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Motorists' Perception

of

Work Zone Safety

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16. Abstract

Highway work zones create potential hazards because motorists are confronted with unexpected and often confusing situations. They present an abnormal, and disruptive element to the motorist who is accustomed to a clear and unobstructed roadway. Motorists should exhibit increased caution and take any needed actions to reduce the added risks caused by the changed conditions. However, many motorists appear to take needless risks such as late lane changes, following too closely, speeding, etc., in highway work zones.

The objective of this research study was to examine motorist's perceptions, opinions, expectations and other psychological factors, which influence their driving activity in highway work zones. The study was carried out in two parts: an opinion survey and focus groups. A two-page questionnaire was distributed to 2246 automobile and truck drivers. A total of 545 completed questionnaires were returned. Five focus groups for automobile drivers and two focus groups for truck drivers were conducted. Spot speeds were recorded for three active work zones.

The opinion survey results and focus group results were similar for automobile drivers and truck drivers. Drivers are aware of the inherent hazards and potential dangers in highway work zones. The majority of drivers perceive that they are driving in a safe manner but that the other drivers are not. Most drivers report that while they usually feel calm in work zones, there are situations when they feel uncertain or confused. Many drivers report that they sometimes feel nervous, uncomfortable or irritated. These undesirable feelings often result from speeding by other drivers and discourteous driving by others. Drivers agreed that increased presence of authority would have the greatest effect on driver behavior in highway work zones.

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MOTORISTS PERCEPTION OF WORK ZONE SAFETY

North Carolina Department of Transportation
Highway Research Project HWY-98-7

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EXECUTIVE SUMMARY

INTRODUCTION

Highway work zones create potential hazards because motorists are confronted with unexpected and often confusing situations. They present an abnormal, and disruptive element to the motorist who is accustomed to a clear and unobstructed roadway. Many motorists appear to take needless risks such as late lane changes, following too closely, speeding, etc., in highway work zones. The reasons for this are not clear but may be attributable, in part, to the motorists' perception of the work zone and the associated expected response. The objective of this research was to examine motorist's perceptions, opinions, expectations and other psychological factors, which influence their driving activity in highway work zones. This study was carried out in two phases: an opinion survey and focus groups. A mail survey is an appropriate way of gathering data and can produce high quality information both quantitative and qualitative in nature, while a focus group creates a permissive environment that encourages different perceptions and points of view, without pressuring the participants to vote, plan, or reach an agreement.

OPINION SURVEY

A two-page, fourteen question, questionnaire for automobile and truck drivers was developed for use in the opinion survey. The questionnaire covered three primary areas for each individual: personal information; usual driving behavior in work zones; and perceived effectiveness of different treatments for slowing traffic and/or making the work zone "safer." A total of 1728 surveys were distributed to licensed automobile drivers by US Postal Service, campus mail at The University of North Carolina at Charlotte, and handed out at Department of Motor Vehicle offices located in Charlotte, NC and Albemarle, NC. Of the 1728 surveys distributed, 487 or 28.2% were returned.

The truck driver questionnaire was identical to the automobile driver questionnaire except for questions asking how long the driver had possessed a CDL and how often they drove professionally. There were 467 surveys mailed to commercial truck drivers or sent to freight carriers for distribution. The number of returned surveys was 58, a return rate of 12.4%.

The driving experience of the automobile drivers ranged from 2 to 70 years with a mean of 32 years and the reported ages ranged from 18 to 85 years with a mean of 48.9 years. The gender responses were divided 306 male and 178 female. Of 485 responses, 479, or 98.7%, indicated that they drove four or more days per week. The individual re-

sponses indicate that the respondents were mature, experienced, frequent drivers who would likely have had significant experience in driving through highway work zones.

The truck drivers reported professional driving experience ranging from 1 to 33 years with a mean of 11.6 years. Truck driver's ages ranged from 24 to 60 years with a mean age of 40.5 years. There were 54 male and 3 female drivers returning surveys and one survey was returned without a gender being indicated. All respondents reported driving professionally four or more days per week. This indicates that, like the automobile drivers, the professional drivers were experienced and would likely have had significant experience in driving through work zones.

With regard to their speed as they entered a work zone, the answer selected most often by automobile drivers was to reduce speed to the posted speed with 43% indicating this response. The second most frequent answer, chosen by 23% of the automobile drivers, was to reduce speed to the speed of surrounding traffic. Approximately 2% indicated they maintained their prior speed, while 75% indicated some degree of speed reduction. The majority of the professional truck drivers, 83%, reported that they reduced their speed to some degree, 66% reduced their speed to the posted speed limit and 14% reduced speed to the speed of surrounding traffic. Three percent indicated they maintained their prior speed. Ninety-one percent of the automobile drivers and 89% of the truck drivers who reduced their speeds when entering a work zone, indicated they maintained their reduced speed throughout the entire length of the work zone or until they were able to observe and match the speed of surrounding traffic.

The conditions rated most effective for reducing both automobile and truck driver speeds when entering and traveling through work zones, were in approximate descending order: obvious presence of law enforcement, workers or flagger present in the work zone, and a good chance of being caught speeding. Each of these received an average rating of 4.5, or greater, out of a possible 5.

The presence of construction workers was viewed by the automobile drivers as the most dangerous situation encountered in work zones. The next most dangerous situation was considered to be the presence of an S-curve or lane shift within the work zone. The remaining conditions were then ranked in order of decreasing danger as: construction equipment, concrete barriers, changeable message sign flashing a message, flashing arrow boards, orange barrels, and work zone signs posted but no workers present. The truck drivers gave similar responses, with the S-curve and construction equipment switching positions in the ranking.

Both automobile drivers and truck drivers perceive that they, themselves, drive far more safely in work zones than do other drivers. The truck drivers rated themselves as safer drivers than did the automobile drivers. Out of a possible 5, the automobile drivers gave themselves an average score of 3.7 and other drivers a 2.5. Truck drivers gave themselves an average score of 4.2 and other drivers a 2.3.

When entering a work zone, a small percentage of respondents indicated they maintained their prior speed regardless of the situation in the work zone. However, the

majority of both automobile drivers and truck drivers indicated they reduced their speed to some degree. The most effective conditions for causing a reduction in speed to the posted speed limit, for both automobile and truck drivers, is presence of flagger, presence of workers, and S-curve, in that order.

Seventy-eight percent of the automobile drivers and 82% of the truck drivers felt that the posted speed limits throughout the State of North Carolina are correct. Similarly, 8% and 4% felt the speed limits are too high, while 14% and 14% felt the posted speed limits are too low.

The most frequently reported attitude of respondents as they traveled through work zones was calm, followed by uncertain and then uncomfortable. For automobile drivers, 44% reported being calm as they passed through work zones, as did 43% of the truck drivers. An attitude of uncertain was reported by 31% of the automobile drivers and 33% of the truck drivers; while uncomfortable was reported by 29% of the automobile drivers and 34% of the truck drivers. Both automobile and truck drivers who reported being calm while driving through work zones, in general felt that remaining calm was the best way to maintain control in the situation.

FOCUS GROUPS

There were seven focus groups. Five consisted of currently licensed automobile drivers and two consisted of truck drivers with a current CDL. The five automobile driver groups were composed as follows: women from a church class, adult university students (2 groups), university staff, and men and women from a rural church. Participants in the two truck driver groups were recruited at a truck stop located on a nearby Interstate highway.

All focus groups were conducted using the same procedure. The same individual acted as moderator for each of the focus groups accompanied by either one or two assistants, all of whom took written notes. Questions were used to guide the focus group discussions. The participants were asked to give their opinion of the relative danger of the following work zone situations:

1. presence of construction workers
2. work zone signs posted, workers present
3 work zone signs posted, no workers present
4. traffic shift (S-curve)
5. changeable message sign flashing message
6. concrete barriers
7 construction equipment
8. orange barrels
9. flashing arrow boards
10. other

With the exception of the flashing arrow boards, most of the participants in the focus groups indicated that all of these situations heightened the danger of traveling in a work zone. Several persons said that seeing workers close to the travel lanes made them very nervous since they felt these people were concentrating on their work and not paying much attention to the traffic around them. A number of participants in the automobile driver focus groups said that they did not like the S-curve (lane shift), especially when concrete barriers were present. Truck drivers did not like the lane shift when the lanes

were narrow because it made it much more difficult to keep their wide truck within the lane markings. Other items that were mentioned during the discussion of this question were: worker clothing needs to be more visible, sign location needs to be more consistent, signs should be placed further ahead of the work zone, and the message on changeable message signs was often too long. Most of the participants liked the flashing arrow board as long as it was correctly placed.

Truck drivers mentioned items that affected them which may not affect automobile drivers. One of these items was the height of the flashing arrow board. Several truck drivers felt the lights "blinded" them because of the height above the ground, especially if the lights were not dimmed after dark. The truck drivers also mentioned that the lighting used during nighttime roadwork could cause serious glare problems if not positioned correctly. When concrete barriers are used, most of the truck drivers said that they preferred to have the barriers on their left as it made the barriers easier to see from the cab of their truck.

The participants were asked to comment on the relative effectiveness of the following in causing a speed reduction in a work zone:

1. very high fine/double fine
2. presence of law enforcement
3. presence of workers
4. good chance of being caught speeding
5. flashing sign showing YOUR speed
6. other

The overwhelming response to this question, by both automobile and truck drivers, was that the presence of law enforcement was the most effective. Most of the participants also equated the answer "good chance of being caught speeding" with the presence of law enforcement. The visible presence of workers was also considered to be very effective. This response was the same for the truck drivers as well as for the automobile drivers. The "flashing sign showing YOUR SPEED" sign generated much discussion. Approximately 60 to 70 percent of the focus group members reported that this device was effective in slowing their speed. The primary reason given for the slowing effect was that other drivers could see their speed and know how fast they were going. Participants who said that this unit was not effective usually mentioned that since there was no penalty involved, there was no compelling reason to slow down. Some participants suggested equipping the sign units with cameras to take pictures of speeders who could then be mailed a ticket. Several suggestions were given with regard to additional signing that could be effective in slowing drivers and reminding them of the need for added caution. These suggestions included signs saying: Headlights On in Work Zones; Exercise Courtesy; Move With Traffic; Let Them Work – Let Them Live; and a sign which indicated the amount of insurance increase for the points assessed when caught speeding in a work zone.

The group members were asked to comment on which of the following best described their attitude as they entered and traveled through a work zone and why.

1. nervous
2. calm
3. irritated
4. confused
5. fearful
6 uncomfortable
7. uncertain
8. other

Most of the participants said that practically all of the selections were appropriate at one time or another, depending upon the situation. If a work zone was well marked, traffic was moving well, and other drivers were "behaving," most participants said they felt calm while driving in the work zone. Several participants said they were more alert or cautious, but not overly uncertain or uncomfortable. When traffic flow became irregular, stop and go, or very slow, other drivers "jumped" the line of traffic, and/or other vehicles passed on the shoulder, most of the participants reported they became irritated. Poor sign location or lack of information usually made the participants uncertain, uncomfortable, and irritated.

The group members were asked to give their opinion of what is the biggest safety problem with highway work zones and the responses varied a great deal. The most prevalent answer appeared to be driver attitude and associated speeding. This was expressed as: impatient drivers, speeders, drivers not taking the situation seriously, and other drivers ignoring signs. Items mentioned as significant safety problems were: water and/or debris on the roadway in the work zone; not enough room for trucks; unclear sign messages; workers sitting on barriers next to the travel lane; working during 'high' traffic periods; and not enough law enforcement.

To end the focus group session, the group members were asked their opinion of the best way to make sure drivers obey the posted speed limit in work zones. The overwhelming response to this question was to increase the presence of law enforcement. The participants presented several scenarios that they felt would be most effective. They included: parked police vehicle with a mannequin dressed as an officer – moving the vehicle about regularly; using construction vehicles as police vehicles; and regular visible police patrols in the work zone.

Other methods participants felt would be effective in reducing vehicle speeds in work zones were: additions of signs with fines posted; advertising of law enforcement; increasing the penalty for speeding in work zones; flashing lights to attract the drivers attention; changeable message signs at the beginning of work zones that reflect the current conditions in the work zone; and better messages on changeable message signs.

SPEED MEASUREMENTS

During January and February 1999, NCDOT recorded spot speeds for vehicles traveling through three active work zones on Interstate 85. Directional spot speeds were recorded for vehicles traveling in both lanes in each direction on the four-lane highways. The posted speed limit for each location was 55 mph.

The recorded speeds show that the majority of the drivers exceeded the work zone posted speed limit of 55 mph at all three locations. As would be expected, the percentage of drivers exceeding the speed limit was greatest in the median lane, with a high of 97% or greater in four of the six median lanes. For five median lanes, the majority of vehicles traveled 10 mph or greater above the speed limit. The 85th percentile speed was 10 mph or greater than the posted speed limit for all lanes and 15 mph or greater for all six median lanes.

SUMMARY

The results of the mailed opinion survey and the focus groups were quite similar. While the opinion survey gave percentages of respondents that gave specific answers to specific questions, the focus groups provided an opportunity for the participants to elaborate and explain their answers. The questionnaires and focus groups indicate that most of the respondents understand the need for reconstruction of highways and therefore the need for work zones. While the most chosen answer for attitude when driving in work zones was calm, the majority of answers given by both automobile and truck drivers were sometimes uncertain, uncomfortable, and/or nervous. Their lack of knowledge or information about the work zone was often given as the primary reason for these feelings. Excessive speed and lack of courtesy on the part of other drivers were consistently reported as contributing factors for these feelings.

