

Rectangular Rapid Flashing Beacons (RRFBs)

APPLICATION GUIDE



Introduction

This guide illustrates the current industry recommendations for selecting and installing an RRFB crosswalk using information from the Federal Highway Administration (FHWA). RRFBs are included in the [Manual on Uniform Traffic Control Devices \(MUTCD\) under Interim Approval 21 \(IA-21\)](#).

This guide will help explain (click to jump to the section):

- [Best practices for RRFBs: what road conditions facilitate selecting an RRFB](#)
- [FHWA / MUTCD IA-21 requirements](#)
- [Installation examples and equipment options](#)

The information provided by Carmanah Technologies is for general informational purposes only. Please consult your local or state transportation department for recommendations and guidelines on RRFB crosswalk installations.

Proper engineering judgment should always be exercised in the selection, application and installation of an RRFB.



Considerations before selecting an RRFB

Before selecting a crosswalk treatment, municipalities should first seek to understand the various safety issues facing each uncontrolled marked crossing. Consult the Federal Highway Administration's (FHWA) [*Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations*](#) for more information.

1. Collect data and engage the public

- Gather pedestrian crash and safety data
- Review and evaluate local pedestrian safety policies (e.g. Complete Streets and Vision Zero) and master plans
- Review the selection of product available on the region's approved product list (APL)

2. Inventory conditions and prioritize locations

- Locate high-risk / high-crash areas
- Inventory the various roadway characteristics (average daily traffic, posted speed limit, number of lanes, etc.)
- Inventory observed pedestrian crossing and overall traffic behavior

3. Analyze crash types and safety issues

- Perform a [*Road Safety Audit \(RSA\)*](#)
- Identify and diagram crash factors and addressable safety issues



Best Practices for Selecting an RRFB



Minimum MUTCD guidance for non-intersection crossings

MUTCD 3B.18.11

*Because non-intersection pedestrian crossings are generally unexpected by the road user, **warning signs should be installed for all marked crosswalks at non-intersection locations** and adequate visibility should be provided by parking prohibitions.*

MUTCD 3B.18.09

New marked crosswalks alone, without other measures designed to reduce traffic speeds, shorten crossing distances, enhance driver awareness of the crossing, and/or provide active warning of pedestrian presence, should not be installed across uncontrolled roadways where the speed limit exceeds 40 mph and either:

- A. The roadway has four or more lanes of travel without a raised median or pedestrian refuge island and an ADT of 12,000 vehicles per day or greater; or*
- B. The roadway has four or more lanes of travel with a raised median or pedestrian refuge island and an ADT of 15,000 vehicles per day or greater.*



Minimum MUTCD guidance for school crossings

MUTCD 7C.02.01

Crosswalks should be marked at all intersections on established routes to a school where there is substantial conflict between motorists, bicyclists, and student movements; where students are encouraged to cross between intersections; where students would not otherwise recognize the proper place to cross; or where motorists or bicyclists might not expect students to cross.

MUTCD 7C.02.03

Because non-intersection school crossings are generally unexpected by the road user, warning signs should be installed for all marked school crosswalks at non-intersection locations. Adequate visibility of students by approaching motorists and of approaching motorists by students should be provided by parking prohibitions or other appropriate measures.



Marked crosswalks alone are compliant, but not enough to make drivers yield

While signs and road markings legally establish a crosswalk, they are often not enough to make drivers yield to pedestrians.

A study comparing the marked versus unmarked crosswalks at uncontrolled locations found:

- On two-lane and multilane roads with annual average daily traffic (AADT) of under 12,000, there were no significant differences in pedestrian crash rates
- On multilane roads with AADTs of 12,000+, sites with marked crosswalks had higher pedestrian crash rates than unmarked crosswalks, increasing significantly as ADT increased

A study evaluating RRFB effectiveness found:

- Driver yield rates before RRFB installation averaged between 18 – 28%, with some locations as low as 0%

Safety Recommendations

Municipalities should avoid using marked crosswalks alone on:

- Two-lane roads with AADTs of 12,000+
- Multilane roads with AADTs of 9,000+



RRFB effectiveness

A range of studies have found that RRFBs have a significant effect on increasing pedestrian safety at uncontrolled crossings, such as midblock crosswalks and roundabouts.

- Pedestrian crashes reduced by 47%
 - Crash modification factor (CMF) = 0.53
- Driver yield rates between 73 – 96% depending on the location
- \$22,250 average cost including installation, labor and materials



Sources: National Academies of Sciences, Engineering, and Medicine, NCHRP Report 841, [Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments](#)

Federal Highway Administration, "[Rectangular Rapid-Flashing Beacon \(RRFB\) Safe Transportation for Every Pedestrian Countermeasure Tech Sheet](#)"



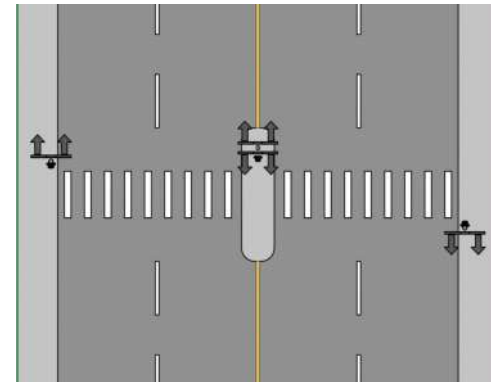
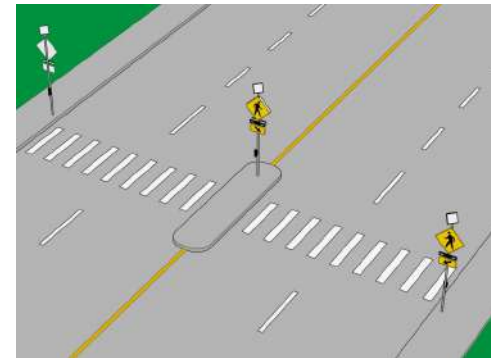
Road conditions associated with highest RRFB effectiveness

The following roadway and traffic control device conditions are associated with the highest RRFB driver yield rates:

- When the distance being crossed is shorter (e.g. how many lanes the pedestrian needs to cross)
- When a median / pedestrian refuge is present
- When the crossing has only two legs (rather than four legs)

Safety Recommendations for High Yield Rates

- Consider shortening the crossing distance (e.g. with curb extensions or pedestrian refuge).
- For 3+ lane roads with AADTs above 12,000, consider installing median-mounted RRFBs together with roadside RRFBs for the best driver compliance (where practical).



When to consider installing an RRFB

The following pages feature selection guides showing where RRFBs are recommended based on particular roadway and crossing conditions.

However, municipalities should always consider RRFBs for roadways 40 mph and under if an uncontrolled crosswalk is experiencing one or more of the following safety issues:



Drivers aren't yielding to pedestrians at the crosswalk



Previous conflicts and/or incidents have occurred at the crosswalk



Visibility of the crosswalk and/or pedestrians is poor



RRFB Selection Matrix

Legend



= RRFBs are not recommended but are an optional enhancement with or following engineering judgment



= RRFBs are a candidate treatment to improving crossing safety on this roadway



= RRFBs are an ideal treatment for this roadway

Use this chart to determine the roadway conditions where RRFBs are recommended or should be considered to maximize pedestrian safety.

Crossing distance (e.g. number of lanes)	Median presence	Posted Speed Limit (mph) and Annual Average Daily Traffic (AADT)								
		< 9,000 AADT			9,000 – 15,000 AADT			> 15,000 AADT		
2 lanes (1 lane in each direction)	-	Engineering judgment	Consider	Recommended	Engineering judgment	Consider	Recommended	Consider	Consider	✗
	-	Engineering judgment	Consider	Recommended	Engineering judgment	Consider	Recommended	Consider	Consider	✗
3 lanes (1 lane in each direction with two-way left-turn lane)	Yes	Engineering judgment	Consider	Recommended	Consider	Recommended	Recommended	Consider	Recommended	✗
	No	Consider	Consider	✗	Consider	Recommended	✗	Consider	✗	✗
4+ lanes (2 or more in each direction)	Yes	Consider	Consider	✗	Consider	Recommended	✗	Recommended	✗	✗
	No	Consider	Consider	✗	Consider	Recommended	✗	Recommended	✗	✗

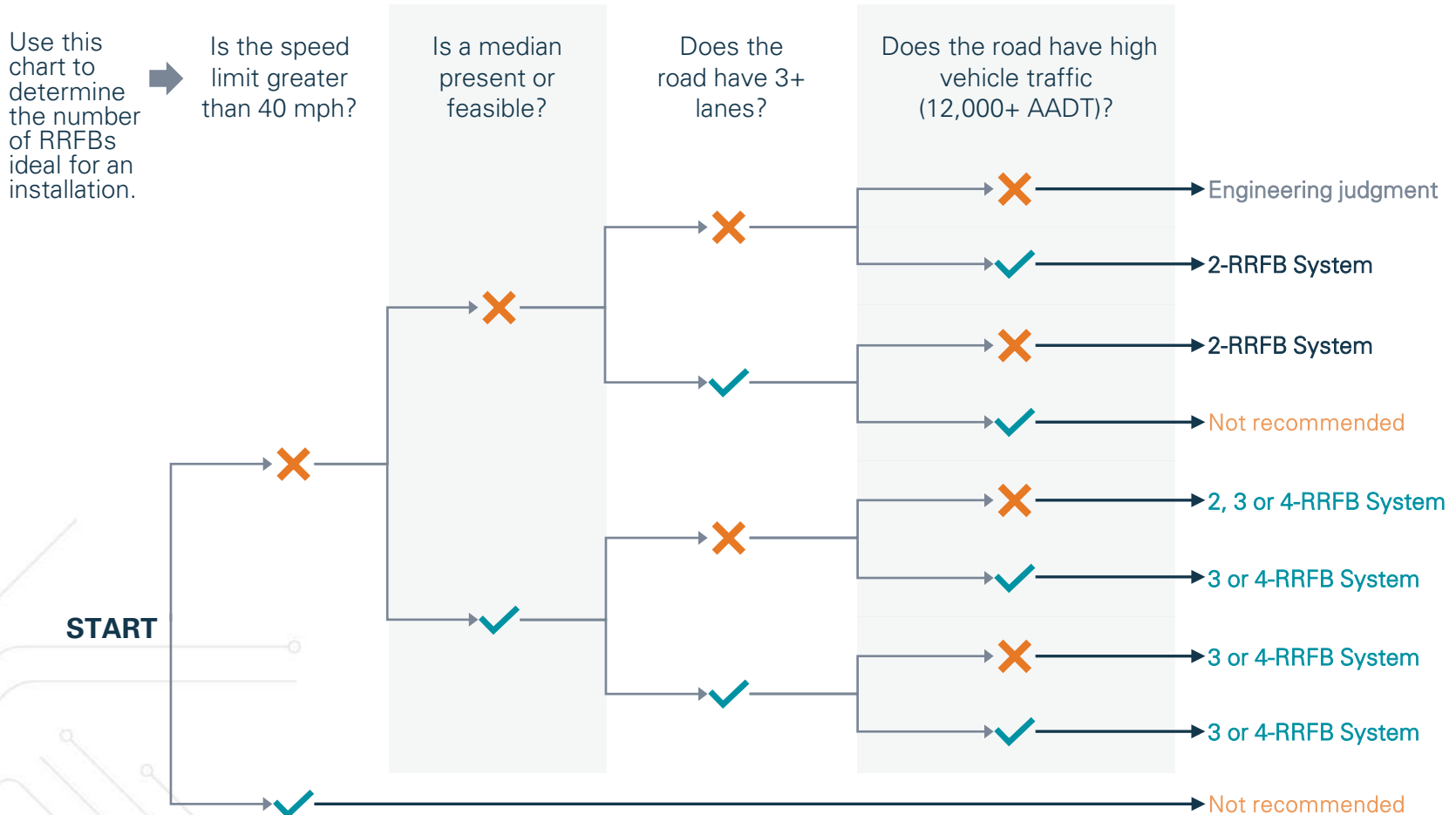
Source: Adapted from Federal Highway Administration, Report No. FHWA-SA-17-072, [Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations](#)



RRFB Selection Flowchart

Legend

- Engineering judgment = RRFBs are not recommended but are an optional enhancement with or following engineering judgment
- 2-RRFB System = Two RRFB units mounted at the roadside
- 3 or 4-RRFB System = Two RRFB units mounted at the roadside + one to two RRFB units mounted on the median refuge



Minimum Crosswalk Sight Distance

The following table suggests the minimum recommended sight distances (in feet) that a crosswalk should be visible to drivers on all approaches per the road's posted speed limit.

