

**17 Avenue SW In-Service
Road Safety Review**

Executive Summary



Prepared for:
The City of Calgary
Transportation - Roads

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EXECUTIVE SUMMARY

17 Avenue SW between Macleod Trail SE and 14 Street SW (see FIGURE ES.1) is scheduled for major road rehabilitation in 2016. The City has identified an opportunity to include safety improvements in the reconstruction project. Therefore, 17 Avenue was identified by the City as the subject on an In-service Road Safety Review (ISRSR). Additionally, the public realm between Macleod Trail and 4 Street SW has been identified for upgrades. As such, a special review of the active transportation infrastructure on the corridor was included in the In-Service Road Safety Review.



Figure ES.1 Study Area

The objective of an ISRSR is to identify ways of reducing the frequency and severity of collisions on a roadway. This ISRSR provides a unique opportunity to analyze traffic collisions, evaluate existing traffic operations, access management, geometry, conflicts, human factors and the identification of issues contributing to collision risk and countermeasures to mitigate these risks.

The review was conducted in accordance with industry best practices and The Canadian Guide to In-service Road Safety Reviews (Transportation Association of Canada, 2004).

The process included detailed site investigations were conducted to collect physical inventory and traffic operational data, and to observe vehicle and pedestrian safety and operations during various conditions.

ES.1 SAFETY ANALYSIS

A comprehensive safety analysis was conducted as a part of this exercise. The safety analysis consisted of five technical components:

1. Geometry – alignment, cross-section, accesses
2. Traffic operations – additional counts; travel time, capacity, vehicle and pedestrian delay and speed analysis; parking utilization
3. Collisions – for corridor, each major mode and for homogeneous segments. Additional analysis was conducted for 12 select intersections.
4. Traffic Conflicts – observations of close-calls at five selected intersections
5. Human Factors – review of driver expectations and encounters within each segment

Based on this analysis, issues contributing to the risk of collisions on the corridor, either at a whole, on particular segments or at specific intersections were identified. For each issue, short-term and long-term improvement options were identified. The improvements were then evaluated from a benefit-cost perspective.

For the purpose of the analysis, the corridor was divided into 4 relatively homogeneous segments, summarized in TABLE ES.1.

Table ES.1 Corridor Segments

	SEGMENT 4 (Richmond Road to 14 Street SW)	SEGMENT 3 (14 Street to 8 Street SW)	SEGMENT 2 (8 Street to 4 Street SW)	SEGMENT 1 (4 Street SW to Macleod Trail NB)
Primary Land Use	Residential Single-Family	Commercial, Residential High-rise	Commercial, Residential High-rise	Industrial
Development Density	Lowest	Higher	Highest	Lower
Operational Speeds	Highest	Lowest	Lowest	Higher
Pedestrian Activity	Lower	Higher	Highest	Lower
Parking Utilization	Lowest	Highest	Highest	Lower

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There were a total of 1,998 collisions along the corridor over the five-year period between 2009 and 2013, between Richmond Road SW and Macleod Trail SE, for an average of 400 per year. The frequency of collisions by year is shown in Figure ES.2, along with a breakdown by mode.

