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Chapter 3 - Planning

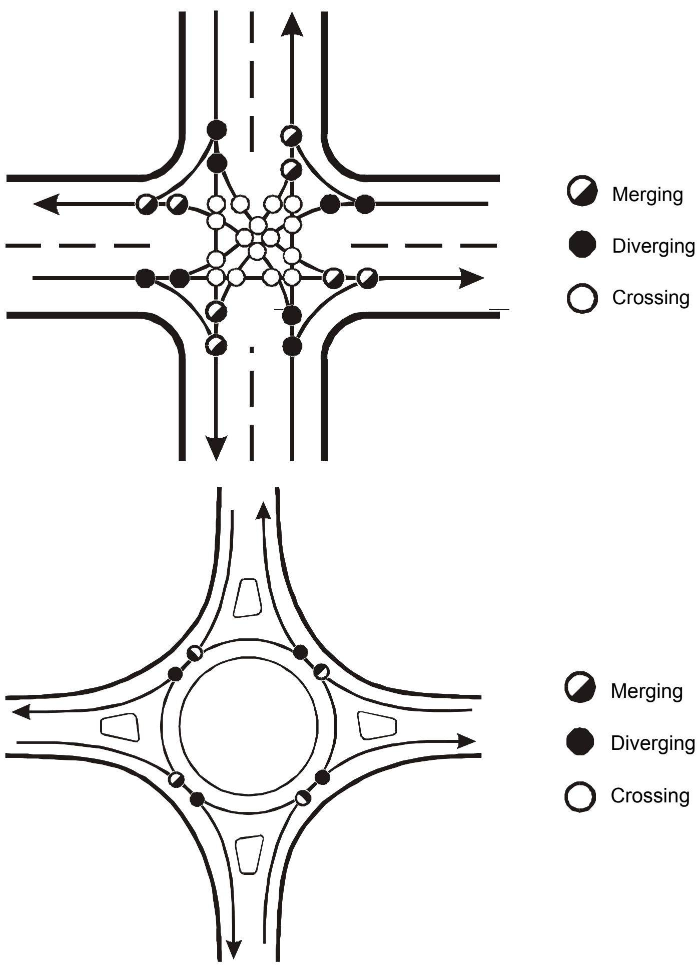
3.1 Roundabout Selection Guidance

Safety and Capacity Benefits of Roundabouts

When planning for intersection improvements, a variety of improvement alternatives should be evaluated, in addition to roundabouts, to determine whether a roundabout is the most appropriate alternative. This section highlights several benefits of roundabouts with respect to safety and capacity that may make them a viable improvement alternative over typical two-way, all-way, and signalized intersections.

With respect to safety, roundabouts provide a number of advantages over other intersection types, including a reduction in the total number of conflict points, which generally results in a reduction in total observed crashes. By removing the majority of the turning conflicts, left-turn and right- angle type collisions are virtually eliminated. Thus, a roundabout may be a viable option for improving an intersection that has a high crash history associated with these types of crashes. Exhibit 3-1 illustrates the number of motor vehicle conflict points at a conventional four-leg intersection (32 conflict points) and roundabout (8 conflict points) respectively.

Exhibit 3-1
Intersection Motor Vehicle Conflict Points:
Conventional and Roundabout Intersections



Crash severity at roundabouts is also dramatically reduced since vehicles are required to operate at lower speeds with a small relative speed differential between conflicting flows. This means that the chance for injury and fatality crashes is greatly reduced. Other safety features at roundabouts include the use of splitter islands and other geometric features that increase the conspicuity of the roundabout, providing advanced warning to drivers of the impending intersection. Pedestrians may also be more safely accommodated due to the presence of low vehicle speeds and the pedestrian refuge within the splitter island, which allows pedestrians to cross the approach in two phases and minimizes exposure time to motorized vehicles.

