2-3-10 Use of Chevrons February 2018

GENERAL

The WisMUTCD classifies the chevron as an alignment sign, but it is basically a delineator with a directional connotation, which is the aspect of the sign that relegates its use to horizontal curves. It is not to be used at roadway width transitions, lane drops, or approaches to narrow bridges. It is also not to be used singly, because that will not adequately develop the directional message. Another inappropriate use is in a cluster at the end of a T-intersection.

Chevrons (W1-8) signs *may* be used in combination with the large night arrow (W1-6) sign or without the large night arrow sign. Table 2C-5 of the WisMUTCD provides guidance as to when chevron signs are used.

The WisMUTCD, Table 2C-6 contains spacing criteria for installations of chevrons, which has been included as part of this policy.

GUIDANCE

The following guidelines apply to these signs:

1. It is desirable to position one chevron directly ahead of an approaching vehicle while the vehicle is on the approach tangent, and begin spacing in both directions from that point.
2. Extend to the point of curvature, and to the point of tangency; do not alter the spacing to meet these points, however.
3. A minimum of three signs **shall** be used, even if they extend beyond the point of curvature. Also, per the WisMUTCD, the spacing of chevron signs *should* be such that the road user has at least two in view, until the change in alignment eliminates the need for the signs.
4. Chevron signs **shall not** be placed on the far side of a T-intersection to warn drivers that a through movement is not possible.
5. Chevron signs **shall not** be used to mark obstructions within the roadway.
6. Follow the spacing table below, making adjustments for conflicts with driveways, signs, etc. The chevron spacing shown below are maximum distances between chevrons. Chevrons may be spaced closer to address curves with tighter radius measurements.

Chevron signs **shall** be mounted at a 4-foot minimum height (measured from the bottom of sign to the elevation of the near edge of traveled way). They **shall** be aimed toward traffic rather than located perpendicular to the curve.

The chevron sign *may* be used only where an emerging or demonstrated crash problem exists. On highways to be reconstructed it is unlikely that crashes will be expected to occur on the re-alignment. Therefore, chevron signs *should not* normally be specified on new construction, unless required by Table 2C-5 of the WisMUTCD.

CHEVRON ALIGNMENT SIGN SPACING

Posted Advisory Speed (mph)	Maximum Spacing (feet)
15 mph or less	40
20	80
25	80
30	80
35	120
40	120
45	120
50	160
55	160
60	160
65	200

7. Existing signs not installed at this spacing *should* be adjusted when opportunity permits, due to improvement projects, knockdowns or if problems are present.

2-3-14 Hill Blocks View Signs June 2005

PURPOSE

The WisMUTCD section 2C.18 says the Hill Blocks View sign (W7-6) *may* be used in advance of a crest vertical curve to advise road users to reduce speed as they approach and traverse the hill as only limited stopping sight distance is available. If used, it *should* be supplemented by an advisory speed (W13-1) plaque indicating the recommended speed for traveling over the hillcrest based on available stopping sight distance. See WisMUTCD section 2C.36 for visibility chart for various speeds. Advisory speed plaque speed is based on available visibility distance. This policy provides guidance on when these signs *may* be considered for usage of state-maintained highways.

TRUCK ENTRANCE signs have been commonly used for driveways with limited sight distance; however, their usage is exclusive to driveways or side streets with high truck traffic volumes.

POLICY

While guidance on crossroad and side road warning sign usage and criteria are provided in the WisMUTCD, less guidance is provided on driveways. This policy provides for the use of HILL BLOCKS VIEW sign where driveways are after a crest vertical curve. Signs such as BLIND ENTRANCE and HIDDEN DRIVEWAY are not in the WisMUTCD. However, the HILL BLOCKS VIEW sign is an approved sign in the WisMUTCD. It has been general practice not to provide warning signs for driveways. The HILL BLOCKS VIEW sign is intended for use in lieu of the BLIND ENTRANCE or HIDDEN DRIVEWAY signs, both of which are not approved in the WisMUTCD.

GUIDELINES

The following step-by-step criteria *should* be used to determine if a HILL BLOCKS VIEW sign is warranted for driveways:

1. First, the driveway must have inadequate sight distance per the visibility chart in the WisMUTCD section 2C.37 when determining the need for the sign due to a crest vertical curve. Vision problems due to horizontal curvature or vegetation **shall not** warrant use of this sign.
2. The volume of the driveway **shall** be a minimum of 50 ADT (25 in, 25 out). A typical one-family residence generates about 10 trips per day and therefore would not qualify for the sign. Note: a side road with 100 ADT or greater requires a type B1/B2 intersection as opposed to a type C/D intersection which would be used for under 100 ADT. 50 ADT provides for a driveway for a small business.
3. Verify that the volumes exceed 50 ADT at least once per week or 50 days per year.

NOTE: Crash history – if the driveway does not meet the volume criteria above, but a crash analysis indicates there is a crash history at the driveway location, a sign *may* be considered.

Location of the sign *should* be per WisMUTCD Table 2C-4.

2-3-18 Merge Sign Locations March 2016

PURPOSE

This policy will define merge sign locations on all freeways and expressways.

POLICY

Merge signs should be placed in accordance with Condition A, Table 2C-4 of the WisMUTCD. This distance shall be measured in an upstream direction, starting at the theoretical gore.

In some cases, particularly existing ramps at tight urban interchanges, this distance may not be achievable, due to substandard geometrics. In these cases, the merge signs will have to be installed where they can be accommodated.

2-3-19 Divided Highway Warning Signing September 2009

GENERAL

The WisMUTCD Sections 2C.22 and 2C.23 covers the usage of the divided highway warning signs (W6-1 and W6-2 signs). However, the WisMUTCD guidance is very general in nature and does not tie into specific factors such as posted speed and length of divided section. Oftentimes for shorter segments with lower speeds, the

DIVIDED HIGHWAY AHEAD warning signs *may* be deleted. This policy will provide for a statewide policy for consistent usage.

POLICY

Below is the statewide policy for the usage of divided highway signs.

1. The DIVIDED HIGHWAY AHEAD (W6-1) warning sign *should* be installed in advance of two-lane-to-four-lane transitions that are physically divided by a median. Standard Detail Drawing 15C21-3 shows a typical installation of this sign.
2. The DIVIDED HIGHWAY AHEAD (W6-1) sign *should* only be used in transition to a section of highway that is divided, not a specific intersection.
3. The DIVIDED HIGHWAY AHEAD (W6-1) warning sign *should not* be used for locations where there is two-way traffic to single-lane divided.
4. If posted speeds are 45 mph or above, the DIVIDED HIGHWAY AHEAD sign *may* be used if the divided area is greater than 1,000 feet. The signs would be used at the beginning of the divided section only.
5. A DIVIDED HIGHWAY ENDS (W6-3) sign *should* be used at the end of the divided highway section, in accordance with Standard Detail Drawing 15C21-3, to give warning and notice that traffic is now two lanes.

2-3-25 Single Diagonal Arrow Signs — February 2018

GENERAL

Section 2C-25 of the Wisconsin MUTCD allows the use of the Double Diagonal Arrow sign (W12-1D) to advise drivers that traffic is permitted to pass on either side of an obstruction. Section 2C-25 of the Wisconsin MUTCD further allows the use of a sign with a single diagonal arrow (W12-1L/R) to advise drivers that traffic is only permitted on one side of an obstruction. In practice, WisDOT has also utilized W12-1L/R signs to warn drivers of lane reduction situations that have experienced an above-average crash rate. This policy will establish guidelines for the use of W12-1L/R signs.

GUIDANCE

The following guidelines apply to these signs:

LANE REDUCTIONS

1. Single Diagonal Arrow signs *should* be used as a bank of signs, not as a single sign installation. A minimum of 3 signs *should* be used.
2. Signs *should* be installed along the entire length of the lane reduction taper, as space is available and geometrics allow. The signs *should not* extend beyond the beginning or end of the taper.
3. Single Diagonal Arrow signs are typically used on conventional roadways. On freeways and expressways, Type 5 pavement marking arrows ("pushover arrows") are typically used for this purpose.
4. Follow the spacing table below, adjusting for conflicts with driveways, signs, etc. The spacings shown below are maximum distances between signs.

Single Diagonal Arrow signs *should* be mounted at a 4-foot minimum height (measured from the bottom of sign to the elevation of the near edge of traveled way). They **shall** be located perpendicular to the through traffic lanes.

The Single Diagonal Arrow sign *may* be used only where an emerging or demonstrated crash problem exists. On highways to be reconstructed it is unlikely that crashes will be expected to occur on the re-alignment. Therefore, Single Diagonal Arrow signs *should not* normally be specified on new construction, unless an existing geometric situation is not being rectified by the project.

SINGLE DIAGONAL ARROW SIGN SPACING

Posted Speed (mph)	Maximum Spacing (feet)
15 mph or less	40
20	80
25	80
30	80
35	120
40	120
45	120
50	160
55	160

60	160
65	200
70	200

5. Existing signs not installed at this spacing *should* be adjusted when opportunity permits, due to improvement projects, knockdowns or if problems are present.

MEDIAN ISLANDS

1. R4-7 "KEEP RIGHT" signs *should* be used to mark the beginning of medians. However, at some smaller median island locations, KEEP RIGHT signs would block the driver's view of other regulatory or warning signs or traffic signal faces. In these situations, Single Diagonal Arrow signs *may* be used to mark the beginning of medians.
2. When used to mark the upstream end of a median island, Single Diagonal Arrow signs should be mounted at a 2-foot minimum height (measured from the bottom of sign to the elevation of the near edge of traveled way).

2-3-27 BUMP and ROUGH ROAD Signs January 2013

PURPOSE

This policy provides guidance on the use of BUMP (W8-1) signs, BUMPS (W8-1A) signs, DIP (W8-2) signs and ROUGH ROAD (W8-8) signs.

DEFINITIONS

A sharp rise or depression is defined as a roadway deficiency that is sufficiently abrupt to create considerable discomfort to passengers, to cause shifting of the cargo, or to deflect a vehicle from its true course at normal roadway driving speeds.

A minor rise or depression is defined as a roadway deficiency that is noticeable enough to divers to cause a minor discomfort, but not enough of a deficiency to be a safety hazard.

POLICY

1. For sharp rises or depressions in the profile of the roadway, the BUMP or DIP sign *should* be installed both in advance of the condition and at the location of the rise or depression. The BUMP or DIP sign installed at the location of the rise or depression **shall** have the diagonal downward arrow sign (W16-7L or W16-7R) installed below it. The BUMP or DIP sign installed in advance of the condition **shall** have the AHEAD (W16-9P) installed below it.
2. For minor rises or depressions in the profile of the roadway, the BUMP or DIP sign *may* be installed both in advance of the condition and at the location of the rise or depression. The BUMP or DIP sign installed at the location of the rise or depression **shall** have the diagonal downward arrow (W16-7L or W16-7R) sign installed below it. The BUMP or DIP sign installed in advance of the condition **shall** have the AHEAD (W16-9P) sign installed below it. If the condition is the result of pavement buckling, BUMP signs **shall** be installed both in advance of the condition and at the location of the condition on higher-speed roadways (45 mph posted speed and above).
3. For segments of roadways with multiple sharp rises or depressions, the ROUGH ROAD sign or BUMPS sign *should* be installed in advance of the segment. The advanced location of the ROUGH ROAD sign or BUMPS sign **shall** be supplemented with the NEXT XX MILES (W57-51) plaque. The BUMP or DIP sign *should* be installed at locations of rises or depressions. The BUMP or DIP sign installed at the location of the rise or depression **shall** have the diagonal downward arrow (W16-7L or W16-7R) sign installed below it.
4. For segments of roadways with multiple minor rises or depressions, the ROUGH ROAD sign or BUMPS sign *may* be installed in advance of the segment. The advanced location of the ROUGH ROAD sign or BUMPS sign **shall** be supplemented with the NEXT XX MILES (W57-51) plaque. The BUMP or DIP sign *should* be installed at locations of rises or depressions. The BUMP or DIP sign installed at the location of the rise or depression **shall** have the diagonal downward arrow (W16-7L or W16-7R) sign installed below it.
5. Type A flashing lights or orange flags *may* be used on the advanced sign assembly, depending on the severity of the bump or dip.
6. Signs *should* have a yellow background. Orange background signs *should* only be used if the roadway deficiencies are construction related.

2-3-30 Speed Reduction Signs (Reduced Speed Ahead) March 2016

PURPOSE

This guidance is to establish the appropriate use and location of the speed reduction sign in relation to the speed limit sign for the lower speed zone. This policy pertains to signing on freeways, expressways and conventional highways.

BACKGROUND (AUTHORITY)

The WisMUTCD in Section 2C-38 covers the usage of the Reduced Speed Limit Ahead sign (W3-5 sign). The WisMUTCD Section 2C, Guidelines for Advanced Placement of Warning Signs, Table 2C-4, Condition B, addresses the placement of advanced warning signs with minimum distances. However, based upon experience and from the establishment of a "comfortable braking distance," these distance guidelines have been increased per the chart contained herein.

