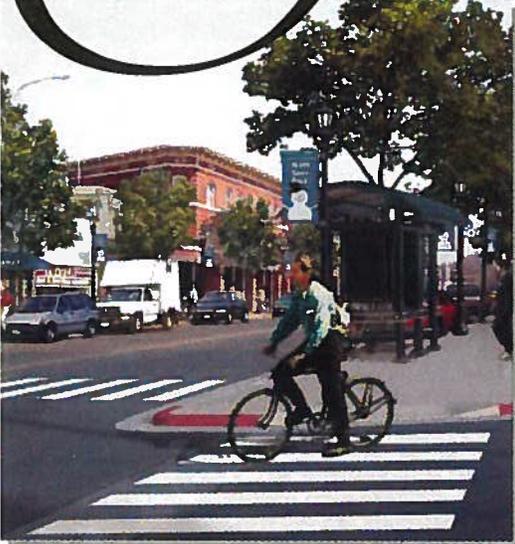


HAHUA PEDESTRIAN SAFETY STUDY UPDATE



PHASE II – FACILITY WARRANTS AND DESIGN GUIDELINES FOR PEDESTRIAN FACILITIES FINAL TECHNICAL MEMORANDUM Product 2.A.2

Prepared for
CITY & COUNTY OF HONOLULU
DEPARTMENT OF TRANSPORTATION SERVICES

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December 2007

FORWARD

The purpose of this document is to update the "Oahu Pedestrian Safety Study Phase I: Facility Warrants and Design Guidelines for Pedestrian Facilities" prepared in September 1993 for the City and County of Honolulu Department of Transportation Services in association with the State of Hawaii Department of Transportation, Federal Highway Administration, and the U.S. Department of Transportation. This update is intended to utilize the latest traffic engineering practices and procedures as related to pedestrian facilities within the public rights-of-way to provide information regarding the warrants for, design of, and installation of pedestrian-related facilities.

The guidance supplied by this document is based on a review of available documentation relating to standards and guidelines for pedestrian facilities utilized by municipalities and jurisdictions around the United States such as those for the City of Boulder, Colorado, City of Stockton, California, and the Virginia Department of Transportation. In addition, treatments and policies of selected foreign countries, as well as, pertinent publications and papers from the Transportation Research Board (TRB), Federal Highway Administration (FHWA), and Institute of Transportation Engineers (ITE) were also reviewed. The guidelines presented herein do not imply that existing streets are unsafe, nor does it mandate the initiation of improvement projects. The intent of this document is to provide guidance to City staff and consultants involved in the planning, design, and maintenance of pedestrian-related facilities, as well as, those involved in the review of project development plans. It is not intended to be a detailed design manual that supercedes the need for good traffic engineering judgement. Sufficient flexibility is permitted to encourage independent designs tailored to particular situations. In addition, it should also be noted that although this document addresses design issues, reasonable and prudent performance by the user of the facility are also necessary for safe and efficient operations.

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CHAPTER 1 CROSSWALKS

1.1 Definition

- The portion of roadway designated for pedestrians to use in crossing the street.
- May be located midblock or at a signalized or unsignalized intersection.
- May be marked or unmarked.
- Crosswalks are (1) that part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the roadway measured from the curbs or, in the absence of curbs, from the edges of the traversable roadway; or (2) any portion of a roadway at an intersection or elsewhere distinctly indicated for pedestrian crossing by lines or other markings on the surface.

1.2 Warrants

The evaluation of crossing locations for the installation of potential crossing treatments should include the following subsequent steps:

- *Step 1: Description of Crossing Location*
- *Step 2: Physical Data Collection*
- *Step 3: Traffic Data Collection*
- *Step 4: Determination of Appropriate Treatment(s)*

A detailed discussion of each of these steps is included below and a Crossing Location Evaluation Worksheet is provided to guide users through these procedures (see Figure 1-1).

Step 1: Description of Crossing Location

- Identify the pedestrian crossing location including the major street and specific location of the crossing (i.e., cross street, street address, etc.).
- Determine if the crossing serves a multi-use path.
- Note the posted speed limit along the major street at the crossing location.
- Identify any existing traffic control and crossing treatments including signs, markings, physical treatments, street lighting, and curb ramps.
- Identify any nearby pedestrian generators such as schools, bus stops, commercial developments, etc.

Step 2: Physical Data Collection

- Determine the existing roadway configuration including the number of lanes and the presence of striped or raised medians at the crossing location.
- Identify the nearest marked or protected crossing and measure the distance to this crossing.
- Measure the available sight distance (ASD) on all vehicular approaches to the crossing. If the ASD is less than ten times (10x) the posted speed limit, determine if improvements are feasible to improve the existing sight distance.

Step 3: Traffic Data Collection

- Collect pedestrian volume data at the crossing location. Typically, data is collected during the AM, mid-day, and PM peak commuter periods. However, locations near schools may require the AM and PM peak periods to coincide with the beginning and ending of the school day. In addition, additional data may be required for crossing locations that do not meet the minimum hourly thresholds, but may meet the minimum four-hour threshold.

Pedestrian volumes should include bicyclists and differentiate between young/elderly/disabled pedestrians and all other pedestrians. For crossings where school-related pedestrian traffic is anticipated, the volume of students (school age pedestrians on their way to/from school) should also be noted separately.

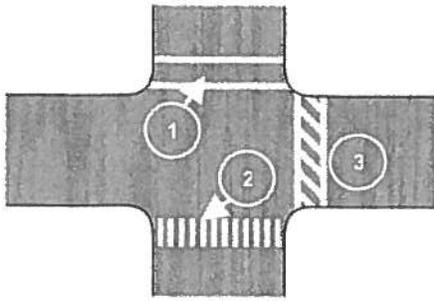
- Collect average daily traffic (ADT) volumes for vehicular traffic along the major street at the crossing location.

Step 4: Determination of Appropriate Treatment(s)

- Apply the collected information to *Figure 1-2 – Pedestrian Crossing Treatment Flowchart* and *Table 1-1 – Criteria for Crossing Treatments at Uncontrolled Locations* (if applicable) to determine appropriate treatment(s) for the crossing location.

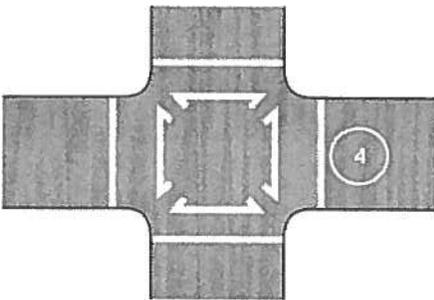
1.3 Design Preference

There are several crosswalk marking patterns used in the United States that are included in the MUTCD. These patterns include transverse markings, longitudinal markings, diagonal markings, and markings that permit diagonal crossing during an exclusive pedestrian phase.



Transverse markings (1) consist of two solid white lines perpendicular to the path of travel not less than 6 inches nor greater than 24 inches in width that mark the outside edges of the crosswalk. The gap between the lines should not be less than 6 feet.

Longitudinal markings (2) consist of a series of solid white lines parallel to the path of travel not less than 12 inches nor greater than 24 inches in width and can be used in conjunction with transverse lines. With or without transverse lines, width of the crosswalk should not be less than 6 feet.



Diagonal markings (3) consist of a series of solid white lines diagonal to the path of travel not less than 12 inches nor greater than 24 inches in width and can be used in conjunction with transverse lines. With or without transverse lines, width of the crosswalk should not be less than 6 feet.

In addition, there are markings that permit diagonal crossing when an exclusive pedestrian phase is provided at a traffic control signal (4).

Although the three crosswalk marking patterns identified above for intersections without an exclusive pedestrian phase are acceptable, longitudinal crosswalk markings without transverse lines are preferred for added visibility and uniformity. Longitudinal markings are highly effective at locations where substantial numbers of pedestrians cross without any other traffic control device, at locations where physical conditions are such that added visibility of the crosswalk is desired, and at places where a pedestrian crosswalk might not be expected.

1.4 Design Standards

Longitudinal crosswalk markings shall be between 12 to 24 inches wide and spaced 12 to 60 inches apart. The marking design should avoid the wheel paths, and the spacing should not exceed 2.5 times the line width. See Figure 1-3.

1.5 Supplemental Policies

School Crossings

Although crossing treatments should generally not be installed at locations where the ADT is lower than 1,500 vehicles per day, exceptions may be made at school crossing locations. School crossings are defined as locations having a significant volume of student pedestrians that meet the minimum pedestrian volume thresholds.

Midblock Crossings

Midblock crossings are defined as locations between intersections where a marked crosswalk has been provided. Midblock crossings are often installed in areas with heavy pedestrian traffic to provide more frequent crossing opportunities. They may also be added near major pedestrian destinations, such as schools, where people might otherwise cross at unmarked locations. Potential midblock crossing locations should be assessed based upon the same criteria as intersection crossing locations. However, consideration should be given to additional improvements (i.e., additional signage, in-pavement warning lights, flashing beacons, etc.) to increase pedestrian visibility to motorists at these locations.

Crosswalk Lighting

The FHWA recommends that adequate nighttime lighting should be provided at marked crosswalks to enhance the safety of pedestrians crossing at night. Adequate lighting is defined as lighting levels that are approved by the City and County of Honolulu Department of Design and Construction (DDC). Such lighting should be provided at all crosswalks where feasible. At crosswalks where there is an expectation of nighttime use, adequate nighttime lighting shall be provided under all circumstances.

Avoiding Overuse of Crossing Treatments

The FHWA recommends that overuse of crosswalk markings should be avoided to maximize their effectiveness. Crosswalks and sign treatments should be used discriminately so that the effectiveness of these treatments is not deteriorated by overuse. Although these treatments may be effective at individual locations, overuse of these treatments may lead to a decrease in their value as drivers become desensitized to them. The minimum pedestrian and vehicular volume criteria in this document have been established with this in mind.