A roundabout may be considered a logical choice if its estimated operational performance is better than that of the other alternative control types. Roundabouts may be implemented to provide an operational improvement at an intersection to reduce delay and/or increase the capacity of an intersection. Typically roundabouts are only limited by the number of adequate gaps available for vehicles to enter the intersection. In many cases, delay at a roundabout will be lower in comparison to other intersection forms, which allow only one alternating traffic stream at a time to proceed through the intersection. Roundabouts allow multiple vehicles to enter simultaneously from different approaches, which may provide additional capacity benefits and delay reductions over some intersection forms, especially in the presence of relatively high left-turn volumes on the minor street approaches. The FHWA Roundabout Guide offers the following planning level guidance for comparisons of control modes:

1. A roundabout will always provide a higher capacity and lower delays than all-way stop control operating with the same traffic volumes and right-of-way limitations.
2. A roundabout is unlikely to offer better performance in terms of lower overall delays than two-way stop control (TWSC) at intersections with minor movements (including cross street entry and major street left turns) that are not experiencing, nor predicted to experience, operational problems under TWSC.
3. A single-lane roundabout may be assumed to operate within its capacity at any intersection that does not exceed the peak-hour volume warrant for signals.
4. A roundabout that operates within its capacity will generally produce lower delays than a comparably sized signalized intersection operating with the same traffic volumes.

While the guidance provided above is adequate at the planning level for estimating the validity of multiple alternatives, more detailed analysis is required to closely approximate the actual intersection operations for each alternative. The FHWA Roundabout Guide provides further guidance on predicting roundabout performance at the planning level for comparing roundabouts to TWSC, all-way stop control, and signalized intersection control types.

Site Selection Guidance

This section identifies locations and conditions at which roundabouts often provide advantages over other traffic control forms. Planners and designers are encouraged to consider and evaluate roundabouts as alternatives to conventional intersection forms at these locations. This section also identifies locations and conditions that can make a roundabout complicated or difficult. At these locations, planners and designers are encouraged to use caution when considering roundabouts.

Sites Where Roundabouts Are Often Advantageous

Roundabouts are often advantageous over other traffic control at the following locations and conditions:

- Intersections with historical safety problems.
- Intersections with relatively balanced traffic volumes.
- Intersections with a high percentage of turning movements.
- Intersections with high traffic volumes at peak hours but relatively low traffic volumes during non-peak hours.
- Existing two-way stop-controlled intersections with high side-street delays (particularly those that do not meet signal warrants).
- Intersections that must accommodate U-turns.
- Intersections at a gateway or entry point to a campus, neighborhood, commercial development, or urban area.
- Intersections where a community enhancement may be desirable.
- Intersections or corridors where traffic calming is a desired outcome of the project.
- Intersections where widening one or more approach may be difficult or cost-prohibitive, such as at bridge terminals.
- Intersections where traffic growth is expected to be high and future traffic patterns are uncertain.
- Locations where the speed environment of the road changes (for instance, at the fringe of an urban environment).
- Locations with a need to provide a transition between land use environments (such as between residential and commercial uses).
- Roads with a historical problem of excessive speeds.

Sites At Which Caution Should Be Exercised With Roundabouts

There are a number of locations and site conditions that often present complications or difficulties for installing roundabouts. Some of these locations can also be difficult or problematic for other intersection alternatives as well. Therefore, these site conditions should not necessarily preclude a roundabout from consideration. However, extra caution should be exercised when considering roundabouts at these locations:

- Intersections in close proximity to a signalized intersection where queues may spill back into the roundabout.
- Intersections located within a coordinated arterial signal system.
- Intersections with a heavy flow of through traffic on the major street opposed by relatively light traffic on the minor street.
- Intersections with physical or geometric complications.

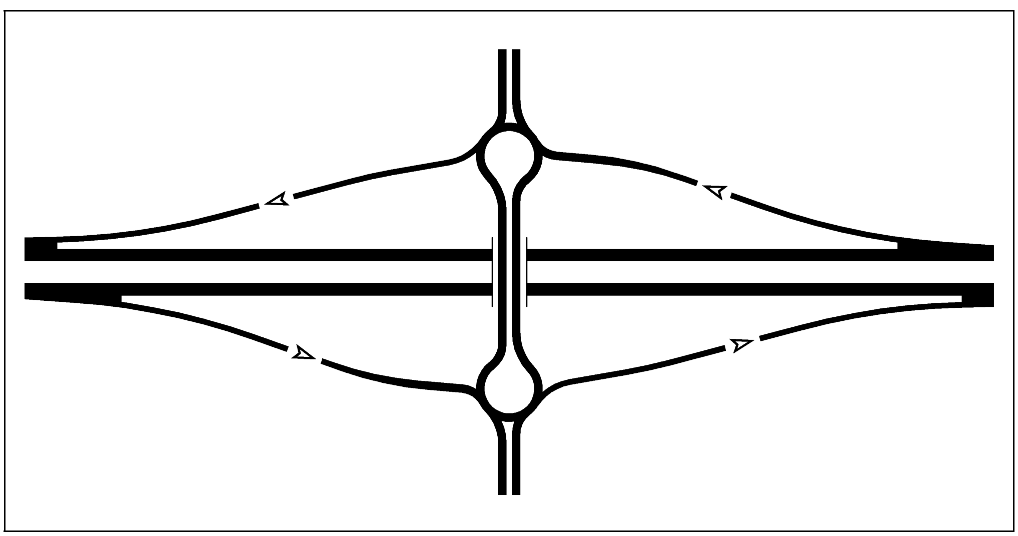
- Locations with steep grades and unfavorable topography that may limit visibility and complicate construction.
- Intersections with heavy bicycle volumes.
- Intersections with heavy pedestrian volumes.