The majority of both automobile drivers and truck drivers indicated that increased presence of law enforcement was by far the best way to ensure compliance with the posted speeds in work zones. Other methods given as potentially effective at lowering speeds were radar trailers showing their speed, flashing lights, and rumble strips. However, the general effectiveness of these passive methods was questioned by several of the focus group participants.

Almost all of the survey respondents and focus group members considered themselves to be better drivers in work zones than the drivers around them. This result is not surprising or unexpected. A majority of the survey respondents and focus group members felt the posted speed limits throughout the state, both in and out of work zones, are appropriate. Many survey respondents and focus group members emphasized the need for more law enforcement to lower speeds in work zones. An increase in the number of highly visible patrol cars was considered desirable to make work zones generally safer.

Work zone signing was a focus group topic of considerable discussion. Several comments were made about the consistency and quality of the signing in work zones. Some respondents reported that they would be calmer and less uncertain if the messages were clearer and more reflective of current conditions. In focus group discussions, the condition of posted work zone signs but no workers present was frequently mentioned as a problem. When workers are not present, the perceived level of danger is lower than when the workers are present. Once a driver passes through a work zone several times and does not observe any workers, the driver then assumes that workers will not be present the next time they pass through. If workers are then unexpectedly encountered, the driver can be surprised and unprepared for a potentially dangerous situation. Most members of the focus groups indicated that they favored the use of changeable message signs if the message was accurate and not too long. Messages that required more than two displays to show the message were usually regarded as being too long to be able to read, interpret the message, and maintain sufficient awareness of the driving situation around the vehicle. Several focus group members indicated that the "Let them Work, Let them Live" or other similar signs were effective in reminding them of the danger of the situation and increased their respect for the workers in the work zone.

Educational methods were discussed as a potential means to improve driver behavior in work zones. Public service announcements on radio and TV and advertisements in newspapers and magazines were mentioned as ways to deliver the message to the driving public. Other methods that could be effective, based on focus group discussions, would be radar trailers showing the speed of the vehicle as it passes by, flashing signs to attract the attention of drivers and remind them of the posted speed limits, and cameras in work zones to identify speeders for ticketing.

CONCLUSIONS AND RECOMMENDATIONS

The driving public is aware of the inherent hazards and potential dangers in highway work zones. However, drivers continue to take needless risks and behave in a manner that results in an accident. The majority of drivers perceive that they are driving in a safe manner but that the other drivers are not. Most drivers report that while they usually feel calm in work zones, there are situations when they feel uncertain or confused. Many drivers report that they sometimes feel nervous, uncomfortable or irritated. The reasons given for the undesirable feelings most often were speeding by other drivers and discourteous driving by others. Some drivers indicated that while they knew they should travel at the posted speed limit, they often felt compelled to drive faster because other drivers were doing so. Based upon the results of this research, one or more of the following could be considered for encouraging drivers to behave in a more responsible manner in highway work zones:

Increased presence of authority would most likely have the greatest effect on driver behavior in highway work zones. This could be in the form of highway patrol vehicles or other highly-visible vehicles that would indicate the presence of an authority with law enforcement capabilities. The increased presence should be accompanies by strict enforcement.

Reminders of work zone hazards and workers' presence could be accomplished by additional signs of the "Let Them Work – Let Them Live" type. Radar trailers showing the vehicles' speed could be used alone as a reminder, or together with a camera to photograph violators for more positive reinforcement.

Current condition signing could be used to inform motorists of changing work zone conditions. These could include signs with the legend Speed Limit XX When Flashing, Worker Present When Flashing, or Active Construction When Flashing.

Public education campaigns could be used to increase driver awareness of work zone dangers. This could begin with high school driver education classes, followed by reminders at license renewal time. Drivers could also be reached through TV, radio, newspapers, and magazines.

MOTORISTS PERCEPTION OF WORK ZONE SAFETY

I. INTRODUCTION

Highway work zones create potential hazards because motorists are confronted with unexpected and often confusing situations. They present an abnormal, and disruptive element to the motorist who is accustomed to a clear and unobstructed roadway. While traveling through the work zone, a motorist is required to recognize and avoid closed lanes, workers in or near the roadway, construction equipment entering and leaving the roadway, and a variety of fixed object hazards. To increase the chance of successfully traversing the work zone and avoiding an accident, the motorist should exhibit increased caution and take any needed actions to reduce the added risks caused by the changed conditions. During daylight hours, the majority of work zone fatality accidents involve a collision between two vehicles while the majority of nighttime fatality accidents involve a collision with a fixed object. Regardless of the type of accident or time of day, driver error is the most frequently cited contributing factor. While there may be other contributing factors, it would appear that in many instances motorists do not take the added precautions necessary to prevent these accidents.

Many motorists appear to take needless risks such as late lane changes, following too closely, speeding, etc., in highway work zones. The reasons for this are not clear but may be attributable, in part, to the motorists' perception of the work zone and the associated expected response. The objective of this research was to examine motorist's perceptions, opinions, expectations and other psychological factors, which influence their driving activity in highway work zones. Based upon the results of this examination of work zone

perceptions, recommendations have been made for improving both motorist and worker safety in the zones.

II. LITERATURE REVIEW

A literature review reveals a substantial body of references relating to highway work zone safety in general, with emphasis on operational controls and measures for improving both motorist and worker safety. However, there is little, if any, information available regarding motorists' perceptions, opinions, views, attitudes or expectations regarding work zone safety. Past research has been mainly focused on various methods for reducing vehicle speeds in highway work zones. The treatments tested have included flagging, lane width reduction, law enforcement, changeable message signs, rumble strips, radar emulators, and flashing beacons. The effectiveness of the treatments have been evaluated and compared. All of the treatments appear to reduce vehicle speeds under certain conditions at given locations. However, none of the past research projects have specifically addressed the question of why motorists speed in work zones and indulge in other unsafe driving practices. A better understanding of motorist perception of work zone safety would enable more effective use of the available safety improvement treatments and perhaps suggest additional safety treatments. The following review includes those studies considered to be most relevant to this current research project.

A study completed by Ogden, Womack, and Mounce determined how well drivers understood construction signing for an urban arterial in Houston, Texas (1). The project studied a segment of Farm to Market road 1960 that was reconstructed from the original four lane undivided configuration to a six lane undivided section with a continuous, two-way left turn lane. Data acquisition for the study was carried out by conducting a survey of motorists at a shopping mall and a driver licensing office located on the road. This sur-

vey contained questions about the motorists general knowledge of work zone signing, problem or confusing areas of construction signing on the road, and other problems that drivers thought were not due to lack of comprehension of work zone signing. Results of the study demonstrated that not all of the surveyed motorists fully understood certain signing used in work zones.

A study completed by Huddleston, Richards, and Dudek evaluated how well drivers understood thirteen work zone flagger signals (2). The thirteen signals were comprised of seven signals recommended by the 1978 Manual on Uniform Traffic Control Devices (MUTCD), two signals from the 1973 MUTCD, two signals recommended by the police and two non-standard signals that combined signals from the 1978 MUTCD. Data was collected by showing licensed drivers a videotape of the flagger making each signal. The participants were then asked what their response would be to each signal. Results from the study indicated that the signals from the 1978 MUTCD were more clearly understood. The signals recommended by the 1973 version of the MUTCD were not as well understood and were not recommended for use. The signals proposed by the police were understood by most participants but were not recommended for use at this time. The non-standard signals tested in the study demonstrated no advantage over the signals recommended by the 1978 MUTCD.

Richards, Wunderlich, and Dudek studied work zone speed control methods in Texas that included flagging, law enforcement, changeable message signs, lane width reduction, rumble strips, and conventional regulatory and advisory speed signing (3). Six work zone areas involving four roadway types were included in the project. The different highways included an undivided multilane arterial, a rural freeway, an urban freeway, and a rural two-lane two-way highway. From this research effort, it was determined the best

method for speed reduction was flagging, followed in order by law enforcement, changeable message signs, and lane width reduction.

A separate study by Fontaine and Garber also investigated the use of a changeable message sign to reduce speeds in work zones (4). The approach was different for this project compared to the Richards, et al. project in that the sign was connected to a radar unit that flashed the message "YOU ARE SPEEDING SLOW DOWN" to speeding motorists as they were detected by the radar. Two work zone sites in Virginia were used in the study. Data collected included speed, vehicle type, and volume in addition to tracking each vehicle that triggered the radar unit. Results of the study showed that the speeds of motorists who were exposed to this treatment were reduced. The speeds of motorists recorded immediately after seeing the sign, and at the middle and end of the work zone were significantly reduced.

An innovative method investigated by Vercruyssen, Williams, and Wade involved the use of pulsing lights to give drivers the appearance of motion (5). This is known as the Phi phenomenon. The lights were arranged parallel to the roadway on either side of the travel lane and as drivers passed through the area they were subjected to a particular lighting pattern. Each driver made 15 passes through a simulated work zone. In the first pass, the driver saw stationary white lights. In subsequent passes no lights, and either forward (appearance of movement in the same direction as traffic) or backward (appearance of movement in the opposite direction of traffic) moving red or green lights were shown to the drivers. Results of the study demonstrated that speeds were lower, compared to the first pass base condition, when the drivers were exposed to the backward moving lights. When exposed to the forward moving lights, speeds were higher. The sta-

tionary light conditions showed minimal effect and green light patterns had a stronger effect when compared to red light patterns.

Another study that involved the use of lights to reduce speed in work zones was done by Benekohal and Shu (6). The study took place on a rural interstate work zone in Illinois. In the study, strobe lights were used to draw motorist's attention to the speed limit sign. The lights were mounted on either side of the sign showing the reduced speed for the work zone. The reduced speed limit was only in effect when the lights were flashing. Overall, there was a reduction in speed of the vehicles traveling through the work zone. The speed reduction was more pronounced for cars than for trucks.

Research conducted by Benekohal, Orloski, and Hashmi involved driver's opinions concerning all components of highway work zones (7). The research was conducted at a rest stop located just after a work zone on an interstate highway in Illinois. Drivers were approached and asked to participate in a survey that included questions about interpreting work zone signs, reactions the driver had to the signs, problems the driver perceived about the work zone, and possible improvements that could be made to the work zone. Results from the study showed that the majority of the drivers responded correctly to the situations presented in the work zone. Over 80% of the participants said they saw a flagger and correctly reacted to the flagger by reducing speed. In addition, data collected showed that over 75% of the drivers recognized the work zone signing and became more attentive. Ninety five percent of the motorists reported that the signing conveyed a clear message and provided enough information to guide them through the work zone. Overall, motorists seemed satisfied with the traffic control plan for the work zone.

A similar project conducted by Benekohal, Resende, and Shim investigated truck driver opinions about work zones (8). At six rest area locations around the state of Illi-

nois, truck drivers were asked to complete a questionnaire that asked about their travel characteristics, types of trucks that they drove, their assessment of work zone traffic control, types of crashes and other bad driving experiences they had encountered, and suggestions for improving work zone safety and traffic flow through construction areas.

While all of these studies deal with highway construction zones, they do not specifically address driver opinions about work zones in general. Past studies that involved innovative signing or flagging and measured drivers responses produced information that is useful for certain situations investigated in the individual research projects. The research that involved driver's opinions about work zones was directed at a small segment of the population and only asked about a specific work zone.

III. RESEARCH METHODOLOGY

This study was carried out in two phases: an opinion survey and focus groups. A mail survey is an appropriate way of gathering data and can produce high quality information both quantitative and qualitative in nature. Mailed questionnaires allow for a large number of respondents, located in a dispersed geographical area, to be surveyed in a relatively short period of time. They allow the research subjects to see the context of a series of questions, give the subjects time to think about their answers, and allow privacy in responding. When the questions are properly phrased, the questionnaires insulate the respondent from the expectations of the interviewer. Targeted mailings to selected individuals can be effective if the survey instrument is well designed and the return rate of the survey is improved by including a no-cost return envelope. A well-designed mail survey should be relatively short with a limited number of questions. The questions should be primarily multiple choice and/or short answer. By using multiple choice questions, data analysis is made easier because categories are established when the survey instrument is

designed. By giving respondents time to study the questions and answer when they are ready, the validity of the responses increases. Return rates for targeted mailings usually fall in the 15 to 30 percent range.

A focus group creates a permissive environment that nurtures different perceptions and points of view, without pressuring the participants to vote, plan, or reach a consensus. The group discussion is conducted several times with similar types of participants to identify trends and patterns in perceptions. The discussion is relaxed, comfortable and often enjoyable for the participants as they share their ideas and perceptions. The focus group is typically composed of five to ten participants who may be unfamiliar with each other, but have certain characteristics in common that relate to the topic of the focus group. Focus groups are particularly helpful when insights, perceptions and explanations are more important than numbers.

