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References
INTRODUCTION:

The roundabout is a successful form of intersection control used throughout the world. Popularity of this type of circular intersection has only recently begun to increase within the United States. Prior to the FHWA publication “Roundabouts: An Informational Guide” there were no existing national guidelines to assist transportation professionals and engineers in developing and implementing roundabouts. The Pennsylvania Department of Transportation’s “Guide to Roundabouts” is designed as a supplement to the FHWA publication. This document will aid transportation professionals and engineers in determining whether a roundabout is a feasible alternative for a specific location.

These guidelines are designed to supplement existing design policies and procedures and are not intended to replace or supersede any current requirements. For any project that involves State or Federal money, or Liquid Fuels funds, the processes outlined in PennDOT’s Design Manual Part 1 and 1A must be followed.

This guide provides an array of questions and insights that can be applied in the planning or study phases of the preliminary design of intersections. Site and traffic characteristics determine the benefits of using a roundabout at a particular location. This guide will help to determine which intersections are best suited for roundabouts.

The Pennsylvania Department of Transportation’s “Guide to Roundabouts” begins with a detailed description of the modern roundabout. Characteristics of rotaries and neighborhood traffic circles are provided to clarify the differences between these older style circular intersections and modern roundabouts. The benefits of implementing a roundabout are then discussed. The core of the guide is a questionnaire that will direct transportation professionals and engineers toward a decision regarding the feasibility of using a roundabout. The questions are applicable to either the planning or study phases of the design process. Following the questionnaire, there are several important issues discussed regarding pedestrians, bicyclists, and educating the public. In order to facilitate the design process, several case studies are also included.

Further design criteria for roundabouts can be found in the FHWA publication “Roundabouts: An Informational Guide” (Publication number FHWA-RD-00-067) which is available from the FHWA publication center on the internet at www.fhwa.dot.gov/pubstats.html.
ROUNDABOUTS VERSUS TRAFFIC CIRCLES

At the mention of the term roundabout many people including some engineers may have a negative reaction because they associate roundabouts with the traffic circles of the past. Roundabouts are a type of circular intersection as are traffic circles and rotaries. However, the modern roundabout has very specific characteristics that differentiate it from traffic circles and rotaries. All modern roundabouts have the following characteristics:

1) Traffic control – yield control used on all entries
2) Approach geometry – the approaching roadways do not enter the roundabout perpendicular to the circulating roadway, but, the traffic is deflected through the use of splitter islands to enter the circulating roadway at as small an angle as possible.
3) Priority to circulating vehicles – circulating vehicles within the roundabout have the right-of-way
4) Pedestrian access – allowed only across the legs of the roundabout behind the yield line
5) Parking – not allowed within the circulatory roadway or at the entries
6) Direction of circulation – vehicles circulate counter-clockwise and pass to the right of the central island
7) Splitter island – All except mini-roundabouts have raised splitter islands. Mini-roundabouts have splitter islands defined only by pavement markings

In addition to the above characteristics, roundabouts may also possess the following characteristics:

1) Adequate speed reduction – good roundabout design requires entering vehicles to negotiate a radius small enough to slow speeds to no greater than 30 mph.
2) Design vehicle - accommodates the appropriate design vehicle (for small roundabouts an apron may be required)
3) Entry flare – flare on the entry to widen the approach to multiple lanes to provide additional capacity and storage at the yield line
4) Pedestrian crossing locations – located at least one vehicle length upstream of the yield point
It is important that the differences between the modern roundabout and the other types of circular intersections are clear.

- **Rotaries** generally had large diameters that resulted in high speeds within the circulatory roadway. They typically provided little or no deflection of the through traffic paths, and some required the circulating traffic to yield to entering traffic. The latter caused congestion, and the intersection would often “lock-up.”

- **Neighborhood traffic circles** are typically built to calm traffic and/or improve the aesthetics of local street intersections. The approaches may by uncontrolled or stop-controlled. Additional information on traffic circles can be found in Section 1.5 of FHWA’s publication “Roundabouts: An Informational Guide.”

There are six categories of modern roundabouts:

1) Mini-roundabouts
2) Urban compact roundabouts
3) Urban single-lane roundabouts
4) Urban double-lane roundabouts
5) Rural single-lane roundabouts
6) Rural double-lane roundabouts

Detailed descriptions of each category, along with fundamental design and operational elements, are provided in Appendix C.
BENEFITS OF USING ROUNDABOUTS

A well-designed roundabout has the potential to improve the conditions of an existing intersection or can be a highly effective component of a new transportation system. A modern roundabout offers benefits such as increased safety, increased capacity, reduced delay, and calmer traffic. In addition, air and noise pollution can be reduced and the aesthetics of the area enhanced.

*Increased Safety:*

One of the most important benefits of a modern roundabout is the increased level of safety resulting from the reduction of vehicle-vehicle conflict points. A conflict point occurs where one vehicle path crosses, merges or diverges with or queues behind the path of another vehicle, pedestrian, or bicycle. A conventional four-leg intersection has 32 vehicle-vehicle conflict points. A four-leg single-lane roundabout reduces the number of conflict points to only eight. But, both types of intersections have potential vehicle-pedestrian conflicts. A traditional signalized intersection has potential for four vehicle-pedestrian conflicts, all originating from different directions. Roundabouts require pedestrians to cross one direction of traffic at a time allowing the pedestrian to concentrate entirely on one direction of traffic. The lower speeds of vehicles entering and exiting a roundabout provide safer conditions for pedestrians.

On average, roundabouts in the United States have shown total crash reductions of 37 percent and injury crash reductions of 51 percent. The reduction is a result of several factors. The geometric layout of a roundabout eliminates the hazardous conflicts such as left turn head-on and right angle crashes. The latter type is the result of the entry angle between the entering and circulating roadways being about 60-degrees rather than 90-degrees. The low speeds allow motorists more reaction time to respond to potential conflicts. If a crash does occur, the severity is reduced due to the lower speeds and the reduced entry angle.

*Increased Capacity/Less Delay:*

Generally both capacity and delay improve with the use of a roundabout when compared to alternate intersection control methods. The capacity at a roundabout will likely be higher than a signalized intersection because there are no losses of time due to yellow and red signal intervals. In addition, vehicles are able to enter the roundabout from each leg simultaneously, which is not possible with other forms of intersection control. Thus, the higher capacity of roundabouts results in shorter delays. Often entering drivers do not need to stop, and during off-peak periods many drivers adjust their speed to take advantage of approaching gaps in circulating traffic.

*Traffic Calming:*

By reducing vehicle speeds, roundabouts can have a traffic calming effect. An appropriately designed roundabout with raised channelization forces vehicles to physically change direction
making it difficult for them to speed. Roundabouts can be used effectively at the interface between rural and urban areas where speed limits change.

In a situation where a roadway can be used as a “cut-through”, a roundabout can serve as a traffic calming method. Using roundabouts along the “cut-through” path requires traffic to slow and may deter some motorists from using the route.

Environment & Aesthetics:
A roundabout can result in a significant lowering of noise and air pollution through reductions in the number of acceleration/deceleration cycles and vehicle idling. In addition, fuel consumption is reduced.

Aesthetics can be an important issue in a construction project. Choosing a roundabout offers residents the opportunity to provide an attractive entrance into their communities.
WHERE TO USE ROUNDBOUTS

It is important to understand where and how a roundabout can be a successful method of intersection control. Intersections with the following characteristics can potentially benefit from the implementation of a roundabout.

- Heavy delay on minor road
- Large traffic signal delays
- Heavy left turning traffic
- More than four legs or unusual geometry
- History of crashes involving crossing traffic
- “Y” or “T” configuration
- Traffic growth expected to be high and future traffic patterns uncertain or changeable
- Need for U-turns
- Freeway interchange ramps
- History of right angle crashes

Furthermore, an array of questions has been created to aid transportation professionals and engineers in the process of determining the feasibility of a roundabout for a specific location. These questions focus on the qualities and issues of an intersection that determine the potential benefits of using a roundabout.

In order to complete the questionnaire, information must be collected about the intersection. Each question is applicable to the planning or study phases of the preliminary design process. These two phases require different levels of information. A list of the data required to complete the form can be found in Appendix A.
ROUNDABOUT QUESTIONNAIRE

Please use the answers to the following questions to aid in the planning or preliminary design phases. Each question is followed by pertinent information that will help analyze the feasibility of using a roundabout.

INTERSECTION LOCATION:

________________________________________

________________________________________

BRIEF DESCRIPTION OF INTERSECTION:

________________________________________

________________________________________

IDENTIFY THE ENVIRONMENT:

• Planning Phase

Question No. 1: Would the roundabout be the first in the area?

________________________________________

The first roundabout in an area will require education and justification efforts. Please refer to the “Issues Associated with Roundabouts” section for further information regarding this topic. Selecting a single-lane roundabout is recommended since this type will initially be more easily understood than a multi-lane type.

Question No. 2: Would the roundabout be part of a new roadway system or a retrofit of an existing intersection?

________________________________________

A roundabout that is part of a new roadway will normally have fewer constraints, and right-of-way should be easier to acquire than for an existing intersection. If the roundabout is a retrofit of an existing intersection, the resulting cost of maintaining traffic can be relatively high.
SITE CHARACTERISTICS:

• Planning Phase

Question No. 1: Would the roundabout be located in the vicinity of a railroad grade crossing?

__________________________________________________________

Special consideration must be given when a railroad grade crossing is located in the vicinity of the roundabout. Queues from a railroad crossing cannot be allowed to back up into the roundabout. The crossing will obviously require railroad crossing signals and/or gates to stop traffic on the crossing roadway. However, due to the proximity of the railroad crossing to the roundabout, it may be necessary to install railroad crossing signals/gates at all legs of the roundabout and shut down the roundabout during train crossings. This condition may negate the beneficial effect of the roundabout.

Question No. 2: Is the intersection on any transit routes?

__________________________________________________________

A roundabout properly designed using the appropriate design vehicle should pose no problem for a bus to traverse. It is important to carefully select the location of bus stops to minimize the probability of vehicle queues backing up into the circulatory roadway.

Question No. 3: Does the community have a need for parking within or near the intersection?

__________________________________________________________

Parking is not allowed within the circulatory roadway or at the entries. This may be an important issue if businesses are located in the vicinity of the intersection.

CAPACITY OF THE INTERSECTION:

• Planning Phase

Question No. 1: What is the required capacity for the intersection?

__________________________________________________________

The following tables provide information to determine which category of roundabout is required for the intersection in question. The data provided below can be found in Chapter 3 of the FHWA publication “Roundabouts: An Informational Guide.” Maximum AADT in the tables below represents the total of the approaching roadways.
**Four-leg Roundabout**

<table>
<thead>
<tr>
<th>Category</th>
<th>Proportion of Traffic on Minor Street</th>
<th>Left Turn Percentage</th>
<th>Maximum AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-lane</td>
<td>33%</td>
<td>0%</td>
<td>22,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>21,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>20,000</td>
</tr>
<tr>
<td>Single-lane</td>
<td>50%</td>
<td>0%</td>
<td>26,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>25,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>23,750</td>
</tr>
<tr>
<td>Double-lane</td>
<td>33%</td>
<td>0%</td>
<td>43,750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>41,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>40,000</td>
</tr>
<tr>
<td>Double-lane</td>
<td>50%</td>
<td>0%</td>
<td>51,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>48,750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>46,875</td>
</tr>
</tbody>
</table>

*For three-leg roundabouts, use 75% of the maximum AADT volumes shown above.

**Mini-roundabout**

<table>
<thead>
<tr>
<th>Percent Cross Traffic</th>
<th>Left Turn Percentage</th>
<th>Maximum AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>0%</td>
<td>14,500</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>12,500</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>12,250</td>
</tr>
<tr>
<td>50%</td>
<td>0%</td>
<td>15,500</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>14,500</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>14,250</td>
</tr>
</tbody>
</table>

* Mini-roundabouts are usually implemented with safety in mind, rather than capacity

**Question No. 2:** Does the intersection under consideration consist of a major arterial and a minor arterial or local road?

One of basic principles of a roundabout is that all intersection movements are given equal priority. This fact may cause major street movements to be delayed more than desired. The overall street classification system and hierarchy should be considered before selecting a roundabout.

- **Study Phase**

**Question No. 3:** What is the volume-to-capacity (v/c) ratio for each leg of the roundabout?

FHWA recommends that the v/c ratio should not exceed 0.85 for any leg of the roundabout.
SAFETY:

- **Planning Phase**

  **Question No. 1:** What is the crash history of the intersection over the past five years?

  Roundabouts have been shown to reduce total crashes by 37 percent and injury crashes by 51 percent. If the intersection has a large number of head-on and angle crashes, a roundabout may help reduce the number and severity of these incidents. The decrease is due to the entry angle being reduced to about 60 degrees from 90 degrees, lower speeds, and the elimination of vehicles traveling in opposite directions.

RIGHT-OF-WAY:

- **Planning Phase**

  **Question No. 1:** Can a roundabout be constructed within the existing right-of-way, or will it be necessary to acquire additional space?

  Roundabouts usually require more space for the circulatory roadway and central island than what would be necessary for a traditional rectangular intersection. Be aware that corner properties at the intersections can create significant right-of-way problems.

- **Study Phase**

  **Question No. 2:** Would selecting a signalized intersection require long or multiple turn lanes to provide sufficient capacity?

  Roundabouts with similar capacity should require less space on the approaches than a signalized intersection. Additional capacity at the intersection can be added by using flared approach lanes. Utilizing flared approach lanes still maintains the benefit of reduced spatial requirements upstream and downstream of the intersection.
ALTERNATE TYPES OF INTERSECTION CONTROL:

Two-Way Stop Controlled Intersection (TWSC)

- **Study Phase**

  **Question No. 1:** (if applicable) Is the existing TWSC intersection experiencing congestion on the minor street caused by a demand that exceeds capacity?

  As stated previously, a basic principle of roundabouts is that all intersection movements are given equal priority. Higher proportions of minor street traffic favor roundabouts while lower proportions favor TWSC.

  **Question No. 2:** (if applicable) Are queues forming on the major street due to inadequate capacity for left turning vehicles?

  Roundabouts provide a more favorable treatment of left turning vehicles than TWSC.

All-Way Stop Controlled Intersection (AWSC)

- **Study Phase**

  **Question No. 1:** Are the cross street traffic volumes heavy enough to meet the MUTCD warrants for an AWSC?

  Roundabouts offer higher capacity and lower delays. A reduction in delay during off-peak periods is a benefit that roundabouts offer but cannot be provided by an AWSC intersection.

Signalized Intersection

- **Planning Phase**

  **Question No. 1:** Would the roundabout be located within a coordinated signal system?

  Introducing a roundabout into a coordinated signal system may disperse and rearrange platoons of traffic if other conflicting flows are significant, thereby affecting progressive...
movement. It may be beneficial to divide the signal system into subsystems separated by the roundabout to minimize overall system delay.

- **Study Phase**

**Question No. 2:** Are traffic volumes heavy enough to warrant signalization?

When comparing roundabouts to signalized intersections, there is a notable delay savings when volumes are evenly split between minor and major approaches, especially on two-lane approaches with high left turn percentages. When the major street approaches dominate, roundabout delay will be lower than signal delay.

Other benefits that roundabouts have when compared to signalized intersections are increased capacity, slower speeds, fewer and less severe crashes, less maintenance costs, greater traffic calming, and a more attractive environment. Roundabouts are self-regulating, while a signal will require periodic adjustments to its timing sequences.

**DESIGN SPEED:**

- **Planning Phase**

**Question No. 1:** What will the design speed of the roadway be?

The following table lists the FHWA recommended maximum entry design speed for various categories.

<table>
<thead>
<tr>
<th>Max. Entry Design Speed</th>
<th>Mini-Roundabout (25 km/h)</th>
<th>Urban Compact (25 km/h)</th>
<th>Urban Single-lane (35 km/h)</th>
<th>Urban Double-lane (40 km/h)</th>
<th>Rural Single-lane (40 km/h)</th>
<th>Rural Double-lane (50 km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Number of entering lanes per approach</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
PERCENT/TYPfE OF TRucks:

• Planning Phase

Question No. 1: What is the largest vehicle that can be reasonably expected to travel through the intersection?

Single-lane roundabouts may require the use of a mountable apron around the perimeter of the central island to provide additional tracking width for large vehicles. Trucks utilizing double-lane roundabouts may track across the entire width of the circulatory roadway.

Question No. 2: Will large emergency vehicles be passing through the intersection?

Emergency vehicles will pass through a roundabout in the same manner as other large vehicles and may require a mountable apron. Unlike signalized intersections, emergency vehicles are not faced with through movement vehicles unexpectedly running the intersection at high speed and hitting them.

