Richards Avenue/College Drive Intersection Roundabout Investigation

Final Report

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RICHARDS AVE./COLLEGE DR. ROUNDABOUT INTERSECTION INVESTIGATION

1.0 INTRODUCTION

1.1 Background

The Santa Fe Community College (SFCC), in cooperation with Santa Fe County (County), has requested an evaluation of the roundabout intersection of Richards Avenue at College Drive in Santa Fe, New Mexico. Through a series of meetings between the SFCC, County staff, and neighborhood representatives, questions concerning the adequacy and functionality of this intersection have been raised. It was therefore agreed that an evaluation of this intersection be conducted in order to assess its current adequacy as well as its future viability.

1.2 Scope of Evaluation

The purpose of this investigation is to conduct a technical evaluation of the adequacy of the Richards Avenue/College Drive roundabout intersection. This investigation encompasses a review of background information, field observation, conceptual traffic evaluation, and a summary of the findings. A detailed operational analysis is not included as part of this evaluation.

The location for the study within the County of Santa Fe is depicted in Figure 1. Figure 2 presents the site of the roundabout intersection under study.

Figure 1- Vicinity Map

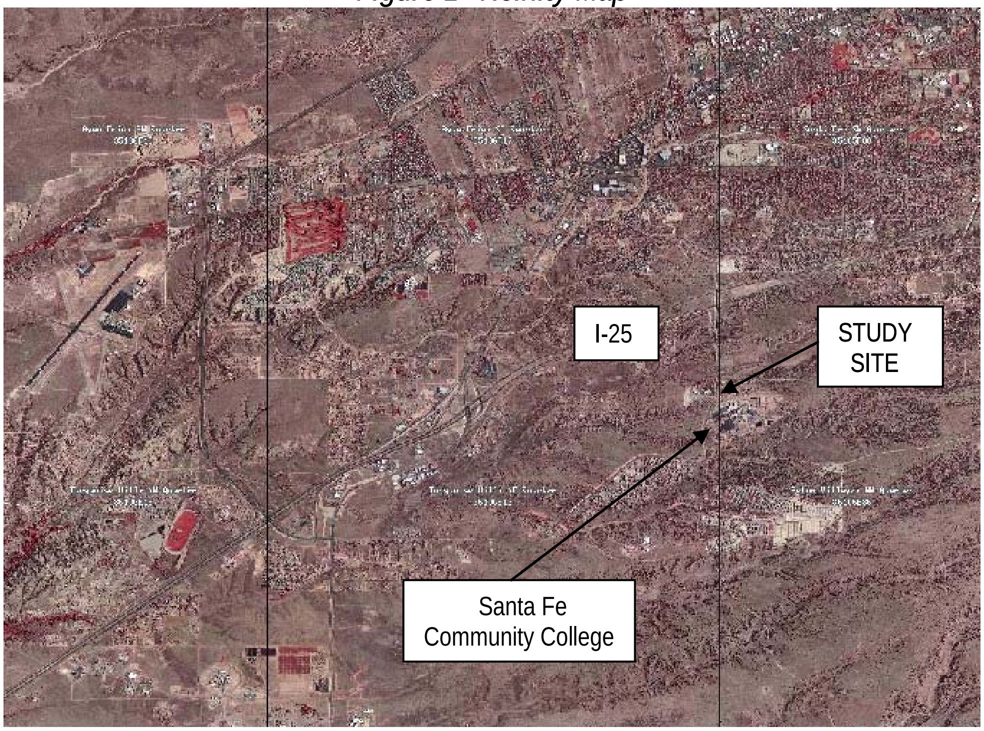


Figure 2 - Study Intersection

2.0 ROUNDABOUT INTERSECTION PROPERTIES

A definitive resource for the design and operation of modern roundabout intersections is the *Roundabouts: An Informational Guide (Federal Highway Administration, 2000)*. The following paragraphs provide a brief overview of modern roundabouts for the purpose of establishing the context for the intersection investigation. The reader is encouraged to consult the *Roundabout Guide* for more detailed information (available at http://www.tfhrc.gov/safety/00068.htm).

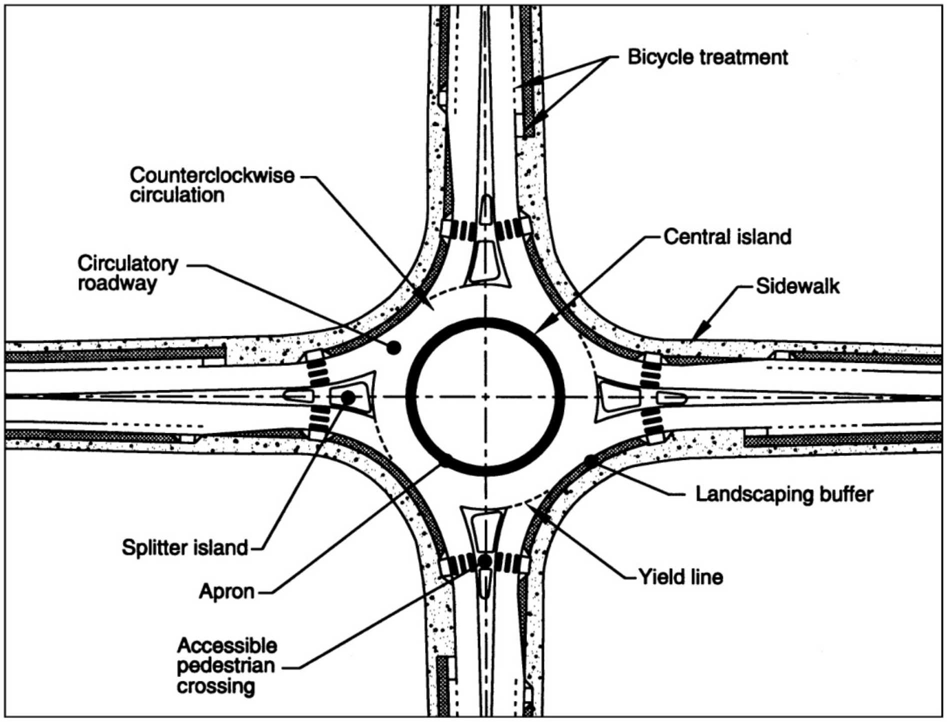
2.1 Characteristics and Categories of Roundabouts

