

CHAPTER 6

AT-GRADE INTERSECTIONS

6.1 GENERAL

Intersections are critical parts of a roadway because the efficiency, safety, speed, cost of operation, and the capacity of the facility depend on the intersection design. The main objective of intersection design is to facilitate the convenience, ease, and comfort of people traversing the intersection while enhancing the efficient movement of passenger cars, buses, trucks, bicycles and pedestrians. Chapter 9 of the AASHTO Green Book provides an in-depth discussion of at-grade intersection design and criteria. Chapter 4, Section 4.1 provides further discussion of sight distance required at intersections.

6.2 INTERSECTION GEOMETRICS

The alignment of the intersecting roadways should be as straight as possible. In addition, profile gradients should be as flat as practical. Consideration should be given to realigning roadways that intersect at acute angles (more than 15 degrees from perpendicular). The realignment should be based on guidance found in Section 9.4 of the AASHTO Green Book.

The safety at an intersection and traffic flow through an intersection may be enhanced by applying several design elements such as sight triangles, turn lanes, traffic control, access management, and channelization.

6.2.1 Sight Triangles

To improve sight distance at intersections, sight triangles should be obtained at all corners of the intersection. Sight triangles enhance safety by providing areas free of obstructions that may block the driver's view of oncoming vehicles. The triangle may be reduced at one or more corners if a substantial amount of right-of-way needs to be acquired as long as sufficient stopping sight distance is maintained on the main roadway. Stopping sight distance, not intersection sight distance, is the controlling factor in setting sight triangles at most intersections. Consideration should be given to providing adequate intersection sight distance when establishing sight triangles on new roadways. The recommended dimensions for sight triangles vary depending on the design speeds of the intersecting roadways and the type of traffic control used at the intersection. For information on establishing sight triangles, refer to Section 9.5.2 of the AASHTO Green Book.

The typical sight triangle used at rural intersections is as shown in [Figure 6-01](#).

Additional right-of-way for large triangles are rarely considered in urban areas due to slower speeds, greater development at intersections, and more expensive property costs. Sight triangles typically used in urban areas are shown in [Figure 6-02](#).

6.2.2 Turn Lanes

Turn lanes are used to increase capacity and reduce crashes at intersections and median openings ([EDSM IV.2.1.4](#) requires turn lanes at all median openings). Turn lanes are considered based on a traffic study and may take into account the following:

- traffic volumes
- traffic control at the intersection
- turning movements
- reduced crash potential
- increased operational efficiency

The Traffic Engineering Division and/or the District Traffic Operations Engineer can provide recommendations for turn lane locations, lengths of storage, and taper lengths.

To develop left turn lanes on two-lane roadways for new construction or reconstruction projects, the pavement is widened using reverse curves and/or nearby horizontal curves on the mainline. Normal crown should be maintained throughout the widening and no superelevation should be used to develop the turn lane. The [Typical Turn Lane Design](#) figure shows the geometry for left turn lane development.

For isolated intersection improvement projects, the pavement is typically widened for left turn lanes using straight-line transitions or by using curvature of the existing alignment.

Once the full widening for left turn lanes is attained, a straight-line turn lane taper of 8:1 is used for design speeds up to and including 30 mph and 15:1 for design speeds of 50 mph and greater. The 30 mph design speed is used for urban highways, while the 50 mph design speed is used for rural highways. Storage lengths should be long enough to store the number of vehicles likely to accumulate during a critical period without blocking through lanes. Typically, a minimum storage length of 150 ft is required for left turn lanes. If site conditions dictate, shorter taper and storage lengths may be used as is discussed in Chapter 9, Section 9.7 of the AASHTO Green Book.

Right turn lanes are generally developed using the same straight-line tapers of 8:1 and 15:1 shown above for left turn lanes.

It may not always be practical to provide the full length of the turn lane due to constraints such as restricted right-of-way, distance available between adjacent intersections, and storage needs. However, providing a left-turn and right-turn on any intersection approach is shown to provide a substantial crash reduction.

6.2.3 Channelization

Channelization is included at intersections to reduce excessive pavement areas, to regulate traffic, and to indicate proper intersection use. Channelization can consist of

pavement markings and/or raised islands. When raised islands are used to channelize traffic, islands less than 150 ft² should be paved. However, the District or local municipality may request that larger islands be paved as well, due to maintenance considerations. Chapter 5, Section 5.5.7 contains additional discussion of raised channelizing islands. Chapter 9, Section 9.6 of the AASHTO Green Book provides an in-depth discussion on islands. Chapter 5, Section 5.5 provides guidance on curb use.