• Study Phase

Question No. 3: What is the percent of trucks on each approach?

Due to their length, trucks will find it more challenging than passenger vehicles to use a roundabout. Careful consideration must be given to the amount of truck traffic anticipated, the types of trucks anticipated and their expected route through a roundabout when evaluating. Accommodating trucks may require that a larger inscribed circle diameter be used which may present right of way issues. Additionally, it may be necessary to include a concrete apron in the center island to accommodate truck turns.

PEDESTRIANS/BICYCLES:

• Study Phase

Question No. 1: What is the amount of pedestrian and bicycle traffic existing/expected at the intersection?

It is very important to consider pedestrian and bicycle activity when choosing an intersection control method. Please refer to the “Issues Associated with Roundabouts” section of this guide for further information regarding these topics.
ILLUMINATION:

- *Planning Phase*

**Question No. 1:** Determine the need for illumination?

It is suggested that the approach roadways serving a roundabout be illuminated. The specific site conditions and design criteria will determine the need for and level of illumination. Care must be exercised to ensure that the clear zone requirements are met.

COST:

- *Study Phase*

**Question No. 1:** What is the project’s budget?

Costs for a roundabout will include construction, engineering and design, land acquisition, and maintenance. It is important to note that costs of installing roundabouts can vary significantly from site to site. The costs of a roundabout and a signalized intersection are comparable at new sites and at existing signalized intersections that require widening at one or more approaches for additional lanes. In most cases, a roundabout will be more expensive to construct than a two-way or all-way stop controlled intersection. Costs of maintaining traffic during construction tends to be relatively high when retrofitting intersections.

Other factors that may contribute to higher costs for roundabouts include large amounts of landscaping, splitter islands, extensive signing, lighting, and curbing. Operation and maintenance costs are somewhat higher than unsignalized intersections but are less than signalized intersections. On-going maintenance costs include restriping and repaving, snow removal/storage, and landscaping.
QUESTIONNAIRE SUMMARY:

Upon completion of the questionnaire, engineering judgment must be used to determine if a roundabout is a feasible alternative. When a roundabout is determined to be feasible, its selection category should be identified. The following five categories indicate the primary reason why a roundabout should be selected:

1) Safety Improvement
2) Operational Improvement
3) Community Enhancement
4) Traffic Calming
5) Special Conditions (such as unusual geometry, high volumes, right-of-way limits, etc.)

In addition, when a roundabout is selected for further study, the roundabout alternative should be compared to alternate intersection control methods (i.e., TWSC, AWSC, signalization). Traffic analyses must be completed to determine the performance of the intersection for each control method. FHWA describes the Australian computer program SIDRA as a method to perform the roundabout analyses.

Upon completion of the study, the results must be documented and a final recommendation made. It is important to remember that this guide is written to be a supplement to the FHWA publication “Roundabouts: An Informational Guide” and should be utilized along with the FHWA publication.
ISSUES ASSOCIATED WITH ROUNDABOUTS

Several roundabout issues (pedestrians, bicyclists, and public education) need further explanation. Each of these issues is discussed below.

Pedestrians:

Pedestrians are accommodated by crossings that are located around the perimeter of the roundabout. Pedestrian crossings are set back from the yield line by one or more car lengths. This placement results in shortened crossing distances when compared with locations adjacent to the inscribed circle. This crossing placement also separates vehicle-vehicle and vehicle-pedestrian conflict points. Entering motorists are able to devote their entire attention to crossing pedestrians while waiting for the vehicle at the yield line to enter the circulating roadway.

There are important design considerations that must be kept in mind. Pedestrians should be discouraged from crossing the circulatory roadway to the central island. Items such as benches, plaques and monuments should not be placed in the center island as they would entice pedestrians to travel to the central island. Providing landscape buffers at the corners of the roundabout will discourage pedestrians from jaywalking.

An important issue with roundabouts is access for blind or visually impaired pedestrians. According to the FHWA guide, crossing roundabouts may be difficult for visually-impaired pedestrians to perform without assistance. The following describes some of the problems that visually impaired pedestrians may encounter when attempting to navigate through a roundabout:

- **Visually-impaired pedestrians must be able to locate the crosswalk.** The crosswalks at roundabouts are located at positions that differ from those at a typical four-leg intersection. Landscaping can be utilized to indicate the crosswalk’s location. The curb edge of the ramp must be detectable which can be accomplished by using a type of warning surface.

- **Visually-impaired pedestrians must listen for a safe gap to cross the entrance or exit lane(s).** The pedestrian may have a problem differentiating the sounds of the entering/exiting traffic from those of the circulating traffic.

- **Visually-impaired pedestrians must be able to locate the splitter island refuge area.** The refuge area must be ramped, curbed or equipped with detectable warnings to aid the disabled pedestrians.

- **Visually-impaired pedestrians must be able to locate the correct walkway to either continue their path or locate the adjacent crosswalk to cross the next leg of the**
**roundabout.** The use of landscaping can again be utilized to indicate the different locations.

Additional design remedies to the problems include using pedestrian crossings with actuated signals, raised pavement markers with in-roadway warning lights, and raised crosswalks. It should be noted that the use of the listed remedies would, most likely, reduce the effectiveness of the roundabout by interfering with the yield conditions entering and exiting the facility. Designers must adhere to the federal guidelines that dictate the use of in-roadway warning lights.

**Bicyclists:**

Accommodating bicyclists with a wide range of skills and comfort levels at a roundabout can be a difficult task. Designers must begin with the policy that bike lanes should never be used within a roundabout due to the complexity of traffic interaction. On a single-lane roundabout bicyclists should have the option of either mixing with traffic or using the roundabout as a pedestrian. With double-lane roundabouts, bicyclists require special attention especially when bicycle traffic is moderate to heavy. A bicycle path that is located outside of the roundabout is the preferable choice.

**Educating the Public:**

Public acceptance of roundabouts has often been one of the biggest challenges that a jurisdiction faces when installing its first roundabout. The initial public reaction may be negative. Previous projects have shown that public attitudes toward roundabouts improve significantly after construction.

Motorists unfamiliar with roundabouts may often experience driver confusion when traversing the intersection for the first time. Therefore when a new roundabout is planned, it is *extremely* important that the public be educated on the various aspects of a roundabout. There are several means by which education can take place. Public meetings can provide a good forum for bringing the public into the design process and allowing them to ask questions and provide some fresh ideas. Informational brochures and videos can also be used to educate the community. Public service announcements in newspapers, on television and radio can also assist in the education process.

**Maintenance:**

Once a roundabout has been constructed and is in service, the need to maintain the facility follows. It should be noted that maintenance of the pavement and roadway would be more challenging than standard signalized intersections. The ability to perform half-width construction may be eliminated if the circulating roadway is too narrow. Because the roundabout uses more land area compared to a standard intersection, the ability to construct a temporary roadway around the facility during construction will likely have substantial right-of-way implications. For these reasons, the cost of maintenance of a roundabout roadway will
be higher than standard signalized intersections primarily due to the maintenance and protection of traffic issues.

Also of concern, is the removal of snow from the facility in the winter. The geometry of the roundabout will make snow removal more difficult. There may be a need to use smaller (pick-up truck) plows within the roundabout to effectively remove the snow to negotiate the circulating roadway as well as the approach roadways and the splitter islands. Additionally, care must be taken when stockpiling the snow to avoid impacting adjoining properties or interfering with sight distance in and approaching the roundabout.

These factors must be considered before a decision can be made to utilize a roundabout facility as the costs and concerns associated with these issues will be around for the life of the facility.
APPENDIX A – INTERSECTION DATA:

- **Planning Phase**
  - Detailed crash records giving the type and frequency of collisions occurring at the existing intersection.
  - Community considerations such as parking needs, the landscaping style of the area and any existing traffic management strategies.
  - Transit routes that exist through the intersection, their frequency, and any stops within the vicinity (.25 mi.) of the intersection.
  - Posted and design speeds for all the approaches.
  - Miscellaneous data, such as existing geometry, population of the surrounding area, land uses and distances to other intersections, and adjacent intersection control treatments.

- **Study Phase**
  - Peak hour turning movement volumes summarized by 15-minute intervals.
  - 24-hour approach volumes for each leg of the intersection to identify the heaviest eight hours for a signal warrant analysis.
  - Pedestrian and bicycle counts and future generators must be considered when the numbers are significant. Care should be taken with planning for pedestrian and bicycle counts as existing counts may not be indicative of future use through the facility.
  - Percentage of large trucks that will be using the intersection.

Note that the future traffic volumes should be projected based on the assumed growth rate for the area.
The following is a list of typical terms associated with roundabouts.

1) **Central Island** – raised area in the center of a roundabout around which traffic circulates

2) **Splitter Island** – raised or painted area on an approach used to separate entering from exiting traffic, deflect and slow entering traffic and provide storage space for pedestrians crossing the road in two stages

3) **Circulatory Roadway** – the curved path used by vehicles to travel in a counter-clockwise fashion around the central island

4) **Apron** – the mountable portion of the central island adjacent to the circulatory roadway (may be required on smaller roundabouts to accommodate the wheel tracking of large vehicles)
5) **Yield line** – a pavement marking used to mark the point of entry from an approach into the circulatory roadway and is generally marked along the inscribed circle. Entering vehicles must yield to any circulating traffic coming from the left before crossing this line into the circulating roadway.

6) **Accessible pedestrian crossing** – should be provided at all roundabouts. The crossing location is set back from the yield line, and the splitter island is cut to allow pedestrian, wheelchairs, strollers, and bicycles to pass through.

7) **Bicycle treatments** – roundabouts provide bicyclists the option of traveling through the roundabout either as a vehicle or as a pedestrian, depending on the bicyclist’s level of comfort.

8) **Landscaping buffer** – provided at most roundabouts to separate vehicular and pedestrian traffic and to encourage pedestrians to cross only at the designated crossing locations. Landscaping buffers can also significantly improve the aesthetics of the intersection.

9) **Inscribed circle diameter** – the basic parameter used to define the size of a roundabout. It is measured between the outer edges of the circulatory roadway.

10) **Circulatory roadway width** – defines the roadway width for vehicle circulation around the central island. It is measured as the width between the outer edge of this roadway and the central island. *It does not* include the width of any mountable apron, which is defined to be part of the central island.

11) **Approach width** – the width of the roadway used by approaching traffic upstream of any changes in width associated with the roundabout. The approach width is typically no more than half of the total width of the roadway.

12) **Departure width** - the width of the roadway used by departing traffic downstream of any changes in width associated with the roundabout. The departure width is typically less than or equal to half of the total width of the roadway.

13) **Entry width** – the width of the entry where it meets the inscribed circle. It is measured perpendicularly from the right edge of the entry to the intersection point of the left edge and the inscribed circle.

14) **Exit width** – the width of the exit where it meets the inscribed circle. It is measured perpendicularly from the right edge of the exit to the intersection point of the left edge and the inscribed circle.

15) **Entry radius** – the minimum radius of curvature of the outside curb at the entry.

16) **Exit radius** – the minimum radius of curvature of the outside curb at the exit.
APPENDIX C – CATEGORIES:

The FHWA publication “Roundabouts: An Informational Guide” divides roundabouts into six categories. The categories are based on the size of the facility, number of lanes and the location of the facility. A listing of the design and operational elements of each of the roundabout categories is included in the table below. The following pages contain a description of each category of roundabouts as well as a typical figure of the facility (these are reprinted from the FHWA publication as noted).

The roundabout categories are:
- Mini Roundabouts
- Urban Compact Roundabouts
- Urban Single-Lane Roundabouts
- Urban Double-Lane Roundabouts
- Rural Single-Lane Roundabouts
- Rural Double –Lane Roundabouts

<table>
<thead>
<tr>
<th>Design Element</th>
<th>Mini-Roundabout</th>
<th>Urban Compact</th>
<th>Urban Single-Lane</th>
<th>Urban Double-Lane</th>
<th>Rural Single-Lane</th>
<th>Rural Double-Lane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recommended maximum entry design speed</td>
<td>15 mph (25 km/h)</td>
<td>15 mph (25 km/h)</td>
<td>20 mph (35 km/h)</td>
<td>25 mph (40 km/h)</td>
<td>25 mph (40 km/h)</td>
<td>30 mph (50 km/h)</td>
</tr>
<tr>
<td>Maximum number of entering lanes per approach</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Typical inscribed circle diameter</td>
<td>45’ - 80’ (13m - 25m)</td>
<td>80’ - 100’ (25m - 30m)</td>
<td>100’ - 130’ (30m - 40m)</td>
<td>150’ - 180’ (45m - 55m)</td>
<td>115’ - 130’ (35m - 40m)</td>
<td>180’ - 200’ (55m - 60m)</td>
</tr>
<tr>
<td>Splitter island treatment</td>
<td>Raised if possible, crosswalk cut if raised</td>
<td>Raised, with crosswalk cut</td>
<td>Raised, with crosswalk cut</td>
<td>Raised, with extended, with crosswalk cut</td>
<td>Raised and extended, with crosswalk cut</td>
<td></td>
</tr>
<tr>
<td>Typical daily service vol. on 4-leg roundabout (veh/day)</td>
<td>10,000</td>
<td>15,000</td>
<td>20,000</td>
<td>Refer to FHWA Publication</td>
<td>20,000</td>
<td>Refer to FHWA Publication</td>
</tr>
</tbody>
</table>

Reprinted from Section 1.6 of FHWA publication “Roundabouts: An Informational Guide”
Publication Number FHWA-RD-00-067
Mini-roundabouts

Mini-roundabouts are small roundabouts used in low-speed urban environments, with average operating speeds of 35 mph (60km/h) or less. The figure below provides an example of a typical mini-roundabout. They can be useful in low-speed urban environments in cases where conventional roundabout design is precluded by right-of-way constraints. In retrofit applications, mini-roundabouts are relatively inexpensive because they typically require minimal additional pavement at the intersection roads – for example, minor widening at the corner curbs. They are mostly recommended when there is insufficient right-of-way for an urban compact roundabout. Because they are small, mini-roundabouts are perceived as pedestrian-friendly with short crossing distances and very low vehicle speeds on approaches and exits. The mini-roundabout is designed to accommodate passenger cars without requiring them to drive over the central island. To maintain its perceived compactness and low speed characteristics, the yield lines are positioned just outside of the swept path of the largest expected vehicle. However, the central island is mountable, and larger vehicles may cross over the central island, but not to the left of it. Speed control around the mountable central island should be provided in the design by requiring horizontal deflection. Capacity for this type of roundabout is expected to be similar to that of the compact urban roundabout. The recommended design of these roundabouts is based on the German method, with some influence from the United Kingdom.

Reprinted from Section 1.6 of FHWA publication “Roundabouts: An Informational Guide”
Publication Number FHWA-RD-00-067
Urban compact roundabouts

Like mini-roundabouts, urban compact roundabouts are intended to be pedestrian and bicyclist friendly because their perpendicular approach legs require very low vehicle speeds to make a distinct right turn into and out of the circulatory roadway. All legs have single-lane entries. However, the urban compact treatment meets all the design requirements of effective roundabouts. The principal objective of this design is to enable pedestrians to have safe and effective use of the intersection. Capacity should not be a critical issue for this type of roundabout to be considered. The geometric design includes raised splitter islands that incorporate at-grade pedestrian storage areas, and a nonmountable central island. There is usually an apron surrounding the nonmountable part of the compact central island to accommodate large vehicles. The recommended design of these roundabouts is similar to those in Germany and other northern European countries. The figure below provides an example of a typical urban compact roundabout.

Reprinted from Section 1.6 of FHWA publication “Roundabouts: An Informational Guide”
Publication Number FHWA-RD-00-067
Urban single-lane roundabouts

This type of roundabout is characterized as having a single-lane entry at all legs and one circulatory lane. The figure below provides an example of a typical urban single-lane roundabout. They are distinguished from urban compact roundabouts by their larger inscribed circle diameters and more tangential entries and exits, resulting in higher capacities. Their design allows slightly higher speeds at the entry, on the circulatory roadway, and at the exit. Notwithstanding the larger inscribed circle diameters than compact roundabouts, the speed ranges recommended in this guide are somewhat lower than those used in other countries, in order to enhance safety for bicycles and pedestrians. The roundabout design is focused on achieving consistent entering and circulating vehicle speeds. The geometric design includes raised splitter islands, a nonmountable central island, and preferable, no apron. The design of these roundabouts is similar to those in Australia, France, and the United Kingdom.

