



Appendix G: Safety Assessment Report

MEMO

TO : City of Barrie
FROM : CIMA+
DATE : November 16, 2022
SUBJECT : [Safety Evaluation of Intersection Realignment: Bradford Street/Essa Road and Tiffin Street](#)

1. Introduction

CIMA+ has been retained by the City of Barrie to undertake a Municipal Class Environmental Assessment (MCEA) study for Bradford Street between Dunlop Street and Lakeshore Drive/Tiffin Street. As part of that project CIMA+ conducted a safety analysis of two conventional intersection design alternatives to justify the impacts on adjacent private properties at the intersection of Bradford Road/Essa Road and Tiffin Street. The existing intersection is shown in **Figure 1**.



Figure 1: Existing intersection

One alternative would be similar to existing conditions with a widened intersection layout to accommodate a dual left-turn lane for the southbound traffic and planned improvements to accommodate pedestrian facilities and cycle tracks (**Figure 2**), while the second alternative is focussed on an intersection realignment, shifting Bradford Street to the east, with similar planned improvements as the preceding alternative (**Figure 3**).

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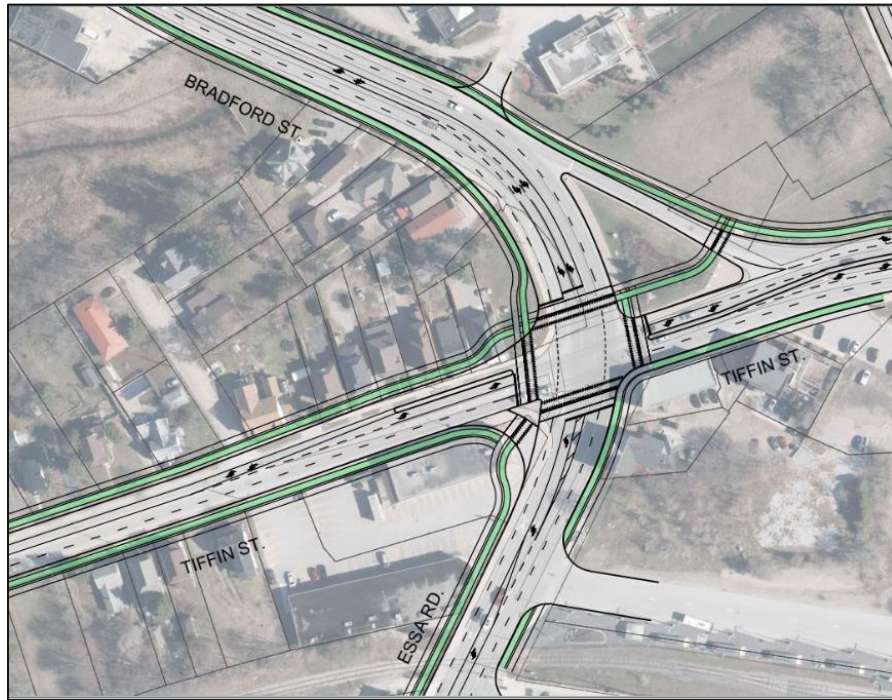


Figure 2: Existing condition with planned improvements (Alternative 1)

