



Calgary South West BRT Functional Planning Study



Calgary SW BRT Functional Planning Study - Project Summary

This functional planning study was initiated to determine if a simple, cost-effective solution could be developed and implemented to improve transit access to the southwest area of Calgary, particularly the residential areas south of Glenmore Reservoir. In addition there are several major nodes along the route including Rockyview Hospital and Mount Royal University which would benefit from greater levels of service and connectivity.

The study did not look at major capital infrastructure solutions to the issues at the 14 St SW and Crowchild interchanges with Glenmore Trail, nor did it consider major grade separations or dedicated lanes along Crowchild Trail or in the downtown. While these types of infrastructure investment may be necessary in the future the aim with this study was to solve the less complex problems, use existing infrastructure more effectively and make selective investments, reflecting budget limitations, in the corridor which would provide major benefits.

Options that were considered and evaluated include extending the successful shoulder lane operation that is current in place on the north end of Crowchild Trail, traffic signal priority at intersections, and widening 14 St SW to provide dedicated transit lanes in a segregated facility between Rockyview Hospital and Southland Drive.

Unlike traditional reports, the work for this study was undertaken as a series of technical memorandums summarizing the work completed on a specific issue. The memos have been compiled into a single "report" for convenience. The set includes 6 memos:

- Station Locations
- 14 Street SW Operation Comparison
- Traffic Analysis of 14 Street SW Corridor
- Potential Crowchild and Glenmore Trail Shoulder Lane Usage
- Potential Terminal Operations in Woodbine
- Order of Magnitude Cost Estimate

In addition a set of functional planning drawings for the 14 Street SW preferred operational arrangement were prepared. They are attached to the Operation Comparison memo.

Public consultation was held to inform the public of the work and to gather feedback on the preferred alternative. A series of four public open houses were held in November 2010 at four separate venues in the corridor. In addition a brochure was developed illustrating the major highlights of the functional planning work. The brochure was distributed...

STATION LOCATIONS

Prior to this study, the City of Calgary had prepared a conceptual plan for this route. Using the conceptual station locations as a starting point, Delcan assessed the locations based on a set of criteria including current and future ridership demand, sufficient right-of-way, operational feasibility and the ability to integrate with conventional transit service.

The functional plan recommends a downtown loop with seven stations. The loop starts at the West Village/Sunalta Station area and uses 9 Avenue SW, 1 Street SW and 6 Avenue SW to enter downtown and return to the West LRT interconnection point.

Along Crowchild Trail stations are proposed at:

- 17 Avenue SW,
- 26 Avenue SW,
- 33 Avenue SW,
- Dieppe Avenue Pedestrian Bridge, and
- Flanders Avenue SW.

The route leaves the Crowchild Trail to serve Mount Royal University and the Lincoln Business park with station on campus and on 50 Avenue SW west of Crowchild Trail.

The route returns to Crowchild Trail and uses Glenmore Trail to access 14 Street SW where stations will be constructed at Rockyview Hospital, Heritage Drive SW (and Heritage Park) and 90 Avenue SW (at Glenmore Landing). Turning west on Southland Drive, stations are proposed at the Southland Leisure Centre and at 24 Street SW.

The alignment turns south on 24 Street SW with stations at Oakfield/Braeside, Woodview Drive SW and a terminal station near Woodbine Park.

The stations are positioned to allow other transit routes to connect into the corridor and provide simple connections for transferring passengers. The Mount Royal University station will also be integrated into a transit centre to be constructed on the east side of campus.

14 STREET SW OPERATION COMPARISON

Three potential options for BRT operation along 14 Street SW between Glenmore Trail and Southland Drive were reviewed. The analysis favours implementation of dedicated transit lanes along the west side of 14 Street SW for a number of reasons, including:

- The majority of the activity along 14 Street SW is on the west side of the street including Rockyview Hospital, Heritage Park and Glenmore Landing,
- Avoids impacts to the utility corridor on the east side of 14 Street SW,
- Has less impact on major intersections (especially 90 Avenue SW), and
- Is the most supportive of future development plans.

The analysis looked at a range of factors from development and traffic impacts to utility and operational impacts. Pedestrian accessibility and safety were considered along with the ability to connect to local transit routes. Major stakeholders were consulted during the development and analysis of the plans.

TRAFFIC ANALYSIS OF 14 STREET SW CORRIDOR

Analysis of the key intersections along the corridor, including the impacts at the ends of the busway where vehicles enter and exit the dedicated lanes, were undertaken using Syncho and Simtraffic. The objective was to determine if the traffic conditions would be impacted by the project.

While some of the intersections posed challenges for the software, the analysis did provide enough guidance to allow for evaluation of potential impacts. Engineering judgement was used to supplement the analysis, determining that the busway would have a negligible impact on service levels along 14 Street SW while providing substantial time savings and reliability improvements for transit.

Recommendations for further traffic work in the next stage, when the project is more clearly defined, include an analysis of the 14 Street SW/75 Avenue SW/Rockyview Hospital intersection where a short west approach must handle buses merging with general left turning traffic, and an analysis of the 14 Street SW/Heritage Drive SW intersection where the busway will cross the west leg of the intersection immediately west of the existing intersection. Analysis to date indicates that neither of these locations have insurmountable issues however more analysis is needed to confirm operational requirements.

POTENTIAL CROWCHILD AND GLENMORE TRAIL SHOULDER LANE USAGE

Expansion of the successful shoulder lane operation on Crowchild Trail was reviewed. For much of the length of Crowchild Trail south of 17 Avenue SW to just north of Glenmore Trail there is potential to provide shoulder lane service. There are some minor works that would need to be done to widen or standardize the shoulder width, however these can be implemented at a relatively low cost.

The shoulder lanes would provide stop locations along Crowchild Trail, and would be available for buses to bypass congested traffic conditions as necessary.

POTENTIAL TERMINAL OPERATIONS IN WOODBINE

The SW BRT service will terminate in the Woodbine area of SW Calgary. At the terminal station, buses will turn back for another trip into the downtown, and will need to layover to wait for their departure time. The two parks straddling 24 Street SW, just north of Woodpark Boulevard SW provide an opportunity for the terminal station facilities and may provide opportunities for community Park and Ride.

A series of options were developed however only two provide an efficient terminal operation with minimal community impacts. The two are:

- Option 1 – Community Loop, would use existing roadways to create a one-way loop. This option would introduce transit service on four blocks of Woodview Drive SW that currently do not have transit service today. The loop however could have additional

stops which would increase coverage and ridership. This option has the lowest required investment and the greatest future flexibility.

- Option 3 – Southeast Park Loop, requires additional investment to create the loop, but offers much the same level of operational flexibility.

It is recommended that both of these options be carried forward into the next design stage to determine the most advantageous option to serve the areas adjacent to the park.

ORDER OF MAGNITUDE COST ESTIMATE

The proposed SWBRT route is approximately 20 km long (one-way) and involves a dedicated busway for an approximate length of 3.3 km and operates on the existing travel lanes or paved shoulder for the remainder of the route. The route is planned to service 35 bus stations that includes two bus stations for northbound and southbound service at fourteen locations, one terminal station in Woodbine and six bus stations within the downtown core. The major capital cost elements included in the estimate are:

- A dedicated new busway along the west edge of the 14 Street SW from Southland Drive SW to 75 Avenue SW,
- Re-alignment of a portion of the 14 Street Roadway to accommodate the busway within the existing ROW,
- An underpass structure for busway at 90 Avenue SW / 14 Street SW Intersection,
- Pathway connecting pedestrian crossing over 14 Street SW (located on North of Anderson Road) to Heritage Drive SW,
- 14 Street intersection modifications, and
- Bus stations.

The approach taken to estimate the construction cost included determination of the approximate quantity for major cost items based on the current conceptual plan for SWBRT and applying the appropriate unit costs. The items that could not be quantified due to the lack of necessary information are estimated on a lump sum basis. The unit costs used in the estimate represent current (2010) industry prices in Alberta.

The cost estimate projects a capital cost of approximately \$39,994,000. This cost includes contingencies and is accurate to +/- 40%.

CONCLUSIONS

The SW BRT project presents an opportunity to provide a high quality transit service to the southwest are of Calgary at a reasonable cost. The functional planning work undertaken confirms the conceptual planning findings, that there are substantial benefits to implementing a bus-based solution for this corridor.