If a crosswalk is not visible within the recommended stopping sight distance for the road's speed limit, **installing an advance crosswalk warning sign using an RRFB system is recommended by the MUTCD**. The advance RRFB system should communicate in conjunction with the RRFB crossing.

Posted speed limit (MPH)	Stopping sight distance (ft)*
15	70
20	90
25	115
30	140
35	165
≤40**	195

* Stopping sight distance may vary based on road grade.

** RRFBs may not be sufficient on roads with speeds 40 mph and greater.



Complementary Treatments: Pedestrian Refuge Island

Pedestrian refuge islands reduce exposure to traffic by providing a refuge for pedestrians crossing a multilane road, allowing them to focus on one direction of traffic at a time.

- Can reduce pedestrian crashes by 32%
- RRFBs installed on the roadside and pedestrian refuge can consistently increase driver yield rates to over 90%

Safety Recommendations

- Pedestrian refuges are recommended on RRFB crossings at 3+ lane roadways with 12,000 AADT and above



Complementary Treatments: Advance Stop / Yield Markings

Advance stop or yield lines encourage drivers to stop further back from the crosswalk, increasing pedestrian visibility and reducing multiple-threat collisions when crossing more than one lane in each direction.

- Can reduce pedestrian crashes by 25%

Safety Recommendations

- Advance markings are recommended on RRFB crossings with 12,000 AADT and above.



R1-5 yield here to pedestrians sign



FHWA Guidelines and Compliance for RRFB Installation



FHWA Interim Approval 21

Issued on March 20, 2018, all new RRFB installations must comply with the conditions detailed in the FHWA Interim Approval 21 (IA-21).

State and local agencies must request and receive permission to use this new Interim Approval from the Federal Highway Administration (FHWA) in accordance with the provisions of Section 1A.10 of the MUTCD before they can use the RRFB, even if prior approval had been given for Interim Approval 11 (IA-11), now terminated.

- Existing RRFB units that use the flash pattern designated by the previous Interim Approval 11 must be reprogrammed to the newly required wig-wag plus simultaneous (WW+S) flash pattern as part of an upgrading process



General Conditions

IA-21 Condition 1

Each RRFB unit shall consist of two rapidly flashing rectangular-shaped yellow indications with an LED-array-based light source.

The use of RRFBs is optional. If an agency opts to use an RRFB, it must meet the conditions of IA-21.

The requirements of IA-21 override any conflicting provisions provided by the MUTCD.



Allowable Signs

IA-21 Condition 2

An RRFB shall only be used to supplement the following post-mounted or overhead-mounted signage located at or immediately adjacent to an uncontrolled marked crosswalk:



W11-2 pedestrian crossing sign



S1-1 school zone crossing sign



W11-15 bicycle and pedestrian crossing sign

These signs should be paired with a W16-7P diagonal downward arrow plaque:



Prohibited Signs

IA-21 Condition 2

Except for crosswalks in roundabouts, RRFBs shall not be used for crosswalks controlled by YIELD signs, STOP signs, traffic control signals or pedestrian hybrid beacons.



R1-1 stop sign



R1-2 yield sign



Above: Pedestrian hybrid beacon

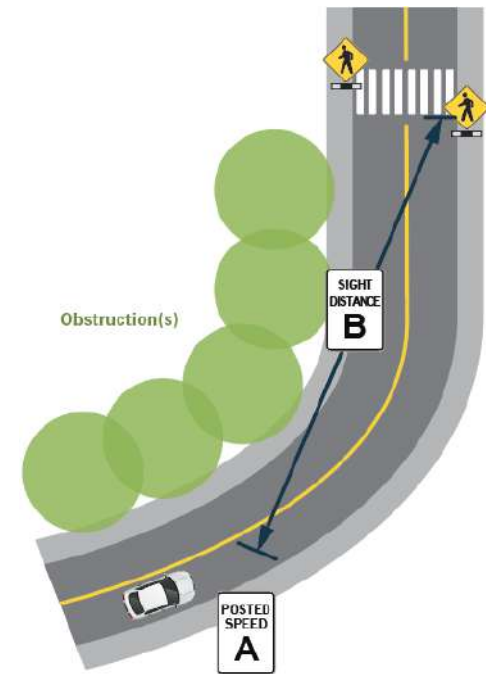


Advance Signs

IA-21 Condition 2

If driver sight distance approaching the crosswalk is low, an additional RRFB may be installed on that approach in advance of the crosswalk. This advance RRFB is supplemental and cannot replace the RRFBs at the crosswalk.

Here are three examples showing when an advance RRFB is recommended to improve visibility of an upcoming crosswalk.



Posted speed (MPH)	Stopping sight distance (ft)
15	70
20	90
25	115
30	140
35	165
≤40	195

	A (posted speed, mph)	B (sight distance to crosswalk, ft)	Recommended stopping sight distance (ft)	Advance RRFB
Example #1	25	70	115	Recommended
Example #2	35	180	165	Optional
Example #3	30	150	140	Recommended

Sources: Federal Highway Administration, [Interim Approval 21 – Rectangular Rapid-Flashing Beacons at Crosswalks](#);

AASHTO, [A Policy on Geometric Design of Highways and Streets](#), Chapter 9-33 Uncontrolled Intersections



Advance Signs

IA-21 Condition 2

An advance RRFB should supplement the W11-2 (pedestrian), S1-1 (school), or W11-15 (trail) with an AHEAD (W16-9P) or distance (W16-2P or W16-2aP) plaque.



W16-9P AHEAD
plaque



W16-2P distance
plaque



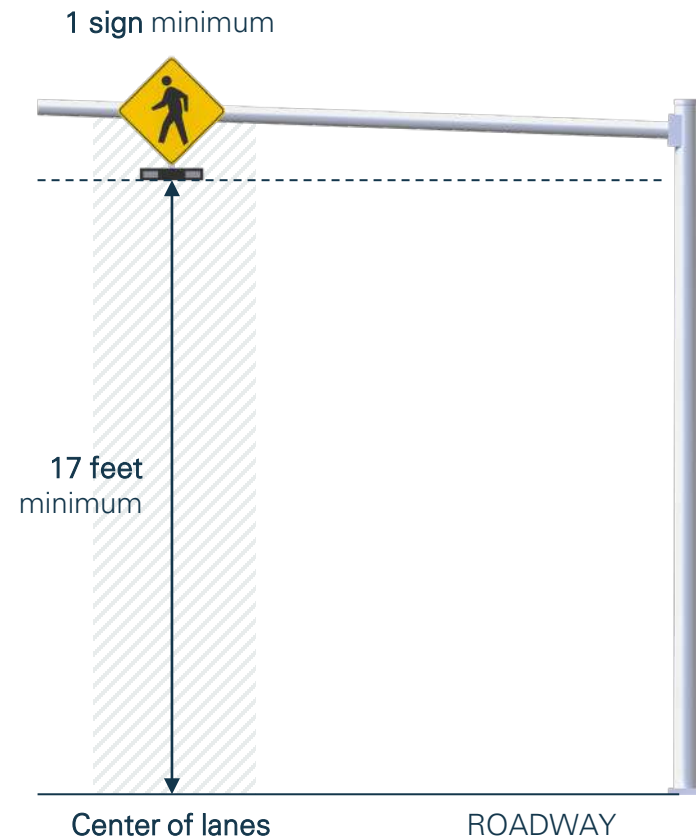
Overhead Signs

MUTCD 2A.18.14

Overhead signs shall provide a vertical clearance of not less than **17 feet to the sign**, light fixture, or sign bridge over the entire width of the pavement and shoulders except where the structure on which the overhead signs are to be mounted or other structures along the roadway near the sign structure have a lesser vertical clearance.

FHWA Interpretation Letter 4-376(I)

- A minimum of one overhead sign and RRFB system per approach is required.
- The sign and RRFB unit should be located over the approximate center of the lanes or where optimum visibility can be achieved.
- No diagonal arrow plaque is required.



Source: FHWA Manual of Uniform Traffic Control Devices, [Chapter 2A](#)

FHWA Interpretation Letter 4-376(I), [RRFB Overhead Mounting](#)

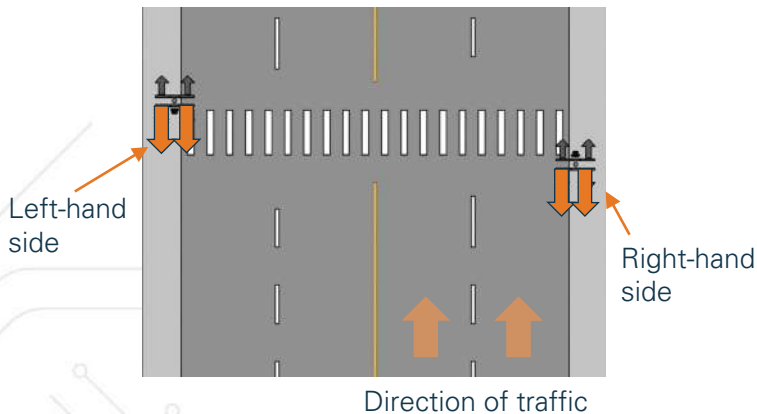


Sign and Beacon Assembly Locations

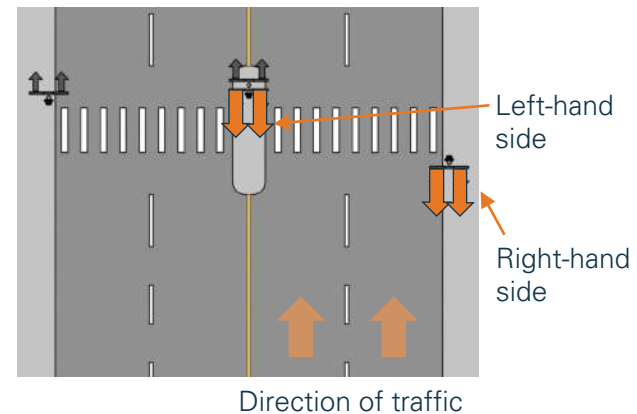
IA-21 Condition 3

For any approach where RRFBs are used to supplement post-mounted signs, at least two W11-2, S1-1, or W11-15 crossing signs (each with an RRFB unit and a W16-7P plaque) shall be installed at the crosswalk.

For non-divided roadways, one shall be installed on the right-hand side of the roadway and one on the left-hand side.



For divided roadways, the left-hand side should be installed on the median if practical.



Sign and Beacon Assembly Locations

IA-21 Condition 3

RRFBs shall not be installed independently of the crossing warning signs.

For post-mounted signs, they should be installed on the same support as the crossing warning signage.



For overhead-mounted sign, they should be mounted directly below the bottom of the sign.

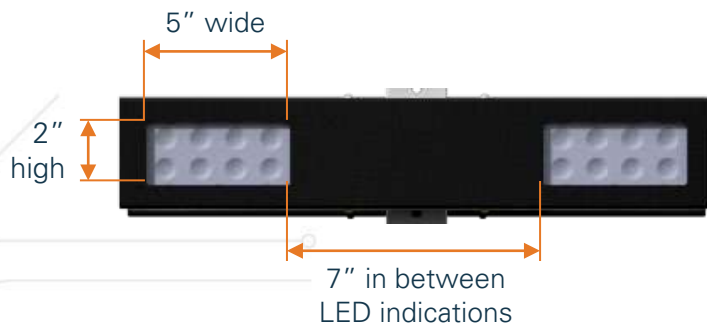


Beacon Dimensions

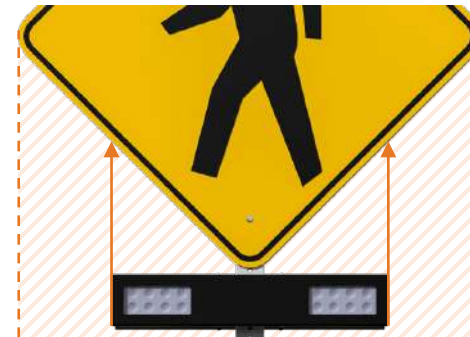
IA-21 Condition 4

RRFBs shall consist of two rectangular-shaped yellow indications each with an LED-array-based light source.

