Minnesota Department of Transportation
Engineering Services Division
Technical Memorandum No. 20-07-TS-03
March 31, 2020

Technical Memorandum

To: **Electronic Distribution Recipients**

From: Mark A. Gieseke, P.E.
Assistant Commissioner (Acting), Engineering Services

Subject: Restricted Crossing U-Turn (RCUT) – Design and Implementation Guidance

Expiration

This Technical Memorandum supersedes TM 17-03-TS-01 and will remain in effect until March 31, 2025 unless superseded or published in the MnDOT Road Design Manual prior to that date.

Implementation

The design guidance on this Technical Memorandum is effective immediately for projects in the early stages of the preliminary design phase, and may be incorporated into projects in a more advanced design phase.

Introduction

Restricted Crossing U-Turns (RCUTs) are alternative intersection layouts designed to minimize conflict points and reduce decision making for cross street approaches at a much lower cost than grade separation while maintaining desirable movements. The RCUT does this by eliminating the left-turn and through movements from the cross street, diverting these movements with a right turn onto the main road to a U-turn maneuver at a one-way median opening. All main road movements continue as expected with dedicated left and right turns.

In high-volume urban conditions, a signalized RCUT intersection can provide better access when gaps are not sufficient to make the desired moves. Signals controlling main road traffic can be independent of the opposing direction only requiring two phases to accommodate left-turning traffic from the main road and cross street traffic onto the main road.

The goal of the RCUT intersection design is to improve safety by reducing the risk of severe right-angle crashes for the cross street movements while maintaining main road capacity.

Purpose

The purpose of this Technical Memorandum is to establish guidance in the design and implementation of Restricted Crossing U-Turns (RCUTs).

Guidelines

See the attached *Restricted Crossing U-Turn, Design and Implementation Guidelines*.

Questions

Any questions regarding the technical provisions of this Technical Memorandum can be addressed to the following:

Douglas Carter P.E., State Geometrics Engineer, Office of Project Management & Technical Support, at **(651) 366-4623**

Any questions regarding publication of this Technical Memorandum should be referred to the Design Standards Unit, DesignStandards.DOT@state.mn.us. A link to all active and historical Technical Memoranda can be found at http://techmemos.dot.state.mn.us/techmemo.aspx.

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Attachments:

Restricted Crossing U-Turn (RCUT) / Design and Implementation Guidelines

-END-

Restricted Crossing U-Turns (RCUTs)
Design and Implementation Guidelines

Minnesota Department of Transportation

March 2020

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Background

RCUTs are a form of alternative intersection design similar to the Diverging Diamond Interchange, Green Tee, Median U-Turn, and Displaced Left Turn. All of these designs have the potential to improve safety and/or reduce driver delay at a lower cost and with fewer impacts as compared to traditional intersection or interchange solutions.

RCUTs were first implemented in Michigan, Maryland, and North Carolina in the early 1980s to improve safety on four-lane divided highways without the need to construct expensive highway interchanges. More recently, other states have begun to implement the intersection type as research has shown very promising improvements in highway safety at a fraction of the cost of a standard grade-separated interchange.

Unfortunately, public perceptions of excessive crossing delay, potentially confusing configuration, and unsafe operations due to rerouting of left-turn and through movements from the minor road have slowed the acceptance of the concept. However, studies now show that these perceptions are not entirely accurate. Ongoing research and evaluation on these types of intersections indicate that, for motor vehicles, they generally reduce intersection delays, provide positive directional guidance, and reduce crashes. Additional public outreach is needed to educate the public on the positive benefits of these intersection treatments.

Types of RCUTs

RCUTs can be categorized as either stop-controlled or signalized. See Figure 1 for an example of a typical stop- controlled RCUT, and Figure 2 for an example of a typical signalized RCUT. Both figures show typical pedestrian & bicycle routes in pink.