OPINION SURVEY

A two-page questionnaire was developed for use in the opinion survey. The 14 questions used in the questionnaire were chosen based upon the literature review and input from North Carolina Department of Transportation personnel. The questionnaire was tested on students and staff members at The University of North Carolina at Charlotte (UNCC). A similar questionnaire was used for truck drivers holding a Commercial Driving License (CDL), which asked for the number of years driving since obtaining the CDL. Each mailed survey was accompanied by a return envelope and a letter of explanation, a copy of which is shown in Appendix A, together with the questionnaire. Only North Carolina Drivers were targeted for the survey. The original intent was to obtain a mailing list from the North Carolina Department of Motor Vehicles (DMV). However, the DMV informed project personnel that because of recent prohibitive legislation they could not provide the project with names and addresses of licensed driver in North Carolina. The names and addresses for the general public mailing were obtained from the American Automobile Association of the Carolinas (AAA), the North Carolina Section of the Institute of Transportation Engineers (NCSITE), and The University of North Carolina at Charlotte (UNCC). Questionnaires were also handed out at DMV offices in Charlotte, NC, and Albemarle, NC. The number of mailed questionnaires and the number of returned questionnaires for each group are shown in Table 1. The commercial driver mailing list was developed through an initial contact with the North Carolina Trucking Association and subsequent contact with 29 freight carriers with offices in North

Carolina. A total of 151 questionnaires were mailed directly to drivers of three carriers who provided names and addresses. Another 366 questionnaires were sent to carriers who indicated they would distribute them to their drivers. There is no way of knowing how many of these actually were distributed.

Table 1. Opinion Survey Distribution

Group	Mailed	Returned
AAA Carolinas	1000	231
NCSITE	342	145
Freight Carriers	517	58
Handouts at NCDMV	207	37
UNCC Faculty and Staff	180	74
TOTALS	2246	545

FOCUS GROUPS

There were seven focus groups. Five consisted of currently licensed automobile drivers and two consisted of truck drivers with a current CDL. The five automobile driver groups were composed as follows: women from a church class, adult students from UNCC (2 groups), staff from UNCC, and men and women from a rural church. Participants in the two truck driver groups were recruited at a truck stop located on nearby Interstate 77. All focus group participants received compensation of $20.00. The characteristics of each focus group are shown in Table 2.

All focus groups were conducted using the same procedure. The same individual acted as moderator for each of the focus groups accompanied by either one or two assistants, all of whom took written notes. The interviews were also audio recorded. At the beginning of each focus group meeting, the moderator read a brief statement, a copy of which is contained in Appendix B, to the participants. The statement gave the purpose of

the focus group, qualifications for participation, sponsorship of the research, and the voluntary aspect of participating in the focus group. He then distributed a list of questions that would be used to guide the discussion. The questions were numbers 8, 12, 14, 16, and 17 taken from the mailed survey. The group session then began with question number 8 as the first topic and proceeded through to question number 17.

Table 2. Focus Group Characteristics

Focus Group	Number of Participants		Age		Meeting Location
	Male	Female	Mean	Range	
1	4	1	24	22-26	UNCC
2	1	9	28	24-35	UNCC
3	0	10	61	55-70	Charlotte
4	1	4	47	27-56	UNCC
5	5	4	49	40-56	Kannapolis
6	6	1	37	24-50	Truckstop on I-77
7	2	1	35	31-41	Truckstop on I-77

IV. OPINION SURVEY RESULTS

The results for questions 1 through 14 of the mailed opinion survey are shown in Table 3, with the exception of question number 11. Because of the space required, the results of question number 11 are shown separately in Table 4. The results for each of the four automobile driver mailing groups are shown separately and then combined in the following summary column. The truck driver results are shown in the last column.

Table 3 - Opinion Survey Results

Question		Source	AAA	NCSITE	UNCC	DMV	Summary	Truckers
		Number of responses	231	145	74	37	487	58
1	How long have you been driving?	Mean	36	28	29	28	32	12
		Median	35	26	32	30	32	10
		Range	2 - 70	4 - 60	8 - 50	3 - 60	2 - 70	1 - 33
2	Your age	Mean	54	44	45	45	49	40
		Median	51	42	48	46	48	40
		Range	18 - 85	26 - 78	23 - 66	22 - 76	18 - 85	24 - 60
3	Gender	Male	129 (56%)	124 (87%)	37 (50%)	16 (43%)	306 (63%)	54 (95%)
		Female	102 (44%)	18 (13%)	37 (50%)	21 (57%)	178 (37%)	3 (5%)
4	How often do you drive (on average)?	7 days	202 (88%)	140 (97%)	69 (95%)	37 (100%)	448 (92%)	27 (47%)
		4 - 5 days	24 (10%)	4 (3%)	3 (4%)	0 (0%)	31 (6%)	31 (53%)
		2 - 3 days	4 (2%)	0 (0%)	1 (1%)	0 (0%)	5 (1%)	0 (0%)
		1 day	0 (0%)	1 (1%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
		< 1 day	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
5	When you first enter a work zone on an Interstate highway your most likely response is:	Maintain speed	2 (1%)	6 (4%)	0 (0%)	0 (0%)	8 (2%)	2 (3%)
		Reduce 1 to 5 mph	22 (10%)	35 (24%)	12 (17%)	3 (8%)	72 (15%)	3 (5%)
		Reduce 6 to 10 mph	39 (17%)	22 (15%)	16 (22%)	6 (17%)	83 (17%)	7 (12%)
		Reduce to Posted	114 (50%)	45 (31%)	27 (38%)	20 (56%)	206 (43%)	38 (66%)
		Surrounding Traffic	52 (23%)	36 (25%)	17 (24%)	7 (19%)	112 (23%)	8 (14%)
6	In response to #5, if you reduce your speed when you first enter a work zone, for how long do you maintain this speed?	.5 mile or less	2 (1%)	3 (2%)	1 (1%)	0 (0%)	6 (1%)	1 (2%)
		1.5-2 miles	2 (1%)	3 (2%)	2 (3%)	2 (6%)	9 (2%)	5 (9%)
		0.5-1mile	7 (3%)	3 (2%)	2 (3%)	0 (0%)	12 (3%)	0 (0%)
		Entire work zone	133 (62%)	57 (45%)	37 (54%)	22 (63%)	249 (56%)	38 (69%)
		1-1.5 miles	5 (2%)	5 (4%)	0 (0%)	1 (3%)	11 (2%)	0 (0%)
		Observe speed	64 (30%)	56 (44%)	27 (39%)	10 (29%)	157 (35%)	11 (20%)
7	On a scale of 1 to 5 rate the following as to their effect on reducing your speed.	construction vehicles	3.9	4.2	4.0	3.7	4.0	4.0
		flagger	4.6	4.5	4.5	4.6	4.5	4.5
		police car	4.4	5.0	4.6	4.2	4.6	4.6
		construction workers	4.3	4.0	4.1	4.3	4.2	4.6
		passengers	2.2	1.8	2.2	2.3	2.1	2.5
		police officer	4.4	4.4	4.5	4.2	4.4	4.5
		flashing speed limit sign	3.9	3.2	3.6	3.9	3.6	4.2
		orange work zone signs	3.4	2.8	3.2	3.4	3.2	3.5
		signs w/flashing lights	3.8	3.1	3.4	3.7	3.5	3.7
		rumble strips	3.7	3.2	3.4	3.7	3.5	3.4
		orange barrels	3.2	2.8	3.1	3.3	3.1	3.4
		concrete barriers	3.5	3.0	3.4	3.6	3.4	3.7
		flashing sign of Your speed	4.1	3.4	4.1	4.3	3.9	4.2

Table 3 continued

Question			AAA	NCSITE	UNCC	DMV	Summary	Truckers
8	On a scale of 1 to 5 rate your perception of following situations.	construction workers	4.1	3.8	3.9	3.9	4.0	4.5
		wz signs posted, workers pres.	3.8	3.5	3.5	3.6	3.7	4.0
		wz signs posted, no workers	2.4	2.1	2.2	2.5	2.3	2.6
		S-curve	3.6	3.2	3.3	3.6	3.4	3.8
		CMS flashing message	3.1	2.5	2.7	3.3	2.9	3.1
		concrete barriers	3.4	3.0	3.1	3.6	3.2	3.6
		construction equip.	3.3	3.3	3.3	3.6	3.3	3.9
		orange barrels	2.8	2.5	2.7	3.1	2.7	3.0
		flashing arrow boards	3.0	2.6	2.6	3.2	2.8	2.9
9	Please rate your perception of how most OTHER people drive in work zones.	Rate other drivers	2.5	2.3	2.7	2.6	2.5	2.3
10	Please rate your perception of how you drive in work zones.	Rate Yourself	3.9	3.5	3.7	3.9	3.7	4.2
11	See Table 4 - Opinion Survey Question Number 11							
12	Please rate the following conditions which may cause you to reduce your speed in a work zone	very high fine	3.8	3.5	3.8	3.9	3.7	3.9
		law enforcement	4.6	4.6	4.6	4.6	4.6	4.6
		workers	4.4	3.9	4.4	4.4	4.3	4.5
		chance of being caught speeding	4.4	4.4	4.4	4.1	4.4	4.5
		flashing sign showing your speed	4.0	3.2	3.9	4.1	3.8	4.1
13	Do you feel the posted speed limits on Interstate are too too low, too high, or correct?	too high	19 (8%)	6 (4%)	7 (11%)	5 (14%)	37 (8%)	2 (4%)
		too low	34 (15%)	14 (10%)	12 (19%)	7 (19%)	67 (14%)	8 (14%)
		correct	172 (76%)	119 (86%)	45 (70%)	25 (68%)	361 (78%)	47 (82%)
14	Which of the following would best describe your attitude as you enter and travel through a work zone	nervous	36 (16%)	18 (12%)	15 (20%)	5 (14%)	74 (15%)	11 (19%)
		calm	112 (48%)	62 (43%)	24 (32%)	17 (46%)	215 (44%)	25 (43%)
		irritated	35 (15%)	14 (10%)	17 (23%)	3 (8%)	69 (14%)	8 (14%)
		confused	22 (10%)	7 (5%)	3 (4%)	1 (3%)	33 (7%)	3 (5%)
		fearful	17 (7%)	6 (4%)	4 (5%)	1 (3%)	28 (6%)	5 (9%)
		uncomfortable	73 (32%)	33 (23%)	27 (36%)	9 (24%)	142 (29%)	20 (34%)
		uncertain	53 (23%)	57 (39%)	32 (43%)	9 (24%)	151 (31%)	19 (33%)

Table 4 - Results for Question Eleven

Question 11: Please choose from the five choices what your most likely response would be for the situations listed below:												
	Maintain Speed											
	AAA		NCSITE		UNCC		DMV		Summary		Truckers	
concrete barriers	16	(7.4%)	11	(8.7%)	8	(12.7%)	2	(8.3%)	37	(7.9%)	5	(8.8%)
signs posted, workers pres.	4	(1.7%)	2	(1.4%)	1	(1.4%)	2	(5.7%)	9	(1.9%)	2	(3.6%)
signs posted, no workers	19	(8.4%)	23	(16.4%)	8	(11.4%)	6	(17.1%)	56	(11.9%)	3	(5.4%)
S-curve	2	(0.9%)	1	(0.7%)	2	(2.9%)	1	(2.9%)	6	(1.3%)	3	(5.4%)
CMS	18	(7.9%)	16	(11.7%)	6	(9.1%)	2	(5.7%)	42	(9.0%)	4	(7.1%)
flashing arrow board	13	(5.8%)	12	(8.6%)	4	(5.7%)	2	(5.9%)	31	(6.6%)	4	(7.1%)
construction equip.	7	(3.1%)	5	(3.6%)	8	(11.8%)	2	(5.9%)	22	(4.7%)	1	(1.8%)
orange barrels	15	(6.7%)	20	(14.4%)	7	(10.1%)	3	(8.6%)	45	(9.6%)	3	(5.4%)
construction workers	0	(0.0%)	3	(2.1%)	3	(4.3%)	0	(0.0%)	6	(1.3%)	2	(3.6%)
presence of flagger	1	(0.4%)	1	(0.7%)	0	(0.0%)	0	(0.0%)	2	(0.4%)	2	(3.6%)
	Reduce speed by 1-5 mph											
	AAA		NCSITE		UNCC		DMV		Summary		Truckers	
concrete barriers	44	(19.2%)	48	(34.8%)	12	(16.9%)	7	(19.4%)	111	(23.6%)	8	(14.0%)
signs posted, workers pres.	14	(6.1%)	25	(17.9%)	8	(11.4%)	4	(11.4%)	51	(10.8%)	2	(3.6%)
signs posted, no workers	46	(20.3%)	34	(24.3%)	11	(15.7%)	9	(25.7%)	100	(21.2%)	11	(19.6%)
S-curve	26	(11.4%)	34	(24.3%)	11	(15.9%)	4	(11.8%)	75	(15.9%)	4	(7.1%)
CMS	36	(15.9%)	34	(24.8%)	11	(16.7%)	7	(20.0%)	88	(18.9%)	9	(16.1%)
flashing arrow board	33	(14.6%)	40	(28.6%)	14	(20.0%)	10	(29.4%)	97	(20.6%)	11	(19.6%)
construction equip.	34	(15.0%)	40	(28.6%)	11	(16.2%)	9	(26.5%)	94	(20.1%)	4	(7.1%)
orange barrels	48	(21.3%)	41	(29.5%)	14	(20.3%)	8	(22.9%)	111	(23.7%)	5	(8.9%)
construction workers	10	(4.4%)	18	(12.9%)	3	(4.3%)	2	(5.7%)	33	(7.0%)	0	(0.0%)
presence of flagger	4	(1.8%)	8	(5.7%)	0	(0.0%)	1	(2.9%)	13	(2.7%)	1	(1.8%)
	Reduce speed by by 6-10											
	AAA		NCSITE		UNCC		DMV		Summary		Truckers	
concrete barriers	55	(24.0%)	31	(22.5%)	18	(25.4%)	7	(19.4%)	111	(23.6%)	12	(21.1%)
signs posted, workers pres.	58	(25.3%)	38	(27.1%)	20	(28.6%)	6	(17.1%)	122	(25.7%)	12	(21.4%)
signs posted, no workers	32	(14.1%)	13	(9.3%)	8	(11.4%)	4	(11.4%)	57	(12.1%)	9	(16.1%)
S-curve	70	(30.7%)	45	(32.1%)	19	(27.5%)	10	(29.4%)	144	(30.6%)	13	(23.2%)
CMS	48	(21.1%)	19	(13.9%)	8	(12.1%)	7	(20.0%)	82	(17.6%)	11	(19.6%)
flashing arrow board	58	(25.7%)	22	(15.7%)	11	(15.7%)	7	(20.6%)	98	(20.9%)	8	(14.3%)
construction equip.	62	(27.4%)	35	(25.0%)	14	(20.6%)	5	(14.7%)	116	(24.8%)	18	(32.1%)
orange barrels	55	(24.4%)	20	(14.4%)	12	(17.4%)	7	(20.0%)	94	(20.1%)	14	(25.0%)
construction workers	45	(19.8%)	49	(35.0%)	20	(29.0%)	9	(25.7%)	123	(26.1%)	12	(21.4%)
presence of flagger	35	(15.4%)	44	(31.2%)	14	(20.0%)	7	(20.0%)	100	(21.1%)	8	(14.3%)