Each RRFB indication shall be a minimum of 5 inches wide by 2 inches high and aligned horizontally with a minimum space of 7 inches in between.



The outside edges of the RRFB indications shall not project beyond the outside edges of the crossing warning sign it supplements.



Outside edges must remain within edges of warning sign



Beacon Mounting

IA-21 Condition 4

An RRFB supplementing a post-mounted sign and plaque may be mounted either directly below the crossing warning sign (and above the plaque) or within 12 inches above it.

Evidence:

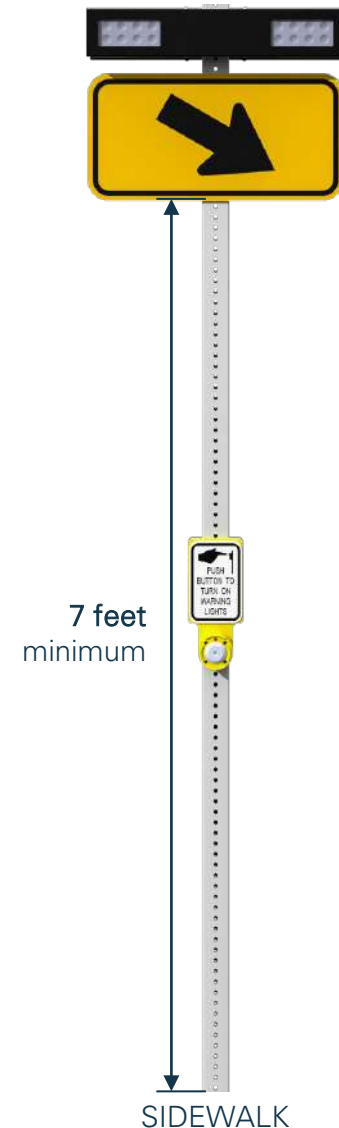
- [FHWA-HRT-16-040](#)
 - Open-road study investigating driver yielding when the beacons were located above and below the warning sign at 13 sites
 - Results indicated that any differences between the above and below positions were minor and statistically insignificant.
 - “The position of the yellow RRFB did not have an impact on whether a driver decided to yield to the waiting pedestrians.”



Sign Mounting

MUTCD Chapter 2A.18.07-08

The W16-7P plaque shall be mounted below the crossing sign and the RRFB light bar at a minimum of 7 feet from the bottom of the plaque to the sidewalk.



Source: FHWA Manual of Uniform Traffic Control Devices, [MUTCD 2A.18.07-08](#)



Beacon Flashing

IA-21 Condition 5

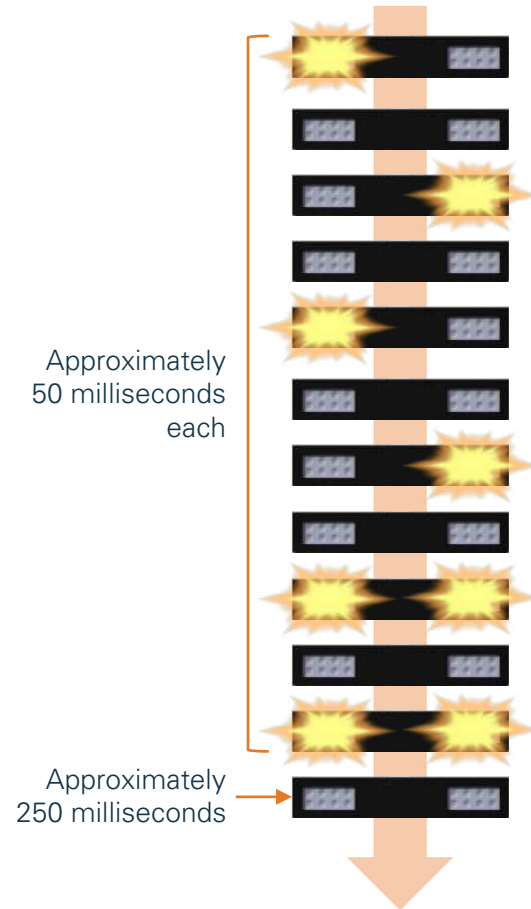
When activated, all RRFB units at the crossing shall flash in sync using a wig-wag plus simultaneous flash pattern (WW+S).

Daytime light intensity shall meet the minimum specifications for **Class 1 yellow peak luminous intensity in the Society of Automotive Engineers (SAE) Standard J595:**

- 600 candela (cd) minimum measured at horizontal and vertical angle of 0 degrees

Light intensity must dim automatically at night to minimize excessive glare.

WW+S flash pattern order



Beacon Flashing Length

IA-21 Condition 6

The duration of the predetermined flash period should be based on the procedures of Section 4E.06 of the MUTCD.

MUTCD 4E.06.14

The total of the walk interval and pedestrian clearance time should be sufficient to allow a pedestrian crossing in the crosswalk who left the pedestrian detector to travel at a walking speed of 3 feet per second to the far side of the traveled way being crossed.

MUTCD 4E.06.10

Where pedestrians who walk slower than 3.5 feet per second or who use wheelchairs routinely use the crosswalk, a walking speed of less than 3.5 feet per second should be considered in determining the pedestrian clearance time.

Beacons should flash at the duration of a pedestrian walking speed of approximately 3 ft/s crossing the length of the crosswalk



Beacon Operation

IA-21 Condition 6

If pedestrian pushbutton detectors are used, a Push Button To Turn On Warning Lights (R10-25) sign shall be installed explaining the purpose and use of the pushbutton.

For ADA compliance, the pushbutton shall be installed at a height of approximately 3.5 feet and no higher than 4 feet.



R10-25 pushbutton sign



ADA Compliance:
3.5 feet
(no higher than 4 feet)



Pedestrian Detection

Various pedestrian detection methods are available for RRFBs.

Standard pushbutton detector (audible tone and LED indicator)



Accessible Pedestrian Signal (APS) audible pushbutton



IA-21 Condition 7

If a speech pushbutton message is used, a locator tone shall be provided, shall not use vibrotactile indications, and should speak "Yellow lights are flashing" twice.

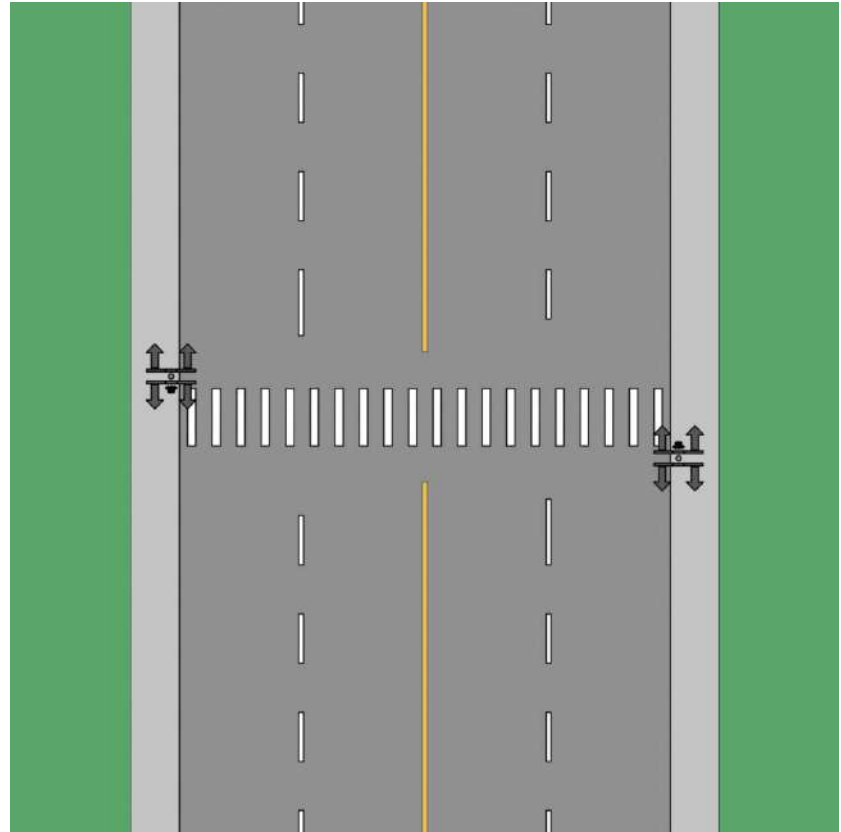
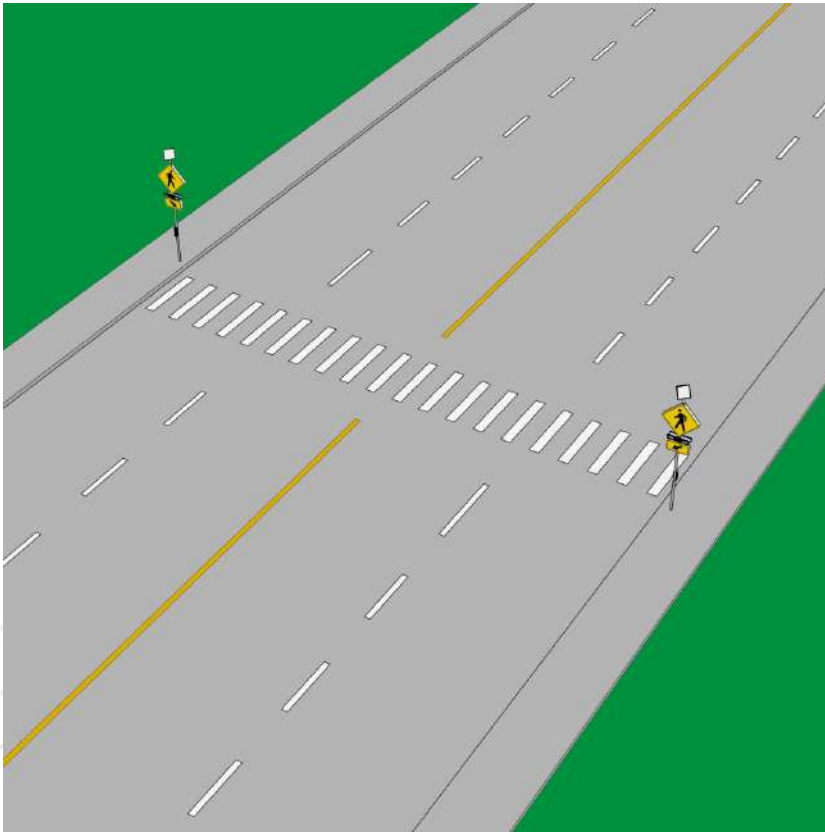
Passive pedestrian microwave detector