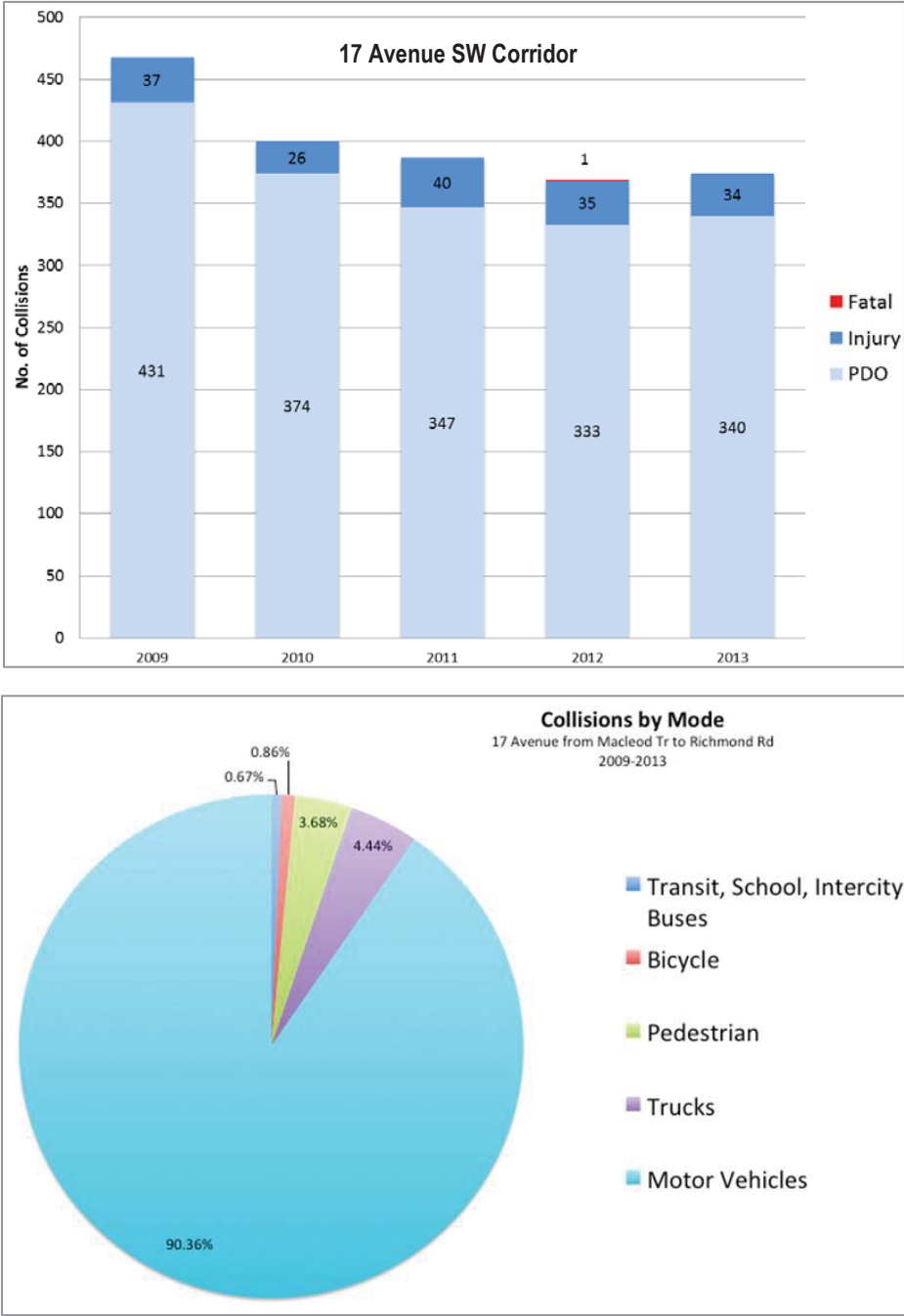


Figure ES.2 Collision Trends

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The 10 signalized intersections and 2 unsignalized intersections identified for further safety analysis are highlighted in TABLE ES.2 and ES.3, respectively.

