

Investigation of the Potential for Infill Stations Along Calgary's LRT System

Introduction

In 2016 March, Calgary City Council directed Administration to investigate the potential for inserting infill Light Rail Transit (LRT) stations along the existing Red Line. With the approved Notice of Motion NM2016-10, Council directed Administration:

- "...to confirm the technical and financial viability of infill stations along the Red Line of the LRT and confirm how operations along the Red Line would be affected;
- "...to identify potential Transit Oriented Development high priority infill areas, particularly in conjunction with the Main Streets program, for those infill stations";
- "...prepare a report summarizing the potential ridership from these stations and report back to the SPC on Transportation and Transit no later than Q4 2017".

Executive Summary

A comprehensive review of the existing Red and Blue CTrain lines has determined that three locations are technically feasible for infill stations based on station design criteria, station spacing, roadway and pedestrian accessibility, adjacent land use, and potential for Transit Oriented Development. These locations are:

- Northland Drive NW – Red Line NW (between Brentwood and Dalhousie Stations)
- 50 Avenue S – Red Line South (between 39th Avenue and Chinook Stations)
- Fisher Park – Red Line South (just south of Glenmore Trail between Chinook and Heritage Stations)

High level estimates have identified construction costs of approximately \$20 million (50 Av S and Fisher Park, each) and approximately \$32 million (Northland Dr NW). The estimates are based on Class 5 in the Corporate Project Management Framework and have a variance of +100% and - 50%. As well, each new station would require the addition of a peak period four-car train valued at \$25 million (four-car train plus one spare) to maintain current service frequencies and to accommodate new ridership. The annual operating costs for each new train is approximately \$1 million (wages, train maintenance, power) with station operating costs of about \$0.3 million per year.

The addition of CTrain stations at these three locations would support and be compatible with the goals and policies of the Calgary Municipal Development Plan, including Main Streets. Within each potential station area, there is opportunity for redevelopment of some adjacent lands for higher density Transit Oriented Development (TOD). Each of the potential station sites would require upgraded public infrastructure such as water, sewer, roads and pathways. Such redevelopment would also result in higher property values and tax revenues.

Higher density TOD adjacent to rapid transit stations has been shown to generate significant new ridership, but, in the case of the potential infill station areas this is difficult to quantify without information on the type, extent and scale of development. Without redevelopment to bring new residents and jobs to these areas, the potential stations would generate only modest ridership increases.

The TOD opportunities at these potential station sites should be reviewed within the context of the development potential at current and planned LRT stations along the Red, Blue and future Green

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Lines, plus stops along the BRT network. Ridership and triple bottom line return on investment of candidate infill stations should be reviewed in conjunction with the TOD implementation strategy being prepared by Planning and Development. It is suggested that private sector interest and support would be the catalyst for pursuing further work related to these potential stations. The information provided by this report will provide a useful reference if The City receives future proposals or requests to construct a station at these three locations.

Investigation

In response to direction from City Council, this report examines:

- LRT design factors that influence station location and spacing,
- Potential locations for infill stations along both the Red and Blue CTrain Lines,
- Capital and operating costs associated with potential infill stations,
- Land use and TOD implications / opportunities at these locations,
- Transit network and ridership implications of potential infill stations,

Light Rail Transit Design Considerations

For the review of potential locations for infill stations along existing CTrain lines in Calgary it is important to first outline the critical design and operating principles inherent with LRT. Typically, an LRT system provides a medium capacity passenger rail service along high demand travel corridors in an urban setting. The capacity of LRT is generally higher than an urban bus service but less than heavy rail such as subways or commuter rail. The capacity of LRT is mainly determined by the size of the vehicles and stations, headway (spacing between trains or frequency) and the average operating speeds of trains along a line.

A well-designed LRT system is attractive to customers because of its speed, comfort, capacity, and directness of service for travel to high demand locations. To achieve these attributes LRT systems usually operate at higher speeds than buses or other traffic by using segregated or semi-segregated rights of way with stations spacing of at least 500 metres. Conversely, slower street car or tram systems are more likely to operate in mixed traffic, with more closely spaced stops, similar to buses.

Among North American LRT systems, average station spacing varies between 600 and 2,000 metres (see Appendix 1). Frequency of LRT service is normally determined by operating budgets, the required line capacity to meet passenger demand during the busiest hours, the schedule of other connecting services (e.g. buses) and the need to provide an attractive and convenient service that meets customer travel needs.

In Calgary, LRT was implemented to provide an attractive, higher capacity and more efficient means of transporting transit passengers along major travel corridors. The focus was to improve transit service to the high concentration of activities in the downtown and at key destinations along these corridors. It was also intended that LRT would attract new higher density Transit Oriented Development (TOD) at suburban LRT stations to reduce the outward spread of the city. LRT in Calgary has proven successful as an attractive transit service with a high capacity for moving large volumes of passengers over longer distances, more directly and comfortably and at higher speeds than would be possible to do by bus. LRT has been instrumental in shaping Calgary's compact and high density downtown. Higher density redevelopment has occurred at some stations and this type of land use is planned at new and future stations.

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Location of LRT Stations

To determine if there is potential to add CTrain stations along existing lines, it is important to review the criteria used for locating the existing stations. In Calgary, the Red and Blue Lines serve four main travel corridors – MacLeod Trail, 36 Street / Memorial Drive NE, Crowchild Trail NW, and Bow Trail / 17 Avenue SW. When planning for LRT in Calgary, stations sites along these corridors were selected to both enable access to LRT service via local bus routes, autos or by customers who are able to walk, cycle or be dropped off by an auto driver. As well, stations sites were selected to enable people from other areas of the city to access high demand land uses in the station areas. Examples of key destinations outside of the downtown include Chinook Station (the busiest station outside of downtown), University of Calgary, Peter Lougheed Hospital (Rundle Station), and Westbrook.

Station Location Factors

The main criteria that influenced the location of stations along Calgary's LRT system are:

- Presence of supportive land use (current and future schools, shopping, other higher density land use) that would contribute ridership to the system.
- Compatibility with existing and planned land uses.
- Locations accessible by multiple modes via supporting roadways and pedestrian facilities and, particularly, via local bus routes. Travel by local 'feeder' bus or regional bus service to an LRT station is the best means of optimizing the transit system with stations that offer a convenient transfer location that minimizes bus travel distance and maximizes LRT travel distance. This provides the greatest attraction to customers and reduces the transit system's cost per passenger. As well, it allows the local bus network to be optimized to serve both LRT stations and local community destinations.
- The availability of land for bus terminals and park and ride lots.
- Ability to achieve a suitable track gradient at the station (less than 2%) and minimum track radius (curvature less than 1%).

In Calgary, the existing roadway and pedestrian network in conjunction with the adjacent community form has influenced station location and design.

LRT Station Spacing

A critical consideration when assessing the possibility of adding stations to an existing line is how an infill station would affect the spacing of stations along the line. The distance between stations is a balance between maximizing distance to provide for more rapid travel and maximizing opportunities for customers to access the system and key destinations. Too far apart and the system effectiveness is reduced; too close together and the attractiveness and efficiency of the service is diminished.

Appendix 1 provides information on the spacing between stations on major North American LRT systems. The average spacing among these systems is approximately 1.3 kilometres. Of the 23 systems listed, 22% have stations spaced an average of 2 or more kilometres apart, 61% average between 1 and 2 kilometres, and 17% have less than a 1 kilometre separation.

Appendix 2 provides a graph that illustrates the effect of station spacing on average system operating speeds for LRT system designs that range from fully grade separated to low speed

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trains operating in an on-street configuration. This data shows that LRT system operating speed is potentially 55% higher when stations are spaced at 1.2 km versus 0.4 km, and 41% higher with a 0.8 km spacing. However, the effect of station spacing drops significantly when stations are greater than 1.2 km apart with only a 9% increase in speed at 1.8 km spacing. This relationship is also influenced by the top speed, acceleration and deceleration capabilities of the trains.

The trade-offs between shorter versus longer station spacing are listed below:

Shorter station spacing - Pros:

- Increased access equals more customers within walking distance and more destinations served,
- Increased opportunities for TOD,
- Smaller stations with potentially lower passenger volumes at each station,
- Decreased bus operating cost – shorter bus routes (depends on road network),

Shorter station spacing - Cons:

- Increased LRT costs – more trains are required to maintain frequency and provide passenger capacity, more stations and infrastructure to build, operate and maintain, more power consumed and higher vehicle maintenance with more starts and stops,
- Decreased speed and passenger comfort = more stops and starts, longer travel time equals lower attractiveness for those on the train.

