AT-GRADE INTERSECTION SPACING ON CONVENTIONAL TWO LEVEL DIAMOND INTERCHANGES

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INTRODUCTION

A problem encountered in the design of diamond interchanges is determination of the distance that should be provided between the at-grade intersections (see Figure 1). The two alternate methods of treating this problem are as follows:

1. Space the intersections far enough apart so that the traffic controls at each intersection may operate independently.

2. Space the intersections close together and operate both intersections with one traffic controller.

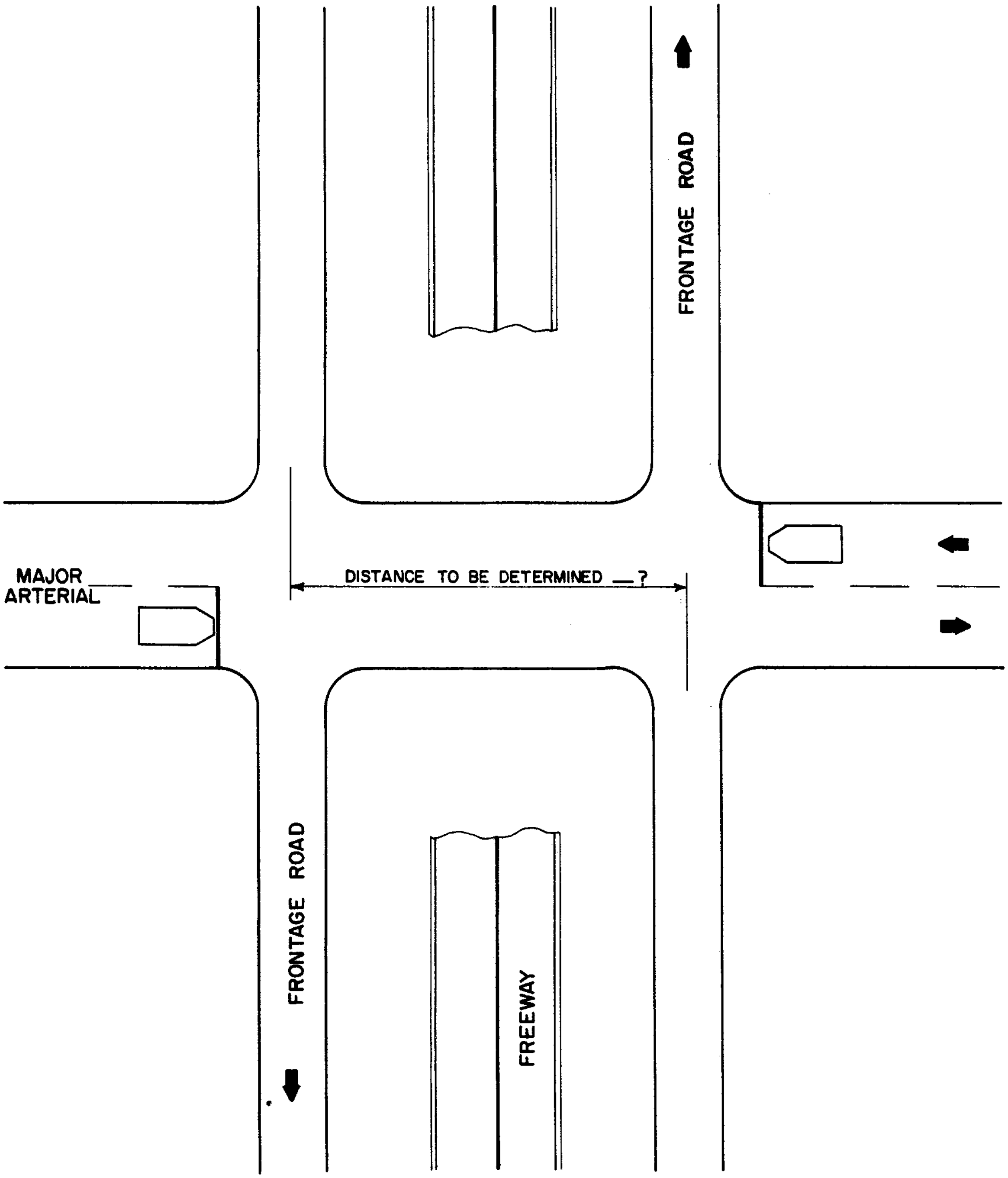
The right-of-way required for the first method keeps it from being a very feasible approach to the problem. Therefore, this publication will deal with the desired space required by method two.