Table ES.2 Identification Of Collision-Prone Signalized Intersections

INTERSECTION	NO. OF LEGS	AVERAGE ANNUAL COLLISION FREQUENCY	MEETS CITY'S CRITERIA?	COLLISION RATE PER MILLION ENTERING VEHICLES	MEETS CITY'S CRITERIA?	COLLISION SEVERITY INDEX	MEETS CITY'S CRITERIA?
Macleod Trail NB	3	6.2	Y	0.5	N	103	Y
1 Street SE (SB)	4	18.8	Y	1.3	Y	220	Y
1 Street SW	3	6.4	Y	1.0	N	113	Y
2 Street SW	4	9.2	Y	1.0	N	82	N
4 Street SW	4	23.4	Y	2.0	Y	225	Y
5 Street SW	4	14.6	Y	1.3	Y	118	Y
6 Street SW	3	4.4	Y	0.6	N	49	N
7 Street SW	4	8	N	1.0	N	76	N
8 Street SW	4	15.4	Y	1.5	Y	149	Y
9 Street SW	4	8.2	Y	1.1	Y	77	N
10 Street SW	4	9.6	Y	1.1	Y	75	N
11 Street SW East Leg	3	5.6	Y	0.7	N	154	Y
12 Street SW	4	6.6	N	0.8	N	78	N
14 Street SW	4	23.8	Y	1.8	Y	272	Y

Table ES.3 Identification Of Collision-Prone Unsignalized Intersections

INTERSECTION	NO. OF LEGS	AVERAGE ANNUAL COLLISION FREQUENCY	MEETS CITY'S CRITERIA?	COLLISION RATE	MEETS CITY'S CRITERIA?	COLLISION SEVERITY INDEX	MEETS CITY'S CRITERIA?
Centre Street	4	8.4	Y	1.3	Y	60	N
5A Street SW	3	1.8	Y	-		18	N
College Lane SW	3	0.8	Y	-		31	N
9A Street SW	3	1	Y	-		5	N
10A Street SW	3	1.2	Y	-		15	N
11 Street SW (West)	3	0.8	Y	0.1	N	22	N
13 Street SW	3	2.8	Y	0.4	N	41	N
14A Street SW	3	1.4	Y	0.2	N	7	N
15 Street SW (combined)	4	9.8	Y	1.0	N	102	Y
16 Street SW	3	4.2	Y	0.5	N	39	N
16A Street SW	3	3.4	Y	0.4	N	53	N
17A Street SW	4	1.8	Y	0.2	N	9	N
18 Street SW	3	1.4	Y	0.2	N	7	N
18A Street SW	3	0.4	Y	-		2	N
19 Street SW	3	3.0	Y	0.4	N	15	N
19A Street SW	3	1.0	Y	-		5	N
Scarboro Avenue SW	4	0.2	N	-		1	N
Scotland Street SW	3	0.4	Y	-		2	N
Summer Street SW	4	0.2	N	-		1	N

ES.2 ISSUES AND SUGGESTIONS

The extensive safety analysis led to the identification of safety issues. There are described in detail in the report, along with illustrative photographs. Issues were identified that pertain to:

- The length of the corridor
- Along specific segments
- At specific intersections

For each issue, suggestions were generated. These are summarized by location in FIGURES ES.3 through FIGURE ES.6.

To assist the City in evaluating and prioritizing the various improvement options for each intersection, a benefit-cost analysis was conducted. The cost estimates were conducted based on quantities identified by the review team and unit costs found in literature or developed by cost estimators on the study team. Benefits were estimated in terms of expected reductions in the target group of crashes the improvement was identified to address. The values for each improvement comes from sources, including:

- US Federal Highway Administration's Collision Modification Factors Clearinghouse;
- Highway Safety Manual (from AASHTO), and
- Alberta Transportation's Methods of Reducing Collisions on Alberta Roads (MORCOAR).

All collision reductions found in literature applied in a context-sensitive manner to each study intersection, based on the experience of the study team. Ranges were provided to account for uncertainty in the likely effectiveness. TABLE ES.4 provides an indication of the expected crash reductions associated with each of the identified corridor-wide improvement options, and TABLE ES.5 for the intersection-specific options.

TABLES ES.4 and ES.5 also show the conversion of estimated benefits to dollar values, and present the estimated costs and benefit-cost ratios over both one year and over the estimated service lives. The analysis shows that after one year, every enhancement would result in a benefit-cost of over 1.0. The corridor-wide enhancement with the highest B/C ratio is the reflective strip on primary signal head displays, with a B/C ratio of 13:1 to 26:1.

