Texas Department of Transportation

MAY 2025

INNOVATIVE INTERSECTIONS DESIGN AIDS

Reduced Conflict U-Turn Intersections

OVERVIEW

As an extension of TxDOT's Roadway Design Manual Chapter 14, this aid provides designers with both geometric and non-geometric design guidance for Reduced Conflict U-Turn Intersections. Reduced Conflict U-Turn (RCUT) Intersections, also known as J-Turns and Reduced Conflict Intersections (RCI), eliminate direct left and thru movements from one of the intersecting roads, typically the minor road. Redirected traffic makes a right-turn followed by a nearby U-Turn in order to complete the through and left turning movements. RCUTs can be signalized, stop-controlled, or yield-controlled.

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Source: Google Earth


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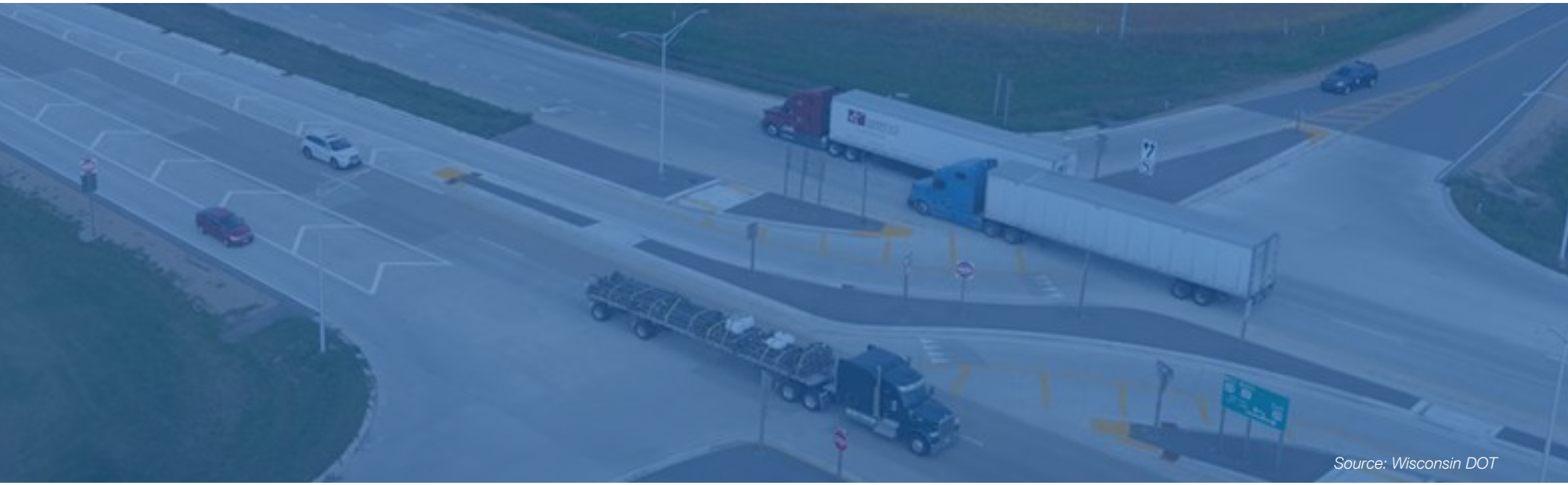
Source: Wisconsin DOT

FIGURES

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RCUTs are applicable in the following situations:

- Roadways with median widths larger than 40 feet or with available locations for U-turns
- Roadways with partial or limited access control
- Intersections with a documented history of crashes, particularly angle crashes
- Along congested corridors where there is a desire to reduce the number of signalized intersections and/or driveways. Roundabouts can provide the U-turn opportunity to mitigate loss of full movement access to developments along a corridor.

A key consideration in evaluating an existing intersection as a possible location for an RCUT is the proximity of U-turn crossovers. Experience has shown that drivers have problems with RCUTs when they cannot see the location for the U-turn. Having visibility of the U-turn opportunity is an important consideration for driver acceptance and compliance. In this design aid, alternative geometries that provide for close proximity of the U-turn opportunity are presented and contrasted with U-turn location designs that are distant from the RCUT to accommodate acceleration and deceleration requirements associated with high-speed installations.

SAFETY CONSIDERATIONS OF A REDUCED CONFLICT U-TURN INTERSECTION

Compared to a traditional intersection, RCUTs reduce the number of conflict points from 32 to 14, shown in **Figure 1** from the FHWA RCUT Informational Guide. Research suggests that RCUTs reduce the number of fatal and serious injury crashes, especially fatal and serious injury angle crashes.

Drivers who are unfamiliar with RCUTs may experience confusion when approaching the intersection. Drivers typically expect to turn left at the intersection when coming from the minor road intending to make a left turn. Proper channelization and signage can help to reduce some of the uncertainty that arises when driver's expectations are not met.

The geometry of an RCUT can result in longer pedestrian crossing distances than a traditional intersection. The inclusion of pedestrian refuge areas can help to mitigate some of these safety concerns.

Exhibit 4-1. Conflict point comparison.

Number of Intersection Legs	Conflict Points	
	Conventional	RCUT
3	9	7
4	32	14

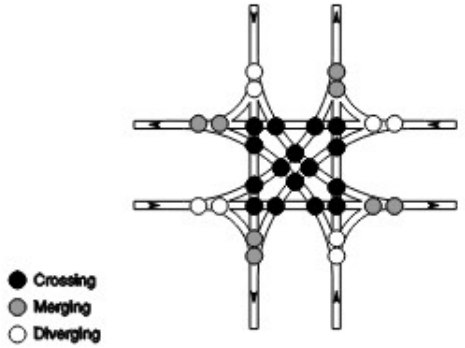


Exhibit 4-2. Vehicular conflict points at a four-approach conventional intersection.

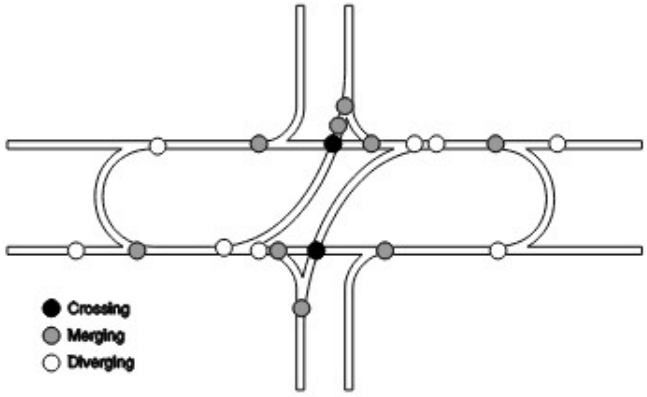


Exhibit 4-3. Vehicular conflict points at a four-approach RCUT intersection.

» **FIGURE 1 –** RCUT Conflict Points (Source: FHWA RCUT Informational Guide Exhibits 4-1, 4-2, and 4-3)

WHEN TO CONSIDER AN RCUT AND WHEN TO SIGNALIZE AN RCUT

As seen in **Figure 2**, an unsignalized RCUT is feasible for a one-lane approach roadway that has an ADT of less than 5,000 VPD. RCUTs with minor streets of two-lanes or more should always be signalized (6). A Signalized RCUT is feasible for a minor street demand of less than 25,000 vehicles per day.

