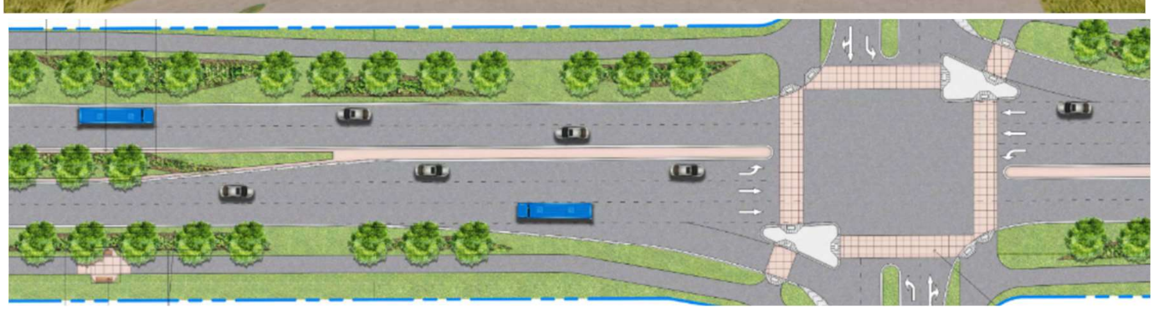
338 Avenue Functional Study
Town of Okotoks



Prepared for Town of Okotoks
by Arcadis
February 16, 2024

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Exhibits

1 Purpose

The purpose of this study is to develop and deliver a functional plan for an upgraded roadway corridor along 338 Avenue in the Town of Okotoks, between Highway 2 and Northridge Drive (Highway 2A), that balances the emerging and future roles of this road within the 2025 - 2045 timeframe. The functional plan is required to refine the ultimate road cross-section of 338 Avenue including the intersecting roads, as well as considering the active transportation and emerging mobility trends. Furthermore, a potential transition in the ultimate road cross-section from west to east, to align with the changes in adjacent land development from residential to commercial-industrial, was reviewed in further detail and confirmed as part of the study.

The Functional Design has been developed based on the proposed adjacent land uses, forecast travel demands, and a multimodal vision for the corridor and its cross streets. The number and configuration of intersections were evaluated as options to help the Town select the most appropriate long-term design for 338 Avenue.

2 Background

This study accounts for the existing and future context for the corridor, including changes to the transportation network, Town of Okotoks land use and development plans, and coordination with a proposed future interchange at Highway 2.

2.1 Context

338 Avenue within Okotoks, Alberta is currently a two-lane rural standard road with no pedestrian infrastructure and minimal landscaping. Currently, there are only a handful of intersections along the corridor where future major streets intersect it. There is also a handful of private businesses and country residences with driveways connecting onto the road.

The road will require upgrading to accommodate existing and ongoing land development along the entire corridor and in adjacent quarter sections of land. These upgrades would introduce a multi-modal cross section with sufficient capacity to serve the adjacent communities and allow 338 Avenue to act as a gateway into northern Okotoks.

Plans for the 338 Avenue corridor will also take into consideration anticipated changes to the overall regional road network to support urban development and enhance operations and safety. These future changes include:

- Proposals for higher capacity and safer operations along Highway 2 which includes the replacement of the unsignalized intersection at 338 Avenue with an interchange (see Section 2.4);
- Proposed extensions to the walking and cycling networks from existing communities into the future developed areas of Okotoks; and
- Shifts in travel patterns related to commuting and goods movement.

2.2 Town of Okotoks Plans

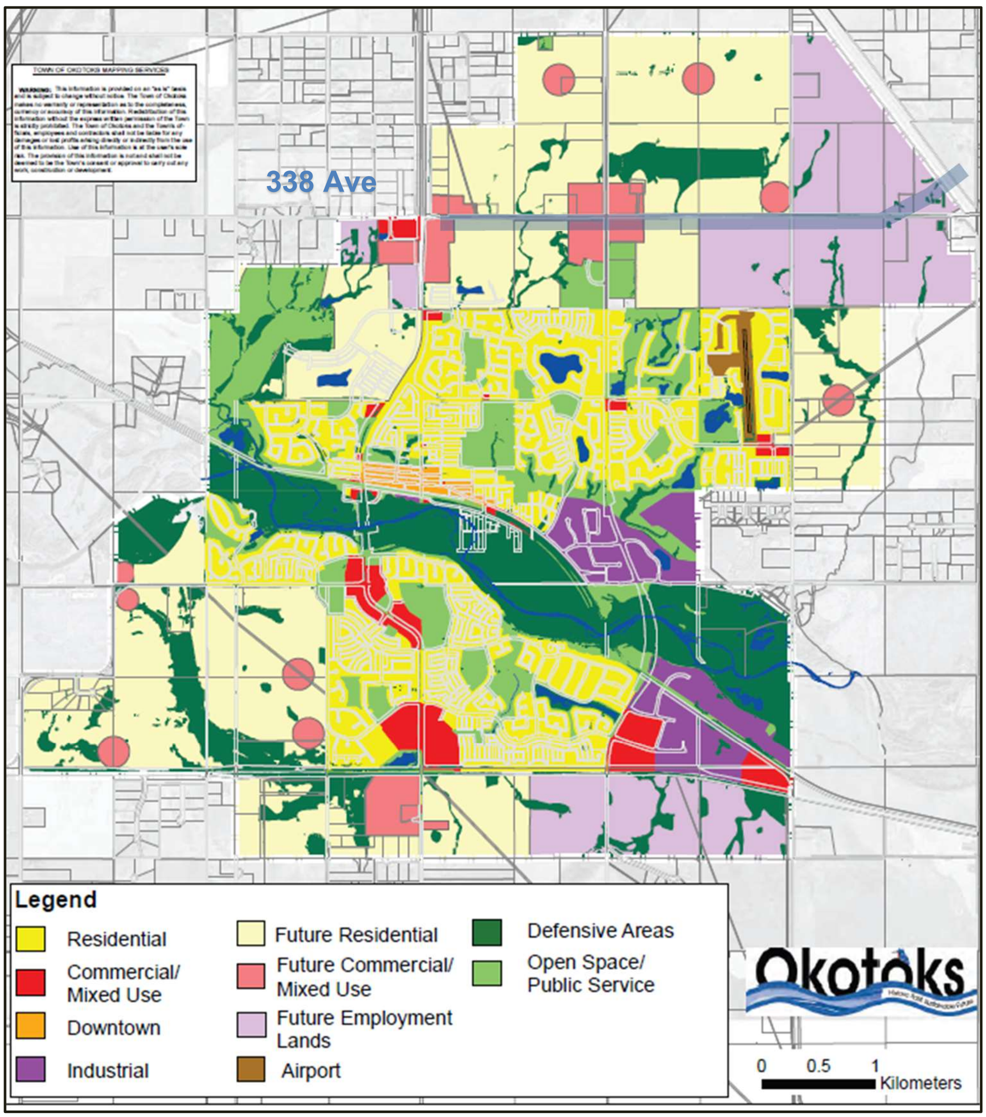
The 338 Avenue corridor is currently rural in character and lies within recently annexed parts of the Town of Okotoks. There are several Area Structure Plans (ASP's) in process along this corridor, focusing on the south side of the road, and the eastern sections near Highway 2. Some of these plans will affect near-term development in the western part of the corridor. The overall concept for 338 Avenue will be based on overarching plans the Town has made.

The Municipal Development Plan (MDP) for the Town defines broad expectations for the land use along and adjacent to 338 Avenue. The most recent MDP, ***Uniquely Okotoks***, was adopted in 2021. Exhibit 2-1 illustrates the proposed future land uses, with the 338 Avenue corridor highlighted.

The land uses proposed in the MDP, as they pertain to 338 Avenue, are as follows:

- Future Residential, west of 48 Street on the north side of the corridor, and west of approximately 40 Street on the south side.
- The eastern part of the corridor is designated as Future Employment Lands which will be more industrial.
- Future Commercial/Mixed-Use nodes are planned for the four corners of 338 Avenue/32 Street, the NW corner at 48 Street, and segments to the north and south of 338 Avenue immediately east of Northridge Drive (Highway 2A).

Exhibit 2-1: Future Land Uses in Municipal Development Plan (MDP)



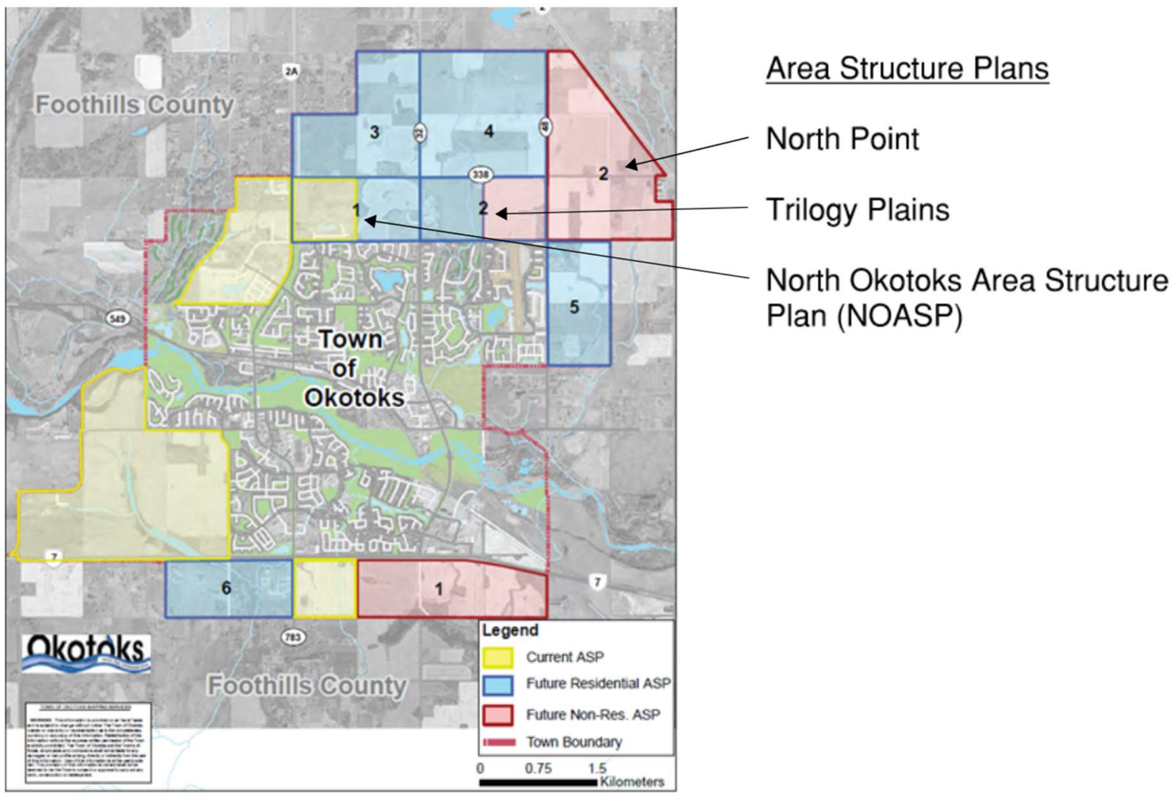
The 338 Avenue corridor is proposed as an arterial street in the Town's MDP, with at least four travel lanes and accommodation of all modes where appropriate. Given its central location to the

future development lands of northern Okotoks, it is expected to act as a gateway into the Town as well as the adjacent communities.

2.3 Development Plans

Exhibit 2-2 shows the sections included in the various current and future Area Structure Plans. Some parcels within these lands have undergone development, such as the Community Campus, accessed from 32 Street.

Exhibit 2-2: Development Segments



The NOASP west quarter section has been in development since 2016, with several iterations of proposal and review having taken place. The Trilogy Plains and North Point ASPs are still earlier in the planning stage.

Intersection locations along 338 Avenue have been proposed by several of the draft ASPs and the current functional planning study has reviewed future operations and several options for intersection locations and configurations.

2.4 Highway 2 Interchange

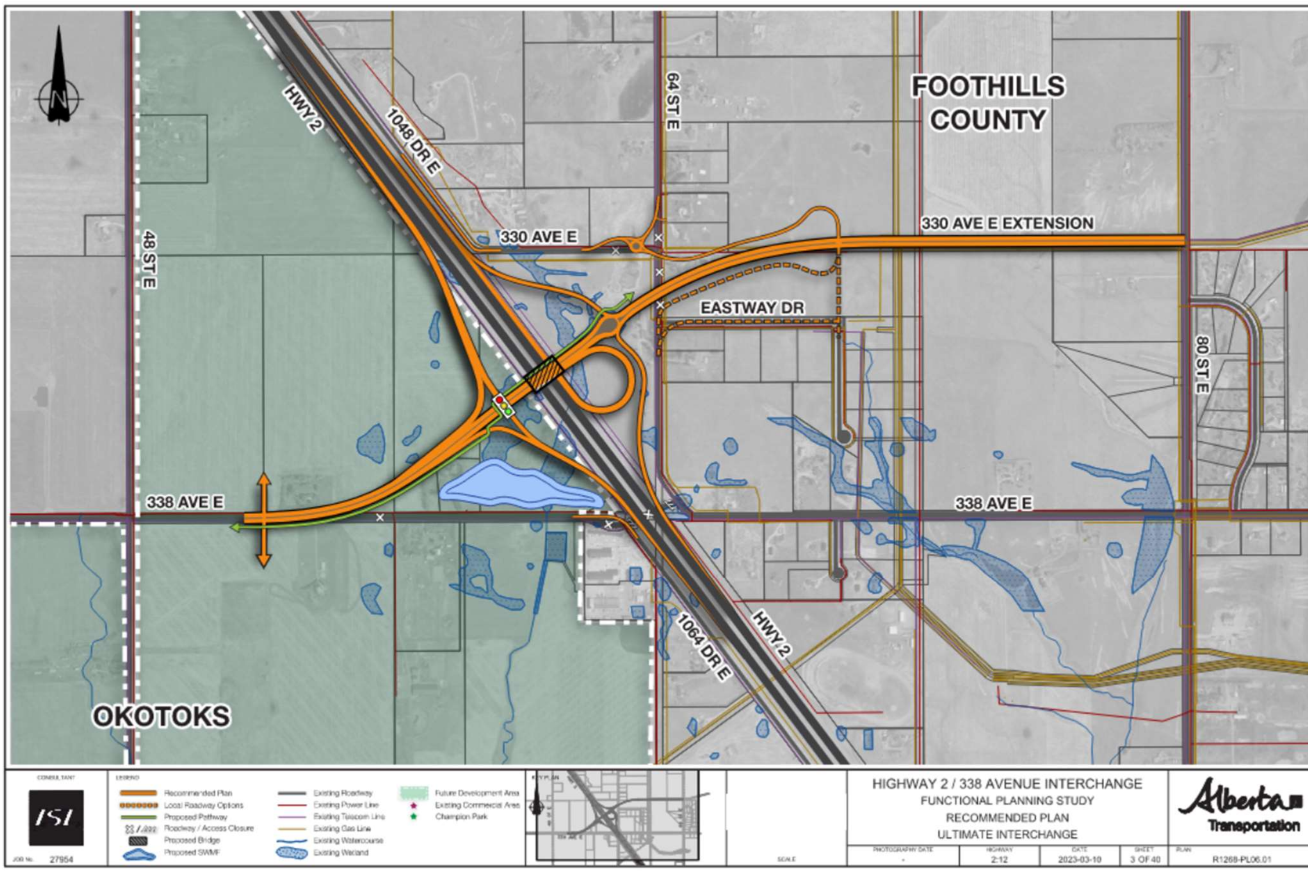
Alberta Transportation and Economic Corridors (ATEC) has completed a study to assess alternatives and develop a design for a future interchange of Highway 2 with a realigned 338 Avenue, at the east end of the study corridor. The Town of Okotoks is a stakeholder in the study and has expressed interest in expediting the construction of the interchange.

The study has gone through several rounds of technical evaluation and public consultation. Several variations of a new alignment and interchange were considered, leading to the recommendation of the current concept.

This new alignment of 338 Avenue would veer towards the northeast, starting east of 48 Street to meet the highway closer to a 90-degree angle. The easternmost segment of 338 Avenue that currently connects at an unsignalized crossing/intersection at Highway 2 is proposed to either become a frontage road providing access to the existing industrial developments and country residences within the County lands, or be completely removed and allow access to these existing eastern developments and residences via the future road network of the North Point development.

Exhibit 2-3 illustrates the layout of the proposed interchange, which would have a partial cloverleaf configuration. On the west side of the interchange, there would be direct ramps from southbound to westbound, and eastbound to southbound, as well as a signal. A pathway is proposed on the north side of the overpass, switching to the south side of 338 Avenue at the signal.

Exhibit 2-3: Proposed Layout of Highway 2 and 338 Avenue Interchange



Source: Highway 2 / 338 Avenue Interchange Functional Planning Study, Prepared For ATEC, Town of Okotoks and Foothills County by ISL Engineering, March 2023.

3 Street Configuration

The 338 Avenue corridor from Northridge Drive (Hwy 2A) to Highway 2 was divided into three segments using 32 Street and 48 Street as the boundaries. This allows for the variations in character and function along the corridor, and it also aligns with the three ASPs currently being defined.

3.1 Functional Requirements

The Municipal Development Plan includes a chart of the modal hierarchy for the Town, which is applicable to the 338 Avenue corridor. Exhibit 3-1 provides an illustration.

Exhibit 3-1: Transportation Hierarchy

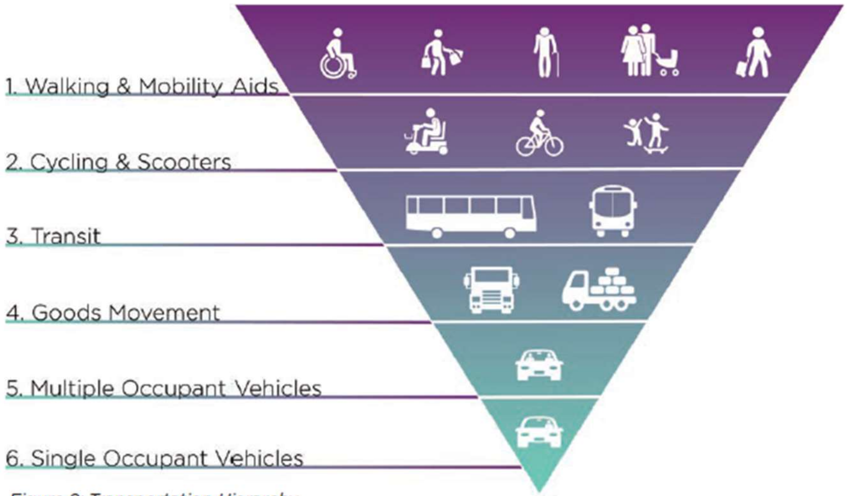


Figure 2: Transportation Hierarchy

3.1.1 Walking, Cycling and Transit

Walking and Cycling will be accommodated throughout the full length of the corridor, with the concept described in Section 4. Transit service is expected to evolve over time, depending on travel patterns and future demand. Future concepts for transit stops are described in Section 5.

3.1.2 Goods Movement

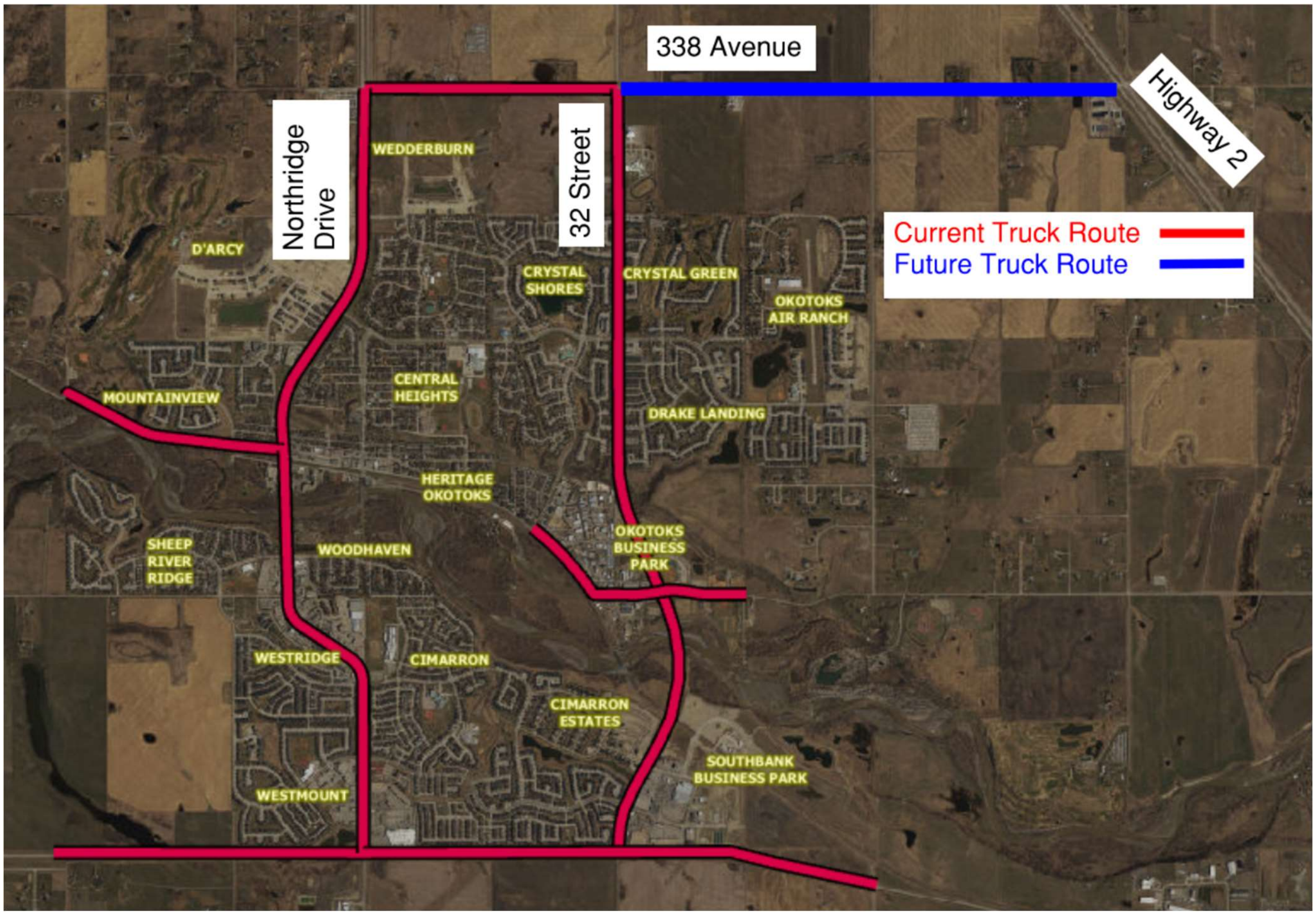
The existing goods movement route (i.e. truck route) to the north use a combination of Highway 2A and 32 Street, with 338 Avenue between these two providing a connection. This is based on the current rural nature of the street, with few driveways and an 80 km/h posted speed.

It is expected that the current truck route will continue as it currently exists until the Highway 2 interchange is constructed, at which point the majority of trucks would shift away from Highway 2A to Highway 2 and 338 Avenue to access Okotoks via 32 Street and Northridge Drive.

The recommendation is that 338 Avenue from Highway 2A to Highway 2 will become a truck route once the interchange is constructed. Furthermore, 338 Avenue is not expected or planned to be a provincial high load corridor.

Refer to Exhibit 3-2 which shows the current truck route (red) and future truck route (blue) within the Town of Okotoks.

Exhibit 3-2: Goods Movement Routes



Source: Modified from City of Okotoks GIS Map of Truck Routes.

3.1.3 Traffic Types and Operating Speeds

Taken as a group of policies, the Municipal Development Plan (MDP), Transportation Master Plan (TMP), and the North Okotoks Area Structure Plan (NOASP) provide guidance as the mix of modes and the "look and feel" of 338 Avenue. While the NOASP is specific to Wedderburn and the interface with 338 Avenue, its guidance is expected to be mirrored closely by Trilogy Plains policies as well since the land use mix will be similar.

These policies identify the following roles for the corridor:

- Active modes with direct connections within the adjacent lands and with permeability into adjacent neighbourhoods.
- Accessibility to future transit services.
- Efficient auto access into the community.
- Efficient access including local goods movement into the commercial hubs at major nodes

North Point is projected to focus more on commercial, retail and light industrial land uses, and therefore the character of the street could be different. In addition, its proximity to the future Highway 2 interchange suggests there would be a greater proportion of non-local traffic on that segment of the corridor.

Exhibit 3-3 summarizes the major assumptions established for each segment of 338 Avenue.

Exhibit 3-3 – Character of 338 Avenue from West to East

Segments	Traffic Types	Travel Lane Speeds	Active Modes	Adjacent Land Use
Northridge(2A) to 32 Street	Mixed traffic, mostly commuters, local access, commercial access, potentially transit and some local goods deliveries. Trucks 2-3%. (Long term)	50 km/h	Walking and cycling on both sides with connections into adjacent community pathway networks	Residential and Commercial
32 Street to 48 Street	Mixed traffic, mostly commuters, local access, commercial access, potentially transit. Trucks up to 10%.	50 km/h	Walking and cycling on both sides with connections into adjacent community pathway networks	Residential, Commercial, and Industrial
48 Street to Hwy. 2	Mixed traffic, some commuters, employment access, and a heavy vehicle route, with trucks approximately10%	70 km/h maximum	Walking and cycling on one or both sides with connections into adjacent networks, across Highway 2	Industrial

3.2 Traffic in the Horizon Year

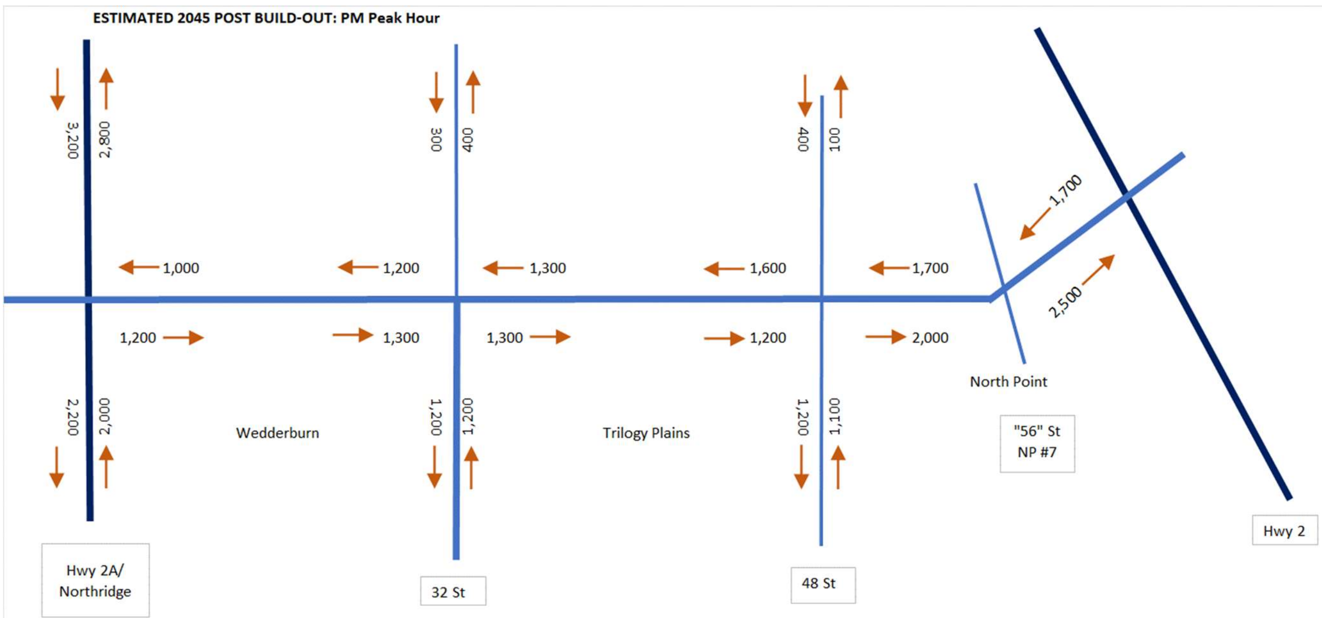
A future horizon of 2045 was selected to help future-proof the design concepts. The intent was to project the travel demands expected from development of lands north and south of the corridor, along with the effects of Highway 2 becoming more limited access, with an interchange on 338 Avenue.

Traffic projections used an average growth rate from the faster 2016 Transportation Master Plan (TMP) and the slower growth rates assumed in the 2020 TMP update. These were complemented by site-specific traffic estimates from the Area Structure Plans (NOASP, Trilogy Plains, and North Point) along the corridor. The resulting estimates allowed for development of the quarter sections both north and south of 338 Avenue, along with increased traffic via a planned Highway 2 interchange, and ongoing growth along Highway 2A. These estimates provided the basis for analysis of the three segments.