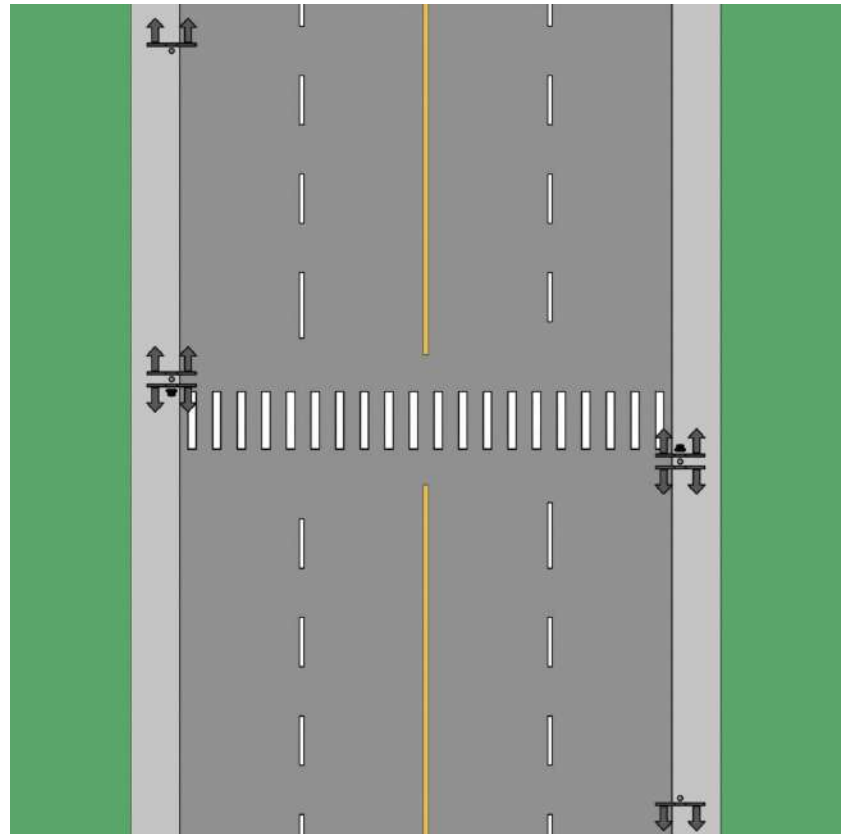
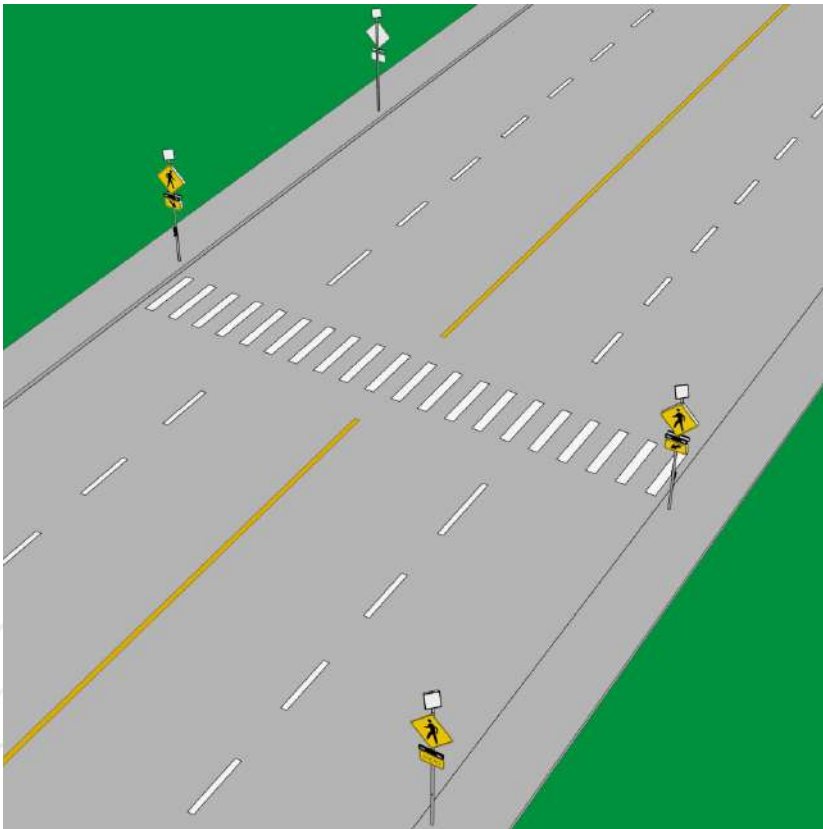
RRFB Installation Examples



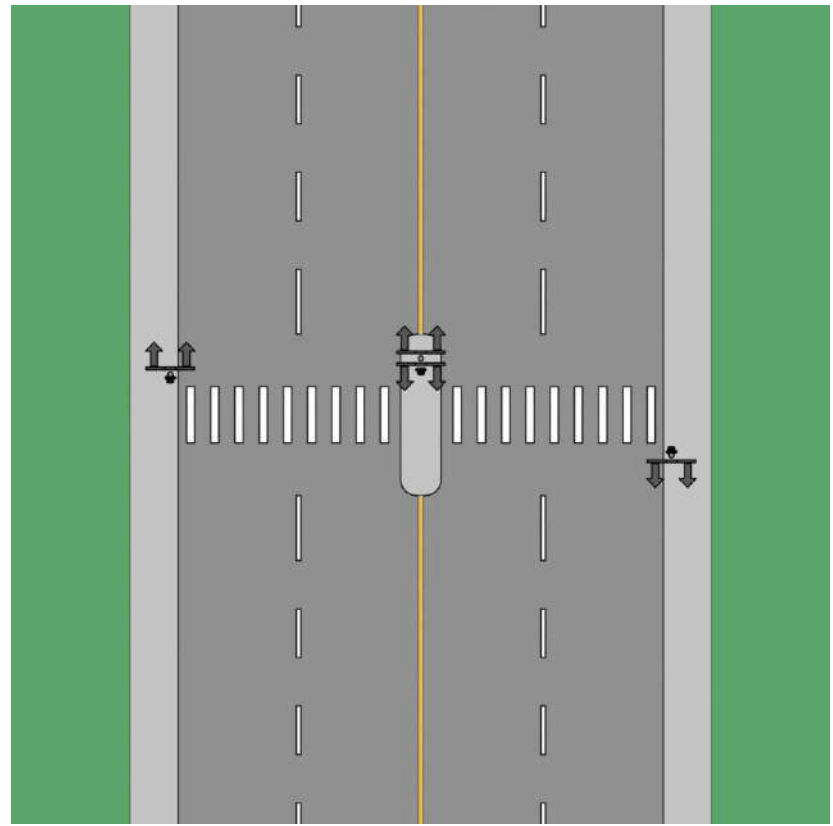
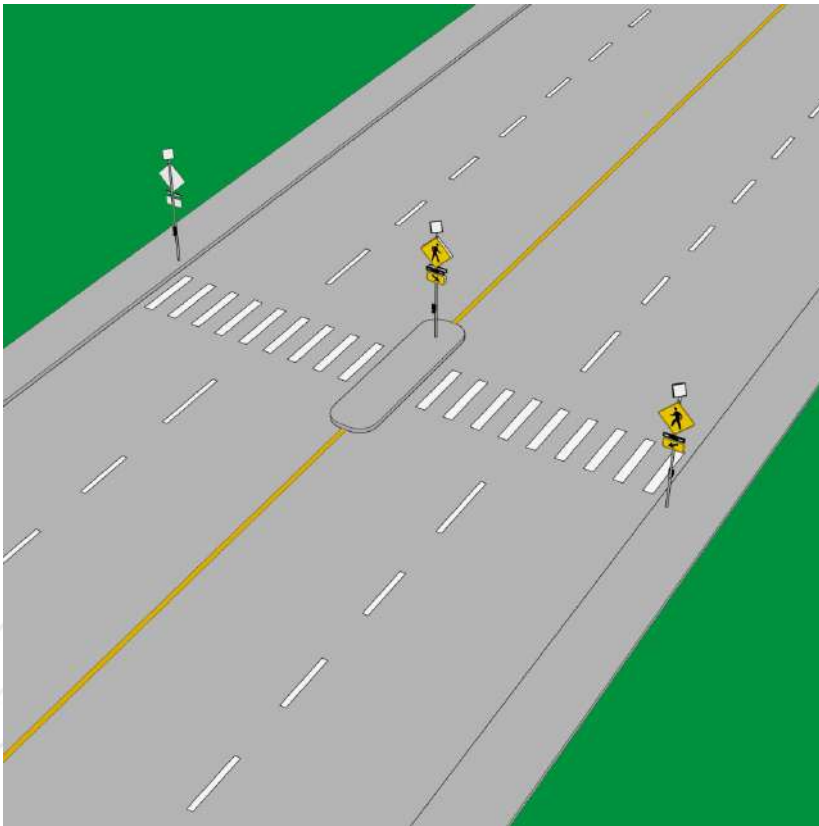
Standard Two-Way Road



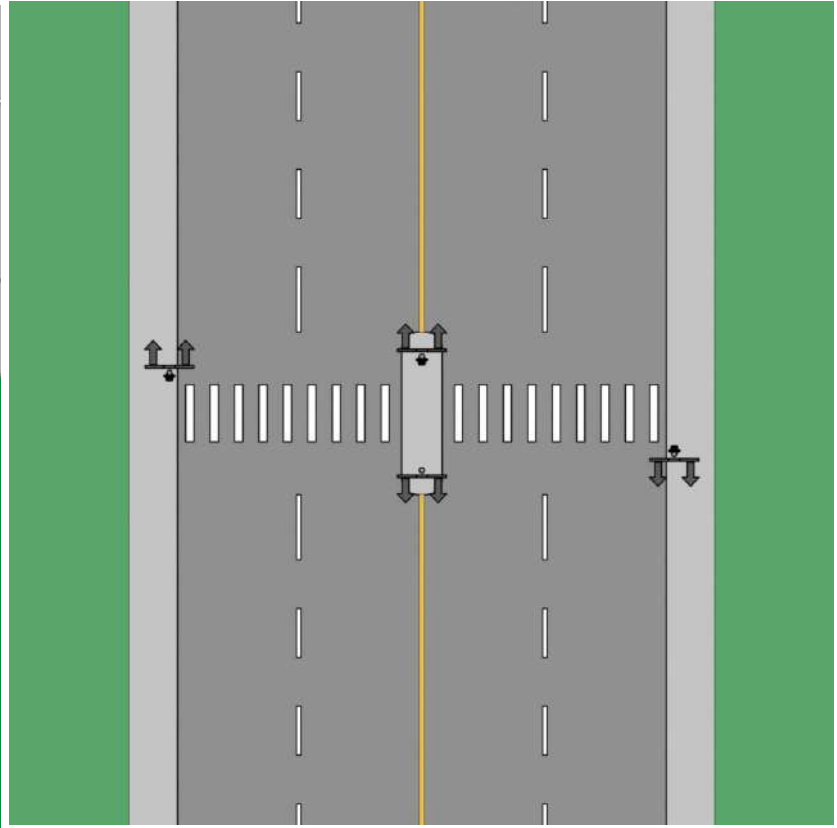
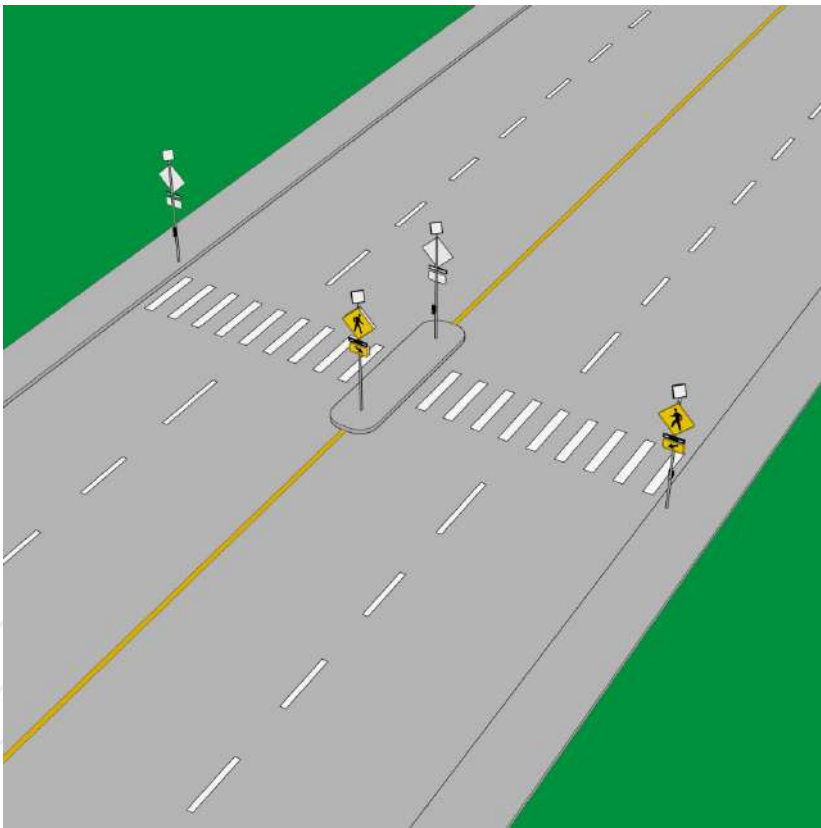
Advance Two-Way Road