» **FIGURE 2 –** Application of Unsignalized and Signalized RCUTs
(Source: FHWA Restricted Crossing U-Turn Intersection Informational Guide (1)

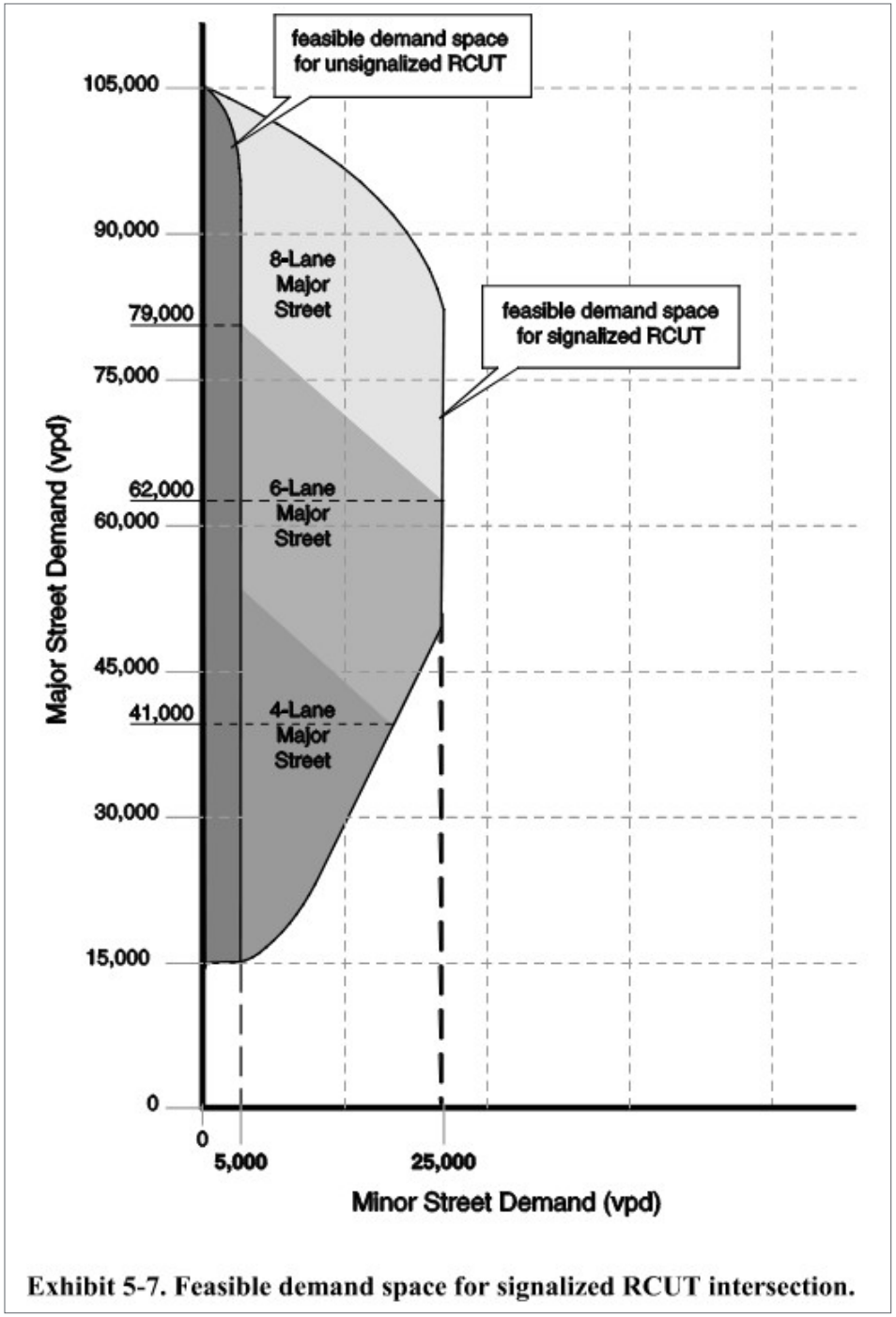


Exhibit 5-7. Feasible demand space for signalized RCUT intersection.

Feasibility of RCUTS includes the following considerations:

- The RCUT intersection should be considered when there is a high through and left-turning volume on the major approach while the minor approach through and left-turning volumes are relatively low. This configuration avoids a fully signalized intersection and both directions of the roadway can operate independently of each other.
- At an RCUT intersection with a high volume of left-turning traffic from the major street, the signal warrant analysis may be performed in a manner that considers the higher of the major-street left-turn volumes as the "minor-street" volume and the corresponding single direction of opposing traffic on the major street as the "major-street" [1]volume. Signalized RCUTs reduce some of the challenges associated with left-turn gap acceptance and pedestrian crossings.
- A frequent application of RCUTs is using them in conjunction with roundabouts along corridors with problematic driveway access. A roundabout may be placed at a primary interaction while the adjacent lower volume intersections or development driveways can function more safely using RCUTs. The roundabout provides the U-turn opportunity to mitigate loss of full movement access to developments along a corridor where it is necessary to divide the highway to reduce driveway related crashes.
- A key consideration in evaluating an existing intersection as a possible location for an RCUT is the proximity of U-turn crossovers. Experience has shown that drivers have problems with RCUTs when they cannot see the location for the U-turn. Having visibility of the U-turn opportunity is an important consideration for driver acceptance and compliance.
- Under conditions where there is not enough median width for a U-turning vehicle to make the turn fully within the existing pavement, the option of adding a dedicated area, such as a loon, for U-turning vehicles should be considered. The location of these loons in relation to the RCUT intersection is an important consideration in the alternative evaluation phase of a project.
- If a stop or yield controlled RCUT intersection operational analysis shows that sufficient gaps are not available for the driver to cross the mainline into the U-turn lane, the RCUT must be signalized or a non-compact RCUT layout must be used.

Table 1 outlines the design considerations required to determine the optimal RCUT configuration for an intersection. It represents the major decisions the planner must consider regarding traffic control and U-turn proximity.

[1]*MUTCD 11th Edition Page 692*

In this design aid, alternative geometries that provide for proximity of the U-turn opportunity are presented and contrasted with U-turn location designs that are distant from the RCUT to accommodate acceleration and deceleration requirements associated with high-speed installations. See **Figure 3** and **Figure 4** for further exploration of the spacing of the U-turn crossovers.

» **TABLE 1 –** RCUT Design Considerations

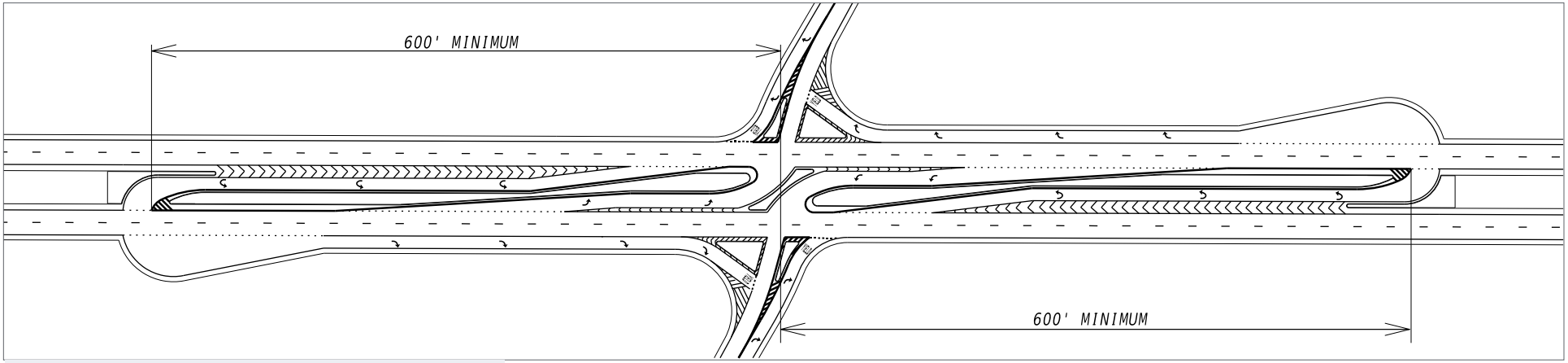
RCUT Design Considerations			
Design Variables	RCUT Traffic Control	Design Criteria	
	Signalized or Unsignalized	Signalized	◆ Minor Road > 5,000 VPD (**Figure 2**) ◆ Minor Road < 25,000 VPD (**Figure 2**) ◆ Minor Road is 2 entering lanes, e.g., dual rights (**Figure 8**)
		Unsignalized	◆ Minor Road < 5,000 VPD (**Figure 2**) ◆ Minor Road is 1 entering lane ◆ Feasibility of an additional free-flowing right-turn lane (**Figure 8**)
	Compact or Non-Compact	Compact U-Turn (Using Auxiliary Lanes for Acceleration/ Deceleration)	◆ Signalized Intersection ◆ Unsignalized Intersection with Availability of Gaps to Cross Mainline Lanes
		Non-Compact U-Turn	◆ Compact U-turn Criteria is Not Met
	High Speed or Low Speed	High Speed	◆ ≥ 50 mph (**Figure 5**)
		Low Speed	◆ < 50 mph (**Figure 6**)
	U-turn within Travel Way or U-turn Loon	U-Turn within travel way	◆ Median Width is Adequate for Design Vehicle to Make U-turn Movement (**Figure 11**) ◆ Number of U-turn Lanes
		U-turn Loon	◆ Median Width is Not Adequate for Design Vehicle to Make U-turn Movement (**Figure 11**) ◆ Areas with limited Right-of-Way