Longer station spacing - Pros:

- Lower LRT costs – fewer trains required, fewer stations to build, operate and maintain, less power consumed, lower vehicle maintenance costs,
- Increased speed and passenger comfort equals fewer stops and starts, shorter travel time and greater comfort for those on the train,

Longer station spacing - Cons:

- Decreased access – fewer customers within walking distance, fewer destinations served,
- Decreased opportunities for TOD,
- Increased bus operating cost – longer routes to access stations.
- Larger stations required to handle higher passenger volumes at each station,

Other Factors Affecting System Average Operating Speed:

- Track quality (rail & track bed), grades, alignment (number of short vs long radius curves with longer radius providing greater speed),
- LRT vehicle characteristics – top speed, acceleration / deceleration,
- Segregation of track (number of level crossings, right of way protection),
- Signaling system / block protection system effectiveness,
- Power supply – location, capacity and number of electrical substations,
- Weather – rain, snow, temperature.

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Calgary LRT Station Spacing

Table 1 summarizes the data for Calgary's CTrain station spacing found in Appendix 3. The maximum distance between stations is 3.9 kilometres (Crowfoot / Dalhousie stations) while the minimum distance is outside the downtown is 0.7 kilometres (between Stampede / Victoria Park and Stampede / Erlton stations). The average distance between stations is about 1.5 kilometres between suburban stations and 0.4 kilometres between downtown platforms. Calgary's relatively close downtown station spacing is a function of available platform capacity within the limited space available along 7th Avenue and the high concentration of passengers boarding and alighting in the downtown. The close spacing in the downtown enables spreading of passengers among more stations and reducing walking distances in the downtown.

Table 1
Calgary LRT Station Spacing

	Total Kms	Stations / Platforms	Average Spacing <u>Kms</u>
Suburban	55.4	38	1.5
Downtown EB	2.2	6	0.4
Downtown WB	2.2	5	0.4
Total System	57.6	49	1.2

It is concluded that Calgary's station spacing enables an effective and efficient service.

Potential for Infill Stations

As directed, this review examines the potential for infill station locations along the Red Line. As well, the opportunity for infill stations along the Blue Line was also examined. As a result, based on the design factors discussed in the previous section, three possible infill station candidates were identified:

- Red Line NW – Northland Dr
- Red Line South – 50 Avenue S
- Red Line South – Fisher Park (south of Glenmore Trail).

Appendix 4 provides aerial photographs that show each leg of the CTrain system with existing and potential infill station locations, and current and potential distances shown between stations. The potential for infill stations was identified based on:

- Maintaining a minimum spacing between existing and potential stations of at least 800 metres,
- Appropriate grade and track alignment at the potential station location (vertical grade 2% or less, horizontal curve 1% or less).

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- Accessibility to the potential infill station locations from existing or potential roadway, pedestrian / cycling connections, and existing or potential local bus routes,
- Compatibility with existing or proposed land uses and land use plans / policies.

The rationale for selecting these potential locations is summarized as follows:

Red Line Northwest – Northland Dr NW

- A station was pre-planned at this location when the Red Line NW was extended from Brentwood to Dalhousie Stations. Sufficient space was provided to insert a centre loading station between the eastbound and westbound tracks with overhead customer access from the Northland Dr overpass.
- This station was not constructed mainly due to budget limitations.
- The potential station could be accessed from the existing pedestrian, road and bus networks with some modest infrastructure modifications or improvements.
- Bus stops could be provided on the existing Crowchild Trail on / off ramps as well as on Northland Dr NW.
- Park and ride, if needed, would require either the purchase of adjacent land or be provided as part of a private sector development.
- The existing land use in the potential station area is:
 - Low to medium density residential to the south (Varsity community).
 - Mainly low-density commercial to the north and residential plus schools in the Brentwood (north) and Varsity(south) communities
- The redevelopment of Northland Mall and the surrounding area has considered the potential for a station at this location.
- The long-term potential for TOD is mainly limited to the lands north of Crowchild Trail.
- The resulting station spacing would be 0.8 km and 1.8 km to Brentwood and Dalhousie stations, respectively.

Red Line South – 50 Av S

- This potential station could be constructed as a centre loading platform immediately south of 50 Avenue S. The station would be similar to the recently reconstructed Chinook Station and would require shifting of the existing southbound LRT tracks to accommodate a centre loading platform.
- City owned land immediately west of the potential station location could be developed as a small bus terminal and station plaza similar to Chinook Station.
- Interference with the existing Canadian Pacific Railway line would be minimal (similar to Chinook Station). Discussions with CP Rail would be required.
- The station would be accessible from 50 Avenue S with minor improvements required to the existing roadway, pedestrian and bus networks.
- The existing land use in the potential station area is low density residential, commercial, business and warehouse uses, a go-cart track and a large office complex (Enmax).
- There is considerable land in the potential station area that could be redeveloped for TOD and there is compatibility with the Main Street planning west of MacLeod Tr.
- Park and ride, if needed would require either the purchase of adjacent land or be provided as part of a private sector development.
- The resulting station spacing would be 1.0 km and 1.3 km to 39 Ave and Chinook stations, respectively.

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Red Line South – Fisher Park

- This potential station would be located south of Glenmore Trail at approximately 73 Avenue SW.
- The likely configuration would be a centre loading platform which would require shifting of the existing southbound LRT tracks (similar to 50 Av S noted above).
- Interference with the existing Canadian Pacific Railway line would be minimal (similar to Chinook Station). Discussions with CP Rail would be required.
- New pedestrian, roadway and bus network facilities would be required since the LRT tracks between Glenmore Trail and Heritage Drive are not accessible by existing public roadways on either the east or west side of the LRT and CP Rail tracks.
- The existing land use is mainly low density commercial warehouse and industrial uses both east and west of the rail lines. Portions of the Kingsland and Fairview residential communities would be within 600 metres of this location.
- There has been interest regarding the potential for a station to support redevelopment of the adjacent lands.
- Park and ride, if needed, would require either the purchase of adjacent land or be provided as part of a private sector development.
- The resulting station spacing would be 1.0 km and 1.1 km to Chinook and Heritage stations, respectively.

This high-level review did not identify any additional locations on the Red or Blue Lines with a reasonable potential to allow an infill LRT station based on the various factors that influence station location as outlined in this report.

Capital Costs

Summary of Construction Cost Estimates for Potential Red Line Infill Stations

Table 2 provides a summary of estimated capital costs for the construction of three potential infill stations along the Red Line. The Northland Station costs are based on the construction of a station similar to the Tuscany Station (2014). Costs for 50 Av S and Fisher Park stations are based on the recently reconstructed Chinook Station (2013). These estimates are based on a 'Class 5' level of costing including a 20% contingency for three main project elements: Civil, Track & Way and Rail Systems. Caveats regarding these cost estimates are explained in the text below.

The higher cost estimate for the potential Northland Station is due to the need for a large, heated station head due to the location within the median of Crowchild Trail. This station and platform would be similar to Tuscany, Dalhousie, Brentwood and University Stations.

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Table 2
Estimated Capital Costs of Potential Infill Stations
Class 5 - \$millions

Location	Civil	Track & Way	Rail Systems	20% Contingency (additional for working in active train right of way)	Total Cost Estimate
Northland Dr NW	\$18.2	\$1.2	\$7.3	\$5.3	\$32.0
50 Ave South	\$8.9	\$4.2	\$3.3	\$3.3	\$19.7
Fisher Park*	\$9.0	\$4.5	\$3.5	\$3.4	\$20.5

The estimates are based on Class 5 in the Corporate Project Management Framework and have a variance of +100% and -50%.

Items included in Cost Estimates:

Civil:

- Utility modifications / connections (where known),
- Station building and platform,
- Utility building(s),
- Bus terminal or bus stops, customer pick up / drop off (does not include park and ride),
- Sidewalk & pedestrian access facilities.

Track & Way:

- Track bed and drainage modifications,
- Track relocation, new rail, ties, other track materials,
- Special track work (e.g. switches, cross-overs),
- Miscellaneous right of way work including site access, road / sidewalk relocation, signage, fencing, temporary track work.

Rail Systems:

- Duct banks and cable,
- Traction power modification and substation (if required),
- Signal system additions / modification,
- Communication system additions / modification,
- Some changes may be required to bring rail systems up to current standards to permit bi-directional running.

Cost Estimate Caveats:

- A Class 5 (high level) cost estimate was developed for all elements since there are no conceptual or preliminary designs for these stations. There are risks associated with this level of estimate since details such as geotechnical, groundwater or other site conditions are not fully available and these may affect overall construction costs. Therefore, a 20% contingency was included for each station estimate.

