Ourston Roundabout Engineering

February 24, 2009

Nantucket Planning & Economic Development Commission
2 Fairgrounds Road
Nantucket, MA 02554

Attention: Mr. T. Michael Burns, AICP

Re: Review of VHB Report
Intersection at Atlantic Ave/Prospect St./Surfside Rd/Sparks Ave. ('Four Corners')
Nantucket, Massachusetts
Our Project Number: 09903

INTRODUCTION

Ourston Roundabout Engineering (ORE) has completed a review of the intersection evaluation of Atlantic Avenue, Prospect Street, Surfside Road and Sparks Avenue ('Four Corners') that was completed by Vanasse Hangen Brustlin (VHB) on June 23, 2008. The tasks which we were to undertake form the headings of the following technical report, namely:

1. A review of the VHB report on alternative intersection controls and layouts.
2. A traffic analysis of the future traffic turning movements using RODEL and a commentary on the comparison of RODEL results to the previous reported results.
3. Critique of the VHB conceptual layouts, Alternatives 1 to 3.
4. A discussion on pedestrian concerns.
5. Identification of any intersection control and/or layout alternatives that haven't been considered but merit inclusion in the overall evaluation of alternatives.

Review of VHB's Intersection Evaluation Report

When comparing one type of control to another, a study should be based on several quantitative criteria and other qualitative measures. The objective or quantitative criteria are normally:

1. Safety performance for all users (collision reduction potential and crash cost savings);
2. Operational performance for motorists;
3. Estimated capital costs; and
4. Life cycle costs (including injury crash and operating costs).

Safety and cost are the primary indicators of the benefits of roundabouts while efficiency is also important but not as high in societal values. Additional factors such as the cost of time (delay) and fuel consumption are generally implied in delay comparisons. When accurate collision data and cost information is available, and is incorporated into a life-cycle economic evaluation of alternatives, the savings due to crash reductions can offset the higher construction costs of roundabouts.

Qualitative measures of effectiveness can include but not limited to:

1. Property impacts;
2. Education of school age children and public acceptance;
3. Effects on pedestrians, cyclists, and emergency services;
4. Compatibility with adjacent land use, accesses and corridor travel times; and,

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5. Aesthetics.

In order to compare the alternatives presented, a preliminary layout of each alternative is developed The foregoing template for a typical intersection control study was used to assess the VHB report content.

General Report Content

- Apart from the numerical comparison of expected operations of each alternative, cost differences between alternatives are not identified. There may be a substantial cost difference between Alternative 1 and Alternative 2 that may affect the final selection.
- If safety benefits are accounted for, then the Do-Nothing option or even the four-way stop control (Alternative 3) is likely to have a negative life-cycle cost impact as compared to the roundabout alternative. Although crash savings are not recoverable by the road authority, it is seen as an expedient measure for society. In addition, emphasis of collision reduction makes easier the acceptance of higher construction costs. There is moderate cause for safety improvement, but no comparison of collision reduction benefits of any alternatives was presented.
- Although the arguments for dismissal of other options is compelling, the documentation on why other alternatives were dismissed is non-numerical, i.e. no cost, safety or capacity analyses to support the conclusions.
- Pedestrian and bicycle considerations are an important consideration for context sensitive design. Even at the preliminary stage of intersection alternative evaluation, the context of cycling friendliness and low speed suggest sensitivity to the entry speed of the layouts.
- The report does not identify the desire lines of the pedestrians. A diagram of existing patterns is suggested to support the decisions being made on location of crossings. The school related traffic and associated patterns will determine location and size of cross walks.
  Due to the proximity of the school and hospital, it is desirable to have crosswalks on all four legs. If possible, the crosswalks should be incorporated in the splitter islands to allow for a pedestrian refuge between crossing the exiting traffic from the roundabout and the traffic entering the roundabout.

Traffic Analysis

Alternative 2 roundabout layout is smaller than Alternative 1. In terms of capacity, the larger roundabout is expected to have a slightly higher capacity but this does not appear to be necessary. Thus, analyzing Alternative 2 for capacity represents a conservative approach between the two alternatives. Assessment of differences in shape and size of a roundabout is only possible using the U.K. research into geometry-capacity relationships[1]. Intersection traffic operations were analyzed using RODEL 1.9.7 roundabout design and capacity analysis software. RODEL uses the U.K. research and it has been applied to many U.S. roundabouts since 1991. The 50th percentile confidence level (CL) for the RODEL analysis was used to represent the most probable capacity of the roundabout, and to be consistent with HCM and other capacity analysis tools which use a mean capacity estimate. Similarly, to be consistent with signalized and unsignalized capacity methods, average delay rather than maximum delay estimates are used.

