17 Avenue SW In-Service Road Safety Review

Executive Summary



Prepared for: The City of Calgary Transportation - Roads

Prepared by: Stantec Consulting Ltd. TranSafe Consulting Ltd.

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.



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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.

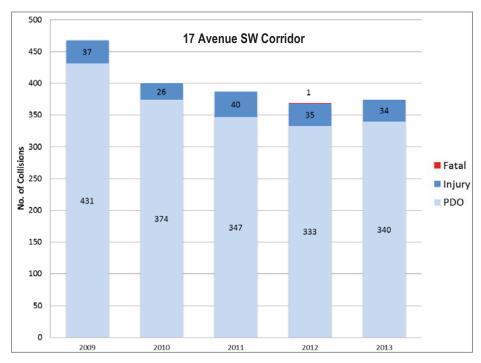
For the purpose of the analysis, the corridor was divided into 4 relatively homogeneous segments, summarized in TABLE ES.1.

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



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.



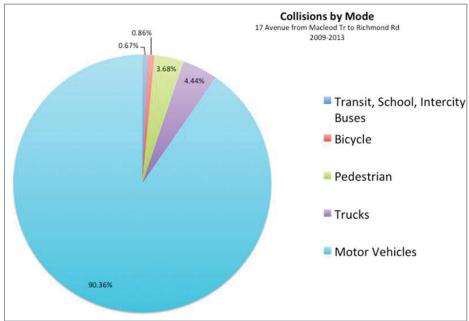


Figure ES.2 Collision Trends



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	Υ	0.5	Ν	103	Υ
1 Street SE (SB)	4	18.8	Υ	1.3	Υ	220	Υ
1 Street SW	3	6.4	Υ	1.0	Ν	113	Υ
2 Street SW	4	9.2	Υ	1.0	Ν	82	N
4 Street SW	4	23.4	Υ	2.0	Υ	225	Υ
5 Street SW	4	14.6	Υ	1.3	Υ	118	Υ
6 Street SW	3	4.4	Υ	0.6	Ν	49	N
7 Street SW	4	8	Ν	1.0	Ν	76	N
8 Street SW	4	15.4	Υ	1.5	Υ	149	Υ
9 Street SW	4	8.2	Υ	1.1	Υ	77	N
10 Street SW	4	9.6	Υ	1.1	Υ	75	N
11 Street SW East Leg	3	5.6	Υ	0.7	Ν	154	Υ
12 Street SW	4	6.6	N	0.8	Ν	78	N
14 Street SW	4	23.8	Υ	1.8	Υ	272	Υ

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	Υ	1.3	Υ	60	N
5A Street SW	3	1.8	Υ	-		18	Ν
College Lane SW	3	0.8	Υ	-		31	N
9A Street SW	3	1	Υ	-		5	N
10A Street SW	3	1.2	Υ	-		15	N
11 Street SW (West)	3	0.8	Υ	0.1	Ν	22	N
13 Street SW	3	2.8	Υ	0.4	Ν	41	N
14A Street SW	3	1.4	Υ	0.2	Ν	7	N
15 Street SW (combined)	4	9.8	Υ	1.0	N	102	Υ
16 Street SW	3	4.2	Υ	0.5	Ν	39	N
16A Street SW	3	3.4	Υ	0.4	Ν	53	N
17A Street SW	4	1.8	Υ	0.2	Ν	9	N
18 Street SW	3	1.4	Υ	0.2	Ν	7	N
18A Street SW	3	0.4	Υ	-		2	N
19 Street SW	3	3.0	Υ	0.4	Ν	15	N
19A Street SW	3	1.0	Υ	-		5	N
Scarboro Avenue SW	4	0.2	N	-	<u> </u>	1	N
Scotland Street SW	3	0.4	Υ	-	<u> </u>	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.





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.