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- No public engagement activities have been undertaken to obtain feedback from nearby residents, community associations, businesses or institutions on the location or design of the stations or the specific needs of the adjacent communities and businesses.
- These estimates do not include design input from other City of Calgary stakeholders such as Roads, Water Resources, Real Estate and Development Services or Planning and Development Approvals to determine their requirements. CP Rail would need to be consulted regarding any infill stations along the Red Line South where the CTrain line is within the CP right of way.
- The impacts to existing utilities (Water, Sanitary, ENMAX, ATCO, Telus, etc.) need to be closely examined. Relocations could potentially result in additional costs.
- Construction work around active CTrain operations will result in higher costs (about 2 to 3 times higher) than would be expected when building a new station (LRT extension) since regular, active LRT service will need to be accommodated. Working within this constraint will also have an impact on maintaining CTrain service with minimal disruption.
- No park and ride facilities have been included and only minor bus terminal facilities have been contemplated in these estimates.

Implications for Calgary Transit Operations

LRT Operations and Capital Costs

The construction of infill stations along the Red Line would result in longer travel times which need to be added to the current CTrain schedule to reflect the time required at each new station to slow down, dwell at the station for passengers boarding and alighting and then to resume speed. The impact on the CTrain schedule would be most noticed during weekday peak periods when passenger boarding and alighting times are longer. Based on current operating experience, each new station would require between 2 to 5 minutes of additional travel time and a reduced average operating speed of 1 to 2 kilometres per hour over the length of a round trip. This will result in the need to add one additional Red Line train for each new station to maintain the current peak period service frequency and to address the additional capacity required to handle new ridership.

Information on Light Rail Vehicle (LRV) requirements for each new station is shown in Table 3. These are conservative estimates based on LRT operations outside of the downtown. The total LRV requirement is based on the need to add a new 4 car train plus the purchase of an additional LRV to maintain an adequate spares ratio. The operating costs of adding each new train is approximately \$1 million per year which includes wages, train maintenance and power. The additional station operating cost (utilities, cleaning, maintenance, and security) is estimated at \$0.3 million per year.

It should be noted that there may be additional impacts on LRT travel time and overall line operating speed depending on the convergence of trains on 7 Avenue in the downtown. However, it should also be acknowledged that these impacts would be no different than those experienced when adding new end of the line stations when lines are extended.

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Table 3
LRV Requirements for New Stations

Infill Station Location	Added Time Required to Maintain Service Round Trip	Additional LRVs Required	Estimated LRV Cost (millions)
Northland Drive (NW)	5 Minutes	5	\$25
50 Av (S)	2 Minutes	5	\$25
Fisher Park (S)	3 Minutes	5	\$25

Bus Service Implications

Redevelopment of the lands adjacent to these potential stations, depending on the nature of the new development, would create another destination in the local community plus the ability to offer shorter bus trips to access CTrain service for some current riders.

Analysis of existing bus service has found that the potential infill stations would contribute only minor benefits to the existing bus network in terms of providing connectivity between local destinations and the CTrain system. This is due to the close proximity of the potential infill stations to existing stations. A summary of the implications, based on current bus routings and land use, is provided below.

Northland

- Enables a new bus route connection for the future Sage Hill BRT service, and improved service to Northland Village Mall and local high schools.
- Requires additional bus service hours to revise or add local routes to serve this station (minor).

50 Avenue S

- Enables shorter bus travel time to LRT for residents of nearby communities and businesses districts along 50 Av S. (Elboya, Manchester, Windsor Park)
- Would provide connectivity between the future Green Line and Red Line via a proposed future extension of 50 Av S across Deerfoot Tr.
- Requires additional bus service hours to revise local routes to serve this station (minor).

Fisher Park

- Bus service connectivity could be provided via existing Route 10 operating along Fairmont Dr SE (with a pedestrian connection over the CP tracks) and by rerouting current Route 81. These connections would provide improved transit service access for residents and employees along these routes. However, since the majority of trips on these routes are generated by Chinook mall and adjacent businesses any route deviation would negatively impact current customers.
- Requires additional bus service hours to lengthen Route 81 to serve this station (minor).

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Land Use and TOD Considerations

Assessment of potential infill LRT station sites included examining their context within the Calgary Municipal Development Plan (MDP). The MDP is a statutory document that provides a 30 to 60-year plan for the future development of the City of Calgary. The seven key foundational goals of the MDP include fostering development of a more compact urban form with greater, more sustainable mobility choices and balancing growth between new and established areas. To achieve this, the plan identifies established areas for development and redevelopment with higher intensity land use clusters at locations that are well served by transit (LRT and major bus services) and along major roadways that have been designated as Urban Main Streets.

Northland Station

The potential Northland Dr NW station site is located immediately adjacent to land designated as Community Activity Centre which currently includes the Northland Village Mall. The majority of the area located within 600 metres of the potential station location is single family residential, but, the area also includes several schools, apartment complexes, and commercial businesses. An LRT station at this location would support the potential for redevelopment of the commercial area for higher density uses. The potential for a new station at this location is recognized in planning for the redevelopment of Northland Village Mall, but, there is no relevant Local Area Plan for this area. There appears to be little possibility for redevelopment of much of the remaining lands within the station area which are established residential communities.

50 Avenue S Station

The potential 50 Avenue S station is located immediately north of lands designated as a Major Activity Centre which includes Chinook Centre, the largest shopping mall in Calgary. This area is served by Chinook Station. Land just east of the 50 Av S site is designated for Industrial, Employee Intensive uses. The area to the south is covered by the Chinook Centre Area Redevelopment Plan (ARP). The site is east of the 50 Avenue ARP and 50 Avenue SE Main Street areas.

Current land use within 600 metres of this potential station site is mainly auto oriented low density commercial and industrial businesses including those located along the MacLeod Trail corridor. An Enmax office complex is located just east of the potential station site. West of MacLeod Trail, some single-family homes in Elboya and Windsor Park communities fall within the 600 metre radius.

50 Av S has the potential to become a very walkable neighbourhood destination if and when the lands on the north side of 50 Av S redevelop. The approved ARP for this area shows a Main Street of mainly medium density residential development anchored by a vibrant Local Activity Centre that is emerging at the west end of the corridor consisting of office, retail, consumer services and residential development. Having a new LRT station at the east end of the corridor would introduce a new anchor that would draw additional activity along 50 Av S. It could also be a catalyst for creation of more intense employment uses near Macleod Trail SE. Having two strong anchors at either end of 50 Av S may help stimulate development along the corridor.

While this is likely a longer-term development scenario, formalizing the possibility of a station at 50 Av S now would potentially change market perceptions of what this corridor could become in the longer term. This could lead to development interest and possible land acquisitions for more intensive urban development that may be enhanced with the presence of an LRT station.

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Fisher Park Station

The potential for a station in this location is linked to the possibility for redevelopment of the lands south of Glenmore Trail and east of MacLeod Trail. Land uses within a 600 metre radius of the potential Fisher Park station are mainly low density commercial and industrial businesses including the MacLeod Trail SE commercial district, which includes some office buildings. Small sectors of the Kingsland and Fairview residential communities, which contain some multi-family dwellings, are also within 600 metres.

In this area, Macleod Trail SE, designated as an Urban Main Street, is generally recognized to be an auto-oriented environment for the long term, especially with the potential southward expansion of Chinook Centre in the coming years (Chinook Centre ARP). Having a CTrain station just off the Main Street Corridor could be an opportunity to create a more walkable environment for more employment intensive uses with some support commercial uses. It is unlikely to have a significant impact on the character of development immediately adjacent to the Macleod Trail corridor unless it was part of a much larger land assembly and re-imagining of the immediate area.

Like most older established communities, the three potential infill stations would serve residential areas that are declining in population since reaching their peak levels. Data for 2017 shows that the communities adjacent to the Northland and 50 Av S station sites have declined at about the same rate experienced by all established communities (about 15% decline since reaching their peak populations). The communities near the potential Fisher Park station have seen a higher rate of decline (28%).¹

Transit Oriented Development (TOD)

In addition to providing a means of access to the transit system and serving pre-existing high-volume origins and destinations, LRT stations can influence Transit Oriented Development (TOD). TOD's are generally compact, moderate to high intensity, mixed use areas within close proximity of LRT stations or major bus terminals station (in some cases up to 1,000 metres walking distance)² and which are designed to maximize the benefit of transit infrastructure. The Calgary Municipal Development Plan defines a Transit Station Planning Area (TSPA) as being located within a 600 metre radius of LRT or Bus Rapid Transit (BRT) stations. TOD's are also characterized by streetscapes and an urban form oriented to pedestrians to promote walking trips to stations and varied other uses within the station planning areas.