Islands delineated with pavement markings should follow the same guidance as curbed islands, except the offsets for the noses and edge lines would not be required.

When channelizing right turns, the designer should try to keep the angle of intersection with the cross street as close to 90 degrees as possible. This design promotes better visibility of approaching traffic and pedestrians waiting to cross. See Section 9.6.1.2 of the AASHTO Green Book for additional guidance.

6.3 SIGNALIZATION

6.3.1 Warrants

The [Traffic Engineering Manual](#) and [EDSM VI.1.1.2](#) requires a detailed study of the geometric design and traffic flow of an intersection before a signal is installed or included in a construction project. For any construction projects where signals are being considered, the Traffic Engineering Development Section will have final approval.

6.3.2 Addition or Replacement

Signal plans and quantities will be requested from the Traffic Engineering Development Section after the decision has been made to include signals in a construction project and the warrant analysis has been performed according to Section 6.3.1. Once available, the details and quantities will be incorporated into the construction plans. Refer to Chapter 8, Section 8.2.20 for more information about traffic signal plans.

6.4 TURNOUTS

Simple connections to intersecting roadways are commonly referred to as turnouts. To expedite construction, turnouts typically utilize the same pavement type and thickness as the main roadway. The typical section at the back of the turnout should match the width required in the Minimum Design Guidelines for the highway classification and traffic volume of the intersecting roadway. For most projects, turning radii that accommodate a single-unit truck (SU-30 or SU-40) design vehicle are provided. Transitions from the back of the turnout to the existing roadway are typically constructed of full depth asphalt.

For drainage and aesthetic purposes, attention should be paid to the edge profiles at intersecting roadways. Smoothness of flow at crossings and connections are required while satisfying the design criteria. See Chapter 5, Section 5.3 and Chapter 9 of the AASHTO Green Book for additional discussion of slope breaks allowed at intersections.

The proper intersection design can be achieved most accurately by using graphical grades (see Chapter 8, Section 8.2.14 of this manual).

Where significant lengths of side roads are reconstructed, vertical curves should be used, where necessary, to provide smooth profiles from the existing side road to the main roadway. Additional plan and profile sheets may be necessary in these situations.

6.4.1 Rural

Typical turnouts for intersecting roadways are shown in [Figure 6-03](#). For high volume intersections, a higher type design may be required, such as a channelized intersection with dedicated turn lanes, a grade separation, or an interchange.

Ideally, side roads (paved or gravel) that intersect the main roadway at an angle that is more than 15 degrees from perpendicular should be realigned. The portion of realigned roadway behind the turnout should meet the Minimum Design Guidelines for its class of roadway and should be paved. See Chapter 9 of the AASHTO Green Book for design speeds that can be used for curves approaching a stop controlled intersection.

6.4.2 Urban

Turnouts for urban and suburban areas are also shown in [Figure 6-03](#). Values in parenthesis are those typically used for urban and suburban locations where vehicles will be traveling at lower speeds. In addition, [Figure 6-03](#) also shows typical treatment of curbs and/or shoulders at turnouts. These details have been developed using the required turning radii for the single-unit truck (SU-30) design vehicle. When the intersecting roadway serves a facility where larger vehicles are expected, the turnout radii may be adjusted based on criteria in Chapter 9 of the AASHTO Green Book.

6.5 INTERSECTION JOINT LAYOUT

Transverse and longitudinal joints are placed in the concrete slabs of all concrete pavements except continuously reinforced concrete pavements to help control cracking. [Standard Plan CP-01](#) provides general guidance on the location of joints required. However, because requirements at each site vary, it is often necessary to include joint layouts in the construction plans. A good jointing plan, when developed as part of the final plans, will ease construction by providing clear guidance and help avoid width changes along the edge of the mainline or primary paving lane(s).

Joints are usually classified as longitudinal or transverse, as shown in [Figure 6-04](#). Longitudinal joints are typically placed at lane lines. However, an intermediate longitudinal joint is required when the width of the pavement slab exceeds 15 ft

Basically, the idea is to eliminate triangles or circles left intact with a rectangular portion of a slab, and to eliminate acute angles between joints, especially angles less than 60°. These areas, if allowed to exist, will create a plane of weakness that will break during temperature movements of the slab. The procedure outlined in the Appendix describes typical steps used in developing a joint layout plan. Examples are shown for both right angle and angled intersections.

