INSTALLATION OF RAISED PAVEMENT MARKERS FOR REDUCING INCIDENCES OF WRONG-WAY DRIVING IN SNOWPLOW REGIONS

by

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(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

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ABSTRACT

Recently completed research had proven the feasibility of using raised pavement markers to alert wrong-way drivers to their errors. In that research, however, the raised markers had been placed only in areas where snowplowing was not a problem; therefore, the research described in the present report was undertaken to determine if problems would be encountered in adapting the system employing the raised markers to areas where snowplowing is prevalent. Based on the results of this research, it is believed that the method described for placing the raised pavement markers is effective in protecting them from damage by snowplows. The method of grooving allows the markers to be protected from damage and provides effective retroreflection for warning wrong-way drivers.

It is recommended that the system of raised pavement markers placed as noted in this report be considered for placement at ramp areas or similar locations where wrong-way entries are a problem.

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INTRODUCTION

Research completed prior to the initiation of the project reported upon here evaluated the feasibility of using raised pavement markers to alert wrong-way drivers to their errors.(1,2) Based on that research, it was concluded that the unique method used in placing the raised pavement markers was effective in alerting drivers as a result of their viewing an unexpected phenomenon. In that research, however, the raised markers were placed only in areas where snowplowing was not a problem; therefore, it was recommended that research into the adaptation of this system to areas where snowplowing is prevalent be undertaken. It was also recommended that observations of the installations used in the research cited should be continued to determine the overall durability of the raised markers and the point at which the system becomes ineffective because of a loss in retroreflectivity.(2) The following report details the implementation of these recommendations.

PURPOSE AND SCOPE

The purpose of the evaluation was to adapt the marker system to areas where snowplowing is prevalent in addition to continuing observation of existing installations to determine their overall durability. The research was limited to a study of commercially available, corner-cube raised markers placed on limited access highways.

PROCEDURE

The procedure described below pertains to the installation of markers for snowplow regions. Information concerning the existing sites, which are located on Route 44 in Virginia Beach, is available in another report.(2)

Method of Placement

Preliminary experiments were conducted with different methods of placing the markers so as to protect them from damage by snowplows. Methods considered included placing the markers in snowplowable steel castings attached to the road surface and

placing them in grooves cut into the pavement. The use of steel castings was eliminated because of the possible adverse effect the markers might have on drivers traveling in the proper direction on the roadway. Pavement grooves were, therefore, used as a means of placing and protecting the markers (see Figure 1).

Since this groove configuration had peaks extending almost to the original road surface, an area had to be cut out so the marker could be placed below the surface to keep it from being damaged by snowplows. Therefore, an area 4 in. (10 cm) wide by 1/2 in. (1.3 cm) deep was cut out at the end of the grooves downstream from potential wrong-way traffic. Also the distance between the peak and valley groove and the depression cut for the marker was varied, with two distances being used. In one the peak of the groove extended to the marker and in the other it was 12 in. (30 cm) from the marker as shown in Figure 2. This distance was varied to investigate the effect of traffic on the durability of the marker; i.e., to determine if the peaks protected the marker when they extended to the marker face and how the proximity of the marker to the peak would influence the cleaning of the marker face by traffic. Drainage grooves 1/2 in. (1.3 cm) by 1/2 in. (1.3 cm) were installed to carry water from those markers susceptible to ponded water.

The groove shown was cut with a concrete saw modified to accommodate a special diamond-drum cutter assembly. The 4 in. (10 cm) wide by 1/2 in. (1.3 cm) deep rectangular area for the marker was cut with a hand-held concrete saw and impact hammer. Once epoxied in place, the marker top was flush with the pavement surface.

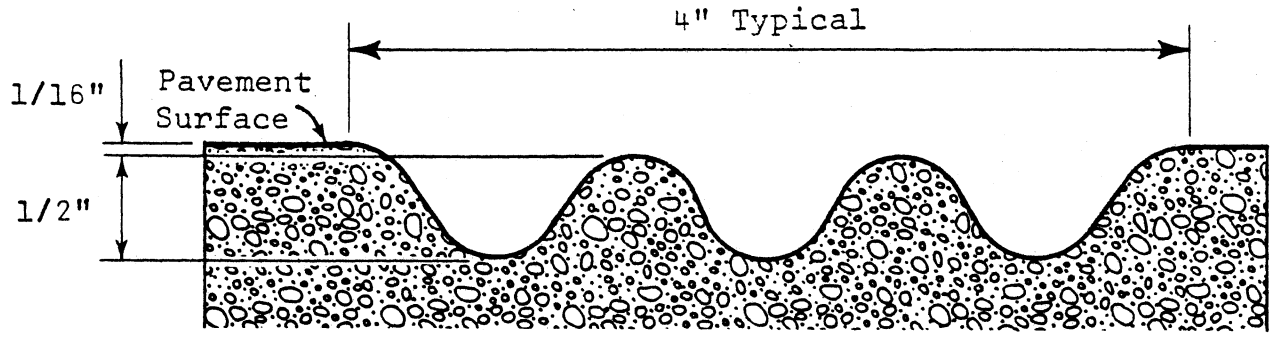

Figure 1. Cross section of groove.
Note: 1 inch = 2.54 cm.

