TECHNICAL MEMORANDUM

DIAGNOSTIC STUDIES OF HIGHWAY VISUAL COMMUNICATION SYSTEMS

HPR-2(108)

STUDY SITE NO. 12

STATE HIGHWAY 101 CANDIA, NEW HAMPSHIRE

TM2(108)-12

STUDY SITE CHARACTERISTICS

Study site No. 12 was a 7.3 mile section of New Hampshire State Highway 101 just outside the city of Manchester, New Hampshire, in the townships of Auburn and Candia. The study section was bounded on the west by the interchange with Bypass State Route 28 and on the east by the intersection with State Highway 101B.

Fields studies were conducted on this site during the week of July 7-11, 1969. The weather throughout the study area was clear and warm, and there were no adverse conditions that could have affected the results of the study.

The diagnostic team assembled for this study were composed of men with the following occupations:

A Traffic Engineer from the New Mexico State Highway Department,
A Geometric Design Engineer from the New Hampshire Highway Department,
A Lieutenant from the Department of Public Safety Division of State Police for the State of New Hampshire,
The Director of New Hampshire Highway Safety Agency,
An administrator from the Department of Administration and Control for the State of New Hampshire, and
A professional truck driver.

Each member of the diagnostic team was given a thorough visual examination by a driver licensing officer from the State of New Hampshire. The examination was administered using a portable unit made by the Keystone View Company. The unit used was a type 46b visual survey telebinocular. All the diagnostic team members were found to have visual capabilities within the requirements of the New Hampshire driver licensing law, and there was no indication of a color deficiency or color-blindness.

New Hampshire State Highway 101 in the approximately 7.3 mile study section is a two-lane rural highway. This section was constructed primarily as a controlled access facility near the West end. Progressing eastward it changes to complete access control and then to uncontrolled. There were two intersections that could be classified as major intersections and one interchange facility. There was virtually no roadside development adjacent to the roadway in the study section.

The traveled lanes were 12 feet wide and constructed of asphaltic concrete. Stabilized aggregate shoulders were provided throughout the study section and were approximately 8 feet in width. Near the west end of the study section the two-lane roadway changes into a four-lane controlled access freeway and interchanges with Auburn Road. A diamond interchange is used at this point. There were several intersecting local roads in the study section, many of which are transitions from the alignment of State Highway 101.

The pavement markings used in this study section are generally typical of two-lane highways. The normal centerline and no-passing barrier line and edge lines are provided throughout the study section. At the intersections with State Highway 107A and State Highway 101B, supplementary pavement messages are painted well in advance of the intersection as advanced notification of the approaching roadway.

The signing in the study section is exclusively on the right side with little, if any, signing other than the regulatory signing for speed limits and advisory signing for intersections and curves. The intersection of State Highway 107A and 101B was identified by advanced junction markers and directional information at the intersection proper. Local road intersections--even those which were of major importance--were not identified by advanced name plates but were in most cases identified by an intersection warning sign only. Intersecting roadways are generally stop controlled; however, a few very minor local roads were uncontrolled.

Post-mounted delineation is used sparingly through the study section on a spot basis. The delineation that is provided is mounted at approximately 48" and is generally used on the outside of horizontal curves.

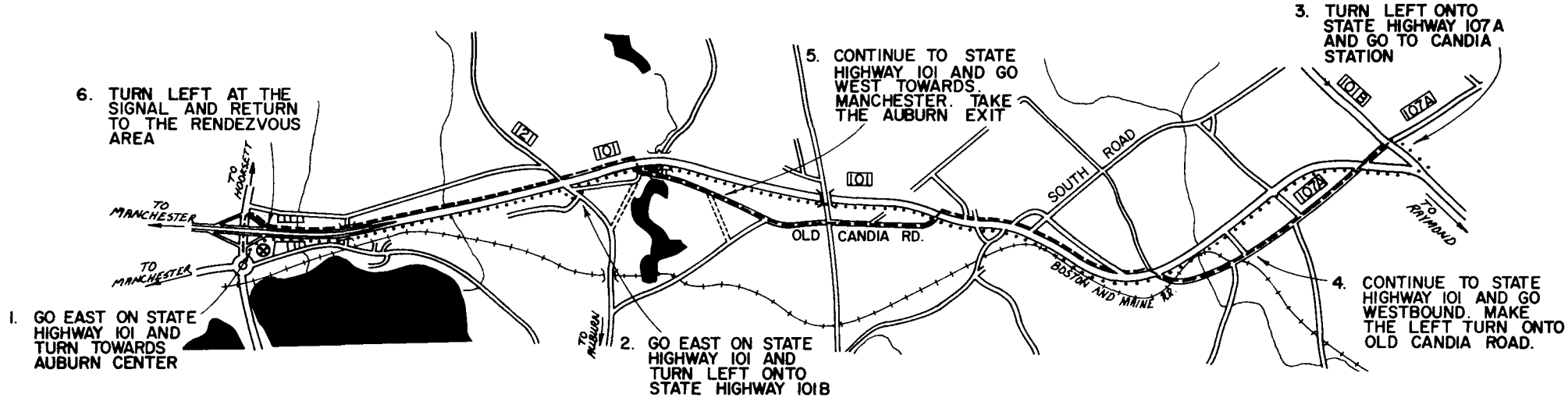
The traffic volumes throughout the study section varied from approximately 4,000 vehicles per day for the average weekday in mid-winter to about 8,500 vehicles per day for an average weekday during the month of July. The weekend traffic volumes are considerably heavier in the summer reaching an average daily total of 13,000 for an average Sunday in July which represents approximately 50% greater volume than the average weekday for the same month. This is the result of the traffic to and from the beach from the Manchester area. The average daily traffic on State Route 101 Candia is 6,138 vehicles. The peak hour traffic load was reported as approximately 1,300 vehicles per hour with the 30th highest hour being approximately 1,000 vehicles per hour. In each case, these peak loadings occur on Sunday.

The posted speed throughout the study section was 60 mph; however, the running speed seems to be somewhat higher than 70 mph in many cases. Several of the team members noted that while driving at or very near the posted speed limit they were pushed very hard by other traffic which apparently desired to travel at a speed approaching 70 mph.