Reprinted from Section 1.6 of FHWA publication “Roundabouts: An Informational Guide”
Publication Number FHWA-RD-00-067
Urban double-lane roundabouts

Urban double-lane roundabouts included all roundabouts in urban areas that have at least one entry with two lanes. They include roundabouts with entries on one or more approaches that flare from one to two lanes. These require wider circulatory roadways to accommodate more than one vehicle traveling side by side. The figure below provides an example of a typical urban multilane roundabout. The speeds at the entry, on the circulatory roadway, and at the exit are similar to those for the urban single-lane roundabouts. Again, it is important that the vehicular speeds be consistent throughout the roundabout. The geometric design will include raised splitter islands, no truck apron, a nonmountable central island, and appropriate deflection.

Alternate routes may be provided for bicyclists who choose to bypass the roundabout. Bicycle and pedestrian pathways must be clearly delineated with sidewalk construction and landscaping to direct users to the appropriate crossing locations and alignment. Urban double-lane roundabout located in areas with high pedestrian or bicycle volumes may have special design recommendations such as those provided in the FHWA publication. The design of these roundabouts is based on the methods used in the United Kingdom, with influences from Australia and France.
Rural single-lane roundabouts

Rural single-lane roundabouts generally have high average approach speeds in the range of 50 to 60 mph (80 to 100 km/h). They require supplementary geometric and traffic control device treatments on approaches to encourage drivers to slow to an appropriate speed before entering the roundabout. Rural roundabouts may have larger diameters than urban roundabouts to allow slightly higher speeds at the entries, on the circulatory roadway, and at the exits. This is possible if few pedestrians are expected at these intersections, currently and in the future. There is preferable no apron because their larger diameters should accommodate larger vehicles. Supplemental geometric design elements include extended and raised splitter islands, a nonmountable central island, and adequate horizontal deflection. The design of these roundabouts is based primarily on the methods used by Australia, France, and the United Kingdom. The figure below provides an example of a typical rural single-lane roundabout.

Rural roundabouts that may one day become part of an urbanized area should be designed as urban roundabouts, with slower speeds and pedestrian treatment. However, in the interim, they should be designed with supplementary approach and entry features to achieve safe speed reduction.

Reprinted from Section 1.6 of FHWA publication “Roundabouts: An Informational Guide”
Publication Number FHWA-RD-00-067
**Rural double-lane roundabouts**

Rural double-lane roundabouts have speed characteristics similar to rural single-lane roundabouts with average approach speeds in the range of 50 to 60 mph (80 to 100 km/h). They differ in having two entry lanes, or entries flared from one to two lanes, on one or more approaches. Consequently, many of the characteristics and design features of rural double-lane roundabouts mirror those of their urban counterparts. The main design differences are designs with higher entry speeds and larger diameters, and recommended supplementary approach treatments. The design of these roundabouts is based on the methods used by the United Kingdom, Australia, and France. The figure below provides an example of a typical rural double-lane roundabout. Rural roundabouts that may one day become part of an urbanized area should be designed for slower speeds, with design details that fully accommodate pedestrians and bicyclist. However, in the interim they should be designed with approach and entry features to achieve safe speed reduction.

![Diagram of a rural double-lane roundabout with annotations for pedestrian accommodations, extended splitter islands and supplemental approach treatments, and an exit that is somewhat more tangential than urban forms.]

Reprinted from Section 1.6 of FHWA publication “Roundabouts: An Informational Guide” Publication Number FHWA-RD-00-067
APPENDIX D – QUESTIONNAIRE:

Appendix D contains a complete copy of the questionnaire from the text. It is intended that this section of the publication will be reproduced and used by planners and designers to evaluate intersections for roundabout facilities.
ROUNDABOUT QUESTIONNAIRE

Please use the answers to the following questions to aid in the planning or preliminary design phases. Each question is followed by pertinent information that will help analyze the feasibility of using a roundabout.

INTERSECTION LOCATION:

________________________________________

________________________________________

BRIEF DESCRIPTION OF INTERSECTION:

________________________________________

________________________________________

IDENTIFY THE ENVIRONMENT:

• Planning Phase

Question No. 1: Would the roundabout be the first in the area?

________________________________________

The first roundabout in an area will require education and justification efforts. Please refer to the “Issues Associated with Roundabouts” section for further information regarding this topic. Selecting a single-lane roundabout is recommended since this type will initially be more easily understood than a multi-lane type.

Question No. 2: Would the roundabout be part of a new roadway system or a retrofit of an existing intersection?

________________________________________

A roundabout that is part of a new roadway will normally have fewer constraints, and right-of-way should be easier to acquire than for an existing intersection. If the roundabout is a retrofit of an existing intersection, the resulting cost of maintaining traffic can be relatively high.
SITE CHARACTERISTICS:

- **Planning Phase**

**Question No. 1:** Would the roundabout be located in the vicinity of a railroad grade crossing?

Special consideration must be given when a railroad grade crossing is located in the vicinity of the roundabout. Queues from a railroad crossing cannot be allowed to back up into the roundabout. The crossing will obviously require railroad crossing signals and/or gates to stop traffic on the crossing roadway. However, due to the proximity of the railroad crossing to the roundabout, it may be necessary to install railroad crossing signals/gates at all legs of the roundabout and shut down the roundabout during train crossings. This condition may negate the beneficial effect of the roundabout.

**Question No. 2:** Is the intersection on any transit routes?

A roundabout properly designed using the appropriate design vehicle should pose no problem for a bus to traverse. It is important to carefully select the location of bus stops to minimize the probability of vehicle queues backing up into the circulatory roadway.

**Question No. 3:** Does the community have a need for parking within or near the intersection?

Parking is not allowed within the circulatory roadway or at the entries. This may be an important issue if businesses are located in the vicinity of the intersection.

CAPACITY OF THE INTERSECTION:

- **Planning Phase**

**Question No. 1:** What is the required capacity for the intersection?

The following tables provide information to determine which category of roundabout is required for the intersection in question. The data provided below can be found in Chapter 3 of the FHWA publication “Roundabouts: An Informational Guide.” Maximum AADT in the tables below represents the total of the approaching roadways.
**Four-leg Roundabout**

<table>
<thead>
<tr>
<th>Category</th>
<th>Proportion of Traffic on Minor Street</th>
<th>Left Turn Percentage</th>
<th>Maximum AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-lane</td>
<td>33%</td>
<td>0%</td>
<td>22,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>21,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>20,000</td>
</tr>
<tr>
<td>Single-lane</td>
<td>50%</td>
<td>0%</td>
<td>26,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>25,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>23,750</td>
</tr>
<tr>
<td>Double-lane</td>
<td>33%</td>
<td>0%</td>
<td>43,750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>41,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>40,000</td>
</tr>
<tr>
<td>Double-lane</td>
<td>50%</td>
<td>0%</td>
<td>51,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>48,750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>46,875</td>
</tr>
</tbody>
</table>

*For three-leg roundabouts, use 75% of the maximum AADT volumes shown above.

**Mini-roundabout**

<table>
<thead>
<tr>
<th>Percent Cross Traffic</th>
<th>Left Turn Percentage</th>
<th>Maximum AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>0%</td>
<td>14,500</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>12,500</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>12,250</td>
</tr>
<tr>
<td>50%</td>
<td>0%</td>
<td>15,500</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>14,500</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>14,250</td>
</tr>
</tbody>
</table>

* Mini-roundabouts are usually implemented with safety in mind, rather than capacity.

**Question No. 2:** Does the intersection under consideration consist of a major arterial and a minor arterial or local road?

One of basic principles of a roundabout is that all intersection movements are given equal priority. This fact may cause major street movements to be delayed more than desired. The overall street classification system and hierarchy should be considered before selecting a roundabout.

- **Study Phase**

**Question No. 3:** What is the volume-to-capacity (v/c) ratio for each leg of the roundabout?

FHWA recommends that the v/c ratio should not exceed 0.85 for any leg of the roundabout.
SAFETY:

• **Planning Phase**

**Question No. 1:** What is the crash history of the intersection over the past five years?

---

Roundabouts have been shown to reduce total crashes by 37 percent and injury crashes by 51 percent. If the intersection has a large number of head-on and angle crashes, a roundabout may help reduce the number and severity of these incidents. The decrease is due to the entry angle being reduced to about 60 degrees from 90 degrees, lower speeds, and the elimination of vehicles traveling in opposite directions.

RIGHT-OF-WAY:

• **Planning Phase**

**Question No. 1:** Can a roundabout be constructed within the existing right-of-way, or will it be necessary to acquire additional space?

---

Roundabouts usually require more space for the circulatory roadway and central island than what would be necessary for a traditional rectangular intersection. Be aware that corner properties at the intersections can create significant right-of-way problems.

• **Study Phase**

**Question No. 2:** Would selecting a signalized intersection require long or multiple turn lanes to provide sufficient capacity?

---

Roundabouts with similar capacity should require less space on the approaches than a signalized intersection. Additional capacity at the intersection can be added by using flared approach lanes. Utilizing flared approach lanes still maintains the benefit of reduced spatial requirements upstream and downstream of the intersection.
ALTERNATE TYPES OF INTERSECTION CONTROL:

Two-Way Stop Controlled Intersection (TWSC)

• Study Phase

Question No. 1: (if applicable) Is the existing TWSC intersection experiencing congestion on the minor street caused by a demand that exceeds capacity?

As stated previously, a basic principle of roundabouts is that all intersection movements are given equal priority. Higher proportions of minor street traffic favor roundabouts while lower proportions favor TWSC.

Question No. 2: (if applicable) Are queues forming on the major street due to inadequate capacity for left turning vehicles?

Roundabouts provide a more favorable treatment of left turning vehicles than TWSC.

All-Way Stop Controlled Intersection (AWSC)

• Study Phase

Question No. 1: Are the cross street traffic volumes heavy enough to meet the MUTCD warrants for an AWSC?

Roundabouts offer higher capacity and lower delays. A reduction in delay during off-peak periods is a benefit that roundabouts offer but cannot be provided by an AWSC intersection.

Signalized Intersection

• Planning Phase

Question No. 1: Would the roundabout be located within a coordinated signal system?

Introducing a roundabout into a coordinated signal system may disperse and rearrange platoons of traffic if other conflicting flows are significant, thereby affecting progressive
movement. It may be beneficial to divide the signal system into subsystems separated by the roundabout to minimize overall system delay.

- **Study Phase**

  **Question No. 2:** Are traffic volumes heavy enough to warrant signalization?

When comparing roundabouts to signalized intersections, there is a notable delay savings when volumes are evenly split between minor and major approaches, especially on two-lane approaches with high left turn percentages. When the major street approaches dominate, roundabout delay will be lower than signal delay.

Other benefits that roundabouts have when compared to signalized intersections are increased capacity, slower speeds, fewer and less severe crashes, less maintenance costs, greater traffic calming, and a more attractive environment. Roundabouts are self-regulating, while a signal will require periodic adjustments to its timing sequences.

**DESIGN SPEED:**

- **Planning Phase**

  **Question No. 1:** What will the design speed of the roadway be?

The following table lists the FHWA recommended maximum entry design speed for various categories.

<table>
<thead>
<tr>
<th>Max. Entry Design Speed</th>
<th>Mini-Roundabout (15 mph (25 km/h))</th>
<th>Urban Compact (15 mph (25 km/h))</th>
<th>Urban Single-lane (20 mph (35 km/h))</th>
<th>Urban Double-lane (25 mph (40 km/h))</th>
<th>Rural Single-lane (25 mph (40 km/h))</th>
<th>Rural Double-lane (30 mph (50 km/h))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Number of entering lanes per approach</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
PERCENT/TYPe OF TRUCKS:

- **Planning Phase**

  **Question No. 1:** What is the largest vehicle that can be reasonably expected to travel through the intersection?

  Single-lane roundabouts may require the use of a mountable apron around the perimeter of the central island to provide additional tracking width for large vehicles. Trucks utilizing double-lane roundabouts may track across the entire width of the circulatory roadway.

  **Question No. 2:** Will large emergency vehicles be passing through the intersection?

  Emergency vehicles will pass through a roundabout in the same manner as other large vehicles and may require a mountable apron. Unlike signalized intersections, emergency vehicles are not faced with through movement vehicles unexpectedly running the intersection at high speed and hitting them.

- **Study Phase**

  **Question No. 3:** What is the percent of trucks on each approach?

  Due to their length, trucks will find it more challenging than passenger vehicles to use a roundabout. Careful consideration must be given to the amount of truck traffic anticipated, the types of trucks anticipated and their expected route through a roundabout when evaluating. Accommodating trucks may require that a larger inscribed circle diameter be used which may present right of way issues. Additionally, it may be necessary to include a concrete apron in the center island to accommodate truck turns.

PEDESTRIANS/BICYCLES:

- **Study Phase**

  **Question No. 1:** What is the amount of pedestrian and bicycle traffic existing/expected at the intersection?

  It is very important to consider pedestrian and bicycle activity when choosing an intersection control method. Please refer to the “Issues Associated with Roundabouts” section of this guide for further information regarding these topics.
ILLUMINATION:

• Planning Phase

Question No. 1: Determine the need for illumination?

It is suggested that the approach roadways serving a roundabout be illuminated. The specific site conditions and design criteria will determine the need for and level of illumination. Care must be exercised to ensure that the clear zone requirements are met.

COST:

• Study Phase

Question No. 1: What is the project’s budget?

Costs for a roundabout will include construction, engineering and design, land acquisition, and maintenance. It is important to note that costs of installing roundabouts can vary significantly from site to site. The costs of a roundabout and a signalized intersection are comparable at new sites and at existing signalized intersections that require widening at one or more approaches for additional lanes. In most cases, a roundabout will be more expensive to construct than a two-way or all-way stop controlled intersection. Costs of maintaining traffic during construction tends to be relatively high when retrofitting intersections.

Other factors that may contribute to higher costs for roundabouts include large amounts of landscaping, splitter islands, extensive signing, lighting, and curbing. Operation and maintenance costs are somewhat higher than unsignalized intersections but are less than signalized intersections. On-going maintenance costs include restriping and repaving, snow removal/storage, and landscaping.
APPENDIX E – CASE STUDIES:

For the purpose of this study, available traffic data was used to evaluate the effectiveness of roundabouts at representative locations throughout the Commonwealth. Locations for the studies were selected with the assistance of District Traffic Engineers. Complete traffic information was not available at all the locations studied and an effort was made to determine appropriate values based on the available data. Actual traffic counts and/or turning movements were beyond the scope of this study. In actual practice, it is imperative that current and reliable traffic information be obtained to properly evaluate the use of a roundabout. Appendix A lists the traffic information needed to make such determination.

The following case studies were performed at the intersections indicated:

1. District 3-0    County: Lycoming    City: Williamsport
Intersection: Via Bella & Hepburn Street
Current Intersection Control: Signal

2. District 8-0    County: Cumberland    City: Centerville
Intersection: S.R. 0174 (Walnut Bottom Road) & S.R. 0233 (Centerville Road)
Current Intersection Control: Two-Way Stop Control

3. District 5-0    County: Northampton    City: Easton
Intersection: S.R. 2022 (Northampton Street) & S.R. 2023 (Third Street)
Current Intersection Control: Signalized Circle

4. District 8-0    County: Dauphin    Town: Linglestown
Intersection: Route 39 and Mountain Road
Current Intersection Control: Two-Way Stop Control – Square

5. District 11-0    County: Allegheny    Township: Franklin Park
Intersection: S.R. 4049 (Nicholson Road) & S.R. 4011 (Rochester Road)
Current Intersection Control: Two-Way Stop Control
Case Study No. 1:

Intersection: Hepburn Street and Via Bella in Williamsport, PA

The intersection of Hepburn Street and Via Bella in the City of Williamsport is a unique intersection. The existing signalized intersection handles traffic generated from the I-180 off-ramp and city traffic entering onto the I-180 on-ramp. Another generator of traffic for the intersection is the Wegman’s grocery store that is located on one corner. Currently, the majority of the traffic passing through this city intersection is traveling between Route 15 and I-180 due to the absence of a direct connection between these two roadways. Presently, such a direct connection is under design. This direct connection will reduce the amount of traffic that the intersection experiences. PennDOT officials are interested in improving this intersection and adding a missing left-turn movement from Hepburn Street. The City of Williamsport is interested in improving the aesthetics of the city. Due to these circumstances, a roundabout may be a viable solution.

In order to determine the feasibility of utilizing a roundabout at the intersection of Hepburn and Via Bella, various parameters were investigated. Recent traffic studies have been performed in the City of Williamsport for the direct connection project that includes this intersection. The PennDOT “Guide to Roundabouts” questionnaire was completed along with a crash investigation and capacity analyses. A preliminary design layout for a single-lane urban roundabout was also produced.