Exhibit 3-4 summarizes the average 2045 PM peak hour traffic by segment. The volumes and turning movements vary in the traffic modelling, depending on the number and configuration of intersections along 338 Avenue.

The approximate two-way traffic on 338 Avenue would range from 22,000 vehicles per day (vpd) near Northridge Drive up to 42,000 vpd near Highway 2. The higher volumes near Highway 2 have implications for the cross-section design of the corridor.

Exhibit 3-4: Average 2045 PM Peak Hour Volumes, 338 Avenue and Major Connecting Streets



3.3 Assessment of Options

In each of the segments, variations in the number and configuration of full control accesses were tested, and several intersections were compared as signals and as roundabouts to determine the impacts on traffic performance and design requirements (i.e., street footprint).

Given the numerous references to active modes, transit, and direct connections in policy documents such as the North Okotoks ASP and the Okotoks TMP, these elements were also important considerations in developing the “Look and Feel” for 338 Avenue, which is envisioned to focus on local and commercial access for the segment west of 32 Street. Higher auto volumes and most of the goods movement traffic would be focused on the future Highway 2 interchange, and the portions of 338 Avenue east of 32 Street.

Therefore, in addition to traffic speeds, delays, and queuing, the types of impacts on active modes, goods movement, and future transit were also considered qualitatively.

Recommendations for the spacing and configuration of cross-street intersections were subject to the performance of the locations, and considerations for multi-modal permeability.

Appendix B includes multiple-criteria assessments of the options, Section 6 of this report describes a comparative safety analysis and Appendices C and D document the traffic and safety analyses in more detail.

3.3.1 Intersection Spacing Options

The conceptual design options for the study corridor included a range of intersection configurations and average spacings between signals.

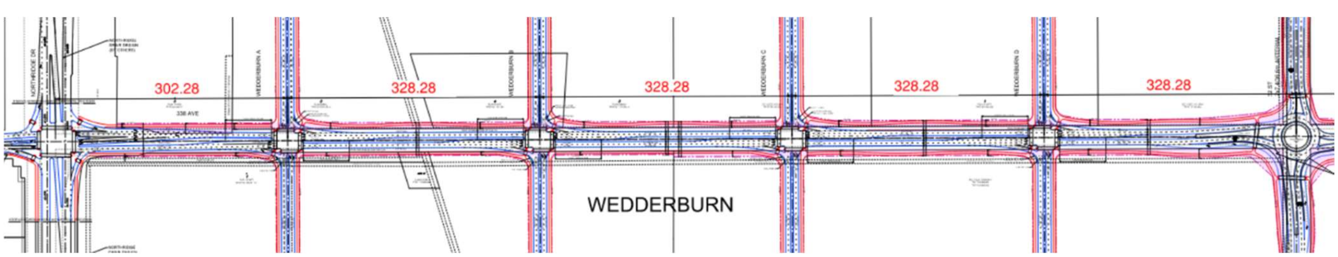
Exhibit 3-5: Intersection Spacing Options by Segment

Segment	# of All-Turns (Min-Max)	In Current ASP(s)	Options Considered
"Wedderburn" Northridge Drive (Hwy 2A) to 32 Street	3 to 5 intermediate intersections.	5 in NOASP, 4 into Wedderburn (per 2022) + 1 into north	• 5 signals • 4 signals • 3 signals All options include the first intersection east of Northridge.
"Trilogy Plains" 32 Street to 48 Street	2 to 4 intermediate intersections	Trilogy Plains - ~36 St, ~40½ St *One more likely for industrial lands*	• 4 signals • 3 signals
"North Point" 48 Street to Hwy 2	1 or 2 intermediate intersections, plus realignment of 338 Avenue to meet Hwy 2 at interchange	North Point ASP concept includes NP Accesses #6 and #7; Interchange ramps for Hwy 2.	• 2 signals • 1 signal and 1 right in/out • Signal includes double left turns

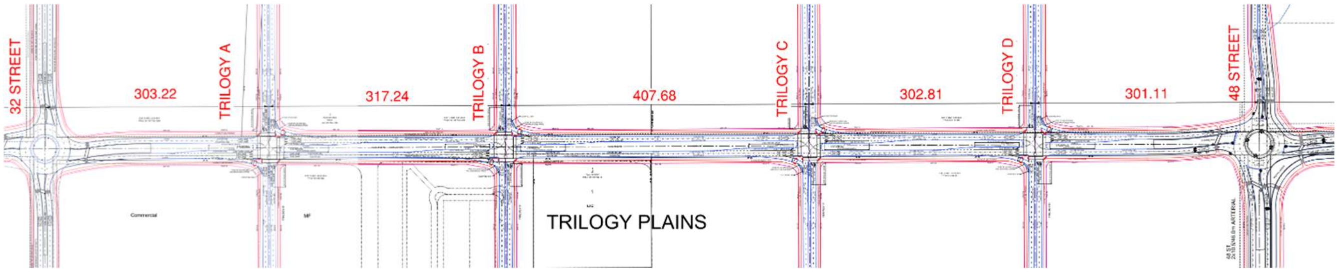
When evaluating these options, projected turn movements were reallocated between adjacent intersections to account for the varying number of signals, and the same overall totals kept for movements in and out of each development zone. This meant that options with fewer signals focused the same amount of traffic on the smaller set of locations.

Exhibit 3-5: 338 Avenue Corridor – Intersection Key Plan

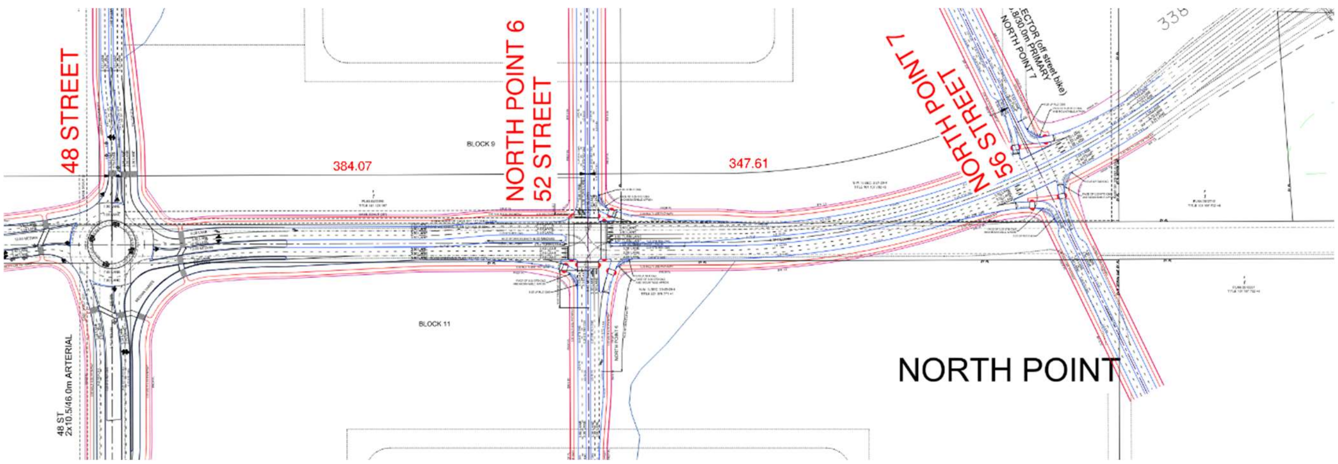
Wedderburn Intersections



Trilogy Plains Intersections



North Point Intersections



3.3.2 Intersection Types

All-Turns Signalized Intersections were considered for each of the spacing options. Lane configurations were developed specifically for each location based on future 2045 volumes.

- Most intersections along 338 Avenue were two to three through lanes with a shared right, and a left turn bay in the median.
- At 32 Street and 48 Street, higher turning volumes meant that additional left and right turn capacity was required, resulting in larger, more complex intersections.
- 56 Street intersection (also referred to as North Point Access #7) which is the second intersection east of 48 Street, was deemed to be too close to the Highway 2 interchange to permit left turns. The weaving distance (to get from the curb lane to the median) between the off-ramp and potential signal would be too short to operate safely. Therefore, it was concluded that the street would connect to both sides of 338 Avenue but as a right-in/right-out (RIRO) only. This meant that left turns would focus on 52 Street (also referred to as North Point #6) instead, which is the first and only all-turns intersection east of 48 Street.

Roundabouts were also considered for most intersections, except at Highway 2A (Northridge), and at the two (2) North Point intersections: 52 Street (North Point Access #6) and 56 Street (North Point Access #7), due to proximity of the Highway 2 interchange.

- Each roundabout was a two-lane configuration at most intermediate signals.
- 32 Street had added complexity and was found to benefit from NBR and EBR slip lanes outside the two circulating lanes.

- 48 Street was designed to act as a transition from the segments to the west (4 lanes) and east (6 lanes), with one westbound lane dropping and one eastbound lane being added, using a bypass from the northbound right.

3.3.3 Assessment Findings

The scenario evaluation was undertaken for the 3, 4 and 5-intersection cases, as applicable to each segment. As noted, this considered multi-modal design and performance factors. Due to the longer spacing between intersections, the level of service for active modes and for potential transit passengers would be lower with only 3 intermediate signals. The 4-signal option was found to provide better equity between travel modes and would provide more direct connectivity between the Wedderburn and Trilogy Plains developments and future developments to the north. For North Point, the proximity of the Highway 2 interchange – and the higher traffic volumes -- governed the selection of a preferred configuration.

General Observation for All Segments

- The effects of combined traffic by 2045 would trigger installation of additional signals and additional turn bays at many intersections, relative to the traffic control assumptions in the TIA's reviewed to date.
- Therefore, the configurations for near-term development of the south side of the corridor will need to make provision for future turn lanes and traffic control features.

Wedderburn Segment

- Assessments of 3, 4, and 5-intersection configurations were tested between Northridge Drive and 32 Street.
- Each of the configurations could be made to perform acceptably for traffic; however, the 3-intersection option concentrates more turning movements at fewer locations, and this produces longer peak queues on 338 Avenue and on the side street approaches.
- The 3-intersection option would produce long distances between safe crossing locations for active modes, and not be as supportive of the networks of sidewalks and trails.
- The 4 and 5-intersection configurations perform better for traffic and for active modes and would also be more compatible with future transit stop spacing.
- The 4-intersection option would be less costly to implement and leave greater room for public space within the corridor in comparison with the 5-intersection option.
- Based on the above considerations, the 4-intersection option is recommended to guide intersection spacing for the Wedderburn segment.

Trilogy Plains Segment

- 3 and 4-intersection options all function reasonably for auto traffic if signals are installed, and left turn bays are included on 338 Avenue and on the Trilogy 'A' intersection (i.e. the first intersection east of 32 Street).
- The spacing of the 3-intersection option creates significant gaps for active modes/transit stops, especially to north, which would limit the flexibility to develop the north.
- A 2-intersection configuration would have long queues and delays for WB and NB at the Trilogy 'A' intersection which is the busiest location within this segment by 2045.
- Given the performance and active modes concerns of the other options, the 4-intersection configuration is recommended for Trilogy Plains.

North Point Segment

- The high volumes of vehicles projected for east of 48 Street require a minimum 6-lane cross section by 2045. This can transition to 4 lanes at 48 Street for the corridor to the west.
- The proximity of the planned interchange requires that 56 Street (i.e. the second intersection east of 48 Street) becomes a RIRO to prevent unsafe weaving for left turns.
- Therefore, access into North Point will consist of RIRO at 56 Street (i.e. second intersection east of 48 Street) and all-turns intersections at 48 Street and 52 Street (i.e. the first intersection east of 48 Street).
- The interchange also produces a difference in the active mode assumptions. For the rest of the corridor, multi-use pathways or parallel sidewalks and off-street bicycle paths are assumed on the north and south side of 338 Avenue. Near the future interchange, there would be no connection on the north side. It is therefore assumed that pedestrians and cyclists would cross to the south at either 48 Street or 52 Street. Furthermore, a grade separated pedestrian crossing at 56 Street would further maximize the north/south pedestrian connectivity across 338 Avenue for this segment. Allocation of a right-of-way to space-proof for this grade separated pedestrian corridor is recommended.
- Remaining variations in the design of this segment relate to management of heavy left and right turn volumes at the two intersections, and how to address these with turn lanes and signal timing strategies.

Comparison of Roundabouts Versus Signals

Trade-offs between the performance and design requirements of roundabouts at several critical and representative locations were assessed.

- The intersections most likely to warrant roundabouts may be at 32 Street and 48 Street, due to high right and left turning volumes. Taken individually, these may perform better for traffic travel times than signals. The imbalances in directional volumes during the peaks mean that a traditional signal is forced to use extra capacity to serve the higher volumes, while keeping other users waiting longer.
- Due to higher right turning movements at these locations, extra approach lanes would be included in the roundabout design. (These lanes would take the form of right turn channels under the signalized intersection scenario.)
- Intermediate intersections within each of the segments would require basic two-lane approaches on 338 Avenue, and no extra turn lanes to perform acceptably for traffic.
- There are some safety advantages to roundabouts, with a modest reduction in injuries and fatalities (based on predictive analysis) due to slower speeds at conflict points with pedestrians and cyclists.
- There can be increases in property damage from sideswiping vehicles especially during the initial period when drivers are becoming more familiar with operations. Over time, the severity of accidents has been demonstrated to improve.
- Roundabouts also produce longer and less direct travel paths for active modes, which can act as an impediment to non-auto users. At larger intersections, this is offset by the shorter waiting times to cross, since roundabouts avoid long signal cycles and sometimes have no signals at all.
- To accommodate the truck route, the inner lanes of any roundabouts between 32 Street and Highway 2 would be wide enough for manoeuvring, and the circle in the middle of the roundabout may feature a lower/mountable curb with textured pavement, which allows the

"chord" of longer vehicles to pass over safely. (This is the part of trucks or buses between the axles that pulls closer to corners while the vehicle turns.)

Exhibit 3-6: Roundabout Performance Relative to Signalized Intersections

Factor	Intermediate Intersections (Signalized)	Major Intersections (32/48) (Roundabout)
Accidents	Overall decrease; more severe	Overall increase; less severe
Peak Period Traffic	Similar overall travel times	Significantly less delay without signals
Off-Peak Traffic	RAB may be somewhat slower	Similar or lower delays with RAB
Active Modes	Safer but more indirect route	Safer but more direct; may be faster to cross without complex signal timings
Goods Movement	Design for large truck	Design for large truck
Footprint	RAB is larger	RAB marginally larger compared with extra lanes

Conclusions

- The corridor will be a four-lane arterial west of 48 Street, until at least 2045. East of 48 Street will require six lanes once triggered by the Highway 2 interchange and adjacent development.
- The typical intersection spacing will be 320m in the zones with adjacent residential areas, and will be context-sensitive in commercial and light industrial areas. This means four (4) intermediate intersections within each of the Wedderburn and Trilogy Plains segments, and two (2) intermediate intersections within the North Point segment. Intermediate intersections will be signalized.
- Major intersections at 32 Street and 48 Street will be multi-lane roundabouts with additional right turn lanes to manage peak traffic and help with lane transitions.

3.4 Recommendations

Within Wedderburn and the Trilogy Plains segment, a configuration with four (4) intermediate signalized intersections has been selected. The resulting average spacing of 320 metres between intersections in Wedderburn and Trilogy Plains has many precedents in more recently developed communities in both Calgary and Edmonton, including other corridors that connect to a mix of residential areas and commercial hubs at the major nodes.

Exhibit 3-7 summarizes this and other design recommendations for the corridor.

The major intersections at 32 Street and 48 Street will be designed as multi-lane roundabouts, which offer performance benefits during peak periods, have the potential to improve safety, and create opportunities for gateway features to help identify the corridor and surrounding neighbourhoods. The intersection at 48 Street will also provide a place for the corridor to transition from four to six lanes as it approaches Highway 2.

Within the North Point segment, only two intermediate intersections are proposed. One will be signalized and act as the first entrance and exit point from the east into North Point, which will also occur via 48 Street. Due to proximity with future Highway 2 interchange ramps, the second intersection will be a right-in/right-out. To help manage potential weaving conflicts, an auxiliary lane would run eastbound from 56 Street to the southbound on-ramp of Highway 2.

Exhibit 3-7: Summary – Recommended Configuration of 338 Avenue

Segment	Number of Lanes	Intersection Spacing	Special Cases
"Wedderburn" Northridge Drive (Hwy 2A) to 32 Street	4 travel lanes (2 each direction) plus median with left turns	4 intermediate intersections	• Double left turns and right channels at Northridge
"Trilogy Plains" 32 Street to 48 Street	4 travel lanes (2 each direction) plus median with left turns	4 intermediate intersections	• Roundabout (multi-lane) at 32 Street
"North Point" 48 Street to Hwy 2	6 travel lanes (3 each direction) plus median with left turns	2 intermediate intersections	• Roundabout (multi-lane) at 48 Street • RIRO at 56 Street with auxiliary EB lane

3.4.1 Northridge/Highway 2A Intersection

The long-term concept for this intersection reflects strong growth in north-south traffic on Northridge Drive in addition to the east-west demands on 338 Avenue. By 2045, approximately 60,000 vpd may be using Northridge to the north, as one of the two major access routes into Okotoks (along with Highway 2).

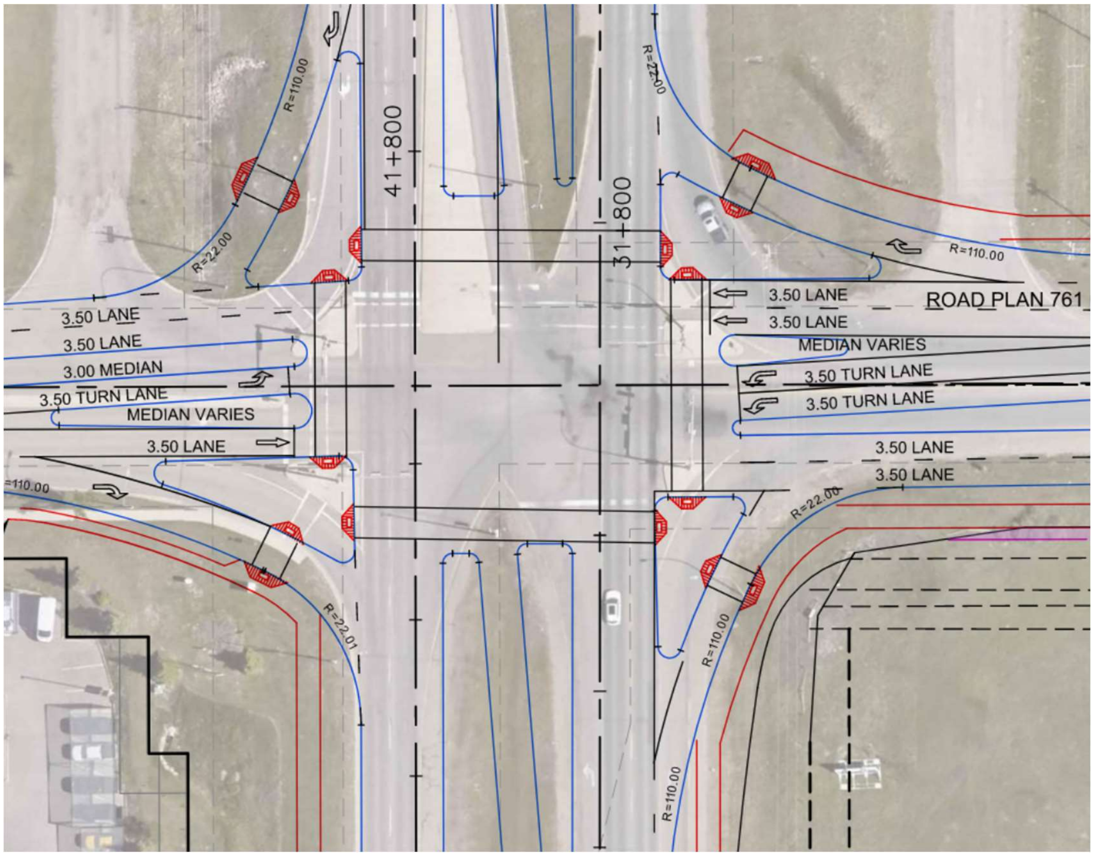
To accommodate this, Northridge Drive would ultimately be widened to six lanes (three per direction) with right turn channels, a dedicated northbound left, and a dual-lane southbound left to handle peak-period demands. The recently approved design for Northridge is a four-lane section with room to expand in the future.

Dual westbound left turn lanes are recommended by 2045 to help manage peak period traffic. The dual lanes process the movements more efficiently and leave more signal time for higher volume through traffic. The initial design for the intersection builds the dual lanes into the median of 338 Avenue. This initial excess capacity for left turns allows more north-south time, and this "buys time" before the widening of Northridge is eventually triggered.

The westbound right turn will also be an important traffic movement, and a right turn channel is recommended to accommodate this. The outside westbound through lane would essentially be feeding the right turn channel while westbound through traffic mostly uses the inside through lane.

Exhibit 3.8 shows the proposed configuration for the intersection, with 338 Avenue built out to the recommended lanes needed through to 2045.

Exhibit 3-8: Proposed Configuration – Northridge Drive / 338 Avenue Intersection



Minor modifications of the road alignment median along the existing 338 Avenue, immediately west of Northridge Drive, (i.e. Northgate Drive) are expected. The existing 15 Street SE, which is within Foothills County, will need to be realigned or closed at the south end, to avoid any impacts to the operation and safety of the Northridge Drive / 338 Avenue intersection. Two (2) conceptual options were developed for this road as outlined in Exhibits 3-9 and 3-10. Further discussion and discussion with Foothills County will be required for the realignment or closure of this road.

Exhibit 3-9: 15 Street SE Option 1 – Road Realignment

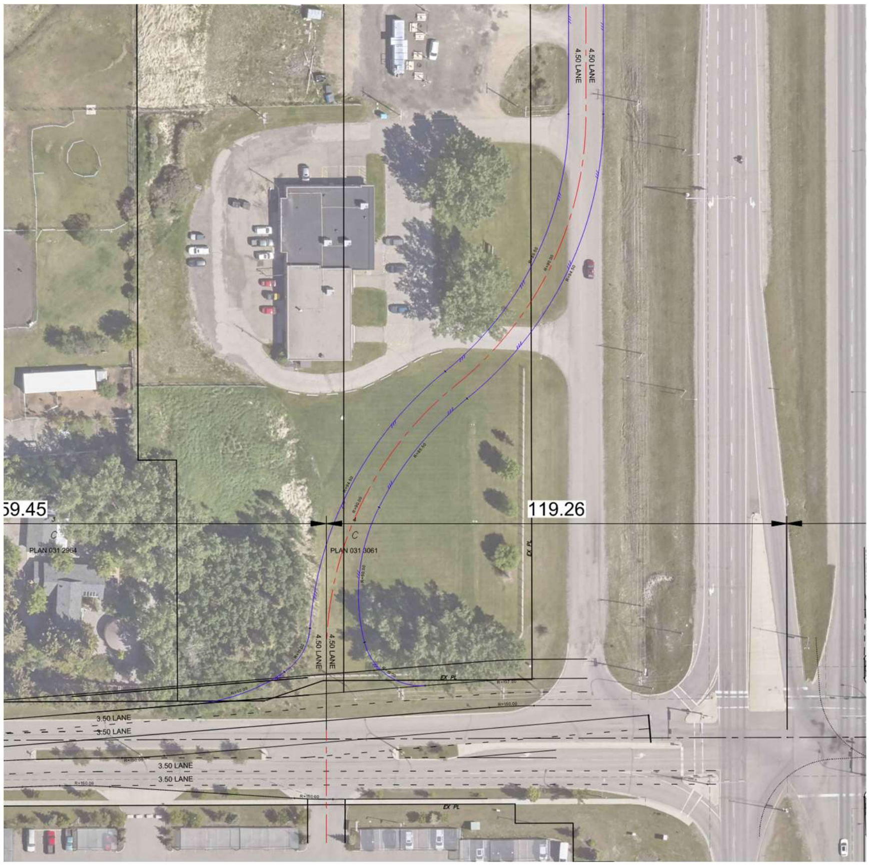
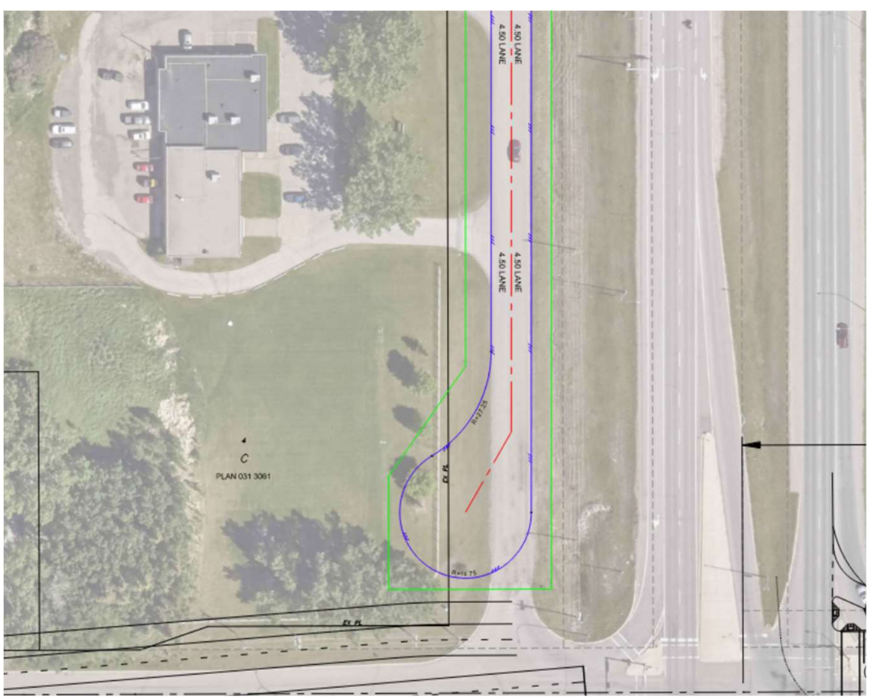


Exhibit 3-10: 15 Street SE Option 2 – Road Closure



3.4.2 Wedderburn Segment

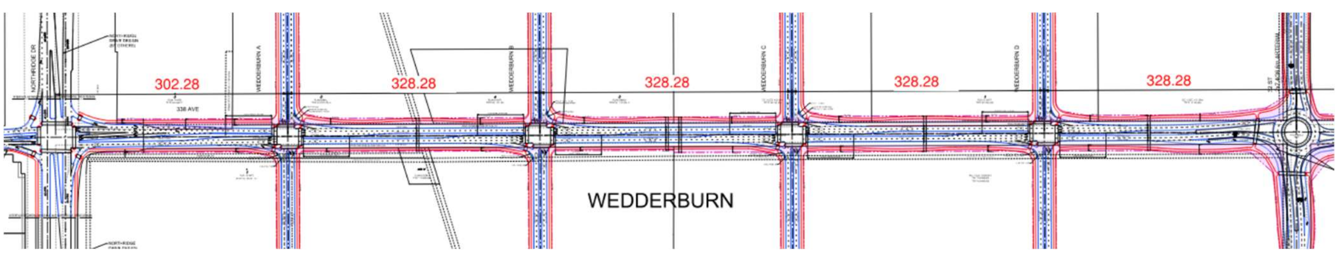
The concept for this segment of the 338 Avenue corridor reflects the requirements for the near to medium term development of the Wedderburn West and East parcels to the south, along with longer term development of the north parcels.

The proposed design is based on the multi-modal assessment that balances requirements in the MDP, reflects the policies and design guidance in the North Okotoks ASP (2016), and refines some of the details to reflect the corridor vision, and current information related to growth rates.

- It is anticipated that 338 Avenue may ultimately be widened to six lanes (three per direction) with 'smart' right turn channels, dedicated left turns in the median, and boulevards with multi-use pathways on both sides of the corridor.
- Interim projections of traffic suggest that four lanes will be sufficient until at least 2045. If the growth rate for background and local traffic were to continue at the same pace after that, then by approximately 2060 six lanes could be required. This analysis is beyond the typical modeling horizons, and therefore it is simply an estimate based on using growth rates to approximate when the 6-lanes will be triggered.
- This segment will include four intermediate intersections at an average spacing of 320 metres. The westernmost of these is referred to as Wedderburn Gate in many of the past studies related to this area. It is expected to provide access to a mix of commercial and residential land uses, as is the easternmost intersection. The two locations shown in the middle of this segment would serve primarily residential land uses to the south; the north is unknown at this time.

Exhibit 3-11 shows the initial configuration for this segment, with 338 Avenue built as a four-lane arterial.