POLICY

General Speed Reductions

A speed reduction (W3-5) sign **shall** be erected in advance of downward changes of the speed limit from 70, 65, 60 or 55 mph regardless of the amount of reduction, and from 50 mph or below for reductions of 15 mph or more. The speed reduction sign **shall not** be used for reductions of 10 mph or less for speeds of 50 mph or below.

School Speed Reductions

In accordance with Section 7B.16 of the WisMUTCD, a Reduced School Speed Limit Ahead Sign (S4-5) should be installed in advance for reductions of 15 mph or more (from posted speed limit to school speed limit).

1. **Sign Spacing in Advance of Reduced Speed Zone:** Signs **shall** be placed to provide adequate time for the driver to perceive, identify, decide and perform the speed reduction. The following table establishes the minimum distances to be used for the speed reduction signs. The table was developed by modifying the distance chart for Advanced Placement of Warning Signs, Table 2C-4, Condition B of the WisMUTCD, (deceleration to listed advisory speed). The modifications provide more time for the driver to respond, as opposed to the warning signs when a driver is required to decelerate to a specific speed, based on a road condition. The increased distance between the speed reduction sign and the speed limit sign provides additional time to decelerate. This is consistent with the guidance in the WisMUTCD, Section 2C-5 which indicates the time necessary for Perception, Identification/understanding, Emotion/decision making, and Volition/execution of decision (PIEV) is higher for signs that involve more driver judgment, as opposed to warning signs. In particular, the comfortable braking distance and therefore the execution distance is being increased to the following:

SPEED REDUCTION SIGN DISTANCE IN ADVANCE OF SPEED LIMIT SIGN
MINIMUM DISTANCES (in feet)

From Speed Limit	To Speed Limit 65	55	50	45	40	35	30	25	20	15
70	700	700	700							
65		700	700	700	-	-	-	-	-	
60		600	600	600	-	-	-	-	-	
55	-		500	500	500	550	600	600	600	600
50	-	-	-	-		550	550	600	600	600
45	-	-	-	-	-		450	475	500	525
40	-	-	-	-	-	-		425	450	475
35	-	-	-	-	-	-	-		375	400
30	-	-	-	-	-	-	-	-		325

2. **Sizes of Signs:** Size of signs **shall** be in accordance with TEOpS 2-1-35.
3. **Double Marking:** Double marking (right and left side) **shall** be employed for any reduction from 70 mph or 65 mph and *may* be employed for other speed limit reductions, especially on divided or multi-lane highways and for added emphasis. If a double-marked REDUCED SPEED AHEAD sign assembly (R2-5A and W13-1W) is replaced on one side of the roadway with a W3-5 SPEED REDUCTION sign, the R2-5A and W13-1W sign on the other side of the roadway **shall** also be replaced with a W3-5 SPEED REDUCTION sign.
4. **Phase in Period:** Signs *should* be adjusted to conform to this guideline when opportunities arise, such as knockdowns or damage, when other work is occurring nearby, or projects make removal practical.

5. **Work Zone Traffic Control Speed Limit and Reduced Speed Ahead Signs:** The spacing shown in this policy does not apply to work zone traffic control speed limit changes. See the Work Zone Standard Detail Drawings for applicable requirements.

2-3-35 Advisory Speed on Curves July 2012

PURPOSE

To establish uniformity and consistency when determining the proper advisory speed for turns and curves and subsequent installation of advisory speed plaques.

BACKGROUND

The WisMUTCD provides requirements for the proper use of horizontal alignment signing, Advisory Speed plaques, Truck Rollover Warning signs, Advisory Exit and Ramp Speed signs. They are contained in the following sections:

1. Horizontal Alignment signs – WisMUTCD Sections 2C.06 and 2C.07
2. Truck Rollover Warning signs – WisMUTCD Section 2C.13
3. Advisory Speed Plaques – WisMUTCD Section 2C.08
4. Supplemental warning plaques – WisMUTCD Section 2C.53 and 2C.54
5. Advisory Exit, Ramp and Curve speed signs – WisMUTCD Section 2C.14
6. Horizontal Alignment Sign Usage – WisMUTCD Table 2C-5

On state trunk highways it is required that all curves and turns less than posted or statutory speed be signed in advance, with curve warning signs for curves 35 mph or above, or turn warning signs for turns 30 mph or less. The WisMUTCD (Sections 2C.06 and 2C.07) has instructions related to signing curves, turns, winding roads, etc. The WisMUTCD states in Section 2C.06 that if the roadway is less than 1000 ADT, an advisory speed plaque *should* be used to supplement the curve or turn warning sign where the posted speed varies from the curve speed by 10 mph or more.

The WisMUTCD Table 2C-5 states that advisory speed plaques are:

1. Recommended where the difference between the speed limit and advisory speed is 5 mph.
2. Required where the difference between speed limit and advisory speed is 10 mph or more.

WisMUTCD Table 2C-5. Horizontal Alignment Sign Selection

Type of Horizontal Alignment Sign	Difference Between Speed Limit and Advisory Speed				
	5 mph	10 mph	15 mph	20 mph	25 mph or more
Turn (W1-1), Curve (W1-2), Reverse Turn (W1-3), Reverse Curve (W1-4), Winding Road (W1-5), and Combination Horizontal Alignment/Intersection (W1-10) (see Section 2C.07 to determine which sign to use)	Recommended	Required	Required	Required	Required
Advisory Speed Plaque (W13-1P)	Recommended	Required	Required	Required	Required
Chevrons (W1-8) and/or One Direction Large Arrow (W1-6)	Optional	Recommended	Required	Required	Required
Exit Speed (W13-2) and Ramp Speed (W13-3) on exit ramp	Optional	Optional	Recommended	Required	Required

INTRODUCTION

The determination and posting of advisory speeds for changes in horizontal alignment is a universal practice throughout the nation. It was initially tried by the State of Missouri in 1937 followed shortly thereafter by a number of other state highway departments. The preeminent research was done by R. A. Moyer and D. S. Berry (1) published by the Highway Research Board in 1940 as a recommendation for signing changes in roadway alignment. Curve advisory speed posting was adopted as a suggested option in the 1948 *Manual on Uniform Traffic Control Devices* (2).

The initial research by Moyer and Berry established the basic need, procedures and criteria for determining advisory speeds. The use of a ball-bank Indicator was recommended as an acceptable instrument for establishing a “safe speed” on a horizontal curve. Their recommendations were the following ranges of values:

Table 1. Recommended Criteria for Curve Advisory Speed Determination
(Source: Moyer and Berry, 1940, Ref. 1)

Speeds (mph)	Ball Bank Reading	Side Friction Factor
≤ 20	14°	0.21
25 – 30	12°	0.18
≥ 35	10°	0.15

The Moyer/Berry research also indicated that the curve "safe speed" could be computed using the standard curve formula if the curve radii and super elevation were known using the above noted equivalent side friction factors. While they noted the advisory speed as being the "safe speed" for the curve, the advisory speed actually represented the comfortable speed that the curve could be driven without experiencing lateral acceleration discomfort.

This procedure and criteria for advisory speed determination has become nearly universally accepted in the highway engineering profession and typically is used by most transportation agencies. However, there has been concern that the ball-bank method of determining advisory speeds *may* be outdated and not the best procedure. The need to update the procedures and criteria has been noted by the highway community for a number of years. Recognizing the age of the research, minor variations have been made in the criteria and its application in some roadway jurisdictions (3).

Many motorists also have observed that advisory speed signing is overly conservative and many exceed the posted advisory speeds. Another factor is that current vehicles have suspension and steering systems that are significantly improved providing better stability, cornering capabilities and driving comfort compared with typical vehicles at the time of the initial research.

The following guidelines establish new values that satisfy the motorists' needs. The current research has been reviewed with three methods addressed to determine an acceptable advisory speed. The recommended criteria have been adjusted to represent the current driving practices. While it is recognized that most roadways are posted with advisory speeds based on the older criteria, it appears logical to raise the values to provide realistic postings that are compatible with driving practices.

The provisions of the WisMUTCD encourage a restudy of the horizontal alignment signing. The WisMUTCD has a liberal compliance period of at least 10 years to implement the new horizontal alignment signing, so the engineering studies for curve advisory speeds can be done over a period of several years on a systematic basis with appropriate publicity so the public understands the revisions. Drivers will have to modify their driving habits so they do not incorrectly assume that posted advisory speeds can be driven at a higher speed. However, an adequate factor of safety is addressed in the new criteria so drivers even assuming a higher speed is acceptable *should not* be subjected to undue hazards. The older postings, while usually a lower speed, can remain in place until the new engineering study is completed and signs installed. It will be desirable to change all advisory speed plaques along a roadway at the same time to minimize motorist confusion.

DISCUSSION

There are several areas of concern/discussion:

- The ball-bank indicator method *may not* be current nor the best method for determining advisory speeds (5).
- The current practice results in advisory speeds that are too conservative and are far below the 85th percentile speed of drivers traversing the curves (5) (6) (7).
- Current vehicle suspension and cornering capabilities are substantially better than those of vehicles that were used to determine the older criteria (8). As a result, drivers today can comfortably drive curves at speeds higher than those that would have been comfortable with older vehicles.
- The criteria for curve advisory speeds *should* be comparable to the design criteria in the AASHTO *Policy on Geometric Design for Highways and Streets* (9).
- The curve advisory speed practices in some jurisdictions have deviated from an adequate and universally accepted criteria resulting in posted advisory speeds well below prevailing curve speeds (3)(6). This results in inconsistent curve advisory speed postings from one jurisdiction to another.
- The current criteria do not consider truck advisory speeds and truck roll-over considerations (10) (11).
- Some inconsistencies have been noted in comparing current ball bank criteria with side friction factors used for curve design (8).

The research generally documented that drivers are often exceeding the existing posted advisory speeds by 7

to 10 miles per hour. An increase of 2 degrees for ball-bank indicator readings and comparable side friction factors is equivalent to 8 to 10 miles per hour increase in advisory speeds. The application of an accelerometer that measures lateral acceleration provides a direct determination of side friction factors and accommodates new instrumentation for advisory speed determinations. Minor adjustments in the relationship between ball-bank readings and side friction factors makes the ball-bank procedure and accelerometer determinations comparable. The use of the horizontal curve design speed equation remains an acceptable procedure using the newly recommended side friction factors.

There appears to be no reason to limit the advisory speed determination methods but instead recognize that any of the three methods are acceptable:

- The traditional ball-bank indicator
- Design speed equation or
- Accelerometer.

There is a fourth method called the Compass Method by Texas Transportation Institute (TTI), but requires extensive field work (measuring points throughout the curve), so is not being considered for WisDOT. The expansion of acceptable determination methods and change in criteria *should* offset current procedural deviations with the new WisMUTCD requirements encouraging wider and universal application of acceptable advisory speeds. The recommended criteria for advisory speed determinations are as follows:

Table 2. Recommended Criteria for Curve Advisory Speed Determination
(Source: Adapted from Carlson and Mason 1999, Ref. 8)
Revised by WISDOT to include Truck Advisory data

Speeds (mph)	Ball Bank Reading	Lateral Acceleration (g)
≤ 20	16º	0.28
25 – 30	14º	0.24
≥ 35	12º	0.21
Truck (All Speeds)	10	0.17

The new criteria are comparable to the current AASHTO design criteria. Some research has proposed higher values, but those values result in advisory speeds that exceed the observed speeds of drivers in curves, are above comfortable lateral acceleration levels, and reduce the margin of safety. Studies show that maximum side friction factors developed between passenger car tires and wet pavement in poor condition can be as low as approximately 0.35 at high speeds (9) (14).

For large trucks, there is a potential danger of overturning if the truck enters a curve at too high of a speed. For sharp curves, such as loop exit ramps, it *may* be necessary to post truck advisory speeds. Current research indicates that truck-overturning situations are limited and inconsistent when side friction factors are less than 0.35 (12). Theoretically, truck advisory speeds could be determined based on a side friction factor of 0.21, or a ball-bank reading of 12 degrees, and still provide a reasonable overturning safety factor below the 0.35 overturning threshold. But this assumes that the truck follows the exact radius of the curve, which is unlikely in actual practice. Most drivers make steering corrections as they traverse a curve, sometimes steering a radius larger than the actual curve radius, sometimes steering a radius sharper that the actual curve radius. It must be recognized that if the truck is steered on a radius of ⅔ to ¾ of the actual curve radius, then the safety factor below the overturning threshold nearly disappears. As a result, it is recommended that the criteria for posting truck advisory speeds be based on a side friction factor of 0.17, or a ball-bank reading of 10 degrees, for all speed ranges to ensure a reasonable overturning safety factor. This would result in truck advisory speeds below the advisory speeds determined for passenger cars.