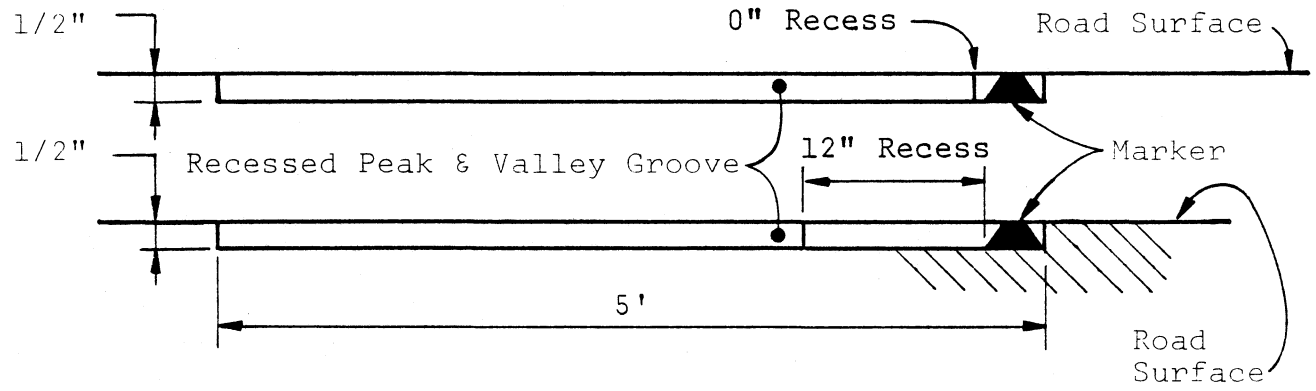

Figure 2. Variables included in each section.
Note: 1 inch = 2.54 cm.

Sites

Two sites were chosen for installation of the pavement marking system on Interstate 64 adjacent to Waynesboro; one at Route 340 and the other at Route 624. Both sites are off-ramps at a diamond interchange; however, one site has a negative grade and the other a positive grade. The sites are shown pictorially in Figures 3 and 4 and schematically in Figure 5. Both sites are on bituminous pavements.

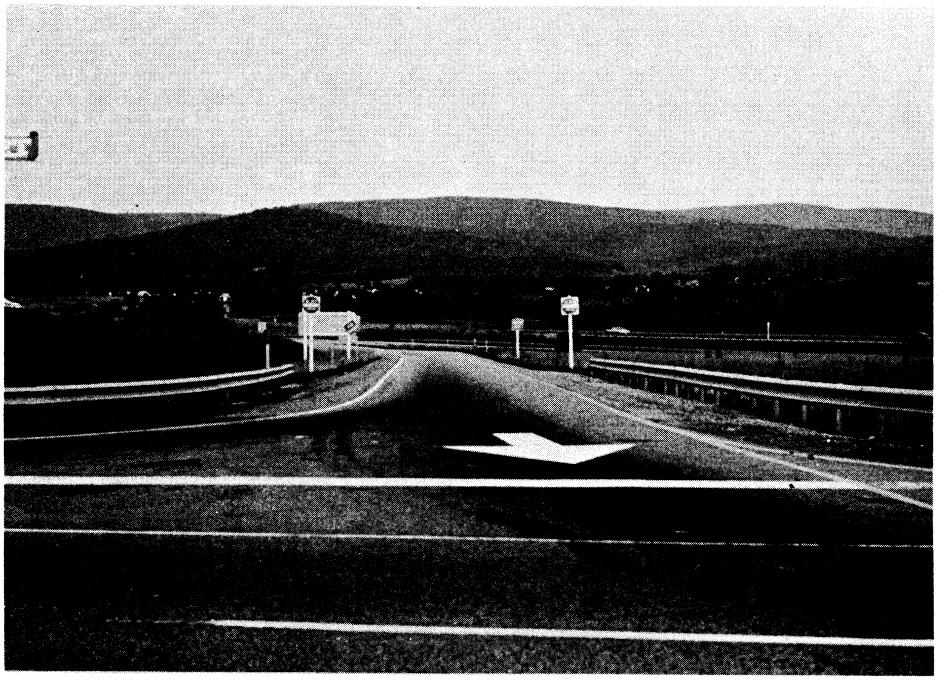

Figure 3. Route 340 site.