Multi-Use Path Crossings

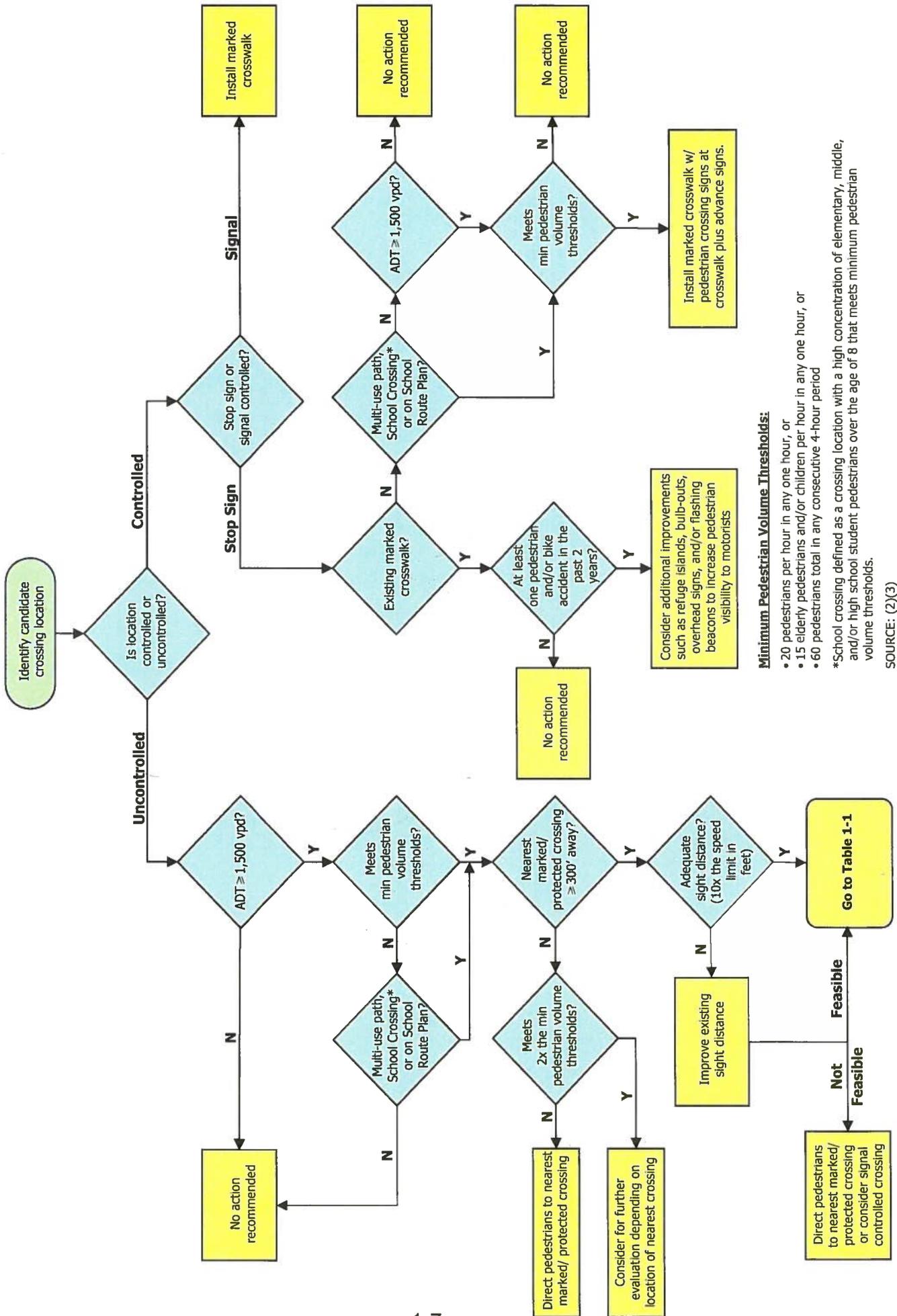
Crossing locations where a multi-use path crosses a roadway should automatically be considered for crossing treatments, regardless of pedestrian crossing volumes. A multi-use path is defined as a paved pathway physically separated from on-street motorized vehicular traffic by an open space or barrier (e.g. landscaping) and designated for the exclusive use by non-motorized traffic. This is to promote the use of multi-use paths recognizing that roadway crossings often create barriers for pedestrians and bicyclists and may contribute to a lack of use. However, the minimum vehicular volume criterion still applies for multi-use path crossing locations.

Removal of Treatments

Conditions that contribute to the need for a crosswalk or crossing treatments may change over time, and an existing crosswalk or treatment may no longer be needed. Existing crosswalks will be reviewed on a case-by-case basis to determine their use and need. If the use of a crosswalk is less than half of that which would be required for it to warrant based on the criteria established in these guidelines for a new installation, the crosswalk and any other treatments should be removed.

Source: (1) (2) (3)

Figure 1-2 -- Pedestrian Crossing Treatment Flowchart



Minimum Pedestrian Volume Thresholds:

- 20 pedestrians per hour in any one hour, or
- 15 elderly pedestrians and/or children per hour in any one hour, or
- 60 pedestrians total in any consecutive 4-hour period

*School crossing defined as a crossing location with a high concentration of elementary, middle, and/or high school student pedestrians over the age of 8 that meets minimum pedestrian volume thresholds.

SOURCE: (2)(3)

Table 1-1 – Criteria for Crossing Treatments at Uncontrolled Locations

Roadway Configuration	Roadway ADT and Posted Speed														
	1,500-9,000 vpd				9,000-12,000 vpd				12,000-15,000 vpd				> 15,000 vpd		
	≤30 mph	35 mph	40 mph	40 mph	≤30 mph	35 mph	40 mph	40 mph	≤30 mph	35 mph	40 mph	40 mph	≤30 mph	35 mph	40 mph
1 or 2 Lanes	A	A	B	B	A	A	B	B	A	A	C	A	A	B	C
3 Lanes	A	A	B	B	A	B	B	B	B	B	C	B	B	C	C
4 or 5 Lanes With Raised Median	A	A	B	B	A	B	C	C	B	B	C	C	C	C	C
4 or 5 Lanes Without Raised Median	A	B	C	C	B	B	C	C	C	C	C	C	C	C	C
6 or More Lanes	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C

A Install marked crosswalk with enhanced signs

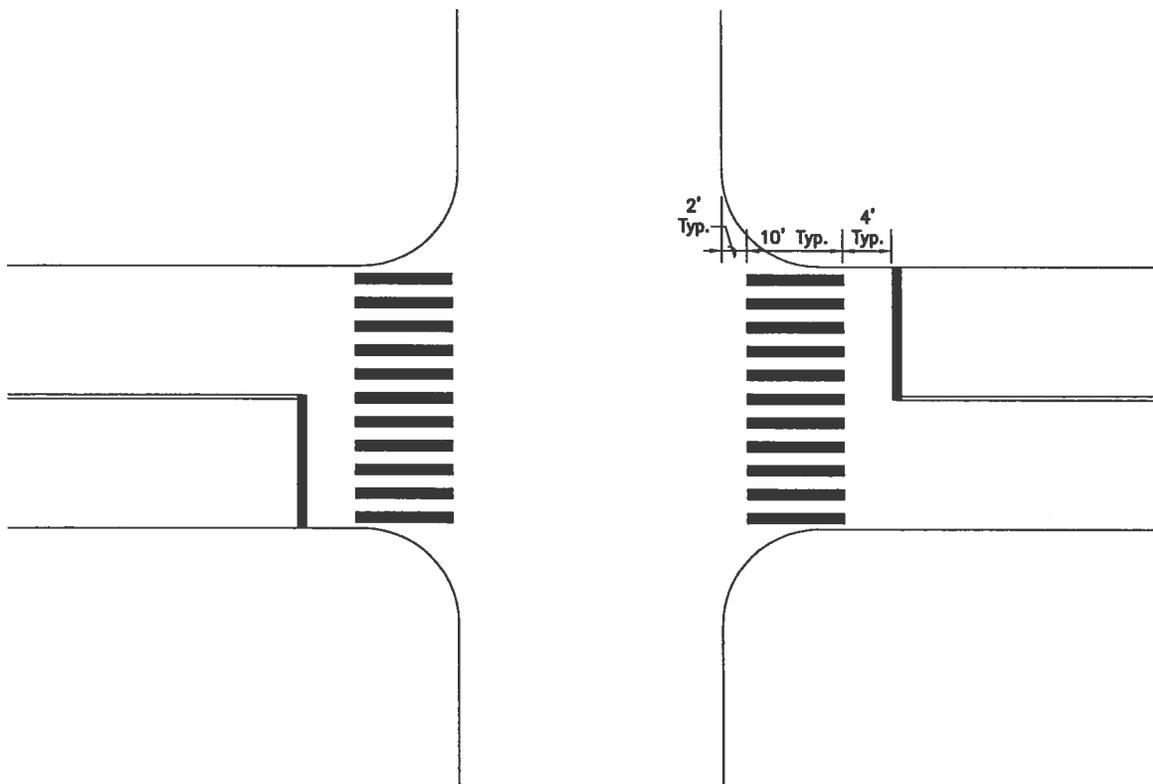
Specific Guidance: Install marked crosswalk with pedestrian crossing sign (W11-2) and down arrow (W16-7p) plus advance warning signs. Use S1-1 signs for School Crossing locations.

B Install marked crosswalk with enhanced signs and geometric improvements to increase pedestrian visibility and reduce exposure

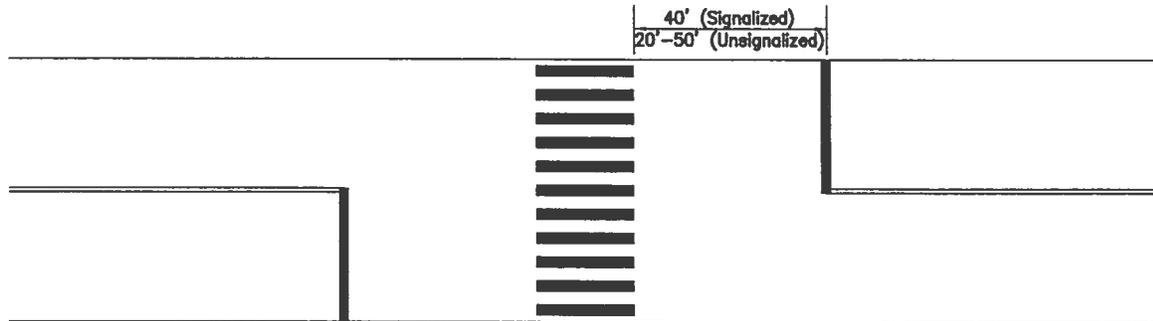
Specific Guidance: Install marked crosswalk with pedestrian crossing sign (W11-2) and down arrow (W16-7p) plus advance warning signs. Use S1-1 signs for School Crossing locations. In addition, install raised crosswalks, refuge islands, bulb-outs, overhead signs, and/or flashing beacons to increase pedestrian visibility to motorists and shorten the pedestrian crossing distance.

C Do not install marked crosswalk.

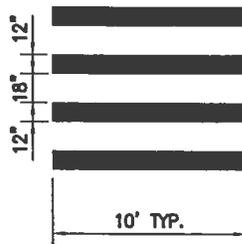
Specific Guidance: Consider traffic signal, grade-separated crossing, or other substantial crossing improvement to improve crossing safety for pedestrians.



CROSSWALK AT INTERSECTION (UNSIGNALIZED AND SIGNALIZED)



MID-BLOCK CROSSWALK



CROSSWALK STRIPING DETAIL

FIGURE 1-3 - TYPICAL CROSSWALK DETAILS

CHAPTER 2 SIDEWALKS

2.1 Definitions

Sidewalks are a critical component of the pedestrian system within the public rights-of-way. They serve as connections within the transportation network providing pedestrian access to commercial districts, businesses, government facilities, schools, and recreational areas. They increase the mobility opportunities of pedestrians to travel from one place to another, and provide a safer walking environment for pedestrian routes along the roadway. When sidewalks are not made available, pedestrians are forced to share the streets with motorists restricting pedestrian mobility. According to the Institute of Transportation Engineers (ITE), Technical Council Committee 5A-5, 1998, sidewalks "reduce the incidence of pedestrian collisions, injuries and deaths in residential areas and along two-lane roadways". Because Federal regulations do not require agencies to build sidewalks, the decision is left to States and local agencies.

2.2 Design Standards

See City and County of Honolulu Standard Details.

Source: (4)

CHAPTER 3 CURB RAMPS

3.1 Definitions

- Defined in the American With Disabilities Act (ADA) as a short ramp cutting through a curb or built up to it.
- City and County of Honolulu has 5 standard curb ramp types:
 - Type "A" (perpendicular ramp)
 - Type "B" (parallel ramp)
 - Type "B" Truncated (combination ramp)
 - Type "C" (island/median cut)
 - Type "D" (directional ramp)

3.2 Warrants

See the City and County of Honolulu's "Draft Accessibility Design Guidelines" dated December 6, 2002 or the updated guideline.

3.3 Design Standards

See the City and County of Honolulu's "Draft Accessibility Design Guidelines" dated December 6, 2002 or the updated guideline.

CHAPTER 4 PEDESTRIAN SIGNALS

4.1 Definitions

Pedestrian signals are indication devices specifically installed at locations for the exclusive purpose of controlling the movement of pedestrian traffic. They are generally installed at signalized roadway intersections or mid-block locations to direct and control conflicts between pedestrian and vehicular flow. In particular, pedestrian signals are generally installed for the following reasons:

- The layout of the intersection is such that vehicular indications or movements are not visible by the pedestrian.
- Pedestrian volumes are high.
- To aid pedestrian movements at intersection with complex operations.
- Direct pedestrians to a particular path or direction at a complex intersection.
- Safety of the pedestrian requires special attention.