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
- 6.4 Reduce Width of Yield Roadway 6.5 Upgrade to Zebra Crosswalk
 6.6 Enhanced Warning and Yield Lines 6.7 Ensure uneven crosswalks will be corrected as part of the pavement rehabilitation 6.8 Install Leading Pedestrian Interval 6.2 Restrict Driveway to Right-in / Right-Out 6.3 Consolidate Driveways

6.1 Revise Signal Timing



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



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



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





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.4 Benefit Cost Analysis Results - Corridor Wide Enhancements

Safahila	Safah, Enha	DL-II-	O !"	C	C1/ "	01	Target	Ind:!	pp.c	CDF	CDF	CDF		Ann			Angual 5 / 2		122		Sanda ···			B/C a!"	$\overline{}$
Safety Issue	Safety Enhancement	Details	Quantity	Comments	Cost/unit	Cost	Collision Types	Injuries 5 yr	PDO 5 yr	CRF Low	CRF Mid	CRF High	Low	Annual Saving Mid	gs High	Low	Annual B/C Mid	High	Life (Years)	Low	Savings over Lif Mid		Low	B/C over Life Mid	High
Risk of higher speeds with re-paved road	Provide lower design speeds Consider providing lower posted	Don't estimate - general comment Don't estimate separately - part of lower				Highly Variable Part of design speed																			
1	speed limit	design speed (above)				option																			
	Provide Gateway Treatments	Oversize speed limit signs on each approach, curb extension on both sides	2	New sign and post, remove asphalt and curb, new curb and sidewalk	\$16,000	\$32,000	All	172	1825	0.01		0.02	\$ 103,64	6	\$ 207,292	3.2		6.5	20	\$ 2,072,924	ļ	\$ 4,145,848	65		130
	High-Friction Pavement Treatment	https://www.fhwa.dot.gov/everydaycounts/ed ctwo/2012/pdfs/fhwa-cai-14- 019 fags hfst mar2014 508.pdf				\$300,000	All	172	1825	0.02		0.04	\$ 207,29	2	\$ 414,585	0.7		1.4	10	\$ 2,072,924		\$ 4,145,848	7		14
Insufficient width of shared westbound curb lane	Option 1: Shift Lanes to provide more space for travel in westbound shared lane														,					, ,,,,,,,,		1,7:10,10:10	·		
	Option 2: Remove westbound parking lane																								
	Option 3: Expand cross-section to more safely accommodate existing lanes																								
Aggressive/impaired road user behavior	Public Awareness Campaigns Enforcement	Don't estimate - highly variable Don't estimate - highly variable				Highly Variable Highly Variable																			
	Create Taxi Areas	Remove 2-3 parking signs and street furniture in- between, place new signs for taxi stand		Remove signs and furniture, install new signs	0.00	\$2,400	All RE/SS	45	0.75	0.005		0.04		,	4 07.500	7.0		45.4		4 075 000		A 750.440	457		
Quality of pavement	More regular painting	Paint the whole section one additional time	4	Repaint 17 Ave corridor from	\$600			45	875	0.005		0.01	\$ 18,76	b	\$ 37,532			15.6	20	\$ 375,320	1	\$ 750,640	156		313
markings		each year http://www.transportation.alberta.ca/Content	1	14 Street to MacLeod	\$10,000	\$10,000	All						\$ -		\$ -	0.0		0.0	2	\$ -		\$ -	0		0
Distraction from Roadside		/docType253/Production/PAVEMENTMARKINGS. pdf	-			\$40,000	All	172	1825	0.01		0.02	\$ 103,64	6	\$ 207,292	2.6		5.2	5	\$ 518,231		\$ 1,036,462	12.955775		26
Advertising	Commercial Signing Regulations	Don't estimate - policy change				Policy change																			
	Discourage Digital Advertising Displays	Don't estimate - policy change				Policy change																			
Inconsistency in signal head design	Upgrade signal head design to provide 12" heads at major intersections	Don't estimate - only for major intersections, part of location-specific estimates				See intersection suggestions																			
Visibility of signal head backboards	Wash or replace signal backboards	Don't estimate - should already be part of City's program				Part of City's program																			