Where appropriate, redevelopment of the land surrounding a station or major bus stop is an important means of contributing to the goal of achieving a more compact city by concentrating mixed use development in a walkable, mini downtown-like setting. As well, the creation of strong public spaces which encourage social interaction and a sense of place is also a critical factor for community building and the provision of passive and active recreation.

Higher density land uses at stations take advantage of the CTrain system's ability to carry large numbers of people, quickly and conveniently to and from distant origins. As well, the mix and scale of uses in TOD's, such as residential, office, recreation and retail are influenced by the location of the station relative to the surrounding community context, the role of the transit station as part of the larger transit system, and the types of transit serving the station (LRT, BRT, local

¹ City of Calgary, Geodemographics, 2017

² Human Transit, Jarrett Walker, 2012, pp63

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buses). As such, the design of the TOD must reflect the surrounding community context and mobility goals.

It is well documented that TOD has a very positive influence on transit ridership. People living within well designed, medium to high density, walkable developments located within close proximity to a rapid transit station are about five times more likely to use transit than similar developments not as well served by transit. Similarly, employees working in such a development are generally 3.5 times more likely to use transit. Uses such as hotels and retail establishments have also been found to attract greater trips via transit.³ As a result, auto ownership and vehicle travel resulting from TOD's is considerably less than other similar developments where rapid transit stations are not present.⁴ Vehicle trip generation reductions of between 8% and 32% have been measured in TODs.⁵

Transit oriented development tends to increase local property values due to the various benefits cited for this more compact and attractive type of development.⁶⁷ As well, transit stations often provide a catalyst for neighbourhood redevelopment and improvement where this is desirable. Property values measured near North American and European rail transit stations have been found to range from slightly higher to over 20% higher.⁸ In some cases, up to 150% higher.⁹ Commensurate with higher property values and rents comes the prospect of higher property tax revenues when compared to other similar non-transit oriented developments.

Therefore, TOD potential and planning at each station must reflect all of these factors so each station area will have its own unique character which requires considerable planning, design and consultation with a variety of stakeholders. As well, such redevelopment usually requires an investment in public utility and infrastructure upgrades. Once a plan for TOD is developed, the full benefits typically occur over a period of time, as each station area evolves in response to market conditions. This evolution can take decades, but some benefits can be realized in the short term and incrementally.

In Calgary, TOD has been relatively slow to develop at existing stations. Recently, there has been some higher density, mixed use redevelopment at various stations including Bridgeland / Memorial, Southland, Heritage, Fish Creek - Lacombe and Brentwood stations. As well, supportive land use development was already in place in the vicinity of relatively new stations such as Somerset – Bridlewood, and Tuscany. Future communities are being planned with supportive TOD in place before LRT is constructed.

For Calgary, progress on achieving TOD at all available locations will take a considerable amount of time based not only on the market potential of each site, but, also the opportunities at other stations. As well, in Calgary, TOD has naturally evolved based on the state of the economy and market demand.

³ "Travel Characteristics of Transit-Oriented Development in California", H.M. Lund, R. Cervero, R.W. Willson, report for FTA Section 5313 (b), 2004.

⁴ "Communicating the Benefits of TOD: The City of Evanston's Transit Oriented Redevelopment and the Hudson Bergen Light Rail Transit System", C. Gorewitz et al, 2006.

⁵ "Rail Transit in America, A Comprehensive Evaluation of Benefits", T. Litman, VTP Institute, 2015

⁶ The Calgary Transportation Effect – Research Report, Real Estate Investment Network, May 2009

⁷ Light Rail Transit – Myths and Realities, Bridges – Federal Reserve Bank of St. Louis, Winter 2003 - 2004

⁸ Ibid,

⁹ "Public Transit Boosts Property Values, If Conditions are Right", National Association of Realtors, 2014
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Some of the planning, real estate and market considerations for this type of development are listed below:

- Extent of existing and proposed transit infrastructure and services,
- Availability of vacant or underutilized lands with low intensity uses,
- Availability of City owned land or land that is likely to be assembled into more contiguous parcels,
- Roads, transit, utilities and pedestrian facilities with sufficient capacity and connectivity to support redevelopment,
- Presence of existing community amenities – e.g. schools and parks, local retail,
- Private sector interest,
- Real Estate market activity or attractiveness of the surrounding area,
- Competing projects in the quadrant or along the line,
- Council approved policies that support development in the area.

Private sector initiatives certainly provide other market driven opportunities to achieve TOD at these and other stations. The three potential infill stations considered by this report would be most likely to occur as private sector led projects.

TOD Priority Areas

Transit Oriented Development in Calgary has been promoted and planned by The City of Calgary, within the context of the Calgary Municipal Development Plan and TOD policies. Some private sector TOD initiatives have also occurred. Areas surrounding many planned and current LRT stations on the Red and Blue Lines have been identified as having potential for development or redevelopment for higher intensity TOD.

Given the substantial investment made in all current and planned LRT lines and the benefits of encouraging higher intensity uses around many stations, The City Administration is developing a TOD Implementation Strategy for the Green Line and consideration should be given to prioritizing all station areas with TOD and Main Streets development potential. A more comprehensive approach would be beneficial since TOD competes with all areas identified for higher intensity development. This would provide clarity regarding the potential for future development of these areas, including the three potential stations identified in this report.

Transit Ridership Implications

Based on current land use, the addition of a CTrain station at any of the potential infill sites will likely result in slightly higher transit ridership from within the existing station area and the surrounding communities and business districts. While these locations are all served, to some extent by existing bus services, the addition of a CTrain station will result in closer walking distances and a shorter or more direct transit trip providing a better customer experience for some existing transit customers who are currently using other routes. Shorter feeder bus routes will improve transit connectivity within the area.

The three potential sites are currently surrounded by generally low intensity uses – mainly single-family homes and small businesses, a small number of multi-family dwellings, car dealerships, strip malls and other car-oriented uses. Therefore, based on current land use, these infill stations would have a very modest ability to increase ridership. The potential ridership at each station, based on existing land use is estimated at between 1,000 and 2,000 daily boardings and alightings, similar to the current ridership at Barlow/Max Bell or Shaganappi Point stations where similar land uses are served.

Investigation of the Potential for Infill Stations Along Calgary's LRT System

The redevelopment of lands adjacent to each of these potential station sites, with higher density uses which would attract new residents and jobs, is required to justify the investment needed to construct a station at any of these locations. However, without details as to the type, extent, density and mix of uses, providing a ridership projection for each of these sites is very difficult.

Conclusions

In response to Council direction in NM2016-10, this report identifies the technical, financial, land use and ridership considerations related to the potential for constructing infill CTrain stations along the existing Red Line. The review also examined the potential for infill stations along the Blue Line. Three potential infill station sites have been identified as technically feasible on the Red Line at Northland Dr NW, 50 Avenue S, and Fisher Park (just south of Glenmore Trail).

High level estimates have identified construction costs of approximately \$20 million (50 Av S and Fisher Park, each) and approximately \$32 million (Northland Dr NW). The estimates are based on Class 5 in the Corporate Project Management Framework and have a variance of +100% and - 50%. As well, each new station would require the addition of a peak period four-car train valued at \$25 million (four-car train plus one spare) to maintain current service frequencies and to accommodate new ridership. The annual operating costs for each new train is approximately \$1 million (wages, train maintenance, power) with station operating costs of about \$0.3 million per year.

The addition of CTrain stations at these three locations would support and be compatible with the goals and policies of the Calgary Municipal Development Plan, including Main Streets. Within each potential station area, there is opportunity for redevelopment of some adjacent lands for higher density Transit Oriented Development (TOD). Each of the potential station sites would require upgraded public infrastructure such as water, sewer, roads and pathways. Such redevelopment would also result in higher property values and tax revenues.

Higher density TOD adjacent to rapid transit stations has been shown to generate significant new ridership, but, in the case of the potential infill station areas this is difficult to quantify without information on the type, extent and scale of development.

The TOD opportunities at these potential station sites should be reviewed within the context of the development potential at current and planned LRT stations along the Red, Blue and future Green Lines, plus stops along the BRT network. Ridership and triple bottom line return on investment of candidate infill stations should be reviewed in conjunction with the TOD Implementation Strategy being prepared by Planning and Development. It is suggested that private sector interest and support would be the catalyst for pursuing further work related to these potential stations.

Recommendation:

It is recommended that the information in this report be used as a reference for any proposals that may arise from the public or private sector regarding the potential to construct a new LRT station in conjunction with the potential redevelopment of lands at these three locations.

Investigation of the Potential for Infill Stations Along Calgary's LRT System

References:

General Guidelines for the Design of Light Rail Transit Facilities in Edmonton, R.R. Clark, 1984 republished 2009.