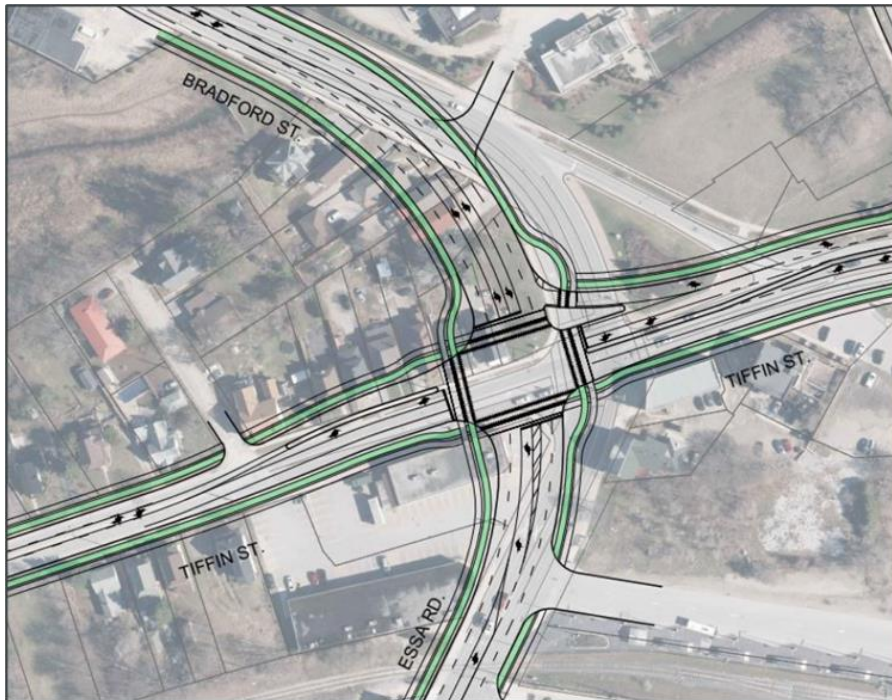


Figure 3: Intersection realignment with planned improvements (Alternative 2)

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The scope of the assessment is to conduct a safety analysis of two conventional intersection design alternatives to justify the impacts on adjacent private properties at the intersection of Bradford Road/Essa Road and Tiffin Street. More specifically, CIMA+ was to review the geometric characteristics of the two design alternatives to ensure that the geometry of the intersection layout is consistent with what drivers are expecting (design consistency) and will provide an adequate level of safety for all road users (drivers, cyclists, and pedestrians). The following roadway elements were included in the evaluation:

- Horizontal and vertical alignment on all approaches along with sightlines
- Intersection spacing
- Cross sectional elements based on prevailing vehicle and site characteristics including lane widths, shoulder widths, median width, and type
- Clear zone characteristics and roadway obstacles
- Bicycle and pedestrian facilities

Where applicable, CIMA+ referred to the FHWA's CMF Clearinghouse. In addition, compliance with the TAC Geometric Design Guide for Canadian Roads and the Ontario Traffic Manual Books (Book 1, 5, 6, 11, 12, 15, 18) was considered. Available traffic counts and findings of the traffic operational capacity analysis conducted by CIMA+ were reviewed.

2. Background Review

The following sections outline our understanding of the current layout, surrounding land use, traffic controls and existing traffic passing through the intersection.

The Bradford Street/Essa Road and Tiffin Street intersection is a four-legged intersection. Characteristics of the approach roads are noted below:

- **Tiffin Street** is an arterial road oriented in the east-west direction and provides a connection to Lakeshore Drive located approximately 115 metres to the east. The segment in the study area has a two-lane cross-section. The posted speed limit is 50 km/h. Left-turn lanes are provided on the east and west approaches to the intersection with a tight radius right-turn channel on the eastbound approach and essentially a slip lane for westbound right turns onto northbound Bradford Street.
- **Essa Road** has a four-lane cross-section within the study area. The posted speed limit is 50 km/h. The south leg (Essa Road) is considerably skewed in relationship to Tiffin Street. The south approach has a shared left-through and through-right turn lane. As a result of the skewness, large commercial vehicles making a northbound left are required to do a considerable amount of off-tracking to complete this movement and northbound right-turn movements can be made at higher operating speeds, given the large radius curve on the southeast corner of the intersection.
- **Bradford Street** is an arterial road oriented in the north-south direction parallel to Lakeshore Drive, with a four-lane cross-section within the study area. The posted speed limit is 50 km/h. The north approach has a right turn only, through and shared through-left turn lane. There is a sharp horizontal curve on the north approach to the intersection, reducing sight lines to the intersection. As a result of this, a traffic signal has been installed on the left near side of the intersection to provide advance visibility of the traffic control at the intersection.

CIMA+'s *Traffic Operational Analysis Report* completed in January 2022 documents existing traffic conditions and capacity at this intersection. Existing traffic volumes at the intersection indicate heavier flows on the north

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and south legs (Bradford Street and Essa Road) as compared to the east and west legs. The heaviest turning movements were the northbound right (both in the AM and PM peak) and the eastbound right (AM peak). In terms of traffic operations, the intersection is operating well below capacity (LOS A and B). However, storage for the westbound left-turn movement was noted as being inadequate.

Review of recent turning movement counts at the intersection indicate considerable numbers of pedestrians and cyclists travelling through the intersection on all four approaches.