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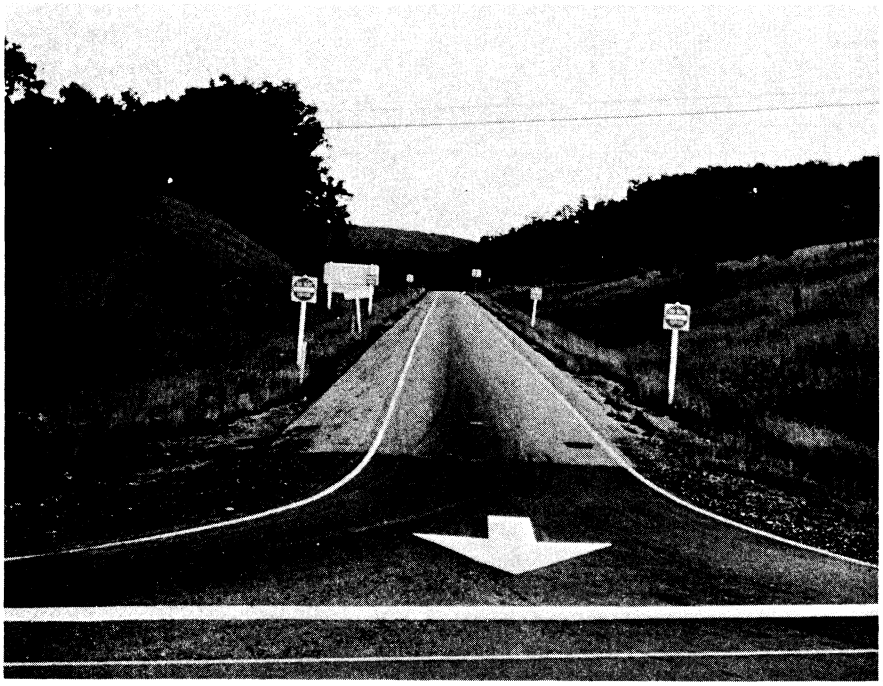

Figure 4. Route 624 site.