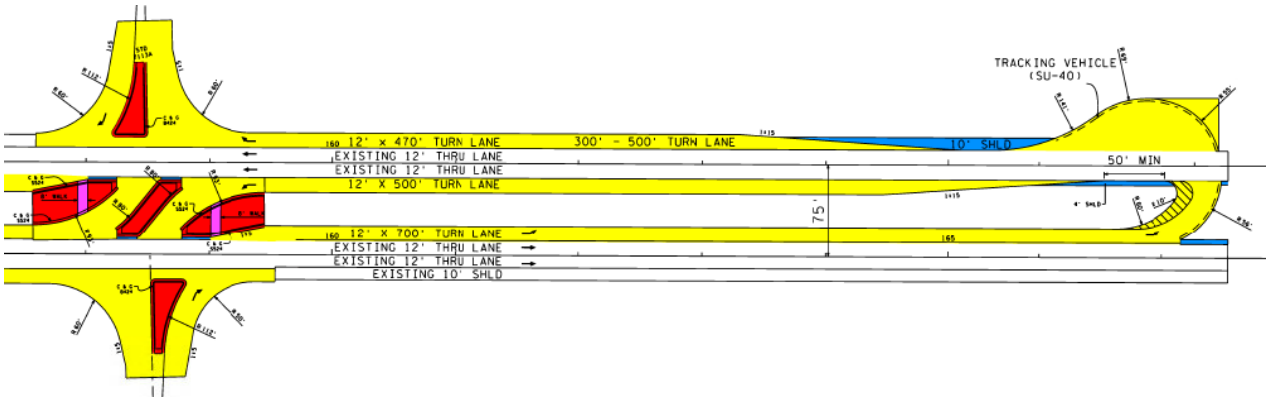

Figure 1: Stop-Controlled RCUT

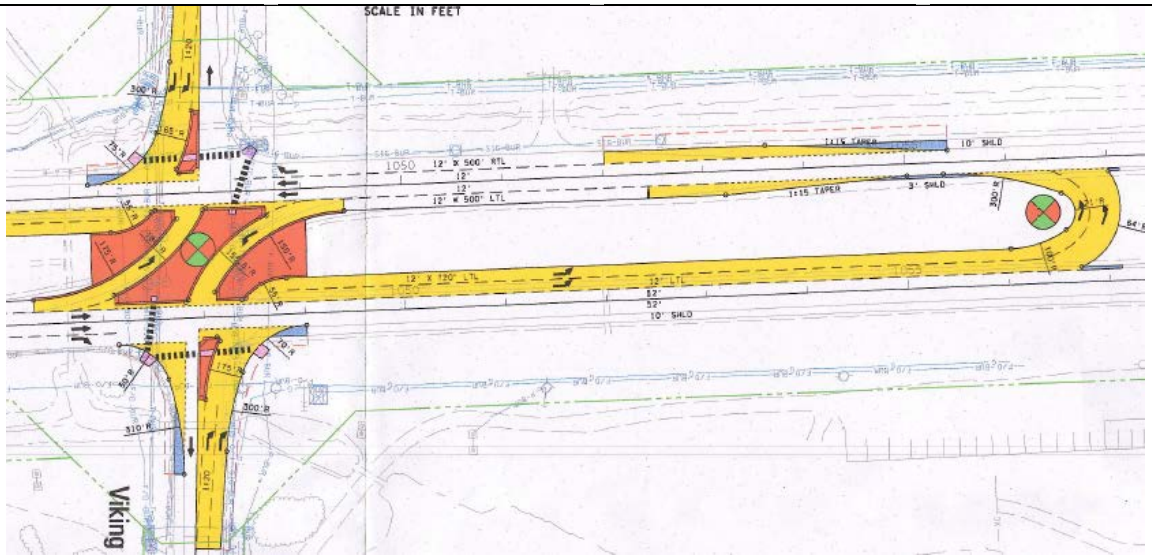

Figure 2: Signalized RCUT

Planning Considerations

RCUT intersections are most often implemented individually. However, they may also be used as part of a corridor-wide safety treatment. In addition to improved safety, installing a series of RCUTs can improve traffic progression and capacity, independent of roadway speed or signal spacing.

Planning considerations include:

Safety Improvements – RCUTs improve driver safety by reducing the number of motor vehicle conflict points from 32 to 14 compared to conventional intersections, particularly movements with potential for far-side high-severity type crashes.

Access Management – RCUTs do not impact the operation of the major road. Full access to the intersecting minor road is provided by routing left turns and through movements through a Median U-Turn (MUT). This rerouting reduces peak-hour delays for the minor road and improves capacity on the major road.

Corridor Operations – The primary benefits of RCUT implementation is the documented ability to dramatically improve safety while maintaining overall system peak capacity within the roadway corridor. This can be accomplished without the need to build grade-separated interchanges or to introduce signalized intersections in unsignalized divided highway corridors. Signalized RCUTs may be used on existing signalized corridors with high minor road volumes. This use can improve safety, increase peak capacity, and improve traffic signal progression.

Investment Level – There is a vast disparity in funding levels required for at-grade intersection improvements compared to grade-separated interchange design solutions. Grade separated interchanges require significantly larger investments in project elements such as bridges, right-of-way, and grading and paving. It is financially prudent to investigate at-grade design solutions, such as RCUT intersections, for increased effectiveness of transportation funding.

Economic Development – RCUTs may be a viable solution for businesses along divided highway corridors experiencing peak-hour traffic delays as well. RCUTs retrofitted within commercial corridors have resulted in improved intersection traffic operations, thereby promoting easier access to and from businesses. Often, motor vehicle access impacts to businesses were minimal due to less restrictive access controls and improved compatibility with existing development. This result is significant when compared to the access control inherent in grade-separated solutions.

Centerline Spacing – Divided highway centerline spacing indicates the space available to facilitate RCUT turning movements. It is often the controlling factor for accommodating larger vehicles at the MUT. In general, a divided highway corridor with 84-ft or greater of centerline spacing can accommodate a semi-truck (WB-62) to make a U-turn without encroaching on the shoulder. For divided highway corridors with narrower centerline spacing, use a "Loon" design to provide adequate space for design vehicle U-turns. See Loon Design in the Geometric Design section.

Pedestrian and Bicycle Facilities - For information on current requirements for bicycle and pedestrian facilities, as well as future bike and pedestrian corridors, refer to:

a. The Statewide Bicycle System Plan
b. Chapter #13 of the Traffic Engineering Manual
c. Local (City) and regional (County) Transportation Plans
d. State Statute
e. MnDOT Bicycle Facility Design Manual – MnDOT TM 20-02-TR-01

Incorporating these resources into the RCUT design early in project development can help identify opportunities for local priorities and shared long-term maintenance with project stakeholders.

Incident Management – RCUTs also provide direct access from the divided highway to the minor road for incident and emergency responders. However, access from the minor road left turn and through movements are provided through an indirect access via the MUT. Since the MUT location is relatively close to the RCUT, ideally between 400-ft and 1000-ft, in general it should not create significant delay when crossing the divided highway. Where higher demands for incident response are anticipated – for instance, if a fire station or a hospital were located along the minor roadway – consider a mountable curb and an emergency vehicle route for the center islands as a flexible design solution.

Signalization – The RCUT Planning Capacity Nomograph, Figure 3, provides planning level guidance for determining whether a signalized or stop controlled (unsignalized) RCUT is warranted. It is based on demand of both the divided highway (Major Street) and minor road (Minor Street).