Exhibit 3-11: Recommended Configuration – Wedderburn Segment



3.4.3 32 Street Intersection

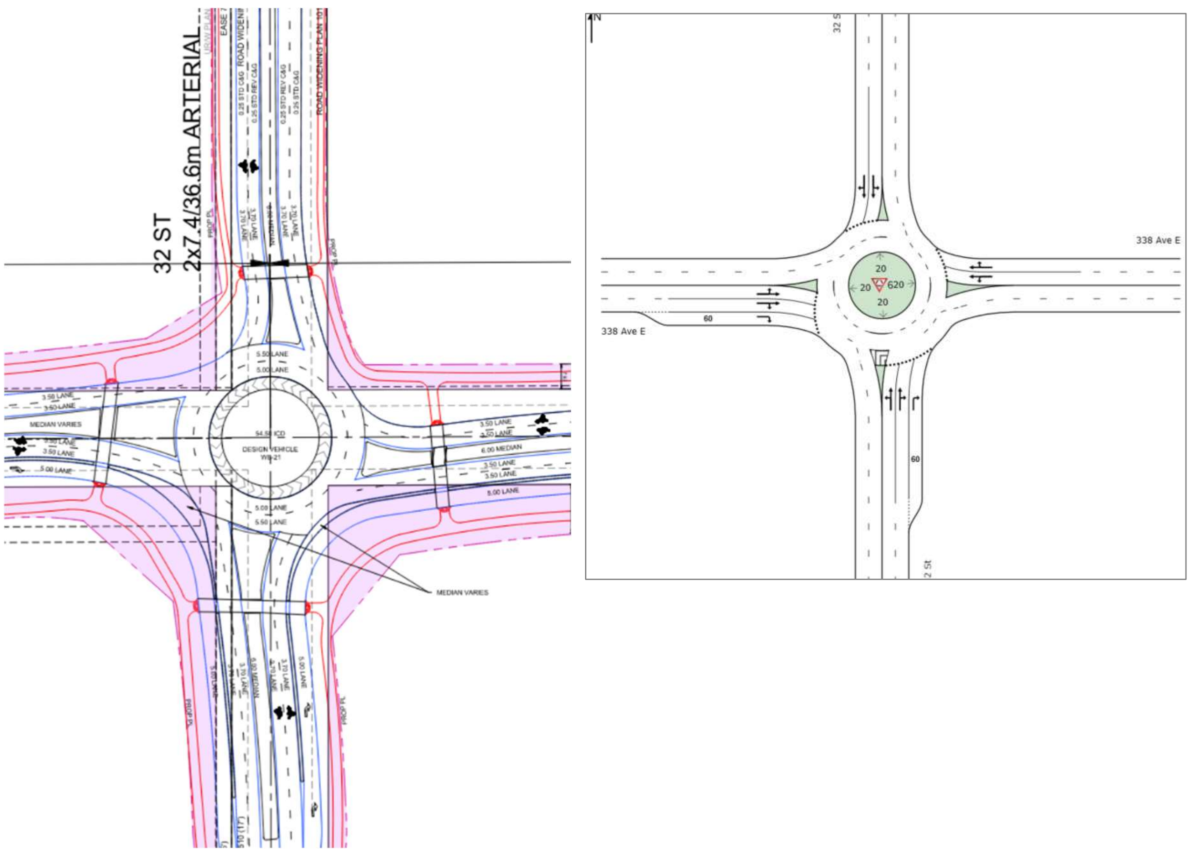
The concept for this intersection reflects the future traffic projections, which include three groups of major movements:

- East-west movements along the corridor, through this junction.
- Turning traffic between the west and south leg (32 Street), manifested as high numbers of NBL and EBR vehicles during both peaks.
- Turning traffic between the east and south legs, producing high numbers of WBL and NBR movements during both peaks.
- Note that the north leg of 32 Street would carry some development and commercial hub traffic but would have the lowest demand. With 338 Avenue as the gateway into Okotoks, there would be less demand spilling over onto other north-south routes aside from Highway 2A.

Two concepts were tested for this junction: an all-turns signalized intersection; and a multi-lane roundabout. In both cases, it was found that the junction had a better level of service if dedicated right turn lanes were provided for the EBR and NBR traffic, freeing up capacity for through movements, pedestrians, and left turns.

Exhibit 3-12 shows the proposed configuration for the roundabout at the junction of 338 Avenue with 32 Street. This is a two-lane roundabout with additional right turn lanes merging into the receiving direction for the EBR and NBR.

Exhibit 3-12: Recommended Configuration – 32 Street / 338 Avenue Intersection



3.4.4 Trilogy Plains Segment

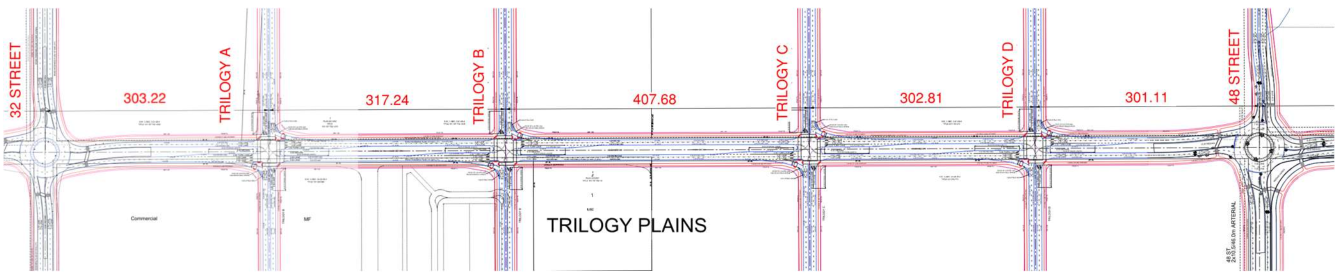
The long-term concept for this segment of the 338 Avenue corridor reflects the requirements for the near to medium term development of the Trilogy Plains parcels to the south, along with longer term development of the north parcels.

The proposed design is based on the multi-modal assessment reflecting the requirements in the MDP and the corridor vision, and current information related to proposed development of the south parcels. As with the Wedderburn segment, it is anticipated that 338 Avenue may ultimately be widened to six lanes (three per direction).

- The initial configuration will be a four-lane arterial with ‘smart’ right turn channels, dedicated left turns in the median, and boulevards with multi-use pathways on both sides of the corridor.
- This segment will include four intermediate intersections at an average spacing of 320 metres. The westernmost of these is referred to as ‘Trilogy A’ in several recent studies and is expected to provide access to a mix of commercial and residential land uses, because of the land use node centered around the 32 Street junction immediately to the west of this segment. The other three locations shown on the plan will serve residential uses to the west and centre of the segment, with some potential commercial/light industrial lands near the east end of this segment.

Exhibit 3-13 shows the initial configuration for this segment, with 338 Avenue built as a four-lane arterial.

Exhibit 3-13: Recommended Configuration – Trilogy Plains Segment



3.4.5 48 Street Intersection

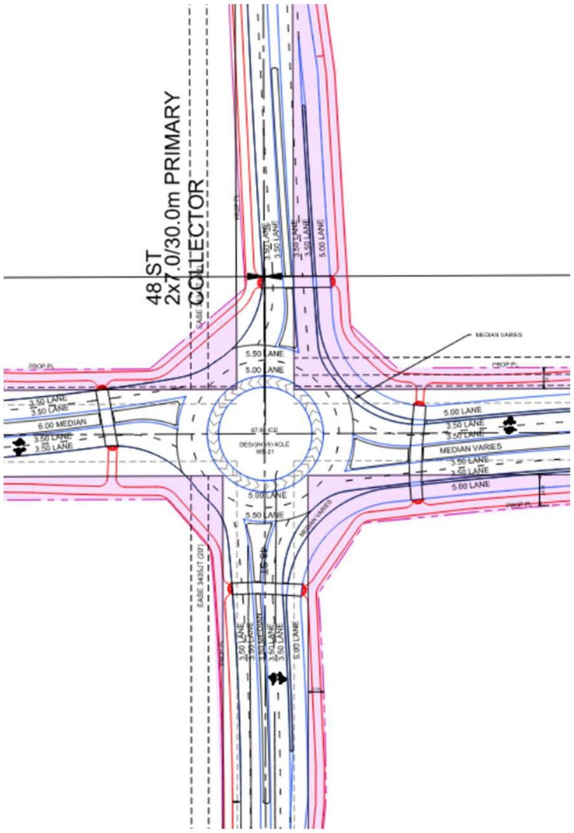
The concept for this intersection reflects the future traffic projections, which include three groups of major movements:

- East-west movements along the corridor, through this junction, with over 60% of the traffic moving eastbound in the AM and westbound in the PM.
- Turning traffic between the east and south (48 Street) legs, producing high numbers of WBL and NBR movements in both peaks. The south leg of 48 Street will be one of the two accesses into the denser commercial and retail developments that make up the North Point lands south of 338 Avenue, with traffic from neighbouring municipalities, plus local pass-by trips, using this route.
- Turning traffic between the west and south leg, manifested as high numbers of NBL and EBR vehicles in both peaks. This is traffic between North Point and other parts of Okotoks.

Two concepts were tested for this junction: an all-turns signalized intersection; and a multi-lane roundabout. Due to higher traffic volumes near Highway 2, the corridor is recommended to have six lanes (three per direction) at the time it is upgraded. This would allow the eastern part of the corridor to connect the future Highway 2 interchange and the North Point ASP developments. 48 Street would thus be a logical place to transition from six lanes (to the east) and the initial design of four lanes (to the west). This is done through right turn lanes that drop a westbound lane and add an eastbound lane.

Exhibit 3-14 shows the proposed configuration for the roundabout at the junction of 338 Avenue with 48 Street. This is a two-lane roundabout with additional right turn lanes (i.e. slip lanes) merging into the receiving direction for the WBR and NBR.

Exhibit 3-14: Recommended Configuration – 48 Street / 338 Avenue Intersection



3.4.6 North Point Segment

The medium to long-term concept for this segment of the 338 Avenue corridor reflects the requirements of the North Point ASP (as defined in fall 2022) along with the preferred concept for the Highway 2 interchange, which includes realignment of the street towards the northeast.

The proposed design was based on a multi-modal assessment of requirements in this area. The design was informed by two main inputs:

- The recent Highway 2 functional design study (and the projected interchange volumes); and
- The proposed land uses and the associated trip generation for the North Point ASP, which includes the lands south and north of the corridor. Most of the development in North Point was not included in past forecasts for this part of the corridor, so the demands needed to be merged.

Once development of the North Point Lands and the interchange proceeds, this will trigger the need to construct this segment of 338 Avenue. The travel demand becomes the highest in the corridor due to those factors, and traffic studies indicated that six lanes would be required to manage peak demands. This also ties in with the functional design for the interchange at the eastern end of this segment.

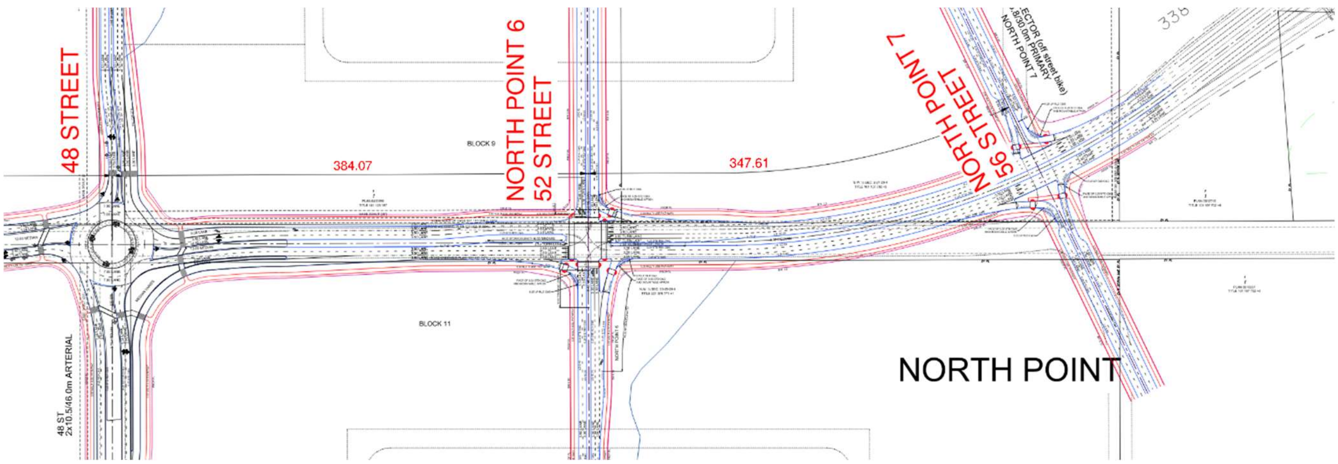
This segment will include two intermediate intersections at the approximate locations of “52 Street” and “56 Street.” These streets are referred to as North Point Accesses 6 and 7, respectively, in the in-progress ASP.

- Due to its proximity to the future interchange, it was determined that 56 Street would not support left turns, because of the risk of traffic weaving from the off-ramp to the left turn bay over too short a distance. Instead, the intersection will be a right-in/right-out configuration.

- It is recommended that the northbound right turn lane from 56 Street feed into an auxiliary lane on 338 Avenue, which would allow for more weaving distance prior to the southbound on-ramp at the Highway 2 interchange.
- To carry the extra turn volumes, 52 Street would have a second westbound left turn.

Exhibit 3-15 shows the proposed configuration for this segment, with 338 Avenue built as a six-lane arterial.

Exhibit 3-15: Recommended Configuration – North Point Segment



4 Active Transportation Concept

Several Town of Okotoks policies indicate a desire for strong active transportation elements in this corridor, and the vision for 338 Avenue includes walking, cycling, and rolling infrastructure along the entire length. In addition, connections into adjacent neighbourhoods and across the corridor were emphasized by various adopted policies.

This section of the study report outlines the requirements and assumptions for active transportation. Section 9 provides complementary material related to the landscape concept for the corridor.

4.1 Needs and Opportunities

The Transportation Master Plan and the Active Transportation Strategy include several policies and strategies to encourage the take-up of active modes by Okotoks residents. In addition, the NOASP includes policies and design guidelines specifically for the Wedderburn segment – subject to confirmation in this study – that may also apply to other parts of the corridor. Furthermore, as outlined in Section 2.2, the Municipal Development Plan (MDP) is the highest statutory document guiding development in the Town of Okotoks and pertains to this study. Based on the aforementioned documents, these policies are intended to produce the following results:

- Regional routes to be provided along the 338 Avenue corridor as a major east-west element.
- Connections to north-south off-street pathways and on-street (sidewalks, cycle lanes) active modes elements.
- Permeability north and south across the corridor, particularly in the Wedderburn and Trilogy Plains sections.

Council and staff provided direction on this topic, including the following provisions:

- ➢ Integrated Multi Use Pathway (MUP) allowing for walking, rolling, and cycling.
- ➢ Can be maintained during winter events by plowing.
- ➢ Can be demarcated using line markings, symbols for non-winter months to reduce potential cycling versus pedestrian space conflicts/reduce confusion over which side to use. The current Town standards will need to be reviewed and updated if paint line demarcation is required for the regional pathway along 338 Avenue.

This guidance has led to the proposed active transportation elements noted below, which are further elaborated in Section 8 (Urban Design/Landscape).

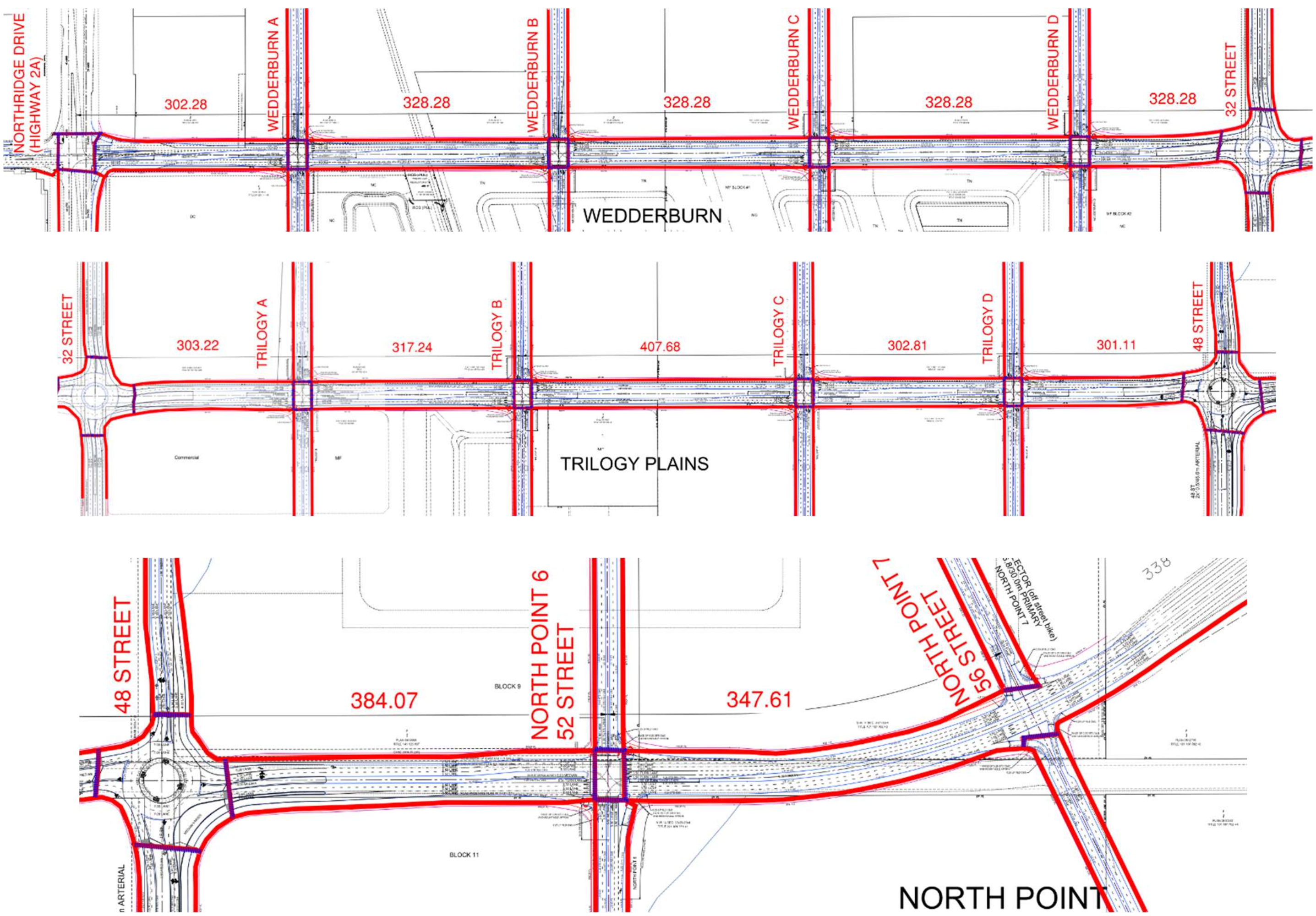
4.2 Proposed Active Transportation Elements

- Walking and cycling will be accommodated along the entire length of the corridor, and at signalized crossings.
- The initial assumption for active transportation is, at a minimum, a regional pathway which allows for seasonal maintenance and shared use.
- The regional pathway will be at least 3-metres wide, and will include long tangent or very gradually meandering sections – to provide a direct and attractive path for active modes users.
- Current plans for the Highway 2 interchange indicate the active modes crossing would be on the north side of an overpass. Active modes users from the north side of 338 Avenue would be directed to use a controlled and safe crossing location west of the interchange,

at 52 Street (i.e. North Point 6) and possibly a grade-separated pedestrian crossing at 56 Street (i.e. North Point 7).

- Accessibility measures need to be implemented along the entire corridor which include, but are not limited to, the following: tactile panels at all wheelchair ramps, audible traffic signals, and changes in surface materials as guidance and traffic delineation for the visually impaired.
- West of 56 Street, the regional pathway will be provided on both the south and north sides of the corridor, adjacent to boulevard and buffer space.
- Near the commercial hubs, additional plaza space for bicycle parking and seating areas may be considered. Refer to Section 8 (Urban Design/Landscape).

Exhibit 4-1: Active Transportation Corridor – 338 Avenue



Note: red lines denote active transportation corridors (i.e. sidewalks/pathways); blue lines denote road crossings

5 Transit Concept

The transit concept for 338 Avenue is to provide sufficient flexibility to install bus stops at strategic locations as development proceeds, depending on future needs. Stops can be accommodated in the boulevard space next to the travel lanes, either as curb-lane stops, or dedicated layby spaces.

5.1 Evolving Needs and Opportunities

The Town of Okotoks currently has two forms of transit:

- a privately-operated but publicly available commuter route operating between a limited set of major stops and the LRT (Light Rail Transit) station in southern Calgary.
- On-demand service between origins and destinations in town.

As the Town grows, the public transit system is likely to increase its service levels and may transition to a hybrid of fixed-route and on-demand offerings. There is a growing collaboration at the Calgary regional level regarding a future transit plan; therefore, in the future there may be a publicly funded regional transit option serving one or more main corridors in Okotoks.

In either case, there may be a desire for transit vehicle laybys along 338 Avenue at strategic locations. Since this is speculative, examples of bus stop layouts have been identified.

5.2 Provisions to Support Future Transit

If bus services operated on segments of 338 Avenue in the future, provisions would depend on urban design objectives as well as basic requirements related to bus operations.

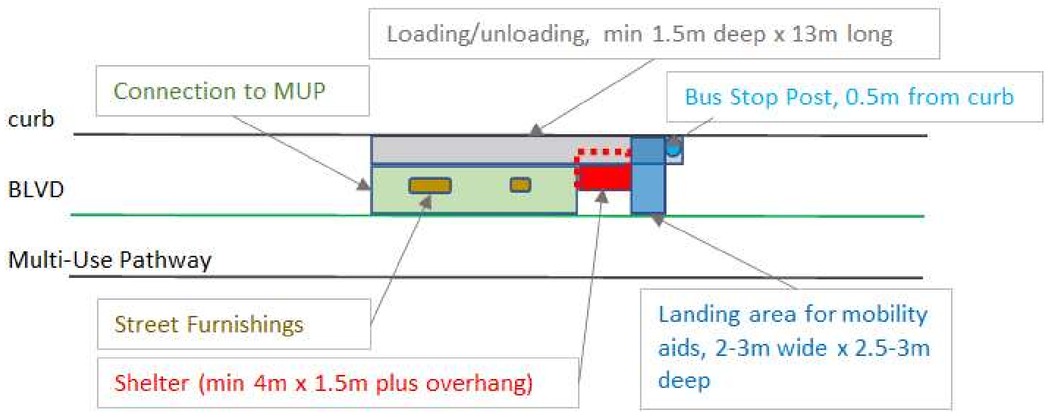
- At higher speeds, pull-outs/laybys are recommended. This reduces the risk of rear-end collisions between other vehicles and buses.
- At 50km/h or less, it is feasible to stop in the curb lane.
- Regardless of speed, if it is planned for the bus to dwell for an extended duration at the stop, then pull-out/layby locations are recommended. This occurs with timed transfer points, or a busy bus stop adjacent to a commercial, major recreational or institutional land use.

The proposed typical cross section for 338 Avenue from Northridge Drive to 48 Street includes four travel lanes, a landscaped median with left turn bays, generous boulevard space, and regional pathways. Passengers would use the pathways to access bus stop areas, which can be “cut out” from the boulevard space. East of 48 Street, there would be six travel lanes and travel speeds would be higher, triggering a need for bus pull-outs/laybys.

Regardless of the layout, bus stops would ideally include the features and minimum dimensions shown on Exhibit 5.1.

The length of the bus stop waiting areas should exceed that of the bus; so, a minimum of 13 metres for standard buses, or 19 metres for articulated buses. Allowing for manoeuvring, the stop would be at least 30 metres long if two back-to-back standard buses were planned to stop there simultaneously. The scale of the illustration matches the standard bus dimension.

Exhibit 5-1: Transit Stop Elements (Ideal)

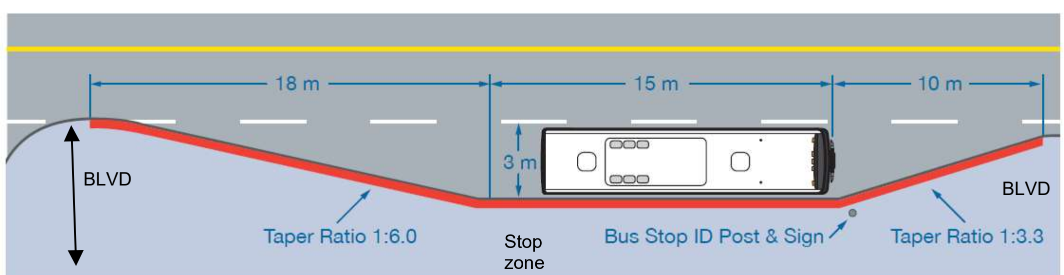


In the scenario where the bus stop is placed in a pull-out, then the bus pullout and bus stop area would be taken from the boulevard space, and depending on the dimensions, the MUP may divert outward to maintain its full width (>3 metres) outside the bus stop zone.

The approach to the bus stop would include an approach taper, the bus zone (3.0 to 3.5 metre lane, ideally), and then a departure taper after the stop. The lengths of these features depend on the posted speed of the street and the width of the bus stop. To allow for the bus to pull up and align with the curb, the bus zone should allow approximately 2.5 metres more than the length of the bus. For example, a standard bus would require 15 metres, as shown here in Exhibit 5.2.

Along 338 Avenue, the boulevard area on either side of the stop would be interrupted by the pullout lane and stop zone, then revert to being the boulevard again after the stop. Circulation would be accomplished by the MUP.

Exhibit 5-2: Transit Stop in Pull-Out/Layby Lane (Example)



Source: Transit Stop Installation Guide, 2018.

6 Road Safety Review

The safety of roadways is an important concern for transportation engineers and planners, as it directly affects the well-being of road users.

A comparative review was carried out for 338 Avenue, based on the period of 2025 to 2045, using the traffic forecasts from the intersection analyses referenced in Section 3. This review used the predictive safety analysis approach, which considers road geometry, forecast volumes, and typical safety performance for the types of facilities. This study applied the Highway Safety Manual 2020 methodology. The National Cooperative Highway Research Program (NCHRP) 888 report proposes different Safety Performance Functions (SPF's) for various roundabout configurations, and these were considered as inputs to the analysis of scenarios with traffic signals versus roundabouts along the 338 Avenue corridor.

A signalized intersection and a roundabout both have their unique safety advantages and disadvantages, as well as different features that can impact the safety of the intersection along an arterial road.

During the study period, the costs of motor vehicle collisions were determined by considering the societal costs of fatalities and injuries resulting from crashes as well as the expenses incurred for maintenance. To arrive at the costs of these collisions, a discount rate of 3.10% over a period of 20 years was applied. Based on the collision types, cost has been estimated for fatal collision (F), injury collision (I), and property damage only collision (PDO). Exhibit 6-1 shows assumed collision costs for different types of collisions.

Exhibit 6-1: Collision Costs for Different Types of Collisions

Collision Costs	
Fatal	$1,656,000
Injury	$60,500
PDO Only	$5,000

One of the advantages of a signalized intersection is that it allows vehicles to make direct turns to reach their destination, which can be more convenient for drivers. Additionally, it can accommodate a higher volume of turning vehicles than a roundabout, especially during peak hours. However, one of the disadvantages of an intersection is that it can be more prone to accidents especially fatal collisions due to the higher speed of vehicles and potential conflicts between turning vehicles and through traffic. Pedestrian safety can also be compromised if there are no proper crossings or signals, and the intersection is too large. To mitigate these issues, traffic signals are usually installed to regulate the flow of traffic, and dedicated turn lanes and channelization can help separate turning and through traffic, reducing conflicts and improving safety.

In contrast, one of the advantages of a roundabout is that it encourages slower vehicle speeds and reduces the likelihood of fatal collisions due to high-speed. This can be especially beneficial for arterial roads, where high-speed crashes can be particularly dangerous. Additionally, roundabouts can improve pedestrian safety by providing designated crossings and medians to wait for gaps in traffic. However, one of the disadvantages of a roundabout is that it can be confusing for drivers who are not familiar with roundabouts and may not know how to navigate them correctly during the early stages of the roundabout. Over time, the drivers will get familiar with the roundabout. The central island provides additional separation between entering and exiting traffic, reducing the risk of collisions.

6.1 Comparative Evaluation

A comparative evaluation has been carried out to assess the potential collision risks along the corridor over the period 2025 to 2045. To perform the safety analysis, the corridor has been divided into 24 sections, which consists of either signalized intersections or roundabouts and segments.

Considering all the above-mentioned facts, three scenarios have been assessed to perform safety analysis over the period 2025 to 2045:

- **Scenario 1** indicates all intersecting roads with 338 Avenue are four-legged/all-turns signalized intersections.
- **Scenario 2** demonstrates all crossing roads with 338 Avenue are four-legged signalized intersections, except for two specific locations, namely 32 Street and 48 Street, which are considered as multilane four-legged urban roundabouts.
- In **Scenario 3**, all intersecting roads are considered four-legged multilane urban roundabouts, except for two locations, Highway 2A and 52 Street (North Point Access 6).