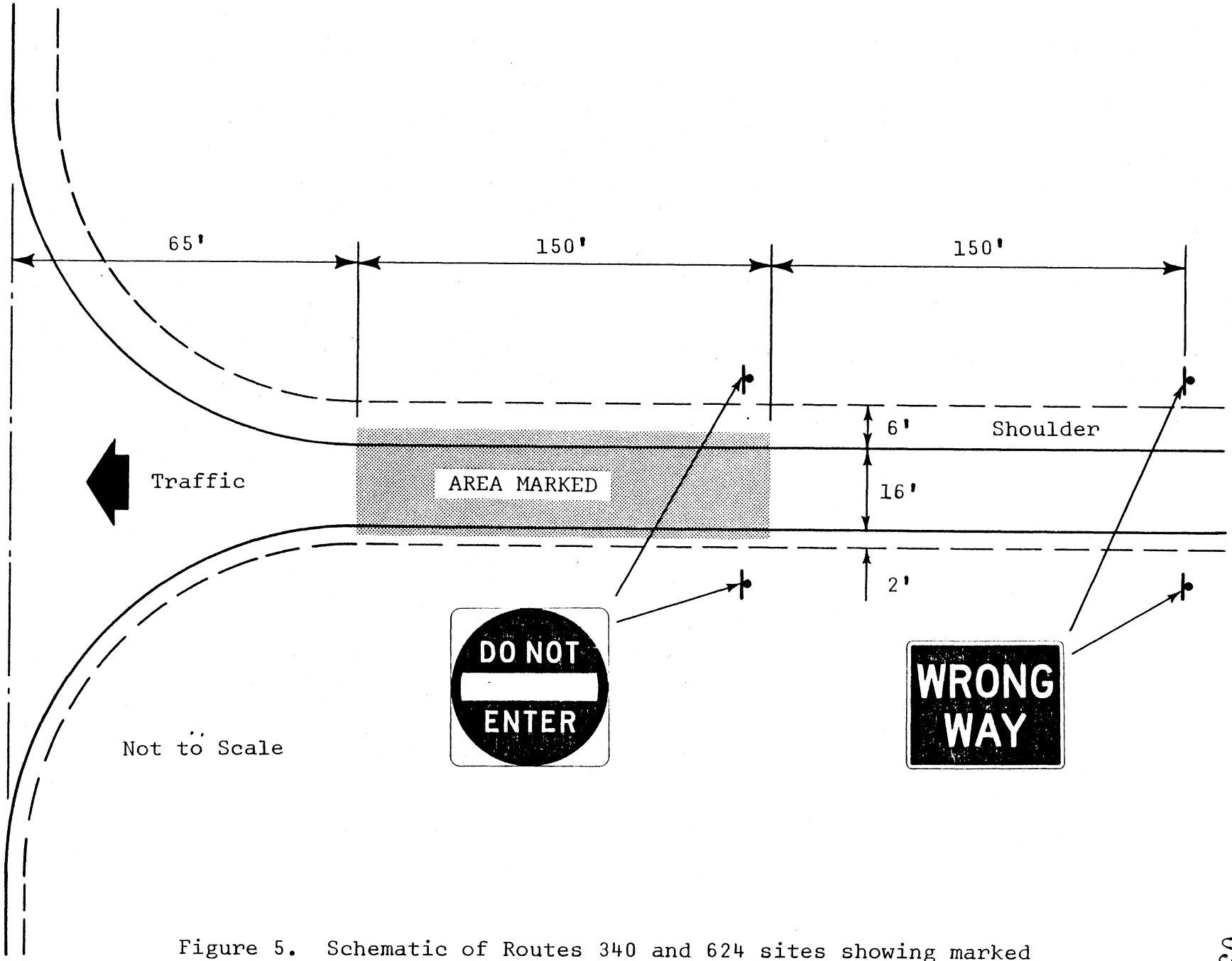

Figure 5. Schematic of Routes 340 and 624 sites showing marked area. Note: 1 foot = 0.30 meter.

Installation of Markers

Stimsonite Type 88 mono-directional red markers were installed. This marker, shown in Figure 6, has a white opaque surface on one side and a red reflectorized surface on the other. All the markers were placed so that the red reflectorized face was perpendicular to the highway alignment facing potential wrong-way drivers. The driver going in the proper direction would see only an opaque surface, which is relatively inconspicuous.

A total of 42 markers were installed at each site in seven equally spaced lines perpendicular to the flow of traffic. Each line contained six randomly spaced markers. Figure 7 shows the marker configuration for both sites. All markers were attached to the pavement with an epoxy adhesive supplied with them.

The length, width, and position of the marked area are dependent on the particular roadway geometrics and alignment; therefore, it is difficult to establish a criterion for placement. However, the markers were placed longitudinally to give the motorist a chance to turn completely into the ramp area before crossing the marked section. Also, it was thought that terminating the marked section in the vicinity of the wrong-way sign would help call attention to the sign.

It is estimated that the total cost of installing each site, which comprised the costs of the markers and adhesive plus labor and equipment, was approximately $500. However, it is thought that this cost can be reduced to approximately $300 - $400 by refining the placement procedure; e.g., by improving the method of cutting the rectangular area in which the marker is placed. Also, more efficient use may be made of the equipment by coordinating the installation of markers at several sites.

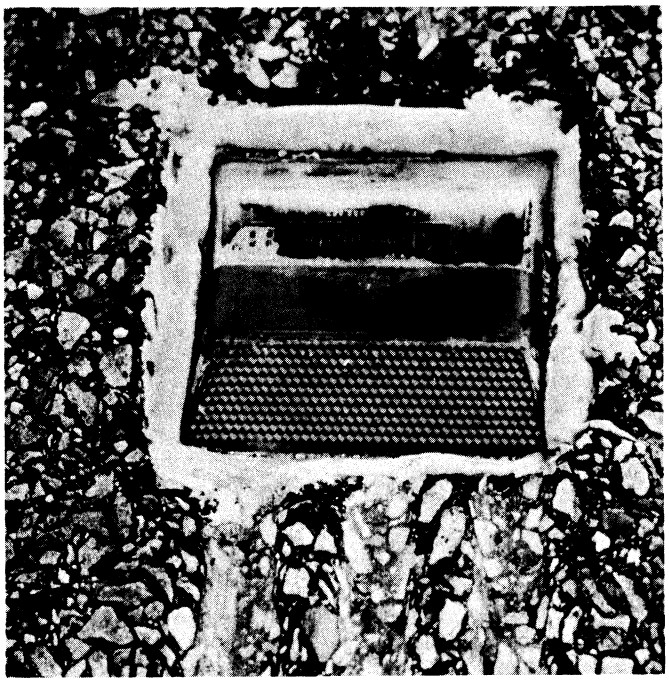

Figure 6. Mono-directional red marker in place.