From the results of this case study, it was determined that a single-lane urban roundabout is a feasible alternative for the intersection of Hepburn Street and Via Bella. A roundabout provides a solution to the unique geometry of this intersection and allows the missing left-turn movement to be easily incorporated. If a signalized intersection was retained, it is probable that an additional turn-lane would be necessary on Hepburn Street and the delay for the entire intersection would increase. A roundabout would lessen the delay and increase capacity. The City of Williamsport would benefit by having an intersection that could be aesthetically pleasing through the use of landscaping. The disadvantages in choosing a roundabout would be the minimal amount of right-of-way that would be necessary to construct sidewalks along Via Bella. In addition, this would be the first roundabout in the area, which would require education and justification efforts. Further study is now necessary to accurately quantify and compare the roundabout to other forms of intersection control.
FIGURE NO. 1B
ROUNDABOUT AT THE
INTERSECTION OF HEPBURN STREET & VIA BELLA
LYCOMING COUNTY, CITY OF WILLIAMSPORT
**Intersection of Hepburn Street and Via Bella: Peak Hour Volumes**

Assign each entry leg a number going counter-clockwise around the roundabout as illustrated by figure on the right. Enter data into shaded areas below for each entry leg roundabout has. For each entry leg present at least one pce/hr must be shown entering or exiting roundabout for the leg. If roundabout has less than five entry legs, then enter zero in the shaded areas for the entry legs not used. (Note: Use of the tab key will toggle through all the data input shaded areas.)

To get accurate results from this spreadsheet the calculated V/C value should not exceed 0.85.

### Exiting (veh/hr)

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<th>X2</th>
<th>X3</th>
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<th>X5</th>
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<td>130</td>
<td>0</td>
<td>0</td>
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<tr>
<td>E2</td>
<td>90</td>
<td>0</td>
<td>90</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E3</td>
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<td>45</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

### Entering Circulating (pce/hr)

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<th></th>
<th>5 \ /</th>
<th>4 \ /</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1</td>
<td>547</td>
<td>48</td>
</tr>
<tr>
<td>X2</td>
<td>525</td>
<td>131</td>
</tr>
</tbody>
</table>

### Exiting (pce/hr)

<table>
<thead>
<tr>
<th></th>
<th>X1</th>
<th>X2</th>
<th>X3</th>
<th>X4</th>
<th>X5</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>0</td>
<td>416</td>
<td>131</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E2</td>
<td>427</td>
<td>0</td>
<td>99</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E3</td>
<td>311</td>
<td>48</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### TOTAL ENTERING ROUNDABOUT (pce/hr) 1,433

### CAPACITY AT AN ENTRY OF A ROUNDBOARD

<table>
<thead>
<tr>
<th></th>
<th>E1</th>
<th>E2</th>
<th>E3</th>
<th>E4</th>
<th>E5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inscribed diameter, D (m)</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entry width, e (m)</td>
<td>5.5</td>
<td>5.5</td>
<td>5.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approach width, v (m)</td>
<td>4.6</td>
<td>4.6</td>
<td>4.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entry angle, Q (degrees)</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entry radius, r (m)</td>
<td>18</td>
<td>21</td>
<td>2114</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average effective flare length, l' (m)</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Hour Factor (PHF)</td>
<td>0.95</td>
<td>0.95</td>
<td>0.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Single-Unit Truck or Bus</td>
<td>4.00%</td>
<td>4.00%</td>
<td>2.00%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Truck With Trailer</td>
<td>2.00%</td>
<td>2.00%</td>
<td>1.00%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### ENTRY CAPACITY (pce/hr) C=Qe

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>1,464</td>
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<tr>
<td>E2</td>
<td>1,427</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E3</td>
<td>1,312</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### V/C

|               | 0.37| 0.37| 0.27|     |     |

### CONTROL DELAY (sec/veh) d

|               | 3.9 | 4.0 | 3.8 |     |     |

### LEVEL OF SERVICE

|               | A   | A   | A   |     |     |

### LEVEL OF SERVICE

|               | A   | A   | A   |     |     |

### QUEUE LENGTH 95th percentile (veh)

|               | 1.8 | 1.7 | 1.1 |     |     |

### Circulating flow across the entry, Qc (pce/hr)

|               | 48  | 131 | 427 | 0   | 0   |

### S

|               | 0.12| 0.12| 0.12|     |     |

### M

|               | 0.05| 0.05| 0.05|     |     |

### X2

|               | 5.33| 5.33| 5.33|     |     |

### F

|               | 1613.72| 1613.72| 1613.72|     |     |

### Ip

|               | 1.48| 1.48| 1.48|     |     |

### fc

|               | 0.64| 0.64| 0.64|     |     |

### k

|               | 0.93| 0.93| 0.98|     |     |

### Entering flow, qe (pce/hr)

|               | 547 | 525 | 360 | 0   | 0   |

Compared to an unsignalized intersection

Compared to a signalized intersection
Definitions:

pce/hr - passenger car equivalent per hour
Inscribed Diameter, D - the diameter of the largest circle that can be inscribed within the junction outline
Entry Width, e - measured at the point of maximum entry deflection, from the left hand end of give-way line along a normal to the nearside curb
Approach Width, v - measured at a point in the approach upstream from any entry flare, from the median line (or edge of travelway on dual lane roads) to the nearside curb, along a normal
Entry Angle, Q - serves as a geometric proxy for the conflict angle between entering and circulating streams.
Entry Radius, r - measured as the minimum radius of curvature of the nearside curbline at entry
Average Effective Flare Length, l' - measured along a curve offset from curbline a distance of (e-v)/2 starting from line where e is measured to intersection with a projected curve offset from median a distance v.

Entering flow, qe=V
Sharpness of Flare, S=1.6*(e-v)/l'
M=exp{(D-60)/10}
X2=v+(e-v)/(1+2*S)
F=303*X2
tp=1+5/(1+M)
fC=2.1*tp*(1+2*X2)^2
k=1-0.0347*(Q-30)-0.978*{(1/r)-.05}
Qe=k*(F-fC*Qc) or Qe=0 when fC*Qc>F
d=3600/C+900*T*[V/C-1]+{sqrt[(1-V/C)^2+(3600/C)*(V/C)/450*T]} where T=analysis time period, hours (T=0.25 for a 15-minute period)
Queue length 95th percentile = 900*T*[V/C-1]+{sqrt[(1-V/C)^2+(3600/C)*(V/C)/150*T]}*(C/3600) where T is the same as defined for d above

References:


ROUNDABOUT QUESTIONNAIRE

Please use the answers to the following questions to aid in the planning or preliminary design phases. Each question is followed by pertinent information that will help analyze the feasibility of using a roundabout.

INTERSECTION LOCATION:

*Hepburn Street and Via Bella*

*Lycoming County, City of Williamsport, PA*

BRIEF DESCRIPTION OF INTERSECTION:

- Traffic generated by I-180
- Missing left-turn movement
- Improvements wanted by PennDOT officials
- City interested in improving aesthetics of the downtown

IDENTIFY THE ENVIRONMENT:

- Planning Phase

Question No. 1: Would the roundabout be the first in the area?

*Yes*

The first roundabout in an area will require education and justification efforts. Please refer to the “Issues Associated with Roundabouts” section for further information regarding this topic. Selecting a single-lane roundabout is recommended since this type will initially be more easily understood than a multi-lane type.

Question No. 2: Would the roundabout be part of a new roadway system or a retrofit of an existing intersection?

*The roundabout would be a retrofit to an existing intersection.*

A roundabout that is part of a new roadway will normally have fewer constraints, and right-of-way should be easier to acquire than for an existing intersection. If the roundabout is a retrofit of an existing intersection, the resulting cost of maintaining traffic can be relatively high.
SITE CHARACTERISTICS:

- **Planning Phase**

**Question No. 1:** Would the roundabout be located in the vicinity of a railroad grade crossing?

*There are railroad tracks in the vicinity, but there are no at-grade crossings.*

Special consideration must be given when a railroad grade crossing is located in the vicinity of the roundabout. Queues from a railroad crossing cannot be allowed to back up into the roundabout. The crossing will obviously require railroad crossing signals and/or gates to stop traffic on the crossing roadway. However, due to the proximity of the railroad crossing to the roundabout, it may be necessary to install railroad crossing signals/gates at all legs of the roundabout and shut down the roundabout during train crossings. This condition may negate the beneficial effect of the roundabout.

**Question No. 2:** Is the intersection on any transit routes?

*The Williamsport city buses may run through this intersection, but it is unlikely that there is currently a stop nearby. This information should be verified in the study phase.*

A roundabout properly designed using the appropriate design vehicle should pose no problem for a bus to traverse. It is important to carefully select the location of bus stops to minimize the probability of vehicle queues backing up into the circulatory roadway.

**Question No. 3:** Does the community have a need for parking within or near the intersection?

*There is no need for parking in the vicinity.*

Parking is not allowed within the circulatory roadway or at the entries. This may be an important issue if businesses are located in the vicinity of the intersection.

CAPACITY OF THE INTERSECTION:

- **Planning Phase**

**Question No. 1:** What is the required capacity for the intersection?

*The 2019 AADT is approximately 12,100 vehicles. This figure is below the maximum allowable AADT’s for a single-lane roundabout.*

The following tables provide information to determine which category of roundabout is required for the intersection in question. The data provided below can be found in Chapter 3 of the FHWA publication “Roundabouts: An Informational Guide.” Maximum AADT in the tables below represents the total of the approaching roadways.
### Four-leg Roundabout

<table>
<thead>
<tr>
<th>Category</th>
<th>Proportion of Traffic on Minor Street</th>
<th>Left Turn Percentage</th>
<th>Maximum AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-lane</td>
<td>33%</td>
<td>0%</td>
<td>22,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>21,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>20,000</td>
</tr>
<tr>
<td>Single-lane</td>
<td>50%</td>
<td>0%</td>
<td>26,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>25,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>23,750</td>
</tr>
<tr>
<td>Double-lane</td>
<td>33%</td>
<td>0%</td>
<td>43,750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>41,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>40,000</td>
</tr>
<tr>
<td>Double-lane</td>
<td>50%</td>
<td>0%</td>
<td>51,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>48,750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>46,875</td>
</tr>
</tbody>
</table>

*For three-leg roundabouts, use 75% of the maximum AADT volumes shown above.

### Mini-roundabout

<table>
<thead>
<tr>
<th>Percent Cross Traffic</th>
<th>Left Turn Percentage</th>
<th>Maximum AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>0%</td>
<td>14,500</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>12,500</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>12,250</td>
</tr>
<tr>
<td>50%</td>
<td>0%</td>
<td>15,500</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>14,500</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>14,250</td>
</tr>
</tbody>
</table>

* Mini-roundabouts are usually implemented with safety in mind, rather than capacity

**Question No. 2:** Does the intersection under consideration consist of a major arterial and a minor arterial or local road?

The intersection consists of two city streets and the on- and off-ramps for I-180.

One of basic principles of a roundabout is that all intersection movements are given equal priority. This fact may cause major street movements to be delayed more than desired. The overall street classification system and hierarchy should be considered before selecting a roundabout.

- **Study Phase**

**Question No. 3:** What is the volume-to-capacity (v/c) ratio for each leg of the roundabout?

The v/c ratio is: 0.43 for Via Bella, 0.34 for Hepburn, and 0.44 for the I-180 ramps. FHWA recommends that the v/c ratio should not exceed 0.85 for any leg of the roundabout.
SAFETY:

• *Planning Phase*

  **Question No. 1:** What is the crash history of the intersection over the past five years?

  Roundabouts have been shown to reduce total crashes by 37 percent and injury crashes by 51 percent. If the intersection has a large number of head-on and angle crashes, a roundabout may help reduce the number and severity of these incidents. The decrease is due to the entry angle being reduced to about 60 degrees from 90 degrees, lower speeds, and the elimination of vehicles traveling in opposite directions.

RIGHT-OF-WAY:

• *Planning Phase*

  **Question No. 1:** Can a roundabout be constructed within the existing right-of-way, or will it be necessary to acquire additional space?

  A minimal amount of right-of-way may be necessary to accommodate sidewalks along the Via Bella approach.

Roundabouts usually require more space for the circulatory roadway and central island than what would be necessary for a traditional rectangular intersection. Be aware that corner properties at the intersections can create significant right-of-way problems.

• *Study Phase*

  **Question No. 2:** Would selecting a signalized intersection require long or multiple turn lanes to provide sufficient capacity?

  The existing intersection is signal controlled. In order for the missing left-turn movement to be added, an additional turn lane on Hepburn may be necessary.

Roundabouts with similar capacity should require less space on the approaches than a signalized intersection. Additional capacity at the intersection can be added by using flared approach lanes. Utilizing flared approach lanes still maintains the benefit of reduced spatial requirements upstream and downstream of the intersection.
ALTERNATE TYPES OF INTERSECTION CONTROL:

Two-Way Stop Controlled Intersection (TWSC)

- **Study Phase**

  Question No. 1: (if applicable) Is the existing TWSC intersection experiencing congestion on the minor street caused by a demand that exceeds capacity?
  
  N/A

  As stated previously, a basic principle of roundabouts is that all intersection movements are given equal priority. Higher proportions of minor street traffic favor roundabouts while lower proportions favor TWSC.

  Question No. 2: (if applicable) Are queues forming on the major street due to inadequate capacity for left turning vehicles?
  
  N/A

  Roundabouts provide a more favorable treatment of left turning vehicles than TWSC.

All-Way Stop Controlled Intersection (AWSC)

- **Study Phase**

  Question No. 1: Are the cross street traffic volumes heavy enough to meet the MUTCD warrants for an AWSC?
  
  N/A

  Roundabouts offer higher capacity and lower delays. A reduction in delay during off-peak periods is a benefit that roundabouts offer but cannot be provided by an AWSC intersection.

Signalized Intersection

- **Planning Phase**

  Question No. 1: Would the roundabout be located within a coordinated signal system?
  
  *There are several signalized intersections along Via Bella. It is assumed that these are not Coordinated but this should be verified in the study phase.*

  Introducing a roundabout into a coordinated signal system may disperse and rearrange platoons of traffic if other conflicting flows are significant, thereby affecting progressive
movement. It may be beneficial to divide the signal system into subsystems separated by the roundabout to minimize overall system delay.

- **Study Phase**

  **Question No. 2:** Are traffic volumes heavy enough to warrant signalization?

  *The existing intersection is signal controlled.*

  When comparing roundabouts to signalized intersections, there is a notable delay savings when volumes are evenly split between minor and major approaches, especially on two-lane approaches with high left turn percentages. When the major street approaches dominate, roundabout delay will be lower than signal delay.

  Other benefits that roundabouts have when compared to signalized intersections are increased capacity, slower speeds, fewer and less severe crashes, less maintenance costs, greater traffic calming, and a more attractive environment. Roundabouts are self-regulating, while a signal will require periodic adjustments to its timing sequences.

**DESIGN SPEED:**

- **Planning Phase**

  **Question No. 1:** What will the design speed of the roadway be?

  *A maximum of 20 mph.*

  The following table lists the FHWA recommended maximum entry design speed for various categories.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Number of entering lanes per approach</td>
<td>15 mph (25 km/h)</td>
<td>15 mph (25 km/h)</td>
<td>20 mph (35 km/h)</td>
<td>25 mph (40 km/h)</td>
<td>25 mph (40 km/h)</td>
<td>30 mph (50 km/h)</td>
</tr>
<tr>
<td>Max. Number of entering lanes per approach</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
PERCENT/TYPE OF TRUCKS:

- **Planning Phase**

**Question No. 1:** What is the largest vehicle that can be reasonably expected to travel through the intersection?

*The largest vehicle that can be expected would be an interstate tractor trailer. A WB-50 design vehicle should be sufficient.*

Single-lane roundabouts may require the use of a mountable apron around the perimeter of the central island to provide additional tracking width for large vehicles. Trucks utilizing double-lane roundabouts may track across the entire width of the circulatory roadway.

**Question No. 2:** Will large emergency vehicles be passing through the intersection?

*Emergency vehicles may pass through the intersection.*

Emergency vehicles will pass through a roundabout in the same manner as other large vehicles and may require a mountable apron. Unlike signalized intersections, emergency vehicles are not faced with through movement vehicles unexpectedly running the intersection at high speed and hitting them.

- **Study Phase**

**Question No. 3:** What is the percent of trucks on each approach?

*The percent of trucks is: 6% for Via Bella, 3% for Hepburn, and 6% for the I-180 ramps.*

Due to their length, trucks will find it more challenging than passenger vehicles to use a roundabout. Careful consideration must be given to the amount of truck traffic anticipated, the types of trucks anticipated and their expected route through a roundabout when evaluating. Accommodating trucks may require that a larger inscribed circle diameter be used which may present right of way issues. Additionally, it may be necessary to include a concrete apron in the center island to accommodate truck turns.

