INTRODUCTION

County and township roads carrying less than 400 vehicles per day are classified as low-volume rural (LVR) roads and make up a high percentage of the total rural road mileage. It has been estimated that LVR roads make up about 2/3 of the rural road mileage, but carry only about 8% of the travel (1). The many miles of these LVR roads present counties and townships with very serious problems, most of which are financial; i.e., how to provide construction and maintenance dollars to improve existing roads or simply maintain them at their current condition; replace or upgrade substandard bridges and install or maintain necessary traffic signs or pavement markings. The problem is to provide, at a reasonable cost, a roadway system on which a reasonably prudent driver, even a stranger to the area, will be able to travel safely.

In order to safely operate the LVR roads, local government officials need assistance in providing traffic control and guidance for persons driving on the LVR roads. The nationally recognized Manual on Uniform Traffic Control Devices (MUTCD) (2) serves as a general guide for traffic control on all types of roads and streets. The MUTCD was developed over the years to meet the needs of drivers on the higher volume roads and does not specifically address many of the operational and guidance problems associated with LVR roads.

In recognition of the needs of county engineers/road supervisors and other local government officials charged with safe operation of LVR roads in Kansas, the Kansas Department of Transportation (KDOT), in cooperation with the Civil Engineering Department of Kansas State University, recently developed the “LVR Handbook” (3). The “LVR Handbook” is intended to serve as a supplement to or interpretation of the MUTCD as applied to LVR roads in Kansas. It should
be noted that material in the "LVR Handbook" does not violate or run contrary to the MUTCD. For example, the shape, color, design and requirements of traffic control devices discussed in the "LVR Handbook" is strictly in accordance with the MUTCD. The meanings of the terms "shall", "should" and "may" are the same for the MUTCD and the "LVR Handbook":

**SHALL** — A mandatory condition. Where certain requirements in the design or application of the device are described with the "shall" stipulation, it is mandatory when an installation is made that these requirements be met.

**SHOULD** — An advisory condition. Where the word "should" is used it is considered to be advisable usage, recommended but not mandatory. Documentation of the reasons for non-usage might be wise.

**MAY** — A permissive condition. No requirement for design or application is intended.

The "LVR Handbook", for the most part, provides guidelines for usage of regulatory and warning signs with a few applications of pavement markings.

The remainder of this paper related to selected topics from the "LVR Handbook".

**PRINCIPLES**

There are some basic principles closely related to good operating practices. Three such principles are driver expectancy, positive guidance, and consistency.

**Driver Expectancy**

Drivers, and people in general, expect things to operate in certain ways. When entering a dark room a person will expect to find an on-off toggle switch for the lights. One also expects the switch to operate up for on and down for off. When it works the other way around, or when there is a rheostat knob, it takes a bit longer to respond to what is actually there. The same situation occurs with drivers. When a driver's expectancy is incorrect, either it takes longer to respond properly or, even worse, the driver may respond poorly or wrongly. (4) If, for example, a curve sign shows a curve to the right but the road actually curves
left, one can imagine the difficulty the driver has in properly negotiating the curve—especially a stranger to the area at night. This may seem to be an extreme example, however, this has been observed rather frequently in the WINDING ROAD sign in which the bottom or beginning curve points in the wrong direction.

What the driver expects on a road is greatly influenced by what was experienced on the previous section of road. Studies have shown that what a driver saw—presence or absence of traffic control devices, road surface type, condition and width, narrow bridges or culverts, etc., (this might be called the “roadway environment”)—is what the driver expects for the next 1/2-1 mile.

Driver expectancy is affected not only by the very recent experiences but also by those things drivers have learned through past experiences, e.g., advance railroad crossing signs are at all railroad grade crossings, stop signs are red, curve warning signs are yellow and diamond shaped, etc. It follows that that consistent use and placement of traffic control devices can do a great deal toward assuring that the driver’s expectancy is correct.

Driver expectancies are also affected by the type of road such as an interstate highway, state highway, county or township road. The driver expects to drive each of these with different levels of caution.