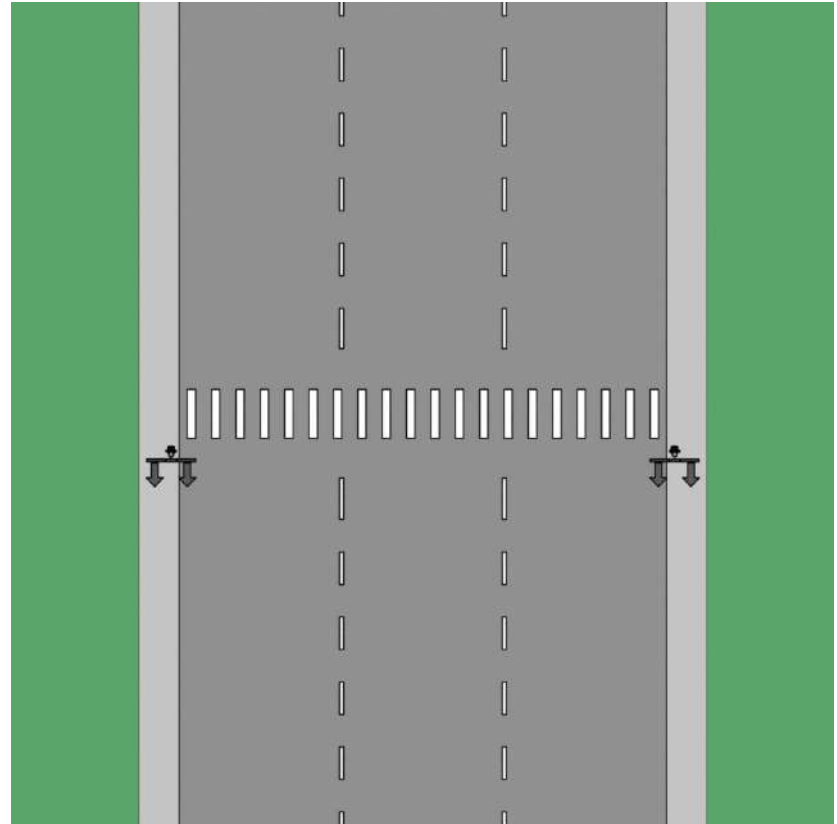
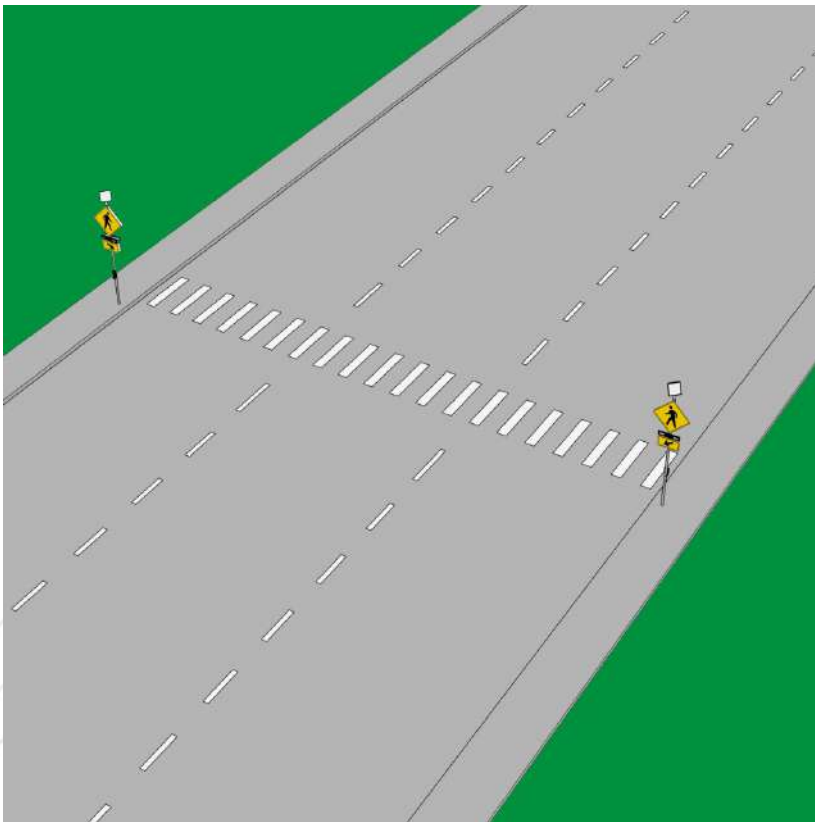
Median Two-Way Road



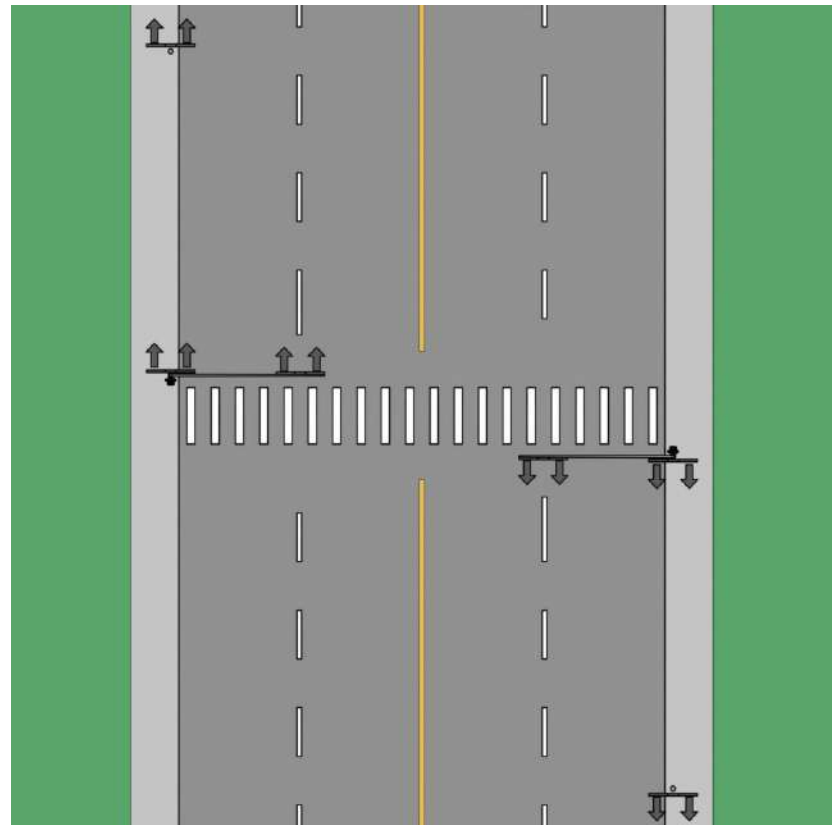
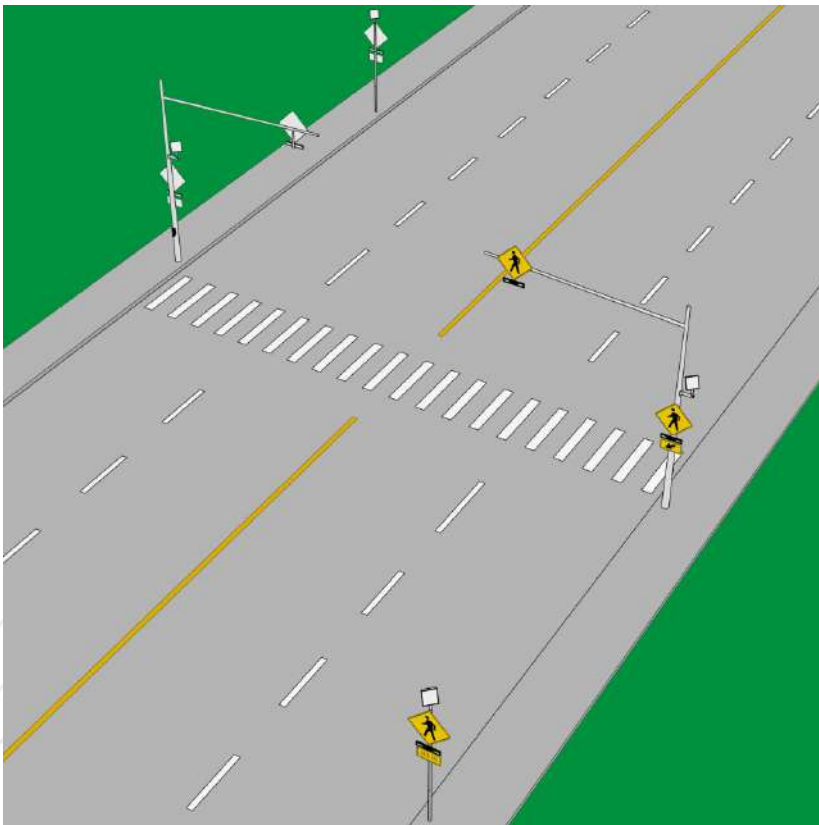
Two-Pole Median Two-Way Road