RCUT PERFORMANCE-BASED GEOMETRIC DESIGN PRINCIPLES

RCUT INTERSECTION OVERVIEW

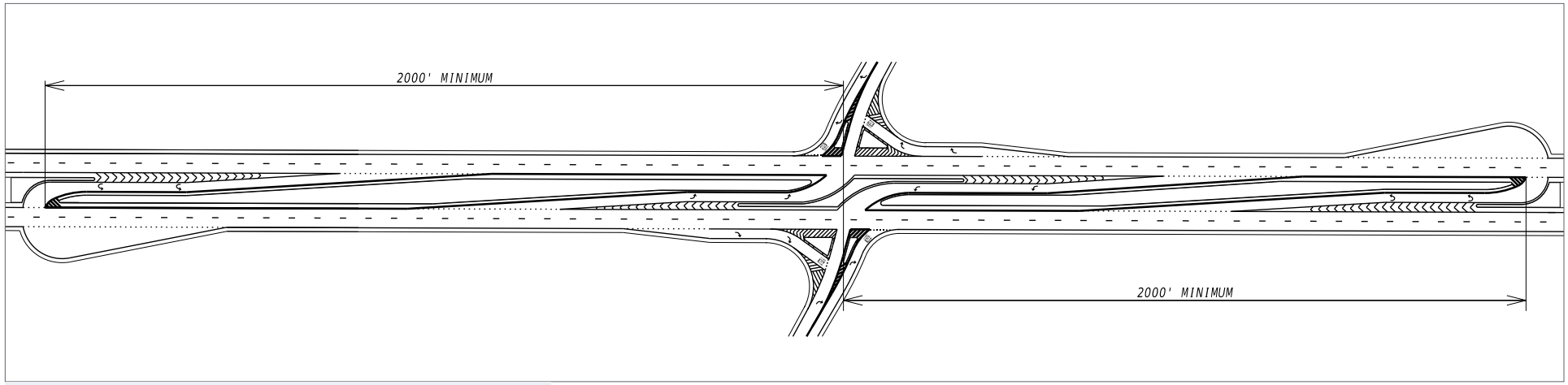
There are two distinct methods that can be used to determine the intersection geometry of an RCUT:

1. **Compact U-turn Concept:** Driver turning from the minor roadway chooses a gap they find acceptable to cross directly into the U-turn deceleration lane. This is the preferred method for signalized RCUTs because it allows the U-turn crossover to be closer to the intersection, typically 600 feet minimum from the intersection, as seen in **Figure 3**. In addition to this, designers have the option to extend the right-turn lanes to the U-turn loons so drivers intending to make the through movement on the minor roadway can enter the right-turn lane directly from the U-turn crossover. If a stop or yield controlled RCUT intersection operational analysis shows that sufficient gaps are not available for the driver to cross the mainline into the U-turn lane, the RCUT must be signalized or a non-compact RCUT layout must be used.



» **FIGURE 3 –** Compact U-turn Concept Overview

2. Non-Compact U-turn Concept (**Figure 4**): Driver merges into traffic from the minor roadway and makes a weaving maneuver to get into the U-turn lane. U-turn crossovers are located 2,000 feet or greater from the intersection with this method. The designer should account for acceleration (AASHTO Table 10-4 and 10-5), weaving, and deceleration distances as well as queue length when determining the spacing of the U-turns.



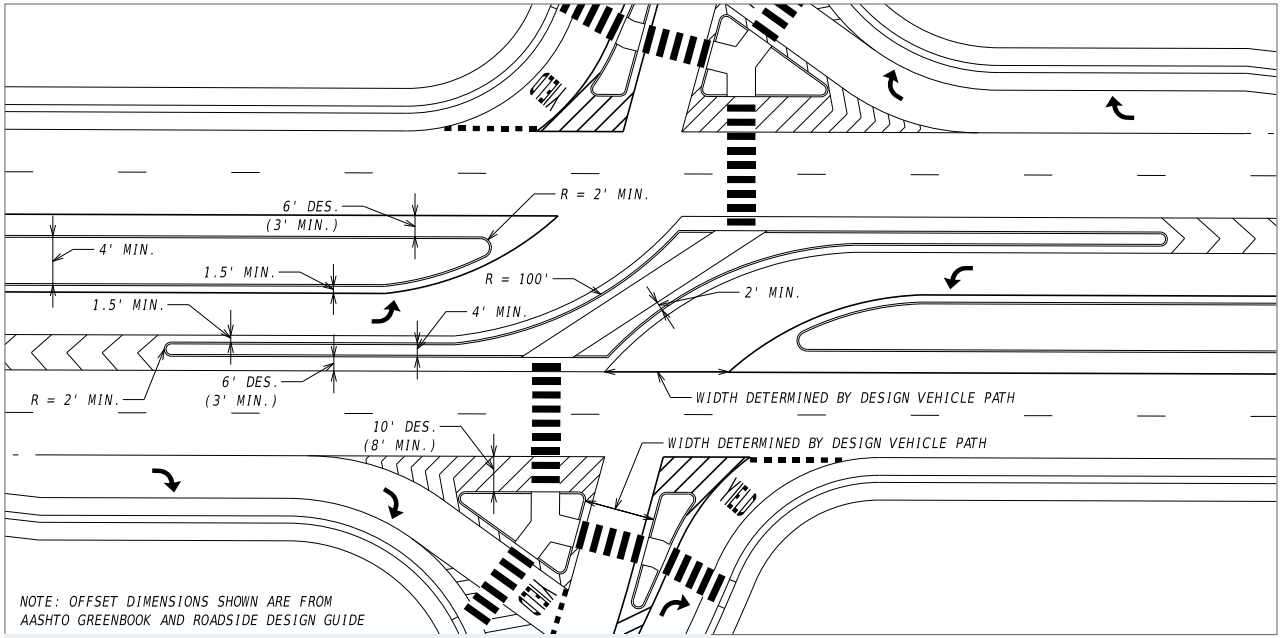
» **FIGURE 4 –** Non-Compact U-turn Concept Overview

Recommend offsetting the left turn lanes at an RCUT intersection can be beneficial for removing oncoming sight distance constraints and should be implemented when possible

RCUT INTERSECTION GEOMETRY

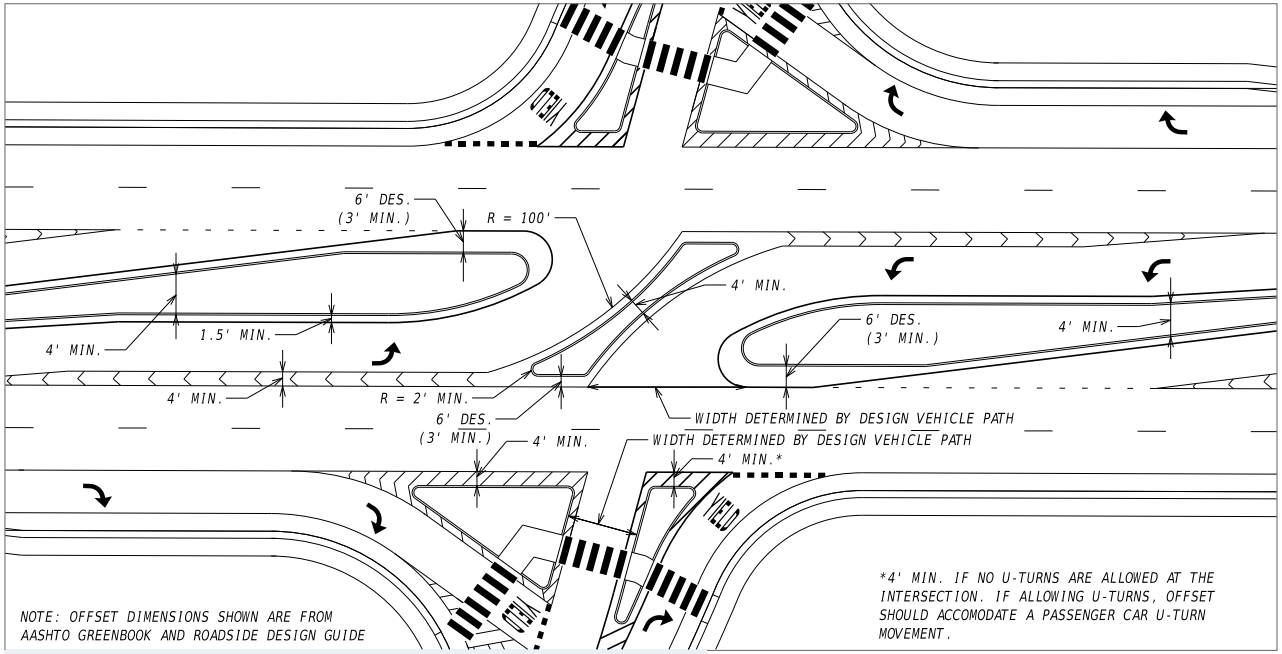
Figure 5 shows typical dimensions for the layout of an RCUT on a high-speed (greater than or equal to 50 mph) facility. Turning movement dimensions are subject to design vehicle swept path checks to ensure the design and check vehicle can safely navigate the intersection. If U-turn movements are allowed at the intersection, the movements should be checked with the NACTO DL-23 vehicle to confirm the offsets of the raised islands.

