Manual on
Uniform Traffic Control Devices I
(MUTCD)

by

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PART 1 – General

INTRODUCTION

This course discusses how to use the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) for establishing roadway traffic control. The contents of this course are intended to serve as guidance and not as an absolute standard or rule. It is intended to help you to use the MUTCD more effectively and not replace it. Should there be any conflicts between the contents of this course and the MUTCD, always follow the MUTCD.

Upon course completion, you should be familiar with the general MUTCD guidelines for traffic control devices. The overall course objective is to give engineers and designers an in-depth look at the principles to be considered when selecting and designing for traffic control.

For this course, the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) 2009 Edition will serve as the text for the fundamental design principles of traffic signs and pavement markings. This document is recognized as the national standard for all traffic control devices installed on any street, highway, bikeway, or private road open to public travel.

Any traffic control device design or application contained within the MUTCD is considered to be in the public domain and available for use.

Traffic signs and pavement markings are the primary communication devices used to inform the roadway user of laws and regulations, traffic and roadway conditions, and guidance and other information. When used properly, these critical tools provide important information to help users to safely travel on any U.S. roadway system.

However, traffic control devices cannot cure all traffic problems. Drivers process different types of visual and non-visual information: speed, roadway conditions, traffic, legal enforcement, noise levels, etc. Also, signs and markings serve as reminders of important information, so road users do not have to memorize everything.

Providing drivers with relevant information when they need it, can make roads safer, more efficient, while reducing liability risks. On the other hand, poor sign management and maintenance can greatly reduce traffic safety and contribute to roadway incidents, thereby increasing liability exposure.

The Standard Highway Signs and Markings book contains detailed specifications for all adopted standard signs and pavement markings. All traffic control devices shall be similar to or mirror images of those shown in this manual. Any symbols or colors cannot be modified unless otherwise stated.
MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD)

By law (23 CFR 655, Subpart F), the *Manual on Uniform Traffic Control Devices* (MUTCD) is recognized as “the national standard for all traffic control devices installed on any street, highway, bikeway, or private road open to public travel”. It is the definitive authority for traffic signs and pavement markings.

Nationwide consistency is the goal of the MUTCD. Its intent is to enhance road safety and operation by requiring uniform, understandable, and effective traffic control devices on all facilities open to public travel. The MUTCD allows us to drive anywhere in the U.S. using the same basic signs. Drivers who see a particular sign should expect it to mean the same thing and be prepared to take the same action regardless of location.

<table>
<thead>
<tr>
<th>Year</th>
<th>Name</th>
<th>Month / Year Revised</th>
</tr>
</thead>
<tbody>
<tr>
<td>1927</td>
<td>Manual and Specifications for the Manufacture, Display, and Erection of U.S. Standard Road Markers and Signs (for rural roads)</td>
<td>4/29, 12/31</td>
</tr>
<tr>
<td>1930</td>
<td>Manual on Street Traffic Signs, Signals, and Markings (for urban streets)</td>
<td>No revisions</td>
</tr>
<tr>
<td>1955</td>
<td>Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)</td>
<td>2/39</td>
</tr>
<tr>
<td>1948</td>
<td>Manual on Uniform Traffic Control Devices for Streets and Highways</td>
<td>9/54</td>
</tr>
<tr>
<td>1961</td>
<td>Manual on Uniform Traffic Control Devices for Streets and Highways</td>
<td>No revisions</td>
</tr>
<tr>
<td>2009</td>
<td>Manual on Uniform Traffic Control Devices for Streets and Highways</td>
<td></td>
</tr>
</tbody>
</table>

The MUTCD is published by the Federal Highway Administration (FHWA) to promote safety and efficiency on our public roads by establishing uniform standards for traffic control devices. It defines the nationwide standards for the installation and maintenance of the devices on all streets and highways.

Roadway safety can many times be increased by exceeding MUTCD requirements. Oversized signs can be used where speed, volume or other factors produce conditions needing additional visibility. Any excessive practice should only be used if a standard...
measure cannot meet the need. Otherwise, road users may disregard the traffic control device.

The MUTCD has nine chapters ("Parts"): 

1. General
2. Signs
3. Marking
4. Highway Traffic Signals
5. Traffic Control Devices for Low-Volume Roads
6. Temporary Traffic Control
7. Traffic Control for School Areas
8. Traffic Control for Highway-Rail Grade Crossings
9. Traffic Control for Bicycle Facilities

This course will present an overview of **Parts 1 through 4**, please consult the MUTCD for specific details.

**SHALL, SHOULD, and MAY**

The terms "shall," "should," and "may" have specific meanings when used in the MUTCD. These words are defined as follows:

**SHALL** – Required, mandatory or specifically prohibitive practice. Statements with "shall" conditions are typically used as a STANDARD in the MUTCD. These items cannot be modified or compromised. There is no allowance for discretion and they must be followed.

**SHOULD** – Advisory or recommended practice in typical situations. Deviation is appropriate if justified by engineering judgment or study. Statements marked as "should" are used for GUIDANCE in the MUTCD.

**MAY** – Permissive or optional practice without requirement or recommendation.
Items marked as “may” are typically used in OPTION statements in the MUTCD and can contain allowable modifications.

SUPPORT statements do not contain the verbs “shall”, “should”, or “may”. These statements are for informational purposes only without any mandate, recommendation, or enforcement.

The Five Basic Requirements of Traffic Control Devices

In order to be effective, any traffic control device has to be used in the right way. The MUTCD lists the following principles to be used when selecting and applying each device:

1. Fulfill a need

A sign should only be installed if there is a need for warning, regulation or guide information. It is also vital to use signs that fulfill that need. If a need exists and the sign in question does not meet that need, use something else. Overusing signs can lead to disrespect and loss of emphasis value while underuse can result in persistent but correctable safety problems.

2. Command attention

Standard signs are designed to be noticed and catch the attention of road users. The high-contrast color combinations were chosen due to their ability to stand out and be easy to read. Oversized signs, doubled signs, or flashing beacons can also be used to emphasize the sign’s message.

3. Command respect

Road users are expected to willingly obey warnings and regulations that obviously fulfill a need. Warning and regulatory signs that seem unneeded or unreasonable are regularly disobeyed. Good sign management and maintenance is crucial to commanding respect for traffic control devices. Amateurish, homemade or damaged signs are more likely to be disregarded.
4. **Have one simple message**

A sign needs to communicate its message in a way that is clear and readable. By using standard signs in the MUTCD that have been researched and evaluated by the FHWA, most drivers should understand their meanings.

5. **Provide adequate time for proper response**

Traffic control devices should meet or exceed MUTCD standards so drivers have adequate time (Perception-Response Time – PRT) to react. Drivers need to have the time and distance to take the appropriate action before they reach a situation. If not, insufficient response time may result in roadway crashes.

Traffic speed is an important factor for determining driver response time. Vehicles operating at high speeds need longer response time and more distance to react. This increased distance can be obtained by using larger signs, or by placing signs in advance of the location where the information is needed.

Using the five basic requirements will help make your traffic control devices more effective. Design, placement, operation, maintenance, and uniformity should be taken into consideration to maximize the ability of a device to meet these principles. However, by disregarding the five requirements, you may find that road users disregard your traffic control devices.

The MUTCD defines a road user as “a vehicle operator, bicyclist, or pedestrian, including persons with disabilities, within the highway or on a private road open to public travel”. This group includes drivers of different skill levels and ages, pedestrians, wheelchairs, runners, rollerbladers, bicyclists, truck drivers, and motorcyclists. The ability to empathize with the road user is important skill for engineers in order to meet the needs of everyone using the road. By meeting their needs, you can minimize any problems that the average road user may encounter.

**The Americans With Disabilities Act (ADA) of 1990**

The regulations of the Americans with Disabilities Act are designed to prevent any discrimination against disabled individuals, including road users. This act requires access needs of the disabled be accommodated through the use of specialized signs, pavement markings, sign placements, etc.
Non-Traffic Control Devices
Non-traffic control devices are signs or markers that are not used to regulate, warn, or guide traffic. Signs that post non-traffic regulations, like dog leash laws, are non-traffic control devices. Devices like fire hydrant markers or culvert markers are also non-traffic control devices, since they are not meant for the public. Signs for civic groups such as Rotary Clubs also fall into this category.