The accidents on the study section were of two primary types: (1) right-angle collisions at intersections and (2) single-vehicle-leaving-the-road type accident. For the three year period from 1966-1968 there were a total of 52 accidents in the study section of which half were associated with intersections and approximately half with single-vehicle-leaving-the-road type accidents. The Sells Corner intersection had a total of 15 accidents including two fatalities and was the only point along the roadway where there was a substantial concentration of accidents.

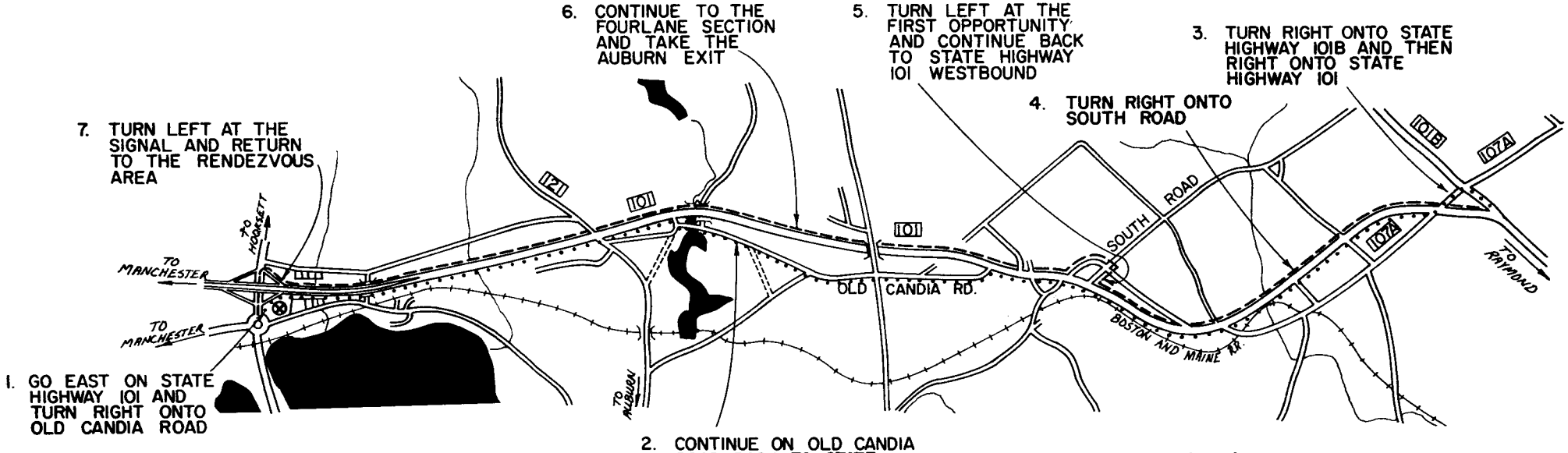
The apparent accident rates for the entire study section based on the 7.3 mile section of roadway with 6,100 vehicles per day or the average daily traffic load and three year experience is approximately 1.06 accidents per million vehicle miles. The associated apparent fatality rate is 8.15 deaths per hundred million vehicle miles.

The strip maps of the study site indicating the driving routes used in the study are presented in Figures 1 and 2.



····· OUTBOUND
——— INBOUND
⊗ RENDEZVOUS POINT

HPR-2(108)
STUDY SITE NO. 12
NEW HAMPSHIRE SH 101
MANCHESTER, NEW HAMPSHIRE
ROUTE NO. 1



HPR-2(108)
STUDY SITE NO. 12
NEW HAMPSHIRE SH 101
MANCHESTER, NEW HAMPSHIRE
ROUTE NO. 2

DIAGNOSTIC TEAM REVIEW

SUGGESTED GEOMETRIC DESIGN IMPROVEMENTS

The transition from four-lane to two-lane was one of the primary concerns of the diagnostic team. It was the feeling of the majority of the team members that the road at that point drops away too rapidly, and you lose sight of the roadway and the roadway markings which could be a critical problem because of the relatively sharp maneuver that is required at that point. It was suggested that the transition could have been moved further to the east away from the crest of the hill, and it would have improved the situation considerably. However, with the situation as it is, there was a feeling that the roadway could be reduced to one lane by using paint on the pavement prior to the actual dropping of the lane which would better inform the driver of the drop and make the maneuver less severe.

Another problem which the diagnostic team noted was the length of the truck lanes used on this section of roadway. It was generally felt by the professional truck driver in particular, that the lanes ended too soon to allow a truck to gain enough speed to merge safely back into the main stream of traffic. It was noted that in many cases the truck lane is dropped at almost identically the same point as the vehicle's lowest speed on the grade. It was suggested by the diagnostic team members that the truck lane be extended well down the grade in order to insure smooth and safe operation.

The lack of an emergency parking lane in areas where the truck climbing lane is provided came under considerable discussion by the diagnostic team. It was the general consensus of opinion that although a shoulder might be desirable it really wasn't necessary at this location because if there were a stalled vehicle in the right lane, there would still be an additional lane of travel available, and complete blockage of the roadway would not exist. It was noted, however, by several of the team members that this would constitute a substantial safety hazard.

SIGNING

The major portion of the discussion on signing for this study site dealt with the problem of informational signing for minor roadways. Several members of the team felt that the problem of informational signing for minor roadways was not as big a problem as would be indicated by the detailed review used in this study. It was their feeling that if a real problem exists, it should be brought to the attention of the department and that every effort should be made to correct it. Otherwise, it should not be the responsibility of the state. Other members of the team tended to disagree with this point of view feeling that the major roadway was the important element, and just one indecisive driver searching for a local road could constitute a substantial hazard even though a significant volume of traffic may not appear to be using the minor roadway.

Another major area of concern is the use of cardinal direction name plates. The diagnostic team had two points of view on this problem: (1) one point of view felt that the change of alignment of the roadway was so severe that cardinal directions would be ineffective and might tend to be confusing. One of the other team members noted, however, that this is true for the local driver, but for an out-of-state driver, it would be virtually impossible to travel from state to state without having some indication of cardinal directions. It was noted that this was particularly true during inclement weather. The general consensus of the diagnostic team was that the cardinal direction plates are effective for the unfamiliar driver and thus, should be used in conjunction with route markers.