For New Construction Projects the following option *may* be used in lieu of the ball bank indicator method:

Method 1: Determining Advisory Speeds Using the Design Speed Equation

The design of highway curves is based on the relationship between design speed, radius of curvature, super elevation, and side friction (centripetal acceleration). The mathematical relationship between these variables is given by the equation (9):

$$V = \sqrt{15R(0.01e + f)}$$

Where: V = Design speed (mph)

R = Curve radius (feet)

e = Super elevation (%)

f = Side friction factor

The same equation can be used to calculate the advisory speed for a curve, if the curve radius and super elevation are known. The side friction factor is the same as lateral acceleration (measured in "g's"), and is based on driver comfort. For highway design, side friction factors are set by AASHTO geometric design policies, and are generally in the range of 0.08 to 0.30 depending on design speed. As previously discussed, recent studies have suggested that the values in the current design manual are overly conservative, and when this equation is used to determine the advisory speed for a curve, the lateral acceleration rates contained in Table 2 can be used. This equation *may* have to be solved iteratively because the value for the side friction factor, *f*, is different for different ranges of advisory speed, *V*. For example, suppose that a curve has a 200-foot radius and a super elevation of 4%. If it is initially assumed that the value of the lateral acceleration is 0.21 (applicable for passenger car advisory speeds of 35 mph or more), the calculated advisory speed is 27 mph. This means that the lateral acceleration value *should* have been 0.24 (applicable for advisory speeds of 25 to 30 mph), and the advisory speed is recalculated as 29 mph. Calculated advisory speeds *should* be rounded to the nearest 5 mph increment, so a 30 mph advisory speed would be used for this curve. The rounded passenger car advisory speeds calculated for various combinations of super elevation and curve radius are shown in Table 3.

Table 3. Rounded Passenger Car Advisory Speeds (mph) Based on Design Speed Equation

Radius (ft)	Super elevation (%)				
	-2	2	4	6	8
100	20	20	20	20	20
200	25	30	30	30	30
400	35	35	40	40	40
600	40	45	45	50	50
800	50	55	55	55	60
1000	55	60	60	65	65

In some cases, the curve radius and super elevation can be taken from as-built plans for a roadway that has been constructed fairly recently. However, it must be considered that a roadway that has been in service for many years *may* have been resurfaced one or more times since original construction. As a result of resurfacing, the super elevation of the curve *may* have changed, and the original plans *may* no longer be representative of field conditions. In other cases, the original plans *may* no longer be available.

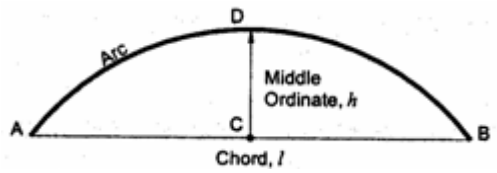
If aerial photography is available, the curve radius can be determined by comparing circular curve templates with the aerial photograph. In the field, the approximate curve radius can be determined by the chord and middle ordinate method of measurement. This is illustrated in Figure 2. To determine the curve radius, measure a chord of any convenient length (usually 100 feet), straight across from one point on the edge of the road to another point on the edge of the road within the curve (line AB in Figure 2) where the curvature is uniform. Also measure the middle ordinate from the center of the chord to the edge of the road (line CD in Figure 2). The radius of the curve can be calculated as:

$$R = \frac{l^2}{8h} + \frac{h}{2}$$

Where: R = Curve radius (feet)
l = Chord length (feet)
h = Middle ordinate (feet)

The precision of this calculation is obviously limited by the ability to accurately measure the middle ordinate which would be as small as 1.25 feet (assuming a chord of 100 feet) for a curve with a radius of 1000 feet.

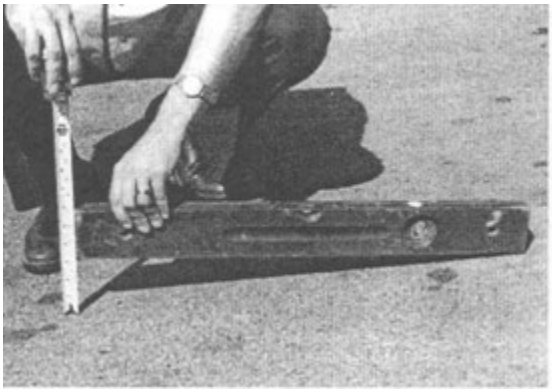
Figure 2. Measurement of Curve Chord and Middle Ordinate



(Source: Northwestern University Center for Public Safety)

The super elevation can be measured in the field using a 4-foot carpenter's level. As illustrated in Figure 3, position the level across the lane. With one end of the level on the road surface, measure the vertical distance from the road surface to the other end of the level. The cross slope of the roadway can then be calculated as the vertical distance divided by the length of the level. The super elevation *should* be measured in several locations along the curve, since it *may* vary. Also, the super elevation *should* be measured separately for each lane of the roadway.

Figure 3. Measuring Super elevation with a Carpenter's Level
(Source: Northwestern University Center for Public Safety)



Another method for determining the super elevation in the field is to stop a vehicle equipped with a ball-bank indicator (discussed in the next section) on the curve and read the degrees of deflection on the ball-bank. The super elevation is calculated as:

$$e = (\tan D) \times 100\%$$

Where: e = Super elevation (%)

D = Degrees of deflection on ball-bank indicator

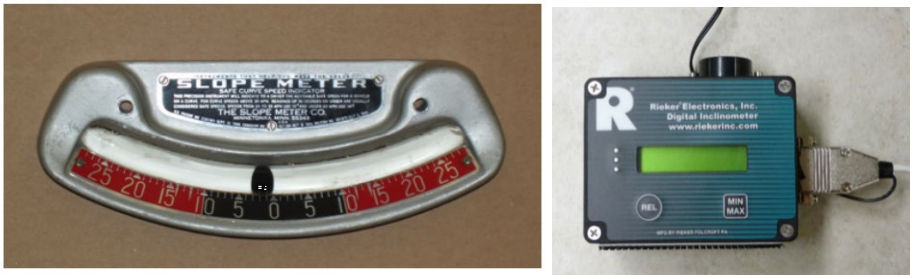
Again, this measurement *should* be made at several locations within the curve, and *should* be measured separately for each lane.

Method 2: Ball-Bank Indicator Method

Advisory speeds *may* be determined in the field using a vehicle equipped with a ball-bank indicator and an accurate speedometer. The simplicity of this technique has led to its widespread acceptance as a guide to determining advisory speeds for changes in horizontal alignment. Figure 4 shows a typical ball-bank indicator.

The ball-bank indicator consists of a curved glass tube, which is filled with a liquid. A weighted ball floats in the glass tube. The ball-bank indicator is mounted in a vehicle, and as the vehicle travels around a curve the ball floats outward in the curved glass tube. The movement of the ball is measured in degrees of deflection, and this reading is indicative of the combined effect of super elevation, lateral (centripetal) acceleration, and vehicle body roll. The amount of body roll varies somewhat for different types of vehicles, and *may* affect the ball-bank reading by up to 1°, but generally is insignificant if a standard passenger car is used for the test. Therefore, when using this technique, it is best to use a typical passenger car rather than a pickup truck, van, or sports utility vehicle.

Figure 4. Ball-bank Indicator



To ensure proper results, it is critical that the following steps be taken before starting test runs with the ball-bank indicator:

- Inflate all tires to uniform pressure as recommended by the vehicle manufacturer
- Calibrate the test vehicle's speedometer
- Zero the ball-bank indicator

The vehicle speedometer *should* be calibrated to ensure proper and consistent test results. This can be done by checking the vehicle speed with a radar or laser speed meter, or by timing the vehicle over a measured distance (such as milepost spacing). Alternatively, a moving radar unit can be used to measure speed while conducting the ball-bank test runs rather than relying on the vehicle's speedometer.

The ball-bank indicator must be mounted in the vehicle so that it displays a 0° reading when the vehicle is stopped on a level surface. The positioning of the ball-bank indicator *should* be checked before starting any test. This can be done by stopping the car so that its wheels straddle the centerline of a two-lane highway on a tangent alignment. In this position, the vehicle *should* be essentially level, and the ball-bank indicator *should* give a reading of 0°. It is essential that the driver and recorder be in the same position in the vehicle when the ball-bank indicator is set to a 0° reading as they will be when the test runs are made because a shift in the load in the vehicle can affect the ball-bank indicator reading.

Starting with a relatively low speed, the vehicle is driven through the curve at a constant speed following the curve alignment as closely as possible, and the reading on the ball-bank indicator is noted. On each test run, the driver *should* reach the test speed at a distance of at least ¼ mile in advance of the beginning of the curve, and maintain the same speed throughout the length of the curve. The path of the car *should* be maintained as nearly as possible in the center of the innermost lane (the lane closest to the inside edge of the curve) in the direction of travel. If there is more than one lane in the direction of travel, and these lanes have differing super elevation rates, drive in the lane with the lowest amount of super elevation. Because it is often difficult to drive the exact radius of the curve and keep the vehicle at a constant speed (cruise-control helps to maintain a constant speed), it *may* take several test runs in each direction be made to more accurately determine the ball-bank reading for any given speed. On each test run, the recorder must carefully observe the position of the ball throughout the length of the curve and record the deflection reading that occurs when the vehicle is as nearly as possible driving the exact radius of the curve.

If the reading on the ball-bank indicator for a test run does not exceed an acceptable level (as indicated by the recommended criteria in Table 2), then the speed of the vehicle is increased by 5 mph and the test is repeated. The vehicle speed is repeatedly increased in 5 mph increments until the ball-bank indicator reading exceeds an acceptable level. The curve advisory speed is set at the highest test speed that does not result in a ball-bank indicator reading greater than an acceptable level.

Figure 5 is an example of a data collection form that can be used to record the results of ball-bank indicator test runs. In the example in Figure 5, test runs were started at 25 mph, with ball-bank indicator reading of about 6°. This is well below the suggested criteria of 14° for a speed of 25 mph. The speeds of the test runs were gradually increased until the speed of 35 mph gave readings of 10° to 12°. These are the highest readings attained without exceeding and the suggested criteria of 12° for a speed of 35 mph or more. This study would result in posting an advisory speed of 35 mph for both directions of travel for this curve. Several alternative field data collection and supervisor approval forms are shown in the Appendix.

Figure 5. Sample Ball-Bank Indicator Data Collection Form

BALL-BANK INDICATOR STUDY						
LOCATION: ***STATE ROUTE 43***						
COUNTY: ***DAVIS***			SECTION:			
POSTED SPEED (MPH): ***55***			PAVEMENT CONDITION: ***DRY***			
DATE:			VEHICLE: ***2008 CHEVROLET IMPALA***			
DRIVER: ***SEYFRIED***			RECORDER: ***PLINE***			
REMARKS:						
DIRECTION OF TRAVEL	PHOTO LOG MILE		SPEED (MPH)	BALL-BANK READING (DEGREES)		
	START CURVE	END CURVE		RUN 1	RUN 2 IF NEEDED	RUN 3 IF NEEDED
NORTH	***8.32***	***8.65***	***25***	***6***	***7***	***6***
			30	***9***	***10***	***10***
			35	***12***	***12***	***11***
			40	***15***	***13***	***14***
SOUTH	***8.65***	***8.32***	***25***	***6***	***6***	***5***
			30	***9***	***8***	***9***
			35	***11***	***10***	***11***
			40	***13***	***14***	***14***

Method 3: Accelerometer

An accelerometer is an electronic device which can measure the lateral (centripetal) acceleration experienced by a vehicle as it travels around a curve. Typically, method 1 and 2 are used. However, if the Region has an accelerometer, this method is acceptable to use as an alternative to the ball-bank indicator method.

Establishing Advisory Speeds

Using any of the three methods noted above *should* result in the same advisory speed for a curve. It is important to reiterate that the advisory speed criteria are based on driver comfort, not safety. A sufficiently skillful driver *may* be able to traverse a curve on dry pavement at a speed considerably higher than the advisory speed without exceeding the friction capabilities of the pavement. However, most drivers would choose not to drive at a higher speed because they would experience uncomfortable levels of lateral acceleration.

The WisMUTCD indicates that the “advisory speed **shall** be determined by an engineering study that follows established engineering practices” (Section 2C.08). The Manual further defines an engineering study as “the comprehensive analysis and evaluation of available pertinent information, and the application of appropriate principles, Standards, Guidance, and practices as contained in this Manual and other sources, for the purpose of deciding upon the applicability, design, operation, or installation of a traffic control device. An engineering study **shall** be performed by an engineer, or by an individual working under the supervision of an engineer or sign shop supervisor, through the application of procedures and criteria established in this policy. An engineering study **shall** be documented” (WisMUTCD Section 1A.13).

Therefore, the establishment of advisory speeds must follow standard procedures developed and adopted by the engineering personnel of an agency. All field work used for determining the advisory speeds must be performed under the supervision of an engineer or sign shop supervisor. Finally, the data collected and analysis performed must be preserved in written documentation. The Appendix contains a sample curve advisory speed study supervisor approval form that can be used to document the field data collection.