Extending the RCUT median to separate and channelize the left turning vehicles from the through moving vehicles on the mainline is desirable, but not always practical depending on the existing median width or required right-of-way. The raised medians should be 4-inches tall with a mountable curb in rural areas or as required by first responders. The left turn should be aligned with the side road entry such that a vehicle can naturally transition to the minor road.



» **FIGURE 5 –** Typical Dimensions for a High-Speed RCUT

Figure 6 shows a typical layout for an RCUT in a lower speed (less than 50 mph) location where there may not be sufficient available right-of-way. **Figure 6** also shows the option for the right-turning driver to enter directly into the U-turn lane, defined as the Compact U-turn Concept previously. Note that the Compact U-turn Concept can also be applied to a higher speed RCUT if there is sufficient median space.



» **FIGURE 6 –** Typical Dimensions for a Low-Speed RCUT

TURN LANES

The length of the turn lanes for the RCUT should be calculated using the methods laid out in the AASHTO Greenbook (2018), Chapter 9. **Figure 7** shows the components of the deceleration lane length.

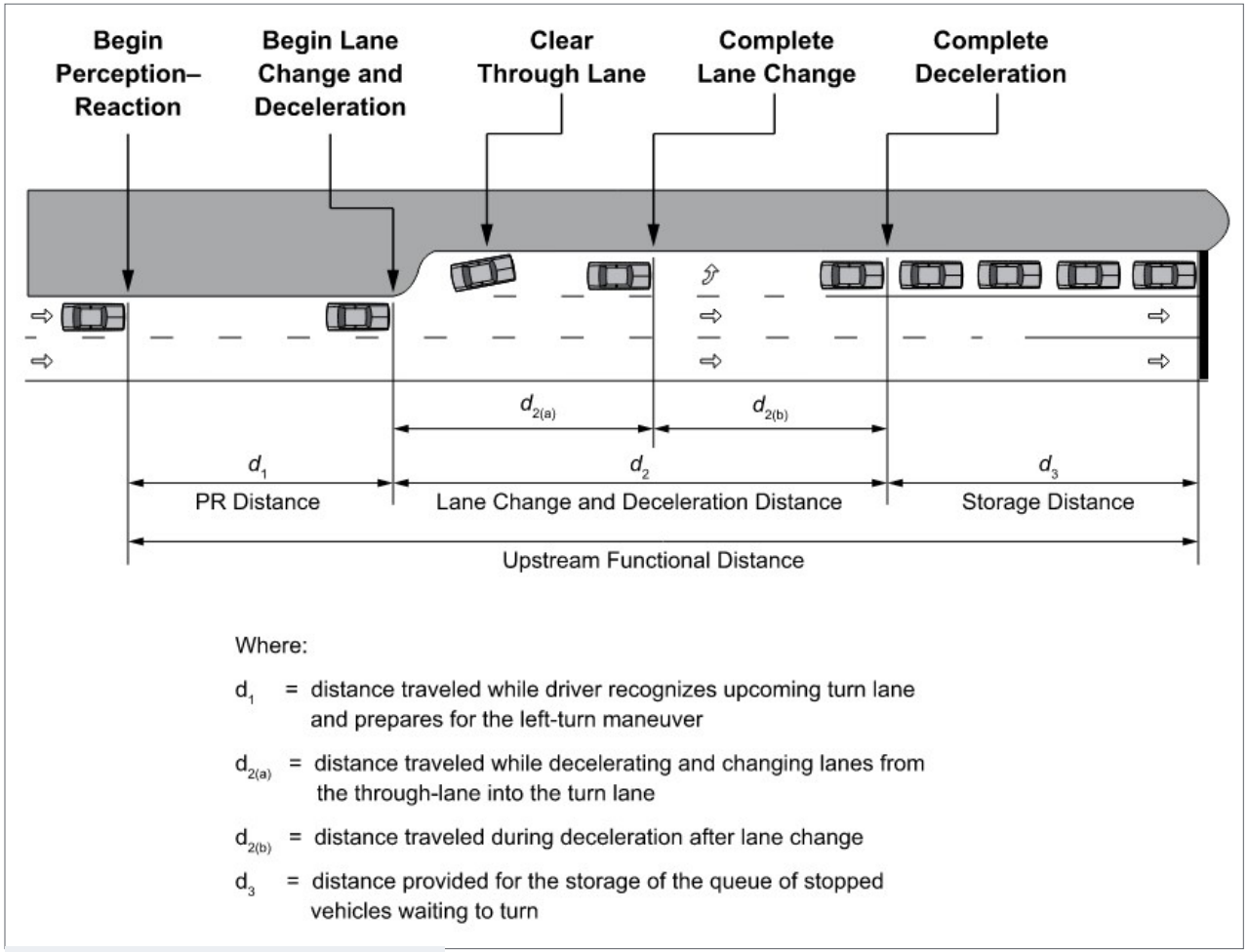


FIGURE 7 – AASHTO Figure 9-32

The lane change and deceleration distances, labeled as d2 in **Figure 7**, are determined based on the design speed. Values for these are seen in **Table 2** to the right. Storage length can be determined using Tables 9-21 through 9-23 in the AASHTO Greenbook Chapter 9. The taper for the turn lane should be 8:1 for speeds up to 30 mph and 15:1 for speeds greater than 50 mph.

TABLE 2 – Desirable Lane Change and Deceleration Distances (Source: AASHTO Greenbook Table 9-20)

Speed (mph)	Lane Change and Deceleration Distance (ft)
20	70
25	105
30	150
35	205
40	265
45	340
50	415
55	505
60	600
65	700
70	815

DUAL RIGHT-TURN LANES

In the case of dual right-turn lanes from the minor roadway the Compact U-turn configuration should be used. This allows the left-most right-turn lane to turn directly into the U-turn while the right-most right-turn lane can be channelized into an acceleration lane and merge into the mainline as shown in **Figure 8**. RCUTs with dual right turn lanes should always be signalized unless the second right-turn lane is a free-flow lane as shown in **Figure 8**.