[Figure 6-05](#) shows alternate joint layouts for a skewed intersection. The layout shown in Detail (b) of [Figure 6-05](#) is useful for simple curve radii greater than 36 ft and compound curves (2 or 3-centered curves). It can simplify field construction when the contractor builds the curve area in a single pour (indicated by the shaded area). As shown in the diagram, it is necessary to add an additional joint near the center of the slabs that exceed the maximum allowed width (15 ft).

[Figure 6-06](#) shows a completed joint layout along a highway with multiple intersections. This figure illustrates only one of the many possible joint layouts.

Joints are required around utility structures in the pavement because otherwise, movement of the pavement will be restricted and cracking will result. At such locations, box-outs are required, as shown in [Figure 6-07](#). Where a joint must be located within 4 ft of a catch basin or manhole, it is desirable to adjust the joint so that it will intersect the structure or box-out surrounding the structure as shown in [Figure 6-08](#).

6.6 MEDIAN OPENINGS

[EDSM IV.2.1.4](#) contains requirements and Chapter 9, Section 9.8 of the AASHTO Green Book contains guidance for median openings.

6.7 DRIVEWAYS

Driveways are essentially low volume intersections and merit special consideration in their design and location. New driveways and modifications to existing driveways are regulated through the use of permits. Driveway regulations generally control:

- right-of-way encroachment
- driveway location
- driveway design
- use of curbs
- parking
- setback, etc.

Driveways are a means of controlling access to the roadway from adjacent properties. In order to achieve this, large graded or paved areas adjacent to the traveled way should be eliminated so that vehicles gain access to the facility only at driveway locations.

6.7.1 Criteria for Driveway Locations

1. Existing Access: Driveway approaches are provided to restore existing access to abutting property.
2. Safe Operation: Additional driveway approaches are provided when they would result in safer operation, particularly when more approaches would substantially reduce the distance traveled by agricultural equipment on the main roadway or on other roadways.
3. Opposite Median Crossovers: On divided highways, approaches should not be located or relocated to fall opposite median crossovers.
4. Severed Property: If property is cut in two, so that the owner has property remaining on both sides of the highway, the following criteria are used:
 - a. Both Sides: At least one approach is provided to the property on each side of the road.
 - b. Existing Field Roads: Approaches are located at existing field roads when possible, or continuous headlands are provided to connect the approach and field roads.
 - c. Lateral Ditches: Approaches are provided for access on each side of lateral ditches or streams, unless a crossing is available to the owner within a short distance.
5. New Frontage: When a roadway is located on new alignment and creates new frontage for adjacent properties, new driveway approaches may be recommended by the plan-in-hand party.
6. At Intersections: Driveways will not be allowed within the limits of the turnout radii at an intersection. The driveway should be located as far away from the intersection as practical, and desirably outside the limits of turning lanes and other auxiliary lanes.

6.7.2 Application of Criteria

1. Undivided Highways on Existing Location: The plan-in-hand party locates driveway approaches based on criteria in Sections 6.7.1.1 and 6.7.1.2.
2. Divided Highways on Existing Location: The plan-in-hand party locates driveway approaches based on criteria in Sections 6.7.1.1, 6.7.1.2, and 6.7.1.3.

3. Undivided Highways on New Location: The plan-in-hand party locates driveway approaches based on criteria in Sections 6.7.1.1, 6.7.1.2, and 6.7.1.4. After the right-of-way base maps showing property lines and owners are available, the designer can use the maps to locate additional approaches based on criteria in Sections 6.7.1.1, 6.7.1.2, and 6.7.1.4. A set of prints showing all approach locations is then transmitted to the District Administrator for review and suggestions. These prints show the following information:
 - property lines
 - property owners' names
 - location of proposed vehicular approaches
 - location of proposed headlands (including drainage structures under headlands)
 - location of cross drains
4. Divided Highways on New Location: The same procedures are used for divided highways on new location as for undivided highways on new location. The location of median crossovers is also shown on the prints transmitted to the District for review.
5. Right-of-Way Considerations: Additional approaches may be added during right-of-way negotiations as part of the offer made for the required property. The designer and District construction personnel should review the placement of these approaches before final agreement is reached to avoid creating traffic hazards and to maintain Department standards.
6. Changes During Construction: If requested by a property owner during construction, the Project Engineer may move the location of approaches within the limits of the property, subject to consideration of criteria 6.7.1.2 and 6.7.1.3.
7. Approaches Added During Construction: Additional approaches may be added during construction using normal plan change procedures. However, each one must be justified individually.

