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PASSIVE CONTROL AT RAIL-HIGHWAY GRADE CROSSINGS

by

I. N. Dommasch, R. L. Hollinger and E. F. Reilly

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16. Abstract

Two combinations of experimental warning and crossing signs were developed for use at passively controlled rail-highway grade crossings. Each combination was installed at three sites for a total of six experimental sites. New conventional signing was installed at four additional sites.

"Before" and "after" studies measured the effectiveness of two control changes; "as is" conventional to upgraded conventional and upgraded conventional to experimental. Effectiveness was measured using motorist interviews, observed brake light applications, and spot speed studies.

Upon comparison of before and after studies, a sharp increase was noticed at experimental sites in "Signs" as a reason for awareness. Other changes included a reduction in standard deviations of spot speeds at nine out of ten sites, and an increase in the percentage of motorists observed to apply brakes at seven out of seven sites.

From the results, it was implied that all control changes increased awareness of the crossings. At experimental sites, the new signing is considered to account for this increase in awareness. The general reduction in standard deviation of spot speeds implies a more uniform motorist reaction at the crossing, although not necessarily caused by the signing. An increase in percentage of motorists observed to apply brakes along with an increase in average spot speed at the track combined with a decrease in the percentage of motorists responding that they (Continued on next page)

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SUMMARY AND CONCLUSIONS

The first phase of this project concentrated on the development of field techniques to measure the effectiveness of passive designs. Four measures were formulated and subsequently tested in three pilot studies, conducted at two sites. The following conclusions were made from these studies:

a) The standard deviation of the spot speed on the crossing itself was found to be very high in relation to the variation of speed on the approach. Spot speeds at the crossing were one measure used in our studies.

b) Head movements of motorists, looking down the tracks, were found to be virtually non-existent. This measure was not used.

c) Brake light applications on the approach to the rail crossing did not exceed 7.6 percent of the approach volume, even though over 60 percent of the motorists claimed to slow down during the pilot studies. This measure was used, although specific conclusions were not made.

d) Motorist interviews were believed to be the most effective method of determining the effect of experimental designs. This measure was used in the study.

After measures of effectiveness were developed, attention was focused on developing experimental signing. Two combinations of experimental advance signs and crossbucks were chosen to evaluate. The choice was made by viewing scaled models of various designs under daytime and nighttime conditions and picking the signs which appeared best under those conditions. From the scale tests, two combinations of advance warning sign/crossing sign were chosen. One combination was tested with yellow Scotchlite and the other with brilliant yellow green Scotchlite backgrounds.

The second phase of this project involved selection of statistical tests, site selection, and conducting the "before" study using evaluation techniques developed in the first phase. Ten sites were selected for study and existing passive control at these sites was evaluated.

Three statistical tests were used on various questionnaire responses and the spot speed standard deviation, namely, the Chi-Square, the Z-Test for proportions, and the F-Test.

Results of the "before" questionnaire study showed that from two percent to 22 percent of the drivers were not aware of the railroad crossing. However, a high proportion of drivers who were aware of the crossing stated that the tracks made them aware. This may indicate that many drivers were only aware of the crossing as they crossed the tracks.

It was found that each of the ten sites used for the study had its own peculiarities at the time of the study. These characteristics are noted in Appendix B, Site Description.

The third phase of this project focused on the "after" study and the comparison and analysis of "before" and "after" data. Of particular interest in this phase was the effectiveness of the control changes in regard to motorist awareness of the crossing.

It was found that motorist awareness increased in the after studies at five out of six sites where experimental control was implemented. Awareness also increased at three out of four sites where control was merely upgraded. The most significant aspect of change in motorist response was found at the experimental sites. At all experimental sites, a substantial increase in "signing" as a reason for awareness was found in the after studies. Five out of six of these increases were statistically significant at a 95 percent confidence level. The increase in "signing" is considered a favorable response to the experimental signing, because it indicates that the approaching motorist was aware of the tracks before he crossed them.

Standard deviations in spot speeds decreased at all but one crossing in the after studies. This is considered a favorable response since it indicates a more uniform motorist reaction at the crossing.

Average spot speeds in the after study increased at all but one site. At the same time, the percent of motorists observed to apply brakes increased at all sites for which data was available. Brake light data was not available for three upgraded sites. When combined, this information implies that less motorists are slowing at the crossings in the after studies, but that those who do are slowing in a more pronounced manner. This is backed up by a decrease, at all experimental sites, in the number of motorists responding that they slowed.

INTRODUCTION

Between the years of 1968 and 1972, accidents at railroad crossings averaged one fatality per seven accidents. Additionally, even though railroad crossing accidents accounted for .06 percent of all accidents, they accounted for one percent of all fatalities.

The seriousness of this kind of accident necessitates the need to develop as effective a warning design as possible. This is especially true in New Jersey where over 60 percent of all railroad crossings in the state have only passive control.

Since such a large percentage of crossings are passively controlled, in the state, this project concentrated solely upon evaluating and improving the current designs for passive control at railroad crossings.

After careful consideration, three basic objectives for passive control were established. These were to: (1) make the motorist aware that he is approaching the crossing (to make him aware of the presence of a train is beyond the scope of passive protection), (2) make the motorist aware that his judgment, and his judgment alone, will determine whether or not it is safe to go over the crossing, and (3) create a uniform motorist response both on the approach and at the crossings in order to reduce the likelihood of conflict between vehicles in the traffic flow. It was with these objectives in mind that measures of effectiveness for evaluating passive protection devices were considered.

PROCEDURE

(A) FORMULATION OF EVALUATION TECHNIQUES

Since the purpose of a control installation at a highway-railroad grade crossing is the prevention of train-vehicle accidents, the most effective measure for the evaluation of various controls is the analysis of accident information. A tabulation of accident information, however, indicates that at any one crossing site there may only be one accident every few years. With information as sparse as this, statistical evaluation of different controls could take decades. Hence, methods other than accident analysis have been considered in this study.

After observing motorists at several passively controlled crossings, five measures of effectiveness of passive control devices were selected for consideration. These included: vehicle speed profiles, standard deviation of spot speed, motorist head movements, brake light applications and motorist interviews.

Of these, the vehicle speed profile was eliminated because it was considered impractical to obtain. A series of tape switches, pneumatic tubes, or other vehicle detection devices placed near or across the road and the related monitoring equipment would be too conspicuous to the motorist, quite possible influencing his speed.

The remaining methods of evaluation were field tested to define and overcome possible difficulties.

(1) Standard Deviation of Spot Speeds

The standard deviation of spot speeds at various distances from the crossing was considered to be a measure of the uniformity of driver response. A large variance in speeds would indicate a lack of uniformity in driver response to the crossing and its associated control. A small variance would indicate more uniform driver response.

At two pilot sites, spot speed studies were taken at 50 foot intervals from the crossing up to 300 feet upstream. Speeds were measured using an Automatic Signal Model S-5 radar unit mounted in a vehicle parked near the crossing.

It was necessary to either mount the radar inside the car or conceal the car, because the radar, combined with a policeman pulling vehicles off the road for an interview further down the road, resembled a speed trap. Obviously, this would influence vehicle speeds. Suspicions of this were confirmed when vehicles travelling in the opposite direction were spotted flashing their headlights at vehicles approaching the crossing. This problem was later eliminated by conducting speed studies on days different from those of the interview.

(2) Head Movements

An increase in the number of motorists looking for trains would indicate an increased motorist awareness of the crossing's existence. It could be implied that the motorist who looked for a train had assumed the responsibility of insuring his own safety.

At the pilot sites, head movements were recorded by an observer inconspicuously positioned at the crossing looking upstream. The observer noted the number of drivers looking right only, left only and in both directions.

Head movements could be used on a comparative basis at the same site to compare an existing control design to an experimental one.

(3) Brake Light Applications

Motorists applying their brakes on the approach to a crossing would indicate their awareness of it. Besides frequency of brake application, the dispersion (in location from the crossing) of the application of brakes would indicate the uniformity of motorist response, among those motorists who were aware of the crossing. This procedure was also considered as a useful technique for use at night.

At a pilot site, brake light applications were recorded by an observer stationed approximately 300 feet upstream of the crossing. The point at which brakes were first applied on the approach to the crossing was noted (in 50 foot intervals). Vehicles required by law to stop at grade crossings were not included in the study.

This measure was initially tested at a smooth crossing to reduce the influence of the crossing's roughness on driver reactions. It must be noted, however, that an unfamiliar motorist who applied his brakes may have done so because he did not know whether or not the crossing was rough.

(4) Motorist Interviews

The use of motorist interviews was evaluated to determine the motorists' awareness of the crossing, the source of their awareness and their subsequent action.

The interviews were taken at a point downstream from the crossing out of the approaching motorist's view. A limit of one minute's travel time, at the speed limit of the road, was chosen as the maximum distance for the interview site from the crossing. A policeman was used to pull vehicles to the side of the road for the interview.

In an effort to determine the most efficient method of conducting this survey technique, a questionnaire was presented to motorists in two ways during a pilot study.

First, the motorists were handed the questionnaires and pencils and were asked to complete it themselves. The interviewer answered any questions, if he was asked. In the second method, the interviewer read each question to the motorist without giving the motorist any suggestions, marking the choice closest to the driver's response or writing in a response in the "other" category.

The rationale behind the format of the questionnaire (Figure 1) was threefold:

1. A comparison of the magnitude of motorist awareness of the crossing, using different control designs, is necessary.

1. Did you just go over a railroad crossing? ____________________

IF YES

a. Can you tell us what made you aware of it?

____________Signs before coming to crossing
____________Signs at crossing
____________Familiar with location
____________Saw tracks
____________Rough crossing
____________Other (Specify)____________________

b. What do you think would make you more aware that you were approaching this crossing?

____________Large signs at crossing
____________Large signs before coming to crossing
____________Several signs before coming to crossing
____________New shape or color to signs
____________Rumble strips
____________Other (Specify)____________________

c. Did you slow down when you approach this crossing?____________________

Why did you slow down?

____________Rough crossing
____________Danger of trains
____________Usually slow down at railroad crossing
____________Other (Specify)____________________

d. Is there a bell, signal, or other warning device at this crossing which tells you that a train is coming?____________________

IF NO

e. What do you think would make you aware that you were approaching a railroad crossing?

____________Large signs at crossing
____________Large signs before coming to crossing
____________Several signs before coming to crossing
____________New shape or color to signs
____________Rumble strips
____________Other (Specify)____________________

f. Do you think all railroad crossings have a signal, bell, or other warning device which tells you that a train is coming?____________________

2. How often do you drive along this section of road?

____________Never
____________Less than once a month
____________Several times a month

3. Have you heard anything about railroad crossings in the past few months?

____________No
____________Yes (Specify)____________________

4. Have you been interviewed at this site before?

____________No
____________Yes

Site No.__________ Date____________ Int. No.__________

FIGURE 1 - QUESTIONNAIRE FORM

2. The reason for a motorists' awareness of the crossing is essential to determine the importance of the control design, and
3. The views of the driving public were sought for control designs that may be used in further studies.