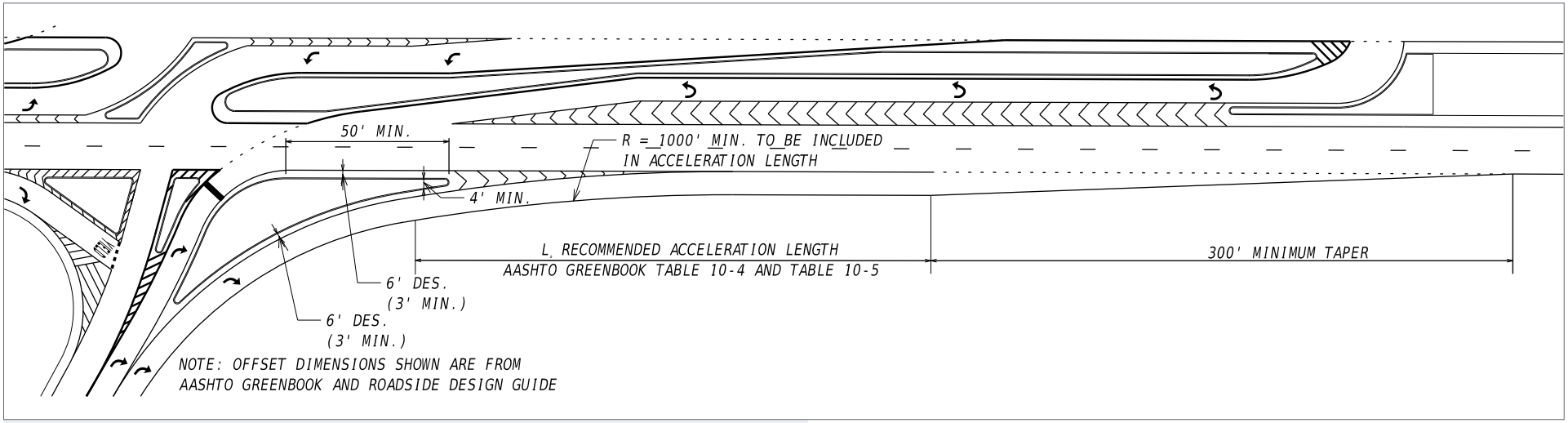
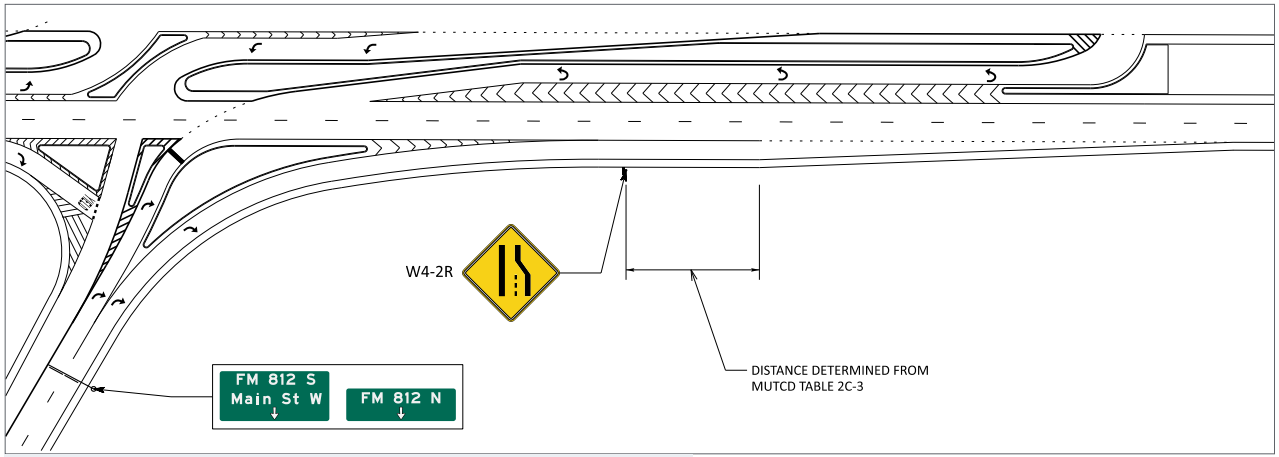


FIGURE 8 – Typical Dimensions for Dual Right-Turn Lanes with a Free-Flow Lane

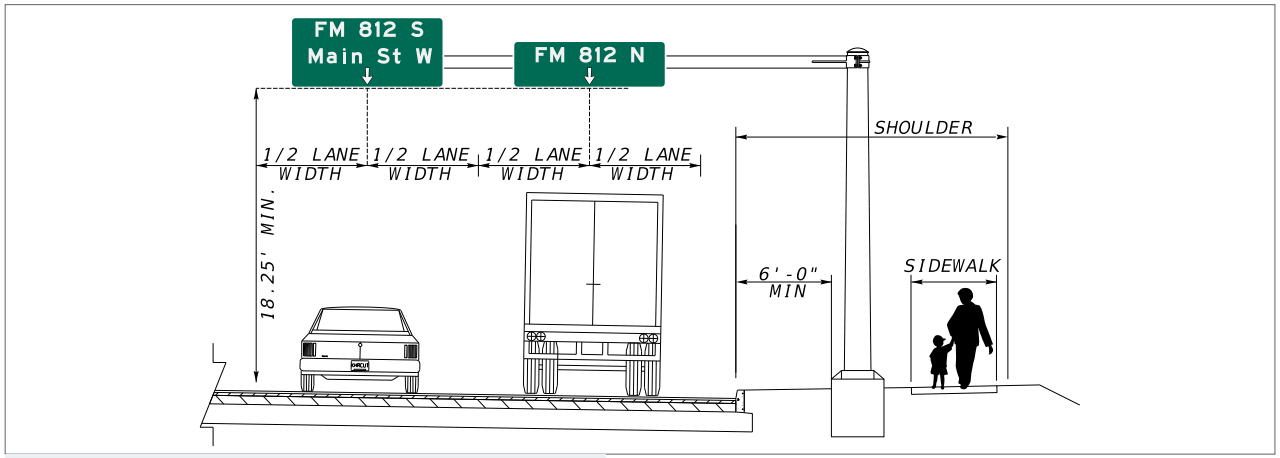
The acceleration length La, seen in **Figure 8**, is determined using AASHTO Greenbook Table 10-4 and Table 10-5. A radius of 1000-feet or greater can be included in the calculation of the acceleration length. Channelizing with a raised median should be used to prevent vehicles in the right-most lane from crossing into the U-turn lane.

Special consideration should be made for signage in cases of dual right-turn lanes. Overhead signage should be utilized to define lane designations prior to the intersection. An example additional signage required for dual right-turn lanes is shown in **Figure 9**, other signage for RCUTs is discussed later in this document.

Details for the overhead signage are shown on **Figure 10**. The signs should be mounted on a cantilever assembly unless there is a median that can accommodate a sign bridge.



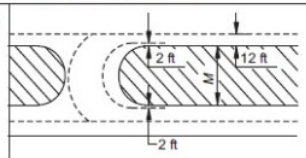
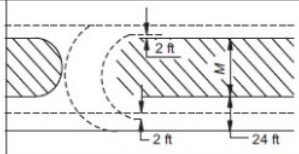
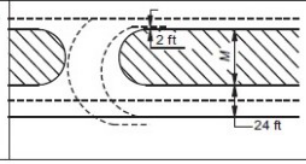
» **FIGURE 9 –** Signage Related to Dual Right-Turn Lanes



» **FIGURE 10 –** Detail of Overhead Lane Signage

U-TURN CROSSOVERS

The U-turn crossover can be fully contained within the existing pavement if the existing median width can accommodate the design and check vehicles. Minimum median widths to accommodate various design or check vehicle U-turns within the existing footprint are presented in **Figure 11**. If the design or check vehicle cannot make the U-turn movement within the pavement footprint a U-turn loon should be added. This may require additional right-of-way.

U.S. Customary							
	M—Minimum Width of Median (m) for Design Vehicle						
	P	WB-40	SU-30	BUS	SU-40	WB-62	WB-67
	Length of Design Vehicle (ft)						
Type of Maneuver	19	50	30	40	40	63	68
Inner Lane to Inner Lane 	30	61	63	63	76	69	69
Inner Lane to Outer Lane 	18	49	51	51	64	57	57
Inner Lane to Shoulder 	8	39	41	41	54	47	47

» **FIGURE 11 –** Minimum Median Widths for Various Design Vehicles (Source: FHWA Restricted Crossing U-Turn Intersection Informational Guide)

LOCATING THE U-TURN CROSSOVERS

For the Compact U-turn Concept RCUTs the loons should be located 600 feet minimum from the RCUT intersection. Shorter travel times result in fewer distance related crashes, shorter travel time for the driver and bicyclists, higher driver compliance, and increased public acceptance of the RCUT. For the Non-Compact U-turn Concept the spacing should be a minimum of 2,000 feet, but the spacing should be confirmed using the acceleration, weaving, and deceleration lengths.