The plan relies on a mix of measures from signal priority to shoulder lanes on Crowchild Trail and a segment of dedicated busway along 14 Street SW from Rockyview Hospital to Southland Drive. The project does not solve all of the traffic issues along the corridor, nor does it find a technical solution that solves the issues related to Glenmore Trail however it

does indicate that a corridor can be developed which will provide substantial travel time savings, link communities and activity centres, and promote transit usage.

The route provides enhanced transit connections for the major activity centres and provides a direct service to Mount Royal University from the South LRT. When combined with other local routes, the improvements recommended will provide benefits beyond the immediate corridor.

There is, in our opinion, sufficient benefits and opportunities to warrant further design and implementation of the project.

Calgary SW BRT Functional Planning Study - Station Locations

This memorandum outlines the preferred station locations along the Calgary SW BRT route based on previous work the City of Calgary has undertaken, which identified:

- Sufficient ridership demand;
- Sufficient future ridership demand;
- Sufficient right-of-way width;
- Operational feasibility; and
- Ability to integrate conventional transit service.

The route has been separated into five sections corresponding to the different road sections the route travels. These sections from north to south are: Downtown Core, Crowchild Trail, 14 Street SW, Southland Drive SW and 24 Street SW. The proposed station locations are shown on Figure 1 below.

Prior to this SW BRT Functional Planning Study, the City of Calgary had prepared background information including preliminary conceptual planning for this route. The station locations envisioned by the City were used as a starting point for this memorandum.

BRT service typically provides travel time savings through the provision of transit priority and limited stop bus service. Limited stops with larger distances between stations provides for a more express service operation than conventional bus service. This distance is typically between 600 metres and one kilometre, however it may vary depending on adjacent land uses and density as well as other geographical features.

Downtown Core

A loop is proposed for downtown, operating in curbside general traffic lanes travelling eastbound on 9 Avenue SW from Bow Trail to 1 Street SW, northbound on 1 Street SW to 6 Avenue SW and then westbound on 6 Avenue SW to Bow Trail. Since the downtown core is an established area, the existing transit stops will be utilized in all cases. The downtown stops will also provide multiple locations to integrate with the LRT along 7 Avenue SW. The downtown stops and locations should be reviewed at implementation to avoid conflicts with conventional transit service, such as timing or lay-by locations which will impact BRT operations. Integration with the future West LRT service will be possible at the future Sunalta Station.

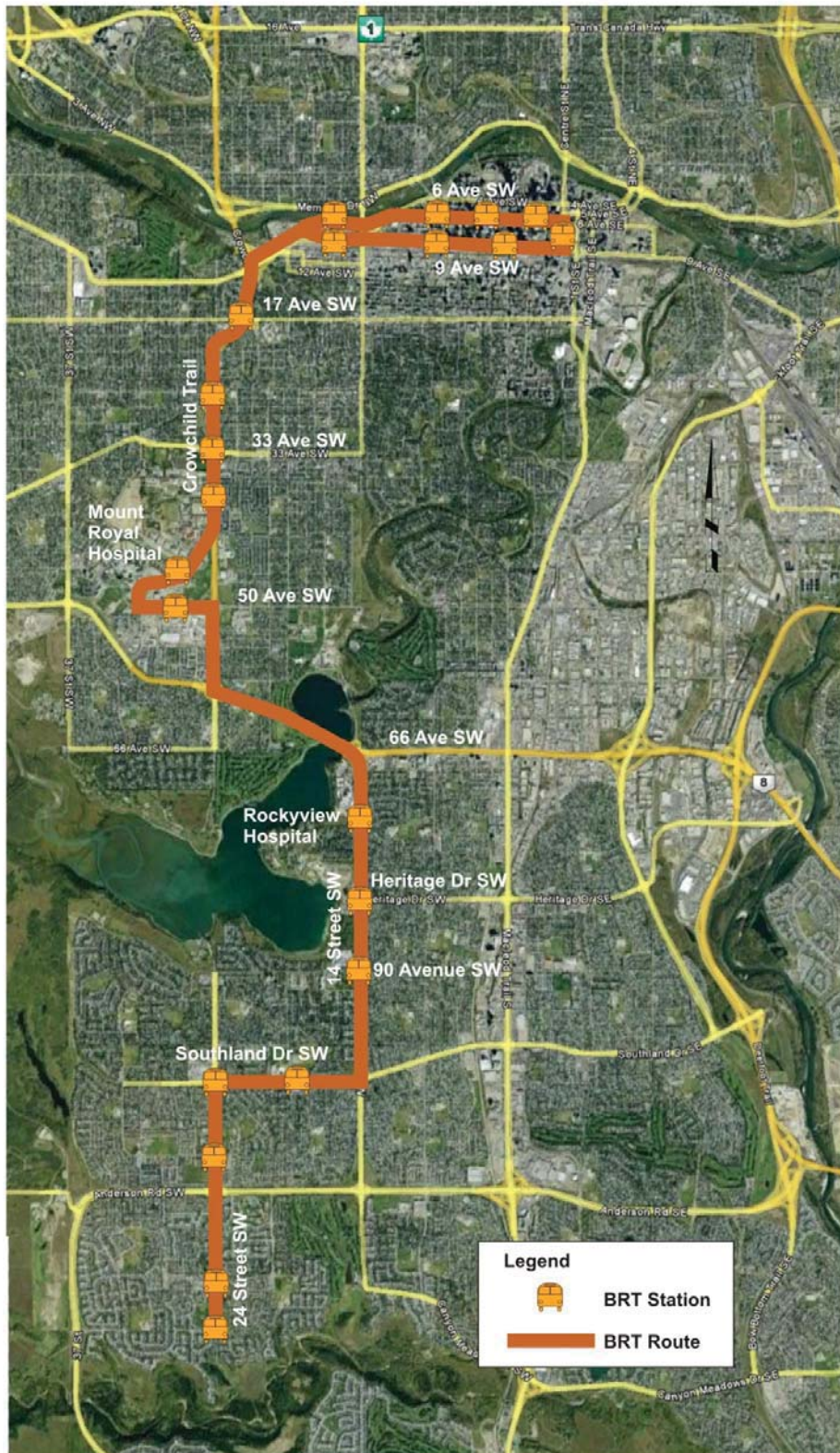


Figure 1 – Route and Station Locations

Eastbound service is proposed at four locations:

- **16 Street SW at 9 Avenue SW.** As the BRT service takes the Bow Trail SW into the downtown core there is an opportunity to provide an integration point with the West LRT service near 16 Street SW (adjacent to the Greyhound Station) in the area of an existing pedestrian bridge. This stop would also provide a connection to the Sunalta Station of the future West LRT and ultimately be integrated with the Downtown West Village, a future redevelopment of the area west of downtown. There is an existing bus stop just east of the pedestrian bridge on 9 Avenue SW that could be used for this location.
- **9 Avenue SW at 9 Street SW,** using the existing regular service stop.
- **9 Avenue SW at 5 Street SW,** using the existing regular service stop.
- **1 Street SW at 8 Avenue SW,** using the existing regular service stop south of the intersection. This stop provides for adequate distance for the transit vehicles to merge into the left lane to facilitate a left turn onto 6 Avenue SW.

These stations yield a spacing of:

- 1,000m between 9 Avenue SW / 16 Street SW and 9 Avenue SW / 9 Street SW,
- 700m between 9 Avenue SW / 9 Street SW and 9 Avenue SW / 5 Street SW, and
- 700m between 9 Avenue SW / 5 Street SW and 1 Street SW at 8 Avenue SW.

Westbound service is proposed at four locations:

- **6 Avenue SW at 2 Street SW,** using one of the regular service stops on either side of 2 Street SW.
- **6 Avenue SW and 6 Street SW,** using one of the regular service stops on either side of 6 Street SW.
- **6 Avenue SW and 9 Street SW,** using one of the regular service stops on either side of 9 Street SW.
- **West Village/Sunalta,** to integrate with the West LRT. In order for this to be accomplished the BRT would exit at 14 Street / 15 Street SW and continue south of the Greyhound Terminal. A station can be located on the south side of the terminal as close to the pedestrian overpass as possible. The service can then travel north on 16 Street SW to access Bow Trail SW.