Because familiarity with the crossing or recent exposure to a crossing incident would affect a motorist's reaction, the questionnaire covered the familiarity of the motorist with the study site and his knowledge of recent events affecting highway-railroad grade crossings, in general. To determine to what extent motorists may be giving false information, an abbreviated motorist interview was conducted on a road that had no upstream grade crossing.

(B) CHANGES IN CONTROL

A "new look" for a sign that serves the same function as a conventional sign may elicit renewed awareness on the part of drivers. For instance, the conventional circular warning sign for highway-railroad grade crossings was replaced in this study by experimental signs, which were different in shape, color, and legend (see section on "Development of Experimental Signing").

It was anticipated that the uniqueness of the experimental signs would be directly responsible for an initial increase in awareness. However, it was felt that upgrading the conventional signing that deteriorated over the years could also possibly elicit a positive increase in awareness on the part of drivers. An effort was made to distinguish between and measure each of these results and to use the comparisons in a qualitative analysis of "upgraded" versus "experimental" signing. Four study locations were chosen to compare the existing

TABLE 1

SCHEDULE OF SIGN INSTALLATIONS AND STUDIES

SITE	BEFORE STUDY: UPGRADED* SITES	UPGRADED* SIGNING INSTALLED	AFTER STUDY: UPGRADED BEFORE STUDY: EXPERIMENTAL	EXPERIMENTAL SIGNING INSTALLED	AFTER STUDY EXPERIMENTAL SIGNING
Upgraded					
2	April 1973	January 1974	September 1974	-------	-------
10	May 1973	January 1974	September 1974	-------	-------
13	April 1973	January 1974	September 1974	-------	-------
18	April 1974	May 1974	October 1974	-------	-------
Experimental					
3	------	January 1974	April 1974	May 1974	September 1974
8	------	January 1974	April 1974	May 1974	September 1974
11	------	January 1974	April 1974	May 1974	September 1974
6	------	March 1974	April 1974	May 1974	September 1974
9	------	January 1974	April 1974	May 1974	September 1974
17	------	February 1974	April 1974	May 1974	September 1974

*Upgraded sites are those at which new, relocated conventional signing will be compared to existing conventional signing.

signing with new, relocated (if necessary) conventional signing (Table 1). Six sites were selected for the installation of experimental signing but were also upgraded with new, relocated conventional signing before being changed to the experimental configuration.

In effect, conventional signing was tested on a "deteriorated versus upgraded" basis, and the experimental signing was tested on an "upgraded-conventional versus experimental" basis. The primary reason for omitting the "deteriorated versus experimental" studies was the lack of sufficient sites. Although there are hundreds of "passive" crossings in New Jersey, very few could be used as study sites. The main drawbacks were the lack of "cover" at the crossing to position an observer and the absence of a safe pull-off area downstream of the crossing to use for driver interview.

Drivers frequently travelling the stretch of road where experimental signing was installed probably tended to become immune to the "uniqueness" effect of the new signing. It was felt, however, that the infrequent user would reflect a greatly increased awareness of the crossing, because the signing experienced at experimental sites was completely new to him. Hence, the frequency of driver use and the type of signing were important considerations for comparison in this study.

Studies at each site were conducted during the hours of 10-12 AM and 1-3 PM. Study times were selected in this manner so that both AM and PM off-peak driver populations were sampled. These hours were also selected to avoid commuter traffic. Commuter hours were avoided because of the relatively high proportion of familiar drivers in the population and, furthermore, it was felt that a commuter going to and from work would be unwilling to spend the time required for the interview.

(C) SITE SELECTION

It was initially intended to select study sites according to criteria set forth in the first interim report of this project. However, after considerable experience reviewing locations, these criteria were modified. The requirement for a smooth crossing was eliminated and two additional criteria were added. The final criteria were:

a) Sufficient traffic to obtain an adequate sample size (100 vehicles per hour in one direction),

b) A location at or near the track where a survey vehicle can be safely positioned for spot speed studies,

c) A downstream location where drivers could be safely interviewed on the side of the road, and

d) A rural location with a minimum number of intervening intersections.

Only ten sites meeting these criteria were selected, after months of searching. As a result, the number of experimental signing combinations was limited.

(D) DEVELOPMENT OF EXPERIMENTAL SIGNING

The previous work in the development of warning and crossbuck signs (References 2 and 3) was used in the studies leading to the choice of signs for this program.

Models of several potential condidate signs were made at a scale of 1 inch/foot. Viewing distances were appropriately scaled and observations of sign visibility and clarity were made for both day and night conditions. Night conditions were simulated by setting the sign models in a dark room and using a motor vehicle headlamp for illumination.

Five Research personnel judged a total of 13 different advance sign and crossbuck models. At the time of judging, all models were constructed of either yellow or white Engineering Grade Scotchlite. The brilliant yellow-green Scotchlite suggested in the references was not available at the time.

It was decided that a "crossbuck" sign should not have a diamond shape as a background. The diamond shape is usually placed as a warning sign at some distance upstream of the actual hazard, and, therefore, some drivers may not expect the crossing to be at the sign location. For the same reason, it was decided to use the diamond shape for the advance warning signs. It was also decided to maintain the crossbuck shape in the signs to be located at the crossing, since the crossbuck shape has been traditionally associated with rail-highway grade crossings. Consideration was given to using a "yield" shape (at the crossing) since the motorist has the responsibility to ensure that no train is within close proximity before crossing. As a result of the evaluations, the four signs shown in Figure 2 were selected.

Sign A was modified (on the basis of a sign in Reference 2) to make the symbol distinguishable from a greater distance. Much of the fine detail shown in the sign in Reference 2 was eliminated and the remaining features were emphasized. This sign had a yellow Scotchlite background.

Sign B was shown in Reference 3. A large black border was added to the crossbuck to add contrast betwen the white Scotchlite crossbuck and yellow Scotchlite "yield sign" background. The crossbuck was made larger than shown in Reference 3.

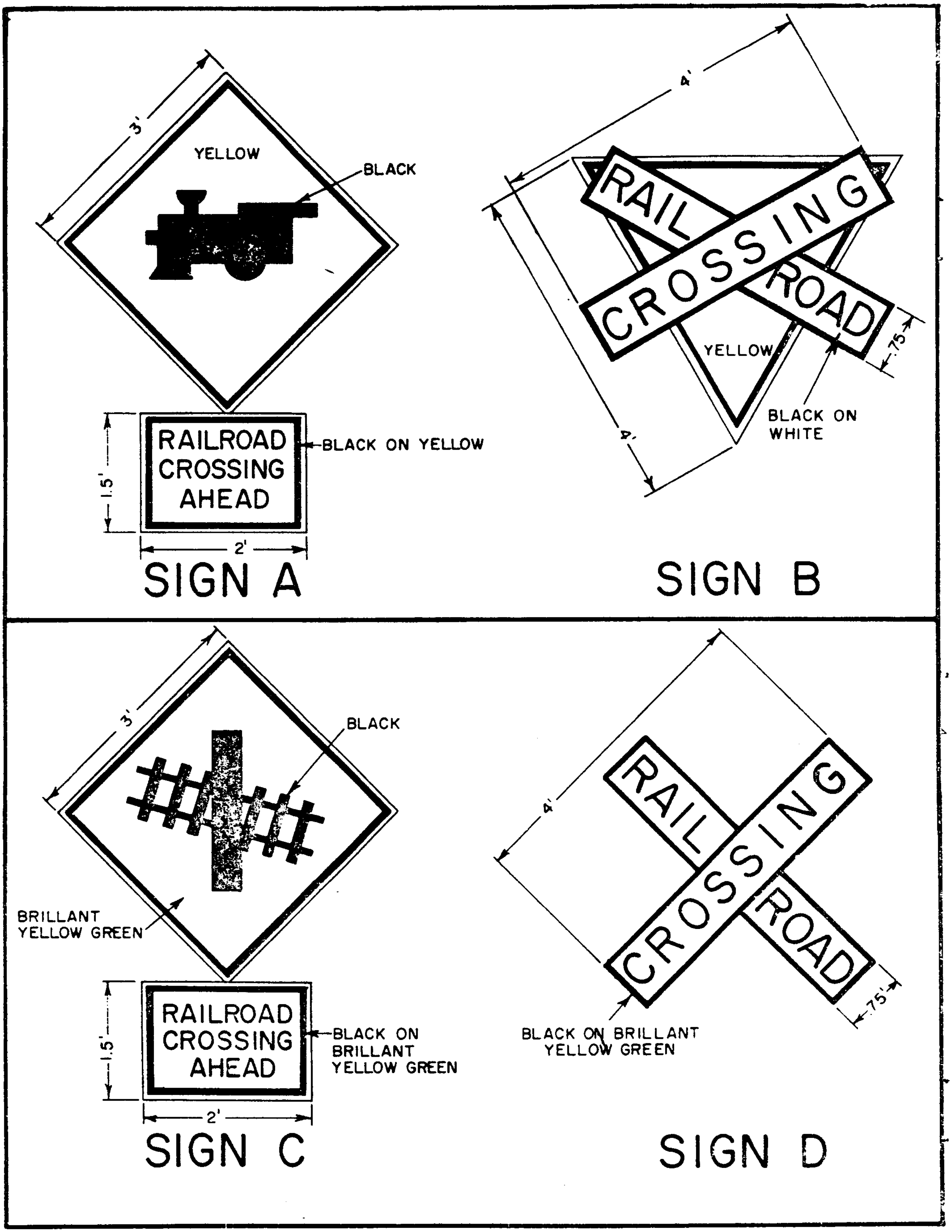


FIGURE 2: EXPERIMENTAL SIGNING

Sign C was also taken from Reference 2. The ties were lengthened to make the symbol distinguishable at a greater distance. The angle of the track and road will be 90° or 105° to indicate the skew of the track at each site. This sign had a brilliant yellow-green Scotchlite background.

Sign D is a standard 4-foot crossbuck with a brilliant yellow-green Scotchlite background. This sign was shown in Reference 2.

Educational signs, with the legend "Railroad Crossing Ahead," were placed on the advance warning signs because of their uniqueness. No educational signs were placed on the signs at the crossing.

The full-scale signs were evaluated at nighttime from various distances in the field. It was noted that the brilliant yellow-green Scotchlite faded in color under headlight illumination when viewed at small horizontal angles. All the signs except the educational signs were legible at a distance of 250 feet. At 325 feet, the crossbuck lettering was not legible and the advance warning sign symbols became difficult to distinguish. However, the crossbuck shape was still distinguishable (on both signs B and D at this distance).

Sign A was paired with sign B, and sign C was paired with sign D for the studies. Other combinations and colors were considered. However, since it was determined that each combination should be tested at three sites, two combinations were chosen because only six sites were available for testing experimental signs.

The signs that were "paired" as advanced warning and crossing signs were matched on a logical basis. The symbolic engine (Sign A) implies a yield (Sign B) at the crossing. The symbolic road-rail crossing is matched with the rail crossbuck at the crossing.

RESULTS AND DISCUSSION

(A) SPOT SPEED STUDIES

(1) Standard Deviation

Upon inspection of Table 2 , it is seen that the standard deviation of the spot speed at the crossing decreased at all but one site for which data is available. (Data unavailable at Site 17.) The decrease is significant at one experimental site and two upgraded sites. Since a reduction in standard deviation implies a more uniform response, it appears that the installation of both experimental and upgraded signing elicits favorable motorist reaction.