**Positive Guidance**

Positive guidance (5) is the concept that a driver can be given sufficient information where he needs it and in a form he can best use to safely avoid a hazard. Positive guidance can be given the driver through combinations of signs, hazard markers, safe speed advisory signs, and probably, most important of all, the view of the road ahead. If drivers could see the curves far enough ahead to judge their sharpness and adjust to a safe speed, or see the approaching cars on cross roads because the intersections were clear of sight obstructions, or if there were no intersections hidden by the crest of a hill, if all narrow bridges and culverts were visible to drivers from both directions, there would be little need for anything more than occasional stop or yield sign to assign the right of way at the intersection of LVR roads with higher volume roads. The condition just described might be called “roadway positive guidance.” Studies have shown that the edge of the roadway ahead is among the most important guidance information the driver uses. Using the edge of roadway in this manner provides an easy and effective way of providing positive guidance at narrow bridges and culverts or other roadside hazards of obstacles.

*An Example of Positive Guidance*—Tapering is a simple technique in which the traveled way (maintained part of the road) is
gradually narrowed (tapered) some distance ahead of, say, a narrow culvert. The driver simply follows, as usual, the edge of roadway and thus is guided away from the roadside obstacle. See Figure 2. If tapering is not used, the driver may not see the end of the short culvert and if he continues to follow the edge of roadway (faulty guidance) he may drop a wheel off the end of the culvert. This is illustrated in Figure 1.

Details of the tapering technique are shown in Table 1 and Figure 3.

Fig. 1. Before Tapering Road: 1. Roadway wider than culvert. 2. Roadway edge leads driver into culvert ditch instead of onto culvert.
Fig. 2. After Tapering Road: 1. Tapered section - roadway edge leads to culvert ends.

Fig. 3. Taper Details

TABLE 1—Minimum Recommended Taper Lengths, L*, feet

<table>
<thead>
<tr>
<th>PREVAILING SPEED</th>
<th>AS SHOWN</th>
<th>LESS THAN 30 MPH</th>
<th>30-40 MPH</th>
<th>OVER 40 MPH</th>
</tr>
</thead>
<tbody>
<tr>
<td>*W (ft.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 or less</td>
<td>30 ft.</td>
<td>50 ft.</td>
<td>100 ft.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>45 ft.</td>
<td>75 ft.</td>
<td>150 ft.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>60 ft.</td>
<td>100 ft.</td>
<td>200 ft.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>75 ft.</td>
<td>125 ft.</td>
<td>250 ft.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>90 ft.</td>
<td>150 ft.</td>
<td>300 ft.</td>
<td></td>
</tr>
</tbody>
</table>

*See Figure 3

(The taper lengths in Table 1 were adapted from Figure 3-10, MUTCD).
Consistency

Consistency relates to the “sameness” of the nature of the road from one section to another. Inconsistencies are sudden changes in the nature of the road. Inconsistencies violate a driver’s expectancy, thus either the road should be made consistent, which is usually impractical, or something should be done to make the driver’s expectancy correct, i.e. restructure the driver’s expectancy. In the case of a hidden curve in a nearly straight roadway, the use of a curve warning sign with, perhaps, an advisory speed plate, will correctly restructure the driver’s expectancy. After seeing the curve sign, the driver expects the curve, knows whether the road curves left or right and knows the speed at which the curve can be comfortably and safely driven.

Other examples of inconsistencies are:
- A two-lane road suddenly narrowing to a one-lane road,
- A blacktop road changing to a gravel road,
- A bridge narrower than the approaching roadway, and
- A blind intersection in an area where most intersections have clear sight distances.

Whether or not a situation is an inconsistency may depend on the direction in which the driver is traveling. The driver, traveling from 1 to 4 in Figure 4, finds the first part of the road, 1 to 2 very consistent, i.e., there is hardly time to pick up speed before seeing or being on another curve. After passing 2, the road is straight, for as much as a mile, and the driver now expects the road to continue — straight — and what is seen confirms this expectancy as the road appears to continue straight from 3 to 4 — “just a little dip,” thinks the driver — what a surprise to have to suddenly handle three 30 m.p.h. curves! Obviously some expectancy restructuring is in order and signing is likely the best way to do it. For the driver traveling from 1 to 4, no signs are needed at 1 or from 1 to 2 since the alignment is consistent. A curve warning sign prior to 3 (probably with a speed advisory plate) will be sufficient to give the driver enough information to handle the situation, i.e., we have satisfactorily charged his expectancy so “what he expects is what he gets!” Now, consider the driver traveling from 4 to 1. Likely,

![Plan View](image)

![Profile View](image)

Fig. 4. Plan and Profile Views of a Road
the driver will need an advance curve warning sign, with speed plate, placed prior to 4. From 3 to 2, an advance WINDING ROAD sign is likely needed for the driver to “know what to expect.”