A modern roundabout consists of an intersection having a one-way circulation around a central island where entering traffic must yield the right-of-way to the traffic circulating within the roundabout. Modern roundabouts provide an alternative intersection treatment to stop-controlled or signalized intersections and are intended to reduce overall traffic delay and improve safety. Costs vary between intersection types, however roundabouts do not require operational costs as would be required for signalized intersections. Common reasons given for installing roundabouts include operations, safety, community enhancement, traffic calming, and special circumstances such as unusual alignment or intersection geometry. Figure 3 provides a graphic representation of a modern roundabout.

Key elements of modern roundabouts include:

A. Yielding upon entry rather than within the intersection. This enhances safety by requiring that entering vehicles yield only to one direction of approaching traffic.
B. Curvature designed to create horizontal deflections thereby promoting reduced speeds.
C. Continuity of traffic flow to reduce delay.
D. Enhanced safety through a reduction in the number of conflict points.

Figure 3 - Modern Roundabout Features



Several categories of modern roundabouts have been defined as presented in Table 1 below. The Richards Avenue/College Drive roundabout will be evaluated based on these definitions.

Table 1- Modern Roundabout Categories

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

[1]Assumes 90-degree entries and no more than four legs.

Source: *Roundabout: An Informational Guide*

2.2 Roundabouts vs. Other Intersection Types

The following excerpt from the *Roundabout Guide* shows what modern roundabouts are not (emphasis added):

> A roundabout is a type of circular intersection, but not all circular intersections can be classified as roundabouts. In fact, there are at least three distinct types of circular intersections:
>
> • *Rotaries* are old-style circular intersections common to the United States prior to the 1960's. Rotaries are characterized by a large diameter, often in excess of 100 m (300 ft). This large diameter typically results in travel speeds within the circulatory roadway that exceed 50 km/h (30 mph). They typically provide little or no horizontal deflection of the paths of through traffic and may even operate according to the traditional "yield-to-the-right" rule, i.e., circulating traffic yields to entering traffic.
>
> • *Neighborhood traffic circles* are typically built at the intersections of local streets for reasons of traffic calming and/or aesthetics. The intersection approaches may be uncontrolled or stop-controlled. They do not typically include raised channelization to guide the approaching driver onto the circulatory roadway. At some traffic circles, left-turning movements are allowed to occur to the left of (clockwise around) the central island, potentially conflicting with other circulating traffic.
>
> • *Roundabouts* are circular intersections with specific design and traffic control features. These features include yield control of all entering traffic, channelized approaches, and appropriate geometric curvature to ensure that travel speeds on the circulatory roadway are typically less than 50 km/h (30 mph). Thus, roundabouts are a subset of a wide range of circular intersection forms.

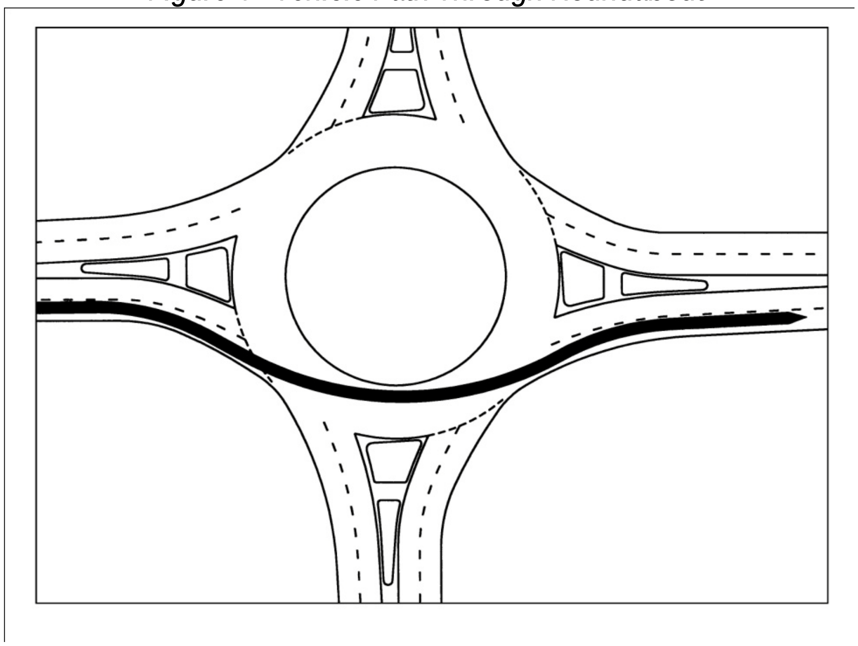
Roundabouts are often compared with other types of intersection control, including: Two-way stop control (TWSC), All-way stop control (AWSC), and Signalized control. Under certain conditions, roundabouts may exhibit superior operations when compared with the other types of intersection control in terms of reduced vehicle delays. However, these benefits may be offset by congestion during heavy peak periods or other traffic characteristics. Detailed operational analyses would be necessary to establish the advantage of any traffic control measure.

