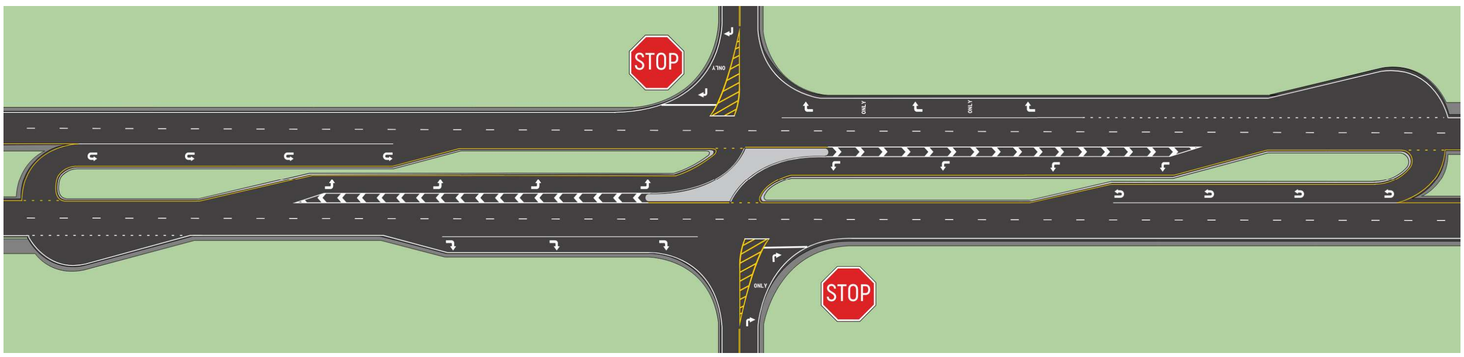
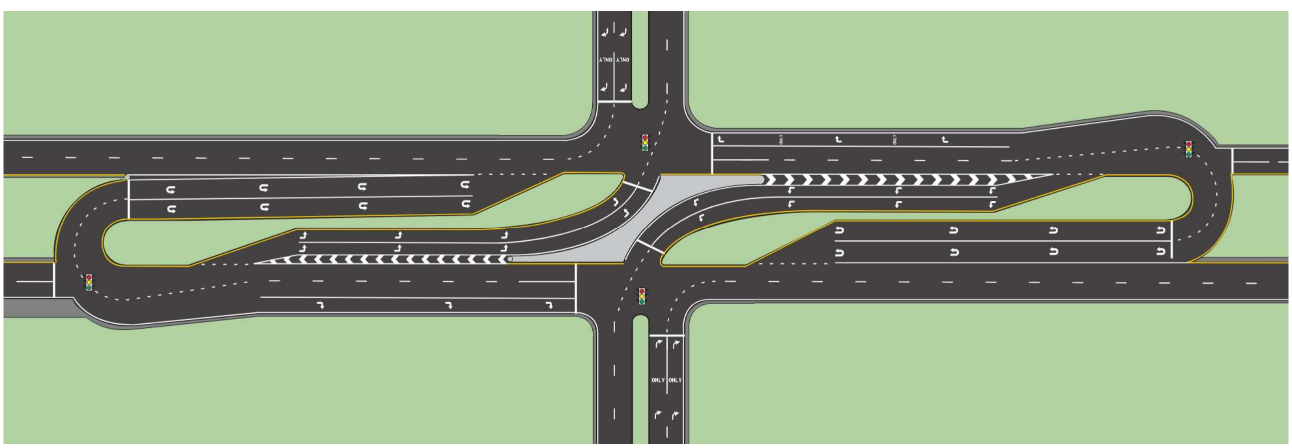
KYTC Reduced Conflict U-turn (RCUT) Design Guidance





August 2026

HIGHWAY Design	***Reduced Conflict U-turn (RCUT)***
	Design Guidance

Table of Contents

1. INTRODUCTION

This guidance document covers Reduced Conflict U-Turn (RCUT) intersection planning, design, construction, maintenance, and operations. RCUT intersections eliminate left-turn and through movements from the minor road. Drivers must instead turn right onto the main road and complete a U-turn at a downstream median opening. Left turns from the main road are typically maintained unless minor road volumes are extremely low.

RCUT intersections perform best on divided roadways with at least four lanes. They can be adapted to multiple contexts and can function either as a standalone intersection or as part of a corridor-wide treatment.

1.1. REDUCED CONFLICT U-TURN TYPES

RCUT intersections come in three configurations: stop-controlled, signal-controlled, and merge (yield) controlled. Each can accommodate three- or four-leg approaches. All configurations share common elements:

- Main intersection, where left turns from the major road are permitted but channelization restricts left-turn and through movements from the minor road.
- Median U-turn openings, which enable minor road through and left-turning traffic to complete their movements and reach their destinations.
- Turn lanes and deceleration lanes connecting the main intersection and median U-turn openings.

1.1.1. STOP-CONTROLLED RCUT INTERSECTION

A stop condition regulates minor road movements at a stop-controlled RCUT intersection. Left turns from the main road and U-turns are typically uncontrolled (i.e., an approach on which vehicles are not controlled by a traffic control signal, hybrid beacon, STOP sign, or YIELD sign). Figure 1 illustrates the basic layout and features of a stop-controlled RCUT intersection, while Figure 2 depicts a stop-controlled RCUT configuration that omits left-turn access from the main road. Eliminating left turns from the main road is generally reserved for special circumstances, such as very low minor-road volumes, close proximity to adjacent intersections, corridor-wide access management considerations, or sight distance restrictions.

1.1.2. SIGNAL-CONTROLLED RCUT INTERSECTION

RCUT intersections on high-volume routes can incorporate traffic signals at both the main intersection and U-turn locations (Figure 3). However, signalizing the median U-turn opening is not always necessary. Any configuration requiring dual left-turn or dual U-turn lanes must be signal-controlled because dual-lane movements are not permitted at stop- or merge-controlled RCUT intersections.

Timing of signalized RCUT intersections can be coordinated throughout a corridor to facilitate progression.

1.1.3. MERGE (YIELD) CONTROLLED RCUT INTERSECTION

An RCUT intersection with merge (yield) control (Figure 4) is more often used at rural high-speed locations that require access control and functionality similar to freeways. As a result, median U-turn openings are spaced farther away than would be the case with a stop- or signal-controlled RCUT intersection. Higher speeds can also be expected from minor road merging traffic. This RCUT configuration is generally less appropriate for urban and suburban contexts where lower operating speeds and a greater pedestrian presence are anticipated.

1.2. BENEFITS OF RCUT INTERSECTIONS

RCUT intersections have multiple benefits:

- They can be adapted to accommodate different
    - traffic volumes
    - roadway contexts
    - functional classifications
    - construction types
    - modes of transportation
- On safety metrics, they consistently outperform conventional intersections.
- They can reduce corridor travel times and move traffic more efficiently than a comparable series of signalized conventional intersections.

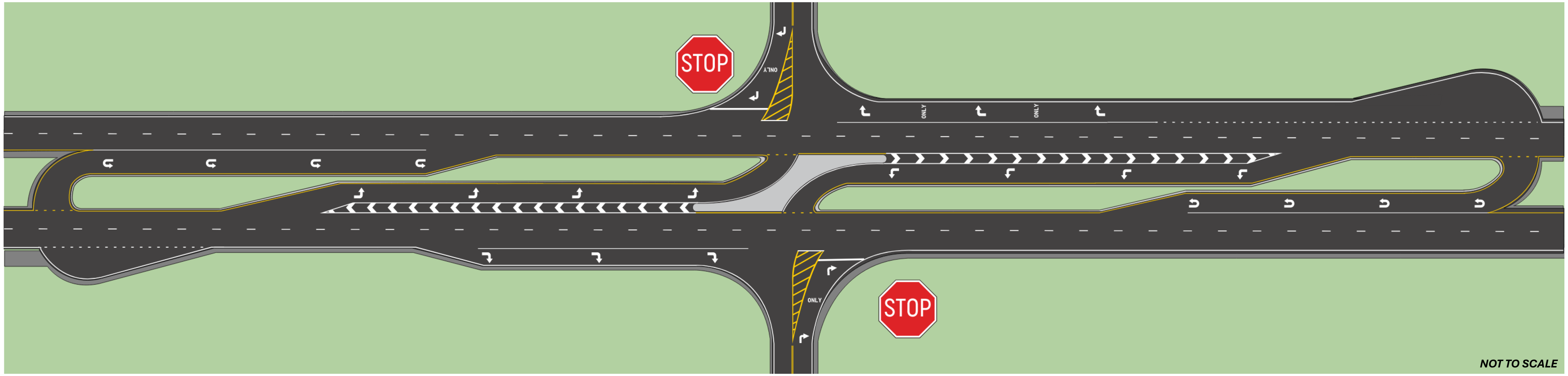


Figure 1: Stop-Controlled RCUT Intersection

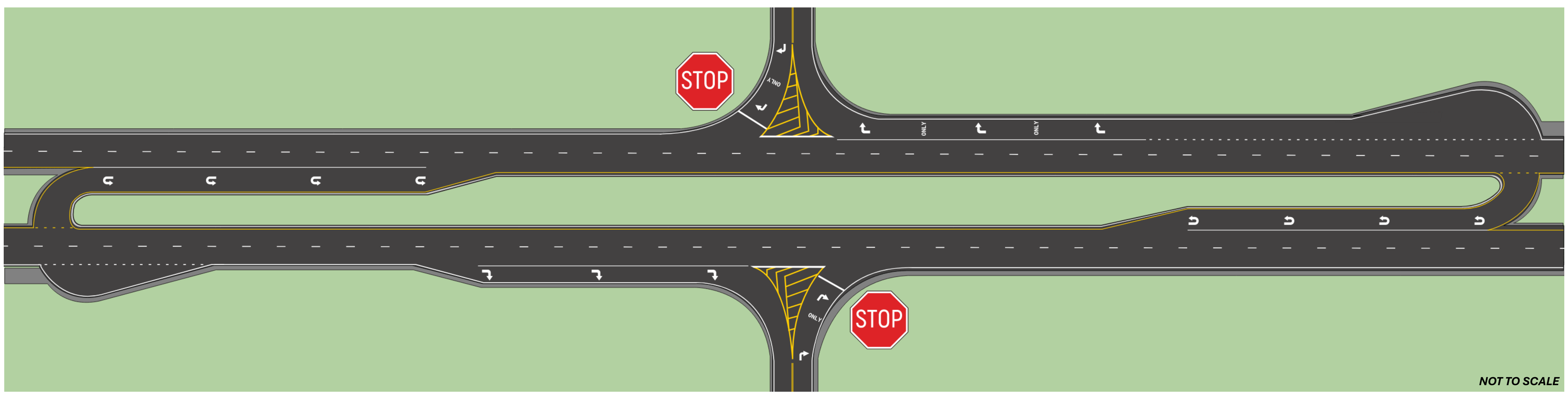


Figure 2: Stop-Controlled RCUT Intersection Without Main Road Left-Turn Lanes

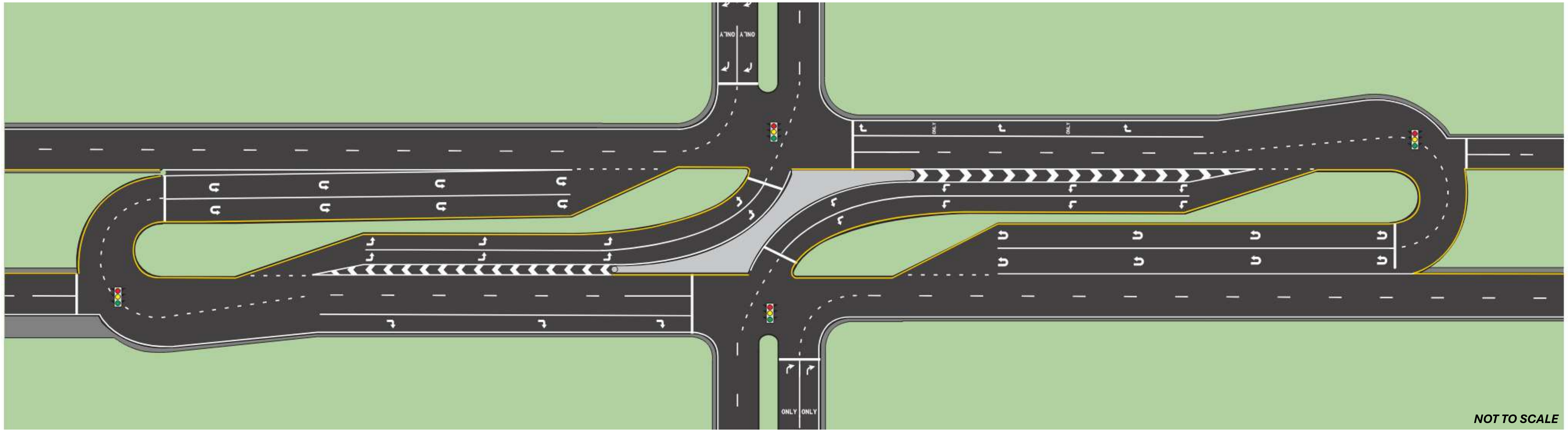


Figure 3: Signalized RCUT Intersection

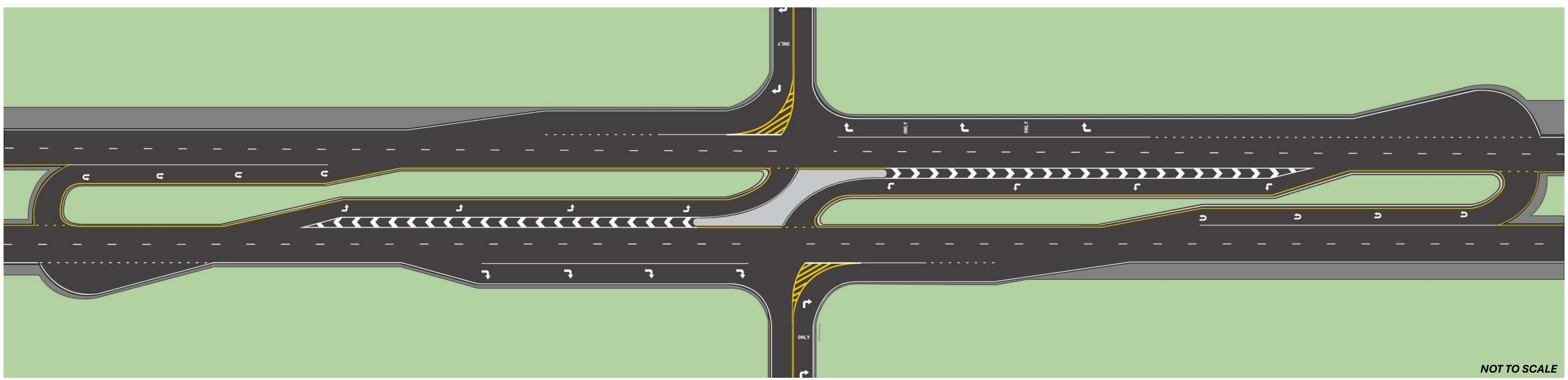


Figure 4: Merge (Yield) Control RCUT Intersection

2. PLANNING / SITE SELECTION

Location exerts a strong influence over RCUT intersection performance. As such, site selection and screening are critical for identifying the most suitable locations. This section describes where RCUT intersections are most effective, how they can be deployed as part of different project types, key factors to consider when siting RCUT intersections along a corridor, and best practices for engaging the public throughout the project development process. When screening potential locations, project teams should systematically evaluate criteria presented below to determine if an RCUT intersection(s) is appropriate.

2.1. CONDITIONS THAT SUPPORT USE OF RCUT INTERSECTIONS

Table 1 lists considerations and favorable conditions that support use of RCUT intersections. Although the table represents favorable conditions for deployment, RCUT intersections are not strictly limited to those settings, as mitigation measures can facilitate their use in less favorable contexts. For example, where median width is insufficient, larger loons may be constructed to adequately accommodate U-turning vehicles, and the median U-turn location can be adjusted to ensure that sight distance requirements are met.