Exhibit 6-2 shows the predicted number of collisions for the 20 years from 2025 to 2045:

- In Scenario 1, it is estimated that there will be 196 fatal and injury collisions, 433 property damage only collisions, for a total of 629 collisions.
- Scenario 2 predicts 201 fatal and injury collisions, 509 property damage only collisions, for a total of 709 collisions.
- Finally, in Scenario 3, the estimated numbers of fatal and injury collisions, property damage only collisions, and total collisions are 231, 787, and 1018, respectively.

Exhibit 6-2: Predicted Number of Collisions for 20 years by Severity

Scenario 1 (all signalized)				Scenario 2 (signalized + roundabouts)				Scenario 3 (all roundabouts)			
Predicted Number of Collisions for 20 years											
F	I	PDO	Total	F	I	PDO	Total	F	I	PDO	Total
59	137	433	629	54	147	509	710	42	189	787	1,018

Note: F= Fatal Collision; I= Injury Collisions; PDO= Property Damage Only Collisions; Total = F + I + PDO

The predicted number of collisions result demonstrate that Scenario 3 (all roundabouts) is expected to cause more total collisions than the future signalized intersections (Scenario 1), but with fewer collisions resulting in fatal collisions. Despite the higher total collision estimate, the roundabout's design is expected to reduce the severity of accidents by decreasing the likelihood of high-speed collisions and angle collisions. This finding highlights the importance of considering both the total number of collisions and the severity.

By understanding the costs associated with collisions, policymakers and stakeholders can allocate resources to reduce collisions and their associated costs. Exhibit 6-3 shows the predicted cost of collisions for each scenario over a 20-year period. The cost estimates have been categorized into fatal collisions, injury collisions, property damage only collisions, and total collisions.

Exhibit 6-3: Predicted Cost of Collisions (in million $) for 20 years by Severity

Scenario 1 (all signalized)				Scenario 2 (signalized + roundabouts)				Scenario 3 (all roundabouts)			
Predicted Cost of Collisions for 20 years (in million dollars)											
F	I	PDO	Total	F	I	PDO	Total	F	I	PDO	Total
3.31	7.75	1.44	12.50	2.96	7.96	1.70	12.62	2.04	9.26	2.66	13.95

Note: F= Fatal Collision; I= Injury Collisions; PDO= Property Damage Only Collisions; Total = F + I + PDO

It is important to note that these cost predictions are based on the estimated number of collisions and the associated costs of each collision type and may not accurately reflect the actual costs that may be incurred over the 20-year period. Nonetheless, these cost estimates provide policymakers and stakeholders with valuable information to prioritize interventions and allocate resources to mitigate the costs associated with collisions and improve road safety.

6.2 Recommendations

Based on the outcome, it can be inferred that Scenario 3, which involves the installation of multiple roundabouts, was the most favorable option in terms of minimizing the number of fatal collisions. Roundabouts are designed to reduce the severity of crashes and minimize the chances of vehicular conflicts. However, it should be noted that they do not eliminate the possibility of accidents. Furthermore, during the initial stages of implementation, drivers may be unfamiliar with roundabouts or may not fully comprehend how to navigate them, resulting in errors such as failing to yield to other vehicles, which may result in collisions causing property damage.

Over time, as drivers become more accustomed and acquainted with these roundabouts, the number of collisions tends to decrease due to a learning curve associated with roundabouts, where drivers adapt their behavior and anticipate the movements of other vehicles. However, it should be noted that Scenario 3 will result in lower traffic throughput than Scenario 2, from an operational perspective. The operational performance of Scenario 1 and Scenario 2 will be more comparable, though implementation of Scenario 2 would result in fewer fatal collisions than Scenario 1. Therefore, Scenario 2 is recommended for future implementation.

7 Corridor Right-of-Way Concept

7.1 Ultimate 2045 Cross-section Requirements

Currently the road right-of-way (ROW) for 338 Avenue ranges between 30.2m and 30.6m for the most part; however, there are deviations in the ROW width at certain locations along the corridor (i.e., approaching Highway 2A and Highway 2). To achieve the vision/look and feel for 338th Avenue as a major gateway into the Town of Okotoks with adequate active transportation infrastructure, urban landscape architecture along the boulevards and median, and four (4) to six (6) traffic lanes, additional ROW width will be required.

Various ROW options were reviewed and considered for the entire corridor which consisted of 30.5-meters, 35.0-metres, 40.0 metres, and 46.0 metres.

Based on the 2045 traffic analysis in Section 3, four (4) lanes of traffic are required for the first two (2) segments of 338 Avenue, between Northridge Drive and 48 Street. Six (6) lanes of traffic are required for the third segment between 48 Street and Highway 2. To maintain the "Look and Feel" and vision of the 338 Avenue corridor, a 40-metre ROW will be required for the first two (2) segments and a 46-metre ROW will be required for the third segment. Refer to Exhibits 7-1 and 7-2 for the 40-metre cross-section, and Exhibit 7-3 for the 46-metre cross-section.

Exhibit 7-1: Ultimate 40-metre ROW Cross-section – 4 Lanes (Northridge Drive to 48 Street)

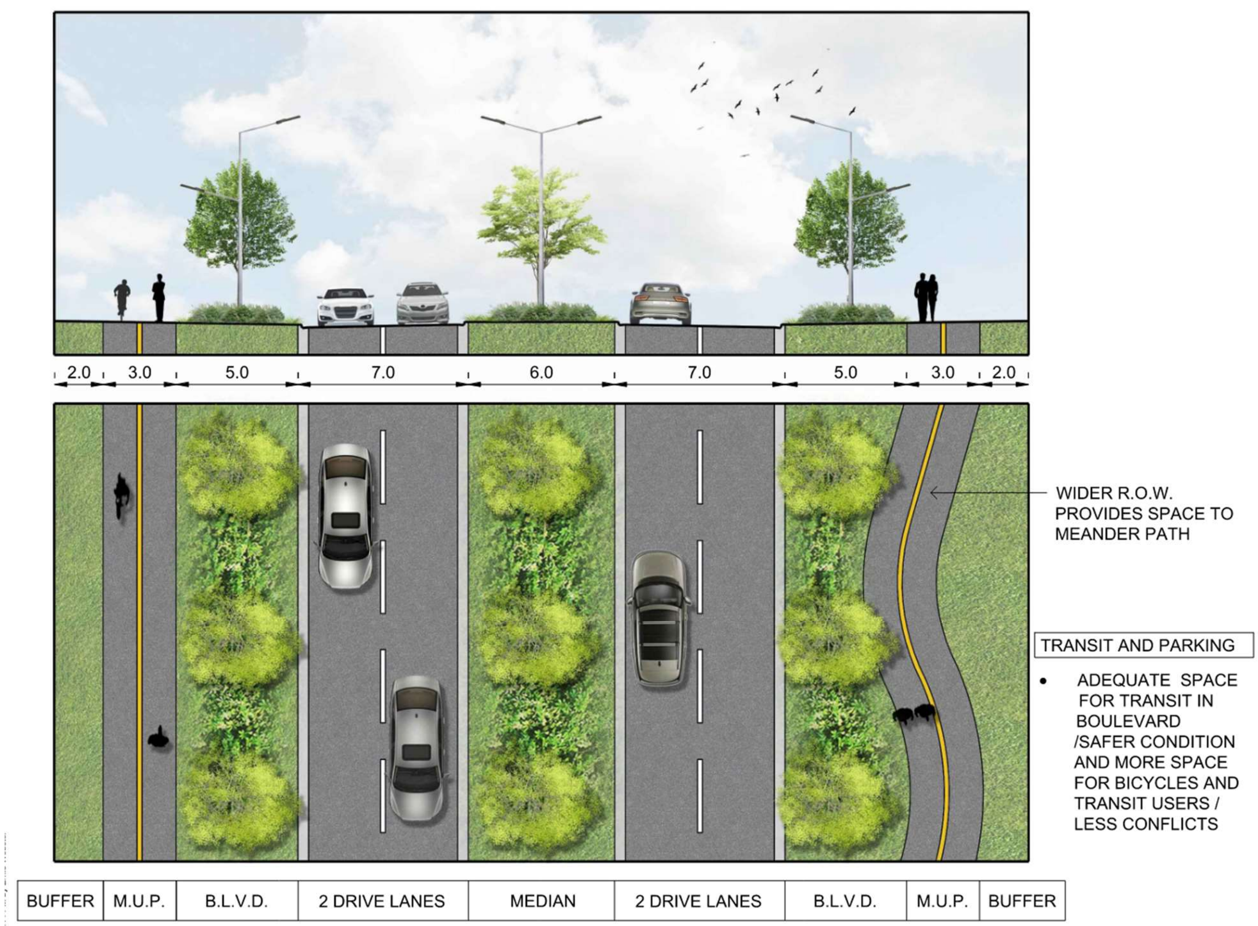


Exhibit 7-2: Ultimate 40-metre ROW Cross-section with Enhanced Features – 4 Lanes (Northridge Drive to 48 Street)

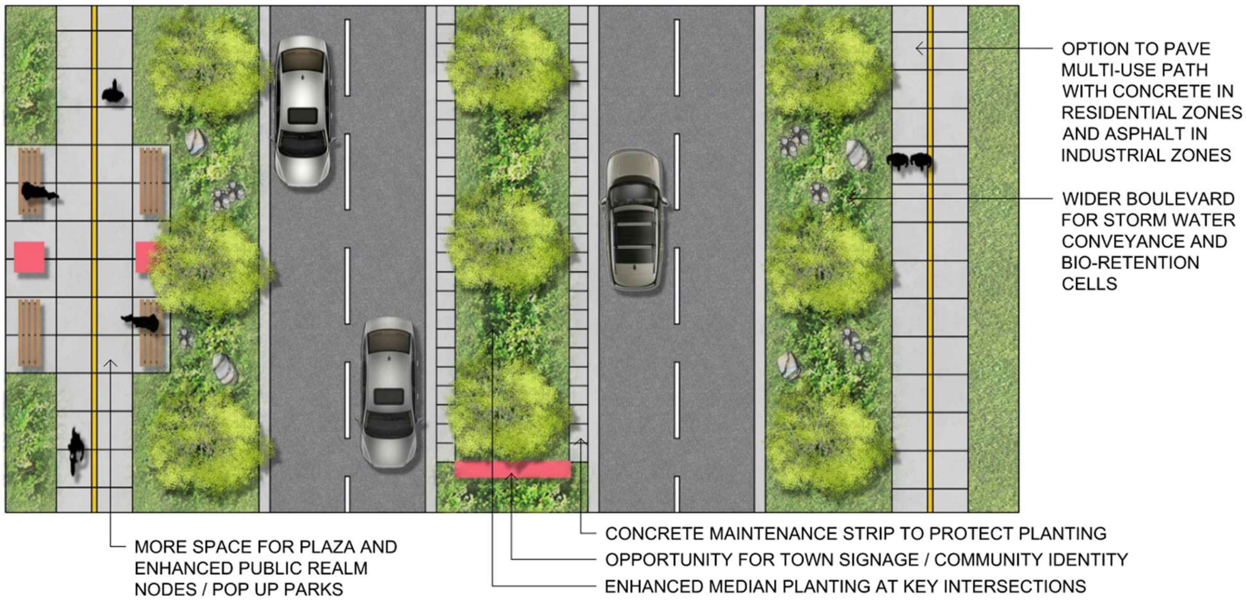
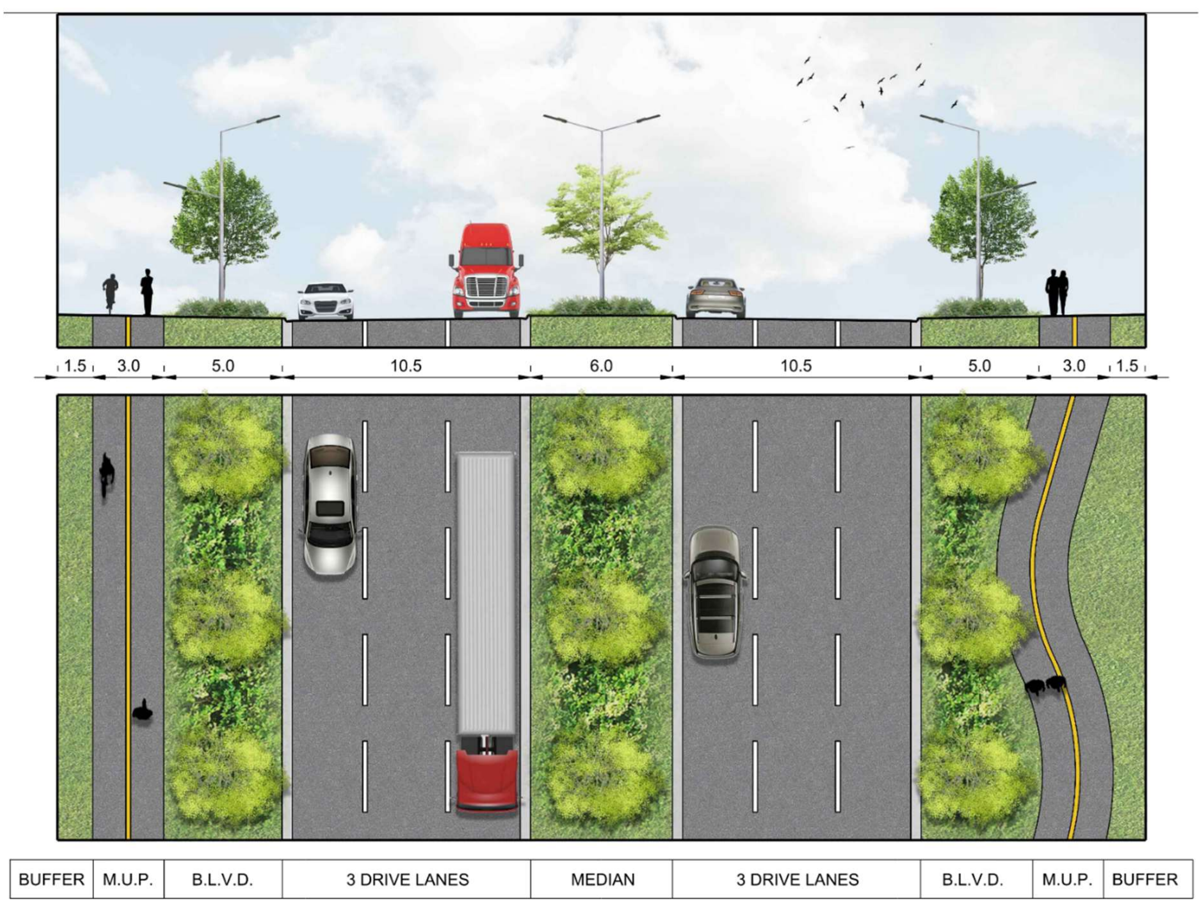


Exhibit 7-3: Ultimate 46-metre ROW Cross-section – 6 Lanes (48 Street to Highway 2)



7.2 Distant Future Traffic Projections

Interim projections of traffic suggest that four lanes will be sufficient until at least 2045 for the segment of 338 Avenue between Northridge Drive and 48 Street. If the growth rate for background and local traffic were to continue at the same pace after that, then by approximately 2060 six lanes could be required. This analysis is beyond the typical modeling horizons, and therefore it is simply an estimate based on using growth rates to approximate if/when 6-lanes will be required between Northridge Drive and 48 Street.

To account for potential traffic lane expansions from four (4) lanes to six (6) lanes in the distant future, protecting for a 46-metre ROW along the entire 338 Avenue corridor would be ideal. Three (3) options were developed that illustrate how the 4-lanes can be constructed within a 46-metre ROW in the interim.

Exhibit 7-4: Interim 46-metre ROW Cross-section (Northridge Drive to 48 Street)
Option 1: Wider Median

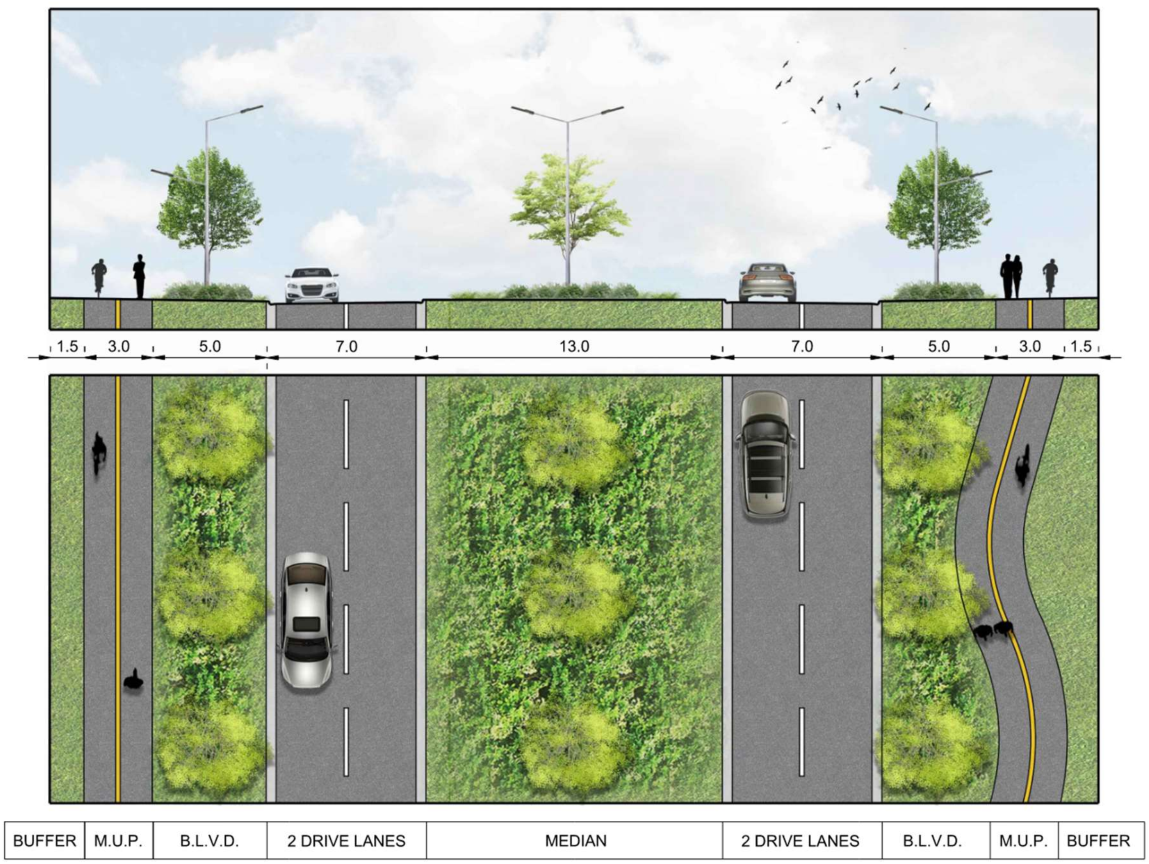


**Exhibit 7-5: Interim 46-metre ROW Cross-section (Northridge Drive to 48 Street)
Option 2: Wider Boulevards**

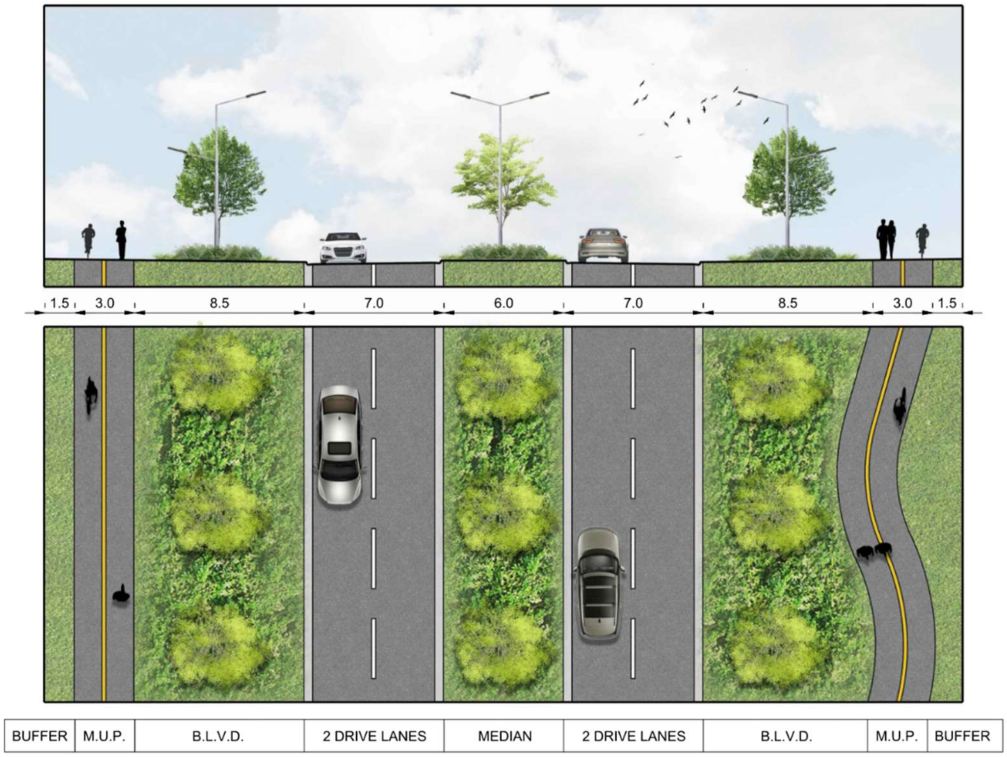
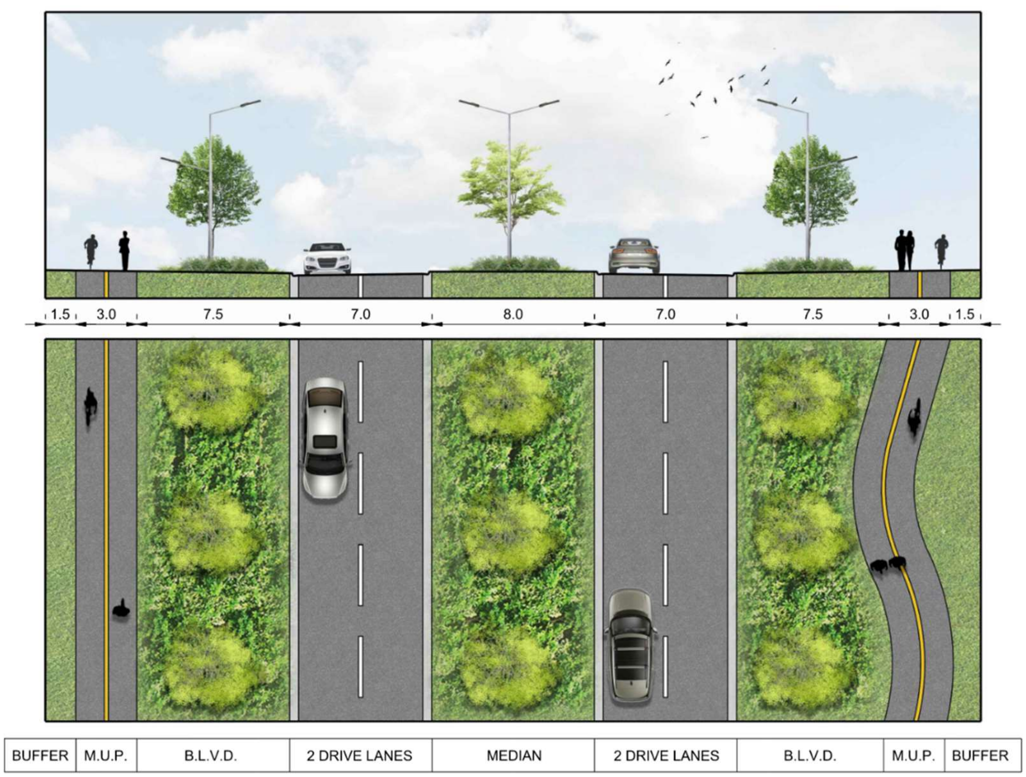


**Exhibit 7-6: Interim 46-metre ROW Cross-section (Northridge Drive to 48 Street)
Option 3: Hybrid - Wider Median and Boulevard**



7.3 Summary and Conclusion

The recommendation is to protect for a 46-metre ROW for the entire 338 Avenue corridor, with the exception to the western quarter section along Wedderburn, immediately east of Northridge Drive. The development was previously approved based on a 40-metre ROW for 338 Avenue. Therefore, the ROW will be reduced by 3m on the south side for the western quarter section. The ROW will increase to 46-metres beyond that western quarter section to Highway 2.

Option 2 is the recommended option to move forward with for the interim lane configuration. The proposed concept drawings in Appendix A are based on Option 2.

8 Landscape Concept

The Town and the Arcadis IBI Team convened a “Look and Feel” workshop in 2022 including numerous other internal stakeholder meetings, developer stakeholder meetings, and a council session. The intent is to create a vision for the 338th Avenue corridor and brainstorm a design strategy and parameters for the streetscape and adjacent public realm within the context of the adjacent land use. Discussions focused on function and aesthetics.

Three key design themes emerged:

1. Connectivity and Mobility

- Cross Section should allow for pedestrian connectivity along both sides of the street to and from the adjacent residential/commercial and industrial lands.
- Cross Section should incorporate a shared multi use path on both sides of the street (ideally 3.0m wide), accommodating bicycles and pedestrians and other emerging forms of travel (for example e-scooters, e-bikes, and single-wheel electric skateboards). Trees and new plantings should be set back sufficiently on boulevards to provide a buffer between paths and vehicles while avoiding salt spray and damage from snow removal.
- Maintain good sight lines for safety. Low planting and a high tree canopy should mitigate wildlife conflicts and collisions.
- Ensure clear definition and delineation for each type of user – mitigate conflicts between users. Paint line demarcation of regional pathways will require an update to the current Town of Okotoks Standards.
- Opportunity to create space for rest places and small seating plazas that incorporate universal design principles throughout the streetscape, with accessible, inclusive site furnishings and landscape treatments.
- The path network should be forward thinking and be able to connect to future path networks through Okotoks and beyond (potentially to Calgary via the old railway line as well as over the new interchange at Highway #2 and the Rotary Mattamy Greenway).
- Asphalt and concrete (or a combination of both) are the preferred materials from a mobility/active transportation perspective as well as from a surfacing perspective (Town of Okotoks Standards for ease of maintenance).
- Integrate future transit stops into the adjacent paths.
- Potential to emphasize health and wellness along the paths – explore fitness circuit/ stations along the route.
- Wayfinding and signage are essential to achieve the above successfully.
- Consider snow removal and roads maintenance all year round.
- Consider traffic calming measures, ensure separation between vehicles and bikes/pedestrians and create safe accessible pedestrian crossings at intersections and roundabouts.

2. Green Infrastructure

- Opportunities to integrate stormwater management from the road (as well as adjacent lands) into sustainable landscape practices including rain gardens, bio-retention and infiltration areas, conveyance of stormwater through bio swales. Adequate space needs to be provided for soil volumes that will support healthy tree growth and root development.

- We don’t anticipate locations with an urban condition, however, should small plazas with tree planting be incorporated, we recommend considering soil cells and/or structural soil to maximize soil volumes and provide opportunities for storm water conveyance.
- Opportunities to expand the tree canopy and establish a planting strategy that defines the different land zones with different tree species. A preferred tree list can be established in partnership with The Town.
- Potential for trial planting areas along the road corridor; Research / explore carbon sequestration; educate and interpret / innovate.

3. Sense of Place

- Visual transition from industrial lands to residential must be legible; the public realm and streetscape design elements should respond to traffic speed and vehicle typology as the look and feel of future development on adjacent lands.
- Uniformity in materials is important and will create a cohesive streetscape that the community and town identify with. A recommended hierarchy of materials should be incorporated into the final urban design guidelines.
- Architectural standards for private property edge treatments and fencing design should be coordinated along the corridor where feasible. The aesthetics of private fences and community features should blend with the road corridor design style and there should be a cohesive approach – most of the adjacent lands are not constructed yet; there is opportunity to be proactive and establish landscape character that will inform the private developers design style.
- Roundabouts and intersections provide opportunities for features and landmarks that relate to adjacent land use. They provide space to celebrate community culture and identity and can be positioned within the clear sight lines
- Wayfinding and signage should be consistent with Okotoks standards and established styles.
- Incorporating First Nations / Blackfoot cultures should be explored based on the origins of Okotoks and the significant contributions of the Blackfoot. This project presents an excellent opportunity to sensitively incorporate art and local history.
- Opportunities to explore interpretation of local history through technology and wayfinding/ signage.

  The road corridor will become an important gateway to Okotoks and warrants quality landscape treatments that will be timeless, easy to maintain, and augment design themes already established closer to the downtown core and in other areas in Okotoks such as Northridge Drive urbanization. There is no need to completely “re-invent the wheel”, however, there are opportunities to innovate and create a road corridor that reflects the character of Okotoks, while considering the design typology of surrounding private residential and industrial lands.

9 Closing

This document summarizes and concludes the Functional Study for the 338 Avenue corridor in the Town of Okotoks. We trust this document meets the present requirements. This project is currently active and as such, the design choices and options proposed in this document are subject to change pending review and final direction provided by the Town of Okotoks.

