CDM Smith
260 West Exchange Street, Suite 300
Providence, RI 02903
tel: 401-751-5360
fax: 401-274-2173

November 18, 2015

Guilford B. Mooring, P.E.
Superintendent of Public Works
Town of Amherst
586 South Pleasant Street
Amherst, Massachusetts 01002

Subject: **Traffic Engineering Services**
East Pleasant Street at Triangle Street – Pedestrian activity

Dear Mr. Mooring:

CDM Smith Inc. (CDM Smith) prepared the initial traffic study of potential improvements at the intersection East Pleasant Street at Triangle Street in January 2014. From these analyses, a proposed roundabout installation was selected to accommodate the projected vehicular traffic flow at the intersection.

It is our understanding that the community has expressed concern over pedestrian safety with the proposed roundabout installation at the intersection. The purpose of this letter is to provide a technical summary of updated capacity analysis including a maximum number of possible pedestrian crossings, and to summarize the industry knowledge of pedestrian safety at roundabouts, supported by our ongoing roundabout workshop participation. Information specifically related to larger vehicle accommodation and the need for channelized turn lanes (CTLs) at the intersection is provided under separate cover.

Updated analysis

As previously presented in our letter dated January 20, 2014, forecasted vehicle turning movement data were obtained from the University of Massachusetts (UMass) Amherst Campus Master Plan[1] . Although pedestrian and bicyclist counts were not provided in the UMass Master Plan, CDM Smith has prepared an updated capacity analysis under traffic signal conditions and the proposed roundabout condition; these updated analyses include an estimated 100 pedestrian crossings per approach per hour. These represent the maximum that the software will accept for inclusion in the capacity analysis. For reference, previous analysis indicates that the signalized intersection has a vehicular level of service (LOS) C without the pedestrian phase. The analysis has been performed on the morning and evening peak hours to present the most conservative scenario (i.e. the highest concentration of vehicles combined with the highest concentration of pedestrians). The results of the updated analyses are illustrated in table 1 for signalized operation and table 2 for roundabout

[1] UMass Amherst Campus Planning Division. *UMass Amherst Campus Master Plan*, 2012.

operation, both with maximum pedestrian crossings to provide an even comparison of traffic controls.

Table 1 – Future (2033) LOS Analysis (signalized with pedestrian crossings)

Intersection	Approach	Lane	2033 AM Peak				2033 PM Peak			
			LOS	Delay	V/C	Queue	LOS	Delay	V/C	Queue
East Pleasant Street at Triangle Street	NB	L	C	22.5	0.37	99	B	17.0	0.28	91
		T R	C	21.9	0.30	154	C	24.6	0.47	237
	SB	L	C	20.6	0.08	27	C	24.0	0.10	26
		T R	D	40.0	0.76	333	C	31.4	0.53	208
	EB	L T	D	41.6	0.63	121	F	228.5	1.37	409
		R	C	29.7	0.07	18	C	30.1	0.13	56
	WB	L T R	F	196.0	1.31	538	F	309.4	1.56	420
	Overall		F	83.2	-	-	F	122.1	-	-

Table 2 – Future (2033) LOS Analysis (roundabout with pedestrian crossings)

Intersection	Approach	Lane	2033 AM Peak				2033 PM Peak			
			LOS	Delay	V/C	Queue	LOS	Delay	V/C	Queue
East Pleasant Street at Triangle Street	NB	L T R	A	8.2	0.40	49	C	15.3	0.62	106
	SB	L T R	C	24.8	0.73	133	B	11.2	0.44	52
	EB	L T R	A	7.8	0.28	27	C	15.3	0.65	120
	WB	L T R	C	16.4	0.64	110	B	13.0	0.49	61
	Overall		C	15.5	-	-	B	14.1	-	-

As shown in Tables 1 and 2, the analysis results indicate that the high volume of pedestrian crossings will degrade level of service (LOS) under signalized conditions from an overall LOS C (without pedestrian crossings) to an overall LOS F. However, under roundabout conditions, the high volume of pedestrian crossings increase the anticipated vehicle delays by less than one second per approach. The traffic signal must stop all traffic flow in order to process the crossing pedestrians under the current exclusive pedestrian phasing. For roundabouts, all traffic does not stop for crossing pedestrians; roundabouts can more readily accommodate crossing pedestrians without experiencing significant reductions in traffic flow nor increases in delays. Therefore, it is anticipated that high volumes of pedestrians at the intersection under roundabout operations will not significantly impact vehicular level of service.

