



August 28, 2018

To: Stewart Schwartz, Executive Director, Coalition for Smarter Growth

From: Ken Ray, PLA, Ian Lockwood, PE, Toole Design Group

Subj: U.S. Highway 15 Roundabout Conceptual Analysis

The purpose of this memo is to summarize the options for constructing a roundabout at the intersection of U.S. Highway 15 ("Hwy 15") and Raspberry Drive/Whites Ferry Road.

Existing Conditions

Hwy 15 is a north-south rural road that connects the Town of Leesburg and its neighboring communities to the Maryland-Virginia state border. The road provides access for farms and rural tourism, local retail and service trips, and is used for commuter traffic during the AM/PM peak periods. The signalized intersection at Raspberry Drive/Whites Ferry Road is one of the main bottlenecks that stops the flow of through traffic and causes backups and safety issues along Hwy 15.

The current lane configuration at the intersection is complex because of the signalization and the need for turn lanes. Currently there is one lane of through traffic in each direction on Hwy 15, and the impulse to relieve any congestion is to widen the road to four lanes. However, the congestion along the roadway is caused by the traffic signal and the time it takes to serve the protected left-turn phases and side-street phases. Hwy 15 has dedicated right-turn lanes on each approach and dedicated left-turns and phases that impact the signal timing and stop the heavier flow of vehicles along Hwy 15.

Raspberry Drive is a two-lane neighborhood street that connects a subdivision to Hwy 15 and has a dedicated right-turn lane to allow a free flow of vehicles turning southbound toward Leesburg. Whites Ferry Road is a two-lane road that connects Hwy 15 to the historic ferry that crosses the Potomac River and connects across the Virginia/Maryland state border. The ferry has limited capacity to move a large volume of vehicles across the river at one time and White Ferry Road experiences gaps in traffic while the ferry loads, floats across, and unloads. These small surges of 10-12 cars every 15-20 minutes contribute a very small volume of vehicles to process through the east side of the intersection, and do not add enough vehicles to significantly impact the volume processed through the intersection, but rather add another variable to impact the signal timing.

Design Desires and Principles

The impetus of studying this intersection derives from shared community concerns about traffic congestion, challenges getting into and out of their neighborhoods, and safety concerns about speeding and accidents. While some in the community support the County staff's proposed recommendation to widen Hwy 15 to Montresor Road, many in the community would like to address the traffic and safety issues while maintaining Hwy 15's context sensitive character as a two-lane rural road, and to draw from the success of Loudoun's U.S. Highway 50 roundabout and traffic calming, which improved safety and flow, while protecting the scenic and historic character of the road.

Other consulting firms have studied this corridor and have recommended everything from grade separated flyovers to widening the roadway to a four-lane cross section, focusing primarily on how to move a greater number of vehicles faster through the corridor, rather than how to address the transportation challenges in a context-sensitive way. Those studies did generate some valuable data and projections that can be analyzed to develop approaches that address traffic flow, safety and the context.

Design Concept

The recent consulting study for the County included investigation of a roundabout at this intersection, but because of the perceived traffic volumes, the consultants concluded a single-lane roundabout would be inadequate and offered a two-lane roundabout as an option to a traffic signal. However, they did not recommend advancing this option because of a high cost estimate (reportedly \$8 million).

It is our conclusion that a roundabout is the best option for this intersection and a single-lane roundabout will be adequate for current and 2020 volumes. As the prior consulting study shows, a roundabout performs better operationally than the signalized intersection because it allows for the free-flowing movement of traffic through the roundabout compared to the stop and go platoons of vehicles processed through the signal.

- 1) A one-lane roundabout is typically sufficient to process an average daily traffic volume (ADT) of between 17,000 and 27,000 vehicles per day, shown in Figure 1. While Hwy 15 is at the higher end of this range – at 24,000 for the year 2015, a single lane roundabout at this location can handle that volume because:
 - a) The percentage of left-turns onto Raspberry Drive and Whites Ferry Roads is low (6% or less) so it will have minimal impact on the overall volume of traffic that the roundabout can process. The AM and PM peak hour volumes and turning percentages per approach are shown in Figure 2.