Roundabouts at Interchanges

Roundabouts can be acceptable and, in some locations, advantageous solutions for ramp terminal intersections within freeway service interchanges. Using a roundabout in an interchange does not represent a new or unique interchange form. Rather, the roundabout can be used within a variety of conventional interchange forms as the means of controlling traffic at the ramp terminal intersections. Most commonly, roundabouts are used at diamond interchanges. They may also be used within partial cloverleaf interchanges at the termini of loop ramps or diagonal ramps.

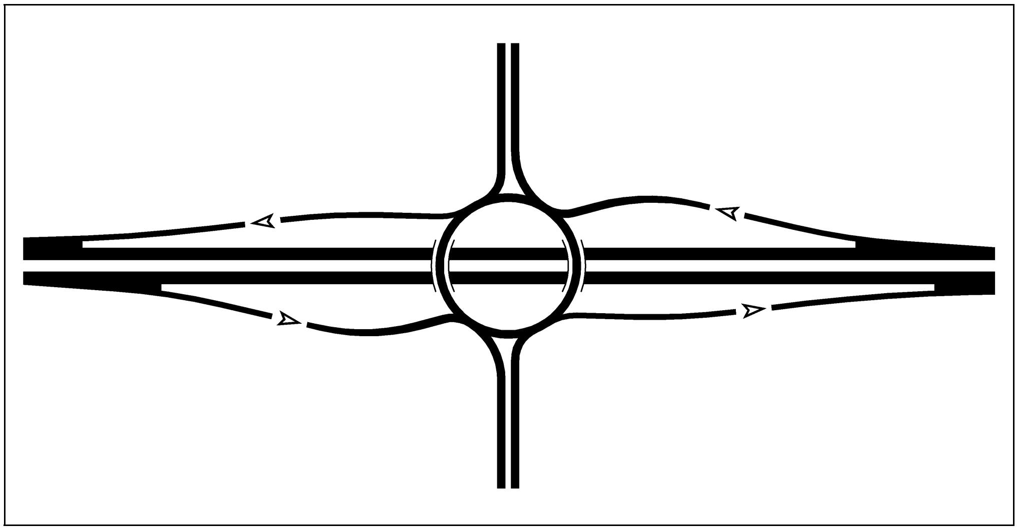
There are two variations of diamond interchanges that can be used with roundabouts. The more common form, shown in Exhibit 3-2, consists of two roundabouts, one on each side of the freeway. There is typically a single bridge structure (or, in some cases, two structures if the freeway crosses over the cross street) between roundabouts. For these interchanges, it is best if the ramp terminal intersections are spread far enough apart to avoid the need for widening of the bridge structure and prevent queues from spilling back between intersections. In some cases, the central islands may be raindrop-shaped with no yielding required for traffic between the two roundabouts. If the intersections consist of frontage roads or need to accommodate U-turns, however, raindrop-shaped central islands should not be used.

Exhibit 3-2
Typical Diamond Interchange with Roundabouts at Ramp Terminal Intersections



Another variation of the diamond interchange with roundabouts consists of a single, large-diameter roundabout centered over or under the freeway. Exhibit 3-3 illustrates this interchange form. As shown in the figure, the interchange requires two overpass or underpass structures. This interchange form can be likened to a typical single-point diamond interchange, where turning traffic from the freeway interchanges with arterial traffic at a single (albeit large) intersection. Due to the large size of this roundabout, care should be taken to ensure adequate entry curvature is achieved to control speeds.