Access points should not be located within 100 feet on either side of the U-turn crossover. Consecutive U-turn crossovers should be spaced a minimum of 100 feet apart, if the minimum spacing cannot be met, the crossover should be signalized. The designer should choose a location for the U-turn crossover that minimizes environmental and right-of-way impacts if a loon is required. The chosen location for the U-turn crossover should be checked to ensure adequate sight distance is available for the U-turn maneuver.

DESIGNING THE U-TURN LOONS

The U-turn crossover should be designed to accommodate the WB-67 check vehicle in rural areas and the NACTO DL-23 vehicle in urban areas. It is recommended to check both the WB-67 and an SU-40 vehicle making the U-turn movement. As displayed in **Figure 12** the turning radius of the SU-40, shown in blue, should determine the outside geometry of the U-turn loon because of its wider turning radius, while the WB-67 (or the applicable design vehicle), shown in red, should define the geometry of the inside of the lane. Note that the design vehicle may vary based on City Ordinance in urban areas.

In locations with lower truck volumes, the design vehicle U-turn can be accommodated by using the existing or widened paved shoulder; this can be a cost saving measure. Strengthening the shoulder may reduce the maintenance long-term if this method is chosen. In cases where there are dual U-turn lanes, the design vehicle should be assumed to use both lanes to complete the turn, unless there is a large percentage of heavy vehicles anticipated, in which case, the U-turn should be designed so that the large vehicles can simultaneously stay in lane for the movement.

Typical offsets to channelizing islands and lane widths can be seen in **Figure 13**. Note that the dimensions presented are a guide and should be adjusted to accommodate the design vehicle as necessary.

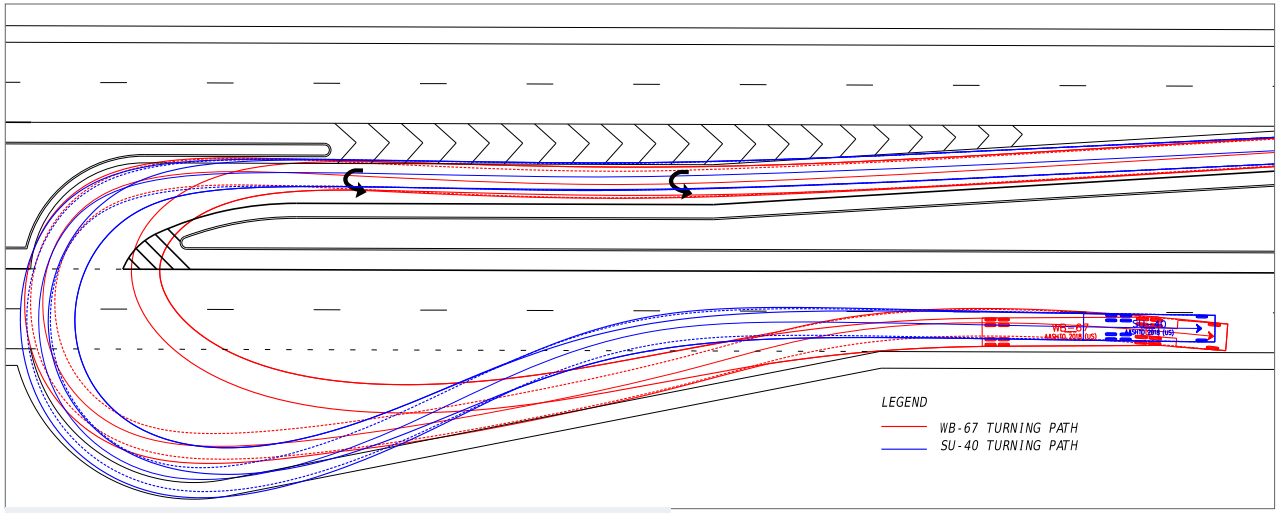


FIGURE 12 – WB-67 and SU-40 U-Turn Movements

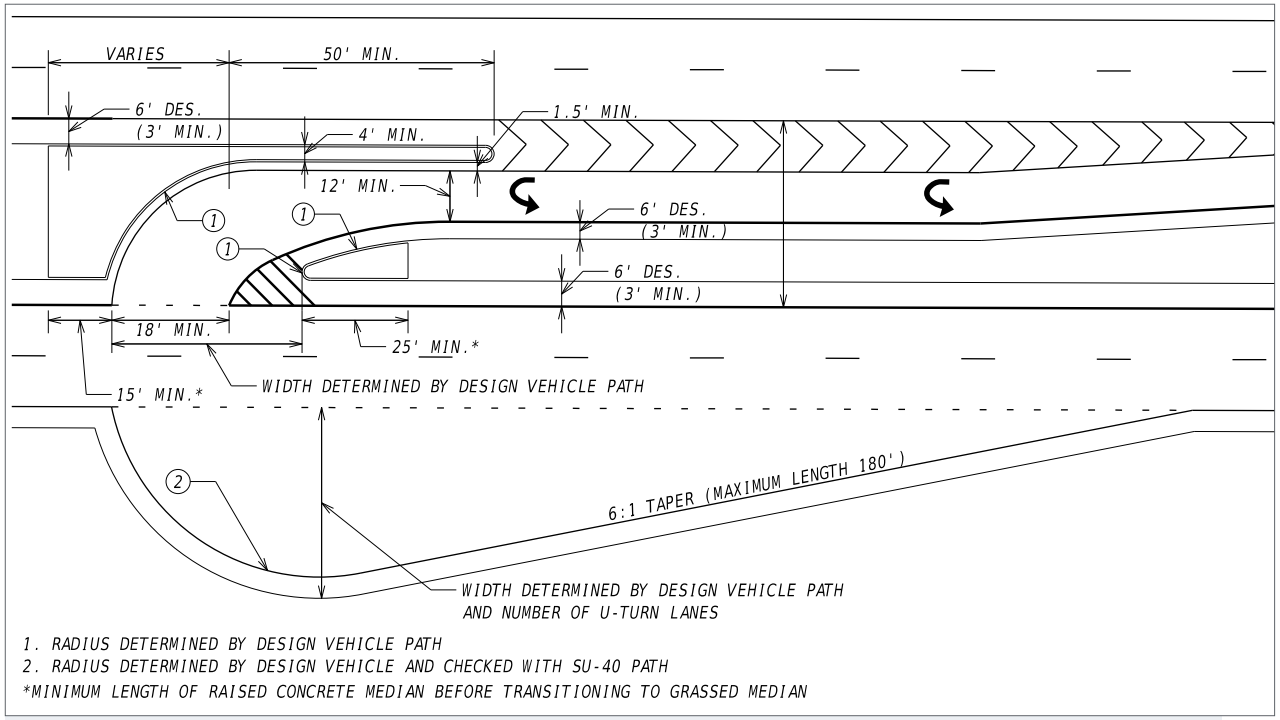


FIGURE 13 – U-Turn Loon Dimensions (Source: Adapted from NCDOT Roadway Design Manual (19))

PEDESTRIAN ACCOMMODATIONS

Pedestrians should only be permitted to cross the mainline roadway at signalized RCUT intersections. Two options for pedestrian crossing locations are presented in **Figure 14**. The preferred crossing method is labeled as Option 1 and has the pedestrian crossing in a "Z" pattern. This method allows the pedestrian to cross the fewest lanes of traffic to complete the maneuver. Option 2 should only be used in locations where the required median width cannot be achieved to allow for the sidewalk to pass through the central median of the RCUT.