Basics: The Spacing of Stops and Stations, Human Transit, Jarrett Walker, 2010.

Light Rail Transit Service Guidelines, VTA Sustainability Policy, 2007

Human Transit, Jarrett Walker, 2012

Rail Transit in America, A Comprehensive Evaluation of Benefits, Todd Litman, Victoria Transport Policy Institute, 2015

Travel Characteristics of Transit-Oriented Development in California, H.M. Lund, R. Cervero, R.W. Wilson, FTA, 2004

Public Transit Boosts Property Values, If Conditions are Right, National Association of Realtors, 2014

Investigation of the Potential for Infill Stations Along Calgary's LRT System

Appendix 1

North American Light Rail Transit Systems					
City	Country	Annual Ridership 2016	System Length Kms	Stations	Average Station Spacing Kms
Guadalajara	Mexico	89,245,000	24.0	29	0.8
Calgary	Canada	88,779,200	57.6	49	1.2
Boston	USA	69,236,700	42.0	74	0.6
Los Angeles	USA	65,829,000	141.8	65	2.2
San Francisco	USA	52,597,300	57.5	152	0.4
Portland, Or	USA	40,240,300	97.0	97	1.0
San Diego	USA	38,068,600	86.1	53	1.6
Edmonton	Canada	34,751,400	24.3	18	1.4
Dallas	USA	29,619,500	150.0	64	2.3
Mexico City	Mexico	29,370,000	12.9	18	0.7
Philadelphia	USA	25,127,600	110.1	100	1.1
Denver	USA	24,585,000	94.1	46	2.0
Minneapolis	USA	22,963,500	35.1	37	0.9
Tacoma	USA	20,577,800	32.8	15	2.2
Salt Lake City	USA	19,220,300	72.1	50	1.4
Houston	USA	18,335,800	36.9	37	1.0
New Jersey	USA	16,691,558	27.0	24	1.1
St. Louis	USA	15,343,900	74.0	37	2.0
Phoenix	USA	15,264,600	42.0	35	1.2
Sacramento,	USA	12,286,600	69.0	53	1.3
San Jose,	USA	9,931,100	67.9	62	1.1
Pittsburgh	USA	8,166,100	42.2	53	0.8
Baltimore	USA	8,092,300	53.1	33	1.6
Portland	USA	5,627,588	11.8	76	0.2
Average :					1.3
Min :					0.2
Max :					2.3
Note: Calgary includes downtown stations					

Sources:

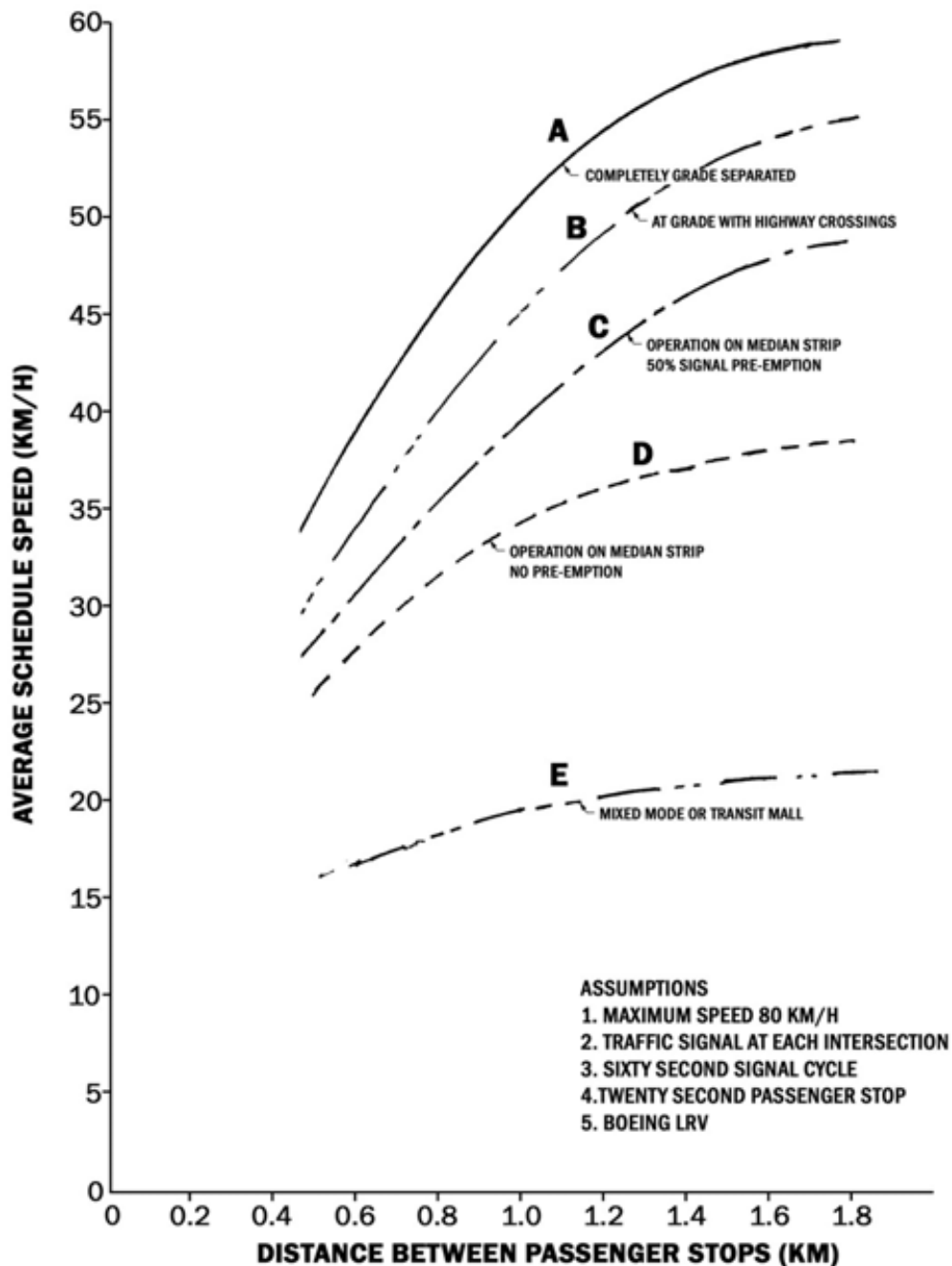
- American Public Transportation Association - Transit Ridership Report - Q4 2014.

Investigation of the Potential for Infill Stations Along Calgary's LRT System

- Banco de Información Económica - Instituto Nacional de Estadística y Geografía (INEGI) 2015.

Appendix 2

LRT Station Spacing vs Average Speed ¹¹



Investigation of the Potential for Infill Stations Along Calgary's LRT System

11 General Guidelines for the Design of Light Rail Transit Facilities in Edmonton, R.R. Clark, 1984 republished 2009.

Appendix 3 Calgary CTrain Station Spacing

Red Line Station Spacing			
Northbound Stations	Kilometres Between Stations	Southbound Stations	Kilometres Between Stations
Somerset Bridlewood		Tuscany	
Shawnessy	1.4	Crowfoot	2.4
Fish Creek - Lacombe	1.5	Dalhousie	3.9
Canyon Meadows	1.5	Brentwood	2.8
Anderson	2.0	University	0.9
Southland	1.1	Banff Trail	1.2
Heritage	1.7	Lions Park	1.3
Chinook	2.1	SAIT	1.0
39 Avenue	2.3	Sunnyside	1.0
Erlton / Stampede	1.6	8 Street West	1.2
Victoria Park /Stampede	0.7	Downtown	
City Hall	1.0	Stampede	1.0
Downtown		Erlton	0.7
Sunnyside	1.4	39 Avenue	1.6
SAIT	1.0	Chinook	2.3
Lions Park	0.9	Heritage	2.1
Banff Trail	1.2	Southland	1.7
University	1.2	Anderson	1.1
Brentwood	0.9	Canyon Meadows	2.0
Dalhousie	2.8	Fish Creek - Lacombe	1.5
Crowfoot	3.9	Shawnessy	1.5
Tuscany	2.4	Somerset Bridlewood	1.4

Investigation of the Potential for Infill Stations Along Calgary's LRT System

Total Kms	32.7		32.7
Avg Spacing	1.6	Avg Spacing	1.6
Max	3.9	Max	3.9
Min	0.7	Min	0.7