2.3 Roundabout Geometry

An important aspect of modern roundabouts is the inherent lateral (horizontal) deflection, which compels vehicles to negotiate an S-shaped path through a series of three short curves, and thereby resulting in reduced speeds through the intersection as depicted in Figure 4. A number of factors contribute to good geometric design that effectively controls speed, including the horizontal curvature and lateral deflections caused by the splitter and central islands. Raised islands are more effective than flush islands (i.e., those that consist of flat pavement and/or designated by pavement markings) as the raised islands compel drivers to negotiate the lateral deflections. In absence of raised islands, motorists may tend to "cut corners" by driving over the flush islands, thus reducing their lateral deflections and allowing for higher speeds.

On the other hand, raised central islands and inadequate turning radii may restrict the ability for larger vehicles to negotiate roundabouts. This situation could be addressed by the construction of a partially raised central island that allows large vehicles to traverse over the apron while simultaneously causing smaller vehicles minor discomfort if they attempt to traverse the apron. Other applicable geometric features affecting the design and performance of a roundabout include the approach alignment, lane widths, transitions, flares, offsets, and vertical profile. Design to accommodate multi-modal users, including pedestrians, bicyclists, and transit, must also be taken into account.

Figure 4 - Vehicle Path Through Roundabout



2.4 Traffic Operations

As stated in the *Traffic Engineering Handbook (Institute of Transportation Engineers, 1999)*, *"the capacity of a transportation facility reflects its ability to accommodate a moving stream of people or vehicles."* Level of Service (LOS) denotes a measure of the quality of traffic flow and is graded from A through F. Numerous factors affect capacity including traffic volumes and composition, roadway geometry, and types of traffic control. The industry standard procedures for capacity analysis computations is contained in the *Highway Capacity Manual (HCM)*.

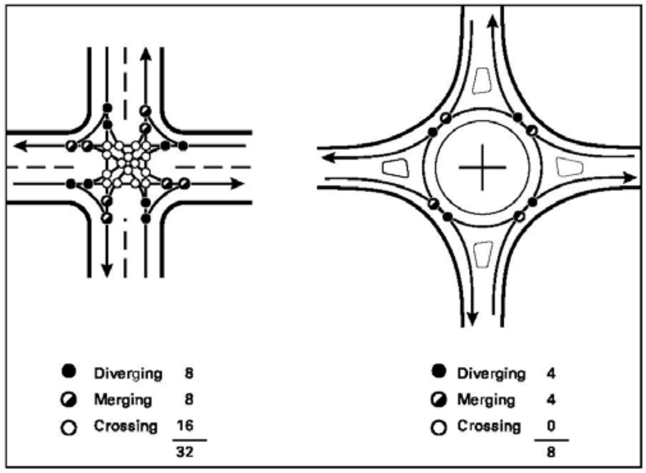
The capacity of street networks is typically limited at intersections. The LOS for intersections is measured in terms of delay, which is defined as "the additional travel time experienced by a driver, passenger or pedestrian due to circumstances that impede the desirable movement of traffic. It is measured as the time difference between actual travel time and free-flow travel time" (source: American Association of State Highway and Transportation Officials [AASHTO] Glossary). A higher calculated delay value for an intersection will result in a lower LOS. In such analyses, the LOS may be evaluated for current conditions as well as for forecast (future) conditions.

A review of traffic operations for the Richards Avenue/College Drive roundabout intersection is presented in Section 3.5 of this document.

2.5 Safety Considerations

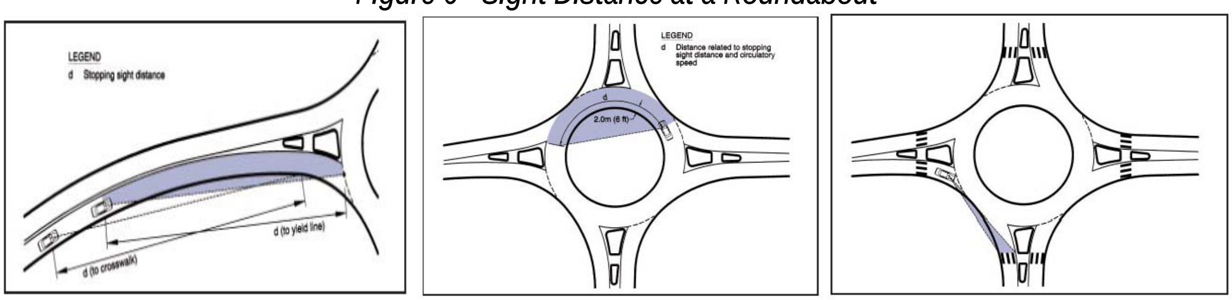
Properly designed modern roundabouts effectively reduce traffic speeds, thereby reducing the potential severity of crashes. Furthermore, single-lane roundabouts reduce the number of conflict points, as depicted in Figure 5, thereby reducing the potential amount of crashes.

Figure 5 - Conflict Point Comparison



Sight distance is another important consideration in the design and operation of modern roundabouts. In particular, stopping sight distance is the minimum distance required for a motorist to perceive a potential hazardous situation, react, brake, and come to a stop before impact. Vertical and horizontal geometry play important roles in ensuring adequate sight distance is available. In addition, objects that obstruct line of sight should be avoided. Figure 6 presents the critical sight distance criteria for approaches, circular roadway, and corners of a roundabout. Section 3.3.3 of this document further addresses this issue with respect to the Richards Avenue/College Drive roundabout intersection.