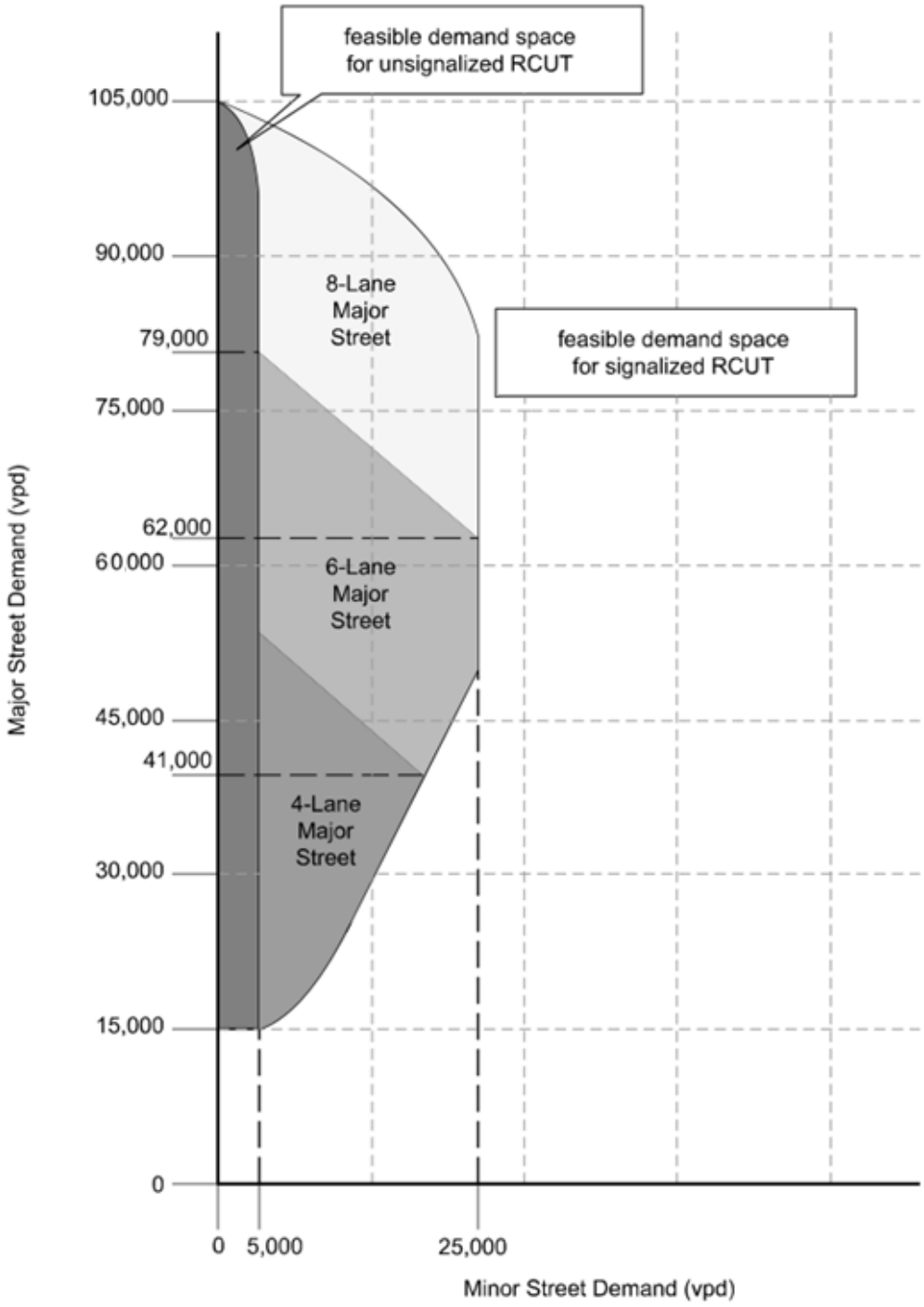

Figure 3 - RCUT Planning Capacity Nomograph

Intersection Control Evaluations
The Office of Traffic Engineering (OTE) has updated the Intersection Control Evaluation (ICE) process to include or consider RCUTs for preliminary intersection design screening and evaluation. Refer to OTE's guidance to determine when to consider the feasibility of an RCUT in comparison to other intersection alternatives.

Layout Approval Process
RCUTs require submittal of a Level 1 Layout to the Geometric Design Support Unit (GDSU) for review and approval. There are many design parameters that can be adjusted to meet the needs of each project location. Together, the GDSU and the District can collaborate toward the appropriate solution and facilitate approval by the State Design Engineer.

Stakeholder Outreach
Stakeholder outreach is vital when evaluating the possible implementation of an RCUT. A majority of the public remains unfamiliar with the concept, and many misconceptions still exist in the public eye. Early stakeholder identification and involvement is critical to a successful implementation. Public education and outreach will aid in gaining stakeholder buy-in and support. Post-installation, the project stakeholders oftentimes become our most influential advocates.

Pedestrian and Bicycle Considerations

The overall RCUT design objective should be to serve all roadway users – including freight, transit, and non-motorized users. Bicycle and pedestrian needs should be taken into consideration early in the design process. This reduces the need for re-work late in the project and results in the best designs.

Important considerations:

a. RCUT intersections may be unfamiliar to users and require additional signing or wayfinding.
b. Provide a clearly identified ADA-compliant pedestrian path through the median with curb cuts unless the absence of need can be justified, and the Bike/Ped and ADA Sections concur.
c. Where the shoulders are currently serving as the pedestrian and bicycle space along the minor road, pedestrian refuge and curb ramps should be considered to allow pedestrians and bicyclists to use the crossing safely.

There are many options for providing pedestrian and bicycle crossings at an RCUT intersection. The options depend on several site-specific factors, including:

d. Geometry of the intersection
e. Width of the highway median
f. Site topography
g. Splitter-island dimensions, and
h. Adjacent access needs

MnDOT recommends working with the Pedestrian and Bicycle section to determine the appropriate solution as early in the design process as possible.

Two of the most common bicycle and pedestrian crossing techniques are described below.

Z-Crossing

For signalized RCUTs, the "Z-Crossing" (Figure 4) is the most likely solution. All pedestrian movements are facilitated by this design, although some of the movements require pedestrians to take a longer, unconventional route. For example, to continue along the minor road, pedestrians facing oncoming traffic will travel from Point B-E-C-D. While cyclists, traveling with traffic, will move from Point A-B-E-C.

Signalized Z-Crossings should allow phasing that moves pedestrians from B to C whenever possible to increase pedestrian level of service. Safe, efficient crossing design will discourage unintended crossing routes (e.g., A to C directly, B to D directly).