At Site 2, which showed significant increase in standard deviation, trains parked near the crossing during both before and after studies might well have influenced standard deviations. However, this increase, when contrasted to decreases at all other sites, cannot be fully explained.

With the exception of Site 2, there are no differences between the experimental and upgraded sites. When before and after changes in standard deviation are considered again, this implies that there is no difference in the uniformity of response between the upgraded and experimental sites.

(2) Average Speed

Average spot speed increased at all but one site in the after study. Two of five increases were significant for the experimental sites, while the changes at all four upgraded sites were significant (Table 2). Site 8 showed a significant decrease in average speed.

Since vehicle speed at the crossing has no clear implication as far as control at the crossing is concerned, the observed speed changes

16. Abstract (Continued)

slowed implies a more pronounced slowing with experimental signing than with conventional.

TABLE 2

SUMMARY SHEET - SPEED STUDIES

Site	SAMPLE SIZE		AVERAGE SPOT SPEED		STANDARD DEVIATION OF SPOT SPEED	
	Before	After	Before	After	Before	After
6	241	215	43.99	44.00	6.27	5.63
9	236	262	43.49	44.64*	5.57	5.40
17	DATA UNAVAILABLE					
3	302	332	39.35	40.32	8.09	5.44*
8	193	231	40.91	39.90*	5.38	4.92
11	213	154	35.07	35.94	5.74	5.37
2	137	124	18.60	19.70	4.66	5.62*
10	383	241	30.99	38.33*	6.10	4.19*
13	162	135	43.03	47.83*	8.38	4.77*
18	337	242	24.01	26.57*	5.14	4.62

* Significant Change Between Before & After Studies

are open to interpretation. However, it should also be pointed out that the trend of increased average speeds in the after study could well have been caused by some external factor not accounted for. Unfortunately, lack of suitable study sites made the use of control sites for this purpose an impossibility.

An additional point should be made concerning both standard deviations and spot speeds. Although definite trends can be seen in both sets of data, changes are generally very small; in the order of less than one mile/hour. These changes are within the tolerable error of the radar used to measure vehicle speeds. They are also within range of reading error, although this factor was accounted for by varying personnel throughout the speed studies.

(B) BRAKE LIGHTS

During the before study, 73% of all motorists interviewed responded that they slowed prior to the crossing. However, observations indicated that only about one in ten of all approaching motorists actually applied their brakes. This does not imply that motorists did not actually slow since they could have slowed by removing their foot from the gas pedal. A braking application is only a more pronounced slowing of motorists. In either case, the motorist could have been conscious of his slowing maneuver.

Table 3 is a summary of motorists slowing at seven of the ten study sites during before and after studies. Data at Sites 2, 10 and 13 was lost due to an error in data collection.

Upon inspection, it is seen that the total percentage of motorists observed to apply brakes during the studies increased at every site

TABLE 3

SUMMARY OF MOTORISTS SLOWING
(BEFORE/AFTER)

Site	% Motorists Interviewed	% Observed To Apply Brakes (All Vehs)	% Responding That They Slowed	% Interviewed Observed To Apply Brakes
6	21/19.1	9/11.7	64/50.2	4/4.3
9	24/21.4	1/10.9	58/62.7	1/6.9
17	17/33.7	16/23.9	77/87.1	12/13.7
3	24/23.5	10/10.2	66/64.1	6/7.6
8	26/30.1	10/18.4	75/77.6	3/15.3
11	24/40.6	11/16.0	80/79.3	7/8.6
18	24/30.8	27/31.2	89/68.8	28/34

for which data was available. This is in contrast to the total percentage of motorists who said they slowed. In this category of response, no discernible pattern was evident from comparison of before and after studies. However, of those motorists who stated that they were aware of the crossing (questionnaire), at every experimental site, a lesser percentage of motorists responded that they slowed in the after study.

The implication of this contradiction is that although less motorists are slowing, those motorists who are slowing are slowing in a more pronounced fashion. This is at least true for the experimental sites. Since brake light data is available for only one upgraded site, no implications can be drawn for this type of change in control. Furthermore, upon inspection of the questionnaire data (Table 6) for the upgraded sites, there is no discernible pattern in the before and after responses of those motorists who stated that they slowed.

Of the number of motorists who were both interviewed and observed to apply brakes (% Interviewed Observed to Apply Brakes, Table 3), an increase in brake light application was again observed at all sites. As expected, these increases corresponded to the increases observed for the total percentage observed to apply brakes.

(C) MOTORIST INTERVIEW

As outlined in the Statistical Analysis, the field data was initially tested for changes in frequency of travel between before and after studies. Field data as recorded in Tables 4 and 5 was used for all analysis. It was found that frequency of travel changed at Sites 11 and 18. Consequently, the remaining statistical analysis at these two sites was broken down by frequency of travel. Due to the small number

TABLE 4 - SUMMARY OF MOTORIST INTERVIEWS - BEFORE SIGNING CHANGES

CONTENT OF QUESTION ASKED		SITE 6 RTE. 206 HILLSBOROUGH	SITE 9 RTE. 70 MEDFORD	SITE 17 RTE. 51 EGG HARBOR	SITE 3 RTE. 27 KINGSTON	SITE 8 PEMBERTON FT. DIX	SITE 11 RTE. 541 LUMBERTON	SITE 2 BROWN AVE. LAKEHURST	SITE 10 RTE. 38 MT. HOLLY	SITE 13 RTE. 539 HORNERSTOWN	SITE 18 RTE. 9 PLEASANTVILLE
Number Aware of Crossing		192	187	104	170	178	148	154	123	140	204
Reasons for Awareness											
Signs		51	66	29	56	48	39	33	22	52	51
Familiarity		120	114	83	130	130	117	112	82	91	145
Tracks		51	54	40	41	62	23	53	3	32	179
Other		5	2	3	2	1	6	11	3	3	5
Slowed Down?	Yes	151	137	94	124	149	126	144	105	109	187
	No	41	50	7	44	27	22	10	18	30	17
	Don't Know	--	--	3	2	--	--	--	--	1	--
Reasons for Slowing											
Rough Crossing		77	70	56	57	91	67	60	72	65	124
Danger		9	14	9	7	14	10	53	5	21	21
Habit		79	69	50	75	70	64	76	38	40	85
Other		12	2	5	13	14	5	11	3	4	9
Crossing is Active	Yes	23	18	15	23	20	15	34	20	17	26
	No	144	150	64	113	134	122	98	89	108	144
	Don't Know	25	19	25	34	22	11	22	14	15	34
Number Unaware of Crossing		36	48	19	17	21	14	3	27	14	6
Number Unsure of Crossing		11	4	2	--	1	--	--	3	2	--
All Crossings are Active?											
	Yes	17	12	7	4	3	3	1	7	2	1
	No	29	40	12	12	19	11	2	22	14	4
	Don't Know	1	--	2	1	--	--	--	1	--	1
All Motorists											
Frequency of Travel on this Road											
Never		19	24	3	10	6	4	13	15	21	8
Less Than Once a Month		63	62	10	30	30	25	22	25	32	41
Several Times a Month		157	153	104	147	162	133	122	113	103	161
Heard About Railroad Crossings Recently?	Yes	32	3	12	34	12	28	32	15	29	20
	No	207	236	113	153	186	134	125	138	127	182
Total Number of Motorists Interviewed		239	239	125	187	198	162	157	153	156	210
Were you Interviewed Before?											
	Yes		1		0						
	No		230		187						

TABLE 5 - SUMMARY OF MOTORIST INTERVIEWS - AFTER SIGNING CHANGES

CONTENT OF QUESTION ASKED		SITE 6 RTE. 206 HILLSBOROUGH	SITE 9 RTE. 70 MEDFORD	SITE 17 RTE. 51 EGG HARBOR	SITE 3 RTE. 27 KINGSTON	SITE 8 PEMBERTON FT. DIX	SITE 11 RTE. 541 LUMBERTON	SITE 2 BROWN AVE. LAKEHURST	SITE 10 RTE. 38 MT. HOLLY	SITE 13 RTE. 539 HORNERSTOWN	SITE 18 RTE. 9 PLEASANTVILLE
Number Aware of Crossing		136	200	101	219	171	200	174	211	141	205
Reasons for Awareness											
Signs		76	91	40	140	122	164	31	35	65	60
Familiarity		85	133	70	157	126	127	140	161	95	151
Tracks		36	53	35	65	44	28	47	73	42	54
Other		6	18	3	5	11	4	21	2	2	11
Slowed Down?	Yes	97	142	88	148	144	165	170	166	114	174
	No	39	56	13	70	27	32	4	45	25	28
	Don't Know	1	1	0	2	0	3	0	0	0	2
Reasons for Slowing											
Rough Crossing		46	60	44	62	71	67	81	106	60	85
Danger		5	13	9	3	8	25	17	13	13	9
Habit		61	86	49	86	91	98	86	72	67	104
Other		3	7	4	14	11	4	20	12	1	10
Crossing is Active?	Yes	17	27	8	29	20	20	26	37	10	28
	No	111	160	80	163	139	167	139	164	121	159
	Don't Know	7	11	12	25	12	8	9	10	8	18
Number Unaware of Crossing		37	30	14	15	11	8	2	34	11	14
Number Unsure of Crossing		7	4	1	1	1	0	0	3	1	3
All Crossings are Active?	Yes	5	10	5	5	2	3	1	16	2	3
	No	34	21	8	11	9	5	0	21	10	12
	Don't Know	2	1	2	0	0	0	1	0	0	0
All Motorists											
Frequency of Travel on This Road											
Never		22	25	3	14	5	19	7	23	20	24
Less Than Once/Month		58	63	26	43	34	30	22	52	39	47
Several Times/Month		100	146	88	178	144	160	147	173	94	151
Heard About Railroad Crossings Recently?	Yes	26	17	5	33	20	16	27	16	14	16
	No	154	216	110	203	163	191	149	232	138	206
Total Number of Motorists Interviewed		180	234	116	235	183	208	176	248	153	222
Were You Interviewed Before?											
	Yes	5	6	1	8	3	9	2	2	2	3
	No	174	228	115	226	180	199	174	246	151	219

