Bus Priority Measures in Calgary: Past, Present and Future

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ABSTRACT

Calgary reached several significant milestones in 2009: the city's population exceeded one million people, Calgary Transit celebrated 100 years of operation, and a new long range plan was approved guiding land use and transportation for the next 60 years. The new Calgary Transportation Plan includes a vision of a Primary Transit Network with the highest standards of level of service, operating speed, connectivity and amenities to attract new customers. The Primary Transit Network will support the intensification of population and employment along designated nodes and corridors within the existing developed area of the city. This vision builds on Calgary's past success in operating an efficient, effective transit system in a relatively young western city. Calgary is known for its highly successful light rail transit (LRT) network and extensive bus network. Approximately 70 per cent of LRT passengers in Calgary access the stations via bus. This paper reflects on past bus priority measures in Calgary, such as bus-only crossings, to highlight the effectiveness of transit priority in encouraging travellers to shift to public transit. It details the implementation of more recent traffic control measures providing bus priority through bottlenecks in Calgary, including queue jumps, high-occupancy vehicle lanes, bypass lanes, and transit signal priority. The dedication of $10 million to transit priority measures under the Build Canada Fund highlights the importance of bus priority in traffic operations. Bus priority is integral to Calgary Transit's future plans, including LRT feeder bus networks, on-street bus-rapid transit (BRT), and bus-only facilities.

Background

Calgary is a city of more than one million people located in southern Alberta. Calgary Transit is the owner and operator of public transit in Calgary, and is a business unit within The City of Calgary. For more than 100 years, Calgary Transit has been providing safe, courteous and accessible public transportation to Calgarians.

Calgary Transit operates a fleet consisting of the following:

- 107 community shuttles
- 803 forty-foot buses
- 63 sixty-foot articulated buses
- 153 light-rail vehicles

The light rail transit (LRT) network forms the backbone of the transit system. However, buses remain the workhorse, covering 95% of the city within a walking distance of 400 metres from their residence to a bus stop. Calgary Transit operates 170 routes covering 4,500 km in network length. Bus rapid transit (BRT) lines, consisting of articulated buses operating in mixed traffic with bus priority measures, have been in place since 2004. Three BRT lines now complement the bus network, providing higher capacity limited stop service. Detailed maps of the BRT and LRT networks are available at www.calgarytransit.com.

In 2009, Calgary Transit carried over 94 million passengers. Of the 494,900 daily weekday boardings, 237,600 are carried by bus and 257,300 are carried by LRT. To further illustrate the importance of the bus network, 70% of the passengers on the LRT system travel to and from stations by bus.

Introduction of Bus-Only Crossings

As with other relatively young, western cities, Calgary's streetcars and buses operated mainly in mixed traffic. In the early 1970's, the concept of the bus-only crossing quickly became entrenched in Calgary (McCleary, 1977) The circuitous layout of the University of Calgary street network led to the introduction of a bus-only crossing between one half of the campus and the other. The bus-only crossing was constructed based on a simple principle: the wheelbase of the bus was wider than that of a car or a truck, so a trap could be constructed that would allow a bus through but not a car. A bus trap, similar to Figure 1, was installed at the University. The City of Calgary Transportation Department adopted the same principle to address a similar issue in new communities.

New community planning in the 1970's included road networks that dealt with growing use of private automobiles through guidelines on the "environmental capacity" of collector streets. To limit the increases in traffic on a neighbouring community's collector streets, the streets were often discontinuous between communities.

Most of these communities were being developed at a density insufficient in population or employment to sustain independent transit service at a desirable frequency and hours of operation. Now, in addition to trying to introduce public transit service into a low-density residential community, transportation planners were faced with the compounded problem of long circuitous transit routes. However, the Transportation Department recognized that the same circuitous transit routes and street networks were present in the University where the bus-only crossing had been introduced (McCleary, 1977). The same crossing configuration was introduced in five other new communities in 1977 to allow public transit to continue seamlessly between communities. Figure 2 illustrates a typical bus-only crossing between communities today.

The bus-only crossings were introduced at a low capital cost and resulted in the following benefits: travel time savings for customers, operating cost savings, improved intercommunity travel (by bus, bike or walking) for school, local employment and personal business; and clear priority to public transit investments.

Challenges included cars getting stuck (1.3 per gate per month on average in 1977) with resultant detours for buses, and signage issues.

The bus-only crossing represents the simplest, yet arguably most effective transit priority measure used to date in Calgary.

Bus-Only Crossings Today

Figure 3 illustrates the location of all bus-only crossings in Calgary, including some potential future bus only crossings. Why haven't more been introduced in Calgary's recently developed communities? There are several reasons:

- Improved community connectivity and/or community traffic engineering: the layout of recently-developed communities has not led to the same concerns for short-cutting traffic as existed in the communities developed in the 1970s.
- Focus on rapid transit corridors – transit service between communities has in many cases been consolidated into higher-capacity rapid transit corridors, typically planned as LRT corridors supported by feeder bus networks. An example is shown in Figure 4.
- Freeway/utility corridors have created a wider separation between recently-developed communities. Efforts to install bus-only crossings between these communities have stalled due to the cost of the facility required to cross this distance. Figure 4 also illustrates the Transportation Utility Corridor (Stoney Trail) in Calgary.

