THE CITY OF CALGARY

Roundabout Guidelines

The City of Calgary

2011/12/13

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1. INTRODUCTION

Internationally, roundabouts are not a new form of traffic control. They are in widespread use in the United Kingdom, Australia, and in many continental European nations. In the 1990's, numerous US state and local road authorities implemented modern roundabouts in various locations including urban and rural settings and at freeway entrances and exits.

In Canada, modern roundabouts have only begun to be constructed in the last 10 years but are becoming increasingly popular. As of 2011, the City of Calgary has over 40 roundabouts in use. With increasing interest in roundabout construction within both the development industry and the transportation industry in Calgary, The City aims to provide formal guidance on roundabout design, evaluation, and implementation.

2. BACKGROUND – WHAT IS A MODERN ROUNDABOUT?

The modern roundabout is a traffic control device. It is a form of circular intersection where traffic flows counterclockwise around a raised central island, thereby preventing vehicles from passing through the intersection on a linear path. Roundabouts offer the opportunity to improve intersection safety and potentially reduce maintenance costs while increasing intersection capacity and reducing delay.

2.1. Modern Roundabouts vs. Rotary Traffic Circles

There is often confusion regarding the difference between modern roundabouts and the more traditional rotary traffic circles. The following are some of the major differences between modern roundabouts and rotary circles:

Table 1: Modern Roundabout versus Rotary

	Modern Roundabout	Rotary
Right of way assignment	Yield at entry	Circulating vehicles yield to entering vehicles
Entry control	Primarily yield control	Stop signs or signals may be used
Design speed	Lower speeds due to smaller diameter and deflected entrances	Higher travel speed due to larger diameters and tangential entrances
Right of way requirements	Smaller diameter allows roundabouts to be retrofitted into smaller right of way	Larger diameter results in large right of way requirements
Parking	Parking not allowed in circulating roadway	Parking may be permitted in circulating roadway

Pedestrian facilities	Pedestrians cross the legs of the roundabout and are prohibited from crossing the circulating roadways/center island	Pedestrians may be permitted to cross the circulating roadway and center island
Splitter islands	Raised triangular splitter islands physically prevent vehicles from traveling the roundabout in a clockwise direction	Splitter islands may or may not be present, and, some smaller traffic circles allow left turning vehicles to pass to the left side of the central island

(Florida Department of Transport, 1996, chap. 1, pp. 3-4; Quebec Ministère des Transports, 2005, chap. 1, p. 3)

Because of these differences, rotaries are not favoured nowadays as a form of traffic control.

2.2. The Benefits of Modern Roundabouts

The benefits attributed to roundabout use can be summarized into the following categories:

Safety

Modern roundabouts are acknowledged to be one of the safest forms of intersection control. The number of collisions and collision severity are generally reduced due to three main roundabout features:

1) Conflict Points

   The number of conflict points between vehicles decreases from 32 conflict points at a standard intersection with four approaches to 8 conflict points at a roundabout. By reducing the number of conflict points, the probability of collisions decreases.

2) Entering and Circulating Speed

   Vehicles entering a roundabout do so at a much lower speed than at many other intersections, generally in the 35-40 km/h range. Lower speeds mean shorter braking distances and longer timeframes for decision making. If an entering vehicle does commit an error (such as failing to yield), the lower speed differential between the entering vehicle and the circulating vehicle results in lower collision severity.

3) Deflection Angle

   Roundabouts provide a deflection for entering vehicles, thereby decreasing the angle of impact during collisions and reducing speeds at entry points. Head-on and right angle collisions are significantly reduced or eliminated entirely due to the circular travel.

Capacity

Roundabouts can generally provide more capacity than a similarly sized 4-Way Stop Controlled (4WSC) or smaller signalized intersection. By slowing vehicles rather than stopping them entirely, roundabouts provide a higher operational capacity when

compared to stop or signal controlled intersections. For intersections with a large number of left turning vehicles, roundabouts could perform better than 4WSC or signal-controlled intersections depending on other volumes.

Delay

Through yielding at the entry to a roundabout rather than coming to a complete stop, total intersection delay is reduced. During low volume times, roundabouts offer less delay than signals, especially for side street movements.

Environment

The reduction in delay generated by roundabouts corresponds to a decrease in fuel consumption and tailpipe emissions. The reduction in idling and acceleration from a complete stop has a particularly positive effect on the reduction of critical air pollutants such as particulate matter (PM) and carbon monoxide (CO).

Costs

Under greenfield scenarios, roundabout capital costs are similar to signalized intersection costs. When comparing roundabouts to signalized intersections under retrofit situations, roundabouts often have higher capital costs due to significant replacement of curb, gutter and asphalt. However, the anticipated maintenance costs for a roundabout could be lower. The absence or limited use of overhead structures, electrical power, and the need for operational maintenance on signals all equate to lower operational costs for roundabouts. As such, the lifecycle costs incurred by the City may be much lower. Over time, a roundabout could be a more cost effective form of traffic control than a traffic signal.

The City of Calgary's Triple Bottom Line (TBL) policy encourages Council and City staff to "consider and address social, economic, environmental and smart growth impacts in all City business". With the City's TBL policy in mind, it is important to acknowledge that intersections impose a number of societal, environmental and economic costs on Calgarians. Societal costs include traffic delays and the cost of collisions (fatalities, injuries and property damage).

- Environmental costs: include wasted fuel from idling and increased emissions.
- Economic costs: include ongoing maintenance and operating costs (eg. Electrical power).
- Societal and environmental costs: roundabouts have a proven history of reducing vehicle collisions and if designed properly, can reduce vehicle delays, save fuel and lower vehicle emissions.

When societal, environmental and economic costs are considered along with the typical capital costs, roundabouts compare very favorably with other forms of intersection control.

Right of Way

At an intersection, a roundabout may need slightly more right of way to construct than a conventional intersection. However, across a corridor, less right of way may be needed

overall. This could allow more land to be used for development purposes. A conceptual example of City of Calgary Roundabout Right-of-Way Requirements is referred to Appendix A. However, FHWA guidelines for right of way and basic geometry should be used for design purposes.

3. APPROPRIATE USE OF ROUNDABOUTS

While the benefits of modern roundabouts are numerous, it is important to realize that roundabouts may not be a perfect solution where full intersection control is likely in the future. While warrant procedures and requirements are used to determine when stop and signal controls are justified, there is no similar warranting procedure for roundabouts. As such, engineering judgment and traffic analysis shall be the basis into the decision making process when roundabouts are being considered, not simply policy. Careful study is required to identify the most appropriate control method at any given location. However, experience with modern roundabouts suggests that some traffic situations are more suitable for roundabout construction whereas other situations are not.

Generally speaking, roundabouts are suitable at intersections having:

- High number of head-on, right angle, and left turn across path collisions
- High collision severity due to excessive speed
- Heavy delay on the minor street
- Traffic signals that would result in greater delay.
- High left turning volumes, especially those with single lane approaches.
- ”T” and “Y” shapes where there are high left turn volumes.
- Limited storage capacities for signalized intersections
- Changing traffic patterns
- Unusual geometry
- Desirable U-turns
- Freeway interchange ramps
- Community gateways
- A benefit for slower speed and/or lower traffic volume.

(Region of Waterloo, 2003, p.5; Florida Department of Transport, 1996, chap.1, pp. 1-6)

By contrast, roundabouts are generally unsuitable at intersections:

- Where satisfactory geometric design cannot be provided. These could include right-of-way limitations, utility conflicts, drainage issues, etc.
- Where there are insufficient gaps in the major flow to allow vehicles from the minor flow into the roundabout, creating unacceptable delays for the minor flow
- Where queuing would frequently back up traffic into the roundabout or adjacent traffic control, such as nearby signals, freeway entrance ramps, etc.
- Along a coordinated signalized corridor, where signalization would provide a better level of service

- Where traffic control devices or services require preemption, such as railroad tracks, LRT tracks, police & fire stations, etc.
- With approach grades of 4% or more. Steep grades pose sight distance concerns, lead to collision issues in icy weather and may pose issues during construction
- Along roadways with peak period reversible lanes
- Along routes where large combination vehicles or over-dimensional vehicles will frequently use the intersection and insufficient space is available
- With heavy pedestrian movements that would have trouble crossing the street because of high traffic volumes. This includes special need pedestrian areas (areas with a large number of children, elderly people, people with disabilities, etc.)
- With a large number of cyclists
- Where there are residential streets approaches with front-drive garages

(Region of Waterloo, 2003, p.5)

4. TRIGGERS FOR INTERSECTION CONTROL EVALUATION

This section lays out when an intersection control evaluation should be triggered. Currently, there are no roundabout warrant procedures in the Manual for Uniform Traffic Control Devices for Canada (MUTCD for Canada). Users of this guideline should NOT consider this a warrant procedure. Warrants are difficult to establish based on the wide range of situations in which a roundabout may be a successful form of traffic control. Rather, this document's aim is to provide a framework within which roundabouts and alternative forms of traffic control can be fairly compared.

The following is an outline of the categories for when a roundabout should be considered or examined on arterial and collector streets:

4.1. Planning for a Greenfield Intersection

Whenever a new intersection is planned that warrants or may warrant a traffic signal or all-way stop, a roundabout should be considered as preferred option of traffic control unless justified as unsuitable. Roundabouts are easier to construct in greenfield areas rather than retrofitting an existing intersection. Having a roundabout evaluation as part of the planning and development approval process will ensure that appropriate right of way is protected and construction staging is considered.

4.2. Warranted Traffic Control Upgrade in Developed Areas

As traffic patterns change, intersection controls may need to be upgraded. City of Calgary warrant procedures may indicate that an all-way stop or signalized intersection is warranted. Once these traffic control upgrades are being considered, a roundabout should be examined. In these cases, it should be demonstrated that a roundabout is not an appropriate alternate form of intersection control (eg. Cost of retrofit).

4.3. Capacity Deficiency

When an intersection begins to operate at an unacceptable level of service, construction of turn bays or road widening may be considered. Roundabout operations should be reviewed and compared with the existing and any other proposed intersection configurations.

Some signalized intersections may also benefit from roundabout installation near the intersection to allow u-turn movements, alleviating issues associated with left turns at the signal. When installing roundabouts near signalized intersections, care must be taken to ensure that there is sufficient spacing from the intersection so vehicles do not queue back to the adjacent intersection, and that the u-turning movement does not negatively impact other movements at the roundabout intersection.

4.4. Capital Improvements

Any capital improvement project, including interchange construction and road widening, should examine using roundabouts in the intersection designs. Although a roundabout is usually not capable of replacing an interchange, it should be considered as the control method for ramp terminals. A single or a pair of roundabouts can often be used instead of signals at diamond interchanges, minimizing stop delays and eliminating signal coordination efforts.

4.5. Safety Issue

When a safety issue is identified at or near an intersection, a roundabout should be examined as a tool to minimize the number and severity of potential collisions. Locations where roundabouts may be beneficial are intersections with a history of right angle and head-on collisions, poor sight distance at two-way stops, severe collisions where speed was a contributing factor, and inadequate separation of turning movements from through movements.

4.6. Traffic Calming

At locations where traffic calming is required, a roundabout may be used to assist in reducing vehicle speeds. Installations in this category must be consistent with the City's Traffic Calming Policy. Additionally, a roundabout with a tear-drop configuration may be used to prohibit some turn movements at an intersection. A demonstrated need for this type of intersection control must be made.

4.7. Special Conditions

Some locations may have issues which would be difficult to resolve through other means of traffic control. Intersections that fall into this category will need to be considered on an individual basis. These situations may include but are not limited to:

- Unusual geometrics
- More than four intersection approaches
- Limited right of way
- Desire to formalize u-turn movements

5. INTERSECTION CONTROL EVALUATIONS PROCEDURE

Once an intersection control evaluation is initiated, several steps should be completed to document the adequacy of the roundabout or, to document why a roundabout is not appropriate. A preliminary evaluation should occur and if a roundabout is favoured, a detailed evaluation should follow. The following is an example of the steps in a detailed evaluation that would allow intersections to be evaluated consistently. Ongoing evaluation and refinement of the steps for an intersection control evaluation should occur by administration to ensure relevant and consistent application.