One must drive the roads to identify the inconsistencies. A, B, and C Roads—as noted earlier, the driver’s expectancy is influenced by the type of road being traveled and how the driver perceives the road. Traditionally, highways have been classified by administrative jurisdiction such as state, county, or township, by volume and most frequently according to function such as arterials, collectors, or local service. It is impossible for a driver to perceive the administrative classification of roads without state, county, or township route markers. It is difficult, if not impossible, for the driver to judge the function of the road or its volume without special training. What the driver does observe are the physical roadway characteristics such as width and kind of surface, riding quality, road surface drainage, the presence or absence of traffic control devices, hills, and sharp curves. The road classifications, Type A, Type B, and Type C, used in this Handbook are based on roadway characteristics that drivers readily perceive and these characteristics in turn influence the driver’s expectancies.

The physical characteristics of each type of road are summarized in Table 2. Upon entering a road, all the physical characteristics, except operating speed and drainage, are almost immediately seen by the driver. After driving a short distance with width of road, type of surface and riding quality will suggest an appropriate safe speed to a

<table>
<thead>
<tr>
<th>Road Type Characteristic</th>
<th>Type A</th>
<th>Type B</th>
<th>Type C—Primitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Width of Traveled Way and number of visible wheel paths</td>
<td>22' or greater, 3 or 4 visible wheel paths (if gravel)</td>
<td>16' - 24'</td>
<td>2 or no visible wheel paths</td>
</tr>
<tr>
<td>Prudent Operating Speed</td>
<td>40 mph or greater</td>
<td>25 - 45 mph</td>
<td>40 mph or less</td>
</tr>
<tr>
<td>Surface Material</td>
<td>paved or gravel</td>
<td>gravel, sand, or dirt</td>
<td>natural surface may have some gravel or sand</td>
</tr>
<tr>
<td>Riding Quality</td>
<td>No adverse effect</td>
<td>may cause reduction in operating speed</td>
<td>typically poor; may be impassable due to poor weather</td>
</tr>
<tr>
<td>Drainage</td>
<td>All-weather road - good surface drainage; water carried to ditches</td>
<td>All weather road - some surface ponding; water carried in ditches</td>
<td>Fair weather road - ditches are narrow or nonexistent; surface ponding likely to affect driveability</td>
</tr>
</tbody>
</table>
reasonably prudent driver. All it takes is a little rain for the effects of the well-drained versus a poorly drained road to become apparent to the driver. Figures 5 through 8 show examples of the types of roads.

Fig. 5. Type A Paved Road

Fig. 6. Type A Gravel Road

Fig. 7. Type B Road
Once the driver has decided what kind of road it is, the driver will choose how to drive the road. In Table 3 are summarized some of the expectancies related to the classification of rural roads just presented. By knowing what a driver expects, inconsistencies can be identified and appropriate actions can be taken to lessen or remedy the problem.

**TABLE 3—Some Driver Expectancies by Roadway Type**

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Type A</th>
<th>Type B</th>
<th>Type C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadside Obstacles</td>
<td>Some</td>
<td>Some</td>
<td>Many</td>
</tr>
<tr>
<td>Vertical Alignment</td>
<td>consistent with previous 1/2 to 1 mile</td>
<td>consistent with previous 1/2 to 1 mile</td>
<td>may be consistent with previous 1/2 to 1 mile</td>
</tr>
<tr>
<td>Horizontal Alignment</td>
<td>consistent with previous 1/2 to 1 mile</td>
<td>consistent with previous 1/2 to 1 mile</td>
<td>consistent with previous 1/2 to 1 mile</td>
</tr>
<tr>
<td>Vehicle Right of Way at Intersection</td>
<td>expects to have right of way</td>
<td>prepared to yield right of way</td>
<td>expects to yield right of way</td>
</tr>
<tr>
<td>Safe Stopping Sight Distance</td>
<td>adequate for usual operating speed</td>
<td>adequate for usual operating speed</td>
<td>adequate for usual operating speed</td>
</tr>
<tr>
<td>Influence of Opposing Traffic</td>
<td>None</td>
<td>slow down to pass opposing vehicle</td>
<td>difficult to pass opposing vehicle</td>
</tr>
</tbody>
</table>

Table 4 shows the recommended handling of some selected inconsistencies for the three types of roads. Note that just as driver expectancies are different for each type of road (drivers expect a lower level of signing and maintenance on a Type C than on a B or A road), incon-
### Summary

Classifying the roads as Type A, B, or C provides guidance for local government agencies to treat all roads in a consistent fashion relative to meeting the driver's expectancy. This is very important in meeting the objective of providing a reasonably safe roadway system at a reasonable cost.