The use of flashers in conjunction with warning signs was discussed in some detail. The team felt that the flasher was an effective means of conveying the hazard message to the driver when it was not obvious from that point what the hazard might be. The use of the flashing beacon at the hazard as opposed to using it in conjunction with warning signs was discussed in some detail, and no consensus of opinion could be reached.

The use of the warning signs "DANGEROUS INTERSECTION" seemed to the diagnostic team to be an over emphasis of the situation involved. One team member cited the possibility of a legal implication. It was the general consensus of the team members that this type of signing tended to over emphasize the apparent hazard involved for the Sells Corner intersection.

The signing of the triangle formed by State Route 101, State Route 101B, and State Route 107A was discussed in some detail. Since Route 107A intersects immediately with 101B after leaving State Highway 101, it was the general consensus that 107A and 101B should be made common for the short leg between 101 and the intersection between the two routes. In this way, the motorist could avoid having to make the very acute left turn maneuver from Route 101 onto State Route 101B should he be following the State Highway map and be inclined to do so.

DELINEATION

The delineation used on this section of roadway seemed to be adequate to a majority of the team members with a few possible exceptions. The primary concern of the team members was the lack of delineation at the end of the guardrail section. It was suggested that the red and green delineator posts used to guide the snowplows be placed at the ends of the guardrail as a minimum. More desirable, it was suggested that some type of delineation be placed at the beginning of the guardrail and if possible throughout the length of the guardrail section.

PAVEMENT MARKINGS

The pavement markings on the study section were generally considered to be adequate. All of the team members concurred that the use of the edge lines is very desirable even when there is good contrast between the shoulder

and the through roadway. This is particularly true if there is a so called "break-down" lane (emergency parking area). There was some discussion of the use of word messages in advance of the intersection with State Highway 107A and 101B. On the pavement approximately 500 feet in advance of the intersection the word message "JCT 107A" appeared for the junction with State Highway 107A. The consensus of the diagnostic team was that generally this was effective under the low traffic volumes that existed during the study period. However, it was noted by several of the team members that this message was relatively new and that during a large percent of the time it would not be available to the driver because of the snow cover and problems of maintaining the paint during the winter months. It was also noted by several of the team members that under heavy traffic conditions the pavement markings would not be visible to the driver; therefore, it could only be a supplementary marking to the standard signing rather than a substitute for it.

LIST OF APPENDICES

APPENDIX "A" - DESCRIPTION OF STUDY PROCEDURE

APPENDIX "B" - SUMMARY OF DIAGNOSTIC QUESTIONNAIRES

APPENDIX "C" - SUMMARY OF DRIVER INTERVIEWS

APPENDIX "B"

SUMMARY OF THE DIAGNOSTIC QUESTIONNAIRES

Study Site No. 12; Route 101; Candia, New Hampshire

The following is a detailed presentation of the comments made by the diagnostic team members on the diagnostic questionnaires, concerning daylight conditions.

DAY PHASE

Question: Did you, as a driver, lose visual contact with the roadway surface at a distance less than you would desire at any point along the vehicle's projected travel path?

Yes	No	Comments
x		In the very beginning, the positive grade was more severe than we would allow today and in two other locations, i.e., one where the roadway changes sharply from four lanes to two, and again where there is a conflict in edge lining.
x		
x		Entrances on improved sections; also, some areas on the main highway the pitch is too steep to see a sufficient distance.
x		Entering Route 101 East from Aurburn Rd.--crest of hill on ramp; also as Route 101 East goes from four-lane to two-lane on a down grade and curves left, them right.
x		At four-lane two-lane transition, Route 101, it was evident by signing that a change in section was pending but geometry of road did not allow visual evaluation of degree.
x		At one location, coming off the divided highway (eastbound) onto the two-lane portion.

Question: How would you evaluate the importance of being able to see the roadway surface in the driving task? (Answers: A--Of Little Importance; B--Of Some Importance; C--Relatively Important; D--Critical Problem).

A	B	C	D	Comments
			x	Some will disagree, but I believe that all roadways must be properly designed for a reasonable speed. Interstate 70--primarily 65 mph--rural two-lane 50 mph, etc. Now when the driver is not able to see the roadway surface there is a failure in the original design. If the original design and speed are compatible, then there is an enforcement problem.
			x	
		x		Necessary to drive safe speed.
			x	Driving safely and correctly depends 100% upon seeing the total picture ahead of you, and an important part of that picture is the road surface.
		x		Signing can warn of impending intersection, or other problems, but does always impart information as to the exact location that you must turn, etc. If you do not have good view of road after receiving the warning you tend to "tighten up."
		x		

Question: Does the obscured visibility along the roadway create any noticeable degree of erratic behavior on the part of the driver?

Yes	No	Comments
x		A foreign driver becomes over-cautious; a foreign driver looking for a specific road or route becomes so engrossed with his problem that he creates traffic problems. The driver (native or otherwise) who enters this highway is competing with traffic moving faster than the design speed, resulting in traffic trouble.
x		
x		Entering primary route involved stopping at appropriate spot and then edging onto highway until safe to proceed.
x		If the driver is trying to find a particular road or street, and it is not clearly marked soon enough.
	x	Cautious, perhaps; I would not say erratic.
	x	

If "Yes," is this the result of trucks or other slow-moving vehicles in the traffic stream?

Yes, in part. We did not notice a slow truck problem; however, on the weekend I did not notice foreign tourists driving too slow with local drivers traveling too fast. Result could be another statistic.

No.

No, not necessarily but could be part of the problem sometimes.

Question: Does the driver appear to have difficulty in maintaining the vehicle within the lane (i.e., does he tend to run off onto the shoulder or over the centerline)? Answers: Yes or NMD (Not to Any Marked Degree).

Yes	NMD	Comments
x	x	There were three areas where the driver had difficulty maintaining the proper lane (1) obvious point where four lanes were channeled to two lanes (2) & (3) old and faulty design, patch-up areas.
	x	
x		Some tendency to ride white guide line on right.
	x	The lining of the Route 101 is very good.
	x	Usually (in this test) it occurred when driver was involved in describing conditions--talking and thinking and not concentrating on road.
	x	Using reasonable care; little trouble would probably result.

Question: Is the through lane clearly identified from the shoulder?

Yes	No	Comments
x	x	In most cases, except for those mentioned above.
x		
x		

Yes	No	Comments
	x	Where there is a slow speed lane or truck lane, there seems to be a little confusion.
x		
x		

If "Yes," how is this accomplished; if "No," how could it best be accomplished?

