7.5	6.1	6.1	6.6	7 3	6.6	6.7	6 1	8.1	6 9
EM LTS	-	4.9	6.0	4.5	-	5.1	-	4.2	4.3	6.0	7.3	5.0	4.4	-	8 0	4.7
D-EM LTS	6.3	6.7	7.0	6.0	5.7	6.8	6.2	6.3	6.1	6.9	8.3	6 9	7.0	6.3	7 9	7 4

Note. For definitions see footnotes (Table 1).

TABLE 13

HEADWAYS

(PERCENTAGE DISTRIBUTION OF HEADWAYS BETWEEN SUCCESSIVE VEHICLES)

	Site 4M								Site 5M							
	Day				Night				Day				Night			
Condition	Ramp Loc. 1	Lane 1 Loc 1	Ramp Loc. 2	Lane 1 Loc. 2	Ramp Loc. 1	Lane 1 Loc. 1	Ramp Loc 2	Lane 1 Loc. 2	Lane 1 Loc. 1	Lane 2 Loc. 1	Ramp Loc. 2	Lane 1 Loc 2	Lane 1 Loc. 1	Lane 2 Loc. 1	Ramp Loc. 2	Lane 1 Loc. 2
Less than 1 4 sec																
Lane lines only	2.0	2.2	4.6	1 8	2.4	-	0.7	1 1	13 1	3.3	10.9	2.8	1 8	2.4	1.2	1.0
EM	5 3	1.6	2.5	2.9	2.4	0 7	1.8	1.1	8 7	3.4	9.2	0 3	2.4	1.4	2.4	-
D-EM	9.6	2 0	3.8	3.2	3.3	0 5	1.0	0 9	14.1	5.7	9.1	2.2	4.8	2 4	4.2	0.2
EM-½ LTS	9.5	1.9	4.4	4.5	2 4	0.7	0 4	1 0	14 2	6.2	10.1	1.7	3.8	1.7	2.5	0.9
D-EM-½ LTS	9.7	2.3	3.8	4.0	3.0	0.3	1 7	1.0	14.9	5.7	10.3	0.7	6.4	1.3	4.9	1 7
D-EM-½ 1 LTS	9.8	2.9	4.3	4.7	4.2	0.9	1.0	2.9	14.1	6.5	10 5	1.4	4 3	3.3	3.8	1 9
D-EM 1 LTS	8 6	1.2	4.1	3 4	4.4	0.3	0 3	1 5	13.9	8.8	10.0	2.5	5.0	3 9	3.7	1.0
EM LTS	6.4	1.3	2.7	3.4	10 2	3.2	7.5	8.4	15.2	4.6	12.0	1.2	8.0	3.6	6.8	2.7
D-EM LTS	7 9	2.0	4.3	2 8	3.2	1.6	1.3	2.0	13 7	6.0	10.1	1.9	5.1	3.7	5.9	0.8
Between 1 4 and 2.8 sec																
Lane lines only	11.0	7.4	15.1	4 4	9.6	2 6	5.6	7.0	35.7	9 0	33.7	4.4	12.2	4.8	10.9	3.1
EM	19.6	5.2	11.1	9.1	7.7	4.3	2 6	4.8	26.1	10.2	30.0	5.3	16.2	4.8	11.5	3.6
D-EM	24.1	5.5	18.0	10.9	10.7	5.0	7 1	8.1	37 2	15.8	38.4	6.7	18.5	9 1	18.4	5.3
EM-½ LTS	25 1	9 0	17.1	14.3	10.5	3.3	4.2	5.8	39 5	14.7	39.0	7.3	18.1	4 5	15.7	4.7
D-EM-½ LTS	26 1	4.6	19.4	13.0	13.7	4.2	7.4	6 8	34 7	13.6	35.1	5.4	17.7	6.6	18.0	4.1
D-EM-½ 1 LTS	23.9	7.1	18.1	12.7	8 9	2.8	6.8	5.4	35.9	14.9	37.0	4.9	17.4	7.7	14.7	5.0