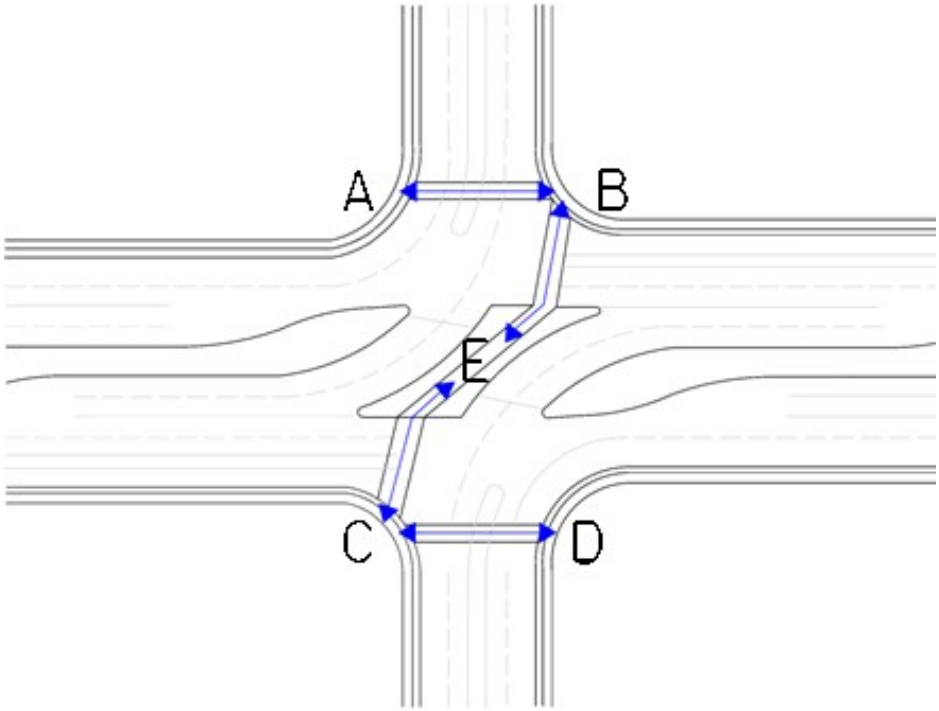

Figure 4 – Z-Crossing Bike and Pedestrian Accommodation in RCUT Intersection (Curb Cut Provided in Raised Median)

Direct Crossing

For unsignalized RCUTs, the direct crossing (Figure 5) is a more likely solution. It is more intuitive to pedestrians due to its shorter, more conventional route. A disadvantage is that pedestrians are required to cross the center left turn lanes.

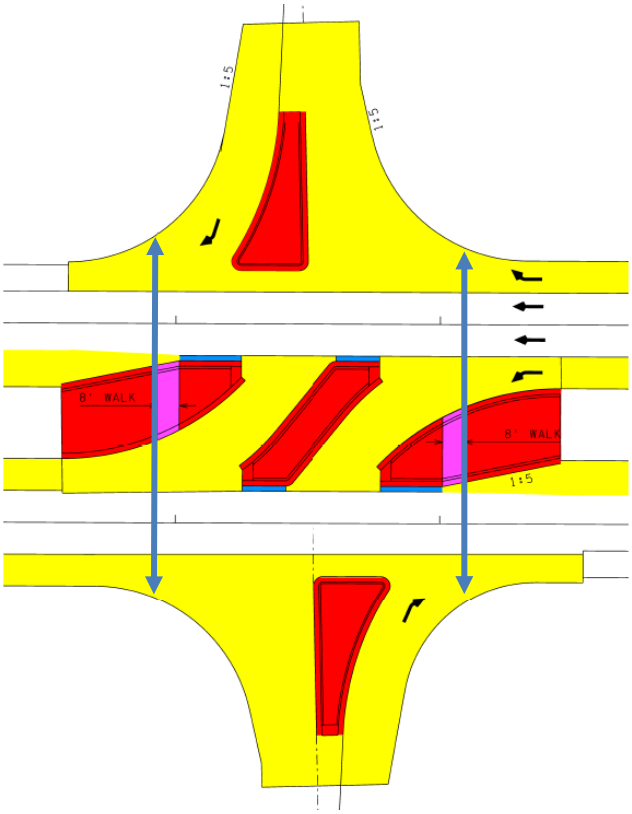

Figure 5 - Direct Pedestrian Crossing in RCUT Intersection

Regardless of the bicycle & pedestrian crossing solution selected, 6-ft to 10-ft is the acceptable width of the path/trail through the RCUT, with 8-ft being preferred. Do not mark (stripe) the crossing area across the major road. Experience has shown this to be an unsafe practice. When choosing trail width and alignment, take into consideration:

a. Local pedestrian generators
b. Facilities in the vicinity of the project
c. Available median space to accommodate refuge, and
d. Signage

Safety Principles and Performance

Reduction of Conflict Points

Crash reduction is largely a result of reducing the number and type of conflict points, and creating more space between the remaining decision-making points. A typical Four-Leg RCUT has 14 motor vehicle conflict points compared to 32 at a conventional intersection (Figures 6 and 7).