By white line along break-down lane.

Two white stripes.

The confusion is at the far end of the lane; reconstruction for better visibility and signing might improve the situation.

By white edge strip and texture of paving (Route 101), "town roads" lack shoulders, as defined by today's standards.

Question: Does there appear to be any substantial amount of traffic running off onto the shoulders?

Yes	No	Comments
x	x	Simply not enough shoulder area and soft slopes. Reason--it is the normal 1940-48 design.
	x	
	x	
	x	Only to allow someone to pass.
	x	
	x	

Question: Would you hesitate to pull off onto the shoulders in wet weather?

Yes	No	Comments
x		Corridor is too tight. If the weather were wet with little shoulders, I would be afraid of being hit from behind.
x		In some places where the break-down lane has been cut in half to make an extra lane.

Yes	No	Comments
x		Shoulders appear to be loose gravel on improved sections or no shoulder on unimproved. Could loose control or sink on either.
	x	It appears to be solid enough in most places, but it is too narrow on the slow or truck lanes.
	x	Not on Route 101!
	x	

Question: Does there appear to be a difference of elevation between the through lane and the shoulder?

Yes	No	Comments
x	x	
	x	
x		Appears to be slight drop to the shoulder.
x		To allow for run-off of water, snow, etc.
	x	Difference in slope rate is obvious (shoulder slope rate is increased).
	x	

If "Yes," does this apparent discontinuity create a tendency to drive nearer the centerline?

One would have a tendency to drive near the centerline because of the short width shoulder. I did not notice a great or large elevation problem.

No.

I don't think so. It is not that pronounced.

No.

Question: Do fixed objects (guardrail, sign post, etc.) along the roadside create a tendency to drive nearer the centerline?

Yes	No	Comments
x		A man driving 10 mph above the speed limit has a tendency to crowd the centerline if impediments (guardrail poles) are close to the highway. Your eyes bring these objects into focus sooner than normal, and your reflexes steer you away from harmful fixed objects. Naturally, you may become a danger to traffic.
	x	
	x	All fixed objects were placed a sufficient distance from through lanes.
	x	They are far enough away not to affect your positioning.
	x	Generally, set back of objects seemed adequate. I felt no requirement to "dodge."
	x	

Question: Are the roadside hazards removed a sufficient distance from the through lanes to insure reasonable safety?

Yes	No	Comments
x	x	Again there are hazards too close to the traveled-way.
x		
x		
x		
x		At least I was aware of no feeling of danger from roadside hazards.
x		

If "No," is the hazard visible for a sufficient distance to prevent the driver's being startled by it?

I am startled by jutting guardrail ends, short shoulder, guide rails, and poles too near the driving lanes.

Question: In your opinion, what is the minimum safe distance to a fixed object (guardrail, sign post, etc.) on rural two-lane highways?

No. of Feet	Comments
30+	I know that there is a certain amount of disagreement among highway engineers on this subject; however, I believe it is just as important to locate fixed objects at least 30' from the traveled-way as a two-lane design is inferior to primary or interstate design. Yet people sometimes drive just as fast.
6	
4	
12	To allow for a parked car safely.
8-10	This is in reference to the primary road (Route 101)--reduced speed roads (town roads, etc.) could be about 4'-6'.
6	There should be sufficient room for a vehicle to stop off the traveled portion, in case of an emergency.

Question: Does the width of the through lanes require an excessive amount of driver concentration and thus increase the hazard of driving this section of roadway?

Yes	No	Comments
x		Since the shoulders were exceptionally short on both sides, the lanes may have been normal; however, they did appear to be smaller.
	x	
	x	
	x	Most two-lane highways in New Hampshire are not this wide unless they have been reconstructed.
	x	Not on S.R. 101, some town roads seem quite narrow in combination with curvature (both horizonal and vertical) and require more concentration.
	x	

Question: Is there sufficient advance notification of intersecting roadways such that a smooth, natural turning maneuver is possible?

Yes	No	Comments
	x	
x		Unless you are looking for a special name of a street or road.
	x	Some intersections marked; others are not.
	x	Advance notice by road and street name does not exist except for the major arteries.
x		Provided that you knew that you were turning at that point (going to enter that road).
	x	Not at all locations.

If "No," how could this best be accomplished?

By redesigning the intersections wherever possible; by resigning with larger letter signs the name of the approaching roadway.

Locate signs a sufficient distance from intersection and provide an exit lane so that speed can be reduced and not impede other traffic.

Added advanced signing.

By placing name of road (intersecting road) on advance warning sign.

Question: Is the intersecting roadway clearly identified and outlined?

Yes	No	Comments
	x	
	x	
	x	Identification usually at roadway; no time to anticipate turn.
	x	Only the major arteries.
x		In most instances the roadway was sufficiently

Yes	No	Comments
		visible to present a "target for turns." There could be improvement.
x		Generally speaking, yes.

If "Yes," how is it accomplished; if "No," how could it best be accomplished?

This is a good point. In some cases the main highway, such as Route 101, has been signed in an average or below average manner; however, the townships or local road responsible authority has done little or nothing in the way of signing the side road. Result--a motorist suddenly approaches a dangerous intersection and traffic becomes a problem.

The name should be back further from the intersection.

Larger sign on right, sufficient distance from exit to reduce speed and make exit.

Added advance signing.

By edge striping radii of intersecting roads.

Adequate markings at almost all locations, both by posted signs and painted markings on the highway surface.

Question: Where advisory speeds (safe operating speeds) are posted, are they reasonable in light of the roadway and traffic conditions ahead?

Yes	No	Comments
x		However, they need to be enforced. Again, it is my opinion that drivers exceed the proper speed by 10 mph when they can; therefore, they are driving offensively and require others to drive safely for them. The old saying "one offensive and one defensive driver represents a traffic sum. Two offensive drivers represent a traffic accident scene" may apply.
x	x	No posted speeds.
x		Where posted! For most part no speeds are posted.

Yes	No	Comments
x		Traffic tends to be faster than the posted speed. May be lack of enforcement.
x		
x		

Question: Are the directional sign messages clear and concise so as to minimize the possibility of driver confusion?