These stations yield a spacing of:

- 400m between 1 Street SW / 8 Avenue SW and 6 Avenue SW / 2 Street SW,
- 575m between 6 Avenue SW / 2 Street SW and 6 Avenue SW / 6 Street SW,
- 525m between 6 Avenue SW / 6 Street SW and 6 Avenue SW / 9 Street SW, and
- 1,200m between 6 Avenue SW / 9 Street SW and West Village/Sunalta.

The station spacing is less than the preferred 600m distance however since the downtown core is quite dense this spacing is acceptable. The larger spacing out to the Greyhound

Terminal is acceptable seeing the purpose of this station is to provide an integration point with the West LRT service before the SW BRT service continues southbound on Bow Trail.

At all existing bus stops proposed to be used for the SW BRT service, there are a number of opportunities to transfer to other Calgary Transit routes.

The possibility of inserting HOV lanes in this section was not pursued, as directed by the City, however future work will need to consider opportunities such as banning parking in certain sections on 6 Avenue SW and / or 9 Avenue SW or creating longer bus bays or adding in specific stops for only the SW BRT service, as required.

Crowchild Trail

Crowchild Trail operates predominately as an expressway, providing high speed limited access operation. Ideally the proposed BRT service will be brought off Crowchild Trail at station locations using on/off ramps in order to provide customers with greater visibility and access at stations. While this approach is possible towards the south end of Crowchild Trail, the limited number of access points north of Flanders Avenue requires that the BRT stations be located on curbside of Crowchild Trail, with improved access and passenger amenities (with the exception of 33 Avenue where those facilities already exist).

There are seven proposed stop locations in the Crowchild Trail portion of the corridor:

- 17 Avenue SW.**
 There would be a significant impact to travel time if the SW BRT service was taken off Crowchild Trail at 17 Avenue SW due to the existing ramp arrangement. It is recommended that the BRT station be located on Crowchild Trail north of 17 Avenue SW. This location removes the stations from the movements associated with the



Figure 2: Crowchild Trail at 17 Ave SW

on/off ramps which are located south of the overpass. Construction of a fully accessible pedestrian ramp on the east side would be required to bring passengers from 17 Avenue SW down to Crowchild Trail. On the west side (for the southbound station) there is currently a staircase however improvements to visibility and lighting of this access should be undertaken at this location.

- 26 Avenue SW.**
 There is no access from Crowchild Trail to / from 26 Avenue SW therefore the service does not have an opportunity to use ramps at this location. There are two station options for this location, one is to reuse the existing stop locations under the 26 Avenue bridge, and the other is to locate the station at the pedestrian overpass (250 metres north of 26 Avenue SW).



Figure 3: Crowchild Trail at 26 Ave SW

The decision will be based on determination of local or area need. As 26 Avenue SW is currently a transit route, and there may be a desire to connect to the existing east-west buses along 26 Avenue SW, serving area needs. The pedestrian overpass provides better neighbourhood connectivity for pedestrians north of 26 Avenue SW, but does not utilize the opportunity to connect to the existing transit network. Ideally a BRT station north of 26 Avenue SW, could provide access to 26 Avenue SW and it would still be within a reasonable walking distance for pedestrians accessing the neighbourhoods to utilize the overpass.

- 33 Avenue SW.** In both the northbound and southbound directions the route can exit at 33 Avenue SW using the refuge island for the station location. The route will continue through the signalized intersection at both locations back onto Crowchild Trail. The intersection operations will need to be reviewed to determine if changes are required to the signal timing or an addition of a bus only signal phase and/or queue jumps are required at the interchange intersections.
- Dieppe Ave. Pedestrian Bridge.** Stops would be placed



Figure 4: Crowchild Trail at 33 Ave SW

to access the pedestrian overpass allowing for connections to the nearby communities and existing commercial development. This stop will also provide access to the redevelopment of the Currie Barracks.

- **Flanders Ave.** This optional location would serve the redevelopment site on the former Farmers' Market and support development on the Currie Barracks lands.
- **Mount Royal University.** It will be essential to locate a convenient station at Mount Royal University (MRU). Discussions with MRU will continue throughout this study, however initial options being considered would locate a transit facility on the east side of Mount Royal Circle, the university's internal circulation road. MRU staff has indicated their wish to integrate a transit facility with a future learning centre / library at this location. They have also indicated that the intent is for the internal circulation road to become pedestrian only and therefore the routing of the SW BRT should remain off of this road. Providing a convenient service to MRU is an important aspect of the SW BRT service however this must be achieved without significant delay to through passengers. Southbound vehicles will exit at Flanders Avenue SW to Richard Road SW then turn right into the facility discussed above. The service will continue southbound via Richard Avenue SW and Mount Royal Gate SW to return to Crowchild



Figure 5: Crowchild Trail at Dieppe Avenue Pedestrian Overpass



Figure 6: Crowchild Trail at Flanders Avenue



Figure 7: Bus Terminal and Access at Mount Royal University

Trail. Refer to **Figure 7** for a schematic of the service within the Mount Royal University Area.

In addition to providing direct access to MRU, the MRU Station would provide convenient service to Ecole Ste-Marguerite Bourgeoys Francophone School and Conseil Scolaire Catholique Et Francophone Du Sud De L'Alberta located on the east side of Richard Road SW.

- **50 Avenue SW.** A station south of the university precinct along 50 Avenue SW (between Richard Road SW and Crowchild) will be provided since it will serve the developing Lincoln Business Park.

These stations yield a spacing of:

- 1,590 m between West Village/Sunalta and 17 Avenue SW,
- 1,050 m between 17 Avenue SW and 26 Avenue SW,
- 700 m between 26 Avenue SW and 33 Avenue SW,
- 515 m between 33 Avenue SW and Dieppe Avenue Pedestrian Bridge,
- 400 m between Dieppe Avenue Pedestrian Bridge and Flanders Avenue,
- 860 m between Flanders Avenue and Mount Royal University, and
- 860 m between Mount Royal University and 50 Avenue SW.

14 Street SW

Along the 14 Street SW right-of-way a dedicated busway is recommended. Details on the stations, including location, please see the 14 St Operation Comparison memo. Three stations are proposed:

- **Rockyview Hospital.** Rockyview Hospital is a major ridership generator located on the west side of 14 Street SW just south of Glenmore Trail. It can be served by a station located between the Hospital and 14 Street SW in the area between Maple Ridge Drive SW and 75 Avenue SW. Not only will this station provide direct access to the Hospital but also to the City's multi-use trail network that runs just west of the Hospital along the Glenmore Reservoir.
- **Heritage Park.** Located on the west side of 14 Street SW, Heritage Park is a popular destination for a variety of recreational activities. A station at this location will also provide a convenient transfer point for other Calgary Transit routes heading east along Heritage Drive.
- **90 Avenue SW,** adjacent to Glenmore Landing Shopping Centre. The northwest corner of the intersection includes a wide boulevard, a portion of which could be utilized for the station.

These stations yield a spacing of:

- 3,800 m between 50 Avenue SW and Rockyview Hospital,
- 900m between Rockyview Hospital and Heritage Park, and
- 750m between Heritage Park and 90 Avenue SW.

Southland Drive SW

The section of the SW BRT along Southland Drive SW has a length of approximately 1,600m and the service will operate in mixed traffic.

Two stations are proposed:

- **Southland Leisure Centre.** Located halfway between 14 Street SW and 24 Street SW opposite Woodbine Square the station will serve the combined commercial and community needs. The existing far side stops at the 19 Street SW intersection will be used.
- **24 Street SW at Southland Drive.** The existing bus stop location on the south side of Southland Drive, east of 24 Street SW, will be used for the northbound direction. The existing stop on the west side of 24 Street SW south of Southland Drive SW will be used for the southbound direction.

These stations yield a spacing of:

- 1,900 m between Heritage Park and Southland Leisure Centre, and
- 800m from the Southland Leisure Centre to 24 Street SW at Southland Drive.

24 Street SW

The SW BRT service will travel in mixed traffic along 24 Street SW similarly to the existing bus services in the area. The adjacent land uses are residential with some retail/commercial and institutional uses. Three stations are proposed:

- **Oakfield Drive/Braeside Drive at 24 Street SW,** using existing stops to serve commercial development in the southeast corner, the higher density development on the west side of 24 Street SW and Braeside Park.
- **Woodview Drive at 24 Street SW,** to serve the commercial area in the southwest corner and residential development surrounding the intersection.
- **Woodbine Park at 24 Street SW.** This will serve as the southern terminal station for the service. A vehicle turn-around is required at Woodbine Park located on the west side of 24 Street SW south of Woodview Drive SW. A station would be located here at the southern terminus of the SW BRT route.