[1] Kimber, R.M. *The traffic capacity of roundabouts.* TRRL Laboratory Report LR 942. Crowthorne, England: Transport and Road Research Laboratory, 1980.

TABLE 1: Capacity Analysis Summary

Capacity Analysis Summary - 2014 Volumes

	Alternative 1 - aaSIDRA 120ft ICD Roundabout				Alternative 2 - aaSIDRA 100ft ICD Roundabout				Alternative 3 Realigned Stop Control				Alternative 2 - Rodel 100ft ICD Roundabout			
	V/C*	Delay **	LOS***	95th Queue(1)	V/C	Delay	LOS	95th Queue(1)	V/C	Delay	LOS	95th Queue(2)	V/C****	Delay ****	LOS****	95th Queue(1)****
Weekday Morning																
Prospect Street	0.58	6.1	A	161	0.61	7.2	A	178	0.84	32.88	D	245	0.41 - 0.51	5.7 - 8.5	A	50 - 75
Sparks Avenue	0.56	6.3	A	129	0.54	6.7	A	143	0.86	36.24	E	263	0.38 - 0.46	5.0 - 7.1	A	50 - 75
Surfside Road	0.42	3.5	A	66	0.74	9.5	A	282	0.64	20.45	C	122	0.51 - 0.62	6.6 - 10.7	A - B	75 - 125
Atlantic Avenue	0.26	4.5	A	51	0.28	4.9	A	55	0.45	15.95	C	75	0.17 - 0.21	4.2 - 5.5	A	25
Overall	**0.58**	**5.1**	**A**		**0.74**	**7.6**	**A**			**29.16**	**D**			**5.6 - 8.6**	**A**	
Weekday Evening																
Prospect Street	0.74	13.9	B	271	0.78	16.5	B	303	1.00	77.57	F	506	0.48 - 0.61	7.2 - 12.6	A - B	75 - 125
Sparks Avenue	0.57	6.9	A	135	0.55	7.3	A	147	1.00	77.56	F	490	0.39 - 0.48	5.1 - 7.2	A	50 - 75
Surfside Road	0.39	3.5	A	64	0.70	8.7	A	250	0.66	27.60	D	145	0.47 - 0.58	6.1 - 9.5	A	75 - 100
Atlantic Avenue	0.47	5.8	A	101	0.47	6.6	A	112	0.73	31.79	D	177	0.29 - 0.36	5.0 - 7.0	A	25 - 50
Overall	**0.75**	**7.5**	**A**		**0.79**	**10.1**	**B**			**59.57**	**F**			**5.9 - 9.3**	**A**	
Saturday Midday																
Prospect Street	0.65	8.7	A	203	0.69	10.3	B	226	0.89	39.65	E	292	0.44 - 0.55	6.3 - 9.8	A	50 - 75
Sparks Avenue	0.55	6.2	A	123	0.53	6.5	A	136	0.90	43.33	E	308	0.38 - 0.47	5.0 - 7.0	A	50
Surfside Road	0.52	3.6	A	83	0.76	9.4	A	312	0.60	20.21	C	112	0.54 - 0.65	6.9 - 11.2	A - B	75 - 100
Atlantic Avenue	0.32	4.6	A	64	0.34	5	A	69	0.52	18.08	C	92	0.21 - 0.26	4.5 - 6.1	A	25
Overall	**0.67**	**5.7**	**A**		**0.76**	**8.4**	**A**			**33.99**	**D**			**6.0 - 9.1**	**A**	

* V/C - Volume-to-capacity ratio.
** Average Intersection delay, expressed in seconds per vehicle.
*** LOS - Level-of-Service
**** The RODEL capacity values shown are a range from the 50th% CL (mean capacity estimate) to the 85th% CL (verification of the capacity sensitivity of the leg).
(1) 95th queue expressed in feet
(2) Calculated using methodology outlined in Tian and Kyte, *Transportation Research Record: Journal of Transportation Board, No. 1988*, Transportation Research Board of National Academics, Washington D.C. 2006

In order to account for either ineffective geometry or poor driver performance, a pessimistic assessment of roundabout capacity was explored using a RODEL value of CL = 85. The RODEL capacity is documented beside the VHB analysis results as shown in Table 1. The ranges of values for the RODEL analysis represent the average (CL = 50) and lower capacity expectations (CL = 85).