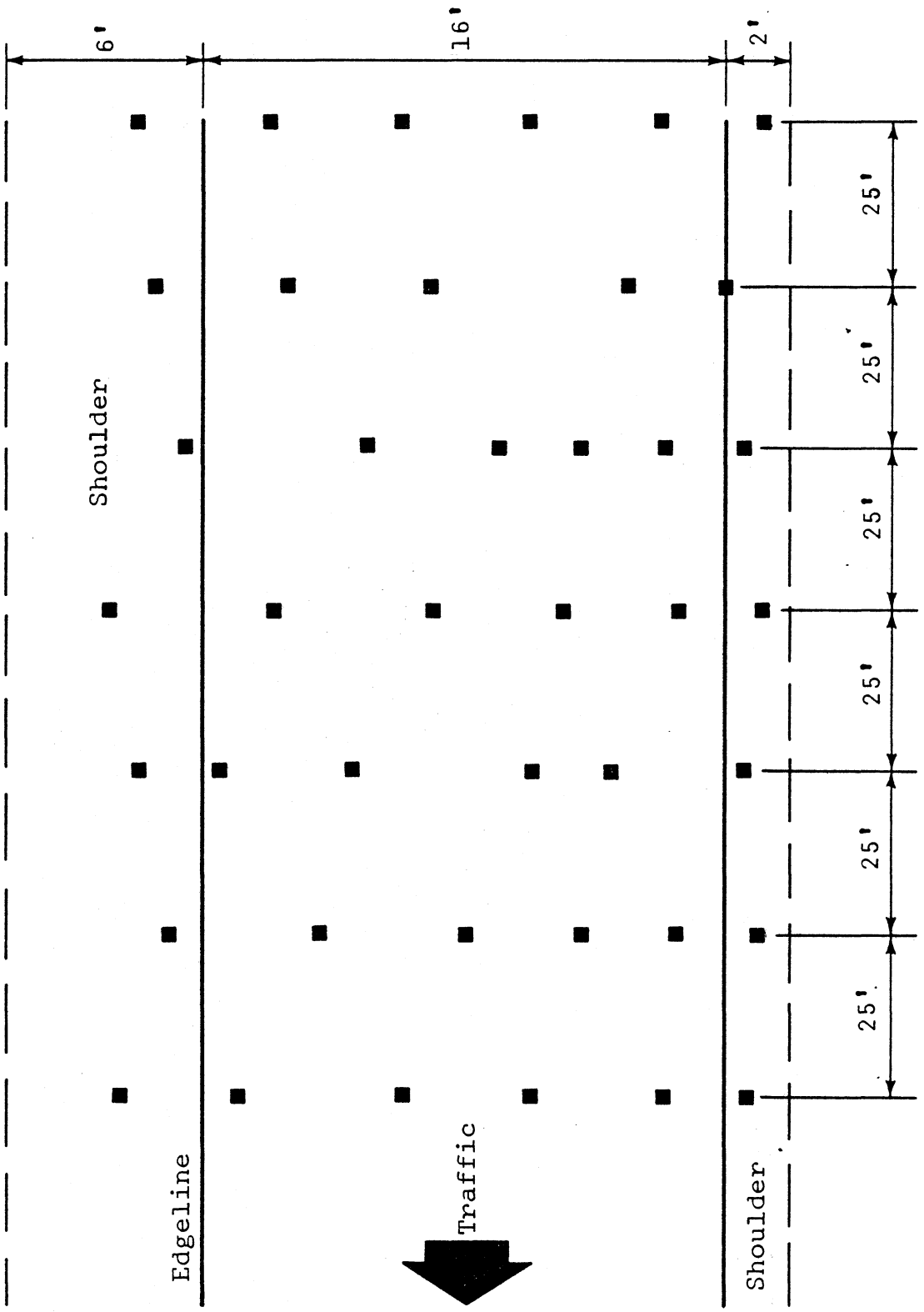

Figure 7. Marker configuration for Route 340 and 624 sites.
Note: 1 foot = 0.20 meter.

EVALUATION

The evaluation was concerned primarily with devising methods of placing the markers so as to protect them from snowplows. Also, any influence the selected method of placement had on the durability and visibility properties was evaluated subjectively.

Observations of the existing installations on Route 44 in Virginia Beach, which were not protected from snowplowing, were continued in an attempt to determine the overall durability and visibility over time.

Durability

The resistance of the markers to damage from snowplowing over one winter was determined by visually noting damage to the markers and the estimated percentage of the face obliterated.