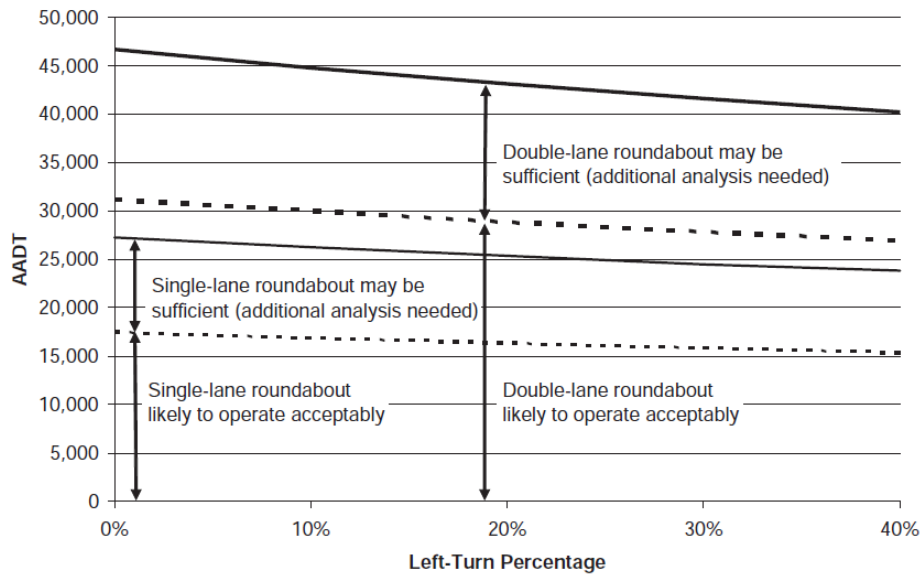


Figure 1: Planning-Level Daily Intersection Volumes¹

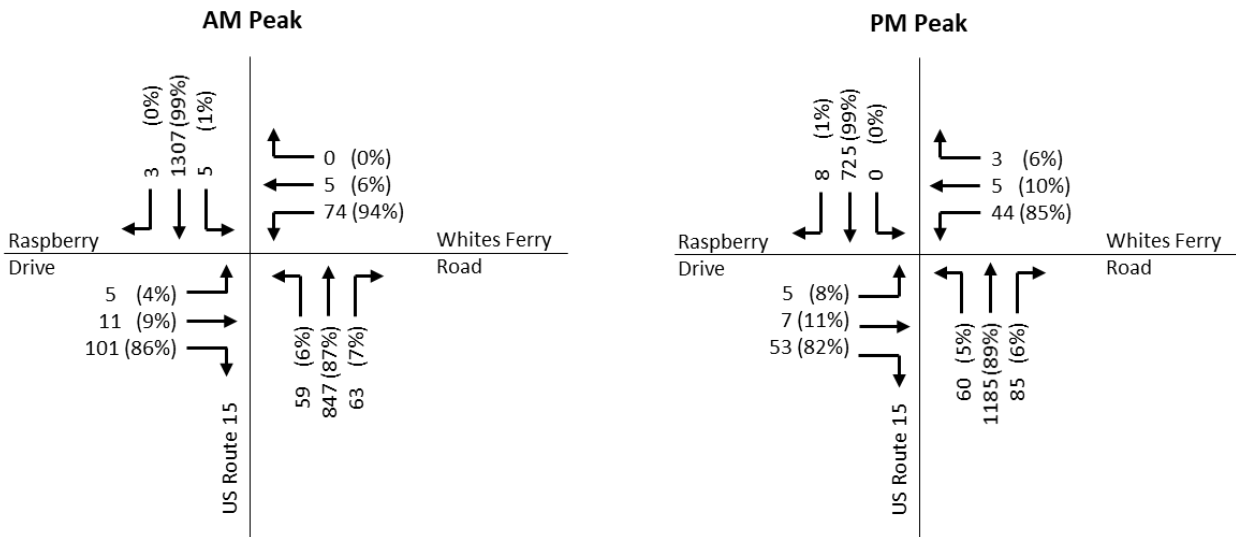


Figure 2: US Route 15 Existing Peak Hour Volumes²

b) What is more important than the ADT is the conflicting flow rate that occurs at each lane entering the roundabout. The conflicting flow rate is the sum of the number of entering vehicles³ and number of circulating vehicles⁴ in the peak hour, shown in Figure 3, which in this case is below the maximum threshold for a one-lane roundabout. One element that

¹ NCHRP Report 672. Roundabouts: An Informational Guide, Second Edition. 2010. Exhibit 3-12.

² US Route 15 Congestion Report. Existing Peak Hour Volumes.

³ Entering vehicles are vehicles located on a roundabout entrance lane.