PEDESTRIANS/BICYCLES:

- **Study Phase**

**Question No. 1:** What is the amount of pedestrian and bicycle traffic existing/expected at the intersection?

*Currently the pedestrian/bicycle volumes are minimal. There is reason to believe that this will increase as the beautification process of the city progresses.*
It is very important to consider pedestrian and bicycle activity when choosing an intersection control method. Please refer to the “Issues Associated with Roundabouts” section of this guide for further information regarding these topics.

**ILLUMINATION:**

- **Planning Phase**

  Question No. 1: Determine the need for illumination?

  *Illumination in an urban area should be provided including most if not all of the approaches.*

It is suggested that the approach roadways serving a roundabout be illuminated. The specific site conditions and design criteria will determine the need for and level of illumination. Care must be exercised to ensure that the clear zone requirements are met.

**COST:**

- **Study Phase**

  Question No. 1: What is the project’s budget?

  *Currently a budget has not been determined.*

Costs for a roundabout will include construction, engineering and design, land acquisition, and maintenance. It is important to note that costs of installing roundabouts can vary significantly from site to site. The costs of a roundabout and a signalized intersection are comparable at new sites and at existing signalized intersections that require widening at one or more approaches for additional lanes. In most cases, a roundabout will be more expensive to construct than a two-way or all-way stop controlled intersection. Costs of maintaining traffic during construction tends to be relatively high when retrofitting intersections.

Other factors that may contribute to higher costs for roundabouts include large amounts of landscaping, splitter islands, extensive signing, lighting, and curbing. Operation and maintenance costs are somewhat higher than unsignalized intersections but are less than signalized intersections. On-going maintenance costs include restriping and repaving, snow removal/storage, and landscaping.
Case Study No. 2:

Intersection: S.R. 0174 Walnut Bottom Rd. & S.R. 0233 Centerville Rd.

NOTE: For the purpose of this study, available traffic data was used to evaluate the effectiveness of roundabouts at representative locations. At this location, complete traffic information was not available. Therefore an effort was made to determine appropriate values based on the available data. Actual traffic counts and/or turning movements were beyond the scope of this study. In actual practice, it is imperative that current and reliable traffic information be obtained to properly evaluate the use of a roundabout. Appendix A lists the traffic information needed to make such determination.

The intersection of Walnut Bottom Road and Centerville Road is located in a rural area of Cumberland County in Penn Township. The intersection is currently a Two-Way Stop Controlled (TWSC) intersection. Over the five years from 1995 to 1999, a number of angle crashes have occurred with 86% resulting in injury. One of these crashes resulted in a fatality. Safety improvements are needed at this intersection. Due to these circumstances, a roundabout may be a viable solution.

In order to determine the feasibility of utilizing a roundabout at the intersection of Walnut Bottom Road and Centerville Road, various parameters were investigated. Since turning movement counts were not available for this intersection, this investigation includes only information applicable to the planning phase of preliminary design. The PennDOT “Guide to Roundabouts” questionnaire was completed along with a crash investigation. A preliminary design layout for a single-lane urban roundabout was also produced.

From the results of this case study, it was determined that a single-lane urban roundabout is a feasible alternative for the intersection of Walnut Bottom Road and Centerville Road. A roundabout provides a solution to the safety issue for this intersection. Roundabouts have been shown to reduce all crashes by 37% and injury crashes by 51%. If a crash did occur the crash would be less severe due to the reduced entry angle between the entering and circulating vehicles. This case study found that according to the ADT, the volumes on the two roadways are less than 5% different. Higher proportions of minor street traffic favor roundabouts while lower proportions favor TWSC. A roundabout would lessen the delay for the minor street since roundabouts give equal priority to all intersection movements. The disadvantages would be that this is the first roundabout in the area, which would require education and justification efforts. The study phase is now necessary to accurately quantify and compare the roundabout to other forms of intersection control.
FIGURE NO. 2A
EXISTING INTERSECTION OF
WALNUT BOTTOM ROAD & CENTERVILLE ROAD
CUMBERLAND COUNTY, PENN TOWNSHIP
FIGURE NO. 2B
ROUNDABOUT AT THE INTERSECTION OF WALNUT BOTTOM ROAD & CENTERVILLE ROAD
CUMBERLAND COUNTY, PENN TOWNSHIP
ROUNDABOUT QUESTIONNAIRE

Please use the answers to the following questions to aid in the planning or preliminary design phases. Each question is followed by pertinent information that will help analyze the feasibility of using a roundabout.

INTERSECTION LOCATION:
S.R. 0174 (Walnut Bottom Road) and S.R. 0233 (Centerville Road)
Cumberland County, Penn Township, Centerville, PA

BRIEF DESCRIPTION OF INTERSECTION:
- Two-Way Stop Controlled (TWSC) Intersection
- History of right angle crashes including one fatality

IDENTIFY THE ENVIRONMENT:
- Planning Phase

Question No. 1: Would the roundabout be the first in the area?
Yes.

The first roundabout in an area will require education and justification efforts. Please refer to the “Issues Associated with Roundabouts” section for further information regarding this topic. Selecting a single-lane roundabout is recommended since this type will initially be more easily understood than a multi-lane type.

Question No. 2: Would the roundabout be part of a new roadway system or a retrofit of an existing intersection?
The roundabout would be a retrofit to an existing intersection.

A roundabout that is part of a new roadway will normally have fewer constraints, and right-of-way should be easier to acquire than for an existing intersection. If the roundabout is a retrofit of an existing intersection, the resulting cost of maintaining traffic can be relatively high.
SITE CHARACTERISTICS:

- Planning Phase

**Question No. 1:** Would the roundabout be located in the vicinity of a railroad grade crossing?

No.

Special consideration must be given when a railroad grade crossing is located in the vicinity of the roundabout. Queues from a railroad crossing cannot be allowed to back up into the roundabout. The crossing will obviously require railroad crossing signals and/or gates to stop traffic on the crossing roadway. However, due to the proximity of the railroad crossing to the roundabout, it may be necessary to install railroad crossing signals/gates at all legs of the roundabout and shut down the roundabout during train crossings. This condition may negate the beneficial effect of the roundabout.

**Question No. 2:** Is the intersection on any transit routes?

The intersection is located in a rural area where transit would not be expected.

A roundabout properly designed using the appropriate design vehicle should pose no problem for a bus to traverse through. It is important to carefully select the location of bus stops to minimize the probability of vehicle queues backing up into the circulatory roadway.

**Question No. 3:** Does the community have a need for parking within or near the intersection?

This is a rural intersection where there is not a current need for parking.

Parking is not allowed within the circulatory roadway or at the entries. This may be an important issue if businesses are located in the vicinity of the intersection.

CAPACITY OF THE INTERSECTION:

- Planning Phase

**Question No. 1:** What is the required capacity for the intersection?

The 2019 AADT is approximately 6,054 vehicles. The proportion of minor street traffic is 50%. The percent of left turning vehicles is currently unknown but should be determined in the study phase. A single-lane rural roundabout would be applicable.

The following tables provide information to determine which category of roundabout is required for the intersection in question. The data provided below can be found in Chapter 3 of the FHWA publication “Roundabouts: An Informational Guide.” Maximum AADT in the tables below represents the total of the approaching roadways.
Four-leg Roundabout

<table>
<thead>
<tr>
<th>Category</th>
<th>Proportion of Traffic on Minor Street</th>
<th>Left Turn Percentage</th>
<th>Maximum AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-lane</td>
<td>33%</td>
<td>0%</td>
<td>22,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>21,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>20,000</td>
</tr>
<tr>
<td>Single-lane</td>
<td>50%</td>
<td>0%</td>
<td>26,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>25,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>23,750</td>
</tr>
<tr>
<td>Double-lane</td>
<td>33%</td>
<td>0%</td>
<td>43,750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>41,250</td>
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<td></td>
<td></td>
<td>40%</td>
<td>40,000</td>
</tr>
<tr>
<td>Double-lane</td>
<td>50%</td>
<td>0%</td>
<td>51,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>48,750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>46,875</td>
</tr>
</tbody>
</table>

*For three-leg roundabouts use 75% of the maximum AADT volumes shown above.

Mini-roundabout

<table>
<thead>
<tr>
<th>Percent Cross Traffic</th>
<th>Left Turn Percentage</th>
<th>Maximum AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>0%</td>
<td>14,500</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>12,500</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>12,250</td>
</tr>
<tr>
<td>50%</td>
<td>0%</td>
<td>15,500</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>14,500</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>14,250</td>
</tr>
</tbody>
</table>

* Mini-roundabouts are usually implemented with safety in mind, rather than capacity.

Question No. 2: Does the intersection under consideration consist of a major arterial and a minor arterial or local road?

*Neither of these roads are major arterials.*

One of basic principles of a roundabout is that all intersection movements are given equal priority. This fact may cause major street movements to be delayed more than desired. The overall street classification system and hierarchy should be considered before selecting a roundabout.

- Study Phase

Question No. 3: What is the volume-to-capacity (v/c) ratio for each leg of the roundabout?

*This information is currently unavailable.*

FHWA recommends that the v/c ratio should not exceed 0.85 for any leg of the roundabout.
SAFETY:

- **Planning Phase**

**Question No. 1:** What is the crash history of the intersection over the past five years?

*Over the five years from 1995-1999, this intersection has experienced a number of angle crashes. Eight-five percent of these crashes involved injuries including one fatality. “Didn’t stop” and “Didn’t see the stop sign” were the most common reasons stated.*

Roundabouts have been shown to reduce total crashes by 37 percent and injury crashes by 51 percent. If the intersection has a large number of head-on and angle crashes, a roundabout may help reduce the number and severity of these incidents. The decrease is due to the entry angle being reduced to about 60 degrees from 90 degrees, lower speeds, and the elimination of vehicles traveling in opposite directions.

RIGHT-OF-WAY:

- **Planning Phase**

**Question No. 1:** Can a roundabout be constructed within the existing right-of-way, or will it be necessary to acquire additional space?

*Assuming that a rural single-lane roundabout would be implemented, the typical range of 115 ft. to 130 ft. inscribed circle diameter would not require any additional right-of-way.*

Roundabouts usually require more space for the circulatory roadway and central island than what would be necessary for a traditional rectangular intersection. Be aware that corner properties at the intersections can create significant right-of-way problems.

- **Study Phase**

**Question No. 2:** Would selecting a signalized intersection require long or multiple turn lanes to provide sufficient capacity?

*This information is currently unavailable.*

Roundabouts with similar capacity should require less space on the approaches than a signalized intersection. Additional capacity at the intersection can be added by using flared approach lanes. Utilizing flared approach lanes still maintains the benefit of reduced spatial requirements upstream and downstream of the intersection.
ALTERNATE TYPES OF INTERSECTION CONTROL:

Two-Way Stop Controlled Intersection (TWSC)

- **Study Phase**

  **Question No. 1:** (if applicable) Is the existing TWSC intersection experiencing congestion on the minor street caused by a demand that exceeds capacity?
  
  *This information is currently unavailable.*

As stated previously, a basic principle of roundabouts is that all intersection movements are given equal priority. Higher proportions of minor street traffic favor roundabouts while lower proportions favor TWSC.

**Question No. 2:** (if applicable) Are queues forming on the major street due to inadequate capacity for left turning vehicles?

*This information is currently unavailable.*

Roundabouts provide a more favorable treatment of left turning vehicles than TWSC.

All-Way Stop Controlled Intersection (AWSC)

- **Study Phase**

  **Question No. 1:** Are the cross street traffic volumes heavy enough to meet the MUTCD warrants for an AWSC?
  
  *This information is currently unavailable.*

Roundabouts offer higher capacity and lower delays. A reduction in delay during off-peak periods is a benefit that roundabouts offer but cannot be provided by an AWSC intersection.

Signalized Intersection

- **Planning Phase**

  **Question No. 1:** Would the roundabout be located within a coordinated signal system?
  
  *No.*

Introducing a roundabout into a coordinated signal system may disperse and rearrange platoons of traffic if other conflicting flows are significant, thereby affecting progressive

Guide to Roundabouts
movement. It may be beneficial to divide the signal system into subsystems separated by the roundabout to minimize overall system delay.

- **Study Phase**

**Question No. 2:** Are traffic volumes heavy enough to warrant signalization?

*This information is currently unavailable.*

When comparing roundabouts to signalized intersections, there is a notable delay savings when volumes are evenly split between minor and major approaches, especially on two-lane approaches with high left turn percentages. When the major street approaches dominate, roundabout delay will be lower than signal delay.

Other benefits that roundabouts have when compared to signalized intersections are increased capacity, slower speeds, fewer and less severe crashes, less maintenance costs, greater traffic calming, and a more attractive environment. Roundabouts are self-regulating, while a signal will require periodic adjustments to its timing sequences.

**DESIGN SPEED:**

- **Planning Phase**

**Question No. 1:** What will the design speed of the roadway be?

*A maximum of 25 mph.*

The following table lists the FHWA recommended maximum entry design speed for various categories.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Number of entering lanes per approach</td>
<td>15 mph (25 km/h)</td>
<td>15 mph (25 km/h)</td>
<td>20 mph (35 km/h)</td>
<td>25 mph (40 km/h)</td>
<td>25 mph (40 km/h)</td>
<td>30 mph (50 km/h)</td>
</tr>
<tr>
<td>Max. Number of entering lanes per approach</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
PERCENT/TYPRE OF TRUCKS:

- **Planning Phase**

**Question No. 1:** What is the largest vehicle that can be reasonably expected to travel through the intersection?

The largest vehicle that can be expected would be a five axle semi-trailer. A WB-50 design vehicle should be sufficient.

Single-lane roundabouts may require the use of a mountable apron around the perimeter of the central island to provide additional tracking width for large vehicles. Trucks utilizing double-lane roundabouts may track across the entire width of the circulatory roadway.

**Question No. 2:** Will large emergency vehicles be passing through the intersection?

Emergency vehicles may pass through the intersection.

Emergency vehicles will pass through a roundabout in the same manner as other large vehicles and may require a mountable apron. Unlike signalized intersections, emergency vehicles are not faced with through movement vehicles unexpectedly running the intersection at high speed and hitting them.

- **Study Phase**

**Question No. 3:** What is the percent of trucks on each approach?

Walnut Bottom Road (S.R. 0174) has 2% trucks while Centerville Road (S.R. 0233) has 4% trucks.

Due to their length, trucks will find it more challenging than passenger vehicles to use a roundabout. Careful consideration must be given to the amount of truck traffic anticipated, the types of trucks anticipated and their expected route through a roundabout when evaluating. Accommodating trucks may require that a larger inscribed circle diameter be used which may present right of way issues. Additionally, it may be necessary to include a concrete apron in the center island to accommodate truck turns.

PEDESTRIANS/BICYCLES:

- **Study Phase**

**Question No. 1:** What is the amount of pedestrian and bicycle traffic existing/expected at the intersection?

There currently is not any data to support significant pedestrian and bicycle traffic. The location of the intersection is a rural area.
It is very important to consider pedestrian and bicycle activity when choosing an intersection control method. Please refer to the “Issues Associated with Roundabouts” section of this guide for further information regarding these topics.

**ILLUMINATION:**

- *Planning Phase*

**Question No. 1:** Determine the need for illumination?

*Illumination in rural areas is not mandatory but is recommended.*

---

It is suggested that the approach roadways serving a roundabout be illuminated. The specific site conditions and design criteria will determine the need for and level of illumination. Care must be exercised to ensure that the clear zone requirements are met.

**COST:**

- *Study Phase*

**Question No. 1:** What is the project’s budget?

*A budget has not been determined.*

---

Costs for a roundabout will include construction, engineering and design, land acquisition, and maintenance. It is important to note that costs of installing roundabouts can vary significantly from site to site. The costs of a roundabout and a signalized intersection are comparable at new sites and at existing signalized intersections that require widening at one or more approaches for additional lanes. In most cases, a roundabout will be more expensive to construct than a two-way or all-way stop controlled intersection. Costs of maintaining traffic during construction tends to be relatively high when retrofitting intersections.

Other factors that may contribute to higher costs for roundabouts include large amounts of landscaping, splitter islands, extensive signing, lighting, and curbing. Operation and maintenance costs are somewhat higher than unsignalized intersections but are less than signalized intersections. On-going maintenance costs include restriping and repaving, snow removal/storage, and landscaping.
Case Study No. 3:

Intersection: Northampton Street and Third Street in Easton, PA

NOTE: For the purpose of this study, available traffic data was used to evaluate the effectiveness of roundabouts at representative locations. At this location, complete traffic information was not available. Therefore an effort was made to determine appropriate values based on the available data. Actual traffic counts and/or turning movements were beyond the scope of this study. In actual practice, it is imperative that current and reliable traffic information be obtained to properly evaluate the use of a roundabout. Appendix A lists the traffic information needed to make such determination.