Blair Smith

Prepared by:
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Associate – Senior Transportation Engineer

Reviewed and Updated by:
Adam Haimour, M.Eng. P.Eng.
Associate Principal – Practice Lead Civil Engineering

Appendix A – Road and Landscape Concept Plans

(1.) Road Concept - 4 and 6 Lane Configuration
4-Lanes (Northridge Drive to 48 Street)
6-Lanes (48 Street to Highway 2)

(2.) Landscape Concept - 4 and 6 Lane Configuration
4-Lanes (Northridge Drive to 48 Street)
6-Lanes (48 Street to Highway 2)

(3.) Road Concept - 6 Lane Configuration
6-Lanes (Northridge Drive to Highway 2)

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338 AVENUE CONCEPTUAL ROAD DESIGN

DECEMBER 15, 2023

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338 AVENUE CONCEPTUAL ROAD DESIGN

DECEMBER 15, 2023

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338 AVENUE CONCEPTUAL ROAD DESIGN

DECEMBER 15, 2023

338 AVENUE IMPROVEMENTS
OKOTOKS, AB

KEY PLAN | LANDSCAPE CONCEPT DRAWINGS

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LANDSCAPE CONCEPT

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OKOTOKS - 338 AVENUE IMPROVEMENTS

LANDSCAPE CONCEPT

N

1:500

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LANDSCAPE CONCEPT - INTERSECTION PLAN

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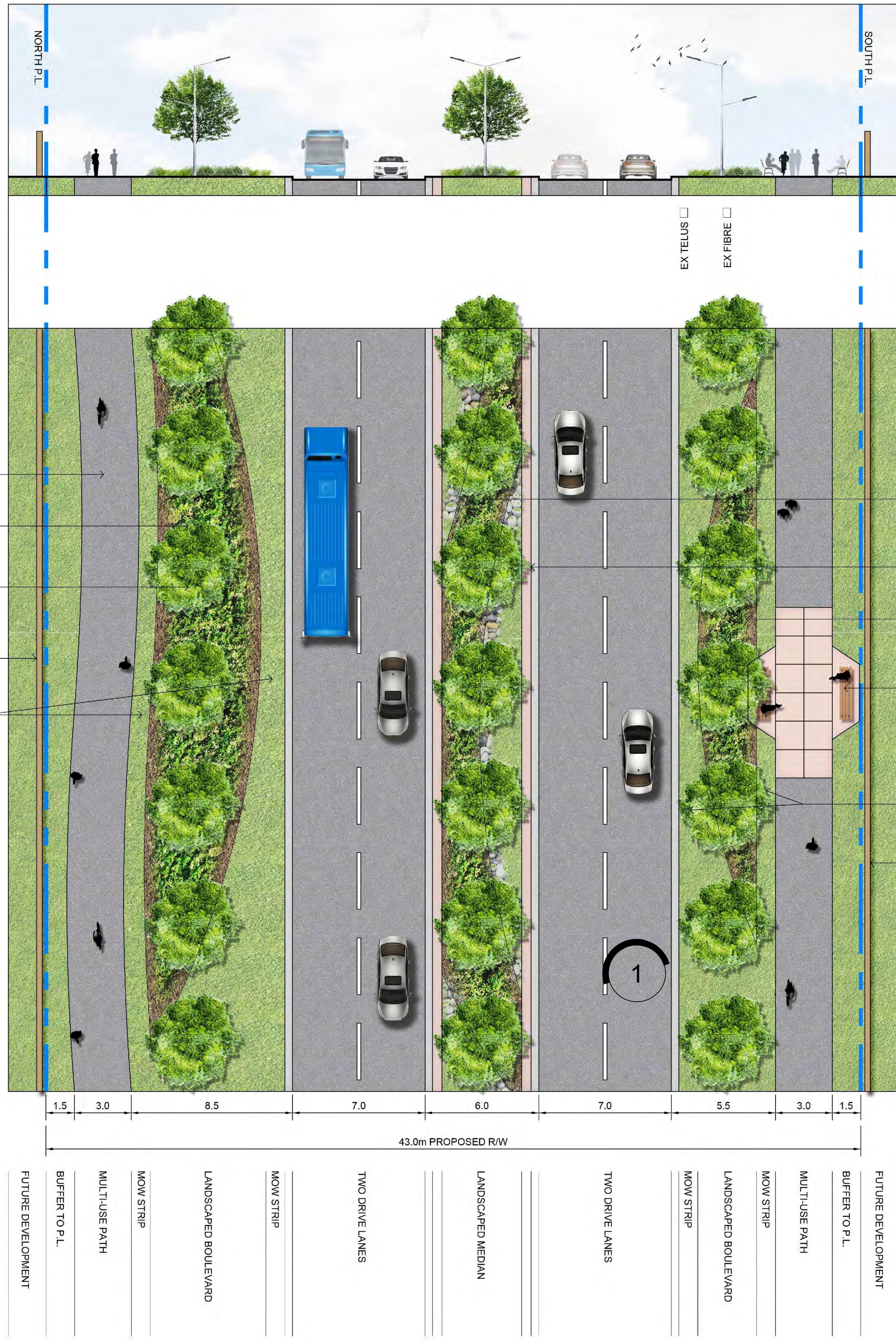
OKOTOKS - 338 AVENUE IMPROVEMENTS

L1.3B

LANDSCAPE CONCEPT - SECTION - NORTHRIDGE TO WEDDERBURN C



1 - DRIVERS VIEW ALONG 338 AVENUE (EASTBOUND)

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1:150 0 1.5 4.5 7.5m

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OKOTOKS - 338 AVENUE IMPROVEMENTS

L1.3C

LANDSCAPE CONCEPT

N

1:500

File Location: J:\138875_22-103_338_AI7.0_Production\7.03_Design\05_Landscape\138875-Landscape Plan.dwg Last Saved: December 20, 2023, by colton.zukowski Plotted: Wednesday, December 20, 2023 3:03:42 PM by Colton Zukowski

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LANDSCAPE CONCEPT

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OKOTOKS - 338 AVENUE IMPROVEMENTS

LANDSCAPE CONCEPT

1:500 0 5 15 25m

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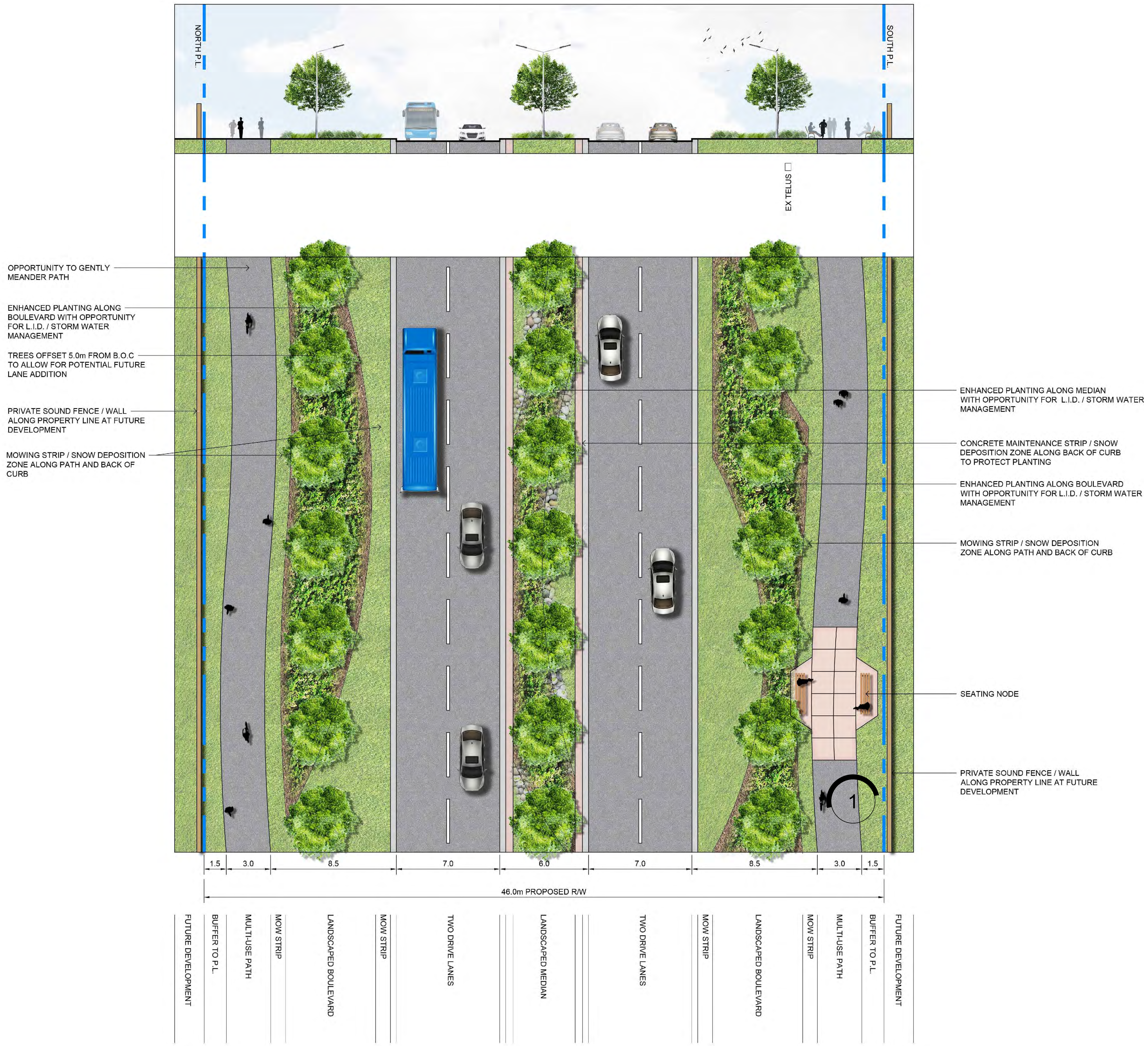
LANDSCAPE CONCEPT - SECTION - WEDDERBURN C TO 48 STREET



1 - PEDESTRIAN VIEW ALONG MULTI-USE PATH

*** 4 LANES OF TRAFFIC REQUIRED FOR THIS SEGMENT TO ACCOMMODATE FULL BUILD OUT OF LANDS ADJACENT TO 338 AVENUE.

*** THE CORRIDOR WILL BE SPACE PROOFED FOR 6 LANES WHICH MAY BE REQUIRED BY 2060 BASED ON TRAFFIC GROWTH EXPECTATIONS IN THE MORE DISTANT FUTURE.

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LANDSCAPE CONCEPT

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LANDSCAPE CONCEPT

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1:500 0 5 15 25m

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LANDSCAPE CONCEPT

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OKOTOKS - 338 AVENUE IMPROVEMENTS

LANDSCAPE CONCEPT

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OKOTOKS - 338 AVENUE IMPROVEMENTS

LANDSCAPE CONCEPT - ROUNDABOUT PLAN

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OKOTOKS - 338 AVENUE IMPROVEMENTS

L1.10B

LANDSCAPE CONCEPT

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LANDSCAPE CONCEPT

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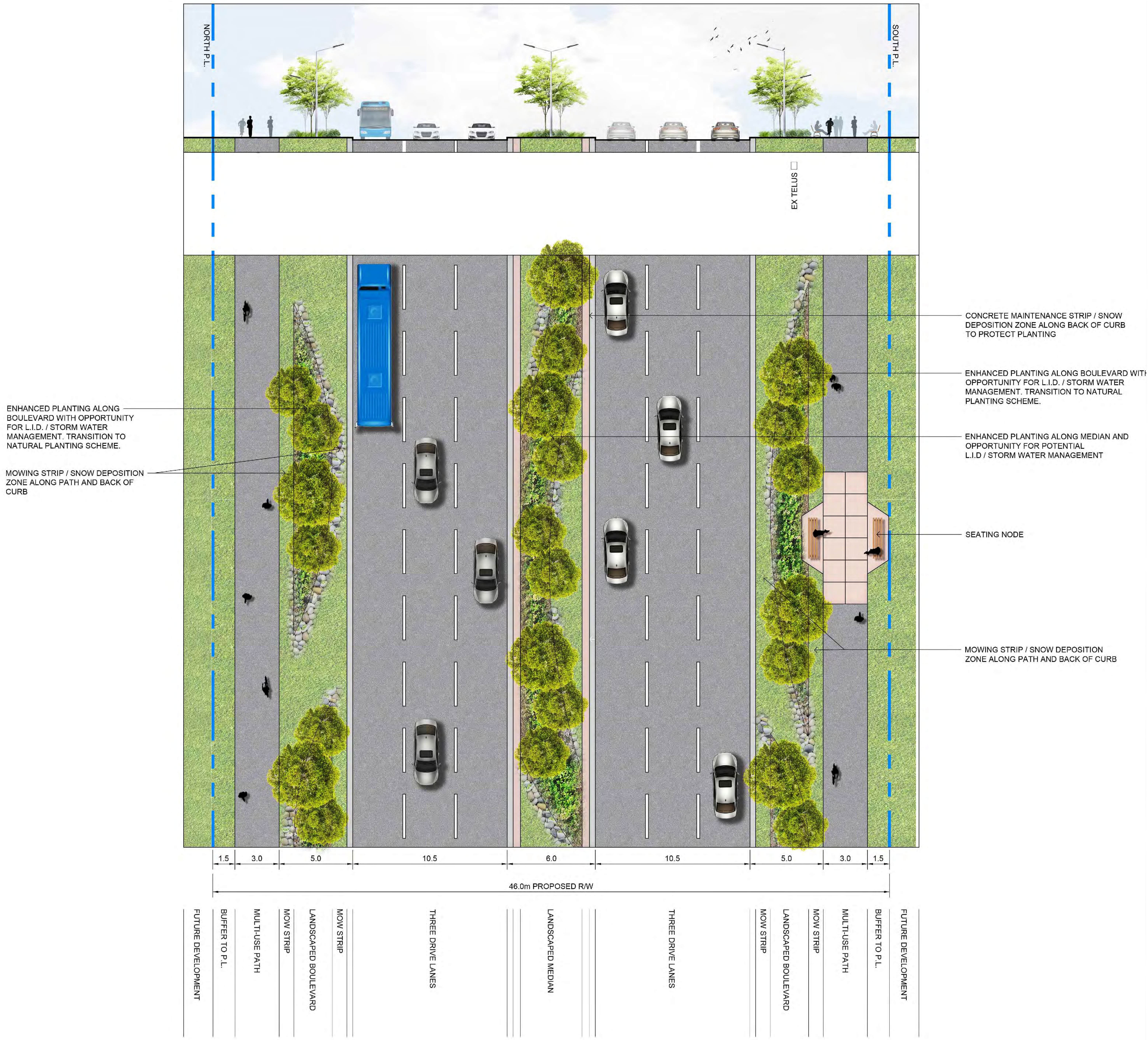
OKOTOKS - 338 AVENUE IMPROVEMENTS

LANDSCAPE CONCEPT - SECTION - 48 STREET TO HIGHWAY 2



*** 6 LANES OF TRAFFIC REQUIRED FOR THIS SEGMENT TO ACCOMMODATE DULL BUILD OUT OF LANDS ADJACENT TO 338 AVENUE INCLUDING TRAFFIC TO AND FROM THE 338 AVENUE / HIGHWAY 2 INTERCHANGE.

1:150

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LANDSCAPE CONCEPT - PRELIMINARY PLANT LIST

PRELIMINARY PLANT LIST

QTY.	BOTANICAL NAME	COMMON NAME	SIZE	COND.	SPACING
DECIDUOUS TREES					
	ACER SACCHARINUM 'SILVER CLOUD'	SILVER CLOUD MAPLE			
	ACER TATARICUM	TATARIAN MAPLE			
	AESCULUS GLABRA	OHIO BUCKEYE			
	CELTIS OCCIDENTALIS	HACKBERRY			
	CRATAEGUS MORDENENSIS 'TOBA'	TOBA HAWTHORN	60mm CAL.	B&B	
	FRAXINUS AMERICANA 'JEFWIS'	NOBILITY WHITE ASH	80mm CAL.	B&B	
	FRAXINUS PENNSYLVANICA 'FOOTHILLS'	FOOTHILLS GREEN ASH	70mm CAL.	B&B	
	FRAXINUS PENNSYLVANICA 'RUGBY'	PRAIRIE SPIRE GREEN ASH	70mm CAL.	B&B	
	PRUNUS MAACKII	AMUR CHERRY			
	PYRUS USSURUENSIS 'MORDAK'	PRAIRIE GEM PEAR	60mm CAL.	B&B	
	QUERCUS MACROCARPA	BUR OAK			
	SORBUS AUCUPARIA 'FASTIGIATA'	PYRAMIDAL MOUNTAIN ASH	70mm CAL.	B&B	
	SYRINGA RETICULATA	JAPANESE TREE LILAC			
	TILIA AMERICANA	AMERICAN LINDEN			
	ULMUS AMERICANA	AMERICAN ELM	80mm CAL.	B&B	
CONIFEROUS TREES					
	LARIX SIBIRICA	SIBERIAN LARCH	3000mm HT.	B&B	
	PICEA GLAUCA	WHITE SPRUCE	3000mm HT.	B&B	
	PICEA PUNGENS	COLORADO SPRUCE	3000mm HT.	B&B	
	PINUS CONTORTA	LODGEPOLE PINE			
	PRUNUS PONDEROSA	PONDEROSA PINE			
DECIDUOUS SHRUBS					
	ELAEGNUS COMMUTATA	WOLF WILLOW			
	POTENTILLA FRUTICOSA 'ABBOTSWOOD'	ABBOTSWOOD POTENTILLA			
	POTENTILLA FRUTICOSA 'PINK BEAUTY'	PINK BEAUTY POTENTILLA	600mm HT.	#2 CONT.	
	RIBES ALPINUM	ALPINE CURRANT			
	RIBES AUREUM	GOLDEN CURRANT			
	SHEPHERDIA ARGENTEA	SILVER BUFFALOBERRY			
	SHEPHERDIA CANADENSIS	CANADA BUFFALOBERRY			
	SORBARIA SORBIFOLIA	FALSE SPIREA			
	SPIRAEA X BUMALDA 'GOLDFLAME'	GOLDFLAME SPIREA	600mm HT.	#2 CONT.	
	SYRINGA MEYERI 'PALIBIN'	DWARF KOREAN LILAC			
	SYRINGA PATULA 'MISS KIM'	MISS KIM LILAC			
	VIBURNUM DENTATUM 'BLUE MUFFIN'	BLUE MUFFIN VIBURNUM			
	VIBURNUM OPULUS 'NANUM'	DWARF EUROPEAN CRANBERRY			
GRASSES					
	ANDROPOGON SCOPARIUS	LITTLE BLUESTEM GRASS		15cm CONT.	
	BOUTELOUA GRACILIS	BLUE GRAMMA GRASS		15cm CONT.	
	CALAMAGROSTIS ACUTIFLORA 'AVALANCHE'	AVALANCHE FEATHER REED GRASS		15cm CONT.	
	CALAMAGROSTIS ACUTIFLORA 'KARL FOERSTER'	KARL FOERSTER FEATHER REED GRASS		15cm CONT.	
	CALAMAGROSTIS ACUTIFLORA 'OVERDAM'	OVERDAM FEATHER REED GRASS		15cm CONT.	
	DESCHAMPSIA CESPITOSA	TUFTED HAIR GRASS		15cm CONT.	
	ELYMUS ARENARIUS 'BLUE DUNE'	BLUE LYME GRASS		15cm CONT.	
	HELICTRICHON SEMPERVIRENS	BLUE OAT GRASS		15cm CONT.	
	KOELERIA MACRANTHA	JUNE GRASS		15cm CONT.	
	PANICUM VIRGATUM 'PRAIRIE SKY'	PRAIRIE SKY SWITCH GRASS		15cm CONT.	
	PHALARIS ARUNDINACEA VAR PICTA	RIBBON GRASS		15cm CONT.	
PERENNIALS					
	ACHILLEA MILLEFOLIUM	MOONSHINE YARROW		15cm CONT.	
	ANEMONE SYLVESTRIS	SNOWDROP ANEMONE		15cm CONT.	
	DALEA PURPUREA	PURPLE PRAIRIE CLOVER		15cm CONT.	
	RUDBECKIA HIRTA	BLACK-EYED SUSAN		15cm CONT.	

*** PRELIMINARY PLANT LIST TO BE REFINED AT DETAIL DESIGN IN CONSULTATION WITH PARKS DEPARTMENT. THE CURRENT LIST HAS BEEN MODIFIED FROM COMMENTS RECEIVED FROM PARKS ON NOVEMBER 6, 2023.

*** ALL TREES TO BE PLANTED IN MULCH BEDS.

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Okotoks

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338 AVENUE CONCEPTUAL ROAD DESIGN (SIX-LANE CONCEPT)

MARCH 15, 2024

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338 AVENUE CONCEPTUAL ROAD DESIGN (SIX-LANE CONCEPT)

MARCH 15, 2024

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338 AVENUE CONCEPTUAL ROAD DESIGN (SIX-LANE CONCEPT)

MARCH 15, 2024

Appendix B – Comparative Evaluation of Options

Appendix B: Evaluation of Roadway Design Trade-offs – 338 Avenue, Okotoks   Wedderburn Segment

Category	Criteria ↓ Options →	3 Interim Accesses	4 Interim Accesses	5 Interim Accesses	4 Roundabouts
Walking and cycling	Directness – N/S distance across street, spacing of crossings	4 lanes with median Avg 405m spacing Least permeable for active modes, greater distance from utility corridor trail likely to result	4 lanes with median Avg 320m spacing Moderate permeability for active modes	4 lanes with median Avg 270m spacing Moderate permeability for active modes	4 lanes plus splitter islands/medians, 320m spacing Moderate permeability for active modes
	Directness E-W, Cross Section offered	Combined crossing by MUP at intersections, direct. MUP both sides of 338.	Combined crossing by MUP at intersections, direct. MUP both sides of 338.	Combined crossing by MUP at intersections, direct. MUP both sides of 338.	Diversion of MUP crossing around roundabouts, but MUP is already set back 3m by boulevard
	Safety (for walking and cycling)	Greatest risks will be at intersections	Greatest risks will be at intersections	Greatest risks will be at intersections	Crossing cut into two segments by splitter islands
Urban Design and Cost Drivers	Footprint/width of street (between curbs)	4 lanes + median = 20m	4 lanes + median = 20m	4 lanes + median = 20m	Same as standard cross section, with some tapering on approaches
	Footprint/width at intersections	20m plus the curb radius effect at the corners, smart channels. Median narrows to 2.5m because of LT lanes.	20m plus the curb radius effect at the corners, smart channels. Median narrows to 2.5m because of LT lanes.	20m plus the curb radius effect at the corners, smart channels. Median narrows to 2.5m because of LT lanes.	Wider to provide roundabout geometry, assuming 2-lane RAB and central island sufficient for small to medium trucks
	Accommodation of landscaping, plazas, urban design	Can be anywhere on corridor but likely to focus on 3 access locations, and potentially at end of cycling trail in utility corridor	Can be anywhere on corridor but likely to focus on 4 access locations, and potentially at end of cycling trail in utility corridor	Plazas can be anywhere on corridor but likely to focus on 5 access locations. Trade-off with extra intersections is there would be less space for landscaping.	Offset from roundabout due to constraints of ROW Potential to use centre of island decoratively?
	Flexibility to incorporate transit in future	405m spacing of streets longer than typical local stop spacing, limited stop feasible at every second access (810m)	320m spacing of streets somewhat longer than typical local stop spacing, limited stop feasible at every second access (640m)	270m spacing of streets closest to typical local stop spacing for urban areas, limited stop feasible at every 2nd/3rd access (540-810m)	320m spacing of streets longer than typical local stop spacing, limited stop feasible at every second access (640m)

Category	Criteria ↓ Options →	3 Interim Accesses	4 Interim Accesses	5 Interim Accesses	4 Roundabouts
		Stops usually far side and easily reached from access points	Stops usually far side and easily reached from access points	Stops usually far side and easily reached from access points	Placement of stop may be downstream of intersection and less direct for passengers
	Assumed traffic controls	3 signals	4 signals	5 signals	Yield signs at approaches; potential to use flashing beacons for pedestrians
	Assumed additional lanes at intersections	Left turn lanes at all approaches on 338, left turn lanes at all 3 cross streets	Left turn lanes at all approaches on 338, left turn lanes at 3 of 4 cross streets	Left turn lanes at all approaches on 338, left turn lanes at 3 of 5 cross streets	None on 338. Double approach lanes at two busiest cross streets (Wedderburn Gate and E Commercial)
	Effects of Above on Costs	Fewest intersections and signals	Moderate intersections and signals	Most intersections and signals	Moderate number of intersections but larger footprint for each
Vehicles	Accommodation of Heavy Vehicles	Long term, HV =3% Wider RTs at commercial access points; may be more conflicts with other traffic due to higher volumes per location	Long term, HV =3% Wider RTs at commercial access points (first and last of interim locations)	Long term, HV =3% Wider RTs at commercial access points (first and last of interim locations)	Long term, HV=3% Wider circulating lanes required for RABs RTs into accesses may be more direct
	Vehicle Performance – Peaks Queuing E/W along 338 Delays	LOS C for most E-W traffic, except D for EB at Wedderburn Gate Longest simulated 95% queue is ~195m (at Wedderburn Gate)	LOS B for through traffic; LOS C for left turns Longest simulated 95% queue is ~180m (at Wedderburn Gate)	LOS B/A for through traffic; C for lefts Longest simulated 95% queue is ~175m (at Wedderburn Gate)	
	Cross Street Queuing and Delays	LOS C and D for cross street lefts Side street 95% queues are 50-70m	Mostly LOS C for lefts, LOS B for rights, minimal thru traffic Longest 95% queue is 85m at Wedderburn Gate, most are ~30-40m	Mostly C for lefts, B for rights Longest 95% queue is 75m at Wedderburn Gate, most are ~30-40m	
	Auto Travel Speeds (between signals)	Average 34 km/hr in peak	Average 33km/hr in peak	Average 32-33 km/hr in peak	Likely same as with signals
	Off-Peak Operations	Fewer signals could potentially result in	Marginally faster than during peak?	Marginally faster than during peak?	Marginally faster than during peak?