⁴ Circulating vehicles are vehicles located on the circulatory roadway within the roundabout.

varies along Hwy 15 is the peak directional volume traveling through the intersection during the AM and PM peak periods. In the morning the peak is in the southbound direction, while in the afternoon the peak is in the northbound direction, and most vehicles travel straight through the intersection during the peaks. In the existing peak hour traffic volumes, the maximum entering volume during the AM peak is 1,315 vehicles per hour and during the PM peak is 1,330 vehicles per hour. The circulating volumes that conflict with these entering volumes are low, 138 vehicles for the AM peak and 22 vehicles for the PM peak. The maximum circulating volume during the AM peak is 1,384 vehicles per hour and during the PM peak is 1,250 vehicles per hour. The entering volumes that conflict with these circulating volumes are low, 117 vehicles for the AM peak and 52 vehicles for the PM peak. The high number of entering or circulating vehicles is what likely caused the previous studies to immediately consider a two-lane roundabout but the low conflicting volumes support a one-lane roundabout for this location. When the numbers are plotted on the FHWA "Approach capacity of a single-lane roundabout" chart, one point for the AM peak and one point for the PM peak are slightly above the threshold line for a one-lane roundabout, as shown in Figure 4 and Figure 5 but the main rule for this FHWA chart is that the sum of the number of entering and circulating vehicles should not exceed 1,800 vehicles per hour, which can be seen by the dotted black line. Hwy 15 does have a steady flow of vehicles traveling through this intersection in the peak direction during AM and PM peak hours, but the flow remains less than 1,800 vehicles per hour. Because there are low left turning volumes from Hwy 15 and low volumes from Raspberry Drive and Whites Ferry Road, the single lane roundabout should be sufficient to process the high volumes in the peak direction. There is also minimal growth expected for the 2020 projected traffic volumes, the opening year for the roundabout, and therefore the 2020 volumes remain less than 1,800 vehicles per hour. The 2020 projected volumes are shown in Figure 6.