One area in which the same principles of bus-only access have been applied is LRT stations. As mentioned previously, approximately 70% of LRT customers arrive at the station by bus. As a result (and in part, vice versa) buses are given priority in station site layout and design. Crowfoot Station opened in 2009 as part of the northwest LRT extension. At this suburban station, community residents adjacent to the station were

concerned with the volume of traffic that would be using collector streets to access large park and ride lots. However, they were generally supportive of providing bus access to the station via the same collector streets. As a result, a bus-only crossing was introduced to provide priority to buses entering and leaving the station area, as shown in Figure 5.

Why is the bus-only crossing welcomed by the same community that is concerned with traffic on its streets? In 1994, Calgary Transit conducted a stated preference survey of its customers and non-users. The results shed light on the value Calgarians see in bus-only crossings. In order of importance, customers most valued the following attributes of public transit:

- service frequency
- travel time
- number of transfers
- fare price

Non transit users identified the following attributes, again in order of importance:

- number of transfers
- travel time
- service frequency
- fare price

Bus-only crossings have a direct impact on both travel time and service frequency (the less circuitous the trip, the more operating hours can be dedicated to additional frequency). Travel time and service frequency happen to be the most sensitive to changes at higher limits, which is typical of the low-density residential communities in which the bus crossings exist. We can conclude our existing customers highly value the benefits bus-only crossings provide (even more than the price of fares, or number of transfers).

Today's bus-only crossings are being designed with a gate rather than a trap, allowing Calgary Transit's community shuttle fleet to use them as well.

Calgary's transportation professionals will be challenged to continue improving the operation of public transit to make the most of our public financial investment. The simple technique of the bus-only crossing promises to be featured in new locations in the future in Calgary.

Bus Priority in Calgary Today

Bus priority measures have played an increasing role in Calgary since the introduction of BRT in 2004. The following bus priority measures have been introduced recently:

- Traffic signal priority
- Transit-only signals
- Bus-only shoulder lanes
- Transit-only and High Occupancy Vehicle (HOV) Lanes

As illustrated in the exhibits and descriptions below, transit priority measures alter the perception of priority on the road for automobile drivers ("I'm not the most important vehicle on the road…") and transit customers ("Hey, we're important!") in Calgary.

Traffic signal priority

Traffic signal priority was already installed at several intersections for use by the Calgary Fire Department for full pre-emption along major routes. In 2000, sixty Calgary Transit buses were equipped with transmitters and receivers were installed at seven intersections. Priority was given to buses through extended green phases and truncated red phases. The initial evaluation of the system showed travel time savings of 15% on the average route travel time, and 30% fewer stops at traffic signals. Buses were also found to have a 9% higher schedule adherence. Additional benefits that were not quantified include lower fuel consumption (approximately 0.2 litres per trip, adding up to thousands of litres per route every year), reduced greenhouse gas emissions, and mechanical benefits from reduced starting/stopping.

Since 2002, all new buses added to Calgary Transit's fleet include traffic signal priority transmitters. There are now 400 buses equipped with transmitters, roughly half the fleet of 40-foot and 60-foot buses (every 60-foot articulated bus has a transmitter). Receivers are installed at an average of eight additional intersections every year. There are currently over 80 intersections with receivers (plus 100 with Fire Department pre-emption).

Traffic signal priority has been deployed on the following routes:

- Route 1 (Forest Lawn/Bowness)
- Route 3 (Elbow Drive/Sandstone) and express buses using the same corridor
- Routes 301, 302 and 305 (BRT routes)

The approximate cost of traffic signal priority is $20,000/intersection. This varies depending on the condition of existing infrastructure and cost sharing opportunities. Transmitters have typically cost $2,000 per bus.

$1.5 million will be invested in traffic signal priority in Calgary over the next five years. Calgary Transit will soon switch to LED emitters on buses (resulting in longer bulb life and less degradation of signal strength over bulb life). In the future, the systems will be integrated with on-board equipment to provide "smart" priority, including assignment by route and location.

Transit only signals

Transit-only signals were first installed in 2008 at two locations: north and southbound on 10 Street at 16 Avenue NW, and northbound on 52 Street at Marlborough Drive NE.

A white-bar signal is used to give buses an advanced green (approximately five additional seconds). This additional time allows buses to pull away from their near-side stops and proceed through the intersection ahead of general purpose traffic. A transit-only signal was also introduced on Parkdale Boulevard at Kensington Road in 2009 (see queue jumps, below).