Yes	No	Comments
x	x	
x		
x		Improved sections adequate; could be improved by adding north, south, etc.
x		In most cases; maybe a couple or poor locations.
x		
x		

Question: Are the directional signs readable at a sufficient distance in advance of the required turn?

Yes	No	Comments
	x	Some of the signs were old, too small, and lacked color. A common problem of twenty years ago.
x		
x		
x		Except for street signs.
x		With exception of identification of town roads and minor communities; in this instance sign's size is not compatible with posted speed.
x		

Question: Did the trucks in the traffic stream block your view of the roadway ahead?

Yes	No	Comments
	x	
	x	
	x	
	x	Not more than usual.
	x	They have, however, on other occasions.
	x	

Question: In my opinion, the sight distance to right-of-way control devices ("STOP" signs, "YIELD" signs, signals, etc.) is: (Answers: A--Adequate; Q--Questionable; I--Inadequate; and C--Critical).

A	Q	I	C	Comments
		x		If the traveling public were traversing the road at a normal rate of speed, the sight distance would be just below fair; however, since the public is driving faster than normal the sight distances are not adequate.
	x			Some of them you have to go past to be able to see.
x				
x				
x				
x				

Question: Are the control devices located in positions where they are readily apparent for a reasonable alert driver? (Answers: A--Yes; B--Possibly; C--Poorly Located).

A	B	C	Comments
	x		
x			

A	B	C	Comments
x			
x			In most instances.
x			
x			

Question: Is there sufficient advance warning of traffic control devices which are not readily apparent?

Yes	No	Comments
x	x	
x		
x		
x		In most instances.
x		
x		

Question: Are the required speed changes accomplished in a manner which minimizes driver alarm and discourages rapid deceleration?

Yes	No	Comments
x		Tapers are generally too short, and there are no advance speed change warning signs.
x		
	x	Visibility poor on change from two to one-lane; and merging lane on entrances to highway makes it difficult to know just when safe to change speed.
	x	Not if a person is looking for a local street without advanced notice or knowledge.
-No answer-		
x		

Question: Could the sign and/or signal posts be relocated further from the roadway so as to reduce the associated accident potential and still retain an acceptable degree of effectiveness? (Answers: A--Yes; B--Possibly; C--Probably Not).

A	B	C	Comments
x			And made larger and clearer to relay the needed message.
		x	
		x	
	x		In some instances.
	x		
		x	

Question: Where hazard warnings are provided can they easily be associated with the hazard involved? (Answers: Yes; ISC--In Some Cases; No).

Yes	ISC	No	Comments
	x		
	x		
x			
x			
x			
x			

Question: Are warnings provided for hazards which are obvious and for which little, if any, warning is actually required? (Answers: Yes; IFC--In A Few Cases; No).

Yes	IFC	No	Comments
x			In general, yes; however, they are not large enough, bright enough, and set far enough back to warn the fast drivers.
x			

Yes	IFC	No	Comments
	x		In some areas probably curve signs are of little value.
	x		
	x		Some intersections are labeled "dangerous" when there is no apparent reason that they are more dangerous than any other, particularly in reference to approach from east.
	x		

Question: In your opinion, is there a question as to which roadway a right-of-way control device ("STOP" sign, "YIELD" sign, signal, etc.) applies?

Yes	No	Comments
x		In some cases, where the major roadway was intersected at any angle. Our records show that angle intersections are potential traffic accident generators.
	x	
	x	
	x	
	x	
x		"STOP" sign (for southbound traffic) Junction 107A, S.R. 101. Operator of westbound vehicle on Route 101 could possibly be confused by angle.

Question: Where a guardrail is used, would you feel just as safe without it (i.e., if you accidentally left the roadway would you just as soon continue down the slope as to be stopped by the guardrail)? (Answers: Answers. A--Most Of The Time; B--Sometimes; C--Seldom; D--Never).

A	B	C	D	Comments
		x		There were very few places where guardrail could be deleted unless the slope was reconstructed to new standards.
			x	
		x		Usually located where slope is so steep car would probably overturn.

A	B	C	D	Comments
		x		
	x			Naturally, this depends on height of fill. Where rail is required for fill condition, flatter grading can eliminate much rail (newer standards provide for this).
			x	

Question: Does there appear to be an excessive amount of official informational signing along this section of roadway? (Answers: Yes; Poss.--Possible; No).

Yes	Poss.	No	Comments
		x	Not on this road; however, I did notice that many signs in New Hampshire have 4-5-6-7 designators, with mileage and have small letters. I would be confused and create a traffic hazard while reading signs.
		x	
		x	
		x	
		x	
		x	

APPENDIX "B"

SUMMARY OF THE DIAGNOSTIC QUESTIONNAIRES

Study Site No. 12; Route 101; Candia, New Hampshire

The following is a detailed presentation of the comments made by the diagnostic team members on the diagnostic questionnaires, concerning night conditions.

NIGHT PHASE

Question: Are the intersecting roadways obvious to the reasonably alert driver so that a smooth, natural turn onto them is possible? (Answers: Yes; ISC--In Some Cases; No).

Yes	ISC	No	Comments
	x		This is an older section of highway (basically two-lane), and it was geometrically designed for approximately 50 mph. Many intersections are not clear, and with drivers exceeding the speed limit by 5-10 mph, you have a high potential accident rate.
	x		
	x		Easier to spot roads that are marked at night.
	x		Bad situation for the stranger looking for a local street.
	x		Some town road intersections would not allow "smooth entry" due to entrance radii. Road is obvious, however.
x			In most cases (at most locations).

Question: Is the through lane easily distinguishable from the shoulder?

Yes	No	Comments
x	x	There were cases where the through lanes were not easily distinguishable from the shoulder; also, the short shoulder was rough-edged which would throw an auto out of control.
x		
x		

Yes	No	Comments
x		Good lining except where the road disappears; break-down lane is of different material.
x		
x		

If "Yes," how is it accomplished; if "No," how could it best be accomplished?

In New Mexico we don't do this, but eventually all shoulders should be different in color and texture from the traveled-way. For instance, main line concrete shoulder, blacktop, or asphaltic lane with edge lines separating shoulder should be in no case less than 8'.

By white edge line.

White lines both sides.

Lines are very good.

White edge strip and texture.

Highway is adequately lined.