Table 4 continued

	Stay with speed of traffic											
	AAA		NCSITE		UNCC		DMV		Summary		Truckers	
concrete barriers	45	(19.7%)	28	(20.3%)	16	(22.5%)	4	(11.1%)	93	(19.8%)	6	(10.5%)
signs posted, workers pres.	18	(7.9%)	23	(16.4%)	6	(8.6%)	6	(17.1%)	53	(11.2%)	3	(5.4%)
signs posted, no workers	85	(37.4%)	55	(39.3%)	34	(48.6%)	8	(22.9%)	182	(38.6%)	19	(33.9%)
S-curve	51	(22.4%)	28	(20.0%)	17	(24.6%)	6	(17.6%)	102	(21.7%)	5	(8.9%)
CMS	65	(28.6%)	43	(31.4%)	30	(45.5%)	8	(22.9%)	146	(31.4%)	13	(23.2%)
flashing arrow board	63	(27.9%)	39	(27.9%)	28	(40.0%)	5	(14.7%)	135	(28.7%)	9	(16.1%)
construction equip.	56	(24.8%)	33	(23.6%)	14	(20.6%)	8	(23.5%)	111	(23.7%)	9	(16.1%)
orange barrels	67	(29.8%)	40	(28.8%)	25	(36.2%)	8	(22.9%)	140	(29.9%)	16	(28.6%)
construction workers	34	(15.0%)	17	(12.1%)	7	(10.1%)	7	(20.0%)	65	(13.8%)	3	(5.4%)
presence of flagger	21	(9.2%)	16	(11.3%)	9	(12.9%)	3	(8.6%)	49	(10.3%)	2	(3.6%)
	Reduce speed to posted speed limit											
	AAA		NCSITE		UNCC		DMV		Summary		Truckers	
concrete barriers	68	(29.7%)	19	(13.8%)	16	(22.5%)	15	(41.7%)	118	(25.1%)	26	(45.6%)
signs posted, workers pres.	135	(59.0%)	52	(37.1%)	35	(50.0%)	17	(48.6%)	239	(50.4%)	37	(66.1%)
signs posted, no workers	45	(19.8%)	15	(10.7%)	9	(12.9%)	8	(22.9%)	77	(16.3%)	14	(25.0%)
S-curve	79	(34.6%)	32	(22.9%)	20	(29.0%)	13	(38.2%)	144	(30.6%)	31	(55.4%)
CMS	60	(26.4%)	25	(18.2%)	11	(16.7%)	11	(31.4%)	107	(23.0%)	19	(33.9%)
flashing arrow board	59	(26.1%)	27	(19.3%)	13	(18.6%)	10	(29.4%)	109	(23.2%)	24	(42.9%)
construction equip.	67	(29.6%)	27	(19.3%)	21	(30.9%)	10	(29.4%)	125	(26.7%)	24	(42.9%)
orange barrels	40	(17.8%)	18	(12.9%)	11	(15.9%)	9	(25.7%)	78	(16.7%)	18	(32.1%)
construction workers	138	(60.8%)	53	(37.9%)	36	(52.2%)	17	(48.6%)	244	(51.8%)	39	(69.6%)
presence of flagger	167	(73.2%)	72	(51.1%)	47	(67.1%)	24	(68.6%)	310	(65.4%)	43	(76.8%)

The results for questions 15 through 18 do not lend themselves to tabular summarization and are discussed separately. As shown in the table, there is little difference in the responses of the automobile driver groups and their combined summary results are used in the following discussion. Inspection of the tables also shows little difference between automobile drivers and truck drivers for most questions.

The driver opinion survey covered three primary areas for each individual: personal information; usual driving behavior in work zones; and perceived effectiveness of different treatments for slowing traffic and/or making the work zone "safer." A total of 1728 surveys were distributed to licensed automobile drivers by US Postal Service, campus mail at UNC-Charlotte, and handed out at Department of Motor Vehicle offices located on North Tryon Street in Charlotte, NC and in Albemarle, NC. Of the 1728 surveys distributed, 487 or 28.2% were returned. Some of the questions were not marked on all surveys and this results in the number of responses to a given question not always totaling 487.

The truck driver questionnaire was identical to the automobile driver questionnaire except for questions asking how long the driver had possessed a CDL and how often they drove professionally. There were 467 surveys mailed to commercial truck drivers or sent to freight carriers for distribution. The number of returned surveys was 58, a return rate of 12.4%. Again, because of unanswered questions, the number of responses do not always total 58.

As shown in Table 3, the driving experience of the respondents ranged from 2 to 70 years with a mean of 32 years and the reported ages ranged from 18 to 85 years with a mean of 48.9 years. The gender responses were divided 306 male and 178 female. Of 485 responses, 479, or 98.7%, indicated that they drove four or more days per week. The

individual responses for question numbers 1, 2, 3, and 4 indicate that the respondents were mature, experienced, frequent drivers who would likely have had significant experience in driving through highway work zones.

In question numbers 1, 2, 3, and 4, the truck drivers reported professional driving experience ranging from 1 to 33 years with a mean of 11.6 years. Truck driver's ages ranged from 24 to 60 years with a mean age of 40.5 years. There were 54 male and 3 female drivers returning surveys and one survey was returned without a gender being indicated. All respondents reported driving professionally four or more days per week. This indicates that, like the automobile drivers, the professional drivers were experienced and would likely have had significant experience in driving through work zones.

In answer to question number 5, with regard to their speed as they entered a work zone, the answer selected most often by automobile drivers was to reduce speed to the posted speed with 43% indicating this response. The second most frequent answer, chosen by 23% of the automobile drivers, was to reduce speed to the speed of surrounding traffic. Approximately 2% indicated they maintained their prior speed, while 75% indicated some degree of speed reduction. This is shown in Figure 1.

The majority of the professional truck drivers, 83%, reported that they reduced their speed to some degree, 66% reduced their speed to the posted speed limit and 14% reduced speed to the speed of surrounding traffic. Three percent indicated they maintained their prior speed.

In answer to question number 6, 91% of the automobile drivers and 89% of the truck drivers who reduced their speeds when entering a work zone, indicated they maintained their reduced speed throughout the entire length of the work zone or until they were able to observe and match the speed of surrounding traffic.

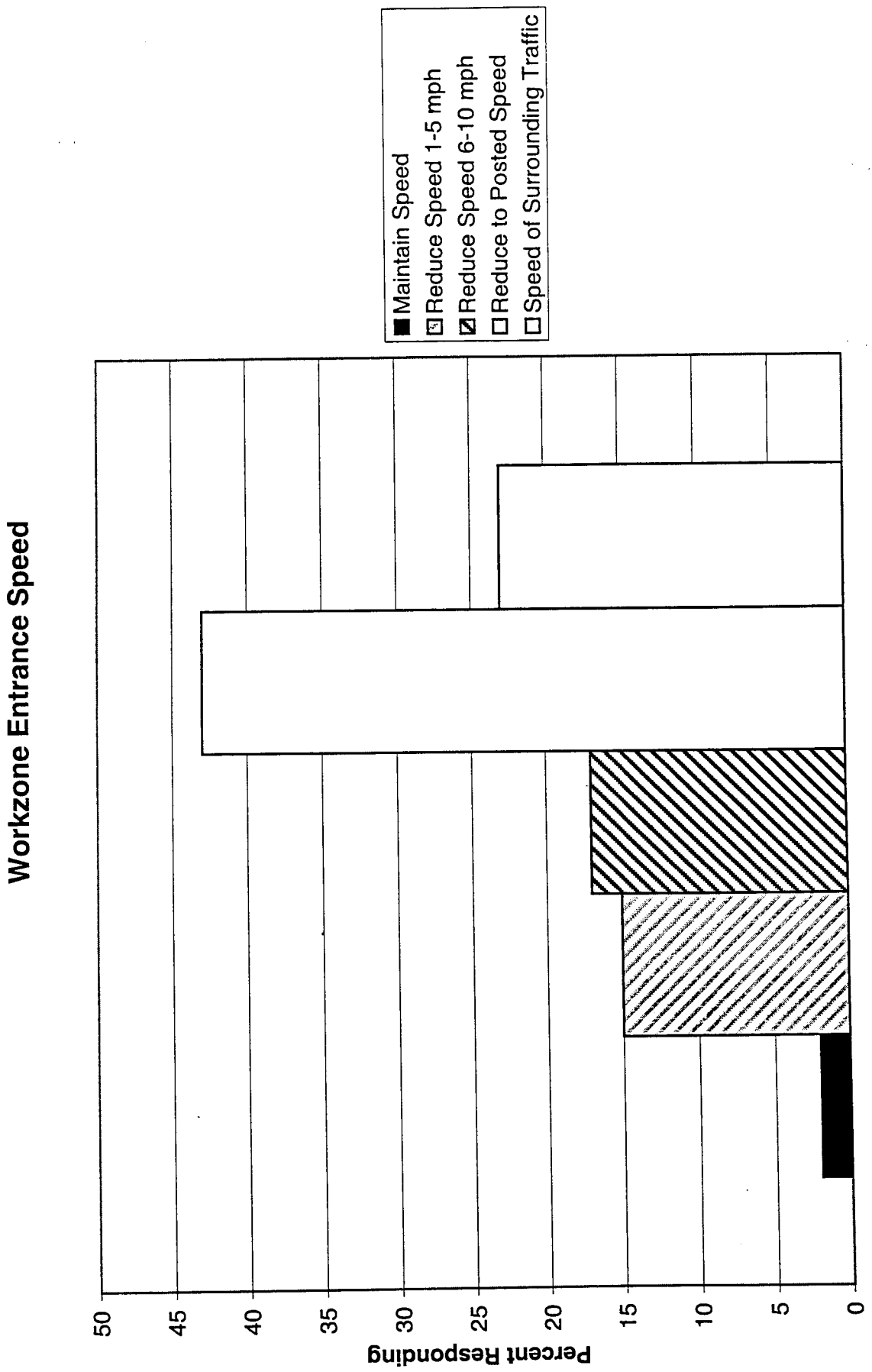

Figure 1. Question Number 5 Response

The conditions listed in questions 7 and 12 that were rated most effective for reducing both automobile and truck driver speeds when entering and traveling through work zones, were in approximate descending order: obvious presence of law enforcement, workers or flagger present in the work zone, and a good chance of being caught speeding. Each of these received an average rating of 4.5, or greater, out of a possible 5. This is shown in Figure 2 and Figure 3.

In question number 8, the presence of construction workers was viewed by the automobile drivers as the most dangerous situation encountered in work zones. The next most dangerous situation was considered to be the presence of an S-curve or lane shift within the work zone. The remaining conditions were then ranked in order of decreasing danger as: construction equipment, concrete barriers, changeable message sign flashing a message, flashing arrow boards, orange barrels, and work zone signs posted but no workers present. This is shown in Figure 4.

The truck drivers gave similar responses, with the S-curve and construction equipment switching positions in the ranking.

For questions 9 and 10, both automobile drivers and truck drivers perceive that they, themselves, drive far more safely in work zones than do other drivers. The truck drivers rated themselves as safer drivers than did the automobile drivers. Out of a possible 5, the automobile drivers gave themselves a score of 3.7 and other drivers a 2.5. Truck drivers gave themselves a score of 4.2 and other drivers a 2.3.

For question number 11,the results of which are shown in Table 4, a small percentage of respondents indicated they would maintain their prior speed regardless of the situation in the work zone. However, the majority of both automobile drivers and truck drivers indicated they would reduce their speed to some degree for all of the situations presented.