6.7.3 Driveway Typical Sections and Materials

[Standard plans DW-01 and DW-02](#) provide details on length and width of drives, as well as the type and thickness of surfacing material.

Existing driveways on highway projects are replaced with a new drive of similar material and width. Special consideration should be given when modifying or replacing existing driveways in order to maintain current functionality.

6.7.4 Horizontal Geometry of Driveways

Residential Driveways on Curbed Roadways: The desirable size of the triangular flare is shown on standard plan DW-01. For special cases, the size of the flare may be reduced, as necessary. The flares for adjacent driveways may be overlapped if a minimum is not obtainable.

Commercial Driveways on Curbed Roadways: Geometric guidelines for various types of commercial driveways are shown on standard plan DW-01. Commercial driveways range in width from a typical minimum of 12 ft to a typical maximum of 35 ft (special cases may require larger width driveways to accommodate design vehicle ingress and egress). The designer should consider using a turnout connection at drives with very heavy traffic, or at locations where the existing drive has a turnout configuration.

Driveways on Non-Curbed Roadways: Guidelines for driveways on non-curbed roadways are shown on standard plan DW-02. For aggregate driveways, a triangular flare is used on each side of the driveway at the edge of the shoulder. The same size flare is used for all shoulder widths. This provides a slightly larger turning radius for roadways with wide shoulders, as compared to roadways with narrow shoulders. This practice is desirable since wider shoulders are typically used on roadways with a higher ADT. The driveway is terminated at the right-of-way line, or as otherwise directed by the Project Engineer, based on field conditions.

6.7.5 Vertical Geometry of Driveways

In order to prevent vehicles from dragging or scraping at driveway entrances and connections, special attention should be given to driveway profiles. It is not necessary to show mathematical grades on the plans for each driveway. However, a check of all driveways (both urban and rural) should be made by the designer to determine whether a satisfactory grade can be provided within the available right-of-way. Generally, problems with driveway grades are encountered in urban areas where right-of-way is restricted, or in rural areas with rolling or hilly terrain. If a satisfactory grade cannot be provided within the available right-of-way, the plans should note that right-of-entry or construction servitude will be required to extend the driveway. If this is impractical, either a realignment of the driveway or an adjustment in the main roadway grade may be required. See standard plans DW-01 and DW-02 for guidance on acceptable driveway grades.

6.8 RAILWAY - HIGHWAY GRADE CROSSINGS

Like any other intersection, railway-highway grade crossings are a potential source of conflict. When crashes occur at these intersections, they usually have catastrophic results. Therefore, the designer should carefully analyze the crossings with the Railroad Construction Unit, who coordinate with the railroad company. This is done to determine the type of crossing that will be provided. If a structure over the railroad cannot be provided, or is not warranted, signals and gates may need to be installed to properly warn motorists of an approaching train.

6.8.1 General

Railway-highway grade crossings on roadway projects are to be in accordance with American Railway Engineering and Maintenance-of-Way Association (AREMA) specifications, railway company requirements and DOTD specifications. The owner of

each railway is responsible for the actual construction of the crossing and payment of all associated costs. Construction details and items for the crossing are not included in the project's plans. However, the cost to construct the crossing is included in the overall project costs.

When a proposed construction project involves a railroad, the project title sheet and plan sheet (showing the location) should be sent to the Railroad Construction Unit. This should be done as early as possible in the plan development process so the necessary agreements can be obtained from the railroad company.

6.8.2 Traffic Control Devices

Traffic control devices required for grade crossings will conform to Part VII of the Manual on Uniform Traffic Control Devices and to [Standard Plan PM-07](#).