3. Evaluation of Designs

The two alternatives are presented earlier in Figure 2 and Figure 3 of this memo. The following is noted relating to each alternative.

3.1. Alternative 1

The most significant change in Alternative 1 to the existing intersection layout is the relocation of the sidewalk and the introduction of a cycle track on all four legs of the intersection, the relocation of the crosswalks across all four legs (including westbound right bypass lane) in addition to a cross ride on each approach. The channelized right-turn island on the eastbound approach has been significantly enlarged. Capacity has been increased on the north approach through the conversion of the southbound single left-turn lane to a dual left-turn lane. A second westbound through lane has been added. Medians have been added on the east and west approaches. A minor modification has been made to the horizontal curvature on the north leg, slightly improving visibility of the signals at the intersection. The skew on the south approach has also been slightly decreased and a single northbound left-turn lane has been added.

3.2. Alternative 2

The change to the intersection in Alternative 2 is significant with the realignment of the north and south approaches to significantly reduce the curvature of the roadway on the north approach and reduce the skew on the south approach, resulting in substantial property impacts in the northwest and southwest quadrants of the intersection. A single northbound left-turn lane has been added. As a result of this, sightlines on the north approach to the intersection are significantly improved. The right-turn channel island on the eastbound approach has been removed with the curb lane functioning as a common lane for through-right turn movements. A second westbound through lane has been added. The large channelization island on the westbound approach has been significantly reduced in size and the westbound bypass lane has been eliminated and is now operating as a smart channel. Similar to Alternative 1, the sidewalk has been relocated and a cycle track has been provided on all four legs of the intersection. The crosswalk has been relocated and a cross ride has been added on all four legs of the intersection.

3.3. Evaluation of Designs

CIMA+ conducted a comparison between the two proposed design concepts by focusing on key roadway elements as follows:

- Horizontal and vertical alignment on all approaches (along with sightlines)
- Intersection spacing
- Cross sectional elements based on prevailing vehicle and site characteristics including lane widths, shoulder widths, median width, and type

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- Clear zone characteristics and roadway obstacles
- Bicycle and pedestrian facilities

Each of the above categories were examined specifically in terms of the north and south legs (combined) and the east and west legs (combined).

Under each roadway element, a qualitative assessment has been made on whether Alternative #1 or Alternative #2 is preferred from a safety perspective. Table 1 provides a summary of our assessments for individual roadway element to identify the preferred design alternative and assess their safety implications. For each roadway element, the design preferred from a safety perspective is indicated as 'Preferred' in green text. The design not preferred from a safety perspective is indicated as 'Not Preferred' in red text. Wherever our team of safety experts could not differentiate between the two designs from a safety perspective, 'No Preference' was indicated in yellow text.

As a whole, Alternative #2 is preferred, specifically with respect to horizontal and vertical alignment (and associated sightlines), intersection spacing (on the east and west legs), cross sectional elements (on the east and west legs), and bicycle and pedestrian facilities (on the east and west legs).

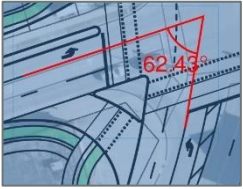
Table 1 – Comparison of Alternatives

Roadway Element	Leg	Alternative 1	Alternative 2
Horizontal and vertical alignment (and associated sightlines)	North and south legs	Not Preferred	Preferred
	East and west legs	Not Preferred	Preferred
Intersection spacing	North and south legs	No Preference	No Preference
	East and west legs	Not Preferred	Preferred
Cross sectional elements	North and south legs	No Preference	No Preference
	East and west legs	Not Preferred	Preferred
Clear zone characteristics and roadway obstacles	North and south legs	No Preference	No Preference
	East and west legs	No Preference	No Preference
Bicycle and pedestrian facilities	North and south legs	No Preference	No Preference
	East and west legs	Not Preferred	Preferred
Overall		Not Preferred	Preferred

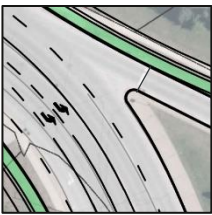
Table 2 on the following page provides a detailed comparison between the two proposed design concepts by focussing on key roadway elements.