These devices should be prevented from interfering with official traffic control devices. They should be installed on crashworthy signposts, in order to keep from creating a hazard to the traveling public.
PART 2 – Signs

READIBILITY and RETROREFLECTIVITY
Drivers must be able to read a sign from a reasonable distance and have adequate time to respond in order to safely travel the roadway.

Retroreflectivity
Retroreflectivity is the ability of a traffic control device to reflect light from its surface and return to its original source. Traffic signs using retroreflective materials are used to increase their visibility at night. Maintaining retroreflectivity is crucial to traffic safety since fatal night crashes occur approximately three (3) times as often as daytime traffic fatalities.

Technologies such as glass beads or prismatic reflectors are used to reflect light back to the driver. These traffic control devices are more visible and bright because they reflect more light directly back at the original source.

To work properly, retroreflectivity needs the following elements:

- **Light source** – vehicle headlights
- **Target** – traffic control device
- **Receptor** – driver’s eyes

Improving nighttime visibility of signs and pavement markings becomes more important as we get older. As we age, our eyes gradually become less sensitive to light. As the national population gets older, the average driver gets older, and people continue driving at older ages.
All signs (regulatory, warning, and guide) and object markers need to be retroreflective or illuminated to display the same shape and color regardless of time of day. New materials or methods can be used as long as the traffic control devices meet the standard color requirements. Sign design will be uniform without any decrease in:

visibility  
legibility  
or  
driver comprehension during day or night conditions.

Sign Type and Designation
Over the years, traffic signs have been responsible for providing messages of increasing complexity. To accomplish this goal, the MUTCD specifies standard design features to encourage adequate perception-reaction time for the road user. These features (size, shape, and color) are specific to the functional category of each traffic sign.

Table 1 - SIGN CATEGORIES AND USE

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulatory</td>
<td>Requires or prohibits actions by the road user</td>
</tr>
<tr>
<td>Warning</td>
<td>Warns user of conditions that may require an action to avoid a hazardous situation</td>
</tr>
<tr>
<td>Guide &amp; Information</td>
<td>Helps user find their way, informs user of traveler services, etc.</td>
</tr>
<tr>
<td>Recreational and Cultural Interest</td>
<td>Guides user to recreation and cultural areas/facilities</td>
</tr>
<tr>
<td>Non-Traffic Control</td>
<td>Not meant for highway use, or contains information not related to highway use or traffic control</td>
</tr>
</tbody>
</table>
Sign Color and Shape
A sign's color and shape can be vital in conveying traffic control information. These specific combinations are used to inform drivers as to the type of sign they are seeing. The colors and shapes are meant to command attention and convey a clear simple message. The Federal Highway Administration (FHWA) established the following color code for appropriate colors to use for traffic control devices.

Table 2 - COLOR CODE FOR TRAFFIC CONTROL DEVICES

<table>
<thead>
<tr>
<th>COLOR</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>Regulation</td>
</tr>
<tr>
<td>Blue</td>
<td>Road user services guidance, tourist information, and evacuation route</td>
</tr>
<tr>
<td>Brown</td>
<td>Recreational and cultural interest area guidance</td>
</tr>
<tr>
<td>Coral</td>
<td>Unassigned</td>
</tr>
<tr>
<td>Fluorescent Pink</td>
<td>Incident management</td>
</tr>
<tr>
<td>Fluorescent Yellow-Green</td>
<td>Pedestrian warning, bicycle warning, playground warning, school bus and school warning</td>
</tr>
<tr>
<td>Green</td>
<td>Indicated movements permitted, direction guidance</td>
</tr>
<tr>
<td>Light Blue</td>
<td>Unassigned</td>
</tr>
<tr>
<td>Orange</td>
<td>Temporary traffic control</td>
</tr>
<tr>
<td>Purple</td>
<td>Lanes restricted to use only by vehicles with registered electronic toll collection (ETC) accounts</td>
</tr>
<tr>
<td>Red</td>
<td>Stop or prohibition</td>
</tr>
<tr>
<td>White</td>
<td>Regulation</td>
</tr>
<tr>
<td>Yellow</td>
<td>Warning</td>
</tr>
</tbody>
</table>
Non-standard colors, or non-standard display methods can create driver confusion. For example, people would be reluctant to recognize a stop sign that is a shape other than octagonal, or a color other than red.

Signs usually have one color for the legend (typically black or white), which includes symbols, text and border. Some signs (such as prohibition signs) have two-color legends containing a red circle and slash over a black symbol.

Table 2A-4 shows how sign shape and function correlate.

<table>
<thead>
<tr>
<th>Shape</th>
<th>Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Octagon</td>
<td>Stop*</td>
</tr>
<tr>
<td>Equilateral Triangle (1 point down)</td>
<td>Yield*</td>
</tr>
<tr>
<td>Circle</td>
<td>Grade Crossing Advance Warning*</td>
</tr>
<tr>
<td>Pennant Shape/Isosceles Triangle (longer axis horizontal)</td>
<td>No Passing*</td>
</tr>
<tr>
<td>Pentagon (pointed up)</td>
<td>School Advance Warning Sign (squared bottom corners)*</td>
</tr>
<tr>
<td>Crossbuck (two rectangles in an “X” configuration)</td>
<td>Grade Crossing*</td>
</tr>
<tr>
<td>Diamond</td>
<td>Warning Series</td>
</tr>
<tr>
<td>Rectangle (including square)</td>
<td>Regulatry Series</td>
</tr>
<tr>
<td></td>
<td>Guide Series**</td>
</tr>
<tr>
<td></td>
<td>Warning Series</td>
</tr>
<tr>
<td>Trapezoid</td>
<td>Recreational and Cultural Interest Area Series</td>
</tr>
<tr>
<td></td>
<td>National Forest Route Sign</td>
</tr>
</tbody>
</table>

* This sign shall be exclusively the shape shown.

** Guide series includes general service, specific service, tourist-oriented directional, general information, recreational and cultural interest area, and emergency management signs.

** Sign Size
Standard sign sizes should be used unless engineering judgment indicates otherwise. Sign sizes shall not be smaller than the minimum sizes contained in the MUTCD. Larger sizes may be used where deemed appropriate. Standard shapes and colors as close to the standard proportions should be used.
Sign Location
Signs requiring different decisions by the road user shall be spaced sufficiently far apart for the required decisions to be made reasonably safely. Signs should be located on the right side of the roadway where they are easily recognized and understood by road users. Signs in other locations should be considered only as supplementary to signs in the normal locations.

Potential sign locations should:

- Be outside the clear zone unless placed on a breakaway or yielding support
- Not be hidden from view
- Optimize nighttime visibility
- Minimize the effects of mud splatter and debris
- Not obscure each other – Avoid clutter

Signs need to be carefully placed so that the motorist is not overloaded with information. Multiple signs should be compatible and provide a logical sequence of communication to the road user. The motorist needs to have adequate time to adjust speed, avoid any potential hazard, and continue on their desired route.
Lateral Distance

A sign’s proximity to the road has a direct impact on visibility. A close placement will make it easier for the road user to read but will also make it more likely to be hit by traffic. If the sign is placed further away from the roadway, it is less vulnerable to damage but harder to read.

Post-mounted signs should have a minimum lateral clearance of 12 feet from the edge of the travel way to the near edge of the sign. For shoulder widths over 6 feet, the minimum offset should be 6 feet from the shoulder’s edge. Locations should be considered that minimize traffic exposure to the traffic sign supports. Potential sites should be located as far as practical from the edge of shoulder.

For locations on curbed roadways where parking or pedestrians are prevalent, the edge of the sign should be a minimum offset of two feet from the face of curb. This distance permits an adequate clearance for opening parked vehicle doors. Increasing this lateral offset distance will minimize chances of sign damage by vehicles. However, caution needs to be exercised to prevent blocking the sidewalk.
Height Above the Roadway
The height of a sign impacts sign visibility, roadway safety, and pedestrian access. The minimum height for signs installed in rural areas is 5 feet and is measured from the edge of pavement elevation to the bottom of the sign.

For urban areas with parking considerations, pedestrian concerns, or sight distance challenges, the minimum height requirement is 7 feet. For curb sections, this distance is measured from the top of curb to the bottom of sign. The minimum height for roadways without curb is measured from the edge of traveled way elevation to the bottom of the sign.