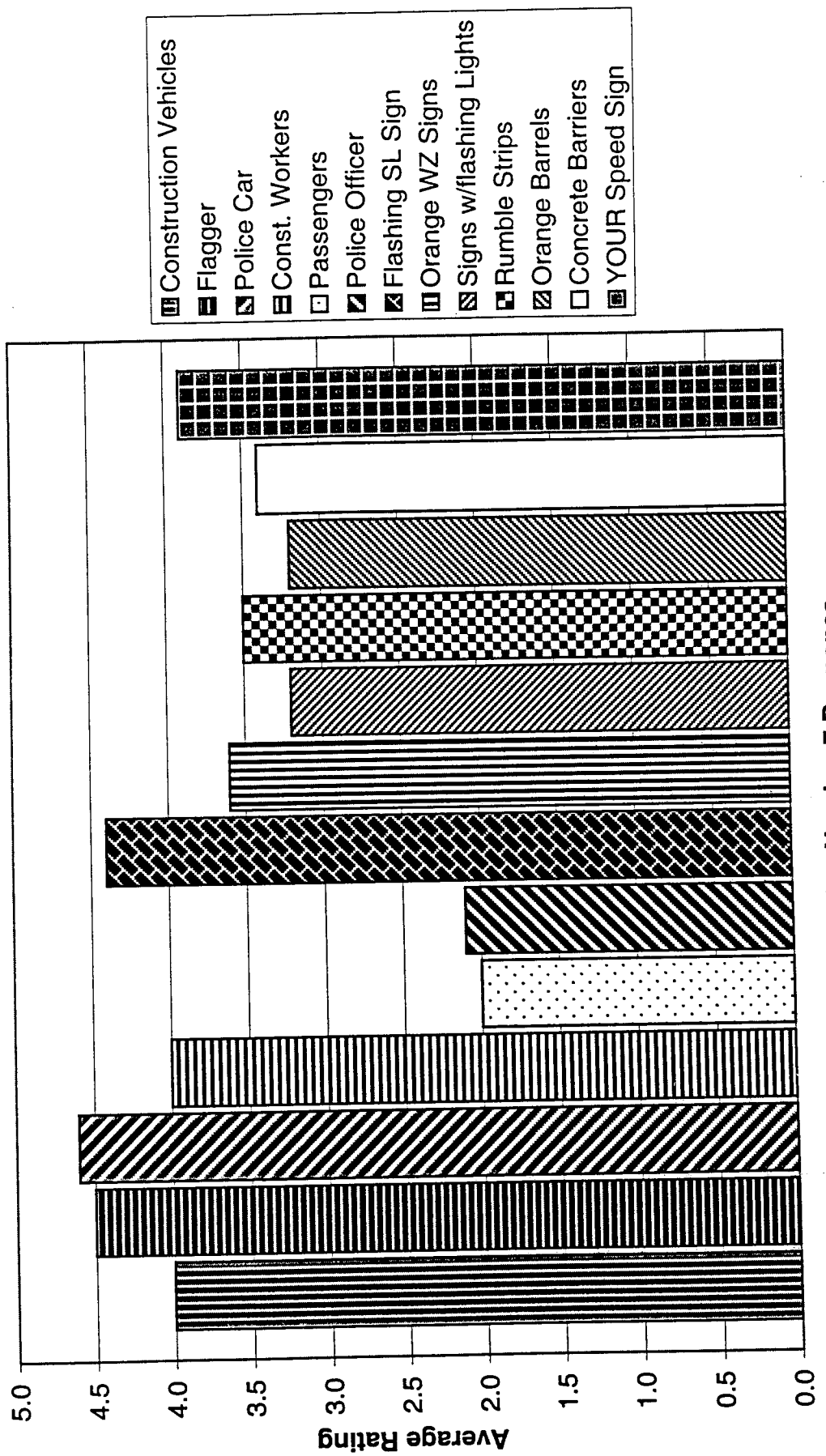

Figure 2. Question Number 7 Response

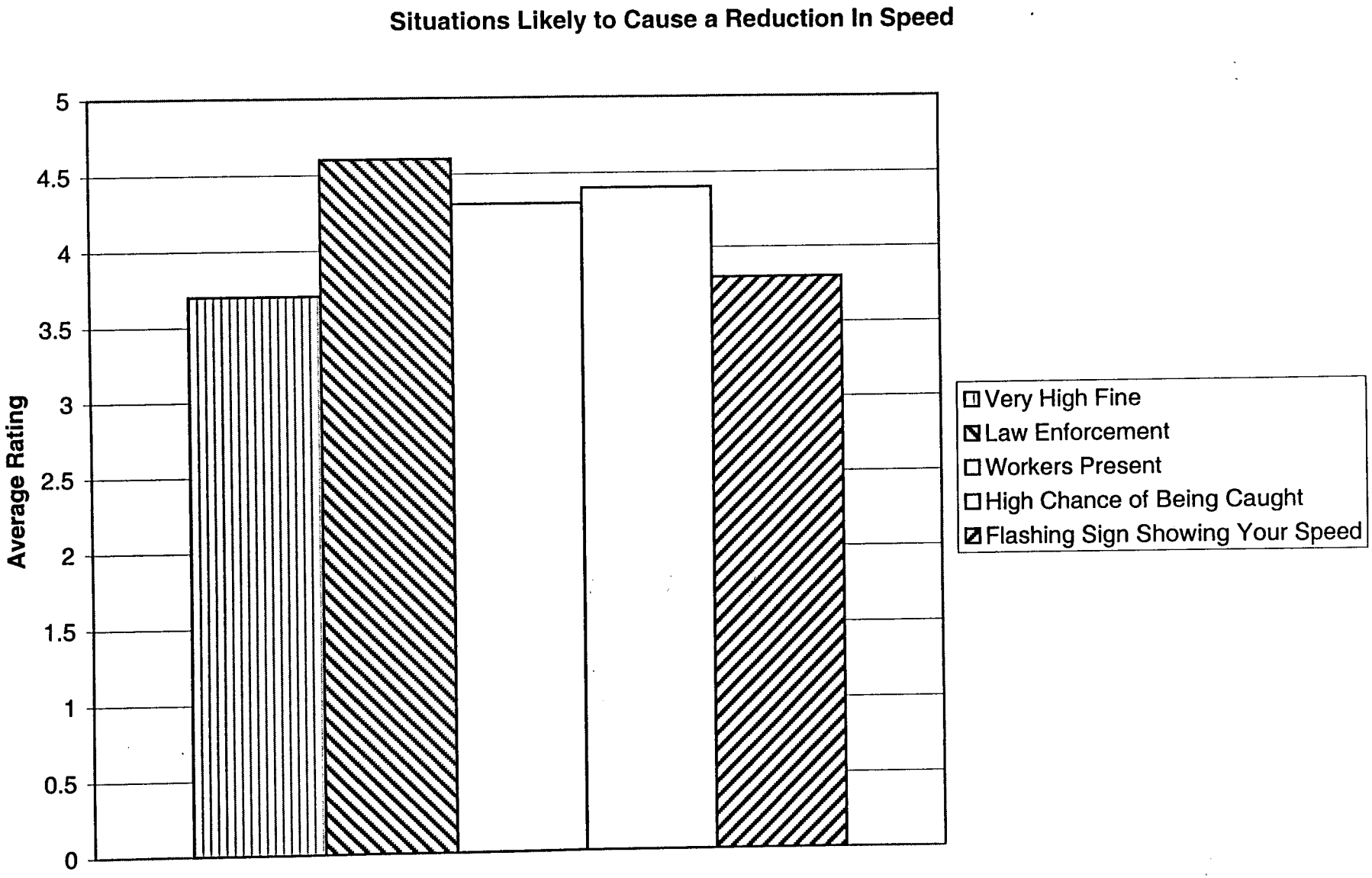

Figure 3. Question Number 12 Response

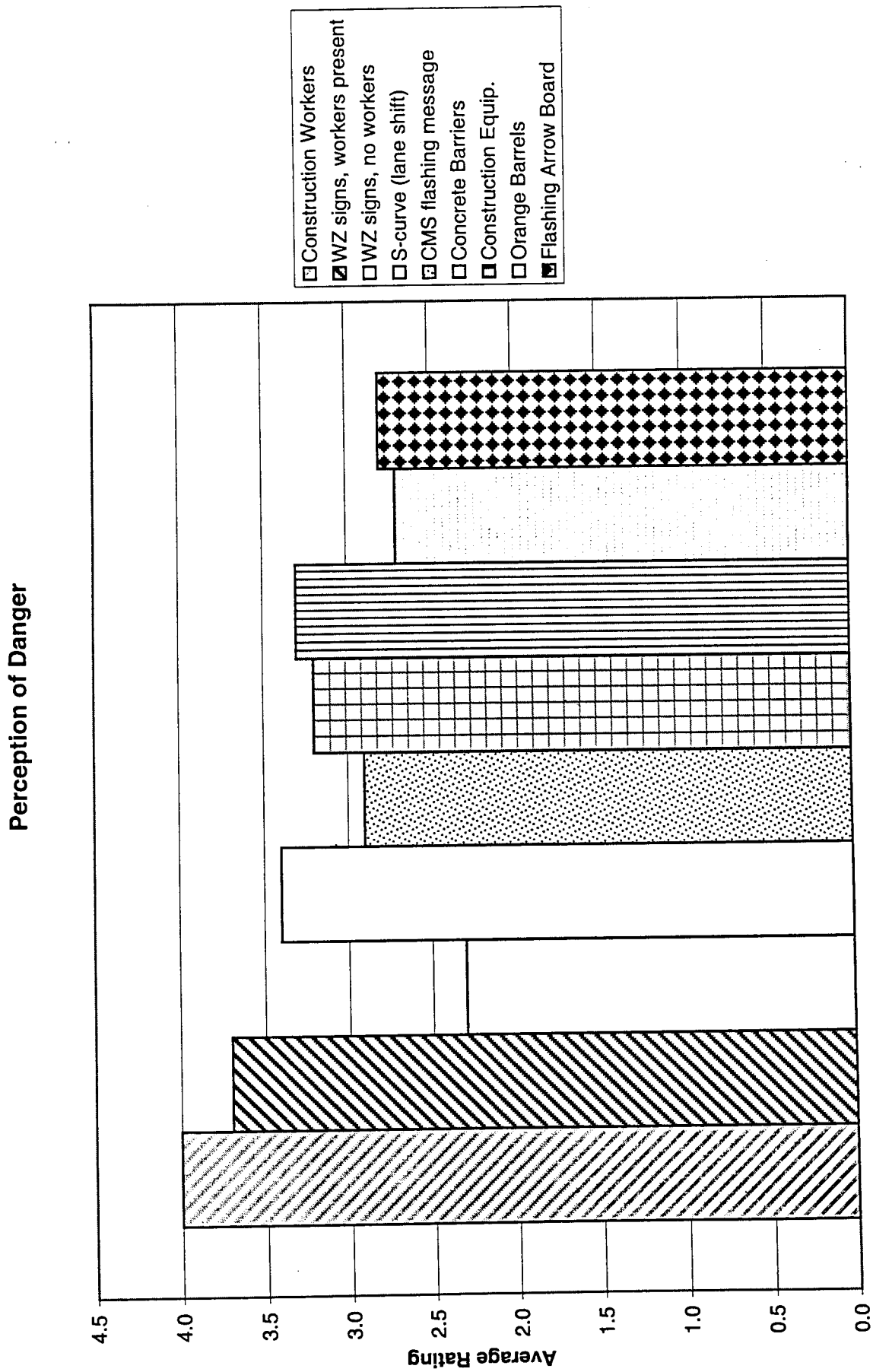

Figure 4. Question Number 8 Response

The most effective conditions for causing a reduction in speed to the posted speed limit, for both automobile and truck drivers, is presence of flagger, presence of workers, and S-curve, in that order.

For question number 13, 78% of the automobile drivers and 82% of the truck drivers felt that the posted speed limits throughout the State of North Carolina are correct. Similarly, 8% and 4% felt the speed limits are too high, while 14% and 14% felt the posted speed limits are too low.

In question 14 more than one answer could be chosen. The most frequently reported attitude of respondents as they traveled through work zones was calm, followed by uncertain and then uncomfortable. For automobile drivers, 44% reported being calm as they passed through work zones, as did 43% of the truck drivers. An attitude of *uncertain* was reported by 31% of the automobile drivers and 33% of the truck drivers; while *uncomfortable* was reported by 29% of the automobile drivers and 34% of the truck drivers.

In answer to question number 15, both automobile and truck drivers who reported being calm while driving through work zones, in general felt that remaining calm was the best way to maintain control in the situation. For those drivers who reported being uncertain, uncomfortable, nervous, etc., some of the reasons given were:

> Very uncertain about what is ahead.
> Signing or advance warning is lacking or inadequate.
> Feels work zones are dangerous and is concerned for workers, themselves, and other drivers.
> Work zones are not always set up properly and that work should be done at night.
> Feels that lanes are too narrow and speed limits too low.
> Feels other drivers do not pay attention and create a lot of the danger experienced in work zones.
> Feels very inconvenienced and irritated by the delays cause by work zones.

In question number 16, both automobile and truck drivers reported that by far the best way to insure drivers obey the posted speed limit in work zones is to increase the presence of law enforcement. Other effective ways included:

Use of flashing signs and innovative messaging.
Ensure that the work zone is correctly set up.
Increase the work zone speed limit.
Want to actually see people working.

For question number 17 the greatest safety problems with work zones, as reported by automobile and truck drivers, are:

Speeders, drivers who do not pay attention to the signs, lack of enforcement.
Work zones signed inconsistently, lanes too narrow, not enough information to effectively inform drivers of what is happening.
Construction goes on too long, causes unnecessary delays, construction should be done at night.
Road in poor condition--potholes, no shoulder, debris in the roadway.
Workers are not protected enough, use more concrete barriers and not orange barrels.

The most effective ways to improve work zone safety as reported in question number 18 included:

Make sure work zone signing and markings are maintained in good condition, markings not faded, signs clean and bright.
Increased presence of law enforcement and heavy fines.
Schedule more work at night or off peak periods.
Educate drivers to the danger of work zones through the media, driver education programs, and driver license exams.
Wider lanes, more notice of upcoming work, get the work done faster.