Visibility

The retroreflective qualities of both the old and new installations were subjectively evaluated by the author and a technician on a scale of 0 to 10, with 10 denoting the brightness or degree of retroreflection when the system was initially installed and 0 when the system had completely failed, i.e., when no light was being reflected from the system. It is noted that the visibility rating is included as a means for judging the relative effectiveness of the system in serving its function of reflecting light. All ratings were made from a vehicle approaching the marking system from the wrong direction at night with headlights on both high beam and low beam.

It should be noted that this procedure did not create a hazard as observations were made late at night when there was little traffic. Also, there was ample sight distance and shoulder-median space to allow time for the test vehicle to retreat when the light from an oncoming vehicle was sighted.

RESULTS

Durability

Interstate 64, Waynesboro

After one winter and approximately 29 inches (73.7cm) of snow and 14 passes of the snowplow, the markers at both sites showed no evidence of damage from snowplows. There was some damage to

the faces of the markers in the form of minute chips or cracks created by traffic; however, in no case was the wear severe enough to render the markers ineffective for their intended use.

After one year of exposure there was no evidence that the method of placing the markers, i.e., the distance of the peak and valley groove from the marker face, influenced the amount of surface wear.

The estimated percentages of the marker faces capable of reflecting light after one year was 89% for the Route 624 site and 79% for the Route 340 site. The major mechanisms by which the marker faces were obliterated were scratches by gravel or dirt films. It is noted that only the Route 340 site showed a dirt buildup, which is primarily responsible for the lower average percentage of light-reflecting surfaces there.

Since the Route 340 site was on a positive grade, the markers were susceptible to the accumulation of water, especially if the drainage grooves became clogged, as was the case for the majority of the markers. The clogging was caused by either a gravel accumulation or the groove being closed as a result of the bituminous pavement creeping under traffic. The area obliterated was always on the lower portion, which causes a limited adverse effect because, as can be seen in Figure 1, a larger portion of the bottom than the top was shielded from headlights by the surface of the pavement.

In all cases that portion of the marker face found to be unobliterated was intact and showed only some minor abrasion that did not impair its retroreflectivity.

Route 44, Virginia Beach

Since the Virginia Beach area does not generally experience much snow, the markers were placed on the pavement surface and durability was noted as resistance to traffic wear. However, during the last two winters there has been more snow and plowing in that area than in several years and there the markers have been damaged severely. Figures 8 and 9 show the percentages of markers lost or chipped along with the percentages of marker faces obliterated for the Lynnhaven and 21st Street installations, respectively. The percentage of face unobliterated is shown as a function of existing markers and as a function of the 49 originally installed. It is difficult to surmise the effect of typical traffic wear on the durability because of the effect of snowplowing; however, it is noted that the percentages of marker face unobliterated for existing unchipped markers were 76% for the Lynnhaven site and 89% for the 21st Street site after 139 weeks. The area of the markers available for reflecting light exhibited surface abrasion in the form of minute scratches and general wear; however, in no case was the wear sufficient to make the markers ineffective for their intended use.

As markers are lost and chipped the percentage of face available for reflecting light decreases as noted from the plots showing the percentage of marker faces unobliterated.