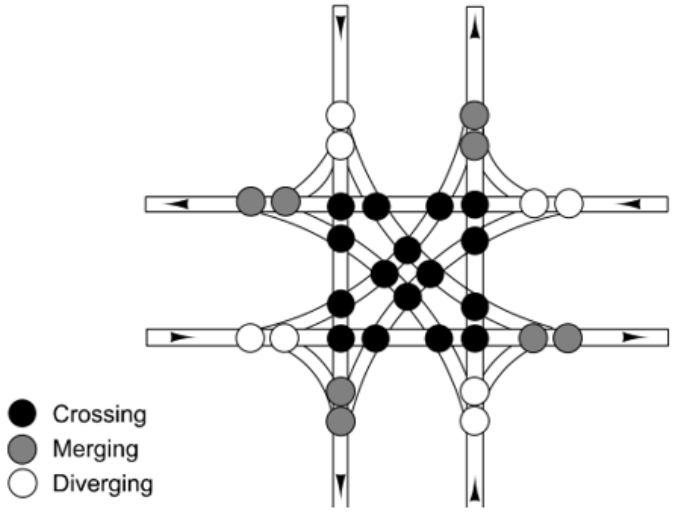

Figure 6 - Vehicular Conflict Points at Conventional Four-Leg Intersection

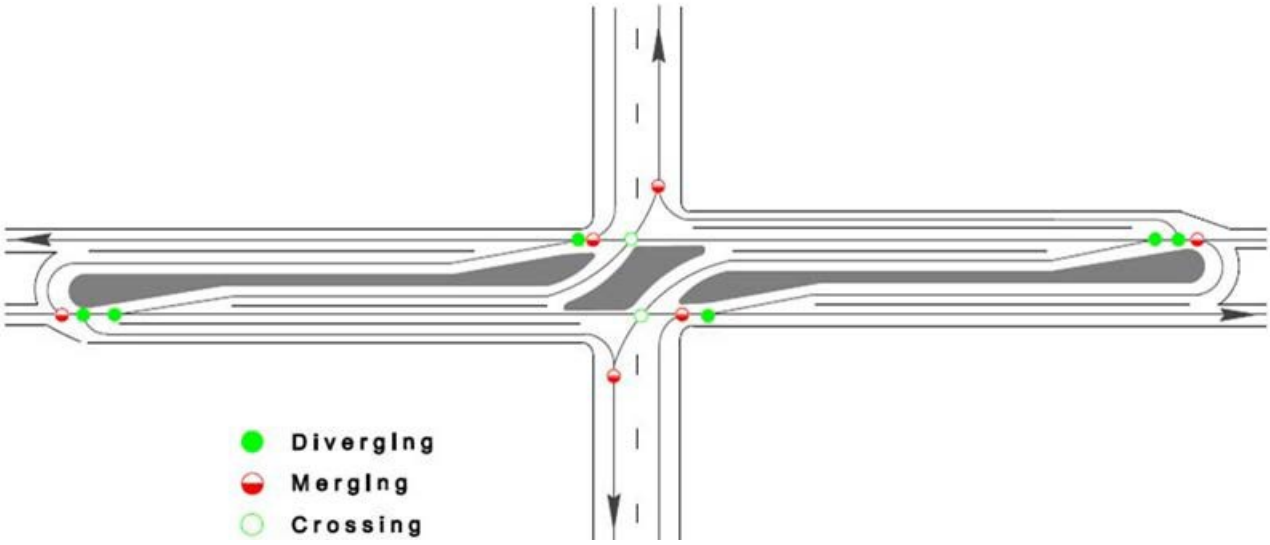

Figure 7 - Vehicular Conflict Points at a Four-Leg RCUT Intersection

Safety Studies

Recent RCUT safety studies from North Carolina, Maryland, and Missouri indicate a 35% average reduction in total number of crashes and a 49% average reduction in injury crashes.

A 2017 MnDOT Study of the Traffic Safety at Reduced Conflict Intersections identified the following results compared to standard intersections:

- 100% reduction of fatal and serious injury right-angle crashes
- 77% reduction of all severity right-angle crashes
- 50% reduction of injury crashes

MnDOT findings indicate positive safety benefits associated with RCUTs, including:

a. Significantly fewer fatal and serious injury, right angle crashes are associated with the Reduced Conflict Intersection compared to a standard through stop intersection.
b. Significantly fewer fatal and serious crashes are associated with the Reduced Conflict Intersection compared to a standard through stop intersection.
c. Significantly fewer right-angle crashes are associated with the Reduced Conflict Intersection compared to a standard through stop intersection.
d. When crashes occur, the injury level is typically lower than at standard intersections. Significantly fewer high severity crashes are associated with Reduced Conflict Intersections.

These findings are consistent with other evaluations throughout the United States. Nationwide, the RCI is associated with fewer injury crashes, and drastically fewer fatal and serious injury crashes. The Reduced Conflict Intersection is gaining in public acceptance and is more widely applied option for intersections at four-lane divided expressways.

Safety for pedestrians and bicyclists at RCUT intersections is less understood and can be challenging to non-motorized users. RCUTs without proper crossing facilities/guidance pose as barriers to non-motorized users. Long signal cycles can strand users in medians, where pedestrians are unlikely to wait for the next cycle. The safety of these users should be considered throughout the design process.

Operational Characteristics

Traffic Capacity and System-wide Considerations

Unsignalized RCUTs are typically used on corridors where mainline roadway volumes are between 10,000 and 45,000 VPD and minor roadway volumes are below 2,500 VPD. In many cases, RCUTs can operate without traffic signals, even with relatively high traffic volumes (see Figure 3). Signalized RCUTs typically provide more capacity than conventional signalized intersections by utilizing a two-phase signal operation and a shorter cycle length. A study by TxDOT showed a significant increase in throughput on mainline after converting a traditional signalized intersection into a signalized RCUT. This is a low-cost/high-benefit solution to increase capacity without constructing additional lanes.

RCUT intersections have been used successfully as part of corridor-wide safety and capacity treatments under the “Superstreet” model. On a corridor with a series of signalized RCUTs, it is desirable to set the system-wide signal timing so that traffic platoons have continuous flow at a designated operating speed. Signalized RCUT corridors allow both directions of the divided highway to operate independently, so desirable signal progression can be achieved for both directions of travel.

On Figure 8, signals on one side of the divided highway, A through F, operate independently of the signals on the other side, G through L. Each side can have its own cycle length and/or progression speed based on changing (AM/PM) demands. This benefits all drivers on the highway and makes bus transit more efficient and reliable. As a rule of thumb, mainline traffic should generally get two-thirds of the signal cycle. Feasible demand space for the minor roadway could be up to 25,000 VPD.

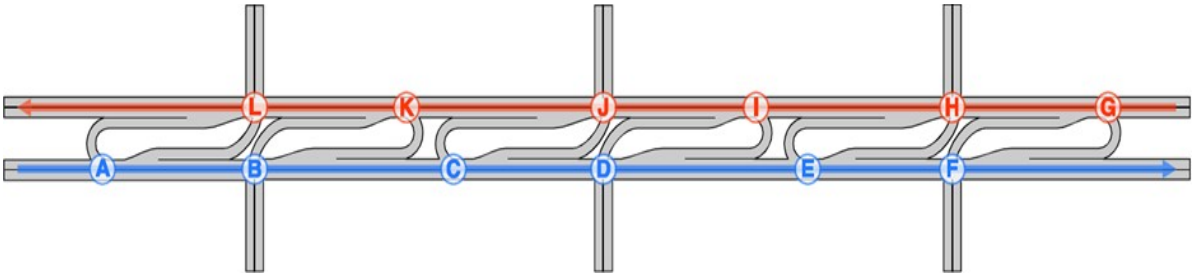

Figure 8 - RCUT Signal Layout

Driver Behavior

Post-implementation studies reveal that shorter distances from the minor road to the MUT result in increased driver compliance and public acceptance. Longer distances to the MUT increase the likelihood that drivers will avoid the intersection or make illegal left turns through the restricted ¾ intersection. Anecdotal observations of existing RCUTs demonstrate that drivers familiar with the facility are the most likely to be non-compliant.

Studies show that most drivers choose an acceptable gap and get into the left-turn lane by crossing all mainline traffic lanes in one maneuver. This maneuver, although illegal in the past, is now allowed by recent Minnesota legislation. *(Sec. 10. Minnesota Statutes 2013 Supplement, section 169.19, subdivision 1)*

Geometric Design

Design Vehicle / Other Large Truck Considerations

The typical design vehicle for an RCUT intersection is a WB-62. MnDOT practice is to use the SU-40 as a control vehicle to ensure that the MUT and the Loon can accommodate common vehicle configurations found on the MnDOT system. Also, depending on the facility or highway corridor, consider the needs of:

a. Transit
b. Emergency vehicles
c. Freight, and
d. Oversize and overweight (OSOW) vehicles
e. Maintenance

See Figure 9 for a Typical RCUT Schematic Layout.