An earlier report entitled "The Value of Signal Phase Overlap in Signalized Intersection Capacity" discussed the desirability of utilizing the phasing shown in Figure 2 and of obtaining a total phase overlap time of 20 seconds. By obtaining the 20-second phase overlap it is possible to obtain maximum capacity with minimum cycle length.

Since the phase overlap time that can be obtained is dependent upon the spacing of the at-grade intersections, it provides an approach to determining the minimum desired spacing. The spacing of the at-grade intersection should be such that it requires at least 10 seconds (one-half of the total overlap time) for a vehicle to start up after receiving a green indication and travel from point A to point B as shown in Figure 3. This spacing would of course be the same for either approach.

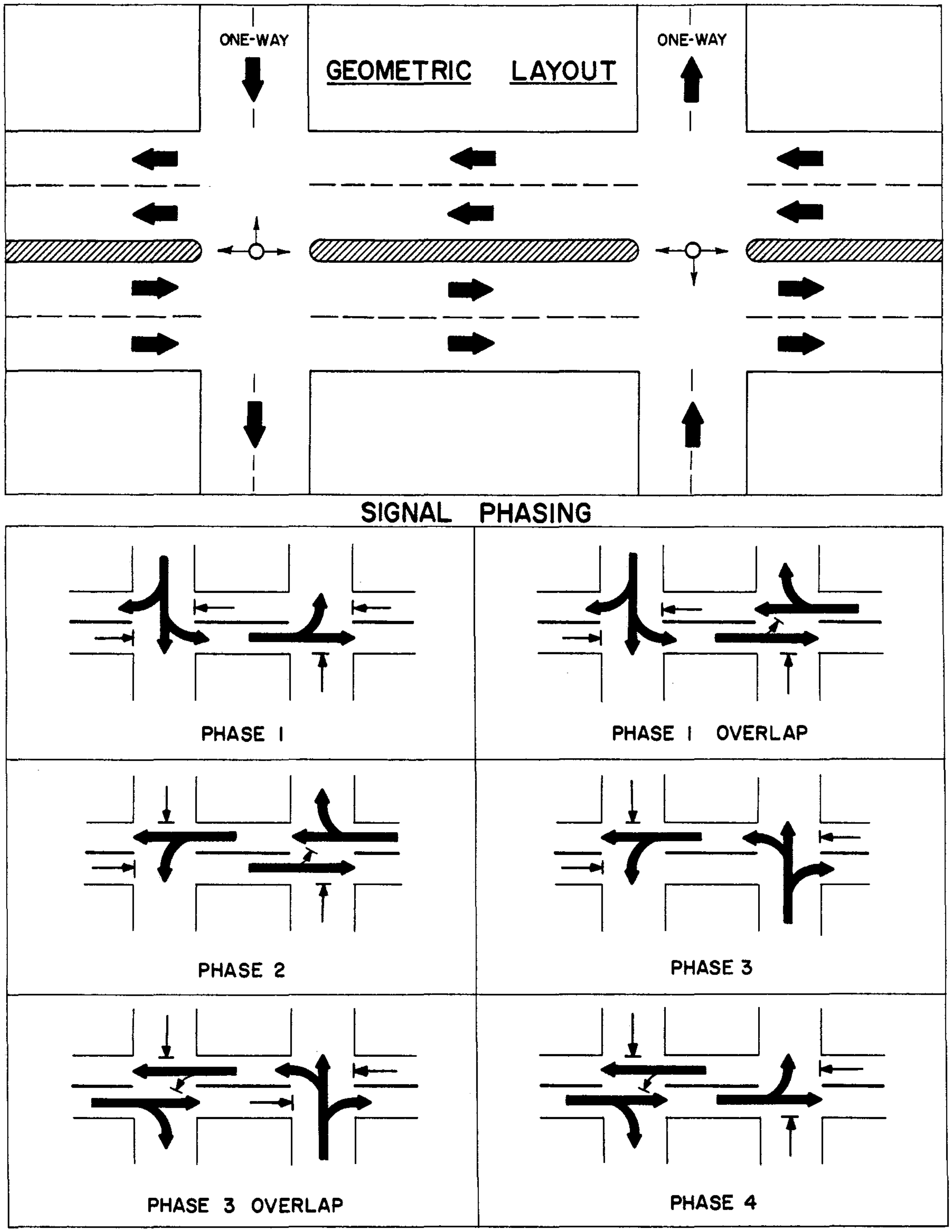
If the signal for approach 2 (Figure 3) turns green when the leading vehicle reaches point B then the platoon of vehicles may move uninterrupted through the second intersection. The distance from point B to point C should be a minimum of 60 feet to avoid having the drivers of leading vehicles start slowing down for a stop at the second intersection.