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Table 2 – Comparison of Alternative 1 and Alternative 2

Roadway Element	Leg	Alternative 1	Alternative 2
Horizontal and vertical alignment	North and south	Not Preferred - Slight improvement in curvature on the north approach to the intersection. Sightlines to the near side traffic signal are still limited by the large horizontal curve (to approximately 120 metres) as the horizontal curve is sharper than presented in Alternative 2. Assuming an 85th percentile speed of 60 km/h, the near side traffic signal must be clearly visible at 110 metres (<i>OTM Book 12: Table 25</i>). - Large radius curve introduced on the northwest corner of intersection which will aid heavy truck movements (southbound rights) but may introduce higher operating speeds. - Skew angle at intersection is 62 degrees. <i>TAC Geometric Design Guide</i> recommends skew angles between 70 -110 degrees (Section 9.7.2). - Adequate sightlines for opposing left turns due to curvature of approaches. - No assumed impacts to the vertical alignment (noted as essentially flat on all approaches). Recommendation: If proceeding with this option, consider: - Restricting northbound left turn heavy truck movements due to significant off-tracking  	Preferred - Considerable improvement in curvature on the north approach to the intersection with near side signal (presumed to be placed on westbound right-turn channel island) visible for at least 160 metres. Reduced risk of rear end / angle collisions due to unfamiliar drivers not seeing the signals earlier. - Large radius curve introduced on the northwest corner of intersection which will aid heavy truck movements (southbound rights) but may introduce higher operating speeds. - Marked improvement in the skew on the south approach to the intersection (to 76 degrees), particularly benefiting the northbound left-turn lane, reducing the swept path for commercial vehicles. - Adequate sightlines for opposing left turns due to curvature of approaches. - No assumed impacts to the vertical alignment (noted as essentially flat on both approaches).  

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Roadway Element	Leg	Alternative 1	Alternative 2
	East and west	Not Preferred - No significant changes to the overall horizontal alignment on both approaches. - Westbound bypass lane (for right turns onto Bradford Street) remains in place. Motorists are required to merge with northbound traffic on Bradford Street (Yield control) by essentially looking 'over their shoulder' to identify gaps in traffic resulting in an increased risk of rear end collisions. - Eastbound right channel island has increased in size. Eastbound drivers making right turns have an improved angle of entry to the southbound departing lane, somewhat decreasing the risk of rear ends (due to a better angle to view oncoming traffic). Improving the angle of a channelized right turn has been found to result in a 60 percent reduction in collisions involving right-turning vehicles¹. - Limited sightlines for opposing left turns (left turns are slightly offset) - No assumed impacts to the vertical alignment (noted as essentially flat on both approaches). Recommendation: If proceeding with this option, consider:  	Preferred - Introduction of a slight horizontal curve on eastbound approach which is not anticipated to impact overall collision risk. - Westbound bypass lane has been converted to a westbound 'smart' channel. Motorists merge with northbound traffic almost at right angles, significantly reducing the risk of rear end collisions for this maneuver. Improving the angle of a channelized right turn has been found to result in a 60 percent reduction in collisions involving right-turning vehicles². - Eastbound right channel island has been removed, eliminating the need to merge with oncoming traffic coming from behind. Motorists make their right turn from the curb lane which is a shared through-right turn lane. A review of traffic operations suggests that the elimination of the channelized right turn will not significantly increase congestion/delay for this movement. This option would be safer for pedestrians/cyclists due to a decreased operating speed. - Limited sightlines for opposing left turns (left turns are slightly offset) - No assumed impacts to the vertical alignment (noted as essentially flat on both approaches).  

¹ Schattler, K. and T. Hanson. "Safety Impacts of a Modified Right Turn Lane Design at Intersections". Presented at the 95th Annual Meeting of the Transportation Research Board, Paper No. 16-0790, Washington, D.C., (2016).