Roundabouts and Pedestrian safety

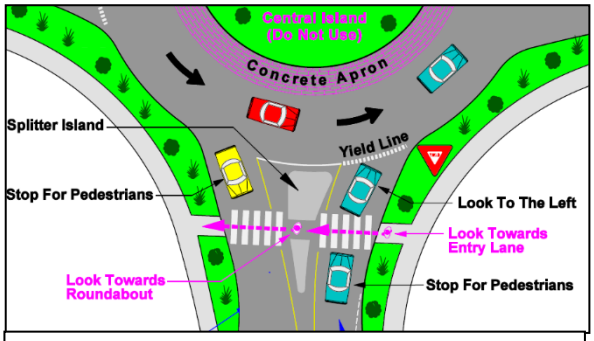
Current Literature

The safety aspects of roundabouts versus traffic signals and other intersection controls have been demonstrated in numerous studies conducted by industry and government agencies. The foremost guidance on roundabout studies and design is promulgated by the National Cooperative Highway Research Program (NCHRP) in cooperation with the US Department of Transportation (USDOT) and the FHWA. NCHRP has studied roundabouts since the 1990's, with publication of several reports, including Report 572 Roundabouts in the US, followed by the second edition of Report 672 Roundabouts: An Informational Guide. Additional research as well as on-going roundabout design workshops are constantly evolving. We note the following research documents that include commentary on pedestrian safety at roundabouts versus traffic signals and summarize the highlights of the literature research into an overall general assessment below.

- NCHRP Report 672 – Roundabouts: An Informational Guide, Second Edition - http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_672.pdf
- Enhancing Intersection Safety Through Roundabouts: An ITE Informational Report - http://trid.trb.org/view.aspx?id=781661
- The Insurance Institute for Highway Safety – http://www.iihs.org/iihs/topics/t/roundabouts/topicoverview
- AARP's liveable communities Modern Roundabout fact sheet - http://www.aarp.org/content/dam/aarp/livable-communities/documents-2014/Livability%20Fact%20Sheets/Modern-Roundabouts-Fact-Sheet.pdf
- October 15, 2015 ASEE – Applied Roundabout Design Workshop

Vehicle speeds

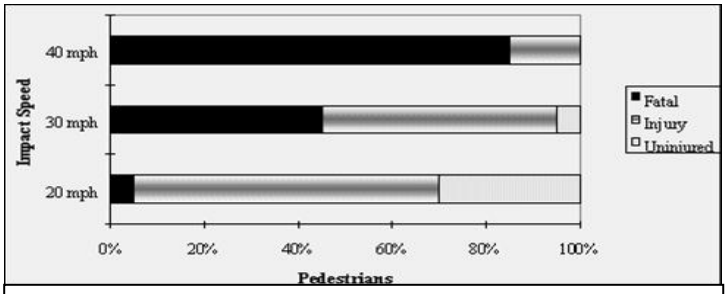
Properly designed roundabouts result in entry and circulating vehicle speeds between 18-25 mph, depending on the approach geometry, size of the roundabout and the exit geometry. The smaller the roundabout diameter, the slower the vehicle speeds in the roundabout.



Vehicle and pedestrian interaction at a properly designed roundabout

Lower vehicle speeds lead to:

- Better interaction between drivers and pedestrians – lower vehicle speeds allow more time for drivers to adjust their behaviors (i.e., drivers are more likely to yield to pedestrians under reduced vehicles speeds) and for pedestrians to adjust their crossing decision.
- Survivability – while no vehicle-pedestrian collision is ideal, statistics illustrated in NCHRP Report 672 indicate a "pedestrian is 8 times more likely to die when struck at 30mph than at 20mph".



Speed versus level of injury for pedestrian-vehicle collisions

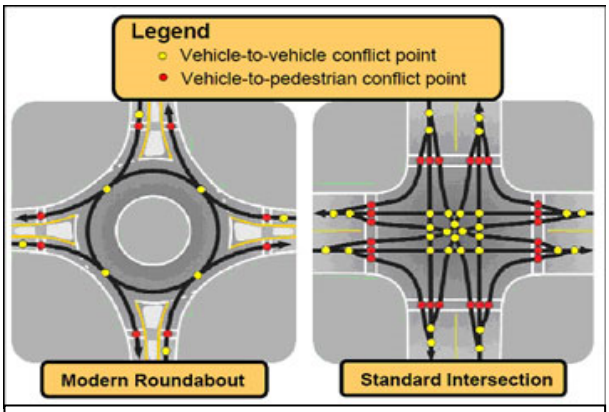
Pedestrian crossing options

Pedestrians crossing roundabout approaches typical cross shorter distances and usually need to focus on crossing only one vehicular travel lane at a time. Pedestrians become an inherent part of the intersection; the more pedestrian activity present, the greater the likelihood of drivers yielding to the pedestrians. Under unsignalized or signalized intersections, pedestrians may need to traverse several travel lanes on any one leg of the intersection.