Category	Criteria ↓ Options →	3 Interim Accesses	4 Interim Accesses	5 Interim Accesses	4 Roundabouts
		higher off-peak speeds; may not be desirable.			
	Safety (between vehicles)	Typical level of risk from signal operations, permitted lefts at minor intersections	Typical level of risk from signal operations, permitted lefts at minor intersections	Typical level of risk from signal operations, permitted lefts at minor intersections	More sideswipe crashes; initially more PDO accidents than with signals, until drivers become used to RAB operations

Appendix B: Evaluation of Roadway Design Trade-offs – 338 Avenue, Okotoks Trilogy Plains Segment

Category	Criteria ↓ Options →	2 Interim Accesses	3 Interim Accesses	4 Interim Accesses	4 Roundabouts
Walking and cycling	Directness – N/S distance across street, spacing of crossings	4 lanes with median Avg 540m spacing Least permeable for active modes	4 lanes with median Avg 405m spacing (but unequal) Poor permeability for active modes	4 lanes with median Avg 320m spacing Moderate permeability for active modes	4 lanes plus splitter islands/medians, 320m spacing Moderate permeability for active modes
	Directness E-W, Cross Section offered	Combined crossing by MUP at intersections, direct. MUP both sides of 338.	Combined crossing by MUP at intersections, direct. MUP both sides of 338.	Combined crossing by MUP at intersections, direct. MUP both sides of 338.	Diversion of MUP crossing around roundabouts
	Safety (for walking and cycling)				
Urban Design and Cost Drivers	Footprint/width of street (between curbs)	4 lanes + median = 20m	4 lanes + median = 20m	4 lanes + median = 20m	**Same?**
	Footprint/width at intersections	20m plus the curb radius effect at the corners, smart channels. Median narrows to 2.5m because of LT lanes.	20m plus the curb radius effect at the corners, smart channels. Median narrows to 2.5m because of LT lanes.	20m plus the curb radius effect at the corners, smart channels. Median narrows to 2.5m because of LT lanes.	Wider to provide roundabout geometry, assuming 2-lane RAB and central island sufficient for medium or large trucks
	Accommodation of landscaping, plazas, urban design	Can be anywhere on corridor but likely to focus on 2 access locations	Can be anywhere on corridor but likely to focus on 3 access locations	Can be anywhere on corridor but likely to focus on 4 access locations	Offset from roundabout due to constraints of ROW Potential to use centre of island decoratively?
	Flexibility to incorporate transit in future	540m spacing of streets longer than typical local stop spacing, limited stop at unequal intervals Stops usually far side and easily reached from access points, but only 2	405m spacing of streets longer than typical local stop spacing, limited stop feasible at every second access (810m) Stops usually far side and easily reached from 3 access points	320m spacing of streets somewhat longer than typical local stop spacing, limited stop feasible at every second access (640m) Best potential Stops usually far side and easily reached from access points	320m spacing of streets longer than typical local stop spacing, limited stop feasible at every second access (640m) Placement of stop may be away from intersection and less direct for passengers
	Assumed traffic controls	2 signals	3 signals	4 signals	Yield signs at approaches

Category	Criteria ↓ Options →	2 Interim Accesses	3 Interim Accesses	4 Interim Accesses	4 Roundabouts
	Assumed additional lanes at intersections	Left turn lanes at all approaches on 338, left turn lanes at busiest cross street (nearest to 32 St)	Left turn lanes at all approaches on 338, left turn lanes at busiest cross street (nearest to 32 St)	Left turn lanes at all approaches on 338, left turn lanes at busiest cross street (nearest to 32 St)	None on 338. Potential need for double approach lane at busiest access (nearest to 32 St)
	Effects of Above on Costs	Fewest intersections and signals	Low number of intersections and signals	Moderate intersections and signals	Moderate number of intersections but larger footprint for each
Vehicles	Accommodation of Heavy Vehicles	Long term, HV ~10% Wider RTs at commercial access point (near 32 St); may be more conflicts with other traffic due to higher volumes per location	Long term, HV ~10% Wider RTs at commercial access point (first interim location nearest 32 St)	Long term, HV ~10% Wider RTs at commercial access point (first interim location nearest 32 St)	Long term, HV ~10% Wider circulating lanes required for RABs RTs into accesses may be more direct
	Vehicle Performance – Queuing E/W along 338 Delays	LOS D/E in peak direction, lefts; LOS C in lower volume direction Longest simulated 95% queue is ~280m (at Trilogy-A)	LOS C for most E-W traffic, except E at EBL at Trilogy A Longest simulated 95% queue is ~145m (at Trilogy-A)	LOS B for through traffic; LOS D at WB Trilogy A Longest simulated 95% queue is ~175m (at Trilogy A)	
	Cross Street Queuing and Delays	LOS D/E at cross street lefts Queues up to 65m	LOS C or D at busier cross street lefts Side street 95% queues are 30-50m	LOS C or D at busier cross street lefts Side street 95% queues are 25-35m; highest is 50m	
	Auto Travel Speeds (between signals)	Average 24 km/h in peak direction; 32 in lower volume direction	Average 32 km/hr	Average 30 km/h in peak direction; 33 in volume direction	
	Off-Peak Operations				
	Safety (between vehicles)				

Appendix B: Evaluation of Roadway Design Trade-offs – 338 Avenue, Okotoks North Point Segment

Category	Criteria ↓ Options →	3 Intersections	2 intersections + 1 RIRO; 1 double left	2 intersections + 1 RIRO; 2 double lefts	1 Roundabout, 1 signal, 1 RIRO
Walking and cycling	Directness – N/S distance across street, spacing of crossings	Incompatible with proximity to interchange	6 lanes with median Avg 280m spacing (but no crossing at RIRO Modest permeability for active modes	6 lanes with median Avg 280m spacing (but no crossing at RIRO, no crossing on east side of “52’ Street) Limited permeability for active modes	6 lanes with median 4 lanes plus splitter plus RT channels at 48 Street Avg 280m spacing (but no crossing at RIRO Modest permeability for active modes
	Directness E-W, Cross Section offered		Combined crossing by MUP at intersections, direct. MUP both sides of 338 west of “52” Street, then south side only.	Combined crossing by MUP at intersections, direct. MUP both sides of 338 until west side of “52”, then south side only.	Combined crossing by MUP at intersections, diversions at roundabout. MUP both sides of 338 west of “52” Street, then south side only.
	Safety (for walking and cycling)				
Urban Design and Cost Drivers	Footprint/width of street (between curbs)		6 lanes + median = 27m	Up to 7 lanes + median = 30m (whole segment east of 48)	27m on approaches to 48 St, could be 27 or 30m around “52” Street depending on # of LT lanes
	Footprint/width at intersections		27m plus the curb radius effect at the corners. Median narrows to 2.5m because of LT lanes.	30m plus the curb radius effect at the corners. Median narrows to 2.5m because of LT lanes.	Wider to provide roundabout geometry, assuming 2-lane RAB and central island sufficient for medium or large trucks Same as other options at signal
	Accommodation of landscaping, plazas, urban design		Can be anywhere on corridor but likely to focus on 2 controlled access locations Location of east “gateway” to be determined More space leftover in ROW with this design	Can be anywhere on corridor but likely to focus on 2 controlled access locations Location of east “gateway” to be determined, maybe west of “52” where median is wider	Can be anywhere on corridor but likely to focus on 2 controlled access locations Location of east “gateway” to be determined, potential to use centre of roundabout?
	Flexibility to incorporate transit in future		Likely to apply only at 48 Street and potentially “52”	Likely to apply only at 48 Street and potentially “52”	Likely to apply only at 48 Street and potentially “52”
	Assumed traffic controls		2 signals	2 signals. Eastern signal at “52” to restrict peds from east leg	1 signal. Yield signs at approaches to 48 Street (RAB)

Category	Criteria ↓ Options →	3 Intersections	2 intersections + 1 RIRO; 1 double left	2 intersections + 1 RIRO; 2 double lefts	1 Roundabout, 1 signal, 1 RIRO
	Assumed additional lanes at intersections	Incompatible with proximity to interchange	Left turn lanes at all approaches on 338, left turn lanes at cross streets; double WBL; and NBR channel approaching from 48 Street Drop lane from NBR east of "56" Street	Left turn lanes at all approaches on 338, left turn lanes at cross streets; double WBLs at 48 and 52; and NBR channel from 48 Street Drop lane from NBR east of "56" Street	At RAB: NBR channel to added lane; WBR to drop lane; SBR from north leg of 48 At "52": LTs on all approaches, option for w WBL
	Effects of Above on Costs		Moderate number of intersections and signals	Moderate intersections and signals, wider interim cross section	Moderate number of intersections but larger footprint for RAB
Vehicles	Accommodation of Heavy Vehicles		Long term, HV ~10% Wider RTs at commercial access points (RIRO and both signals) Double LT may cause wider intersection at 48 Street (angled slot lanes)	Long term, HV ~10% Wider RTs at commercial access points (RIRO and both signals) Double LT may cause wider intersections (angled slot lanes)	Long term, HV ~10% Wider circulating lanes required for RABs, wider RTs at "52" and RIRO, angled LT slot lanes at 48 and 52
	Vehicle Performance – Queuing E/W along 338 Delays		LOS B/C WB, except E at WBL; LOS D/E for EB EB queues 130-160m simulated	LOS B/C WB, except D at WBLs; LOS D/E for EB EB queues 145-150m simulated	
	Cross Street Queuing and Delays		LOS E for busier cross street lefts; E/F for busier cross street rights Side street 95% queues are up to 120-130m	LOS D for busier cross street lefts; E/F for busier cross street rights Side street 95% queues are up to 100-115m	
	Auto Travel Speeds (between signals)		~65 km/h WB until signal, then ~35 km/h ~27 km/h EB through signals, then ~45 km/h approaching interchange	~65 km/h WB until signal, then ~37 km/h ~25 km/h EB through signals, then ~45 km/h approaching interchange	
	Off-Peak Operations				
	Safety (between vehicles)				

Appendix C – Traffic Analysis

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Technical Memorandum

To/Attention	James Cameron, P.Eng. Town of Okotoks	**Date**	September 8, 2022 (V4 – November 16, 2022)
From	Blair Smith, P.Eng. Nabila Haque, M.Sc.	**Project No**	138875
cc	Adam Haimour, M.Eng. P.Eng. Rob Schebesch, M.Eng. P.Eng.		
Subject	338 Avenue - Post 2045 Scenario - Traffic Assessment and Sensitivity Testing		

This memo was prepared to outline the establishment of the high-level traffic volumes and the analysis which followed to develop anticipated lane requirements and test various scenarios for intersection spacing and configuration. This is part of the overall Functional Planning Study process which will consider traffic volumes and performance as one of the factors in identifying a preferred design.

Executive Summary

To organize the configuration options, the 338 Avenue corridor from Northridge Drive (Hwy 2A) to Highway 2 was divided into three segments using 32 Street and 48 Street as the boundaries.

A future horizon of 2045 was selected to help future-proof the design concepts. Traffic projections used an average growth rate from the faster 2016 TMP and the slower 2020 TMP update. These were complemented by site-specific traffic estimates from TIAs being conducted for the Area Structure Plans (Wedderburn, Trilogy Plains, North Point) along the corridor. The resulting estimates allowed for development of the quarter sections both north and south of 338 Avenue, along with increased traffic via a planned Highway 2 interchange, and ongoing growth along Highway 2A. These estimates provided the basis for analysis of the three segments.

In each of the segments, variations in the number and configuration of full control accesses were tested, and several intersections were compared as signals and as roundabouts to determine the impacts on traffic performance and design requirements (i.e. street footprint). In addition to traffic speeds, delays, and queuing, the types of impacts on active modes, goods movement, and future transit were also considered qualitatively.

General Observation for All Segments

- The effects of combined traffic by 2045 would trigger installation of additional signals and additional turn bays at many intersections, relative to the traffic control assumptions in the TIA's reviewed to date.
- Therefore, the configurations for near-term development of the south side of the corridor will need to make provision for future turn lanes and traffic control features.

Wedderburn Segment

- Assessments of 3, 4, and 5-intersection configurations were tested between Northridge Drive and 32 Street.
- Each of the configurations could be made to perform acceptably for traffic; however, the 3-intersection option concentrates more turning movements at fewer locations, and this produces longer peak queues on 338 Avenue and on the side street approaches.
- The 3-intersection option would produce long distances between safe crossing locations for active modes, and not be as supportive of the networks of sidewalks and trails.
- The 4 and 5-intersection configurations perform better for traffic and for active modes and would also be more compatible with future transit stop spacing.
- The 4-intersection option would be less costly to implement and leave greater room for public space within the corridor in comparison with the 5-intersection option.
- Based on the above considerations, the 4-intersection option is recommended to guide intersection spacing for the Wedderburn segment.

Trilogy Plains Segment

- 3 and 4-intersection options all function reasonably for auto traffic provided that signals are installed and left turn bays are included on 338 Avenue and on the Trilogy 'A' intersection.
- The spacing of the 3-intersection option creates significant gaps for active modes/transit stops, especially to north, which would limit the flexibility to develop the north.
- A 2-intersection configuration would have long queues and delays for WB and NB at the Trilogy 'A' intersection which is the busiest location within this segment by 2045.
- Given the performance and active modes concerns of the other options, the 4-intersection configuration is recommended for Trilogy Plains.

North Point Segment

- The high volumes of vehicles projected for east of 48 Street require a minimum 6-lane cross section by 2045. This can transition to 4 lanes at 48 Street for the corridor to the west.
- The proximity of the planned interchange requires that access point 7 (also referred to as 56 Street) becomes right in/out to prevent unsafe weaving for left turns.
- Therefore, access into North Point will consist of RIRO at "56 Street" and full turns intersections at "52 Street" and 48 Street.
- The interchange also produces a difference in the active mode assumptions. In the rest of the corridor, multi-use pathways or parallel sidewalks and off-street bicycle paths are assumed on the north and south side of 338 Avenue. Near the future interchange, there would be no connection on the north side. It is therefore

assumed that pedestrians and cyclists would cross to the south at either 48 Street or 52 Street.

- Remaining variations in the design of this segment relate to management of heavy left and right turn volumes at the two intersections, and how to address these with turn lanes and signal timing strategies.

Comparison of Roundabouts Versus Signals

- The intersections most likely to warrant roundabouts may be at 32 Street and 48 Street, due to high right and left turning volumes. Taken individually, these may perform better for traffic travel times if implemented. Due to turning movements at these locations, extra approach lanes would be included in the roundabout design.
- Intermediate intersections within each of the segments would generally require basic two-lane approaches on 338 Avenue, and no extra turn lanes to perform acceptably for traffic.
- The effects of roundabout design on goods movement and active modes need to be considered, as well as the required right of way to construct them, before coming to any final conclusions. There may be some safety advantages to roundabouts, but they also produce longer and less direct travel paths for active modes, which can act as an impediment to non-auto users.
- Trade-offs between the performance and design requirements of roundabouts at several critical and representative locations will proceed with the Functional Planning Study.

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1. Background

This draft memo was prepared outlining the establishment of the high-level traffic volumes and the analysis which followed to develop anticipated lane requirements and intersection spacing. The study was based on the assumptions agreed with the Town, including a truck route that extends from Highway 2 to 32nd Street (as a worst-case scenario for higher volumes).

This memo was revised on October 5 and on October 18, to reflect the results of several suggested sensitivity analyses and report on roundabout configuration testing at several intersections.

2. Assumptions & Inputs

The following sections describe the study area and sources of inputs and assumptions.

2.1 Study Intersections

Intersection spacing was initially taken from the Design Basis Memorandum, which built off the “Look and Feel” workshop of June 23, 2022. Some clarification was provided near the Highway 2 interchange, where the proposed access roads from the North Point ASP were assumed. In that configuration, the new streets would be at approximately 52 and 56 Streets, and the frontage road [i.e. the segment that would replace the existing easternmost part of 338 Avenue] would be accessed via other routes connecting with those two streets.

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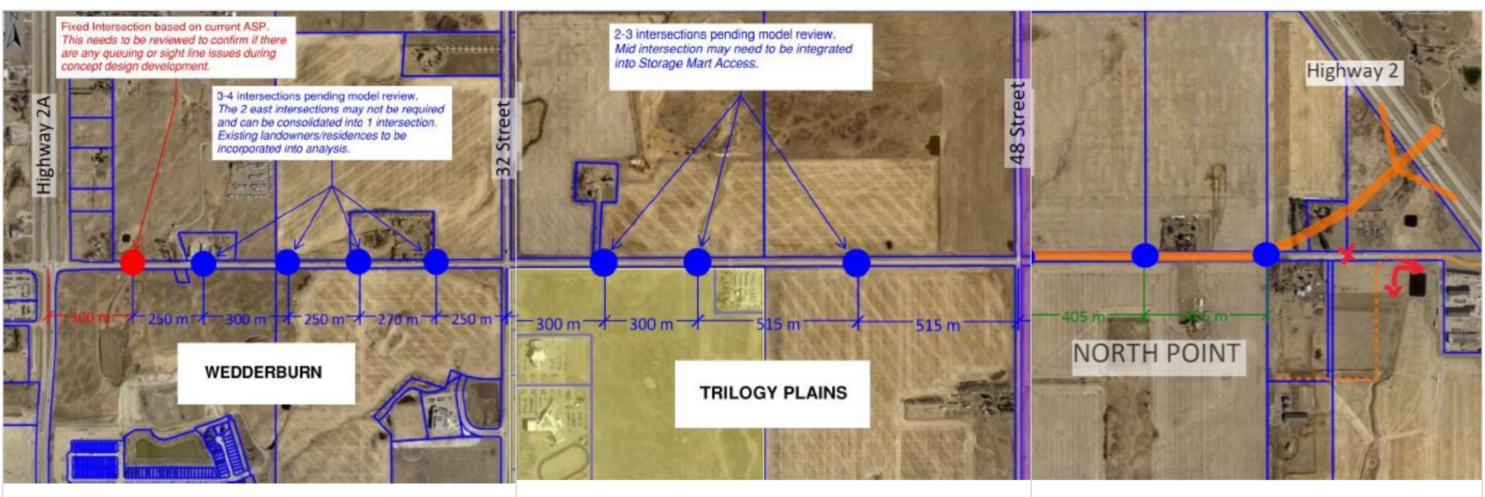
As indicated the following intersections were considered for this study (as a starting point):

- Hwy 2A/Northridge Dr & 338 Ave - Signalized
- 338 Ave & Wedderburn Gate – Signalized
- 338 Ave & Wedderburn Heights – Stop-controlled
- 338 Ave & Primary Collector A - Signalized
- 338 Ave & Wedderburn Commercial – Stop Controlled
- 338 Ave & 32 St - Signalized
- 338 Ave & Tri-A Rd - Signalized
- 338 Ave & Tri-B Rd - Signalized
- 338 Ave & Tri-C Rd – Stop Controlled
- 338 Ave & 48 St – Signalized
- 338 Ave & 52 St (North Point Access 6) – Signalized
- 338 Ave & 56 St (North Point Access 7) – Signalized

Exhibit 1 shows this configuration; the note for Wedderburn indicates 4 or 5 accesses, and the initial test assumed 4 (with the same volumes from 5).

Exhibit 1 – Initial Configuration for 338 Avenue and Connecting Streets



2.2 Peak Period

Analysis was undertaken for the weekday afternoon (PM) peak hour (in line with TMP Visum demand models).

2.3 Horizon Year

A post-2045 full build out scenario is being evaluated (building on the TMP horizon, and the TIAs for current ASPs).

2.4 Traffic Volumes

None of the previous forecasts prepared for 338 Avenue contained all the future sources of traffic, and there were two different versions of the TMP forecast (2016 and 2020) with markedly different growth assumed. Many of the individual TIA's used the lower growth rates. To help future-proof the long-term assessment and resulting concept for 338 Avenue, the different sources of traffic needed to be merged to produce a new forecast.

The principles of this forecast were:

- Assume an average growth rate for traffic, midway between the 2016 (higher) and 2020 (lower) growth rate assumptions. The two assumptions reflected a more aggressive schedule to achieve servicing capacity, versus a slower rate.
- For turning movements into the ASP's (Wedderburn and Trilogy), the turning movements on/off 338 Avenue can be assigned (or allocated) to the assumed signals.
- The traffic volumes approaching Highway 2 should match those of the compromise forecast selected as part of the Interchange study.
- For developments north of 338 Avenue, the longer term would eventually add two quarter sections of development that would feed south via the connecting roads and 32 Street. As a proxy for this, the 2016 TMP forecasts (of in/out traffic) for those areas were doubled.

These sources of traffic would roughly balance with each other once assembled. East-west volumes were approximately midway between the 2016 and 2020 TMP forecasts, plus some through movement adjustments to produce volumes consistent with the interchange forecast at Highway 2.

None of the previous work had accounted for development traffic in North Point. A draft traffic demand assessment of that ASP was shared with this study. The turning volumes in/out of the North Point, to the north and south of 338 Avenue, were added on top of the previous volumes. While much of the traffic was oriented towards Highway 2, a significant portion also connected west via 338 Avenue. Our analysis carried that traffic and distributed it to the connecting intersections along the corridor, including 32 Street, Highway 2A and incremental volumes at each cross street.

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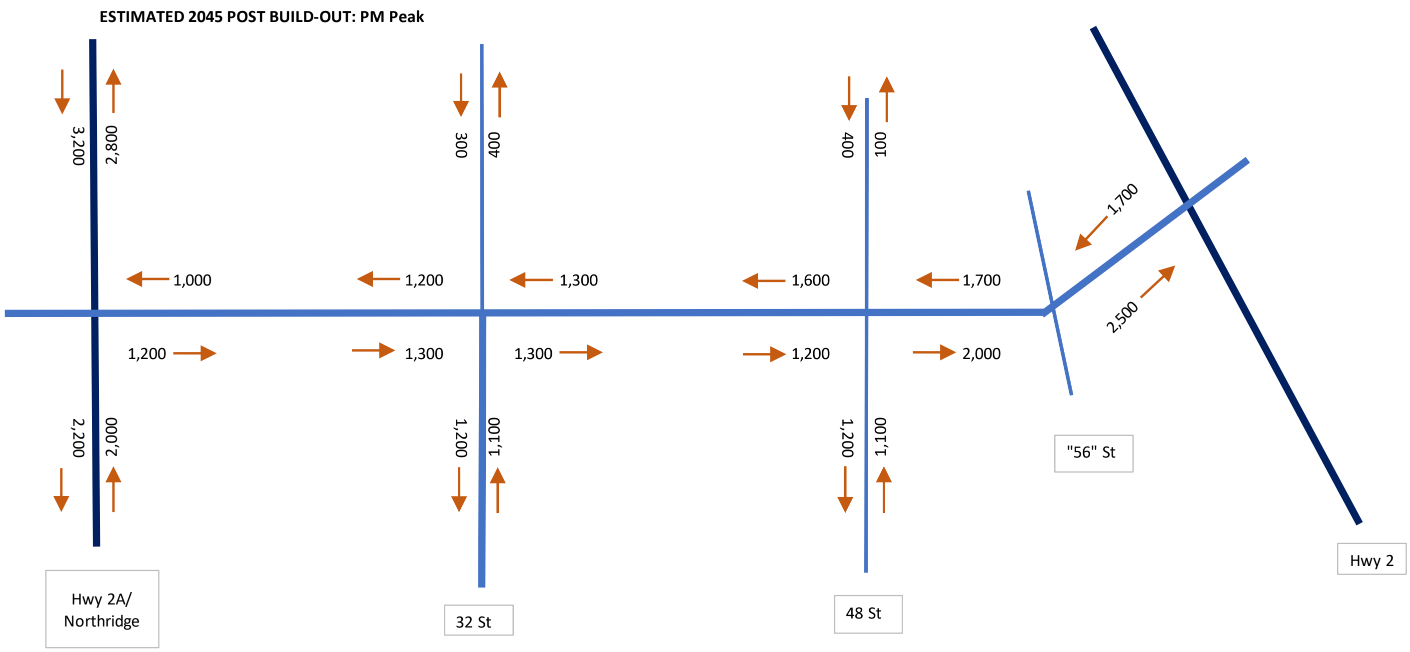
Exhibit 2 - Future Traffic Volumes – 2045 PM Peak



These forecasts reflect high volumes in the corridor, with several locations expected to process significant traffic, beyond any previous demand estimates:

- *338 at 32 Street*. A fair amount of traffic here turns on/off the 32 Street south leg, and a smaller amount onto the north leg. The new estimates indicate significant EBR volumes, paired with NBL; and likewise, WBL paired with a high volume of NBR.
- *338 at 48 Street*. The new volume here is mostly consistent with the North Point ASP but we carry a little more traffic because that ASP lacks some of the 'north side' development we're considering for the corridor. The two main patterns here are east west on 338, and some turning traffic between the east leg of 338 and 48 Street, related mostly to the North Point proposal.
- *338 at 56 Street*. This is the first intersection nearest Highway 2, and it has the highest east and west traffic in the corridor. About half is related to trips to/from west of 48 Street, while the rest is accessing North Point. There are moderately high left turns off 338 onto 56 (and at 52 St), and these compete with high eastbound PM volumes for signal time. There is an even higher flow of NBR off 52 and off 56 onto 338 headed east towards the interchange. This is the PM pattern, so we can expect in the AM that the patterns would be reversed (although with different magnitudes).

2.5 Design Speed

For analysis purposes it was assumed,

- 338 Ave between Hwy 2A and 48 St will operate with a posted speed limit of 50 km/hr
- 338 Ave between 48 St and Hwy 2 Interchange Ramp will operate with a posted speed limit of 70 km/hr

Note: As per the practice of AT, Design speed is usually considered 10k/hr above the posted speed limit.

2.6 Heavy Vehicle % (Truck Routes)

As a worst-case scenario, 32 Street has been assumed as the heavy vehicle route connecting north south. This would result in higher truck volumes on 32 Street and on 338 Avenue between there and Highway 2. This has been reflected in the analysis so far.

Heavy Vehicle (HV) data from AT Turning Movement Counts were compared with the truck route map for Okotoks (including the High load Corridor maps). It was observed that on the existing routes, PM Peak HV% is about 8 to 12% on Hwy 2. On Hwy 2A, approaching the town, HV% ranges between 2-4%. Similar was observed on Hwy 7/2A, south of the Town. It only increases as it approaches Hwy 2 on the east.

Based on the above observation, in addition to the land use assumptions in the North Point ASP, following HV% were assumed for the study corridor:

- Hwy 2A to 32 St:
  - 3% going East-West on 338 Ave
  - 2% entering and leaving the north and south roads (Wedderburn TIA area)
- On 32 St:
  - 10 % both entering and leaving 338 Ave to and from the east, and 3% for traffic to and from the west
- 338 Avenue, from 32 St to 48 St:
  - 10 % going East-West on 338 Ave
  - 2% entering and leaving the north and south roads
- At 48 St and towards Hwy 2:
  - 10 % going East-West on 338 Ave
  - 5 % entering and leaving the north and south roads (North Point ASP Area)

2.7 Signal Timings

- For Hwy 2A and 338 Ave. Signal Timing was compared between Trilogy Plains TIA and Intermunicipal Transportation Analysis - Final Draft. The timings for our future baseline scenario were aligned with the Trilogy TIA.
- Timing plans adopted from D'Arcy and Wedderburn TIA (2035 Horizon) – Intersections at Wedderburn Gate, Wedderburn Heights, and Primary Collector A.
- Adopted from Trilogy TIA (2040 Horizon) – All intersections from 32 St & 338 Ave until 48 St & 338 Ave

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- Adopted from North Point ASP Transportation Impact Assessment (2045 Horizon) – Intersection of 338 Ave with 48 St, 52 St (NP Access 6) and 56 St.
- The signal timing parameters for analysis build from typical values used on previous studies for the above-noted TIAs. The distances across the street assume 3.5m lanes and a 6-metre median, from which the first of any left turn lanes is assumed to be taken (i.e. left turn plus reduced median is still 6 metres).
  - 8 seconds of initial green
  - Pedestrian minimum time is based on crossing distance, an assumed walking speed of 1 metre per second. Pedestrian minimum = FDW plus yellow/red clearance.

3. Analysis – Traffic Scenarios and Performance Evaluation

The initial intersection configuration and traffic control assumptions from Section 2.8 were tested against the future traffic volumes. Given that the future volumes in this memo are cumulative from other forecasts, and generally represent the highest, or close to the highest volumes assessed, there is an expectation of poor level of service at some locations. The analysis verifies which locations could have performance degradation over the long term, and assesses what types of interventions could mitigate this,

A capacity analysis was carried out by using the Highway Capacity Manual (HCM 2010) methodology and specifically the Synchro software.

The following intersection performance criteria were used to assess traffic operations under existing and future conditions, following the City of Calgary Transportation Impact Assessment (TIA) Guidelines (2011):

- Overall Level of Service ‘D’ or better.
- Volume/capacity (v/c) ratio of 0.85 or less
- Individual Level of Services ‘E’ or better.
- Individual Volume/Capacity (v/c) ratio of 0.90 or less.

3.1 Traffic Analysis Scenarios

Three scenarios were developed to try to accommodate the forecast future traffic, and were evaluated to understand their performance:

- Scenario 1 – All intersections to operate as signalized or stop-controlled (stop on N-S), as per the information is available in the Wedderburn TIA, Trilogy Plain TIA, and the Okotoks – North Point ASP TIA. The TIAs typically assumed 2 through lanes per direction, plus turn pockets as needed, along 338 Avenue.
- Scenario 2 – Mitigation measures were applied to help improve those intersections (and individual movements) that were over capacity or had major delay and queuing issues for certain movements in Scenario 1. Mitigation measures included:
  - Six lanes for through traffic on 338 Avenue east of 48 Street, and on the approaches to 32 Street.
  - Other modifications of intersection lane configuration.

  - Change of intersection control.
  - Adjusting signal timing plans.
- Scenario 3 - Intersections of 338 Ave with 32 St, 48 St and 56 St were analysed as Roundabouts, with the remainder operated as per Scenario 2.

3.2 Traffic Analysis Observations

Scenario 1:

Scenario 1 was based off by assuming the traffic controls proposed in the various TIAs.

- Hwy 2A and 338 Ave is over-capacity. Multiple movements are failing including the NBT. Even with Dual-left-turns and protected phase, SBL is still failing. Different options such as, longer cycle Length, protected/permitted phases for EBL and WBL were tested. Such measures provided minimal effect on their own. ***However, these results are comparable to those reported in previous TIAs.***
- ***The LOS was poor (F) at 32 Street, 52 Street and 56 Street***. Through movements at 56 Avenue were over capacity.
- At 48 St, some of the individual movements were experiencing poor LOS (E or F), and overall, at LOS D.
- At the three unsignalized intersections, the north-south movements experience significant delays, due to not finding enough gaps in the heavy E-W traffic, to enter and clear the intersection. SBL and NBL movements often experience LOS F.

Scenario 2:

Scenario 2 was the next step which undertook modifying intersection set-ups to determine what it took to improve operations.

- No further modifications were tried for Hwy 2A and 338 Ave.
- For the unsignalized intersections, additional left or right turn bays were tried. Improvement was observed to be local, but not so much overall for the intersection. Therefore, these were changed fully signalized intersections, to alleviate the issue of finding enough gaps. All three intersections improved significantly in operation.
- East of 48 Street, the cumulative EB and WB volumes appear to warrant 3 lanes per direction. There is too much through traffic and the number of lefts needing signal time make it infeasible to stay at 2 lanes per direction, long term.
- At 32 Street, the south, west, and east legs benefit from additional turn lanes to accommodate EBR, NBR, NBL and WBL. To balance the lanes and provide storage, the approaches end up extending most of the way back to the previous intersection, effectively becoming 3-lane per direction segments
- Otherwise, optimization and green time adjustment improved the v/c and delay for most of the intersections, although many remained above 0.85 v/c.