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Roadway Element	Leg	Alternative 1	Alternative 2
		- Modifying the westbound right-turn bypass lane to intersect with Bradford Street closer to a right angle to aid drivers merging with northbound traffic (and to manage their speeds) and ensure that this lane remains stop controlled - Increasing offset between opposing eastbound-westbound left-turn lanes to improve visibility or implement protected permissive phase (both approaches)	Recommendation: If proceeding with this option, consider: Increasing offset between opposing eastbound-westbound left-turn lanes to improve visibility or implement protected permissive phase (both approaches)
Intersection spacing	North and south	No Preference - Slight reduction in intersection spacing on south leg. Allandale GO station access would be located approximately 50 metres south of intersection (stop bar). Queued northbound queues may occasionally spill past this access in congested conditions. - Slight reduction in intersection spacing on north leg. Dixie Road would be located approximately 60 metres north of intersection. Queued southbound traffic may occasionally spill past this road in congested conditions potentially interfering with left-turn movements. Recommendation: If proceeding with this option, consider: - Increasing spacing between south plant access and Tiffin Street or installing a median.	No Preference - Slightly larger reduction in intersection spacing on south leg. Allandale GO station access would be located approximately 45 metres south of intersection (stop bar). Queued northbound queues have a slightly higher likelihood of spilling past this access in congested conditions. - Larger reduction in intersection spacing on north leg. The new access to Dixie Road is located approximately 50 metres north of intersection. Queued southbound traffic has a higher likelihood of occasionally spilling past this road in congested conditions interfering with left-turn movements.  Recommendation: If proceeding with this option, consider: - Increasing spacing between south plant access and Tiffin Street or installing a median.
	East and west	Not Preferred No change in intersection spacing on west leg. Short Street is located 100 metres west of the intersection. Eastbound queues may occasionally spill past this access in congested conditions.	Preferred Shift in alignment will decrease spacing to Short Street to the west (to 60 metres), increasing the likelihood of eastbound queues to spill past this access in congested conditions.

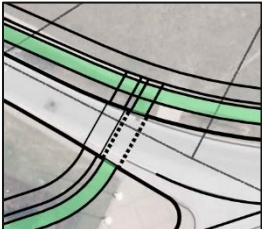
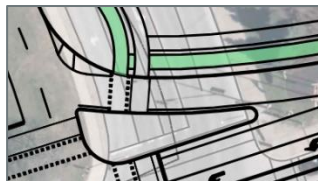
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Roadway Element	Leg	Alternative 1	Alternative 2
		- No change in intersection spacing on east leg. Major arterial road (Lakeshore Drive) is located approximately 115 metres to the east. The close proximity may result in queue spillback between the two intersections in congested conditions (although this is a low probability given the forecasted queues in 2051; 61 m in the PM). - Closely spaced signals can be problematic due to driver expectancy issues (required to stop in quick succession, attention focused on downstream signal). - OTM Book 12 does not recommend traffic signals spaced less than 215 metres from each other (OTM Book 12, Section 3.7) due to this issue. Recommendation: If proceeding with this option, consider: - Coordinating the two signals (Bradford Street/Essa Road and Lakeshore Road @ Tiffin Road) so they operate in tandem	- Shift in alignment will increase spacing to Lakeshore Drive to 135 metres, decreasing the likelihood of queue spillback between the two intersections in congested conditions. - As a whole, the westward shift away from Lakeshore Drive is seen as better overall for safety, given the amount of traffic this road carries (as compared to Short Street). Recommendation: If proceeding with this option, consider: - Coordinating the two signals (Bradford Street/Essa Road and Lakeshore Road @ Tiffin Road) so they operate in tandem 
Cross sectional elements	North and south	No Preference - Addition of left-turn lane on south approach - Flush median added between northbound left-turn lane and adjacent through lane (on south approach) - Addition of second left-turn lane on north approach (dual left-turn lane) - Guide (skip) lines added to assist drivers in making northbound-southbound through movements; no guidelines provided for southbound dual left turns (recommended) - All lane widths in acceptable range	No Preference - Addition of left-turn lane on south approach - Flush median added between northbound left-turn lane and adjacent through lane (on south approach) - Addition of second left-turn lane on north approach (dual left-turn lane) - No guide (skip) lines provided for southbound dual left turns (recommended) - All lane widths in acceptable range
	East and west	Not Preferred Second eastbound through lane added	Preferred Second eastbound through lane added; curb lane becomes a shared through-right turn lane