Table 1: Conditions That Support RCUT Intersection Use

Consideration	Favorable Conditions
Access Control	• Partial control or access control by permit. ○ Not appropriate for interstates or other facilities with fully controlled access.
Number of Through Lanes	• Multilane divided highways with at least four through lanes. ○ RCUT intersections can be installed on an existing multilane facility or when a roadway is widened to a multilane configuration.
Median Width	• ≥ 24 ft. in urban or suburban contexts • ≥ 40 ft. in rural contexts
Crash Types	• Safety analysis demonstrates that installation will reduce intersection crashes. ○ RCUT intersections are a good solution for reducing angle or left-turning crashes.
Traffic Volumes	• Minor road left-turn and through volumes are relatively low. • The ratio of minor road volume to total intersection volume is < 0.20. ○ Stop-controlled RCUT intersections are practical where minor road demand is < 5,000 vehicles per day (vpd). ○ Consider signalization where minor road demand is 5,000 – 25,000 vpd. ○ If minor road demand is > 25,000 vpd, consider a different intersection type.
Sight Distance	• A site where intersection sight distance requirements can be obtained for the minor road right-turn, major road left-turn, and major road U-turn locations. • A site where stopping sight distance requirements can be provided throughout the intersection.
U-turn Opening	• A cross section wide enough to allow U-turns of design vehicles, or right of way (ROW) available to construct a loon. ○ Where ROW is constrained, consider alternative accommodations within the roadway network or provide truck U-turn access at designated signed U-turns.
Peds. & Cyclists	• Best accommodated at a signalized RCUT intersection.

2.2. CONDITIONS THAT DO NOT SUPPORT USE OF RCUT INTERSECTIONS

The following conditions typically do not support the use of RCUT intersections:

- **Inadequate Space for U-Turn Maneuvers** — The configuration is generally less suitable for two-lane roadways or roadways with narrow medians because they typically lack adequate space for U-turning vehicles.
- **Mountainous Terrain with Constrained Geometry** — Mountainous terrain with constrained horizontal and vertical geometry may lack sufficient sight distance and may not provide room for wide medians or loons, particularly on roadways that follow the topography alongside features such as adjacent streams.
- **Urbanized Contexts** — Although RCUT intersections have been applied in a variety of roadway contexts, they are generally less suitable for densely developed urban corridors with closely spaced access points or in rural town settings.
- **High Minor Road Left-Turn and Through Volumes** — RCUT intersections may not be suitable where minor road left-turn and through volumes are higher and the ratio of minor road to total intersection volume is 0.2 or greater. In these cases, other intersection types may function more effectively.

2.3. CONSTRUCTION AND PROJECT TYPES

RCUT intersections can be installed as part of new construction, reconstruction, or construction on existing roads (the three categories of construction listed in AASHTO's *A Policy on Geometric Design of Highways and Streets* (Green Book)).

Available ROW may constrain use of RCUT intersections as part of reconstruction or construction on existing roads. ***For new construction or reconstruction projects involving rural four-lane divided highways with wide medians, RCUT intersections are recommended as the baseline intersection type within the project area.***

RCUT intersections can also be incorporated into Resurfacing and Restoration (2R) or Resurfacing, Restoration, and Rehabilitation (3R) projects.

During the planning or design phase, if a project team determines that an RCUT intersection will provide value at a location but there are insufficient project funds for construction, the Project Manager should coordinate with KYTC Leadership. Coordination may help identify alternative funding sources (e.g., Highway Safety Improvement Program (HSIP)) to support construction of the RCUT intersection.

If an alternative funding source is not available, the Project Manager should request that District Planning staff create a Continuous Highway Analysis Framework (CHAF) entry to document the need and establish a mechanism for pursuing future funding opportunities.

2.4. INTERSECTION CONTROL EVALUATION

When considering if an RCUT intersection would be a good candidate for an intersection, use KYTC's *Intersection Control Evaluation* (ICE) *Guidance* to assist with selecting an intersection type.

Even if an intersection does not meet the minimum criteria for ICE analysis, RCUT intersections should be considered where a lower-volume route intersects a median-divided highway.

ICE analysis is performed during the planning and preliminary engineering phases. Sections 3 and 4 provide additional information on applying the ICE process when considering RCUT intersections.

2.5. SPECIAL CONSIDERATIONS FOR MULTIPLE RCUT INTERSECTIONS ON A CORRIDOR

Where multiple RCUT intersections are planned along a corridor, evaluate site conditions using the criteria listed in Sections 2.1 and 2.2 **plus** the items listed below:

- Safety and traffic analysis for a corridor with multiple RCUT intersections is more complex than for a corridor that has a single RCUT intersection, making it important to scope the level of effort and identify appropriate analysis tools early in the project development process, such as when selecting project team members and developing a consultant scope of work, if applicable.
- RCUT intersections are most effective on corridors that have multiple minor roads with low traffic volumes, rather than at a limited number of junctions where two major roads intersect.
- A corridor may use a mix of intersection configurations, including signalized conventional intersections, signalized and non-signalized RCUT intersections, roundabouts, and other alternative intersections. Evaluate the influence of RCUT intersections on the capacity and operations of adjacent intersection control types. The evaluation should assess the corridor as an integrated system. Section 4 contains additional guidance on defining corridor study areas.
- RCUT intersections can be combined with access management techniques to facilitate organized access along a corridor. This approach can enhance safety and promote more efficient traffic flow.
- In areas with closely spaced intersections, median U-turn openings can be repositioned to serve traffic from more than one access point or minor road.

2.6. PUBLIC INVOLVEMENT ACTIVITIES

Communicating the benefits of RCUT intersections to the public can be challenging because many people do not know how they operate. Several resources are available to assist project teams with this effort.

KYTC's SAFERoad Solutions website provides information on the benefits of RCUT intersections, highlights successful Kentucky projects, and includes a video explaining how they function.

During public involvement activities, project teams should emphasize that RCUT intersections have better safety records than other intersection types. Referencing examples of safety improvements at existing RCUT intersections in Kentucky is a particularly effective strategy. Another effective strategy is displaying visualizations that demonstrate how motorists, pedestrians, and bicyclists navigate RCUT intersections.

Table 2 lists resources project teams can use during public involvement activities. Many sites feature videos that demonstrate how RCUT intersections operate and highlight their advantages over conventional intersections.

Table 2: Other Agency RCUT Informational Videos

Agency	Website	Contents
FHWA	https://www.youtube.com/watch?v=nzpdTdXDfRw	Overview of RCUT intersections and their benefits.
Minnesota DOT	https://www.dot.state.mn.us/jturn/index.html	Videos of passenger car, tractor trailer, pickup truck with trailer, and fire truck making U-turn.
North Carolina DOT	https://www.ncdot.gov/initiatives-policies/Transportation/safety-mobility/reduced-conflict-intersections/Pages/default.aspx	Informational video, educational materials, FAQs.
Texas DOT	https://www.txdot.gov/about/programs/innovative-transportation/innovative-intersections/reduced-conflict-u-turn.html	Overview, safety benefits, educational materials, and videos.
Virginia DOT	https://www.vdot.virginia.gov/about/our-system/highways/innovative-intersections/restricted-crossing-u-turn/	Overview, safety benefits, navigation instructions, and videos.

3. SAFETY PERFORMANCE

RCUT intersections are a FHWA Proven Safety Countermeasure. Many states have adopted them because they have better safety records than conventional intersections.

3.1. CONFLICT POINTS

A four-leg approach RCUT intersection has 14 conflict points while a conventional intersection has 32 (Table 3). Four leg approach RCUT intersections also have six fewer crossing conflicts, which are most commonly associated with severe angle crashes. Figure 5 shows the locations of vehicle conflict points inventoried in Table 3. RCUT intersections distribute conflict points across a wider area and stagger them over time, rather than concentrating them at a single point as conventional intersections do.

Table 3: Vehicle Intersection Conflict Points

	Conventional Intersection		**RCUT Intersection**	
Number of Approaches	3	4	3	4
Total Conflict Points	9	32	7	14
Crossing Conflicts	3	8	1	2
Merging Conflicts	3	8	3	6
Diverging Conflicts	3	16	3	6

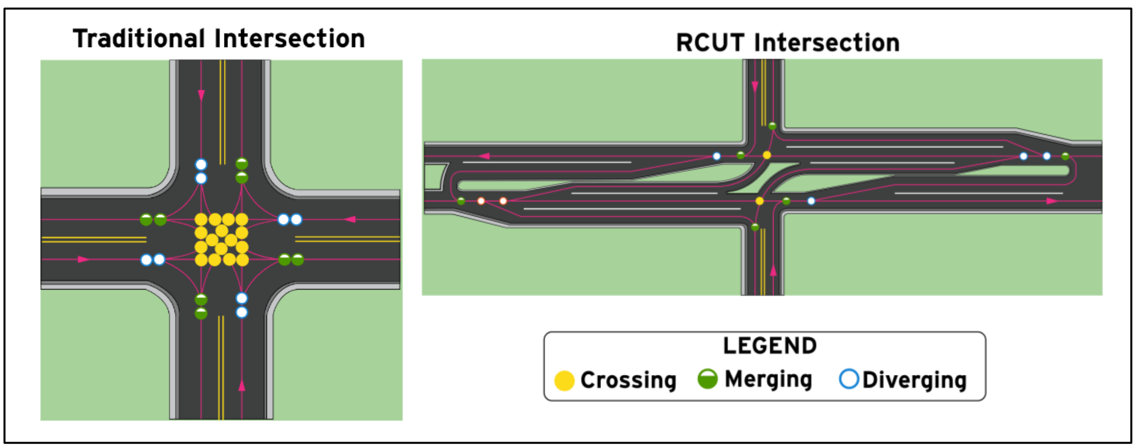


Figure 5: Conventional and RCUT Intersection Conflict Points

RCUT intersections also have fewer pedestrian – vehicle conflict points. Installing an RCUT intersection with a pedestrian Z-type crossing (see Section 5.1) instead of a conventional intersection reduces the number of pedestrian – vehicle conflict points from 24 to 8.

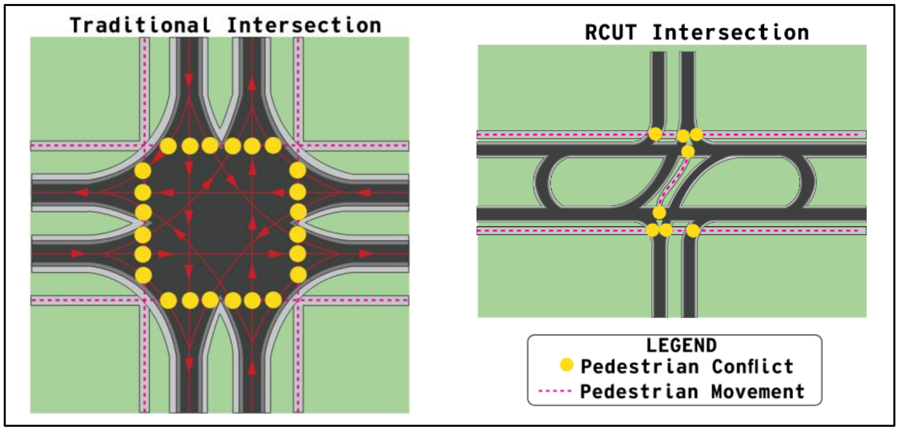


Figure 6: Intersection Pedestrian Conflicts

3.2. CRASH ANALYSIS

Several methods are available to quantify RCUT intersection safety benefits. KYTC's *Intersection Control Evaluation (ICE) Guidance* process specifies opportunities for assessment during both Stage 1 (Screening) and Stage 2 (Alternative Selection). Tools used in the ICE process were developed as part of NCHRP Research Report 1087 (SSI and SPICE tools are available at this link). Project teams should determine the appropriate safety evaluation methods during project scoping.

During Stage 1 analysis, use the SSI Score Calculator Tool to conduct a motor vehicle safety assessment based on Safe System Approach principles, such as eliminating or reducing conflict points and angle collisions, as well as lowering vehicle speeds and exposure. This tool was designed for high-level screening and has minimal data requirements.

During Stage 2 analysis, additional tools are available to assess safety performance. These include the SPICE tool, which is used to compare predicted safety outcomes across intersection alternatives, and *Highway Safety Manual* methods that apply crash modification factors (CMFs) to estimate safety benefits. Table 4 lists applicable CMFs for multiple RCUT intersection construction scenarios.

Table 4: RCUT CMFs (CMF ID links to FHWA's CMF Clearinghouse entry)

Source	Situation	CMF – All Crashes	CMF – Fatal & Injury Crashes
CMF ID: 5556 (2013)	Rural Two-way Stop-Controlled to RCUT		0.46
CMF ID: 9985 (2017)	Suburban Signalized Intersection to Signalized RCUT		0.78
CMF ID: 4883 & 4884 (2010)	Rural Unsignalized Intersection to Unsignalized RCUT	0.54	0.37
SPICE Tool		0.85	0.78

4. TRAFFIC OPERATIONS

Most often, Kentucky installs RCUT intersections to enhance safety. But they can improve traffic movement and operations as well.

4.1. TRAFFIC ANALYSIS TOOLS AND METHODS

If the main road and minor road have low traffic volumes, traffic operational analysis is generally unnecessary for RCUT intersections.

As traffic volumes increase, evaluating the impact on traffic operations assumes greater importance. KYTC's *Intersection Control Evaluation (ICE) Guidance* provides opportunities for assessment during Stage 1 (Screening) and Stage 2 (Alternative Selection). Tools used for ICE were developed through NCHRP Research Report 1087 (the CAP-X tool is available at this link). Project teams should identify the most appropriate traffic operational evaluation methods and tools to apply during project scoping.

During Stage 1 screening, use the CAP-X Tool to perform an operational assessment based on critical lane volumes. This allows project teams to compare the performance of multiple intersection types and screen potential alternatives for further evaluation. Even if the project team has concerns that the tool may rule out an RCUT intersection as a viable alternative prematurely, the intersection should still be carried forward to Stage 2 for a more detailed assessment.

During Stage 2, additional tools are available to more thoroughly analyze and compare alternative intersection types. Selection of the appropriate tool depends on the corridor and intersection's level of complexity.

A single intersection or a series of RCUT intersections can often be evaluated using deterministic traffic analysis tools. An arterial corridor that has a mix of intersection types (e.g., signalized and non-signalized RCUT intersections, conventional signalized intersections, roundabouts, interchanges) may require more advanced tools, such as microsimulation. For further guidance on selecting appropriate traffic analysis tools, refer to KYTC's *Microsimulation Guidelines*.

The Division of Planning's Traffic Forecasting and Modeling Branch can also help project teams select the most suitable tools for analysis and estimating the level of effort needed to use them.

Another important consideration is the extent of the traffic study area. Because a series of RCUT intersections along an arterial corridor can operate more efficiently than a series of conventional intersections, traffic may arrive at intersections beyond the project limits sooner than it does under existing conditions. Given the potential impacts on adjacent intersections and interchanges, include at least one intersection or interchange on either side of the project area within the traffic study boundaries.

4.2. TRAFFIC CONTROL VOLUME RANGES

General ranges of traffic demand can be used to assess if the signalization of an RCUT intersection is a viable option. Figure 7 can aid with preliminary analysis. It is a graph from the *FHWA Restricted Crossing U-Turn Intersection: Informational Guide* that plots traffic demand on the minor street against traffic demand on the major street and indicates under what conditions a signalized RCUT intersection may be appropriate. When signalization is being considered, conduct a more detailed analysis as outlined in Section 4.1 and Section 9. Table 5 lists the type of intersection most appropriate for different traffic conditions and roadway geometric characteristics.

Table 5: RCUT Intersection Traffic Control Demand Volume Ranges

Minor Road Demand	Traffic Control Type
< 5,000 vpd	Non-signalized RCUT intersection
5,000 – 25,000 vpd	Signalized RCUT intersection, depending on the number of major road through lanes.
> 25,000 vpd	Other intersection types are likely to perform better.
• Four-Lane Major Road ○ Minor Road Volumes ≤ 20,000 vpd	Signalized RCUT intersection is a viable option.
• Six-lane Major Road ○ Minor Road Volume ≤ 25,000 vpd.	Signalized RCUT intersection is a viable option.