TABLE 6

BEFORE/AFTER SIGNING CHANGES - RESPONSES BY PERCENT

	SITE 6 BELLE MEAD [A & B]	SITE 9 MEDFORD [A & B]	SITE 17 EGG HARBOR [A & B]	SITE 3 KINGSTON [C & D]	SITE 8 FT. DIX [C & D]	SITE 11 LUMBERTON [C & D]			SITE 2 LAKEHURST	SITE 10 MT. HOLLY	SITE 13 HORNERSTOWN	SITE 18 PLEASANTVILLE		
Frequency of Travel	All Freqs.	All Freqs.	All Freqs.	All Freqs.	All Freqs.	Never	Less Than	Several	All Freqs.	All Freqs.	All Freqs.	Never	Less Than	Several
Percent Aware	80/76	*78/85	83/87	91/93	89/93	75/94	76/83	*95/99	98/99	80/85	90/92	89/62	95/89	98/98
Reasons for Awareness														
Signs	*27/56	*35/46	28/40	*33/64	*27/71	*0/100	*53/100	*23/77	21/18	18/17	37/46	62/33	31/50	23/23
Familiarity	67/62	61/67	80/69	76/72	74/74	67/0	47/44	*84/73	73/80	67/76	65/67	12/20	46/50	82/86
Tracks	27/26	29/27	38/35	24/30	35/26	33/29	32/20	13/11	34/27	29/34	23/30	75/53	*56/29	34/23
Other	3/4	*1/9	3/3	1/2	*1/6	33/6	5/0	3/2	7/12	2/1	2/1	12/0	8/12	*1/4
Slowed Down - Yes	79/70	73/71	90/87	73/67	85/84	67/88	100/84	83/82	93/98	85/79	78/82	100/93	95/83	90/84
No	21/29	27/28	7/13	26/32	15/16	33/12	0/12	17/17	7/2	15/21	21/18	0/7	5/12	10/16
Don't Know	0/1	0/1	3/0	1/1	0/0	0/0	0/4	0/1	0/0	0/0	1/0	0/0	0/5	0/0
Reasons for Slowing														
Rough	51/48	51/42	60/50	46/42	*61/49	100/53	63/43	50/39	42/48	68/64	60/52	37/36	*65/37	*70/54
Danger	6/5	10/9	10/10	6/2	9/6	50/7	5/14	8/16	37/10	5/8	19/11	12/0	13/9	11/5
Habit	52/64	50/61	53/56	60/58	*47/63	50/73	47/57	51/58	52/51	36/43	*37/58	62/43	51/66	*44/60
Other	8/3	1/5	5/4	10/9	9/8	0/0	0/0	5/2	8/12	3/7	4/1	0/42	11/6	3/4
Crossing is Active														
Yes	12/13	10/14	14/8	14/14	11/11	0/18	10/20	10/9	22/15	16/17	12/8	13/0	8/17	14/14
No	75/82	80/80	62/80	66/74	76/81	100/82	84/76	82/86	64/80	72/78	77/86	37/80	74/71	71/79
Don't Know	13/5	10/6	24/12	20/12	13/8	0/0	6/4	8/5	14/5	12/5	11/6	50/20	18/12	15/7
Percent Unaware of Crossing	15/20	20/13	15/12	9/6	10/6	25/6	24/17	5/1	2/1	18/14	9/7	11/29	5/11	2/1
Percent Unsure of Crossing	5/4	2/2	2/1	0/1	1/1	0/0	0/0	0/0	0/0	2/1	1/1	0/9	0/0	0/1
All Crossings Active?														
Yes	36/14	23/32	33/33	24/31	14/17	0/100	0/20	43/50	33/100	23/43	12/17	0/11	50/20	0/67
No	62/79	77/62	57/54	70/69	86/83	100/0	100/80	57/50	67/0	73/57	88/83	100/89	50/80	67/33
Don't Know	2/7	0/6	10/13	6/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	33/0
Heard About Railroad Crossings Recently?														
Yes	13/14	*1/7	10/5	18/14	6/11	50/22	*36/3	13/7	20/15	10/7	*19/10	*22/0	25/4	13/9
No	87/86	*99/93	90/95	82/86	94/89	50/78	*64/97	87/93	80/85	90/93	*81/90	*78/100	85/96	87/9[illegible]
Total Number of Interviews	239/180	239/234	117/116	187/235	198/183	4/18	25/30	133/160	157/176	153/248	156/153	9/24	41/47	160/1[illegible]

* Statistically Significant Difference

of responses in the "Never" and "Less Than Once a Month" categories, trends and analysis were limited to the "Several" categories at these two sites.

(1) Motorist Awareness of Crossing

Motorist awareness of the crossing increased at five out of six experimental sites in the after studies (Table 6). Increases at two sites were significant. A similar increase in awareness occurred at three out of four sites where signing was upgraded, although no change at upgraded sites was significant.

In viewing these results, it appears that both kinds of control changes induce a greater motorist awareness, although the significant increases occurred at the experimental sites. It should also be pointed out that the significant increases occurred for each of the two experimental control changes.

(2) Reasons for Awareness

Perhaps the most noticeable change in motorist response occurred in answer to this question as asked in the questionnaire. In particular, at all experimental sites, large increases in "Signs" as a reason for awareness (Table 6) were observed. Increases at all but one experimental site were statistically significant. For experimental sites, the increases in the "Signs" response was the only discernible pattern among the sites.

The increase in "Signs" as a reason for awareness is a strong indication that the motorists who were aware of the crossing were aware before passing over it. This response combined with the general increase in motorist awareness leads to the conclusion that the experimental signs are conducive to a favorable motorist reaction to the railroad crossing.

At sites where control was upgraded, a change occurred in the "Familiar" response. In the after study, all upgraded sites showed an increased percentage of motorists answering with this response. The implications of the "Familiar" response are not nearly as clear as the "Signs" response. It is assumed that a familiar driver will know in advance if he is approaching a crossing. This is a favorable response, although it cannot be attributed to a change in control. Hence, on the basis of this response, little can be said of the motorist reaction to the upgrading of the controls.

(3) Slowing Before Crossing

As mentioned earlier, the number of motorists responding that they slowed prior to the crossing decreased in the after study at all experimental sites. By itself, this trend in response is difficult to interpret. However, when combined with the increased percentage of brake lights found at every experimental site, along with a higher average spot speed at the crossing, the implication is that a lesser number of motorists are slowing, but in a more pronounced fashion.

At sites where control was upgraded, no discernible patterns were evident among the "Yes", "No", "Don't Know" response. No conclusions could be drawn about upgraded signs from this data.

(4) Reasons for Slowing

Perhaps the ideal change in response to this question would be an increase in the percentage of motorists using "Danger" as a reason for slowing. An increase of this sort would imply that motorists were aware of the crossing, and that they were looking for trains before they crossed over it. Unfortunately, no pattern of change among sites was evident for this response. Rather, the "Rough" response decreased at all experimental sites and the "Habit" response increased at five out of six sites. The meanings of the chanoes in the "Rough" and "Habit" response regarding motorist safety is another pattern open to interpretation.

(5) Awareness of Control at Crossing

Increases in the correct response "No" (i.e.,the crossing is not active) occurred at nine out of ten sites. Decreases in the "Don't Know" response occurred at all ten sites, while no discernible pattern of increase/decrease occurred for the "Yes" response. Since the "No" responses comprised, by far, the largest proportion of motorists aware of the crossings, and since numerical changes in responses are the largest for this category, changes in the "No" response are the most significant of the three.

The increase in the correct identification of control is another indication of favorable motorist reaction. It implies that the motorist is aware that he will not be aided in determining whether or not a train is near or at the crossing.

The role of new signing, either experimental or upgraded, is not clear in regard to correct identification of control. It is possible that more noticeable signing at the crossing prompted closer inspection of the crossing, but this cannot be implied from the pattern of responses.

REFERENCES

1. Dommasch, I. N., et al, "Passive Protection at Rail-Highway Grade Crossings," Interim Report, August 1974.

2. Hulbert, S. F. and Vanstrum, R. C., "Passive Devices at Railroad-Highway Grade Crossings," Proceedings-1972 National Conference on Railroad-Highway Grade Crossing Safety, August 29-31, 1972, pp. 26-29.

3. "Factors Influencing Safety at Highway-Railroad Crossings,"NCHRP Report 50, 1968

APPENDIX A

STATISTICAL ANALYSIS

(A) SCREENING OF MOTORIST INTERVIEW FORMS

Before statistical summaries were made, interview forms were checked for validity. In general, there were three reasons for voiding an interview: [1] the questionnaire was answered in a manner which indicated that the motorist was not responding in a cooperative manner, for example, interviews in which all possible responses to a particular question were made; [2] the questionnaire was answered in a manner which gave conflicting information, for example, the motorist was aware of the crossing (Question 1 - Figure 1), was also familiar with the location (Question 1-a), and yet had never traveled the road before (Question 2). This conflict occurred several times at all sites. [3] During the interview, the motorist tried to detect the crossing in his rearview mirror or by turning around.

At Site No. 6, interviews were also discarded because motorists were confusing the study crossing with a grade separated crossing further upstream. Motorists were answering that a curve had made them aware of the crossing, but there is no curve at the study site.

(B) FREQUENCY OF TRAVEL

A test of the similarity of the "before" and "after" population of motorists was made using Question 2 (Figure 1) on the frequency of travel along this section of road. If a significant difference was found in the distribution of replies, then all responses to Question 1 (excluding 1b. and 1e.) were grouped according to frequency of travel. Subsequent analysis of the responses was then made within each of the three frequency groups.

If frequency of travel population distributions was found to be similar, then the analyses of responses to Question 1 (except 1b. and 1e.) were made using the sample population as a whole.

The Chi-Square statistic was used to test the distribution of travel as shown in the following example:

Frequency of Travel	Number of Responses Before	After	Total
Never	3	7	10
Less Than Once/Month	35	40	75
Several Times/Month	160	130	290
TOTAL	198	177	375

Frequency of Travel	Expected Number of Responses Before	After
Never	5.3	4.7
Less Than Once/Month	39.6	35.4
Several Times/Month	153.1	136.9

$$X^2 = \frac{(3-5.3)^2}{5.3} + \frac{(7-4.7)^2}{4.7} + \frac{(35-39.6)^2}{39.6} + \frac{(40-35.4)^2}{35.4} + \frac{(160-153.1)^2}{153.1} + \frac{(130-136.9)^2}{136.9} = 8.87$$

$$X^2_{.95,2} = 5.99 < 8.87$$

Therefore, we would conclude that there is a significant difference in the distribution of the frequency of travel in the populations of motorists. Hence, we would not compare the total samples of 198 (before) and 177 (after) as a single population. Comparisons would be made on the basis of their frequency of travel, that is, the three different populations would be tested separately.

(c) QUESTION 1 - AWARENESS OF CROSSING

The proportion test was used to compare the "before" and "after" studies. The Z statistic in this test is used with a pooled standard deviation $\sigma_{1-2} = \sqrt{pq\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}$; N_1 and N_2 are the sample sizes of "before" and "after" populations, respectively; p is the expected proportion of a yes response for both samples; q = 1 - p. The calculated Z statistic is compared to a value of 1.96 for 95 percent confidence. Those motorists who were not sure if they had gone over railroad crossings were considered to be unaware (they were placed in the "no" category).

This procedure can be summarized by the following example:

Response	Before	After
Yes	156	160
No	42	17

$$p = \frac{156 + 160}{198 + 177} = .843 \qquad N_1 = 198 \qquad N_2 = 177$$

$$\sigma_{1-2} = \sqrt{(.843)\ (.157)\left[\frac{1}{198} + \frac{1}{177}\right]} = 0.038$$

$$P_1 = \frac{156}{198} = .788$$

$$P_2 = \frac{160}{177} = .904$$

$$Z = \frac{.788 - .904}{.038} = -3.08$$

Therefore, with 95 percent confidence, we can conclude that there is a significant difference in the "before" and "after" awareness of the crossing. Significantly more motorists are aware of the crossing in the "after" study than the "before" study.