The problem then becomes one of determining how far the average vehicle will travel in 10 seconds after starting from the stop line of an intersection. The remainder of this report will discuss a study



CONVENTIONAL TWO LEVEL DIAMOND INTERCHANGE

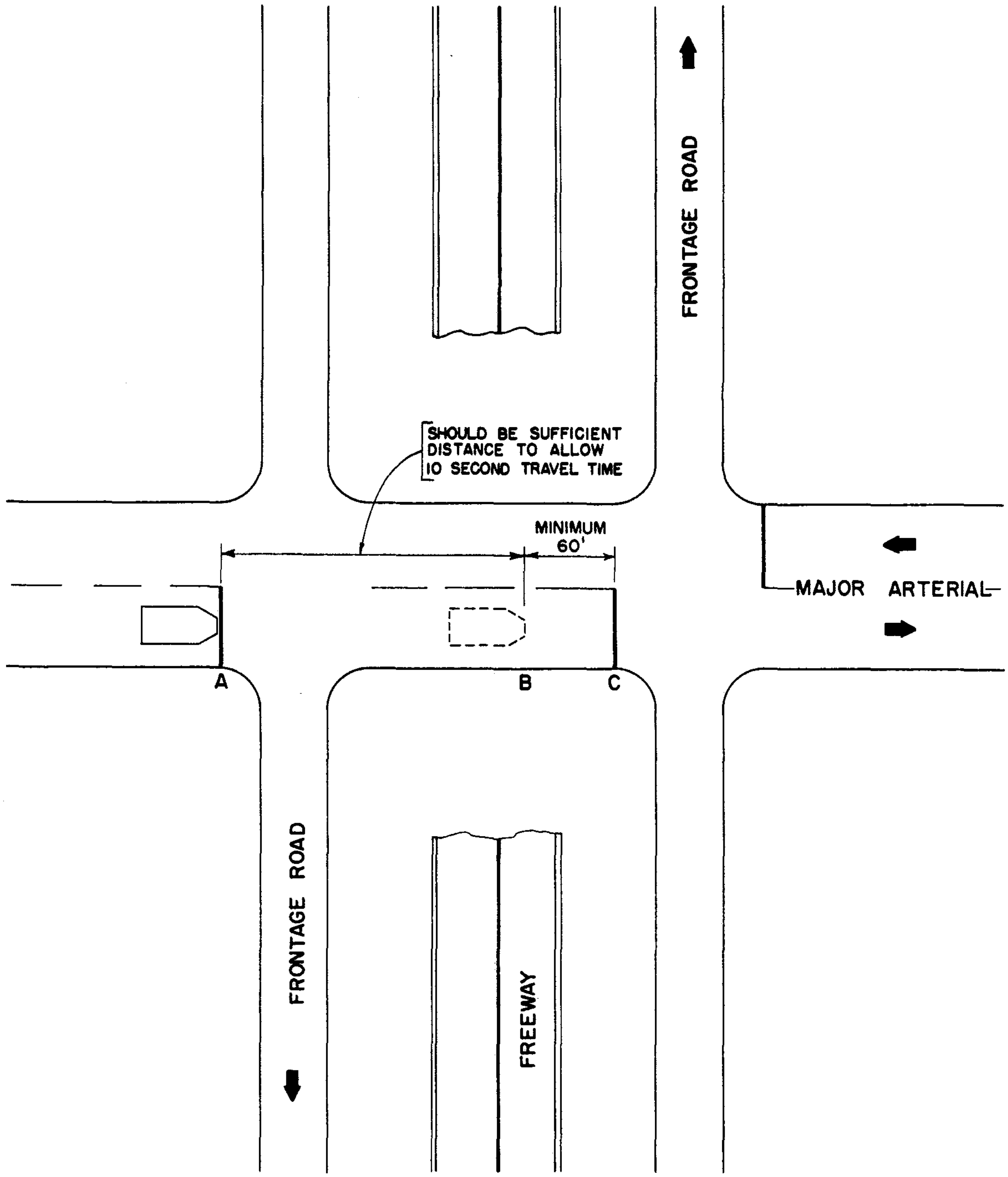
FIGURE 1



DIAMOND INTERSECTION

TWO-WAY WITH ONE-WAY

FIGURE 2



TRAVEL REQUIREMENTS
CONVENTIONAL DIAMOND INTERCHANGE

FIGURE 3

designed to obtain data on this problem and the results and conclusions of such a study.

STUDY PROCEDURE

After preliminary investigation of several possible study sites in the Bryan-College Station area, the southbound vehicular movement on S.H. 6 at the S.H. 6 - Villa