Question: Are the roadside hazards visible for a sufficient distance to prevent the driver's being startled by them?

Yes	No	Comments
	x	Again, this means simply bringing this section up to present standards or enforcing rigidly the posted speed limits.
x		
x		
x		There are a few exceptions where wider shoulders would improve the safety.
x		At no point was I startled; in some instances attention and caution were increased.
x		

If "Yes," how is this accomplished; if "No," how can it best be accomplished?

By hazard markers.

Blinking amber lights.

Signing, and they are far enough away to have time to respond.

By delineation.

Posted signs and paint on highway surface.

Question: Is a clear and distinct outline of the roadway ahead provided?

Yes	No	Comments
x	x	In the darkness the outline is vague and not clearly defined in many cases.
x		
x		
x		Lining and reflectors, except on the off-ramp at Aubury exit.
x		Only exceptions being caused by geometry.
x		

If "Yes," how is this accomplished; if "No," how can this best be accomplished?

As mentioned before, true delineation of traveled-way and shoulder should be built into every road.

In most instances reflectors on right and white lines provide good outline.

Improvement on ramp exit by continuing the side line at least part way down the ramp.

By delineation.

Question: Is the light provided by the vehicle's headlights sufficient for safe operation of this facility?

Yes	No	Comments
x	x	Headlights (for the year 1969) are not the answer for night driving. Research must be advanced; headlight glare must be reduced and headlights must be able to show greater side coverage. Believe a new concept in design of headlights or lighting must be found.
x		
x		When on low beam some signing doesn't stand out but for the most part good.
x		In most instances except where roadway disappears as on Old Candia Road where it ends, the east end is especially marked and signed.
x		
x		

Question: Is there sufficient advance notification of intersecting roadways?

Yes	No	Comments
	x	Bigger, clearer, cleaner, signs are needed as well as flashers in some cases.
x		
	x	Not in all cases as some are unmarked. Major intersections are very good.
	x	Especially the local streets and roads; signs too small and poorly located. No advanced warning (names).
x		
x		Generally speaking.

Question: Can the existing directional signs be easily read at a glance?

Yes	No	Comments
x	x	Some are placed on the wrong side of the road. It is my belief that all signs even those indi-

Yes	No	Comments
		cating left hand movements should be placed on your right driving side.
x		
x		In most cases more easily read at night.
x		Except street and road naming signs. Route 101B could be confusing to strangers.
	x	They require attention; sometimes there are too many at one location to read at a "glance."
x		

Question: Are the directional sign messages clear and concise so as to eliminate the possibility of driver confusion?

Yes	No	Comments
	x	In some cases there are too many messages on one sign. Three lines, I believe, should be maximum.
x		
x		
x		In most instances except in signing of local streets and roads.
x		There are isolated instances where there is confusion; most are good.
x		

Question: In my opinion, the sight distance to right-of-way control devices ("STOP" signs, "YIELD" signs, signals, etc.) at night is: (Answers: A--Adequate; B--Questionable; C--Inadequate; D--Critical).

A	B	C	D	Comments
			x	One basic reason for this judgement; entire route must be redesigned; geometrics are old. Intersections are not clearly indicated and traffic enters at angles.
x				

A	B	C	D	Comments
x				
	x			Occasionally poor.
x				
x				

Question: Where hazard warnings are provided, can they be easily associated with the hazard involved?

Yes	No	Comments
x	x	Intersection hazards are not clearly defined except in some cases and with higher speeds than road was designed for; traffic accidents can result.
x		
	x	
x		
x		
x		

Question: Do commercial signs and lights along the roadside attract your attention?

Yes	No	Comments
	x	Oddly enough; except for one obvious case, roadside signs did or do not constitute a major traffic hazard. This is not the case in other states and other areas.
	x	
	x	
x		But not to the extent that they interfere with road safety.
	x	In this area, no; in other areas, yes.
	x	

If "Yes," which signs or lights were of concern to you?

Personally, I am against the weakening of our present laws or restrictions concerning signs. We are being pressured by the oil industry at present and the U.S. Congress to soften our attitude; however, our objective view of this problem is: keep only directional signs in the right-of-way.

APPENDIX "C"

SUMMARY OF DRIVER INTERVIEWS

Study Site No. 12; New Hampshire State Highway 101; Candia, New Hampshire

GEOMETRIC DESIGN

DAY PHASE

This transition from the four-lane to the two-lane is particularly disturbing. I think it would be greatly improved if there were a better sight distance. The road just drops off, and then you just squeeze down to two lanes.

I definitely have some confusion here; I'm not sure whether I can turn left here or not. The angle of this intersection is certainly not conductive to making a left turn (driver is attempting to make the left turn onto State Highway 101B from State Highway 101).

I believe the geometry of the road would determine whether or not the pavement markings are needed in conjunction with the signs for proper identification of intersecting roadways. If the road were sloping toward you so that you could see the sign, then it is effective. If it slopes away, then it is not effective at all (the driver is on State Highway 107A approaching State Highway 101).

There seems to be little or no deceleration lane here. The road just seems to drop off (the driver is referring to the off-ramp from the four-lane section to the Auburn Rd. intersection going westbound).

The lack of sight distance here does bother me a great deal. I think it is bad because of the vertical curve and combination of grade (the driver is referring to the transition from four-lane to two-lanes at the west end of the study section).

NIGHT PHASE

Very few people make this left turn onto S.A. 101B. The natives will turn onto S.H. 107A, and the tourists will take 28 alternate. So there is really no demand for correction here.

Now these shoulders here are plenty wide enough to pull off onto if you have to (the driver is referring to the shoulders immediately adjacent to the South Road intersection).

I believe this truck lane should be extended over the hill. If a heavy truck were using that lane he would still be going pretty slow when he had to merge back (the driver is eastbound between the two intersections with Old Candia Rd.).

DAY PHASE

NIGHT PHASE

This is a very difficult maneuver to make. I am sure that it is just because it is such an old road. They will probably make it into a T-intersection, but right now it would be extremely difficult to make (driver is referring to the left turn onto State Highway 101B from State Highway 101).

I think perhaps this truck climbing lane should be extended on over the hill in such a way to make it safer.

I really like this deceleration lane here (the driver is referring to the deceleration lane at the westbound exit ramp to Auburn Rd.).