All of the intersection-specific enhancements are expected to yield a benefit-cost of over 1.0 within one year, with the exception of:

- Installing a full traffic signal at 17 Avenue and Centre Street. However, this has a return of over 1.0 within its 15-year service life. On this basis, the City may wish to first implement the alternative of the enhanced STOP sign.
- Restricting the southwest corner driveway at 5 Street to right-in / right-out access only. Since few collisions have been recorded although there may still safety benefits to this restriction to mitigate future incidents at this location.

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1.1 Minimize Tourist-Oriented Signs



2.2 Remove digital advertising on casino



3.5 Install traffic signal



Figure ES.3 Macleod Trail To Centre Street S.E.

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4.1 Enhanced Pedestrian Crosswalk Displays



5.1 Monitor Left-Turn Collisions
 5.2 Extend Left-Turn Restrictions to Evening Period
 5.3 Enforce Traffic Signal Control and Speed
 5.4 Consider Providing Leading Pedestrian Interval
 5.6 Review Feasibility of Scramble Phase



6.1 Revise Signal Timing



Figure ES.4 1 Street S.W. To 6 Street S.W.

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7.1 Increase Traffic Signal Conspicuity



8.4 Restripe Crosswalk paint or investigate new pavement marking material

8.6 No Right Turn on Red and/or Leading Pedestrian Interval

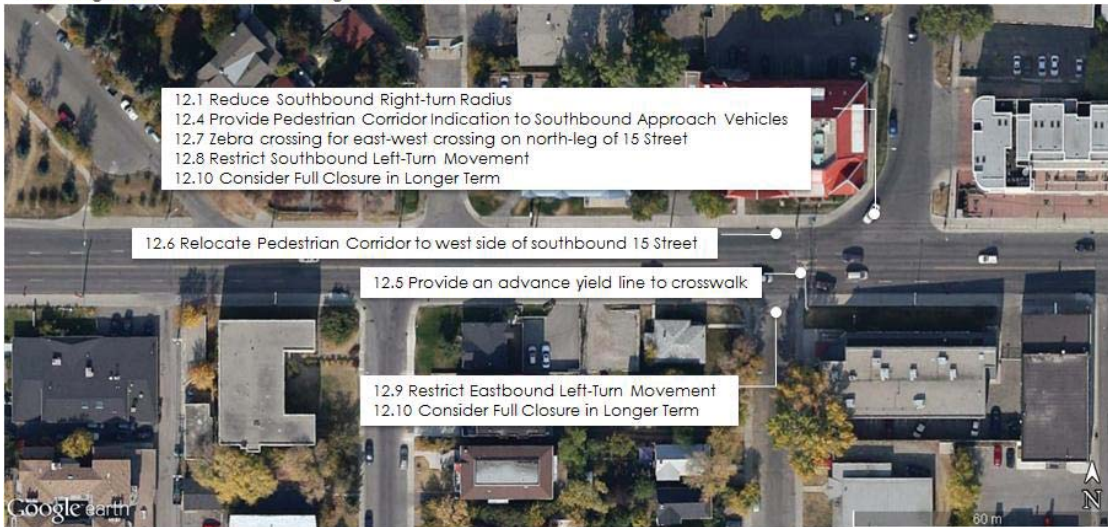


Figure ES.5 8 Street S.W. To 11 Street S.W.

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11.1 Signal Timing Enhancements
11.3 No Right Turn on Red and/or Leading Pedestrian Interval



12.2 Impose Access Restriction at 14 Street
12.3 Neighborhood Traffic Calming

Figure ES.6 12 Street S.W. To 15 Street S.W.