6.8.3 Roadway Vertical Geometry at Railway Crossings

In most cases, the grade of the proposed roadway must be set to match the elevation of any intersecting railroad tracks, particularly mainline tracks. The intersection should be made as level as possible to improve:

- sight distance
- rideability
- braking and acceleration distances

In some instances, the roadway vertical alignment may not meet acceptable geometrics for a given design speed because of restrictive topography or limitations of right-of-way. The crossing surface should be set at the same plane as the top of the rails for a distance of 2 ft outside the rails to prevent low-clearance vehicles from becoming caught on the tracks. Also, the highway surface should not be more than 3 in. higher or lower than the top of the nearest rail, at a point 30 ft from the rail, unless track superelevation dictates otherwise.

6.8.4 Plan Procedures

Railway-highway grade crossings are noted on the title sheet and plan/profile sheet in the same manner as bridge sites and equations. When the crossing is to be constructed by others, it should be considered as an exception.

Typically, all railway companies require pre-cast concrete crossing units. Most companies use a 10 ft crossing.

6.9 ROUNDABOUT DESIGN

A roundabout is an intersection with a curbed central island around which traffic must travel counterclockwise and in which entering traffic must yield to circulating traffic. Roundabouts are characterized by a generally circular shape and geometric features that create a low speed environment (see [Figure 6-09](#)).

6.9.1 General

1. For this section only, the use of “Shall” designates mandatory conditions, and the designer will make every practical effort to follow the criteria. If it is impractical to follow these criteria, authorization for a design waiver will need to be obtained from the Traffic Engineering Division Administrator.
2. The roundabout design shall conform to the results in the roundabout study as defined in [EDSM VI.1.1.2](#). If this changes, a new analysis shall be required.
3. All movements including u-turns shall be accounted for in the design.
4. Roundabouts should be designed for future traffic volumes. However, constructing a roundabout with more lanes than are needed can result in increased crashes. For this reason, multi-lane roundabouts may need to be built in stages. The initial stage should be designed for the build year which, can be assumed to be 3 years from the date of the study. The final stage should be designed for full build, measured from the build year.
5. Roundabouts should be designed so that as traffic volumes warrant additional circulating lanes, the center island of the roundabout can be reduced to accommodate the additional lanes. Another way to do this is to build the splitter islands to only allow one circulating lane and then reduce them to allow additional lanes as traffic volumes increase. By carefully planning the construction of the roundabout for the initial and full build stages, the designer can acquire the full build required right of way, design a permanent drainage plan, complete final utility relocations, and final sidewalks location. This is to accommodate any future expansion without completely rebuilding the roundabout.

6.9.2 Operational

1. Commercial driveways shall not be located within 50 ft of the yield point.

6.9.3 Geometry

1. The design of a roundabout approach is independent of the design criteria for the corresponding roadway classification of the approaching roadways. For design

purposes, the roundabout intersection design criteria begins 200 ft prior to the intersection for approaching roadways posted 45 mph and below and 400 ft prior to the intersection for approaching roadways posted greater than 45 mph.

2. All Roundabouts (see [Figures 6-09](#) and [Figure 6-10](#))
 - a. All speed control shall take place prior to the yield point on entry. A reverse curve on the approaches should be used to geometrically reduce the speed of vehicles entering the roundabout. The recommended design speed for all vehicles entering the roundabout is 15 mph.
 - b. The offset alignment shall be to the left (see [Figure 6-11](#)).
 - c. Approach legs should be designed as near to perpendicular to each other as possible.
 - d. Entry width should be 18 ft for a single lane roundabout unless a wider entry is needed due to a WB-67 or larger design vehicle. Entry widths for dual movements are to be designed using AutoTURN.
 - e. Circulatory roadway width shall accommodate buses and fire trucks so that they do not use the truck apron. A 3 in. sloping curb should be provided on the outside of the circulatory roadway. A minimum clearance of 1 ft should be provided between the outside edge of a vehicle's tire track to the curb line.
 - f. An appropriate entry radius is dependent upon other components of design: entry width, circulatory roadway width, entry deflection, design vehicle. Entry radius should be between 90 ft and 130 ft
 - g. For designs using an offset left approach alignment, the exit radius should be between 400 ft to 800 ft. For other alignments, the exit radius may be smaller.
 - h. Roundabouts shall be designed for the WB-67 design vehicle.
 - i. The cross slope for the circulating lane should not exceed 1.5%.
 - j. Truck Aprons
 - i. Typically range from 5 ft to 20 ft wide. A 0.5% -1.5% cross slope away from the center island is recommended. The exact width of the truck apron should be determined from AutoTURN. A 3 in. sloping curb should be provided on the outside of the circulatory roadway.
 - ii. Truck aprons shall be tinted (brick red – broom finish) to provide a visual distinction between the circulating traffic lane and the truck apron and to differentiate from nearby sidewalks. The truck apron shall not be stamped or textured.