These stations yield a spacing of:

- 800m between Southland Drive at 24 Street SW and Oakfield Drive/Braeside Drive at 24 Street SW,
- 1,400m between Oakfield Drive/Braeside Drive at 24 Street SW and Woodview Drive SW at 24 Street SW, and
- 325m between Woodview Drive SW at 24 Street SW and the terminal station at Woodbine Park.

A station at Anderson Road was considered as there are existing stops, however the adjacent land uses do not warrant a station because the four corners of the intersection have large boulevards with residential backyards making direct access to the intersection

challenging. The result is a wide station spacing between Oakfield/Braeside Drive and Woodview Drive.

It is noted that the distance between the last two stations is below the typical station spacing, however Woodbine Park serves as a good location for the BRT vehicles to be able to turn around, lay over if necessary (as it brings the vehicles off of the roadway), and may be suitable for a passenger pick-up / drop-off area. Details on the selection of the terminal station location can be found in a separate memo entitled "Potential Terminal Operations in Woodbine".

Glenmore Trail Alternate Routing

An alternate routing along Richard Road SW to Glenmore Trail was assessed. This routing would require the vehicles to make a southbound left turn from Richard Road SW to Glenmore Trail, which would require a signalized intersection on Glenmore Trail. Addition of a signal at this location is not desirable making the route impractical without a costly grade separation. For the grade separation to occur, the existing Glenmore Trail alignment would be required to shift north to create space for the southbound to eastbound ramp.



Figure 5: Alternate Routing to Glenmore Trail via Richard Rd.

This routing and the use of a signal or a flyover should be reconsidered should widening of Glenmore Trail through the area occur as this route is more direct for passengers. Policy decisions would also need to be made to the use of the overpass, whether it would become bus only or available to all motorists.

Table 1 – Summary of Station Locations and Spacing Distance

Station Location	Distance
Sunalta Station	
9 Ave SW at 9 St SW	1,000m
9 Ave SW at 5 St SW	700m
1 St SW at 8 Ave SW	700m
6 Ave SW at 2 St SW	400m
6 Ave SW at 6 St SW	575m
6 Ave SW at 9 St SW	525m
West Village/Sunalta	1,200m
Crowchild at 17 Ave SW	1,590m
Crowchild at 26 Ave SW	1,050m
Crowchild at 33 Ave SW	700m
Crowchild at Dieppe Pedestrian Bridge	515m
Crowchild at Flanders Ave	400m
Mount Royal University	860m
50 Ave SW	860m
Rockyview Hospital	3,800m
Heritage Park	900m
90 Ave SW at 14 St SW	750m
Southland Leisure Centre	1,900m
24 St SW at Southland	800m
Oakfield/Braeside at 24 St SW	800m
Woodview Dr at 24 St SW	1,400m
Woodbine Park	325m

Calgary SW BRT Functional Planning Study - 14 Street SW Operation Comparison

This memorandum will evaluate three options and recommend a preferred option to develop dedicated BRT lanes within the 14 Street SW right-of-way. The limits of 14 Street SW within this study are from Glenmore Trail to Southland Drive SW, a length of approximately 3.5km. The proposed operation conditions are developed based on the following principles:

1. Bus operations will be predominantly dedicated bus lanes through the corridor, realizing opportunity to avoid mixed-use traffic wherever possible on 14 Street.
2. Bus operations will have priority over conventional traffic.
3. Options are evaluated based on the criteria outlined below including opportunities for improved bus operations.
4. Privately held titled land will be avoided as much as possible.
5. High level operations analysis will be conducted rather than detailed traffic and traffic signal analysis.
6. Proper transitioning to/from the mixed traffic and the dedicated bus lanes must be feasible at both ends of the facility.

The following three options to develop bus only lanes the SW BRT within the 14 Street SW right-of-way were examined:

- East side of 14 Street SW;
- West side of 14 Street SW; and,
- Median of 14 Street SW.

The existing 14 Street SW right-of-way is limited, with the road itself utilizing most of the current right-of-way. Specific constraints include:

- Existing park and undeveloped space along portions of the west side of 14 Street SW which may be opportunity to expand the right-of-way for bus operations.
- At the north end of 14 Street SW between the pedestrian overpass and Heritage Drive , there is no opportunity to expand the right-of-way as it is bounded by residential communities on both the east (Chinook Park) and west (Eagle Ridge).
- Residential areas directly adjacent to, or backing onto, 14 Street SW have 3-metre noise walls which would be challenging to relocate.
- Direct access to the Glenmore Landing Commercial Area from the southbound lanes will need to be reconsidered.

- There is a substantial utility corridor on the east side of 14 Street between Southland Drive and Heritage Drive which limits potential road development. The utility corridor consists of various deep utilities; stormwater, sanitary and water, and shallow utilities including; street lighting, pipelines and likely telecommunications. Between Heritage Drive and Southland Drive SW there is a wide green space on the east side of the right-of-way (approximately 25m to 35m wide) where this utility corridor is located.
- There are berming and grade differences north of Southland Drive on the west side.

The land use along the corridor will also influence the selection of the recommended option. The land use on the east side of 14 Street SW is predominantly residential, with the major activity centres on the west side of the street (Rockyview Hospital, Heritage Park and Glenmore Landing).

Description of the Options

Option #1 – East Side Operation within 14 Street SW Right-of-Way

The two-lane facility on the east side of 14 Street SW would be located over the utility easement area. There is a utility corridor that runs parallel to 14 Street SW along the east side within the right-of-way. It is not desirable to construct or operate a roadway or busway over these utilities. Utility relocation would be significant.

North of Heritage Park the right-of-way is tight and there is a lack of sufficient available space on the east side to locate the busway, without shifting the roadway. There is also a grade difference between the current road and east side of the road (slight berming) which would need retaining walls and would reduce the cover on the existing utilities.

Stations on the east side of 14 Street SW would require all of the pedestrians to cross the street to access the major activity centres.

There may be more significant noise and vibration impacts that would need to be analyzed since the primary receptors are the residential properties.

Traffic operations issues would include conflicts at Heritage Drive SW and Southland Drive SW due to the large volumes of traffic that would be required to cross the busway. This alignment avoids conflicts at 90 Avenue SW. Complex operational issues arise at the south end, at Southland Drive SW, as it is not practical to locate the busway on the east side since the SW BRT service turns to the west at this location and it would be difficult to operate the intersection with the eastbound to northbound bus movement to the far side of the intersection.

Option #2 – West Side Operation within 14 Street SW Right-of-Way

The two-lane facility would be constructed to the west of the current roadway for most of its length. Stations could provide direct access to the major activity centres located on the west side of the street. Locating the BRT lanes on this side of the right-of-way provides direct access to these locations with relative ease. Glenmore Landing Shopping Centre is a

commercial development which is also located on the west side at 90 Avenue SW, which may be considered a future opportunity for additional development.

The west side operation avoids impacting the intersections with Southland Drive and Heritage Drive (as traffic volumes into and out of the park are low during commute hours), however there is significant impact to 90 Avenue. A grade separation for the busway under 90 Avenue would avoid degrading the intersection operations as a result of the busway.

The busway on the west side will fit within the existing 14 Street SW right-of-way south of Heritage Drive SW. However, for the segment on north of Heritage Drive to 75 Ave SW, a re-alignment of 14 Street SW is required regardless of the location of the busway given the tight right-of-way in this corridor. In this section, the busway would utilize the two current outside southbound lanes of 14 Street SW, with the current six lane traffic section shifting east through a combination of road widening, median reduction and traffic lane width reduction.

The existing pedestrian grade separation south of 75 Avenue SW will need to be considered, as it will be likely that a relocation of the main supporting pier to will be required, if possible to accommodate the traffic lane shifts.

Option #3 – Median Operation 14 Street Right-of-Way

In this option the two-lane facility is placed in the centre of the roadway. Specialized intersection treatments would be provided to protect the BRT operation. In order to minimize the impact to the right-of-way, the stations are located on the far side of the intersections so that they are opposite the left turn lanes. This orientation limits excessive widening at the intersections.