For areas with sidewalks, the minimum height is 7 feet and is measured from the top of sidewalk to the bottom of the sign.

The MUTCD only specifies minimum heights for sign assemblies. For sign locations on hillcrests, it may be useful to place the sign higher than normal so that it will be visible to road users.

Figure 1 – MINIMUM SIGN HEIGHT

<table>
<thead>
<tr>
<th>Height (ft)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Rural</td>
</tr>
<tr>
<td>7</td>
<td>Parking or pedestrian movements (non-rural)</td>
</tr>
<tr>
<td>7</td>
<td>Directional signs on expressways and freeways</td>
</tr>
<tr>
<td>8</td>
<td>Height of sign if secondary sign present</td>
</tr>
<tr>
<td>5</td>
<td>Secondary sign above the level of the pavement edge</td>
</tr>
<tr>
<td>7</td>
<td>All route signs, warning signs, and regulatory signs on expressways and freeways</td>
</tr>
</tbody>
</table>

Sign Priority
For locations where more than one sign is required, priority needs to be established regarding the order of placement. Regulatory signs take precedence over the other signs since they are typically located where a regulation is in effect. Guide, informational, recreational, and cultural interest signs are less crucial due to their location flexibility.
Traffic signs are commonly prioritized by importance into the following categories:

1. Regulatory
2. Warning
3. Guide
4. Emergency services
5. Motorist services
6. Public transportation
7. Traffic Generators
8. General Information

REGULATORY SIGNS

Regulatory signs are used to inform drivers of traffic regulations, laws, and applicable legal requirements. They require or prohibit the movement of vehicles, pedestrians, and other road users. Regulatory signs are intended to encourage the safe and orderly flow of traffic. All signs should clearly communicate its message and provide adequate visibility (retroreflective or illumination).

Unless specifically designated otherwise, all regulatory signs shall be rectangular. Notable exceptions include stop signs, yield signs and railroad crossing signs. The colors used for regulatory signs are white, black, and red.

Regulatory signs should be used to fulfill a need. If drivers perceive a regulation to be unneeded, they are likely to disobey it. However, other road users may expect them to
obey the sign, and act accordingly which may result in traffic accidents (example: 4-Way Stop).

### Table 2B-1. Regulatory Sign and Plaque Sizes (Sheet 1 of 4)

<table>
<thead>
<tr>
<th>Sign or Plaque</th>
<th>Designation</th>
<th>Section</th>
<th>Conventional Road</th>
<th>Expressway</th>
<th>Freeway</th>
<th>Minimum</th>
<th>Oversized</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Single Lane</td>
<td>Multi-Lane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stop</td>
<td>R1-1</td>
<td>2B.05</td>
<td>30 x 30&quot;</td>
<td>36 x 36&quot;</td>
<td>36 x 36&quot;</td>
<td>36 x 36&quot;</td>
<td>30 x 30&quot;</td>
</tr>
<tr>
<td>Yield</td>
<td>R1-2</td>
<td>2B.08</td>
<td>36 x 36 x 36&quot;</td>
<td>48 x 48 x 48</td>
<td>48 x 48 x 48</td>
<td>60 x 60 x 60</td>
<td>30 x 30 x 30&quot;</td>
</tr>
<tr>
<td>To Oncoming Traffic</td>
<td>R1-2aP</td>
<td>2B.10</td>
<td>24 x 18</td>
<td>24 x 18</td>
<td>36 x 30</td>
<td>48 x 36</td>
<td>24 x 18</td>
</tr>
<tr>
<td>All Way</td>
<td>R1-3P</td>
<td>2B.05</td>
<td>18 x 6</td>
<td>18 x 6</td>
<td>36 x 36</td>
<td>36 x 36</td>
<td>—</td>
</tr>
<tr>
<td>Yield Here to Peds</td>
<td>R1-5</td>
<td>2B.11</td>
<td>—</td>
<td>36 x 36</td>
<td>—</td>
<td>36 x 36</td>
<td>—</td>
</tr>
<tr>
<td>Yield Here to Pedestrians</td>
<td>R1-5a</td>
<td>2B.11</td>
<td>—</td>
<td>36 x 48</td>
<td>—</td>
<td>36 x 48</td>
<td>—</td>
</tr>
<tr>
<td>Stop Here for Peds</td>
<td>R1-5b</td>
<td>2B.11</td>
<td>—</td>
<td>36 x 36</td>
<td>—</td>
<td>36 x 36</td>
<td>—</td>
</tr>
<tr>
<td>Stop Here for Pedestrians</td>
<td>R1-5c</td>
<td>2B.11</td>
<td>—</td>
<td>36 x 48</td>
<td>—</td>
<td>36 x 48</td>
<td>—</td>
</tr>
<tr>
<td>In-Street Ped Crossing</td>
<td>R1-6.6a</td>
<td>2B.12</td>
<td>12 x 36</td>
<td>12 x 36</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Overhead Ped Crossing</td>
<td>R1-9.3a</td>
<td>2B.12</td>
<td>90 x 24</td>
<td>90 x 24</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Except Right Turn</td>
<td>R1-10P</td>
<td>2B.05</td>
<td>24 x 18</td>
<td>24 x 18</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Speed Limit</td>
<td>R2-1</td>
<td>2B.13</td>
<td>24 x 30&quot;</td>
<td>30 x 36</td>
<td>36 x 48</td>
<td>48 x 60</td>
<td>18 x 24&quot;</td>
</tr>
<tr>
<td>Truck Speed Limit</td>
<td>R2-2P</td>
<td>2B.14</td>
<td>24 x 24</td>
<td>24 x 24</td>
<td>36 x 36</td>
<td>36 x 48</td>
<td>—</td>
</tr>
<tr>
<td>Night Speed Limit</td>
<td>R2-3P</td>
<td>2B.15</td>
<td>24 x 24</td>
<td>24 x 24</td>
<td>36 x 36</td>
<td>36 x 48</td>
<td>—</td>
</tr>
<tr>
<td>Minimum Speed Limit</td>
<td>R2-4P</td>
<td>2B.16</td>
<td>24 x 30</td>
<td>24 x 30</td>
<td>36 x 48</td>
<td>48 x 60</td>
<td>—</td>
</tr>
<tr>
<td>Combined Speed Limit</td>
<td>R2-4a</td>
<td>2B.16</td>
<td>24 x 48</td>
<td>24 x 48</td>
<td>36 x 72</td>
<td>48 x 96</td>
<td>—</td>
</tr>
<tr>
<td>Unless Otherwise Posted</td>
<td>R2-5P</td>
<td>2B.13</td>
<td>24 x 18</td>
<td>24 x 18</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Citywide</td>
<td>R2-5aP</td>
<td>2B.13</td>
<td>24 x 6</td>
<td>24 x 6</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Neighborhood</td>
<td>R2-5bP</td>
<td>2B.13</td>
<td>24 x 6</td>
<td>24 x 6</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Residential</td>
<td>R2-5cP</td>
<td>2B.13</td>
<td>24 x 6</td>
<td>24 x 6</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Fines Higher (plaque)</td>
<td>R2-6P</td>
<td>2B.17</td>
<td>24 x 18</td>
<td>24 x 18</td>
<td>36 x 24</td>
<td>48 x 36</td>
<td>—</td>
</tr>
<tr>
<td>Fines Double (plaque)</td>
<td>R2-6aP</td>
<td>2B.17</td>
<td>24 x 18</td>
<td>24 x 18</td>
<td>36 x 24</td>
<td>48 x 36</td>
<td>—</td>
</tr>
<tr>
<td>6XX Fine (plaque)</td>
<td>R2-6bP</td>
<td>2B.17</td>
<td>24 x 18</td>
<td>24 x 18</td>
<td>36 x 24</td>
<td>48 x 36</td>
<td>—</td>
</tr>
<tr>
<td>Begin Higher Fines Zone</td>
<td>R2-10</td>
<td>2B.17</td>
<td>24 x 30</td>
<td>24 x 30</td>
<td>36 x 48</td>
<td>48 x 60</td>
<td>—</td>
</tr>
<tr>
<td>End Higher Fines Zone</td>
<td>R2-11</td>
<td>2B.17</td>
<td>24 x 30</td>
<td>24 x 30</td>
<td>36 x 48</td>
<td>48 x 60</td>
<td>—</td>
</tr>
<tr>
<td>Movement Prohibition</td>
<td>R3-1,2,3,4,18,27</td>
<td>2B.18</td>
<td>24 x 24&quot;</td>
<td>36 x 36</td>
<td>36 x 36</td>
<td>48 x 48</td>
<td>—</td>
</tr>
<tr>
<td>Mandatory Movement Lane Control</td>
<td>R3-5.5a</td>
<td>2B.20</td>
<td>30 x 36</td>
<td>30 x 36</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Left Lane</td>
<td>R3-5P</td>
<td>2B.20</td>
<td>30 x 12</td>
<td>30 x 12</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>HOV 2+ (plaque)</td>
<td>R3-5cP</td>
<td>2B.20</td>
<td>24 x 12</td>
<td>24 x 12</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Taxi Lane</td>
<td>R3-5dP</td>
<td>2B.20</td>
<td>30 x 12</td>
<td>30 x 12</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Regulatory signs can be used to remind road users of statutory traffic laws (no parking, no turn on red, one way, etc.). Some laws may not need signs to be enforceable.