	Provide reflective strip along border	For all primary heads at all intersections (15 int x 8 heads)	120	Price per signal head	\$100	\$12,000	All intersection collisions	135	931	0.05		0.1	\$ 341,06	6	\$ 682,132	28.4		56.8	10	\$ 3,410,660		\$ 6,821,320	284		568
Inconsistency in street name signing	Provide consistency in sign placement			Remove sign and post, re- install post and sign, for each			All intersection																		
	Upgrade smaller signs at east and	Assume 2 signs on each intersection approach	8	intersection Remove sign, install new sign,	\$400	\$3,200	collisions All collision s	135	931	0.005		0.01	\$ 34,10	7	\$ 68,213	10.7		21.3	10	\$ 341,066		\$ 682,132	107		213
	west ends	At 14 St, 1 St SE and Macleod (3 intersections)	6	2 per intersection for 3 intersections	\$300	\$1,800	at 3 intersections	38	213	0.005		0.01	\$ 8,95	В	\$ 17,915	5.0		10.0	10	\$ 89,577	,	\$ 179,154	50		100
Fixed objects within clear High workload parking		Don't estimate - part of re-construction Don't estimate - too variable and difficult to				Part of reconstruction																			
restriction signs	Remove the more "obvious" signs Consolidate information on	estimate benefit Don't estimate - too variable and difficult to				Highly Variable																			
Uneven sidewalk surface	customized sign	estimate benefit Don't estimate - too variable and difficult to				Highly Variable																			
	Sidewalk reconstruction	estimate benefit Don't estimate - too variable and difficult to				Highly Variable																			
Driveways	Sidewalk Condition Assessment	estimate benefit				Highly Variable																			
				Fisher of Cook floor decreasing an																					
				Extend Curb/landscaping on private property,remove				No doto	No doto																
	Reduce Number of Driveways		1	driveways,rebuild concrete curb and sidewalk	\$40,000	\$40,000		No data available			0.25														
				Extend Curb/landscaping on private property,remove																					
	Reconstruct driveways		1	driveways,rebuild concrete curb and sidewalk	\$40,000	\$40,000			No data available	No (data availa	ble													
	Keep sightlines clear	Don't estimate - too variable and difficult to estimate benefit																							
				Extend Curb/landscaping on private property,remove																					
	Reconstruct unused driveways		1	driveways,rebuild concrete curb and sidewalk	\$40,000	\$40,000		No data available	No data	No.	data availa	ble													
Blocked walkway through				bus stop furniture (shelter,	\$4U,UUU	940,000		Svanable	avaliable	INO (uata dVällä	DIE													
zone				bench, garbage can)\$5000/shelter,\$1500/ben				No data																	
	Bus stop redesign	Use different bus stop furniture Don't estimate - too variable and difficult to	1	ch,\$500/garbage can	\$7,000	\$7,000		available	available	No	data availa	ble													
Un-marked crossings	Street Furniture relocation	estimate benefit Don't estimate - too variable and difficult to				Highly Variable																			
	Add signage	estimate benefit http://www.transportation.alberta.ca/Content				Highly Variable																			
	Create marked crossing	/docType253/Production/PAVEMENTMARKINGS.pdf																							
	Use Zebra Crossings	http://www.transportation.alberta.ca/Content /docType253/Production/PAVEMENTMARKINGS. pdf	=																						
Faded crosswalks		http://www.transportation.alberta.ca/Content /docType253/Production/PAVEMENTMARKINGS.	-																						
	More regular painting	http://www.transportation.alberta.ca/Content																							
	More durable pavement markings	/docType253/Production/PAVEMENTMARKINGS. pdf	-																						