The maximum comfortable operating speed on a curve can be determined using any of the three methods discussed above (design speed equation, ball-bank indicator, or accelerometer). The advisory speed for the curve *should* be set at the 5-mph increment nearest to this maximum comfortable speed. The advisory speed to be posted *should not* be arbitrarily reduced below the comfortable speed determined using these methods, because an unrealistically low advisory speed will lose credibility among drivers, and create inconsistencies that *may* lead drivers into traveling at too high a speed through other curves.

Advisory speed plaques are only used in conjunction with appropriate warning signs, and never alone. Turn, Curve, Reverse Turn, Reverse Curve, and Winding Road signs are used in locations where it is desirable to warn drivers of changes in the horizontal alignment of the roadway. The WisMUTCD indicates that the use of Turn or Reverse Turn signs *should* be limited to changes in alignment where the advisory speed is 30 mph or less. The Curve or Reverse Curve signs are intended for use where the advisory speed is greater than 30 mph.

Where a Reverse Curve warning sign or a Winding Road warning sign is used, the advisory speed *should* be based on the curve with the lowest comfortable operating speed. However, if one curve in the series has a dramatically lower comfortable speed, it would be desirable to place a separate warning sign with the appropriate advisory speed for that individual curve.

In some cases, there *may* be other factors that influence the selection of the advisory speed in addition to the comfortable operating speed on the curve. Available sight distance or deceleration distance (on an exit ramp) *may*, in some cases, require an advisory speed lower than the comfortable operating speed for the curve.

Truck Advisory Speeds

The appropriate warning signs for truck rollover concerns require more than just determination of truck advisory speeds. Large trucks, tank trailers and truck freight trailers have a high center of gravity and are susceptible to rollover crashes on a sharp curve. The loop ramps on freeway interchanges and direct freeway-to-freeway connections are sometimes subject to truck rollover problems. The potential for such crashes *may* increase because of radius of horizontal curvature, inadequate deceleration length or deficient specific signing. Truck rollover theoretically can occur when the lateral acceleration exceeds 0.30, but no calculated lateral acceleration less than 0.35 has been determined in any truck rollover collisions. A Ball Bank reading of 10 degrees (side friction = 0.17) be used to provide a reasonable factor of safety. This value is about half the critical side friction factor accommodating those occasions where the truck *may* exceed the posted truck advisory speed or the truck travels a curve radius that is less than the actual roadway curvature. These criteria will generally produce a truck advisory speed that is approximately 5 mph less than the advisory speeds determined for passenger cars, except for the lower speed ranges.

The WisMUTCD, Section 2C.13, Section 2C.14 and Table 2C-5 (Figure 1 of this policy), covers the use of the Truck Rollover Warning sign (W1-13), Advisory Exit Speed sign (W13-2), and the Advisory Ramp Speed sign (W13-3). The application of these signs **shall** be based on an engineering study that considers the roadway and operational characteristics that *may* contribute to a loss of vehicle control and potential truck rollovers. It is suggested that the engineering study for Truck Rollover Warning signs address the following considerations;

1. Speed data and advisory speed determinations.
2. Traffic characteristics.
3. Roadway geometrics.
4. Recommended traffic control devices.

It *should* be noted that any posted Advisory Speed for the Truck Rollover signing *should* reflect the truck advisory speed determination. The WISMUTCD provides a number of other devices that can be used in conjunction with the above signs to address truck rollover consideration such as:

- Chevron Alignment signs (W1-8)
- Combination Horizontal Alignment/Advisory Speed sign (W1-1a and W1-2a)
- One Direction Large Arrow sign (W1-6)
- Combination Horizontal Alignment/Advisory Exit and/or Advisory Ramp Speed Signs (W13-6 and W13-7).

See TEOpS 2-3-36 for policies related to exit advisory speed signage.

Additionally, the warning can be enhanced with enlarged signing, a TRUCK header panel, or flashing beacons. The traffic engineering study *should* address the recommended signing for the specific field conditions.

POLICY

FIELD REVIEW OF CURVES AND TURNS

1. The setting of advisory speeds on existing curves and turns *should* be performed by the ball-bank indicator method for existing roadways utilizing Table 2 above.
2. The Accelerometer (Method 3) *may* be used as an alternative to the ball-bank indicator for Regions that

have this device.

3. For ramps that have problems with truck rollovers and/or have the tippy truck signs installed, the truck ball bank reading of 10 degrees *should* be used.
4. For new construction, the design speed chart (Table 3) noted above *may* be used where the super elevation and radius are known.

Curve signing determined on the basis of calculated values *should* always be verified in the field by the ball bank method.

SIGNING IMPLEMENTATION

1. For consistency of motorist expectation, signing field changes *should* be organized where entire routes are done at approximately the same time. Breakpoints *should* occur in the route at locations where the highway travels through a community that has a speed zone reduction.
2. Signing field changes *should* be incorporated into improvement projects as much as possible. Roadway segments on each side of the improvement project *should* terminate at a STH/STH or municipal limit breakpoint.
3. Table 2C-5 in the WisMUTCD (see Figure 1 of this policy) **shall** be utilized in the determining the proper treatment of horizontal alignment sign(s).
4. For advisory speed reductions of 25 mph or greater, chevrons (W1-8 signs) *should* be used. For these advisory speed reductions, a night arrow (W1-6 sign) *may* be used to supplement the chevrons for advisory speed reductions of 25 mph or greater.
5. For advisory speed reductions that are greater than 5 mph and less than 25 mph, the usage of the night arrow (W1-6 sign) is the first choice of sign that *should* be used. For these advisory speed reductions, chevrons (W1-8 signs) are typically used in locations where there are demonstrated problems.
6. For a Winding Road (W1-5 sign)/Advisory speed (W13-1sign) application, where night arrows (W1-6 signs) and/or chevrons (W1-8 signs) are required on specific curves, the first curve in the series **shall** be signed with the night arrow and/or chevrons. Subsequent curves in the winding road series **shall** be signed with night arrows and /or chevrons if recommended/required by Table 2C-5 in the WisMUTCD (see Figure 1 of this policy).
7. For a Reverse Curve (W1-4 sign)/Advisory speed (W13-1 sign) application, the curves in the series **shall** be signed with night arrows and /or chevrons if recommended/required by Table 2C-5 in the WisMUTCD (see Figure 1 of this policy).
8. Turn warning signs **shall** be used where advisory speeds have been determined to be 30 mph or less.
9. Regulatory speed limit signs are normally not posted on ramps. For application of warning signs on service interchange ramps (non-freeway to freeway), relative to WisMUTCD Table 2C-5, a 10-mph reduction from the mainline posted speed should be used.
10. Each direction on the roadway should be evaluated independently of the other direction in the determination of the proper horizontal alignment signing.

PHASE IN COMPLIANCE

- In order to allow for resources to make the changes to the advisory speeds, the following **shall** apply:
- When signing is replaced with an improvement project, the advisory speeds **shall** be established based on the new policy. This can either be accomplished by one of the methods noted in this policy.
- For other sections of roadway, the changes **shall** be made for an entire segment of highway between two cities, towns or villages. Curve and turn advisories *should not* be changed for one isolated location; rather for an entire segment between communities or within a county.
- Phase in period – December 31, 2019 (WisMUTCD Compliance Date).

ACKNOWLEDGMENTS

NCUTCD – Regulatory and Warning Signs Technical Committee and Task Force and Bob Seyfried, Northwestern University Center for Public Safety**.**

REFERENCES

1. Guidelines for the Determination of Advisory Speeds (NCUTCD Task force from the Regulatory and Warning Signs Technical Committee.)
2. *Manual on Uniform Traffic Control Devices for Streets and Highways,* Public Road Administration, Washington, D.C., August 1948, page 39 and 53.
3. Paul J. Carlson and John M. Mason, "Relationship Between Ball Bank Indicator Readings, Lateral Acceleration Rates and Vehicle Body-Roll Rates", *Transportation Research Record 1658*. Washington DC: Transportation Research Board, January 1999.
4. *A Policy on Geometric Design of Highways and Streets,* American Association of State Highway and Transportation Officials, Washington, D. C., 2004.
5. R. Milstead, X. Qin, B. Katz, J. Bonneson, M. Pratt, J. Miles, and P. Carlson, "Procedures for Setting Advisory Speeds on Curves, Federal Highway Administration, Washington D.C., 2011.

APPENDIX

SAMPLE FIELD DATA COLLECTION FORMS

1. Curve Advisory Speed Calculations
2. Ball-Bank Indicator Test Supervisor Approval
3. Ball-Bank Indicator Study Form
4. Ball-Bank Indicator Test Summation
5. Curve Advisory Speed Determination Field Data Sheet

Advisory Speed Approval

Jurisdiction: _____

Location: _____

From: _____ to: _____

Project No. /Title: _____

Advisory Speed Study Attached:

Ball Bank Indicatory Study _____ Date: _____

Speed Formula Calculations_____ Date: _____

Accelerometer Readings _____ Date: _____

Completed By: _____ Date: _____

Study Approval:

Name: _____ Title: _____

Date: _____

Curve Advisory Speed Calculations
Method # 1

Sheet ___of____

Completed By: _____ Date: _____

Jurisdiction: _____

Location: _____

From: _____ To: _____

Project No. /Title: _____

$$V = \sqrt{15R(0.01e + f)}$$

DIRECTION OF TRAVEL	CURVE BEGIN STA.	CURVE END STA.	CURVE RADIUS (ft)	SUPER-ELEVATION (%)	SIDE FRICTION	ADVISORY SPEED (mph)	WARNING SIGN

Remarks: _____

Study Approval:

Name: _____ Title: _____
Date: _____

BALL-BANK INDICATOR STUDY						
LOCATION:						
COUNTY:			SECTION:			
POSTED SPEED (MPH):			PAVEMENT CONDITION:			
DATE:			VEHICLE:			
DRIVER:			RECORDER:			
REMARKS:						
DIRECTION OF TRAVEL	PHOTO LOG MILE		SPEED (MPH)	BALL-BANK READING (DEGREES)		
	START CURVE	END CURVE		RUN 1	RUN 2 IF NEEDED	RUN 3 IF NEEDED

BALL BANK INDICATOR TEST SUMMATION
(OPTIONAL)

Jurisdiction: _____ Date: _____

Location: _____

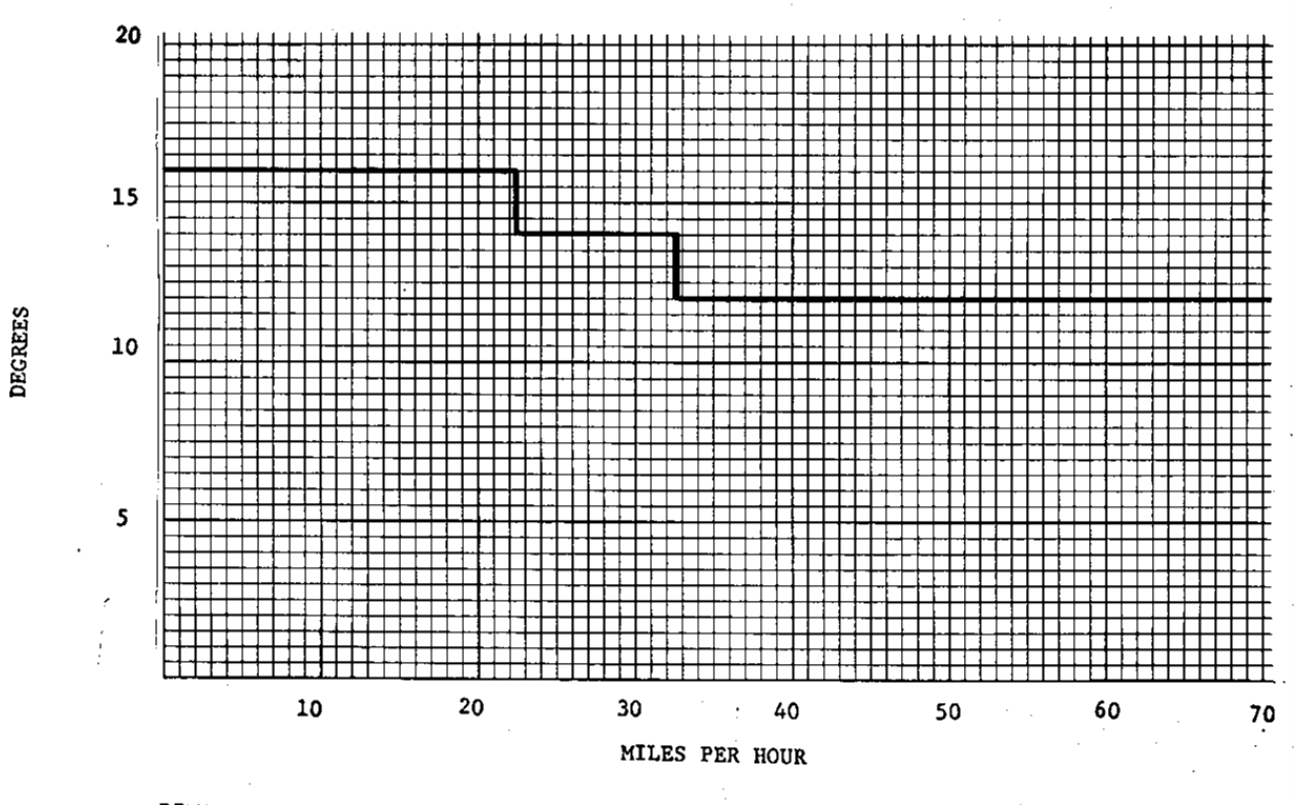
Weather: _____ Road Surface: _____

Driver: _____ Recorder: _____

Vehicle: _____ Posted Speed Limit: _____

Direction: _____ Begin Curve: _____ End Curve: _____

Show each vehicle test run as a dot on the graph



SUMMARY FOR A SECTION OF ROADWAY

CURVE ADVISORY SPEED DETERMINATION FIELD DATA SHEET	
Highway:	**County:**
Section:	**Date:**
Posted Speed (mph):	**Pavement Condition:**
Vehicle:	**Driver/Recorder:**
Remarks:	
BALL BANK READINGS: 12 degrees for speeds of 35 mph or more 14 degrees for speeds of 25 to 30 mph 16 degrees for speeds of 20 mph or less	