The median busway at the north end of 14 Street SW would begin at the intersection of 75 Avenue SW, which is the Rockyview Hospital access. Since buses will operate in mixed traffic on Glenmore Trail, the southbound buses can enter the median busway north of 75 Avenue SW where there could be a station. The northbound vehicles could merge into mixed traffic north of 75 Avenue SW, crossing over to the desirable lane on 14 Street, through the interchange with Glenmore Trail.

At the south end the median busway on 14 Street SW would need to be integrated with the mixed traffic operation on Southland Drive SW. This may involve a short median busway on the west leg of the 14 Street SW / Southland Drive SW intersection in order for the vehicles to merge safely into and out of mixed traffic on Southland Drive SW.

Evaluation of the Options

The evaluation is based on a set of ten criteria, outlined in the table below, range from pedestrian and development opportunities, intersection operation, impact on underground utilities and the existing roadway, and feedback from major stakeholders. At this point the costs have not been developed to a degree that would allow them to be considered as a factor.

The evaluation indicates that:

- ***Option #1 - East Side Operation within 14 Street SW Right-of-Way.*** Is the least preferred option. The alignment is closest to single-family residential development introducing noise and vibration concerns, has the greatest impact on the utility corridor, does not connect to the activity centres on the west side of the street and has operational challenges.
- ***Option #2 – West Side Operation within 14 Street SW Right-of-Way.*** Connects to the major activity centres, avoids impacts on the utility corridor, has less impact on major intersections (especially with a grade separation at 90 Avenue SW), and is most supportive of future development plans.
- ***Option #3 – Median Operation 14 Street Right-of-Way.*** Places the stations in the median of the roadway, making connections to the activity centres somewhat accessible. Road operations are normalized compared to east or west side operation however entry and exit points are more challenging.

A summary table showing the comparison of the three options is included in the following chart.

Conclusion

The recommended location for the SW BRT on 14 Street SW is within the right-of-way along the west side. As noted above the activity centres are located on the west side of the right-of-way as well as this locates the busway away from the utility corridor located on the east side of the right-of-way.

Several busway options were developed at four of the main intersections along 14 Street SW; Rockyview Hospital, Heritage Park, 90 Avenue SW and Southland Drive SW. The recommended design is included in the attached drawings.

The operation of the Heritage Drive intersection will need to be reviewed with Traffic Signals to determine if crossing arms and controls similar to the C-Train are required to control the intersection. As the service will be operated by buses, signal phasing and turn restrictions across the BRT alignment (no southbound right turn on red and no northbound permissive left turn) could also be implemented to control the intersection. This will require more detailed analysis in the next phase of the project.



COMPARISON CHART 14 STREET SW OPERATIONS – CALGARY SW BRT

Criteria		Indicators	Alignment Options on 14 Street SW				
			Option 1 East Side of 14 Street SW	Option 2 West Side of 14 Street SW	Option 3 Median of 14 Street SW	Notes	
A	Pedestrian Accessibility and Safety	<ul style="list-style-type: none"> Are the stations accessible Are the stations located in a safe environment 	<ul style="list-style-type: none"> Activity centres are on the west side, which requires crossing of 14 Street to the east from the west at every station 	<ul style="list-style-type: none"> Direct pedestrian access to activity centres 	<ul style="list-style-type: none"> Access to stations requires crossing of either northbound or eastbound traffic 	<ul style="list-style-type: none"> All pedestrian access is near major intersections, with signalized crossings 	
B	Potential for Alignment to Attract Ridership, including TOD opportunity	<ul style="list-style-type: none"> Where are the activity centres Is the busway located in such a way to attract passengers Station integrated with TOD 	<ul style="list-style-type: none"> Activity centres are on the east side of 14 Street, visibility is lower on the east side 	<ul style="list-style-type: none"> Will serve activity centres well Good visibility in the corridor 	<ul style="list-style-type: none"> Very good visibility within the corridor, less convenient for users 	<ul style="list-style-type: none"> Major ridership generators are on west side. Those accessing Rockyview Hospital would benefit the greatest with a busway on the west side. TOD opportunities are the similar for the 3 options 	
C	Potential for Intersection Operations – Southland Drive	<ul style="list-style-type: none"> Turning movements at all intersections and accesses into adjacent properties Impact to signal timings and operations 	<ul style="list-style-type: none"> Very difficult for intersection operations to transition buses from eastbound on Southland Drive to the east side of 14 Street 	<ul style="list-style-type: none"> There is no impact to the existing Southland Drive and 14 Street intersection 	<ul style="list-style-type: none"> Buses would impact operations transitioning into the median. difficult to transition out of the median southbound to westbound on Southland Drive 		
D	Potential for Intersection Operations - 90 Avenue	<ul style="list-style-type: none"> Turning movements at all intersections and accesses into adjacent properties Impact to signal timings and operations 	<ul style="list-style-type: none"> No impacts to 90 Avenue 	<ul style="list-style-type: none"> An at grade crossing of 90 Avenue would be difficult to operate the intersection in peak hours. Can be mitigated with a grade separation under 90 Avenue 	<ul style="list-style-type: none"> Through movement can be operated with relative ease, difficult to manage buses turning to/from 90 Avenue 	<ul style="list-style-type: none"> Undergrounding alignment across 90 Avenue SW will eliminate impact to traffic operations at this location. Special intersection treatments would be required for median option 	
E	Potential for Intersection Operations – Heritage Drive	<ul style="list-style-type: none"> Turning movements at all intersections and accesses into adjacent properties Impact to signal timings and operations 	<ul style="list-style-type: none"> An at grade crossing of Heritage Drive on the east side of 14 Street would be difficult to operate the intersection in peak hours 	<ul style="list-style-type: none"> Minimal impacts to Heritage Drive as the west side is access to Heritage Park 	<ul style="list-style-type: none"> Through movement can be operated with relative ease, difficult to manage buses turning to/from Heritage Drive from the east 	<ul style="list-style-type: none"> At Heritage Park Drive, the east leg of the intersection has greater traffic volumes than the west leg. Therefore, the east side option would have the largest negative impact to traffic operation 	
F	Potential for Intersection Operations – Rockyview Hospital Accesses	<ul style="list-style-type: none"> Turning movements at all intersections and accesses into adjacent properties Impact to signal timings and operations 	<ul style="list-style-type: none"> Minimal impacts to the Rockyview Hospital northbound Difficult to transition southbound buses to the east side. 	<ul style="list-style-type: none"> Minimal impacts to the accesses, utilizing the existing intersection to transition northbound buses to mixed traffic Great access from southbound buses from Glenmore Trail 	<ul style="list-style-type: none"> Can transition both southbound and northbound buses, although they would have to cross mixed traffic. Through movement can be operated 		
G	Potential for Alignment to Effect Utilities	<ul style="list-style-type: none"> Utility corridor runs along the east side of the 14 Street SW right-of-way 	<ul style="list-style-type: none"> Very high impact as the busway would be over the utility corridor, or 14 Street SW would need to be shifted west 	<ul style="list-style-type: none"> Minimal impacts, could implement a pedestrian facility 	<ul style="list-style-type: none"> Some impact to corridor as 14 Street would be widened to the east Could still implement a pedestrian facility on the east side 	<ul style="list-style-type: none"> Existing utility corridor located on east side of 14 Street SW south of Heritage Park. Widening of the right-of-way for the median option will be required and therefore will affect the utility corridor 	
H	Conventional Bus Operations & Flexibility	<ul style="list-style-type: none"> Ability for conventional transit routes to integrate or utilize the busway (access at 90 Avenue, Heritage Drive & Southland Drive) 	<ul style="list-style-type: none"> Difficult to access busway at 90 Avenue and Heritage Very difficult to access or leave busway at Southland Drive 	<ul style="list-style-type: none"> Very good access at all points, especially with a grade separation and access ramps at 90 Avenue 	<ul style="list-style-type: none"> Access can happen through signal phase timings at intersections, however will impact intersection traffic capacities 	<ul style="list-style-type: none"> More available space on west side of 14 Street SW. Adjacent land use on east side is predominantly residential and therefore an increase in noise and vibration may be an issue 	
I	Impact on 14 Street SW to existing Infrastructure	<ul style="list-style-type: none"> Relocation or realignment of existing 14 Street roadway infrastructure 	<ul style="list-style-type: none"> Large impact as sections of 14 Street will need to be shifted west, largely between Southland Drive and Heritage Drive 	<ul style="list-style-type: none"> Minimal impacts as most of the busway will be to the west, with realignment of traffic lanes required south of 75 Avenue 	<ul style="list-style-type: none"> Both sides of 14 Street as well as the medians will be impacted. Large impacts at the intersections to provide for stations. 		
J	Key Stakeholder Involvement	<ul style="list-style-type: none"> Support from Key Stakeholders along route; RGH, Heritage Park, Glenmore Landing 	<ul style="list-style-type: none"> Difficult to access RGH, Heritage Park and Glenmore Landing, must cross 14 Street 	<ul style="list-style-type: none"> Supported fully, most notably by Glenmore Landing developers 	<ul style="list-style-type: none"> Less desirable by key stakeholders 	<ul style="list-style-type: none"> All options are supported by Mount Royal University on 14 Street Key comment by stakeholders is to connect with SLRT at Heritage or Anderson Stations 	