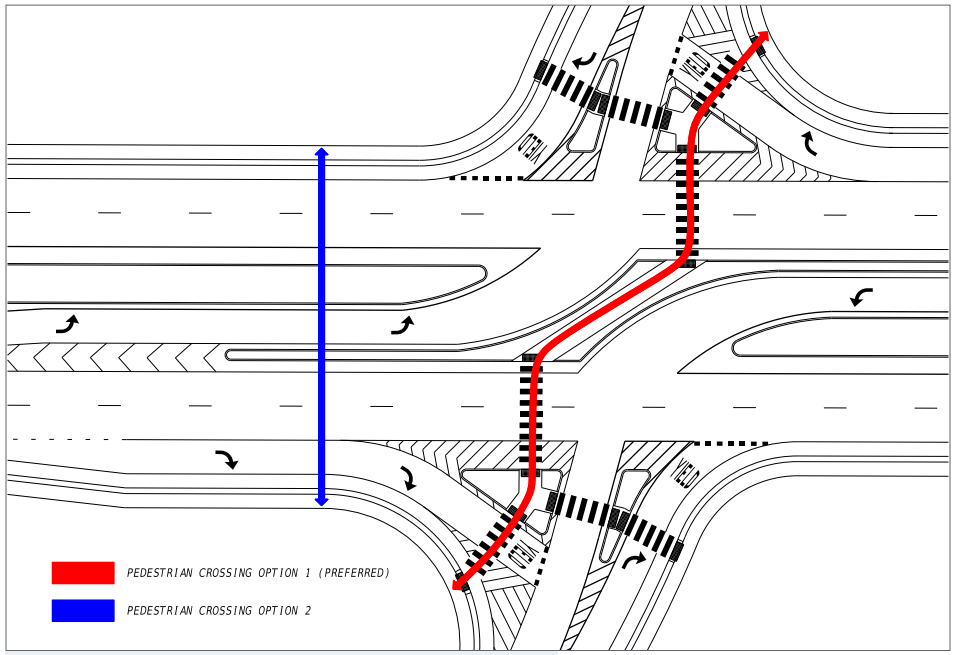


FIGURE 14 – Pedestrian Crossing Options

SIGNING AND PAVEMENT MARKINGS

An example signing layout for a yield or stop controlled RCUT intersection is shown in **Figure 15.** A yield condition is not recommended for main-line posted speeds over 35mph, or where the view angle (Figure 18) is greater than 105 degrees.

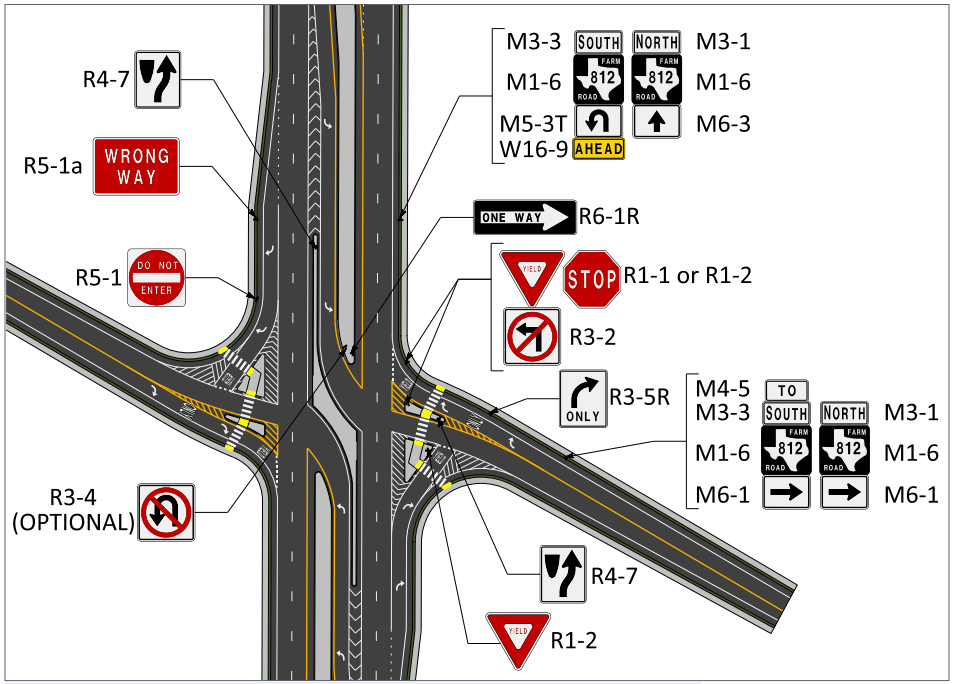


FIGURE 15 – Yield or Stop Controlled Signing Example

Pedestrian crossing items to consider:

- Ensure landing areas do not overlap with truck turning movements
- Recommend raised crosswalks at smart channel right turns to slow vehicle speeds at conflict point
- Crossing of two-lane roadways may require signalization or PHB installation for added safety benefits
- Consider whether pedestrians cross in one or two stages at the crossing
- Stop bars to be set back from the crosswalk in compliance with the TMUTCD

The typical signing layout for a signalized RCUT is shown in **Figure 16**, this also includes an example of signal pole locations.

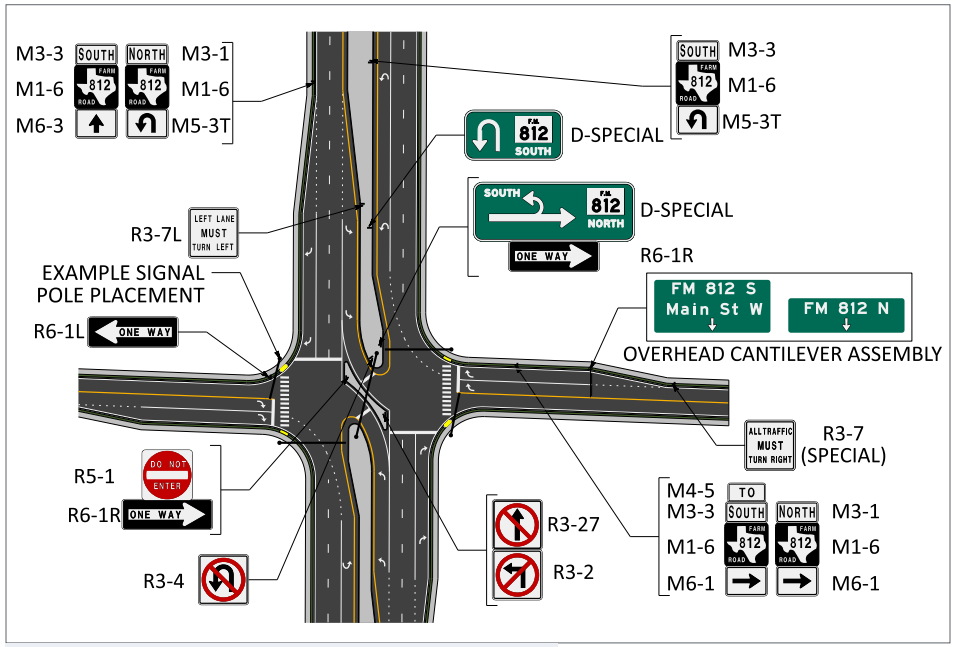


FIGURE 16 – Signalized Signing Example

The typical signing layout for the U-turn crossover is shown in **Figure 17**.