In the VHB report the roundabout analysis was completed with aaSIDRA design software. To compare the aaSIDRA and the RODEL analysis, the table in the original report was replicated with an addition of a RODEL analysis of Alternative 2. The results of aaSIDRA and RODEL are similar except queue lengths for the aaSIDRA analysis are higher in magnitude. The RODEL analysis predicts approximately half the queue length of the aaSIDRA output. The RODEL analysis confirms that a single lane roundabout will have acceptable operations for the design year and will have an additional residual capacity of 44%. With a 3% growth rate the roundabout could be congested (LOS D/E) at approximately the year 2027. Since the Alternative 1 roundabout is larger than Alternative 2 the expectation of capacity for Alternative 1 is likely to show more favorable operation during peak periods.

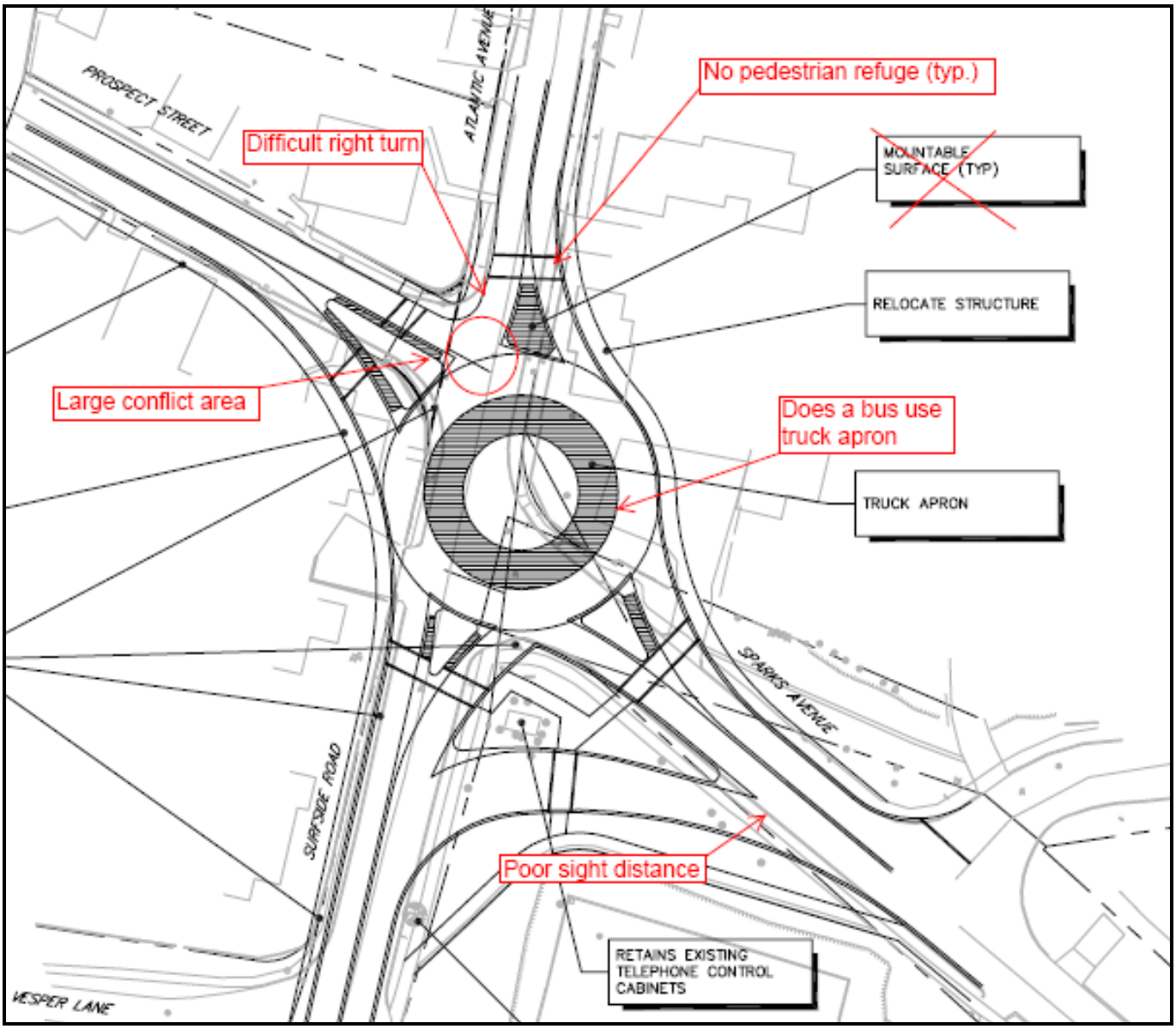
Critique VHB's Designs Alternatives

- Alternative 1 provides slightly improved pedestrian accommodations and space for larger trucks. Depending on the number of large trucks expected, Alternative 1 is preferred.
- The vehicle paths for entering the roundabout are similar but Alternative 1 has more circulating space for EB left turn movements to conflict with SB movements in the circulating roadway. Some SB right turners may not yield for this reason. Therefore a larger circle should have better definition of entry paths. This can be achieved using the splitter island curve and entry widths to develop straighter-in entry paths.
- Consider maintaining a raised median on Atlantic Avenue. The occasional right turning truck can go around the roundabout to go WB on Prospect Street by turning 270 degrees. Alternatively, consider relaxing the SB right turn path using a wider exit with a narrower splitter island.

The remaining concerns identified are common to both Alternative 1 and Alternative 2, namely:

- The Surfside bypass lane has potential conflicts with traffic yielding to EB traffic on Sparks Avenue. The yielding drivers have poor sight of the traffic that has to merge with them. Consider using a similar design to the right turn bypass lane from Alternative 3, this will improve the sight distance of the EB traffic.
- With Alternative 1 there is a possible conflict with "inside truck apron" on SB Atlantic Avenue and pedestrians. Truck blisters, as we call them, are a sign of a weak layout and should be avoided because pedestrians may consider this a pedestrian refuge and mistakenly assume that they are out of the way of traffic. Truck drivers have run over pedestrians with this type of design.
- Can a bus maneuver in the roundabout without using the central island? We typically avoid having a bus use the truck apron to avoid passenger discomfort. There may be the need to increase circulating width to accommodate buses.
- It does not appear possible for a WB-50 truck to make the right turn from SB Atlantic to WB Prospect Street. The occasional right turning truck could go around the roundabout to go WB on Prospect Street turning through 270 degrees.

Figure 1: Alternative #2 Deficiencies



Pedestrian Concerns

With the proximity of the school and hospital, pedestrian conflicts will need to be kept to a minimum. A roundabout does reduce the number of vehicular and pedestrian conflicts from 16 to 8, (see Figure 2 and Figure 3). At any roundabout it is desirable to have a refuge in the splitter island. This allows for a two staged crossing for pedestrians, pedestrians will only have to look for traffic in one direction. An advantage or disadvantage to a roundabout is that it requires the pedestrians to verify their own gaps instead of having protected phasing. It has been argued that this is a benefit because it keeps pedestrians vigilant. Although traffic regulations require drivers to yield to pedestrian traffic in the crosswalks, a roundabout can be very difficult for younger pedestrians and pedestrians with a visual impairment. In this case, due to the children walking to the nearby school, a crossing guard may be required.