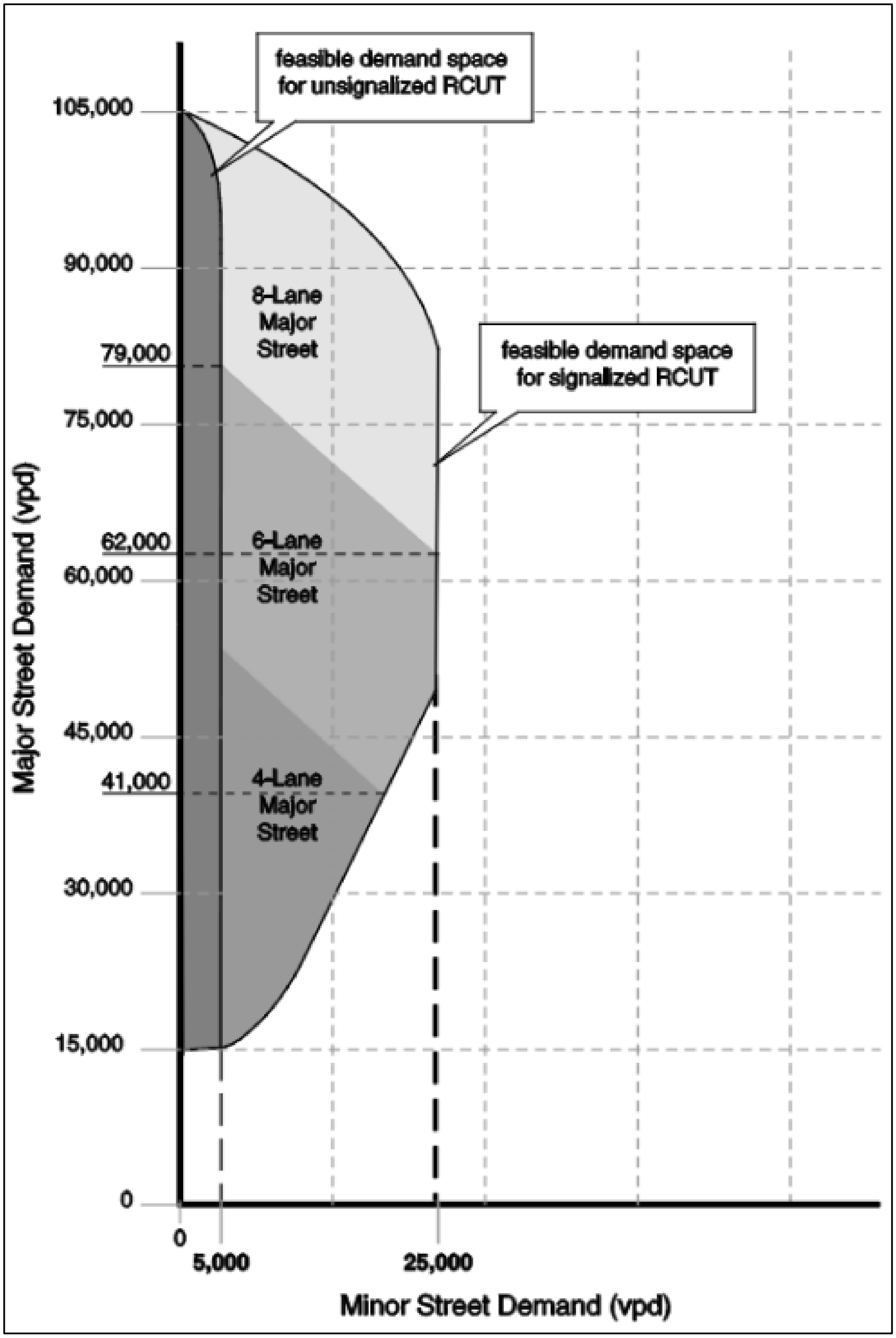


Figure 7: Feasible Traffic Demand for Signalized RCUT Intersections (Exhibit 5-7 FHWA RCUT Informational Guide)

5. NONVEHICULAR ROAD USERS

This section reviews RCUT intersection design strategies for accommodating pedestrians, bicyclists, and transit users.

5.1. PEDESTRIANS

Pedestrian facilities are most often found at signalized RCUT intersections, although they can also be provided at stop-controlled locations. Project teams must decide whether to include pedestrian facilities at a stop-controlled RCUT intersection.

The most common configuration for pedestrian facilities at stop-controlled RCUT intersections are direct crossings of intersection approaches (Figure 8). If an intersection may be signalized in the future, consider installing raised channelization at the main intersection wide enough to support a sidewalk or shared-use path. This allows for a future conversion to a Z-type crossing.

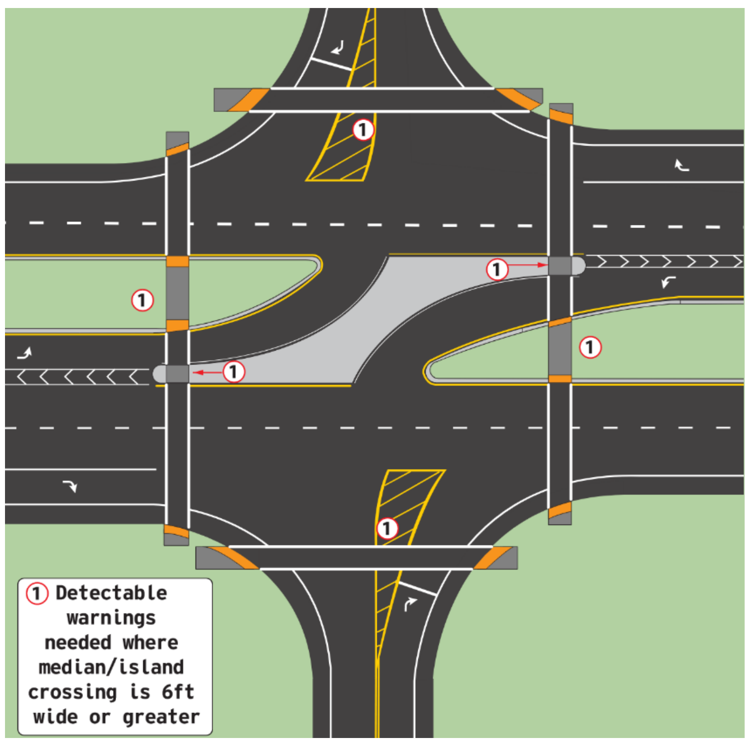


Figure 8: Direct Pedestrian Crossing

At signalized RCUT intersections, the Z-type crossing is the preferred method for accommodating pedestrians (Figure 9). Rather than crossing the main road directly, pedestrians traverse one main road approach to reach raised channelization in the center of the intersection. After moving across the channelized area, they cross the intersection approach on the opposite side of the main road to complete the walking movement.

Crossings on minor road approaches function the same as at conventional intersections. From above, the overall crossing pattern resembles the letter Z. Figure 10 illustrates an option for a more direct pedestrian crossing, which is possible when minor road approaches are offset to increase separation between left-turn lanes.

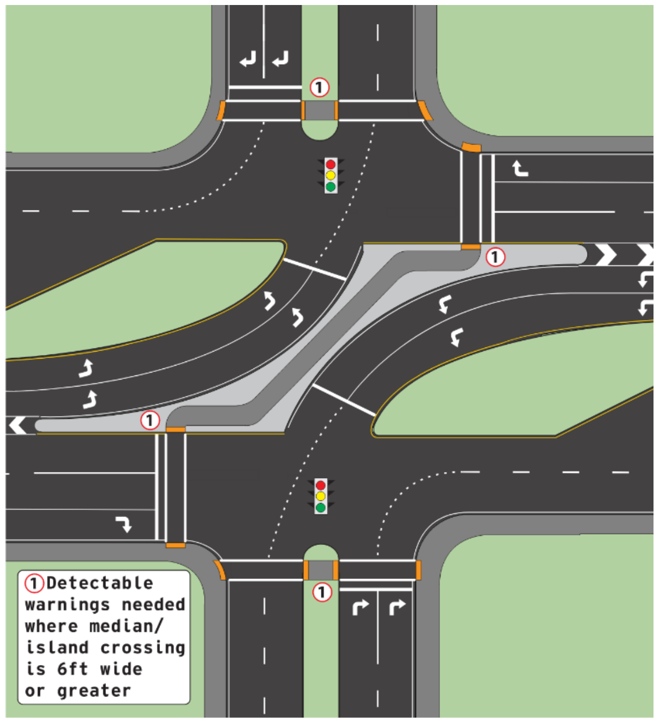


Figure 9: Z-Type Pedestrian Crossing

On a Z-type crossing, pedestrians walk a longer distance to traverse the main road than they do at a conventional intersection. Since pedestrians cannot cross the main road directly, it is suggested to space pedestrian ramp locations so that a single ramp can serve each crossing point. Ramp Types 1, 2, or 4 (see KYTC Standard Drawing RPM-170) are the most applicable configurations because they help pedestrians with vision disabilities remain oriented and cross along the correct path.

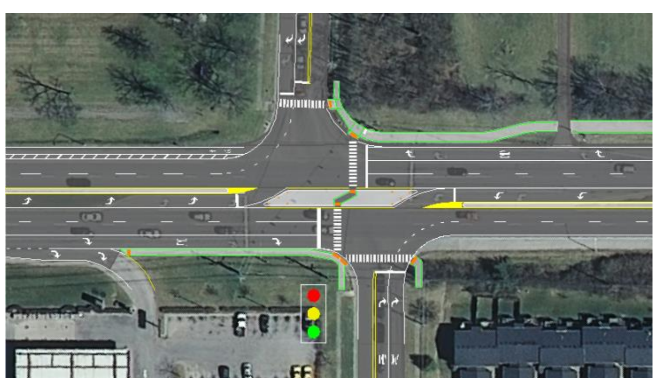


Figure 10: Signalized Offset Intersection Pedestrian Crossing (US 25 at Yorkshire Blvd.)

At signalized three-legged RCUT intersections, a direct crossing of the main road can be provided (Figure 11). However, this requires adding a mid-block pedestrian crossing that traverses the main road lanes on the side opposite the minor road approach.

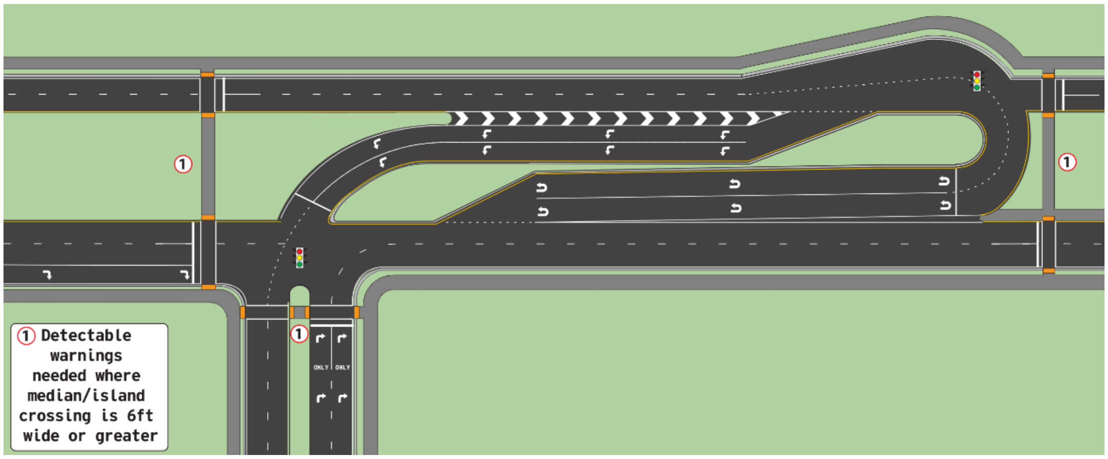


Figure 11: Signalized Three-Legged RCUT Pedestrian Crossing

Signalized RCUT intersections can also accommodate pedestrians at median U-turn openings. This is particularly beneficial for pedestrian access along corridors that have a series of signalized RCUT intersections — more pedestrian crossing opportunities can be provided than with signalized conventional intersections. Figure 12 illustrates several methods for accommodating pedestrian crossings at signalized median U-turns.

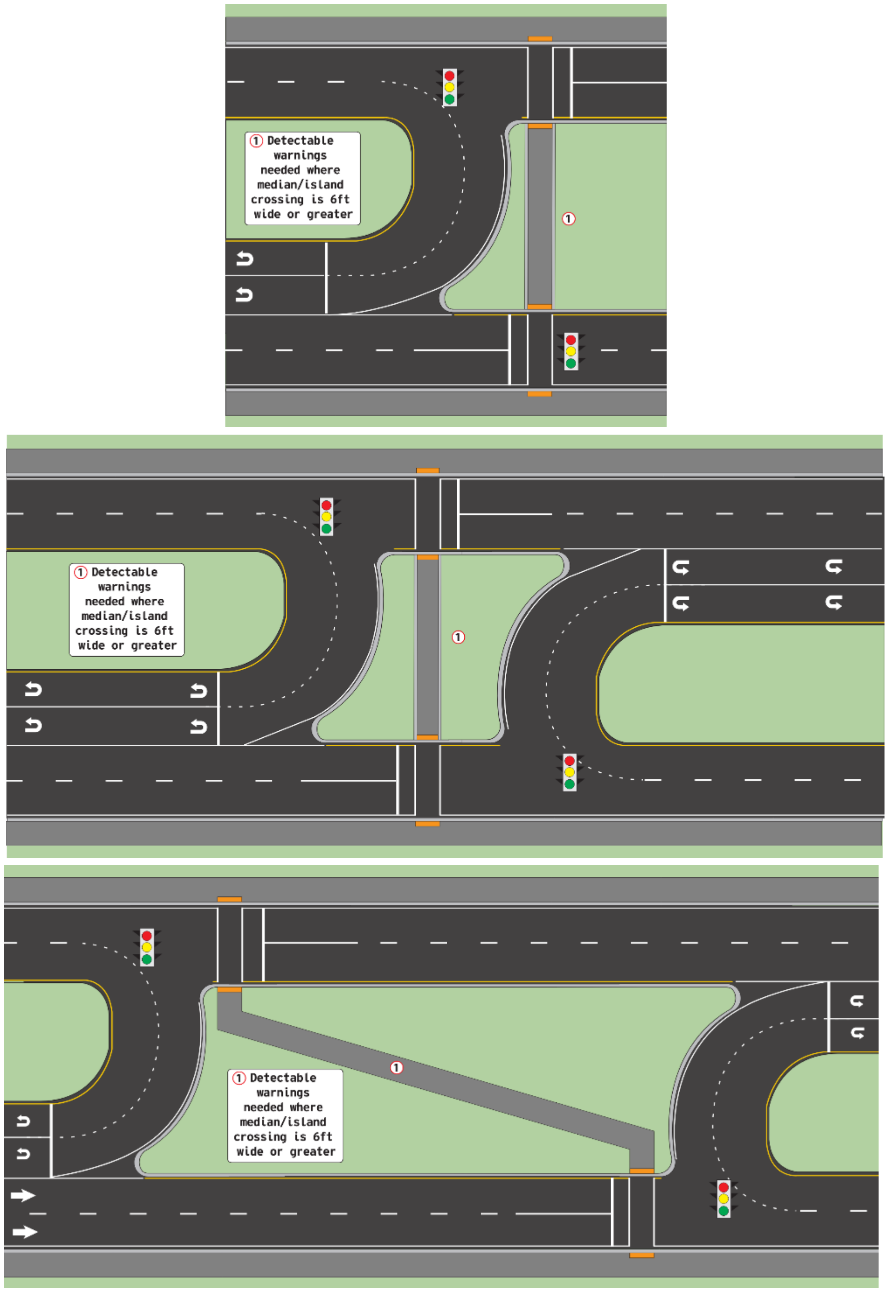


Figure 12: Median U-Turn Pedestrian Crossing Options

When considering a merge (yield) controlled RCUT intersection in areas with known pedestrian activity, be aware that this configuration allows vehicles to maintain higher speeds when turning from the minor road and merging onto main road traffic due to the presence of acceleration lanes. In locations where pedestrian activity is expected, a stop-controlled or signal-controlled RCUT intersection may be a more appropriate choice.

5.2. BICYCLISTS

At stop-controlled and signal-controlled RCUT intersections, bicyclists traveling the main road use turn lanes to access the minor road, or they remain in the bike lane to continue through on the main road (similar to a conventional intersection). Where a shared-use path is present, bicyclists and pedestrians can utilize the shared facilities provided at the RCUT intersection.