4.2 Warrants

Pedestrian signals should be considered for the following reasons:

- Pedestrian Volume or School Crossing Warrants are satisfied. A Pedestrian Volume and School Crossing Warrant worksheet is included as Figure 4-1 and general guidance regarding the warrants is provided in the following section.
- An exclusive interval or traffic signal phase is provided for pedestrian movements.
- Vehicular signal indications are not visible to pedestrians or provide complex operations.
- School crossings located at signalized intersections.
- A disproportionate pedestrian demand at a particular crossing compared to other crossings at the intersection.

4.3 General Guidance

Pedestrian Volume

The Pedestrian Volume 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.

The need for a traffic control signal at an intersection or mid-block crossing shall be considered if an engineering study finds that both the following criteria are met:

- The pedestrian volume crossing the major street at an intersection or mid-block location during an average day is 100 or more for each of any four hours or 190 or more during any 1 hour; and,

Traffic Signal Warrants Worksheet

CALC _____ DATE _____

CHK _____ DATE _____

Major St: _____

Critical Approach Speed _____ km/h

Minor St: _____

Critical Approach Speed _____ km/h

Critical speed of major street > 64 km/h (40 mph)..... }
 OR } **RURAL (R)**
 In built up area of isolated community of < 10,000 population..... }
 URBAN (U)

WARRANT 4 - Pedestrian Volume (All Parts Must Be Satisfied)

100% SATISFIED YES NO

Hours -->			
Pedestrian Volume			
Adequate Crossing Gaps			

Any hour > 190 Yes No

OR 4 hours > 100 Yes No

AND < 60 gap/hr Yes No

AND, The distance to the nearest traffic signal along the major street is greater than 90m (300 ft)

----- Yes No

AND, The new traffic signal will not seriously disrupt progressive traffic flow in the major street.

----- Yes No

WARRANT 5 - School Crossing (All Parts Must Be Satisfied)

SATISFIED YES NO

Part A Gap/Minutes and # of Children

Each of Two Hours ---->			
Gaps vs Minutes	Minutes Children Using Crossing		
	Number of Adequate Gaps		
School Age Pedestrians Crossing Street			

Gaps < Minutes SATISFIED YES NO

Children > 20/hr SATISFIED YES NO

Part B Distance to Nearest Controlled Crossing

Is Nearest Controlled Crossing More Than 180 m (600 ft) away? SATISFIED YES NO

Figure 4-1: Pedestrian Volume and School Crossing Warrant Worksheet

- There are fewer than 60 gaps per hour in the traffic stream of adequate length to allow pedestrians to cross during the same period when the pedestrian volume criterion is satisfied. Where there is a divided street having a median of sufficient width for pedestrians to wait, the requirement applies separately to each direction of vehicular traffic.

The Pedestrian Volume signal warrant shall not be applied at locations where distance to the nearest traffic control signal along the major street is less than 300 feet (90 m), unless the proposed traffic control signal will not restrict the progressive movement of traffic.

School Crossing

The School Crossing signal warrant is intended for application where the fact that school children cross the major street is the principal reason to consider installing a traffic control signal.

The need for a traffic control signal shall be considered when an engineering study of the frequency and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of school children at an established school crossing across the major street shows that the number of adequate gaps in the traffic stream during the period when the children are using the crossing is less than the number of minutes in the same period and there are a minimum of 20 students during the highest crossing hour.

Before a decision is made to install a traffic control signal, consideration shall be given to the implementation of other remedial measures, such as warning signs and flashers, school speed zones, school crossing guards, or a grade-separated crossing.

The School Crossing signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 300 feet (90 m), and 600 feet (180 m) for locations of other control types.

Accessible Pedestrian Signals

Although people with visual impairments generally rely on traffic surges to determine when it is safe to cross an intersection, additional information about crossing conditions can be very useful when traffic sounds are sporadic or masked by ambient noise, the geometry of the intersection is irregular, or acoustics are poor. Accessible pedestrian signals (APS) can provide supplementary information, such as timing (when the signal cycle allows pedestrians to cross the street), wayfinding (which roads intersect at the junction), and orientation (the directional heading of each crosswalk). Accessible pedestrian signals are generally installed at complex intersections; intersections experiencing high volumes of turning traffic; major corridors leading to areas of fundamental importance such as post offices, courthouses, and hospitals; and places where people with visual impairments make a request for installation.

A number of different types of accessible pedestrian signals have been developed. These include audible broadcast, tactile, vibro-tactile, and receiver-based systems, many of which may be integrated with each other to provide additional sources of information. However, this document does not discuss the various types of APS systems in detail, but instead provide factors for consideration within the confines of the Americans with Disabilities Act (ADA).

Factors that jurisdictions consider in evaluating signalized intersections to determine whether accessible pedestrian signals are warranted include:

- Proximity to a facility for persons who are blind;
- Proximity to alternate crossings, transit stops, and key facilities used by all pedestrians;
- Intersection configuration and width of street;
- Vehicle speed;
- Traffic volume (both heavy and light);
- Pedestrian accident records;
- Demonstrated need or user request;
- Presence of pedestrian push buttons;
- Surrounding land uses and neighborhood acceptance; and,
- Existence of a signal which is susceptible to retrofitting.

The information provided by APS may be necessary at any time, along any route, to residents, occasional travelers, and visitors. Thus, warranting schemes should place only limited emphasis on factors related to frequency or likelihood of use.

Source: (5) (6) (7) (8)

CHAPTER 5 FLASHING BEACONS

5.1 Definitions

Flashing Beacons are roadway or highway traffic signals with one or more signal sections that operate in a flashing mode. It can provide traffic control when used as an Intersection Control Beacon or Warning Beacon in alternative uses.

5.2 General Guidance

Flashing beacon units and their mountings shall follow the provisions for traffic control signals, except as specified herein. General guidance is provided regarding the design and placement of these devices, but their installation should be based upon engineering judgement.

Beacons shall be flashed at a rate of not less than 50 nor more than 60 times per minute. The illuminated period of each flash shall not be less than one-half and not more than two-thirds of the total cycle.

If used to supplement a warning or regulatory sign, the edge of the beacon signal housing should normally be located no closer than 12 inches (300 mm) outside the nearest edge of the sign. An automatic dimming device may be used to reduce the brilliance of flashing yellow signal indications during night operations.

Intersection Control Beacon

An Intersection Control Beacon shall consist of one or more signal faces directed toward each approach to an intersection. Each signal face shall consist of one or more signal sections of a standard traffic signal face, with flashing CIRCULAR YELLOW or CIRCULAR RED signal indications in each signal face. They shall be installed and used only at an intersection to control two or more directions of travel.

Application of Intersection Control Beacon signal indications shall be limited to the following:

1. Yellow on one route (normally the major street) and red for the remaining approaches; and
2. Red for all approaches (if the warrant for a multi-way stop is satisfied).

Flashing yellow signal indications shall not face conflicting vehicular approaches.

A STOP sign shall be used on approaches to which a flashing red signal indication is shown on an Intersection Control Beacon.

An Intersection Control Beacon should not be mounted on a pedestal in the roadway unless the pedestal is within the confines of a traffic or pedestrian island. Supplemental signal indications may be used on one or more approaches in order to provide adequate visibility to approaching road users. Intersection Control Beacons may be used at intersections where traffic or physical conditions do not justify conventional traffic control signals but crash rates indicate the possibility of a special need. An Intersection Control Beacon is generally located over the center of an intersection; however, it may be used at other suitable locations.

Warning Beacon

A Warning Beacon shall consist of one or more signal sections of a standard traffic signal face with a flashing CIRCULAR YELLOW signal indication in each signal section. A Warning Beacon shall be used only to supplement and appropriate warning or regulatory sign or marker. The beacon shall not be included within the border of the sign except for SCHOOL SPEED LIMIT sign beacons. Warning Beacons, if used at intersections, shall not face conflicting vehicular approaches. If a Warning Beacon is suspended over the roadway, the clearance above the pavement shall be at least 15 feet (4.6 m) but not more than 19 feet (5.8 m).

Typical applications of Warning Beacons include the following:

1. At obstructions in or immediately adjacent to the roadway;
2. As supplemental emphasis to warning signs;
3. As emphasis for mid-block crosswalks;
4. On approaches to intersections where additional warning is required, or where special conditions exist; and
5. As supplemental emphasis to regulatory signs, except STOP, YIELD, DO NOT ENTER, and SPEED LIMIT signs.

The condition or regulation justifying Warning Beacons should largely govern their location with respect to the roadway. If an obstruction is in or adjacent to the roadway, illumination of the lower portion of the beginning of the obstruction or a sign on or in front of the obstruction, in addition to the beacon, should be considered. Warning Beacons should be operated only during those hours when the condition or regulation exists. If Warning Beacons have more than one signal section, they may be flashed either alternately or simultaneously. A flashing yellow beacon interconnected with a traffic signal controller assembly may be used with a traffic signal warning sign.

Speed Limit Sign Beacon

A Speed Limit Sign Beacon shall be used only to supplement a Speed Limit sign. A Speed Limit Sign Beacon shall consist of one or more signal sections of a standard traffic control signal face, with a flashing CIRCULAR YELLOW signal indication in each signal section. The signal lenses shall have a nominal diameter of not less than 8 inches (200 mm). If two lenses are used, they shall be vertically aligned, except that they may be horizontally aligned if the Speed Limit sign is longer horizontally than

vertically. If two lenses are used, they shall be alternately flashed. A Speed Limit Sign Beacon may be used with a fixed or variable Speed Limit sign. If applicable, a flashing Speed Limit Sign Beacon (with an appropriate accompanying sign) may be used to indicate that the speed limit shown is in effect.

Stop Beacon

A Stop Beacon shall consist of one or more signal sections of a standard traffic signal face with a flashing CIRCULAR RED signal indication in each signal section. If two horizontally aligned signal lenses are used, they shall be flashed simultaneously to avoid being confused with a highway-rail grade crossing flashing light signals as used in other parts in the country. If two vertically aligned signal lenses are used, they shall be flashed alternately. The bottom of the signal housing of a Stop Beacon shall not be less than 12 inches (300 mm) nor more than 24 inches (600 mm) above the top of a STOP sign.

Source: (7)

CHAPTER 6 PEDESTRIAN REGULATORY SIGNS

Regulatory signs are intended to inform drivers of selected traffic laws or regulation and indicate the applicability of the legal requirements. They are typically rectangular in shape and should be retroreflective or illuminated to show the same shape and similar color by both day and night (with a few exceptions). Regulatory signs applicable to pedestrians include the following:



- **Yield Here to Pedestrians (R1-5, R1-5a)** signs are placed 20 to 50 feet in advance of the nearest crosswalk line if yield lines are used in advance of an unsignalized marked midblock crosswalk.



- **Pedestrians Prohibited (R5-10c) or No Pedestrian Crossing (R9-3a)** signs are placed at locations where safe pedestrian facilities are not provided and should be installed so as to be clearly visible to pedestrians at locations where an alternative route is available. The optional combination or grouped signs such as **Pedestrians Bicycles Motor-Driven Cycles Prohibited (R5-10A)** or **Pedestrians and Bicycles Prohibited (R5-10B)** signs may also be used.



- **Walk on Left Facing Traffic (R9-1)** signs can be installed on the right side of the road where pedestrians walk on the pavement or shoulder in the absence of pedestrian pathways or sidewalks.



- **No Hitchhiking (R9-4, R9-4a)** signs may be used to prohibit standing in or adjacent to the roadway for the purpose of soliciting a ride.



R9-2



R9-3



R9-3a



R9-3b

- **Pedestrian Crossing** signs may be used to limit pedestrian crossing to specific locations. The **Cross Only at Crosswalks** (R9-2) may be used to discourage jaywalking or unauthorized crossing. The **No Pedestrian Crossing** (R9-3, R9-3a) may be used to prohibit pedestrians from crossing a roadway at an undesirable location or in front of a school or other public building where crossing is not designated. The **Use Crosswalk** (R9-3b) sign may be installed with an arrow below either no crossing sign to designate the direction of crossing.