### Intersections

It is desirable for a driver to have an unobstructed view of the intersection and a length of the intersecting road sufficient to permit stopping or slowing the vehicle to avoid collisions. When traffic at the intersection is controlled by signs, there is less need for an unobstructed view. The minimum sight distance considered safe under various conditions is related to vehicle speeds and to the distances traveled while the driver sees the situation, reacts, and brakes.

### Discussion

It is important to take great care to place signs only where they are needed in order to prevent breeding disrespect for the signs.

### Table 4—Handling of Selected Inconsistencies

<table>
<thead>
<tr>
<th>Inconsistency</th>
<th>Type A</th>
<th>Type B</th>
<th>Type C</th>
<th>Detailed Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>T or Y Intersection</td>
<td>should be signed unless adequate sight is provided</td>
<td>should be signed unless adequate sight is provided</td>
<td>should be signed unless adequate sight is provided</td>
<td>pages 24; 33</td>
</tr>
<tr>
<td>Railroad Crossing</td>
<td>shall have advance sign and crossbucks</td>
<td>shall have advance sign and crossbucks</td>
<td>shall have advance sign and crossbucks</td>
<td>pages 45-49</td>
</tr>
<tr>
<td>Narrow Bridge or Culvert</td>
<td>all shall be signed</td>
<td>all shall have positive guidance — some should be signed</td>
<td>all shall have positive guidance (few should be signed)</td>
<td>pages 51-59</td>
</tr>
<tr>
<td>Low Water Stream Crossing</td>
<td>should be signed</td>
<td>may be signed</td>
<td>may be signed</td>
<td>pages 61-65</td>
</tr>
</tbody>
</table>

Inconsistencies are also different. For example, what may be an inconsistent situation on a Type A road often is a consistent situation on a Type C road and consequently may require no positive guidance or signing.
If it is economically feasible, sight obstructions should be removed so that signs become unnecessary. At all times, signs shall be visible and kept clear of obstructions such as trees, bushes, and weeds.

The two basic criteria for placement of advance signs are the approach speed and the reduced speed required to comply with the sign message. (See Table 5) In rural areas, two signs should not be located closer together than 200 ft. along the highway. All signs should be located so as to be viewed by motorists without obstruction for a distance of at least 400 ft. Placing signs in dips or beyond the crest of hills, and placing informational signs on curves should be avoided.

**Type A Road Intersecting Type A Road:**

Intersection traffic control devices should be installed on the minor legs. YIELD signs should be used when there is at least 50-ft. clear sight triangle in both quadrants. STOP signs should be used when the clear sight triangle in either quadrant is less than 50 ft.

If the STOP or YIELD sign is not visible from 450 ft. then an advance warning sign should be placed. (See Figure 9 and Table 5)

**Type B or Type C Road Intersecting Type A Road:**

Intersection traffic control devices should be installed on the minor legs. YIELD signs should be used when there is at least a 50-ft. clear sight triangle in both quadrants. STOP signs should be used when the clear sight triangle in either quadrant is less than 50 ft.

If, on a Type B road, a STOP or YIELD sign is not visible from 300 ft. or, on a Type C road a STOP or YIELD sign is not visible from 225 ft., then an advance warning sign should be placed. (See Figure 9 and Table 5)

**Type B Road Intersecting Type B Road:**

If either the intersection or vehicles on the intersecting road cannot be seen from 300 ft. away, a CROSSROAD or T symbol sign should be used.

More positive control such as YIELD or STOP signs may be used on the minor legs. If more positive control is needed, the YIELD sign should be used when there is at least a 50-ft. clear sight triangle in both quadrants; and the STOP sign should be used when the clear sight triangle in either quadrant is less than 50 ft. (See Figure 9).