Maria Intersection was selected for use in the study. This site was selected because there are no commercial or residential driveways in the study section and the grade of S.H. 6 is practically level in this area. The geometrics of this intersection are shown in Figure 4.

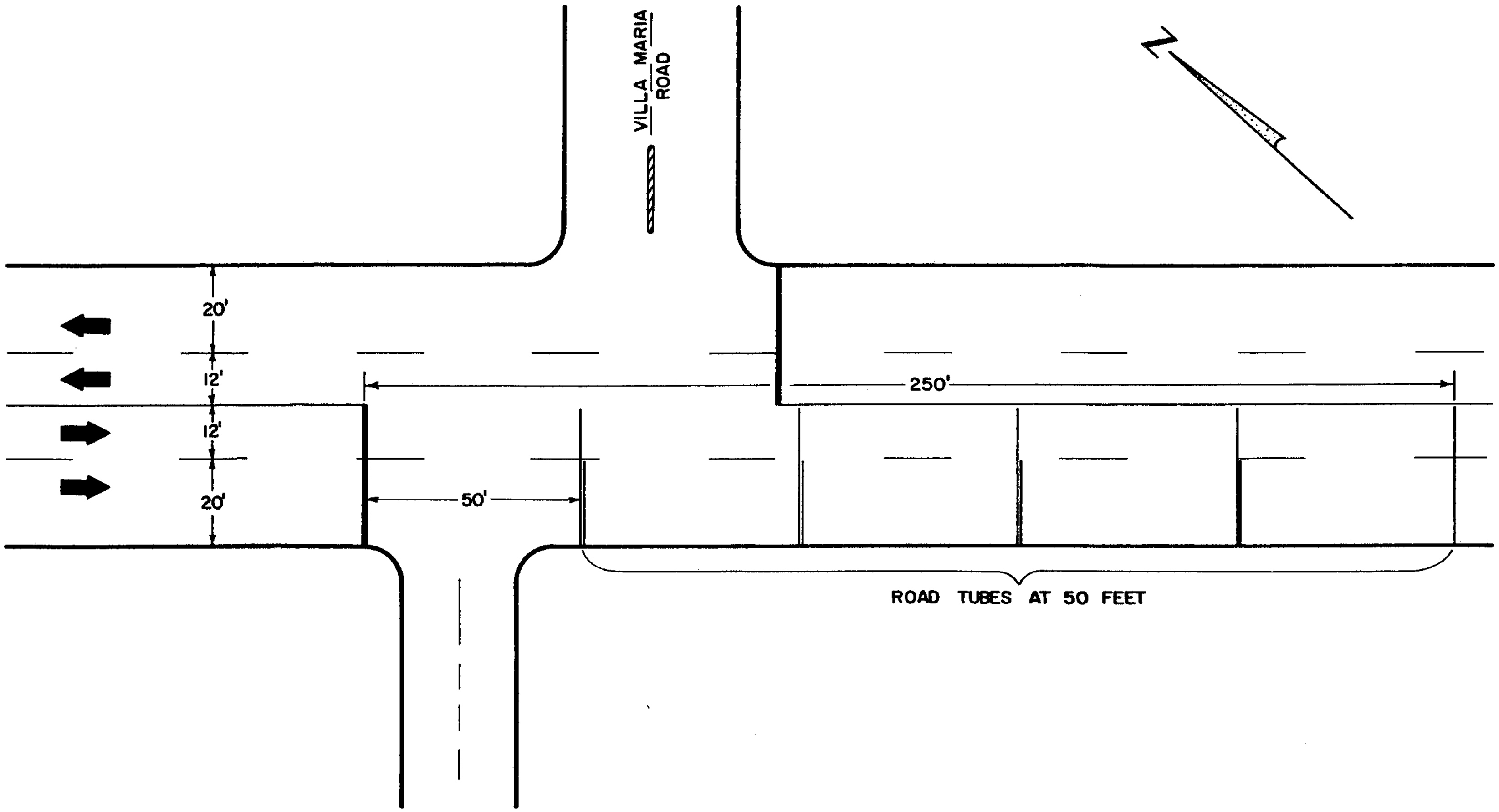
After consideration as to the type of data desired, it was deemed appropriate to measure the travel time of the first vehicle of the queue in each lane which had come to a complete stop during the red phase. These travel times were measured for 50-foot increments from the stop line as shown in Figure 4. The travel time measurements were started at the beginning of the green phase.