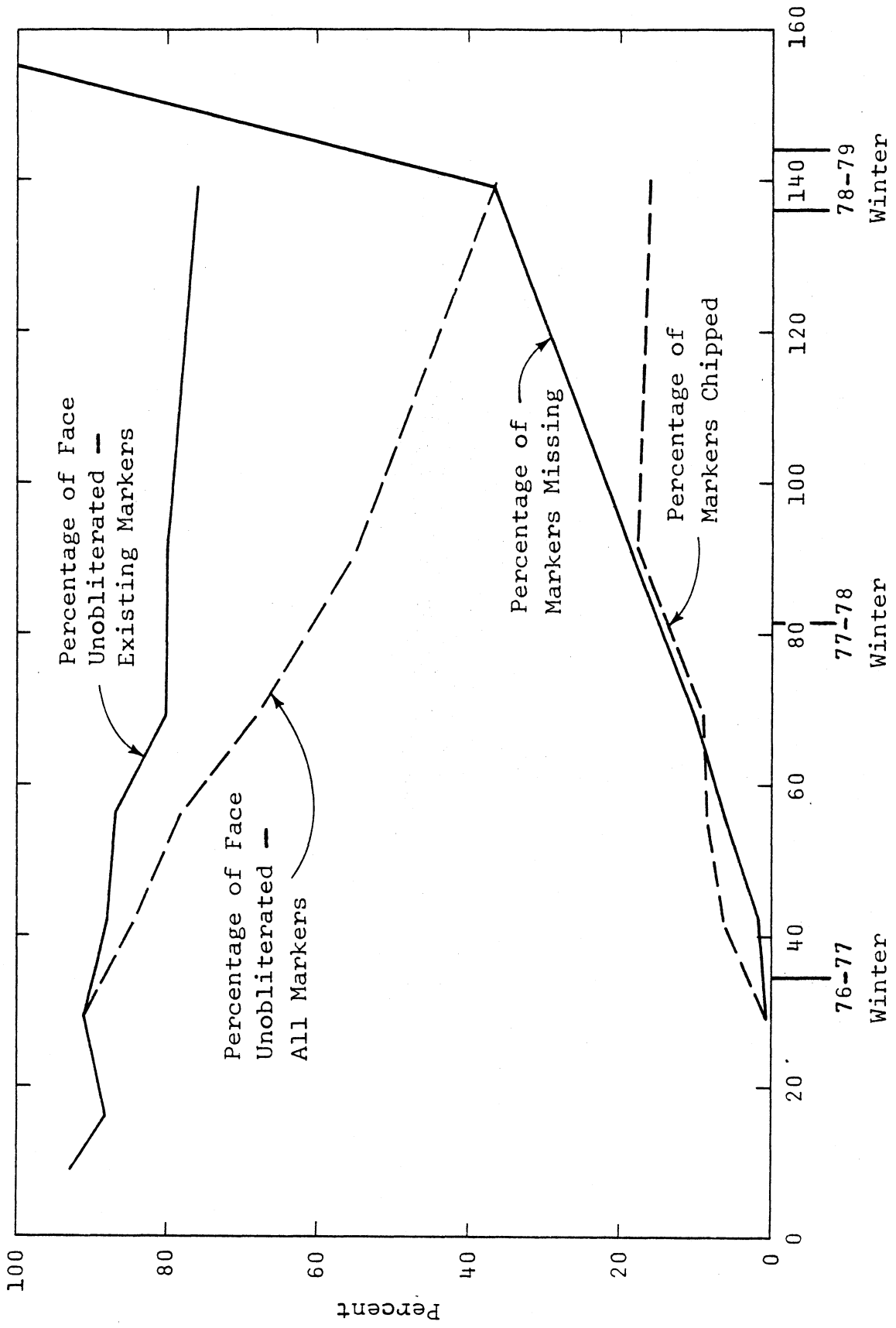

Figure 8. Marker damage for Lynnhaven site.