Generally, the signals are activated by video detection (two visual loops pointed at bus stop, both must be occupied for the signal to be activated). Benefits are significant: the operation reduces delay, improves schedule adherence (particularly during peak periods), and clearly highlights to the public the priority assigned to public transit.

The cost of the signals is relatively low (camera for detection, new signal head, signage), but costs depend on the condition of existing infrastructure.

Bus-only shoulder lanes

A bus only lane was implemented on the shoulder of Crowchild Trail, a congested expressway, in 2008. The bus-only lane is 1.5 km long, approximately equal to the length of peak period queues on the expressway. Calgary Transit buses operate at reduced speed in this lane, and only use it when there is a queue on the expressway. Benefits include elimination of service delays and improved schedule adherence on three busy routes during peak periods (16 buses per hour), and travel time reductions of up to 15 minutes.

Queue jumps

Bus-only queue jumps have been installed at the following intersections:

Kensington Road / Parkdale Boulevard NW (Figure 6)

- This is a previously unsignalized intersection where buses make a left turn across two lanes of heavy commuter traffic. There are considerable delays as left-turning general-purpose vehicles try to find gaps.
- In 2009, the median on Parkdale Blvd was modified to create a separate left turn bay for buses, and a half signal was installed to stop westbound vehicles and give a green turn arrow to the waiting bus.
- When the bus arrives at the intersection, it is detected by a video camera, and an immediate amber signal (followed by a red signal) is given to opposing vehicles. The bus proceeds within eight seconds of arrival.
- Route 1 and the Route 305 BRT save an average of 90 seconds in the peak periods (10-15 buses per hour).

Parkdale Boulevard / 29 Street NW

- Buses are able to use the westbound right turn bay for through movement.
- With minor curb modifications on the northwest corner of the intersection, the bus can bypass the queue of general-purpose vehicles in the underutilized right turn lane, and proceed into the far-side bus bay.
- There is no transit-only traffic signal. The bus proceeds on green with general-purpose westbound traffic.

5 Avenue flyover at Memorial Drive NW (Figure 7)

- Buses can enter the queue jump lane from a free-flow right turn lane.

10 Street at 16 Avenue NW (Figure 8)

- Buses can use a right turn lane to bypass queues in through lanes and proceed into a near side bus stop (on a pork-chop island separating the right-turn movements).
- Buses receive an advance green signal which allows them to pull into the intersection and merge into the curb lane (there is no separate receiving lane).

Transit-only lanes

A transit-only lane was installed at Shepard Road and 85 Street SE, one of the transit priority measures implemented for the new Southeast BRT, Route 302, which entered service in September 2009. The bus initially encountered a difficult left turn from eastbound 85 Street, which "T's" into Shepard Road. Shepard Road is a higher speed facility and traffic is free flow in the northbound direction. A full traffic signal installation would have been costly due to nearby overhead power lines, and it would also have attracted more general traffic onto 85 Street. This would have resulted in the need for additional bus priority measures. A protected left turn lane was installed for exclusive use by buses at a cost of approximately $30,000. Now buses are only required to wait for a gap in the southbound flow (which is metered by an upstream signal). This installation is shown in Figure 9.

Similar transit-only lanes have been installed as means of access into bus terminals (BRT and at LRT stations) and others are planned in the future.

Arterial HOV lane

An arterial HOV lane and lane reversal was implemented on Centre Street south of 20 Avenue N in 2000 (Figure 10). Express buses, local buses and the Route 301 BRT all operate in the curb lane along with HOV traffic. Several modified-width bus bays were constructed to allow express and BRT buses to pass buses at local stops. In peak periods, the curb lane in the peak direction is limited to buses, cars carrying two or more passengers, and bicycles. There are several challenges with this installation:

enforcement is difficult, off-peak traffic is growing, and customers on buses in off-peak directions are faced with significant delays.

The corridor is the heaviest-travelled bus corridor in Calgary, with approximately 55-60 buses in the peak direction in the peak hour (with 20 buses per hour in the off-peak direction). Conflicts with general purpose traffic (HOV or single-occupant) are resulting in significant delays to bus customers, leading to pressure to create transit-only lanes on the corridor. The corridor is likely one of the first bus corridors to feature "Primary Transit Service", as described below.

Bus Priority in Calgary's Future

In 2009, Calgary's City Council approved a new integrated land use and transportation plan, the Municipal Development Plan (MDP) and Calgary Transportation Plan (CTP). These were developed over the previous two years in a process branded "Plan It Calgary". These documents guide land use planning and transportation decisions in Calgary.