V. FOCUS GROUP RESULTS

Question numbers 8, 12, 14, 16 and 17 were used to guide the focus group discussions. From question number 8, the moderator asked the participants to give their opinion of the relative danger of the following work zone situations:

presence of construction workers
work zone signs posted, workers present
work zone signs posted, no workers present
traffic shift (S-curve)
changeable message sign flashing message
concrete barriers
construction equipment
orange barrels
flashing arrow boards
other

With the exception of the flashing arrow boards, most of the participants in the focus groups indicated that all of these situations heightened the danger of traveling in a work zone. Several persons said that seeing workers close to the travel lanes made them very nervous since they felt these people were concentrating on their work and not paying much attention to the traffic around them. A number of participants in the automobile driver focus groups said that they did not like the S-curve (lane shift), especially when concrete barriers were present. Truck drivers did not like the lane shift when the lanes were narrow because it made it much more difficult to keep their wide truck within the lane markings. Other items that were mentioned during the discussion of this question were: worker clothing needs to be more visible, sign location needs to be more consistent, signs should be placed further ahead of the work zone, and the message on changeable message signs was often too long. Most of the participants liked the flashing arrow board as long as it was correctly placed.

Truck drivers mentioned items that affected them which may not affect automobile drivers. One of these items was the height of the flashing arrow board. Several truck drivers felt the lights "blinded" them because of the height above the ground, especially if the lights were not dimmed after dark. The truck drivers also mentioned that the lighting used during nighttime roadwork could cause serious glare problems if not positioned correctly. When concrete barriers are used, most of the truck drivers said that they preferred to have the barriers on their left as it made the barriers easier to see from the cab of their truck.

From question number 12, the participants were asked to comment on the relative effectiveness of the following in causing a speed reduction in a work zone

very high fine/double fine	good chance of being caught speeding
presence of law enforcement	flashing sign showing YOUR speed
presence of workers	other

The overwhelming response to this question, by both automobile and truck drivers, was that the presence of law enforcement was the most effective. Most of the participants also equated the answer "good chance of being caught speeding" with the presence of law enforcement. The visible presence of workers was also considered to be very effective. This response was the same for the truck drivers as well as for the automobile drivers. The "flashing sign showing YOUR SPEED" sign generated much discussion. Approximately 60 to 70 percent of the focus group members reported that this device was effective in slowing their speed. The primary reason given for the slowing effect was that other drivers could see their speed and know how fast they were going. This situation was equated to other situations where peer group pressure is the reason for changing individual behavior. Participants who said that this unit was not effective usually mentioned that since there was no penalty involved, there was no compelling reason to slow down. Some participants suggested equipping these units with cameras to take pictures of speeders who could then be mailed a ticket. Several suggestions were given with regard to additional signing that could be effective in slowing drivers and reminding them of the need for added caution. These suggestions included signs saying: Headlights On in Work Zones; Exercise Courtesy; Move With Traffic; Let Them Work – Let Them Live; and a sign

which indicated the amount of insurance increase for the points assessed when caught speeding in a work zone.

One interesting comment was made, separately, at two different focus group meetings regarding the fine for speeding. The paraphrased comment was: "Why is littering is a $1000 fine and speeding in a work zone is only $100? Is littering 10 times worse than speeding in a work zone?"

From question number 14, the group members were asked to comment on which of the following best described their attitude as they entered and traveled through a work zone and why.

nervous	irritated	fearful	uncertain
calm	confused	uncomfortable	other

Most of the participants said that practically all of the selections were appropriate at one time or another, depending upon the situation. If a work zone was well marked, traffic was moving well, and other drivers were "behaving," most participants said they felt calm while driving in the work zone. Several participants said they were more alert or cautious, but not overly uncertain or uncomfortable. When traffic flow became irregular, stop and go, or very slow, other drivers "jumped" the line of traffic, and/or other vehicles passed on the shoulder, most of the participants reported they became irritated. Poor sign location or lack of information usually made the participants uncertain, uncomfortable, and irritated. Several of the participants said that they had seen examples of "road rage" when the traffic flow in work zones was breaking down.

From question number 17, the group members were asked to give their opinion of what is the biggest safety problem with highway work zones.

The responses to this question varied a great deal. The most prevalent answer appeared to be driver attitude and associated speeding. This was expressed as: impatient drivers, speeders, drivers not taking the situation seriously, and other drivers ignoring signs. Items mentioned as significant safety problems were: water and/or debris on the roadway in the work zone; not enough room for trucks; unclear sign messages; workers sitting on barriers next to the travel lane; working during 'high' traffic periods; and not enough law enforcement.

To end the focus group session, from question number 16, the group members were asked their opinion the best way to make sure drivers obey the posted speed limit in work zones.

The overwhelming response to this question was to increase the presence of law enforcement. The participants presented several scenarios that they felt would be most effective. They included: parked police vehicle with a mannequin dressed as an officer – moving the vehicle about regularly; using construction vehicles as police vehicles; and regular visible police patrols in the work zone.

Other methods participants felt would be effective in reducing vehicle speeds in work zones were: additions of signs with fines posted; advertising of law enforcement; increasing the penalty for speeding in work zones; flashing lights to attract the drivers attention; changeable message signs at the beginning of work zones that reflect the current conditions in the work zone; and better messages on changeable message signs.

Several truck drivers reported that when vehicles are not allowed to "jump ahead" by passing on shoulders or speeding to the end of a lane that is closing, traffic flow through the work zone is improved. This could be accomplished using law enforcement or by private vehicles, usually trucks, preventing vehicles from operating in this manner.

Another recommendation from several truck drivers was for new drivers and drivers renewing their license to be educated regarding the truck driver's inability to see a car in his blind areas, a condition frequently encountered in work zones.

The focus group results were quite similar to the responses on the mail survey. The discussions helped to reinforce the interpretation of the responses on the mail surveys as well as providing insight on driver perspectives of traveling through work zones.

VI. SUMMARY

The results of the mailed opinion survey and the focus groups were quite similar. While the opinion survey gave percentages of respondents that gave specific answers to specific questions, the focus groups provided an opportunity for the participants to elaborate and explain their answers. The questionnaires and focus groups indicate that most of the respondents understand the need for reconstruction of highways and therefore the need for work zones. While the most chosen answer for attitude when driving in work zones was calm, the majority of answers given by both automobile and truck drivers were sometimes uncertain, uncomfortable, and/or nervous. Their lack of knowledge or information about the work zone was often given as the primary reason for these feelings. Excessive speed and lack of courtesy on the part of other drivers were consistently reported as contributing factors for these feelings.

The majority of both automobile drivers and truck drivers indicated that increased presence of law enforcement was by far the best way to ensure compliance with the posted speeds in work zones. Other methods given as potentially effective at lowering speeds were radar trailers showing their speed, flashing lights, and rumble strips. However, the general effectiveness of these passive methods was questioned by several of the focus group participants.

Almost all of the survey respondents and focus group members considered themselves to be better drivers in work zones than the drivers around them. Most drivers felt that they were driving in a safe and responsible manner but that many other drivers were behaving in a way that threatened them and could contribute to an accident. This result is not surprising or unexpected since drivers are reluctant to criticize themselves. A majority of the survey respondents and focus group members felt the posted speed limits throughout the state, both in and out of work zones, are appropriate.

Many survey respondents and focus group members emphasized the need for more law enforcement to lower speeds in work zones. An increase in the number of highly visible patrol cars was considered desirable to make work zones generally safer.

Work zone signing was a focus group topic of considerable discussion. Several comments were made about the consistency and quality of the signing in work zones. Some respondents reported that they would be calmer and less uncertain if the messages were clearer and more reflective of current conditions. In focus group discussions, the condition of posted work zone signs but no workers present was frequently mentioned as a problem. When workers are not present, the perceived level of danger is lower than when the workers are present. Once a driver passes through a work zone several times and does not observe any workers, the driver then assumes that workers will not be present the next time they pass through. If workers are then unexpectedly encountered, the driver can be surprised and unprepared for a potentially dangerous situation. Most members of the focus groups indicated that they favored the use of changeable message signs if the message was accurate and not too long. Messages that required more than two displays to show the message were usually rated as being too long to be able to read, interpret the message, and maintain sufficient awareness of the driving situation around the ve-

hicle. Several focus group members indicated that the "Let them Work, Let them Live" or other similar signs were effective in reminding them of the danger of the situation and increased their respect for the workers in the work zone.

Educational methods were discussed as a potential means to improve driver behavior in work zones. Public service announcements on radio and TV and advertisements in newspapers and magazines were mentioned as ways to deliver the message to the driving public. Other methods that could be effective, based on focus group discussions, would be radar trailers showing the speed of the vehicle as it passes by, flashing signs to attract the attention of drivers and remind them of the posted speed limits, and cameras in work zones to identify speeders for ticketing.

VII. CONCLUSIONS AND RECOMMENDATIONS

The driving public is aware of the inherent hazards and potential dangers in highway work zones. However, drivers continue to take needless risks and behave in a manner that results in an accident. The majority of drivers perceive that they are driving in a safe manner but that the other drivers are not. Most drivers report that while they usually feel calm in work zones, there are situations when they feel uncertain or confused. Many drivers report that they sometimes feel nervous, uncomfortable or irritated. The reasons given for the undesirable feelings most often were speeding by other drivers and discourteous driving by others. Some drivers indicated that while they knew they should travel at the posted speed limit, they often felt compelled to drive faster because other drivers were doing so. Based upon the results of this research, one or more of the following could be considered for encouraging drivers to behave in a more responsible manner in highway work zones:

Increased presence of authority would most likely have the greatest effect on driver behavior in highway work zones. This could be in the form of highway patrol vehicles or other highly-visible vehicles that would indicate the presence of an authority with law enforcement capabilities. The increased presence should be accompanies by strict enforcement.

Reminders of work zone hazards and workers' presence could be accomplished by additional signs of the "Let Them Work – Let Them Live" type. Radar trailers showing the vehicles' speed could be used alone as a reminder, or together with a camera to photograph violators for more positive reinforcement.

Current condition signing could be used to inform motorists of changing work zone conditions. These could include signs with the legend Speed Limit XX When Flashing, Worker Present When Flashing, or Active Construction When Flashing.

Public education campaigns could be used to increase driver awareness of work zone dangers. This could begin with high school driver education classes, followed by reminders at license renewal time. Drivers could also be reached through TV, radio, newspapers, and magazines.

VIII. ADDENDUM

This research project was completed and a draft final report submitted in August 1998. After reviewing the draft report, NCDOT personnel felt that it would be desirable to make some field measurements of vehicle speeds in active highway work zones and to include the results in the final report. The project investigators also felt that this would be a meaningful addition to the report and readily agreed to include the field data, hence this addendum.

During January and February 1999, NCDOT recorded spot speeds for vehicles traveling through three active work zones on Interstate 85. Location 1 was North of Webb Road (SR 1500) in Rowan County; location 2 was North of Peach Orchard Road (SR 2539) in Rowan County; and location 3 was North of Exit 10B at SR 1302 in Gaston County. Directional spot speeds were recorded for vehicles traveling in both lanes in each direction on the four-lane highways. The posted speed limit for each location was 55 mph. The summarized data by location is contained in Appendix C.

Each Appendix C table shows the directional spot speed data for the single location indicated. In the "Group" column, the "All" represents all directional spot speeds recorded at the location. "Weekday" represents speeds recorded Monday through Friday, "Weekend" represents speeds recorded on Saturday and Sunday. "Night" represents speeds recorded between 8 pm and 5 am. "Day" represents speeds recorded between 8 am and 5 pm. The data was further divided into outside (shoulder) lane and inside (median) lane. The recorded spot speeds were used to determine the percentage of vehicles exceeding the 55 mph speed limit, the percentage of vehicles traveling 10 mph or greater than the speed limit, and the 85^{th} percentile speed for each group. Each of the table values was calculated using the total number of vehicles shown. It may be noted that for each of

the locations there is little variation between the groups; therefore, for this study, the "All" values have been used to represent each location.

The percentage of vehicles traveling above the 55 mph speed limit for each location is shown in Figure 5. For the median lane in both directions, greater than 90% of the vehicles exceeded the posted speed limit of 55 mph at all three locations, with a directional high of 98% at two locations. For the shoulder lane in both directions, greater than 85% of the vehicles exceeded the posted speed limit at each location.

The percentage of vehicles exceeding the 55 mph posted speed limit by 10 mph or more is shown in Figure 6. For the median lane, or "fast" lane, the percentage is greater than 56, except at Location 2 Northbound. A high of 73% was recorded for Location 3 Northbound. The percentage is considerably lower in the shoulder lane at each location.

Figure 7 shows the 85th percentile speed at each location by direction. For each location, the median lane 85th percentile speed is greater than 69 mph, with a high of 74 mph at Location 3 Northbound. The shoulder lane 85th percentile speed is greater than 64 mph at all locations.

In summary, the three figures show that the majority of the drivers exceeded the work zone posted speed limit of 55 mph at all three locations. As would be expected, the percentage of drivers exceeding the speed limit was greatest in the median lane, with a high of 97% or greater in four of the six median lanes. For five median lanes, the majority of vehicles traveled 10 mph or greater above the speed limit. The 85th percentile speed was 10 mph or greater than the posted speed limit for all lanes and 15 mph or greater for all six median lanes.