Table ES.5 Benefit Cost Analysis Results - Intersection Enhancements

No.	Location	Safety Enhancement	Cost	Target Collision Types	Injuries 5 yr	PDO 5 yr	CRF Low	CRF High	CRF Source	Annual Savings		Annual B/C		Life (Years)	Savings over Life		B/C over Life	
										Low	High	Low	High		Low	High	Low	High
5.5	17 Ave / 4 St	Mark Zebra Crosswalks Across N/S Approaches																
5.6	17 Ave / 4 St	Review Feasibility of Scramble Phase																
5.7	17 Ave / 4 St	Close Unused Driveways	\$15,000							\$ -	\$ -	0.0	0.0		\$0	\$0	0	0
5.8	17 Ave / 4 St	Impose Restrictions on Commercial Signs	n/a (policy change)															
5.9	17 Ave / 4 St	Repaint Centerline on Southbound Approach	\$400	All SB Approach	0	4	0.5	0.8	FHWA	\$ 5,240	\$ 8,384	13.1	21.0	2	\$10,480	\$16,768	26	42
5.10	17 Ave / 4 St	Require Permits for Extended Deliveries	n/a (policy change)															
5.12	17 Ave / 4 St	Convert Curb Lane on Northbound Approach to Right-Turn Only Lane	\$1,600	NB Rear End/SS	0	21	0.2	0.4		\$ 11,004	\$ 22,008	6.9	13.8	2	\$22,008	\$44,016	14	28
5.11	17 Ave / 4 St	Move northbound bus stop further north	\$2,000	NB Rear End/SS	0	21	0.1	0.2		\$ 5,502	\$ 11,004	2.8	5.5	5	\$27,510	\$55,020	14	28
5.2	17 Ave / 4 St	Extend LT restrictions to evening period	\$2,400	All LT	4	15	0.2	0.4		\$ 33,828	\$ 67,656	14.1	28.2	5	\$169,140	\$338,280	70	141
6.1	17 Ave / 5 St	Revise Signal Timing	n/a (staff time)															
6.5	17 Ave / 5 St	Upgrade to Zebra Crosswalk																
6.7	17 Ave / 5 St	Ensure this will be corrected as part of the pavement rehabilitation	n/a (part of reconstruction)															
6.8	17 Ave / 5 St	Install Leading Pedestrian Interval																
6.4	17 Ave / 5 St	Reduce Width of Yield Roadway and RT radius	\$30,000							\$ -	\$ -	0.0	0.0		\$0	\$0	0	0
6.6	17 Ave / 5 St	Enhanced Warning and Yield Lines	\$300							\$ -	\$ -	0.0	0.0		\$0	\$0	0	0
6.2	17 Ave / 5 St	Restrict Southwest Corner Driveway to Right-in / Right-Out	\$2,500	Collisions at dway	0	1	0.4	0.8		\$ 1,048	\$ 2,096	0.4	0.8	10	\$10,480	\$20,960	4	8
6.3	17 Ave / 5 St	Consolidate Southeast Corner Driveways	\$40,000	Collisions at dways	0	0	0.4	0.8		\$ -	\$ -	0.0	0.0	10	\$0	\$0	0	0
7.1	17 Ave / 8 St	Increase Traffic Signal Conspicuity	\$28,000	All	8	69	0.3	0.6	FHWA	\$ 132,138	\$ 264,276	4.7	9.4	15	\$1,982,070	\$3,964,140	71	142
7.2	17 Ave / 8 St	Review Compliance with Commercial Sign Bylaws	n/a (staff time)															
7.4	17 Ave / 8 St	Enforce Left-Turn Restrictions	n/a (enforcement)															
7.7	17 Ave / 8 St	Install Leading Pedestrian Interval for the east, west, and north crosswalks																
7.3	17 Ave / 8 St	Extend E/W Left-Turn Restrictions to 24/7	\$1,200	E/W LT	3	6	0.4	0.8		\$ 45,240	\$ 90,480	37.7	75.4	5	\$226,200	\$452,400	189	377
7.6	17 Ave / 8 St	Reduce Southbound Cross-section	\$32,000															
8.1	17 Ave / 9 St	Curb Extension on Southeast Corner	\$16,000															
8.2	17 Ave / 9 St	Zebra Crosswalks																
8.3	17 Ave / 9 St	Reconstruct Wheelchair Ramp	\$1,000															
8.4	17 Ave / 9 St	Restripe Crosswalk paint or investigate new pavement marking material																
8.5	17 Ave / 9 St	No Right Turn on Red and/or Leading Pedestrian Interval																
8.6	17 Ave / 9 St	No Right Turn on Red and/or Leading Pedestrian Interval																
9.1	17 Ave / 10 St	Restrict East/West Left-turn Movements	\$600	E/W RE/SS	0	26	0.5	1		\$ 34,060	\$ 68,120	56.8	113.5	5	\$170,300	\$340,600	284	568
9.2	17 Ave / 10 St	Monitor Northbound Traffic Volumes and Right Turn on Red Compliance	n/a (staff time)															
9.3	17 Ave / 10 St	Reconstruct walkway																
10.1	17 Ave / 11 St	Relocate Driveways	\$20,000	At driveways	0	1	0.4	0.8		\$ 1,048	\$ 2,096	0.1	0.1		\$0	\$0	0	0
11.1	17 Ave / 14 St	Signal Timing Enhancements	n/a (staff time)															
11.2	17 Ave / 14 St	Reduce Eastbound Cross-Section Prior to Intersection	\$25,000	EB RE & SS	3	18	0.2	0.4	HSM Segments	\$ 28,908	\$ 57,816	1.2	2.3		\$0	\$0	0	0