Direction of Travel	Curve Direction		Beg. Curve	End Curve	Tangent Length	Ball Bank Reading	Advisory Speed (mph)		Curve Warning Sign	
	LT	RT	MP	MP	Miles	Degrees	Current	Recom-mended	Sign No.	Size

2-3-36 Ramp Warning Signs August 2009

PURPOSE

The WisMUTCD in Section 2C.36 sets forth standards for Exit, Ramp and Curve advisory speed signs, which *may* be used to advise motorists of the maximum recommended speed on a ramp. In usual practice, the speed and condition warned of is just beyond the gore of the ramp. Other guidance in 2C.36 indicates that where additional advisory speed indication is needed on the ramp well beyond the gore area, a standard warning sign with an ADVISORY SPEED plaque (W13-1) is to be used.

To provide for the uniformity of the application of the EXIT, RAMP, and CURVE advisory speed signs, the following use and application guidelines are prescribed where ramp speed control is determined to be necessary.

The WisMUTCD, Table 2C-4, provides advanced placement distances for EXIT, RAMP, and CURVE advisory speed signs along with other warning signs such as STOP AHEAD, YIELD AHEAD, SIGNAL AHEAD and ROUNDABOUT AHEAD. This is determined by the posted or 85th percentile speed and then suing Table 2C-4 in the WisMUTCD to determine the appropriate sign placement distance. Oftentimes for ramps there is no posted speed and speed studies are not normally performed. Utilization of the posted speed on the mainline roadway instead can result in an unreasonable placement distance that is too far back and the sign *may* end up on the mainline roadway, especially for shorter exit ramps. Ultimately, this can lead to inconsistencies in sign placement. Guidance is necessary for the placement of these signs.

POLICY

STOP AHEAD (W3-1), YIELD AHEAD (W302), SIGNAL AHEAD (W3-3) AND ROUNDABOUT AHEAD (W2-6 and W2-6P) Signs

The following methods *may* be utilized to determine the appropriate placement of STOP AHEAD, YIELD AHEAD, SIGNAL AHEAD and ROUNDABOUT AHEAD warning signs on ramps. Table 2C-4 *should* be used for placement of the signs.

1. Assumption of a 10 mph reduction from the mainline speed for the placement of the signs.
2. For ramps of a short length (where utilization of Table 2C-4 cannot be met), placement of the signs *should not* exceed a distance of 50 feet upstream of the EXIT gore sign (E5-1 or E5-1A).

EXIT Advisory Speed Sign (W13-2)

The EXIT SPEED sign will normally be used at:

1. Off-ramps on freeways and expressways when the ramp connects to a conventional state trunk highway or local crossroad.
2. Ramp connections between freeways where the guide signing establishes that the ramp is an exit. The EXIT DIRECTION sign will have an exit number panel. Ramps between freeways, which are not identified with an exit number on the EXIT DIRECTION sign *should* be signed with a CURVE or TURN sign with appropriate advisory speed when reduced speed is necessary.

The following methods *may* be utilized to determine the appropriate placement of EXIT ADVISORY SPEED signs. WisMUTCD Table 2C-4 *should* be used for placement of the signs.

1. Assumption of a 10 mph reduction from the mainline speed for the placement of the signs.
2. Utilization of a ball bank indicator or design speed equation, shown in TEOpS 2-3-35, to determine the start of curvature and the appropriate exit speed.

Modified EXIT ADVISORY SPEED Signs (W13-2A and W13-2B)

The modified exit advisory speed signs (see Figures 1 and 2) *may* be used at the following locations, provided the following criteria are met:

1. For advisory speeds of 30 mph or less for off-ramps on freeways and expressways or ramp connections between freeways where the guide signing establishes that the ramp is an exit.
2. Existing locations where there are run-off-the-road crashes as a result of a sharp horizontal alignment. The signs *may* also be installed in new locations that are perceived to be potential problem areas. The usage of signs in new locations **shall** be approved by the Region Traffic Engineer.

RAMP ADVISORY SPEED Sign (W13-3)

The RAMP ADVISORY SPEED sign will normally be used at:

1. Ramps along freeways or expressways that provide access to safety rest areas, scales, scenic outlooks and tourist information centers where traffic must return directly to the freeway or expressway upon leaving the facility.
2. Ramps from local roads or conventional state trunk highways serving as connections to freeways or expressways, or to other conventional highways.

CURVE ADVISORY SPEED Sign (W13-5)

The CURVE ADVISORY SPEED sign (W13-5) **shall not** be used on WisDOT roadways. For curve delineation on ramps, the standard curve warning sign (W1-2L or W102R) with ADVISORY SPEED plaque (W13-1) *should*

be used. The standard curve warning sign with advisory speed plaque gives motorist s more positive guidance as to the direction of the curve versus the W13-5 sign.

General Criteria

In accordance with directions prescribed in Section 2C.36, the EXIT SPEED or RAMP ADVISORY SPEED sign *should* be posted along the deceleration lane. Final locations *should* be carefully established which are devoid of visual conflicts with other signs or physical roadway elements, such as bridge columns. Practically, the sign locations *should* be midway along the deceleration lane, but moved closer to the beginning of the ramp taper for conditions requiring significant reductions in speed. The distance values of Table 2C-4, Condition B, for general warning sign placement suggest desirable minimum values, but will have to be modified in order to keep the sign “along the deceleration lane” and far enough away from the EXIT DIRECTION signs to avoid its being hidden or obscured. Approach speeds *may* be assumed to be the posted speed limit.

Figure 1. W13-2A Sign

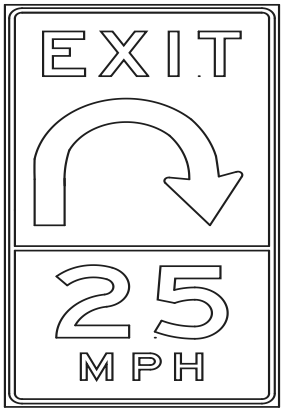
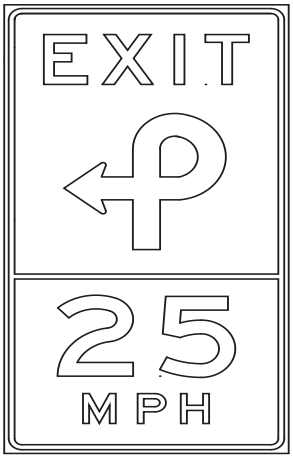


Figure 2. W13-2B Sign



2-3-38 NO PASSING ZONE Signs April 1996

NO PASSING ZONE (W14-3) signs **shall** be placed at the beginning of all no passing zones whether for sight restrictions, narrow bridges, passing lanes, divided highway and approaches or intersectional except as provided below. In making the pennant mandatory on state trunk highways in the early 1970s, it was the intent of the administration that they *should* be installed at all zones, including barrier lines at intersections. This is implied in a memo to all Regions on April 18, 1973.

Where a no passing zone related to sight conditions occurs at a stop sign-controlled or signal-controlled intersection, the zone will be broken for the intersection and resume on the other side. The continuation of the zone beyond the intersection does not require another W14-3 to be installed.

In communities where the state trunk highway is maintained by the Department, it is not necessary to install W14-3 signs at the beginning of no passing zones or barrier lines that occur within speed zones of 35 mph or less.

2-3-40 Trail Crossing Signs — September 2010

PURPOSE

This policy provides guidance on the use of TRAIL CROSSING signs where emphasis is needed to alert motorists of recreational vehicles crossing highways. In order for a trail crossing to be signed under this policy, the trail itself must be federal, state, or locally authorized and open to the public.

TRAIL CROSSING signs covered under this policy include the following signs:

1. SNOWMOBILE CROSSING (W11-6) sign
2. BICYCLE CROSSING (W11-1) sign
3. EQUESTRIAN CROSSING (W11-7) sign
4. BRIDLE PATH sign (W11-56) sign
5. TRAIL CROSSING, symbol message (W11-15) sign*
6. TRAIL CROSSING, word message (W11-15a) sign**

*The TRAIL CROSSING symbol message (W11-15) sign is normally used to sign trails that have predominantly pedestrian and bicycle usage.

**The TRAIL CROSSING word message (W11-15a) sign is normally used to sign trails that have other groups using the trail in addition or besides pedestrian and bicycle usage.

DEFINITIONS

Freeways are defined as divided arterial highway facilities that have full controlled access, by means of grade separations at interchanges only.

Expressways are defined as divided arterial highway facilities that have partial control of access and generally with grade separations at major intersections.

POLICY

1. Trail crossing signs are not permitted on freeways.
2. Trail crossing signs **shall** be installed for all 65 mph expressway trail crossings, whether there is a sight restriction or not. This only applies to non-intersection crossings on 65mph expressways (see Item 4 below).
3. Trail crossing signs *may* be placed on all other highways provided there is deficient sight distance per Section 2c.46 of the WisMUTCD. Sections 2C-49 and 50 of the WisMUTCD also give additional criteria when trail crossing signs *may* be desirable.
4. Trail crossing signs *may* also be used to alert motorists to unexpected entries of recreational vehicles, pedestrians or bicyclists in the roadway.
5. Trail crossing signs *should* only be used for non-intersection crossings. There *may* be extreme cases where there is a demonstrated crash history or site problems at intersections that would warrant trail crossing signs in addition to the crossroad or side road warning signing.
6. STOP signs (18” x 18”) are required on the recreational trail per the Wisconsin DNR trails handbook and they are required per the WisMUTCD for any shared-use path where bicyclists are required to stop. The trail owner **shall** install the STOP signs on the recreational trail prior to the installation of the trail crossing warning signs on the roadway.
7. Because the trail STOP signs are in the STH right-of-way, the Region **shall** issue a permit, in form of a letter, to the trail owner for the placement of the STOP signs on the trail. The permit *should* make it clear that the trail owner is responsible for the initial installation and long-term maintenance of the signs.

2-3-41 Deer Crossing Signing — August 2009

GENERAL

Deer crashes have been one of the highest crash types on state highways in recent years. There are a number of factors which *may* influence the deer crash rate, including herd population, herd migration, herd location, roadside vegetation management, roadway factors (speed limits, lighting, etc.), driver education, use of deer crossing deterrent devices (reflectors, scent boxes, vehicle whistles, wildlife underpasses, etc.), active warning devices such as motion detectors/warning light or static warning signs. Traditionally, static warning signs have been installed in areas with higher deer-vehicle crashes (DVCs). There has been much debate over the usage of static deer crossing signs and their effectiveness. Many transportation professionals recognize the fact that

warning signs are most effective *result in alteration of speed and/or path choice) when there is an obvious danger ahead (example would be curve or turn). The use of warning signs that alert drivers to sporadic or general possibilities *deer crossing and slow children moving signs) have been shown to not have a consistent impact on driver behavior. The widespread use or sign proliferation also reduces the effectiveness of the sign and leads to driver disregard. Several states and agencies have performed studies to assess the effectiveness of static deer crossing warning signs. The studies have concluded that the usage of static deer crossing warning signs do not generally reduce vehicle speeds (one measure of warning sign effectiveness). As a result, the studies have yielded no reduction in DVCs.