Blue Line Station Spacing			
Eastbound Stations		Westbound Stations	
	Kilometres Between Stations		Kilometres Between Stations
69 Street		Saddletowne	
Sirocco	1.4	Martindale	1.7
45 Street	1.3	McKnight - Westwinds	1.1
Westbrook	1.4	Whitehorn	2.6
Shaganappi Point	0.9	Rundle	1.3
Sunalta	1.9	Marlborough	1.8
DT West Kerby	0.8	Franklin	1.8
Downtown		Barlow Max Bell	0.8
Bridgeland / Memorial	1.5	Zoo	1.5
Zoo	1.0	Bridgeland / Memorial	1.0
Barlow Max Bell	1.5	City Hall	1.5
Franklin	0.8	Downtown	
Marlborough	1.8	Sunalta	0.8
Rundle	1.8	Shaganappi Point	1.9
Whitehorn	1.3	Westbrook	0.9
McKnight - Westwinds	2.6	45 Street	1.3
Martindale	1.0	Sirocco	1.3
Saddletowne	1.7	69 Street	1.4
Total Kms	22.7	Total Kms	22.7
Avg Spacing	1.4	Avg Spacing	1.4
Max	2.6	Max	2.6

Investigation of the Potential for Infill Stations Along Calgary's LRT System

Min	0.8	Min	0.8
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Downtown Station Spacing			
Westbound		Eastbound	
	Kms		Kms
City Hall	0.0	DT West / Kerby	0.0
1 Street West	0.5	8 Street West	0.5
4 Street West	0.6	6 Street West	0.4
7 Street West	0.4	3 Street West	0.4
DT West / Kerby	0.7	Centre Street	0.5
Total Kms	2.2	City Hall	0.3
		Total Kms	2.2
Avg Spacing	0.5	Avg Spacing	0.4