Figure 6 - Sight Distance at a Roundabout



2.6 Space Requirements

The "footprint" of a roundabout intersection junction typically requires more area, and therefore right-of-way, than stop- or signal-controlled intersections. This situation could be exacerbated by larger roundabout designs required to accommodate large vehicles or for multi-lane roundabouts. However, this may be partially offset by reduced turning lane area requirements for other intersection types. Therefore, proposed improvements should account for the potential right-of-way impacts in addition to cost considerations.

3.0 EXISTING CONDITIONS

3.1 Site Description

The study intersection is located south of the City of Santa Fe within the suburban County environs in what is designated as the Community College Planning District. The area is characterized by a mixture of scattered residential developments of moderate intensity, commercial and institutional land uses.

Immediately adjacent to the study intersection lies a residential subdivision in the northeast quadrant; the SFCC campus in the southeast quadrant; vacant land planned for mixed-use development in the southwest quadrant; and a church and school in the northwest quadrant.

3.2 Roadways

The study intersection is situated south of Interstate 25 along Richards Avenue, a two-lane undivided roadway with a six foot shoulder, no curbing, and a posted speed of 35 miles per hour (mph). Along the north intersection approach, a right turn lane existed prior to the roundabout construction. This lane was eliminated through pavement markings, although it receives partial use as an auxiliary lane to the adjacent Catholic Church driveway located in the northwest quadrant. College Drive is a two-lane residential roadway measuring approximately 20 feet in width with no curbing, no shoulders, and a posted speed of 25 mph. All four approaches to the intersection are posted at 15 mph at the intersection proper.

Richards Avenue is designated as a Principal Arterial - Rural according to the *Draft Santa Fe Metropolitan Transportation Plan (August, 2010)*. The *Future Regional Roadway Network Map* contained in the *Metropolitan Plan* depicts Richards Avenue as a Study Road for Improvement. College Drive is not currently designated on the transportation plan, but a future eastward extension is shown on the *Future Regional Roadway Network Map*. It is presumed that future improvements to either corridor would comply with County design standards.

3.3 Intersection Geometry

3.3.1 General

A request was made through the County for record plan information (as-builts) of the study intersection, although no record information was located. However, plan information for the adjacent Richards Avenue/Oshara Boulevard roundabout intersection, situated approximately one-half mile north of the study intersection, was available. Because the two roundabouts appear, upon visual inspection, to be approximately identical in most regards (with the exception of the number of approaches), the Oshara Boulevard roundabout was used for the review of geometric properties. Certain geometric components were field-measured for verification.

While the basic properties are similar between the two roundabouts, listed below important distinctions are noted in Table 2 below:

Table 2- Roundabout Property Comparison

Property	College Dr.	Oshara Blvd.
Inscribed Circle	115'	110'
Circular Roadway	20'	20'
Apron Width	6'	10'
Raised Splitter Islands	Y	Y
Raised Apron	N	Y

The inscribed circle for both roundabouts fall into the range of an Urban Single-Lane Roundabout capable of servicing up to 20,000 vehicles per day (refer to Table 1). Both roundabouts provide good horizontal deflection through the swept S-curve path, entry widths, approach alignments, offsets, flared and tapered splitter islands, delineation, and pedestrian crossings. In summary, the design of the Richards Avenue/College Drive roundabout followed appropriate guidelines.

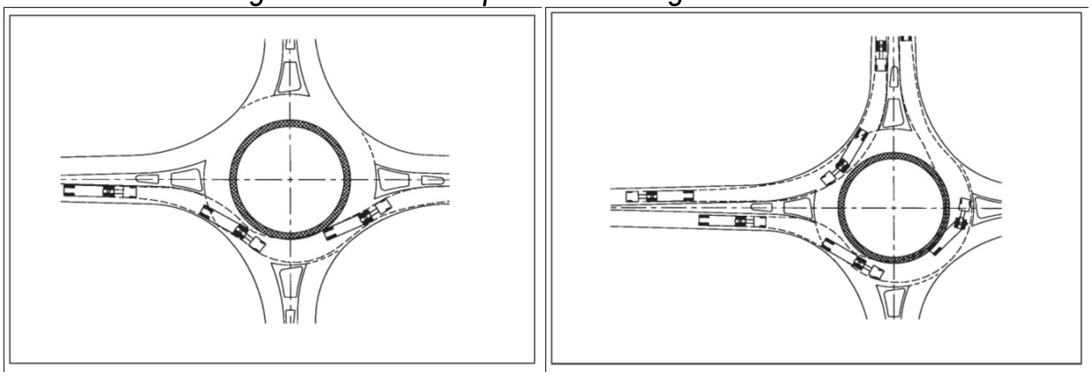
The Oshara roundabout has a raised apron utilizing a mountable roll curb and concrete apron, with a raised header curb delineating the interior edge of the central island. The Richards Avenue/College Drive roundabout has a concrete apron that measures six feet in width and is flush with the asphalt pavement. There is no landscaping within the central island. Figure 7 presents the study intersection roundabout.

Figure 7- College Drive Roundabout

3.3.2 Vehicle Swept Paths

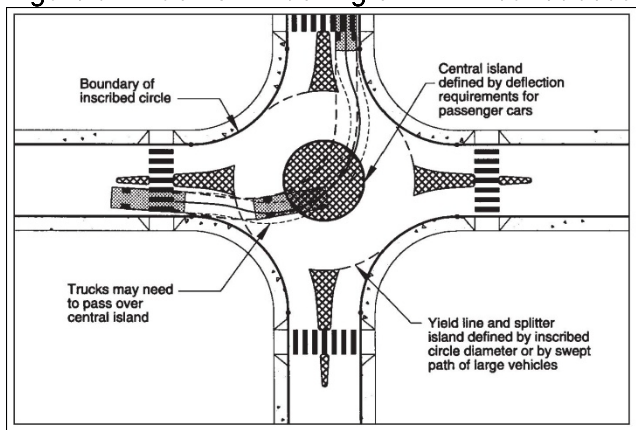
The swept path of a vehicle describes the turning path of the front and rear tires of a vehicle as it traverses through turns. Off-tracking is the additional width of vehicle overhang, i.e., from the bumper or trailer. Adequate offset distance should be provided to accommodate these maneuvers for the appropriate design vehicle. These items are illustrated in Figure 8 below.