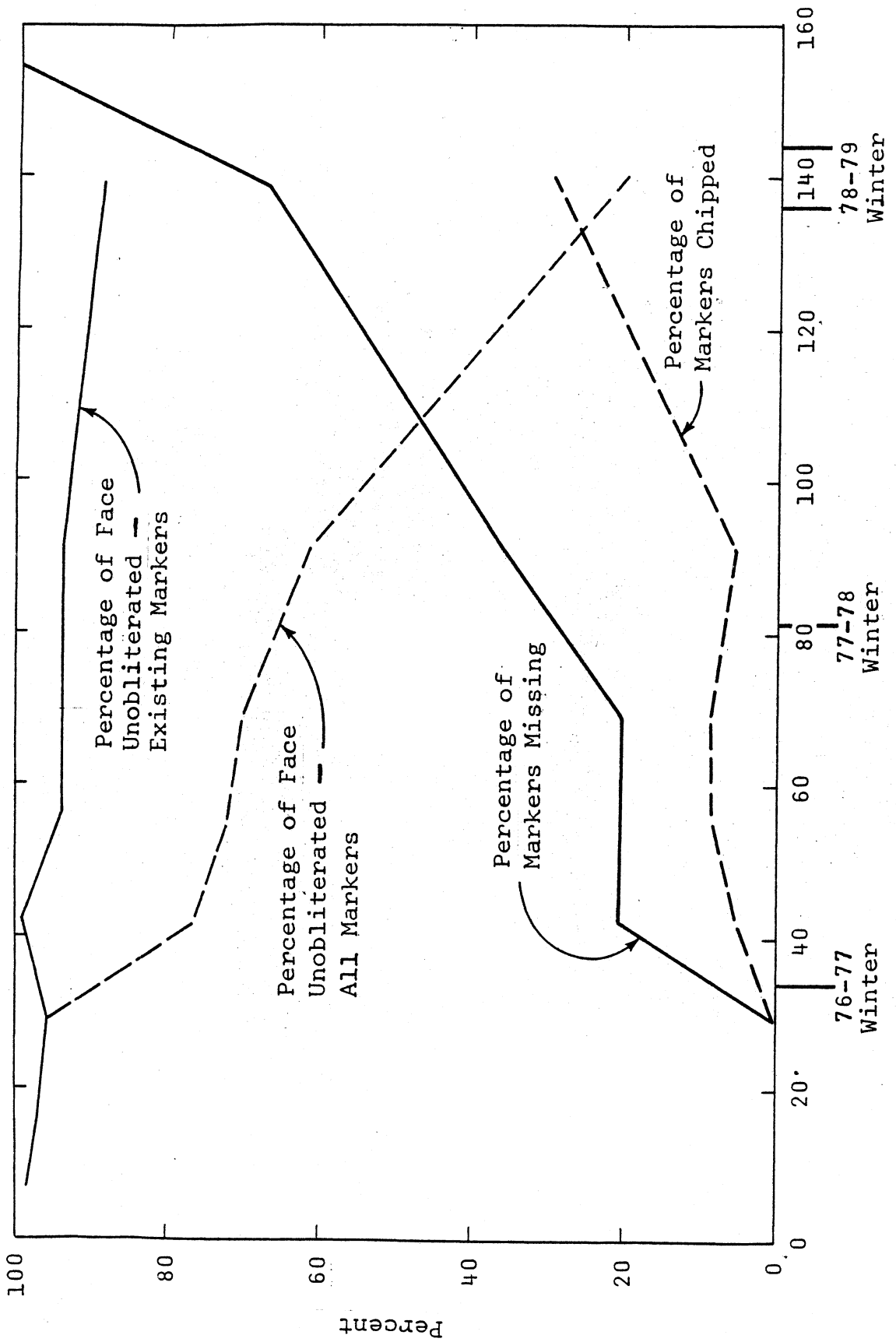

Figure 9. Marker damage for 21st St. site.

Visibility Characteristics

Interstate 64, Waynesboro

After one year, which saw 29 inches (73.7 cm) of snow requiring approximately 14 passes of snowplows, both of the I-64 installations had a rating of 8 to 9, which is considered to be very good. It is not known at which rating the system would be ineffective; however, it is surmised that a rating of 2 to 3 would be unsatisfactory. Since there was no snowplow damage to the markers the relative visibility of each installation, in terms of the amount of light reflected, is a function of the face area available for reflecting light.

Based on subjective observations, it was not apparent that the visibility had been influenced by the distance from the marker face to the start of the groove peaks.

Route 44, Virginia Beach

A rating of the relative visibility of each installation in terms of light being reflected is shown in Table 1. This rating, which was greatly influenced by the loss or chipping of markers by snowplowing, decreased as markers were lost.

Under the conditions of test, it is felt that the systems were still effective at the 2 to 3 level; however below this value the overall effectiveness is doubtful.

It should be noted that most of the decrease in total area of the existing markers available for retroreflection was a result of the faces of various markers being obliterated or partially covered with a black, hard substance. This substance is thought to be an accumulation of rubber from vehicle tires, and the greatest accumulation is in the wheel paths. It is noted that the accumulation tended to increase with time; however, during the winter months, it decreased.

Table 1

Rating of System Effectiveness Related to Brightness

Site	Weeks after Installation							
	7	16	29	42	56	69	91	139
Lynnhaven	9	9	9	8	7	6	5	3
21st Street	9	9	8	7	7	6	5	2

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the evaluation of the marker systems placed on the Interstate 64 ramps it is believed that the method of placing the raised pavement markers is effective in protecting the markers from damage by snowplows. The method of grooving allows the markers to be protected from damage and provides effective retroreflection for warning wrong-way drivers. Improvements in drainage, however, should be made to ensure that the markers retain their reflective characteristics.

After one year of exposure there was no evidence that the distance from the face of the marker to the start of the peak and valley groove influenced the durability of the markers.

Observations of the existing marker systems on Route 44 indicated that the systems are still effective after a loss of over 50% of the markers.

It is recommended that the Department adopt a policy of placing raised pavement markers at ramp areas or similar locations where wrong-way entries are a problem. The placement of the markers should conform with the configurations and be protected from snowplowing as noted in this report.

REFERENCES

1. Shepard, F.D., "Evaluation of Raised Pavement Markers for Reducing Incidences of Wrong-Way Driving", Virginia Highway and Transportation Research Council, June 1975.

2. _____, "Installation of Raised Pavement Markers for Reducing Incidences of Wrong-Way Driving", Virginia Highway and Transportation Research Council, June 1977.