### WARNING SIGNS

Warning signs alert road users to unexpected or unapparent conditions on or near the roadway. These signs may require actions by the driver in order to ensure safe traffic operations and can be categorized as shown in the following table.
<table>
<thead>
<tr>
<th>Category</th>
<th>Group</th>
<th>Section</th>
<th>Signs or Plaques</th>
<th>Sign Designations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes in Horizontal</td>
<td></td>
<td></td>
<td>Turn, Curve, Reverse Turn, Reverse Curve, Winding Road, Hairpin Curve, 270-Degree</td>
<td>W1-1,2,3,4,5,6,11,15</td>
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<tr>
<td>Alignment</td>
<td></td>
<td></td>
<td>Advisory Speed</td>
<td>W13-1P</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chevron Alignment</td>
<td>W1-8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Combination Horizontal Alignment/Advisory Speed</td>
<td>W1-1,2,3,4a</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Combination Horizontal Alignment/Intersection</td>
<td>W1-10,10a,10b,10c,10d</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Large Arrow (one direction)</td>
<td>W1-4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Truck Rollover</td>
<td>W1-10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Advisory Exit of Ramp Speed</td>
<td>W13-2,3</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Combination Horizontal Alignment/Advisory Exit or Ramp Speed</td>
<td>W13-6,7</td>
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<tr>
<td>Vertical</td>
<td></td>
<td></td>
<td>Hill</td>
<td>W7-1,2,3,4,5,6,7,8,9,10,11,12,13,14</td>
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<tr>
<td>Roadway</td>
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<td></td>
<td>Truck Escape Ramp</td>
<td>W7-4,5,6,7,8,9,10,11,12,13,14</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Hill Blocks View</td>
<td>W7-6</td>
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<tr>
<td></td>
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<td></td>
<td>Flood Narrow</td>
<td>W5-1</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>Narrow Bridge, One Lane Bridge</td>
<td>W5-2</td>
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<td></td>
<td></td>
<td></td>
<td>Divided Highway, Divided Highway Ends, Double Arrow</td>
<td>W6-1,2,3,4</td>
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<td></td>
<td></td>
<td></td>
<td>Freeway or Expressway Ends, All Traffic Must Exit</td>
<td>W10-1,2,3,4,5</td>
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<td>Dead End, No Outlet</td>
<td>W14-1,2,3,4a,5a</td>
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<td></td>
<td>Low Clearance</td>
<td>W12-2,3</td>
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<td>Bump, Dip, Speed Hump</td>
<td>W8-1,2,3,4,5,6,7,8,9,10,11,12,13,14</td>
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<td></td>
<td></td>
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<td>Pavement Ends</td>
<td>W8-3</td>
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<td></td>
<td>Shoulder, Unpaved Lanes</td>
<td>W9-1,2,3,4,5,6,7,8,9,10,11,12,13,14</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Slippery When Wet, Loose Gravel, Rough Road, Bridge Ices, Winter Road, Fallen</td>
<td>W8-5,6,7,8,9,10,11,12,13,14</td>
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<td>Rocks</td>
<td>W8-5,6,7,8,9,10,11,12,13,14</td>
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<td>Grooved Pavement, Metal Bridge Deck</td>
<td>W9-1,2,3,4,5,6,7,8,9,10,11,12,13,14</td>
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<td></td>
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<td>No Contact Line</td>
<td>W9-12</td>
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<td>Roadway Surface</td>
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<td>Roadway Surface Condition</td>
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</tr>
<tr>
<td>Condition</td>
<td></td>
<td></td>
<td>Weather</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Stop Ahead, Yield Ahead, Signal Ahead</td>
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<td></td>
<td>Advance, Yield Ahead, Signal Ahead</td>
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<td></td>
<td></td>
<td></td>
<td>Advance, Yield Ahead, Signal Ahead</td>
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<td></td>
<td></td>
<td></td>
<td>Be Preceeded To, Stop, Speed Reduction, Drawbridge Ahead, Ramp Motor Ahead</td>
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<td></td>
<td></td>
<td></td>
<td>Merge, Non-Merge Area, Lane Ends, Added Lane, Two-Way Traffic, Right Lane Ext</td>
<td></td>
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<tr>
<td>Traffic Flow</td>
<td></td>
<td></td>
<td>Only Ahead, No Passing Zone</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Cross Road, Side Road, T, Y, Circular Intersection, Side Roads</td>
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<td></td>
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<td></td>
<td>Large Arrow (two directions)</td>
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<td></td>
<td>Oncoming Extended Green</td>
<td></td>
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<td></td>
<td>Truck Crossing, Truck (symbol), Emergency Vehicle, Tractor, Bicycle, Golf Cart</td>
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<td></td>
<td></td>
<td></td>
<td>Horse-Drawn Vehicle, Trail Crossing</td>
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<td></td>
<td></td>
<td>Pedestrian, Deer, Cattle, Snowmobile, Equestrian, Wheelchair, Large Animals</td>
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<td></td>
<td>Playground</td>
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<td></td>
<td>New Traffic Pattern Ahead</td>
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<td></td>
<td>Location</td>
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<td>HUV</td>
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<td></td>
<td>High-Capacity Vehicle</td>
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<td></td>
<td></td>
<td>Distance</td>
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<td></td>
<td></td>
<td>XX Foot, XX Miles, Next XX Foot, Next XX Miles</td>
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<td></td>
<td></td>
<td></td>
<td>Arrow</td>
<td></td>
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<td></td>
<td>Advance Arrow, Direction Arrow</td>
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<td></td>
<td></td>
<td>Advance Street Name</td>
<td></td>
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<td></td>
<td>Intersection</td>
<td></td>
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<td></td>
<td>Cross Traffic Does Not Stop</td>
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<td></td>
<td>Share The Road</td>
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<td>Photo Enterted</td>
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<td>New</td>
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<tr>
<td>Other Supplement Plaques</td>
<td></td>
<td></td>
<td>New</td>
<td></td>
</tr>
</tbody>
</table>

[Table 2C-1. Categories of Warning Signs and Plaques]
The majority of warning signs are diamond-shaped with a black legend/border and yellow background. Exceptions include:

- **School signs**  
  Pentagon-shaped  
  ![S1-1](image)

- **Railroad warning signs**  
  Circular  
  ![W10-1](image)

- **No passing signs**  
  Triangular  
  ![W14-3](image)

The background color on warning signs is dependent on their use. Signs regarding pedestrians, bicyclists and playgrounds may have a black legend/border and yellow or fluorescent yellow-green background. For buses, schools and supplemental plaques, the signs should have a black legend/border on a fluorescent yellow-green background.

The minimum size for all diamond-shaped signs is 36 x 36 inches for multilane roadways with a posted speed greater than 35 mph.
Properly located warning signs can reduce incidents by improving driver Perception-Response Times (PRT). A standard value for PRT is typically 2.5 seconds, with 2.5 to 3.0 seconds for older drivers, and longer times for unexpected events.