(D) QUESTION 1a. - REASON FOR AWARENESS

For simplification, the responses to Question 1a. were grouped under four headings: signs, familarity, tracks, and other (refer to Questionnaire form). Differences in "before" and "after" responses were statistically analyzed using the proportion test checking the proportions of each group separately. The proportions tested in this case were based on the number of "yes" responses to Question 1, not on the total number of responses to Question 1a., since many motorists gave more than one response to Question 1a. The following example is based on numbers used during the preceding example.

Response	Before	After
Signs	55	65
Familiarity	130	140
Tracks	40	38
Other	5	4

For illustration, we shall test to see if the installation of experimental signing has increased the "Sign" response as the reason of awareness.

$$P = \frac{55 + 65}{156 + 160} = .380 \qquad q = .620 \qquad N_1 = 156$$

$$N_2 = 160$$

$$P_1 = \frac{55}{156} = .352, \quad P_2 = \frac{65}{160} = .406$$

$$\sigma_{1-2} = \sqrt{(.380)\ (.620)\ \left[\frac{1}{156} + \frac{1}{160}\right]} = .055$$

$$Z = \frac{.352 - .406}{.06} = -0.989 < -1.96$$

We would, therefore, conclude that experimental signing did not significantly contribute to increasing motorist awareness.

Notice in this example that N_1 and N_2 are equal to the number of Question 1 "yes" responses.

The same procedure was used to check for significant changes in proportion of the other three groups.

(E) QUESTION 1c. - SLOWING ON APPROACH AND REASONS FOR SLOWING

A proportion test was used for the statistical analysis of Question 1c. The base population used for determining proportions was the "yes" responses to Question 1.

A proportion test was also used to analyze the reasons for slowing. Since many motorists gave more than one response, the same procedure was used as in (D) above.

(F) QUESTION 1d. AND 1f. - ARE CROSSINGS ACTIVE?

A "yes" response to these questions indicated that the motorist expected to be warned in the event of a train at the crossing. Since passive control provides no such warning, a "yes" answer indicated either an uneducated motorist or a motorist who misinterpreted what he saw at the crossing. This question, however, does not infer any significant information in regard to the signing. Hence, responses to this question were only used for descriptive purposes, and no statistical analyses were performed.

(G) MOTORIST KNOWLEDGE OF RECENT EVENTS CONCERNING RAILROAD CROSSING

Changes in motorist knowledge were tested by using a X^2 test. The entire interviewed population was used in the test. When significant increases in motorist knowledge were found, it was anticipated that a corresponding increase in motorist awareness of the crossing would also result.

(H) SPOT SPEEDS AND STANDARD DEVIATION OF SPOT SPEEDS

It was initially proposed to study only the standard deviation of the spot speed, but as a point of interest, changes in "before" and "after" mean spot speeds were also tested.

Change in mean speed was tested with the standardized Z statistic using a pooled standard deviation. It was tested at a 95 percent confidence level.

Changes in standard deviation were tested using a two tailed F test at a 95 percent confidence level. For illustration, suppose that data for a speed study results in the following table:

	Before	After
Sample Size	160	190
Standard Deviation	5.3 mph	4.8 mph

$$\text{Calculated } F = \frac{(5.3)^2}{(4.8)^2} = 1.22$$

$$F_{.025}\ (159,189) = .765,\ F_{.975}\ (159,189) = 1.41$$

Therefore, we would conclude that since the calculated F is within the acceptable range, no significant change has occurred in the standard deviation.

APPENDIX B

SITE DESCRIPTIONS

Diagrams of the study sites are shown in Figures 3 through 12. Comments on pecularities which were observed during the "before" and "after" questionnaire surveys, at the individual sites are given below:

Site 2 - Brown Avenue - Lakehurst

General:

1. There are three tracks at this crossing. Trains were frequently standing in view of passing motorists during both "before" and "after" studies.
2. A utility pole partially obscures the crossings on the study approach.
3. There is a relatively high frequency of daily train traffic at this crossing.

Before:

1. Two trains crossed the roadway during the survey. Those motorists stopped by the trains were not interviewed.

After:

1. Six train crossings occurred during the survey. They were the result of two trains involved in switching operations. Those motorists stopped by the trains were not interviewed.

Site 3 - Route 27 - Kingston

1. An accident on an alternate route diverted traffic through the site on the day of the "before" survey.

Site 6 - Route 206 - Hillsborough

General:

1. There is a grade separated crossing approximately one mile upstream from the railroad crossing. During the motorist interviews, it became apparent that some motorists confused the at-grade crossing with the overpass. It was necessary to void these interviews.
2. Although the interview location was located approximately a half mile from the crossing, the distance was not considered excessive.

Before:

1. The interviewer's questioning was cut short by many motorists. The interviewing staff had not conducted an interview for over a year, prior to this study. Hence, the motorist was allowed to anticipate answers resulting in an interruption of the question. This problem was rectified after this study and did not occur at subsequent surveys.
2. One train crossing occurred during the survey. Motorists that were stopped by the train were not interviewed.

After:

1. Two train crossings occurred during the survey. Motorists that were stopped by the train were not interviewed.

Site 8 - Wrightstown-Pemberton Road - Fort Dix

General:

1. The two tracks at this site are separated by approximately 70 feet.

2. A traffic signal was located between the crossing and the survey location. One of the interviewing staff had to determine which vehicles turned onto Wrightstown-Pemberton Road, downstream of the railroad crossings. Spot speeds at the crossing may have been affected by the proximity of the signal.
3. The interview location could be seen by motorists from the crossing.
4. Although the interview location was located approximately a half mile from the crossing, the distance was not considered excessive.

After:

1. Roadside construction along the approach to the study site was completed one week prior to the roadside interviews.
2. One of the staff stationed at the crossing was noticed by several motorists.

Site 9 - Route 70 - Medford

1. A traffic circle upstream of the crossing may have affected the spot speeds at the crossing.

After:

1. One of the staff stationed at the crossing was noticed by several motorists.

Site 10 - Route 38 - Lumberton

General:

1. A traffic signal was located between the interview location and the crossing.

Before:

1. There was a car on fire between the interview location and the crossing for twenty minutes during the survey.

Site 11 - County Route 541 - Lumberton

General:

1. The interview location was visible from the crossing.
2. Because of inadequate shoulder width, motorists partially blocked the travelled way.

Before:

1. The policeman used to stop motorists for interviewing issued several summonses. Although he issued them to motorists after they were interviewed, this might have affected motorists' responses during the "after" study at this site.

After:

1. Although local police were used during the "before" study, State Police were used during the "after" study. This change was due to scheduling problems with the local police.

Site 13 - County Route 539 - Hornerstown

General:

1. The interview location was 1,800 feet from the interview site.

Before:

1. The policeman used to stop moto-ists for interviewing issued several summonses after the interview.

Site 17 - Fire Road - Egg Harbor

General:

1. A traffic signal was located between the crossing and the interview location. One of the interviewing staff had to determine which vehicles came from the cross street at the intersection.
2. The pull over area at the interview location was too small for vehicles to adequately clear the travelled way. Because of this, motorists may have a tendency to end the interview as quickly as possible.

Before:

1. A train used the crossing during the survey. Those motorists forced to stop were not interviewed.

After:

1. Two trains used the crossing during the survey. Those motorists forced to stop were not interviewed.

Site 18 - Route 9 - Pleasantville

General:

1. The interview location was relatively close to the crossing and could be seen from the crossing.
2. There is a "bump" of approximately five feet elevation at the crossing.

After:

1. Two trains used the crossing during the survey. Those motorists forced to stop were not interviewed.

SITE DESCRIPTION

Crossing Condition - Smooth 1____2____3____4____5 X Rough

Number Tracks 3 Train Frequency 3/Day Speed Limit 25 M.P.H.

Original Crossbuck Condition.................... Poor

Original Advance Sign Condition................. Excellent

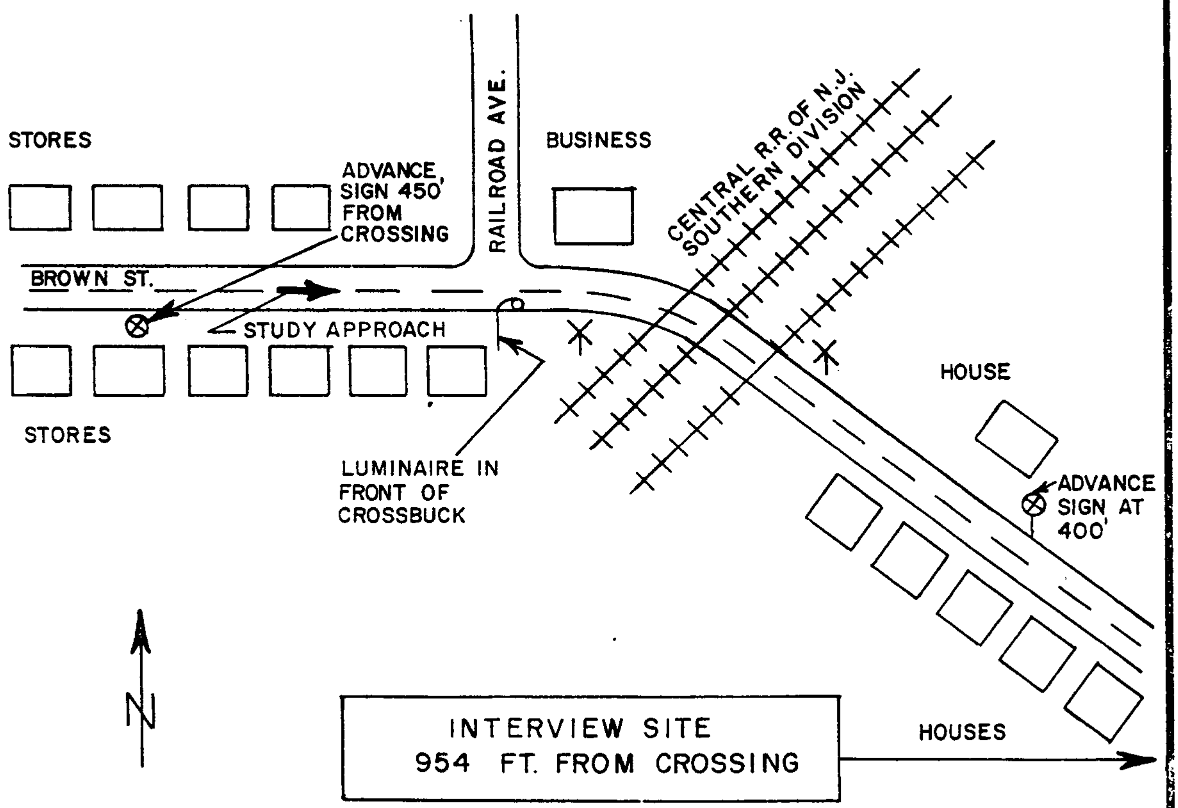
Pavement Marking Condition...................... Poor

Shoulder Width.................................. 9'

Sight Distance of Crossing on Approach.......... Over 300'

Distance Tracks Visible from Safe
Stopping Distance............................. 100' Left - 100' Right

Sight Distance of Advance Sign on Approach...... Over 300'



BROWN AVE.- LAKEHURST
UPGRADED SIGN SITE

SITE 2

SITE DESCRIPTION

Crossing Condition - Smooth 1___2___3 X 4___5___ Rough

Number Tracks 1 Train Frequency 2/Week Speed Limit 45 M.P.H.