Investigation of the Potential for Infill Stations Along Calgary's LRT System

Appendix 4

CTrain Line Maps With Current and Potential Infill Station Locations

Red Line NW,

Red Line South,

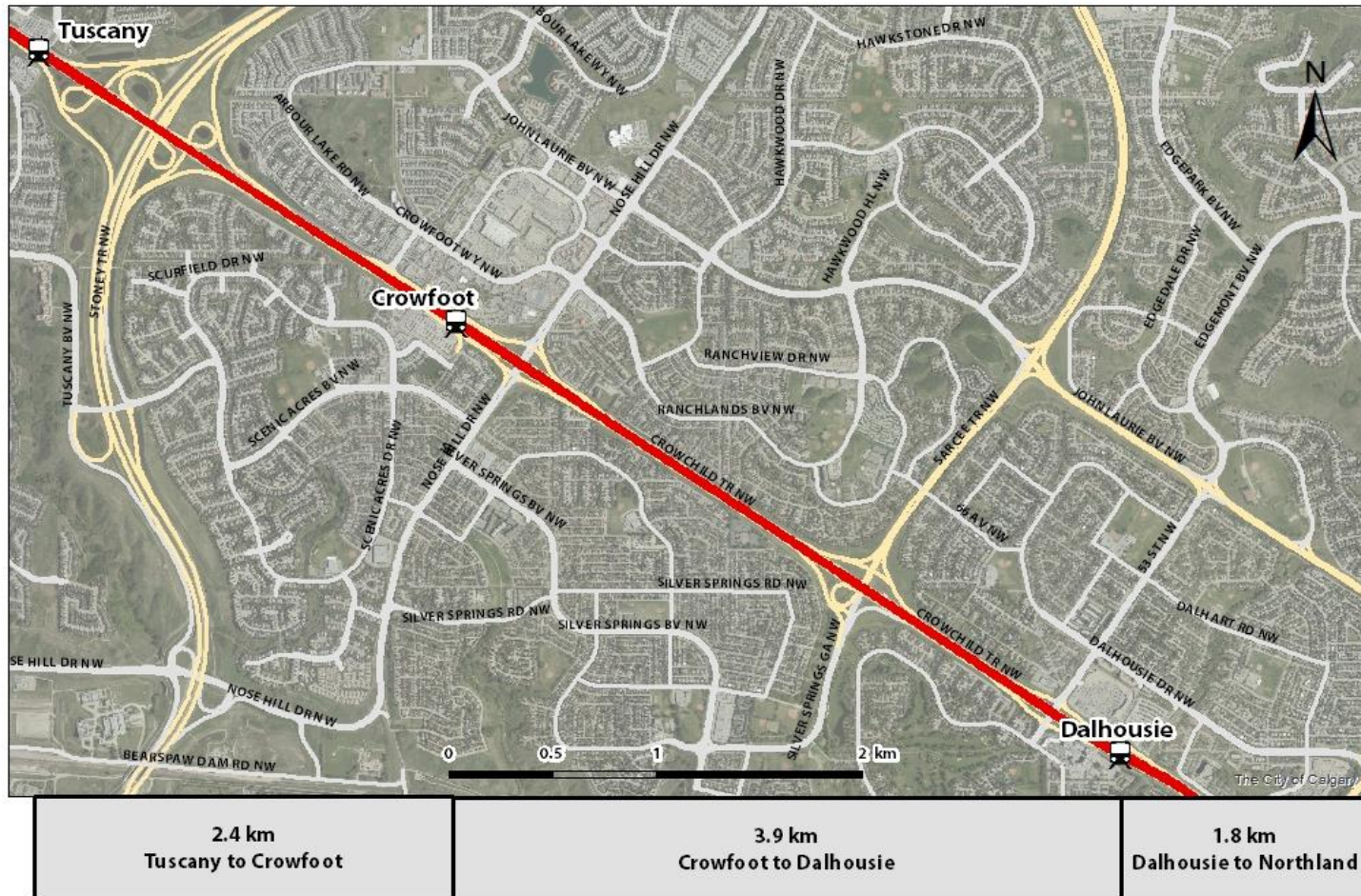
Blue Line West,

Blue Line NE

Investigation of the Potential for Infill Stations Along Calgary's LRT System

Red Line NW

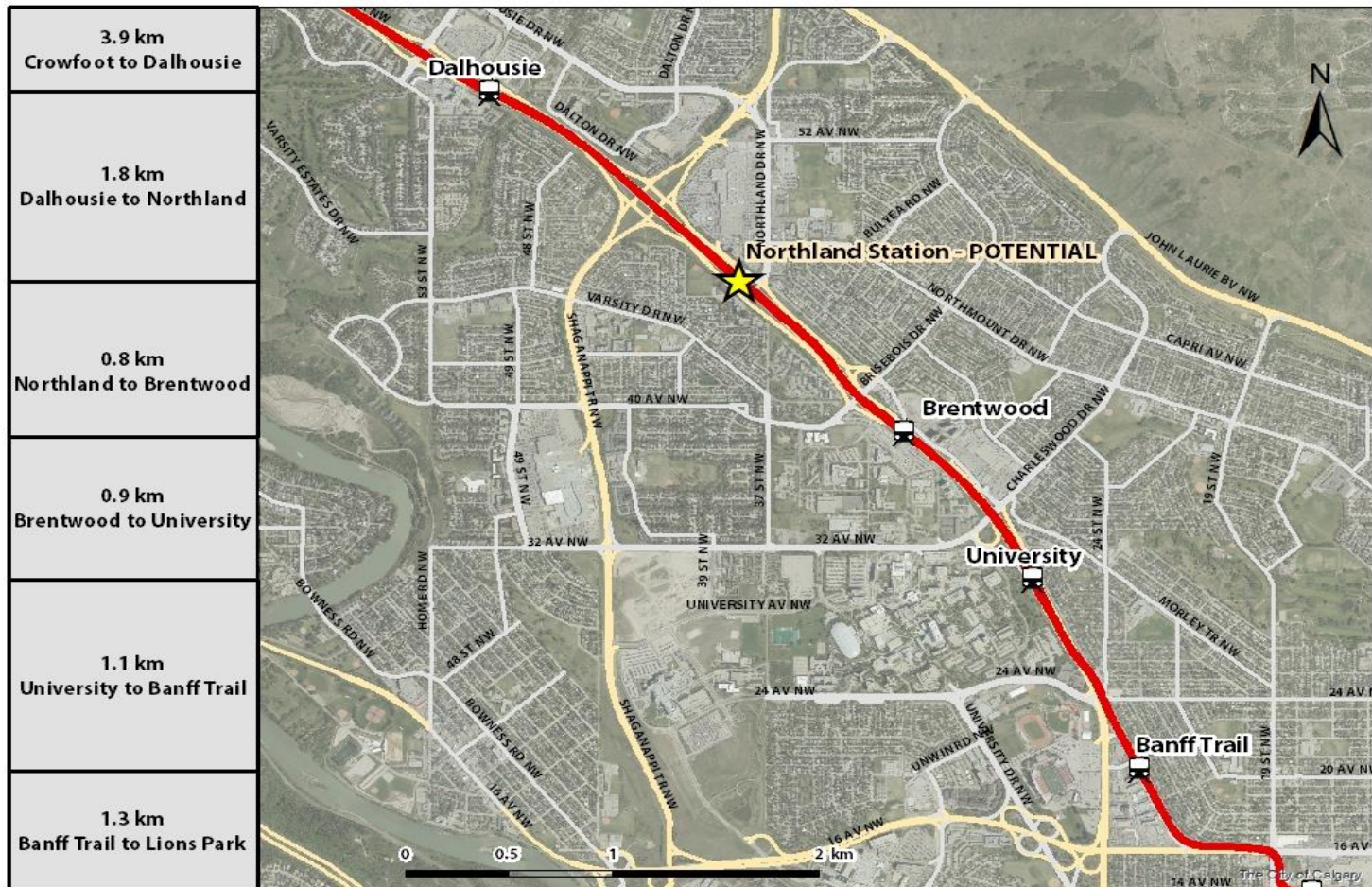
Tuscany Station to Dalhousie Station



Investigation of the Potential for Infill Stations Along Calgary's LRT System

Red Line NW

Dalhousie Station to Banff Trail Station



Investigation of the Potential for Infill Stations Along Calgary's LRT System

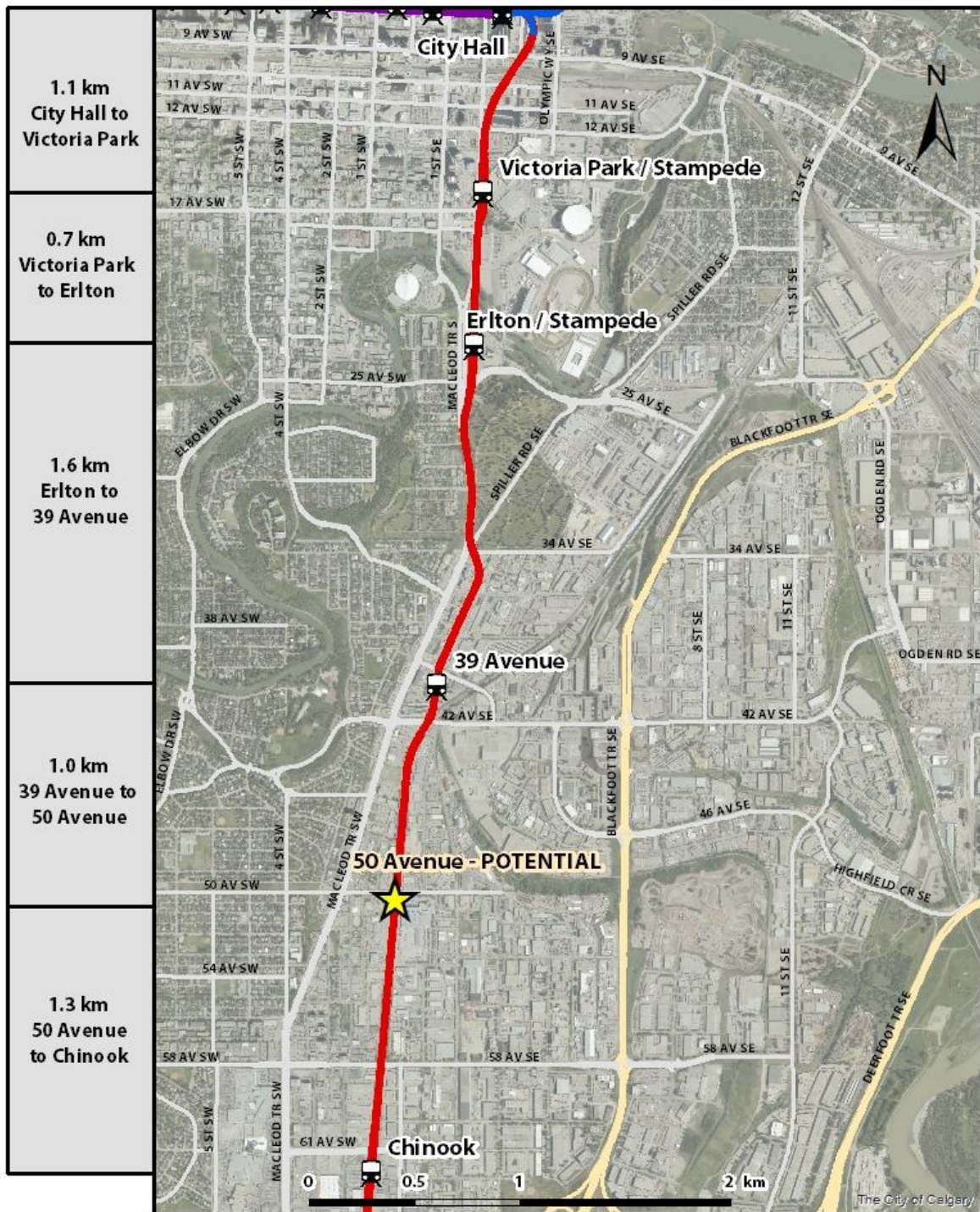
Red Line NW

Banff Trail Station to 8 Street SW Station



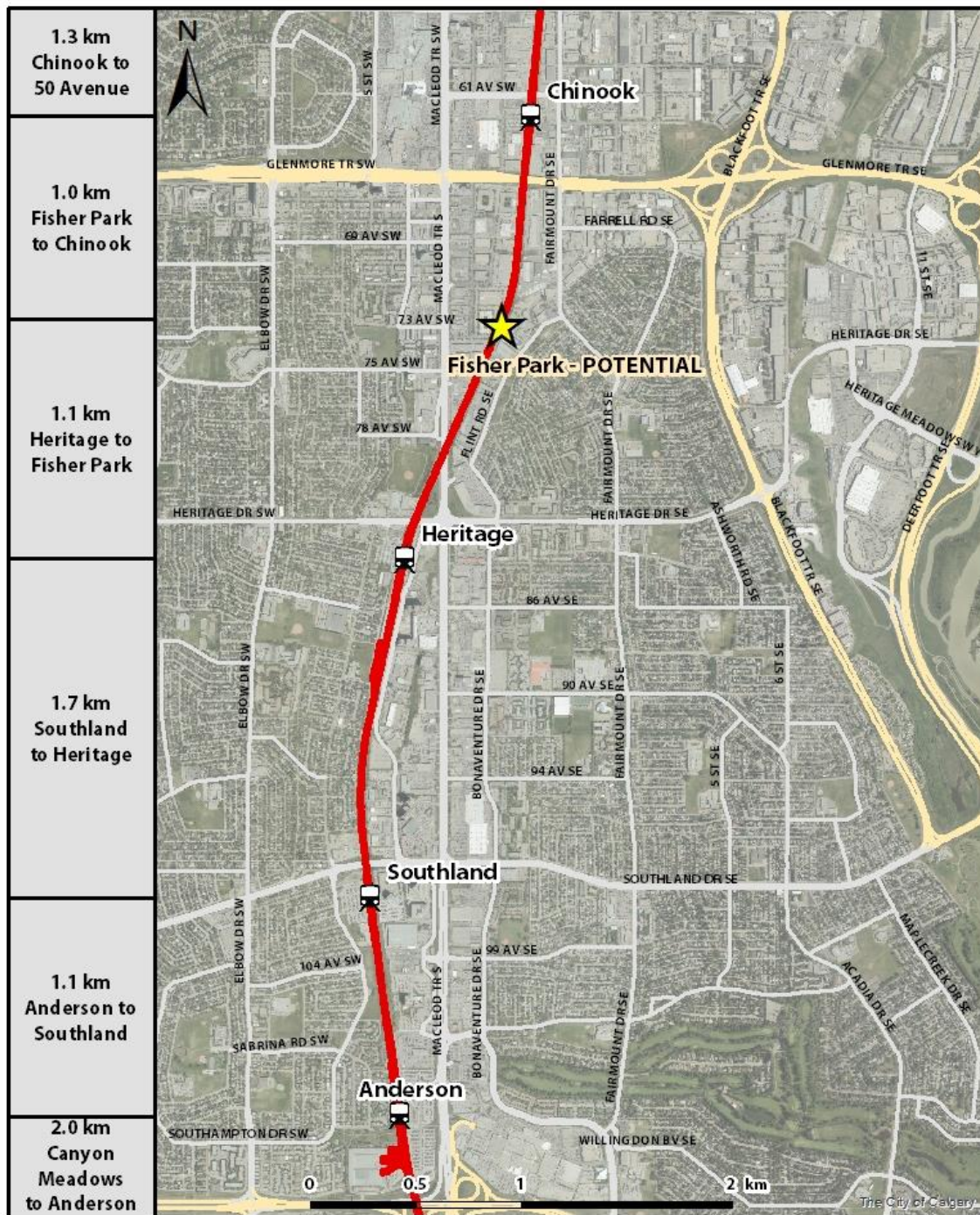
Investigation of the Potential for Infill Stations Along Calgary's LRT System Red Line South