Table ES.4 Benefit Cost Analysis Results - Corridor Wide Enhancements

				T.		ı																		
Safety Issue	Safety Enhancement	Details	Quantity	Comments	Cost/unit	Cost	Target Collision Inj	uries PDO	CRF	F CRF	CRF		Annual Saving	5		Annual B/C		Life		Savings over Life			B/C over Life	
								yr 5 yr	Low	v Mid	High	Low	Mid	High	Low	Mid	High	(Years)	Low	Mid	High	Low	Mid	High
		http://www.transportation.alberta.ca/Content/docType253/Production/PAVEMENTMARKINGS.																						
	Change pavement marking type																							
Curb ramps angled			-				Peestrian																	
	Reconstruct curb ramps			ove one wheelchair , install 2 new ramps	\$16,000	\$16,000	collisions at inersections	2 0		No data availal	ole													
Curb ramp transition to				-	,																			
roadway	Reconstruct curb ramp area																							
Turning speed due to curb radii			Require	es the removal of curb,																				
			asph	nalt and wheelchair																				
	Reduce curb radii		ram 1 w	np, new curb and wheelchair ramp	\$14,000	\$14,000		data No data ilable availab		No data availal	alo													
	Reduce carb radii				\$14,000	\$14,000	ava	ilabic availab		NO Uata avallal	Jie													
				ve curb, asphalt and chair ramp, new curb,																				
				crete sidewalk and																				
				chair ramp, \$17000 for oad, \$27000 for both			No	data No data	а															
0 1 11	Introduce curb extensions		1	roads	\$27,000	\$27,000	ava	ilable availab	le	No data availal	ole													
Crossing distance across 1 Avenue	Curb Extensions																							
Lighting		Don't estimate - too variable and difficult to																						
1	Lighting study	estimate benefit Don't estimate, too variable and difficult to																						
1	Use pedestrian-oriented lighting	Don't estimate - too variable and difficult to estimate benefit																						
Pedestrians at intersection	Leading pedestrian interval	Don't estaimte - staff time																						
1	Crossing time review	Don't estaimte - staff time																						
			Count	down timer on each roach of crosswalk,			Pedestrians at																	
			replace	e the pedestrian signal		40.000	intersections																	
	Countdown timers		8 hea	ad, 8/intersection	\$1,000	\$8,000	with signal	40 14	0.001	16	0.7	\$ 2,136		\$ 934,556	0.3		116.8	15	\$ 32,042		\$ 14,018,340	4		1752
			raise	intersection to curb				data No data																
	Raised Intersections		1 heigh	t, price /intersection	\$200,000	\$200,000	ava	ilable availab	le I	No data availal	ole													
Pedestrians jaywalking from parked vehicles							D- d- di-																	
, , , , , , , , , , , , , , , , , , , ,			Remov	ve asphalt, new curb			Pedestrians jaywalking -																	
	Madian instead of parked vehicles			oncrete median.Price	****	¢120.000	collisions with		0.44		0.7	40 470												45
Jaywalking at Midblock	Median instead of parked vehicles Pedestrian improvements at		1	/100m of road	\$120,000	\$120,000	automobiles	4 0	0.14	4	0.7	\$ 18,178		\$ 90,888	0.2		0.8	20	\$ 363,552		\$ 1,817,760	3		15
Locations	intersections																							
	Physically prevent jaywalking Enforcement	Don't estaimte - staff time				Staff time																		
Bicycles riding through	Enforcement	http://www.transportation.alberta.ca/Content				Stall tille																		
crosswalks		/docType253/Production/PAVEMENTMARKINGS.																						
Sidewalk bicycle riding	Install Crossrides	<u>pdf</u>																						
sidewalk bicycle fiding				nillions/km between eod and 14 Street, 1.0																				
	47.4		million/k	km west of 14 Street to		*7.0F0.000																		
	17 Avenue Bicycle Facility			Richmond Road 0,000/km for the same	\$7,350,000	\$7,350,000		0 0		No data availal	ole													
	Parallel Route Bicycle Facility		1	length	\$720,000	\$720,000		0 0		No data availal	ole													
Visibility of crosswalk																								
	Update pedestrian crossing lights			rian actuated crossing hing lights, NOT half			Pedestrians at intersections																	
	Update pedestrian crossing lights and signs		1	signal)	\$85,000	\$85,000		5 2	0.19	9	0.4	\$ 31,833		\$ 67,016	0.4		0.8	15	\$ 477,489		\$ 1,005,240	6		12
Poor drainage			Nove	curb and 3m sidewalk			No.	data No data	a															
	Upgrade curb and gutter design		1 New C	for 100m	\$100,000	\$100,000		ilable availab		No data availal	ole													
Eastbound sign clutter	Simplify parking regulation signs					Staff time																		
towards east end of corridor	Remove non-essential commercia signs	Il Don't estimate - policy change				Policy change																		
		and the systematic				,																		
Collisions between 4 and 5 Streets	Consider Revisions to Parking Restrictions	Don't estimate - policy change				Policy change																		
Overhead Lighting		Don't estimate - policy change Don't estimate - too variable and difficult to				rolley change																		
J . J	Provide transition lighting	estimate benefit				Highly Variable																		
	Consider providing more pedestrian-friendly overhead	Don't estimate - too variable and difficult to																						
	lighting	estimate benefit				Highly Variable																		
Snow and ice	Review snow clearing priority	Don't estaimte - staff time				General																		
Access Management	Encourage lower speeds	Don't estimate - general comment																						
towards west end of	Conduct access management																							
corridor	review along Segment 4	Don't estaimte - staff time				Staff time																		
Sight lines at some intersections obstructed by	/ Trim trees																							
trees or poles		Don't estaimte - staff time				Staff time																		