I think that on-ramp was adequate with respect to sight distance (the on-ramp to State Highway 101 from Auburn Rd.).

Right here where it changes to two-lanes, it is on a curve and a down grade. It is adequately signed. I think the motorists have ample warning, but I think it is poor from an engineering standpoint.

I think I would like to have some emergency parking area along here, but then you can't have everything. I think this road is adequate (the driver is referring to an emergency parking lane adjacent to the truck climbing lanes).

I missed the visual contact with the road on this ramp. I can't tell exactly where the road is (the driver is referring to the on-ramp to State Highway 101 from Auburn Rd.).

This ramp kind of leaves me wondering whether or not there is an acceleration lane up ahead (on-ramp to State Highway 101 from Auburn Rd.).

DAY PHASE

NIGHT PHASE

At this point, if it were not for that car ahead, I would think that the road just dropped-off (it is the beginning of the transition from the four-lane to the two-lane going eastbound on Route 101).

I lost my sight distance here, too (the driver is referring to the transition from truck climbing lane back to a normal two-lane cross section at the crest of the hill).

I believe that truck climbing lane should be extended over the hill (the driver is referring to the truck climbing lane between the east and west ends of Old Candia Rd.).

There is very poor sight distance here where you turn off to S.A. 107A. I see a great deal of value in these paved shoulders, not only from an emergency standpoint, but they are handy if you just want to pull off the road for some reason.

I feel kind of blind here, I can't see the road (on-ramp to State Highway 101 on Auburn Rd.).

This is the same as the ramp coming on, but I think it is mainly because you can't see the centerline and tell where the road is going (the driver is referring to the transition from four lanes to two lanes at the west end of the study section).

I think right along here the truck climbing lane is good, but I think they should have maintained the "break-down" lane (paved shoulders) along with the truck climbing lane (this comment is made between the west and east intersections with Old Candia Rd.).

I think if it would have been me,

DAY PHASE	NIGHT PHASE
I would have turned onto S.A. 107A and then to S.A. 101B rather than the way we did it (the driver is referring to the left turn from State Route 101 onto State Route 101B).	

SIGNING

DAY PHASE

I don't believe that I was aware that we were entering a two-way roadway. Perhaps I just missed a sign, but if it weren't for the cars coming in the opposite direction I would be tempted to drive in the left lane.

I just completely missed that turn (the Auburn Center turn--Sells Corner).

There was no advance notification; however, there was a flashing light both on the intersection warning sign and over the intersection proper. The congestion of cars there indicated that it was a major intersection.

It was on the crest of a vertical curve, and I was just too distracted to see that little sign.

On an intersection warning sign such as that one, I don't think I would recognize the value of having a street name sign. I think perhaps the sign here telling you that this is State Highway 101 would be helpful. But then this is just a small road, and it might not justify it (the driver is referring to the intersection of Old Candia Rd. with State Highway 101).

The only reason I knew this was where to turn is I saw a flashing beacon and was alerted to something. Then I saw the sign "Old Candia Road" (the driver is referring to the left turn onto Old Candia Rd. coming westbound on State Highway 101; this is the east intersection with Old Candia Rd.).

As you approach this intersection you anticipate an intersection because of the geometrics; I think there should be an advanced "STOP" sign so that you would be sure (the driver is referring to the approach to State Highway 101 from Old Candia

NIGHT PHASE

Actually, the state doesn't have the responsibility for placing the street name signs. We do in some cases where there is a real problem, but we don't have to.

I personally am not enthusiastic about the idea of placing street name signs on the intersection warning sign mainly because of maintenance problems.

If there were a lot of people using this road it might warrant better advance notification, but I don't think it would be realistic to try to do that on all of those little roads (the driver is referring to the eastbound approach to Sells Corner trying to make the turn toward Auburn Center).

I don't have too much trouble reading these types of reflectorized signs, but on those freeway signs I have noticed that they have a tendency to wash out.

I believe that arrow on the sign was misleading. It seemed to me to indicate a right angle turn when it most certainly does not (the driver is referring to the left turn onto S.A. 101B from State Highway 101).

The main problem with our law about not passing on the right is out-of-state people who are not familiar with this law, and then we have problems.

I think it would be a real good idea to have the names of those intersections below the warning signs. I think it would definitely do more good than harm. I believe it would enhance rather than detract from the warning aspect of the sign.

There is some moisture condensation on the signs, but I don't really think it is too bad as yet.

DAY PHASE

Rd, and apparently is refering to a "STOP AHEAD" warning sign in advance to the "STOP" sign).

This sign "DANGEROUS INTERSECTION AHEAD" is confusing to me. As you approach this intersection, it looks very innocent because you can see all the approaches and everything. There is a question in my mind as to whether this is really dangerous or whether it is just the drivers (the approach to Sells Corner).

The only comment I could make was that there was either inattentiveness on his part or deficiency in the signing that caused him to miss the turn at Auburn Center.

Evidently, the signing at that intersection was inadequate. I completely missed the turn (driver was attempting to make the right turn onto Old Candia Rd., from State Highway 101 at the west intersection with Old Candia Rd.).

I guess I just completely missed that South St. turn (the street name plate for South Rd., was on the left side of the roadway, and the driver failed to see it).

I missed the turn to Auburn Center Rd. I thought this was called Sells Corner and wasn't able to read the sign.

I think the flasher treatment at this intersection was well-founded; this is an extremely hazardous area.

We have several locations here in New Hampshire where we have used over-sized "STOP" signs when the traffic doesn't warrant signals, but accident records show that they need some kind of treatment.

NIGHT PHASE

I think there should be a sign at this intersection. Not only to tell me that the cross street is State Highway 101, but also west or east (the driver is referring to intersection with State Highway 101 from the Auburn Center Rd.--northbound approach to Sells Corner).

DAY PHASE

NIGHT PHASE

There is just too much message here to be easily read; you must almost stop to read it all (eastbound approach to Sells Corner--Auburn Center Rd.).

I think this whole intersection area should be redesigned or designated as something so that the drivers could be made aware that they can turn onto S.H. 107A to get to S.H. 101B.

Now I had to slow to almost 35 mph to read that cluster of small signs (the eastbound approach to Sells Corner).

I read the sign about 150' in advance, but by the time I made the decision to turn it was too late (the driver is referring to an attempted right turn onto Old Candia Rd. at the west intersection).