<table>
<thead>
<tr>
<th>Condition A: Speed reduction and lane changing in heavy traffic</th>
<th>Condition B: Deceleration to the listed advisory speed (mph) for the condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advance Placement Distance (ft)</td>
<td>0</td>
</tr>
<tr>
<td>20 mph</td>
<td>225 ft</td>
</tr>
<tr>
<td>25 mph</td>
<td>235 ft</td>
</tr>
<tr>
<td>30 mph</td>
<td>260 ft</td>
</tr>
<tr>
<td>35 mph</td>
<td>295 ft</td>
</tr>
<tr>
<td>40 mph</td>
<td>325 ft</td>
</tr>
<tr>
<td>45 mph</td>
<td>355 ft</td>
</tr>
<tr>
<td>50 mph</td>
<td>390 ft</td>
</tr>
<tr>
<td>55 mph</td>
<td>425 ft</td>
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<tr>
<td>60 mph</td>
<td>460 ft</td>
</tr>
<tr>
<td>65 mph</td>
<td>495 ft</td>
</tr>
<tr>
<td>70 mph</td>
<td>530 ft</td>
</tr>
<tr>
<td>75 mph</td>
<td>565 ft</td>
</tr>
</tbody>
</table>

Although some warning signs may be more effective than others, their use should result in a significant reduction in related incidents. But like all traffic signs, improper use usually causes disrespect for all warning signs, and minimizes their effectiveness.

**When considering the use of a warning sign:**
- Determine if the hazard can be removed.
- If it will take time to remove the hazard, use a temporary sign to warn traffic.
- If the hazard is impossible or too expensive to remove, install a warning sign.
- Any temporary signage should be removed as soon as it is no longer needed.
GUIDE AND INFORMATION SIGNS

Guide and information signs give information that guides the road user to their destination in the most simple, direct manner possible. These signs direct drivers using streets and highways by informing them of intersections, directing them to various destinations, or identifying nearby rivers, streams, parks and historical sites.

Guide signs on streets or highways are usually rectangles with white text and border on green, blue, or brown backgrounds. Signs that guide traffic through work zones or detours are black with an orange background. All guide and information signs (message, border, legend and background) shall be retroreflective or illuminated.

As a general rule, guide signs should be limited to a maximum of 3 lines to give road users adequate time for comprehension. Guide signs with long messages (regardless of letter size) take longer for the reader to comprehend. It may prove beneficial to provide a distance message or action information on guide signs in addition to destinations.

Providing accurate and timely navigation information to the road user is crucial to traffic safety. Guide and information signs can prevent erratic maneuvers, and minimize potential incidents with other road users.

Freeways

Freeway and expressway signing should be a planned system of installations. An engineering study can be helpful for solving the problems of many individual locations within the context of an entire route. Road users should be guided with consistent signing that takes into account the geographical, geometric, and operating factors that create significant differences between urban and rural conditions.
Functions of Guide Signs on Freeways and Expressways

- Provide directions to destinations, or to streets or highway routes, at intersections or interchanges;
- Advance notice of the approach to intersections or interchanges;
- Direct road users in advance of diverging or merging movements;
- Identify routes and provide directions;
- Show distances to destinations;
- Indicate access points to general motorist services, rest, scenic, and recreational areas;
- Provide other information of value.

TOLL ROAD SIGNS

Toll highways are typically (but not always) limited-access freeway or expressway facilities with portions being a toll highway, bridge, tunnel, or other crossing point. The general signing requirements for toll roads depends on the type of facility and access (freeway, expressway, or conventional road). The presence of toll plazas and collection points will require additional modifications to the typical signing.
Figure 2F-6. Examples of Guide Signs for the Entrance to a Toll Highway on which Tolls are Collected Electronically Only.
PREFERENTIAL AND MANAGED LANE SIGNS

Preferential lanes are designated for special traffic uses (high-occupancy vehicles (HOVs), light rail, buses, taxis, bicycles, etc.). These lane treatments range from restricting a turning lane to a certain class of vehicles during peak periods to providing a separate roadway system within a highway corridor for certain vehicles.

Types of Preferential Lanes

**Barrier-separated**: on a separate alignment or physically separated from the other travel lanes by a barrier or median

**Buffer-separated**: separated from the adjacent traffic lanes by a narrow buffer area with longitudinal pavement markings

**Contiguous**: separated from the adjacent lanes by a lane line

Preferential lanes might allow access with the adjacent traffic lanes or restrict access to designated locations. They can also be operated in a constant direction or as reversible lanes. For a divided highway, reversible preferential lanes can be operated counter-flow to the direction of traffic on the adjacent general-purpose lanes.

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**Figure 2G-1. Preferential Lane Regulatory Signs and Plaques (Sheet 1 of 2)**

**POST-MOUNTED PREFERENTIAL LANE SIGNS**

- R3-10: HOV 2+ Only (2 or more persons per vehicle)
- R3-10a: Inherently Low Emission Vehicles Allowed
- R3-11: HOV 2+ Only (6 AM - 9 AM Mon-Fri)
- R3-11a: Left Lane
- R3-11b: Buses Only (6 AM - 9 AM Mon-Fri)
- R3-11c: HOV 2+ Only (24 Hours)
- R3-11P: Motorcycles Allowed
GENERAL INFORMATION SIGNS

General Information signs convey numerous kinds of information that may be of interest to the traveler (though not directly necessary for guidance). These include: State lines, city limits, other political boundaries, time zones, stream names, elevations, landmarks, geographical interest, safety and transportation-related messages. Recreational and cultural interest signs are commonly used in combination with these signs. On all such signs, the designs should be simple and dignified, without advertising, and in compliance with other signage.

![Figure 2H-1. General Information and Miscellaneous Information Signs](image)

CHANGEABLE MESSAGE SIGNS

A changeable message sign (CMS) is a device capable of displaying one or more alternative messages. Some of these signs have a blank mode when no message is displayed, with others displaying multiple messages - one message displayed at a time.

**Typical Changeable Message Sign Applications**

- Incident management and route diversion
- Warning of adverse weather conditions
- Special event applications
- Crossing situations control
- Lane, ramp, and roadway control
- Lane management
- Travel times
State and local highway agencies typically use changeable message signs to display safety messages, transportation-related messages, emergency homeland security messages, and America’s Missing: Broadcast Emergency Response (AMBER) alert messages.

**EMERGENCY MANAGEMENT SIGNING**

Contingency planning for an emergency evacuation should be considered by all State and local jurisdictions for all applicable roadways.

In the event of a disaster with highway closures, a contingency plan should address the following elements:

- Controlled operation of certain designated highways,
- Establishment of traffic operations for expediting essential traffic,
- Provision of emergency centers for civilian aid.

Emergency Management signs should guide and control highway traffic in the event of an emergency. These signs should not permanently displace any of the standard signs that are normally applicable.

![Figure 2N-1. Emergency Management Signs](image)
State and local authorities are responsible for any advance planning for transportation operations’ emergencies. The Federal Government will provide guidance to the States due to changing circumstances.

RECREATIONAL AND CULTURAL INTEREST SIGNS
Recreational and cultural interest areas are open to the general public for the purpose of relaxation, play, or amusement. The purpose of recreational and cultural interest signs is to guide road users to general areas first and then to specific facilities.

Recreational attractions include:
- Parks
- Campgrounds
- Gaming facilities
- Ski areas

Cultural attractions include:
- Museums
- Art galleries
- Historical buildings or sites

Recreational or cultural interest signs are rectangular with white symbols and borders on either a green, brown, or black background. The signs that are located on highways outside of recreational interest areas will have white symbols/borders on brown backgrounds with the following exceptions:

- Ferry, Post Office, Airport, Bus Stop, and Helicopter signs - white symbols with green backgrounds.
- Camping Tent and Trailer, Gas, Handicapped, Lodging, Picnic area, Rest Area, Telephone, Rest Room, Trailer Sanitary Station, Group Camping, Group Picnicking, Parking - white symbols with blue backgrounds.
PART 3 – Markings

PAVEMENT MARKINGS
All pavement markings should be maintained as needed to assure good daytime and nighttime visibility. It is the municipality’s responsibility to maintain the marking once the decision has been made to install it. If the municipality decides that the marking is no longer needed, documentation of the decision process should be recorded. Any markings deemed non-applicable or confusing should be removed as soon as practical.