Legend: Positive ● ● ● ● ● Negative ○ ○ ○ ○ ○

Calgary SW BRT Functional Planning Study - Traffic Analysis of 14 Street SW Corridor

This memorandum will summarize the preliminary analysis done for the 14 Street SW corridor, based on the 14 Street SW Operation Comparison technical memorandum (September 29, 2010). For 14 Street, a busway has been recommended along the west side of 14 Street SW; this was analysed in Synchro and Simtraffic to determine what effect the transit would have on the existing traffic conditions. The analysis was done to determine what upgrades would be needed along the corridor to accommodate the busway and maintain an acceptable level of service. Even though the buses will be running on this busway they still cross several roads that intersect 14 Street at grade. There are also the connections at the north and south ends of the busway where buses must switch back into the main traffic stream.

At the functional planning stage the intent of the analysis was to develop a strategy that demonstrates that the additional facilities proposed, and the SW BRT service, can be added without adversely impacting existing levels of service. Engineering judgement was used to assess the preliminary analysis, as some of the solutions require more sophisticated modelling and more detailed information than was available at this stage.

The service that was modelled was a 10-minute service in each direction. A conservative assumption of a bus arriving every 5 minutes (alternating by direction) has been used, although in reality buses arriving in opposite directions will not be evenly spaced. This will account for a more frequent service than the initial assumption.

TRAFFIC ANALYSIS

Synchro Inputs

Seven intersections were analysed in Synchro:

- 14 Street and 75 Avenue / Rockyview Hospital Access
- Rockyview Hospital Access and Eagle Ridge Drive
- 14 Street and Heritage Drive
- 14 Street and Glenmore Landing Access
- 14 Street and 90 Avenue – Note that the busway is actually grade separated with 90 Avenue, but the impact that this intersection has with the adjacent intersections along the corridor required it to be included in the model.
- 14 Street and Southland Drive
- Southland Drive and Bradbury Drive

The recommended busway is on the west edge of 14 Street and has the following interactions with the roads within this corridor:

- At the north end of the corridor, the southbound busway branches off from Eagle Ridge Drive potentially requiring a traffic signal for this left turn. Northbound the busway ends at Eagle Ridge Drive and travels through the intersections of Rockyview Hospital Access and Eagle Ridge Drive, and 14 Street and 75 Avenue / Rockyview Hospital Access, making a right then left turn, respectively. The buses then continue northbound along 14 Street.
- At Heritage Drive the busway crosses the west leg of the intersection. This also requires a signal to stop the traffic from using the west leg and allow the buses to travel past.
- At the access to Glenmore Landing right turning traffic is stopped by a signal to allow buses to travel north-south along the busway.
- At the south end of the corridor the busway becomes a north leg to the Southland Drive and Bradbury Drive intersection. A traffic signal is added to this location to aid buses in turning left off Southland Drive onto the busway northbound. Southbound buses turn right onto Southland Drive and then continue to the west.

The volumes used in the Synchro analysis were obtained from the City of Calgary, and the AM and PM peak hours were used. The volumes for the Rockyview Hospital Access and Eagle Ridge Drive intersection were not available, so the volumes were assumed and balanced with the adjacent 14 Street and 75 Avenue / Rockyview Hospital Access intersection. The intersection layouts were created by using aerial photographs. The signal timings were not available, so each signal was optimized as an uncoordinated traffic signal. Although this will not provide a calibrated model that addresses actual conditions, it does provide a base line for comparison to see the effects that the addition of the busway within the 14 Street corridor will have.

Simtraffic Inputs

There were no additional inputs provided in Simtraffic; both peak hour models were simulated with a 15 minute seeding interval. Both peak hour simulations were run with and without the busway to provide the comparison data.

Busway Impact Analysis

It was assumed that the buses would be on 10 minute headways in both directions, and that the number of buses in the north and south directions are the same. To model the interaction that the buses would have with the existing traffic, pre-timed traffic signals were added at these locations:

- North end of busway and Eagle Ridge Drive
- 14 Street and Heritage Drive (west leg of intersection)
- 14 Street and Glenmore Landing Access
- Southland Drive and Bradbury Drive

These pre-timed signals have a cycle length of 300 seconds to simulate a bus arriving every 5 minutes. The 5 minutes is based on the 10 minute headways with buses in both directions; although in reality buses in opposite directions would not be evenly spaced, this

assumption simplifies the model. A minimum amount of green time was given to the busway to simulate a bus crossing the intersecting street.

Since it is not possible to have a vehicle arrive at a scheduled time within a simulation, the pre-timed signal creates this scheduled event regardless of an actual vehicle arriving at the signal or not. In an actual situation the signals along the busway might be actuated and the detectors placed well in advance of the intersections to allow buses to travel along the busway with no need to stop, except at the bus stations.

RESULTS

After running the simulations in both the AM and PM peak hours and comparing the results with and without the busway the following observations were made:

North End of Busway

Since in both peak hours 14 Street is already above capacity in the base line scenario, adding an extra vehicle every 5 minutes creates no noticeable disruption on 14 Street at the north end of the busway. There was no change to the level of service to the intersections of 14 Street and 75 Avenue / Rockyview Hospital Access, and Rockyview Hospital Access and Eagle Ridge Drive at this level of analysis however the impact of the northbound buses will need to be analyzed in more detail.

With the current road layout, the northbound buses will have to make a right turn off Eagle Ridge Drive, and then merge across two lanes to turn left onto 14 Street; all within a distance of approximately 50 metres. Due to the limitations of the software, this could not be analysed in Synchro or Simtraffic. During shift changes at the hospital this could create an issue if the left turn lane to get onto 14 Street northbound is queued up to Eagle Ridge Drive; this is particularly true in the PM peak when volumes coming out of the hospital are almost double that in the AM peak.

The analysis of the 14 Street/75 Avenue/Rockyview Hospital access indicates that the buses can be accommodated, however it is recommended that the bus movements from the north end of busway onto 14 Street northbound be analysed using more sophisticated traffic modelling software to better determine how the buses will interact with the existing traffic and if modifications to the intersection, such as the addition of a bus-only left turn lane, are required.

Although there were no traffic counts along Eagle Ridge Drive, the number of buses turning on and off this road to and from the busway is also not expected to create an issue. Eagle Ridge Drive is a residential street, and a bus turning left once to get onto the busway and one turning right onto the street from the busway every 10 minutes for each direction is not going to reduce the level of service for the street.

14 Street and Heritage Drive

Due to the high through volumes on 14 Street, combined with heavy turning movements on and off of Heritage Drive, there is not enough capacity at the intersection to provide an adequate level of service to all the movements. Dual left turn lanes for the southbound and

westbound lefts would help relieve some of the capacity issues. The west leg of the intersection is very low volume, as this is the access to the Heritage Park parking lots; there is no commuter traffic heading into this area. When special events occur at Heritage Park this west leg can get busier, but generally these events do not overlap with the peak hour commuting traffic along 14 Street.

Since there are relatively low traffic volumes on the west leg of this intersection, the busway has little overall impact to the level of service of the intersection. When the busway signal gives priority to the buses, southbound right, northbound left and westbound through traffic needs to be stopped before leaving the 14 Street and Heritage Drive intersection. Eastbound traffic is stopped prior to crossing the busway. This would be similar to a train crossing in close proximity to a traffic signal, much like the existing situation at McLeod Trail and 25 Avenue just south of the Erlton Stampede C-Train station.