The data were collected through the use of nine pneumatic road tubes and a multi-pen recorder. The tubes were placed at 50-foot increments from the stop line as shown in Figure 4 and were then connected to the recorder. Two tubes of different lengths were placed at each 50-foot station for the purpose of establishing which lane the respective vehicles were traveling. As a result, one tube traversed both lanes while the shorter tube covered the curb lane only. Due to a shortage of equipment only one tube was used at the 250-foot station.

Since the tubes were connected to the multi-pen recorder, a vehicle could be detected and noted on the revolving graph as it passed over the tube or tubes at each 50-foot station. Also, the beginning of the green phase was noted on the graph. In order to determine the travel time to each station, the distances on the graph between the notation of the beginning of the green phase and the notations caused by the vehicles crossing the tube or tubes at each station were measured for each movement. Then by measuring the speed at which the graph was moving, the travel time to each station could be computed.

STUDY RESULTS

Two studies were made at the intersection with the data from each study being analyzed separately. Computations included the determination of the mean and standard deviation of the travel times to each



STUDY SITE
STATE HIGHWAY 6 – VILLA MARIA ROAD INTERSECTION

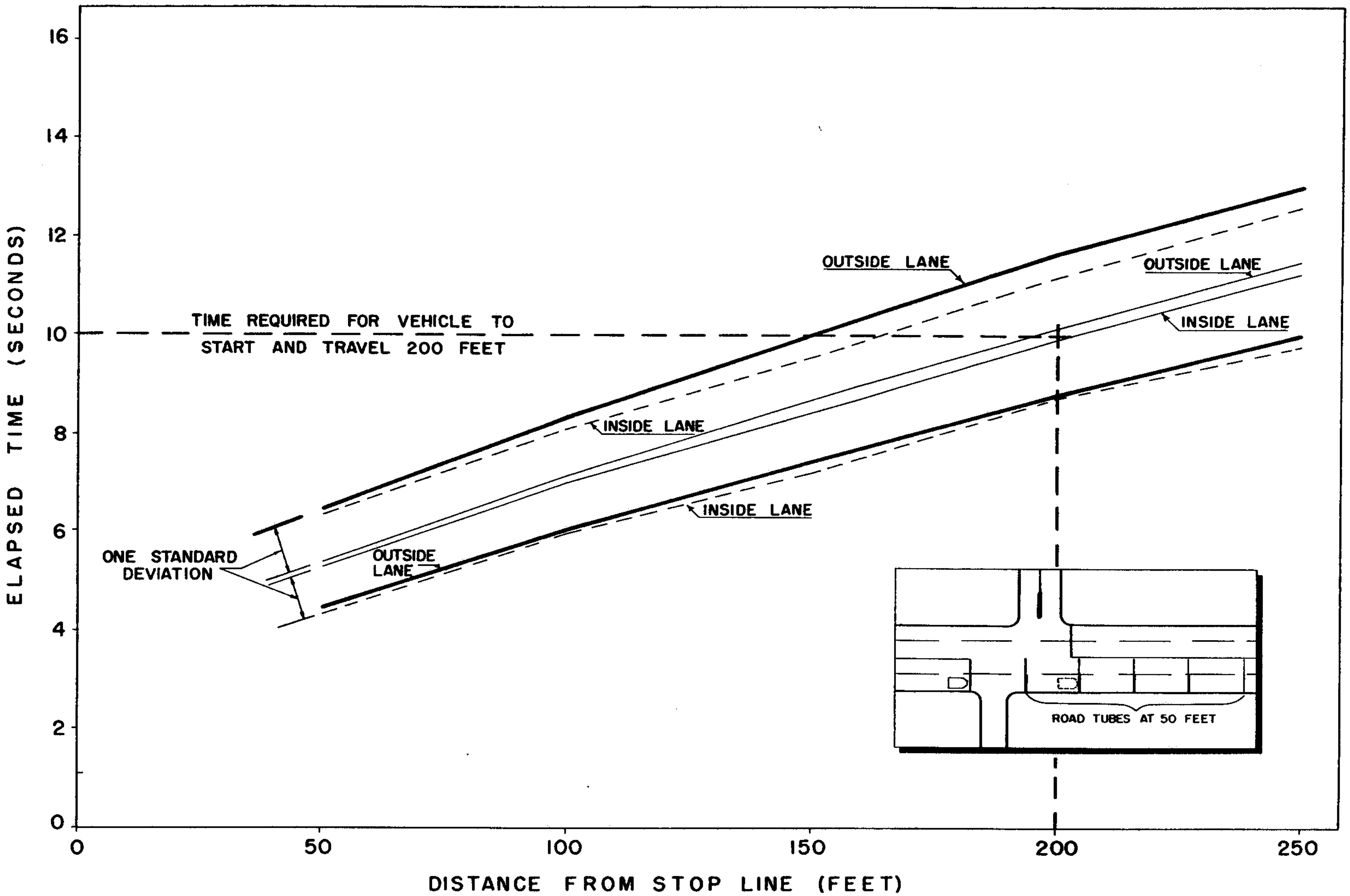
FIGURE 4