SUPPORTING DOCUMENTATION

Static sign studies have been performed by the following states and/or agencies:

1. *Assessing the Effectiveness of Deer Warning Signs*. Published by Kansas Department of Transportation and University of Kansas at Lawrence, April 2006,
2. *Wildlife—Vehicle Collision and Crossing Mitigation Measures: A Toolbox for the Montana Department of Transportation*. Published by Montana Department of Transportation and Montana State University, May 2007.
3. *An Ecological Landscape Study of Deer-Vehicle Collisions in Kent County, Michigan*. Published by Kent County Road Commission and White Water Associates, Inc., January 2004.
4. *Deer Crossing Signs and Technologies*. Published by Deer-Vehicle Crash Information Clearinghouse (DVCIC), Maintained by Texas Transportation Institute, www.deercrash.com
5. *Deer Signs Research Study*. Published by Minnesota Department of Transportation and University of Minnesota, www.lrrb.gen.mn.us/pdf/200413.pdf

Several dynamic types of deer crossing signs are currently being explored as potential countermeasures and are discussed in the studies listed above. These types of signs have been designed to activate when deer are detected near the roadway. Studies are taking place in Indiana, Minnesota, Montana, Pennsylvania, Utah and Washington. The development of methods to control car/deer collisions is continuing to evolve, and over time policies such as this will be subject to change. At present, due to funding limitations, WisDOT is not utilizing dynamic deer crossing warning sign systems. However, WisDOT is periodically reviewing studies from other states and municipalities as they progress. WisDOT will consider issuing a permit to an entity to pursue the usage of dynamic deer crossing signs.

One effective countermeasure pointed out in the Kansas study is the usage of public awareness techniques to educate the motoring public regarding the seasonal and time of day characteristics of deer-vehicle crashes. This could be accomplished effectively through the different types of media outlets.

POLICY

Based upon the findings of various studies mentioned above, WisDOT will implement the following policy for usage of static deer crossing warning signs:

1. No new static deer crossing warning signs will be installed on state highways.
2. Static deer crossing signs that are currently in place will be allowed to remain until the end of their useful life or when opportunities for removal are available. These opportunities would include sign knockdowns and improvement projects.

2-3-43 Parallel On-Ramp Lane Reduction Signing — July 2012

BACKGROUND AND PURPOSE

At some interchange locations, long parallel (acceleration) entrance ramps are constructed to allow vehicles ample distance to get up to the mainline travel speeds, thus helping to eliminate slowing down of the mainline traffic. Questions have arisen as to whether warning signs, such as the LANE ENDS symbol (W4-2 sign). The WisMUTCD, Section 2C-42 states that LANE ENDS signs *should not* be installed in advance of the downstream end of an acceleration lane. It *should* also be noted that the WisMUTCD, Section 2C-42 states that a LANE ENDS sign *may* be installed on a freeway entrance ramp. These would be cases where the signs would be beneficial by exercising engineering judgment in certain locations. In absence of specific guidance in the WisMUTCD, this policy will provide additional guidance as to where the LANE ENDS sign *may* be utilized for long parallel entrance ramps.

GUIDELINES

The following is guidance relating to the usage of the LANE ENDS (W4-2) sign on long parallel (acceleration)

ramps:

1. Issues with motorists not realizing that the entrance ramp is not a mainline or auxiliary exit lane. This could be exhibited by last-minute merge movements or braking.
2. Slowing down and last of mainline traffic caused by last-minute lane changes.
3. Crash issues relating to the last-minute, quick lane changes or braking.
4. The LANE ENDS (W4-2) sign *should not* be used on all parallel entrance ramps. Parallel entrance ramps should be evaluated on a case-by-case basis.
5. Parallel entrance ramps that have been previously signed *should* be evaluated as opportunities permit (improvement projects, routine sign replacements, knockdowns, etc.). This *should* be done prior to removing any signs. Any parallel entrance ramps not meeting the above guidance criteria *should* have the LANE ENDS (W4-2) sign removed.

2-3-45 Icy Bridge Deck Signing — April 1989

GENERAL

The Regional Traffic Engineer *may* use the BRIDGE MAY BE ICY (W8-64) sign on bridges which display problems caused by the formation of ice.

The use of the BRIDGE MAY BE ICY sign **shall** be based on Region discretion. The Region can be aided in this decision by checking with local maintenance and law enforcement officials to see if an ice problem exists at a bridge site. The Region can also analyze crash rates at the bridge site that are based on ice.

The WATCH FOR ICE ON BRIDGE sign **shall** no longer be used. The existing WATCH FOR ICE ON BRIDGE signs *should* be replaced as they wear out.

2-3-49 Determination of Sight Distance for Warning Signs — June 2015

PURPOSE

The WisMUTCD provides guidance for the installation of several types of vehicular and non-vehicular warning signs. Some of these signs include the SCHOOL BUS STOP AHEAD, SNOWMOBILE CROSSING, fire truck, side road and crossroad warning signs. The WisMUTCD states that many of these types of warning signs *should* be used where the road user's sight distance is restricted, or the condition, activity or entering traffic would be unexpected.

The May 25, 2011, WisMUTCD Section 2C.46, provides additional guidance regarding proper sight distance in determining the need for a warning sign. This table on minimum visibility distances references Table 9-6, pages 9-38 (intersection sight distance—left turn from stop) of the AASHTO Standard Highway and Street Design Manual. This table provides an added factor of safety beyond the traditional stopping sight distances.

It *should* be noted that the minimum visibility table shown below is just for determination if the warning sign is needed. These are not sign placement criteria. Sign placement criteria is provided in WisMUTCD Table 2C-4.

Minimum Visibility Distance

Posted or 85th Percentile Speed	Minimum Visibility Distance (ft.)
25 MPH	280
30 MPH	335
35 MPH	390
40 MPH	445
45 MPH	500
50 MPH	555
55 MPH	610
60 MPH	665
65 MPH	720
70 MPH	775

One question that has been commonly asked is "What are the acceptable field methods that can be utilized to determine the actual minimum visibility distance in order to provide accuracy and consistency?" Listed below are several guidelines that *may* be utilized to assist in this effort and to provide for a consistent application statewide.

GUIDELINES

Cone Method (Preferred)

1. A 28” height cone *should* be used as a target at the location of the hazard (i.e. snowmobile crossings, pedestrian crossings and school bus stops). In lieu of a 28” height cone, a mailbox or other alternative methods approved by the Region *may* be used as a target.
2. Set the Distance Measuring Instrument (DMI) when the entire cone is first visible and measure the distance to the cone.

Vehicle Visibility Method (Optional)

1. For the installation of side road and crossroad warning signs, park on the side road and determine where mainline vehicle is first visible. Measure the distance between the mainline vehicle and the side road vehicle to determine minimum visibility distance.
2. An optional method that *may* be used is to park at the intersection or crossing and count the seconds, starting when the mainline vehicle is first visible and equate the time to a distance. For example, at 60 mph, a vehicle travels approximately 88 feet per second. Therefore, at a minimum visibility distance of 665 feet, it would take 8 seconds for the vehicle to reach the intersection or crossing.

2-3-50 Horse Drawn Vehicles — January 2003

GENERAL

The use of highways by horse drawn vehicles is a common activity of some farming religious sects active in several regions of the state. These low-speed vehicles traveling on the roadway proper or on the shoulder introduces some hazards which are magnified because of the frailty of the horse drawn vehicles and the vulnerability of the occupants and the horse. In view of the potential for injury, HORSE DRAWN VEHICLE (W11-14) signs *should* be installed at locations which satisfy the following conditions:

1. The usage of the segment of the state trunk highway by horse drawn vehicles is on a frequent or recurring basis.
2. To the satisfaction of the region, the farmer(s) are using the state trunk highway only where other routes are not available or otherwise not safe or attractive. The Region *should* get input from the local highway and law enforcement officials and *should* make an effort to try and convince the religious sects to drive their horse drawn vehicles on the shoulder and not in the travel lane.
3. The Region *should* consider the shoulder width and configuration (i.e. rumble strips, etc.) and sight distance of the roadway in their decision on whether to sign the roadway.

Each segment being used *should* be identified by the Region and/or County Highway Safety Committee and HORSE DRAWN VEHICLE signs **shall** be posted at the beginning of the segment. The Region has the option of adding the NEXT XX MILES (W57-5 1) sign to the HORSE DRAWN VEHICLE sign. The HORSE DRAWN VEHICLE sign **shall** be placed after every major intersection, such as a STH or CTH intersection.

The Region *should* be alert for discontinuance of usage and remove the signs under that condition.

2-3-51 Pedestrian Crossing Warning Signs — July 2018

PURPOSE

The WisMUTCD provides general guidance for the installation of pedestrian related warning signs. These signs are considered to be the W11-2 (pedestrian crossing sign), W11-9 (wheelchair crossing sign) and the S1-1 (school crossing sign assembly).

There are some standards and guidance contained in the WisMUTCD. However, there are several undocumented state practices involving the application of these types of signs. There is a need to encompass the guidance and standards from all of these resources into a single document that will be able to assist the practitioner and provide for a consistent statewide application.

POLICY

Pedestrian Crossing Signs

1. Pedestrian crossing signs *should* be used where there are higher volumes of pedestrian activity and at mid-block crossings where crossings are unexpected or the visibility distance, as defined in WisMUTCD section 2C.46 is deficient. Pedestrian crossings signs *may* be used at unsignalized and non-stop control

intersections.

2. The Pedestrian Crossing Sign with AHEAD plaque (W16-9P) *may* be used in sight deficient areas where pedestrians walk along the edge of the roadway.
3. A Pedestrian Crossing Sign *may* be installed in locations without a crosswalk. For crosswalk markings, refer to TEOpS 3-2-3.
    a. A Pedestrian Crossing Sign *may* be installed in locations without a crosswalk.
    b. On state highways, crosswalks are maintained by the local unit of government by permit (DT 2136 form).
    c. A crosswalk *may* be installed without a pedestrian crossing sign for roadways with posted speeds of 40 mph or less.
    d. For roadways with posted speeds of 45 mph or higher, new marked crosswalks alone, without other measures to reduce traffic speeds, shorten crossing distances, enhance driver awareness of the crossing, and/or provide active warning of pedestrian presence, *should not* be installed across uncontrolled roadways (see WisMUTCD, Section 3B.19, paragraph 09).
4. Pedestrian Crossing Signs located on WisDOT maintained roadways, **shall** be installed and maintained by WisDOT.
5. Pedestrian Crossing Signs **shall not** be utilized at a signalized or stop controlled intersection. The Wheelchair Crossing Sign *may* be used at a signalized or stop controlled intersection.
6. Pedestrian Crossing Signs *may* be used at an unsignalized right turn bypass. Another option at an unsignalized right turn bypass is to utilize the Yield Here to Pedestrians (R1-5 sign) at the crosswalk location.
7. The Pedestrian Crossing Sign (W11-2) and arrow plaque (W16-7L/R) **shall** be placed at the point of crossing.
8. For roadways with posted speeds of 45 mph or greater, the Pedestrian Crossing Sign (W11-2) with ahead plaque (W16-9P) **shall** be installed in advance of the crossing.
9. For multiple pedestrian crossings that are close together on roadways with posted speeds that are lower than 45 mph, the Pedestrian Crossing Sign (W11-2) with ahead plaque (W16-9P) *may* be used in lieu of signs at the point of crossing.
10. The W11-15 or W11-15a, Recreational Trail Crossing sign **shall** follow the parameters listed above similar to the W11-2 Pedestrian Crossing Sign.
11. The W11-9 Wheelchair Crossing Sign **shall** follow the parameters listed above similar to the W11-2 Pedestrian Crossing Sign, with the exception that it *may* be used at signalized and stop controlled intersections.

School Crossing Signs

1. School Crossing Signs *may* be used at signalized controlled intersections.
2. Regardless of posted speed, the School Crossing Assembly (S1-1 sign with S16-7L/R plaque) **shall** be installed at every crossing. If two crossings are at one intersection (far side and near side), both crossings do not need to be signed.
3. For multiple School Crossings, the advance warning sign is not required in advance of every crossing.
4. Engineering Judgment should be utilized to determine if the advance sign is required in advance of each crossing in a series.
5. For placement of School Crossing signs, refer to TEOpS 2-3-54.

Refer to TEOpS 4-5-1 for pedestrian actuated warning device options.

2-3-54 School Area Signing — December 2018

PURPOSE

The WisMUTCD has expanded the usage of signing for school areas. This policy will summarize the standards and guidance contained in WisMUTCD Part 7 and will address three specific applications of School Area signing on the state highway system. This policy pertains to signing on conventional highways and expressways.

BACKGROUND

Part 7 of the WisMUTCD and Wisconsin State Statute 118.08 provide support for the guidelines listed in this policy.

POLICY FOR SCHOOL AREA SIGNING

The installation of School Area signing on the State Highway System can be addressed with three different types of applications:

1. School Zone Signing. School Zones are school areas that would include buildings and/or grounds that border the roadway, but would have no specific crossing. The grounds may or may not have fencing. "School grounds" refers to public and private schools and their surrounding grounds where any of grades K through 12 are regularly taught during the normal school year.