The intersection of Northampton Street and Third Street in the City of Easton is a large rotary that is signalized for pedestrians. Under normal operation, motorists traveling on the circulatory roadway receive a flashing yellow signal while approaching motorists receive a flashing red signal. When pedestrians activate the pedestrian signal, all motorists receive a steady red signal. Parking currently exists on the outer edge of the circular intersection for the nearby businesses. The City of Easton refers to this intersection as the Centre Square. Retrofitting a roundabout at this location may improve the operations, safety and aesthetics of the intersection.

In order to determine the feasibility of utilizing a roundabout at the intersection of Northampton and Third, various parameters were investigated. Since turning movement counts were not available for this intersection, this investigation includes only information applicable to the planning phase of preliminary design. The PennDOT “Guide to Roundabouts” questionnaire was completed along with a crash investigation. A preliminary design layout for a single-lane urban roundabout was also produced.

From the results of this case study, it was determined that a single-lane urban roundabout is a feasible alternative for the intersection of Northampton Street and Third Street. A roundabout would provide an improvement in the safety conditions. Roundabouts have been shown to reduce all crashes by 37% and injury crashes by 51%. If a crash did occur it would be less severe due to the reduced entry angle between the entering and circulating vehicles. The existing condition of the intersection allows pedestrians to cross to the center island. The investigation found that a pedestrian crash did occur within the past six years. One of the basic philosophies of a roundabout is that pedestrians are not allowed to cross to the center island. This would improve safety for the pedestrians. The reduction in the vehicle speed would also be a benefit for the safety of pedestrians and motorists. Since pedestrians would no longer have access to the center island, the pedestrian signals would no longer be required. This would be a great financial savings for the City of Easton. This case study found that the ADT requires only a single-lane urban roundabout. No additional right-of-way is required and in actuality the area for the roundabout is dramatically less when compared to the area used by the rotary. Another advantage would be the opportunity for the City to improve the aesthetics of the area by landscaping the center island. In terms of operations a roundabout
may lessen the delay and increase capacity. The disadvantages would be that this is the first roundabout in the area, which would require education and justification efforts. In addition, roundabouts do not allow parking with the circulatory roadway. The issue of how to accommodate parking for the nearby businesses would need further investigation. The study phase is now necessary to accurately quantify and compare the roundabout to other forms of intersection control.
FIGURE NO. 3A
EXISTING INTERSECTION OF
NORTHAMPTON STREET & THIRD STREET
NORTHAMPTON COUNTY, CITY OF EASTON
ROUNDABOUT QUESTIONNIARE

Please use the answers to the following questions to aid in the planning or preliminary design phases. Each question is followed by pertinent information that will help analyze the feasibility of using a roundabout.

INTERSECTION LOCATION:
Northampton Street and Third Street
Northampton County, City of Easton, PA

BRIEF DESCRIPTION OF INTERSECTION:
- Existing intersection is a rotary that is signalized for pedestrians
- When pedestrians are not accessing the intersection, the circulating traffic receives a flashing yellow. Traffic entering the square receives a flashing red.
- Urban environment, existing intersection is the city’s Centre Square.
- Parking is located at three of the four corners of the existing intersection.

IDENTIFY THE ENVIRONMENT:

- Planning Phase

Question No. 1: Would the roundabout be the first in the area?
Yes

The first roundabout in an area will require education and justification efforts. Please refer to the “Issues Associated with Roundabouts” section for further information regarding this topic. Selecting a single-lane roundabout is recommended since this type will initially be more easily understood than a multi-lane type.

Question No. 2: Would the roundabout be part of a new roadway system or a retrofit of an existing intersection?
The roundabout would be a retrofit to the existing rotary.

A roundabout that is part of a new roadway will normally have fewer constraints, and right-of-way should be easier to acquire than for an existing intersection. If the roundabout is a retrofit of an existing intersection, the resulting cost of maintaining traffic can be relatively high.
SITE CHARACTERISTICS:

- **Planning Phase**

**Question No. 1:** Would the roundabout be located in the vicinity of a railroad grade crossing?

*There are not any railroad tracks in the vicinity of the intersection.*

Special consideration must be given when a railroad grade crossing is located in the vicinity of the roundabout. Queues from a railroad crossing cannot be allowed to back up into the roundabout. The crossing will obviously require railroad crossing signals and/or gates to stop traffic on the crossing roadway. However, due to the proximity of the railroad crossing to the roundabout, it may be necessary to install railroad crossing signals/gates at all legs of the roundabout and shut down the roundabout during train crossings. This condition may negate the beneficial effect of the roundabout.

**Question No. 2:** Is the intersection on any transit routes?

*The Lehigh and Northampton Transportation Authority has services that run through this intersection.*

A roundabout properly designed using the appropriate design vehicle should pose no problem for a bus to traverse. It is important to carefully select the location of bus stops to minimize the probability of vehicle queues backing up into the circulatory roadway.

**Question No. 3:** Does the community have a need for parking within or near the intersection?

- Currently parking exists at three of the four corners surrounding the rotary for the nearby businesses.

Parking is not allowed within the circulatory roadway or at the entries. This may be an important issue if businesses are located in the vicinity of the intersection.

CAPACITY OF THE INTERSECTION:

- **Planning Phase**

**Question No. 1:** What is the required capacity for the intersection?

*The 2001 AADT is approximately 17,200 vehicles. The proportion of minor street traffic is 37%. The percent of left turning vehicles is currently unknown. This figure is below the maximum allowable AADT’s for a single-lane roundabout.*

The following tables provide information to determine which category of roundabout is required for the intersection in question. The data provided below can be found in Chapter 3 of the FHWA publication “Roundabouts: An Informational Guide.” Maximum AADT in the tables below represents the total of the approaching roadways.
### Four-leg Roundabout

<table>
<thead>
<tr>
<th>Category</th>
<th>Proportion of Traffic on Minor Street</th>
<th>Left Turn Percentage</th>
<th>Maximum AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-lane</td>
<td>33%</td>
<td>0% 22,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>20% 21,250</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>40% 20,000</td>
<td></td>
</tr>
<tr>
<td>Single-lane</td>
<td>50%</td>
<td>0% 26,250</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>20% 25,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>40% 23,750</td>
<td></td>
</tr>
<tr>
<td>Double-lane</td>
<td>33%</td>
<td>0% 43,750</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>20% 41,250</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>40% 40,000</td>
<td></td>
</tr>
<tr>
<td>Double-lane</td>
<td>50%</td>
<td>0% 51,250</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>20% 48,750</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>40% 46,875</td>
<td></td>
</tr>
</tbody>
</table>

*For three-leg roundabouts, use 75% of the maximum AADT volumes shown above.

### Mini-roundabout

<table>
<thead>
<tr>
<th>Percent Cross Traffic</th>
<th>Left Turn Percentage</th>
<th>Maximum AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>0% 14,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30% 12,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50% 12,250</td>
<td></td>
</tr>
<tr>
<td>50%</td>
<td>0% 15,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30% 14,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50% 14,250</td>
<td></td>
</tr>
</tbody>
</table>

* Mini-roundabouts are usually implemented with safety in mind, rather than capacity

**Question No. 2:** Does the intersection under consideration consist of a major arterial and a minor arterial or local road?

*The intersection consists of two city streets.*

One of basic principles of a roundabout is that all intersection movements are given equal priority. This fact may cause major street movements to be delayed more than desired. The overall street classification system and hierarchy should be considered before selecting a roundabout.

- **Study Phase**

**Question No. 3:** What is the volume-to-capacity (v/c) ratio for each leg of the roundabout?

*This information is currently unavailable.*

FHWA recommends that the v/c ratio should not exceed 0.85 for any leg of the roundabout.
SAFETY:

- **Planning Phase**

**Question No. 1:** What is the crash history of the intersection over the past five years?

*Over the past six years 1995-2000 (inclusive), this intersection has experienced a number of rear-end crashes. In addition, one crash involved a pedestrian. Currently pedestrians are allowed to travel onto the center island.*

Roundabouts have been shown to reduce total crashes by 37 percent and injury crashes by 51 percent. If the intersection has a large number of head-on and angle crashes, a roundabout may help reduce the number and severity of these incidents. The decrease is due to the entry angle being reduced to about 60 degrees from 90 degrees, lower speeds, and the elimination of vehicles traveling in opposite directions.

RIGHT-OF-WAY:

- **Planning Phase**

**Question No. 1:** Can a roundabout be constructed within the existing right-of-way, or will it be necessary to acquire additional space?

*A single lane roundabout with an inscribed diameter of 100 ft. to 130 ft. would dramatically reduce the area used by the circular intersection. The center island would be reduced as much as 68%.*

Roundabouts usually require more space for the circulatory roadway and central island than what would be necessary for a traditional rectangular intersection. Be aware that corner properties at the intersections can create significant right-of-way problems.

- **Study Phase**

**Question No. 2:** Would selecting a signalized intersection require long or multiple turn lanes to provide sufficient capacity?

*This information is currently unavailable.*

Roundabouts with similar capacity should require less space on the approaches than a signalized intersection. Additional capacity at the intersection can be added by using flared approach lanes. Utilizing flared approach lanes still maintains the benefit of reduced spatial requirements upstream and downstream of the intersection.
ALTERNATE TYPES OF INTERSECTION CONTROL:

Two-Way Stop Controlled Intersection (TWSC)

- **Study Phase**

  Question No. 1: (if applicable) Is the existing TWSC intersection experiencing congestion on the minor street caused by a demand that exceeds capacity?
  
  N/A

  As stated previously, a basic principle of roundabouts is that all intersection movements are given equal priority. Higher proportions of minor street traffic favor roundabouts while lower proportions favor TWSC.

  Question No. 2: (if applicable) Are queues forming on the major street due to inadequate capacity for left turning vehicles?
  
  N/A

  Roundabouts provide a more favorable treatment of left turning vehicles than TWSC.

All-Way Stop Controlled Intersection (AWSC)

- **Study Phase**

  Question No. 1: Are the cross street traffic volumes heavy enough to meet the MUTCD warrants for an AWSC?
  
  An AWSC is not a feasible solution.

  Roundabouts offer higher capacity and lower delays. A reduction in delay during off-peak periods is a benefit that roundabouts offer but cannot be provided by an AWSC intersection.

Signalized Intersection

- **Planning Phase**

  Question No. 1: Would the roundabout be located within a coordinated signal system?
  
  The intersection is currently a rotary therefore retrofitting a roundabout at this location should not be a problem with respect to a coordinated signal system.

  Introducing a roundabout into a coordinated signal system may disperse and rearrange platoons of traffic if other conflicting flows are significant, thereby affecting progressive
movement. It may be beneficial to divide the signal system into subsystems separated by the roundabout to minimize overall system delay.

- **Study Phase**

**Question No. 2:** Are traffic volumes heavy enough to warrant signalization?

*This information is currently unavailable.*

When comparing roundabouts to signalized intersections, there is a notable delay savings when volumes are evenly split between minor and major approaches, especially on two-lane approaches with high left turn percentages. When the major street approaches dominate, roundabout delay will be lower than signal delay.

Other benefits that roundabouts have when compared to signalized intersections are increased capacity, slower speeds, fewer and less severe crashes, less maintenance costs, greater traffic calming, and a more attractive environment. Roundabouts are self-regulating, while a signal will require periodic adjustments to its timing sequences

**DESIGN SPEED:**

- **Planning Phase**

**Question No. 1:** What will the design speed of the roadway be?

*A maximum of 20 mph.*

The following table lists the FHWA recommended maximum entry design speed for various categories.

<table>
<thead>
<tr>
<th>Max. Entry Design Speed</th>
<th>Mini-Roundabout (15 mph (25 km/h))</th>
<th>Urban Compact (15 mph (25 km/h))</th>
<th>Urban Single-lane (20 mph (35 km/h))</th>
<th>Urban Double-lane (25 mph (40 km/h))</th>
<th>Rural Single-lane (25 mph (40 km/h))</th>
<th>Rural Double-lane (30 mph (50 km/h))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Number of entering lanes per approach</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
PERCENT/TYPedef of Trucks:

- **Planning Phase**

  **Question No. 1:** What is the largest vehicle that can be reasonably expected to travel through the intersection?
  The largest vehicle that can be expected would be a single-unit truck. This should be verified in the study phase.

Single-lane roundabouts may require the use of a mountable apron around the perimeter of the central island to provide additional tracking width for large vehicles. Trucks utilizing double-lane roundabouts may track across the entire width of the circulatory roadway.

**Question No. 2:** Will large emergency vehicles be passing through the intersection?
Emergency vehicles may pass through the intersection.

Emergency vehicles will pass through a roundabout in the same manner as other large vehicles and may require a mountable apron. Unlike signalized intersections, emergency vehicles are not faced with through movement vehicles unexpectedly running the intersection at high speed and hitting them.

- **Study Phase**

  **Question No. 3:** What is the percent of trucks on each approach?
  The percent of trucks is: 4% for Third Street, and 2% for Northampton Street.

Due to their length, trucks will find it more challenging than passenger vehicles to use a roundabout. Careful consideration must be given to the amount of truck traffic anticipated, the types of trucks anticipated and their expected route through a roundabout when evaluating. Accommodating trucks may require that a larger inscribed circle diameter be used which may present right of way issues. Additionally, it may be necessary to include a concrete apron in the center island to accommodate truck turns.

PEDESTRIANS/BICYCLES:

- **Study Phase**

  **Question No. 1:** What is the amount of pedestrian and bicycle traffic existing/expected at the intersection?
  Existing count data is unavailable but a large amount of pedestrian activity can be expected due to the urban environment. Bicycle traffic should also be expected. Pedestrians are currently allowed to cross the circulatory roadway into the center island.
It is very important to consider pedestrian and bicycle activity when choosing an intersection control method. Please refer to the “Issues Associated with Roundabouts” section of this guide for further information regarding these topics.

**ILLUMINATION:**

- **Planning Phase**

  **Question No. 1:** Determine the need for illumination?

  *Illumination in an urban area should be provided including most if not all of the approaches.*

  It is suggested that the approach roadways serving a roundabout be illuminated. The specific site conditions and design criteria will determine the need for and level of illumination. Care must be exercised to ensure that the clear zone requirements are met.

**COST:**

- **Study Phase**

  **Question No. 1:** What is the project’s budget?

  *Currently a budget has not been determined.*

  Costs for a roundabout will include construction, engineering and design, land acquisition, and maintenance. It is important to note that costs of installing roundabouts can vary significantly from site to site. The costs of a roundabout and a signalized intersection are comparable at new sites and at existing signalized intersections that require widening at one or more approaches for additional lanes. In most cases, a roundabout will be more expensive to construct than a two-way or all-way stop controlled intersection. Costs of maintaining traffic during construction tends to be relatively high when retrofitting intersections.

  Other factors that may contribute to higher costs for roundabouts include large amounts of landscaping, splitter islands, extensive signing, lighting, and curbing. Operation and maintenance costs are somewhat higher than unsignalized intersections but are less than signalized intersections. On-going maintenance costs include restriping and repaving, snow removal/storage, and landscaping.
Case Study No. 4:

Intersection: Linglestown Road and Mountain Road in Linglestown, PA

**NOTE:** For the purpose of this study, available traffic data was used to evaluate the effectiveness of roundabouts at representative locations. At this location, complete traffic information was not available. Therefore an effort was made to determine appropriate values based on the available data. Actual traffic counts and/or turning movements were beyond the scope of this study. In actual practice, it is imperative that current and reliable traffic information be obtained to properly evaluate the use of a roundabout. Appendix A lists the traffic information needed to make such determination.

The intersection of Linglestown Road and Mountain Road in the town of Linglestown is a Two-Way Stop Controlled (TWSC) intersection that has a small circular island containing a flagpole at its center. The intersection is referred to as the Linglestown Village Square. The Village of Linglestown Action Plan currently has plans for many improvements for Linglestown that include the addition of a roundabout at the square. A roundabout at this location may improve the operations, safety and aesthetics of the intersection.

In order to determine the feasibility of utilizing a roundabout at the intersection of Linglestown and Mountain, various parameters were investigated. Since turning movement counts were unavailable for this intersection, this investigation includes only information applicable to the planning phase of preliminary design. The PennDOT “Guide to Roundabouts” questionnaire was completed along with a crash investigation. A preliminary design layout for a single-lane urban roundabout was also produced.