50-foot station by lane. Examination of these results revealed a close proximity between the two studies. As a result, the data collected in each of the two studies were combined with the mean and standard deviation being computed as before. These results are shown in Figure 5 and are based on sample sizes of 186 and 134 vehicles for the curb lane and inside lane respectively. Since the truck volume was approximately one per cent of the total volume, these curves may be considered to represent passenger vehicles only.

Observation of the curves reveals that the travel time is slightly longer for the curb lane in all cases. This may be attributed to the fact that the slower moving vehicles show a tendency to use the curb lane. Also, the curves do not extend down to zero distance since no study was made of initial delays.

CONCLUSIONS AND RECOMMENDATIONS

It was determined from previous research studies that the minimum desired spacing of at-grade intersections on diamond interchanges was related to the two distances shown in Figure 3. Reaction time and driver behavior studies indicate that distance BC should be a minimum of 60 feet and the results of vehicle studies at a signalized intersection indicate that distance AB should be a minimum of 200 feet. Thus a minimum spacing of 260 feet from stop line to stop line as shown in Figure 6 is recommended for conventional diamond interchanges. If it is possible to obtain a larger distance between stop lines, then it will be possible to utilize longer overlap phases.



VEHICLE PERFORMANCE AT SIGNALIZED INTERSECTION

FIGURE 5