Original Crossbuck Condition.................... Excellent

Original Advance Sign Condition................. Excellent

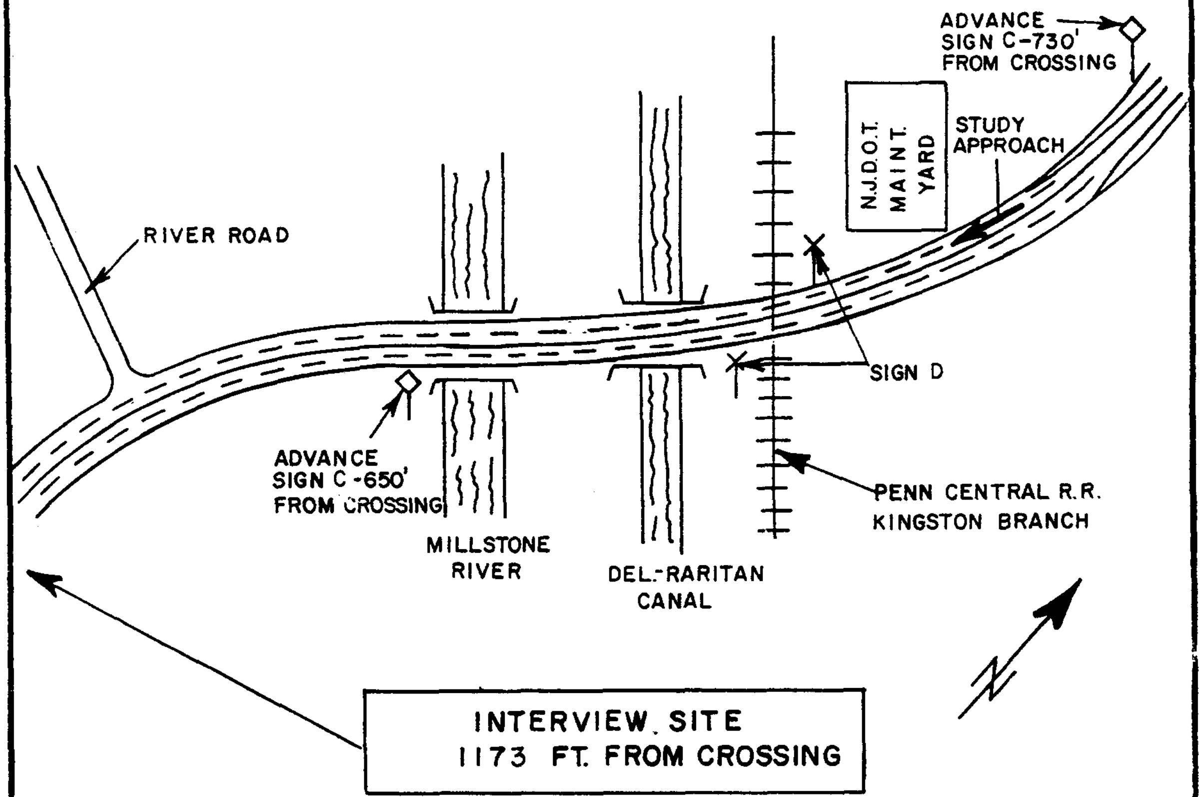
Pavement Marking Condition...................... Poor

Shoulder Width.................................. 10'

Sight Distance of Crossing on Approach.......... Over 300'

Distance Tracks Visible from Safe
Stopping Distance............................... 100' Left - 100' Right

Sight Distance of Advance Sign on Approach...... Over 300'



RTE. 27 - KINGSTON
EXPERIMENTAL SIGN SITE

SITE 3

SITE DESCRIPTION

Crossing Condition - Smooth 1 X 2 ___ 3 ___ 4 ___ 5 ___ Rough

Number Tracks 1 Train Frequency 1/Week Speed Limit 50 M.P.H.

Original Crossbuck Condition.................. Excellent

Original Advance Sign Condition................ Excellent

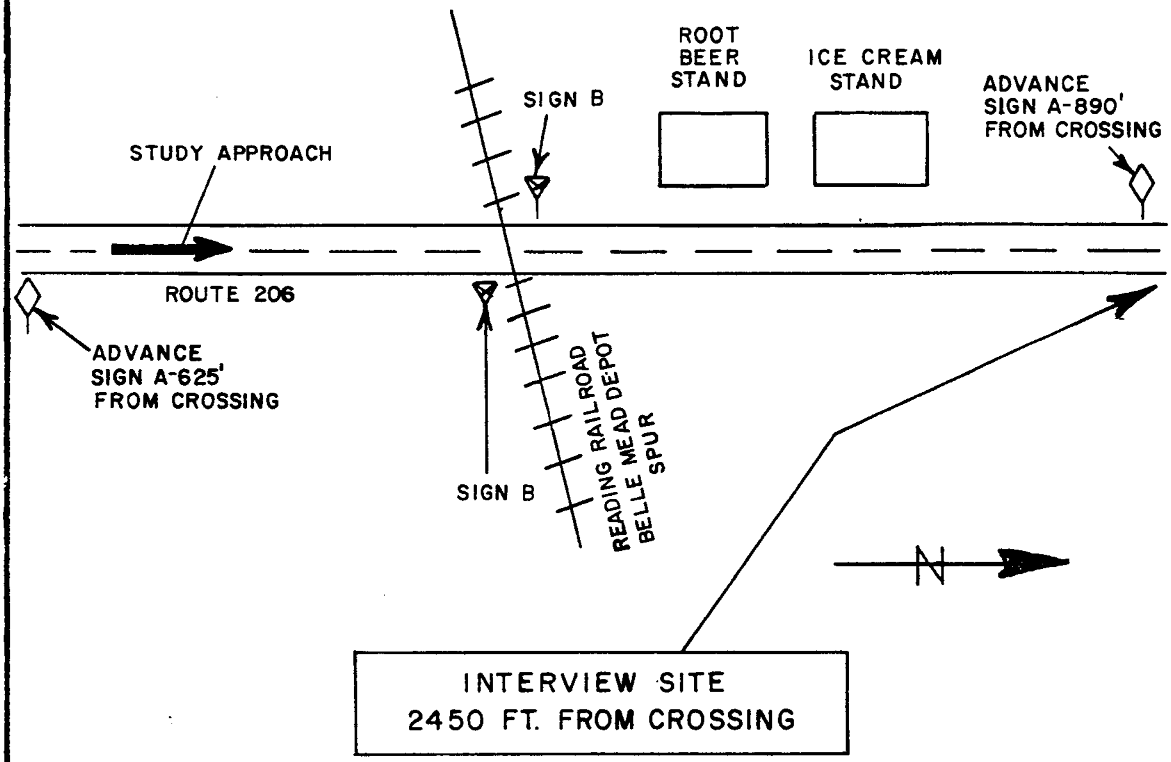
Pavement Marking Condition..................... Poor

Shoulder Width................................. 10'

Sight Distance of Crossing on Approach.......... Over 300'

Distance Tracks Visible from Safe Stopping Distance........................... 100' Left - 60' Right

Sight Distance of Advance Sign on Approach...... Over 300'



RTE. 206-HILLSBOROUGH
EXPERIMENTAL SIGN SITE

SITE 6

SITE DESCRIPTION

Crossing Condition - Smooth 1___2_X_3___4___5___ Rough

Number Tracks 2 Train Frequency 1/Week Speed Limit 40 M.P.H.

Original Crossbuck Condition.................. Fair

Original Advance Sign Condition................ Poor

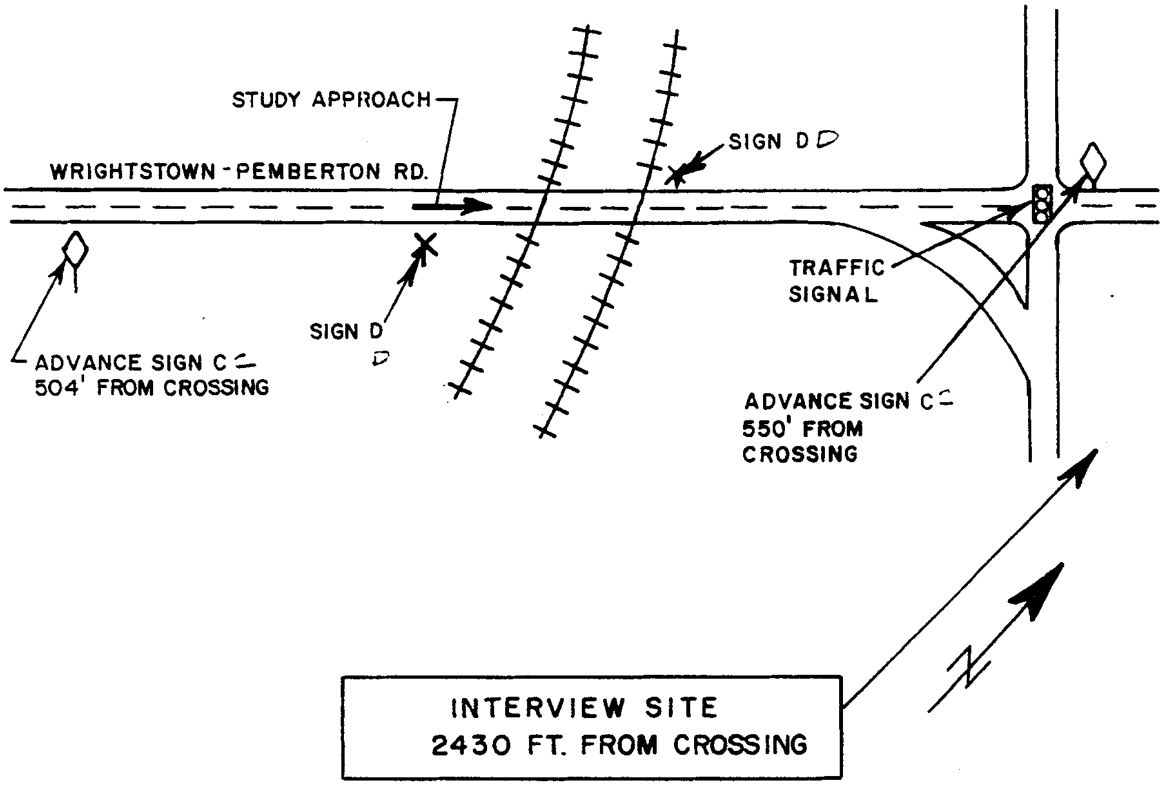
Pavement Marking Condition..................... None

Shoulder Width................................. 8'

Sight Distance of Crossing on Approach.......... Over 300'

Distance Tracks Visible from Safe Stopping Distance........................... 100' Left - 100' Right

Sight Distance of Advance Sign on Approach...... Over 300'



WRIGHTSTOWN-PEMBERTOWN RD.-FORT DIX
EXPERIMENTAL SIGN SITE

SITE 8

SITE DESCRIPTION

Crossing Condition - Smooth 1____2 X 3____4____5____ Rough

Number Tracks 1 Train Frequency 1/Day Speed Limit 55 M.P.H.