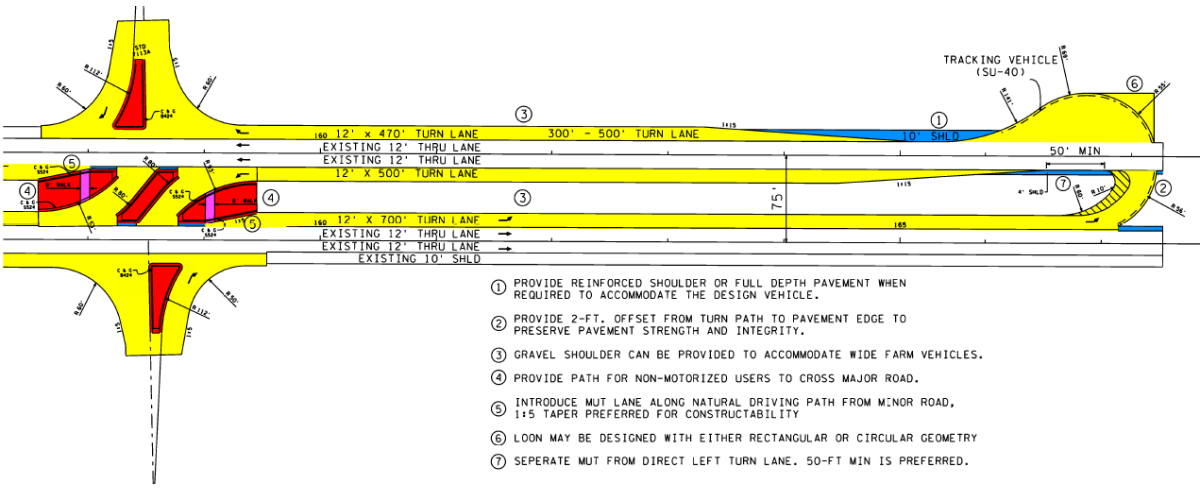

Figure 9 - Typical RCUT Schematic Layout

Design Methods

The G*ap-Acceptance* method is preferred for designing RCUTs. This method allows the driver turning right from the minor road to choose a gap they can use to cross to the far lane and accelerate sufficiently to enter the left turn lane. This method allows for a more compact intersection design and limits the disruption to mainline traffic operations. Moreover, MN Statute 169.19 was modified to permit this double lane-change maneuver in order to make a U-turn at a RCUT.

When sufficient gaps are not available, it may be necessary to:

- Use the Acceleration-Merge method, or
- Signalize the RCUT

The *Acceleration-Merge* method involves providing sufficient distance between the minor road and the MUT to accommodate full acceleration, weaving, and deceleration to the MUT based on the design vehicle operational characteristics. This method significantly increases the downstream distance to the MUT. As this design approaches its capacity limits, design adjustments like acceleration lanes can be added to prolong acceptable operations.

Median Width

RCUTs are typically retrofitted onto existing divided highway corridors. When sufficient median width is available, the design vehicle will turn from the median to the outside through lane. The shoulder pavement should be reinforced in areas that will be subject to this movement. The MUT should also be designed to accommodate a passenger vehicle turning to the inside lane.

Median U-Turn (MUT) Location

When choosing a MUT location, verify that

- Adequate intersection sight distance is available (see Sight Distance)
- A flat landing area with sufficient drainage can be provided at the yield location, and
- The location of nearby driveway entrances are tolerable (see Access Locations).

MnDOT preference is to locate the MUTs as near to the intersection as practical to minimize minor road delay. This location is generally controlled by the location of the opposing left turn lane.

An effective MUT location:

- Minimizes disruption of traffic on divided highways
- Minimizes the delay on minor roads
- Provides adequate opportunities for safe lane change movements

Loon Design

When the median does not provide sufficient width to accommodate the turning movement for the design vehicle within the available pavement, a “Loon” is recommended. Loons consist of additional pavement added outside of the existing mainline shoulder to provide enough width to allow the design vehicle to complete the MUT maneuver and merge back into traffic (Figure 10).

The loon may be located so that vehicles are allowed to turn directly from the MUT to the existing right turn lane, with all additional widening occurring prior to the turn lane. Right turn lanes should not be artificially lengthened to make this connection (Figure 11).