Highway pavement marking is more than striping on a roadway. It is a guidance system that relays regulatory and vehicle-path information to the user without requiring them to divert their attention from the road. These markings are intended to encourage safe, orderly traffic flow while optimizing roadway capacity. In order to be effective, pavement markings need to be readily recognized and understood. A uniform system of marking color, shape, and application has been developed so motorists see the same type of markings convey the same message each time they encounter a particular situation.

COLORS

WHITE PAVEMENT MARKING
Separates traffic flows in the same direction
Delineates the right edge of the roadway.

YELLOW PAVEMENT MARKING
Separates traffic traveling in the opposite directions
Delineates the left edge of the roadways of divided and one-way highways and ramps
Separates two-way left turn lanes and reversible lanes from other lanes.

BLUE PAVEMENT MARKING
Supplements white markings for handicap parking spaces

PURPLE PAVEMENT MARKING
Supplements toll plaza approach lane lines or edgelines that are restricted for registered electronic toll collection vehicles.
BLACK PAVEMENT MARKING
Used in combination with other pavement markings (yellow, white, red, blue, or purple) where a light-colored pavement does not provide sufficient contrast.

MATERIALS
While pavement markings typically include paints and thermoplastics, they may also utilize other marking materials such as colored paving and raised pavement markers. Highly visible delineators and channelizing devices can also be placed vertically above the roadway.

Due to poor nighttime visibility, retroreflectivity is improved by adding glass beads into the wet paint. Paint is the easiest, cheapest, and most commonly used marking material, but it is also the least durable.

Thermoplastic pavement markings use a temperature-setting plastic material that is heated to its melting point for use on asphalt pavements. Based on the temperature-related expansion and contraction differentials between plastic and concrete, which can result in thermoplastic separation, this type of material is refrained from use on concrete paving.

The color, pattern, and orientation of pavement markings provide vital information to the roadway user. Compliance to these standards is critical in order to provide positive guidance and should be maintained throughout the useful life of the product. Materials that minimize tripping or loss of traction for users (pedestrians, bicyclists, motorcycles, etc.) should be considered when choosing pavement markings.

LONGITUDINAL MARKINGS
Longitudinal markings (long lines) which guide traffic along the roadway by providing visual clues to the travel path are commonly applied in white and yellow. Dashed lines (broken lines) permit vehicles to pass or change lanes. These white or yellow markers are four to six inches wide and applied with ten foot painted dashes and thirty foot spacing. The distance from the beginning of one dash to the beginning of the next dash is 40 feet. These lines provide an excellent way to estimate distances along roadways.
For example, if there are three dashes between two side roads; then the estimated distance equals 120 feet separating the roadways (3 x 40).

The widths and patterns of longitudinal lines shall be as follows:

**Normal Line** - 4 to 6 inches wide.

**Wide Line** - at least twice the width of a normal line. The width of the line indicates the degree of emphasis.

**Double Line** - two parallel lines separated by a discernible space.

**Broken Line** - normal line segments (10 feet) separated by (30 feet) gaps.

**Dotted Line for Extensions** - noticeably shorter line segments (typically 2 feet) separated by shorter gaps (typically 2 to 6 feet). The width of a dotted line shall be at least the same as the width of the line it extends.

**Dotted Line for Lane Lines** - 3 feet line segments with 9 feet gaps.

### YELLOW CENTER LINE PAVEMENT MARKINGS AND WARRANTS

Yellow center line pavement markings are used to separate traffic lanes with opposite directions of travel on a roadway. These markings can be installed at sites that are not the geometric center of the roadway.

Short roadway sections may be marked with center line pavement markings to control traffic at specific locations (curves, over hills, grade crossings, bridges, etc.) for roadways without continuous center line pavement markings,

Options for the center line markings on two-lane, two-way roadways* include:

**Two-direction passing zone markings**
- a normal broken yellow line
- passing with care is permitted for traffic traveling in either direction;
One-direction no-passing zone markings
- a double yellow line, one of which is a normal broken yellow line and the other is a normal solid yellow line
- passing with care is permitted for the traffic traveling adjacent to the broken line, but is prohibited for traffic traveling adjacent to the solid line

Two-direction no-passing zone markings
- two normal solid yellow lines
- passing is prohibited for traffic traveling in either direction.

*Please note that a single solid yellow line shall never be used for center line marking on a two-way roadways.

For undivided two-way roadways with four or more lanes for moving motor vehicle traffic, the centerline markings shall be the two-direction no-passing zone markings (solid double yellow line).

Center line pavement markings are required on:

- Paved urban arterials & collectors
  - Traveled way 20 feet or wider
  - ADT = 6000 vehicles/day or more**
- Paved two-way streets or highways
  - Three or more lanes
- Rural arterials & collectors
  - Traveled way 18 feet or wider
  - ADT = 3000 vehicles/day or more

Where engineering judgment indicates a need

**May be used for a minimum ADT of 4000 vehicles/day

Center line markings may be placed on paved two-way roads with a minimum width of 16 feet.

ROUNDABOUT MARKINGS
A roundabout is a specific type of circular intersection designed for safety and speed control that contains specific traffic control features. Any pavement markings for a roundabout should be integrally designed to correspond to the location and intended purpose of a roundabout.
Markings on the approaches to a roundabout and on the circular roadway should provide a consistent message to road users. These should promote movement through the roundabout with minimal lane changes within the circulatory roadway in order to exit the roundabout.

**White Lane Line Pavement Markings**
Multi-lane roundabouts need to have lane line markings on the approaching roadways as well as within the circulatory roadway to channelize traffic to the appropriate exit. There are no continuous concentric lane lines within the roundabout's circulatory roadway.

Edge lines should be located on the outer (right) side of the circulatory roadway with a solid line adjacent to the splitter island with a wide dotted line across the entrance approaches.
For pedestrian facilities, marked crosswalks should indicate where pedestrians should cross roundabout entrances and exits. These crosswalks should be a minimum of 20 feet from the edge of the circulatory roadway.

For further information, Chapter 3C of the MUTCD provides guidance, details, and examples for proper roundabout pavement markings.
TOLL PLAZAS

Toll plaza pavement markings help road users identify the proper lane for the type of toll payment, to channelize movements, and to delineate roadway obstructions.

When one or more ORT (Open Road Tolling) lanes is restricted for use by only registered ETC (Electronic Toll Collection) vehicles that bypass a mainline toll plaza on a separate alignment, these word markings and longitudinal markings shall be used on the approach to the point where the ORT lanes diverge from the lanes destined for the mainline toll plaza.

Where an ORT lane is immediately adjacent to a mainline toll plaza but not separated from adjacent cash payment toll plaza lanes by a curb or barrier, channelizing devices,
and/or pavement markings should be used to discourage or prohibit lane changing. The separation of the ORT lane from the adjacent cash payment lane should begin on the approach to the mainline toll plaza at approximately the point where vehicle speeds in the adjacent cash lanes drop below 30 mph during off-peak periods, and should extend downstream approximately to the point where the vehicles departing the toll plaza in the adjacent cash lanes have accelerated to 30 mph.

For a toll plaza approach lane that is restricted to use only by vehicles with registered ETC accounts, the ETC Account-Only lane word markings and preferential lane longitudinal markings shall be used. The solid white lane line or edge line on the right-hand side of the ETC Account-Only lane and the solid white lane line or solid yellow edge line on the left-hand side of the ETC Account-Only lane may be supplemented with purple solid contiguous longitudinal markings placed to the inside edges of the lane lines.

The purple markings shall be a minimum of 3 inches in width and a maximum width equal to the width of the line it supplements.

Toll booths and their islands are considered to be obstructions and shall be provided with markings that comply with these conditions.

Any longitudinal pavement markings may be omitted alongside toll booth islands between the approach and departure markings.

**DELINEATORS**

Delineators are beneficial at locations with long continuous sections of highway or through short stretches where the alignment might be confusing or unexpected (lane-reduction transitions, horizontal curves, etc.). These are effective guidance devices at night and during adverse weather since they remain visible when the roadway is wet or snow covered. For these reasons, delineators may be considered guidance devices rather than warning devices.