Original Crossbuck Condition.................... Poor

Original Advance Sign Condition................. Excellent

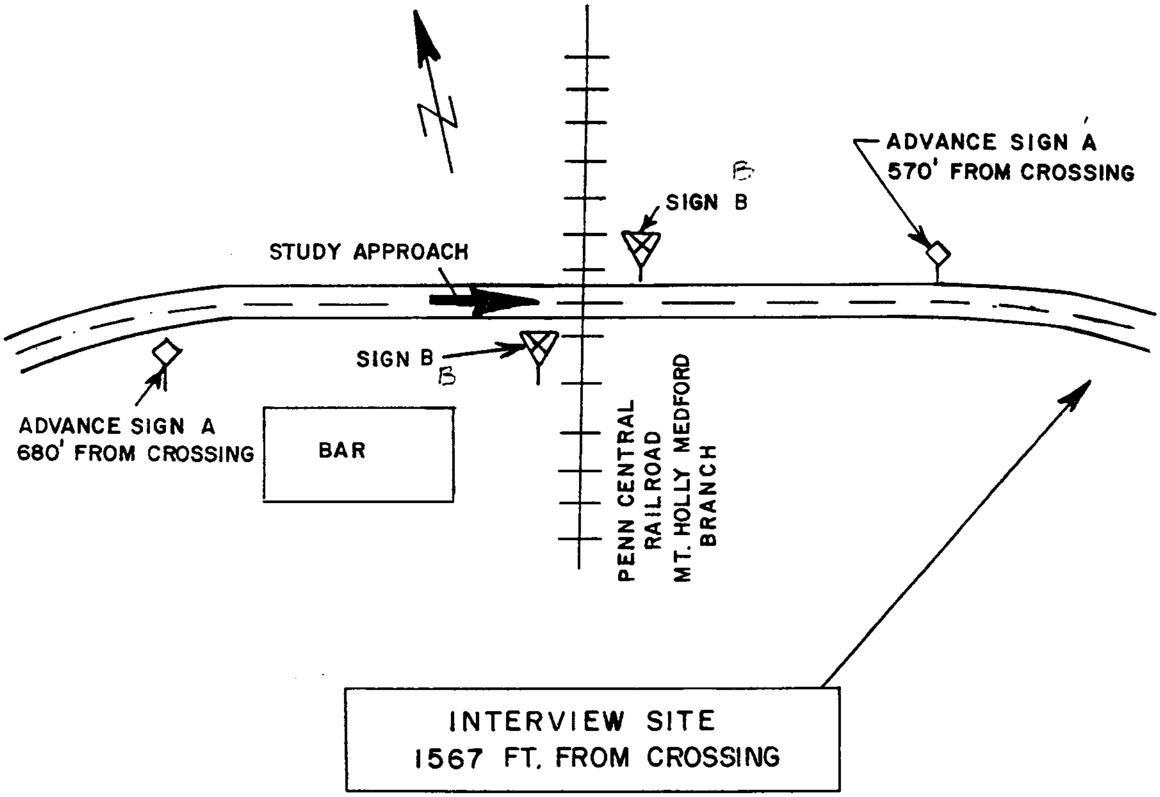
Pavement Marking Condition...................... Fair

Shoulder Width.................................. 12'

Sight Distance of Crossing on Approach.......... Over 300'

Distance Tracks Visible from Safe Stopping Distance............................ 21' Left - 100' Right

Sight Distance of Advance Sign on Approach...... Over 300'



RTE. 70 - MEDFORD
EXPERIMENTAL SIGN SITE

SITE 9

SITE DESCRIPTION

Crossing Condition - Smooth 1____2____3__X__4____5____ Rough

Number Tracks ___1___ Train Frequency ___1/Day___ Speed Limit ___45 M.P.H.___

Original Crossbuck Condition.................... Poor

Original Advance Sign Condition................. Excellent

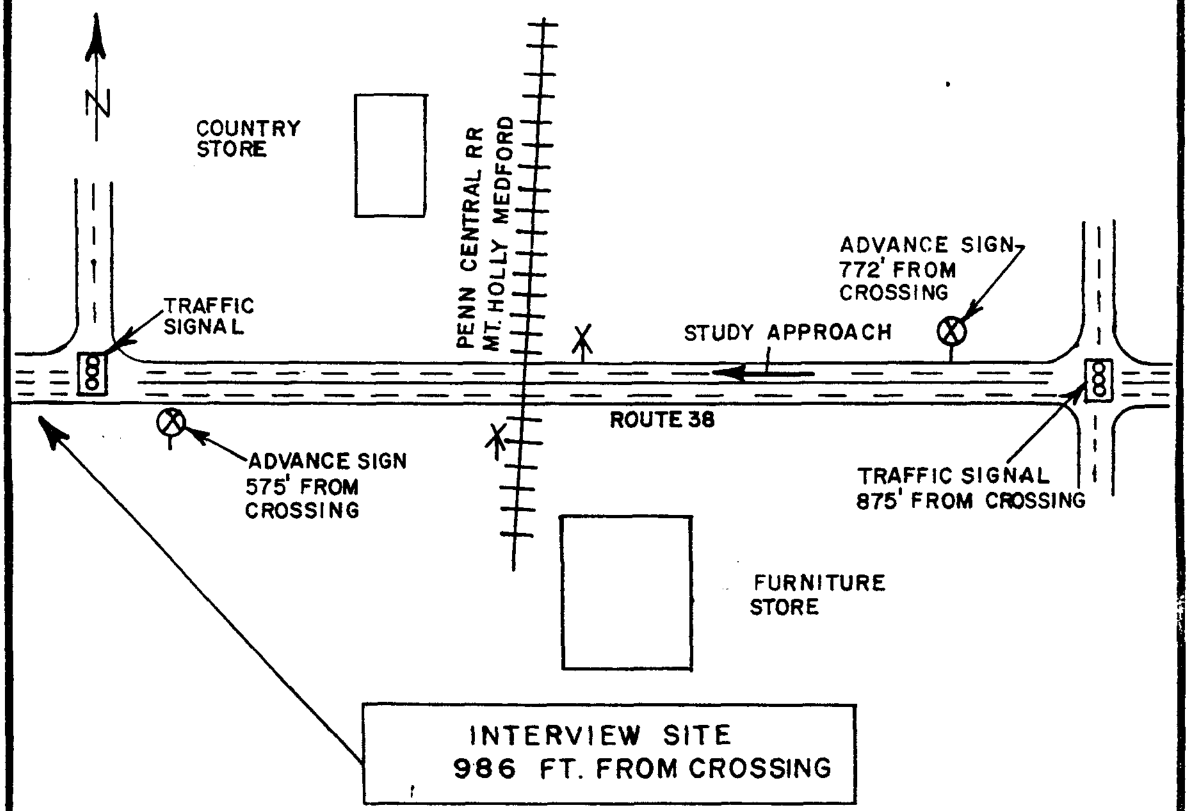
Pavement Marking Condition...................... Poor

Shoulder Width.................................. 18'

Sight Distance of Crossing on Approach.......... Over 300'

Distance Tracks Visible from Safe Stopping Distance............................ 100' Left - 100' Right

Sight Distance of Advance Sign on Approach...... Over 300'



RTE. 38-LUMBERTON
UPGRADED SIGN SITE

SITE 10

SITE DESCRIPTION

Crossing Condition - Smooth 1____ 2____ 3 X 4____ 5____ Rough

Number Tracks 1 Train Frequency 1/Day Speed Limit 50 M.P.H.

Original Crossbuck Condition.................... Poor

Original Advance Sign Condition................. Fair

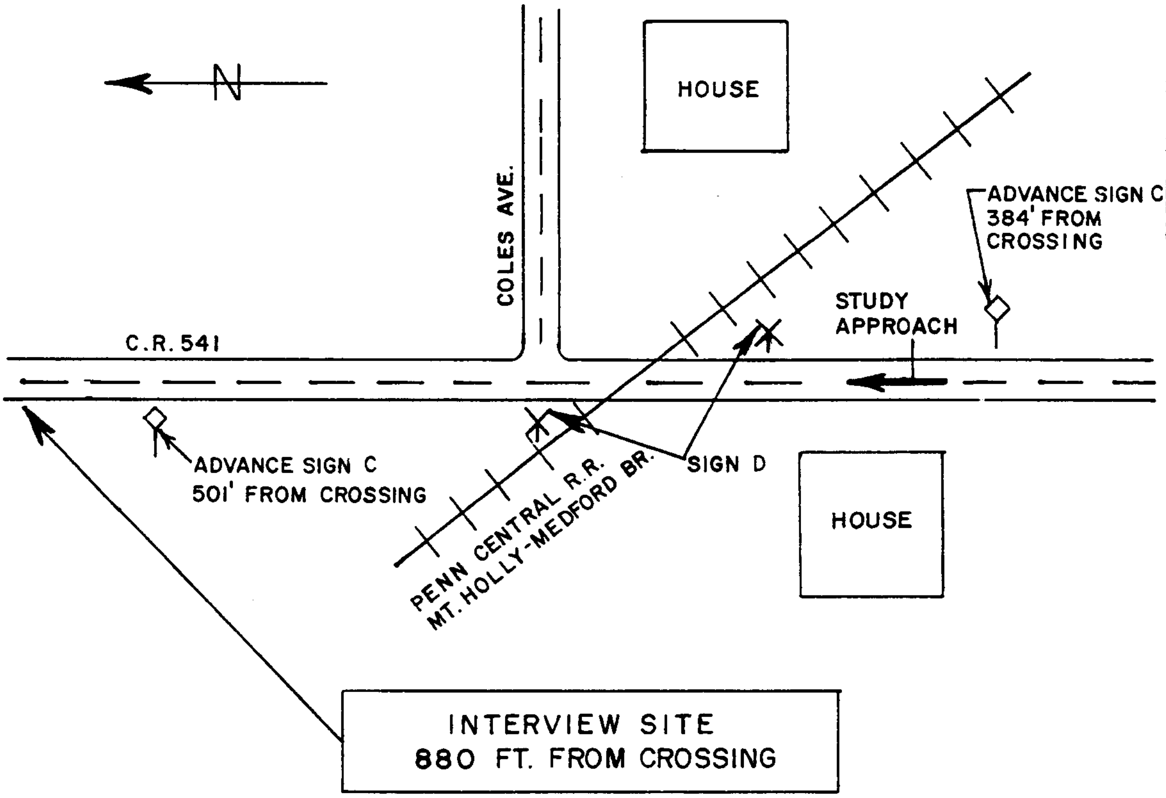
Pavement Marking Condition...................... None

Shoulder Width.................................. 0'

Sight Distance of Crossing on Approach.......... Over 300'

Distance Tracks Visible from Safe
Stopping Distance............................... 100' Left - 100' Right

Sight Distance of Advance Sign on Approach...... Over 300'