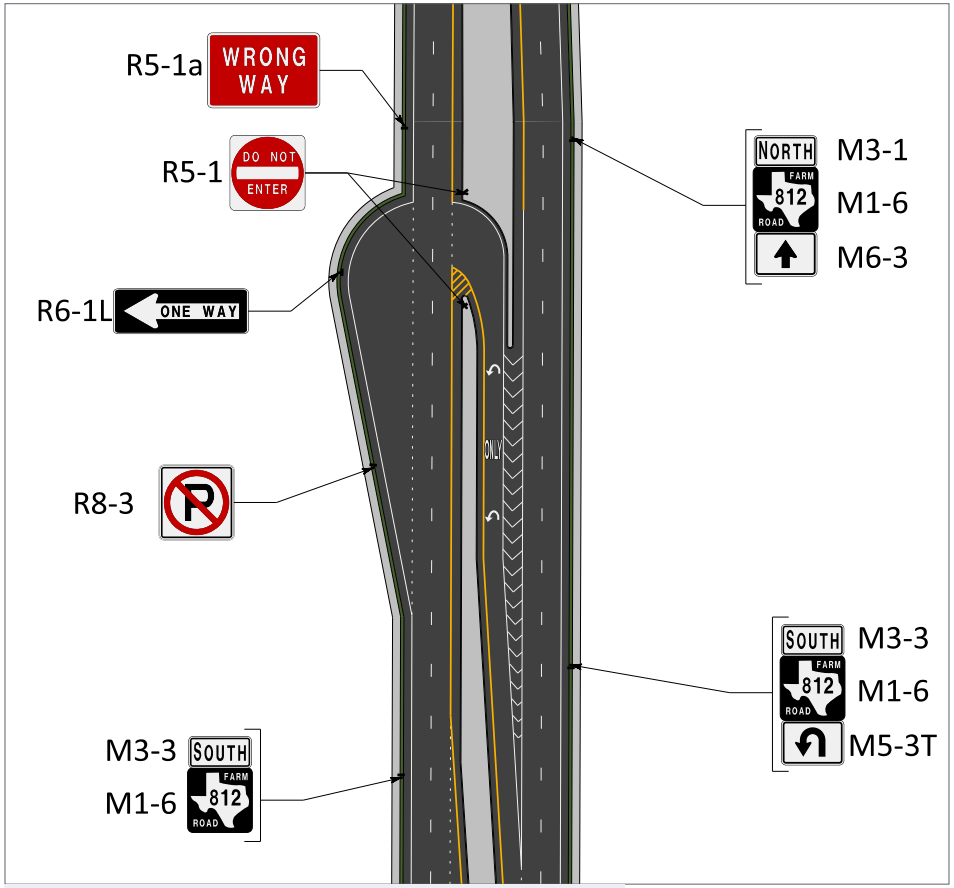


FIGURE 17 – U-turn Crossover Signing Example

SIGHT DISTANCE/VIEW ANGLE

The sight distance at the U-turn crossover should be checked using AASHTO Case B1 – Left-Turn from the Minor Road. Sight distance for the left turn onto the minor road should be checked using AASHTO Case F – Left-Turns from the Major Road. Sight distance for the right-turns should be based on Case B2 – Right-Turn from the Minor Road. See AASHTO Chapter 9.5 (4) for more details.

The view angle of the turns should be checked to ensure that a driver can comfortably see oncoming vehicles when they are judging a gap. This should be checked for all turning movements. An example of the vehicle placement for this check is provided in **Figure 18**. The driver should be assumed to be a distance of 14.5-feet from the yield line and should have to turn their head no more than 105 degrees in order to see oncoming vehicles.

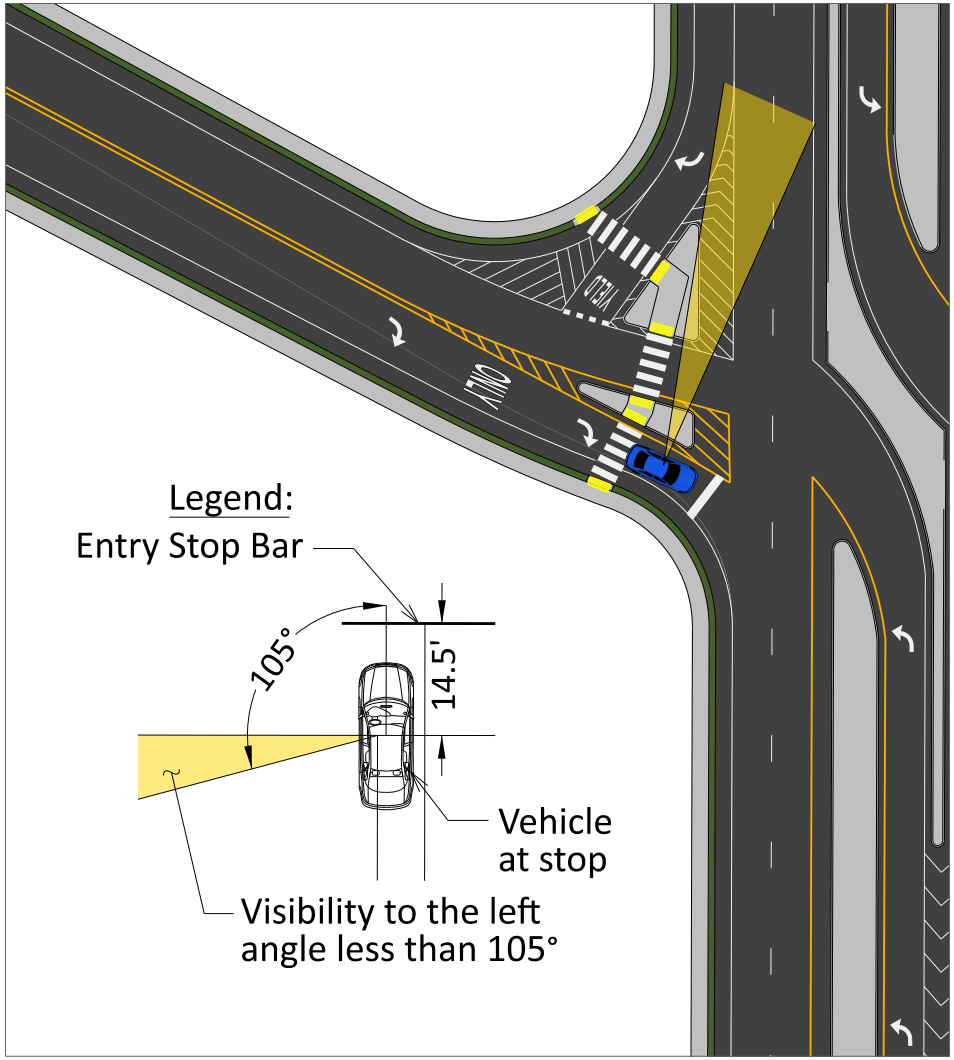


FIGURE 18 – View Angle from the Right-Turn Lane

REFERENCES

1 Restricted Crossing U-Turn Intersection: Informational Guide. U.S. Department of Transportation Federal Highway Administration, 2014.

2 FHWA Publication No. FHWA-HRT-17-083: Safety Evaluation of Restricted Crossing U-Tun Intersection. U.S. Department of Transportation Federal Highway Administration, 2017.

3 FHWA Publication No. FHWA-HRT-17-082: Safety Evaluation of Signalized Restricted Crossing U-Tun Intersection. U.S. Department of Transportation Federal Highway Administration, 2017.

4 AASHTO Greenbook, Seventh Edition, 2018.

5 Proven Safety Countermeasure: Reduced Left-Turn Conflict Intersections. U.S. Department of Transportation Federal Highway Administration, FHWA Safety Program, 2020.

6 Selecting Optimum Intersection or Interchange Alternatives. North Carolina Department of Transportation, Hummer, Joseph E. PhD, PE, State Traffic Management Engineer, 2024.

7 Development of Safety Performance Functions for Restricted Crossing U-Turn (RCUT) Intersections. Department of Civil & Environmental Engineering, Florida A&M University – Florida State University, Ozguven, Eren Erman Ph.D., Ulak, Mehmet Baran, M.Sc., Moses, Ren, Ph.D., Dulebenets, Maxim, Ph.D., 2019.

8 MnDOT Technical Memorandum No. 21-06-TS-05: Restricted Crossing U-Turn (RCUT) – Design and Implementation Guidance, Gieseke, Mark A., P.E., 2021.

9 Traffic Safety Evaluation at Reduced Conflict Intersections in Minnesota. Moreland, Max, PE, PTOE, Minnesota Department of Transportation, Office of Traffic Engineering, 2021.

10 Nebraska Department of Transportation (NDOT): Roadway Design Division – Policy Letter: Reduced Conflict Intersections. Policy Number DES 23-01, 2023.

11 Product 0-7036-P2: Restricted Crossing U-Turns (RCUTs) Brochure. Texas A&M Transportation Institute.

12 Product 0-7036-P2: Guidance for TxDOT Innovative Intersections. Texas A&M Transportation Institute.

13 Technical Report 0-7036-R1: Research and Findings on Roundabouts and Innovative Intersections for High-Speed and Rural Locations. Texas A&M Transportation Institute.

14 FHWA Publication No. FHWA-HRT-22-032: Traffic Control Devices Pooled Fund Study: Signing for Intersection Geometrics that Require U-Turns. U.S. Department of Transportation Federal Highway Administration, 2022.

15 Facilities Development Manual. Wisconsin Department of Transportation, 2022.

16 FHWA Publication No. FHWA-HRT-14-006: The ABCs of Designing RCUTs. Zhang, Wei and Kronprasert, Nopadon, 2014.

17 Manual on Uniform Traffic Control Devices for Streets and Highways. U.S. Department of Transportation Federal Highway Administration, 2023.

18 AASHTO Roadside Design Guide: 4th Edition. AASHTO, 2011.

19 North Carolina Department of Transportation Roadway Design Manual. North Carolina Department of Transportation, 2023.