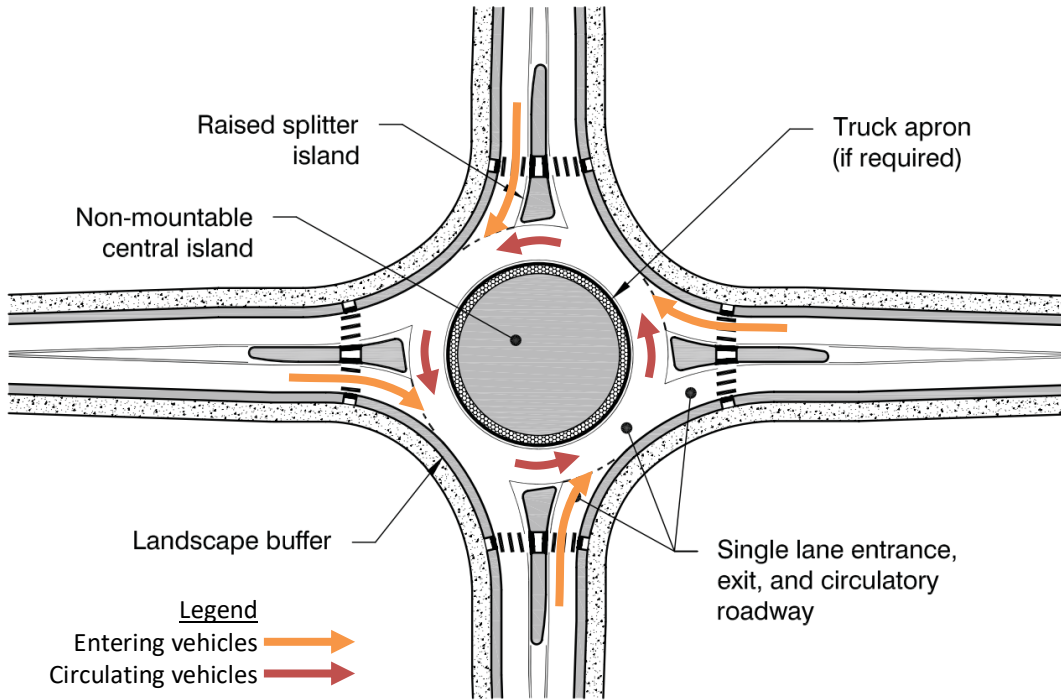


Figure 3: Conflicting flow rate elements⁵

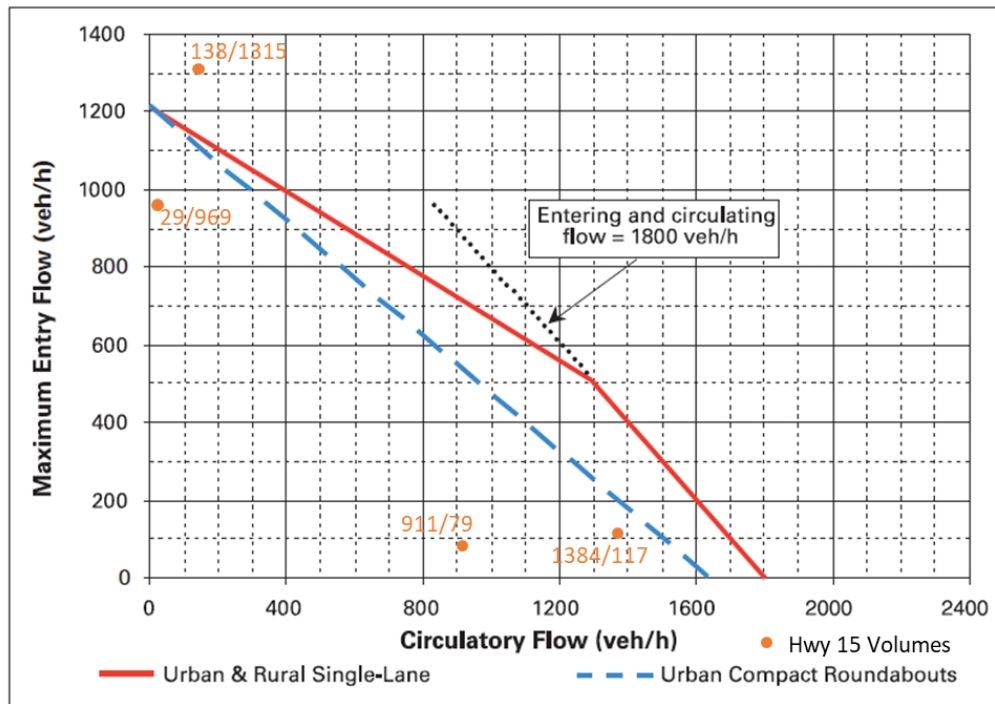


Figure 4: Approach capacity of a single-lane roundabout: AM Peak⁶

⁵ NCHRP Report 672. Roundabouts: An Informational Guide. 2010. Exhibit 1-2.

⁶ NCHRP Report 672. Roundabouts: An Informational Guide. 2000. Exhibit 4-3.