The above results from the field measured work zone spot speeds do not agree with the driver perceptions of the main study. In the main study, 43% of the automobile

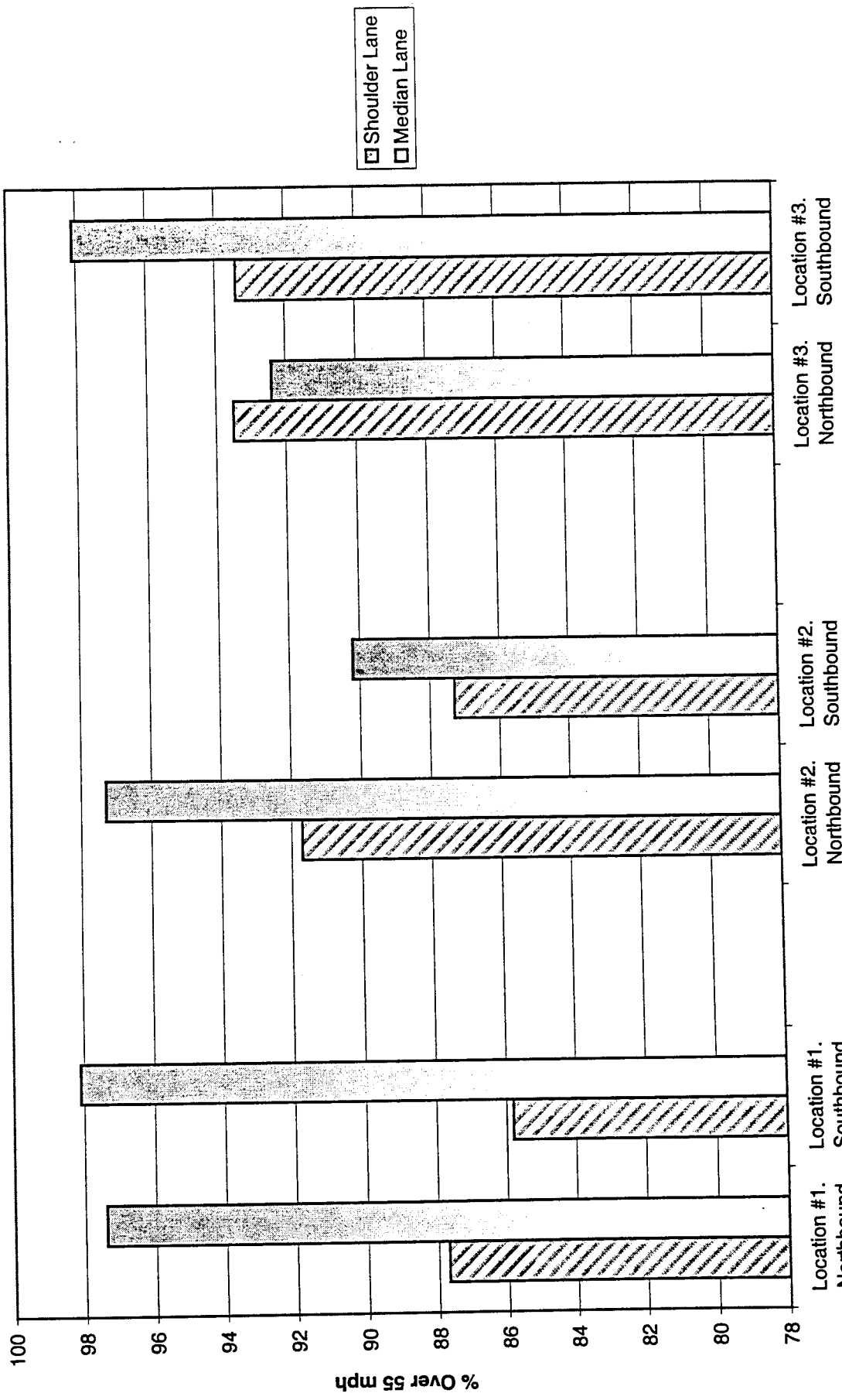

Figure 5. Percentage of Vehicles Exceeding Posted Speed Limit

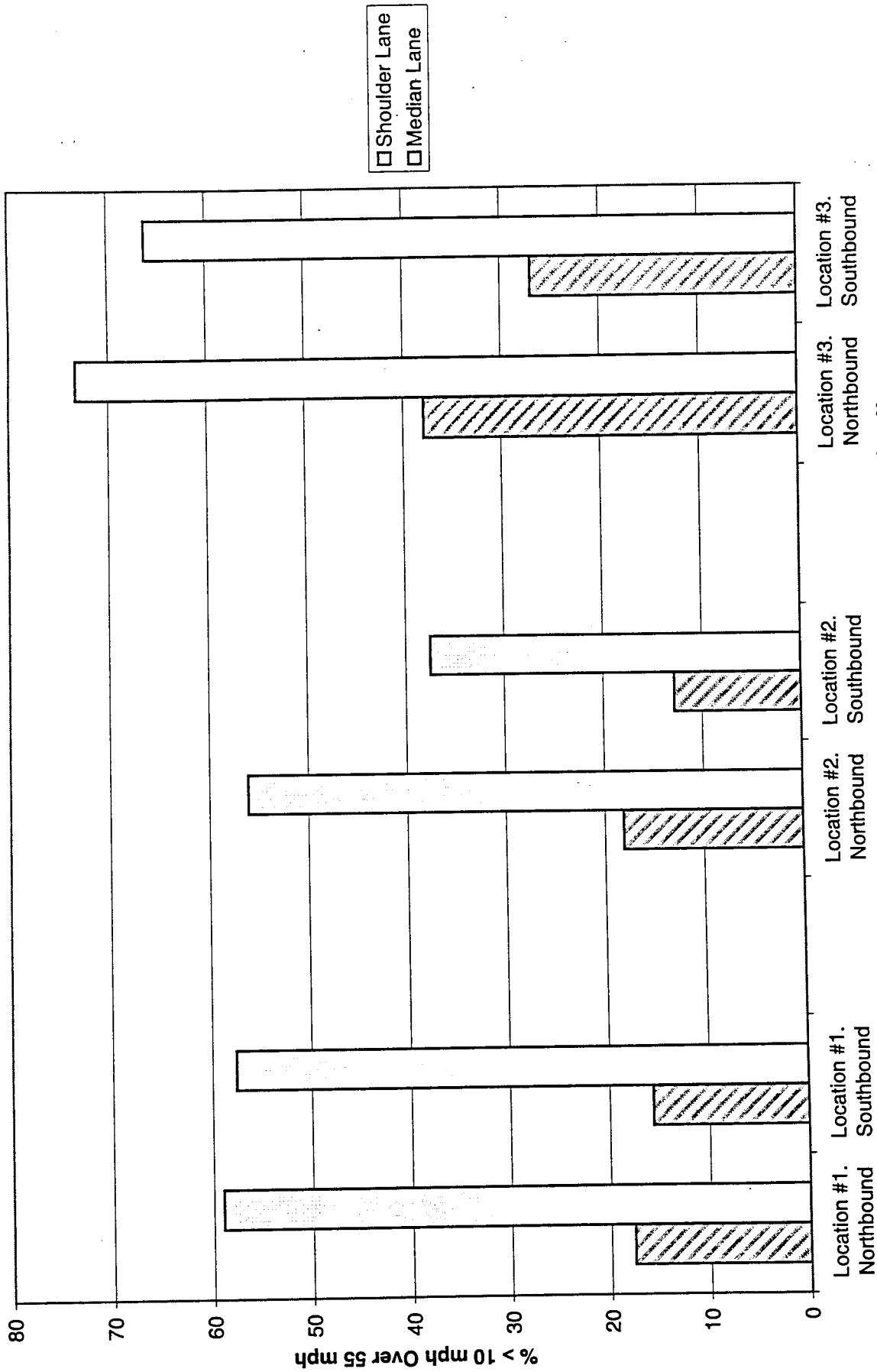

Figure 6. Percentage of Vehicles Exceeding the Posted Speed Limit by 10 mph or More

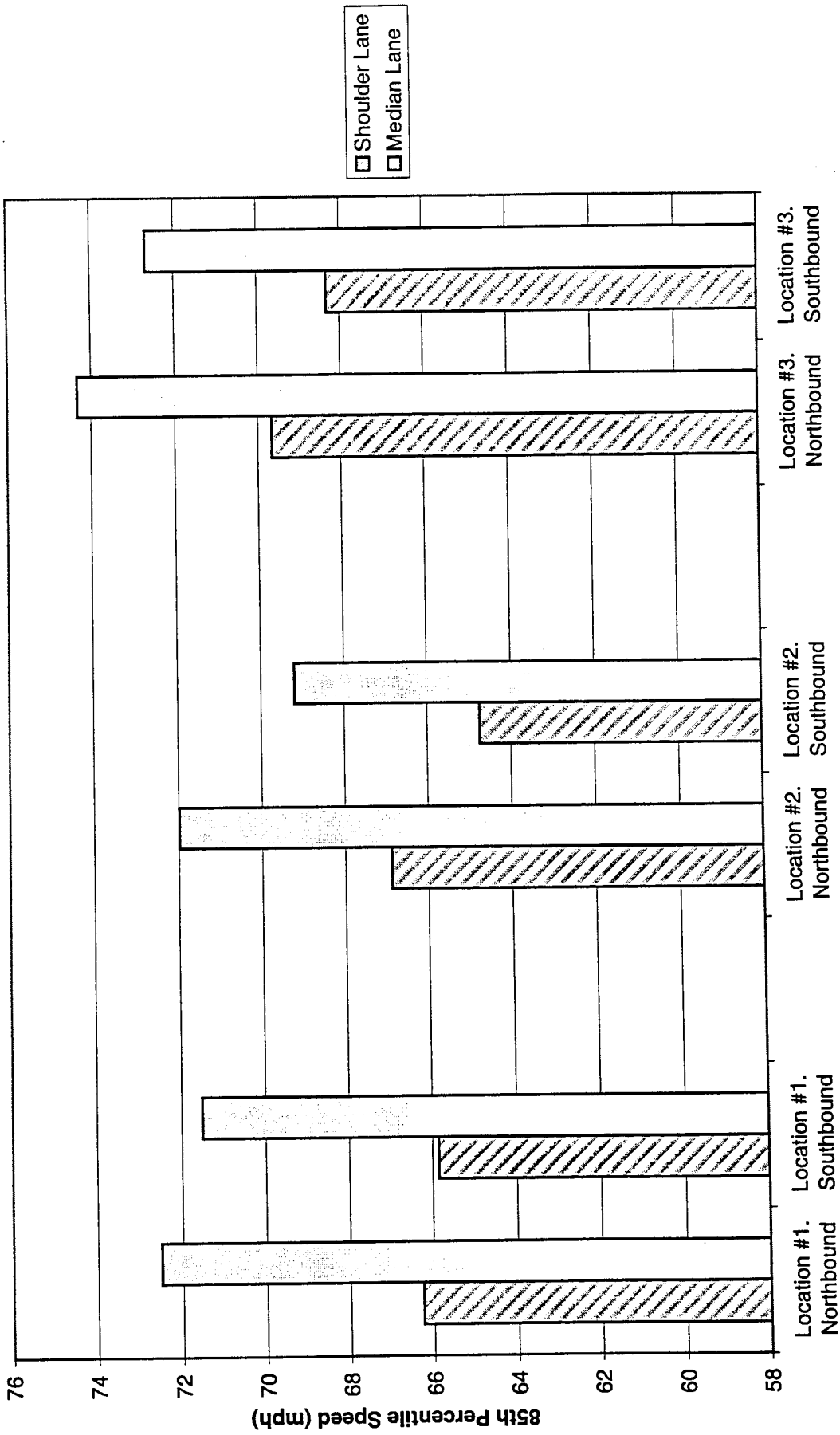

Figure 7. 85th Percentile Speeds

drivers and 66% of the truck drivers reported that they reduced their speed to the posted speed limit when entering a work zone. Of the drivers who reported reducing their speed to the posted limit, 91% of the automobile drivers and 89% of the truck drivers indicated they maintained their reduced speed throughout the entire length of the work zone or until they were able to observe and match the speed of surrounding traffic.

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Mr. Brad Hibbs, P.E.
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Appendix A.

Driver Opinion Survey Questionnaires and Cover Letter

Individual Information:
1. How many years have you been a licensed driver? _____ years 2. Age? ____ years 3. ___ male ___ female

4. How often do you drive (on average)?

____ every day
____ 4 - 5 days per week
____ 2-3 days per week
____ about once per week
____ less than once per week

5. In regards to the speed of your vehicle, *when you first enter a work zone* on an Interstate highway or other major state route, **YOUR** most likely response is to(check one):

____ maintain your pre-work zone speed
____ reduce your speed by 1 to 5 miles per hour
____ reduce your speed by 6 to 10 miles per hour
____ reduce your speed to the posted work zone speed limit
____ drive at the speed of surrounding traffic

6. In response to #5 above, *if you **reduce** your speed when you first enter a work zone*, how far into a long work zone (for example 2 miles long) do you maintain this lower speed?

____ 1/2 mile or less
____ 1/2 mile to 1 mile
____ 1 mile to 1.5 miles
____ 1.5 miles to 2 miles
____ entire length of the work zone
____ Until I observe speed of other vehicles

7. Based on a scale of 1 to 5, (*1 = not effective, 5 = very effective*), rate the following as to their effect on reducing **YOUR** speed in a work zone.