Chinook Station to City Hall Station



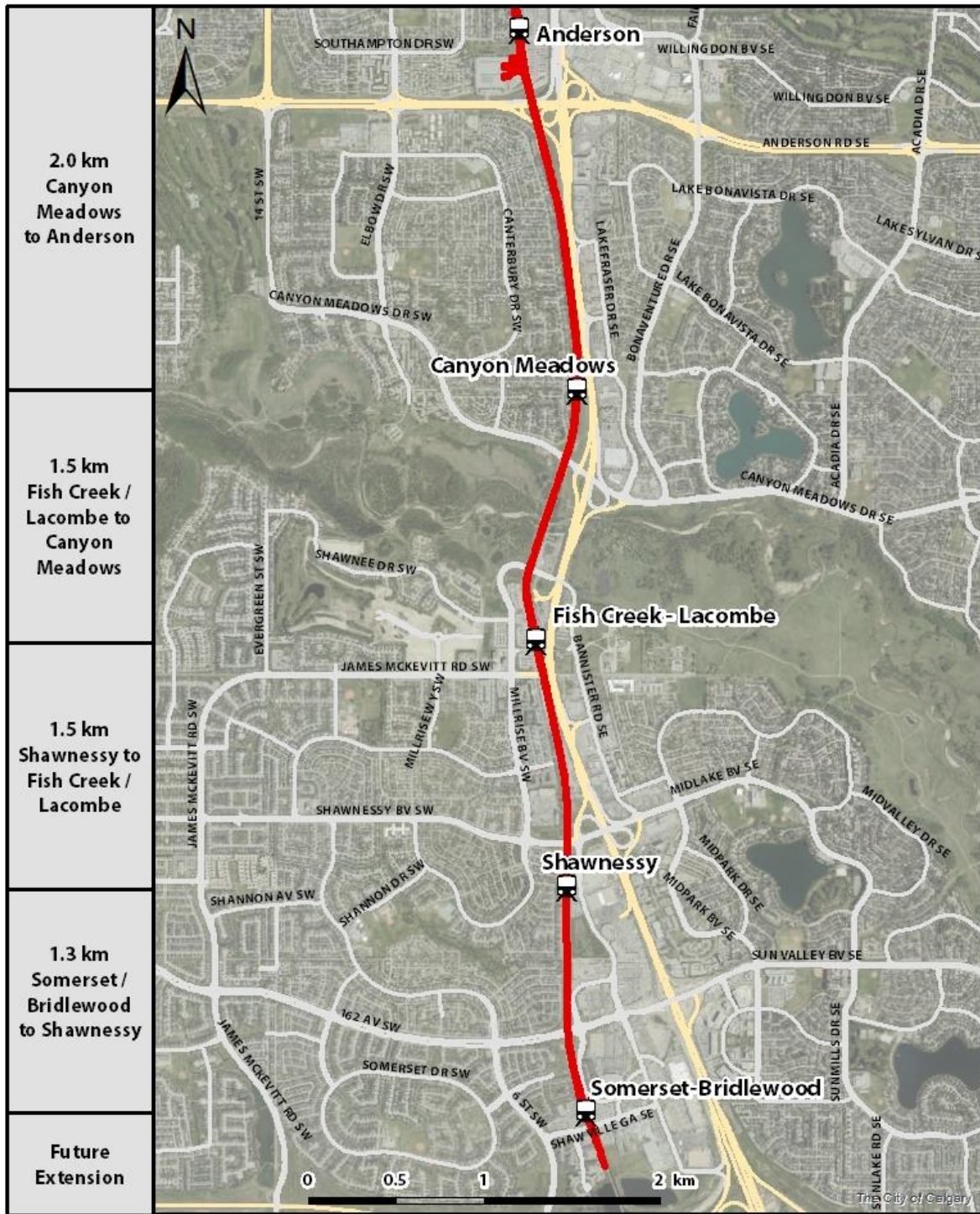
Investigation of the Potential for Infill Stations Along Calgary's LRT System Red Line South

Anderson Station to Chinook Station



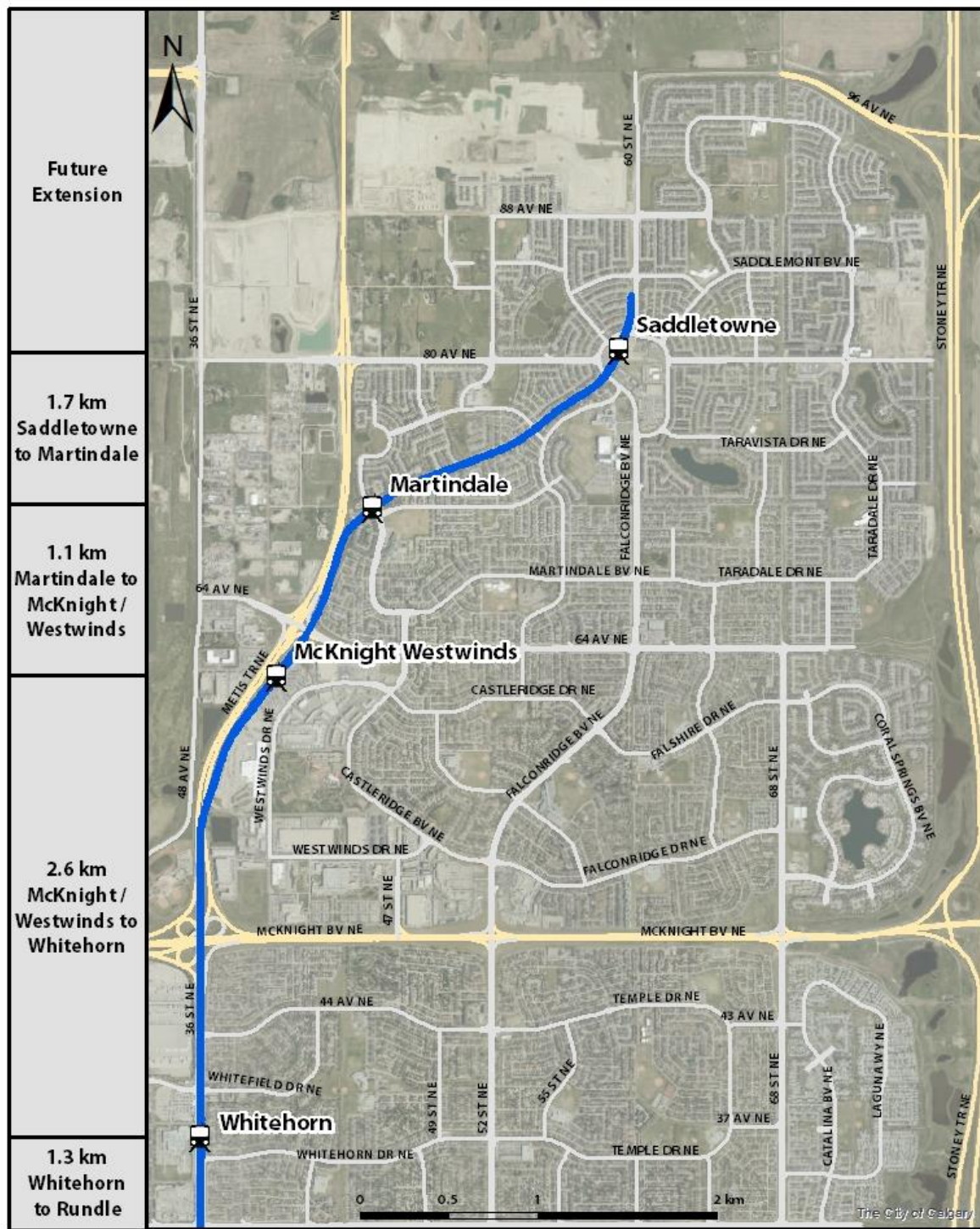
Investigation of the Potential for Infill Stations Along Calgary's LRT System Red Line South

Somerset-Bridlewood Station to Anderson Station



Investigation of the Potential for Infill Stations Along Calgary's LRT System Blue Line NE

Saddletowne Station to Whitehorn Station



Whitehorn Station to Marlborough Station



Investigation of the Potential for Infill Stations Along Calgary's LRT System

Blue Line NE

Franklin Station to City Hall Station



Investigation of the Potential for Infill Stations Along Calgary's LRT System

Blue Line West

69 Street Station to Downtown West / Kerby Station