Early in the Plan It Calgary process, City Council adopted the Sustainability Principles for Land Use and Transportation. These principles guided the development of the integrated plans. The principles are:

1. Create a range of housing opportunities and choices
2. Create walkable environments
3. Foster distinctive, attractive communities with strong sense of place
4. Provide a variety of transportation options
5. Preserve open space, agricultural land, natural beauty, and critical environmental areas
6. Mix land uses
7. Strategically direct and manage redevelopment opportunities within existing areas
8. Support compact development
9. Connect people, goods and services locally, regionally and globally
10. Provide transportation services in a safe, effective, affordable and efficient manner that ensures reasonable accessibility to all areas of the city for all citizens
11. Utilize green infrastructure and buildings

Subsequently, Council approved the eight Key Directions for Land Use and Mobility that were used to develop the MDP and CTP. These are:

1. Achieve a balance of growth between established and greenfield communities
2. Provide more choice within complete communities
3. Direct land use change within a framework of nodes and corridors

4. Link land use decisions to transit
5. Increase mobility choices
6. Develop a Primary Transit Network
7. Create Complete Streets
8. Optimise infrastructure

Based on these principles and key directions, a new transit vision to guide long-term decisions (30 years) was developed for Calgary. The new vision recognizes the need for substantial improvements in the frequency, speed, comfort, reliability, convenience and safety of public transit service in order to make public transit the *preferred mobility option for Calgarians.* Transit investments are seen as key to supporting the land use intensification envisioned in the MDP. At the same time, sustaining the delivery of transit service depends on increasing ridership. The CTP proposes the creation of an integrated family of transit services, including a base transit network (providing good coverage and a basic level of service throughout the city), connections to municipalities in the Calgary region through a regional transit network, and a Primary Transit Network (a well-connected, high frequency network supporting intensified land use in activity centres and corridors). The Primary Transit Network is shown in Figure 11.

The Primary Transit Network is built on two types of service:

- skeletal network of existing and proposed LRT lines
- network of other radial and cross-town services that operate in dedicated rights of way, HOV lanes, and/or mixed traffic, with priority over automobiles. Transit service will likely begin with buses on these corridors, transitioning to higher capacity rail transit based on future corridor development and travel demand.

Service on any part of the Primary Transit Network will be defined by the following attributes:

- Frequency – 10 minutes or better, 15 hours a day, 7 days a week
- Speed and directness – a range of transit priority measures will be implemented, with a “transit-first” philosophy
- Service reliability – services will operate within 3 minutes of scheduled arrivals
- Capacity – sufficient capacity must be provided to accommodate ridership demand, through frequency and selection of appropriate vehicles

There is a key role for bus priority in delivering this vision. Transit priority measures used today in Calgary will be expanded to improve speed, directness and service reliability. As suggested above, buses will remain the workhorse of the system. Bus priority to improve operations in mixed traffic will enable the introduction of Primary Transit service in the near future, just as it has enabled Calgary’s successful public transportation delivery in the past.

ILLUSTRATIONS AND TABLES

REFERENCES

Bus Only Gates. Roads and Transportation Association of Canada Annual Conference, 1977. R.E. McCleary
Calgary Municipal Development Plan, 2009.
Calgary Transportation Plan, 2009.