If the STOP or YIELD sign is not visible from 300 ft., an advance warning sign should be used.

**Type C Road Intersecting Type B or Type C Road:**

If either the intersection or vehicles on the intersecting road cannot be seen from 225 ft. away, a CROSSROAD or T symbol sign may be used.

More positive control such as YIELD or STOP signs may be used on the minor legs. If more positive control is needed, the YIELD sign
### TABLE 5—Advance Warning Sign Placement

**RECOMMENDED MINIMUM WARNING SIGN PLACEMENT DISTANCE—FT**

<table>
<thead>
<tr>
<th>POSTED OR 85th*</th>
<th>GENERAL WARNING SIGNS**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PERCENTILE CONDITION I</strong></td>
<td>CONDITION II</td>
</tr>
<tr>
<td>(PREVAILING) STOP SPEED MPH CONDITION</td>
<td>DECELERATION CONDITIONS TO LISTED ADVISORY SPEED—MPH (OR DESIRED SPEED AT CONDITION)</td>
</tr>
<tr>
<td>20 MPH</td>
<td>100 FT</td>
</tr>
<tr>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>35</td>
<td>150</td>
</tr>
<tr>
<td>40</td>
<td>225</td>
</tr>
<tr>
<td>45</td>
<td>300</td>
</tr>
<tr>
<td>50</td>
<td>375</td>
</tr>
<tr>
<td>55</td>
<td>450</td>
</tr>
<tr>
<td>60</td>
<td>550</td>
</tr>
<tr>
<td>65</td>
<td>650</td>
</tr>
<tr>
<td>70</td>
<td>750</td>
</tr>
</tbody>
</table>

* "85th percentile (prevailing) speed" is that speed at or below which 85% of the vehicles travel.

** Distance provides for 3 second reaction perception (PIEV) time, 125 ft. Sign Legibility Distance, and Comfortable Braking Distance.*** If 48-in. signs are used the legibility distance may be increased to 200 ft. This would allow reducing the above distances by 75 ft.

Typical Signs for the Listed Conditions:
Condition I—Cross Road, Stop Ahead, Signal Ahead, Ped-Xing, Railroad Advance Warning, etc.
Condition II—Turn, Curve, Divided Road, Hill, Dip, etc.

*** A Policy on Geometric Design of Rural Highways, 1965, AASHTO, Figure VII-15B

Reference
<table>
<thead>
<tr>
<th>Speed (MPH) (Minor Road)</th>
<th>10</th>
<th>10</th>
<th>10</th>
<th>10</th>
<th>10</th>
<th>10</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed (MPH) (Major Road)</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>45</td>
<td>50</td>
<td>55</td>
</tr>
<tr>
<td>Distance &quot;D&quot; (feet)*</td>
<td>45</td>
<td>90</td>
<td>130</td>
<td>180</td>
<td>200</td>
<td>220</td>
<td>240</td>
</tr>
</tbody>
</table>


**Fig. 9. 50-Foot Sight Triangle**

should be used when there is at least a 50-ft. clear sight triangle in both quadrants; and the STOP sign should be used when the clear sight triangle in either quadrant is less than 50 ft. (See Figure 9).

If the STOP or YIELD sign is not visible from 225 ft., an advance warning sign should be used.

The intersection of two Type C roads seldom requires intersection signing.

**Sight Triangle**

The decision to use a specific traffic control device at an intersection is based upon the driver's ability to see the other legs of the triangle. The sight triangle is used to describe the area which must be
clear of obstacles over 3 ft. in height. A 50-ft. sight triangle is shown in Figure 9.

Usually, when there is a sight problem at an intersection, STOP signs or YIELD signs are used in pairs; however, there may be some locations where this does not apply. When a minor road (Type A, B, or C) intersects a major road (Type A) the location may indicate that only one quadrant does not have a clear 50-ft. sight triangle. Due care is recommended in the installation of non-paired STOP signs or YIELD signs. Such installations should be considered only if justified and recommended by an engineering and traffic study.

Note that YIELD signs are recommended where sufficient sight distance for safe approach speeds greater than 10 mph exist (50-ft. sight triangles).

Recent research by Stockton, et al (6) shows that STOP controlled intersections are not, in general, safer than YIELD controlled intersections; YIELD control requires less travel time than STOP control and also provides some savings in operational costs.