**Delineator Design**

Delineators shall consist of retroreflective devices (minimum of 3 inches) that normally retroreflect light from a distance of 1,000 feet when illuminated by standard automobile high beam headlights.
**Single delineators**: One retroreflective element for a given direction of travel at a specific location

**Double delineator**: Two identical retroreflective elements mounted together for a direction

*An appropriately sized vertically elongated delineator may be substituted for a double delineator.

**Delineator Application**

A series of single delineators shall be provided on the right side of freeways and expressways and on one side of interchange ramps, except when either of the following two conditions are met:

1) On tangent sections of freeways and expressways when both of the following conditions are met:
   a. Continuous raised pavement markers are used to supplement pavement markings on lane lines throughout all curves and on all tangents,
   and
   b. Roadside delineators are used to direct traffic into all curves.

2) On sections of roadways with continuous lighting between interchanges.

Delineators may also be used on other classes of roads. Plus, single delineators may be installed on the left-hand side of roadways where needed.

The colors of delineators should comply with the edge line color.

**Delineator Colors**

<table>
<thead>
<tr>
<th>Color</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>Left-hand side of a two-way roadway</td>
</tr>
</tbody>
</table>
| Red   | Wrong direction of ramp or roadway
       | Truck escape ramp                                |
Delineators of the appropriate color may be used to indicate where either an outside or inside traffic lane merges into an adjacent lane.

Delineators should be installed adjacent to the lane reduced for the full transition length and should be installed to show the reduction.

Red delineators may be used on the reverse side of any delineator where it would warn a road user traveling in the wrong direction on that particular ramp or roadway. These delineators should also be used on both sides of truck escape ramps. The delineators should be spaced at 50-foot intervals to identify the ramp entrance. Spacing beyond the entrance should be adequate for the length and design of the escape ramp.

**Delineator Placement and Spacing**
Delineators should be mounted at a mounting height of approximately 4 feet measured vertically from the bottom of the device to the elevation of the edge of the pavement, They may be mounted at a lower elevation mounted on the face or top of guardrails or other barriers.

Delineators should be placed at a constant distance from the edge of roadway 2 to 8 feet outside the outer edge of the shoulder; or in line with roadside barriers that are a maximum distance of 8 feet outside the outer edge of the shoulder. Where an obstruction is between the pavement edge and the line of the delineators, the delineators should be transitioned to the innermost edge of the obstruction. For guardrail or other longitudinal barrier, the delineators should be transitioned just behind, directly above, or on the barrier’s innermost edge.

Delineators should be spaced 200 to 530 feet apart on **mainline tangent sections** and 100 feet apart on **ramp tangent sections**.

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**CHANNELIZING DEVICES**
Channelization devices (cones, tubular markers, vertical panels, drums, lane separators, raised islands, etc.) can be used to add emphasis to traffic control sites. Examples include islands, reversible lane delineation, and channelizing lines.
Colors for channelizing devices will be either orange or the same color as the pavement marking that they supplement, or substitute.

Channelizing devices need to be retroreflective or internally illuminated for nighttime use. For devices that separate traffic in the same direction, retroreflective material should be white. If the channelization separates flows in the opposite direction or are located on the left side edge line of a one-way roadway, the sheeting or bands should be yellow. These devices should be kept clean and bright to maximize target value.

**ISLANDS**

Design guidelines for islands are specified in “A Policy on Geometric Design of Highways and Streets” (AASHTO “Green Book”). Any traffic island can be designated by curbs, pavement edges, pavement markings, channelizing devices, or other devices.

**Approach-End Treatment**

The approach ends of islands should be preceded by divergent longitudinal pavement markings on the pavement surface, to guide vehicles along the island edge.

The neutral area between approach-end markings sometimes contains slightly raised (usually less than 1 inch high) sections of coarse aggregate or other suitable materials. Although this area can be transversed at great speeds, the aggregate/materials create rumble sections that provide higher visibility and produce an audible warning to road users. Bars or buttons (projecting 1 to 3 inches above the pavement surface) can also be placed in the neutral area to warn the operator with only minimal effects on control of the vehicle. These raised bars or buttons should be marked with white or yellow retroreflective materials, as determined by the direction or directions of travel they separate.

However, these channelizing devices, when used in advance of islands having raised curbs, shall not be placed in such a manner as to constitute an unexpected obstacle.

**Island Marking Application**

Traffic island markings should consist of pavement and curb markings, channelizing devices, and delineators. Pavement markings for the approach to an obstruction may be omitted on a particular island deemed necessary by engineering judgment.
Island Marking Colors
Islands outlined by curbs or pavement markings should be marked with retroreflective white or yellow material and should be of sufficient length to denote the general alignment of the edge of the island along which vehicles travel, including the island's approach end.

For long islands, curb retroreflection may be discontinued along the entire length of the curb, especially if the island is illuminated, delineated or marked with edge lines.

Island Delineation
Delineators shall be the same colors as the related edge lines. The only exception is for wrong-way traffic where they shall be red.

Locating delineators for each roadway of an intersection shall be considered separately to assure maximum effectiveness.

Retroreflective or internally illuminated markers of appropriate color may be placed in front of the curb and/or on the top of curbed approaches of raised medians and curbs of islands, as a supplement or substitute for retroreflective curb markings.

Pedestrian Islands and Medians
Raised islands or medians in the center area of a street or highway can serve as pedestrian refuge island for those who are attempting to cross at a midblock or intersection location. These areas allow pedestrians to find an adequate gap in one direction of traffic at a time and wait for an adequate gap in the other direction of traffic before crossing the second half of the street or highway. The “Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)” provides the minimum widths for accessible refuge islands and for design and placement of detectable warning surfaces.

RUMBLE STRIP MARKINGS

Longitudinal Rumble Strip Markings
Longitudinal rumble strips are either a series of rough-textured or slightly raised or depressed road surfaces intended to warn drivers through vibration and sound of the edges of the travel lane.
Possible Longitudinal Rumble Strip Locations

- Shoulder
  Roadway shoulder near travel lane
- Divided Highway
  Median side (left) and/or outside shoulder (right)
- Two-way Roadways
  Along center line

An edge line or center line may be installed over a longitudinal rumble strip to create a *rumble stripe*. However, edge lines shall not be used in addition to a shoulder rumble stripe.

Transverse Rumble Strip Markings

Transverse rumble strips consist of intermittent narrow, transverse areas of roughly textured or slightly raised or depressed road surface that extend across the travel lanes. Through noise and vibration, they attract driver attention to unusual vehicular traffic conditions, such as unexpected changes in road alignment or conditions that require a stop or speed reduction.

For instances where the color of a transverse rumble strip within a travel lane does not match the color of the pavement, the color of the strip will be either black or white. In this case, white transverse rumble strips should not be placed in locations where they could be confused with other transverse markings (stop lines, crosswalks, etc.).
PART 4 – Highway Traffic Signals

Standards for traffic control signals are crucial for attracting the attention of different types of road users - those who are older, visually impaired, fatigued, distracted, or those not expecting to encounter a traffic signal.

<table>
<thead>
<tr>
<th>Types of Highway Traffic Signals</th>
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<tbody>
<tr>
<td>Traffic control signals</td>
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<tr>
<td>Emergency-vehicle signals</td>
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<tr>
<td>Entrance ramps signals</td>
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<tr>
<td>Toll plaza traffic signals</td>
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<tr>
<td>Pedestrian signals</td>
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<tr>
<td>One-lane, two-way signals</td>
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<tr>
<td>In-roadway lights</td>
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<tr>
<td>Flashing beacons</td>
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<tr>
<td>Hybrid beacons</td>
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<tr>
<td>Movable bridges signals</td>
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<tr>
<td>Lane-use control signals</td>
</tr>
</tbody>
</table>

Traffic signals are extremely valuable for controlling vehicular and pedestrian traffic by assigning right-of-way for various movements, and influencing traffic flow.

Advantages of Proper Traffic Control Signals

- Orderly movement of traffic.
- Increases traffic-handling capacity of intersections
- Reduces frequency and severity of certain types of crashes
- Continuous or nearly continuous movement of traffic at a definite speed
- Interrupts heavy traffic at intervals to permit other traffic to cross.

Traffic control signals are often considered a solution to all traffic problems at intersections. Although justified by traffic and roadway conditions, they can still be ill-designed, ineffectively located, improperly operated, or poorly maintained.