Signal Pedestrian Conflicts

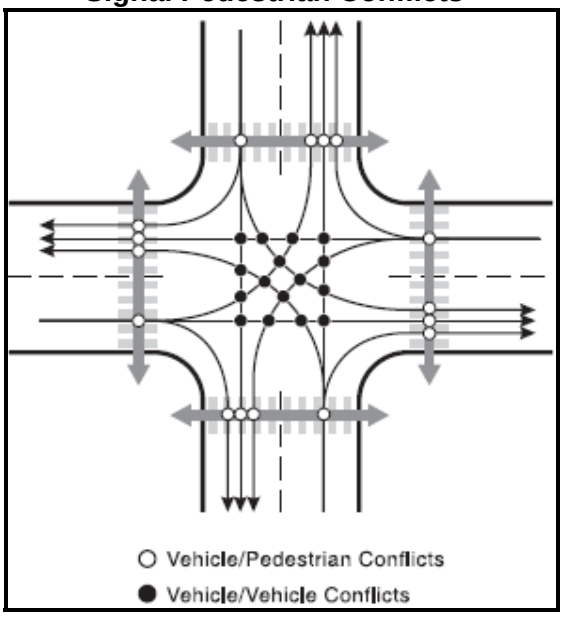


Figure 2

Roundabout Pedestrian Conflicts

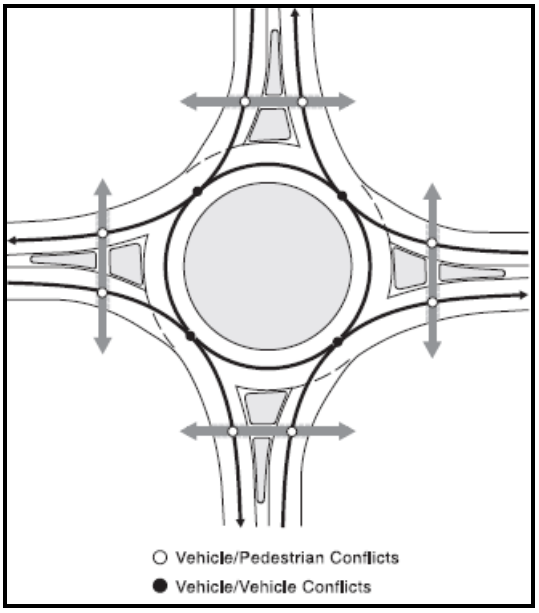


Figure 3

Additional Design Alternatives

Two separate roundabout options for the intersection were sketched. The first option uses the same foot print as the original report's Alternative 3 except with a roundabout in lieu of a stop controlled intersection in order to take advantage of the benefits of realigning the west leg. The second option uses a pair of mini roundabouts at the four corners intersection and places a roundabout at the Surfside Road and Vesper Lane intersection opposite the high school driveway.

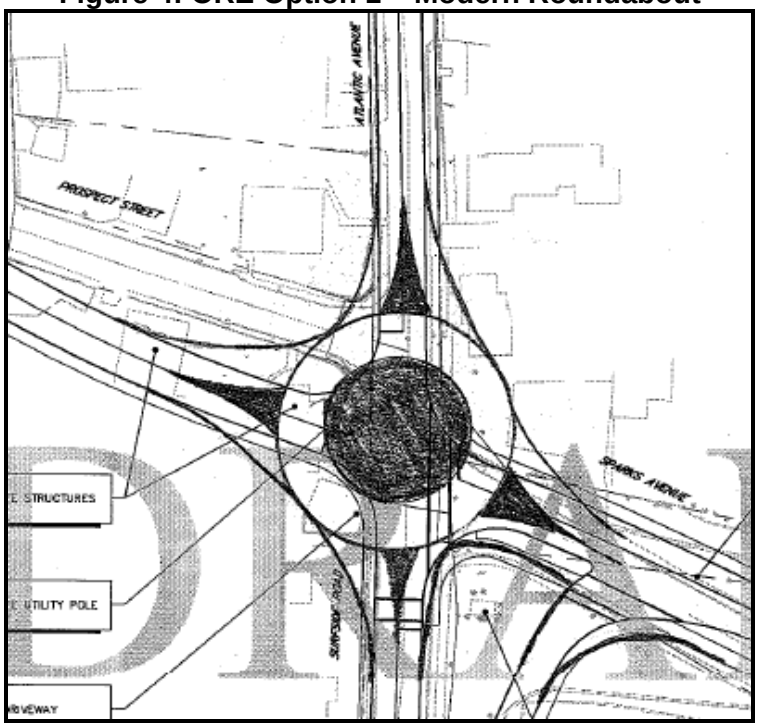
<u>ORE Option 1</u>

This option uses a roundabout in the VHB's Alternative 3 foot print, see Figure 4. The Alternative 3 design realigns the Prospect Street leg to the south and by squaring the alignment the following benefits are achievable:

- Balancing of entry paths of all four legs of the roundabout;
- Allows for better deflection on the Atlantic Avenue entry; and,
- Improves the right turning radius for SB to WB right turns.
- Decreases the conflict area at the Atlantic Avenue entrance.

This alternative will have a higher right-of-way cost, possible house relocations, but it is an improvement on Alternative 1 and Alternative 2 horizontal geometrics.