Table ES.5 Benefit Cost Analysis Results - Intersection Enhancements

No. Location	Safety Enhancement	Cost	Target Collision	Injuries	PDO	CRF	CRF	CRF	Annual	Savings	Annu	ial B/C	Life	Savinas	over Life	B/C ov	er Life
	,		Types	5 yr	5 yr	Low	High	Source	Low	High	Low	High	(Years)	Low	High	Low	High
1.1 17 Ave / MacLeod Trail	Minimize tourist-oriented signs	\$200	WB All	1	5	0.05	0.1		\$ 2,278	\$ 4,556	11.4	22.8	5	\$11,390	\$22,780	57	114
	Reconstruct Northwest and Southwest curb																
1.2 17 Ave / MacLeod Trail	radii	\$2,000							\$ -	\$ -	0.0	0.0		\$0	\$0	0	0
	Install Leading Pedestrian Interval for west																
1.3 17 Ave / MacLeod Trail	crosswalk																
	Reconstruct walkway																
1.4 17 Ave / MacLeod Trail	Neconstruct warkway	\$17,000							\$ -	\$ -	0.0	0.0		\$0	\$0	0	0
	Restripe Crosswalk paint or investigate new																
17 Ave / Marel and Trail	pavement marking material																
1.5 17 Ave / MacLeod Trail	, ,																
2.2 17 Ave / 1 St SE	Remove digital advertising on casino	n/a (policy decision)															
2.3 17 Ave / 1 St SE	Install red light camera on eastbound	¢21.000	EB Right Angle	_	0.1	0.0	0.4	ELIVA / A	¢ 40.704	¢ 07.400	1 /	2.1	4.5	¢720 F/0	¢1 4/1 100	2.4	47
2.3 17 Ave / 1 St SE 2.4 17 Ave / 1 St SE	approach	\$31,000 n/a (enforcement)	EB RIGHT Angle	5	31	0.2	0.4	FHWA	\$ 48,704	\$ 97,408	1.6	3.1	15	\$730,560	\$1,461,120	24	47
2.4 17 AVC / 13t 3E	Conduct speed enforcement	n/a (enforcement)															
2.6 17 Ave / 1 St SE	Reduce southbound approach width	\$14,000	SB Right Angle	9	38	0.2	0.4	HSM Segments	\$ 78,340	\$ 156.680	5.6	11.2	20	\$1,566,800	\$3,133,600	112	224
2.0		ψ14,000		,	30	0.2	0.4	How beginerits	Ψ 70,540	\$ 130,000	3.0	11.2	20	\$1,500,000	\$3,133,000	112	227
2.7 17 Ave / 1 St SE	Review red light violation and speed data	n/a (staff time)															
	Install Leading Pedestrian Interval for west	= (-1.2															
2.8 17 Ave / 1 St SE	and south crosswalk																
2.9 17 Ave / 1 St SE	Reconstruct walkway																
	j																
	Restripe Crosswalk paint or investigate new																
2.10 17 Ave / 1 St SE	pavement marking material																
2.11 17 Ave / 1 St SE	Reconstruct wheelchair ramp	\$2,000							\$ -	\$ -	0.0	0.0		\$0	\$0	0	0
2.12 17 Ave / 1 St SE	Restrict Right-Turns on Red Lights																
	Provide larger eastbound/westbound																
2.1 17 Ave / 1 St SE	signal heads	\$14,000	E/W Right Angle	9	38	0.3	0.6	FHWA	\$ 117,510	\$ 235,020	8.4	16.8	15	\$1,762,650	\$3,525,300	126	252