Figure 1: Busway at Heritage Drive at 14 Street SW compared to the LRT at McLeod Trail at 25 Avenue SE

Due to the limitations of Synchro and Simtraffic this situation could not be effectively simulated as a train crossing, so a different approach was used to analyze the intersection. In this approach, a pre-timed signal stops the traffic on the west leg of the intersection as described above and a bus is allowed to cross Heritage Drive. There is no discernable effect on the 14 Street and Heritage Drive intersection in the simulation during one of these bus events. In Synchro, because the busway and 14 Street intersections are separate signals along Heritage Drive, the two intersections do not impact each other – they are considered isolated in the model.

It is recommended that a double left turn from southbound to eastbound be implemented at Heritage Drive and 14 Street. This will reduce volumes on the west leg where a southbound right turn combined with a U-turn is currently used to augment the southbound left turn movement.

It is recommended that this intersection be modelled, during preliminary engineering, using more sophisticated software to show

the interaction between the operation of the busway with the intersection of 14 Street and Heritage Drive. This may result in improvements being required to this intersection now, even without the busway to achieve an acceptable level of service.

Glenmore Landing Access

Ideally this access to Glenmore would be closed to avoid the conflict point as well as provide space to transition the busway below grade, to cross under 90 Avenue SW, as well as allowing a station to be constructed between 14 Street SW and the Mall.

As access to the Mall is constrained and additional traffic would be required to use the right turn movement at the 90 Avenue SW intersection if the access is removed, additional analysis of alternatives will be required at the next design stage to determine if the access can remain in place. In both peak hours there is sufficient storage within the existing parallel right turn lane on 14 Street to prevent traffic from queuing up into the through lanes while traffic is stopped to allow a bus to cross the access point. The access would require a signal to control the conflict point, creating an unusual traffic arrangement.

90 Avenue SW

The heavy traffic volumes at the intersection of 14 Street SW and 90 Avenue SW will not permit at-grade operation of the busway across the west leg of the intersection. The functional planning recommends a grade separation to take the busway under 90 Avenue SW. As a result no analysis of an at-grade option was undertaken.

Southland Drive and Bradbury Drive

Initially a signal was added at the intersection of Southland Drive and Bradbury Drive to provide a gap in traffic on Southland Drive to allow buses to turn left onto the busway. After reviewing the traffic simulation it was noticed that there was already substantial gaps in traffic every signal cycle on Southland Drive due to the nearby traffic signal at 14 Street, which would allow the existing left turns off of Southland Drive onto Bradbury Drive southbound make this turn without the aid of a signal. The median is wide enough west of Bradbury Drive to create a small bus-only turn bay for buses to wait to make the left turn to access the busway without blocking through traffic. As buses exit southbound off the busway they need to make a right turn and merge onto Southland Drive, as with the left turns to go north, there are sufficient gaps in the traffic to allow this manoeuvre.

Delcan does not recommend that a signal is needed at this location based on the adequacy of adjacent signals to create sufficient gaps for the new bus movements to and from the busway.

If there are concerns with the safety of buses turning left across or merging onto Southland Drive, or it is determined that gaps are not sufficient then a signal (should traffic volumes change significantly) can be added to aid the bus movements. The signal in the simulations did not appear to adversely impact the operation of the intersections along Southland Drive at either Bradbury Drive or 14 Street. The short duration of green time given to the buses and the long headways does not create a significant disruption to the existing traffic operations.

COMPATIBILITY WITH 14 STREET WIDENING

In October 2009, Associated Engineering completed a functional design report for the City of Calgary providing plans to widen 14 Street from 90 Avenue to Canyon Meadows Drive. There were recommendations to add turn lanes to the intersections on 14 Street at 90 Avenue and Southland Drive, as well as add through lanes on 14 Street. A summary of the improvements that impact intersections modelled for this project are as follows:

- | | |
|-----------------|--|
| 90 Avenue | <ul style="list-style-type: none"> • New southbound through lane (no indication in report how far new through lane will extend to the north) • New north to west left turn lane (proposed double left) • New east to north left turn lane (proposed triple left) • New east to south right turn lane (no longer a shared lane) |
| Southland Drive | <ul style="list-style-type: none"> • New southbound through lane • New south to east left turn lane (proposed double left) • New northbound through lane (to connect with existing 3 lanes at 90 Avenue) • New north to west left turn lane (proposed double left) • New east to south right turn lane (no longer a shared lane) • New west to north right turn lane (no longer a shared lane) |

The improvements proposed at 90 Avenue will likely not impact the busway as it is proposed to have a grade separation between the busway and 90 Avenue. The widening of 14 Street between 90 Avenue and Southland Drive will result in less space available for the busway; coordination will be required with any future plans or designs to widen 14 Street. The improvements at Southland Drive should also not impact the busway, as the busway alignment deviates to the west and connects to Southland Drive at the Bradbury Drive intersection. The only improvement on the west leg of the 14 Street and Southland Drive intersection is to make a parallel right turn lane for east to south traffic. It is assumed that this lane will not impact the Bradbury Drive intersection to the west, and thus not impact the operation of buses turning off and on Southland Drive.

RECOMMENDATIONS

This simplified Synchro and Simtraffic review of the busway along the 14 Street SW corridor demonstrates that there will be few operational impacts of parallel bus-only lanes on the existing traffic. There are two areas that should be reviewed further:

- The north end of the busway requires northbound buses to make a right turn followed by a left turn in a very short distance to get from Eagle Ridge Drive to 14 Street. This manoeuvre could be difficult to achieve if traffic leaving the hospital queues up along the access road between 14 Street and Eagle Ridge Drive.
- The operation of 14 Street and Heritage Drive is the primary bottleneck within this corridor, even though the busway is crossing a minor leg of the intersection, the existing operation of this intersection indicates that it needs capacity improvements.

The busway should be located and operated to accommodate future improvements to this intersection.

- The south end of the busway requires a storage bay at the intersection with Bradbury Drive for buses turning left off of Southland Drive onto the busway heading north. A signal is not required for Southland Drive and Bradbury Drive to accommodate this turn due to gaps created by the signal at Southland Drive and 14 Street.

In addition to the areas for further review, a more complete and sophisticated traffic simulation should be completed for the 14 Street corridor in its entirety. Software such as VISSIM would be able to dynamically assign vehicle trips on the corridor, trips entering or existing the corridor as well as the interaction of the busway through the corridor and more specifically at the intersections.

The review undertaken along the 14 Street SW corridor demonstrates that there will be few operational impacts of parallel bus-only lanes on the existing traffic. The number of buses operating on street, and the number of cars that will be removed as residents choose transit over cars will likely have no impact on travel times or congestion levels, but will provide an opportunity to increase the capacity of 14 Street to move people to and from the southwest area of Calgary.

While the general review undertaken for this memo does not foresee major operational impacts, the design would be enhanced by reviewing three areas in more detail:

- The northbound buses at the north end of the busway which are turning left from Eagle Ridge Drive, should be reviewed in more detail to determine the potential impacts on traffic exiting the Rockyview Hospital site at the 75 Avenue intersection.
- Determining the necessary improvements at 14 Street and Heritage Drive to resolve the southbound and westbound left turn congestion such that the busway can be designed to accommodate the future improvements to this intersection.
- A more complete and sophisticated traffic simulation, using dynamic simulation, should be undertaken to assess the potential to improve traffic flow and busway operations through the corridor.

Calgary SW BRT Functional Planning Study - Potential Crowchild and Glenmore Trail Shoulder Lane Usage

One of the measures to increase functionality for the SW BRT is to take advantage of the shoulder areas along the Glenmore and Crowchild Trail sections of the proposed route. Use of the shoulder on part of this corridor has already been established, and would be expanded to provide as many opportunities as possible in both the northbound and southbound directions to give transit vehicles a higher degree of segregation from general traffic. Figure 1 illustrates where the shoulder lanes exist today and where they could be implemented as part of this project.

The use of the shoulder is possible in some sections of the corridor however existing constraints, particularly at ramp access points and long Glenmore Trail mean that the shoulder-running option cannot be continuous. Where the shoulder is not available, buses would need to merge back into mixed traffic.