TURNS AND CURVES

The TURN and CURVE warning signs inform a driver of a change in the horizontal direction of the roadway. Before the decision can be made to use this type of sign, and which specific sign to use, many factors must be taken into consideration. First, the higher of the operating approach speed (prevailing speed) or the established speed limit must be compared with the advisory safe speed of the curve in order to establish whether a TURN sign or a CURVE sign is necessary as well as to determine the need for an advisory speed plate. Other considerations include determining if the curve is consistent with the previous roadway alignment, and the classification of the road type with regard to driver expectancy.

Advisory Safe Speed Determination

The advisory safe speed of a curve can be determined by the use of a ball bank indicator, also known as a slope meter. The indicator will give a reading of ten (10°) when the vehicle in which it is mounted negotiates a curve at the highest speed which is considered safe and comfortable.

Table 6 is intended for use in determining signing for Type A and Type B roads. It may also be used for signing Type C roads if positive guidance is considered inadequate at specific locations.

Table 5 should be used for consistent placement of TURN and CURVE signs.
NARROW BRIDGES, CULVERTS AND ROADSIDE OBSTACLES

Bridges and culverts that are narrower than the approach roadway and narrow roadways with obstacles adjacent to the shoulder violate the driver’s expectancy and are, therefore, considered to be inconsistencies. As such, it is necessary to provide positive guidance so that the driver has sufficient information to safety negotiate the narrow bridge, culvert or adjacent obstacle. This section covers several different, but related problems—narrow bridges and culverts, one-lane bridges and culverts, and roadside obstacles.

Discussion

Since the driver’s expectancy changes with the physical characteristics of the roadway, the degree of positive guidance required also changes. The following guidelines are intended for use at or near a narrow or one-lane bridge or culvert. These guidelines are divided according to the type of road on which they are to be used.

**TABLE 6—Signing for Curves and Turns**

<table>
<thead>
<tr>
<th>Safe Speed*</th>
<th>60</th>
<th>55</th>
<th>50</th>
<th>45</th>
<th>40</th>
<th>35</th>
<th>30</th>
<th>25</th>
<th>20 (or less)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Usual Operating Speed</strong></td>
<td>60</td>
<td>C</td>
<td>CA</td>
<td>CA</td>
<td>CA</td>
<td>TA</td>
<td>TA</td>
<td>TA</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>55</td>
<td>C</td>
<td>CA</td>
<td>CA</td>
<td>TA</td>
<td>TA</td>
<td>TA</td>
<td>TA</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>C</td>
<td>CA</td>
<td>TA</td>
<td>TA</td>
<td>TA</td>
<td>TA</td>
<td>TA</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>C</td>
<td>TA</td>
<td>TA</td>
<td>TA</td>
<td>TA</td>
<td>TA</td>
<td>TA</td>
<td>T</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td>TA</td>
<td>TA</td>
<td>TA</td>
<td>TA</td>
<td>T</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TA</td>
<td>TA</td>
<td>TA</td>
<td>T</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TA</td>
<td>TA</td>
<td>T</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TA</td>
<td>T</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>T</td>
</tr>
</tbody>
</table>

* That speed which gives a reading of 10° on the Ball Bank indicator.

C - Curve Sign, Reverse Curve Sign
(or winding road sign if applicable)

T - Turn Sign, Reverse Curve Sign
(or winding road sign if applicable)

A - Advisory Speed Plate
Type A:
1. A NARROW BRIDGE sign or a ONE-LANE BRIDGE sign should be used on each approach.
2. Type 3 object markers shall be used on each approach.
3. The approaches to the structure should be tapered.
4. Guardrail may be used.
5. Delineators may be used.
6. Pavement markings may be used.

Type B and Type C:
1. A NARROW BRIDGE sign or a ONE-LANE BRIDGE sign may be used.
2. Type 3 object markers shall be used on each approach, unless the approaches to the structure are tapered such that the structure is no longer narrower than the roadway. If tapering is used, Type 3 object markers may be used to warn of an additional hazard (e.g. concrete bridge rails).

In addition to the signs which designate narrow bridges or culverts, or one-lane bridges or culverts, the existence of the structures and/or adjacent obstacles can be shown through the use of object markers or other means of positive guidance. Since it is generally believed that the driver gets the most information from the physical characteristics of a roadway, there is a greater potential for providing the driver with positive guidance by modifying those physical characteristics to lead the driver safely through the hazard. This is the principle involved in the practice of tapering the approach of a roadway so that it gradually narrows to the width of the structure.