Exhibit 3-3
Diamond Interchange with Roundabout at Single Ramp Terminal Intersection



3.2 Use of Single- and Multilane Roundabouts

Among the first steps in examining the feasibility of a roundabout is determining the preliminary configuration needs. The roundabout configuration is specified in terms of the number of entry and exit lanes needed on each approach to serve the design year traffic volumes. Future year design volumes should be used to determine the ultimate configuration of the roundabout to serve traffic on a twenty-year planning horizon.

Typically, roundabouts are identified in terms of the number of circulating lanes (i.e. single-lane, double-lane, etc.). The number of circulating lanes required for a particular roundabout is usually equal to the number of entering lanes required on the largest approach. Planning-level guidance is provided in Exhibit 3-4 to estimate the number of lanes required based upon the context of the intersection location. This planning level analysis is intended to aid in the decision making process to select or reject a roundabout as a viable improvement option prior to proceeding in to detailed analysis and design.

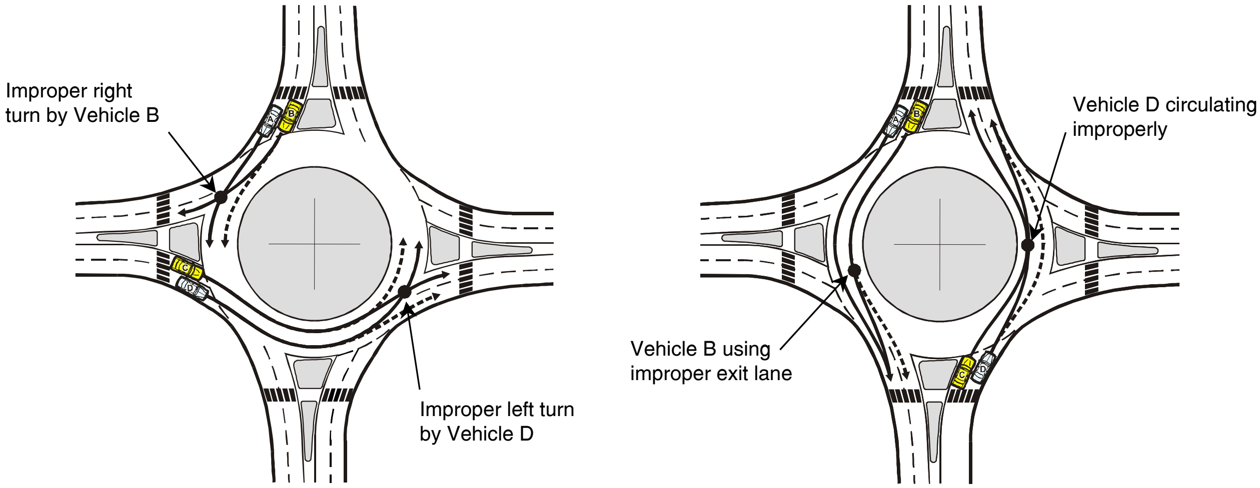
Exhibit 3-4
Roundabout Categories and Design Characteristics

Design Element	Mini-Roundabout	Urban Compact	Urban Single-lane	Urban Double-lane	Rural Single-lane	Rural Double-Lane
Recommended maximum entry design speed	15 mph (25 km/h)	15 mph (25 km/h)	20 mph (35 km/h)	25 mph (40 km/h)	25 mph (40 km/h)	30 mph (50 km/h)
Maximum number of entering lanes per approach	1	1	1	2	1	2
Typical inscribed circle diameter	50 to 90 ft (15 to 27 m)	100 to 120 ft (30 to 37 m)	120 to 150 ft (37 to 45 m)	150 to 220 ft (45 to 67 m)	120 to 200 ft (37 to 60 m)	175 to 250 ft (55 to 75 m)
Splitter island treatment	Raised if possible, crosswalk cut if raised	Raised, with crosswalk cut	Raised, with crosswalk cut	Raised, with crosswalk cut	Raised and extended, with crosswalk cut	Raised and extended, with crosswalk cut
Typical daily service volume on 4-leg roundabout (veh/day)	10,000	15,000	20,000	Approximately 40,000 – 50,000 Refer to FHWA publication: "Roundabouts: An Informational Guide"	20,000	Approximately 40,000 – 50,000 Refer to FHWA publication: "Roundabouts: An Informational Guide"

Exhibit 3-4 also provides a range of inscribed circle diameters for each category to assist in estimating the size of the roundabout footprint and aid in creating a preliminary assessment of right-of-way impacts. Information is provided in later sections regarding more detailed operational evaluations and specific geometric design considerations.