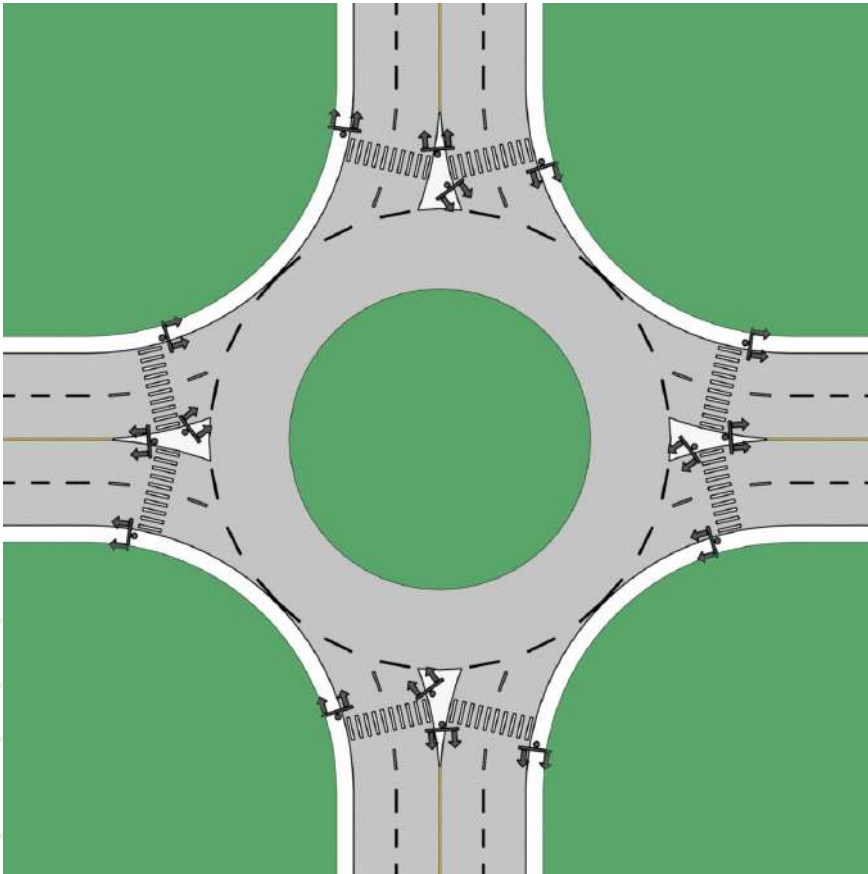
Standard One-Way Road



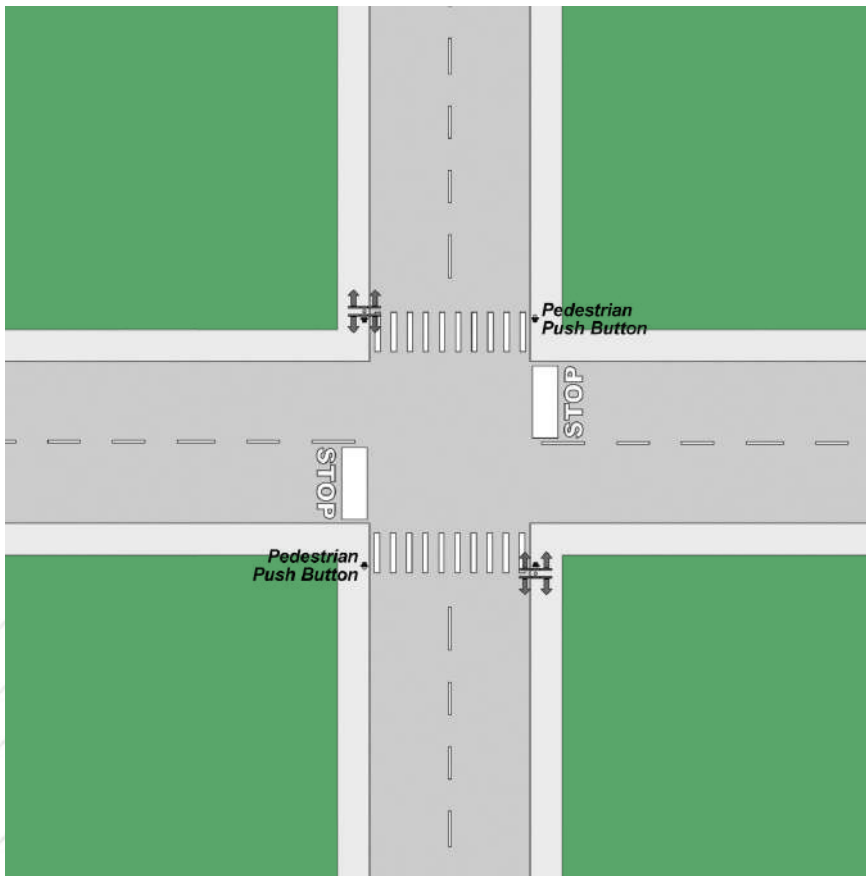
Overhead Two-Way Road



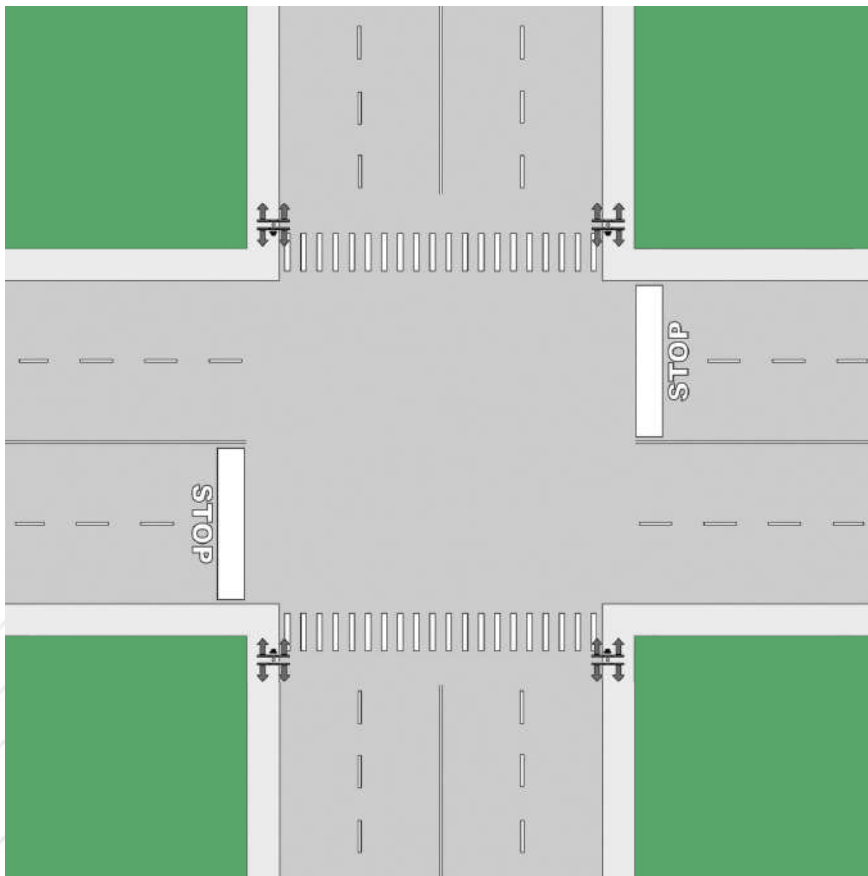
Roundabout



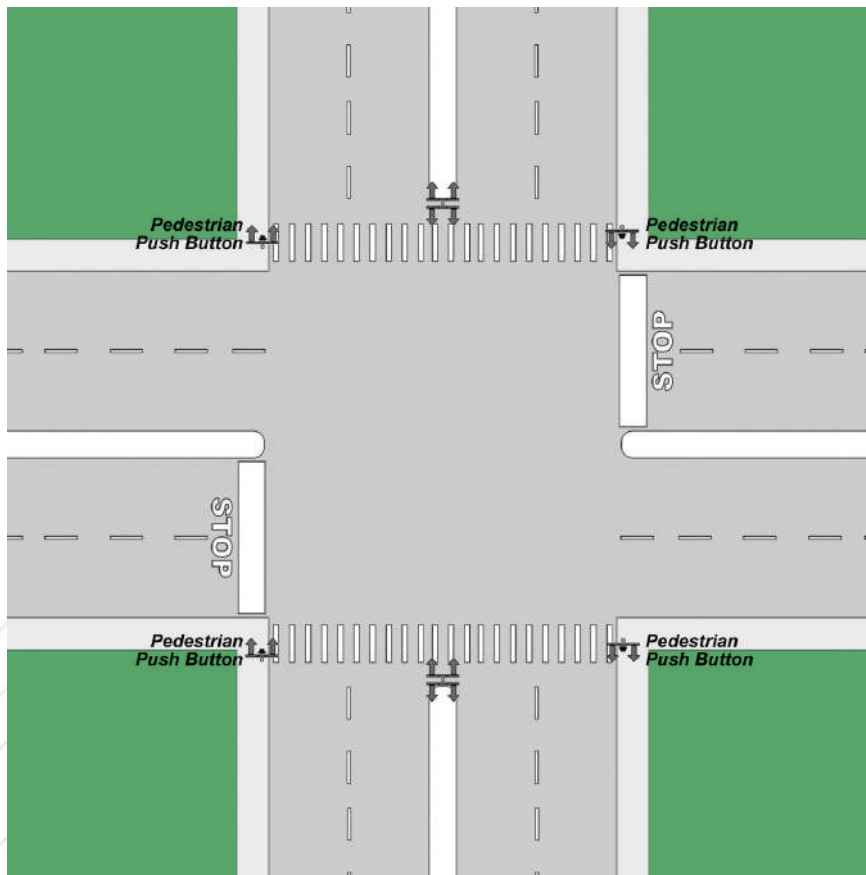
Two-Pole Parallel Crosswalk



Four-Pole Parallel Crosswalk



Four-Pole Parallel Crosswalk with Median



RRFB Equipment Options



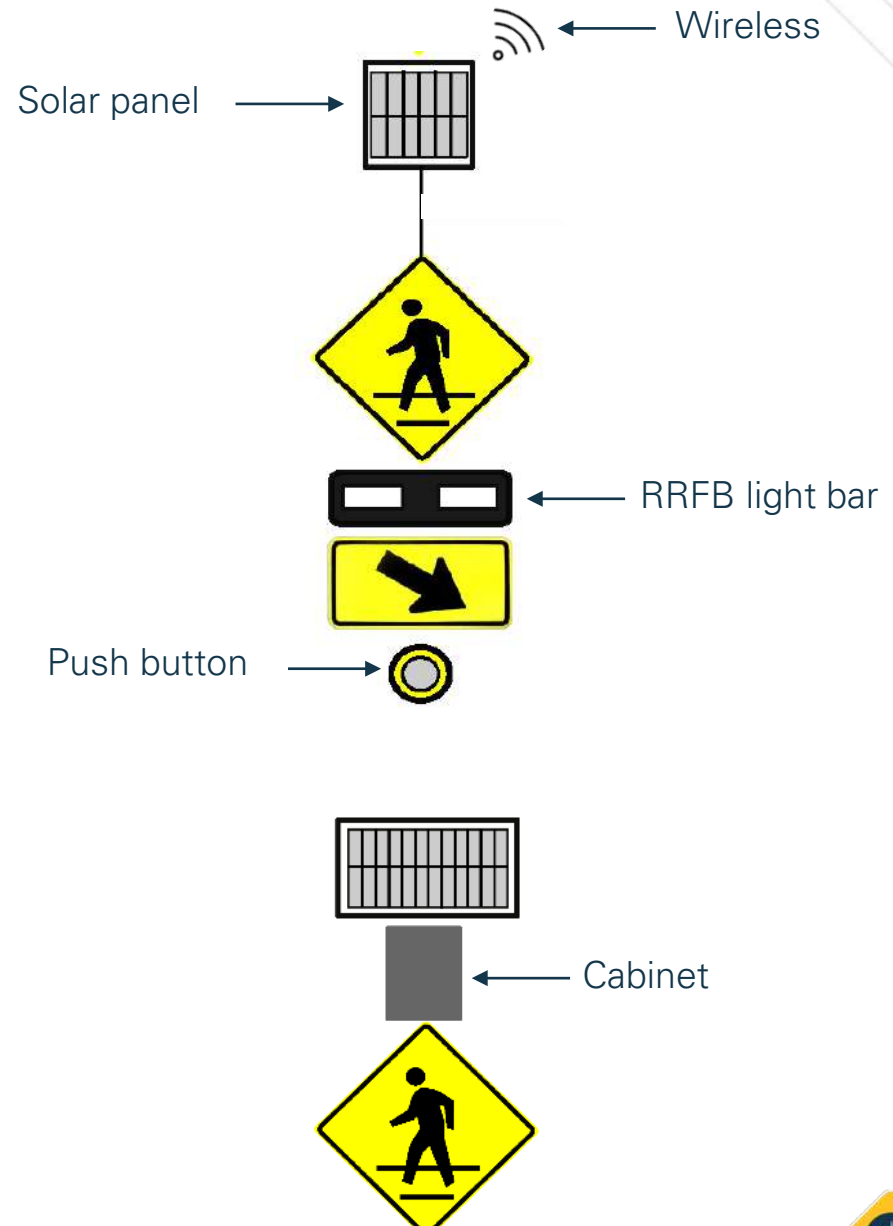
Equipment Options

Based on Carmanah RRFB models:

- [R920-E](#)
- [R920-F](#)
- [SC315-G](#)

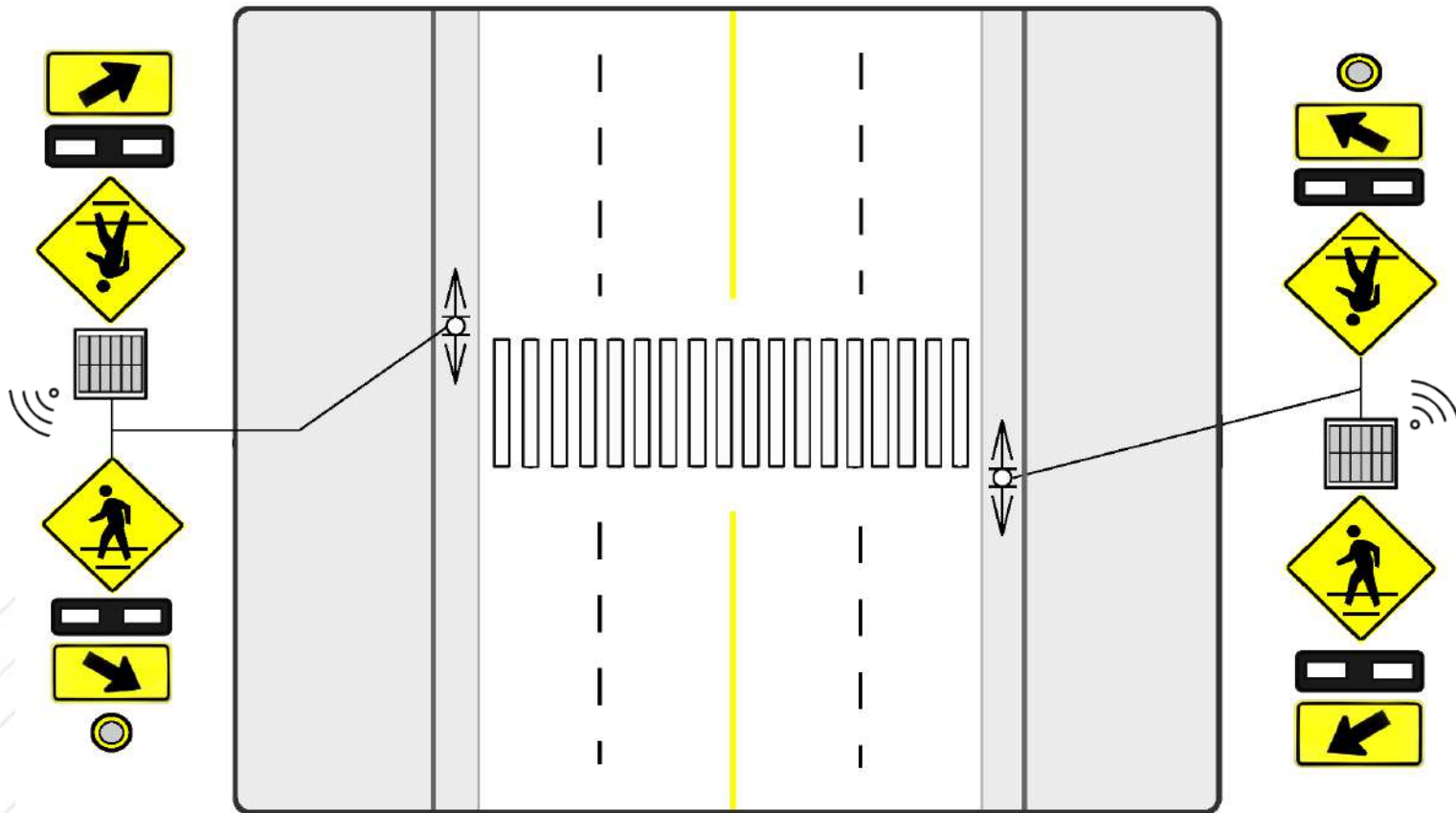
Provides options for:

- Built-in wireless functionality, or
- Trenching some or all of wiring



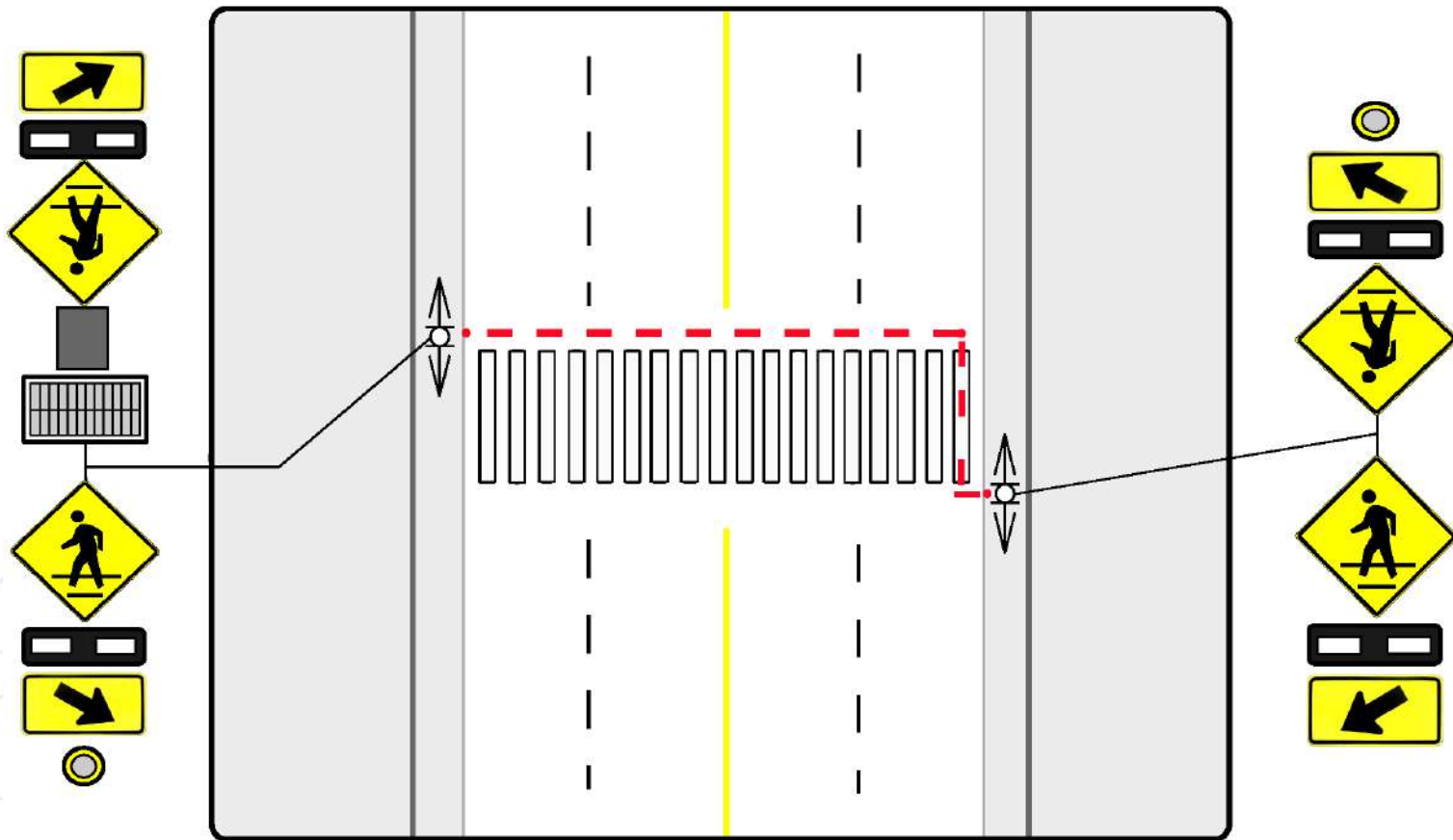
Standard Two-Way Road

Solar-powered with wireless communication



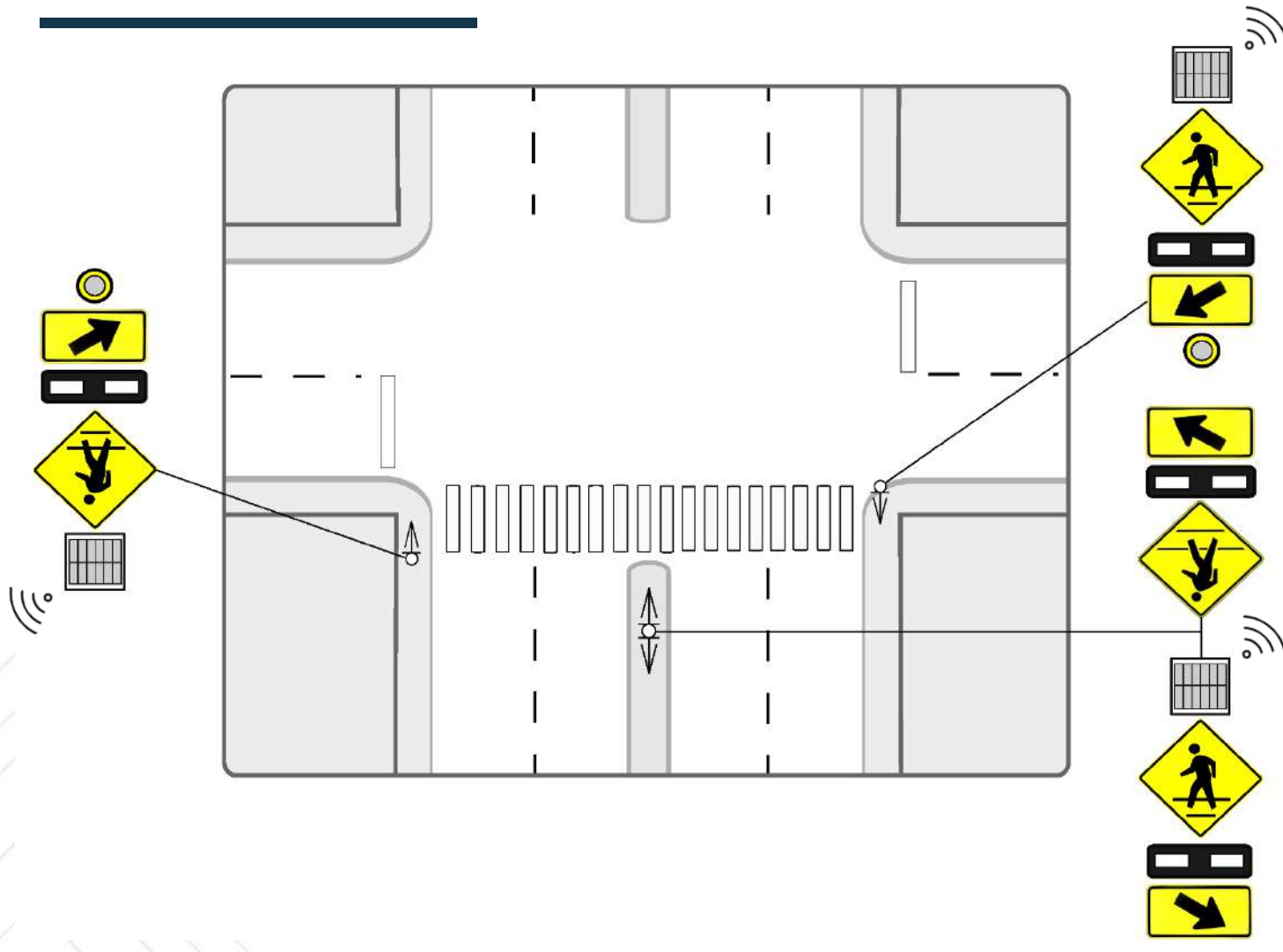
Standard Two-Way Road

Solar-powered with hardwiring



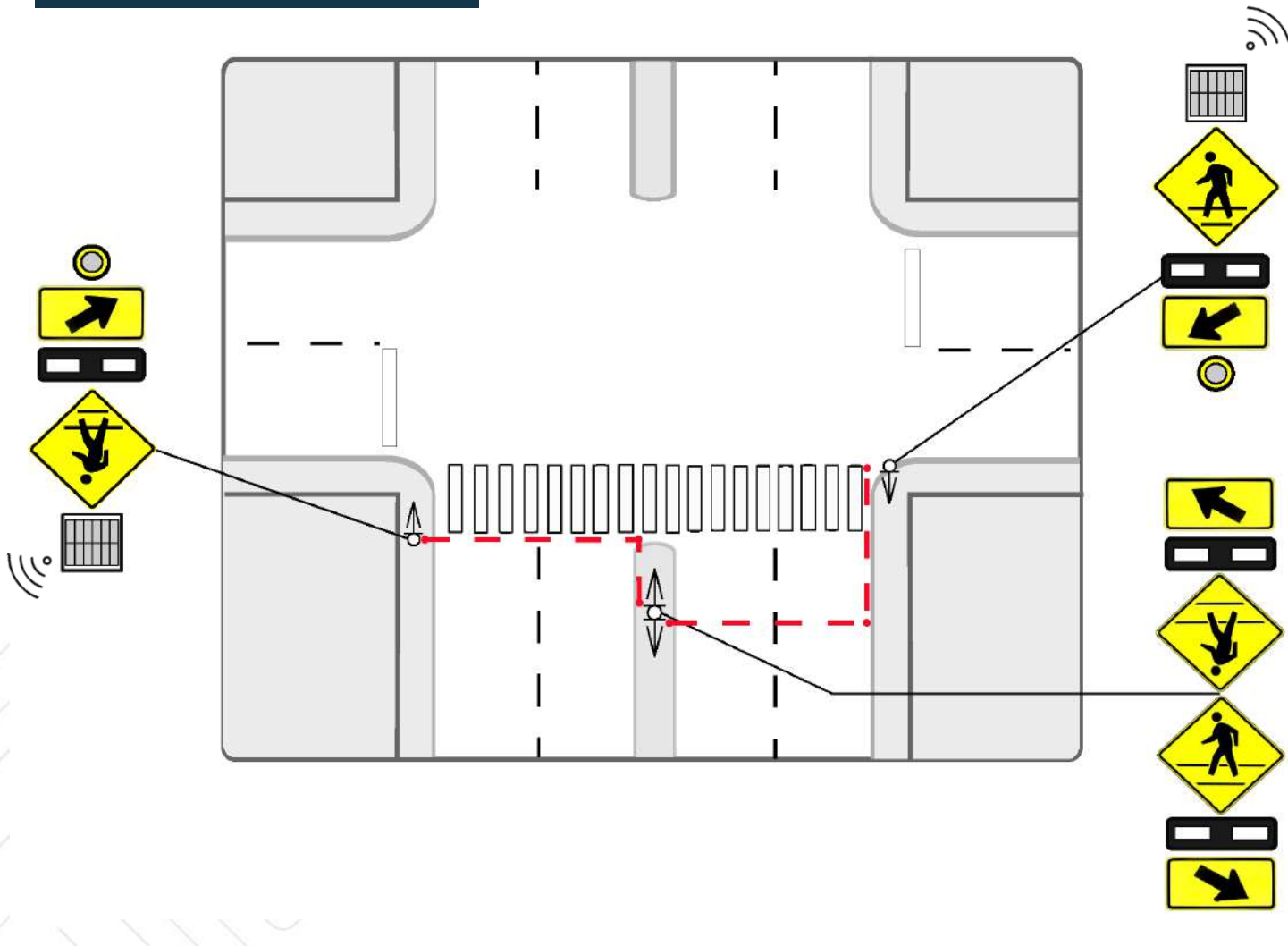
Median Two-Way Road

Solar-powered with wireless communication



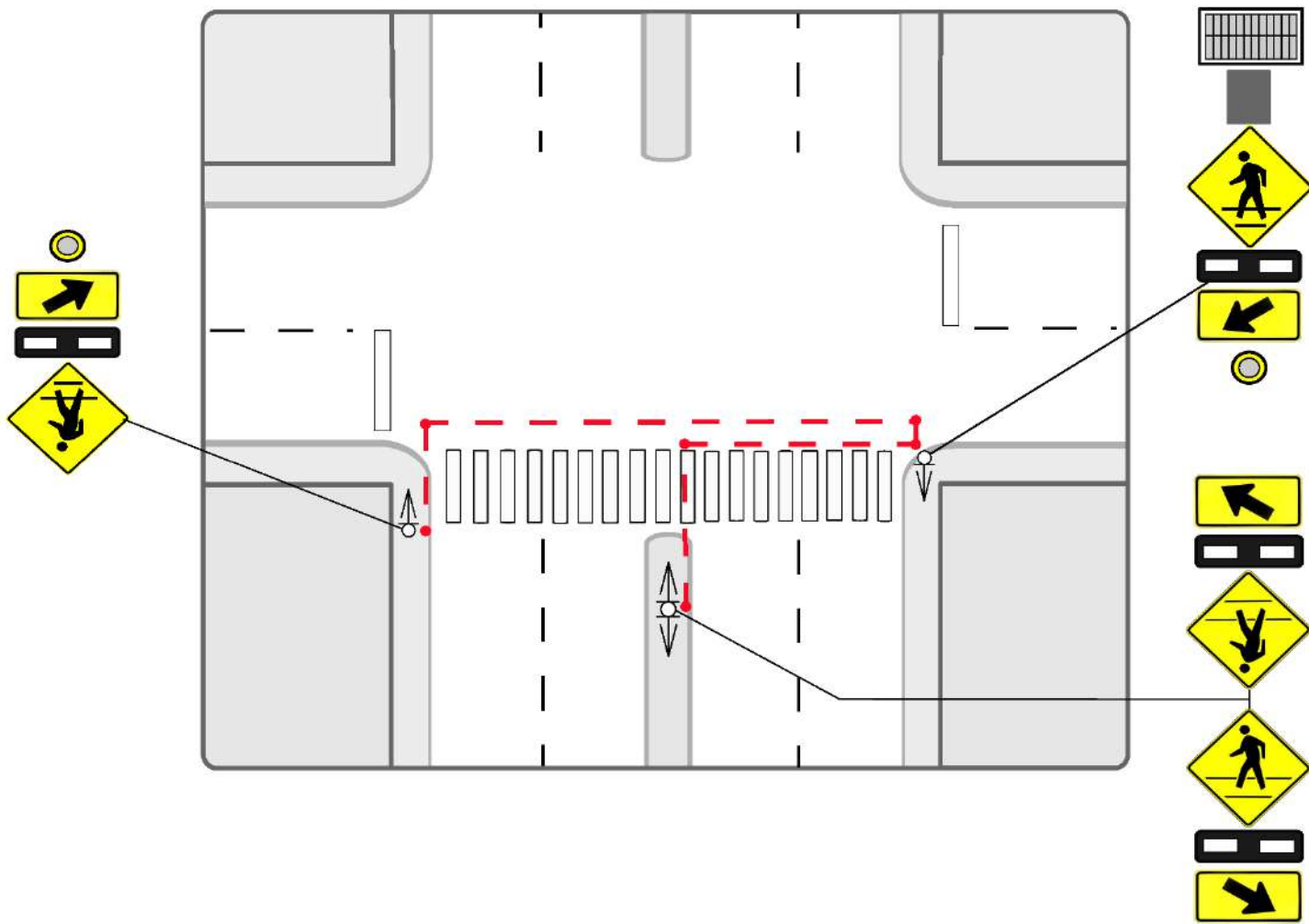
Median Two-Way Road

Solar-powered with wireless and partial hardwiring



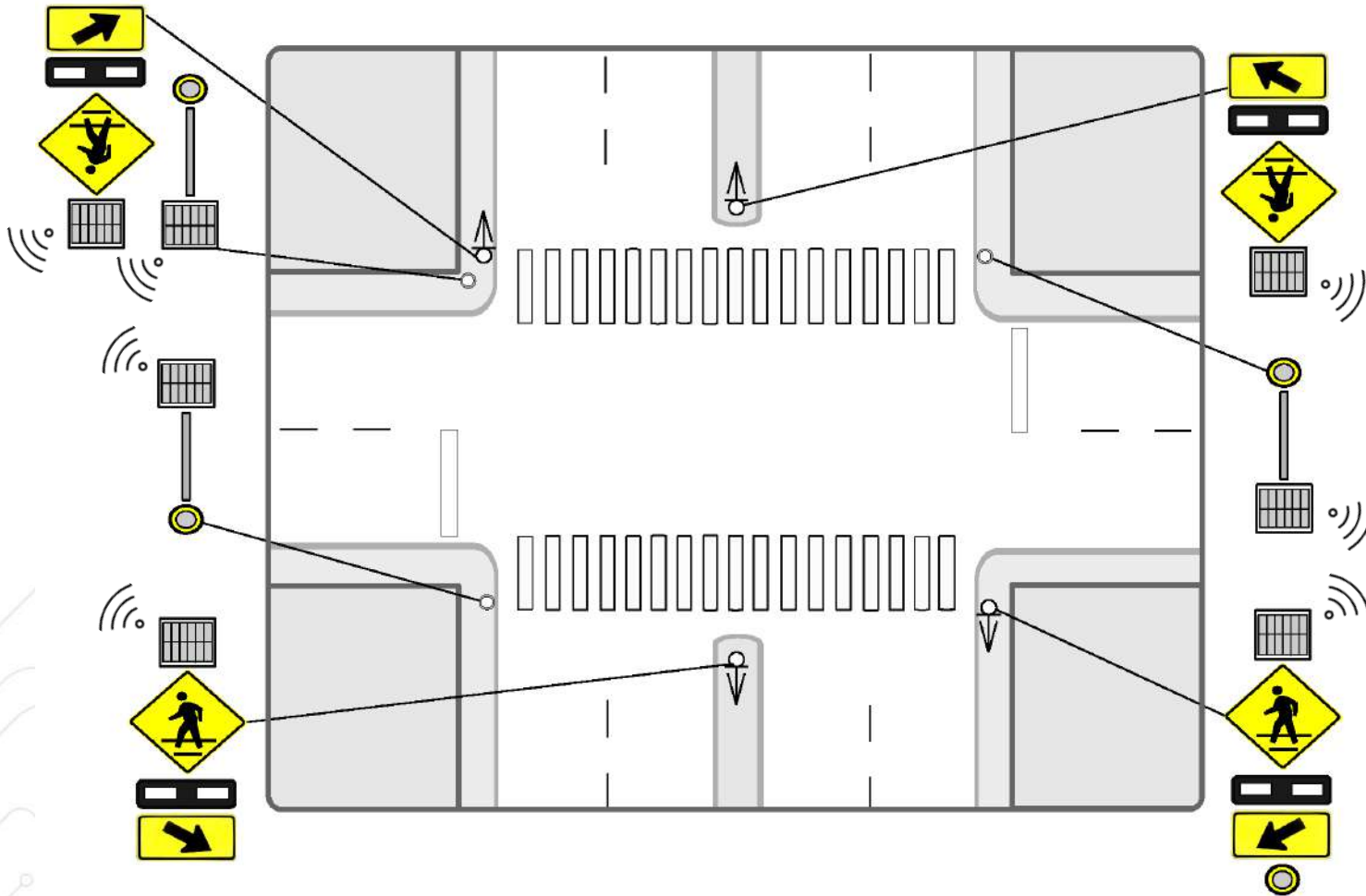