Additional Comments

The Kansas Secondary Roads Policy (S.R.P.) 4.05-80 permits a variation in mounting height of object markers only at certain narrow bridges used by wide farm equipment. When the bridge rail is 36 in. or more above the bridge deck install a Type 3 object marker (12 in. x 36 in.) flush with the top of the rail at the rail end. When the bridge rail is less than 36 in. above the bridge deck use a Type 2 object marker, (all yellow reflective panel 6 in. x 12 in. minimum size), with the top of the panel flush with the top of bridge rail. Type 2 markers may be larger if conditions permit.

When object markers are installed below the normal mounting height of 4 ft. the county must keep weeds mowed in front of the sign and periodic cleaning is necessary for the sign to function properly or maintain sign visibility and reflectivity. (See Figure 10)

LOW WATER STREAM CROSSINGS

Low water stream crossings (LWSCs), (fords) are rarely encountered by the driver; therefore, they can be considered inconsist-
cies. The recommendations for signing LWSCs are based on research by Carstens and Woo (7).

**Discussion**

Experience reported (7) by persons having responsibility for road systems including LWSCs indicates some concern with liability problems growing out of their use. However, a majority of officials having this experience report that they are satisfied with LWSCs and the road users seem to accept them.

This experience suggests that a risk analysis generally will show that the potential for accidents and liability will be reduced, rather than increased, when an LWSC is substituted for a bridge that is structurally deficient or functionally obsolete. It is recommended that adequate warning of the presence of an LWSC be given if the risk of accidents and liability results from the use of an LWSC is to be kept within acceptable limits.

![Diagram of typical mounting of object marker on narrow bridge](image)

**Fig. 10. Typical Mounting of Object Marker on Narrow Bridge Which is Used By Wide Farm Equipment (KS S.R.P. 4.05-80)**

One of the conclusions from the research (7) is that the risk of accidents and liability would be further reduced if motorists were discouraged from crossing an LWSC while it was flooded. The findings from an evaluation of alternative signing patterns support this conclu-
sion by suggesting the use of a regulatory sign with the message DO NOT ENTER WHEN FLOODED. The intent of this sign is to prohibit passage across the LWSC if the roadway is covered with water.

At LWSCs, debris or mud may remain on the roadway after flood waters have receded and erosion of the roadway may have occurred. Thus, it is important that road segments with LWSCs be checked following heavy rains so that the required maintenance may be performed promptly or that the road can be closed if necessary.

On Type A and Type B roads, the three signs FLOOD AREA AHEAD, IMPASSABLE DURING HIGH WATER and DO NOT ENTER WHEN FLOODED should be used (See Figure 11).

On Type C roads, the FLOOD AREA AHEAD sign should be used. The IMPASSABLE DURING HIGH WATER and/or DO NOT ENTER WHEN FLOODED signs may be used in addition.

For Type A, Type B, and Type C roads, if only one sign is used, it shall be the FLOOD AREA AHEAD sign. If only two signs are used, the first sign shall be the FLOOD AREA AHEAD sign.

The placement of the sign(s) may vary depending on the usual operating speed and the terrain. It is important not to give the driver too much information or too many tasks to perform, such as a steep grade to negotiate with the FLOOD AREA AHEAD sign on the steep grade. In this case it is best to warn of the steep grade and also warn of the LWSC before the grade. Distances longer or shorter than those shown in Figure 11 may be used if an engineering study so indicates.
NOTE: Signing as shown should be used on Type A and Type B roads; may be used on Type C roads.

Fig. 11. Typical Signing of Low Water Stream Crossing

Note: The FLOOD AREA AHEAD and IMPASSABLE DURING HIGH WATER signs are warning signs and shall conform to MUTCD standards for warning signs.

The DO NOT ENTER WHEN FLOODED sign is a regulatory sign and shall conform to MUTCD standards for regulatory signs.
CONCLUSION

The consistent use of the suggested traffic controls for LVR roads should result in:

1. more consistent signing and increased guidance on LVR roads
2. increased safety for the LVR road user
3. reduced liability for local government units in case of lawsuits arising from highway accidents
4. reduced amount of signing
5. reduced costs of signing

REFERENCES