Table ES.5 Benefit Cost Analysis Results - Intersection Enhancements

No.	Location	Safety Enhancement	Cost	Target Collision Types	Injuries 5 yr	PDO 5 yr	CRF Low	CRF High	CRF Source	Annual Savings		Annual B/C		Life (Years)	Savings over Life		B/C over Life	
										Low	High	Low	High		Low	High	Low	High
11.3	17 Ave / 14 St	No Right Turn on Red and/or Leading Pedestrian Interval																
12.3	17 Ave / 15 St	Neighborhood Traffic Calming	n/a (highly variable)															
12.4	17 Ave / 15 St	Provide Pedestrian Corridor Indication to Southbound Approach Vehicles	\$200	Ped Collisions	0	2	0.5	1		\$ 2,620	\$ 5,240	13.1	26.2	15	\$39,300	\$78,600	197	393
12.5	17 Ave / 15 St	Provide an advance yield line to crosswalk																
12.6	17 Ave / 15 St	Zebra crossing for east-west crossing on north-leg of 15 Street																
12.8	17 Ave / 15 St	Consider Full Closure in Longer Term (right-in only)	\$27,000	All SB Approach	2	27	0.4	0.8		\$ 54,264	\$ 108,528	2.0	4.0	20	\$1,085,280	\$2,170,560	40	80
12.1	17 Ave / 15 St	Reduce Southbound Right-turn Radius	\$10,000							\$ -	\$ -	0.0	0.0		\$0	\$0	0	0
12.7	17 Ave / 15 St	Convert SB approach to RIRO	\$18,000							\$ -	\$ -	0.0	0.0		\$0	\$0	0	0
12.2	17 Ave / 15 St	Discourage SBRT at 14 Street and 16 Avenue	\$14,000	All SB Approach	2	27	0.2	0.4		\$ 27,132	\$ 54,264	1.9	3.9	20	\$542,640	\$1,085,280	39	78

ES.3 IMPLEMENTATION STRATEGY

The enhancements estimated to be the most effective and first implemented are summarized in TABLE ES.6 for corridor-wide enhancements and TABLE ES.7 for intersection-specific enhancements. The measures are divided into short-, medium- and long-term, based on costs and cost-benefit ratios. It is assumed that short-term can be conducted as part of operational budgets, that medium-term can be budgeted for the next 1-2 fiscal years, and the long-term need to be programmed for year 3 into the future or later. It is, however, hoped and assumed that some of the medium and longer term enhancements can also be incorporated as part of the reconstruction scheduled for 2016.