Given shorter pedestrian crossing distances, pedestrians can typically navigate a roundabout crossing in less time than present at a traffic signal. With several lanes of traffic to navigate under traffic signal control, pedestrians could experience longer delay waiting for the appropriate traffic signal phase to cross.

Conflict points

As illustrated in the accompanying image, traditional intersections can experience over 32 conflict points while roundabouts typically experience far fewer conflict points. Vehicle-pedestrian conflict points are typically less at a roundabout than at an intersection because of



Conflict points for a modern roundabout compared with a standard signalized intersection

the "one lane at a time" crossing function, shortened crossing distances, and the elimination of left-turn movements.

NCHRP 672 has summarized pedestrian crashes per million trips for roundabouts versus traffic signals; based upon previous studies showing modern roundabouts (newer designs) have less than half the number of pedestrian crashes than traffic signalized intersections.

Intersection Type	Pedestrian Crashes per Million Trips
Mini-roundabout	0.31
Conventional roundabout (older designs)	0.45
Flared roundabout (newer designs)	0.33
Signals	0.67

Site specific

The existing intersection is signal controlled with exclusive pedestrian phasing, where all vehicle traffic flow is stopped with red signal phases to allow pedestrians to cross the intersection using the existing crosswalks. The intersection is significantly skewed, with Triangle Street approaches angled approximately 30 degrees, where a typical four legged intersection has approaches closer to 90 degrees (perpendicular). Acute angle intersections typically present issues with intersection sight lines, requiring drivers to look beyond their normal 180 degree vision to look down the skewed approach if turning right on red or during times when the signal is flashing. This condition is exacerbated with the two existing Channelized Turn Lanes (CTL) for the right turns on the northbound and southbound East Pleasant Street approaches.

With these existing intersection geometrics, pedestrians crossing the intersection approaches must be more vigilant in looking for vehicles either turning right on red, violating the signal control or using the CTL's.

Existing pedestrian activity at the intersection

While the traffic signal has exclusive phasing and pedestrian push buttons to activate the phase requesting all vehicular traffic stop, pedestrians should and must wait for the phase to come up in the signal cycle. Many pedestrians do not wait and

cross anyways at the next opportunity. For pedestrians who do wait, the delay can be upwards of a minute or longer depending on when the button was pushed during the cycle.

As noted above, the pedestrian conflict points present at the intersection are four times more than with a proposed roundabout installation. These potential conflicts include pedestrians in longer cross walks, especially for the skewed approaches. With three lanes on three of the intersection legs, the crosswalks are at least 36-40 feet in length in which a pedestrian will be on the pavement for at least 10 seconds while crossing the leg. In this crossing, they must be wary of both directions of travel if crossing without the signal, and with right turning traffic as well if crossing with the pedestrian signal.

In summary, while the existing signalized intersection has exclusive pedestrian phasing, there are more potential conflicts with vehicles, the intersection approaches are significantly skewed, creating longer crosswalk lengths, and pedestrians may wait up to a minute or longer to cross, increasing the likelihood they will cross without the exclusive pedestrian phase.

Conclusions

- A traffic signal installation will likely experience a LOS F under future conditions with an exclusive pedestrian phase activated frequently.
- A single lane roundabout will likely be sufficient for anticipated traffic conditions even with the inclusion of a maximum number of pedestrian crossings.
- Studies indicates that a single lane roundabout exhibits a smaller rate of vehicle-pedestrian collisions and associated fatalities due to lower vehicle speeds and reduced pedestrian crossing lengths.
- The existing intersection configuration under traffic signal control has more conflict points between vehicles and pedestrians than a proposed roundabout installation.
- Pedestrians will experience longer delay in crossing the intersection under signalized conditions versus a proposed roundabout installation, due to the number of lanes required to cross under signalized conditions.

We trust that this technical letter illustrating updated capacity analysis, a summary of current literature on roundabouts and pedestrian safety as well as our site-specific commentary on the skewed nature of the intersection of East Pleasant Street at Triangle Street has provided you with the necessary information to address resident concerns regarding the proposed roundabout installation.

We welcome the opportunity to meet with you to review in person.

Thank you for this opportunity to provide the Town of Amherst with continued traffic engineering services. Should you have any questions or comments, please do not hesitate to contact me at 401-457-0366.

Very Truly Yours,

Lisa Sherman, P.E., PTOE
Senior Project Manager

Attachments
Revised Future Intersection Capacity Analysis
Revised Future Roundabout Capacity Analysis

cc: Joseph Balskus, CDM Smith
Tim Dupuis, CDM Smith