At stop-controlled RCUT intersections, bicyclists on the minor road wanting to proceed through the intersection or turn left do not have the same direct route options. Where pedestrian facilities are present, it is preferable for bicyclists to use these to complete their crossing. If there are no pedestrian facilities, bicyclists navigate the RCUT intersection as a vehicle would, by turning right onto the main road and using the median U-turn (Figure 13).

At signal-controlled RCUT intersections, bicyclists on the minor road are encouraged to use pedestrian facilities to navigate their crossing.

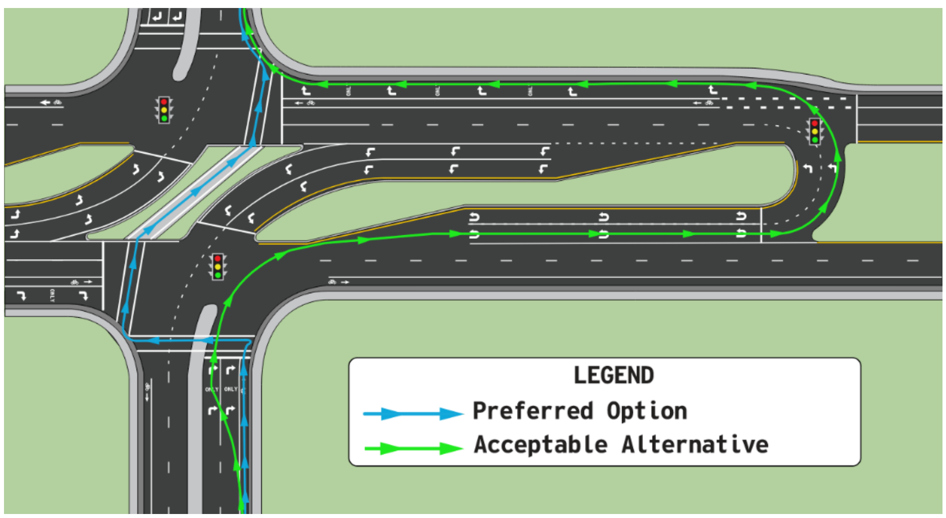


Figure 13: RCUT Minor Road Bicycle Crossings

Project teams are encouraged to verify whether a US Bicycle Route passes through the proposed RCUT intersection location. These routes may generate higher volumes of bicycle traffic on rural roadways.

5.3. TRANSIT

In urban and suburban contexts, transit facilities may need to be considered. The *FHWA Restricted Crossing U-Turn Intersection: Informational Guide* provides guidance on bus stop placement along both the major and minor road legs of an RCUT intersection. Designers should coordinate with local transit authorities to determine appropriate bus stop locations at RCUT intersections.

6. GEOMETRIC DESIGN ELEMENTS

This section covers geometric design elements of RCUT intersections for both individual and multiple installations along a corridor.

6.1. DESIGN VEHICLES

Design vehicles help determine turning radii and establish sight distance needs (see Sections 6.2 and 6.3). Select a design vehicle based on the largest vehicle type expected to execute turning movements at the intersection with notable frequency. Account for site-specific factors (e.g., proximity to a school entrance, fire station, unique traffic generator) when making this selection. Because each turning movement at an RCUT intersection differs, a design vehicle must be selected for each movement to properly define the geometric layout. Sections 6.1.1, 6.1.2, and 6.1.3 discuss recommended design vehicles.

When larger or unique vehicles (e.g., large farm machinery) are expected to make turns at an intersection infrequently, a control vehicle may be selected in addition to the design vehicle. Because accommodating the full pavement width for these control vehicles would create significant impacts, full width is typically not provided. Instead, features such as signs, drainage boxes, headwalls, curbs, and other roadside elements are set back outside the turning paths of control vehicles.

Conduct an Autoturn analysis for the design vehicle and control vehicle. Retain output files in the project design file.

6.1.1. RIGHT TURN ONTO AND FROM MINOR ROAD

For vehicles turning right at the main intersection, the suggested design vehicle is a WB-67 tractor trailer. During the turn, the design vehicle should not encroach onto curbs, raised channelization, raised islands, raised medians, or into opposing traffic lanes (Figure 14). A smaller turning radius is acceptable when a striped area is provided to accommodate truck overtracking as long as pedestrian facilities are not impacted, appropriate pavement markings are applied, and the overtracking area includes adequate pavement structure. When a truck turns right from the minor road onto the major road, it is expected that both lanes will be used to complete the turn into the nearest receiving lane.

6.1.2. LEFT TURN FROM MAIN ROAD

The suggested design vehicle for vehicles turning left at the main intersection is a WB-67 tractor trailer. During a turn, the design vehicle should not encroach onto curbs, raised channelization, raised islands, or raised medians (Figure 15). Striping an area to accommodate truck overtracking is acceptable, provided pedestrian facilities are avoided and appropriate pavement markings are applied.

6.1.3. MEDIAN U-TURN OPENING

At a single-lane median U-turn opening, two design vehicles are suggested for the U-turn movement: a SU-40 delivery truck and a WB-67 tractor trailer. The SU-40 is used because its larger steering radius governs the outside of the U-turn opening, while the WB-67 is used because the wider sweep of the trailer path governs the inside of the opening. During the turn, neither design vehicle should encroach onto curbs, raised channelization, raised islands, or raised medians (Figure 16).

If design vehicles cannot complete the U-turn within the receiving lanes, refer to Section 6.6 for guidance on paved shoulder and loon design. In urban areas with limited ROW and multiple median U-turn openings along a corridor, not every U-turn location has to accommodate larger vehicles. Proper signing can be used to restrict truck usage at these locations (see Section 8.2).

Different design vehicles may be used for each U-turn lane at a dual U-turn median opening. At a minimum, the outside U-turn lane should accommodate a WB-67 tractor trailer, while the inside lane should accommodate a Passenger Car (P) turning simultaneously. Vehicle type restrictions can be signed to clarify lane usage for drivers (see Section 8.2). Where heavy truck traffic is anticipated, larger design vehicles may be used for the inside U-turn lane.

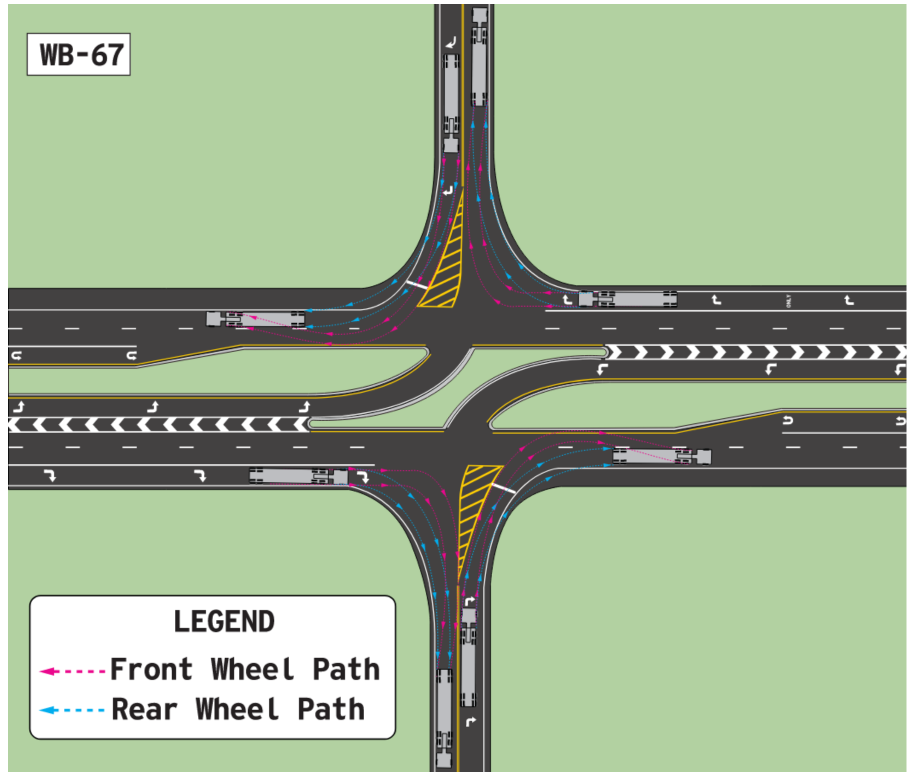


Figure 14: Main Intersection Right-Turn Design Vehicle (WB-67)

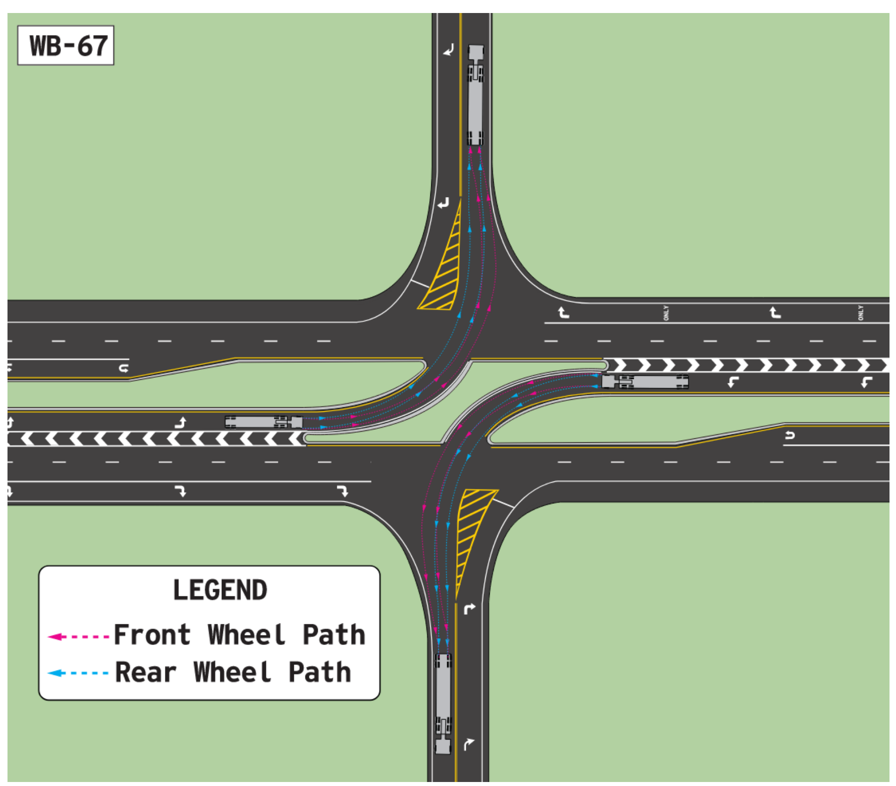


Figure 15: Main Intersection Left-Turn Design Vehicle (WB-67)

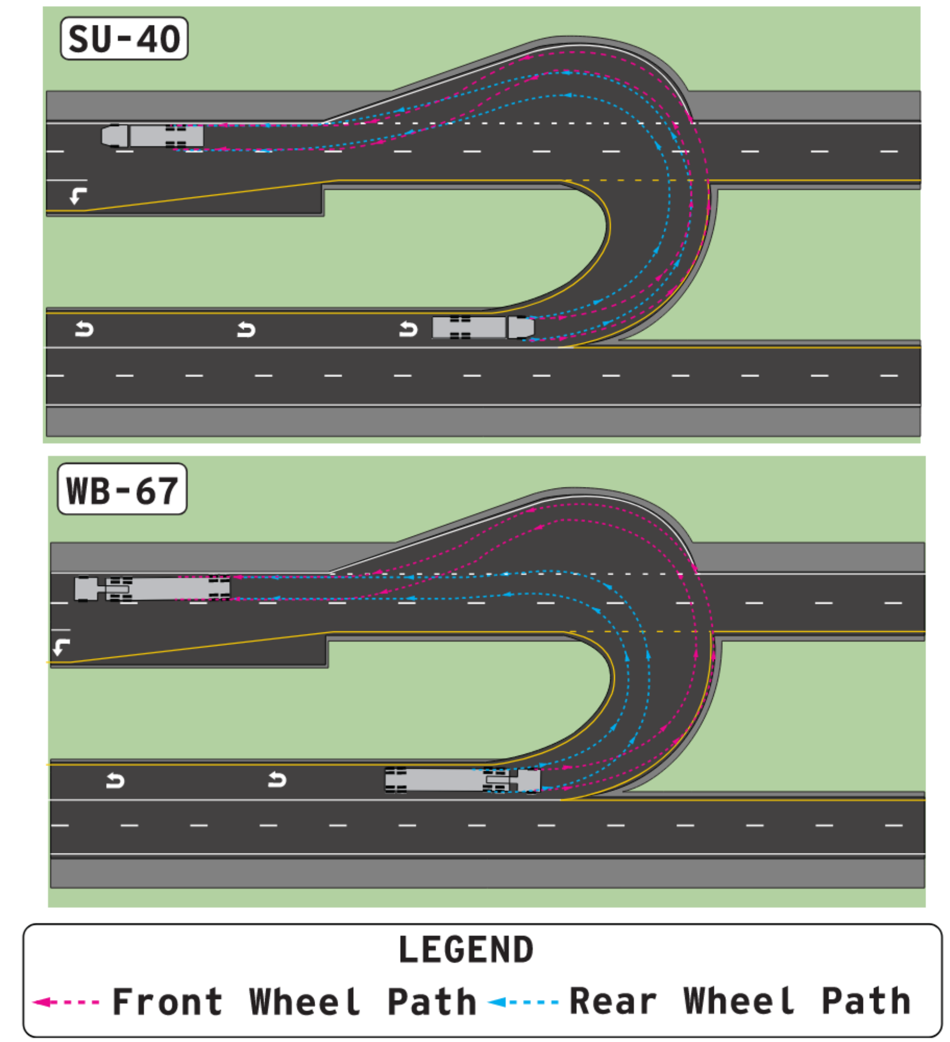


Figure 16: Median U-turn Opening Design Vehicles (SU-40 and WB-67)

6.2. STOPPING SIGHT DISTANCE

Stopping sight distance should be provided at all points through the intersection. This includes the major road approaching median U-turn openings, main intersection, and the length of major road between the median U-turn opening and main intersection. Providing stopping sight distance gives drivers sufficient length of roadway to avoid striking an unexpected object in the traveled way.

Stopping sight distance calculations, including the effects of grade, can be found in Chapter 3 of the Green Book. Exhibits 700-01 through 700-05 in KYTC's *Highway Design Guidance Manual* (HDM) list minimum stopping sight distance lengths for different roadway classifications and contexts.

6.3. INTERSECTION SIGHT DISTANCE

Drivers approaching an intersection should have an unobstructed view of the entire intersection so they can see all traffic control devices and a sufficient length along the intersecting highway to anticipate and avoid potential collisions.

At RCUT intersections, intersection sight distance (ISD) is checked for the following conditions:

- Minor road right turn to major road
- Major road left turn to minor road
- Major road median U-turn

Signalized RCUT intersections also have ISD needs.

Check ISD for a passenger car design vehicle (P) and a combination truck (e.g., WB-67). The driver eye height to use for a passenger car design vehicle is 3.5 ft.; for a combination truck it is 7.6 ft. The object height for ISD is 3.5 ft. Clear sight triangles between the driver eye and the object, accounting for horizontal and vertical alignment must be provided.

While one equation (Equation 1) is used to determine each ISD case (e.g., right turn from minor road), different time gaps are selected for different maneuvers and design vehicles. Depending on the case, the basic ISD equation is adjusted for number of lanes crossed, median width crossed, and approach grades. Given the uniqueness of each case, the designer should keep ISD calculations in the design file.

$$ISD = 1.47 * V_{major} * t_g$$
$$ISD = intersection\ sight\ distance\ (feet)$$
$$V_{major} = major\ road\ design\ speed\ (mph)$$
$$t_g = time\ gap\ (seconds)$$

Equation 1: Basic ISD Equation (AASHTO Equation 9-1, Green Book, 2018, pg. 9-45)

6.3.1. RIGHT-TURN FROM MINOR ROAD — AASHTO CASE B2

Check ISD for the minor road stop-controlled approach to an RCUT intersection using AASHTO Case B2 (*Right Turn from the Minor Road*). Time gaps (t_g) are selected by design vehicle and adjusted for minor road approach upgrades that exceed 3% (Green Book Table 9-8). A clear sight triangle must be provided to the left for a vehicle stopped on the minor road approach (Figure 17). Consult the Green Book (Section 9.5.3.2.2) for more information.