D-EM 1 LTS	25.3	6.2	18.4	10 9	10.4	3.5	7.2	7 1	38.1	19.9	39.0	6.8	16.1	13.1	14.8	4 9
EM LTS	19.9	4.9	12.8	10.4	20.4	6.2	10.5	12 6	34.1	11.1	33.7	5 3	22.0	5 3	19.6	2.7
D-EM LTS	25.6	8 3	18.5	11.6	12.7	2 6	8 3	6.8	36.5	13.2	35.1	5.9	18.0	5.9	15.4	2.7
Over 2.8 sec																
Lane lines only	86.6	90.0	80.0	93.2	87 8	96.7	93 4	91.7	51.1	87 5	55.3	92.5	85.9	92.5	87.8	95.1
EM	75 6	93.0	86 3	87 9	89.7	94.5	95 2	93.9	65.1	86.3	60.7	94.1	81.3	93.3	85.6	96.0
D-EM	66.2	92.3	78.0	85.7	85.8	94.2	91 6	90.8	48.7	78.4	52.5	90.9	76.6	88 3	77 3	94.3
EM-½ LTS	65.3	89 0	78.4	81 2	86.6	95.3	94.6	92.7	46.5	79.0	50.9	90.8	77.9	93.6	81.7	93.8
D-EM-½ LTS	64.2	92.8	76.7	82 8	83.2	95.3	90.8	91.9	50.3	80.5	54.5	93 4	75.8	91 9	76.9	93.9
D-EM-½ 1 LTS	66 2	89.6	77.3	82 4	86.6	95.7	91.6	90.9	49.9	78.5	52.5	93.6	78.1	88 6	81.2	92.5
D-EM 1 LTS	68.0	92.3	77.3	85.5	85 0	95.9	92.2	91.2	48.1	71.3	51.0	90.4	78.8	82.9	81.5	93 7
EM LTS	73 6	93.5	84.3	86 0	69 3	90 4	81.7	78 8	50.6	84.2	54.2	93.3	70.0	90.8	73.2	93.6
D-EM LTS	66 4	89.5	77.0	85 4	84.0	95.5	90.2	91.1	49.7	80.6	54.7	91.7	76.7	90.3	78 4	95 8
Unknown																
Lane lines only	0.4	0.4	0.3	0.6	0 2	0 7	0.3	0.2	0.1	0.2	0.1	0 3	0.1	0 3	0.1	0.7
EM	0 1	0.2	0.1	0.1	0.2	0.4	0.4	0.2	0.1	0.1	0.1	0.3	0.1	0.5	0.2	0.4
D-EM	0.1	0.2	0.2	0.2	0.2	0 3	0.3	0.2	-	0 1	-	0.2	0.1	0 2	0.1	0.2
EM-½ LTS	0.1	0.1	0.1	0.1	0.5	0.7	0.8	0.5	-	0.1	-	0.2	0.1	0.2	0.1	0.6
D-EM-½ LTS	0.1	0.2	0.1	0.1	0.1	0 3	0 2	0.2	0.1	0.2	0.1	0.5	0 1	0.2	0 1	0.3
D-EM-½ 1 LTS	0.1	0.4	0.2	0.2	0.4	0.6	0.6	0.8	-	0.1	-	0.1	0.2	0 5	0 3	0.6
D-EM 1 LTs	0.1	0.3	0.2	0.2	0.2	0.3	0.3	0.2	-	-	-	0.3	0.1	0.1	0 1	0.3
EM LTS	0.1	0 3	0.2	0.2	0.1	0.2	0.2	0.1	-	0.1	-	0.2	0 1	0.3	0.3	0.9
D-EM LTS	0 1	0.2	0.2	0.2	0.1	0.3	0.3	0 2	0.1	0.2	0.1	0.5	0.2	0.5	-	0.8

Note For definitions see footnotes (Table 1)