Figure 8 - Truck Swept Paths Through Roundabout



For an arterial roadway, a full range of vehicles would be expected to use the facility including passenger vehicles, buses, and trucks. While the proportion of trucks along Richards Avenue would be expected to be low due to its proximity to adjacent development, the roundabout should be able to accommodated a low volume of truck traffic. For smaller roundabouts, trucks would be expected to traverse over the central island as depicted in **Figure 9** below.

Figure 9 - Truck Off-Tracking on Mini-Roundabout



To verify that the study intersection could accommodate trucks, the *Autoturn* program was employed to model the swept paths of a single-unit truck (SUT) and multi-trailer truck (MTT). **Figure 10** presents the results for a SUT, which indicate that it can negotiate turns adequately within the driving lanes. It should be noted that, while the exhibit depicts an encroachment of the curb, more width is available to negotiate a wider turn and thus no encroachments should be expected. Furthermore, SUT's and City Transit buses were observed traversing the roundabout with no encroachments of the apron.

Figure 11 depicts a MTT negotiating a through movement and **Figure 12** presents a MTT left turn. Both exhibits indicate that trucks would be expected to encroach over the apron by as much as 8 to 10 feet. Tire tracks were observed on the apron, and the yellow safety paint has been worn off in the north-south direction. This attests that traffic has been driving over the apron consistently, a fact that was observed on site. Given that the apron is flush, a proportion of traffic, namely passenger vehicles, regularly traverse over the apron. This effectively reduces the lateral deflections and smoothens the S-curve, thereby enabling motorists to travel faster than the design conditions intended. This condition fosters a differential in speeds as some vehicles apparently exceed the safe operating speed and may encroach on others. If the apron was raised and perhaps textured, this would induce a feeling of discomfort that would encourage avoidance of the apron and thus discourage excessive speeds through the roundabout.

Small tire marks were observed on the curbed islands at a few locations. No damage curb was observed, indicating excessive off-tracking is not apparent.

3.3.3 Sight Distance

The study intersection occurs at the crest of a vertical curve. Based on observation, there appears to be ample approach sight distance. No objects within the central island obstruct line of sight through the roundabout along the circulating roadway. The crest condition facilitates drainage and no drainage deficiencies were observed. The crosswalks are visible from the approaches; however, a small hill in the northeast quadrant may partially obscure the north crosswalk and should be evaluated in further detail.