- k. The splitter islands shall be raised and have a minimum length measured along the approach as per the following table (mitigation will be required for any deviations from this table):

| Posted Speed | Minimum Length of Curbed Splitter Island |
|---------------------|--|
| ≤ 35 mph | 50 ft |
| 35 mph < x ≤ 45 mph | 75 ft |
| > 45 mph | 150 ft |

- l. A 3 in. sloping curb should be used for the entire length of the splitter island. The approach nose of the splitter island should be tapered down according to AASHTO guidance and meet AASHTO guidance on offsets and minimum island area.
- m. Sloping face curb should begin at the edge of the finished shoulder on the approach roadway, then taper inward using a shifting taper to the edge of the travel way. Continue the curb adjacent to the edge of the travel way through the roundabout entrance and along the outside diameter to the various exits.
- n. The center island shall be earthen mounded to create increased conspicuity, obscure the headlight glare of oncoming vehicles, and promote lower speeds throughout the roundabout. Typically use a 6:1 slope on the central island for roadways with posted speeds of 45 mph or greater. The slope can level out once 2-3' of vertical height is achieved. This may need to be adjusted due to the size of the central island and if landscaping is installed at the time of construction. A 6 in. vertical curb should separate the truck apron from the center island.
- o. Roundabouts on grade require special consideration. They should be constructed on relatively level terrain with a maximum of a 3% grade. Entry grade profiles shall not exceed 3% within 50 ft of the circulatory roadway. Additional grading may be necessary to achieve the desired terrain in order to maintain the safe operation of the circulating lane(s) while adequately achieving the required drainage of the intersection.
3. Single Lane Roundabouts
- a. The inscribed circle shall be at least 110 ft in diameter for a WB-67 design vehicle. An inscribed circle of 130 ft is recommended.
- b. Circulatory widths shall be at least as wide as the maximum entry width and up to 120% of the maximum entry width. An 18 ft -20 ft circulatory width is desirable.
4. Multi-Lane Roundabouts
- a. The size for the inscribed circle shall be at least 175 ft diameter.
- b. Gore striping shall be used between entry lanes to keep 12 ft lane widths for passenger vehicles.
- c. If inner lane can exit, outer lane shall be an exit only.

- d. The design vehicle may encroach into the adjacent lane, but a clear width of 11 ft on the encroached lane must be maintained. A 30 ft to 32 ft circulatory width is recommended. 30 ft circulatory widths may be appropriate for roundabouts with inscribed circles that have larger than the minimum diameter.
- e. Path overlap/Path intrusion

Vehicle path overlap is a type of conflict that occurs when the normal path of the adjacent lanes cross one another. Roundabout designs shall not have entry path overlap.

- i. Striping shall not be used to mitigate path overlap or path intrusion.
 - ii. A diagram should be furnished illustrating that path overlap and path intrusion do not exist. Designers should determine the natural path overlap and path intrusion by assuming the vehicles stay within their lanes up to the yield point. At the yield point the vehicle maintains its natural trajectory into the circulatory roadway. The vehicle will then continue into the circulatory roadway and exit with no sudden changes in curvature or speed.
5. Mini Roundabouts
- a. Mini roundabouts are a type of roundabout characterized by a small inscribed circle diameter (45 ft to 90 ft) and a traversable island (central island and splitter island). Mini roundabouts are primarily used on under capacity residential or collector streets.

Mini roundabouts shall only be installed on a state highway where the 85th percentile speed is 30 mph or less.

6.9.4 Pedestrians

1. At minimum, all projects will include at least a berm, curb cuts, and a refuge area in splitter islands for the accommodation of a 7ft sidewalk adjacent to the circulating lane. The Project Manager must obtain an entity/state agreement for the maintenance of the sidewalk before it can be added to the plans.
2. The Project Manager/lead designer should investigate adding a sidewalk whenever there are existing sidewalks on the approaches to the roundabout or when it is in an MPO area and future pedestrian facilities are likely. Refer to Complete Streets [EDSM.II.2.1.14](#).
3. The requirement to add a sidewalk to the roundabout or provisions to accommodate a future sidewalk is not limited to a rural or urban roundabout.
4. When a sidewalk is added and the district has specifically requested outside barrier curb on the approaches, a 7ft paved sidewalk adjacent to the circulating lane(s) will be required. If the outside curbing is mountable, the designer will add a green integrally colored concrete buffer (for maintenance purposes) with a 5 ft sidewalk.