Figure 1. Bus-Only Crossing Trap

Figure 2. Bus-Only Crossing

Figure 3. Bus-Only Crossings in Calgary

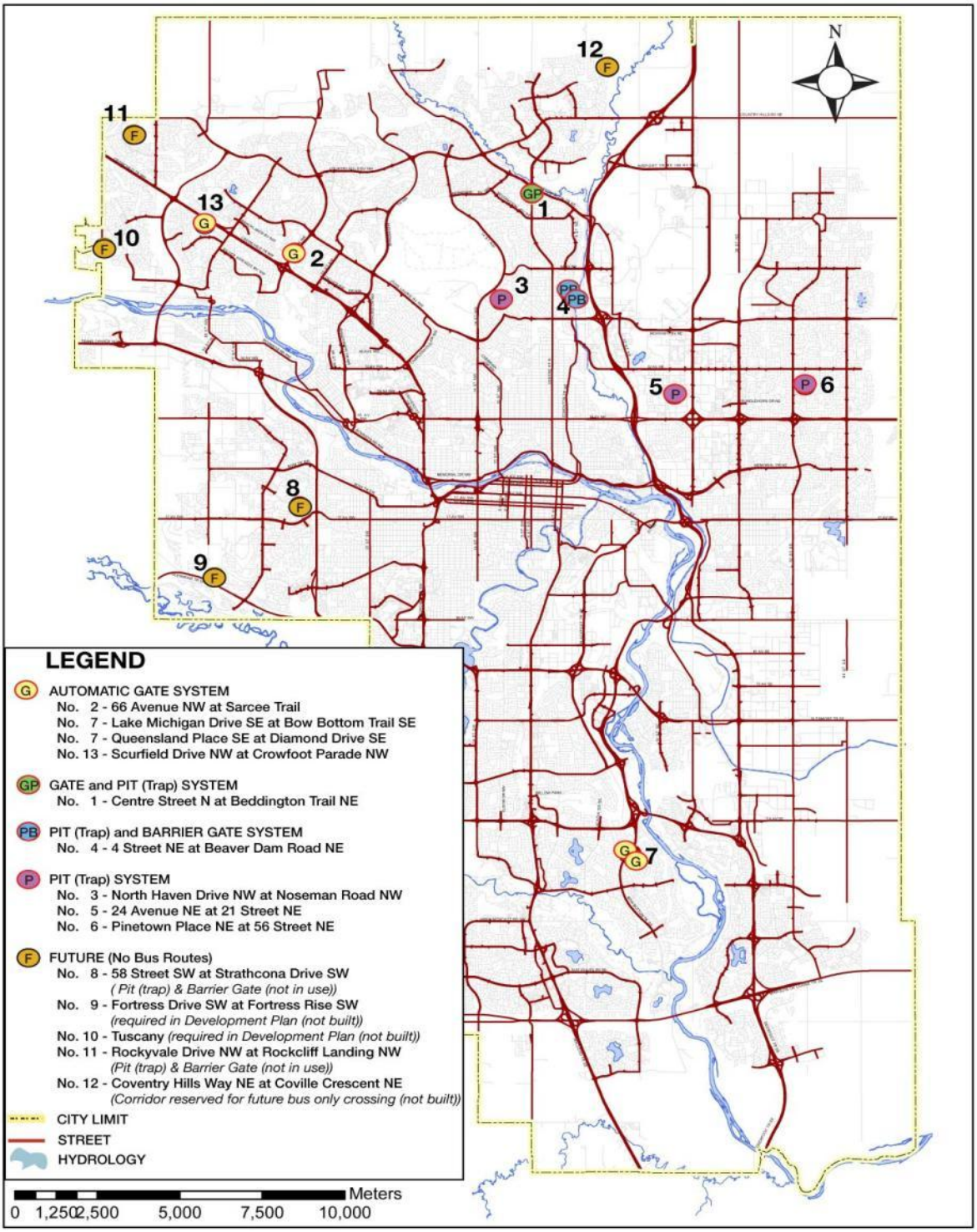


Figure 4. Rapid Transit Corridor in Northwest Calgary

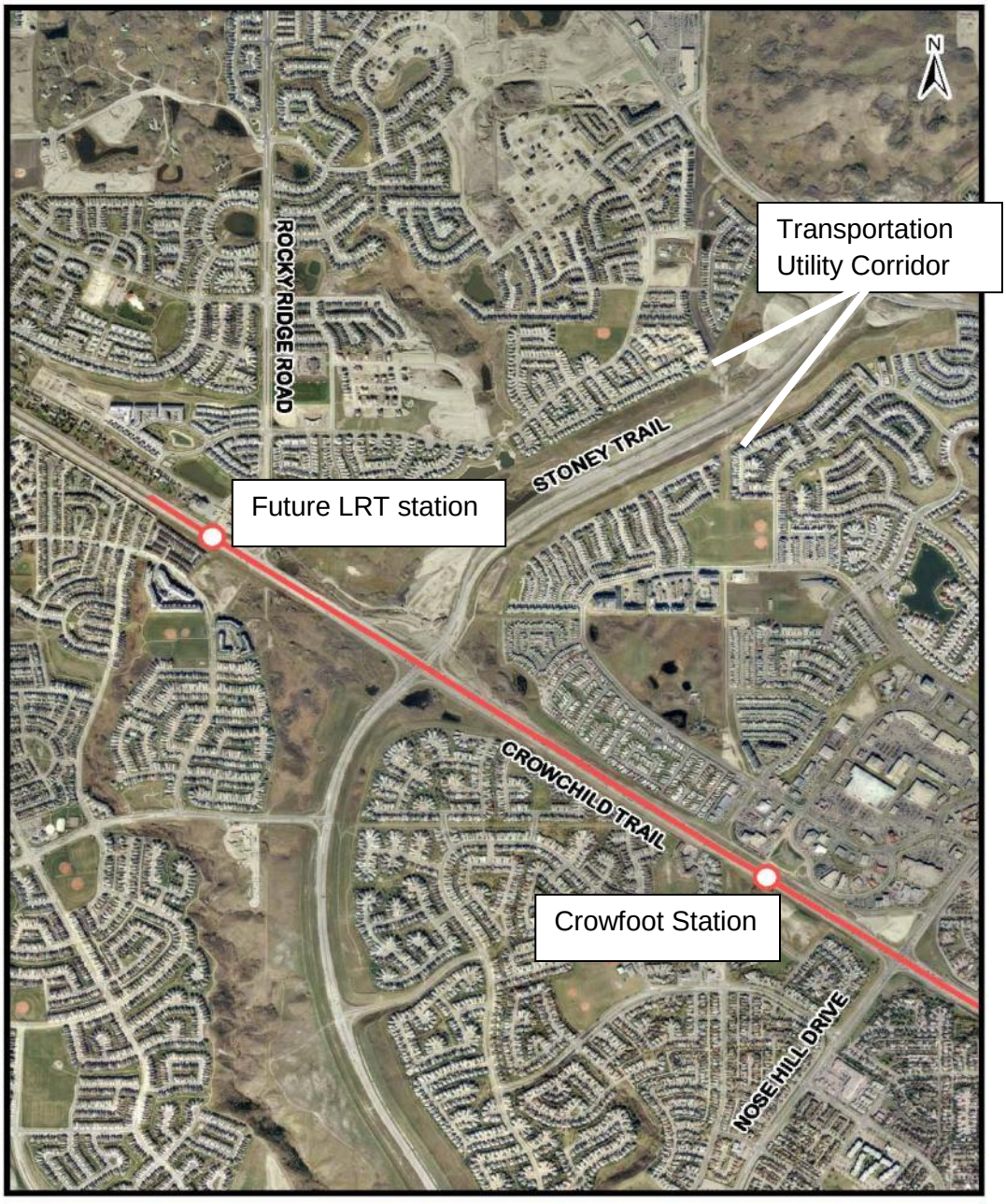


Figure 5. Crowfoot LRT Station Bus-Only Crossing

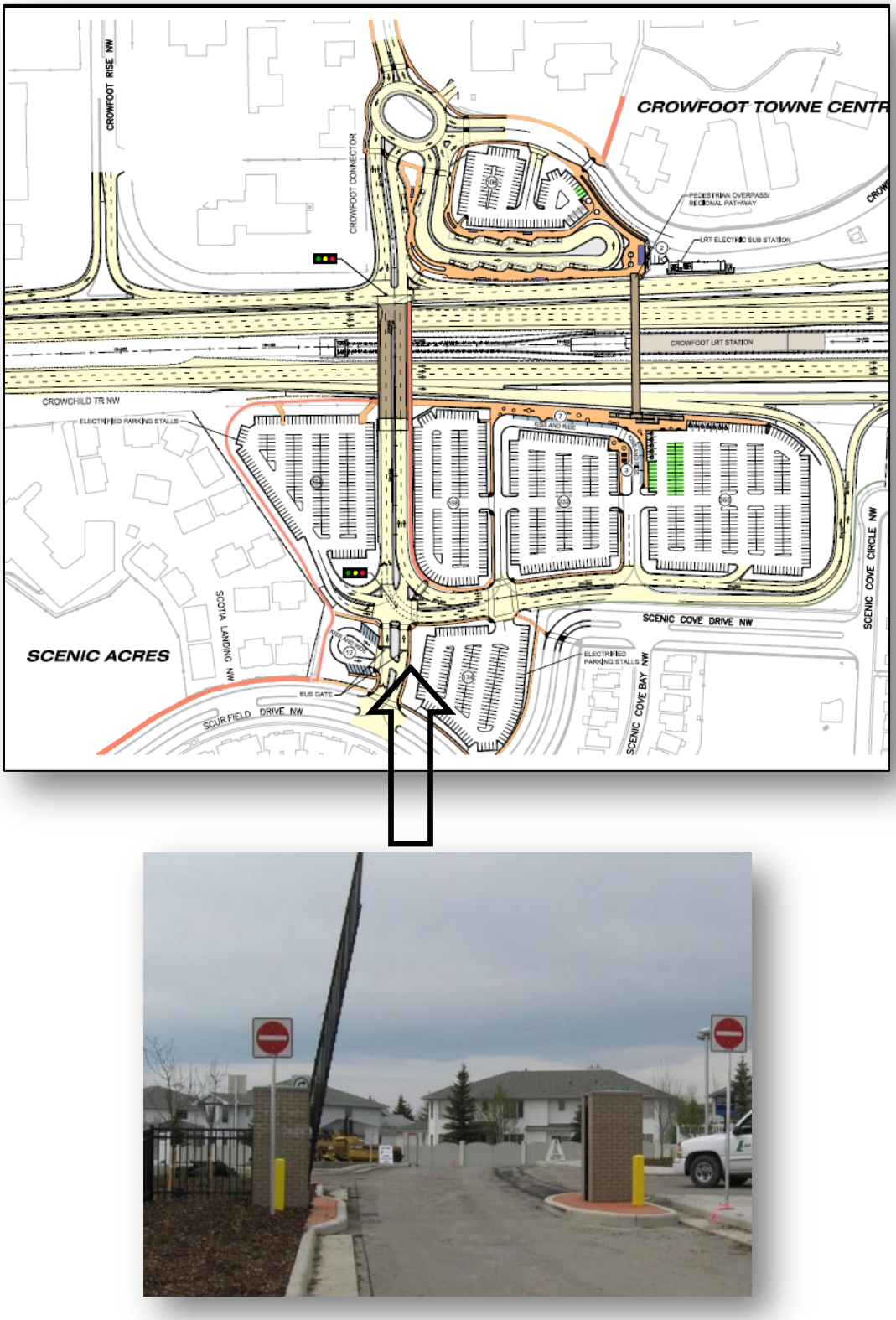