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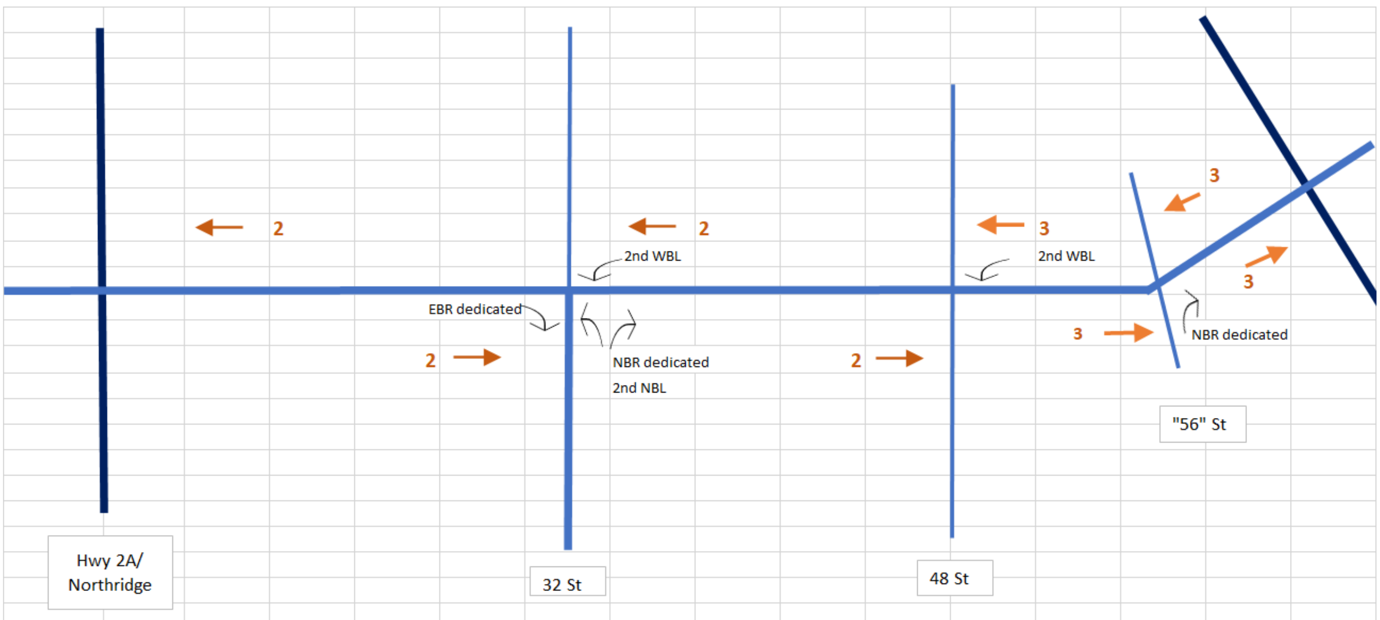
- In Sim Traffic, apart from Hwy 2A & 338 Ave, no significant congestion or backup queuing was observed at the other intersections. No queueing was observed to block the upstream intersection.

Exhibit 3 provides a visual summary of the Scenario 2 corridor configuration.

Exhibit 3 – Scenario 2 High-Level Configuration



Scenario 3:

A very high-level sensitivity analysis was carried out to test to see, with the same volumes, what happens at the worst intersections if they were changed to multi-lane roundabouts.

2-lane roundabouts were placed at 32 St and 48 St, and a 3-lane roundabout was tested at 56 St. The analysis is termed high-level because the results reported here are from Synchro, using HCM 6th edition method. However, more fine-tuned results, the roundabouts (as well as any other) will be analysed using SIDRA.

The 2-Lane roundabouts produced a reduced LOS compared with the Scenario 2 modifications, at these locations. Other intersections, to be evaluated as work continues, may produce different results. In addition, roundabouts with bypass lanes may perform better in more detailed evaluation.

Intersection Summary

Intersection-level results, based on Synchro signal analysis, are tabulated in Exhibit 4.

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Exhibit 4 – Intersection-Level Assessment of Post-2045 Build-Out

		Scenario - Original (Assembled from all TIAs)		Scenario 2 (Strategic 6-Laning and Turn Lanes)			Scenario 3- Roundabout[1]		
Intersection #	Intersection	Type	Intersection LOS	Modifications	Intersection LOS	Notes	Modifications	Intersection LOS - Based on HCM 6th Edition	Notes
1	338 Ave @ Hwy 2A	Signalized	E	None	E	- Longer cycle lengths do not provide any benefit; - Multiple individual movement failing, including NBT.	None		
2	338 Ave @ Wedderburn Gate	Signalized	D	None	D	- NBL and WBL remain at LOS E; - Both Perm, Pm+Pt makes it worse; - Longer cycle length improves v/c ratio only slightly, not worth it.	None		
3	338 Ave @ Wedderburn Heights	Unsignalized	F	- Changed to Signalized; - Optimized;	B		None		
4	338 Ave @ Primary Collector A	Signalized	C	None	C		None		
5	338 Ave @ Wedderburn Commercial	Unsignalized	F	- Changed to Signalized; - Added EBL and WBL turn bays, 30 m long; - Optimized;	C	- WBL and SB (w Heavy SBL) stays at LOS E with longer cycle lengths. - If Green time for SB is increased enough to have LOS D for SB, then WBL goes to F.	None		

[1] Roundabout analysis will be carried out using SIDRA at a later stage to fine tune the analysis.

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		Scenario - Original (Assembled from all TIAs)		Scenario 2 (Strategic 6-Laning and Turn Lanes)			Scenario 3- Roundabout[1]		
Intersection #	Intersection	Type	Intersection LOS	Modifications	Intersection LOS	Notes	Modifications	Intersection LOS - Based on HCM 6th Edition	Notes
6	338 Ave @ 32 St	Signalized	F	- Added 80 m long EBL storage; - Separated WBR from Through and provided a 30 m long right-turn bay. - EBL gets a Permissive phase (WBL is protected with dual left-turns); - In addition to the dedicated NBL lane, added an 80 m long storage bay for NBL; - Now NBL needs to have a "Protected" phase;	D	- Very long Cycle Lengths allow v/c to drop below 0.95, but movements start to fail and overall LOS falls to E.	2-Lane Roundabout	F	
7	338 Ave @ Tri-A	Signalized	E	- Added 60 m long EBL storage; - Added 30 m long WBR storage; - EBL now has Pm+Pt phase - LOCKED Cycle Length at 90 seconds	C	- EBL is still at LOS E;	None		
8	338 Ave @ Tri-B	Signalized	C	None	C		None		
9	338 Ave @ Tri-C	Unsignalized	F	- Changed to Signalized; - Added a 30 m long storage bay for WBL; - Optimized;	C		None		
10	338 Ave @ 48 St	Signalized	D	- 6 Lane cross section starts with the West Leg here; -Already proposed 40m long WBL storage bay remains with the addition of a dedication WBL lane; - WBL gets "Protected" phase; - LOCKED cycle length at 125 sec to achieve LOS D for EB.	D	- 6 Lane cross section starts with the West Leg here; - NBL is LOS E (though improved from F from the original version).	2-Lane Roundabout	F	

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		Scenario - Original (Assembled from all TIAs)		Scenario 2 (Strategic 6-Laning and Turn Lanes)			Scenario 3- Roundabout[1]		
Intersection #	Intersection	Type	Intersection LOS	Modifications	Intersection LOS	Notes	Modifications	Intersection LOS - Based on HCM 6th Edition	Notes
11	338 Ave @ NP Access 6 (52 Street)	Signalized	E	- Added an additional 'Through" lane for both EBT and WBT; 6-Lane cross section continues; - Increased NBR storage from 80 m to 100 m; - Optimized	C	- 6 Lane cross section	None		
12	338 Ave @ 56 St	Signalized	F	- Added an additional 'Through" lane for both EBT and WBT; 6-Lane cross section continues; - Increased EBL and EBR storage from 15 m to 30 m; - Modified NBR lane configuration; Provided a full lane leading to a Channelized NBR movement; - Optimized	D	- 6 Lane cross section	3-Lane Roundabout	N/A	HCM 6th (or 10th Edition Roundabout analysis is limited to a maximum of 2 lanes per approach

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4 Analysis – Sensitivity Testing

This section presents the analyses of alternative intersection spacings for the Wedderburn, Trilogy Plains and North Point segments of the corridor.

Scenario 4 – "Wedderburn 3/Trilogy 4/ 56 Street RIRO"

Scenario 4 builds on the above-noted Scenario 2, with the changes made to the number of intersections in Wedderburn and Trilogy, and interchange-related changes in North Point. Specifically, this considers the following modifications:

- Decreased number of intersections for Wedderburn - Wedderburn Height @ 338 Ave was removed.
- Increased number of intersections for Trilogy – Trilogy -C @ 338 Ave was split up into two separate intersections at equal intervals approximately 330 metres apart.
- Due to the proximity of the proposed interchange ramps for Hwy 2, notably the SB to WB free flow, the intersection at 56 St @ 338 Ave was changed from an all-turn signalized intersection to Right-in/Right out only.

These changes resulted in reallocation of the turning traffic to adjacent intersections based on the intended direction of travel and available capacities. (It was assumed that drivers would bypass a congested intersection if the next one performed better, until a situation closer to equilibrium is reached.)

The intersection-level analyses with the reallocated volumes triggered several modifications to allow them to function:

- Volumes were re-balanced near Wedderburn Gate @ 338 Ave and Primary Collector A @ 338 Ave, to account for the removal of the intermediate intersection at Wedderburn Heights. With additional left-turn storage bays and adjusted phasing and timing, Wedderburn Gate would perform with LOS C and Collector A maintains LOS D.
- Splitting the traffic volumes within Trilogy Plains produces two intersections with moderately better Levels of Service than previously.
- The conversion of 56 Street (Access Point 7 for North Point) to right-in/out resulted in significant left turn volumes being reallocated to 52 Street and 48 Street. To help the NBR work at 48 Street, the turn lane was made right turn channelized. At 52 Street, the NBR would be green during the northbound through phase and overlap with the WBL to increase the available green time, aiding its performance.
- 56 St @ 338 Ave, however, fails as a RI/RO. In the HCM analysis, the heavy eastbound volumes were free--flowing and this was blocking the NBR movement, even if configured as a free flow channel. When observed in SIMTraffic, the gaps created by the signals at 52 and 48 Streets appeared to be sufficient to process the PM peak right turns. *Another potential solution here [not yet tested] could be to signalize the eastbound movement only, allowing for a double northbound right lane with a protected green phase, and operate most of the cycle as eastbound.*
- Again, optimization and green time adjustment improved the v/c and delay for most of the intersections, although many remained above 0.85 v/c.

Intersection Summary

Intersection-level results for Scenario 4, based on Synchro signal analysis, are tabulated in Exhibit 5.

Exhibit 5 – Intersection-Level Assessment of Post-2045 Build-Out – Sensitivity Tests

Scenario - Original (Assembled from all TIAs)			Scenario 2 - Strategic 6 Laning and Turn Lanes			Scenario - Wedderburn 3, Trilogy 4, 56 RIRO	
Intersection	Type	Intersection LOS	Modifications	Intersection LOS	Notes	Modifications	Intersection LOS - Based on HCM 6th Edition
338 Ave @ Hwy 2A	Signalized	E	None	E	- Longer cycle lengths do not provide any benefit; - Multiple individual movement failing, including NBT.	None	E
338 Ave @ Wedderburn Gate	Signalized	D	None	D	- NBL and WBL remain at LOS E; - Both Perm, Pm+Pt makes it worse; - Longer cycle length improves v/c ratio only slightly, not worth it.	- Volume rebalanced - 60m EBL turn bay added; - Both EBL and WBL given Pm+Pt	C
338 Ave @ Wedderburn Heights	Unsignalized	F	- Changed to Signalized; - Optimized;	B		- Intersection removed - Volume redistributed at #2 and #4	N/A
338 Ave @ Primary Collector A	Signalized	C	None	C		-Additional dedicated EBL turn lane; - 60m SBL turn bay. - Cycle length coordinated 100 s with 32 St	C EBL at LOS E
338 Ave @ Wedderburn Commercial	Unsignalized	F	- Changed to Signalized; - Added EBL and WBL turn bays, 30 m long; - Optimized;	C	- WBL and SB (w Heavy SBL) stays at LOS E with longer cycle lengths. - If Green time for SB is increased enough to have LOS D for SB, then WBL goes to F.	- Cycle length 100 sec;	C - WBL and SBL at LOS D
338 Ave @ 32 St	Signalized	F	- Added 80 m long EBL storage; - Separated WBR from Through and provided a 30 m long right-turn bay. - EBL gets a Permissive phase (WBL is protected with dual left-turns); - In addition to the dedicated NBL lane, added a 80 m long storage bay for NBL; - Now NBL needs to have a "Protected" phase;	D	- Very long Cycle Lengths allow v/c to drop below 0.95, but movements start to fail and overall LOS falls to E.	No changes	D overall but **EBT F**; WBL E; NBL E; SBL E

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Scenario - Original (Assembled from all TIAs)			Scenario 2 - Strategic 6 Laning and Turn Lanes			Scenario - Wedderburn 3, Trilogy 4, 56 RIRO	
Intersection	Type	Intersection LOS	Modifications	Intersection LOS	Notes	Modifications	Intersection LOS - Based on HCM 6th Edition
338 Ave @ Tri-A	Signalized	E	- Added 60 m long EBL storage; - Added 30 m long WBR storage; - EBL now has Pm+Pt phase - LOCKED Cycle Length at 90 seconds	C	- EBL is still at LOS E;	- WBL turn bay/lane provided	C Improves EBL to D; SBL at E
338 Ave @ Tri-B	Signalized	C	None	C		None	C
338 Ave @ Tri-C	Unsignalized	F	- Changed to Signalized; - Added a 30 m long storage bay for WBL; - Optimized;	C		- Divided into two (2) intersections, numbered as 91 and 92 respectively. -Signalization maintained for both;	#91 - C #92 - B
338 Ave @ 48 St	Signalized	D	- 6 Lane cross section starts with the West Leg here; -Already proposed 40m long WBL storage bay remains with the addition of a dedication WBL lane; - WBL gets "Protected" phase; - LOCKED cycle length at 125 sec to achieve LOS D for EB.	D	- 6 Lane cross section starts with the West Leg here; - NBL is LOS E (though improved from F from the original version).	- double WBL [added lefts from closure of 56] - NBR storage increased and feeds into RT channel - Cycle length set at 110 sec..	D WBL, NBL at E
338 Ave @ NP Access 6	Signalized	E	- Added an additional 'Through" lane for both EBT and WBT; 6-Lane cross section continues; - Increased NBR storage from 80 m to 100 m; - Optimized	C	- 6 Lane cross section	- WBL and EBL volumes and phase timing increased to account for extra volume from 56 Street closure to lefts - NBR overlap phase with WBL to increase efficiency - 110 Second cycle (to match 48)	D overall but **NBR F**; WBL E; SBL E
338 Ave @ 56 St	Signalized	F	- Added an additional 'Through" lane for both EBT and WBT; 6-Lane cross section continues; - Increased EBL and EBR storage from 15 m to 30 m; - Modified NBR lane configuration; Provided a full lane leading to a Channelized NBR movement; - Optimized	D	- 6 Lane cross section	- All-turn Intersection changed to being a RI/RO; - All right turns being channelized; - Option of a 30m merge lane for NBR tested.	N/A - NBR is LOS F (using HCM) but LOS B in simulation; LOS A if merge lane assumed

Scenario 5 – “Wedderburn 5/Trilogy 2/ 56 Street RIRO”

Scenario 5 also builds on the above-noted Scenario 2, with the changes made to the number of intersections in Wedderburn and Trilogy, and interchange-related changes in North Point. Specifically, this considers the following modifications:

- Increased number of intersections for Wedderburn – a second access point was added to East Wedderburn between Primary A and Wedderburn Commercial.
- Decreased number of intersections for Trilogy – one midpoint access for the western lands and one for the eastern.
- As in Scenario 4, the intersection at 56 St @ 338 Ave was changed from an all-turn signalized intersection to Right-in/Right out only. In this case, 52 Street is tested with a different turn lane configuration, taking some pressure off 48 Street.

As before, these changes resulted in reallocation of the turning traffic to adjacent intersections based on the intended direction of travel and available capacities. (It was assumed that drivers would bypass a congested intersection if the next – or previous -- one performed better, until a situation closer to equilibrium is reached.)

The intersection-level analyses with the reallocated volumes triggered several modifications to allow them to function:

- Volumes were re-balanced in Wedderburn East to account for the additional access point. Two of the intersections would improve from overall LOS C to B with the reallocation of traffic.
- Deferring or eliminating Trilogy B from consideration adds pressure to Trilogy A. Even with additional left turn storage, the performance of the intersection degrades to D.
- The conversion of 56 Street (Access Point 7 for North Point) to right-in/out resulted in significant left turn volumes being reallocated to 52 Street and 48 Street. To help the NBR work at 48 Street, the turn lane was made right turn channelized. At 52 Street, the NBR would be green during the northbound through phase and overlap with the WBL to increase the available green time, aiding its performance.
- A second westbound left lane was tested at 52 Street (NP Access 6) and this improved performance of the intersection. However, the wide cross section does present issues for active modes crossing 8 lanes plus a median strip.
- Again, optimization and green time adjustment improved the v/c and delay for most of the intersections, although many remained above 0.85 v/c.

Intersection Summary

Intersection-level results for Scenario 5, based on Synchro signal analysis, are tabulated in Exhibit 6. Key results from other scenarios are also shown to allow for comparisons to be made.

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Exhibit 6 – Intersection-Level Assessment of Post-2045 Build-Out – Additional Sensitivity Tests

Scenario - Original (Assembled from all TIAs)			Scenario 2 - Strategic 6 Laning and Turn Lanes		Scenario - Wedderburn 3, Trilogy 4, 56 RIRO		Test W5, T2, 52 dual left	
Intersection	Type	Intersection LOS	Modifications	Intersection LOS	Modifications	Intersection LOS - Based on HCM 6th Edition	Modifications	Intersection LOS - Based on HCM 6th Edition
338 Ave @ Hwy 2A	Signalized	E	None	E	None	E	None	E
338 Ave @ Wedderburn Gate	Signalized	D	None	D	- Volume rebalanced - 60m EBL turn bay added; - Both EBL and WBL given Pm+Pt	C	- Volume rebalanced - 60m EBL turn bay added; - Cycle length coordinated 70 s with Northridge	C
338 Ave @ Wedderburn Heights	Unsignalized	F	- Changed to Signalized; - Optimized;	B	- Intersection removed - Volume redistributed at #2 and #4	N/A	- 60m EBL turn bay added; - A 70 Sec Cycle Length provided.	B
338 Ave @ Primary Collector A	Signalized	C	None	C	-Additional dedicated EBL turn lane; - 60m SBL turn bay. - Cycle length coordinated 100 s with 32 St	C EBL at LOS E	- 60m EBL turn bay added; - A 70 sec cycle length provided.	B EBL at LOS F
338 Ave @ Wedderburn East	Not Assumed	N/A		N/A	Not Assumed	N/A	- A new addition to the network; - Volume redistributed from ID #5. - A 70 sec cycle length provided.	B
338 Ave @ Wedderburn Commercial	Unsignalized	F	- Changed to Signalized; - Added EBL and WBL turn bays, 30 m long; - Optimized;	C	- Cycle length 100 sec;	C - WBL and SBL at LOS D	- Added 60m long EBL storage; - Volume re-distributed with the new additional intersection ID#23. - Cycle length 70 sec; - Improved LOS for WBL and SBL.	B
338 Ave @ 32 St	Signalized	F	- Added 80 m long EBL storage; - Separated WBR from Through and provided a 30 m long right-turn bay. - EBL gets a Permissive phase (WBL is protected with dual left-turns); - In addition to the dedicated NBL lane, added a 80 m long storage bay for NBL; - Now NBL needs to have a "Protected" phase;	D	Same as Scen. 2	D overall but **EBT F**; WBL E; NBL E; SBL E	Same as Scen. 2	D

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Scenario - Original (Assembled from all TIAs)			Scenario 2 - Strategic 6 Laning and Turn Lanes		Scenario - Wedderburn 3, Trilogy 4, 56 RIRO		Test W5, T2, 52 dual left	
Intersection	Type	Intersection LOS	Modifications	Intersection LOS	Modifications	Intersection LOS - Based on HCM 6th Edition	Modifications	Intersection LOS - Based on HCM 6th Edition
338 Ave @ Tri-A	Signalized	E	- Added 60 m long EBL storage; - Added 30 m long WBR storage; - EBL now has Pm+Pt phase - LOCKED Cycle Length at 90 seconds	C	- WBL turn bay/lane provided	C Improves EBL to D; SBL at E	- Volume rebalanced, as the majority of the intersection #8 has been relocated here. - 60 m WBL turn bay provided - Control Type - Actuated Coordinated - Cycle length 100 sec - In addition to EBL, the rest three left-turns are also coded as Protective-permissive.	D EBL, WBT and NBL at LOS E
338 Ave @ Tri-B	Signalized	C	None	C	None	C	Intersection removed.	N/A
338 Ave @ Tri-C	Unsignalized	F	- Changed to Signalized; - Added a 30 m long storage bay for WBL; - Optimized;	C+D9:I12	- Divided into two (2) intersections, numbered as 91 and 92 respectively. -Signalization maintained for both;	#91 - C #92 - B	- Some volume balancing due to volume from Tri-B being relocated here. - Added a 60 m long EBL storage; -Intersection control changed to Actuated-coordinated; - Cycle length 110 sec	C
338 Ave @ 48 St	Signalized	D	- **6 Lane cross section starts with the West Leg here**; -Already proposed 40m long WBL storage bay remains with the addition of a dedication WBL lane; - WBL "Protected" phase; - Cycle length at 125 sec to achieve LOS D for EB.	D	- double WBL [added lefts from closure of 56] - NBR storage increased and feeds into RT channel - Cycle length set at 110 sec..	D WBL, NBL at E	- double WBL [added lefts from closure of 56] - Cycle length set at 125 sec.	D EBL, EBT-R at LOS F' WBL and NBR at LOS E
338 Ave @ NP Access 6	Signalized	E	- **Additional 'Through" lane for both EBT and WBT; 6-Lane cross section continues;** - Increased NBR storage from 80 m to 100 m; - Optimized	C	- WBL and EBL volumes and phase timing increased to account for extra volume from 56 Street closure to lefts - NBR overlap phase with WBL to increase efficiency - 110 Second cycle (to match 48)	D overall but **NBR F**; WBL E; SBL E	- Added a second left-turn lane Westbound. - Cycle length 100 sec - WBL and EBL volumes and phase timing increased to account for extra volume from 56 Street closure to lefts - NBR overlap phase with WBL to increase efficiency	D; No Movements at LOS F
338 Ave @ 56 St	Signalized	F	- **Additional 'Through" lane for both EBT and WBT; 6-Lane cross section continues**; - Increased EBL and EBR storage from 15 m to 30 m; - Modified NBR lane configuration; Provided a full lane leading to a Channelized NBR movement; - Optimized	D	**- All-turn Intersection changed to being a RI/RO**; - All right turns being channelized; - Option of a 30m merge lane for NBR tested.	N/A - NBR is LOS F (using HCM) but LOS B in simulation; LOS A if merge lane assumed	- **All-turn Intersection changed to being a RI/RO**; - All right turns being channelized.	N/A - NBR is LOS F (using HCM) but LOS B in simulation

Commentary for Scenarios 4 and 5

Wedderburn (and adjacent north side of 338):

- Reducing intersections in Wedderburn will function, with some additional delays for vehicles, more queuing on side streets, and two-lane approaches required on those collectors.
- Assuming five intersections for Wedderburn reduces pressure on the easternmost signal and improves its performance.
- Active modes permeability is best with five access points and worst with only three in Wedderburn. Four to five active modes crossings would be preferred.

Trilogy Plains (and adjacent north side of 338):

- Adding an intersection in Trilogy improves performance; noting that the delays for the three-access configuration were already acceptable.
- Dropping an access point from Trilogy put extra pressure to manage left turns, which takes away cycle time at signals from through traffic. While capacity still exceeds volumes, peak direction queues build up in the higher volume direction while waiting for the signal. These queues extend more than 100 metres.

North Point

- The reconfiguration of 56 Street is more compatible with the interchange design. Weaving from the ramp entrance to a left turn bay could be impractical. Changing to right-in/right-out triggers downstream changes at 48 Street (additional left turn bays) and 52 Street, and some challenges with NBR from 56 Street (NP Access 7).
- Having fewer intersections has the potential to save on signal costs, but may trigger more access road (collector) spot widening to manage queues approach 338 Avenue

5 Analysis – Roundabouts

This section presents a more detailed analysis of roundabout performance at critical intersections, and builds from Section 4:

- The volumes at 32 Street are the same in Scenarios 2 and 4 and are carried forward here.
- The volumes in Scenario 4 are higher at 48 Street, which was triggered by the planned configuration of the Highway 2 interchange and the consequent reallocation of some traffic to 52 and 48 Streets.

Two versions of multi-lane roundabout were evaluated as shown in Exhibit 6 below:

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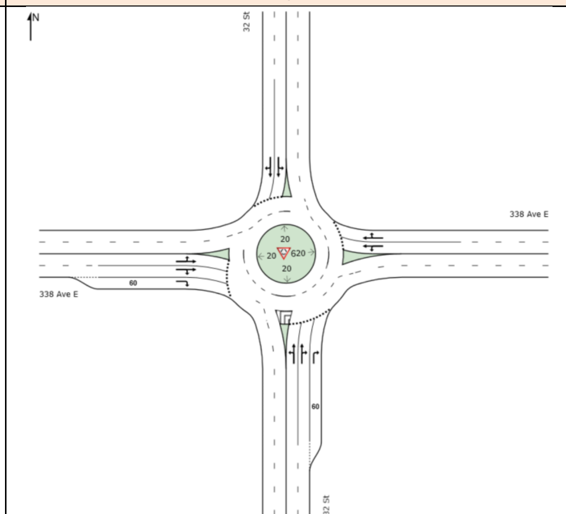
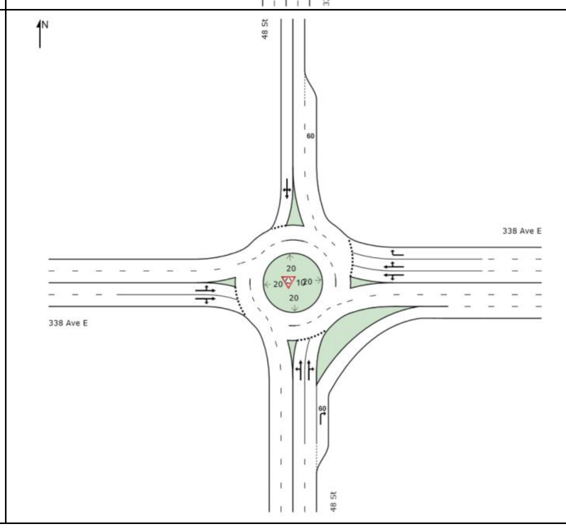
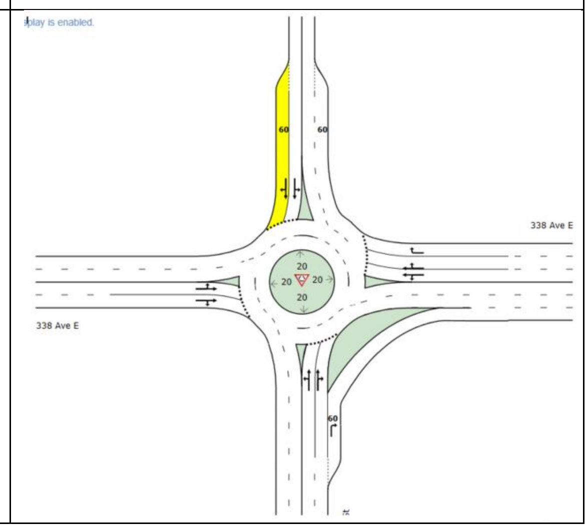
Exhibit 6 – Roundabout Options at 32 and 48 Streets – Sensitivity Tests

Intersection	Trial 1	Trial 2
32 St @ 338 Ave		No Change
48 St @ 338 Ave		

Analysis

- 32 St @ 338 Ave:

1. A 2-lane roundabout
2. Two additional bypass lanes (~60 m storage), one each, for the Eastbound and the Northbound approach. These are analogous to the right turn lanes included in the intersection analysis for signals, due to higher right turn movements.
3. Other than the bypass lanes, each approach was assumed to be two lanes.
4. The longest queues and delays were observed on the East Approach (this would be westbound PM peak traffic).