5. If the roundabout has an outside truck apron, the sidewalk will be constructed on the back side of the truck apron with either mountable or barrier curb as required by note 4.
6. Crosswalks shall be marked across roundabout entrances and exits to indicate where pedestrians are intended to cross.
7. Stopping sight distance to the crosswalk on the approach and exit shall be provided.
8. The pedestrian crossing shall be located at least 20 ft from the yield point to the center of the crosswalk. The raised splitter islands shall be a minimum 6' wide at these locations.
9. If the cost to add a sidewalk or Berm is beyond the 20% threshold, documentation and approval by the Chief engineer will be required to eliminate the sidewalk. Any other circumstance that merits an exception to the policy such as a roundabout that impacts 4F/6F property will need to be documented and will also require approval from the Chief Engineer. Refer to Complete Streets [EDSM.II.2.1.14](#).
10. Sidewalk, ramp and crosswalk shall meet current DOTD guidelines.

6.9.5 Bicycles

1. All shoulders and bike lanes shall be ended with a 7:1 min. taper 100 ft in advance of the yield point. The bicycle lane should be dotted 50 ft to 200 ft in advance of the taper.
2. If applicable, curb ramps should be placed where the shoulder/bike lane terminates to allow cyclists to access a multi-use path.

6.9.6 Transit

1. Bus pullouts shall not be located on the circulatory roadway.
2. A bus stop is best situated:
 - a. On an exit lane in a pull out just past the crosswalk.
 - b. On an approach leg 60 ft minimum upstream from the crosswalk, in a pullout.

6.9.7 Signing

1. Signing in roundabouts shall be an approved breakaway system. See [Figure 6-12](#) and [Figure 6-13](#) for signing layouts.
2. Junction assemblies should be placed in advance of a roundabout.

3. Confirmation assemblies should be placed no more than 500 ft beyond the intersection.
4. Signs placed in center island shall be 48 in. from bottom of sign to the elevation of the near edge of the travel way.
5. Fishhook arrows shall be used on signs.

6.9.8 Pavement Markings

1. Fishhook pavement markings shall be used on the approach lanes to multi-lane roundabouts.
2. Single lane roundabouts do not need lane arrows or circulatory roadway pavement markings except for edge line markings.
3. Bike lane markings shall not be permitted within the circulatory roadway.
4. Yield lines (shark teeth) should not be used.

6.9.9 Landscaping

1. Landscaping is not mandatory. If landscaping is provided, DOTD will not be responsible for the maintenance of the landscaping and a gateway permit/agreement with the local government to maintain the landscaping is required.
2. Sponsorship for landscaping is permitted, and may require placement of a sign that is visible to each approach. The sign shall have 2 in. lettering and must be retro-reflective. The sign shall be placed such that the ground clearance from the bottom of the sign is a maximum of 2 ft
3. Provide two conduits to the central island, 1 for water and 1 for electrical.
4. No hard wall, benches, large spraying fountains, or any object that would encourage pedestrians shall be allowed in the center island.
5. Select plantings to ensure adequate sight distance and to minimize maintenance for the life of the project.
6. Splitter islands must not contain trees, planters or light poles.
7. Do not obstruct the sight triangle.
8. The perimeter portion of the central island may be landscaped with low-level vegetation so that stopping sight distances are maintained for vehicles within the circulatory roadway and at the entrance lines of the roundabout.
9. Avoid landscaping within 50 ft in advance of the yield point.

10. Use low profile landscaping in the corner radii if a crosswalk is provided so as not to obstruct the pedestrians.

6.9.10 Lighting

Lighting is not mandatory. Where lighting is installed, illumination design shall comply with the current edition of the IES Design Guide for Roundabout Lighting. Right-of-way permits and the Certification for Permit Lighting Supplement must be obtained prior to design and/or installation. Liability, ownership, maintenance, electricity, and operation of the lighting and electrical system are the responsibility of the permit applicant.