Figure 4: ORE Option 1 – Modern Roundabout



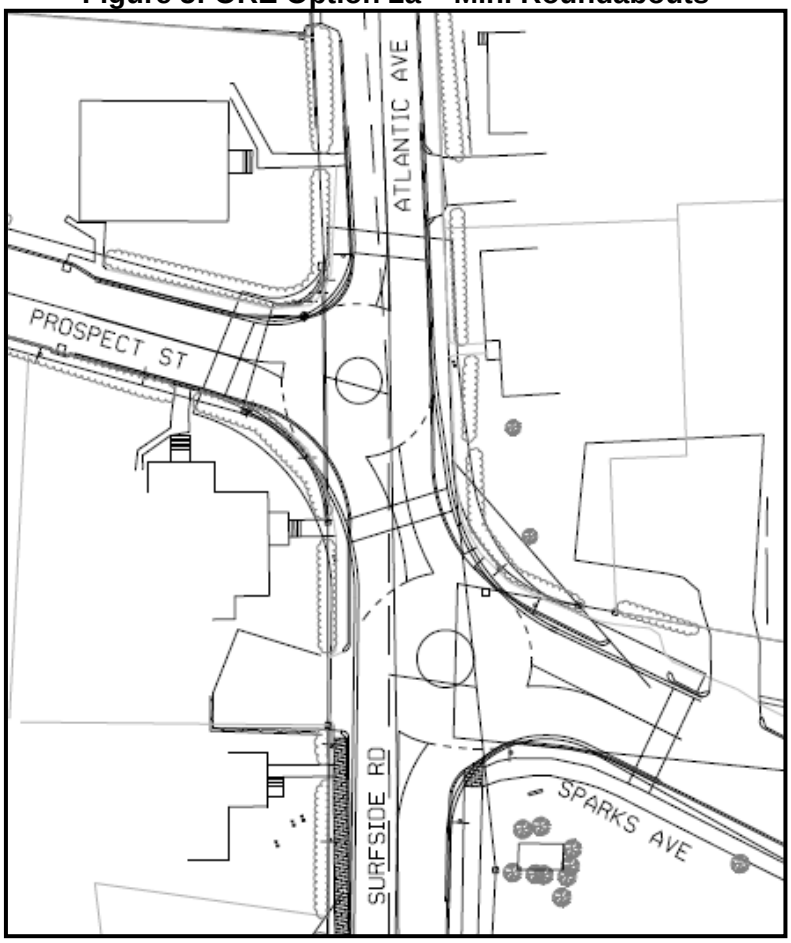
ORE Option 3a & 3b

This option utilizes a pair of roundabouts at the Four Corner's intersection, see figure 5. The mini roundabouts will utilize the existing intersection with minor curb adjustments which minimizes right-of-way impacts and home acquisitions. The savings in construction and right of way cost could contribute to the construction of a modern roundabout at the Surfside Road and Vesper Lane intersection opposite the high school driveway. Although we are not aware of the safety and capacity performance of this intersection, knowing the access requirements and mix of pedestrian and vehicular traffic near schools, this alternative provides multiple benefits.

Mini roundabouts are roundabouts that are used in tight urban settings with approach speeds that are equal to or less than 30 mph and are completely traversable. They have been implemented in Europe, at numerous intersections, with much success. It is a relatively new intersection control device in the United States. Due to the low speed corridor, speed reduction is not required, but the central island should still deflect the entering driver, similar to modern roundabouts. To allow for the

occasional trucks the central and splitter island are traversable. In advance of the roundabout a traversable eliminated bollard is placed to alert drivers of the upcoming mini roundabout.

Figure 5: ORE Option 2a – Mini Roundabouts



Due to the cost savings of the mini roundabout option 2b has been proposed. The combined roundabout option will improve the safety of the mini roundabouts and pedestrians in the area by providing a traffic calming effect on the Surfside NB traffic. The roundabout will reduce speeds and provide pedestrian refuges for pedestrian crosswalks closer to the school. It will also improve the access to and from Vesper Lane and the school parking lot. The mini roundabouts with or without the Surfside Road and Vesper Lane roundabout are both viable options that will need further investigation to confirm the anticipated benefits based on the above mentioned criteria.

CONCLUSIONS AND RECOMMENDATIONS

- The VHB's intersection evaluation report consists of mainly qualitative measures which are a compelling argument, but the conclusions should be supported with a more thorough quantitative comparison including costs and safety benefits.
- The do-nothing and 4-way realignment options would have negative life-cycle costs due to safety deficiencies and user delay compared to the roundabout alternatives.

- The RODEL capacity software confirms the aaSIDRA analysis and also predicts approximately half the queue length of the analysis conducted in the VHB report.
- The NB Surfside's right turn bypass lane designed for the roundabout options has deficient sight distance which could impact safety. The sight distance can be improved by squaring the right turn bypass lane with the EB exiting traffic.
- It is desirable to maintain raised splitter islands at roundabout approaches to maximize pedestrian safety. Pedestrian desire lines need to be identified at the intersection.
- Two additional alternatives have also been sketched for further comparison. Both designs are functional but will require the quantitative and qualitative analysis defined above in order to arrive at a preferred alternative among the five alternatives identified.

Yours truly,

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