R10-1



R10-2a



R10-3



R10-3a

- **Traffic Signal** signs applicable to pedestrians include:
 - **Cross on Green Light Only** (R10-1)
 - **Cross on Walk Signal Only** (R10-2, R10-2a)
 - **Push Button For Green Light** (R10-3)
 - **To Cross Street (arrow), Push Button Wait for Green Light** (R10-3a)
 - **Push Button for Walk Signal** (R10-4, R10-4b)
 - **To Cross Street (arrow), Push Button Wait for Walk Signal** (R10-4a).



R10-3



R10-4a



R10-4b

In addition to the signs for pedestrians, other regulatory signs such as stop, yield, left-turn prohibition, and speed limit signs which are intended for vehicular traffic affect vehicular speed or movement and therefore can influence the interaction between vehicular and pedestrian traffic. The MUTCD provides general guidance regarding the application of these types of regulatory signs and, in the case of the **No Turn on Red** (R10-11a, R10-11b) sign, it also provides pedestrian-related warrants. With regards to pedestrians, this sign should be considered to prohibit a right turn on red (or a left turn on red from a one-way street to a one-way street) if one or more of the following conditions exists at the location:

- Exclusive pedestrian phase
- Unacceptable number of pedestrian conflicts with right-turn-on-red maneuvers, especially involving children, older pedestrians, or persons with disabilities
- More than three right-turn-on-red accidents reported in a 12-month period for the particular approach

Source: (7)

CHAPTER 7 PEDESTRIAN WARNING SIGNS

Warning signs are used to call attention to unexpected conditions on or adjacent to the roadway and to situations that might not be readily apparent to road users. The use of these signs should be kept to a minimum since overuse may result in a general disrespect of traffic control signs. Warning signs are diamond-shaped with black letters and border on either a yellow or fluorescent yellow-green background. These signs should be placed to provide adequate time for drivers to react and perform any necessary maneuvers. Guidelines regarding the advance placement of these signs based on the vehicle's speed and required maneuver are provided in section 2C.05 of the MUTCD. Warning signs applicable to pedestrians include the following:



W11-2



W16-7p



W15-1

- **Pedestrian Crossing (W11-2)** sign should be used only at locations where crossing activity is unexpected or at location not readily apparent. These signs should be supplemented with a diagonal downward pointing arrow (W16-7p) at the crossing to show its location.
- **Playground (W15-1)** sign may be used to give advance warning of a designated children's playground that is located adjacent to the road. This sign is serves to warn drivers of locations where they may need to slow down due to potential conflicts such as children playing near the roadway.
- **School Warning (S series)** signs include school crossing signs, school advance warning signs, bus stop ahead signs, and others. School-related traffic control measures are discussing in more detail in Chapter 8.

Source: (7)

CHAPTER 8 PAVEMENT MARKINGS

8.1 General

The following descriptions of pavement markings related to pedestrian safety are based on Part 3 of the Manual on Uniform Traffic Control Devices (MUTCD).

8.2 Function and Limitations

Markings have important functions in providing guidance and information for the road user. In some cases, they may be used to supplement other traffic control devices such as signs, signals, and other markings. In other instances, they can be used alone to effectively convey regulations, guidance, or warnings in ways not obtainable by the use of other devices. Pavement markings have limitations such as limited visibility under wet conditions and durability when subjected to heavy traffic. However, under most conditions, pavement markings provide important information while allowing minimal diversion of attention from the roadway. Pavement markings applicable to pedestrians include:

- Marked crosswalks
- Stop and yield lines
- Pavement word and symbol markings (e.g., STOP)

8.3 Materials and Colors

Although pavement markings are commonly placed by using paints or thermoplastics, a wide variety of other suitable materials are also available. Materials used should provide the specified color throughout their useful life. Consideration should be given to selecting materials used in the vicinity of pedestrian activity that will minimize tripping or loss of traction. The pavement markings described in this section are typically white or yellow, however, the use of black is permitted in combination with the aforementioned colors as a means of achieving contrast on light-colored pavements.

8.4 Marked Crosswalks

Marked crosswalks are discussed in more detail in Chapter 1. In general, crosswalks are comprised of a series of 12-inch longitudinal white lines spaced 18 inches apart.

8.5 Stop and Yield Lines

Stop lines are solid white lines to indicate the point at which vehicles are required to stop. Stop lines are 12 inches in width and extend across all approach lanes. Yield lines consist of a row of solid white triangles pointing toward approaching vehicles extending across approach lanes that indicate the point at which vehicles are required to yield. The individual triangles comprising the yield line should have a minimum

dimension at the base of 12 inches wide, a height of 18 inches, and be spaced 6 inches apart.

When used in conjunction with marked crosswalks, stop and yield lines should be 4 feet in advance of the crosswalks. Where no marked crosswalk exists, lines should be located between 10 and 30 feet from the edge of the intersecting street.

For signalized midblock crossings, stop lines should be placed at least 40 feet in advance of the nearest signal indication. Drivers who yield too close to crosswalks on multi-lane approaches place pedestrians at risk by blocking other drivers' view of pedestrians, and pedestrians' view of other vehicles. At unsignalized mid-block crossings, yield lines should be placed adjacent to the Yield Here to Pedestrians sign located 20 to 50 feet in advance of the nearest crosswalk line, and parking should be prohibited in the area between the yield line and crosswalk.

8.6 Pavement Word and Symbol Markings

Word and symbol markings on pavement are used for the purpose of guiding, warning, or regulating traffic. Such markings are white in color and limited to no more than 3 lines of information. The longitudinal space between word or symbol message markings, including arrow markings, should be at least four times the height of the characters for low speed roadways, but not more than ten times the height of the characters under any conditions. Pavement markings are typically directed at vehicular traffic although they can be used in some cases to convey information to pedestrians (i.e., CAUTION or LOOK BOTH WAYS). Examples of pavement word markings related to pedestrians include: PED X-ING, SCHOOL X-ING, and SCHOOL. Other pavement markings such as STOP, STOP AHEAD, and SIGNAL AHEAD can also affect pedestrians since they can reinforce the need for motorists to obey speed and stopping requirements where pedestrians may be crossing. In cases where the markings are directed at pedestrians, they are usually placed in the crosswalk or on the sidewalk facing the direction of pedestrian travel (i.e., parallel to the vehicular travelway).

8.7 In-Roadway Warning Lights

General

In-roadway warning lights are special types of highway traffic signals installed in the roadway surface to warn road users that they are approaching a condition on or adjacent to the roadway that might not be readily apparent and might require the road users to slow down and/or come to a stop. This includes, but is not necessarily limited to, situations warning of marked school crosswalks, marked mid-block crosswalks, marked crosswalks on uncontrolled approaches, marked crosswalks in advance of roundabout intersections, and other roadway situations involving pedestrian crossings. General guidance is provided regarding the design and placement of these devices, but their installation should be based on engineering judgement.

If used, in-roadway warning lights shall not exceed a height of 0.75 in. (19 mm) above the roadway surface. The flash rate for in-roadway lights may be different from the flash rate of standard beacons.

Installation at Crosswalks

- In-roadway warning lights at crosswalks shall be installed only at marked crosswalks with applicable warning signs. They shall not be used at crosswalks controlled by YIELD signs, STOP signs, or traffic control signals.
- In-roadway warning lights at crosswalks shall be installed along both sides of the crosswalk and shall span its entire length.
- In-roadway warning lights at crosswalks shall initiate operation based on pedestrian actuation and shall cease operation at a predetermined time after the pedestrian actuation or, with passive detection, after the pedestrian clears the crosswalk.
- In-roadway warning lights at crosswalks shall display a flashing yellow signal indication when actuated. The flash rate for in-roadway warning lights at crosswalks shall be at least 50, but not more than 60, flash periods per minute. The flash rate shall not be between 5 and 30 flashes per second to avoid frequencies that might cause seizures.
- If used on one-lane, one-way roadways, a minimum of two in-roadway warning lights shall be installed on the approach side of the crosswalk. If used on two-lane roadways, a minimum of three in-roadway warning lights shall be installed along both sides of the crosswalk. If used on roadways with more than two lanes, a minimum of one in-roadway warning light per lane shall be installed along both sides of the crosswalk.
- In-roadway warning lights shall be installed in the area between the outside edge of the crosswalk line and 10 feet (3 m) from the outside edge of the crosswalk. In-roadway warning lights shall face away from the crosswalk if unidirectional, or shall face away from and across the crosswalk if bi-directional.

If used, the period of operation on the in-roadway warning lights following each actuation should be sufficient to allow a pedestrian crossing in the crosswalk to leave the curb or shoulder and travel at a normal walking speed of 4 feet (1.2 m) per second to at least the far side of the traveled way or to a median of sufficient width for pedestrians to wait. Where pedestrians who walk slower than normal, or pedestrians who use wheelchairs, routinely use the crosswalk, a walking speed of less than 4 feet (1.2 m) per second should be considered in determining the period of operation. Where the period of operation is sufficient only for crossing from a curb or shoulder to a median of sufficient width for pedestrians to wait, additional measures should be considered, such as median-mounted pedestrian actuators.

If used, in-roadway warning lights should be installed in the center of each travel lane, at the centerline of the roadway, at each edge of the roadway or parking lanes, or at other suitable locations away from the normal tire truck paths. The location of the in-roadway warning lights within the lanes should be based on engineering judgment.

8.8 Design Standards

See Figures 8-1 to 8-3.

Source: (7)