TABLE 14

AVERAGE CLEARENCES

(FOR ADJACENT VEHICLES ONLY FOR EACH CONDITION BY VEHICLE TYPE)

	Site 4M								Site 5M							
	Day				Night				Day				Night			
Condition	Ramp Loc 1	Lane 1 Loc. 1	Ramp Loc 2	Lane 1 Loc. 2	Ramp Loc 1	Lane 1 Loc 1	Ramp Loc. 2	Lane 1 Loc. 2	Lane 1 Loc 1	Lane 2 Loc. 1	Ramp Loc. 2	Lane 1 Loc. 2	Lane 1 Loc. 1	Lane 2 Loc 1	Ramp Loc. 2	Lane 1 Loc. 2
Passenger cars																
Lane lines only	7.1	6 9	4 9	5 2	6 3	6.2	4 9	5.0	8.6	8.6	7 1	7.2	7.8	8.0	3.2	4.6
EM	7.5	7 4	5.2	4.9	6 6	6.8	5.5	5.5	8.1	8.0	6.2	6.6	7.0	7.3	6 1	5.8
D-EM	7.2	7 4	5 1	5.2	7.4	7.0	4.1	4.3	8.4	8.3	5.3	4.9	8.4	8.3	4.6	4.8
EM-½ LTS	7 5	7 4	4 5	4 5	6 1	6.2	5 5	4.9	8.5	8.4	6 3	6.1	8.0	8.0	5.0	6.6
D-EM-½ LTS	7.1	7.1	4.9	4.9	7.4	7.8	4.2	4.1	7.9	8.1	5.9	5.9	8.4	8.5	6.1	5.4
D-EM-½ 1 LTS	7 4	7 2	5 0	5.1	6 6	6.8	3 5	3 8	8 3	8 1	6.2	6 3	8.1	7.9	5 9	6.2
D-EM 1 LTS	7 0	7 1	4.6	4 8	7 0	7.6	4.4	4.8	8.6	8 4	6.6	6 3	8.2	8.2	6.6	7.1
EM LTS	7.5	8.3	5.4	5.9	6.8	7 6	3.7	4.1	8 7	8.2	6.1	6.2	8.6	8 4	5.6	5.9
D-EM LTS	7.5	7.6	4 9	5 1	7 2	7 3	5 4	5.4	8 5	8.4	5.9	6.1	7.9	7.9	6 2	6.4
Commercial vehicles																
Lane lines only	6.7	7 7	4.3	3 8	7 6	6 2	6 9	2.6	6.9	6 3	6.1	6.5	4.2	5.4	10.5	3.1
EM	7 1	7.2	3.3	5.4	-	6.0	-	6.2	6 5	6 8	7.5	6.0	7.4	6.3	-	6.1
D-EM	8.2	6.7	3 8	3.8	-	7 5	-	3.6	6 0	7.1	8 2	5.5	5.3	7.2	-	5.4
EM-¼ LTS	7 4	7 5	4.7	4.3	8 0	7 2	8 2	6 8	5.8	6 9	-	6.2	6.3	6.8	-	3.4
D-EM-½ LTS	7 8	7 5	4.8	4 9	-	7.2	-	3.6	6 0	6.7	7 1	5.7	5.3	7.1	-	6.8
D-EM-½ 1 LTS	5 1	7 5	5.8	4.9	-	6.6	5 5	4.0	6.1	7.1	7 9	5 4	6 0	7.4	-	7 0
D-EM 1 LTS	7.1	7 3	5.1	4.9	13 0	7 1	8 5	2.3	6.7	7 6	5.0	5.8	5.8	5.8	-	6.0
EM LTS	-	5.1	-	4.3	-	4.8	-	1 6	7 9	8.2	7 0	3.4	8.5	-	-	-
D-EM LTS	7 3	7 4	6.4	5.1	-	6 7	-	4.6	6 6	7.0	-2.2	5 4	4 7	6.7	-	6.4

Note For definitions see footnotes (Table 1).