- 48 St @ 338 Ave:

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1. A 2-lane roundabout
2. Two additional bypass lanes, one each, for the Northbound and the Westbound approach. Here the by-pass lanes also help in transitioning to and from the six-lane cross-section for 338 Avenue that is recommended east of 48 Avenue, as noted in other Scenarios.
3. To provide a smooth the transition to the six-lane configuration, the Northbound bypass lane was set with a low angle.
4. The north leg in trial 1 was observed to have long delays due to difficulties merging from one lane, against a steady flow of westbound through and left turns, and northbound left turns
5. The second trial for this roundabout added a second lane to the north leg, and this dramatically improved performance. LOS for the North Approach changes from F to B, with delay and queue reducing significantly for that leg

Exhibit 7 – Roundabout Options at 32 and 48 Streets – Performance

Trial	Intersection	SIDRA			
		Delays (sec)	LOS	Worst Movement	95th Queue Length (m)
1, 2	32 St & 338 Ave	10	B	East approach (dominant lane on roundabout approach)	123.8
1	48 St & 338 Ave	52	E	North Approach	736.6
2	48 St & 338 Ave	10	B	North Approach	66.9

Conclusions

From these results, it appears that roundabouts could be feasible from an operational perspective and may present some advantages in delays and queuing for some of the critical movements.

There is the trade-off of additional right of way and the effects on active modes (less direct routes) and on goods movement (large radii are required to facilitate turns by heavy vehicles).

6 Intersection Spacing - Summary

This section presents a summary of the results from the traffic forecasting and analysis for the post-2045 Build-Out on 338 Avenue. It includes high-level commentary and images (Exhibit 8 through 10) showing the configurations and results from different scenarios.

One general conclusion was that the effects of combined traffic by 2045 would trigger installation of additional signals and additional turn bays at many intersections, relative to the traffic control assumptions in the TIAs reviewed to date. This is largely a function of the development growth rate being expected to proceed at “medium” pace, which is faster than the recent 2020 TMP update had assumed.

Wedderburn

4-, 5- and 3-access options all function reasonably for auto traffic provided that:

- Full signals are installed
- Left turn bays are included

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- In some cases, the additional controls and signals are a significant step up from the TIA assumptions.
- Some intersections also require multi-lane approaches from the north and south, and queues start to spill back over 50m during peaks when traffic is concentrated into fewer accesses

Spacing from a 3-access option creates significant gaps for active modes and leaves fewer logical locations for transit stops in longer-term future.

Trilogy Plains

3- and 4-access options all function reasonably for auto traffic provided that:

- Full signals are installed
- Left turn bays are included

Spacing of the 3-access option creates significant gaps for active modes/transit stops, especially to north.

A 2-access configuration has long queues and delays for WB and NB at the Trilogy ‘A’ access

North Point

The proximity of the planned interchange will likely trigger access point 7 (also referred to as 56 Street) into North Point becoming right in/out to prevent unsafe weaving for left turns over too short a distance.

Given the high travel demand to destinations south of 338 Avenue, there is a high volume of left turns. These end up being reallocated to NP#6 (“52” St) and 48 St. These movements thus require more LT capacity, in the form of a second WBL at one or both intersections.

There are benefits to overlapping the NBR phases with WBL, EBL in peaks as they do not conflict and need the extra time to reduce conflicts with EB through traffic.

The NBR at “56 St” may need a drop lane to mitigate PM peak queuing, since it does not have a signal. The timing at the signals to the west of “56” may create sufficient gaps at most times.

Effects of Roundabouts

The intersections most likely to warrant roundabouts may be at 32 Street and 48 Street, due to high right and left turning volumes. Taken individually, these may perform better for traffic travel times if implemented. Their effects on goods movement and active modes need to be considered, as well as the required right of way to construct them, before coming to any conclusions.

Also note, due to their role in handling traffic into the southern section of North Point, 48 Street (as a roundabout) may need to be evaluated in tandem with 52 Street (operating as a signal) to determine if it would perform better.

Exhibit 8 - Intersection Spacing Tests – Wedderburn

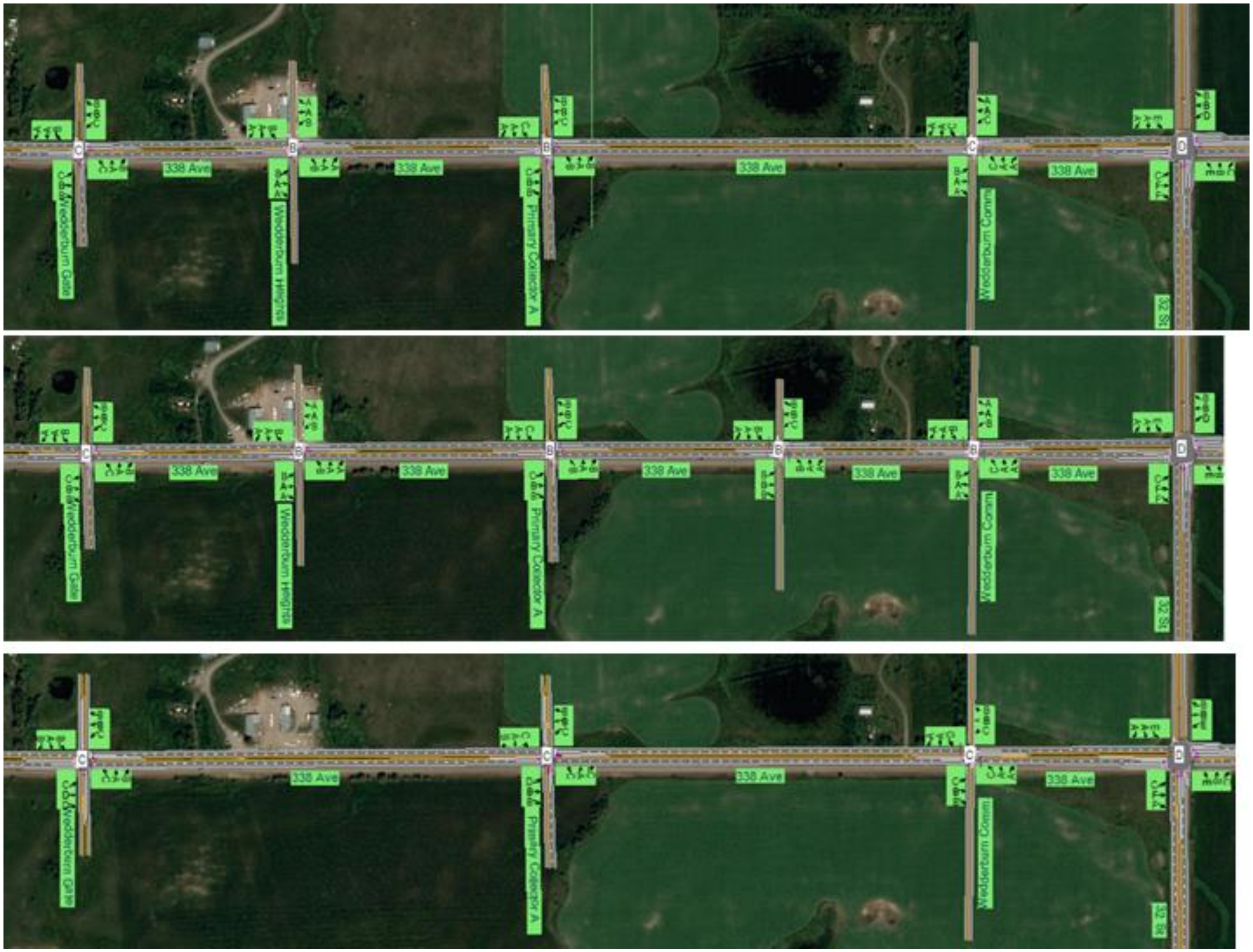

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Exhibit 9 - Intersection Spacing Tests – Trilogy

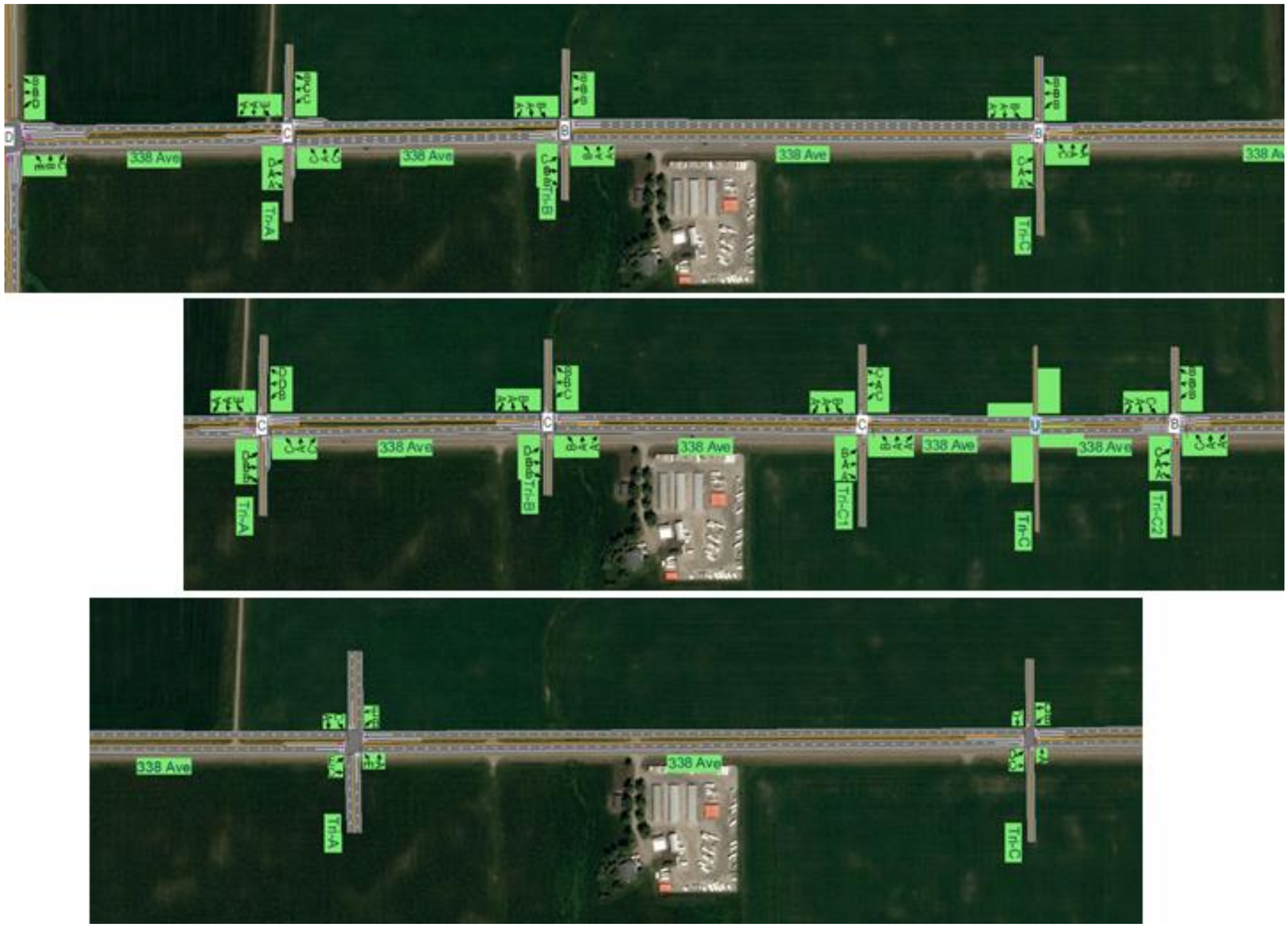

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Exhibit 10 - Intersection Spacing – North Point

Appendix D – Comparative Safety Analysis

Appendix D – Comparative Safety Analysis

The safety of roadways is an important concern for transportation engineers and planners, as it directly affects the well-being of road users.

One of the objectives of this study is to perform safety assessment of different design alternatives for roadways, using a predictive safety analysis methodology. Researchers have been working for decades developing safety performance functions that can estimate, and ideally predict, expected safety performance based on the road geometric and traffic control features. Safety-based decision making in the field of transportation engineering has gained traction as a procedure for decision making. The Highway Safety Manual (HSM) 2010 and 2020 edition provides insight directions to estimate safety performance of existing as well as designed roadways. The methodology used in this study is based on the HSM 2020 edition, which provides a technical framework grounded in scientific research for estimating predictive safety performance of roadways.

Predictive safety analysis methodology is a quantitative approach used to estimate the safety performance of roadways. To perform this safety performance analysis, HSM suggested the use of safety performance functions (SPFs) for roadway segment and intersection. Similarly, the National Cooperative Highway Research Program (NCHRP) 888 report proposed different SPFs for various roundabout configurations. SPFs are developed based on mathematical models and used statistical analysis of crash data collected from past incidents on similar roadways, that estimate the expected number of collisions based on roadway type, geometric configurations, and traffic volume. This analysis allows for the identification of the relationship between crash frequency and different roadway characteristics, such as lane width, curvature, and traffic volume. The resulting SPF can then be used to predict the expected number of crashes for a given roadway based on its characteristics. However, SPFs do not account for the potential impact of treatments that can improve safety, such as adding a roundabout or installing a traffic signal.

Exhibit D-1, D-2, D-3, D-4, D-5 and D-6 presents the SPF coefficients for different urban and suburban intersections and roadway segments. Crash Modification Factors (CMFs) are applied in predictive collision estimation because they provide a quantitative way to estimate the expected reduction or increase in collisions resulting from the implementation of a specific treatment.

The use of SPFs in combination with CMF allows for the estimation of safety performance for both existing and proposed roadway designs. By comparing the expected crash frequency for different design alternatives, transportation professionals can identify the design with the lowest expected number of crashes and make informed decisions about roadway improvements

.

Exhibit D-1: SPF Coefficients for Multiple-Vehicle Collisions at Intersections

Intersections Control Type	F-I				PDO				Total			
	a	b	c	k	a	b	c	k	a	b	c	k
Unsignalized three-leg intersection (Stop control on minor-road approaches)	-14.01	1.16	0.30	0.69	-15.38	1.20	0.51	0.77	-13.36	1.11	0.41	0.80
Signalized four-leg intersection	-13.14	1.18	0.22	0.33	-11.02	1.02	0.24	0.44	-10.99	1.07	0.23	0.39

Exhibit D-2: SPF Coefficients for Single-Vehicle Collisions at Intersections

Intersections Control Type	F-I				PDO				Total			
	a	b	c	k	a	b	c	k	a	b	c	k
Unsignalized three-leg intersection (Stop control on minor-road approaches)	-	-	-	-	-8.36	0.25	0.55	1.29	-6.81	0.16	0.51	1.14
Signalized four-leg intersection	-9.25	0.43	0.29	0.09	-11.34	0.78	0.25	0.44	-10.21	0.68	0.27	0.36

Exhibit D-3: SPF Coefficients for Vehicle-Pedestrian Collisions at Intersections

Intersections Control Type	Total					
	a	b	c	d	e	k
Signalized four-leg intersection	-9.53	0.40	0.26	0.45	0.04	0.24

Exhibit D-4: SPF Coefficients for Roundabout

Control Type	F-I					PDO					Total				
	a	b	c	d	k	a	b	c	d	k	a	b	c	d	k
Multi-Lane Four-Legged Urban Roundabout	-10.34	0.91	0.19	-0.51	0.56	-5.77	0.50	0.31	-0.46	1.06	-5.66	0.52	0.29	-0.46	0.93

Exhibit D-5: SPF Coefficients for Multiple-Vehicle Collisions on Roadway Segments

Segment Type	F-I			PDO			Total		
	a	b	c	a	b	c	a	b	c
Four-lane divided arterials	-12.76	1.28	1.31	-12.81	1.38	1.34	-12.34	1.36	1.32
Five-lane arterials	-10.47	1.12	0.62	-9.97	1.17	0.88	-9.70	1.17	0.81

Exhibit D-6: SPF Coefficients for Single-Vehicle Collisions on Roadway Segments

Segment Type	F-I			PDO			Total		
	a	b	c	a	b	c	a	b	c
Four-lane divided arterials	-8.71	0.66	0.28	-5.04	0.45	1.06	-5.05	0.47	0.86
Five-lane arterials	-4.43	0.35	0.36	-5.83	0.61	0.55	-4.82	0.54	0.52

To upgrade the segments of 338 Avenue, safety assessment has been conducted for three different design alternatives in combination of signalized intersections and roundabout. A signalized intersection and a roundabout both have their unique safety advantages and disadvantages, as well as different features that can impact the safety of the intersection along an arterial road.

During the study period, the costs of motor vehicle collisions were determined by accounting for the societal costs of fatalities and injuries resulting from crashes as well as the expenses incurred for maintenance. To arrive at the costs of these collisions, a discount rate of 3.10% over a period of 20 years was applied. Based on the collision types, cost has been estimated for fatal(F) collision, injury(I) collision, property damage only (PDO) collision.

- Fatal collision costs are typically higher than injury collision costs, as they include the costs associated with the loss of life. This cost estimates the economic value of human life based on factors such as the victim's age, income, and other demographic characteristics.
- Whereas injury collision costs are typically lower than fatal collision costs but can still be significant. These costs can include medical expenses, lost wages, and other economic losses resulting from the accident. To estimate injury collision costs, economists often use a variety of data sources, such as insurance claims, hospital records, and government statistics on the costs of medical treatment and rehabilitation.
- PDO collision cost refers to the economic costs associated with damage to property resulting from an accident or other event. This can include damage to buildings, vehicles, equipment, and different types of physical property. To estimate the cost of property damage, economists and insurance companies often use a variety of data sources, such as repair estimates, replacement costs, and market values of the damaged property.

Exhibit D-7 shows assumed collision costs for different types of collisions.

Exhibit D-7: Collision Costs for Different Types of Collisions

Collision Costs	
Fatal	$1,656,000
Injury	$60,500
PDO Only	$5,000

One of the advantages of a signalized intersection is that it allows vehicles to make direct turns to reach their destination, which can be more convenient for drivers. Additionally, it can accommodate a higher volume of turning vehicles than a roundabout, especially during peak hours. However, one of the disadvantages of an intersection is that it can be more prone to accidents especially fatal collisions due to the higher speed of vehicles and potential conflicts between turning vehicles and through traffic. Pedestrian safety can also be compromised if there are no proper crossings or signals, and the intersection is too large. To mitigate these issues, traffic signals are usually installed to regulate the flow of traffic, and dedicated turn lanes and channelization can help separate turning and through traffic, reducing conflicts and improving safety.

In contrast, one of the advantages of a roundabout is that it encourages slower vehicle speeds and reduces the likelihood of fatal collisions due to high-speed. This can be especially beneficial for arterial roads, where high-speed crashes can be particularly dangerous. Additionally, roundabouts can improve pedestrian safety by providing designated crossings and medians to wait for gaps in traffic. They also generally have lower maintenance costs compared to a signalized intersection, as there are no traffic signals to maintain. However, one of the disadvantages of a roundabout is that it can be confusing for drivers who are not familiar with roundabouts and may not know how to navigate them correctly during the early stage of the roundabout. However, by the time, the drivers will get familiar with the roundabout. It may also not be suitable for high-volume turning movements, as roundabouts can become congested if too many vehicles are trying to enter or exit at the same time. To mitigate these issues, yield signs are typically used to regulate traffic flow, and roundabouts can operate efficiently with little to no delay during low to moderate traffic volumes. They also typically have a central island that provides additional separation between entering and exiting traffic, reducing the risk of collisions.

Overall, the choice between a signalized intersection and a roundabout will depend on various factors, such as the traffic volume, the available space, and the needs of the community. Proper planning and design, including the use of appropriate traffic control devices and pedestrian facilities, can help improve the safety of either intersection type along an arterial road.

Considering all the above-mentioned facts, three scenarios have been assessed to perform safety analysis over the period 2025 to 2045. Here, **Scenario 1** indicates all intersecting roads with 338 Avenue are four-legged signalized intersections. **Scenario 2** demonstrates all crossing roads with 338 Avenue are four-legged signalized intersections, except for two specific locations, namely Trilogy A and 48 Street, which are considered as multilane four-legged urban roundabouts. Last but not least, in **Scenario 3**, all intersecting roads are considered four-legged multilane urban roundabouts, except for two locations, namely 2A and North Point Access 6.

Comparative Evaluation

A comparative evaluation has been carried out to assess the potential collision risks along the corridor over the period 2025 to 2045. To perform the safety analysis, the corridor has been divided into 24 sections, which consists of either signalized intersections or roundabout and segments. Exhibit D-8 shows the difference among each section of Scenario 1, Scenario 2, and Scenario 3 along with intersecting road control type and the length of each segment.

Exhibit D-8: Comparison of Intersecting Road Control Types in Different Scenarios

Section ID	Name (Intersection /Roundabout/ Segment)	From	To	Intersecting Road Control Type			Length (m)
				Scenario 1	Scenario 2	Scenario 3	
1	2A			Signalized four-leg intersection	Signalized four-leg intersection	Signalized four-leg intersection	
2	Segment 1	2A	Wedderburn Gate	Four-lane divided arterials	Four-lane divided arterials	Four-lane divided arterials	302
3	Wedderburn Gate			Signalized four-leg intersection	Signalized four-leg intersection	Multi-lane four-legged urban roundabout	
4	Segment 2	Wedderburn Gate	Wedderburn Heights	Four-lane divided arterials	Four-lane divided arterials	Four-lane divided arterials	357
5	Wedderburn Heights			Signalized four-leg intersection	Signalized four-leg intersection	Multi-lane four-legged urban roundabout	
6	Segment 3	Wedderburn Heights	Primary Collector A	Four-lane divided arterials	Four-lane divided arterials	Four-lane divided arterials	357
7	Primary Collector A			Signalized four-leg intersection	Signalized four-leg intersection	Multi-lane four-legged urban roundabout	
8	Segment 4	Primary Collector A	Wedderburn Comm	Four-lane divided arterials	Four-lane divided arterials	Four-lane divided arterials	357
9	Wedderburn Comm			Signalized four-leg intersection	Signalized four-leg intersection	Multi-lane four-legged urban roundabout	
10	Segment 5	Wedderburn Comm	32 St.	Four-lane divided arterials	Four-lane divided arterials	Four-lane divided arterials	246
11	32 St.			Signalized four-leg intersection	Signalized four-leg intersection	Multi-lane four-legged urban roundabout	
12	Segment 6	32 St.	Trilogy A	Four-lane divided arterials	Four-lane divided arterials	Four-lane divided arterials	300
13	Trilogy A			Signalized four-leg intersection	Multi-lane four-legged urban roundabout	Multi-lane four-legged urban roundabout	

Section ID	Name (Intersection /Roundabout/ Segment)	From	To	Intersecting Road Control Type			Length (m)
				Scenario 1	Scenario 2	Scenario 3	
14	Segment 7	Trilogy A	Trilogy B	Five-lane arterials	Five-lane arterials	Five-lane arterials	317
15	Trilogy B			Signalized four-leg intersection	Signalized four-leg intersection	Multi-lane four-legged urban roundabout	
16	Segment 8	Trilogy B	Trilogy C	Five-lane arterials	Five-lane arterials	Five-lane arterials	408
17	Trilogy C			Signalized four-leg intersection	Signalized four-leg intersection	Multi-lane four-legged urban roundabout	
18	Segment 9	Trilogy C	Trilogy D	Four-lane divided arterials	Four-lane divided arterials	Four-lane divided arterials	303
19	Trilogy D			Signalized four-leg intersection	Signalized four-leg intersection	Multi-lane four-legged urban roundabout	
20	Segment 10	Trilogy D	48 St.	Four-lane divided arterials	Four-lane divided arterials	Four-lane divided arterials	301
21	48 St.			Signalized four-leg intersection	Multi-lane four-legged urban roundabout	Multi-lane four-legged urban roundabout	
22	Segment 11	48 St.	North Point Access 6	Five-lane arterials	Five-lane arterials	Five-lane arterials	384
23	North Point Access 6			Signalized four-leg intersection	Signalized four-leg intersection	Signalized four-leg intersection	
24	Segment 12	North Point Access 6	Township Rd 210	Five-lane arterials	Five-lane arterials	Five-lane arterials	661

Note: Length has been calculated from the center of the intersecting road to the next center of the intersecting road

The above-mentioned SPF functions from HSM and CMF for specific treatment have been used to estimate the number of predicted collisions for specific road sections on an annual basis. This prediction has been made by taking into consideration various factors such as traffic volume, the expected future growth rate of traffic, and the geometric configuration of intersecting road control types. To estimate the number of collisions for each scenario over a 20-year period, the predictive collisions for each year have been summed up for each type of collision. Specifically, the number of predicted fatal and injury collisions and property damage only collisions have been summed up for each scenario to arrive at the estimated total number of each type of collision over the 20-year period. Exhibit D-9 shows predicted number of collisions for the 20 years from 2025 to 2045.

Exhibit D-9: Predicted Number of Collisions for 20 years by Severity

Scenario 1			Scenario 2			Scenario 3		
Predicted Number of Collisions for 20 years								
F+I	PDO	Total	F+I	PDO	Total	F+I	PDO	Total
196	433	629	201	509	709	231	787	1018

Note: F+I= Fatal and Injury Collisions; PDO= Property Damage Only Collisions; Total = (F+I) + PDO

According to Exhibit D-9, three scenarios were evaluated, and each scenario provided an estimate of the number of collisions that may occur over the next 20 years. In Scenario 1, it is estimated that there will be 196 fatal and injury collisions, 433 property damage only collisions, and a total of 629 collisions. Scenario 2 predicts 201 fatal and injury collisions, 509 property damage only collisions, and a total of 709 collisions. Finally, in Scenario 3, the estimated numbers of fatal and injury collisions, property damage only collisions, and total collisions are 231, 787, and 1018, respectively. These numbers are only predicted numbers and may not necessarily reflect the actual number of collisions that will occur over the next 20 years, as various factors can influence the number of collisions.

The predicted number of collisions result demonstrate that Scenario 3 (roundabouts) is expected to cause more total collisions than the future signalized intersections (Scenario 1), but with fewer collisions resulting in fatal and injury collision. Despite the higher total collision estimate, the roundabout's design is expected to reduce the severity of accidents by decreasing the likelihood of high-speed collisions and angle collisions. This finding highlights the importance of considering both the total number of collisions and the severity of those collisions when evaluating different intersection designs.

Estimating collision costs is an important factor because it helps to quantify the economic impact of road crashes. By understanding the costs associated with collisions, policymakers and stakeholders can allocate resources to reduce collisions and their associated costs. Collision cost estimates can be used to justify investments in road safety measures, determine insurance premiums, and raise public awareness of the importance of road safety. Estimation of collision costs is an important tool to develop effective strategies to reduce collisions and improve road safety. Exhibit D-10 shows the predicted cost of collisions for each scenario over a 20-year period. The cost estimates have been categorized into fatal collisions, injury collisions, property damage only (PDO) collisions, and all collisions combined.

Exhibit D-10: Predicted Cost of Collisions for 20 years by Severity

Scenario 1				Scenario 2				Scenario 3			
Predicted Cost of Collisions for 20 years (in million)											
F	I	PDO	Total	F	I	PDO	Total	F	I	PDO	Total
3.31	7.75	1.44	12.50	2.96	7.96	1.70	12.62	2.04	9.26	2.66	13.95

Note: F= Fatal Collision; I= Injury Collisions; PDO= Property Damage Only Collisions; Total = F +I + PDO

In Scenario 1, the predicted cost of collisions over 20 years is $3.31 million for fatal collisions, $7.75 million for injury collisions, $1.44 million for PDO collisions, and $12.50 million for all collisions combined. Similarly, Scenario 2 predicts a cost of $2.96 million for fatal collisions, $7.96 million for injury collisions, $1.70 million for PDO collisions, and $12.62 million for all collisions combined. Finally, in Scenario 3, the predicted cost of collisions is $2.04 million for fatal collisions, $9.26 million for injury collisions, $2.66 million for PDO collisions, and $13.95 million for all collisions combined.

It is important to note that these cost predictions are based on the estimated number of collisions and the associated costs of each collision type and may not accurately reflect the actual costs that may be incurred over the 20-year period. Nonetheless, these cost estimates provide policymakers and stakeholders with valuable information to prioritize interventions and allocate resources to mitigate the costs associated with collisions and improve road safety.

Recommendations

Based on the outcome, it can be inferred that Scenario 3, which involves the installation of multiple roundabouts, is the most favorable option in terms of minimizing the number of fatal collisions. Roundabouts are designed to reduce the severity of crashes and minimize the chances of vehicular conflicts. However, it should be noted that they do not eliminate the possibility of accidents. Furthermore, during the initial stages of implementation, drivers may be unfamiliar with roundabouts or may not fully comprehend how to navigate them, resulting in errors such as failing to yield to other vehicles, which may result in collisions causing property damage.

Over time, as drivers become more accustomed to roundabouts, the number of collisions tends to decrease due to a learning curve associated with roundabouts, where drivers adapt their behavior and anticipate the movements of other vehicles. However, it should be noted that Scenario 3 will result in lower traffic throughput than Scenario 2, from an operational perspective. The operational performance of Scenario 1 and Scenario 2 will be more comparable, though implementation of Scenario 2 would result in fewer fatal collisions than Scenario 1. Therefore, we recommend that Scenario 2 be considered as a potential alternative for future implementation.