Multilane roundabouts produce increased capacity. They also introduce additional conflict points that may prevent a multilane roundabout from achieving the same level of crash reduction as their single-lane counterparts. However, even with an expected lower overall crash reduction, multilane roundabouts should still result in fewer serious injuries and fatalities as compared to the alternative intersection control. Exhibit 3-5 illustrates two examples of additional vehicle conflicts possible at multilane roundabouts.

Exhibit 3-5
Additional Vehicle Conflicts at Multilane Roundabouts



When projected traffic volumes indicate that a multilane roundabout is required for future year conditions, designers should evaluate the duration of time that a single-lane roundabout would operate acceptably before requiring additional lanes. Where a single-lane roundabout will be sufficient for much of its design life, designers should evaluate whether it is best to first construct a single lane roundabout until traffic volumes dictate the need for ultimate expansion to a multilane roundabout.

Single-lane roundabouts are generally simpler for motorists to learn and are more easily accepted in new locations. This, combined with fewer vehicle conflicts, should result in a better overall crash experience and allow for a smooth transition into the ultimate multilane build-out of the intersection. Single-lane roundabouts introduce fewer conflicts to pedestrians and bicycles and provide increased safety benefits to pedestrians by minimizing the crossing distance and limiting exposure time to vehicles while crossing an approach.

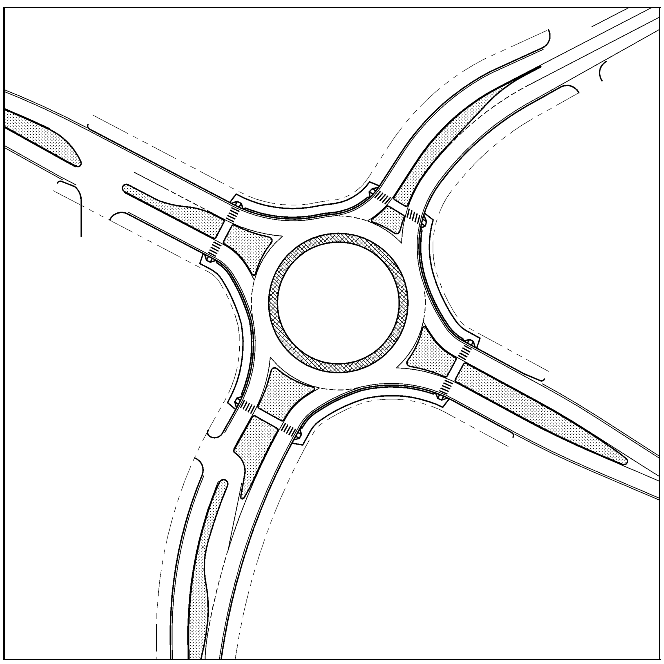
When considering an interim single lane roundabout, the designer should evaluate the right-of-way and geometric needs for both the single and multilane configurations. Consideration should also be given to the future construction staging for the additional lanes. There are generally two ways to expand from a single-lane to a double-lane roundabout:

1) **Construct additional entering, circulating, and exiting lanes on the outside of the single-lane roundabout.** Under this option, it may be easier for construction to occur while maintaining traffic flow. However, when using this option, care should be taken to provide adequate geometric features including entry and splitter island design to ensure that speed reduction and adequate natural paths will be provided at ultimate build-out. In preparing for this type of construction staging, it may be appropriate to initially design the roundabout for the ultimate-double lane condition to ensure adequate geometry and then remove the outside lanes from the design to form the initial single-lane roundabout. It is also helpful to evaluate the ultimate roundabout footprint to reserve right-of-way to accommodate the future widening.

2) **Construct the additional entering, circulating, and exiting lanes on the inside of the single-lane roundabout.** Under this option, the initial single-lane roundabout is designed to occupy the same inscribed circle diameter as the ultimate double-lane roundabout. This allows the designer to set the outer limits of the intersection during the initial construction. This limits the future construction impacts to surrounding properties during widening, as sidewalks and outer curb lines will not typically require adjustment. In this case, the roundabout is again initially designed for the ultimate multilane configuration. However, the modification to a single-lane design is done by providing wide splitter islands and an enlarged central island that occupy the space required for the inside travel lanes. Future expansion to the multilane roundabout is accomplished by reducing the width of the splitter islands and widening on the inside of the existing travel lanes. Typically, the splitter islands, central island curbing, and truck apron would require replacement. This type of expansion is illustrated in Exhibit 3-6.