1) Identify Trigger for Intersection Control Evaluation

   The purpose for the intersection control evaluation should be documented to identify what concerns are being solved through this process. The triggers for the intersection evaluation should fall under at least one of:
   - New Intersection Planning
   - Warranted Traffic Control Upgrade
   - Capacity Issue
   - Capital Improvement
   - Safety Issue
   - Traffic Calming
   - Special Conditions

2) Summarize Data

   Known background data on the intersection being evaluated needs to be documented. Emphasis on data should be the stimulus for the intersection control evaluation.

3) Review Operations

   The intersection should be evaluated to ensure adequate operations of the roundabout and the alternate form of intersection control. The operational review should document how the roundabout will address the issues that triggered the intersection control study.

4) Estimate Costs

5) Provide Recommendations

The recommendation for roundabout installation and what will be required to successfully implement the roundabout should be summarized. If a roundabout is not the recommended form of intersection control, the rationale why it has not been recommended should be documented.

6. ROUNDABOUT DESIGN

6.1. Design Guidelines

At the time of this report, the Transportation Association of Canada (TAC) has not adopted a formal roundabout design guideline. In the interim, for new installations, the City of Calgary will follow the approaches outlined in Roundabouts: An Informational Guide, Second Edition (NCHRP Report 627, Dec 2010). Once the Transportation Association of Canada publishes a roundabout design guide, the City of Calgary will evaluate and consider TAC guidelines for adoption.

6.2. Right of Way Requirements

Within the City of Calgary report "Roundabout Right-of-Way Requirements" (Nov, 2007) (see Appendix A), typical conceptual roundabout templates have been overlaid with standard City of Calgary roadway cross-sections. The conceptual right of way requirements have been identified based on the classifications of the intersecting roadways. Although this report is not a design guide, it provides an example on the requirements for adequate right-of-way during the planning process. FHWA guidelines for right of way and basic geometry should be used for design purposes.

6.3. Initial Limitations on Roundabout Designs

While the City of Calgary has a number of roundabouts in use citywide, its use as a form of intersection control is still relatively new to most Calgarians. To provide Calgarians with an opportunity familiarize themselves with roundabouts, designs should be limited to no more than two circulating lanes. By doing so, Calgarians will be given further opportunities to judge acceptable gaps when entering a roundabout and understand appropriate lane choice as they approach the intersection.

6.4. Staging of Roundabouts to Accommodate Future Growth

In some situations, the intersection performance analysis may reveal that a single lane roundabout is sufficient for current traffic volumes. However, volume forecasts may indicate that a multi-lane roundabout would be more appropriate in the future. In these cases, the construction of the roundabout should be built to full requirements with other measures used to restrict or control traffic movements in the interim. When considering staging a

roundabout, the designer should evaluate the right-of-way and geometric needs for both the single and multi-lane configurations at the outset.

6.5. Bypass Lanes

Bypass lanes, which are also referred to as slip lanes, are occasionally used to improve capacity for high volumes of right turning vehicles at a roundabout. The bypass lanes increase the number of potential conflict points with pedestrians and cyclists, and they increase overall crossing distance for pedestrians. As such, implementation of bypass and slip lanes should be evaluated on a case by case basis.

6.6. Approach Grades

Approach grades are an important consideration when designing roundabouts. Steep grades (>4%) create operational and sight distance issues and may require roundabouts to be re-examined. Steep grades also pose particular concerns with Calgary's climate as snow and icy conditions could negatively impact stopping distance and safety.

6.7. Landscaping

The landscaping within and adjacent to a roundabout has a direct impact on the safety and operations of the intersection. Good landscaping design provides adequate stopping sight distance without encouraging excessive speeds on the approaches. This is accomplished by providing only the required sight distance and not more. Ultimately, a roundabout is a traffic control device and must meet the standards for safe and effective operation regardless of the desired landscaping intentions. Without exception, the minimum circulating sight distances and pedestrian sight distances should be met at all City of Calgary roundabouts. A Landscaping Guideline report for roundabouts has been developed and is included for information Appendix B. Current practice is to landscape the central island with grass and/or low maintenance/drought-tolerate plants. Any enhancements to this must be maintained by someone other than the City of Calgary (ex. Homeowners' Association through an Optional Amenities Agreement). Landscaping features in a roundabout central island should not be a destination for pedestrians; pedestrians should not be encouraged to cross the circulating roadway. Landscaping features must also not interfere with the access to utilities or ability to perform maintenance on utilities that may pass through the roundabout. For details on utilities layout through a roundabout, contact Water Resources.

6.8. Signage and Pavement Marking

The City of Calgary will follow the Transportation Association of Canada recommendations on signage and pavement marking until a formal roundabout signage and pavement guideline has been adopted.

7. SPECIAL USER CONSIDERATIONS

This section discusses a number of implementation issues that designers, engineers and developers should be aware of to ensure that roundabouts address the needs of all roundabout users, not just vehicles.

7.1. Pedestrians

Pedestrians, particularly children, the elderly, and persons with disabilities, represent the most vulnerable users at an intersection. At a roundabout, pedestrians cross one approach leg at a time on the outside perimeter of the roundabout. Splitter islands on each approach leg provide a space for pedestrians to pause and allow them to consider only one direction of traffic at a time, which simplifies the task of crossing the street. Pedestrian crossings are setback one or two vehicle lengths from the yield line to shorten the crossing distance, to separate vehicle-vehicle conflicts from vehicle-pedestrian conflicts, and to allow drivers at least one vehicle length back to devote their full attention to crossing pedestrians while waiting for the driver ahead to enter the circulating roadway.

Roundabouts can be less convenient for pedestrians than signalized intersections because the placement of the pedestrian crossings creates a longer overall path to traverse a roundabout. However, at signals, pedestrians may experience lengthy delays as they wait for the walk phase. Signalized intersections also offer positive guidance to pedestrians by providing visual pedestrian signal indications informing pedestrians when they can and cannot cross. In this respect, the decision process for pedestrians requires less judgment at a signalized intersection than at a roundabout. However, pedestrians are still vulnerable at signalized intersections because of permissive left-turns, right-turns on red, higher speeds and drivers violating the traffic signals.

Roundabouts are generally safer for pedestrians than other forms of traffic control because:

- Vehicle speeds are generally lower
- Fewer vehicle-pedestrian conflict points
- Refuge provided by splitter islands makes the crossing distances shorter
- Splitter islands allow pedestrians to cross one direction of traffic at a time
- Pedestrians cross directly in front of drivers, making driver yield decisions simple

When designing roundabouts, it is important that pedestrian accessibility issues be accommodated (e.g. treatments to help persons with vision loss use the crossings or splitter island pedestrian refuges designed in accordance with CSA Standards Article 6.6.2.2.2.).

7.2. Cyclists

As with motor vehicles, there are fewer points of conflict with bicycles at roundabouts than at signalized intersections. Speed differential is also an important consideration in cyclist collision severity. A properly designed roundabout should reduce motor vehicle speeds which creates a much lower speed differential between bikes and vehicles than would be

prevalent at a signalized intersection. This lower differential allows users more time to make adjustments to avoid conflicts, and when collisions do occur, the severities are usually lower.

Based on international experience with roundabouts, the City of Calgary aims to follow these general guidelines when considering cyclists needs at roundabouts:

- Separate cycling lanes within the circulatory roadway are to be avoided
- Bicycles will be allowed to mix with vehicle traffic without any separate facility within or outside of the circulatory roadway when traffic volumes are low at single-lane roundabouts

Special consideration for the installation of multi-lane roundabouts should be undertaken where cycle volumes are high. If an installation of a roundabout is recommended, separate cycling facilities outside of the circulatory roadway (bike ramps and pathways) should be provided when vehicle and cycling volumes are high.

7.3. Transit

Where roundabouts are considered for implementation along bus routes, the bus zone locations at intersections must be incorporated into the roundabout design. The bus zones must be located in accordance with Calgary Transit's design requirements and to minimize walking distances, particularly where bus zones are located on all four corners of an intersection to facilitate transfers. All bus zone design criteria must be accommodated within the streetscape. Where a roundabout is being considering in a greenfield location, bus zone spacing should be incorporated along with the speed of the road, number of lanes and projected traffic volume. Where a roundabout is being considered at retrofit and a bus zone is to be relocated, adjacent residents must be contacted so there is no objection to the relocated bus zone in front of their property. Also, it may not be possible to construct a roundabout and address bus zone requirements without compromising design standards in retrofit locations. In such cases, an alternative traffic control measures should be considered. A Calgary Transit bus should be used as the design vehicle for single lane roundabouts on Collector streets with the added design criteria that the bus should not be required to mount the truck apron while maneuvering through the roundabout (FHWA).

7.4. Trucks

Although the proposed roundabout designs should be capable of safely accommodating large vehicles, careful consideration should be given to locations where truck volumes are high, such as marked truck routes and industrial areas. In these types of areas, a roundabout may not be the preferred option for traffic control. On single lane roundabouts, trucks may have to slow substantially to safely mount the truck apron, thereby decreasing the intersection's effective capacity. On multi-lane roundabouts, large trucks may stray slightly into the adjacent lane when negotiating the roundabout. This may cause conflicts if two large vehicles are attempting to circulate simultaneously. Multilane roundabouts must be designed to accommodate large trucks as well as a service/delivery vehicle (SU-9) concurrent with a passenger vehicle (dependant on adjacent land uses).

7.5. Emergency Vehicles

Like any other vehicle, emergency vehicles will be required to reduce their speed upon entering and traversing a roundabout. This is likely to have an impact on emergency service response time. The Region of Waterloo has estimated the increase in response time on arterial roadways to be in the range of 5 to 8 seconds per roundabout (Region of Waterloo, 2003, p. 11]. However, Waterloo believes this may be offset in some circumstances, as traffic queues tend to be shorter at roundabouts than at signalized intersections, allowing for faster passage of emergency vehicles.

8. EDUCATION

Although the Alberta Basic License Driver's Handbook discusses how to maneuver and yield in roundabouts, further driver education may be required for motorists on how to maneuver and yield in roundabouts.

REFERENCES

Florida Department of Transportation. (1996). *Florida Roundabout Guide*. Tallahassee, FL.

Kansas Department of Transportation. (2003). *Kansas Roundabout Guide: A Supplement to FHWA's Roundabouts: An Informational Guide*.

Region of Waterloo. (2003). *Modern Roundabouts – A Review of their Applicability to Regional Road Intersections.*

Quebec Ministère des Transports. (2005). R*oundabouts: A Different Type of Management Approach*.

FHWA, FHWA-RD-00-67 (2000), *Roundabouts: An Informational Guide*.

Alberta Transportation , (2010), *Design Bulletin 68 – Roundabout Design Guidelines on Provincial Highways*

APPENDIX A: CITY OF CALGARY ROUNDABOUT RIGHT OF WAY REQUIREMENTS

City of Calgary

ROUNDABOUT RIGHT-OF-WAY REQUIREMENTS

FINAL REPORT

November 2007

CITY OF CALGARY

ROUNDABOUT PROPERTY REQUIREMENTS

FINAL REPORT

TSH Project No. 51-250008

CITY OF CALGARY
ROUNDABOUT RIGHT-OF-WAY REQUIREMENTS
FINAL REPORT

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CITY OF CALGARY
ROUNDABOUT RIGHT-OF-WAY REQUIREMENTS

1. INTRODUCTION

TSH was retained by the City of Calgary to develop standard roundabout concepts based on the City's typical street cross sections. Working with the City's staff, we have developed this document of standard roundabout right-of-way requirements. The primary purpose of this document is to identify the property requirements by ensuring that effective designs can be implemented if a roundabout is the selected traffic control device. Included in the document are the second set of concepts presented to the City which have evolved through the feedback provided by the various City departments. This document provides standard sizes which provide the basis for planning right-of-way (ROW) requirements. The concepts that were developed can be used as the starting point for designing the intersection. Detailed design of roundabouts is a thorough process and it is important to remember that **this document is not a design guide**. The concepts presented within illustrate the components that need to be considered and protected in the planning process.

2. PHILOSOPHY

It is worth restating that the design philosophy of this process has been guided by a consistency between safety and effective intersection operation. Specific components are unique to roundabouts but must be consistent with existing City of Calgary practices. Of primary importance was consistency with the City's *Design Guidelines for Subdivision Servicing*. All of the concepts match up to the standard cross sections within that document. Other reference documents include Calgary Transit's *Transit Friendly Design Guide*, the *Calgary Cycle Plan,* Transport Quebec's *Roundabouts – A Different Type of Management Approach*, and the US Federal Highway Administration's *Roundabouts: An Informational Guide*.

The project philosophy pays attention to pedestrian needs with three consistent components. First, each of the concepts separates pedestrians from the circulating roadway by including a minimum 1.0m boulevard between the sidewalk and the curb. This will provide a buffer and direct pedestrians to the designated crosswalks. Second, all approaches have pedestrian crosswalks with refuges in the median. Single-lane approaches have their crosswalk located approximately one car length behind the stop line and two-lane approaches have their crosswalks located two car lengths behind the stop line. Third, the lengths of pedestrian travel distances have been minimized by aligning the sidewalks close to the shortest path between any two points. This has been done in balance with minimizing ROW requirements.

Roundabouts in the City of Calgary must be designed to accommodate the specified design vehicle. For residential streets, the design vehicle is a fire truck. Collector streets are designed to accommodate a standard Calgary Transit bus. The concepts strictly adhere to the philosophy that Calgary Transit buses will not be expected to mount the truck apron during normal operations. Arterial streets are designed to accommodate a WB-15. Accommodation of these vehicles constrains and dictates the design of the roundabout, particularly a single-lane roundabout. The minimum turning radius and the sweep path of the design vehicle determines what the minimum size of the circle can be.

The concepts are based on intersections with four legs at 90^{o} to each other. Intersections that have skewed approaches or more than four legs will require larger center islands to accommodate all movements. Each concept assumes relatively level terrain (<2% slope). Legs of the roundabout with grades greater than ±4% will impact the design of the approaches but not the size of the center island. Finally, traffic volumes are assumed to be appropriate to the classification of the street. It is recognized that single-lane roundabouts may be built at intersections where the volumes do not require a multi-lane roundabout. Single lane designs will always fit within multi-lane designs at the same intersection.

3. OVERALL CHANGES

Based on comments by City staff, there were changes to the original set of concepts that impacted all of the requirements. Each of these changes were incorporated as appropriate. Two changes in particular had a direct impact on the required ROW at the intersections. The first change is that all streets with a designation of Primary Collector and higher must provide sufficient ROW for the inclusion of bike ramps and pathways adjacent to the intersection. This resulted in the widening of 1.4m sidewalks to 2.0m pathways around the corners. Additional detail on the bike facility design is discussed in Section 11. The second major change is that utility line assignments require 3.0m of boulevard throughout the intersection. The combination of these two requirements, in combination with the 1.0 m pedestrian buffer on each corner, dictate the geometry at most of the intersections.

4. RESIDENTIAL SINGLE-LANE ROUNDABOUT

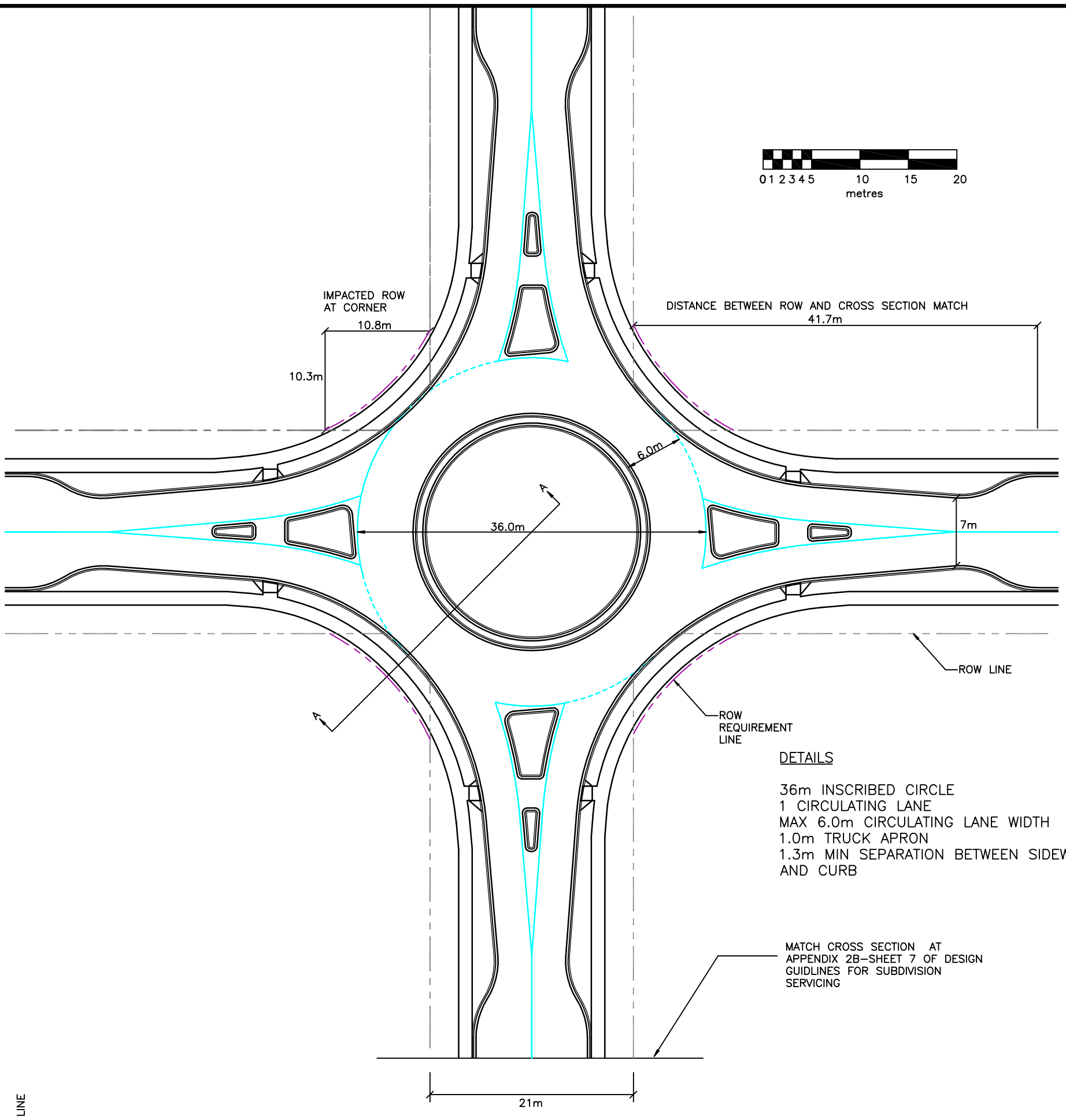
The technical committee agreed that the environmental volumes on residential streets will rarely result in a roundabout being necessary solely for operational or capacity reasons. As such, a minimum single-lane roundabout has not been developed. When small single-lane roundabout are selected for residential streets, they will require specific designs for those sites and will likely be similar to existing City of Calgary traffic calming circles. A residential roundabout will include splitter islands, Yield signs and will be designed for low speeds. **Photo 1**, at left, is from the Transports Quebec document *Roundabouts: A Different Type of Management Approach* which adapted the photo from the Australian Roads Authority design document *Part 6 – Austroads 1998*. It shows a small roundabout with minimal splitter islands and a landscaped center island in a residential setting. Note that this design has pedestrian refuges on the splitter islands but they are located at the stop bar rather than one car length behind the stop bar, as in typical single-lane roundabout designs. There is also no signage or landscaping of the splitter islands because they are mountable and permit trucks and oversized vehicles to drive over the medians.

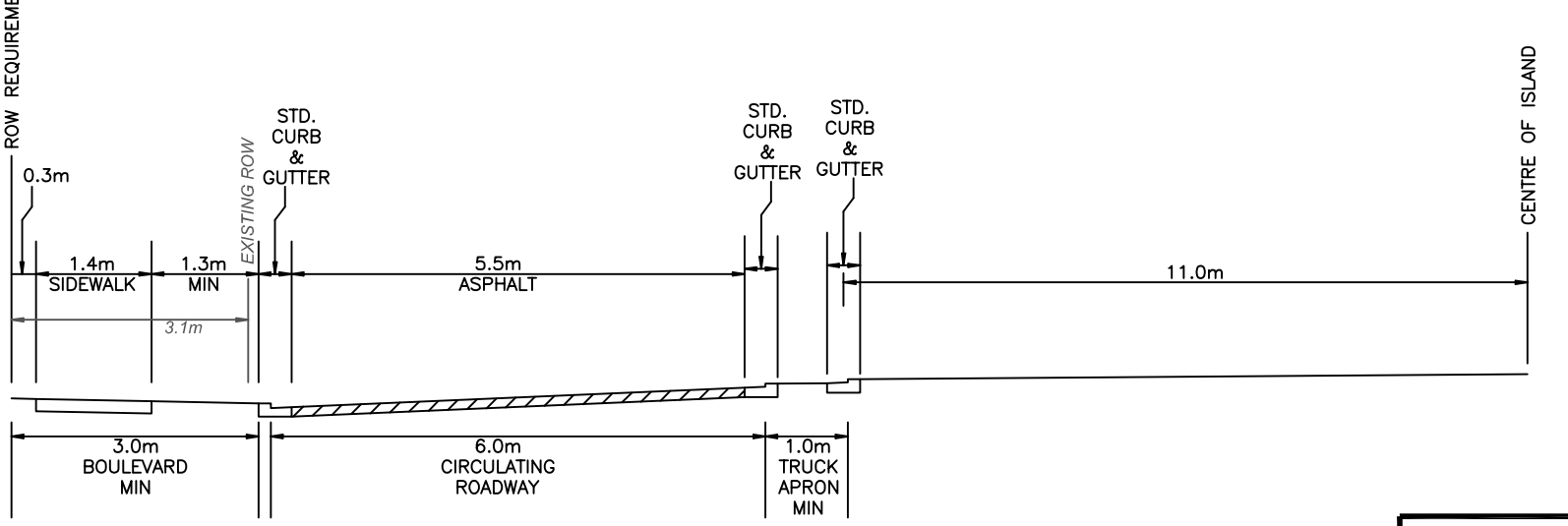
Photo 1 – Residential Roundabout

5. COLLECTOR STREET SINGLE-LANE ROUNDABOUT

Figures A and **B** illustrate the single-lane roundabout concepts for Collector Streets with 21.0m ROW and Undivided Primary Collector Streets with 23.5m ROW, respectively. The central island design in each of these figures is identical with a 36.0m inscribed circle and a single-lane design that accommodates buses without mounting the truck apron. Based on comments provided by the City, the circulating roadway was limited to a width of 6.0m to avoid drivers thinking that there are two circulating lanes. The added benefit of narrowing the circulating roadway is slightly lower speeds.

Figure A shows the impact on the ROW at the corner of two streets as 10.8m and 10.3 m with a curved boundary. Figure B includes bike ramps and the appropriate pathways at the intersection. Figure B shows impact distances of 9.0m and 8.6m with a curved boundary. These impact distances will be discussed in more detail in Section 12.





SECTION A–A
N.T.S.

CONCEPT - NOT FOR CONSTRUCTION

FIGURE A
COLLECTOR STREET
21.0m ROW

engineers
architects
planners
Totten Sims Hubicki Associates (1997) Ltd.

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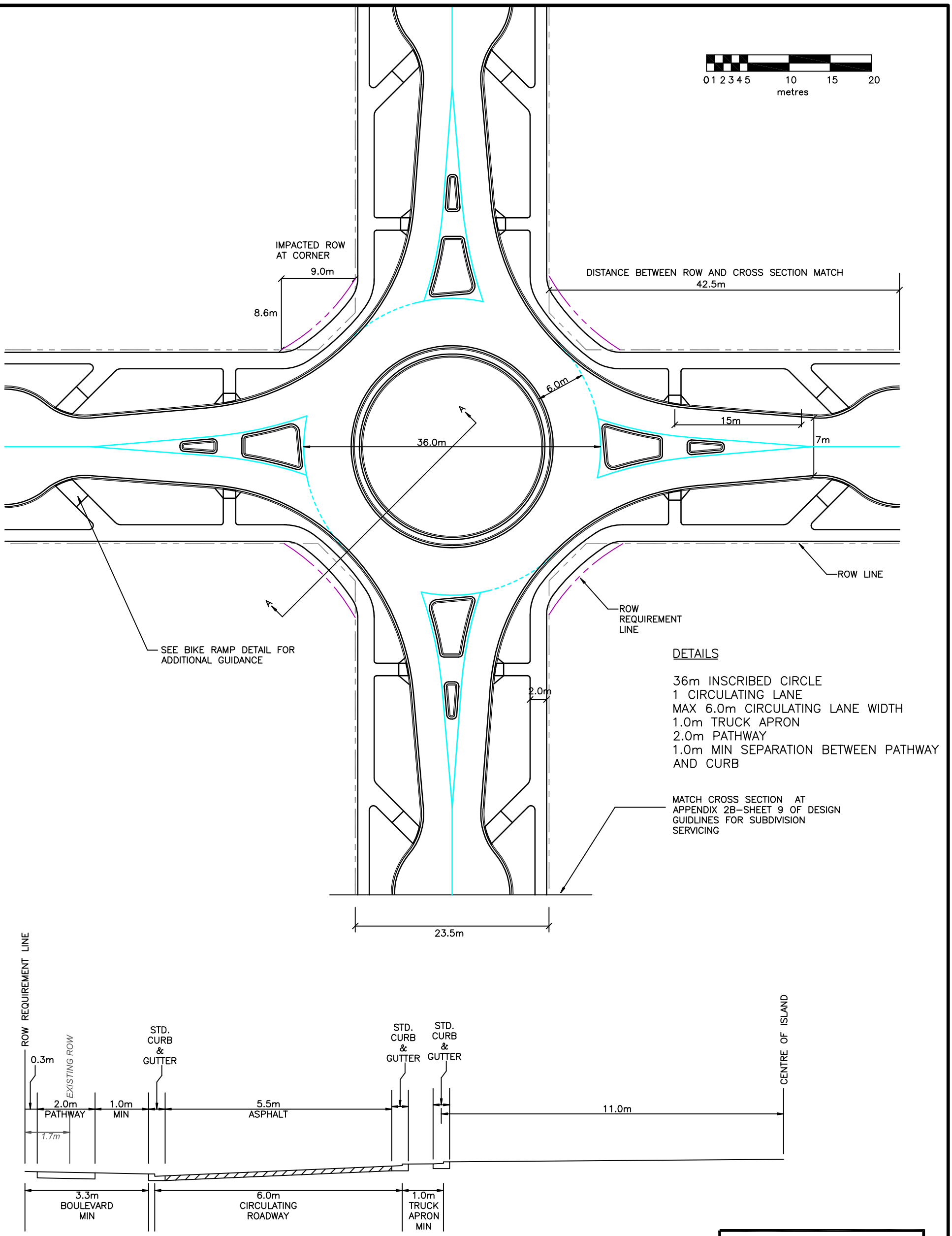

CONCEPT - NOT FOR CONSTRUCTION

engineers
architects
planners
Totten Sims Hubicki Associates (1997) Ltd.

FIGURE B
UNDIVIDED PRIMARY COLLECTOR
TWO LANE 23.5m ROW

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6. UNDIVIDED PRIMARY COLLECTOR TWO-LANE ROUNDABOUT

During the last review process, it was determined that the concepts that involve undivided roadways should not have reverse curves on the approaches. There are two ways to mitigate the effect of introducing the splitter islands into the four-lane roadway without reverse curves. The first technique is to widen the street over an extended distance thereby effectively eliminating the initial curve of the reverse curves. This technique was not used because it would require a very long distance from the intersection until the original cross section could be matched. This would significantly increase the impact area of the intersection design. However, in green field development this would not be a limiting factor. The second technique is to shift the exit away from the centerline and create an asymmetric median design. This method results in an irregular intrusion into the ROW boundary. The intrusion will be greater on the right-hand side of the approach due to the shifting of the exiting lanes away from the centre line.

Figure C illustrates a two-lane roundabout concept integrated with the Undivided Primary Collector (23.5 m ROW) standard cross section. The inscribed circle is 45 metres diameter with a 10 metre wide circulating roadway. Transitioning from the standard cross section occurs 49.1m from the ROW of the cross street. ROW intrusions start 20.9m away from the intersection on the approach and conclude 40.1m away from the intersection. The ROW intrusion at the corner is 6.3m away from the corner of the two ROWs.

7. DIVIDED PRIMARY COLLECTOR AND DIVIDED LOCAL MAJOR STREET TWO-LANE ROUNDABOUT

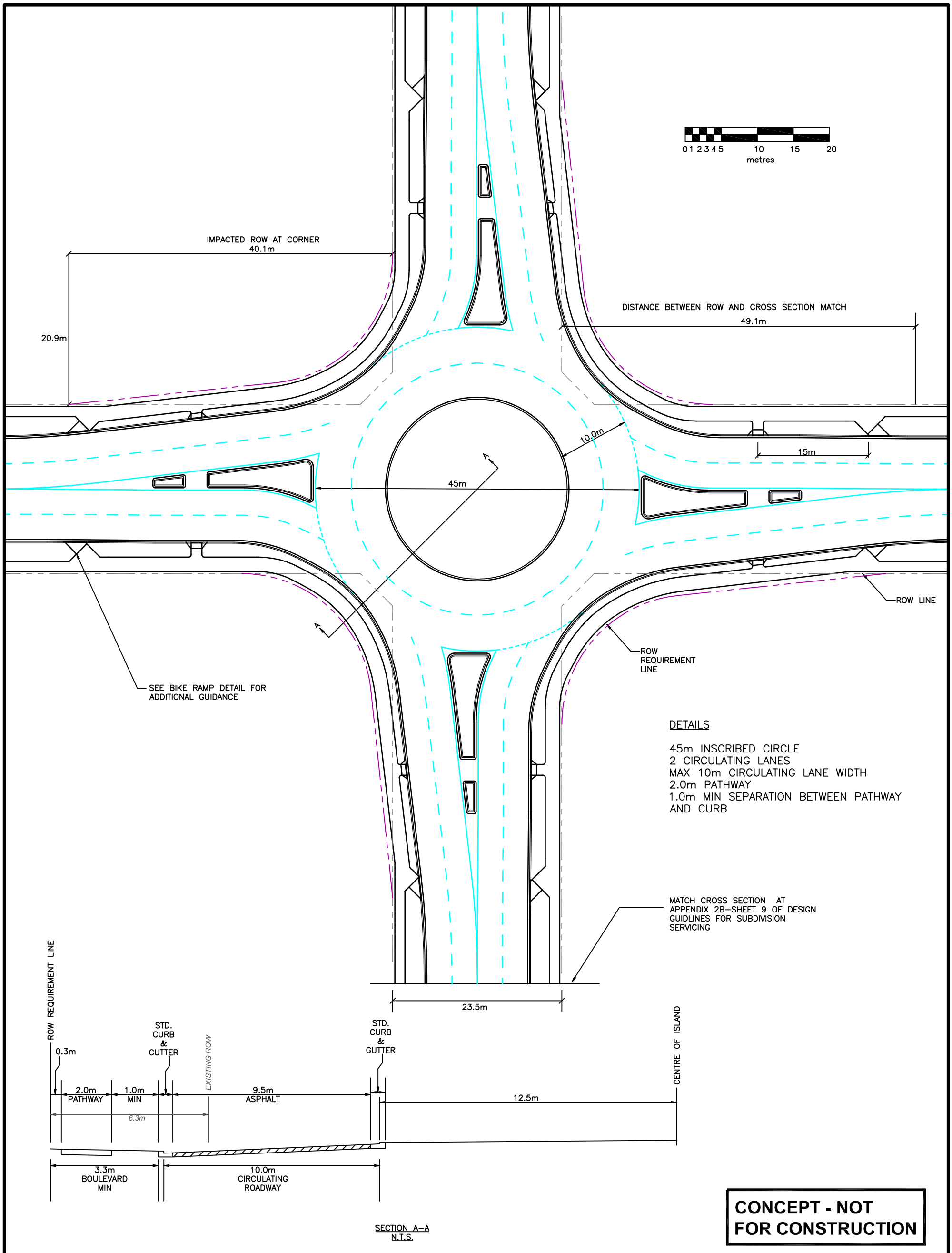
Figure D illustrates a two-lane roundabout concept for use on intersecting 27.0m ROWs. Both the Divided Primary Collector and Divided Local Major Street standard cross sections fit this criterion. The presence of the wide center median causes the inscribed circle to increase to a diameter of 48 metres. The circulating roadway remains at 10 metres wide. Transitioning from the standard cross section occurs 44.7m from the ROW of the cross street. ROW intrusions start 16.0m away from the intersection on the approach and conclude 17.0m away from the intersection. The ROW intrusion at the corner is 5.1m away from the corner of the two ROWs.

8. UNDIVIDED MAJOR STREET TWO-LANE ROUNDABOUT

Figure E shows a two-lane roundabout concept integrated with the Undivided Major Street (30.0 m ROW) standard cross section. This is the same roundabout concept as Figure C but the wider ROW aids in minimizing the corner intrusions. Transitioning from the standard cross section occurs 42.2 m from the ROW of the cross street. There is no ROW intrusion at the corner of the two ROWs.

9. DIVIDED MAJOR STREET TWO-LANE ROUNDABOUT

Figure F shows a two-lane roundabout concept integrated with a Divided Major Street (36.0 ROW) standard cross section. The inscribed circle diameter is 50 metres with a 10-metre circulating width. Transitioning from the standard cross section occurs 36.9 metres from ROW of the cross street. There is no ROW intrusion at the corner of the two ROWs.



SECTION A–A
N.T.S.

CONCEPT - NOT FOR CONSTRUCTION

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FIGURE C
UNDIVIDED PRIMARY COLLECTOR
FOUR LANE 23.5m ROW

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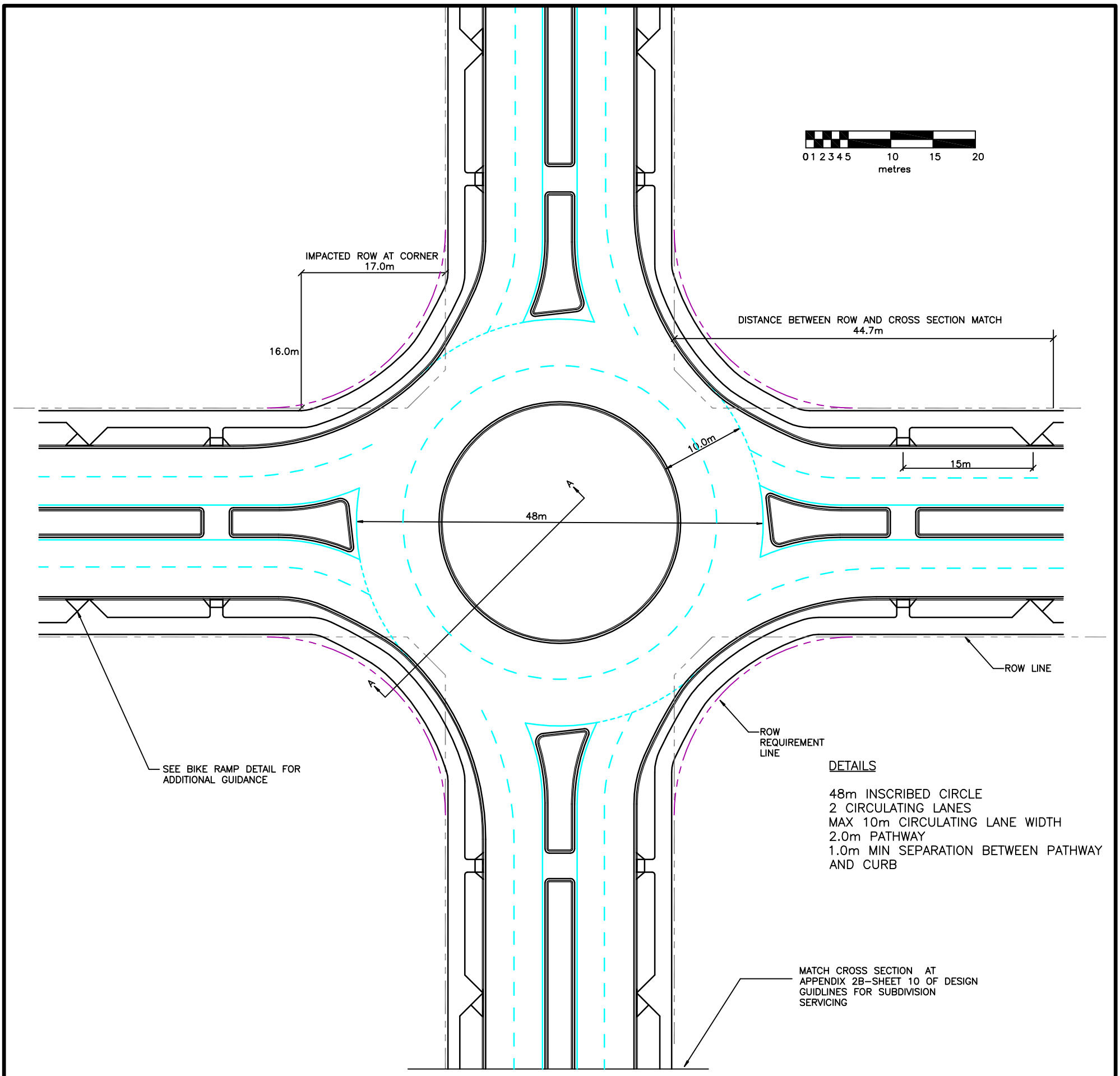
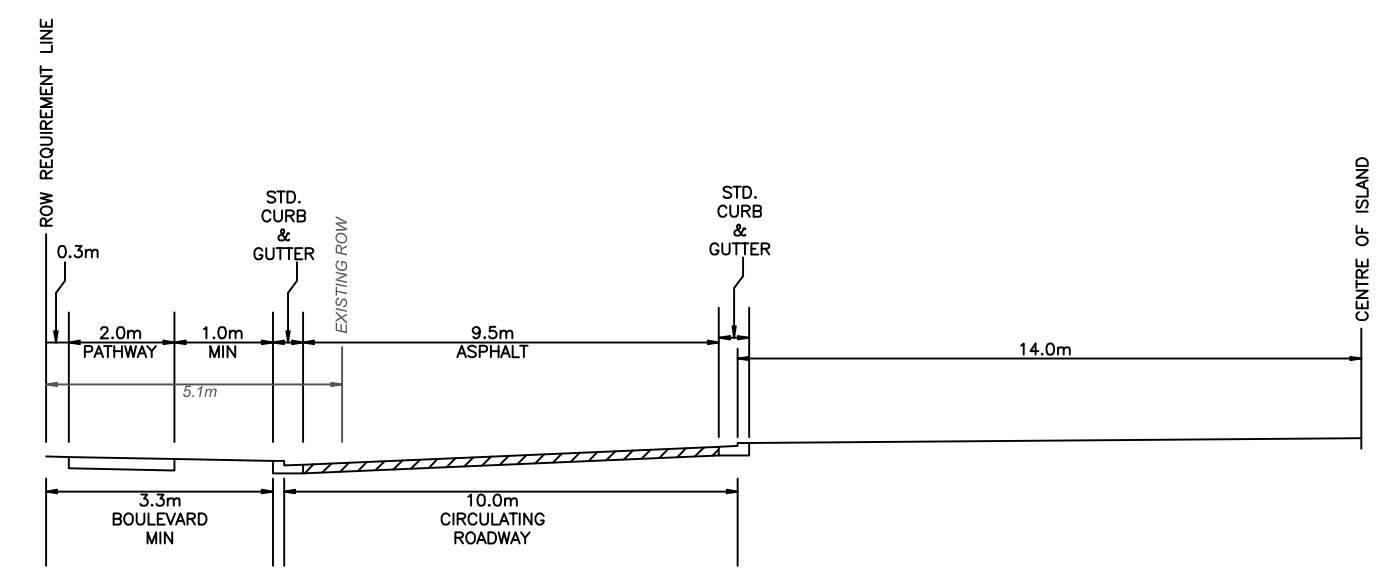


DETAILS

48m INSCRIBED CIRCLE
2 CIRCULATING LANES
MAX 10m CIRCULATING LANE WIDTH
2.0m PATHWAY
1.0m MIN SEPARATION BETWEEN PATHWAY AND CURB



SECTION A–A
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FIGURE D
DIVIDED PRIMARY COLLECTOR 27.0m ROW & DIVIDED LOCAL MAJOR 27.0m ROW

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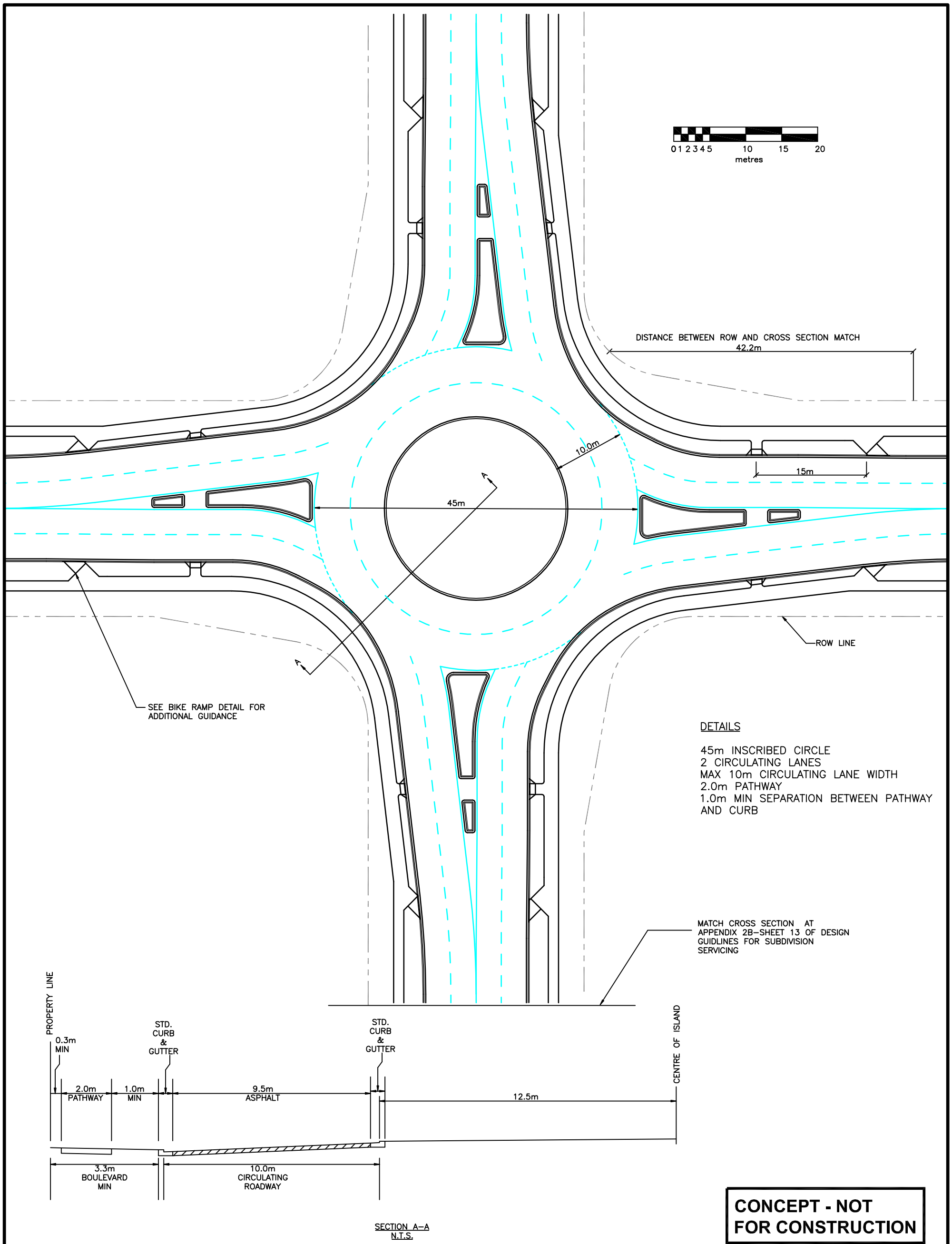

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FIGURE E
UNDIVIDED MAJOR STREET
30.0m ROW

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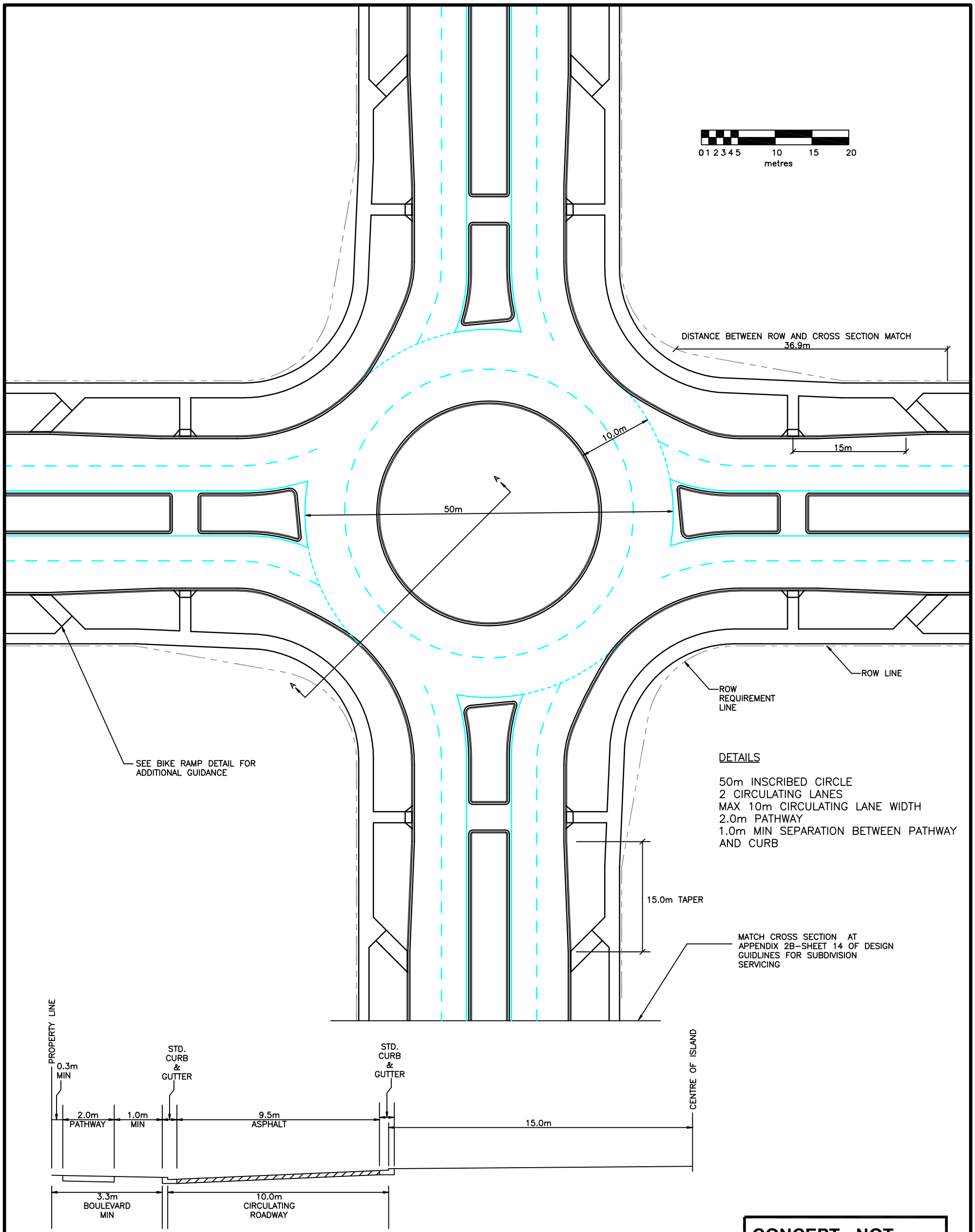

SECTION A–A
N.T.S.

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FIGURE F
DIVIDED MAJOR STREET
36.0m ROW

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10. TRANSIT

The determination of the overall ROW requirements incorporated the Calgary Transit fleet requirements. The critical dimensions are the width of circulating roadway and the location of transit stops. Calgary Transit practice is for buses to avoid mounting the truck apron on the centre island of the roundabout. Therefore, the physical requirements have been determined by using AutoTurn to simulate the movements of standard Calgary Transit buses.

Based on a presentation at Canadian ITE annual conference in May 2007, it was considered whether to place the transit stops on the approaches of roundabouts rather than downstream of the exit. This idea was implemented in the Region of Waterloo with reported success. However, after discussion with Calgary Transit, it was felt that relocating the transit stops would decrease pedestrian safety.

After reviewing various configurations, it was ultimately confirmed that the design of the transit stops has no effect on the required ROW associated with a roundabout. Therefore, transit stops are not shown on any of the concepts. Each transit stop can be designed as part of the overall intersection but it will not affect the required ROW.

11. BICYCLE RAMPS

During the review of the draft concepts, it was determined that all single lane roundabouts on Collector Streets and all multilane roundabouts will incorporate bicycle ramps and pathways into the final design. **Exhibit 1** and **Exhibit 2** illustrate the potential bicycle ramp designs we used in determining the special requirements at the intersections. The bike ramp designs provide cyclists two options; merge into traffic or take a bike ramp to a 2.0m pathway where they can dismount and cross as a pedestrian. Particularly on single-lane roundabouts, the design speed is low enough for commuting cyclists to "claim the lane" and circulate like a vehicle. Recreational, less experienced and less confident cyclists can take the ramp up to the pathway.

The inclusion of these bike ramps has an impact on the required ROW on the corners. In order to accommodate the bikes, the sidewalk must be upgraded to a pathway design. Pathways are wider than standard sidewalks and intrude into the ROW by that additional width.

The detail design of bicycle ramps is not addressed in this document. Detailed design should conform to best practices in North America. This document contains roundabout concepts that have sufficient flexibility for major modification to the bike ramp concepts presented in this document.

12. IMPACTS ON RIGHT-OF-WAY REQUIREMENTS

Exhibit 3 illustrates the differences between the existing City of Calgary ROW requirements from the *Subdivision Guide* and the recommended ROW requirements. As described earlier, the impacted areas are irregular in shape but can be approximated by basic geometry. Exhibit 3 shows the recommended corner cuts for the respective ROWs.

Single Lane

- Collector Street (21.0m ROW) – Additional corner area required is a 25m radius curve that intersects with the standard ROW at 10.8m and 10.3m on the approaches and exits, respectively.
- Undivided Primary Collector (23.5m ROW) – Additional corner area required is a 25m radius curve that intersects with the standard ROW at 8.9m and 8.6m on the approaches and exits, respectively.

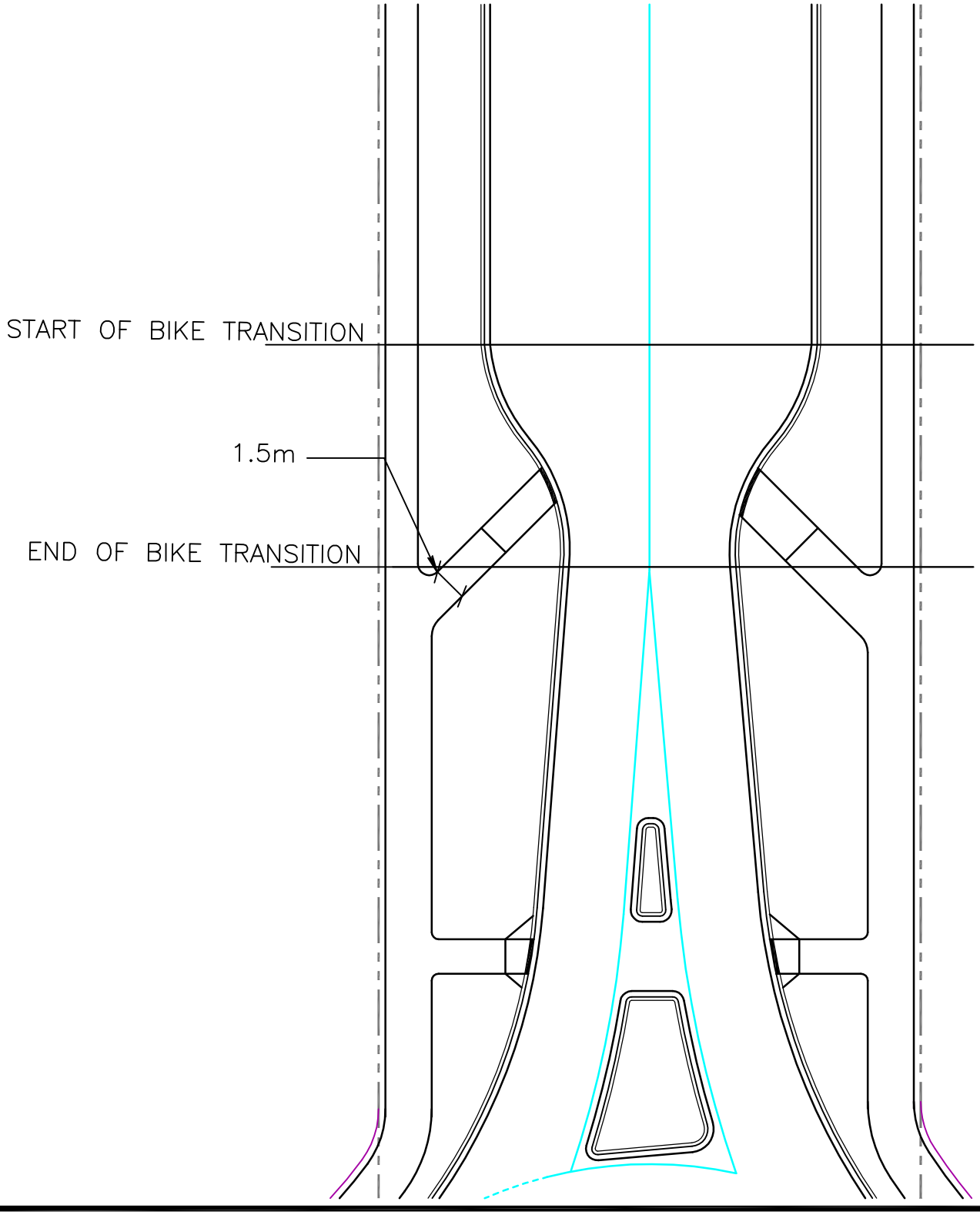

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EXHIBIT 1: BIKE RAMP CONCEPT FOR ONE LANE ROUNDABOUT

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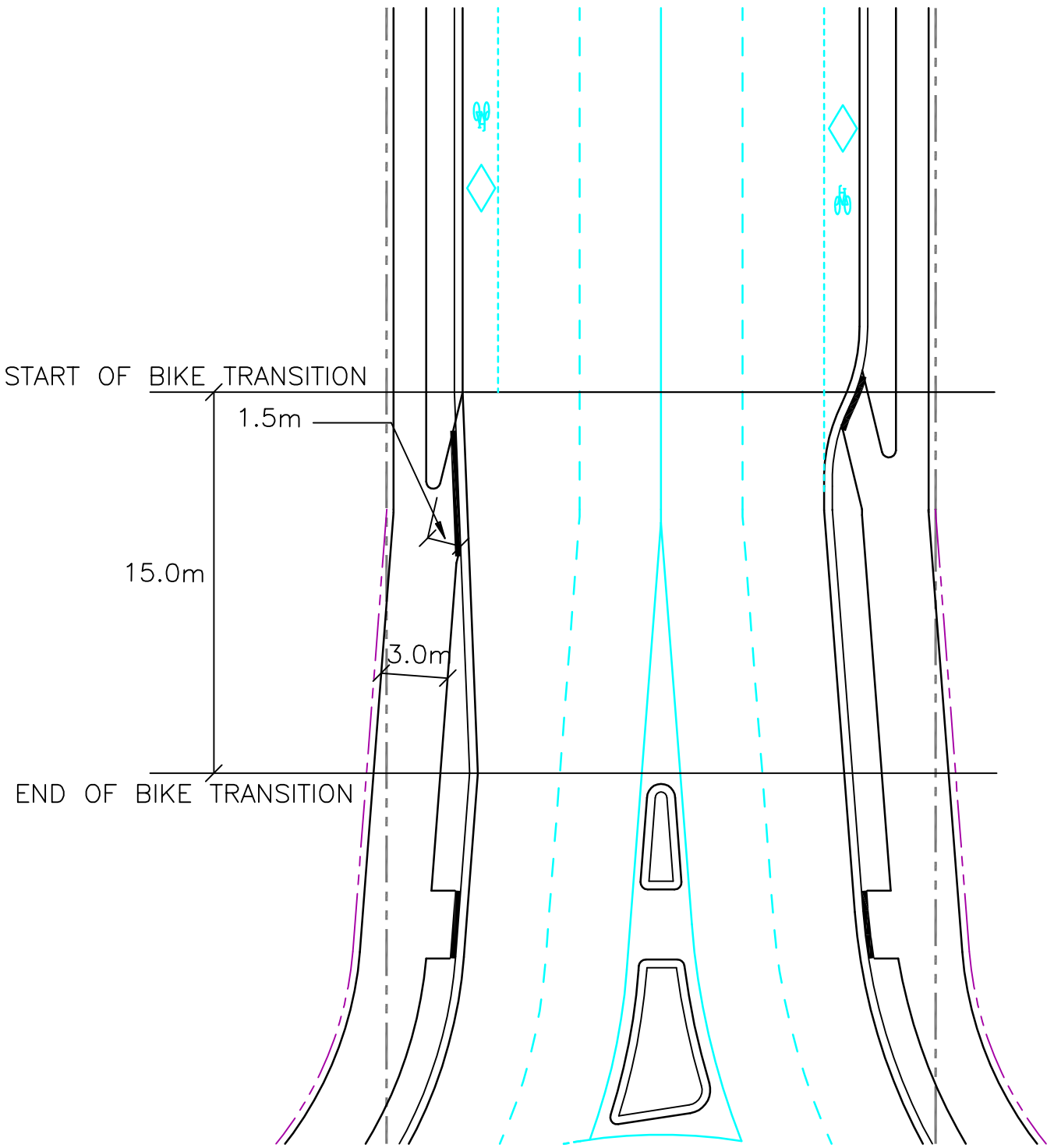

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EXHIBIT 2: BIKE RAMP CONCEPT FOR TWO LANE ROUNDABOUT

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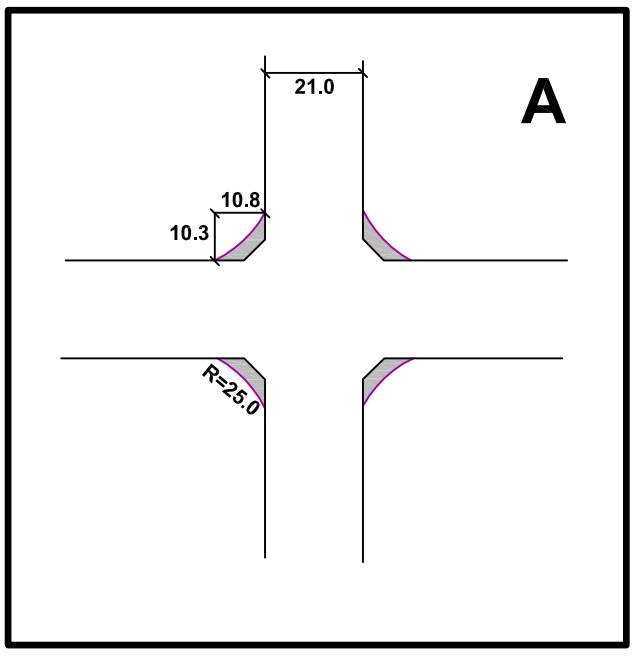
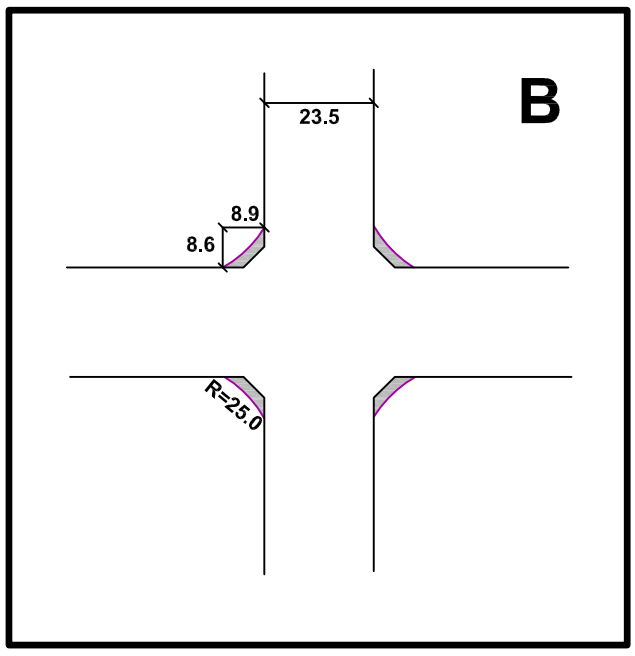
SINGLE LANE ROUNDABOUTS

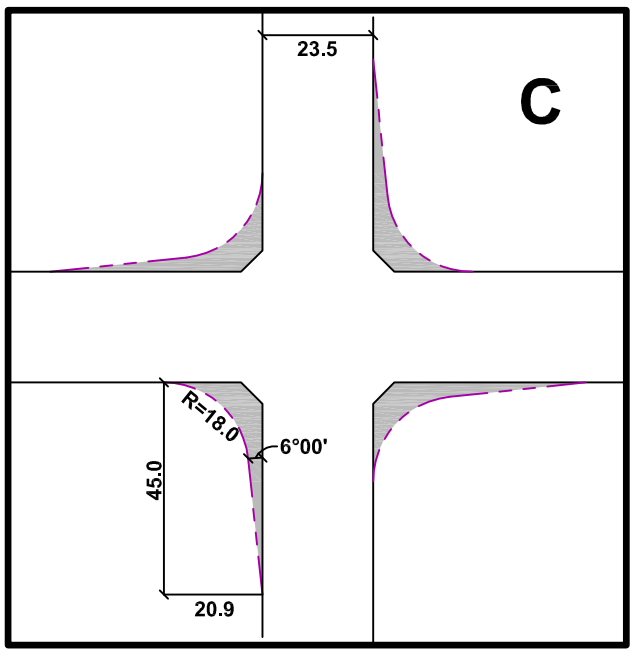


COLLECTOR STREET

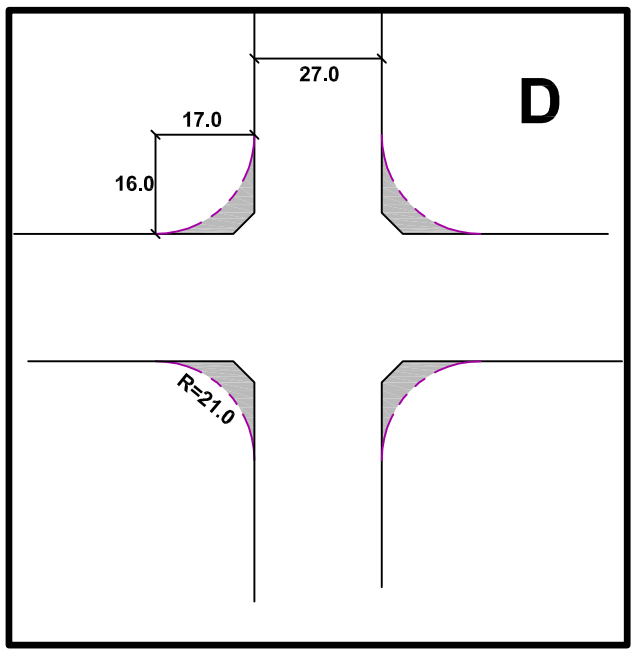


UNDIVIDED PRIMARY COLLECTOR

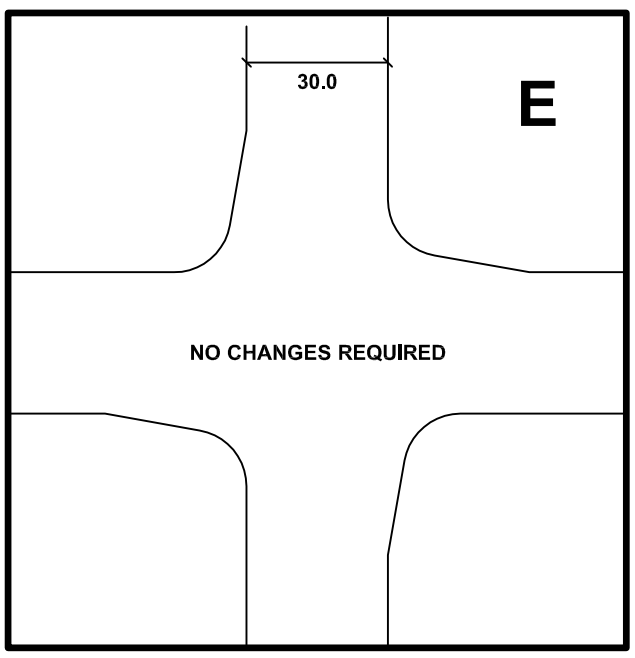
TWO LANE ROUNDABOUTS



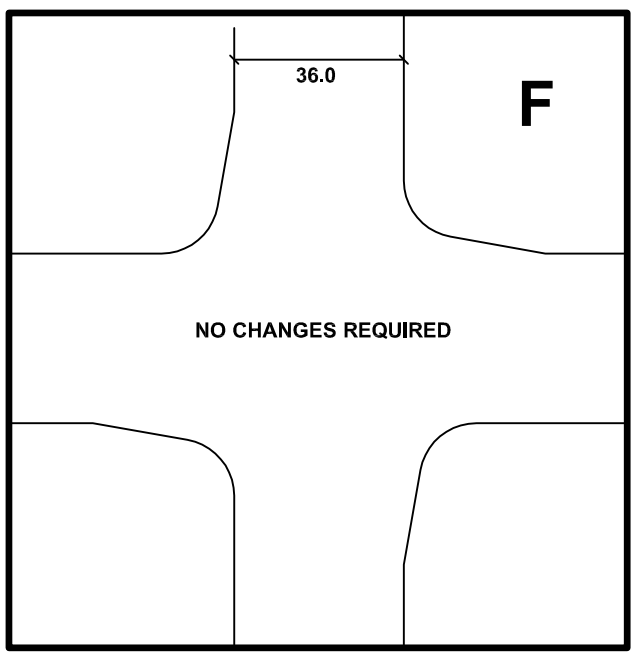
UNDIVIDED PRIMARY COLLECTOR



DIVIDED PRIMARY COLLECTOR & DIVIDED LOCAL MAJOR



UNDIVIDED MAJOR STREET



DIVIDED MAJOR STREET

EXISTING PROPERTY LINE

RECOMMENDED PROPERTY LINE

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EXHIBIT 3: RECOMMENDED RIGHT -OF-WAY REQUIREMENTS

THE CITY OF CALGARY

PROJECT # 51-250008

NOVEMBER 2007

Two Lane

- Undivided Primary Collector (23.5m ROW) – Additional corner area required is an 18.0m radius curve tangential to the approach ROW and intersecting with a line that extends from 45.0m on the exiting ROW at a 6 degree angle.
- Divided Primary Collector and Divided Local Major (27.0m ROW) – Additional corner area required is a 21m radius curve that is tangent with the standard ROW on the approaches and exits.
- Undivided Major Street (30.0 ROW) – No ROW required beyond existing City of Calgary requirements.
- Divided Major Street (36.0 ROW) – No ROW required beyond existing City of Calgary requirements.

13. CONCLUSIONS

The process used to determine property requirements at intersections that may use roundabouts as the traffic control option has involved consideration of all transportation modes. By combining the planning and design requirements of the City of Calgary with the state of the practice roundabout design, the recommended right-of-way requirements provide adequate space for designers to create effective designs.

The concepts presented in this document represent the basis for planning and constructing roundabouts as traffic control devices. The concepts provide assurance that:

- Effective designs can be constructed within the reserved area.
- Designs will be able to accommodate Calgary Transit vehicles and facilities,
- Cyclist needs can be met, and
- Pedestrian facilities can be fully accommodated.

Reservation of adequate right-of-way for construction of future traffic control devices is an extremely important component of planning. The recommended requirements will allow the City to meet its planning goals and permit designers sufficient flexibility for site specific requirements.

APPENDIX B: CITY OF CALGARY ROUNDABOUT LANDSCAPING GUIDELINES

LANDSCAPING GUIDELINES FOR CITY OF CALGARY ROUNDABOUTS

The landscaping within and adjacent to a roundabout has a direct impact on the safety and operations of the intersection. Good landscaping design provides adequate stopping sight distance without encouraging excessive speeds on the approaches. This is accomplished by providing only the required sight distance and not more.

Establishing adequate sight distances for safe and efficient operations is a key component of intersection design. Figure 1 is a compilation of the most critical driver sight distance calculations for roundabout design. Included are: circulatory sight distance, operational sight distance, crosswalk sight distance, and approach sight distance. To ensure an adequate level of safety, these sight distances are calculated based on the design speeds at various locations in the design. The details of these calculations are included in Quebec's Roundabouts: A Different Type of Management Approach and FHWA's Roundabouts: An Informational Guide. Dimensions are not included on Figure 1 because they vary based on design speeds on a location by location basis.

Landscaping Zones

When the sight distance calculations are conducted for each of the approaches and the circulating roadway, the resulting landscaping zones for single lane and two lane roundabouts will resemble Figure 2 and Figure 3, respectively. Within the intersection area, there are three distinctly different landscaping zones High, Low and Exterior.

1. High Landscaping Zone: The first is the High zone located in the center of the roundabout. This zone is the most important for establishing a visual mass to the roundabout. Since the roundabout will be highest at the center of the roundabout, it serves as a visual clue that drivers should reduce their speed on the approaches. It is acceptable to place fixed objects within the High zone as long as they are outside of the direct path of the approaches, do not pose an unreasonable risk if drivers have an accident into the center island and do not interfere with the access to utilities or ability to perform maintenance on utilities that may pass through the roundabout. At most roundabouts the risk of an accident occurring with the high zone is extremely low since approaching vehicles would have to be travelling a high rate of speed, fail to make any steering corrections and cross one or two barrier curbs prior to entering the High zone. Table 1 lists the acceptable and unacceptable treatments for the landscaping zones. Within the High zone, evergreens are preferable to deciduous trees as evergreens provide visual screening throughout the year.

   With smaller roundabouts, there may not be a High zone due to the requirements for sight distance of circulating vehicles. In these situations, there is less visual indication of the intersection but these locations will tend to be very low speed applications where the center island massing is less important.

1 Low Landscaping Zone: The Low zone includes areas of the intersection where sight distance must be maintained throughout the year. These areas tend to coincide with the clear zones where fixed objects are highly discouraged. Care should be taken that as planting mature they do not require excessive maintenance to achieve the appropriate sight distances. The vertical height of these plantings should not exceed 0.60 m above the roadway. Within the center circle and when there are very wide center medians with raised landscaping, it is important to remember that the grading will increase the elevation thereby further limiting the height of plantings.

2 Exterior Landscaping Zone: The third zone is the landscaping area outside of the High and Low zones. Within the City, this Exterior area is typically on private property and there may be limited ability to control or influence the design. The sightline boundary defines the location where obscuring items can be located. The presence of solid screening along the boundary encloses the intersection thereby encouraging lower speeds. The placement of deciduous trees, fences, buildings, monuments and other obscuring features ensures that drivers are limited in their ability to anticipate the actions of other drivers until near the intersection.

Public Art and Operations

The center of a roundabout can be a visually attractive location. However, the design must balance the desire for an aesthetically attractive design and proper operation. The landscaping should not include features that invite pedestrians to the center island. Benches, large grassed areas (potential picnic area), statues with name plates located in the center island, and climbing objects should be avoided. Fountains should be avoided in most applications as water tends to spray on the circulating roadway (and vehicles driving on it). Fountains also have maintenance requirements that are higher than other designs thereby requiring a location within the center circle for maintenance vehicles. Public art can best be accommodated when the object(s) is best viewed from afar. Information plates, viewing areas and other associated facilities can be located outside the operational area of the intersection.

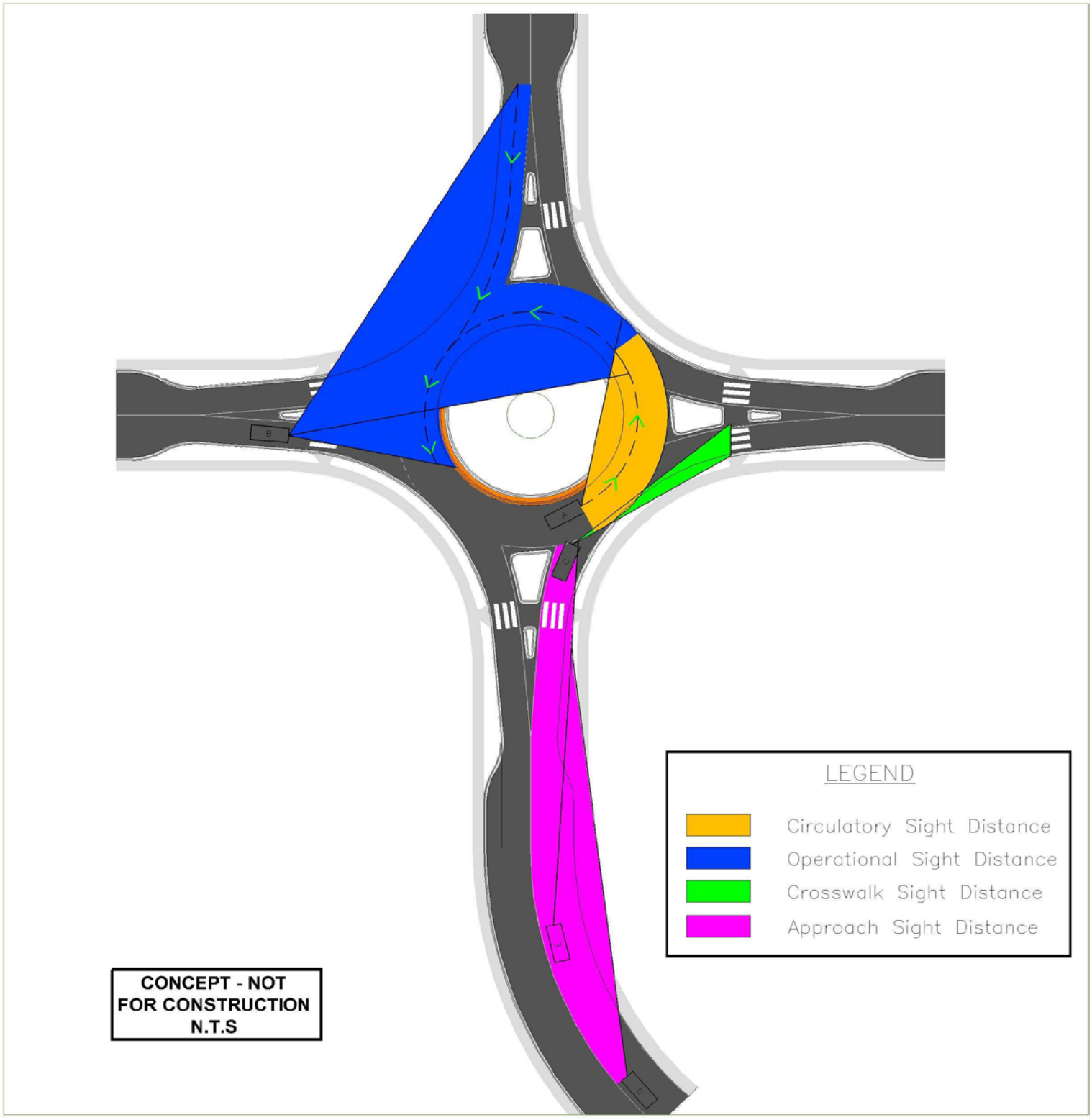
Unacceptable
All areas of intersection • Play structures • Benches not part of transit zone • Recreational facilities • Advertising signs Centre island only • Descriptive plaques • Fountains and water features • Art with exterior moving parts (clocks excepted) • Art with variable lighting patterns • Permanent decorative lighting fixtures • Concrete resembling a sidewalk • Asphalt • Grassed areas suitable for sitting

Ultimately, a roundabout is a traffic control device and must meet the standards for safe and effective operation regardless of the desired landscaping intentions. Without exception, the minimum circulating sight distances and pedestrian sight distances should be met at all City of Calgary roundabouts.

This information provides the City with sufficient information to control the landscaping of proposed roundabouts while maintaining flexibility necessary for creating attractive features.

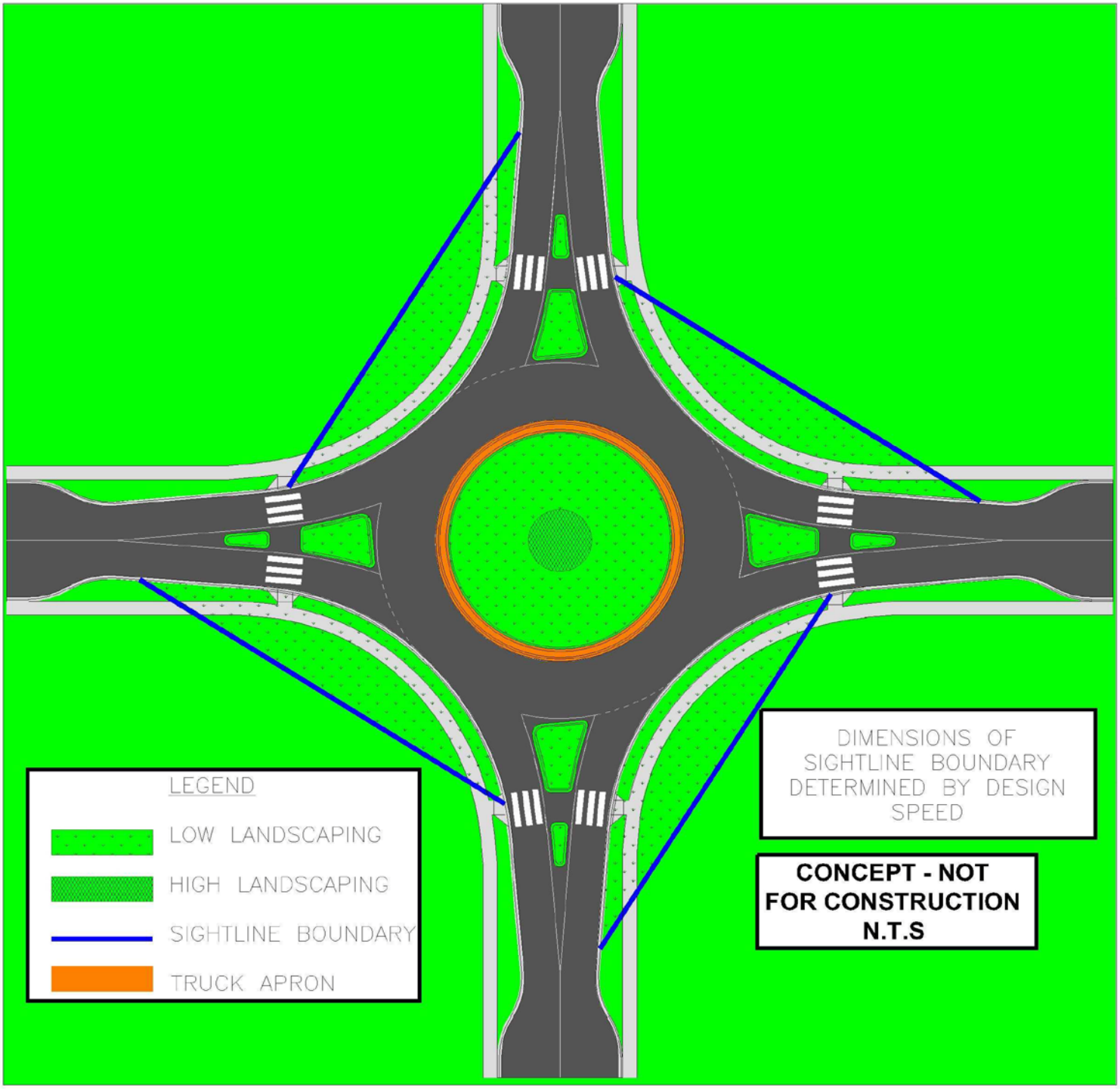
Acceptable
Low zones (<0.6 m above roadway) • Grasses – native grasses preferred • Coloured concrete • Gravel • Stones • Regulatory signs High zones • Stationary art • Statues • Trees – canopy can extend into low zone if vertical clearance maintained • Stones and boulders • Walls • Fencing • Regulatory signs • Other items deemed safe

Sight Distances



Landscaping Plan - Single Lane Roundabout

AECOM Project #51-250008 City of Calgary Roundabout Guidelines
November 2008



Landscaping Plan - Double Lane Roundabout

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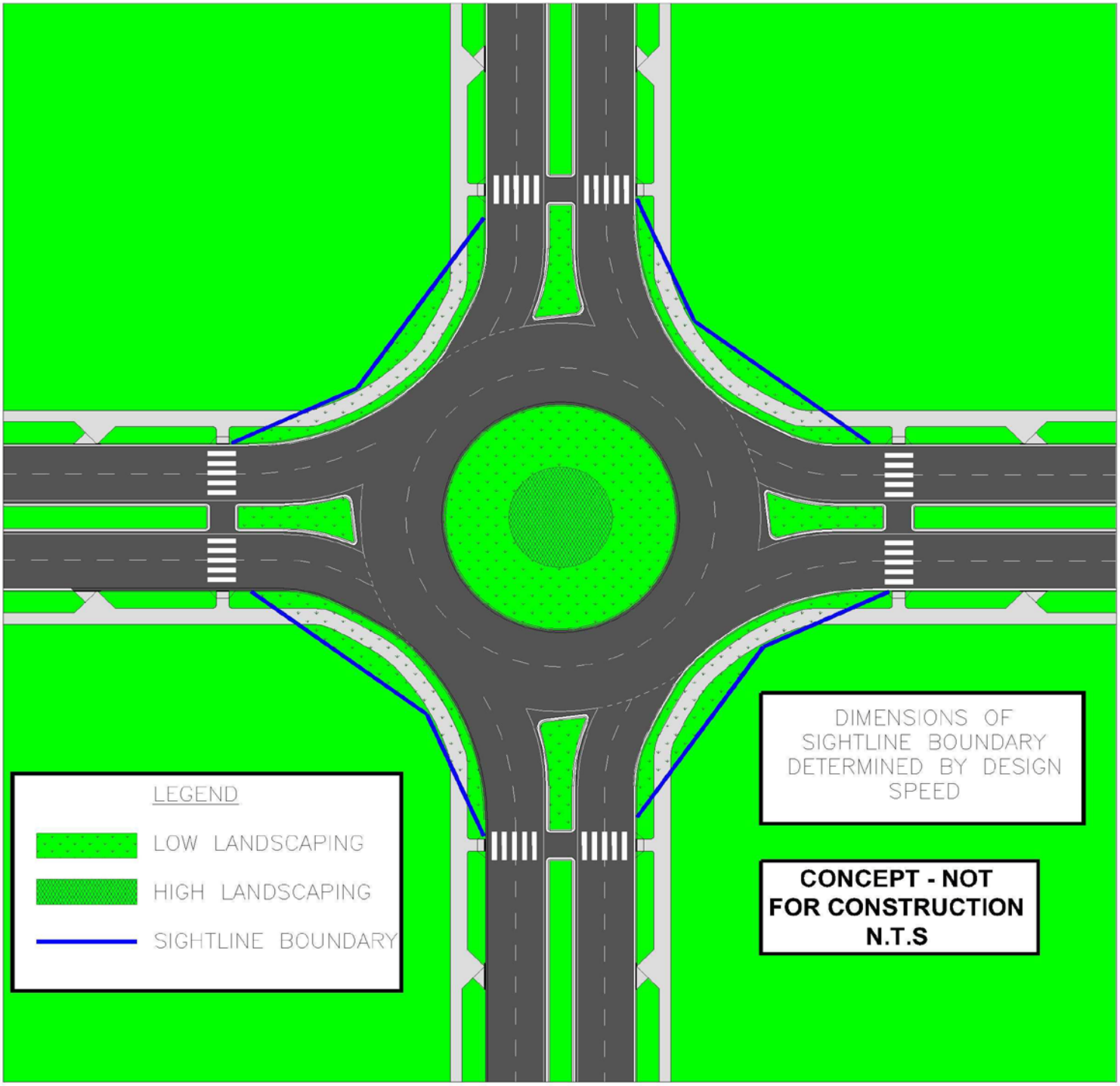

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