Figure 6. Kensington Road Queue Jump

Figure 7. 5 Avenue Flyover Queue Jump

Figure 8. 10 Street/16 Avenue NW Transit-Only Signal

Figure 9. Shepard Road/85 Street SE Transit-Only Lane

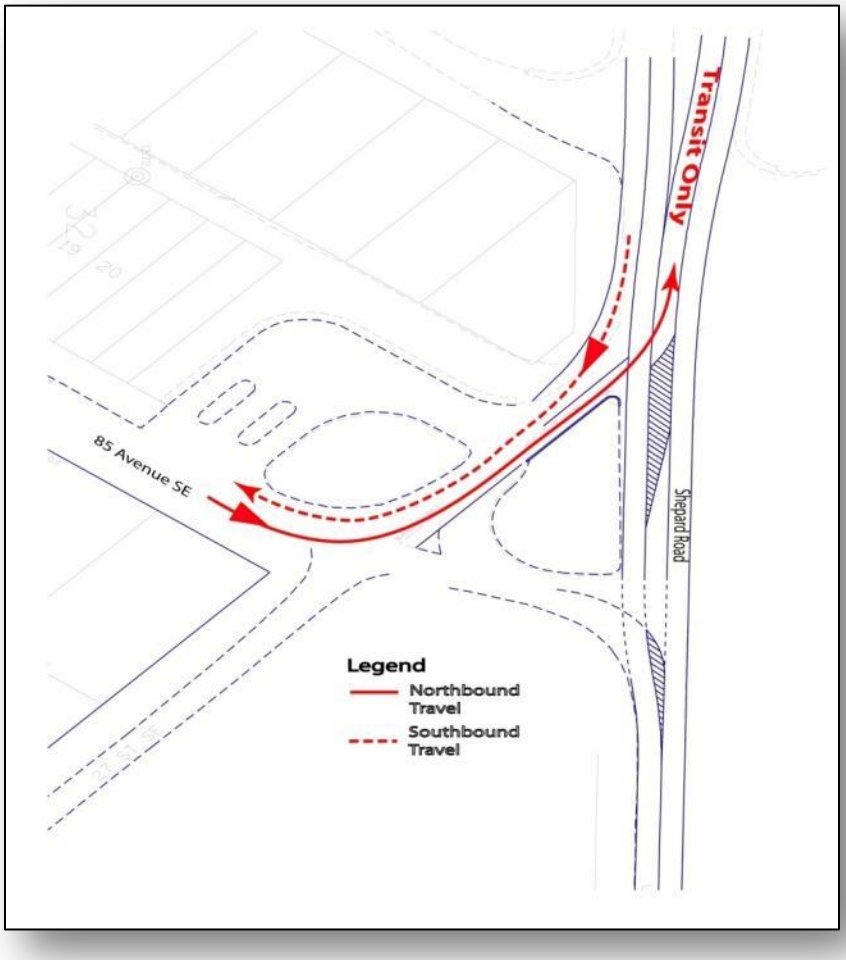
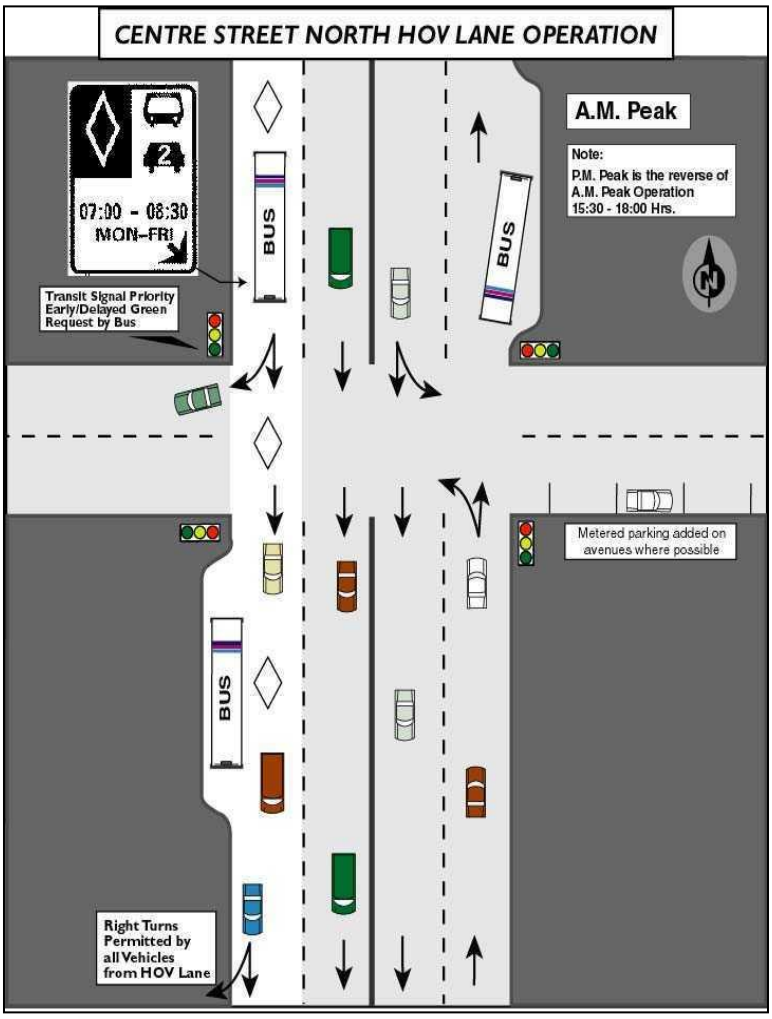
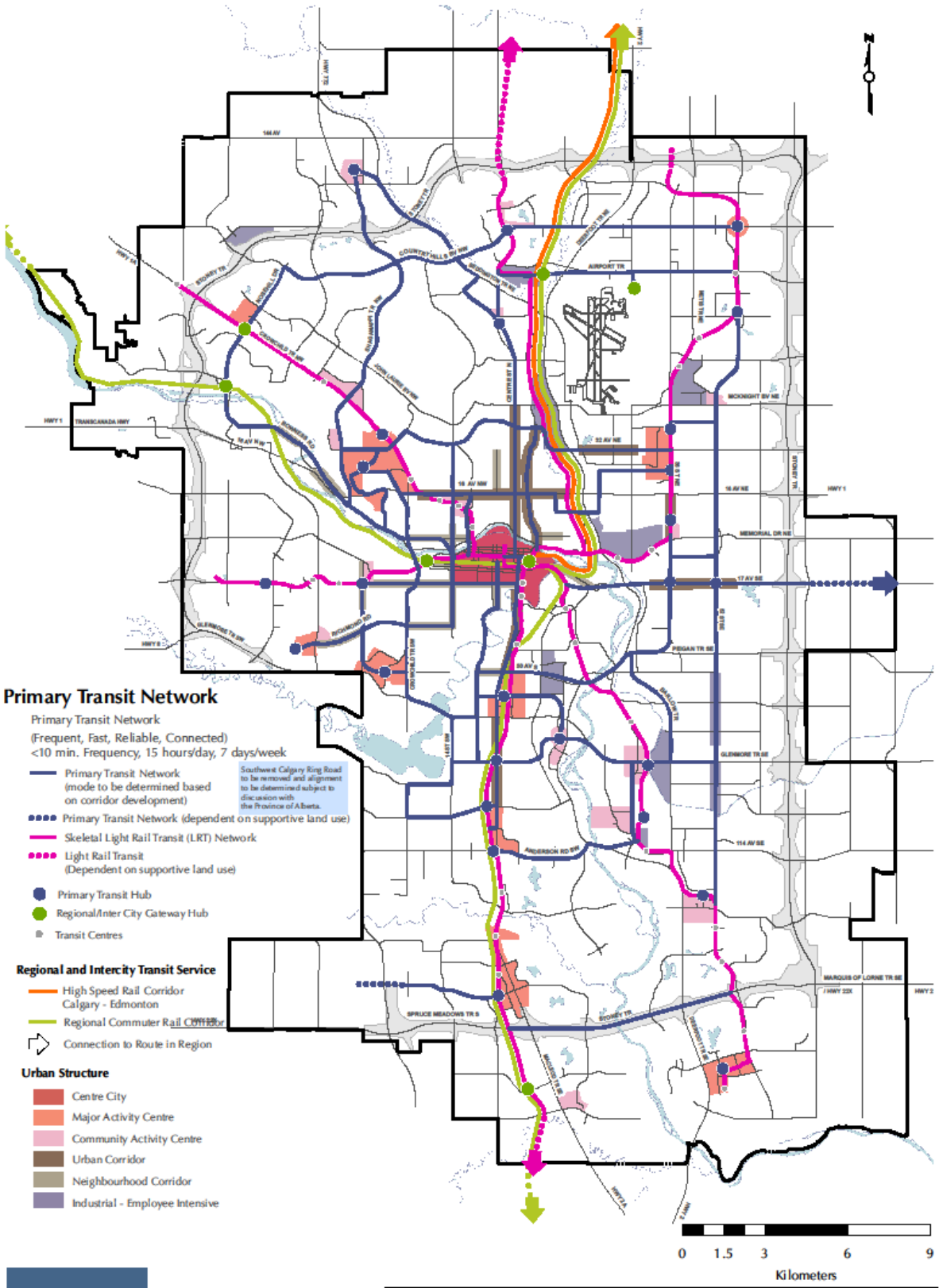


Figure 10. Centre Street HOV Operation



12. CTP Primary Transit Network



This map represents a conceptual land use structure and transportation networks for the city as a whole.
No representation is made herein that a particular site use or City investment, as represented on this map, will be made.
Site specific assessments, including environmental contamination, as well as the future financial capacities of the City of Calgary must be considered before any land use or City investment decisions are made.

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Primary Transit Network

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