Figure 10 - SUT Left Turn Swept Path

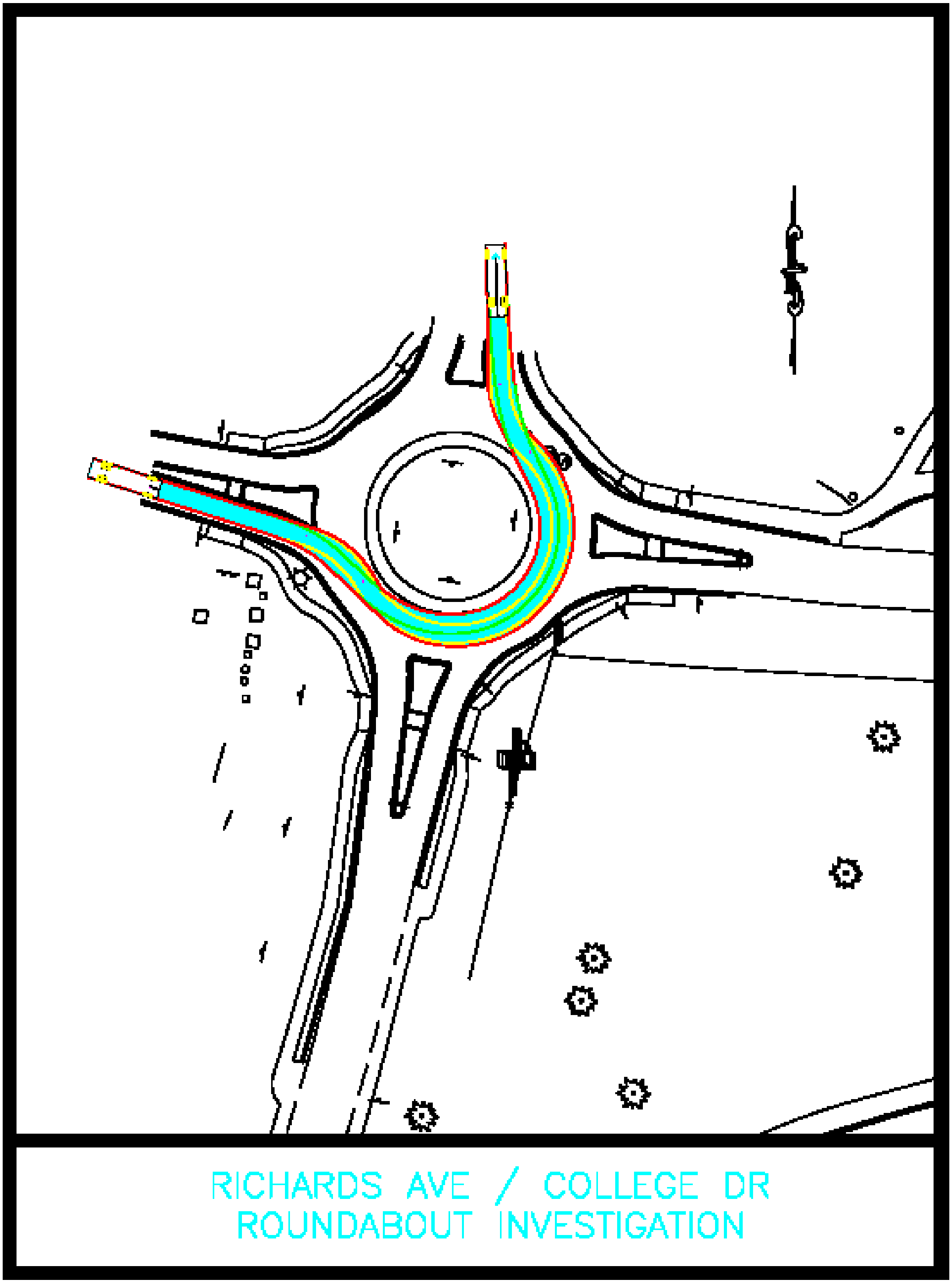


Figure 11 - MTT Through Movement Swept Path

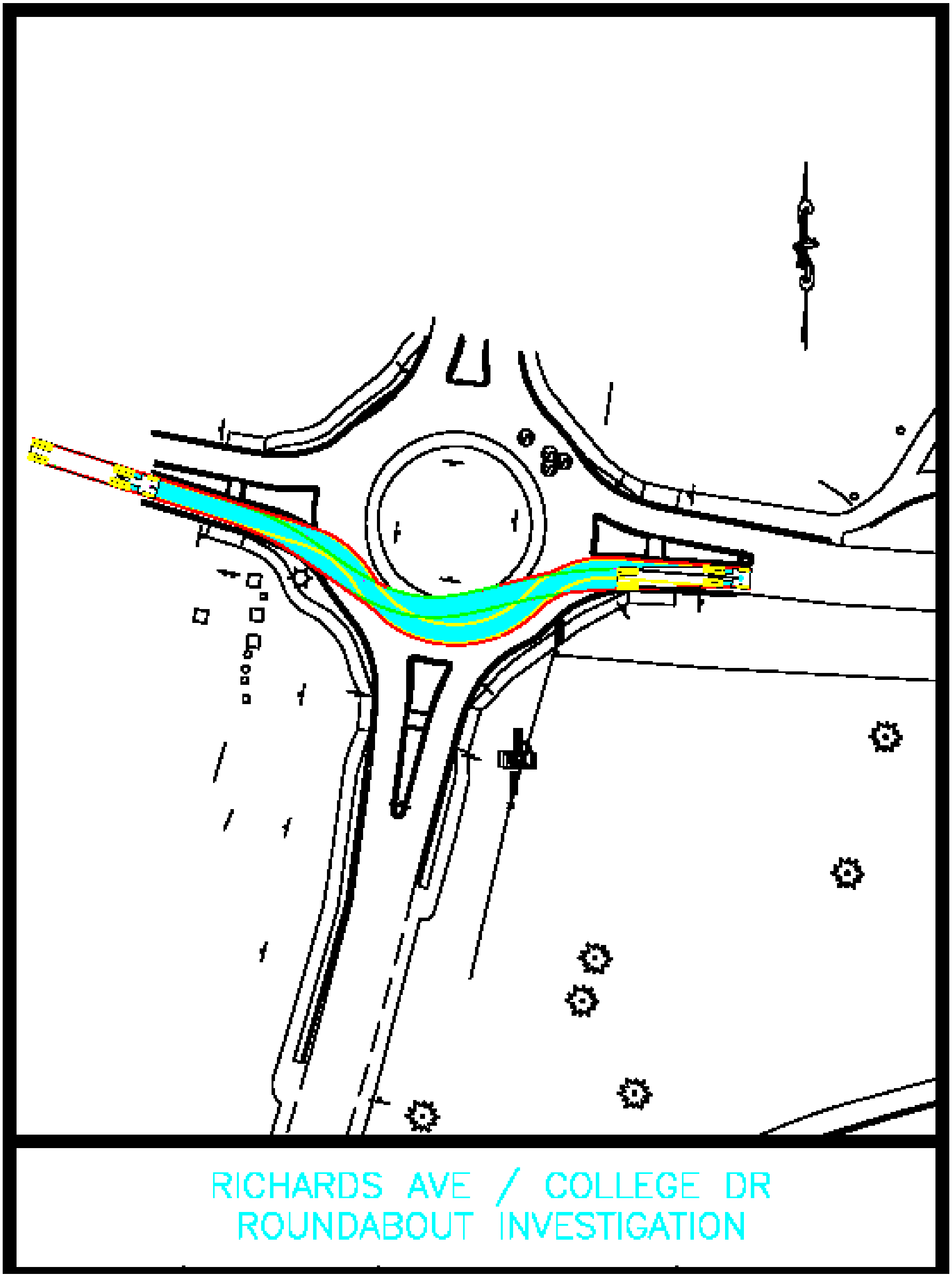
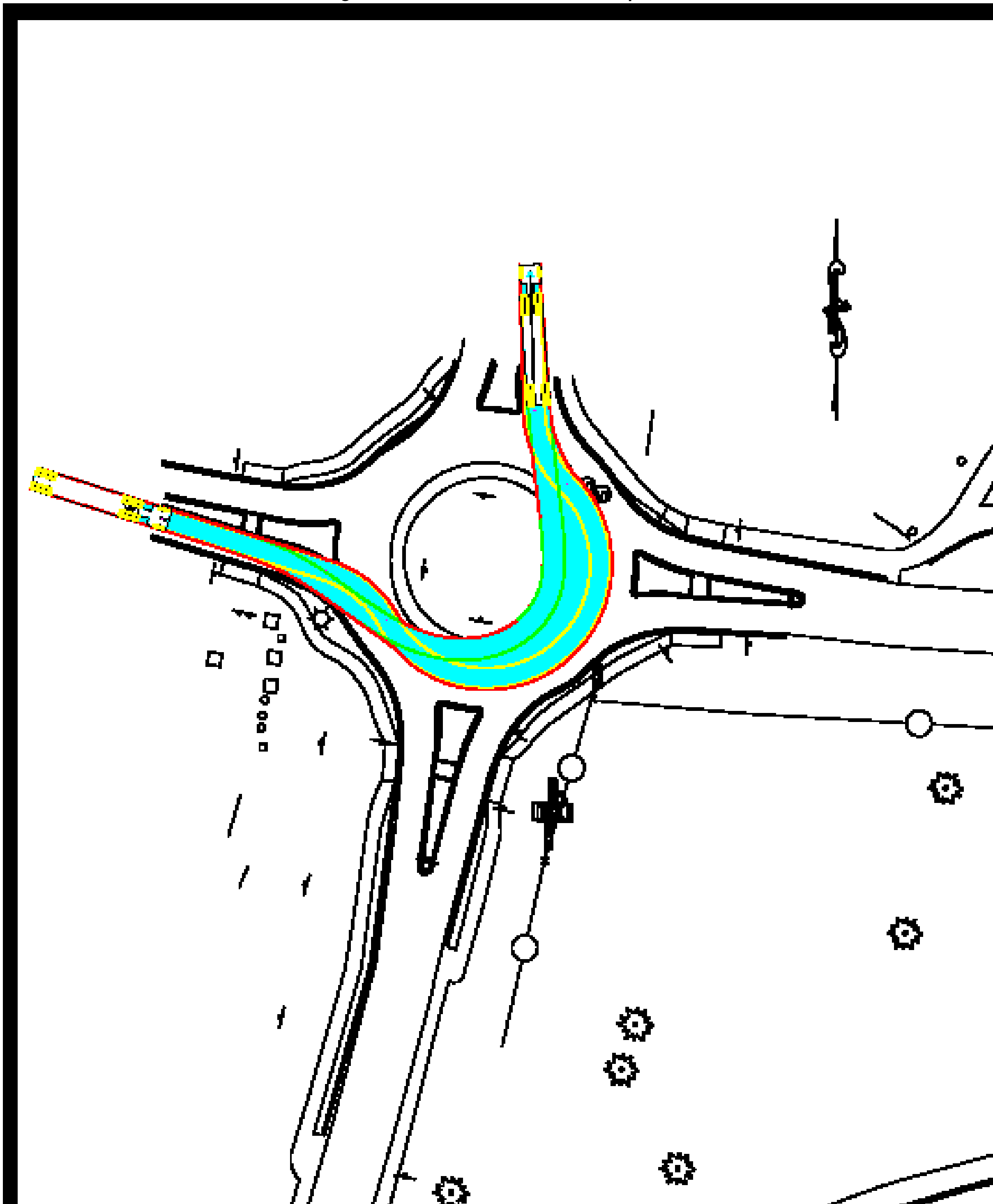