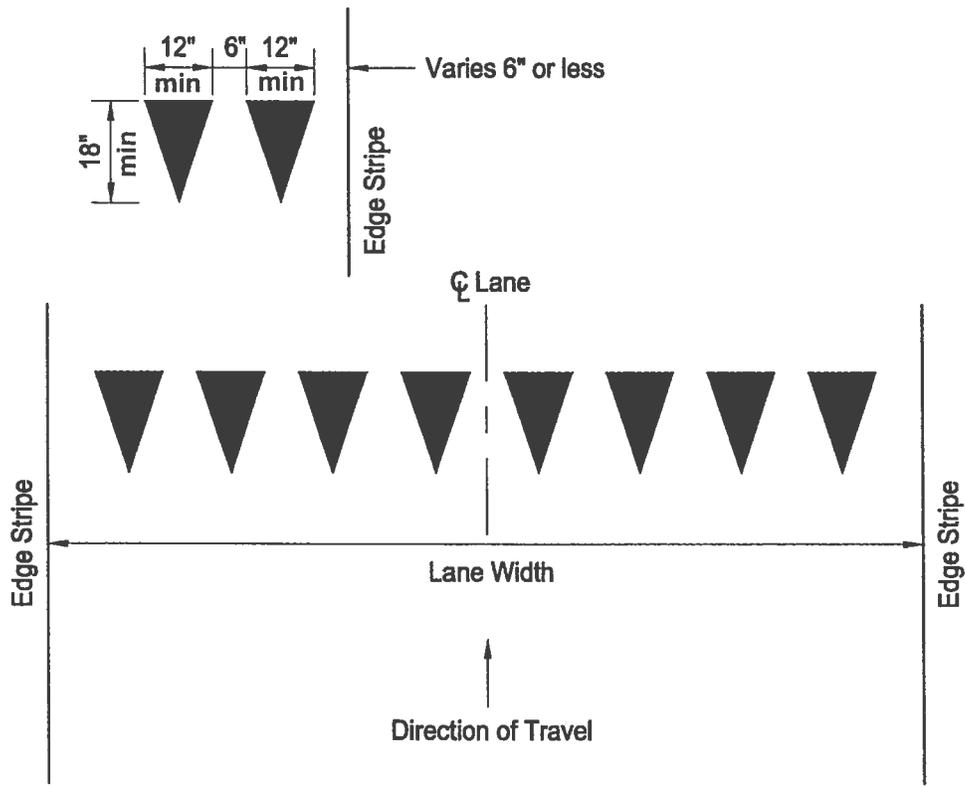
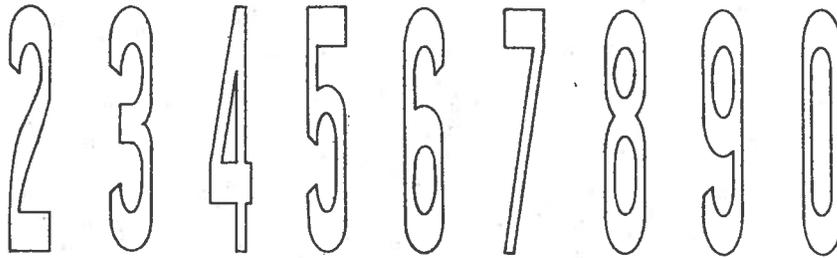
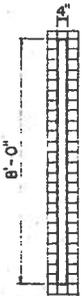
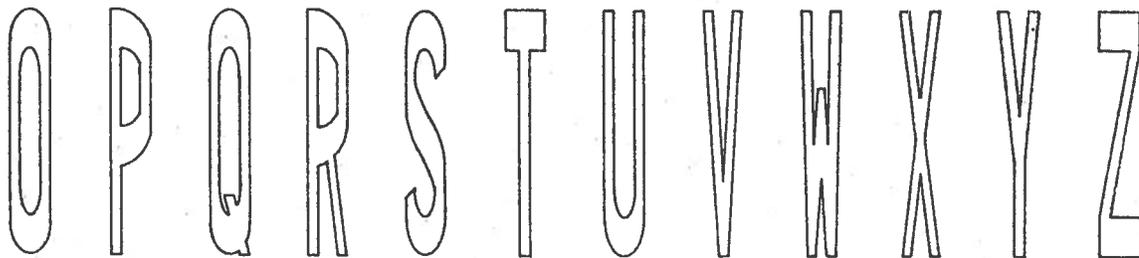
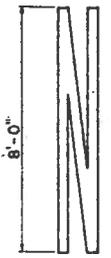
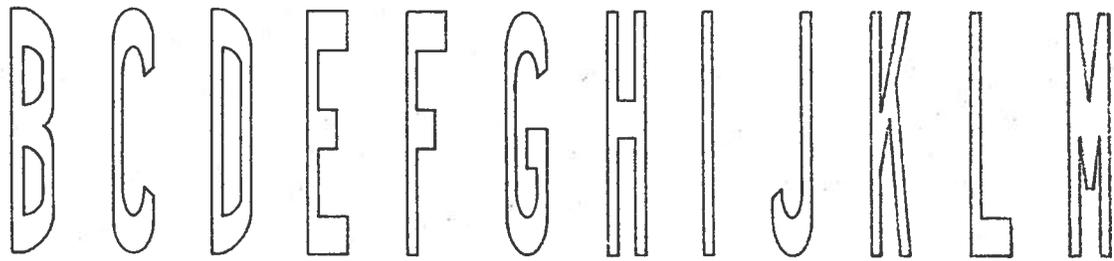
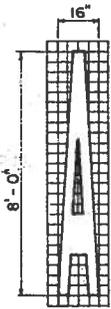


FIGURE 8-1 – TYPICAL YIELD LINE DETAIL

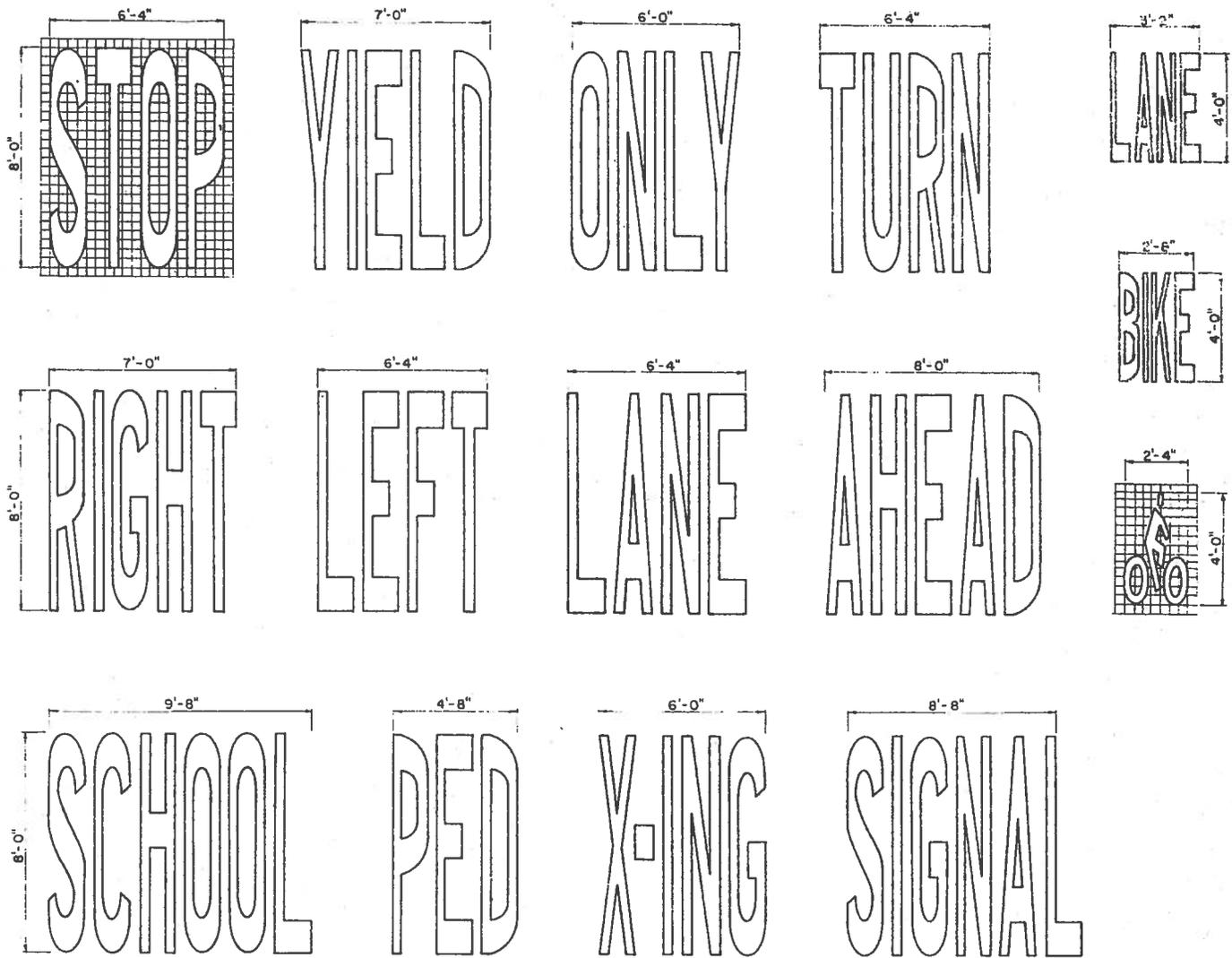


GENERAL NOTES

1. Pavement Alphabets, Numbers and Symbols shall conform to the latest edition of the FHWA publication, "Manual on Uniform Traffic Control Devices for Streets and Highways" and its amendments.
2. The characters are based on a 24x4 (height x width) grid system to facilitate enlarging. Horizontal strokes are 4 units high and vertical strokes are 1 unit wide.
3. Unless otherwise noted, the typical height and width of each character shall respectively be 8'-0" and 1'-4". The horizontal strokes shall be 16" high and the vertical strokes shall be 4" wide.
4. All pavement messages and symbols shall be laid out by the Contractor and approved by the Engineer prior to installation.

(Source: SDOT Standard Plans)

FIGURE 8-2 – PAVEMENT ALPHABET AND NUMBERS



GENERAL NOTES

1. All messages not shown must be approved by the Engineer prior to installation.
2. The space between characters in a message shall be 1 grid unit unless otherwise shown or directed.
3. All pavement messages shall be white in color.

(Source: SDOT Standard Plans)

FIGURE 8-3 – PAVEMENT SYMBOLS

CHAPTER 9 SCHOOL AREA PEDESTRIAN SAFETY

9.1 General

It is important to stress that regardless of the school location, the best way to achieve reasonably safe and effective traffic control is through the uniform application of realistic policies, practices, and standards developed through engineering judgment. Pedestrian safety depends upon public understanding of accepted methods for efficient traffic control. This principle is especially important in the control of pedestrians, bicycles, and other vehicles in the vicinity of schools. Neither pedestrians on their way to or from school nor road users can be expected to move safely in school areas unless they understand both the need for traffic controls and how these controls function for their benefit.

Procedures and devices that are not uniform might cause confusion among pedestrians and road users, and prompt wrong decisions. To achieve uniformity of traffic control in school areas, comparable traffic situations need to be treated in a consistent manner. Each traffic control device and control method described in this section fulfills a specific function related to specific traffic conditions. A uniform approach to school traffic controls assures the use of similar controls for similar situations (which promotes uniform behavior on the part of motorists, pedestrians, and bicyclists). A school traffic control plan permits the orderly review of school area traffic control needs, and the coordination of school/pedestrian safety education and engineering activities.

A school route plan serving elementary students may be prepared by each school in coordination with the School Traffic Safety Committee in order to develop uniformity in the use of school area traffic controls and to serve as the basis for a school traffic control plan for each school. A school route plan serving middle school or high school students prepared by each school may also be prepared or considered.

A school route plan, developed in a systematic manner by the school, law enforcement, and traffic officials responsible for school pedestrian safety, should consist of a map (sample included in Appendix A) showing streets, the school, existing traffic controls, established school walk routes, and established school crossings. The type(s) of school area traffic control devices used, either warning or regulatory, should be related to the volume and speed of vehicular traffic, street width, and the number and age of the students using the crossing. School area traffic control devices should be included in a school traffic control plan.

Reduced speed limit signs for school areas and crossings are included solely for the purpose of standardizing signing for these zones and not as an endorsement of mandatory speed zones. Parents, school administrators, traffic officials, civic leaders, and vehicle drivers share the responsibility of educating school pedestrians on the use of traffic control devices. Programs in the home and school to train the child as a responsible pedestrian are an important factor in improving their understanding of traffic

control devices. The words "School Pedestrians", "Children", and "Students" are used interchangeably and could include student bicyclists for the purpose of determining appropriate cross protection measures.

School Routes and Established Crossings

The planning criterion for school work routes might make it necessary for children to walk an indirect route to an established school crossing located where there is an existing traffic control and to avoid the use of a direct crossing where there is no existing traffic control. School walk routes should be planned to take advantage of existing traffic controls.

The following factors should be considered when determining the feasibility of requiring children to walk a longer distance to a crossing with existing traffic control:

- The availability of adequate sidewalks or off-road roadway sidewalk areas to and from the location with existing control;
- The number of students using the crossing;
- The age levels of students using the crossing, and
- The total extra walking distance.

There is a need in each school district to establish an organization concerned with students en-route to and from school. Through such an organization, the school district can be responsibly involved in processing requests for traffic safety controls and for safety programs and can coordinate activities within and between the community and public agencies.

In order to provide a responsible administrative structure for the school area, each school district is encouraged to:

- Assign student pedestrian responsibilities to a competent staff member and/or
- Organize a school student pedestrian advisory committee to serve the needs of each public and private school.

When the advisory committee structure is used, the committee should include governmental and school district staff who have the responsibility and authority to initiate and provide programs and projects. Representatives from the city and/or the school superintendent office should be the official members. Advisors should include representatives of the School Traffic Safety Committee, local area Safety Council, traffic engineers, police authorities, the Parent-Teachers Association, Automobile Clubs (AAA), plus others as needed.