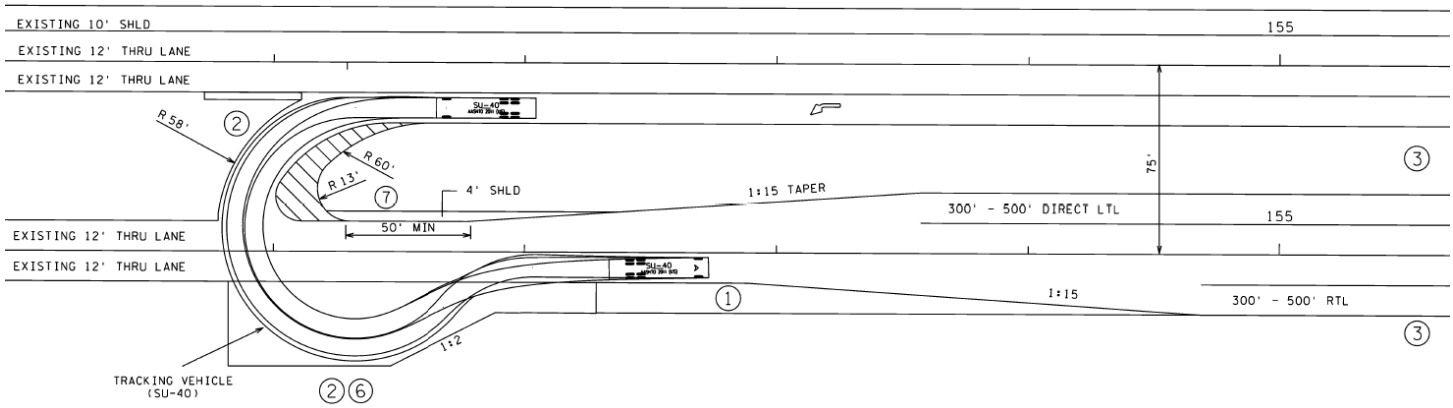

Figure 10 - Typical Loon Design Schematic 1

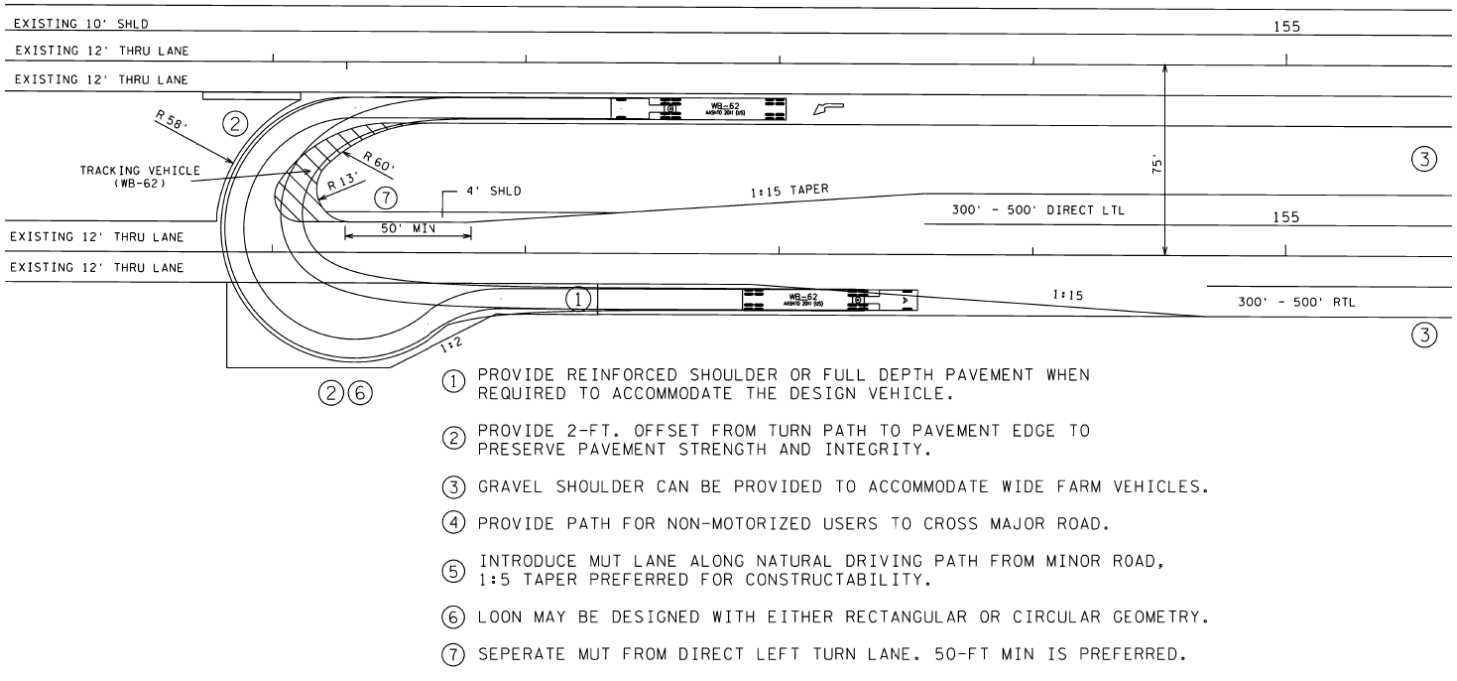

Figure 11: Typical Loon Design Schematic 2

Design Considerations

While right turn lanes only need to be long enough to decelerate to the turning speed at the intersection, the left turn lane must be designed to accommodate deceleration to a stop and in some cases provide turn vehicle storage. For this reason, the left turn lane length has a large impact on RCUT design. A longer left turn lane results in increased spacing to the MUT, which impacts travel time and project cost. Care should be taken to choose appropriate turn lane length, while avoiding unnecessary length.

The MUT lane needs to provide storage, but their length is often dependent on other RCUT factors. When the gap-acceptance method is used, the left turn lane will begin adjacent to the minor road allowing direct entrance from the minor road. The MUT will be located where the turnaround will not impact the left turn lane from the divided highway and the MUT maneuver can be accomplished with a minimum of 50-ft from the right turn lane from the highway (see Figure 10). Where the acceleration-merge method is being used, the left turn lane should not exceed 500-ft in length unless justified by storage capacity needs.

Offset turn lanes are used to improve sightlines in cases where queuing in adjacent turn lanes or roadway geometry restrict sightlines in a way that impacts safety performance, evidenced by functional problems. Providing offset turn lanes increases pavement area (impervious area), lengthens pedestrian crossing, increases project cost, and are a disadvantage for winter maintenance operations. Therefore, MnDOT preference is to only provide additional offsets when functional benefits will be achieved.

Rural Areas

In rural areas, give consideration to large agricultural vehicles (combines, grain carts, and sprayers). These types of vehicles are typically slow-moving and may not provide the operator with ideal sightlines. The preferred design is to allow these vehicles to cross highway lanes when they are perpendicular and have the best sightlines (i.e., from the minor road to the median and from the MUT to the outside shoulder). Wider vehicles can be accommodated by providing aggregate shoulders adjacent to the turn lanes.

Exclusion of ¾ Intersection (Minor Road Direct Left Turn Lanes)

Inclusion of the ¾ intersection is not a necessary component of RCUT design. There are many advantages of excluding the ¾ intersection, which include:

a. Reduced construction cost
b. Significant reduction in maintenance activities
c. Reduced signage needed for wayfinding and to control non-compliant drivers (wrong way moves through the median)
d. Reduced minor road work required to direct drivers and control non-compliant drivers;
e. Reduced spacing to the MUT, which reduces minor road travel time for left and through maneuvers
f. Simplified crossing for non-motorized users
g. Increased public acceptance

Consider excluding the ¾ intersection when the ADTs on the minor road are low (approximately 1,000 ADT and less) and analysis of MUT operations show that the new traffic patterns will result in an acceptable level of service. In the absence of the ¾ intersection, the MUT location will be based on storage capacity and the adjacent turn lanes (see Figure 12).