C.R. 541 - LUMBERTON
EXPERIMENTAL SIGN SITE

SITE 11

SITE DESCRIPTION

Crossing Condition - Smooth 1____2__X__3____4____5____ Rough

Number Tracks __1__ Train Frequency __1/Week__ Speed Limit __50 M.P.H.__

Original Crossbuck Condition.................. Poor

Original Advance Sign Condition............... Fair

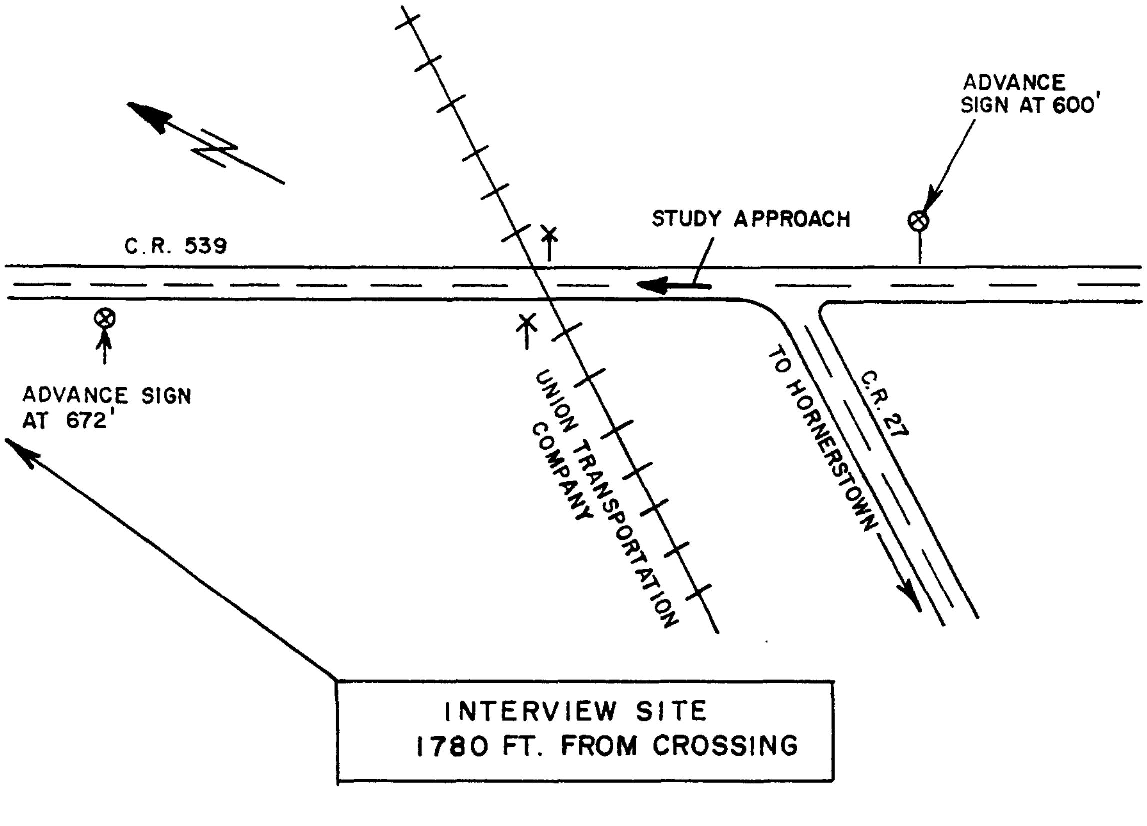
Pavement Marking Condition.................... Excellent

Shoulder Width................................ 9'

Sight Distance of Crossing on Approach......... Over 300'

Distance Tracks Visible from Safe Stopping Distance.......................... 100' Left - 34' Right

Sight Distance of Advance Sign on Approach..... Over 300'



C.R. 539 - HORNERSTOWN
UPGRADED SIGN SITE

SITE 13

SITE DESCRIPTION

Crossing Condition - Smooth 1____ 2____ 3 X 4____ 5____ Rough

Number Tracks 1   Train Frequency 1/Day   Speed Limit 45 M.P.H.

Original Crossbuck Condition.................... Fair

Original Advance Sign Condition................. None

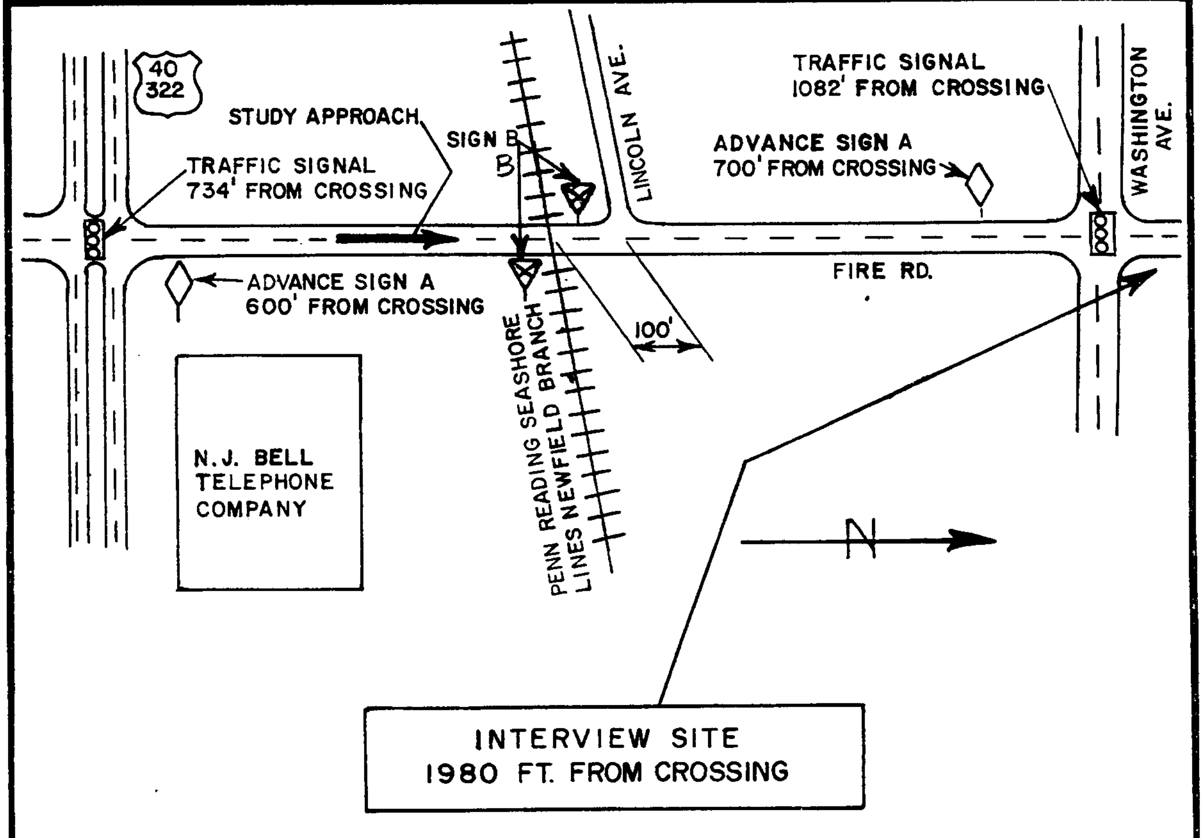
Pavement Marking Condition...................... None

Shoulder Width.................................. 6'

Sight Distance of Crossing on Approach.......... Over 300'

Distance Tracks Visible from Safe
Stopping Distance............................... 100' Left - 100' Right

Sight Distance of Advance Sign on Approach...... ---



FIRE ROAD - EGG HARBOR
EXPERIMENTAL SIGN SITE

SITE 17

SITE DESCRIPTION

Crossing Condition - Smooth 1____ 2____ 3____ 4 X 5____ Rough

Number Tracks 1 Train Frequency 1/Day Speed Limit 30 M.P.H.

Original Crossbuck Condition.................... Excellent

Original Advance Sign Condition................. Excellent

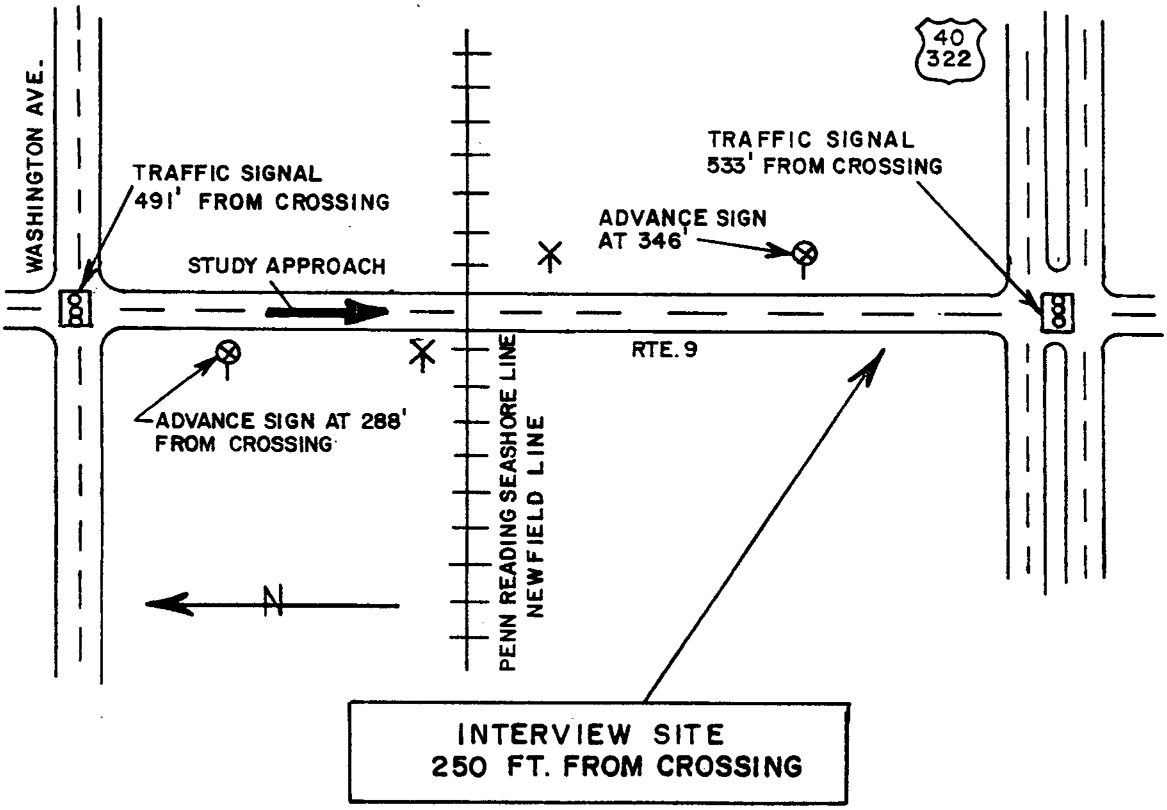
Pavement Marking Condition...................... Fair

Shoulder Width.................................. 12'

Sight Distance of Crossing on Approach.......... Over 300'

Distance Tracks Visible from Safe
Stopping Distance............................ 100' Left - 100' Right

Sight Distance of Advance Sign on Approach...... Over 300'



RTE. 9 - PLEASANTVILLE
UPGRADED SIGN SITE

SITE 18