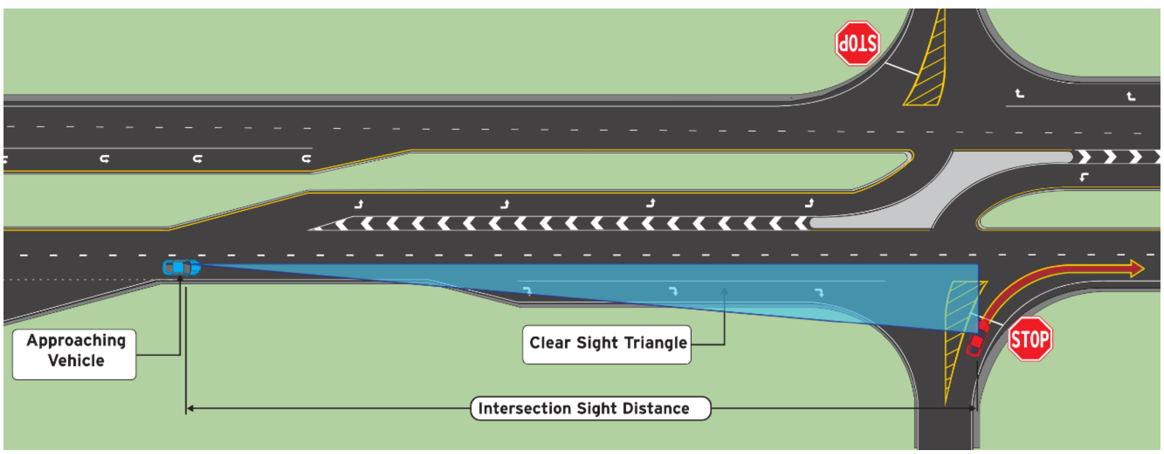


Figure 17: Right-Turn from Minor Road Sight Triangle

6.3.2. LEFT-TURN FROM MAJOR ROAD — AASHTO CASE F

Check ISD for the major road left-turn approach at the main intersection using AASHTO Case F (*Left Turns from the Major Road*). Time gaps (t_g) are selected by design vehicle and adjusted for the number of lanes crossed and median width crossed (Green Book Table 9-16). A clear sight triangle must be provided toward approaching traffic for a vehicle stopped in the major road left-turn lane (Figure 18). Consult the Green Book (Section 9.5.3.6) for more information.

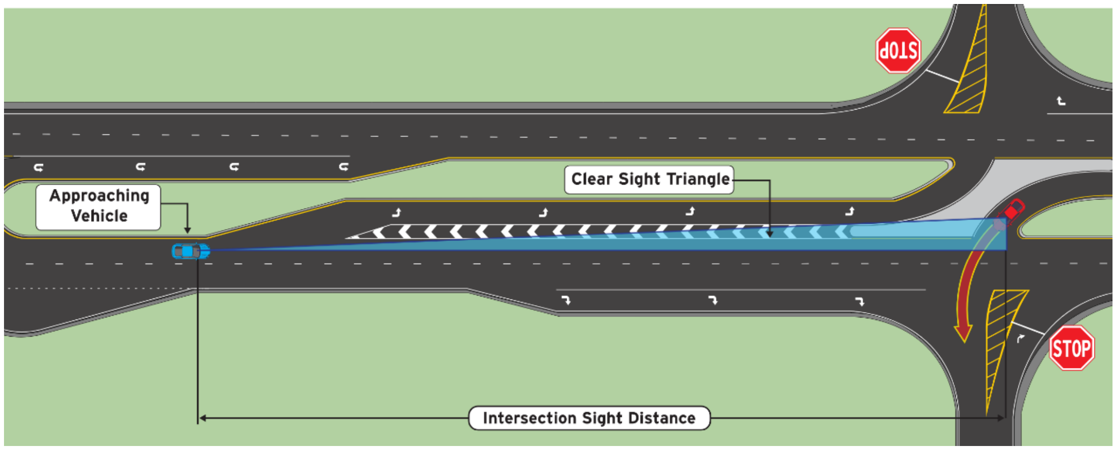


Figure 18: Left Turn from the Major Road Sight Triangle

6.3.3. MAJOR ROAD U-TURN

Check ISD at major road median U-turn openings. While the Green Book does not provide a specific method for calculating U-turn ISD, a Georgia Department of Transportation research study developed an approach based on Green Book principles to address this gap. The calculation follows a multistep process:

Step 1: Select a design vehicle.

Step 2: Determine whether the U-turn maneuver will follow a 90-degree path or 180-degree path based on the median nose width, using Table 6, Figure 19, and Figure 20.

Table 6: U-Turn Maneuver Selection from Median Nose Width

Design Vehicle	Median Nose Width (See Figure 19)	U-turn Maneuver (See Figure 20)
Passenger Car	< 14 feet	180-degree
	≥ 14 feet	90-degree
Single Unit Truck	Any width	180-degree
Combination Truck		

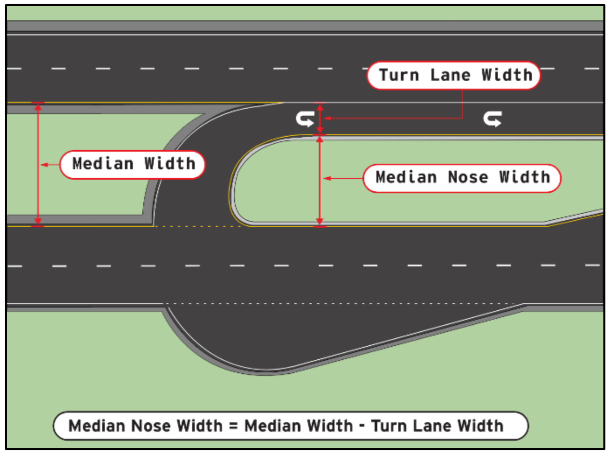


Figure 19: Median Nose Width Measurement

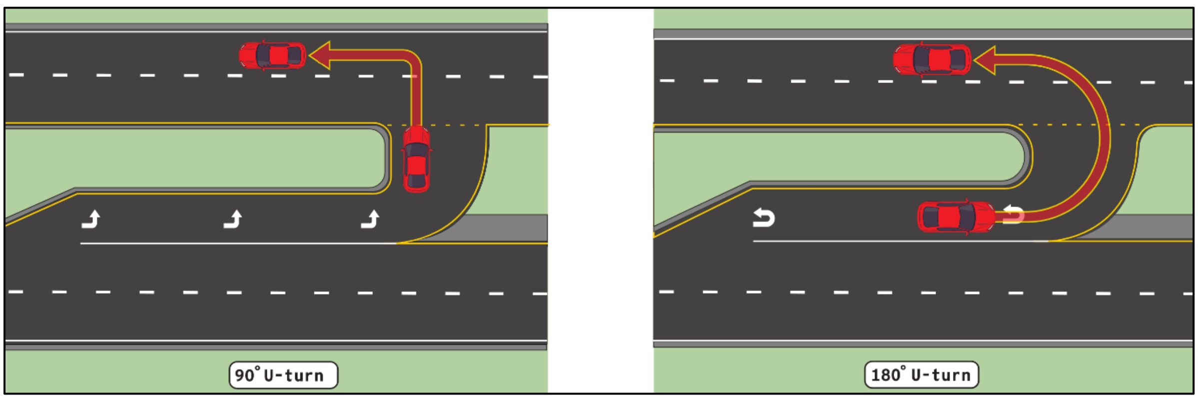


Figure 20: Type of U-Turn Maneuver

Step 3: Use the main road design speed and U-turn maneuver type to determine the base U-turn ISD from Table 7.

Table 7: Base U-Turn Intersection Sight Distance

	U-turn Maneuver	
Design Speed (mph)	**90-degree U-turn (ft)**	**180-degree U-turn (ft)**
25	220	275
30	290	360
35	370	450
40	450	545
45	540	640
50	625	740
55	745	870
60	835	975
65	1010	1155

Step 4: Apply an approach grade adjustment factor from Table 8 to the base U-turn ISD obtained for the design speed. The grade used should correspond to the grade of the main road in the direction of travel approaching the median U-turn opening.

Table 8: Grade Adjustment Factors

Approach Grade (%)	Design Speed (mph)								
	25	30	35	40	45	50	55	60	65
-6	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2
-5	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2
-4	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
-3 to +3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
+4	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9
+5	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
+6	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Step 5: If the design vehicle is a single unit truck or a combination truck apply the appropriate correction factor from Table 9.

Table 9: Truck Correction Factors

Design Vehicle	Correction Factor
Passenger Car	1.00
Single Unit Truck	1.27
Combination Truck	1.53

Provide a clear sight triangle toward approaching traffic for a vehicle stopped in the median U-turn opening (Figure 21).

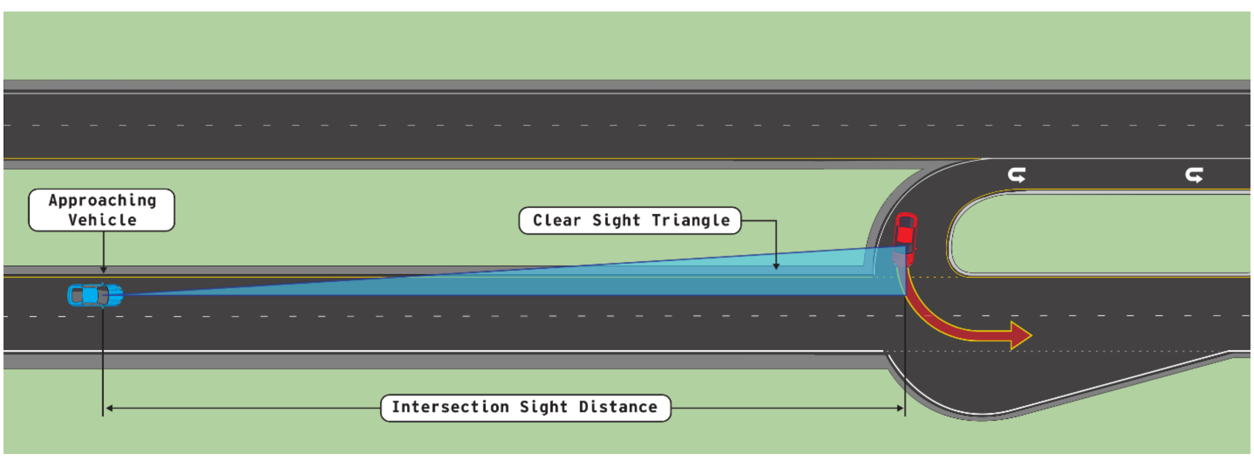


Figure 21: U-Turn from the Major Road Sight Triangle

6.3.4. SIGNALIZED RCUT INTERSECTION — AASHTO CASE D

Check ISD for signalized intersections, whether at the main intersection or at the median U-turn opening, using AASHTO Case D (*Intersections with Traffic Signal Control*). At traffic signals, the first vehicle stopped on one approach should be visible to the drivers of the first vehicles stopped on all other approaches.

Where right turn on red (RTOR) is permitted from the minor road approach, AASHTO Case B2 is to be provided (see Section 6.3.1). Where permissive left turns are allowed from the main intersection, AASHTO Case F is to be provided (See Section 6.3.2). Consult the Green Book (Section 9.5.3.4) for more information.

6.4. U-TURN LOCATION SPACING

Locate the median U-turn opening as close to the main intersection as practical. This minimizes travel times for motorists on the minor road using the U-turn. For stop-controlled and signal-controlled RCUT intersections, spacing typically falls in the 600 – 1,000 ft. range (Figure 22). For merge (yield) controlled RCUT intersections, spacing is greater, up to 0.5 miles.

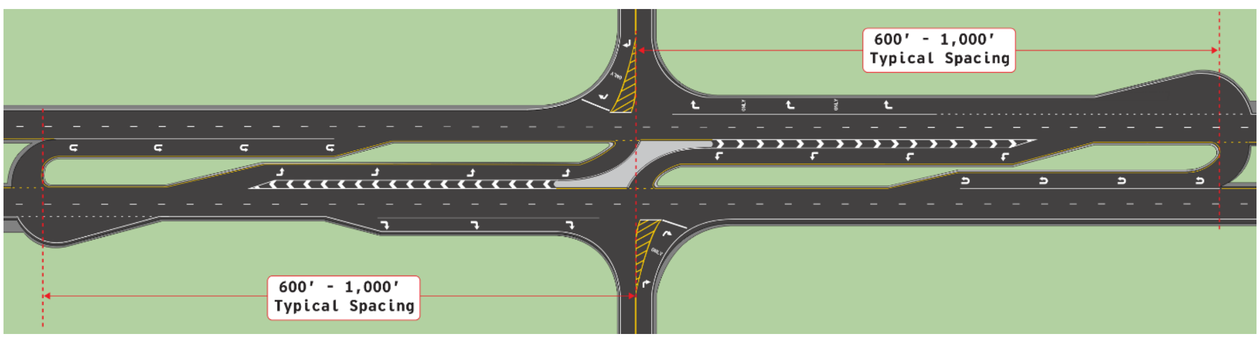


Figure 22: Stop-Controlled and Signal-Controlled RCUT Median U-Turn Opening Typical Spacing

When setting the location for a median U-turn opening, the minimum spacing should be long enough to accommodate deceleration and storage lengths of both the U-turn lane and main road left-turn lane. Table 10 lists factors to consider when establishing median U-turn opening locations.

Table 10: Median U-Turn Opening Location Factors

U-Turn and Left-turn Lane Lengths	At a minimum, the median U-turn opening should be spaced to accommodate deceleration and storage lengths.
Median Width	Wider medians can allow overlap in U-turn and left-turn lanes, resulting in shorter distances.
Intersection Sight Distance	Adjust location to obtain U-turn ISD. Consider horizontal and vertical geometry as well as other sight obstructions.
Feature Avoidance	Avoid placing a U-turn (and loon, if present) where a bridge, box culvert, utility, or other roadside feature is present that cannot be relocated.
Superelevation	If possible, avoid locating a U-turn with a loon in a superelevated section. This results in larger grade differences at the far edge of the loon.
Right-of-Way Restriction	Adjust a U-turn with a loon location where ROW is constrained.
Driveway/Access Point	Adjust the U-turn to avoid an entrance or access point. See Section 6.10 for more information.
Partial Access Control	Move closer to the main intersection to allow spacing between adjacent RCUT median U-turn openings.

On roadways with multiple RCUT intersections, sufficient spacing between adjacent median U-turn openings is important to maintain clear sight lines. A minimum distance of 100 ft. between adjacent median U-turn openings is suggested (Figure 23). This situation typically occurs along corridors with partial access control, where intersections are spaced 1,200 ft. apart, in rural areas. In cases where an adjacent median U-turn opening already exists or may be added in the future, the distance between the main intersection and median U-turn opening may need to be less than 600 ft. When placing median U-turn openings, evaluate whether adjacent intersections could be converted to RCUT designs in the future.

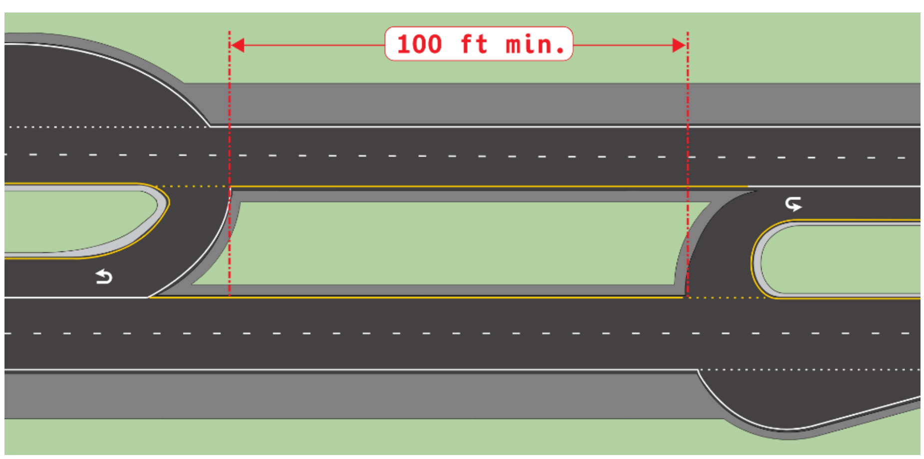


Figure 23: Minimum Distance Between Adjacent Median U-Turn Openings

6.5. INTERSECTION SKEW

Intersection skew angle can influence traffic operations and sight distance. This angle, as measured from the major road centerline to the minor road centerline, should be as close to 90 degrees as practical. If the intersecting angle is less than 75 degrees or more than 105 degrees, ISD may need to be adjusted.