1 ——— 2 ——— 3 ——— 4 ——— 5
not effective moderately effective very effective

____ construction vehicles near your traffic lane
____ presence of a flagger
____ presence of parked police car
____ presence of construction workers
____ presence of passengers in your vehicle
____ presence of a police officer
____ flashing speed limit sign
____ orange work zone signs prior to the work zone
____ signs with flashing lights
____ rumble strips in the pavement
____ orange barrels
____ concrete barriers
____ flashing sign showing YOUR speed
____ other (please specify below) *

8. Using a scale of 1 to 5, (*1 = not dangerous, 5 = very dangerous*), rate your perception of the following situations:

1 ——— 2 ——— 3 ——— 4 ——— 5
not dangerous moderately dangerous very dangerous

____ presence of construction workers
____ work zone signs posted, workers present
____ work zone signs posted, no workers present
____ traffic shift (S-curve)
____ changeable message sign flashing message
____ concrete barriers
____ construction equipment
____ orange barrels
____ flashing arrow boards
____ other (please specify below)*

9. On a scale of 1 to 5, with 1 indicating not safe and 5 indicating very safe, please rate your perception of how most **OTHER** people drive in work zones.

1 ——— 2 ——— 3 ——— 4 ——— 5
not safe usually safe very safe

_____ your perception of other drivers

10. On a scale of 1 to 5, with 1 indicating not safe and 5 indicating very safe, please rate **YOUR** driving performance in work zones.

_____ your self-rating of performance

11. Please choose from the five choices listed what YOUR most likely response would for the situations listed below:

1 = maintain your pre-work zone speed
2 = reduce your speed by 1 - 5 mph
4 = drive at the speed of surrounding traffic
5 = reduce your speed to the posted work zone speed limit

3 = reduce your speed by 6 - 10 mph

___ concrete barriers
___ work zone signs posted, workers present
___ work zone signs posted, no workers present
___ traffic shift (S-curve)
___ changeable message sign flashing message
___ other (please specify below)*

___ flashing arrow boards
___ construction equipment
___ orange barrels
___ presence of construction workers
___ presence of a flagger

12. On a scale of 1 to 5, (*1 = not likely, 5 = very likely*), please rate the following conditions which may cause you to reduce your speed in a work zone.

1 ——————2——————— 3 ——————4——————— 5
not likely somewhat likely very likely

___ very high fine/double fine
___ presence of law enforcement
___ presence of workers

___ good chance of being caught speeding
___ flashing sign showing YOUR speed
___ other (please specify below)*

13. In general, do you feel the ***posted speed limits*** (Black on White signs) on Interstate and other high speed highways (e.g., US-29) are too low, too high, or set at the correct level?

___ too high ___ too low ___ correct

comments?

14. Which of the following would best describe your attitude as you enter and travel through a work zone (Check all that apply):

___ nervous ___ irritated ___ fearful ___ uncertain
___ calm ___ confused ___ uncomfortable ___ other (please list):

15. In response to your answer(s) to item 14 above, explain why you may feel this way.

16. In your opinion, what is the best way to make sure that drivers obey the posted speed limit in work zones?

17. In your opinion, what is the *biggest safety problem* with highway work zones?

18. As a motorist, what recommendations do you have to improve work zone safety.

UNCCHARLOTTE
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THE WILLIAM STATES LEE
COLLEGE OF ENGINEERING

Department of Civil Engineering
704/547-2304
FAX: 704/547-2352

To All Research Participants:

The purpose of this research is to investigate motorist perceptions, opinions, expectations and other psychological factors which influence driving behavior in highway work zones. Results of this research will produce recommendations designed to improve both motorist and worker safety in the zones. The research involves the completion of the attached survey by North Carolina residents holding a current Commercial Driver's License.

Your participation in this research is completely voluntary, and you may discontinue your participation at any time without any consequences.

Your responses to the attached survey are anonymous; do not write your name or any other identifying information on the survey. Your survey responses are also confidential. The number on your survey is to allow the researchers to know when a particular survey has been returned, so that redundant follow-up surveys will not be sent. Names will be matched with numbers for this tracking purpose only, and this information will be confidential and known only by the researchers. Finally, the information obtained for this research will be used for research purposes only; only aggregated, group data will be publicly shared.

If you have any questions about the research, you may contact the researchers listed below:

Dr. Ellis King (704) 547-4172
Dr. Martin Kane (704) 547-4890

UNC-Charlotte is eager to ensure that all research participants are treated in a fair and respectful manner. If you have any concerns or questions about your treatment as a subject in this project, contact Dr. David Test, Department of Counseling, Special Education, and Child Development, Charlotte, NC 28223, (704) 547-3731.

The time involved to complete the survey is only about 10 minutes. Please return the completed survey in the enclosed envelope. We greatly appreciate your taking this time to help us improve highway safety. Thank you for your participation!

Appendix B.

Focus Group Introduction and Guide Questions

Introduction: The meeting today is part of a research project being conducted by UNC-Charlotte sponsored by the North Carolina Dept. of Transportation (NCDOT). The purpose of this meeting is to discuss and find out your opinions about driving in work zones on interstate highways in the state of North Carolina. Work zones occur whenever maintenance or reconstruction is taking place on or near the driving lanes of a highway and can include such things as mowing operations, pothole patching, and complete lane closures. We are concerned primarily with work zones on Interstate highways or similar highways throughout the state. There are several discussion questions which I will present to you. There are no right or wrong answers as this is an opinion survey. The meeting is being recorded on audiotape so that your responses can be replayed and further analyzed at a later time. This tape will remain in possession of the research team and will not be released to any person or organization at any time. Your participation in this process is voluntary and you may terminate your participation at any time you decide.

Results from this research effort may lead to safer conditions in work zones for workers and drivers and improve the overall level of safety on North Carolina roads. Your time and comments are appreciated.

(These are the questions to be addressed during the focus group meetings. The wording of the question is not as important as the content of the question.)

1(8). Using a scale of 1 to 5, (1 = not dangerous, 5 = very dangerous), rate your perception of the following situations:

1 ----------2---------- 3 ----------4---------- 5
not dangerous moderately dangerous very dangerous

____ presence of construction workers
____ work zone signs posted, workers present
____ work zone signs posted, no workers present
____ traffic shift (S-curve)
____ changeable message sign flashing message
____ concrete barriers
____ construction equipment
____ orange barrels
____ flashing arrow boards
____ other (please specify below)*

In regard to the above situations ..... that you may encounter when traveling through a work zone, do any of the situations give you any particular problem or cause you to have any strong feelings?

prompts: for example, some reports have noted that drivers feel less safe when concrete barriers are on the edge of a traffic lane because it makes the lane seem narrower. Do any of you have similar feelings about concrete barriers?

responses:

2(12). On a scale of 1 to 5, (1 = not likely, 5 = very likely), please rate the following conditions which may cause you to reduce your speed in a work zone.

1 ----------2---------- 3 ----------4---------- 5
not likely somewhat likely very likely

____ very high fine/double fine
____ presence of law enforcement
____ presence of workers
____ good chance of being caught speeding
____ flashing sign showing YOUR speed
____ other (please specify below)*

Are there any reasons why you feel that any of the above conditions ..... e.g., ... would be any more effective for reducing speeds, from your perspective, in work zones? Why?

prompts: for example, the Pennsylvania Turnpike has the fine structure posted on large signs when you enter the turnpike. Have any of you encountered this or a similar situation?

responses:

3(14). Which of the following would best describe your attitude as you enter and travel through a work zone (Check all that apply):

____ nervous	____ irritated	____ fearful	____ uncertain
____ calm	____ confused	____ uncomfortable	____ other (please list):

Are there any other words that would better describe how you feel as you enter and travel through a work zone than those already listed?

prompts: for example, if construction zone signs are too close to the beginning of a work zone, would you be irritated and who would you be irritated at?

responses:

4(15). In response to your answer(s) to item 14 above. explain why you may feel this way.
responses:

5(17). In your opinion, what is the biggest safety problem with highway work zones?

prompt: too many trucks? not enough exits? poor signs?

6(16). In your opinion, what is the best way to make sure that drivers obey the posted speed limit in work zones?

Appendix C.

Spot Speed Data

Location #1. I-85 north of SR1500

Northbound

	Lane	SpLimit	%over 55	%over 10+	85th %ile	Total # vehicles
Averages	outside	55	87.7	17.6	66.25m/h	60409
	inside	55	97.4	59	72.5	44945
Weekday	outside	55	85.6	13.7	64.84	33200
	inside	55	96.8	51.2	71.5	25927
Weekend	outside	55	89.8	21.5	67.65	27209
	inside	55	98.1	66.8	73.5	19018
Night 8pm-5am	outside	55	88.9	22.7	n/a	12247
	inside	55	94	56.4	n/a	6358
Day 8am-5pm	outside	55	87.5	18.6	n/a	31949
	inside	55	97.9	59.9	n/a	26247
Weekday (Day)	outside	55	84.4	13.3	n/a	16575
	inside	55	97.2	49.7	n/a	14208
Weekend (Day)	outside	55	90.5	22.01	n/a	15374
	inside	55	98.8	68.6	n/a	12039

Southbound **********

	Lane	SpLimit	%over 55	%over 10+	85th %ile	Total # vehicles
Averages	outside	55	85.8	15.6	65.85m/h	59483
	inside	55	98.1	57.6	71.51	48835
Weekday	outside	55	82.6	11.9	64.6	32594
	inside	55	97.3	49.4	69.81	29747
Weekend	outside	55	88.8	19.01	67.01	26889
	inside	55	98.98	65.3	73.15	19088
Night 8pm-5am	outside	55	85.9	17.1	n/a	11918
	inside	55	97.05	52.3	n/a	7105
Day 8am-5pm	outside	55	85.25	16.5	n/a	31953
	inside	55	98.15	59.1	n/a	28177
Weekday (Day)	outside	55	81.56	11.57	n/a	16737
	inside	55	97.3	49.5	n/a	16439
Weekend (Day)	outside	55	88.97	19.7	n/a	15216
	inside	55	99.3	68.9	n/a	11738

Location #2. I-85 north of Peach Orchard Road (SR2539)

Northbound

	Lane	SpLimit	%over 55	%over 10+	85th %ile	Total # vehicles
Averages	outside	55	91.7	18.1	66.88	30529
	inside	55	97.3	56.1	71.99	23961
Weekday	outside	55	91.7	18.1	66.88	30529
	inside	55	97.3	56.1	71.99	23961
Weekend	outside	55	no data	no data	no data	
	inside	55	no data	no data	no data	
Night 8pm-5am	outside	55	92.6	21.3	n/a	6147
	inside	55	91.1	52.3	n/a	3309
Day 8am-5pm	outside	55	91.9	17.6	n/a	15500
	inside	55	98.6	57.3	n/a	13065
Weekday (Day)	outside	55	91.9	17.6	n/a	15500
	inside	55	98.6	57.3	n/a	13065
Weekend (Day)	outside	55	no data	no data	no data	
	inside	55	no data	no data	no data	

Southbound **********

	Lane	SpLimit	%over 55	%over 10+	85th %ile	Total # vehicles
Averages	outside	55	87.3	12.8	64.74	15656
	inside	55	90.2	37.5	69.19	summary
Weekday	outside	55	87.3	12.8	64.74	15656
	inside	55	90.2	37.5	69.19	summary
Weekend	outside	55	no data	no data	no data	
	inside	55	no data	no data	no data	
Night 8pm-5am	outside	55	88.6	15.7	n/a	3255
	inside	55	no data	no data	no data	
Day 8am-5pm	outside	55	88.2	12.99	n/a	8011
	inside	55	no data	no data	no data	
Weekday (Day)	outside	55	88.2	12.99	n/a	8011
	inside	55	no data	no data	no data	
Weekend (Day)	outside	55	no data	no data	no data	
	inside	55	no data	no data	no data	

Location #3. I-85 north of Exit 10B (SR1302)

Northbound

	Lane	SpLimit	%over 55	%over 10+	85th %ile	Total # vehicles
Averages	outside	55	93.5	37.9	69.67	93743
	inside	55	92.4	73.3	74.33	69094
Weekday	outside	55	97.3	36.18	69.22	52021
	inside	55	96.08	74.76	73.92	39842
Weekend	outside	55	97.93	45.73	70.73	29803
	inside	55	98	81.57	75.62	20586
Night 8pm-5am	outside	55	97.49	43.07	n/a	16741
	inside	55	88.82	64.61	n/a	8544
Day 8am-5pm	outside	55	97.53	39.25	n/a	41539
	inside	55	98.09	80.83	n/a	31952
Weekday (Day)	outside	55	97.11	33.47	n/a	25619
	inside	55	97.81	78.42	n/a	20114
Weekend (Day)	outside	55	98.22	49.05	n/a	15920
	inside	55	98.58	84.92	n/a	11838

Southbound **********

	Lane	SpLimit	%over 55	%over 10+	85th %ile	Total # vehicles
Averages	outside	55	93.4	26.9	68.32	69687
	inside	55	98.1	66.2	72.68	60454
Weekday	outside	55	92.39	23.97	67.93	38511
	inside	55	98.04	66.11	72.57	42563
Weekend	outside	55	94.41	29.71	68.7	31176
	inside	55	98.21	66.32	72.86	17891
Night 8pm-5am	outside	55	91.17	23.23	n/a	14709
	inside	55	95.73	51.65	n/a	10551
Day 8am-5pm	outside	55	94.27	28.46	n/a	36289
	inside	55	98.71	70.43	n/a	33605
Weekday (Day)	outside	55	93.21	24.67	n/a	19579
	inside	55	98.68	69.57	n/a	23103
Weekend (Day)	outside	55	95.51	32.9	n/a	16710
	inside	55	98.8	72.34	n/a	10502