From the results of this case study, it was determined that a single-lane urban roundabout is a feasible alternative for the intersection of Linglestown Road and Mountain Road. The Village of Linglestown Action Plan is looking to enhance the landscaping of the square, and provide a traffic calming device that would discourage pass-through truck traffic using the intersection as a short cut to I-81 and/or SR 322. A roundabout would be able to provide these goals. In addition, a roundabout would provide an improvement in the safety conditions. Roundabouts have been shown to reduce all crashes by 37% and injury crashes by 51%. If a crash did occur it would be less severe due to the reduced entry angle between the entering and circulating vehicles. With the improvements planned for the area, increased amounts of pedestrian and bicycle traffic can be expected. With the reduced speed the safety for the pedestrian and bicyclists will be improved. This case study found that the ADT requires a single-lane urban roundabout. Additional right-of-way will be required. A disadvantage of utilizing a roundabout would be that this would be the first roundabout in the area. Education and justification efforts would be necessary. In addition, roundabouts do not allow parking within the circulatory roadway or at the entries. The issue of how to accommodate parking for the nearby businesses would need further investigation. The Village of Linglestown Action Plan is also looking to keep the flagpole at its current location in the center of the intersection. Careful attention must be shown when designing the flagpole’s location within the roundabout. Pedestrians will not be allowed to cross the circulatory roadway to the central island. The study phase is necessary to accurately quantify and compare the roundabout to other forms of intersection control.
FIGURE NO. 4A
EXISTING INTERSECTION OF
LINGLESTOWN ROAD & MOUNTAIN ROAD
DAUPHIN COUNTY, LOWER PAXTON TOWNSHIP
FIGURE NO. 4B
ROUNDABOUT AT THE INTERSECTION OF
LINGLESTOWN ROAD & MOUNTAIN ROAD
DAUPHIN COUNTY, LOWER PAXTON TOWNSHIP
ROUNDABOUT QUESTIONNAIRE

Please use the answers to the following questions to aid in the planning or preliminary design phases. Each question is followed by pertinent information that will help analyze the feasibility of using a roundabout.

INTERSECTION LOCATION:

S.R. 0039 (Linglestown Road), S.R. 3019 (Mountain Road) and Township Road #440
Dauphin County, Lower Paxton Township, Linglestown, PA

BRIEF DESCRIPTION OF INTERSECTION:
- These two roads form what is known as the Linglestown Square
- The current intersection has a small circular island that contains a flagpole in its center
- The intersection is Two-Way Stop Controlled (TWSC)
- Delay occurs on the minor roads
- Community wants to retain the existing flagpole (considered a landmark)

IDENTIFY THE ENVIRONMENT:

• Planning Phase

Question No. 1: Would the roundabout be the first in the area?
Yes.

The first roundabout in an area will require education and justification efforts. Please refer to the “Issues Associated with Roundabouts” section for further information regarding this topic. Selecting a single-lane roundabout is recommended since this type will initially be more easily understood than a multi-lane type.

Question No. 2: Would the roundabout be part of a new roadway system or a retrofit of an existing intersection?
The roundabout would be a retrofit of an existing intersection.

A roundabout that is part of a new roadway will normally have fewer constraints, and right-of-way should be easier to acquire than for an existing intersection. If the roundabout is a retrofit of an existing intersection, the resulting cost of maintaining traffic can be relatively high.
SITE CHARACTERISTICS:

- **Planning Phase**

**Question No. 1:** Would the roundabout be located in the vicinity of a railroad grade crossing?

*No.*

Special consideration must be given when a railroad grade crossing is located in the vicinity of the roundabout. Queues from a railroad crossing cannot be allowed to back up into the roundabout. The crossing will obviously require railroad crossing signals and/or gates to stop traffic on the crossing roadway. However, due to the proximity of the railroad crossing to the roundabout, it may be necessary to install railroad crossing signals/gates at all legs of the roundabout and shut down the roundabout during train crossings. This condition may negate the beneficial effect of the roundabout.

**Question No. 2:** Is the intersection on any transit routes?

*Capital Area Transit has a route that runs through this area.*

A roundabout properly designed using the appropriate design vehicle should pose no problem for a bus to traverse. It is important to carefully select the location of bus stops to minimize the probability of vehicle queues backing up into the circulatory roadway.

**Question No. 3:** Does the community have a need for parking within or near the intersection?

*The intersection currently has parking along the approaches and future planned improvements to the community may increase the need for parking.*

Parking is not allowed within the circulatory roadway or at the entries. This may be an important issue if businesses are located in the vicinity of the intersection.

CAPACITY OF THE INTERSECTION:

- **Planning Phase**

**Question No. 1:** What is the required capacity for the intersection?

*AADT data for all legs of this intersection were unavailable at the time of this study. The AADT was estimated to be 17,400 vehicles. Traffic turning movement counts should be performed in the study phase. A single-lane urban roundabout would be applicable.*

The following tables provide information to determine which category of roundabout is required for the intersection in question. The data provided below can be found in Chapter 3 of the FHWA publication “Roundabouts: An Informational Guide.” Maximum AADT in the tables below represents the total of the approaching roadways.
Four-leg Roundabout

<table>
<thead>
<tr>
<th>Category</th>
<th>Proportion of Traffic on Minor Street</th>
<th>Left Turn Percentage</th>
<th>Maximum AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-lane</td>
<td>33%</td>
<td>0%</td>
<td>22,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>21,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>20,000</td>
</tr>
<tr>
<td>Single-lane</td>
<td>50%</td>
<td>0%</td>
<td>26,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>25,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>23,750</td>
</tr>
<tr>
<td>Double-lane</td>
<td>33%</td>
<td>0%</td>
<td>43,750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>41,250</td>
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<tr>
<td></td>
<td></td>
<td>40%</td>
<td>40,000</td>
</tr>
<tr>
<td>Double-lane</td>
<td>50%</td>
<td>0%</td>
<td>51,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>48,750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>46,875</td>
</tr>
</tbody>
</table>

*For three-leg roundabouts, use 75% of the maximum AADT volumes shown above.

Mini-roundabout

<table>
<thead>
<tr>
<th>Percent Cross Traffic</th>
<th>Left Turn Percentage</th>
<th>Maximum AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>0%</td>
<td>14,500</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>12,500</td>
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<tr>
<td></td>
<td>50%</td>
<td>12,250</td>
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<tr>
<td>50%</td>
<td>0%</td>
<td>15,500</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>14,500</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>14,250</td>
</tr>
</tbody>
</table>

*Mini-roundabouts are usually implemented with safety in mind, rather than capacity

Question No. 2: Does the intersection under consideration consist of a major arterial and a minor arterial or local road?

The western approach of Linglestown Road and Mountain Road can be considered major arterials.

One of basic principles of a roundabout is that all intersection movements are given equal priority. This fact may cause major street movements to be delayed more than desired. The overall street classification system and hierarchy should be considered before selecting a roundabout.

- **Study Phase**

Question No. 3: What is the volume-to-capacity (v/c) ratio for each leg of the roundabout?

This information is currently unavailable.

FHWA recommends that the v/c ratio should not exceed 0.85 for any leg of the roundabout.
SAFETY:

• Planning Phase

Question No. 1: What is the crash history of the intersection over the past five years?

*Over the five years from 1995-1999, this intersection has experienced a number of angle crashes. Seventeen percent of these crashes involved injuries. “Pulled out too soon” was the most common reason stated for the crashes.*

Roundabouts have been shown to reduce total crashes by 37 percent and injury crashes by 51 percent. If the intersection has a large number of head-on and angle crashes, a roundabout may help reduce the number and severity of these incidents. The decrease is due to the entry angle being reduced to about 60 degrees from 90 degrees, lower speeds, and the elimination of vehicles traveling in opposite directions.

RIGHT-OF-WAY:

• Planning Phase

Question No. 1: Can a roundabout be constructed within the existing right-of-way, or will it be necessary to acquire additional space?

*Additional right-of-way will be necessary to construct a roundabout at this location (see the conceptual design for details).*

Roundabouts usually require more space for the circulatory roadway and central island than what would be necessary for a traditional rectangular intersection. Be aware that corner properties at the intersections can create significant right-of-way problems.

• Study Phase

Question No. 2: Would selecting a signalized intersection require long or multiple turn lanes to provide sufficient capacity?

*This information is currently unavailable.*

Roundabouts with similar capacity should require less space on the approaches than a signalized intersection. Additional capacity at the intersection can be added by using flared approach lanes. Utilizing flared approach lanes still maintains the benefit of reduced spatial requirements upstream and downstream of the intersection.
ALTÉRNATE TYPES OF INTERSECTION CONTROL:

Two-Way Stop Controlled Intersection (TWSC)

- Study Phase

Question No. 1: (if applicable) Is the existing TWSC intersection experiencing congestion on the minor street caused by a demand that exceeds capacity?
  
  During peak periods queues form on Mountain Road.

As stated previously, a basic principle of roundabouts is that all intersection movements are given equal priority. Higher proportions of minor street traffic favor roundabouts while lower proportions favor TWSC.

Question No. 2: (if applicable) Are queues forming on the major street due to inadequate capacity for left turning vehicles?
  
  No.

Roundabouts provide a more favorable treatment of left turning vehicles than TWSC.

All-Way Stop Controlled Intersection (AWSC)

- Study Phase

Question No. 1: Are the cross street traffic volumes heavy enough to meet the MUTCD warrants for an AWSC?
  
  N/A

Roundabouts offer higher capacity and lower delays. A reduction in delay during off-peak periods is a benefit that roundabouts offer but cannot be provided by an AWSC intersection.

Signalized Intersection

- Planning Phase

Question No. 1: Would the roundabout be located within a coordinated signal system?
  
  No.

Introducing a roundabout into a coordinated signal system may disperse and rearrange platoons of traffic if other conflicting flows are significant, thereby affecting progressive...
movement. It may be beneficial to divide the signal system into subsystems separated by the roundabout to minimize overall system delay.

- **Study Phase**

  Question No. 2: Are traffic volumes heavy enough to warrant signalization?

  *This information is currently unavailable.*

When comparing roundabouts to signalized intersections, there is a notable delay savings when volumes are evenly split between minor and major approaches, especially on two-lane approaches with high left turn percentages. When the major street approaches dominate, roundabout delay will be lower than signal delay.

Other benefits that roundabouts have when compared to signalized intersections are increased capacity, slower speeds, fewer and less severe crashes, less maintenance costs, greater traffic calming, and a more attractive environment. Roundabouts are self-regulating, while a signal will require periodic adjustments to its timing sequences.

**DESIGN SPEED:**

- **Planning Phase**

  Question No. 1: What will the design speed of the roadway be?

  *A maximum of 20 mph.*

The following table lists the FHWA recommended maximum entry design speed for various categories.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15 mph (25 km/h)</td>
<td>15 mph (25 km/h)</td>
<td>20 mph (35 km/h)</td>
<td>25 mph (40 km/h)</td>
<td>25 mph (40 km/h)</td>
<td>30 mph (50 km/h)</td>
</tr>
<tr>
<td>Max. Number of entering lanes per approach</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
PERCENT/TYPt OF TRUCKS:

- **Planning Phase**

**Question No. 1**: What is the largest vehicle that can be reasonably expected to travel through the intersection?

*The largest vehicle that can be expected would be a five axle semi-trailer. A WB-50 design vehicle should be sufficient.*

Single-lane roundabouts may require the use of a mountable apron around the perimeter of the central island to provide additional tracking width for large vehicles. Trucks utilizing double-lane roundabouts may track across the entire width of the circulatory roadway.

**Question No. 2**: Will large emergency vehicles be passing through the intersection?

*The Linglestown Fire Company is located approximately ¼ mile from the square.*

*Emergency vehicles should be expected to traverse through the intersection.*

Emergency vehicles will pass through a roundabout in the same manner as other large vehicles and may require a mountable apron. Unlike signalized intersections, emergency vehicles are not faced with through movement vehicles unexpectedly running the intersection at high speed and hitting them.

- **Study Phase**

**Question No. 3**: What is the percent of trucks on each approach?

*Linglestown Road (S.R. 0039) has 3% trucks while Mountain Road (S.R. 3019) has 3% trucks. Data on the Township Road #440 was unavailable, however, <1% trucks can be anticipated.*

Due to their length, trucks will find it more challenging than passenger vehicles to use a roundabout. Careful consideration must be given to the amount of truck traffic anticipated, the types of trucks anticipated and their expected route through a roundabout when evaluating. Accommodating trucks may require that a larger inscribed circle diameter be used which may present right of way issues. Additionally, it may be necessary to include a concrete apron in the center island to accommodate truck turns.

PEDESTRIANS/BICYCLES:

- **Study Phase**

**Question No. 1**: What is the amount of pedestrian and bicycle traffic existing/expected at the intersection?

*Count data unavailable, but a large amount of pedestrian activity can be expected due to the urban environment. Bicycle traffic should also be expected.*
It is very important to consider pedestrian and bicycle activity when choosing an intersection control method. Please refer to the “Issues Associated with Roundabouts” section of this guide for further information regarding these topics.

**ILLUMINATION:**

- **Planning Phase**

  Question No. 1: Determine the need for illumination?
  
  *Illumination in an urban area should be provided including most, if not all, of the approaches.*

  It is suggested that the approach roadways serving a roundabout be illuminated. The specific site conditions and design criteria will determine the need for and level of illumination. Care must be exercised to ensure that the clear zone requirements are met.

- **Study Phase**

  Question No. 1: What is the project’s budget?
  
  *Currently a budget has not been determined.*

Costs for a roundabout will include construction, engineering and design, land acquisition, and maintenance. It is important to note that costs of installing roundabouts can vary significantly from site to site. The costs of a roundabout and a signalized intersection are comparable at new sites and at existing signalized intersections that require widening at one or more approaches for additional lanes. In most cases, a roundabout will be more expensive to construct than a two-way or all-way stop controlled intersection. Costs of maintaining traffic during construction tends to be relatively high when retrofitting intersections.

Other factors that may contribute to higher costs for roundabouts include large amounts of landscaping, splitter islands, extensive signing, lighting, and curbing. Operation and maintenance costs are somewhat higher than unsignalized intersections but are less than signalized intersections. On-going maintenance costs include restriping and repaving, snow removal/storage, and landscaping.
Case Study No. 5:

Intersection: Nicholson Road and Rochester Road in Franklin Park, PA

The intersection of Nicholson Road and Rochester Road in the Franklin Park is a rural intersection in the western side of the state. The intersection is currently Two-Way Stop Controlled (TWSC) and has experienced a number of angle crashes over a five year period. PennDOT officials feel that a method to improve this intersection may be the implementation of a roundabout.

In order to determine the feasibility of utilizing a roundabout at the intersection of Nicholson and Rochester, various parameters were investigated. Traffic studies were performed in 1997 on this intersection that included turning movement counts. The PennDOT “Guide to Roundabouts” questionnaire was completed along with a crash investigation and capacity analyses. A preliminary design layout for a single-lane urban roundabout was also produced.

From the results of this case study, it was determined that a single-lane rural roundabout offers marginal benefits to the operation of the intersection and that the disadvantages outweigh the advantages. The primary advantage for this intersection is the reduction in delay time and increase in capacity through the intersection. The current crash data indicates that only 10 crashes have occurred over the five year observation period with no fatalities and only five injury crashes. Any reduction in crashes at this intersection would be minimal, if at all, by implementing a roundabout intersection.

One of the disadvantages of implementing a roundabout would be the intersection of Locust Road with Nicholson Road that is less then 100 feet southwest of the entry to the roundabout. The close proximity of Locust Road to the roundabout is not a desirable feature and would likely require left turns out of Locust Road to be prohibited. Another disadvantage is that a reverse curve would be required on Nicholson Road to achieve the desired entry angle at the eastern approach to the roundabout. In addition, this would be the first roundabout in the area, which would require education and justification efforts.

A roundabout would not be recommended at this location as the benefits of such a facility would be minimal compared to a standard intersection. The additional costs associated with maintenance of the roundabouts and the undesirable geometric conditions discussed above suggest that a standard intersection would be more practical here.
FIGURE NO. 5A
EXISTING INTERSECTION OF
NICHOLSON ROAD & ROCHESTER ROAD
ALLEGHENY COUNTY, FRANKLIN PARK BOROUGH
Intersection of Nicholson Road and Rochester Road: Peak Hour Volumes

Assign each entry leg a number going counter-clockwise around the roundabout as illustrated by figure on the right. Enter data into shaded areas below for each entry leg roundabout has. For each entry leg present at least one pce/hr must be shown entering or exiting roundabout for the leg. If roundabout has less than five entry legs, then enter zero in the shaded areas for the entry legs not used. (Note: Use of the tab key will toggle through all the data input shaded areas.)

To get accurate results from this spreadsheet the calculated V/C value should not exceed 0.85.