Figure 12 - MTT Left Turn Swept Path



RICHARDS AVE / COLLEGE AVE
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Should the central island be raised and landscaped, care should be taken to ensure line of sight is maintained across the roundabout.

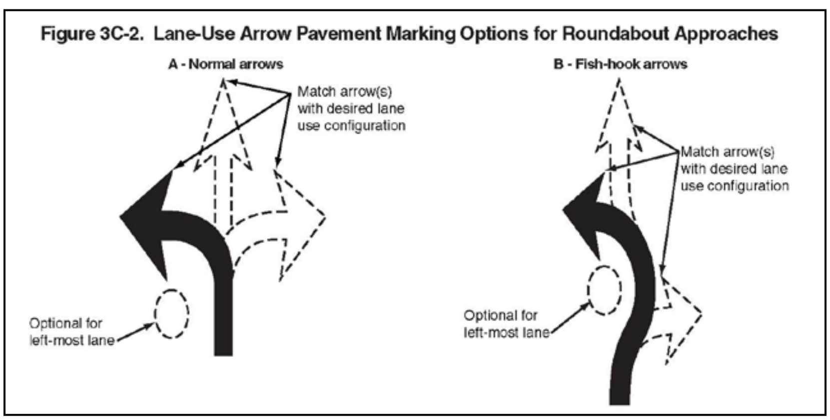
3.4 Traffic Control

Pavement markings observed at the study intersection included:

- yellow center line at splitter islands
- white dotted edge line extension stripes at approach lanes
- "shark-tooth" yield lines
- crosswalks
- yellow painted island radii
- "through" directional arrows on approach lanes

The pavement markings comply with current standards per the MUTCD. White edge striping is not needed as raised curb is introduced at the intersection, providing adequate delineation. Some markings show signs of wear and should be repainted in accordance with the County's maintenance cycle. Using all plastic markings would improve durability, albeit at greater initial expense. The use of new directional arrows might also be considered for clarity to unfamiliar drivers (see Figure 13).

Figure 13 - Lane Use Arrow Options



Source: *MUTCD*

Traffic signs observed at the study intersection included:

- Yield, placed at the yield line
- One way and roundabout directional arrow at central island
- Pedestrian Symbol signs with supplemental plaque at crosswalks
- Keep Right signs at splitter islands
- Circular Intersection symbol sign, in advance of the intersection
- Yield Ahead warning sign with supplemental regulatory speed sign posted at 15 mph, in advance of the intersection
- Bicycle Symbol sign with share the road plaque
- Right Lane Must Turn Right on the southbound approach, adjacent to the church
- Bus stop signing adjacent to the church

Intersection signing is well-placed and generally compliant with the MUTCD. No knocked-down signs were observed, which could potentially indicate out-of-control vehicles due to excessive speeding or other factors (a knocked-down sign was observed at the Oshara roundabout). The roundabout directional arrow is a warning sign (black on yellow background) rather than regulatory sign (black on white background). Street name signs are not clearly visible and consideration might be given to providing special directional signing or adding street name signs to all approaches at the junction. If sign clutter is of concern, eliminating the yield ahead sign might be considered as appropriate.

3.5 Traffic Operations

Site observations were made in July 2010. Traffic was observed in the AM, Mid-day, and PM peak periods to flow smoothly through the study intersection with only minor queues of two to three vehicles forming for short periods. It should be noted, however, that public schools were not in session and thus traffic volumes would be lower than expected during the school year.

Although the scope of this investigation did not encompass a detailed traffic operations analysis, analogous information is available for review. This includes the daily traffic data and peak period analyses.

3.5.1 Daily Volumes

Documentation contained in the *Institutional Master Plan* showed an average daily traffic (ADT) volume of 9700 for year 2005. Compounding this value at an annual growth rate of 5% per year would yield a daily traffic volume of approximately 12,400 for year 2010. This value falls well below the 20,000 vpd threshold for the roundabout (see Table 1), and would constitute about 62% of capacity; thus sufficient reserve capacity exists. However, this daily capacity value does not account for peak operating conditions. The daily capacity is also affected by higher proportions of left-turning traffic and other factors.

3.5.2 Peak Conditions.

A *Traffic Impact & Mitigation Analysis* was conducted in December 2008 to complement the recommendations of the *Institutional Master Plan* with regard to a relocated main entrance along Richards Avenue. A Planning Level analysis was computed for the intersection utilizing HCM methodologies which indicated adequate levels of service (LOS) of "C" during the AM and PM peak periods. The analysis also computed forecast conditions to year 2014, which indicated that the intersection operations may fall below acceptable levels to LOS F during the peak periods. It should be noted that the analysis assumed continued development growth including SFCC expansion as well as other adjacent developments. It should be further noted that a more detailed analysis would be required to definitively assess operations utilizing commercially-available software, as current HCM methodology is limited. Furthermore, the intersection should be monitored to validate the growth assumptions and to verify any capacity concerns.

3.5.3 Other Considerations

Under present operating conditions, there is a traffic imbalance as the predominant traffic flows are in the north-south direction with low east-west volumes. Introducing new cross-street traffic could initially be a cause for concern as drivers who are currently accustomed to low side friction may not anticipate more cross-street demand. This concern would be expected to diminish over time. With regard to roundabout capacity, it decreases as cross-street traffic decreases; thus roundabouts tend to work better with higher proportions of cross-street traffic.

A review of crash data was not conducted as part of this investigation due, in part, to limited data availability as the main data repository was being redeveloped at the time of printing. It would be appropriate to include such a review in a detailed traffic study or corridor analysis.

4.0 CONCLUSIONS

Several conclusions can be drawn with regard to the adequacy and functionality of the existing Richards Avenue/College Drive roundabout intersection.

1. The geometric design elements of the roundabout are sound and within current guidelines.

2. Proper traffic control measures are in place and no major deficiencies were observed.

3. Traffic operations at satisfactory levels of service under current conditions; however, the intersection may reach capacity limits in the near future if traffic growth persists.

4. Some traffic was observed to nominally yield and appeared traveling through the roundabout at higher speeds than the prevailing traffic stream. In addition, a proportion of the vehicles traverse over the central island, indicating a disregard of the central island for creating lateral deflections in order to reduce speeds.

5.0 RECOMMENDATIONS

Based on the principle study findings discussed above, the following improvements are recommended for consideration to maintain and enhance the Richards Avenue/College Drive roundabout.

1. Reconstruct the apron of the central island with a raised profile as follows:

   a. Mountable roll curb maintaining the original diameter of the central island.

   b. Concrete apron with patterned concrete (to help create tire vibrations and cause discomfort for passenger cars in order to discourage repeated travel over the apron).

   c. Enlarge the width of the apron to at least 10 feet to accommodate truck off-tracking.

   d. Install a header curb at the interior edge of the apron to prevent run-over traffic.

2. Review signing plan in consideration of:

   a. Adding directional signing and/or street name signs.
   b. Removal of redundant signs to reduce sign clutter.

3. Landscaping and aesthetic improvements would enhance the roundabout. Several considerations should be made when developing potential improvements, such as:

   a. Colored treatments of the patterned concrete apron and header curb would enhance the aesthetics.

b. Raised features within the central island, including plant materials and artwork, should be of a low profile and placed such that sufficient sight distance is maintained along the circulatory roadway.

c. Boulders or other large objects may prove useful in helping discourage travel over the apron as well as providing "target value" for the roundabout; however, sufficient setbacks should be provided in consideration of truck off-tracking. Also, it is desirable that views across the roundabout be available to help drivers evaluate acceptable gaps.

d. Perimeter landscaping should not obstruct views of the pedestrian crosswalks and paths. The northeast quadrant may require minor grading to ensure that the view of the north crosswalk from the east approach is not obstructed.

4. It is further recommended that a corridor study of Richards Avenue be conducted to evaluate long-term travel demand and determine any capacity improvements to the corridor and intersections. This would provide opportunity to preserve rights-of-way for potential corridor and intersection enhancements or expansion in the future.