At RCUT intersections the optimal skew angle is 75 – 90 degrees (top of Figure 24). This layout better serves left turns from the main road and right turns from the minor road. Skew angles greater than 90 degrees (bottom of Figure 24) are not preferred because they increase overtracking for vehicles turning left from the major road and increase the amount of time needed to complete a turning maneuver.

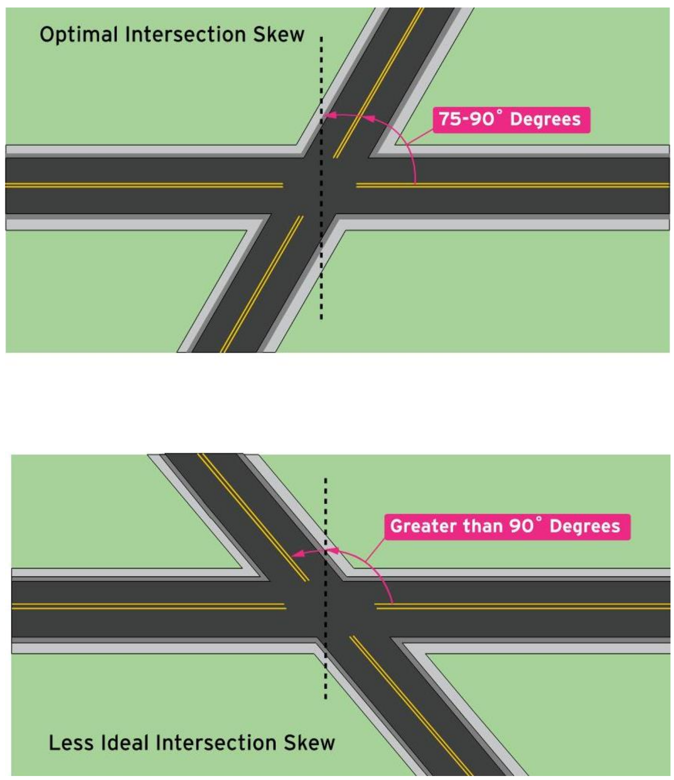


Figure 24: Intersection Skew Angles

If an existing intersection with an intersection skew angle greater than 90 degrees is being considered for conversion to an RCUT intersection, it can benefit from offsetting the intersection (Figure 25).

Offsetting minor road approaches when greater than 90 degrees at an RCUT intersection does not negatively impact safety since vehicles turning left do not overlap other turning, merging, or diverging movements. At signalized RCUT intersections, this offsetting has the added benefit of providing a shorter pedestrian crossing distance than the Z-type crossing.

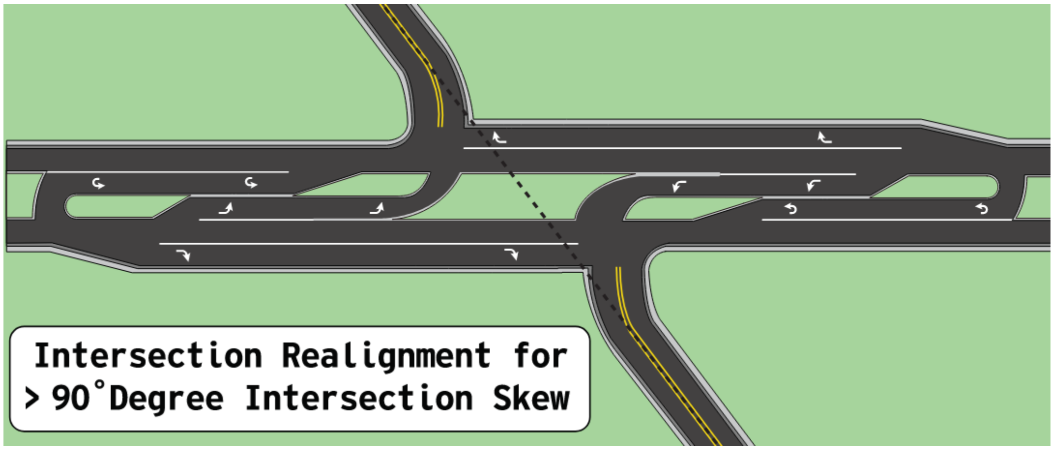


Figure 25: RCUT Intersection Realignment

6.6. MAJOR ROAD MEDIAN U-TURN OPENING

Median U-turn openings from the major road are divided into two categories: single-lane and dual-lane median U-turn openings. U-turn dimensions are based on the design vehicles selected for this turning movement (see Section 6.1.3).

Plan sheets must denote all relevant dimensions, including radius values, station and offset values, beginning and ending points of transitions and tapers, and dimensions of raised medians (where applicable). Retain Autoturn files in the project design file.

Unless needed to manage access to nearby driveways or side streets, median U-turn openings on divided highways with depressed medians do not typically include raised islands.

6.6.1. SINGLE-LANE MEDIAN U-TURN

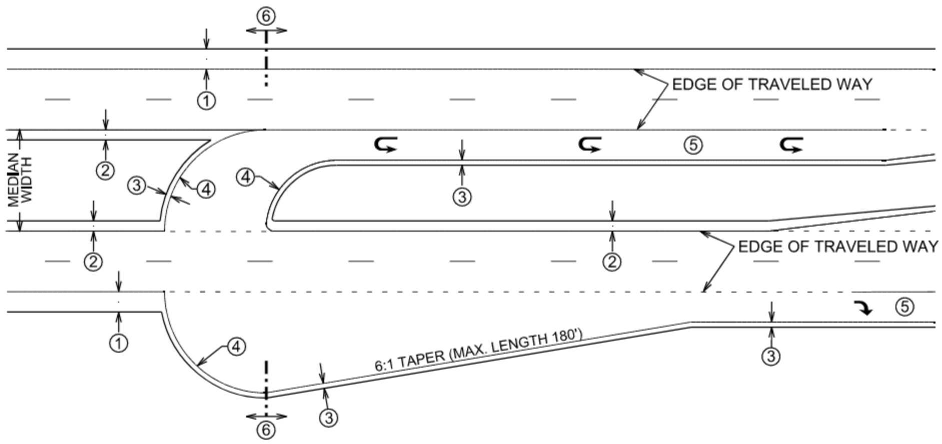
If the receiving travel lanes are not wide enough to accommodate the design vehicle(s), a paved shoulder can be used or a loon constructed.

If a paved shoulder is to be used, investigate existing shoulder pavement depths to determine if the pavement structure can support U-turning vehicles.

Use of a tapered loon design (Figure 26) is suggested over pavement closely matching vehicle turning paths. Where standard curb and gutter is not present through the loon, provide a 2 ft. paved shoulder (1 ft. minimum) that matches the main road pavement depth.

If a loon will be located on a superelevated roadway section, consider its effects on the loon (e.g., cut/fill, drainage onto roadway or into a sump, ROW impacts).

MEDIAN U-TURN OPENING TYPICAL DIMENSIONS



① SEE PROJECT PLANS FOR PAVED SHOULDER WIDTH.

② IF DESIGN SPEED IS 50 MPH OR GREATER, PROVIDE A PAVED SHOULDER WITH A MINIMUM WIDTH OF 4 FEET.

IF DESIGN SPEED IS 45 MPH OR LESS, PROVIDE EITHER A PAVED SHOULDER WITH A PREFERRED WIDTH OF 2 FEET (1 FOOT MINIMUM) OR CURB AND GUTTER WITH A PREFERRED GUTTER PAN WIDTH OF 2 FEET (1 FOOT MINIMUM).

③ AT THE INSIDE OF THE U-TURN LANE, MEDIAN OPENING, LOON, AND RIGHT-TURN LANE, PROVIDE EITHER A PAVED SHOULDER WITH A PREFERRED WIDTH OF 2 FEET (1 FOOT MINIMUM) OR CURB AND GUTTER WITH A PREFERRED GUTTER PAN WIDTH OF 2 FEET (1 FOOT MINIMUM).

④ RADII DETERMINED USING DESIGN VEHICLE(S).

⑤ SEE HIGHWAY DESIGN MANUAL CHAPTER 902 FOR TURN LANE LENGTH DETERMINATION.

⑥ IF ACCESS POINTS ARE LOCATED WITHIN 100 FEET UPSTREAM OR DOWNSTREAM OF THE U-TURN OPENING ON EITHER SIDE OF THE MEDIAN, PROVIDE A RAISED ISLAND IN THE MEDIAN.

7. SEE SECTION 8 FOR SIGNING AND PAVEMENT MARKING LAYOUT DETAILS.

Figure 26: Typical Single Lane Median U-turn Layout

6.6.2. DUAL-LANE MEDIAN U-TURN

Dual-lane median U-turns are only appropriate at signalized RCUT intersections. Reserve their use for locations where traffic analysis demonstrates they will improve intersection operations. A tapered loon design (Figure 27) is recommended over pavement that closely follows vehicle turning paths. The shoulder width and superelevation design elements that apply to single-lane median U-turns also apply to dual-lane configurations.

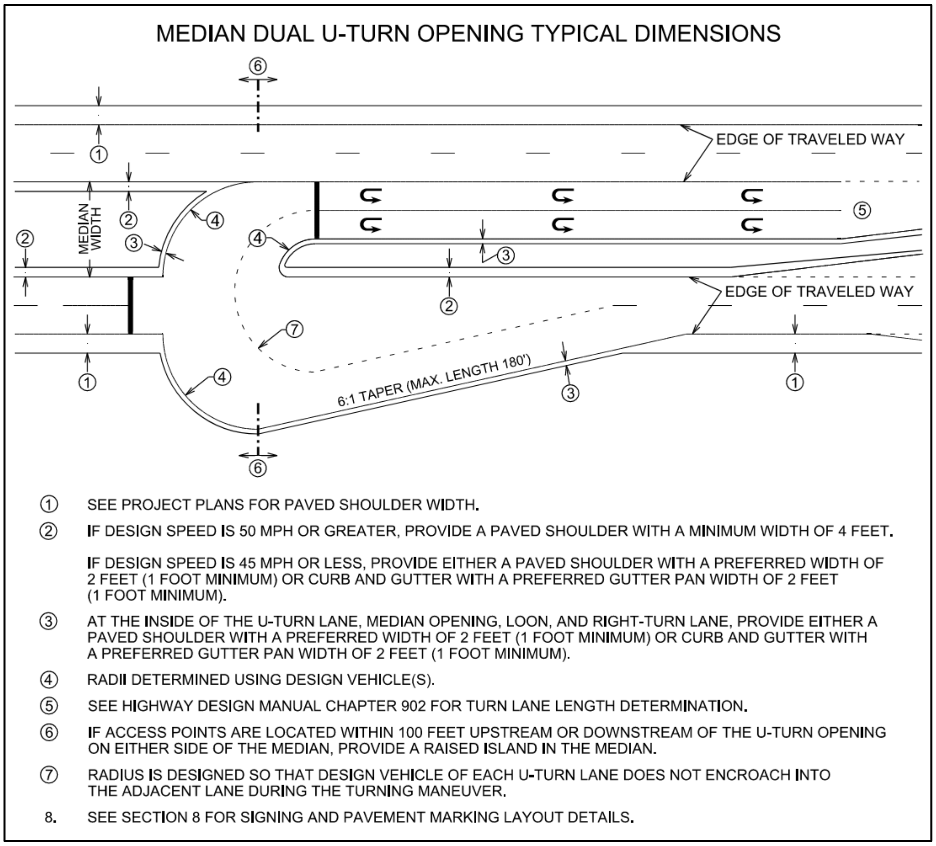


Figure 27: Typical Dual Lane Median U-turn Layout

If traffic forecasts indicate dual U-turn lanes will not be necessary until near the design year, the pavement and supporting components can be sized for a dual U-turn lane ultimate configuration. In this scenario, only striping and traffic signals for a single U-turn are installed initially.

6.6.3. RIGHT-TURN LANE BETWEEN MAIN INTERSECTION AND MEDIAN U-TURN

Where budget and site conditions permit, extending the main road right-turn lane back to connect with the loon is recommended (Figure 28). This allows vehicles completing a median U-turn to turn directly into the right-turn lane without merging back into main road traffic.

If the right-turn lane is extended where a dual U-turn lane is present, striping should indicate which U-turn lane connects to the right-turn lane (see Section 8.2). Where standard curb and gutter is not present along the right-turn lane, provide a 2 ft. paved shoulder (1 ft. minimum), matching the main road pavement depth.

Figure 28: Right-Turn Lane Between Median U-turn and Main Intersection (Source: Google Earth)

6.7. MAJOR ROAD LEFT-TURN OPENING

Tapered left-turn lanes with positive offset between opposing left-turn lanes at the main intersection are preferred where median width permits. Narrower medians are more likely to require parallel left-turn lane configurations. Raised channelization at the main intersection can help achieve the desired positive offset.

Left-turn lane widths should generally match lane widths on the main road. On reconstruction projects with existing 12-ft. lanes, 11-ft. lanes within the median are acceptable when necessary to avoid conflicts with existing drainage structures.

Plan sheets should denote all relevant dimensions, including radius values, station and offset values, beginning and ending points of transitions and tapers, and raised median dimensions where applicable. Retain AutoTurn files in the project design file.

6.8. TURN LANE DECELERATION LENGTH

Deceleration and storage lengths for main road left-turn, U-turn, and right-turn lanes should be designed in accordance with methods outlined in HDM Section HD-902. The HDM method also allows for the provision of full deceleration and storage on high-speed roadways ($\geq$ 50 mph), consistent with Green Book Table 9-20.

Although U-turn lanes are not specifically addressed in the HDM, the methods used to determine left-turn lane dimensions can be applied. Where conditions allow (e.g. wider medians, having sufficient budget) extend the U-turn deceleration lane back toward the main intersection to provide a more direct path for minor road turning vehicles entering the U-turn lane.

Final design plan sheets must include all relevant geometric information, such as taper rates, taper beginning and ending station/offset points, and turn-lane lengths.

6.9. CHANNELIZATION

Channelization is important for directing motorists into the appropriate lanes and to minimize the potential for wrong-way movements, such as traffic on the minor road attempting a left turn at the main intersection.

Plan sheets should identify the type of curbing used, dimensions of channelization, including station/offset values for the beginning and ending points of radii, as well as applicable bid items and quantities for each type of channelization.

6.9.1. LEFT-TURN LANE CHANNELIZATION

Raised channelization is used in the median between opposing left-turn lanes at the main intersection (Figure 29). Raised channelization should extend 200 ft. (100 ft. in each direction from the main intersection). If site conditions are constrained, a minimum length of 100 ft. may be used (50 ft. in each direction).

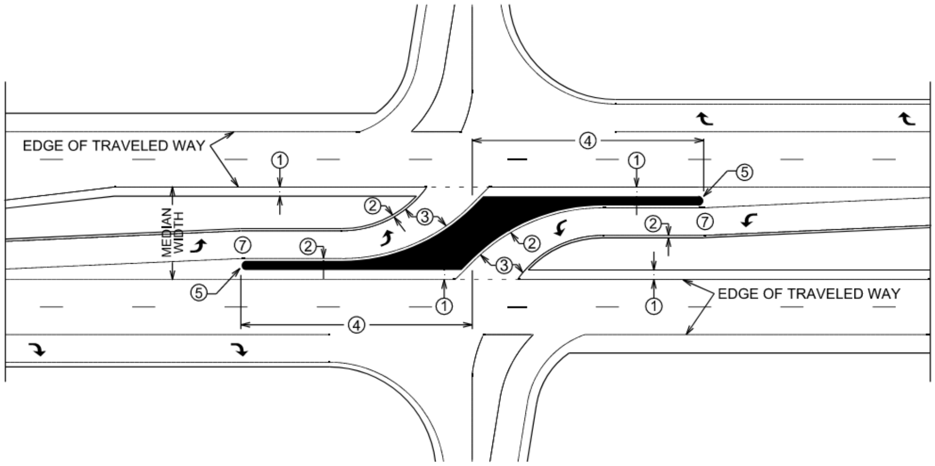
Channelization should consist of 6-in. tall standard curbing (see KYTC Standard Drawing RPM-100). The leading edge of channelization, where it faces oncoming traffic is to be tapered down as indicated in KYTC Standard Drawing RPM-010.