2.5 17 Ave / 1 St SE	Provide larger southbound signal heads	\$10,500	SB Right Angle	9	38	0.3	0.6	FHWA	\$ 117,510	\$ 235,020	11.2	22.4	15	\$1,762,650	\$3,525,300	168	336
17.4 (0 1 6)	Reduce north/south approach width		All D' LLA														
3.1a 17 Ave / Centre St 3.1b 17 Ave / Centre St	` `	\$28,000	All Right Angle All Right Angle	3	21	0.2	0.4	HSM Segments		\$ 60,960	1.1	2.2	20	\$609,600	\$1,219,200	22	44
	Introduce parking	\$1,000	All Right Angle	3	21	0.1	0.2		\$ 15,240		15.2	30.5	5	\$76,200	\$152,400	76	152
3.2 1/ Ave / Centre St 3.4 17 Ave / Centre St	Markings on north/south approaches	\$600	All Right Angle	3	21	0.05	0.1		\$ 7,620	\$ 15,240	12.7	25.4	2	\$15,240	\$30,480	25	51
3.4 17 AVC / Gentie 3t	Improve sight lines	n/a (private property)															
3.6 17 Ave / Centre St	Change direction of signs	\$1,600	Pedestrian	0	0				\$ -	\$ -	0.0	0.0	5	\$0	\$0	0	0
3.7 17 Ave / Centre St	Reconstruct walkway	\$1,000	1 caestilai1	0	0				φ -	Ψ -	0.0	0.0	3	\$ 0	Φ0	0	0
3.7	Reconstruct warkway																
	Restripe Crosswalk paint or investigate new																
3.8 17 Ave / Centre St	pavement marking material																
3.5 17 Ave / Centre St	Install traffic signal	\$300,000	All collisions	4	39	0.25	0.5	FHWA	\$ 58.005	\$ 116,010	0.2	0.4	15	\$870,075	\$1,740,150	2.9	5.8
					- /					,				,			
3.3 17 Ave / Centre St	Provide median-mounted STOP Sign	\$2,000	All Right Angle	3	21	0.1	0.2		\$ 15,240	\$ 30,480	7.6	15.2	15	\$228,600	\$457,200	114	229
	Enhanced Deduction Co. 11 St. 1																
4.1 17 Ave / 1 St SW	Enhanced Pedestrian Crosswalk Displays																
4.2 17 Ave / 1 St SW	Increase Crosswalk Visibility																
4.3 17 Ave / 1 St SW	Provide Leading Pedestrian Interval																
	Reconfigure Laning on Southbound																
4.4 17 Ave / 1 St SW	Approach																
4.5 17 Ave / 1 St SW	Close Crosswalk																
17 6:- /10:04	Relocate signal box outside of through																
4.6 17 Ave / 1 St SW	walkway zone																
4.7 17 Ave / 1 St SW	Reconstruct corner	¢14.000							.	.	0.0	0.0		40	40	0	0
	Manathan Laft Time Call'	\$14,000							\$ -	\$ -	0.0	0.0		\$0	\$0	0	0
5.1 17 Ave / 4 St	Monitor Left-Turn Collisions	n/a (staff time)															
5.3 17 Ave / 4 St	Enforce Traffic Signal Control and Speed	n/a (enforcement)															
3.3 17,007 4 30	Consider Providing Leading Pedestrian	пла (еппогсеппени)															
5.4 17 Ave / 4 St	Interval																
3.7	morvai																