<table>
<thead>
<tr>
<th>Exiting (veh/hr)</th>
<th>Entering</th>
<th>Circulating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X1</td>
<td>X2</td>
</tr>
<tr>
<td>E1</td>
<td>0</td>
<td>191</td>
</tr>
<tr>
<td>E2</td>
<td>110</td>
<td>0</td>
</tr>
<tr>
<td>E3</td>
<td>119</td>
<td>126</td>
</tr>
<tr>
<td>E4</td>
<td>6</td>
<td>55</td>
</tr>
<tr>
<td>E5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL ENTERING ROUNDABOUT (pce/hr)</td>
<td>1,148</td>
<td></td>
</tr>
</tbody>
</table>

CAPACITY AT AN ENTRY OF A ROUNDABOUT

| Inscribed diameter, D (m) | 35 | 35 | 35 | 35 |
| Entry width, e (m) | 4.25 | 4.25 | 4.25 | 4.25 |
| Approach width, v (m) | 3.048 | 3.048 | 3.048 | 3.048 |
| Entry angle, Q (degrees) | 50 | 45 | 50 | 45 |
| Entry radius, r (m) | 21 | 21 | 21 | 21 |
| Average effective flare length, l' (m) | 12 | 12 | 12 | 12 |
| Peak Hour Factor (PHF) | 0.89 | 0.87 | 0.83 | 0.63 |
| % Single-Unit Truck or Bus | 4.00% | 4.00% | 4.00% | 4.00% |
| % Truck With Trailer | 1.00% | 1.00% | 1.00% | 1.00% |

ENTRY CAPACITY (pce/hr) C=Qe

| ENTRY CAPACITY (pce/hr) C=Qe | 982 | 1,058 | 979 | 913 |
| V/C | 0.32 | 0.36 | 0.34 | 0.13 |
| CONTROL DELAY (sec/veh) d | 5.4 | 5.3 | 5.6 | 4.5 |

LEVEL OF SERVICE

<table>
<thead>
<tr>
<th>LEVEL OF SERVICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
</tr>
<tr>
<td>E2</td>
</tr>
<tr>
<td>E3</td>
</tr>
<tr>
<td>E4</td>
</tr>
<tr>
<td>E5</td>
</tr>
</tbody>
</table>

| QUEUE LENGTH 95th percentile (veh) | 1.4 | 1.7 | 1.5 | 0.4 |

| Circulating flow across the entry, Qc (pce/hr) | 268 | 150 | 273 | 434 |
| S | 0.16 | 0.16 | 0.16 | 0.16 |
| M | 0.08 | 0.08 | 0.08 | 0.08 |
| X2 | 3.96 | 3.96 | 3.96 | 3.96 |
| F | 1199.35 | 1199.35 | 1199.35 | 1199.35 |
| tp | 1.46 | 1.46 | 1.46 | 1.46 |
| fc | 0.55 | 0.55 | 0.55 | 0.55 |
| k | 0.93 | 0.95 | 0.93 | 0.95 |

Entering flow, qe (pce/hr)

<table>
<thead>
<tr>
<th>Entering flow, qe (pce/hr)</th>
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<th>381</th>
<th>336</th>
<th>119</th>
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<tbody>
<tr>
<td>X1</td>
<td>35</td>
<td>35</td>
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</tr>
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<td>X2</td>
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<td>0.87</td>
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<tr>
<td>X8</td>
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<td>4.00%</td>
<td>4.00%</td>
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<td>1.00%</td>
<td>1.00%</td>
<td>1.00%</td>
<td>1.00%</td>
</tr>
</tbody>
</table>

Compared to an unsignalized intersection
Compared to a signalized intersection
Definitions:

pce/hr - passenger car equivalent per hour
Inscribed Diameter, D - the diameter of the largest circle that can be inscribed within the junction outline
Entry Width, e - measured at the point of maximum entry deflection, from the left hand end of give-way line along a normal to the nearside curb
Approach Width, v - measured at a point in the approach upstream from any entry flare, from the median line (or edge of travelway on dual lane roads) to the nearside curb, along a normal
Entry Angle, Q - serves as a geometric proxy for the conflict angle between entering and circulating streams.
Entry Radius, r - measured as the minimum radius of curvature of the nearside curbline at entry
Average Effective Flare Length, l' - measured along a curve offset from curbline a distance of (e-v)/2 starting from line where e is measured to intersection with a projected curve offset from median a distance v.

Entering flow, qe=V

Sharpness of Flare, S=1.6*(e-v)/l'
M=exp((D-60)/10)
X2=v+(e-v)/(1+2*S)
F=353*X2
tp=1.5(1+M)
fc=.21*tp*(1+2*X2)
k=1-.00347*(Q-30)-.978*(1/r)-.05
Qe=k*(F-fc*Qc) or Qe=0 when fc*Qc>F
d=3600/C+900*T*[V/C-1+sqrt((V/C-1)^2+(3600/C)*(V/C)*150*T)] where T=analysis time period, hours (T=0.25 for a 15-minute period)
Queue length 95th percentile = 900*T*[V/C-1+sqrt((V/C-1)^2+(3600/C)*(V/C)*150*T)]*(C/3600) where T is the same as defined for d above

References:


United Kingdom Department of Transport, Geometric Design of Roundabouts, Design Manual for Roads and Bridges, Volume 6, United Kingdom, 1993.
ROUNDABOUT QUESTIONNAIRE

Please use the answers to the following questions to aid in the planning or preliminary design phases. Each question is followed by pertinent information that will help analyze the feasibility of using a roundabout.

INTERSECTION LOCATION:
Nicholson Road and Rochester Road
Allegheny County, Franklin Park Borough, Franklin Park, PA

BRIEF DESCRIPTION OF INTERSECTION:
- Rural environment
- History of angle crashes
- Two-Way Stop Controlled (TWSC) intersection

IDENTIFY THE ENVIRONMENT:

- Planning Phase

Question No. 1: Would the roundabout be the first in the area?
Yes

The first roundabout in an area will require education and justification efforts. Please refer to the “Issues Associated with Roundabouts” section for further information regarding this topic. Selecting a single-lane roundabout is recommended since this type will initially be more easily understood than a multi-lane type.

Question No. 2: Would the roundabout be part of a new roadway system or a retrofit of an existing intersection?
The roundabout would be a retrofit to an existing intersection.

A roundabout that is part of a new roadway will normally have fewer constraints, and right-of-way should be easier to acquire than for an existing intersection. If the roundabout is a retrofit of an existing intersection, the resulting cost of maintaining traffic can be relatively high.
SITE CHARACTERISTICS:
  • **Planning Phase**

**Question No. 1:** Would the roundabout be located in the vicinity of a railroad grade crossing?
*There are no railroad tracks in the vicinity.*

---

Special consideration must be given when a railroad grade crossing is located in the vicinity of the roundabout. Queues from a railroad crossing cannot be allowed to back up into the roundabout. The crossing will obviously require railroad crossing signals and/or gates to stop traffic on the crossing roadway. However, due to the proximity of the railroad crossing to the roundabout, it may be necessary to install railroad crossing signals/gates at all legs of the roundabout and shut down the roundabout during train crossings. This condition may negate the beneficial effect of the roundabout.

**Question No. 2:** Is the intersection on any transit routes?
*No.*

---

A roundabout properly designed using the appropriate design vehicle should pose no problem for a bus to traverse. It is important to carefully select the location of bus stops to minimize the probability of vehicle queues backing up into the circulatory roadway.

**Question No. 3:** Does the community have a need for parking within or near the intersection?
*There is no need for parking in the vicinity.*

---

Parking is not allowed within the circulatory roadway or at the entries. This may be an important issue if businesses are located in the vicinity of the intersection.

CAPACITY OF THE INTERSECTION:
  • **Planning Phase**

**Question No. 1:** What is the required capacity for the intersection?
*The 2012 AADT is approximately 10,436 vehicles. This figure is below the maximum allowable AADT’s for a single-lane roundabout.*

---

The following tables provide information to determine which category of roundabout is required for the intersection in question. The data provided below can be found in Chapter 3 of the FHWA publication “Roundabouts: An Informational Guide.” Maximum AADT in the tables below represents the total of the approaching roadways.
Four-leg Roundabout

<table>
<thead>
<tr>
<th>Category</th>
<th>Proportion of Traffic on Minor Street</th>
<th>Left Turn Percentage</th>
<th>Maximum AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-lane</td>
<td>33%</td>
<td>0%</td>
<td>22,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>21,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>20,000</td>
</tr>
<tr>
<td>Single-lane</td>
<td>50%</td>
<td>0%</td>
<td>26,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>25,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>23,750</td>
</tr>
<tr>
<td>Double-lane</td>
<td>33%</td>
<td>0%</td>
<td>43,750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>41,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>40,000</td>
</tr>
<tr>
<td>Double-lane</td>
<td>50%</td>
<td>0%</td>
<td>51,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
<td>48,750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>46,875</td>
</tr>
</tbody>
</table>

*For three-leg roundabouts, use 75% of the maximum AADT volumes shown above.

Mini-roundabout

<table>
<thead>
<tr>
<th>Percent Cross Traffic</th>
<th>Left Turn Percentage</th>
<th>Maximum AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>0%</td>
<td>14,500</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>12,500</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>12,250</td>
</tr>
<tr>
<td>50%</td>
<td>0%</td>
<td>15,500</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>14,500</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>14,250</td>
</tr>
</tbody>
</table>

* Mini-roundabouts are usually implemented with safety in mind, rather than capacity

Question No. 2: Does the intersection under consideration consist of a major arterial and a minor arterial or local road?

*The intersection consists of two local roads.*

One of basic principles of a roundabout is that all intersection movements are given equal priority. This fact may cause major street movements to be delayed more than desired. The overall street classification system and hierarchy should be considered before selecting a roundabout.

- Study Phase

Question No. 3: What is the volume-to-capacity (v/c) ratio for each leg of the roundabout?

*This information is currently unavailable.*

FHWA recommends that the v/c ratio should not exceed 0.85 for any leg of the roundabout.
SAFETY:

- **Planning Phase**

  **Question No. 1:** What is the crash history of the intersection over the past five years?
  
  Over the past five years 1995-1999, this intersection has experienced <10 angle crashes.

  Roundabouts have been shown to reduce total crashes by 37 percent and injury crashes by 51 percent. If the intersection has a large number of head-on and angle crashes, a roundabout may help reduce the number and severity of these incidents. The decrease is due to the entry angle being reduced to about 60 degrees from 90 degrees, lower speeds, and the elimination of vehicles traveling in opposite directions.

RIGHT-OF-WAY:

- **Planning Phase**

  **Question No. 1:** Can a roundabout be constructed within the existing right-of-way, or will it be necessary to acquire additional space?
  
  A minimal amount of right-of-way may be necessary to accommodate sidewalks along the eastern approach of Nicholson Road.

  Roundabouts usually require more space for the circulatory roadway and central island than what would be necessary for a traditional rectangular intersection. Be aware that corner properties at the intersections can create significant right-of-way problems.

- **Study Phase**

  **Question No. 2:** Would selecting a signalized intersection require long or multiple turn lanes to provide sufficient capacity?
  
  This information is currently unavailable.

  Roundabouts with similar capacity should require less space on the approaches than a signalized intersection. Additional capacity at the intersection can be added by using flared approach lanes. Utilizing flared approach lanes still maintains the benefit of reduced spatial requirements upstream and downstream of the intersection.
ALERATE TYPES OF INTERSECTION CONTROL:

Two-Way Stop Controlled Intersection (TWSC)

- **Study Phase**

  **Question No. 1:** (if applicable) Is the existing TWSC intersection experiencing congestion on the minor street caused by a demand that exceeds capacity?
  
  *This information is currently unavailable.*

As stated previously, a basic principle of roundabouts is that all intersection movements are given equal priority. Higher proportions of minor street traffic favor roundabouts while lower proportions favor TWSC.

**Question No. 2:** (if applicable) Are queues forming on the major street due to inadequate capacity for left turning vehicles?

*This information is currently unavailable.*

Roundabouts provide a more favorable treatment of left turning vehicles than TWSC.

All-Way Stop Controlled Intersection (AWSC)

- **Study Phase**

  **Question No. 1:** Are the cross street traffic volumes heavy enough to meet the MUTCD warrants for an AWSC?
  
  *This information is currently unavailable.*

Roundabouts offer higher capacity and lower delays. A reduction in delay during off-peak periods is a benefit that roundabouts offer but cannot be provided by an AWSC intersection.

Signalized Intersection

- **Planning Phase**

  **Question No. 1:** Would the roundabout be located within a coordinated signal system?
  
  *No.*

Introducing a roundabout into a coordinated signal system may disperse and rearrange platoons of traffic if other conflicting flows are significant, thereby affecting progressive
movement. It may be beneficial to divide the signal system into subsystems separated by the roundabout to minimize overall system delay.

- **Study Phase**

**Question No. 2:** Are traffic volumes heavy enough to warrant signalization?

*This information is currently unavailable.*

When comparing roundabouts to signalized intersections, there is a notable delay savings when volumes are evenly split between minor and major approaches, especially on two-lane approaches with high left turn percentages. When the major street approaches dominate, roundabout delay will be lower than signal delay.

Other benefits that roundabouts have when compared to signalized intersections are increased capacity, slower speeds, fewer and less severe crashes, less maintenance costs, greater traffic calming, and a more attractive environment. Roundabouts are self-regulating, while a signal will require periodic adjustments to its timing sequences.

**DESIGN SPEED:**

- **Planning Phase**

**Question No. 1:** What will the design speed of the roadway be?

* A maximum of 25 mph.

The following table lists the FHWA recommended maximum entry design speed for various categories.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Entry Design Speed</td>
<td>15 mph (25 km/h)</td>
<td>15 mph (25 km/h)</td>
<td>20 mph (35 km/h)</td>
<td>25 mph (40 km/h)</td>
<td>25 mph (40 km/h)</td>
<td>30 mph (50 km/h)</td>
</tr>
<tr>
<td>Max. Number of entering lanes per approach</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
PERCENT/TYPe OF TRUCKS:

- **Planning Phase**

  **Question No. 1:** What is the largest vehicle that can be reasonably expected to travel through the intersection?
  
  The largest vehicle that can be expected would be an interstate tractor trailer. A WB-50 design vehicle should be sufficient.

  Single-lane roundabouts may require the use of a mountable apron around the perimeter of the central island to provide additional tracking width for large vehicles. Trucks utilizing double-lane roundabouts may track across the entire width of the circulatory roadway.

  **Question No. 2:** Will large emergency vehicles be passing through the intersection?
  
  Emergency vehicles may pass through the intersection.

  Emergency vehicles will pass through a roundabout in the same manner as other large vehicles and may require a mountable apron. Unlike signalized intersections, emergency vehicles are not faced with through movement vehicles unexpectedly running the intersection at high speed and hitting them.

- **Study Phase**

  **Question No. 3:** What is the percent of trucks on each approach?
  
  This information is currently unavailable.

  Due to their length, trucks will find it more challenging than passenger vehicles to use a roundabout. Careful consideration must be given to the amount of truck traffic anticipated, the types of trucks anticipated and their expected route through a roundabout when evaluating. Accommodating trucks may require that a larger inscribed circle diameter be used which may present right of way issues. Additionally, it may be necessary to include a concrete apron in the center island to accommodate truck turns.

PEDESTRIANS/BICYCLES:

- **Study Phase**

  **Question No. 1:** What is the amount of pedestrian and bicycle traffic existing/expected at the intersection?
  
  Current counts are unavailable. Due to the rural environment pedestrian activity should not be expected but future activity should be taken into consideration.
It is very important to consider pedestrian and bicycle activity when choosing an intersection control method. Please refer to the “Issues Associated with Roundabouts” section of this guide for further information regarding these topics.

**ILLUMINATION:**

- **Planning Phase**

  Question No. 1: Determine the need for illumination?
  
  *Illumination in rural conditions is not mandatory but is recommended.*

It is suggested that the approach roadways serving a roundabout be illuminated. The specific site conditions and design criteria will determine the need for and level of illumination. Care must be exercised to ensure that the clear zone requirements are met.

**COST:**

- **Study Phase**

  Question No. 1: What is the project’s budget?
  
  *Currently a budget has not been determined.*

Costs for a roundabout will include construction, engineering and design, land acquisition, and maintenance. It is important to note that costs of installing roundabouts can vary significantly from site to site. The costs of a roundabout and a signalized intersection are comparable at new sites and at existing signalized intersections that require widening at one or more approaches for additional lanes. In most cases, a roundabout will be more expensive to construct than a two-way or all-way stop controlled intersection. Costs of maintaining traffic during construction tends to be relatively high when retrofitting intersections.

Other factors that may contribute to higher costs for roundabouts include large amounts of landscaping, splitter islands, extensive signing, lighting, and curbing. Operation and maintenance costs are somewhat higher than unsignalized intersections but are less than signalized intersections. On-going maintenance costs include restriping and repaving, snow removal/storage, and landscaping.
References:


Articles:


