Alberta Transportation Roundabout Design Guidelines

- C-TEP Lunch and Learn

By

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What's new?

- Alberta Transportation has approved and published a new Design Bulletin (# 68, May 2010) titled **"Roundabout Design Guidelines on Provincial Highways"**
- **Roundabouts are the first option when a greater degree of traffic control than 2 way stop control is required.**

Question

- How many roundabouts are built in France every year?

- Answer : Later…..

ROUNDABOUTS - September 29, 2010 in Calgary
course by C-TEP (Phil Demosthenes)

- *Roundabout Types and Uses ·*
- *Geometric Design (The new Alberta Transportation Design Practice will be covered) ·*
- *Capacity Analysis ·*
- *Traffic Operations ·*
- *Multimodal Aspects ·*
- *Safety ·*
- *System Considerations ·*
- *Accommodating the needs of Pedestrians, Bicyclists, Emergency Response Vehicles and Trucks ·*
- *Best Practices and Lessons Learned from Prior Design Experiences ·*
- *Fixing Problem Roundabouts*

Roundabout Myths

- 1.Roundabouts cause more crashes than the stop signs or signals they replace.
  2. Roundabouts cause longer commutes.
  3. The public will never accept roundabouts.
  4. Roundabouts are difficult to maneuver.
  5. Roundabouts cost more.
  6. Roundabouts are not good for pedestrians and bicyclists.

See: Alaskaroundabouts.com

Why? – see Alberta Traffic Collisions

- For Safety – see 2008 collision data for example:
- # of reported collisions = 158,055
- # of injuries = 22,016 (16,153 crashes)
- # of fatalities = 410 (375 crashes)
- # of property damage only crashes = 141,527.

Alberta Traffic Safety Plan –
Goal 1 : Reduce serious collisions by 30%.

How many are rural / urban?

Number of non animal collision at INTERSECTIONS in 2008 *

COLLISION_SEVERITY	rural	urban	Grand Total
FATAL	56	7	63
MAJOR	179	18	197
MINOR	540	283	823
PROPERTY DAMAGE ONLY	1523	969	2492
Grand Total	2298	1277	3575

* Alberta Highway Data only, 80% of crashes are non-highway.

How many are rural / urban?

Sample figures from 2008.

COLLISION SEVERITY	rural	urban	Grand Total
FATAL	261	114	375
INJURY	3930	12223	16153
PROPERTY DAMAGE ONLY	25562	115965	141527
Grand Total	29753	128302	158055

Highway Intersections Crashes

What types?

PRIMARY_EVENT	FATAL	MAJOR	MINOR	PDO	rural Total
BACKING			1	37	38
HEAD ON	4	6	4	6	20
LEFT TURN - ACROSS PATH	2	18	52	82	154
OFF ROAD LEFT	5	18	47	154	224
OFF ROAD RIGHT	7	35	96	299	437
OTHER		1	8	32	41
PASSING - LEFT TURN	4	3	24	66	97
PASSING - RIGHT TURN		1	1	5	7
REAR END	4	20	117	412	553
RIGHT ANGLE	25	66	152	207	450
SIDESWIPE - OPPOSITE DIRECTION	1	5	9	52	67
SIDESWIPE SAME DIRECTION		3	18	118	139
STRUCK OBJECT	4	3	11	53	71

How many are intersection related?

Year: 2008	Fatal	Injury	pdo	total
Rural	38	466	1018	1522
Urban	39	6068	26,759	32866
Total	77	6534	27,777	34,388

What is the annual societal cost for intersection collisions in Alberta?

Year: 2008	Fatal X $1,345,068	Injury X $100,000	Pdo X $12,000	total
Rural	38	466	1018	1522
Urban	39	6068	26,759	32866
Total	77	6534	27,777	34,388

What is the annual societal cost for intersection collisions in Alberta?

Year: 2008	Fatal X $1,345,068	Injury X $100,000	Pdo X $12,000	total
Rural	38 = $51,112,584	466 =$46,600,000	1018 = $12,216,000	1522 = $109,928,584
Urban	39 = $52,457,652	6068 = $606,800,000	26,759 = $321,108,000	32866 = $980,365,652
Total	77 = $103,570,236	6534 = $653,400,000	27,777 = $333.324,000	34,388 = $1,090,294,236.

Safety effects of Roundabouts.

- 1. Collision rate reduction = 39%
- 2. Fatal collision reduction = 90%
- 3. Injury collision reduction = 76%
- 4. Pedestrian Crash reduction = 73%

- Sources: Transport Canada, Clearinghouse for CMFs, Desktop Reference for CRF (FHWA), NCHRP 617 (TRB).

Potential annual benefits on Alberta intersections.

Year: 2008	Fatal x (1- 0.9)	Injury x (1- .76)	Pdo x (1 - .244)	Total 39% less
Rural	38 = 3.8	466 = 112	1018 = 812	1522 = 928
Urban	39 = 3.9	6068 = 1456	26,759 = 18,588	32866 = 20,048
Total	77 = 7.7	6534 = 1568	27,777 = 19,401	34,388 =20,977

Current collisions (expected collisions)

Potential annual benefits. (63%)

Year: 2008	Fatal 90% X $1,345,068	Injury 76% X $100,000	Pdo 30% X $12,000	total
Rural	38 = $51,112,584 = $46,001,326	466 =$46,600,000 =$35,416,000	1018 = $12,216,000 = $3,664,800	1522 = $109,928,584 = $85 million
Urban	39 = $52,457,652 = $47,211,887	6068 = $606,800,000 = $461,168,000	26,759 = $321,108,000 = $96,332,400	32866 = $980,365,652 = $605 million
Total	77 = $103,570,236 = $93,213,212	6534 = $653,400,000 = $496,584,000	27,777 = $333.324,000 = $99,997,200	34,388 = $1,090,294,236 = $690 million.

Project analysis

- If existing intersection, use multiyear collision record for "before" condition.
- If new intersection, use Alberta's current benchmark rates and severities as defaults (highways only).

	Rate/mve*	Fatal %	Injury %	PDO %
Roundabout	0.35	0.20	7.55	92.25
Unsignalized	0.57	2.35	32.58	65.07
Signalized	0.92	0.50	26.0	73.5

* Collisions per million vehicles entering.

Presentation Outline

- Alberta Transportation's new policy
- Public response
- Safety improvement
- Environmental improvement
- Aesthetic improvement
- Capacity analysis
- Geometric design guidelines
- Traffic control and lighting
- Recommendations

Hwy 8 and 22
Near Bragg Creek, Alberta.

Recommended Policy

Roundabouts shall be considered:

- As the first option for intersection designs where a greater degree of traffic control than a two-way stop is required, i.e. signalization or 4-way stop.
- On all roadways including high speed (70 km/h or greater) corridors.

Recommended Policy (cont)

Locations favoured, where:

- Traffic calming: urban and rural boundary; low speed urban areas; high speed roadway intersect lower speed roadways; ramp terminals
- A corridor with a series of consistent intersection layouts (all roundabouts)

(Source: MTJ Engineering, Lake Forest, MN)

Recommended Policy (cont)

Locations ***NOT*** favoured:

- Existing freeways
- Divided highways (identified as future freeways) and national highways (Posted ≥ 90km/h), unless roundabouts are an interim stage and compatible with a staging plan (future urban by-pass).
- High posted speed on through highways (highly desirable and feasible)
- Unsuitable geometric conditions

Recommended Policy (cont)

Installation triggered by:

- To provide a higher degree of traffic control (to improve traffic operations)
- A clear economic benefit based on safety and other considerations
- Implementation of a traffic calming measure

(Source: MTJ Engineering, US 23/Lee Road, Livingston County, MI)

Recommended Policy (cont)

Roundabout shall be evaluated:

- If an intersection warrants a signal or a 4-way stop control within 10 years of a proposed project
- If an existing four-way stop control or signalized intersection has operational and safety problems with the current traffic control.

A right-turn channelized roadway on a roundabout (from public road to public road) may be considered when:

- Heavy right turn volumes and LOS lower than D or special circumstances.

Public Response

Attitude	NCHRP Synthesis 264 (1998)		Survey (2002) Kansas, Maryland & Nevada	
	Before	Vs. After	Before	Vs. After
Very Negative	23%	0	41%	15%
Negative	45%	0	14%	13%
Neutral	18%	27%	14%	9%
Positive	14%	41%	15%	31%
Very Positive	0	32%	16%	32%

Public Communications

- 1. Driver Handbook (for new drivers) shows how roundabouts work. “Yield” on entry is key message.
- 2. Alberta Transportation’s website has educational section on “roundabouts in Alberta”
  - animation for “how to use roundabouts”
  - pictures, video. Consultants may refer to these resources.

Safety Improvement

Country	Collision Reduction		
	Fatalities	Injuries	Total
USA (2007)	90%	76%	35%
Germany (2005)	88%	60-87%	30%
France (2002)	-	-	88%
Australia (1995)	-	-	71%
Denmark (1996)	-	-	53-84%
Netherlands (1994)	-	-	71%

Environmental Improvement

- A Swedish study (2002): roundabouts replaced signalized intersections – CO decreased by 28%, NOx by 21%, fuel consumption by 28%.
- A simulation study (2003) reported: cutting down vehicle emissions.
- Research in North America (2001): fuel consumption and air pollution reduced, CO2 significantly cut.

Aesthetic Improvements

Capacity Analysis

- North America main reference - Highway Capacity Manual 2000
- NCHRP 572 (2002):

- Researched 310 roundabouts in the USA over the last ten years
- One finding: all existing models over-predicted capacity compared to observations in North America
- Recommended new models will be included in Highway Capacity Manual 2010.

Capacity Analysis (cont)

- Single-lane roundabout: peak hourly traffic flow < 1,100 v/h (circulating plus entering flow at any leg entry) e.g. up to 25,000 vehicles entering per day = 9.125 million vehicles entering /annum
- Predicted collisions:
- - Roundabout: 3 crashes per year, 1 injury in 5 years, 1 fatality every 167 years.
- - Signalised: 5 crashes per year, 1.6 injuries/year, 1 fatality every 40 years.

Capacity Analysis (cont)

- Double-lane roundabout: peak hourly traffic flow $< 1{,}900$ v/h; (circulating plus entering flow at any leg entry) e.g. up to 45,000 vehicles entering per day.
- Roundabouts may be designed with a combination of single-lane and double-lane segments

Mini - Roundabout

Mini-Roundabout


J.COPESTAKE & SONS
BIDDULPH STOKE-ON-TRENT

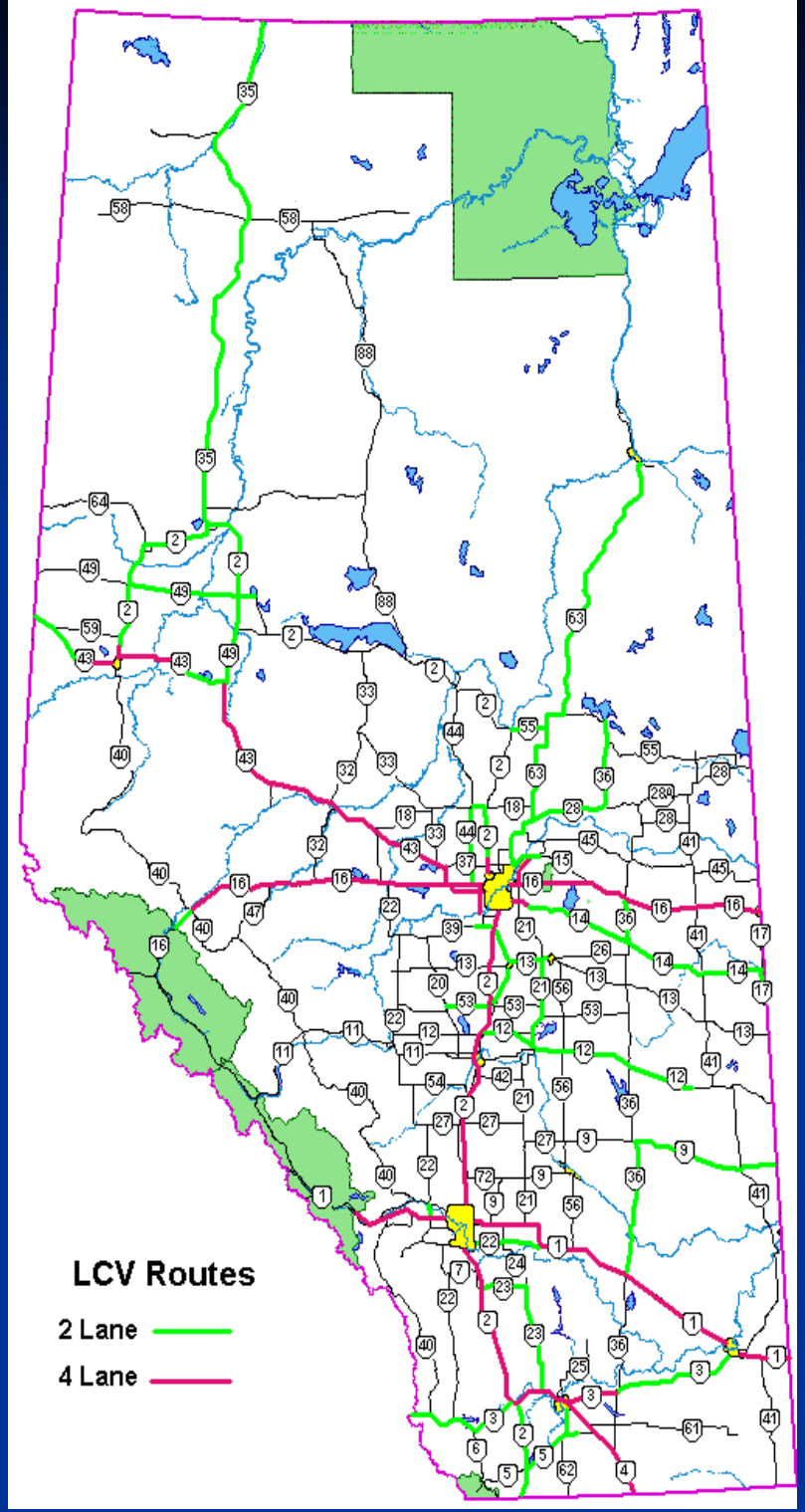
Single Lane Roundabout

- Roundabout in northern France (Urban).

- Roundabout in Britain?
- Rural with single light standard.

- Grade Separated Roundabout (opened 2009 in Kosovo)

Turnpike Double



Long Combination Vehicle Routes for Alberta.

4 Lane – Turnpike Double, Triple Trailer Combination.

2 Lane – Rocky Mountain Double.

Refer to AT website.

- Multilane Roundabout (Missouri, USA)

2 and 1 Lane Roundabout

2 and 1 Roundabout, NY DOT.

- 3 Leg Roundabout in Michigan, USA.
- - 2 and 1 lane arrangement.

Dumbbell Interchange, Indiana, USA.

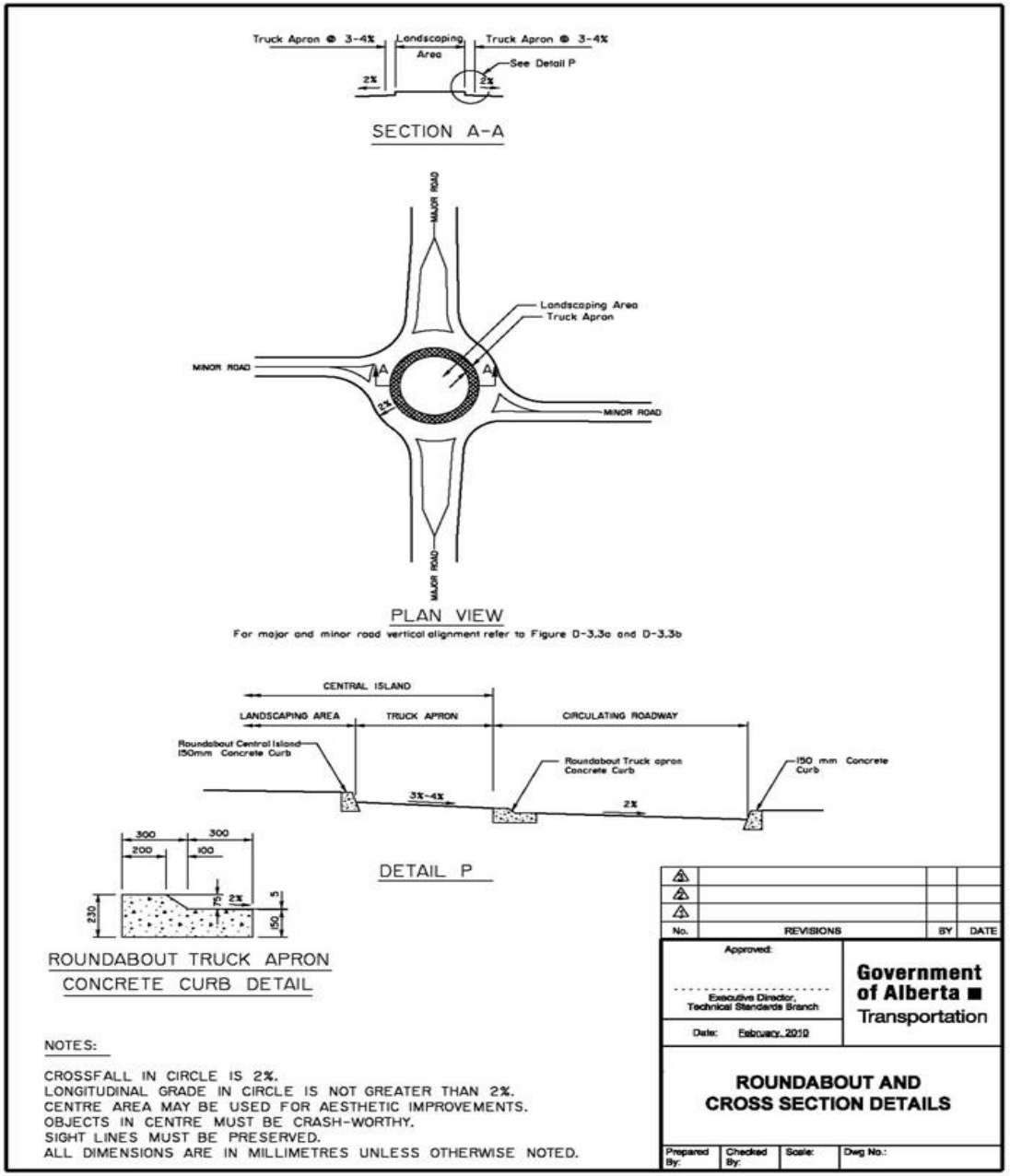
Capacity Analysis (cont)

- Available software:

- Based on gap theory: SIDRA, SYNCHRO, VISSIM, PARAMICS, etc.
- Based on empirical models: RODEL, ARCADY
- All over-estimated capacity (NCHRP 572)
- Field calibration needed
- Capacity analysis results to be compared to NCHRP 572 formulas.

Geometric Design

- Main References: AT Highway Geometric Design Guide; TAC Geometric Design Guide; FHWA Roundabout: An Information Guide; NCHRP 572: Roundabouts in the United States, etc.

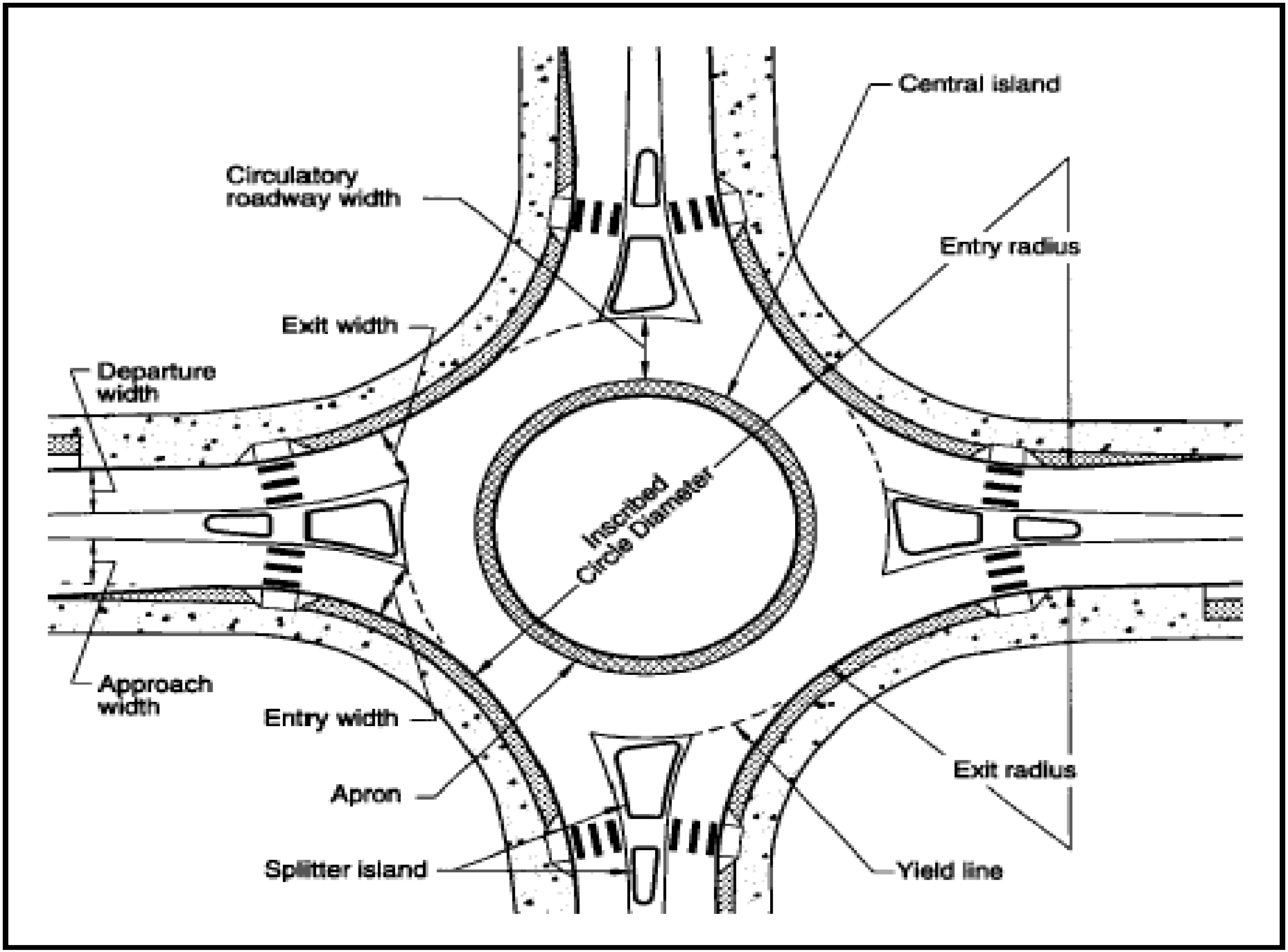


2010 FHWA Guide for Roundabouts*

- Kittleson & Associates, Inc. and TranSystems Corporation.
- Kansas Roundabout Guide: A Supplement to FHWA's Roundabouts: An Informational Guide. Kansas Department of Transportation, Topeka, KS, October 2003.

- * Not published yet (as of June 2010).

Geometric Design (cont)



Inscribed Circle Diameter

Site Category	Typical Design Vehicle	Inscribed Circle Diameter Range*
Mini-Roundabout	Single-Unit Truck	13–25m (45–80 ft)
Urban Compact	Single-Unit Truck/Bus	25–30m (80–100 ft)
Urban Single Lane	WB-15 (WB-50)	30–40m (100–130 ft)
Urban Double Lane	WB-15 (WB-50)	45–55m (150–180 ft)
Rural Single Lane	WB-20 (WB-67)	35–40m (115–130 ft)
Rural Double Lane	WB-20 (WB-67)	55–60m (180–200 ft)

* Assumes 90-degree angles between entries and no more than four legs.

Roundabouts: An Informational Guide, FHWA-RD-00-067
Published in 2000.

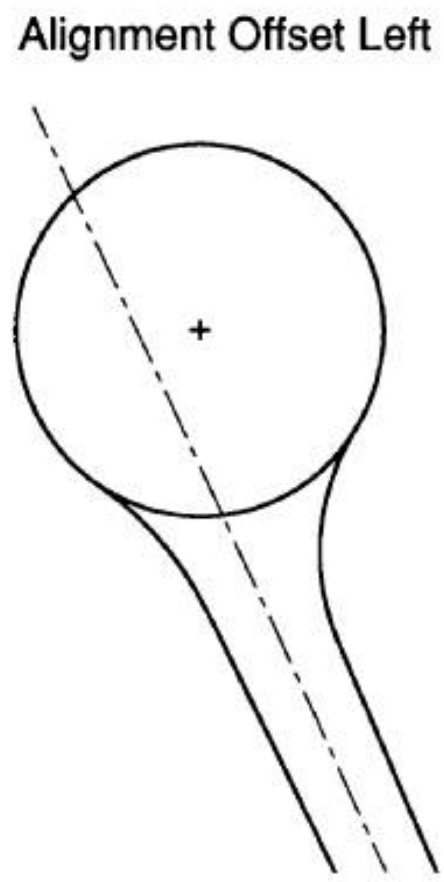
Table 69. Relationship between crashes and geometry, sorted on crash frequency.

	Crash Frequency (crashes/yr)	Crash Rate (crashes/MEV)	Average Number of Lanes in Group	Average Inscribed Circle Diameter	Average Daily Traffic (veh/day)	Average Number of Legs in Group
Total Dataset	4.95	0.75	1.39	133 ft (41 m)	16,606	3.89
First Ten	0.01	0.00	1.20	97 ft (30 m)	8,604	3.60
First Thirty	0.44	0.16	1.13	114 ft (35 m)	9,585	3.67
Bottom Thirty	12.13	1.59	1.83	162 ft (49 m)	23,935	4.13
Bottom Ten	22.89	2.64	2.20	215 ft (66 m)	28,300	4.30

Legend: MEV = million entering vehicles; veh = vehicles

Excerpted from NCHRP Report 572, "Roundabouts in the United States", published 2007.

Geometric Design (cont)



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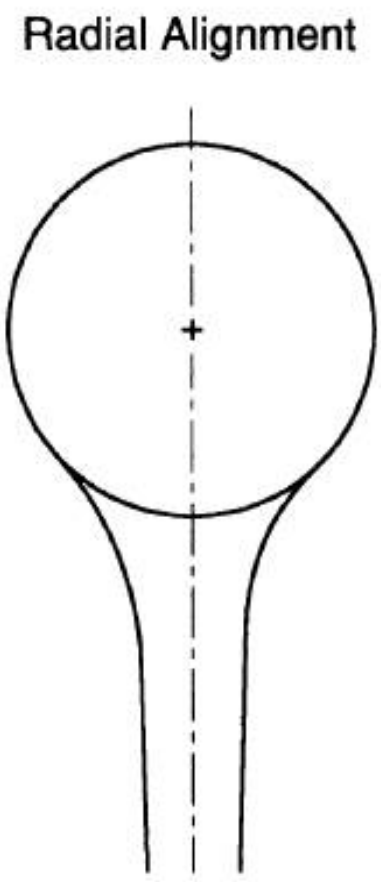

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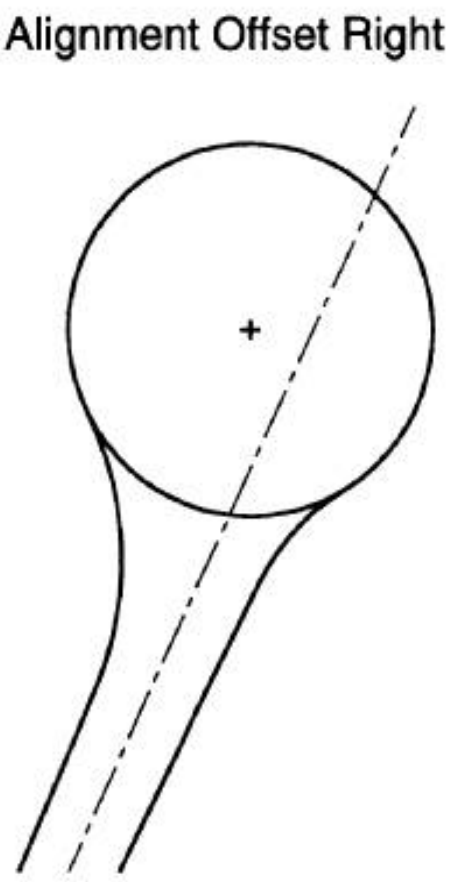

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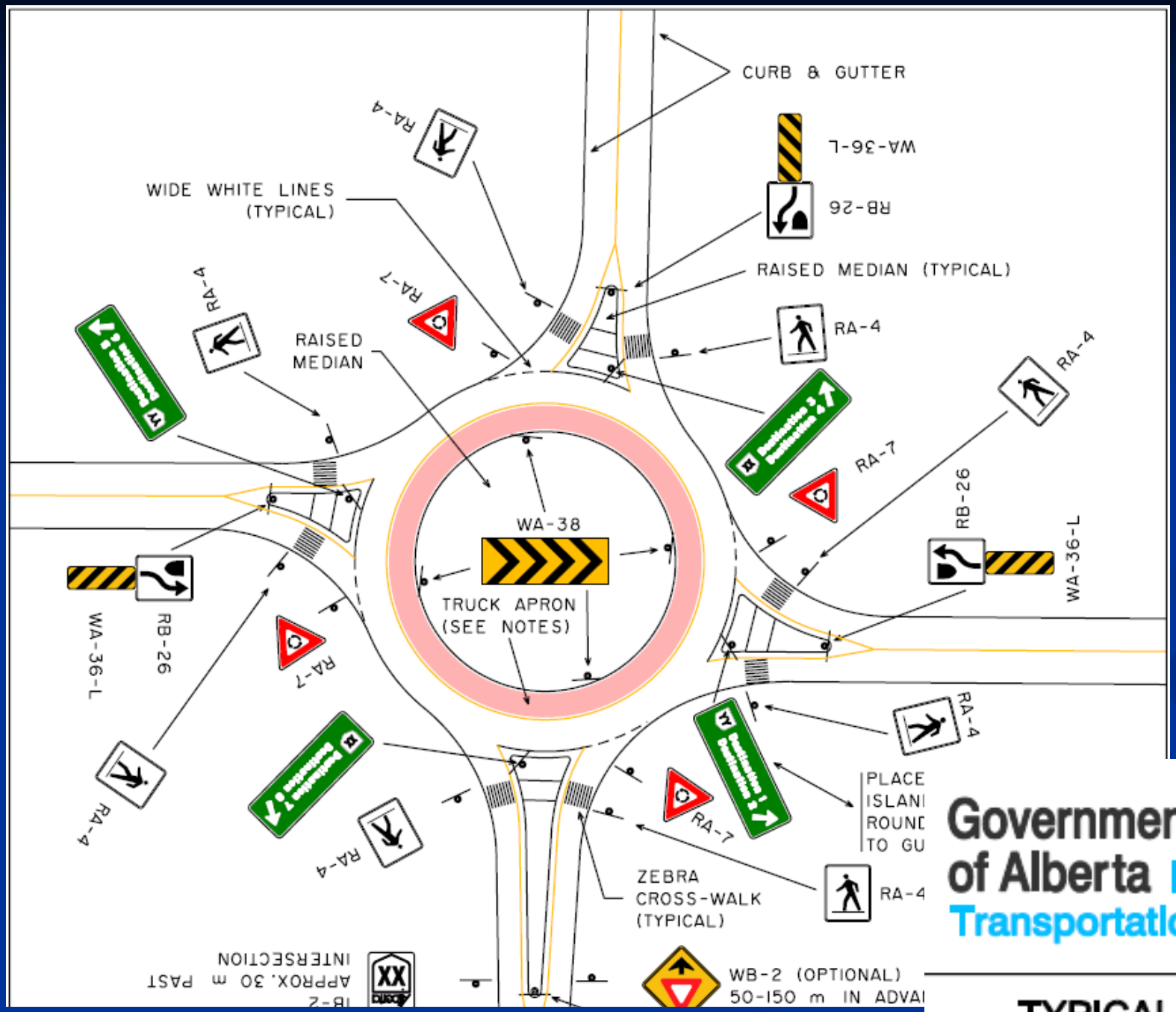

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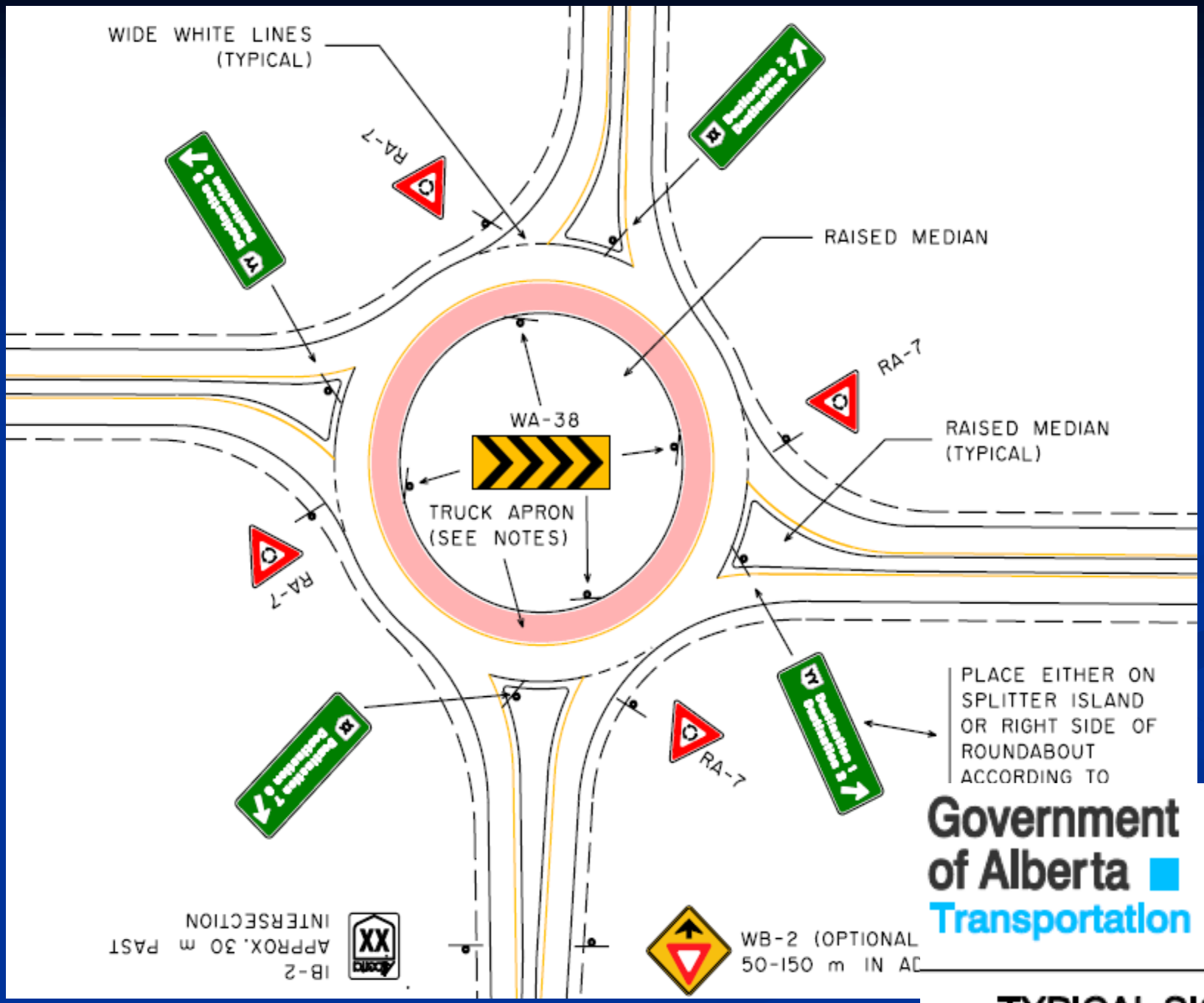
Date: June 2010

TYPICAL SIGNING AT SINGLE-LANE ROUNDABOUT (URBAN)



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TCS-A7-100.2

Date: June 2010

TYPICAL SIGNING AT SINGLE-LANE ROUNDABOUT (RURAL)

Traffic Control and Lighting (cont)

- All roundabouts should be adequately illuminated.
- Illumination should be designed in accordance with Chapter 11 of the Transportation Association of Canada "Guide for the Design of Roadway Lighting".

Recommendations

- The guidance as shown here is to be implemented immediately as per the usual practice.
- There is no change in Access Management practices as a result the use of roundabouts.

Answer to Question (next).

Roundabout Practice in France

- Before 1984 “yield to the right” was the rule.
- 1984, “yield on entry” was adopted.
- By 1997, 15,000 modern roundabouts were in operation.
- By 2010, approximately 40,000 roundabouts are in place.
- Other countries with many roundabouts: Britain, Germany, (most European countries), South Africa, Australia, New Zealand, Israel.

Questions?