Staff and Committee Responsibility

The duties of staff members and/or each committee should be to guide and coordinate all activities connected with the school traffic safety program, such as:

- Establish traffic safety policies and procedures.
- Recommend priorities for proposed improvement projects.
- Notify the responsible agencies of school-pedestrian-traffic related issues.
- Review and approve the various phases of the school student traffic safety program.
- Review and process requests and complaints.
- Promote good public relations.

The school superintendent's office should coordinate all student pedestrian committee's actions in establishing and promoting uniform practices for school pedestrian safety throughout the associated regions.

School Responsibility

Traffic related issues about school pedestrians on the approaches to the school should be referred to the school district or local school principal for review and transmission to the appropriate staff person or the school student pedestrian advisory committee.

Government Traffic Agency Responsibility

Upon request of the local school district, responsible traffic authorities shall investigate all locations along the school route and recommend appropriate traffic control measures.

School Crossing Control Criteria

Alternate gaps and blockades are inherent in the traffic stream and are different at each crossing location. For safety, students need to wait for a gap in traffic that is of sufficient duration to permit reasonably safe crossing. When the delay between the occurrences of adequate gaps becomes excessive, students might become impatient and endanger themselves by attempting to cross the street during the inadequate gap. A recommended method for determining the frequency and adequacy of gaps in the traffic stream is given in the Institute of Transportation Engineers' publication, *School Trip Safety Program Guideline*.

Properly conducted engineering and traffic studies will determine the appropriate measures to be developed at school crossings. Types of school pedestrian measures that can be considered could include:

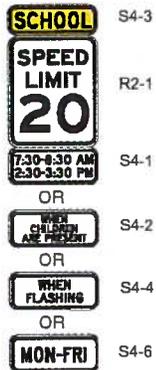
- Warning signs and markings
- Variable speed limits
- Intersection stop signs
- Flashing yellow beacons
- Traffic signals
- Remove visibility obstructions
- School Safety Patrol
- Adult Crossing Guard
- Pedestrian separation structures
- Pedestrian walkways along the roadway
- Pedestrian walkways separated from the roadway
- Parking controls and curb-use zones
- Bus transportation

9.2 Signs

General discussions regarding regulatory and warning signs are included in Chapters 5 and 6 of this document. However, there are also signs specifically intended for use within school areas. These signs can be rectangular or diamond shaped and should be retroreflective or illuminated to show the same shape and similar color by both day and night. There are conventional sizes for school signs, but oversized signs may be used for applications that require increased emphasis, improved recognition, or increased legibility. School signs should be placed in positions where they will convey their messages most effectively without restricting lateral clearance or sight distance or sight distances. When signs are offset 30 feet or more from the pavement edge, signs should generally be turned toward the road. School signs include the following:



- **School Advance Warning Assembly** (S1-1 with Supplemental Plaque) should be installed in advance of locations where schools are adjacent to the roadway except where school children are separated from the roadway by a physical barrier (i.e., fencing). This assembly should be used in advance of any School Crosswalk Warning or School Speed Limit assembly not less than 150 feet or more than 700 feet in advance of school grounds or crossings. If used, the assembly should consist of a **School Advance Warning** (S1-1) sign supplemented with a plaque to provide advance notice to road users (i.e., **AHEAD** (W16-9p) or **XXX FEET** (W16-2a)). Fluorescent yellow-green signs may be used as an alternative.



- School Crosswalk Warning Assembly** (S1-1 with Diagonal Arrow) should be installed at marked crosswalks or as close as possible used by students going to and from school, unless the approach is stop controlled. The assembly should consist of a **School Advance Warning** (S1-1) sign with a diagonal downward pointing arrow (W16-7p) to show the location of the crossing.
- School Bus Stop Ahead** (S3-1) sign should be installed in advance of locations where a school bus, when stopped to pick up or discharge passengers, is not visible to road users for a distance of 500 feet in advance.
- School Speed Limit Assembly** (S4-1, S4-2, S4-3, S4-4, S4-6, S5-1) should be used to indicate the speed limit where a reduced speed zone for a school area has been established. The assembly should be placed at the point where the reduced speed zone begins or as close as possible. The reduced speed zone should begin either 200 feet from the crosswalk or 100 feet from the school property line, whichever is encountered first as traffic approaches the school. The assembly should consist of a top plaque (S4-3) with the legend SCHOOL, a Speed Limit (R2-1) sign, and a bottom plaque (S4-1, S4-2, S4-4, or S4-6) indicating the specific periods of the day and/or days of the week that the special school speed limit is in effect. Changeable message signs and flashing beacons can be used in place of or in conjunction with the assembly.
- Reduced Speed School Zone Ahead** (S4-5, S4-5a) sign may be used to inform road users of a reduced speed zone. If used, this sign should be followed by a School Speed Limit sign or School Speed Limit assembly.
- End School Zone** (S5-2) sign should be used to indicate the end of a school speed zone.

- **Parking and Stopping Signs** (R7 and R8 series) may be used to prevent parked or waiting vehicles from blocking pedestrians' views and drivers' views of pedestrians, and to control vehicles as part of the school traffic plan. Parking signs and other signs governing the stopping and standing of vehicles in school areas have a standard size of 12 inches x 18 inches and cover a wide variety of regulations. In general, these types of signs can be used to:
 - Limit parking to two hours or less on school days
 - Prohibit parking during specified times or days along school frontage or school approaches for adequate visibility of walkways, gates, entrances, crossing and unfenced grounds; or for adequate passenger, bus and commercial loading; or for unrestricted walkway access on a school approach (i.e., "No Stopping", "No Parking" or "No Stopping – Buses Excepted" during specified times or days)
 - Temporarily prohibit or restrict parking for special events to minimize congestion and delay during periods of extra heavy traffic demand

The legend on parking signs shall state whatever regulations apply, and the signs shall conform to the standards of shape, color, position and use. Generally, parking signs should display such of the following information as appropriate, from top to bottom of the sign, in the order listed:

- Restriction or prohibition.
- Time of day it is applicable, if not at all hours.
- Days of week applicable, if not every day.

Typical examples of regulations are as follows:

- No Parking X:XX AM to X:XX PM School Days Only;
- No Stopping X:XX AM to X:XX PM School Days Only;
- X Min Loading X:XX AM to X:XX PM School Days Only; and
- No Standing X:XX AM to X:XX PM School Days Only.

In addition, there should be a single-headed arrow pointing in the direction the regulation is in effect (if the sign is at the end of a zone). As an alternate to the arrow (if the signs are posted facing traffic at an angle of 90 degrees to the curb line), there may be included on the sign, or on a separate plate below the sign, such legends as BEGIN, END, HERE TO CORNER, HERE TO ALLEY, THIS SIDE OF SIGN, or BETWEEN SIGNS.

Where parking is prohibited at all times or at specified times, parking signs shall have red letters and border on a white background (Parking Prohibition signs). Where only limited-time parking is permitted, or where parking is permitted only in a particular manner, the signs shall have green letters and border on a white background (Parking Restriction signs).

For emphasis, the word NO or the numeral showing the time limit in hours or minutes may be in a reversed color arrangement in the upper left hand corner of the sign, i.e., in white on a rectangular area of red or green. The **No Parking** symbol (R26D) may be used as an alternative to the words NO PARKING on signs. In urban applications the symbol sign shall have a minimum size of 12 inches x 12 inches.

9.3 Pavement Markings

Crosswalk Markings

Marked crosswalks are discussed in more detail in Chapters 1 and 7.

Stop and Yield Lines

Stop and yield lines are discussed in more detail in Chapter 7.

Curb Markings for Parking Regulations

Signs shall always be used with curb markings in those areas where curb marking are frequently not visible. Where curb markings are used they shall conform to the following guidelines:

- Red indicates no stopping, standing, or parking, whether the vehicle is attended or unattended, except for the purpose of loading or unloading passengers for times as specified by signs including buses that may stop in a red zone marked or sign posted as a bus loading zone.
- Yellow indicates stopping only for the purpose of loading or unloading freight for times as specified by signs.

Pavement Word and Symbol Markings

General discussion regarding pavement word and symbol markings are included in Chapter 7. In school areas, the SCHOOL word marking may extend the width of two approach lanes. If the two-lane SCHOOL word marking is used, the letters should be 10 feet or more in height.

9.4 School Flashing Yellow Beacons

Flashing yellow beacons may be installed to supplement standard school signing and markings for the purpose of providing advance warning during specified times of operation when justified. (See Figure 9-1). A flashing yellow beacon may be justified when ALL of the following conditions are fulfilled:

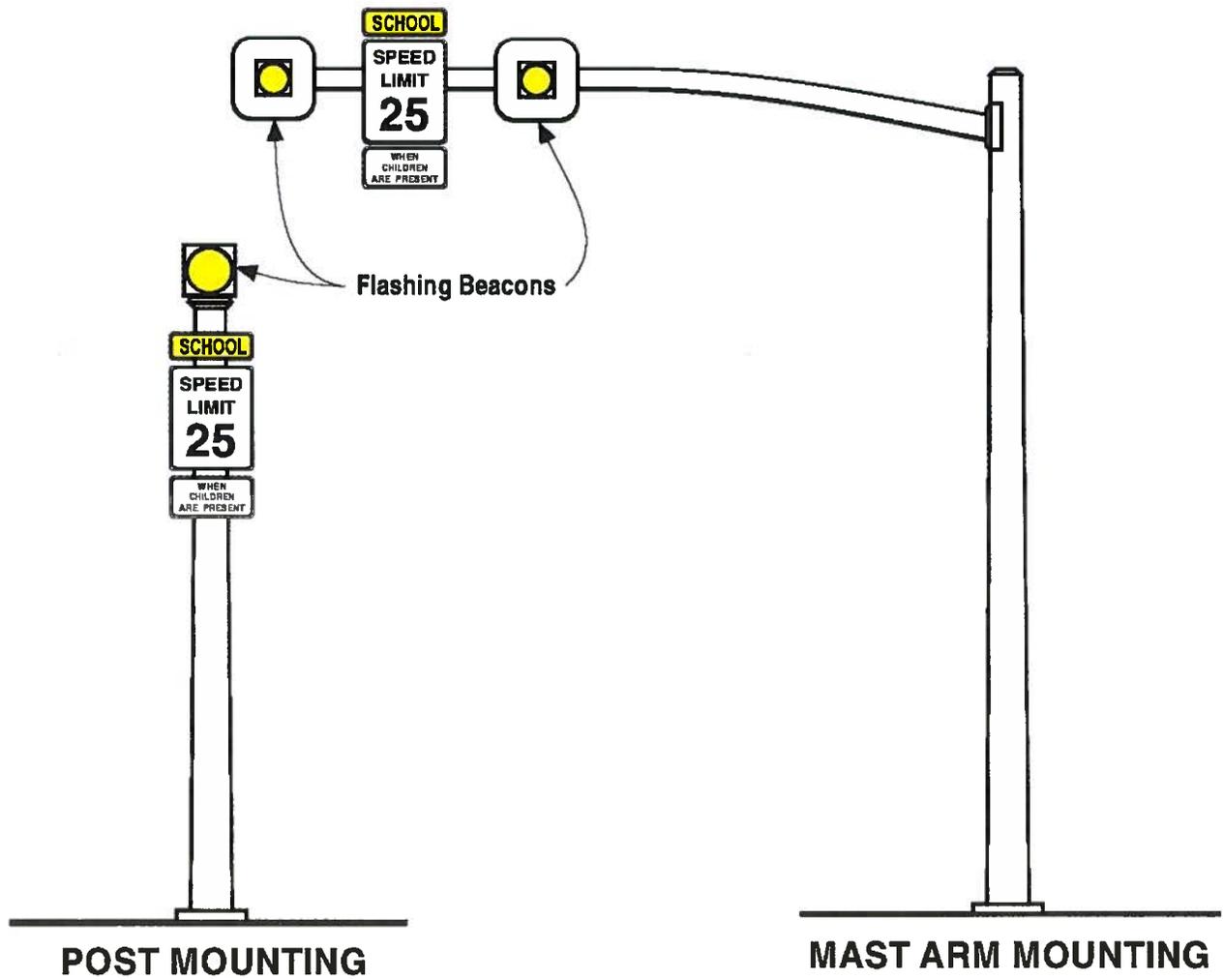


FIGURE 9-1 – TYPICAL INSTALLATIONS FOR FLASHING YELLOW BEACONS AND OVERHEAD SCHOOL SIGNS

- The uncontrolled school crossing is on the “Suggested Route to School”; and
- At least 40 school pedestrians use the crossing during each of any two hours (not necessarily consecutive) of a normal school day; and
- The crossing is at least 600 feet from the nearest alternate crossing controlled by traffic signals, stop signs or crossing guards; and
- The vehicular volume through the crossing exceeds 200 vehicles per hour in urban areas or 140 vehicles per hour in rural areas during the same hours the students are going to and from school during normal school hours; and
- The critical approach speed (85 percentile) exceeds 35 mph or the approach visibility is less than the stopping sight distance calculated utilizing the design speed of the roadway.