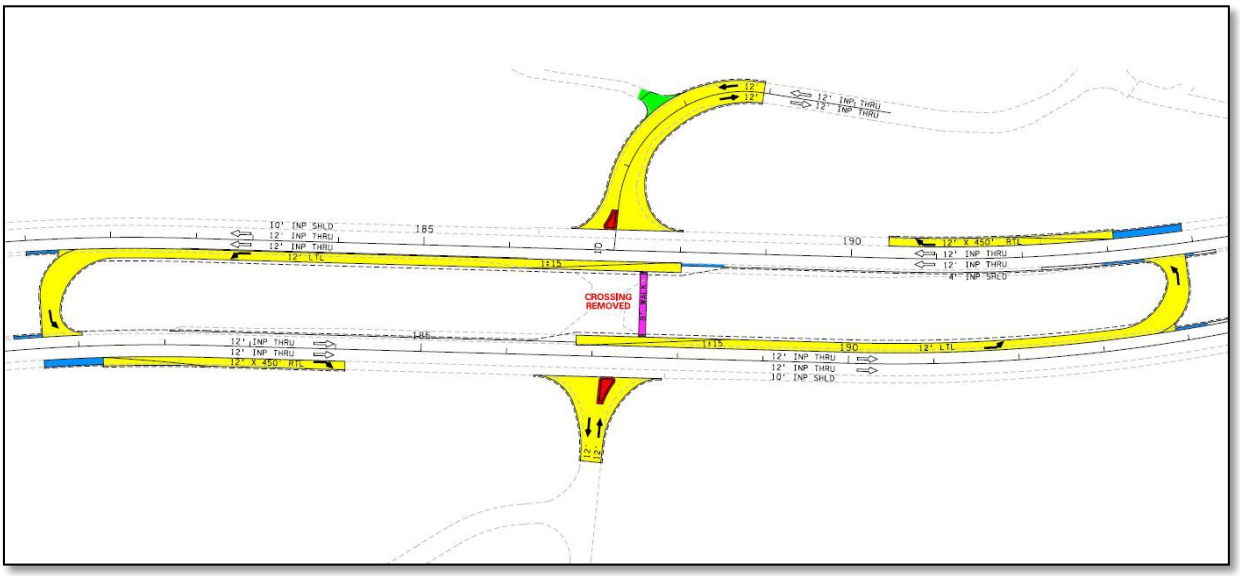

Figure 12 - RCUT without ¾ Intersection

Sight Distance

The sight distance, both at the minor road–mainline intersection and at the MUT, should meet the requirements for at-grade intersections as set forth in the MnDOT Road Design Manual and any applicable Technical Memorandum, including Intersection Sight Distance Technical Memorandum 18-06-TS-04.

MUT sight distance should be evaluated similar to a yielding right turn from a minor road (AASHTO - Case B2). MUT maneuvers should not be encouraged or located in areas with limited sight distance. To improve passenger vehicle sight lines at the MUT, a striped or raised truck apron may be provided on the inside curb radii (see Figure 11).

Raised median on the minor road approach is used to discourage illegal left turns, but can impact sightlines by increasing the skew of the approach. Approaches may need to be realigned to provide acceptable sightlines.

Turn Templates

- Right turn from minor road: Design so that a WB-62 utilizes the first two lanes for off-tracking to minimize pavement area necessary for the turn.
- Left turns from major road: Design first for the driving path of the primary users (use passenger vehicle to set the inside pavement edge) and second to allow space for the design vehicle. Verify that the appropriate Plow Truck can make a U-turn at the intersection.
- MUT and Loon: Use a SU-40 to define the outside turning path and a WB-62 (or design vehicle) to define the inside turning path.

Acceleration Lanes

Right turn acceleration lanes (RTALs) allow turning vehicles to accelerate to mainline traffic speed before merging, thereby reducing abrupt and right-angle merges. However, contrary to this perceived advantage, studies show that divided highway intersection crash rates tend to be higher when RTALs are present. Additionally, research has shown that drivers merge at the first available opportunity and do not utilize acceleration length as intended when gaps are available.

In general, acceleration lanes are not recommended within RCUT intersections because they discourage proper gap acceptance and introduce additional weaving conflicts. The AASHTO Green Book indicates that acceleration lanes are not recommended at stop-controlled intersections; at these intersections drivers can wait for an opportunity to merge without disrupting through traffic. If acceleration lanes are used within an RCUT intersection, use the acceleration-merge method for locating the MUT and refer to the Design Methods section above.

Access Locations

RCUTs do not require frontage roads to provide access to adjacent lands or parcels. It is acceptable to have driveway entrances located within the intersection footprint, but the entrances should not be located directly across from a MUT. When locating the MUT, verify driveways and right turn lanes meet the minimum lateral clearance.

Signing

Refer to Figures 6.28A and 6.28B of the MnDOT Traffic Engineering Website Manual for the typical RCUT Signing Layout.

Pavement Marking

Pavement markings on RCUT intersections should complement the signing. Refer to the RCUT pavement marking typical details found on the Pavement Marking Typical Detail Sheets webpage. http://www.dot.state.mn.us/trafficeng/pavement/typicaldetail/index.html

Lighting

Individual sites must be evaluated for lighting needs.

For signalized RCUTs located on higher volume divided urban highways, it is desirable to provide lighting at the primary and MUT intersections. The light level for the highway segment between the intersections will be dependent on the spacing of the intersections and may be reduced to street segment light levels.

Lighting at unsignalized RCUTs should follow conventional intersection lighting, with the addition of lighting at the MUT locations. Additional lighting may be needed based on intersection spacing and presence of continuous lighting on the roadway.

To determine optimal lighting at RCUTs, the lighting standards and specifications in the following resources are recommended:

- AASHTO's Street Lighting Design Guide
- FHWA's Lighting Handbook, and
- Publications of the Illuminating Engineering Society of North American (IESNA), including RP-8 Roadway Lighting

Maintenance

Clearing snow from RCUTs represents an increase in cost and time for maintenance crews. On higher ADT roadways, this increased effort becomes more apparent. If multiple RCUTs are planned on a given corridor, consult with maintenance staff to understand their needs and to develop a snow-removal methodology.

GDSU is working with the Office of Maintenance and with Districts statewide to determine best practices to improve operation and maintainability without compromising the safety benefits of the design. Below are the best practices developed so far:

a. Use S-Type curb on the raised medians. This curb type presents a visible face to approaching traffic and is friendly to tires and plow blades.
b. Locate signs to maximize the area on the median raised island that can be cleared by a plow truck.
c. Locate the MUT where good sight distance and flat grades at the decision point can be made.
d. Additional measures are sometimes necessary to encourage compliance, particularly when the AADT of the major road is below 12,000 VPD. These measures can include:
    - Increasing the overlap between the minor road approach median and ¾ intersection opening
    - Installing tube delineators or similar parallel to the major road to provide an additional visual cue

Plan and design for maintenance of the pedestrian facilities to ensure maintenance (especially during winter) is responsibly managed. Local maintenance agreements will reduce the burden on MnDOT maintenance forces.