   Sites that provide only 4-year-old kindergarten do not qualify for school zone signing, as these sites typically do not meet the minimum number of instructional hours required of schools. Additionally, many school districts operate their 4-year-old kindergarten as community based programs, and these sites are therefore subject to change from year to year.

   a. The S1-1 School Warning sign **shall** be installed in advance of the school grounds at the prescribed warning sign distance outlined in WisMUTCD Table 2C-4.

   b. The supplemental S16-9P AHEAD plaque **shall** be installed under the S1-1 School Warning sign.

   c. The R2-6P FINES HIGHER plaque **shall** be installed under the School Zone assembly (S1-1 Sign with S16-9P plaque).

   d. The END SCHOOL ZONE (S5-2 Sign) **shall** be installed at the end of all school zones and areas. If there is a regulatory speed limit at the end of the school zone or area, the END SCHOOL ZONE (S5-2) sign should be mounted under the R2-1 sign. The mounting height of the END SCHOOL ZONE sign mounted under a speed limit sign should be 4' to the bottom of the secondary sign or 5' to the bottom of the lowest plaque in urban areas where there are pedestrians or parked cars.

2. School Advance Crossing Signing. The School Advance Crossing Signing is used to warn motorists that they are approaching a crossing where school children are present. The crossing may be in the same roadway where the school is located or may be on a neighboring roadway, based on the school's master plan of the school routes.

   a. The S1-1 School Warning sign **shall** be installed in advance of the school grounds at the prescribed warning sign distance outlined in WisMUTCD Table 2C-4.

   b. The supplemental S16-9P AHEAD plaque **shall** be installed under the S1-1 School Warning sign.

   c. The R2-6P FINES HIGHER plaque **shall** be installed under the School Zone assembly (S1-1 Sign with S16-9P plaque). The mounting height should be 4' to the bottom of the lowest plaque or 5' to the bottom of the lowest plaque in urban areas where there are pedestrians or parked cars.

   d. If the school crossing is located on a cross street in close proximity to the turning motorist, the S16-6P Advance Direction Arrow should be used in lieu of the S16-9P AHEAD plaque.

3. School Crossing Signing. The School Crossing signing is used at the location where the school children cross the roadway. Crosswalk marking is required whenever school crossing signs are used per the WisMUTCD. Crossing locations are established based on the school's route master plan as shown in the WisMUTCD, Section 7A.02.

   a. The S1-1 School Warning sign **shall** be installed at the crossing location.

   b. The S16-7L/R Diagonal down arrow warning sign **shall** be installed under the S1-1 School Warning sign.

4. End School Zone sign. Per WisMUTCD, the End School Zone sign is required to be installed whenever the R2-6P FINES HIGHER plaque is installed underneath an S1-1 School Warning sign. Therefore, the S5-2 END SCHOOL ZONE sign **shall** be installed downstream of all signed school zones and crossings.

If the school crossing is located on the same roadway as the school property, then the school advance assembly can function in a dual purpose as the advanced sign for the school bordering the roadway and the advance sign for the school crossing. The school advanced sign does not need to be duplicated for this situation (See Figures 2 and 3). The same is true for the end school zone sign.

POLICY FOR ADDITIONAL SIGNING FOR SCHOOL AREAS

Listed below are other signs covered in the WisMUTCD, Part 7, that are installed on the state highway system.

1. School Bus Stop Ahead (S3-1) Sign
    a. The word message SCHOOL BUS STOP AHEAD (S3-1 signs) shall no longer be used. The new sign is a School Bus / Children symbol that is fluorescent yellow green in color and is still the S3-1 sign code. The existing SCHOOL BUS STOP AHEAD word message signs in the field shall be replaced with the new symbol signs by no later than December 31, 2015.
    b. In order to determine if a School Bus Stop *qualifies* for a sign, the Minimum Visibility Distance table in WisMUTCD Section 2C.36 *should* be used.
    c. If a School Bus Stop qualifies for a sign (based on the Minimum Visibility Distance outlined above), WisMUTCD Table 2C-4 **shall** be used to determine field placement of the sign(s).
2. Reduced School Speed Limit Ahead (S4-5 Sign).
    a. A Reduced School Speed Limit Ahead Sign (S4-5) **shall** be installed for reductions of 15 mph or more.
    b. The distance table in TEOpS 2-3-30 *should* be used in determining the placement distance of the Reduced School Speed Limit Ahead Sign (S4-5) from the School Speed Limit (S4-51 Sign).
3. School Speed Limit (S4-51 Sign).
    a. Wisconsin State Statute 346.57 places a Statutory Fixed Speed Limit of 15 mph on school crossings when children are present and the crossing is properly signed. Wisconsin State Statute 349.11 allows the Department of Local units of government the authority to modify this speed restriction on their respective maintained roadways. WisDOT recommends that the school speed limit be 10 mph less than the speed limit of the roadway. The School Speed Limit (S4-51 Sign) **shall** be installed at all school areas and crossings where the speed restriction is modified.
    b. For school areas and crossings, the School Speed Limit (S4-51 Sign) should be installed in areas that are urban or have school children walking/crossing within the right-of-way.
    c. For school areas and crossings in fringe or rural areas, the School Speed Limit (S4-51 Sign) *may* be installed. However, the signs are generally not installed in these areas, unless school children are walking or crossing within the right-of-way. If the signs are installed in these areas, they should be 10 mph less than the posted speed limit of the roadway.
4. Flashing Beacons.
    a. The local unit of government *may* be allowed by permit to install a flashing beacon on one of the school area signs in each direction of roadway travel. RRFB's (Rectangular rapid flash beacons) may be allowed by permit on the school crossing sign assembly (S1-1 and S16-7L/R) only, since this would be the location of the physical crossing. Policy criteria for flashing beacon usage is covered in TEOpS 4-5-1 and the application/permit form (refer to conditions on DT 1877 form).

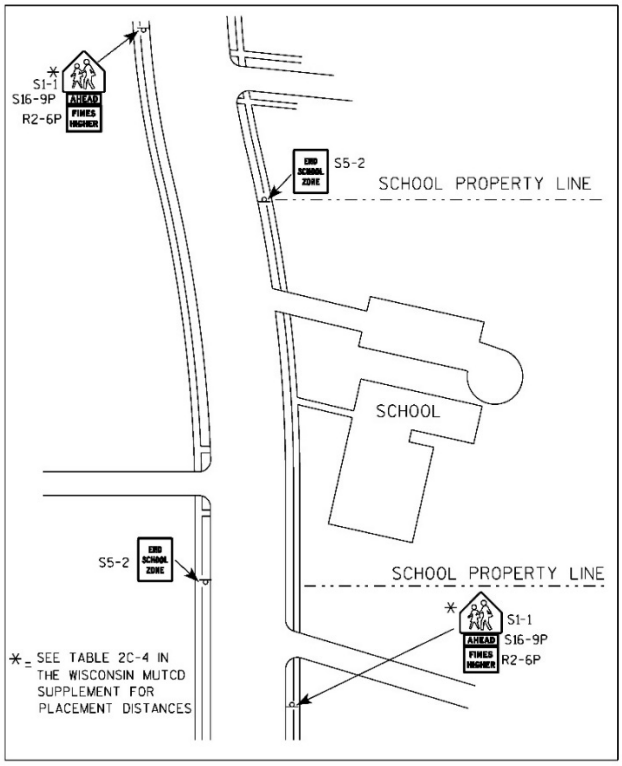


FIG. 1 RURAL SCHOOL WITHOUT CROSSING

NOTE: SIGNING IS SHOWN AS TYPICAL SIGN PLACEMENT. FIELD CONDITIONS MAY DICTATE CHANGES IN SIGN PLACEMENT.

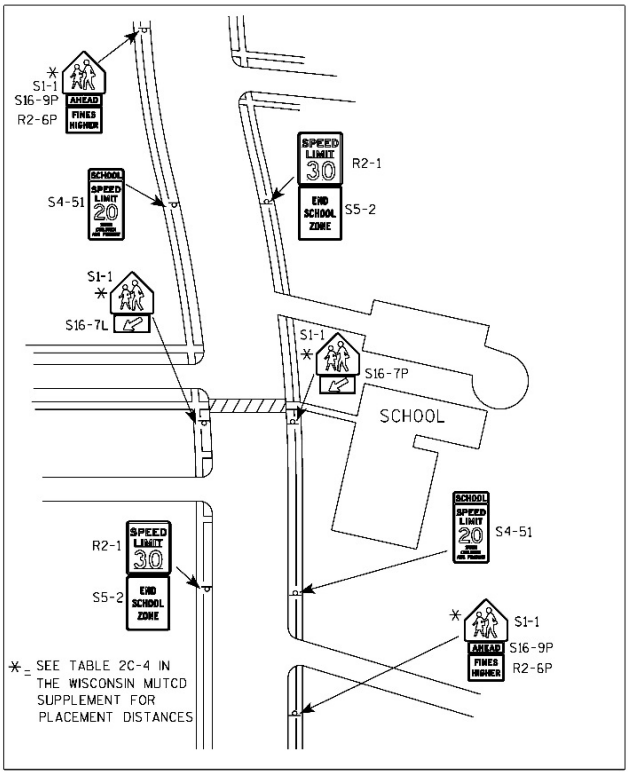


FIG. 2 URBAN SCHOOL CROSSING (WITHOUT REDUCED SCHOOL SPEED ZONE SIGNS)

NOTE: SIGNING IS SHOWN AS TYPICAL SIGN PLACEMENT. FIELD CONDITIONS MAY DICTATE CHANGES IN SIGN PLACEMENT.

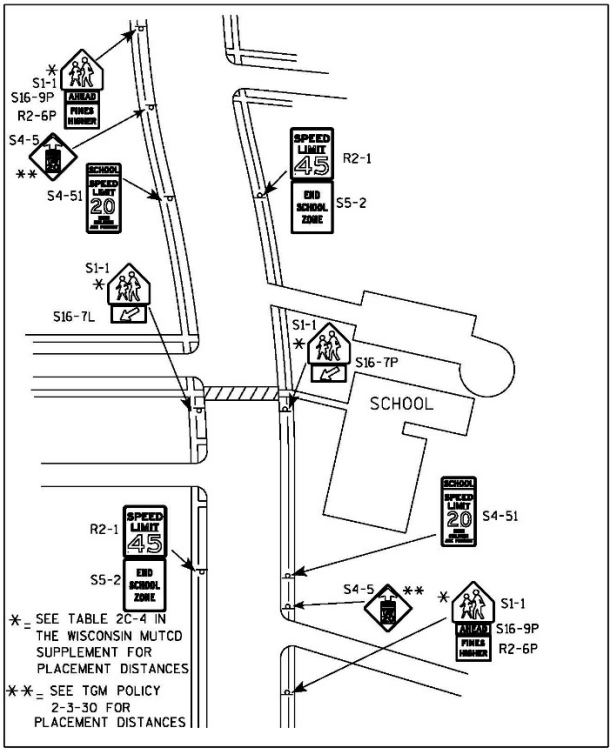


FIG. 3 URBAN SCHOOL CROSSING (WITH REDUCED SCHOOL SPEED ZONE SIGNS)

NOTE: SIGNING IS SHOWN AS TYPICAL SIGN PLACEMENT. FIELD CONDITIONS MAY DICTATE CHANGES IN SIGN PLACEMENT.

2-3-55 School Bus Stops on 65 mph Expressway — December 2013

PURPOSE

The WisMUTCD Section 7B-13 states that school bus stop signs are not intended to be used at every school bus stop location. It *should* be used where terrain and roadway features limit the approach sight distance and where there is no opportunity to relocate the stop to another location with adequate visibility. However, with the expanding usage of 65 mph multilane expressways, there is a natural safety concern about school buses stopping on these routes. This concern stems from the fact that motorists typically do not expect to encounter school buses stopping on 65 mph highways and also because of the higher operating speeds of traffic. Therefore, inadequate sight distance is not exclusively a factor. As a result, the crash potential on 65 mph expressways between school buses and other vehicles is increased. The purpose of this policy is to provide a consistent statewide policy on the signing of school bus stops on 65 mph expressways. **This policy only applies to expressways having 65 mile per hour speed limits and having school bus traffic either on or beside the expressway.**

DEFINITIONS

Expressways are defined as divided arterial highway facilities that have partial control of access and generally with grade separations at major intersections. This definition of expressway includes both designated and non-designated expressways.