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Roadway Element	Leg	Alternative 1	Alternative 2
		- Median added on west leg; it is assumed that the properties on the north side of Tiffin Street will be removed (therefore no issues with accesses to these properties) - Median added on east leg extending back to Lakeshore Road - Westbound left-turn lane storage is 20 metres; operational analysis indicates 95th percentile queues extend 35 metres in the PM peak under existing conditions (queue spillback will extend into the adjacent through lane during peak hour conditions, increasing the risk of rear ends). - All lane widths in acceptable range Recommendation: If proceeding with this option, consider: - Increasing the storage of the westbound left-turn lane to exceed 2051 horizon year (45 metres).	- Median added on west leg; it is assumed that the properties on the north side of Tiffin Street will be removed (therefore no issues with accesses to these properties) - Median added on east leg extending back to Lakeshore Road - Additional storage for westbound left turns (45 metres storage provided), matching 2051 horizon year - All lane widths in acceptable range
Clear zone characteristics and roadway obstacles	North and south	No Preference No issues identified; provided that all utilities are relocated outside the clear zone on all approaches	No Preference No issues identified; provided that all utilities are relocated outside the clear zone on all approaches
	East and west	No Preference No issues identified; provided that all utilities are relocated outside the clear zone on all approaches or are crashworthy	No Preference No issues identified; provided that all utilities are relocated outside the clear zone on all approaches or are crashworthy
Bicycle and pedestrian facilities	North and south	No Preference - Cycle tracks and sidewalks proposed on north and south legs - Crossing distance for pedestrians and cyclists increased due to additional eastbound through lane (approximately 20 m across west leg; 16 m across east leg)	No Preference - Cycle tracks and sidewalks proposed on north and south legs - Crossing distance for pedestrians and cyclists increased due to additional eastbound through lane (approximately 19 m across west leg; 18 m across east leg)
	East and west	Not Preferred	Preferred Cycle tracks and sidewalks proposed on east and west legs

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Roadway Element	Leg	Alternative 1	Alternative 2
		• Cycle tracks and sidewalks proposed on east and west legs • Right-turn channelization island on southwest corner of the intersection has been enlarged, providing a safer waiting area for pedestrians • Crossing distance for pedestrians and cyclists increased due to additional southbound left-turn lane (north approach) and slotted northbound left-turn lane (south approach); approximately 25 m across north and south legs • Separate crossing of the westbound bypass lane right-turn lane – due to width of this lane, speeds may be higher than desirable approaching this crossing  Recommendation: If proceeding with this option, consider: • Narrowing the width of the westbound right turn bypass lane approaching the pedestrian crossing to discourage higher operating speeds • Evaluate the need for a PXO at this location	• Right-turn channelization island on west approach has been removed (pedestrians wait on corner; removal of potential conflict area) • Crossing distance for pedestrians and cyclists has increased due to additional southbound left-turn lane (north approach) and slotted northbound left-turn lane (south approach); approximately 25 m across north and south legs • Separate crossing of the westbound channelized right-turn lane; speeds approaching the crosswalk are controlled due to the requirement for westbound right-turning drivers to make a close to 90-degree turn onto northbound Bradford Street 

4. Conclusions and Recommendations

As a whole, Alternative 2 is considered to provide a safer design for the intersection of Tiffin Road and Bradford Street/Essa Road due to a number of factors, specifically due to the following:

- The curvature on the north approach has been considerably reduced in Alternative 2 compared to Alternative 1, improving sightlines to the intersection
- The skew on the south approach has been increased to 76 degrees in Alternative 2 while there is only a marginal improvement in Alternative 1
- The westbound bypass lane for right turns have been eliminated and replaced with a smart channel
- Spacing to the Lakeshore Road intersection has been increased in Alternative 2 compared to Alternative 1
- Storage for the westbound left-turn lane has been increased in Alternative 2 compared to Alternative 1
- Vehicle speeds at the smart channel crossing for westbound right-turn movements is better managed in Alternative 2 compared to Alternative 1

Given the cost and land impact relative to the cost of widening the Bradford Street corridor, we recommend that the City proceed with realigning the intersection as part of the EA by means of the Alternative 2 option given the following:

- The realigned intersection will be safer and operate better with the Alternative 2 realignment, especially as traffic volumes grow
- While the impact to adjacent lands will be greater than Alternative 2, it is noted that there will be costs and construction activity associated with both alternatives because of the widening of Bradford Street, the addition of a southbound left-turn lane, and the introduction of cycle tracks
- There will be impacts to lands west of Bradford Street with both alternatives (although the realignment will have more of an impact, by a margin of 1920 m²)
- Both options will have considerable costs and construction impacts – in view of the MCEA undertaking, this is likely the only opportunity the City will ever have the realign the intersection