Exhibit 3-6
Example – Staged Multilane Roundabout Construction

Interim Design – Single-Lane Roundabout



Ultimate Design - Double-Lane Roundabout

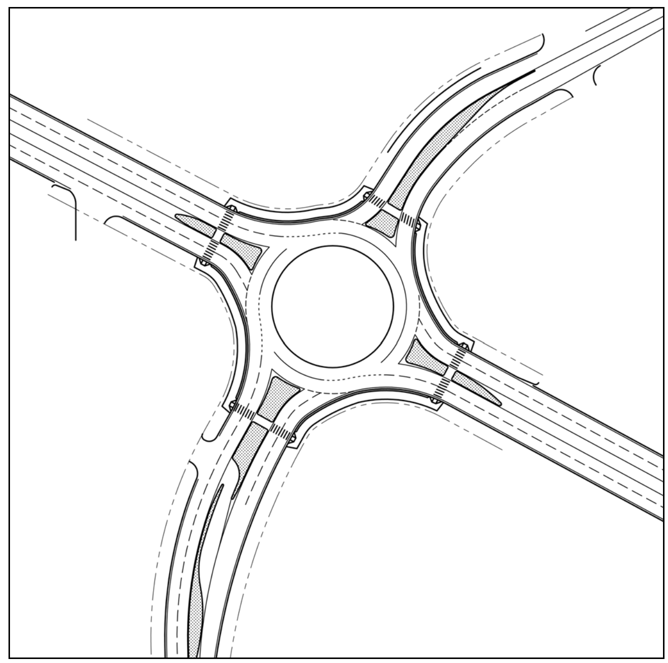


Exhibit 3-6 shows a sample multilane roundabout design where staged construction was utilized to provide a single-lane roundabout in the interim years until traffic volumes dictate the need for additional lanes. Note that the footprint of the roundabout and the approaches does not change between the interim and the ultimate design. Narrowing the splitter islands and reducing the diameter of the central island to accommodate the additional travel lanes accomplish the conversion to a multilane roundabout. It is also important to note that the ultimate roundabout design was established and refined *first*. Then, the interim design was produced by modifying the ultimate design to provide single entering, circulating, and exiting lanes, as shown in Exhibit 3-6. This ensures that the ultimate double-lane design will have the appropriate geometric features at the time it is constructed.

3.3 Typical Construction Costs

The cost of a roundabout varies greatly depending on a wide variety of factors. Some factors include the setting (urban/suburban/rural), the complexity of the improvements, in particular the amount of reconstruction necessary on the approach, and the methodology for maintenance of traffic. Some specific issues to consider when a roundabout is under consideration for intersection improvements include:

- Construction costs for roundabouts vary from one location to another, similar to other types of intersection control. The costs can vary at a roundabout due to several factors. Costs can be lower when there is minimal approach work necessary, there is no change in grades, and there is not a need to add a significant amount of pavement for the footprint of the roundabout. Costs can significantly increase in urban settings and other areas where there are substantial utility relocations, significant right-of-way needs, or urban design and streetscape elements are a considerable portion of the project.
- Roundabouts are typically, but not always more expensive than relatively simple signal design projects. A signal will be less expensive than a roundabout if the signal project only requires installation of the signal equipment with minimal roadway widening or reconstruction. However, if the intersection improvement requires a change in the vertical alignment or the addition of left-turn or right-turn lanes, the costs are often comparable.
- Maintenance of traffic can be a much higher percentage of the construction cost of a roundabout when compared to other intersection treatments, often comprising as much as a third of the total construction cost. This is related to the difficulty associated with the construction of the central island while maintaining traffic in all directions. Savings are possible if all approaches to the intersection can be detoured, or if two of the approaches to the intersection can be detoured.
- When developing costs for a project, future maintenance costs should be considered. For example, the maintenance of the central island can have a significant annual cost. Also, state maintenance crews typically do not have this type of maintenance included in their budget and often are not capable of, or interested in, landscape maintenance. If a high maintenance landscape is proposed, agreements with local municipalities, garden clubs, or civic organizations should be considered.
- Roundabouts in interchanges can often reduce the number of lanes necessary across the interchange structure. This will reduce the initial construction cost as well as the future maintenance costs.
- Costs for a roundabout constructed as part of a new facility or new development are typically comparable to other intersection treatments.