Disadvantages of Improper or Unjustified Traffic Control Signals

- Excessive delays,
- Excessive disobedience of the signal indications,
- Increased use of less adequate routes to avoid traffic control signals
- Increased frequency of collisions
TRAFFIC SIGNAL WARRANTS

In order to determine if a traffic control signal is justified at a particular location, an engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location should be performed. This study needs to analyze factors related to the existing operation and safety, and the potential for improving these conditions, plus the applicable factors in the following traffic signal warrants:

Warrant 1 - Eight-Hour Vehicular Volume
The Minimum Vehicular Volume (Condition A) is meant for application at locations with large volumes of intersecting traffic.

The Interruption of Continuous Traffic (Condition B) is intended for locations where Condition A is not satisfied and the traffic volume on a major street affects traffic on a minor intersecting street.

Warrant 1 should be treated as a single warrant. If Condition A is satisfied, then Warrant 1 is satisfied. Similarly, if Condition B is satisfied, then Warrant 1 is satisfied. Any analysis of the combination of Conditions A and B is not needed.

Warrant 2 - Four-Hour Vehicular Volume
The Four-Hour Vehicular Volume signal warrant conditions are intended for locations where the volume of intersecting traffic is the principal reason for consideration.

Warrant 3 - Peak Hour
The Peak Hour signal warrant is meant for locations where the minor-street traffic suffers undue delay (a minimum of 1 hour of an average day) when entering or crossing the major street. This warrant shall be used only for unusual cases: office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities, etc.

Warrant 4 - Pedestrian Volume
The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

Warrant 5 - School Crossing
The School Crossing signal warrant is intended for locations where schoolchildren crossing a major street is the principal reason to consider a traffic control signal.
Warrant 6 - Coordinated Signal System
The Coordinated Signal System signal warrant is intended for locations with progressive traffic movement in a signal system in order to maintain proper vehicle platooning. This signal warrant should not be applied where the resultant signal spacing is less than 1,000 feet.

Warrant 7 - Crash Experience
The Crash Experience signal warrant conditions are meant for locations where severe and frequent crashes are the main reasons to consider installing a traffic control signal.

Warrant 8 - Roadway Network
The Roadway Network signal warrant is intended for some intersections to encourage concentration and organization of traffic flow in a roadway network.

Warrant 9 - Intersection Near a Grade Crossing
The Intersection Near a Grade Crossing signal warrant can be used where none of the conditions described in the other eight traffic signal warrants are met. The proximity to the intersection of a grade crossing on an approach controlled by a STOP or YIELD sign is the principal reason for consideration.

Meeting the conditions of a traffic signal warrant/warrants should not in itself require the installation of a signal. For further details addressing these warrants, consult Chapter 4C.

SIGNAL FEATURES
The most important features of traffic control signals to road users are the location, design, and meaning of the signal indications. Uniform design features that affect traffic is especially important for the safety and efficiency of operations.

MODES OF TRAFFIC CONTROL SIGNALS

Pre-timed
Fixed time schedule
Does not change in response to changes in traffic flow

Semi-actuated
Timing affected by detected vehicles on some intersection approaches

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Used on high-volume (major) road intersections with low-volume (minor) roads

**Full-actuated** Timing completely affected by detected traffic on all approaches

Used at major street intersections with varying traffic volumes

Typical installation methods for a temporary traffic control signal minimize the costs of installation, relocation, and/or removal. Temporary traffic control signals with specific purposes include: one-lane, two-way facilities in temporary traffic control zones; haul-road intersections; or future access to a location that will have a permanent access point developed at another site.

Traffic signal signs are sometimes used at signal locations for pedestrians, bicyclists, or motorists.

### Typical Signalized Location Signs

<table>
<thead>
<tr>
<th>Movement Prohibition</th>
<th>Lane Control</th>
<th>Pedestrian Crossing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian Actuation</td>
<td>Traffic Signal</td>
<td>Signal Ahead Warning</td>
</tr>
<tr>
<td>Street Name</td>
<td></td>
<td>Advance Street Name</td>
</tr>
</tbody>
</table>

Proper pavement markings for an intersection play an important role in the effective operation of traffic control signals by designating the number of lanes, lane use, the length of additional approaches, and stopping points. The engineer can then match the signal phasing and timing to best match the goals of the intersection’s operational plan.

### PEDESTRIAN CONSIDERATIONS

Pedestrian signal heads provide special types of traffic signals exclusively for controlling pedestrian traffic. Engineering judgment should always be used to determine if separate pedestrian signal heads and accessible pedestrian signals are needed.

Pedestrian detectors may contain pushbuttons or passive detection devices. **Passive detection devices** register the presence of a pedestrian in a position to cross the roadway. Some passive detection devices can track the progress of a pedestrian crossing the roadway for the purpose of adjusting certain pedestrian timing intervals.
Pedestrian pushbuttons are conspicuous and placed within reach of pedestrians intending to cross each crosswalk. Pushbutton poles are also positioned in optimal locations for easy pedestrian access. The “Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)” provides further information regarding pedestrian devices.

Accessible pedestrian signals and detectors also provide non-visual communication to road users (audible tones, speech messages, and/or vibrating surfaces, etc.). A common method that visually-impaired pedestrians use to cross streets at signalized intersections is to start crossing when they hear the traffic in front of them stop and the traffic alongside them begin to move ("green interval"). In many locations, insufficient
information is provided for pedestrians with visual disabilities needing to cross at a
signalized location.

A pedestrian hybrid beacon may be used to warn and control traffic at an unsignalized
location in order to assist pedestrians in crossing a marked crosswalk. These beacons
may be appropriate for crossing locations not meeting traffic signal warrants, or for
locations meeting traffic signal warrants without a traffic control signal.

DIFFERENT TYPES OF SIGNALS

An **emergency-vehicle traffic control signal** assigns the vehicle right-of-way to an
authorized emergency vehicle. Its location may not meet other traffic signal warrants
such as at locations to permit direct access from a building housing the emergency
vehicle.

A **traffic control signal at a narrow bridge, tunnel, or roadway section** assigns the
right-of-way for traffic passing over a bridge or through a tunnel or roadway section with
insufficient width for two opposing vehicles to pass.

**Temporary traffic control signals** are the most common application of one-lane, two-
way facilities.

**Ramp control signals** control the traffic flow entering a freeway facility. This practice is
also referred to as “ramp metering.”

**Freeway entrance ramp control signals** can be used to control traffic entering the
freeway to reduce the total expected delay to traffic, including freeway ramps and local
streets.

**Traffic control signals for movable bridges** notify road users of a road closure rather
than alternately giving the right-of-way to conflicting traffic movements. These signals
are coordinated with the operation of the movable bridge, the movable bridge warning
and resistance gates, or other devices to control traffic.

Movable bridge warning gates decrease the likelihood of road users entering an area
where potential bridge hazards exist.
A movable bridge resistance gate is sometimes used downstream of the movable bridge warning gate to provide a physical deterrent to road users. Requirements for bridge gates are contained in AASHTO’s “Standard Specifications for Movable Highway Bridges”.

A **Flashing Beacon** consists of one or more signal sections that operates in a flashing mode. This device can be used as an intersection control beacon or provide other warning applications.

**Typical Locations for Warning Beacons**
- Obstructions adjacent to the roadway;
- Emphasis for warning signs;
- Midblock crosswalks;
- Emphasis for regulatory signs (except STOP, DO NOT ENTER, WRONG WAY, and SPEED LIMIT signs);
- In conjunction with regulatory or warning signs (includes WHEN FLASHING in its legend to indicate effective times).

**Lane-use control signals** are overhead signals that specify the use of roadway lanes or indicate impending prohibition. These signals are distinguished by special signal face placement over certain roadway lanes and by their distinctive shapes and symbols. Supplementary signs may also be used to explain the signal’s meaning and intent.

Lane-use control signals are typically used for reversible-lane control, but they are also suitable for certain non-reversible lane applications and toll plaza lanes.

**In-Roadway Lights** are installed in the road surface to warn road users of a condition on or adjacent to the roadway that might not be readily apparent and require action by the road users (school crosswalks, midblock crosswalks, crosswalks on uncontrolled approaches, roundabout crosswalks, and other pedestrian crossings).
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(Note: All figures, tables, exhibits, etc. contained in this course are from the MUTCD,
except where noted otherwise.)