Table ES.5 Benefit Cost Analysis Results - Intersection Enhancements

No.	Location	Safety Enhancement	Cost	Target Collision	Injuries	PDO	CRF	CRF	CRF	Annu	ıal Savin	ngs	Annu	ial B/C	Life	Savings	over Life	B/C ov	er Life
				Types	5 yr	5 yr	Low	High	Source	Low	ŀ	High	Low	High	(Years)	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	\$ 5,24	10 \$	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		\$ 11,00)4 \$	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		\$ 5,50)2 \$	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		\$ 33,82	28 \$	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)																
	17 Ave / 5 St	Upgrade to Zebra Crosswalk	ii/a (stall tillle)																
		Ensure this will be corrected as part of the																	
6.7	17 Ave / 5 St	pavement rehabilitation	ı/a (part of reconstruction	n)															
6.8	17 Ave / 5 St	Install Leading Pedestrian Interval																	
		De done Middle of Middle De advisor and DT																	
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	\$30,000							\$ -	- 	-	0.0	0.0		\$0	\$0 \$0	0	0
0.0		Restrict Southwest Corner Driveway to	Ψ300							Ψ -	Ψ	_	0.0	0.0		Ψ0	ΨΟ	0	0
6.2	17 Ave / 5 St	Right-in / Right-Out	\$2,500	Collisions at dway	0	1	0.4	0.8		\$ 1,04	18 \$	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	\$ 132,13	88 \$ 2	264,276	4.7	9.4	15	\$1,982,070	\$3,964,140	71	142
7.0	17 Ave / 8 St	Review Compliance with Commercial Sign	n/a (staff time)																
	17 Ave / 8 St	Bylaws Enforce Left-Turn Restrictions	n/a (stair time) n/a (enforcement)																
7.4	177407000	Install Leading Pedestrian Interval for the	Tiva (chiorecinent)																
7.7	17 Ave / 8 St	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		\$ 45,24	10 \$	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																
	17 Ave / 9 St	Curb Extension on Southeast Corner	\$16,000																
	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		\$ 34,06	50 \$	68,120	56.8	113.5	5	\$170,300	\$340,600	284	568
	17 A / 10 0	Monitor Northbound Traffic Volumes and																	
—	17 Ave / 10 St	Right Turn on Red Compliance	n/a (staff time)																
9.3	17 Ave / 10 St	Reconstruct walkway																	
	17 Ave / 11 St	Relocate Driveways	\$20,000	At driveways	0	1	0.4	0.8		\$ 1,04	18 \$	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	\$ 28,90)8 \$	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	Injuries	PDO	CRF	CRF	CRF	Annual	Savings	Annu	al B/C	Life	Savings	over Life	B/C ov	ver Life
			Types	5 yr	5 yr	Low	High	Source	Low	High	Low	High	(Years)	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 CAPTIAL 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.



Table ES.7 Intersection Enhancements - Implementation Strategy

100		icemenis - implemenian	
INTERSECTION	SHORT-TERM	MEDIUM-TERM (1-2	LONG-TERM (3
	(WITHIN ANNUAL	YEAR CAPTIAL	OR MORE YEARS
	OPERATING BUDGETS)	BUDGETS)	AWAY)
17 Ave /	Minimize tourist-oriented	DODOLIO	7,117,117
MacLeod Trail	signs		
Macteod II all	319113		
17 Ave / 1 St SE	Remove digital advertising	Install red light camera on	
	on casino	eastbound approach	
	Review red light violation	Provide larger	
	and speed data	eastbound/westbound AND	
		southbound signal heads	
17 Ave / Centre St	Encourage parking on	Curb extensions with	Install full traffic signal
	Centre Street approaches	enhanced stop sign location	
	Markings on north/south		
	approaches		
17 A / 1 CL CW	Improve sight lines	Not acceptified	Not avantified
17 Ave / 1 St SW 17 Ave / 4 St	Not quantified Monitor Left-Turn Collisions	Not quantified Require Permits for Extended	Not quantified
17 Ave / 4 31	Enforce Traffic Signal Control	Deliveries	
	and Speed	Convert Curb Lane on	
	Repaint Centerline on	Northbound Approach to	
	Southbound Approach	Right-Turn Only Lane	
	Extend LT restrictions to	Move northbound bus stop	
	evening period	further north	
	evering pened	Torritor Horni	
17 Ave / 5 St	Revise Signal Timing		Restrict Southwest
			Corner Driveway to
			RIRO
			Consolidate
			Southeast Corner
			Driveways
17 Ave / 8 St	Increase Traffic Signal	Extend E/W Left-Turn	
101 101 111 111	Conspicuity	Restrictions to 24/7	
	Review Compliance with	Enforce Left-Turn Restrictions	
	Commercial Sign Bylaws		
17 Ave / 9 St	Not quantified	Not quantified	Not quantified
17 Ave / 10 St	Restrict East/West Left-turn		
	Movements		
17 Ave / 11 St	0. 15. 5.	5 1 5 11 16	Relocate Driveways
17 Ave / 14 St	Signal Timing Enhancements	Reduce Eastbound Cross-	
17 Ave / 15 St	Provide Pedestrian Corridor	Section Prior to Intersection	Noighborhood Traffic
1/ Ave / 15 31	Indication to Southbound	Discourage SBRT at 14 Street and 16 Avenue	Neighborhood Traffic Calmina
	Approach Vehicles	did to Averide	Consider Full Closure
	Approduit verticles		(or right-in only)
			(or rigini-in only)