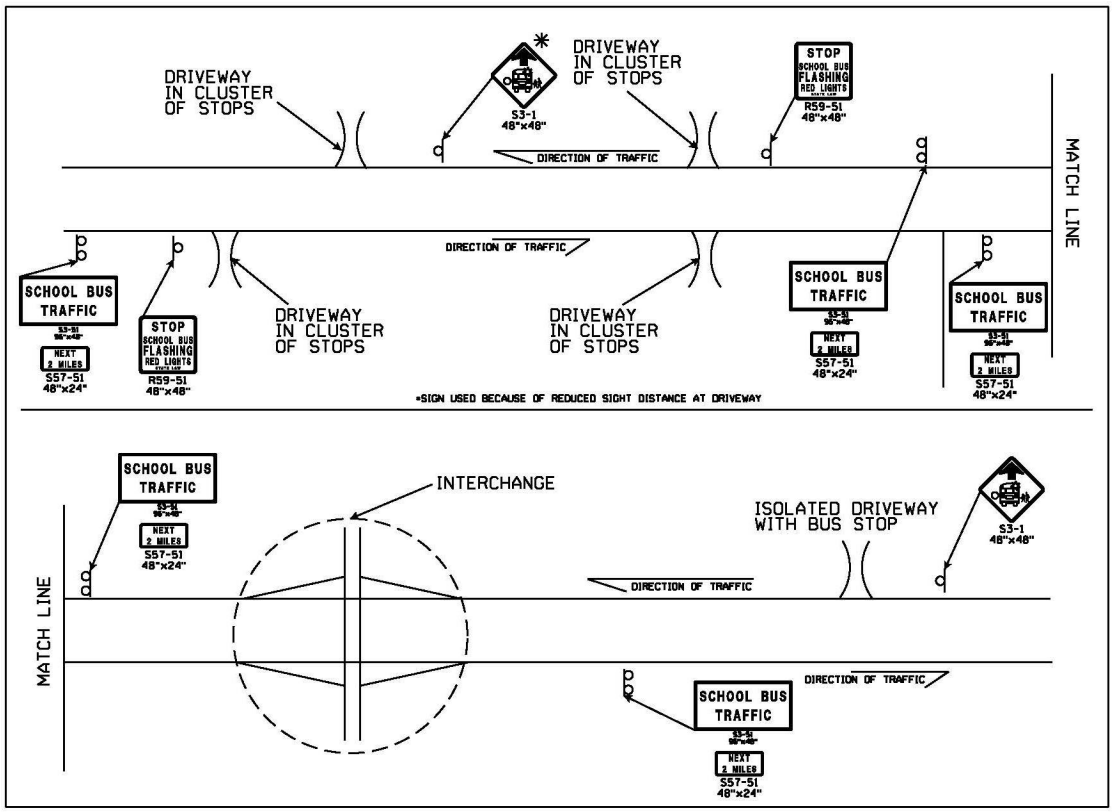
POLICY AND INSTALLATION GUIDELINES

For the application of this policy, the Region is encouraged to obtain a school bus route map or other information supplied by the school district to identify locations of the stops. The Region *should* contact school Districts each year as to where stops are no longer made so the signing can be adjusted accordingly, or where new stops are made. The Region *may* convey to the school officials that signs will be removed unless this information is provided. If the Region is not aware of stops, or the expectation of stops, the school bus stop signs will not be installed.

A map is provided by the Wisconsin Department of Public Instruction that shows all of the school district boundaries in the state. To order a copy of this map, the telephone number is 1-800-243-8782.

1. The "SCHOOL BUS TRAFFIC" (S3-51) sign, when required, *should* be placed on the right side of the roadway at the beginning of the segment of the expressway that includes the stops or driveways with potential stops. This sign is not intended to be used for isolated stops (see item #4 for isolated school bus stop signing). This sign **shall** be supplemented with the "NEXT __ MILES" (S57-51) sign. For this sign, the Region *may* permit the school district the option of supplementing it with one or two flashing yellow beacons mounted directly above the sign. The beacons **shall** be activated by 365 day timers to accurately define the periods of school bus activity. The school district will be solely responsible for the installation, operation and maintenance of the flashing beacons. All existing flashing beacons that have been installed, operated and maintained by the Regions can continue to be operated and maintained by the Regions.
2. The "STOP FOR SCHOOL BUS FLASHING RED LIGHTS STATE LAW" (R59-51) sign *should* be used at the beginning of the segment of the expressway that includes the stops or driveways with potential stops. This sign *should* be erected after the "SCHOOL BUS TRAFFIC" (S3-51) sign outlined in item 1 above.
3. The "SCHOOL BUS TRAFFIC" (S3-51) sign *should* be repeated after every interchange and *may* be repeated after every State Trunk Highway, County Trunk Highway or after higher volume local road intersections. These signs **shall** be placed on the right side of the roadway only. Higher volume local road intersections are those serving retail shopping, commercial activity, recreational activity or other activities with high concentrations of entering/leaving traffic or heavy slow moving vehicle traffic. The S3-51 sign would not be installed after at-grade intersections of lower volume local roads that are dead ends or only serve individual property owners. The "NEXT __ MILES" (S57-51) sign **shall** be used with these signs.
4. For individual school bus stops, within a cluster or isolated stops, the Region has the option of using the "SCHOOL BUS STOP AHEAD" (S3-1) warning sign at those selected stops. Criteria for this usage could be reduced sight distance, heavy volume of trucks, etc. The minimum site distance criteria for this facility is 720 feet, per the minimum visibility distance table for warning signs in the WisMUTCD 2C-36. If the Region elects to use these signs at selected stops, they *should* be placed a suggested minimum of 1000 feet in advance of the stop per the WisMUTCD 2C-05. Flags and double marking of these signs are also optional.

Figure 1.



2-3-60 Children at Play Signs May 2011

GENERAL

Section 2C.03 of the WisMUTCD allows for the development of customized word messages on warning signs. These customized word messages *may* be developed to fulfill signing needs based on engineering study or engineering judgment. However, Section 2C.02 of the WisMUTCD states that the usage of warning signs *should* be kept to a minimum, as the unnecessary use of warning signs tends to breed disrespect for all signs. The over usage of signs *may* result in information overload for the motorist, which can impact safety.

BACKGROUND

Periodically, the Department receives requests to install the following types of Child Crossing Signs:

Children at Play

Watch For Children

Slow Children

Usage of these types of signs has been discouraged by the Federal Highway Administration, Institute of Transportation Engineers, and many other States and Local Units of government for the following reasons:

1. Signs lose credibility with motorists when they appear too often.
2. Warning signs are most effective when they warn of consistent, not occasional conditions. Children are not likely to be consistently playing at a particular location in the street at all times (unlike at playgrounds or parks).
   As a result, the signs mentioned above could lose their effectiveness.
3. These signs provide parents and children with a false sense of security that their children are safe when playing in or near the street.
4. Some before and after studies have indicated no reductions in vehicle speeds or crashes with the signs present.
5. Because these signs are typically warning signs, they are not enforceable.
6. In lieu of signing, more effective countermeasures *may* be employed to increase motorist visibility on the roadway. Some of these countermeasures could include:
   a. Restricting parking or trimming vegetation to increase sight distance.
   b. Education and awareness efforts.
   c. Installation of traffic calming devices for urban low-speed areas.

POLICY FOR CHILD CROSSING SIGNS

1. No new Child Crossing Signs **shall** be installed on State Highways.
2. Existing Child Crossing Signs on State Highways *may* be allowed to remain until the end of their useful life. Other opportunities such as knockdown damage, improvement projects or change in conditions *may* make it possible to have the signs removed earlier.

2-3-64 Type I Object Markers under Keep Right Signs December 2011

GENERAL AND BACKGROUND

The WisMUTCD, Section 2C-64 allows the usage of a Type I Object Marker (W5-54 sign) to emphasize the approach end of a median island. This can give the median island additional visibility during nighttime, poor weather conditions or situations where the pavement markings or curb and gutter is covered by snow. The Object Marker can be especially helpful in higher speed areas (45 mph and above) and areas where medians start. Typically, many of these areas *may* have a Keep Right (R4-7) sign installed. An advantage of installing a secondary object marker (W5-54 sign) below the Keep Right will allow for increased visibility of the approach end of the median because the Object Marker (W5-54 sign) is mounted at 4 feet, which is more in the line of sight for a motorist. The Object Marker (W5-54 sign) is manufactured with fluorescent yellow sheeting, so it will reflect well at night and have better daytime conspicuity as well.

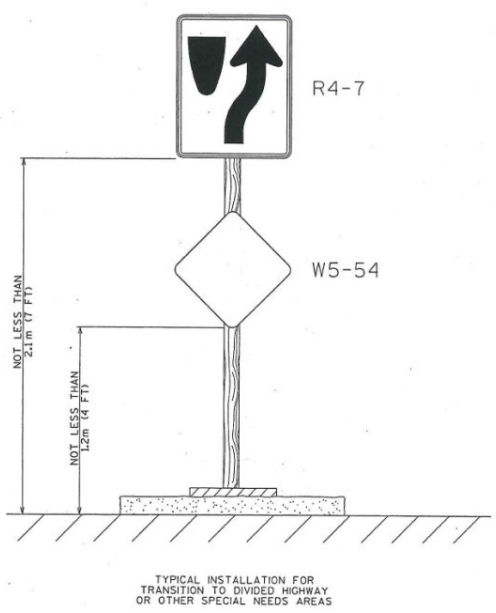
POLICY

1. The W5-54 sign **shall** be placed below the Keep Right (R4-7 sign) at all 45 mph or higher posted speed limits where the highway transitions from an undivided to divided roadway (See Standard Detail Drawing 15C21-3).

2. The W5-54 sign *should* be placed below the Keep Right (R4-7 sign) at the first median in a series of medians, where the posted speed in 45 mph or higher.
3. The W5-54 sign *may* be used (with or without the R4-7 sign) to emphasize approach ends of median islands for other areas that have exhibited problems with limited visibility or vehicle impacts.
4. The mounting height of the W5-54 sign **shall not** be less than 4 feet (see Figure 1).
5. The W5-54 sign *may* be placed on the back side of the post for the Keep Right (R4-7 sign), where additional emphasis is needed (typically areas with no curb and gutter). The W5-54 signs *should* be mounted back-to-back at the same mounting height.

IMPLEMENTATION

There is no formal phase-in period for installation of this signing. Signing field revisions *may* be accomplished through improvement projects or through the TMA process as Keep Right signs are routinely replaced. Signs *may* also be installed through the TMA process to address problem areas.



2-3-65 Rumble Strip Signing January 2018

GENERAL

In an effort to reduce run off the road and head-on collisions, the Department has implemented the usage of continuous rumble strips on rural two-lane roadways, in accordance with FDM 11-15-1. The rumble strips will be installed on the centerline location and the edgeline locations. The centerline and/or edgeline marking can either be applied within the rumble strip or to the side of the rumble strip.

The usage of centerline and shoulder rumble strips has proven to be quite effective since they were installed on STH 142, Kenosha County in 2006 as a test location. A 2005 NCHRP Report (Synthesis 339) has shown several states where crashes were reduced as a result of centerline rumble strips. However, the NCHRP report did indicate some potential concerns with the application of the centerline rumble strips. Motorists are not normally accustomed to continuous rumbles, especially on the centerline. There is the concern that upon running over a centerline rumble, a motorist could “react to the left” and thus move to the left of the centerline. There are also concerns from ambulance drivers that the driving over a centerline rumble would potentially cause monitors to malfunction.

Because the centerline rumbles are more unexpected to the motorist than edgeline rumbles, and in response to the concerns outlined above from the NCHRP report, WisDOT previously installed the Centerline Rumble Strip (W8-70 sign) on roadway segments having the centerline rumbles as an interim measure to assist in the education of motorists. Since that time, additional rural two-lane roadway segments have received centerline rumble strips, and motorists have become more accustomed to them. Therefore, these signs are no longer necessary.

The policy below will address the installation of centerline rumble strip warning signs on WisDOT maintained

roadways.

POLICY

1. The Centerline Rumble Strip (W8-70 sign) with a supplemental mileage plaque (W57-51 sign) **shall not** be installed.
2. Centerline Rumble Strip (W8-70 sign) with a mileage plaque (W57-51 sign) that have previously been installed on projects will be allowed to remain until the end of their useful life or when opportunities arise such as knockdown or damage or projects make removal practical.

2-3-70 Low Flying Plane Sign — November 2016

GENERAL AND BACKGROUND

Federal Aviation Regulations require aircraft, except when necessary for takeoff and landing, to maintain a minimum altitude of 1000' in congested areas, and 500' in other-than congested areas. Exceptions are also granted for certain restricted category aircraft, such as crop-dusting airplanes. These exceptions may cause airplanes to fly at a low altitude over the roadway, causing potential hazard or concern for motorists.

In the past, various signs have been installed to alert motorists to these low-flying aircraft. This policy will clarify when these signs *may* be installed, and establish a statewide standard sign for these locations.

POLICY

Low flying plane warning signs *may* be installed at locations where planes regularly fly at altitudes below 500' over or in the immediate vicinity of the roadway. Examples of these locations include airports with runways adjacent to the highway and fields with regular crop-dusting activities. FAA and Bureau of Aeronautics comments *may* also be taken into consideration.

Standard sign plate W11-57 has been developed for use at these locations. This sign *should* be installed per Condition B: Deceleration to the listed advisory speed (0 mph) in Table 2C.4 of the WisMUTCD. No sign is necessary at the crossing itself.

IMPLEMENTATION

There is no formal phase-in period for installation of this signing. Existing signs will be allowed to remain in place until the end of their useful life. Useful life ends when the sign message no longer meets legibility or condition standards. Existing signs *may* be replaced prior to the end of their useful life when opportunities arise such as knockdown or damage, when other work is occurring nearby, or when projects make replacement practical.