Median Two-Way Road

Solar-powered with hardwiring



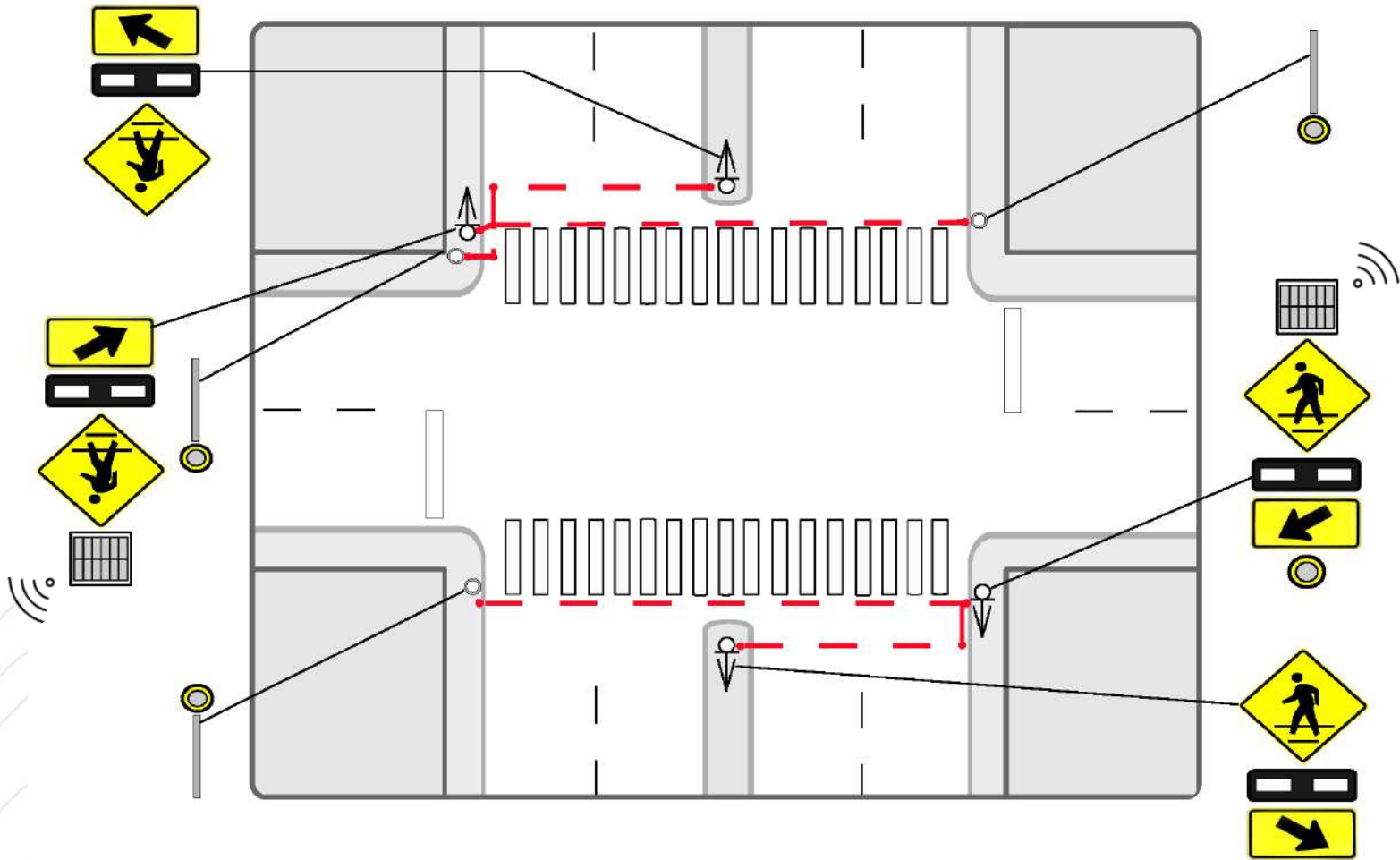
Parallel Crosswalk with Median

Solar-powered with wireless communication



Parallel Crosswalk with Median

Solar-powered with wireless and partial hardwiring



Resources

Learn more:

- [Rectangular Rapid Flashing Beacons](#)
- [School Zone Safety: Rectangular Rapid Flashing Beacons](#)
(6 min. video)

Stay connected with us!



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1-844-412-8395 toll-free