I wish they would have put a "W" and "S" on these signs to tell you which direction S.H. 101 runs (the intersection with S.H. 101B and State Highway 101).

I believe the state was trying to save money by just using one sign, but I don't believe it is sufficient (the driver is referring to the signing for South Road).

On these exit arrows, I think there should be some uniformness as to the placement of these signs. Either they should be placed in the gore or in front of the ramp, but regardless I think they should be uniform (the driver is referring to the exit ramp to Auburn Rd. from State Highway 101).

I believe that sign should be further in advance and possibly bigger.

You're going too fast to make that turn safely (this is the eastbound approach to Sells Corner trying to make a turn toward Auburn Center).

DAY PHASE

NIGHT PHASE

I like the idea of having these confirmatory route markers right here where you can see them from the intersection (the driver is referring to the confirmatory markers just downstream from the Old Candia Rd. intersection).

PAVEMENT MARKINGS

DAY PHASE

We (of the New Hampshire Highway Department) like to use the pavement markings whenever we have any volume at all and whenever we have any major roads intersecting.

I really like these pavement markings, but I think they could be larger and perhaps reserve all pavement markings to a specific naming (i.e., "STOP," "DANGEROUS INTERSECTION," "SCHOOL," etc.).

I think these edge lines should be broken and perhaps even partially channelized in some instances at the intersection of local roads.

I think that these pavement markings are a little too abbreviated to be useful. I think they should be elongated to be more effective (the driver is referring to the messages on the pavement in advance of the intersection with S.H. 107A and S.H. 101B).

I like the edge line even in the daytime. Whenever I drive on a road that does not have one I miss it.

I like these pavement markings, but they sure don't last very long. These look good, but I imagine they have just been repainted (the driver is referring to the advance marking on the pavement at the intersection of State Highway 107A).

NIGHT PHASE

I really have a selfish reason for liking the manual change to yellow centerline. Our yellow paint last a lot longer than does the white.

I guess I do use the edge line a little, although I really don't concentrate on it (the driver is responding to a direct question to whether or not he uses the edge line in guiding the vehicle).

I think these pavement markings indicating intersections are alright when they are freshly painted as these are. Of course they are useless in the winter and when it is raining (the driver is referring to the pavement markings in advance to the intersection with State Highway 107A).

I don't believe I would recognize the value of a wiggle line when it is used for startle effect at a dangerous intersection.

I don't believe I would recognize the meaning if all of a sudden I came upon a dashed yellow line. I'm afraid it wouldn't mean much to me.

When I'm driving at night, I guess I guide myself with the combination of both the edge line and centerline.

I believe that I didn't have too much trouble associating the arrow pointing left with the word message.

I really like having the "JUNCTION" painted on the road (the driver is referring to the pavement marking in advance to the intersection with State Highway 107A).

There is no edge line at all along here. I think that it just has not been repainted.

I noticed that this driver tends to guide himself by the edge line rather than the cen-

DAY PHASE

NIGHT PHASE

terline. I'm not sure that this is intentional; I think that I tend to use the edge line on a curve to the right and the centerline on a curve to the left.

DELINEATION

DAY PHASE

NIGHT PHASE

I like to have post-mounted delineators on both the left and right because then there is no doubt where the road is. It gives you a real good picture of where it is.

I think the curbs on this ramp serve as a pretty good delineator. I think that this is adequate (the driver is referring to the curbs on the ramp to State Route 101 from Auburn Rd.).

As far as I am concerned, it doesn't make any difference whether the delineators are amber or white.

GUARDRAIL AND HAZARD PROTECTION

DAY PHASE

We have found the cable-type guardrail reasonably effective in restraining vehicles depending, of course, on the angle of impact.

They cut down the poles, and there is some unwinding, but they have proven to be adequate.

Just as we turned east (the off-ramp going westbound on State Route 101 to Auburn Rd.), I saw a guardrail that was blunt-ended. I believe that this is an immediate problem and should be taken care of.

NIGHT PHASE

I like the idea of having reflectorized tabs on the ends of the guardrail section. It is real good if you are pulling over to know if there is something there.

I think the ends of the guardrail should be delineated, particularly on a curve.

MISCELLANEOUS COMMENTS

The lack of sight distance on this ramp was disturbing to me, but then I was distracted by that truck up there picking up trash (that truck was parked on the acceleration lane for the on-ramp to State Route 101).

The discontinuity of the pavement surfaces between the through lanes and the shoulders is not at all disturbing. In fact, I really like it (this comment is made just in advance of the intersection (west) with Old Candia Road).

I don't get the sensation at all of approaching a major highway except for the "STOP" sign (driver is approaching State Highway 101 on Old Candia Road at west intersection).

I had some genuine confusion at the instruction to turn left on S.H. 101B. I couldn't make myself feel secure about turning left into that acute angle. Had there been a break in the centerline striping along about the area where everybody else had been turning, then I would have felt a lot better about turning there. I could view the geometrics well enough to tell what had to be done, it just didn't look to me like what one was suppose to do.

I noticed that the driver did not use the full acceleration lane. I didn't because I had a chance to merge conveniently, so I pulled in and used the full lane.

I'm cruising along about 50 mph, and the people behind are really crowding me. I think perhaps instead of using linear measurements, some consideration should be given to using time measurement. For example, 30 sec. rather than 1000 ft. in giving the distance to a particular point on the roadway.

It seems to be a tendency in my part of the country (New Mexico) for the people to drive 10 mph or more over the posted speed. I think that this is a tendency almost anywhere.

I think I would rather see them use feet rather than miles in giving distances. Most people can't relate miles to a distance involved.

I like this speed limit, even though I have a tendency to push 60 mph. I believe it is realistic in light of the conditions.

I hope this street doesn't sneak up on me; the cars behind me are starting to crowd me very hard (the driver is looking for South Road going westbound on State Route 101).

Whenever I see a lot of black (tire) marks on the pavement like this, I can't help but wonder what the problem was (this comment is made at the end of the truck climbing lane between the two intersections with Old Candia Rd. going westbound).

When I see the flashing beacon I can't particularly associate it with anything. I feel I am just alerted to something although nothing in particular (this comment is made approximately at Sells Corner from the west).

I believe on the whole the driver is adequately informed of what is going on, on this road.