Regarding the most significant safety and operational issue – the westbound curb lane crosssection, it is recommended that Option 1 – to shift the lanes after the pavement overlay, to provide an extra 0.3 metres so that the travel portion of the shared lane can be properly used when parked vehicles are present.

Table ES.6 Corridor-Wide Enhancements - Implementation Strategy

SHORT-TERM (WITHIN ANNUAL OPERATING BUDGETS)	MEDIUM-TERM (1-2 YEAR CAPITAL BUDGETS)	LONG-TERM (3 OR MORE YEARS AWAY)
Public Awareness and Enforcement based on Collision Trends	Provide reflective border for signal heads	Gateway Treatments
More Regular Painting	More Durable Pavement Markings	Create Taxi Areas
Discourage Digital Advertising	Commercial Signing Regulations	
Wash Signal Backboards	Replace signal backboards as required	
Provide consistency in sign placement	High-Friction Pavement Treatments	
Upgrade smaller street name signs	Bury utility cables (with reconstruction)	
Remove unnecessary parking signs	Develop customized no parking signs	
Re-stripe paint for all crosswalks along the corridor	Apply more durable pavement markings	
Update pedestrian crossing lights and signs	Install pedestrian actuated crossing lights	

To reinforce and supplement the engineering initiatives in this report, the following educational and enforcement initiatives are identified for the City's consideration:

- Jaywalking: To address the jaywalking issue, it is suggested that the City and police supplement upgrades to pedestrian infrastructure with public campaigns that include messages to discourage jaywalking.
- Cycling in crosswalks and on sidewalks: With most cyclists not dismounting to cross at crosswalks, education and enforcement initiatives may encourage cyclists to act like vehicles or pedestrians in the vicinity of intersections, in the absence of cycling facilities through intersections.



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Table ES.7 Intersection Enhancements - Implementation Strategy

INTERSECTION	SHORT-TERM (WITHIN ANNUAL OPERATING BUDGETS)	MEDIUM-TERM (1-2 YEAR CAPITAL BUDGETS)	LONG-TERM (3 OR MORE YEARS AWAY)
17 Ave / MacLeod Trail	Minimize tourist-oriented signs		
17 Ave / 1 St SE	Remove digital advertising on casino Review red light violation and speed data	Install red light camera on eastbound approach Provide larger eastbound/westbound AND southbound signal heads	
17 Ave / Centre St	Encourage parking on Centre Street approaches Markings on north/south approaches Improve sight lines	Curb extensions with enhanced stop sign location	Install full traffic signal
17 Ave / 1 St SW	Not quantified	Not quantified	Not quantified
17 Ave / 4 St	Monitor Left-Turn Collisions Enforce Traffic Signal Control and Speed Repaint Centerline on Southbound Approach Extend LT restrictions to evening period	Require Permits for Extended Deliveries Convert Curb Lane on Northbound Approach to Right-Turn Only Lane Move northbound bus stop further north	
17 Ave / 5 St	Revise Signal Timing		Restrict Southwest Corner Driveway to RIRO Consolidate Southeast Corner Driveways
17 Ave / 8 St	Increase Traffic Signal Conspicuity Review Compliance with Commercial Sign Bylaws	Extend E/W Left-Turn Restrictions to 24/7 Enforce Left-Turn Restrictions	
17 Ave / 9 St	Not quantified	Not quantified	Not quantified
17 Ave / 10 St	Restrict East/West Left-turn Movements		
17 Ave / 11 St			Relocate Driveways
17 Ave / 14 St	Signal Timing Enhancements	Reduce Eastbound Cross- Section Prior to Intersection	
17 Ave / 15 St	Provide Pedestrian Corridor Indication to Southbound Approach Vehicles	Discourage SBRT at 14 Street and 16 Avenue	Neighborhood Traffic Calming Consider Full Closure (or right-in only)