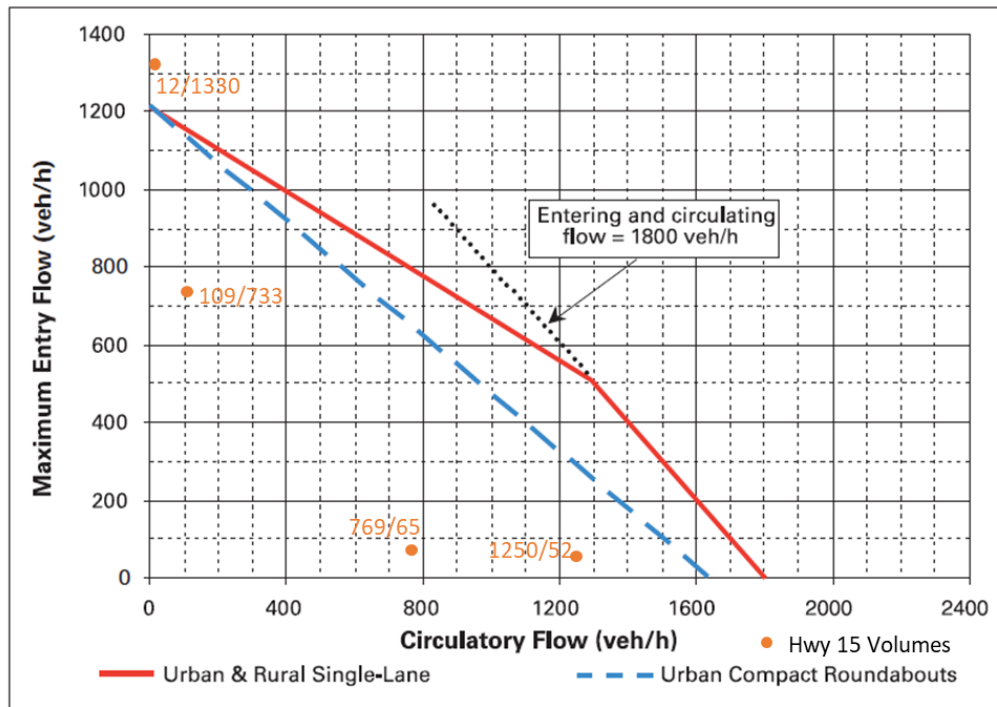


Figure 5: Approach capacity of a single-lane roundabout: PM Peak⁷

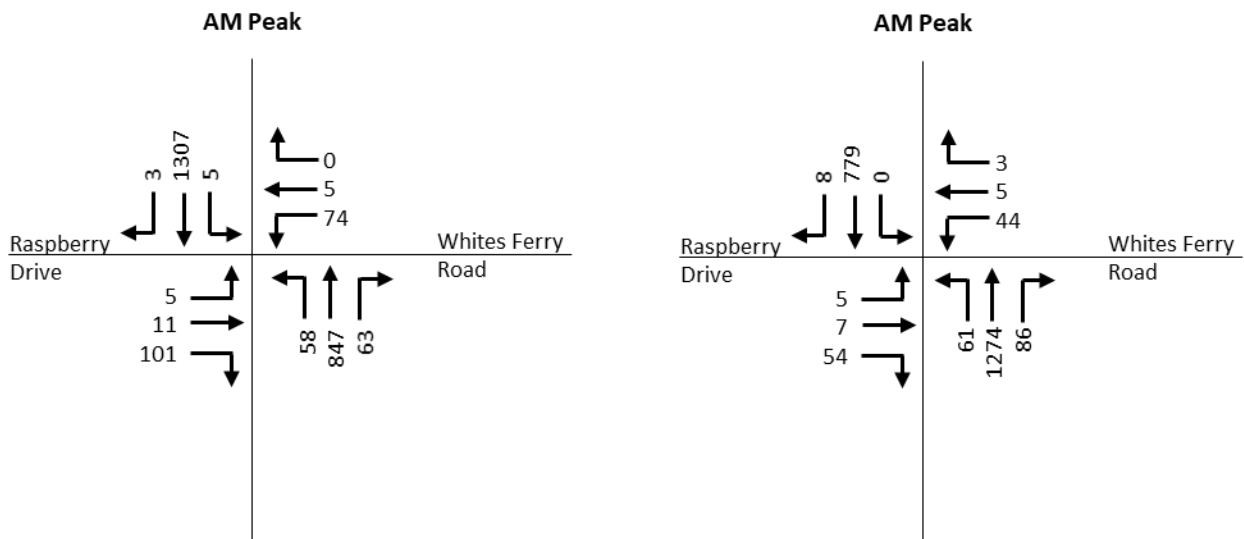


Figure 6: US Route 15 2020 Peak Hour Volumes⁸

- 2) Design judgement also informs that widening the roundabout to two-lanes will likely make the roundabout more dangerous for all users.

⁷ NCHRP Report 672. Roundabouts: An Informational Guide. 2000. Exhibit 4-3.

⁸ US Route 15 Congestion Report. 2020 Peak Hour Volumes.

- a) A single lane roundabout will require vehicles to deflect before entering it and slow them down to a steady speed as they travel through it.
 - b) By widening the roundabout to two-lanes the vehicles will not necessarily have to deflect and can pass through it at a faster speed and negate the traffic calming benefits of the roundabout. Placing additional concrete islands and diverters to direct vehicles to different lanes will not help resolve this issue because most of the vehicles are traveling straight through the intersection and do not turn east or west out of it. Essentially the two-lane roundabout would split the approach lane on Hwy 15 into two lanes, cycle the two lanes through the roundabout, and then merge it back down on the other side. At intersections it is necessary to provide the extra lanes to hold the additional vehicles in the queue, but the additional lanes in roundabouts don't provide the same benefit because the vehicles must weave and merge through and after the roundabout.
- 3) The roundabout will have additional benefit of allowing vehicles on Raspberry Drive to yield and turn south just as they do today with the free right-turn lane.
 - 4) The roundabout will also act as a pedestrian safety enhancement and allow for new trails and sidewalks to be added along Hwy 15 and process the pedestrians through the roundabout. In contrast, today's signalized intersection does not have a pedestrian phase and adding pedestrian phases would increase the congestion because of the additional signal crossing time.

A single lane roundabout is also cheaper than widening the roadway and impacting property outside of the existing right of way. The single lane roundabout will fit easily within the right of way and the reclaimed space along the edges of Hwy 15 can be repurposed for a shoulder, bike facilities, sidewalk, trail, trees, etc.

The rural single lane roundabout will provide efficient travel along Hwy 15 while processing the existing (Figure 2) and projected 2020 (Figure 6) traffic volumes. This roundabout can act as a gateway to White's Ferry and into Leesburg, and as a traffic calming treatment to slow vehicles to a reasonable speed at intersections and as they enter the communities along Hwy 15.