On high-speed roadways (≥ 50 mph), curbing should be placed 4 ft. from the main road travel lanes. On low-speed roadways (≤ 45 mph), placing curbs 2 ft. (1 ft. minimum) from travel lanes is acceptable. Along the left-turn lane, curbs may be offset 1 – 2 ft.

Where a pedestrian crossing is present or anticipated in the future, raised channelization should be wide enough to accommodate a pedestrian facility (e.g., sidewalk, shared-use path).

Additional guidance on striping, pavement markings around the main intersection channelization, and placement of tubular markers atop the raised median is provided in Section 8.

MAIN INTERSECTION LEFT-TURN LANE CHANNELIZATION



① IF DESIGN SPEED IS 50 MPH OR GREATER, PROVIDE A PAVED SHOULDER WITH A MINIMUM WIDTH OF 4 FEET.

IF DESIGN SPEED IS 45 MPH OR LESS, PROVIDE EITHER A PAVED SHOULDER WITH A PREFERRED WIDTH OF 2 FEET (1 FOOT MINIMUM) OR CURB AND GUTTER WITH A PREFERRED GUTTER PAN WIDTH OF 2 FEET (1 FOOT MINIMUM).

② ALONG THE LEFT-TURN LANE, PROVIDE EITHER A PAVED SHOULDER WITH A PREFERRED WIDTH OF 2 FEET OR CURB AND GUTTER WITH A PREFERRED GUTTER PAN WIDTH OF 2 FEET. WHERE EXISTING DRAINAGE STRUCTURES ARE TO BE REUSED, A MINIMUM 1' PAVED SHOULDER WIDTH OR 1' GUTTER PAN CAN BE USED.

③ EDGE OF PAVEMENT RADII DETERMINED USING DESIGN VEHICLE(S). OUTSIDE RADIUS FOLLOWS PATH OF LEFT FRONT WHEEL AND INSIDE RADIUS FOLLOWS PATH OF RIGHT REAR WHEEL.

④ THE MAIN INTERSECTION LEFT-TURN CHANNELIZATION TO EXTEND 100' IN EITHER DIRECTION OF THE MINOR ROAD CENTERLINE. IN CONSTRAINED CONDITIONS A MINIMUM LENGTH OF 50' MAY BE USED.

⑤ THE LEADING EDGES OF LEFT-TURN CHANNELIZATION ARE TO BE TAPERED DOWN OVER 5' AS SHOWN IN STANDARD DRAWING RPM-010.

6. WHERE PEDESTRIAN FACILITIES ARE PRESENT IN MAIN INTERSECTION LEFT-TURN CHANNELIZATION, PROVIDE A MINIMUM CLEAR WIDTH OF 5', EXCEPT WHEN A SHARED USE PATH IS PRESENT, IN WHICH CASE PROVIDE A MINIMUM CLEAR WIDTH EQUAL TO THE WIDTH OF THE SHARED USE PATH.

WHERE PEDESTRIAN FACILITIES ARE NOT PRESENT BUT ARE LIKELY IN THE FUTURE, CONSIDER MAKING THE MAIN INTERSECTION LEFT-TURN CHANNELIZATION WIDE ENOUGH TO ACCOMMODATE A PEDESTRIAN FACILITY IN THE FUTURE.

⑦ SEE HIGHWAY DESIGN MANUAL CHAPTER 902 FOR TURN LANE LENGTH DETERMINATION.

8. SEE STANDARD DRAWING RPM-100 FOR CURB AND GUTTER DIMENSIONS.

9. SEE SECTION 8 FOR SIGNING AND PAVEMENT MARKING LAYOUT DETAILS.

Figure 29: Raised Main Intersection Channelization

6.9.2. MEDIAN U-TURN OPENING CHANNELIZATION

On roadways with depressed medians, raised channelization is generally not required at median U-turn openings unless access points are located at or near the opening.

Where raised channelization is provided, curbing should be offset 4 ft. from the main road travel lanes on high-speed roadways (≥ 50 mph) and 2 ft. (1 ft. minimum) on low-speed roadways (≤ 45 mph). See Section 6.9.1 for additional information. The leading edges of channelization facing oncoming traffic are to be tapered down, consistent with the approach used for left-turn channelization.

Provide a raised median island where access points are located within 100 ft. upstream or downstream of the median U-turn opening on either side of the median. The island should extend a distance sufficient to discourage wrong-way driving, typically at least 50 ft. beyond the access point.

6.9.3. MINOR ROAD APPROACH CHANNELIZATION

Flush painted channelization is preferred over raised channelization on the minor road approach. Typically, this does not include tubular markers. An exception applies at signalized RCUT intersections, where a raised island may be beneficial as a pedestrian refuge for crossing movements. A channelizing island resembling the configuration on the right side of Figure 30 is preferred on this approach because it provides better sightlines for drivers on the minor road looking for gaps in oncoming traffic and promotes reduced turning speeds, both of which are key benefits when pedestrians are present.

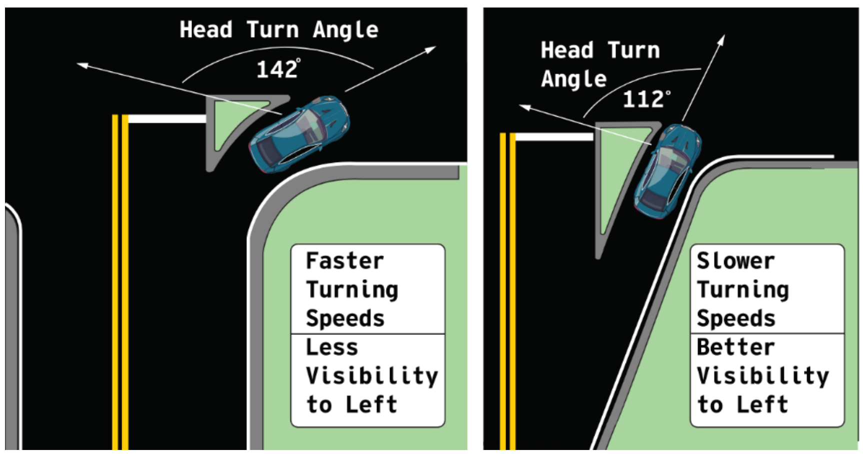


Figure 30: Minor Road Approach Entry Angle (Measured from Driver Facing Forward)

6.10. ACCESS MANAGEMENT

Given that RCUT intersections can extend 600 ft. or more along the main roadway, interactions with entrances, driveways, and other roadways should be anticipated, particularly along urban corridors where access is controlled by permit.

Entrances or driveways located between the main intersection and median U-turn opening should be avoided where possible. Because the raised median facilitates access management along the main road, additional access control can be achieved by restricting right-out movements where alternative exit routes from a parcel are available.

In general, no access points should be located within 100 ft. upstream or downstream of a median U-turn opening on either side of the main road (Figure 31). If neither the median U-turn opening nor the access point can be relocated, a low-volume access point (e.g., single-family residence, farm entrance) may remain across from the U-turn opening on the downstream (receiving) end, permitting left-turn access into the property.

When a loon is present, the access point will be positioned farther from the main road. Therefore, potential impacts on ISD for exiting motorists should be evaluated. If the access point generates higher traffic volumes, relocate either the access point or median U-turn opening. At signalized median U-turn openings, consider the potential effects of nearby access points on signal timing and phasing when determining whether relocation is necessary.

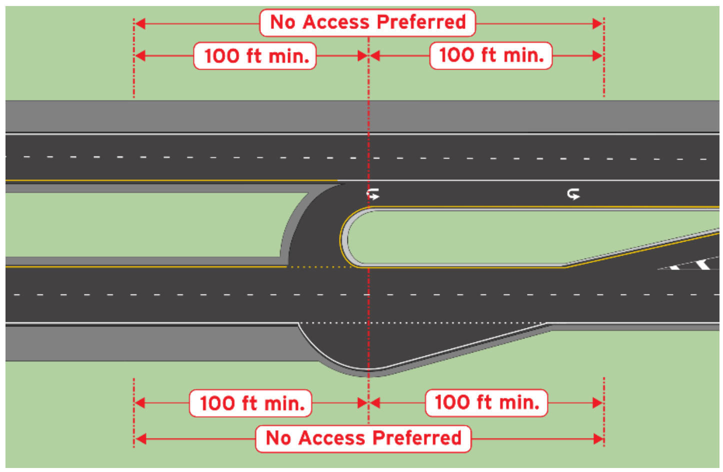


Figure 31: Access Management at Median U-turn Opening

Consider purchasing access at the median U-turn opening to prevent a future access connection at this location if land use changes.

6.11. DRAINAGE AND PAVEMENT DESIGN

Adding raised channelization and deceleration lane pavement within medians and approaches may alter existing drainage patterns. Evaluate pavement cross slopes for left-turn lanes, median U-turn openings, and minor road approaches to establish positive drainage. Make minor adjustments as needed to prevent ponding. Additionally, complete checks to minimize the amount of water flowing across the main or minor roadway (e.g., checks at cuts in raised channelization or at loons placed on the high-side of superelevation).

The preferred method for capturing roadway drainage is to connect curb box inlets to existing drop box inlets in the median, rather than providing a new connection across the main road to the roadside. Another acceptable approach to drainage is providing cuts in raised channelization. These cuts should be wide enough to allow the use of a flat shovel for debris removal.

Match turn lane, U-turn opening, and loon (if present) pavement design with the main road pavement design. Where U-turning vehicles will utilize shoulders, assess the existing pavement structure to determine if it can support anticipated loading. Pavement cores can be used to verify adequacy of the existing structure.

7. RIGHT-OF-WAY AND UTILITY CONSIDERATIONS

At the main intersection, RCUT configurations and conventional intersections have similar ROW needs. However, where median U-turn openings use a loon to accommodate turning vehicles, additional ROW may be necessary. The public involvement resources discussed in Section 2.6 may also help project teams communicate project needs to property owners during ROW acquisition.

Installing RCUT intersections may affect existing utilities. On RCUT intersection projects, project teams may need to identify existing utility locations across a broader area than they would on conventional intersection projects because median U-turn openings are typically located 600 ft. or more from the main intersection.

8. SIGNING AND PAVEMENT MARKINGS

8.1. GENERAL

The *Manual on Uniform Traffic Control Devices* (MUTCD) contains no specific provisions or illustrations that address the unique features of RCUT intersections. Using basic principles from the MUTCD and the Division of Traffic Operations Guidance Manual (TOGM), Figures 32, 33, and 34 illustrate recommended traffic control devices for an isolated rural RCUT intersection. Depending on an intersection's location, design, and other characteristics, traffic control devices may be modified from what is shown in the figures based on engineering judgment. Most signs in the figures are standard MUTCD signs or signs unique to Kentucky that are available from the central sign shop. Layouts for signs unique to RCUT intersections will be published by the Division of Traffic Operations and added to the sign inventory list.

8.2. SIGNING

Figure 32 illustrates typical regulatory, warning, and guide signs for an isolated, rural RCUT intersection where a U.S. route and state route intersect.

The TOGM contains KYTC policy for route signs at intersections and is applicable to RCUT intersections. All numbered U.S. and state highway routes, excluding frontage roads and roads numbered primarily for maintenance purposes, shall be identified by route signs and auxiliary plaques. Route sign assemblies fall into one of four categories: Junction, Advance Route Turn, Directional, or Confirming. MUTCD Chapter 2D contains additional information.

If the minor road is not a numbered state route, street names may be used as destinations on guide signs along RCUT intersection approaches to direct motorists. Adhere to TOGM policy when selecting cities and towns on destination signs.

The WATCH FOR U-TURNS AHEAD warning sign (see Figure 32) may be beneficial at locations where RCUT intersections are first introduced in a region and where drivers may be unaccustomed to U-turning vehicles. On a corridor with multiple RCUT intersections, this sign may be placed at each end of the corridor in advance of the first median U-turn location for each direction of travel. It may also be used as a safety countermeasure at existing RCUT intersections if additional warning is deemed necessary based on crash history or engineering judgment.

In some cases, a median U-turn opening may not be designed to accommodate all design vehicles. At locations with dual median U-turn lanes, some larger vehicles may be restricted to the outside U-turn lane (See Section 6.1.3). In these cases, consult the Division of Traffic Operations for guidance on signing options to restrict specified vehicle classes from U-turns or to restrict certain vehicle classes to a specific lane for U-turn movements.

To prevent vehicles from parking in loons, NO PARKING signs may be installed at the District Traffic Engineer's discretion.

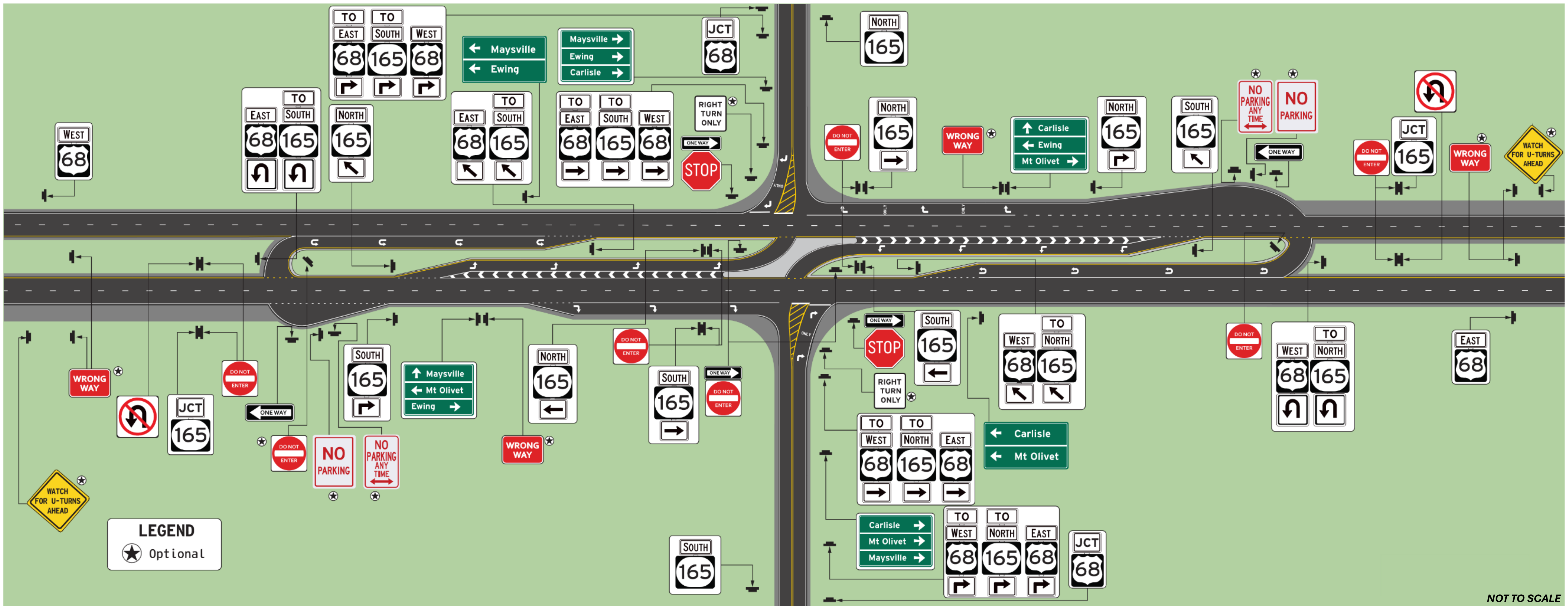


Figure 32: RCUT Intersection Signing Layout - Rural Stop-Controlled

8.3. PAVEMENT MARKINGS

Figure 33 illustrates typical pavement markings for an isolated, rural RCUT intersection. The left side of the illustration shows the loon taper into the main road with a right-turn lane added upstream of the minor road intersection. The right side shows the loon connected to the right-turn lane for the minor road, creating a mandatory lane drop. Signing and pavement markings differ for these scenarios.