9.5 School Crossing Traffic Signals

A traffic signal assigns intersection right-of-way and promotes the orderly movement of pedestrians and vehicles. However, improper signal controls may lead to intentional violations, unnecessary delays and traffic diversion to less desirable alternate routes. Occasionally it is necessary to install a traffic signal to extend or create crossing gaps in the flow of traffic when the occurrence of adequate gaps becomes scarce enough to cause students to endanger themselves by attempting to cross the street during an inadequate gap.

School crossing traffic signals shall be investigated when the frequency and adequacy of gaps in the vehicular traffic stream during the period when school pedestrians are crossing is less than the number of minutes in the same period. An acceptable gap may be defined as the minimum time between vehicles that 85 percent of all groups of pedestrians waiting to cross a street will accept as adequate to cross the street. If there is at least one safe gap per minute of crossing time, there may be no need for any special traffic controls. If, however, there is not at least one safe gap per minute, other remedial measures (i.e., warning signs and flashers, school crossing guards, etc.) are not feasible, and the distance to the nearest traffic control signal is greater than 300 feet, consideration should be given to the installation of a traffic signal to create safe gaps.

The design of school crossing traffic signals shall conform to current traffic signal design practices and include the following for consideration:

- The signals shall be designed for full-time operation.
- If at an intersection, the entire intersection should be signalized, the traffic control signal should be traffic-actuated, and include pedestrian pushbuttons or other detectors.
- If at a non-intersection crossing, the traffic control signal should be pedestrian-actuated, parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the crosswalk, and the installation should include suitable standard signs and pavement markings.

9.6 School Crossing Supervision

Types of Crossing Supervision

There are two types of school crossing supervision:

- Adult control of pedestrians and vehicles by adult crossing guards or uniformed law enforcement officers; and
- Student control of pedestrians only with student patrols.

Information for the organization, operation, and administration of an adult crossing guard program are given in *Civilian Guards For School Crossing*" (available from the Center for Public Safety of Northwestern University, 405 Church Street, Evanston, IL 60204) and *Adult School Crossing Guards* (available from the American Automobile Association, 1000 AAA Drive, Heathrow, FL 32746). Information for the organization, administration and operation of a student patrol program are given in *Policies and Practices for School Patrols* (also available from the American Automobile Association).

Adult Crossing Guards

Adult crossing guards may be used to provide gaps in traffic at school crossings where an engineering study has shown that adequate gaps need to be created. They may be assigned at designated school crossings to assist school pedestrians at specified hours when going to and from school.

Student Patrols

Student patrols may be used to direct and control pedestrians at crossings near schools where adequate gaps in traffic occur frequently enough so that gaps do not need to be created. Student patrols may be used to direct and control pedestrians at signalized intersections where turning movements are not a significant problem, and may be used to assist adult crossing guards in the control of pedestrians at crossing locations used by large number of pedestrians. Student patrols should not be responsible for directing vehicular flow. They should not function as uniformed law enforcement officers or adult crossing guards.

9.7 School Grade Separation Crossings

Grade separation crossings may be used to physically separate the crossing of school pedestrian traffic and vehicular flow. They may eliminate vehicular-pedestrian conflicts but are necessarily limited to selected locations where the benefits clearly balance the public investment. Separation crossings are supplemental techniques for reducing school pedestrian accidents and are not traffic control devices.

Grade separation crossings may be either overcrossings or undercrossings. Overcrossings are easier to maintain and supervise than undercrossings. Grade

separation crossings provide for the crossing of a particular street by pedestrians that avoid conflict with vehicular flow on the surface street that maintains the movement of vehicles. Oftentimes, the ability to conform to the Americans with Disabilities Act to allow the non-discriminatory use of the overcrossings or undercrossings by pedestrians with disabilities is very difficult in retrofit conditions because of the limited area or right-of way.

Criteria for Use of School Grade Separation Crossings

Grade separation crossings should be considered when the physical characteristics of the location make such a structure feasible. If use of the grade separation will be less convenient than an at-grade crossing, barriers or supervision will be needed to assure a satisfactory level of use.

Grade separation crossings should be considered when ALL of the following conditions are fulfilled:

- The prevailing conditions that require a school pedestrian crossing must be of sufficient duration to justify the separation crossing structure; and
- The location shall be on the "Suggested Route to School" at an uncontrolled intersection or mid-block location along an expressway or major arterial street where the traffic conditions make it very difficult for pedestrians to cross; and
- Revision of the "Suggested Route to School" or the attendance boundaries to eliminate the conflict is not reasonable; and
- Physical conditions make a separation crossing structure reasonable from an engineering standpoint, including pedestrian channelization to ensure usage of the structure; and
- Adjacent controlled school pedestrian crossings are more than 600 feet from the proposed structure and would require total out-of-direction walking of at least 1200 feet; and
- Bus transportation, traffic signals, adult crossing guards or other means of resolving the school pedestrian-vehicular conflicts are not reasonable.

9.8 School Pedestrian Walkways

School pedestrian issues are not limited to crossing locations and may occur where physical conditions require students to walk in or along rural or suburban roadways.

Where students walk on the roadway, a shoulder width of 6 feet is desirable along both sides so that they may walk facing oncoming traffic. Where a pedestrian walkway is provided, and is at least 4 feet wide and physically separated from the traveled way, it may be limited to one side of the roadway. This measure is a supplemental technique, not a traffic control device.

Criteria for Use of School Pedestrian Walkways

A pedestrian walkway may be considered when ALL of the following conditions are fulfilled:

- The roadway lies on the Suggested Route to School"; and
- Existing road shoulders outside the traveled way are less than 6 feet wide; and
- More than 20 school pedestrian use the route while walking to or from school and vehicular volume exceeds 100 per hour during those periods of the day; and
- The governing board of the school district officially requests the pedestrian walkway improvements; and
- Revision of the "Suggested Route to School" of the attendance boundaries to eliminate the conflict is not reasonable.

Source: (6) (7) (9)

CHAPTER 10 PLANNING AND DESIGN OF BICYCLE FACILITIES

10.1 Bikeway Classifications

There are three general classifications of bikeways. Descriptions and general design guidelines for these classifications are included in the following sections and illustrated in Figure 10-1.

Class I Bikeway

Typically called a “bike path” or “shared use path,” Class I bikeways provide bicycle travel on a paved right-of-way completely separated from any roadway. The recommended width is dependent upon the anticipated usage:

- 8 feet is the minimum width, most applicable to unpaved and/or rural facilities.
- 8 feet may be used for short neighborhood connector paths (generally less than one mile in length) due to low anticipated volumes of use.
- 10 feet is the recommended minimum width for a two-way bicycle path.
- 12 feet is the preferred minimum width if more than 300 users per peak hour are anticipated, or if there is heavy mixed bicycle and pedestrian use.

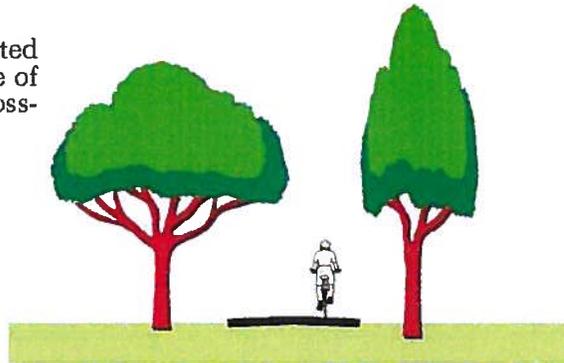
A minimum 2-foot wide graded area should be provided adjacent to the path to provide clearance from trees, poles, walls, etc. A yellow centerline stripe is recommended to separate travel in opposite directions.

Other design recommendations for Class I bikeways are as follows:

- Bike paths that cross roadways with average daily trips over 20,000 vehicles should be considered for signalization or grade separation.
- Lighting should be considered where commuters will use the bike path in the evenings.
- Barriers at pathway entrances should be clearly marked with reflectors and be ADA accessible (minimum 3 feet clearance).
- Path construction should take into account impacts of maintenance and emergency vehicles on shoulders and vertical and structural requirements. Paths should be constructed with adequate sub grade compaction to minimize cracking and sinking.
- All structures should be designed to accommodate appropriate loadings. The width of structures should be the same as the approaching trail width, plus minimum two-foot wide clear areas.
- Where feasible, provide two-foot wide unpaved shoulders for pedestrians/runners, or a separate tread way.
- Direct pedestrians to the right side of pathway with signing and/or stenciling.
- Provide adequate trailhead parking and other facilities such as restrooms and drinking fountains at appropriate locations.

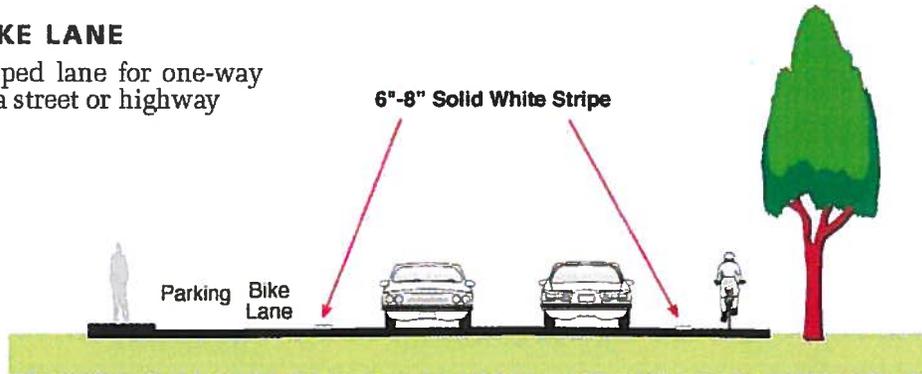
CLASS I BIKE PATH

Provides a completely separated right-of-way for the exclusive use of bicycles and pedestrians with cross-flow minimized



CLASS II BIKE LANE

Provides a striped lane for one-way bike travel on a street or highway



CLASS III BIKE ROUTE

Provides for shared use with pedestrian or motor vehicle traffic typically over lower volume roadways

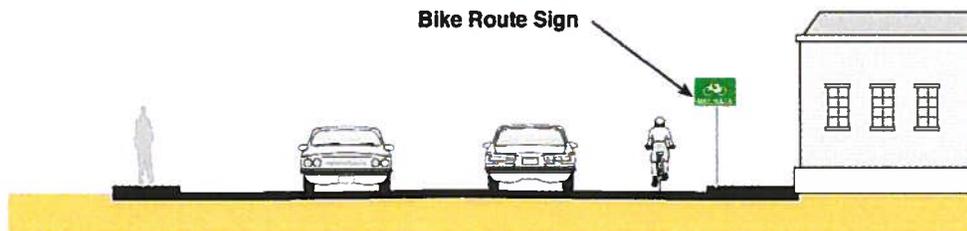


FIGURE 10-1 – GENERAL BIKEWAY CLASSIFICATIONS

Class II Bikeway

Typically referred to as a "bike lane," Class II bikeways provide a striped and stenciled lane for one-way travel in the same direction as traffic on either side of a roadway. To provide bike lanes along corridors where insufficient space is currently available, extra room can be provided by removing a traffic lane, narrowing traffic lanes, or prohibiting parking. The width of bike lanes vary according to parking and street conditions:

- 5 feet minimum when parking stalls are marked.
- 12 feet minimum for a shared bike/parking lane where parking is permitted but not marked on streets.
- 4 feet minimum if no gutter exists, measured from edge of pavement.
- 5 feet minimum with normal gutter, measured from curb face.

Other design recommendations for Class II bikeways are as follows:

- Where bottlenecks preclude continuous bike lanes, they should be linked with Class III route treatments
- A bike lane should be delineated from motor vehicle travel lanes with a solid 6-inch white line per the MUTCD. An 8-inch line width may be used for added distinction
- Word and symbol pavement stencils should be used to identify bicycle lanes

Class III Bikeway

Typically referred to as a "bike route," Class III bikeways provide routes through areas not served by Class I or II facilities or to connect discontinuous segments of a bikeway. They can be shared with either motorists on roadways or pedestrians on a sidewalk (not advisable) and generally identified only by signing. There are no recommended minimum widths for Class III facilities, but when encouraging bicyclists to travel along selected routes, traffic speed and volume, parking, traffic control devices, and surface quality should be acceptable for bicycle travel. A wide outside traffic lane (14 feet) should be provided where feasible to enable cars to safely pass bicyclists without crossing the centerline.

10.2 Intersection Considerations

Roadway intersections represent one of the primary collision points for bicyclists. Generally, the larger the intersection, the more difficult it is for bicyclists to cross. On-coming vehicles from multiple directions and increased turning movements make it difficult for motorists to see non-motorized travelers. Most intersections do not provide a designated place for bicyclists. Bike lanes and pavement markings often end before intersections, causing confusion for bicyclists. Bicyclists wanting to make left turns can face quite a challenge. Bicyclists must either choose to behave like motorists by crossing travel lanes and seeking

refuge in a left-turn lane, or they act as pedestrians and dismount their bikes, push the pedestrian walk button located on the sidewalk, and then cross the street in the crosswalk. Bicyclists traveling straight also have difficulty maneuvering from the far right lane, across a right turn lane, to a through lane of travel. Furthermore, motorists often do not know which bicyclist movement to expect. Some solutions to these conflicts include the installation of detectors for bicycles (i.e., bicycle-activated loop detectors or cameras) and the provision of bike boxes at intersections. Bike boxes are formed at intersections by setting the stop line for vehicles back further and adding a closer stop line for bicycles (i.e., just before the crosswalks where they exist). When the traffic signal is red, bicyclists are more visible and can move into a more comfortable position to make a turn since they are allowed to encroach further into the intersection ahead of motorized vehicles.

Where trails meet roadways at mid-block locations, motorists are less likely to expect bicyclists and pedestrians. The success of a trail can be largely determined by the quality of the crossing. Implementing a well-planned and attractive system of signing can greatly enhance bikeway facilities by signaling their presence and location to both motorists and existing and potential bicycle users.

10.3 Signage

Bicycle signs are retroreflectorized signs used on bikeways, including shared-use paths and bicycle lane facilities. The minimum sizes and placement of these signs are described in detail in Chapters 9B of the MUTCD. The following includes brief descriptions of signs applicable to bicycles:



R3-17



R3-17a



R3-17b

- **Bike Lane** (R3-17) sign should be used in conjunction with marked bicycle lanes and be placed in periodic intervals along bicycle lanes. May be supplemented with the **Ahead** sign (R3-17a) or **Ends** sign (R3-17b) mounted directly below.



R4-4

- **Begin Right Turn Lane Yield to Bikes (R4-4)** sign may be used when motor vehicles entering an exclusive right-turn lane must weave across bicycle traffic in bicycle lanes. This sign should not be used when bicyclists need to move left because of a right turn lane drop situation.



R5-1b



R9-3c

- **Bicycle Wrong Way (R5-1b)** sign and **Ride with Traffic (R9-3c)** plaque may be placed facing wrong-way bicycle traffic, such as on the left side of the roadway.



R5-3

- **No Motor Vehicles (R5-3)** sign may be installed at the entrance to a shared –use path.



R5-6

- **No Bicycles (R5-6)** sign should be installed at the entrance to facilities where bicyclists are prohibited.



R7-9



R7-9a

- **No Parking Bike Lane (R7-9, R7-9a)** sign should be used where it is necessary to restrict parking, standing, or stopping in a bicycle lane.



R9-5



R9-6

- **Bicycle Regulatory (R9-5)** may be used where the crossing of a street by bicyclists is controlled by pedestrian signal indications. Where it is not intended for bicyclists to be controlled by pedestrian signal indications, the R10-3 sign may be used. The R9-6 sign may be used where a bicyclist is required to cross or share a facility used by pedestrians and is required to yield to the pedestrians.



R10-3



R9-7



R10-22



W8-10



W8-10a



W8-1



W8-2



W11-1



W16-7b



W5-4a



W7-5



W16-1

- **Shared-Use Path Restriction (R9-7)** sign may be installed on facilities that are to be shared by pedestrians and bicyclists.

- **Bikeway Signal Actuation Sign (R10-22)** sign may be installed at signalized intersections where markings are used to indicate the location where a bicyclist is to be positioned to actuate the signal.

- **Bicycle Surface Condition Warning (W8-10)** sign may be used where roadway or shared-use path conditions could cause a bicyclist to lose control of the bicycle. Supplemental plaques such as **Bump (W8-1)** and **Dip (W8-2)** can be used to clarify the specific condition.

- **Bicycle Warning Sign (W11-1)** sign alerts the road user to unexpected entries into the roadway by bicyclists, and other crossing activities that may cause conflicts. These conflicts may be confined or may occur randomly over a segment of roadway. A supplemental plaque with the legend **AHEAD** or **XXX FEET** can be used with the bicycle warning sign. When used at the location of the crossing, the sign should be supplemented with a diagonal downward pointing arrow (**W16-7p**) plaque to show the location of the crossing.

- **Other Bicycle Warning Signs** such as **Bikeway Narrows (W5-4a)** and **Hill (W7-5)** may be installed on bicycle facilities to warn bicyclists of conditions not readily apparent. In situations where there is a need to warn motorists to watch for bicyclists traveling along the roadway, the **Share the Road (W16-1)** plaque may be used in conjunction with the **W11-1** sign.



D11-1



D1-b



D1-c



M4-11



M4-12



M1-8



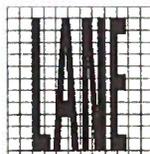
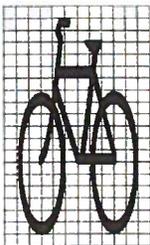
D4-3

- **Bicycle Route Guide (D11-1)** sign should be provided at decision points along designated bicycle routes, including signs to inform bicyclists of bicycle route direction changes and confirmation signs for route direction, distance, and destination. These signs should be repeated at regular intervals. **Destination (D1-1b, D1-1c)** signs may be mounted below these signs, supplemental plaques such as **Begin (M4-11)** and **End (M4-12)** may be mounted above, and arrow signs may be mounted below to furnish additional information.

- **Bicycle Route (M1-8)** sign is used to establish a unique identification (route designation) for a State or local bicycle route. Innovative signing (i.e., customized bike route logo sign that shows a custom designed graphic) can also be developed to increase bicycle awareness and improve visibility.

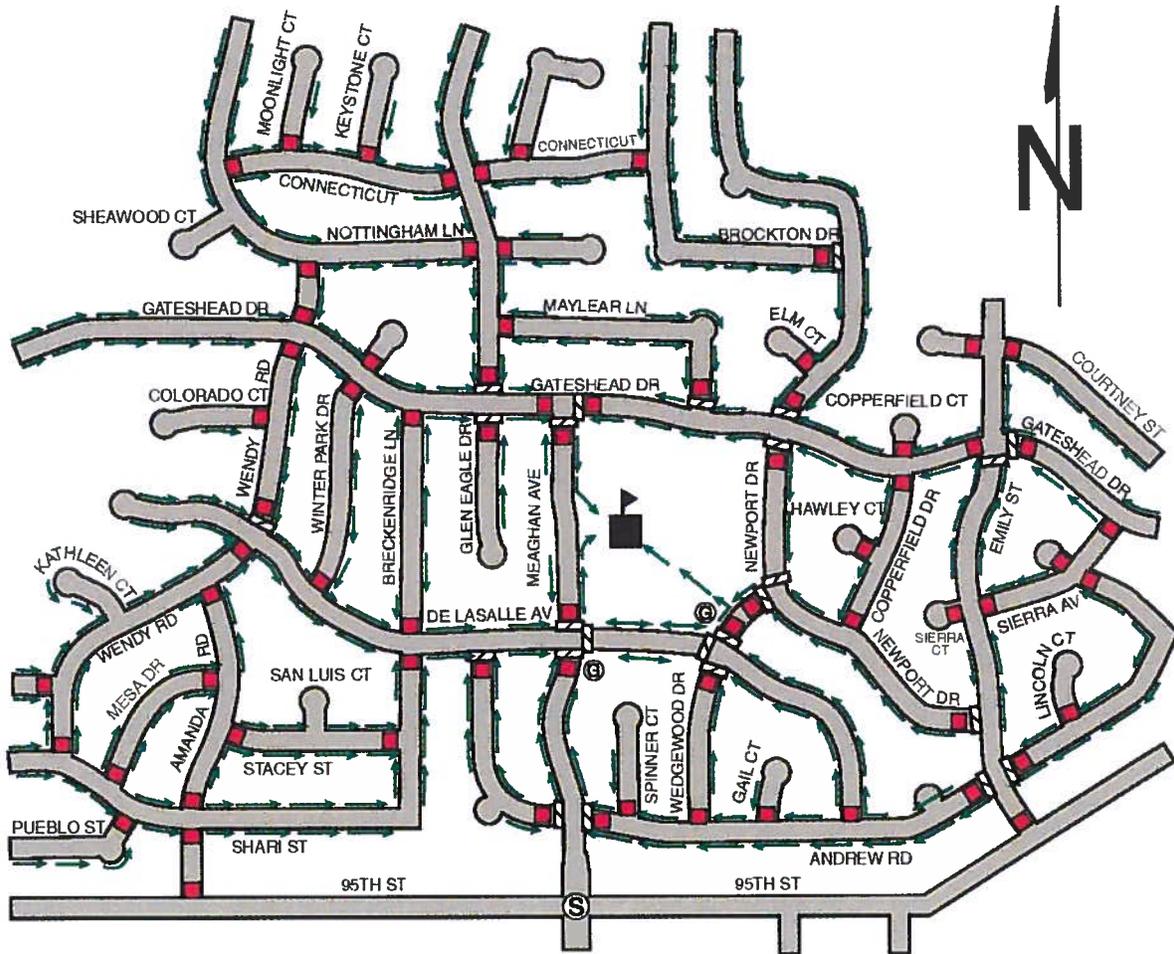
- **Bicycle Parking Area (D4-3)** sign may be installed where it is desirable to show the direction to a designated bicycle parking area.

10.4 Pavement Markings



Pavement marking symbols and/or word messages may be used on bikeways where appropriate to designate that portion of the roadway for preferential use by bicyclists. Consideration should be given to selecting materials that will minimize loss of traction for bicycles under wet conditions. The **Bicycle Lane Symbol** should be white and placed immediately after an intersection and at other locations as needed. If used in conjunction with other word or symbol messages (i.e., direction arrows), it should precede them.

EXAMPLE OF SCHOOL ROUTE PLAN MAP



Legend

- | | |
|---|--|
| <ul style="list-style-type: none"> School Marked Crosswalk Crossing Guard | <ul style="list-style-type: none"> Signalized Intersection STOP Sign Approach Pedestrian Route |
|---|--|