Figure 34 illustrates pavement markings for a median dual U-turn opening at a signalized RCUT intersection. Dotted line extensions used to guide vehicles making a U-turn may connect to a different location on the main road depending on how the U-turn lane design vehicle tracks. The recommended orientation and location of the STOP LINE for U-turn vehicles provides optimal visibility of the signal indications controlling those movements.

Section 5 includes guidance on pedestrian and bicycle movements at RCUT intersections. Refer to the TOGM and KYTC Standard Drawings for more information on crosswalks, crosshatching, intersection, symbol, and word pavement markings.

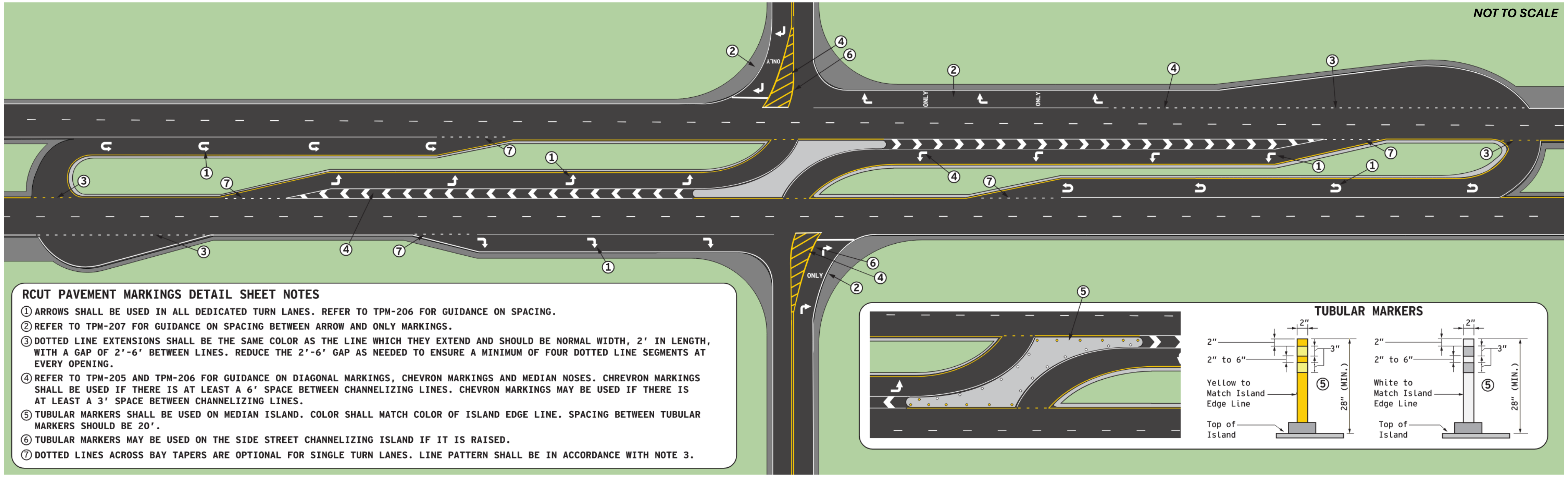


Figure 33: RCUT Intersection Pavement Marking Layout - Rural Stop-Controlled

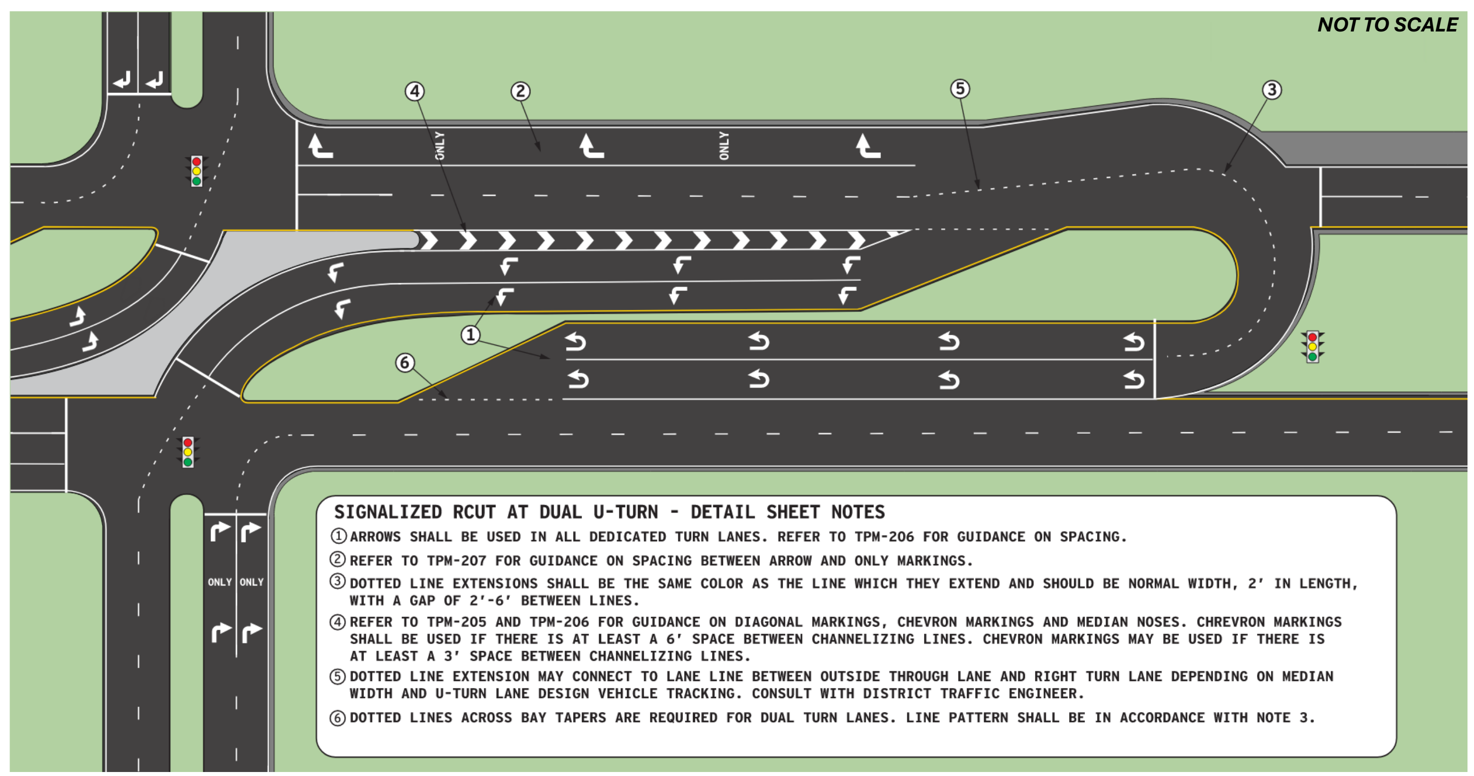


Figure 34: RCUT Dual U-turn Pavement Marking Layout - Signal Controlled

9. TRAFFIC CONTROL SIGNALS

The approval process for traffic control signals at RCUT intersections follows procedures outlined in the TOGM. If signal control is being considered, early coordination between the project team, District Traffic Engineer, and Division of Traffic Operations is critical during the preliminary engineering phase. A traffic control signal is required at locations where (1) dual U-turns are provided at the median U-turn opening or (2) dual left-turns are provided at the main intersection.

The MUTCD does not include procedures to analyze prescriptive warrants for RCUT intersections with displaced turning movements. To determine whether a traffic signal is needed, the Division of Traffic Operations will conduct a warrants analysis that replicates the conflicting traffic movements at a traditional intersection. In addition to warrants analysis, a cross-product evaluation of left-turn and/or U-turn traffic versus the directional through traffic will be completed to determine if a traffic control signal is required. Assess each portion of an RCUT intersection (the main intersection and each median U-turn opening) independently to make this determination.

This guidance omits illustrations of a typical signalized RCUT intersection because signal design varies based on site conditions. Factors to consider during the signal design process include pedestrian accommodations, push button locations, and optimizing the visibility of signal heads along each approach. Early coordination between the project team and District Traffic Engineer should occur to identify potential placement of signs on the signal supports.

Use U-turn signal indications to control U-turning traffic movements, except where protected/permissive phasing is adopted. The MUTCD has no provision for using a flashing yellow U-turn indication to inform motorists of a permissive U-turn. If a protected/permissive phase is needed for U-turn movements, left-turn signal indications must be used.

10. LIGHTING

In most cases, RCUT intersections can operate safely and efficiently without roadway lighting. Signs, pavement markings, and delineation should provide sufficient guidance for motorists to navigate an RCUT intersection correctly. Follow processes and policies outlined in the TOGM when making any recommendations related to roadway lighting at an RCUT intersection. Each portion of an RCUT intersection (the main intersection and each median U-turn opening) may be evaluated independently when making determinations about lighting as well as the roadway segment that incorporates the entire RCUT intersection.

11. CONSTRUCTION

When a conventional intersection is converted to an RCUT intersection, typically the first step is to construct the median U-turn openings and loons (if applicable). Next, the main intersection is reconfigured. Figure 35 illustrates maintenance of traffic during each phase of construction.

For projects with larger footprints (e.g., widening a corridor from a two-lane undivided roadway to a four-lane divided facility incorporating RCUT intersections), a more detailed construction phasing plan is necessary.

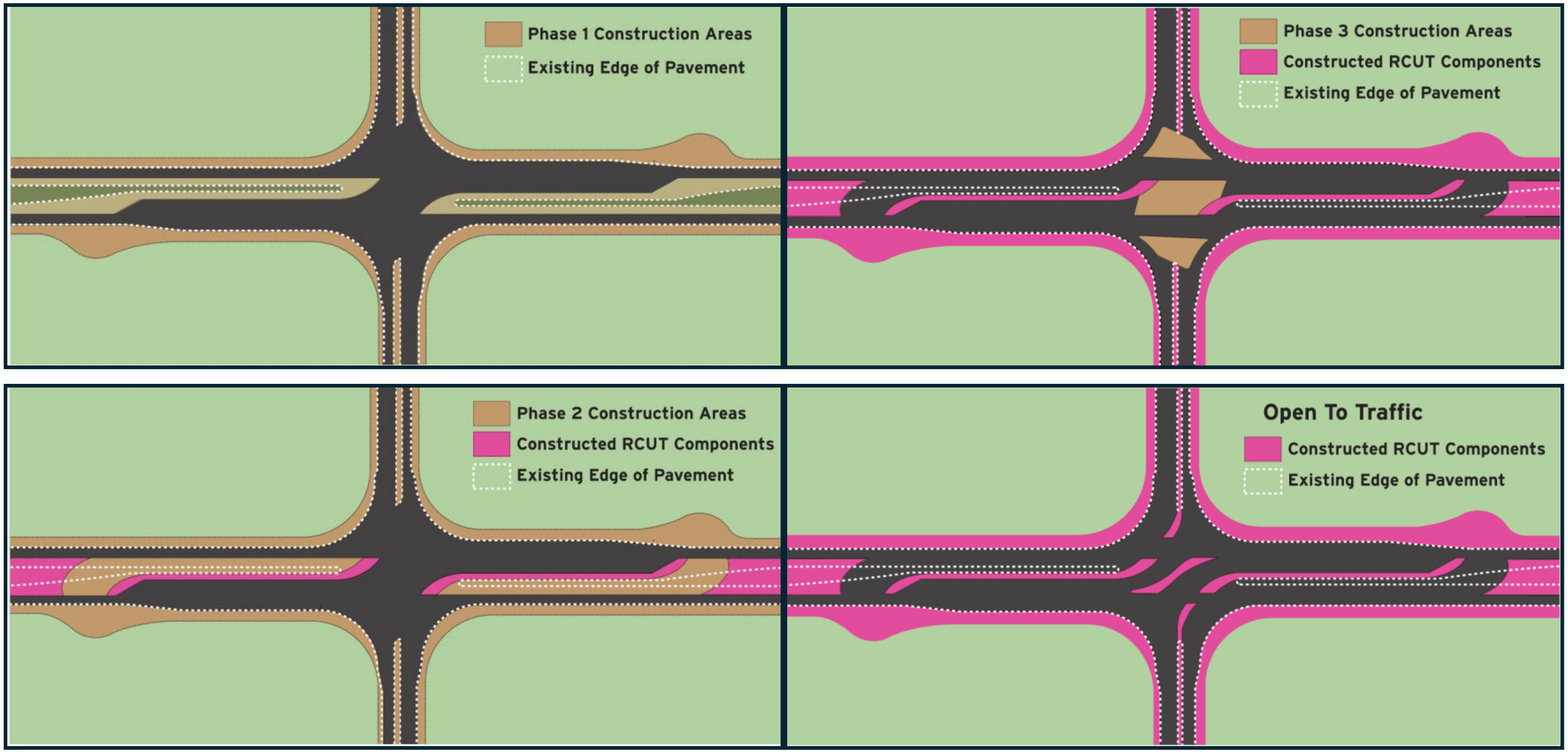


Figure 35: RCUT Reconstruction Maintenance of Traffic

12. OPERATIONS AND MAINTENANCE

While maintenance regiments for RCUT intersections and conventional intersections are similar, RCUT intersections require additional considerations. In addition to routine upkeep of signing and pavement markings, tubular markers on raised channelization must be maintained regularly. The areas surrounding raised channelization may need periodic street sweeping.

When planning snow and ice removal operations, consider how to address the functional components of an RCUT intersection (loons, left-turn and median U-turn lanes, center island). Maintaining clear left-turn lanes and median U-turn openings (including the loon, if present) helps preserve intersection functions. Design left-turn lanes and median U-turn openings so they are wide enough to accommodate snowplow access and maneuverability. Snowplow blades used in Kentucky are typically 10 – 14 ft. wide, although the effective width is less since plowing is conducted with the blade angled to the direction of travel.

13. RCUT INTERSECTION COMMON TERMS

Access Management – The control of the location, spacing, design, and operation of driveways, median openings, intersections, and interchanges along a roadway.

Conflict Point – Any location where the paths of road users (e.g., vehicles, pedestrians, bicyclist) coincide and can be classified as either crossing, merging, diverging, or pedestrian conflicts.

Construction on Existing Roads – A project that keeps the existing roadway alignment, except for minor changes, and does not change the basic roadway type.

Control Vehicle – An infrequent roadway user that must be accommodated. Encroachment into the opposing traffic lanes, multiple point turns, or minor encroachments into the side street are acceptable.

Conventional Intersection – An at-grade junction of two roadways that permits all turning movements (left turns, right turns, through movements) directly at the intersection and is typically controlled by yield signs, stop signs, or traffic signals.

Design Speed – The speed selected to determine the various geometric design features of the roadway.

Design Vehicle – A vehicle that represents a designated vehicle classification used to determine values of design elements.

Loon – A paved area constructed along the outside of a median U-turn opening. It is designed to provide additional space for vehicles to complete a U-turn maneuver.

Main Intersection – The intersection of the major and minor roads where left-turn movements from the major road are accommodated, not including the median U-turn openings.

Major Road – The higher-volume, higher-priority roadway at an intersection.

Median U-turn Opening – A break in the median to allow a U-turn maneuver.

Minor Road – The lower-volume, lower-priority roadway at an intersection.

New Construction – Projects on new alignment, including realigning existing roadways.

Reconstruction – A project on an existing alignment that changes the basic roadway type. These projects utilize the existing roadway alignment or make only minor changes to it.

Resurfacing, Restoration (2R) Project – Projects that restore pavement to its original condition with minor roadway upgrades to maintain the roadway in acceptable condition.

Resurfacing, Restoration, Rehabilitation (3R) Project – Projects that typically involve pavement improvement works (short of full-depth replacement) and targeted safety improvements and generally involve retention of the existing three-dimensional alignment.

Safe System Approach – Recognizes the possibility of human error and takes into account the tolerances for human injury, focusing on reducing fatal and serious injury collisions.

Traffic Demand – The number of vehicles desiring to use a given system element during a specific time period, typically one hour.

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