The opportunities and constraints for each section of the route are outlined below:

- 14 St from 75 Av to Glenmore Trail
 - Northbound – BRT service will exit at the traffic signal at 75 Av and use the general traffic lanes and share the existing ramp. The two lane ramp starts approximately 300 metres north of the intersection. The paved area is 8 m wide up to the bridge that flies over the Glenmore, which widens out to 10 m at curved bridge.
 - Southbound - BRT service would share the right-hand lane of the existing two lane ramp from the Glenmore Trail as far as the start of the new busway connection onto the Hospital's internal circulation road.
- Glenmore Trail
 - Northbound - BRT service will need to share the right-hand lane on westbound Glenmore Trail from the 14 St. on-ramp to off-ramp at Crowchild Trail. The width of the roadway is constrained crossing the causeway. The WB Glenmore consists of 5 lanes (3 through lanes and 2 auxiliary lanes) which reduces to 4 lanes (3 through and 1 auxiliary) at the pedestrian crossing at the Crowchild ramp. Approximate pavement width at 5-lane sections is 22.7m (5 - 3.6m lanes, 1.5m left shoulder and a 3.2m right shoulder). At the pedestrian crossing is the pavement is 18.4m wide (4 -3.6m lanes, 1.5m left shoulder and a 2.5m right shoulder).
 - Southbound - BRT service will need to share the right Lane of the two lane Crowchild to Glenmore ramp and continue on the right-hand lane of the eastbound Glenmore Trail to the two-lane exit ramp to 14th St.
 - Table 1 outlines the available shoulder width at different points along Glenmore Trail.

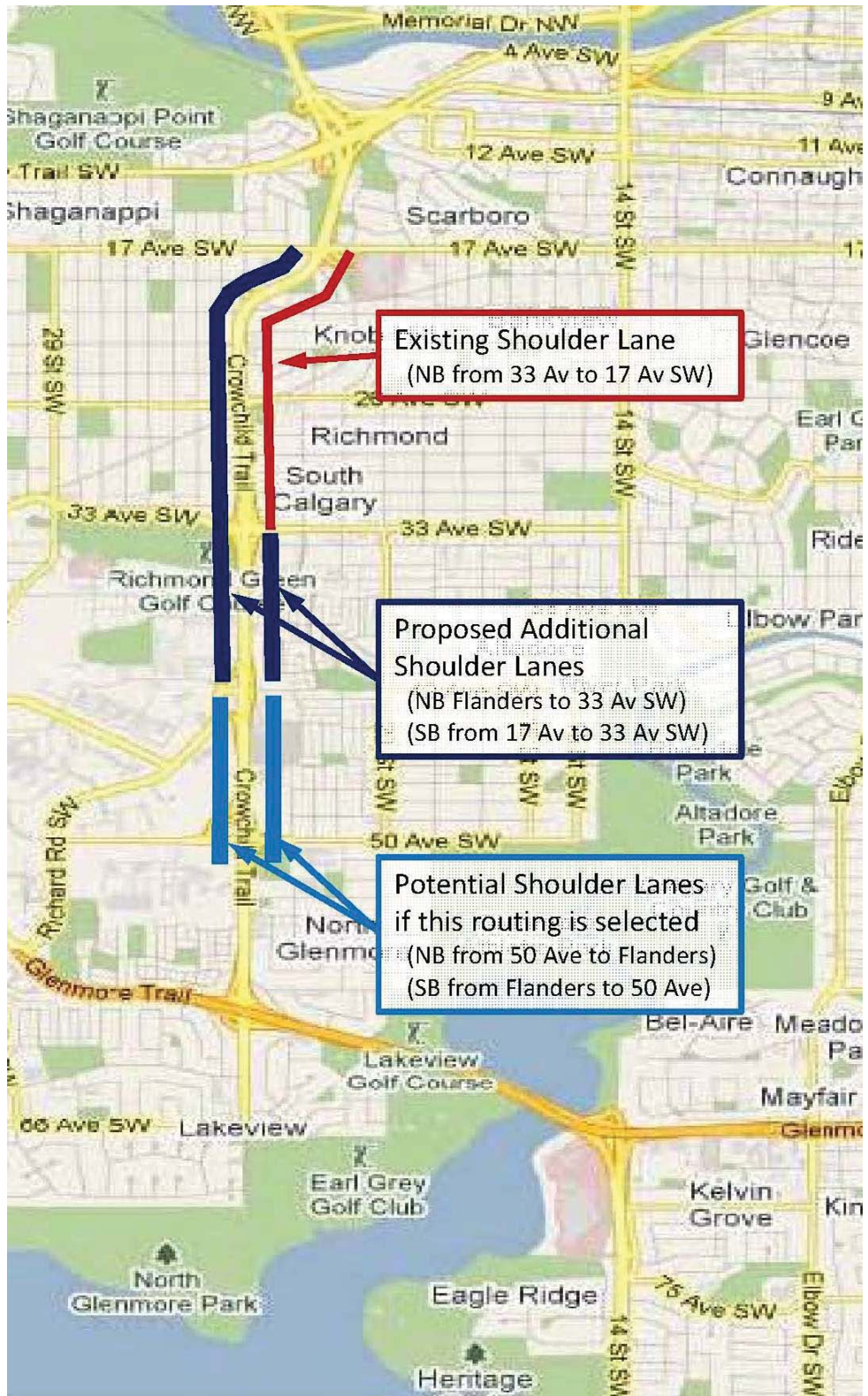


Figure 1: Extent of Existing and Proposed Shoulder Lane Operations

Direction	Start	End	Shoulder (m)
EB	Crowchild to Glenmore Ramp	West of Pedestrian Overpass	1.5
	West of Pedestrian Overpass	Sign Bridge	2.2 + Gutter
	Sign Bridge	West end of Bridge	3.4*
	West end of Bridge	East end of Bridge	2.5
	East end of Bridge	Glenmore to 14 St Ramp	Gutter
WB	14 St to Glenmore Ramp	East of Causeway	Gutter
	East of Causeway	East end of Bridge	1.8
	East end of Bridge	Sign Bridge	2.6
	Sign Bridge	End of 5 Lanes	3.3*
	End of 5 Lanes	Pedestrian Overpass	3.0*
	Pedestrian Overpass	Glenmore to Crowchild Ramp	2.4
	Glenmore to Crowchild Ramp	Crowchild	Gutter

* - Shoulder lane can be used where it is 3.0m or wider.

- Crowchild Trail
 - Northbound - BRT service will primarily run on the existing bus-only lane from 50 Ave to Bow Trail without impacting the three through traffic lanes. However, for the section from the Glenmore Trail ramps to 50 Ave, there is no separate bus-only lane or wide shoulder on Crowchild Trail and the BRT service will need to share the right-hand lane of existing three traffic lanes. BRT services will cross over the exit and entrance ramps at the interchanges. At the north end of the route, BRT services will merge into the right-hand lane and use the ramp to Bow Trail.
 - Southbound – BRT services will use the right-hand lane on the ramp from Bow Trail to Southbound Crowchild Trail. Buses would access the shoulder by merging across the two southbound lanes and have access to the shoulder before reaching the 17 Av station. The shoulder is available from here to south of 33 Av where an auxiliary lane connects the 33 Av on ramp and the Flanders off ramp. This auxiliary lane provides a better level of service than the adjacent through lane. There is little flexibility to add a shoulder in this area due to the pedestrian bridge, the historic access to the armed forces base and internal roads which are immediately adjacent to the Glenmore Trail. South of 50 Av there is a long auxiliary ramp lane which ends to pass under the pedestrian crossing between 54 and 55 Av. There is space to widen the roadway here however the pedestrian bridge would need to be rebuilt. South of the pedestrian bridge is the start of the ramp to the eastbound Glenmore Trail, and BRT services would be required to use the right-hand lane.

Conclusions

While there is scope to extend the use of the shoulder lanes along the Crowchild Trail, there is no opportunity to expand the ramps at the north or south end or the Glenmore Trail segment across the causeway to provide for a dedicated shoulder lane that BRT services

could access. The benefits of implementing the shoulder lanes along more of the Crowchild Trail are sufficient to provide a good level of service for the proposed BRT services.

Calgary SW BRT Functional Planning Study - Potential Terminal Operations in Woodbine

The south end of the SW BRT is planned in Woodbine, adjacent to the commercial centre near Woodview Drive. Figure 1 illustrates the conceptual end of the line in the neighbourhood context. While the infrastructure planned for this project could allow several bus routes to enter and exit the corridor at various points along the BRT route, a terminal station for a dedicated SW BRT service needs to be identified. To operate the service, it is necessary to provide a location to turn the buses around. In reviewing the corridor there are five opportunities that provide a good operational termination point.

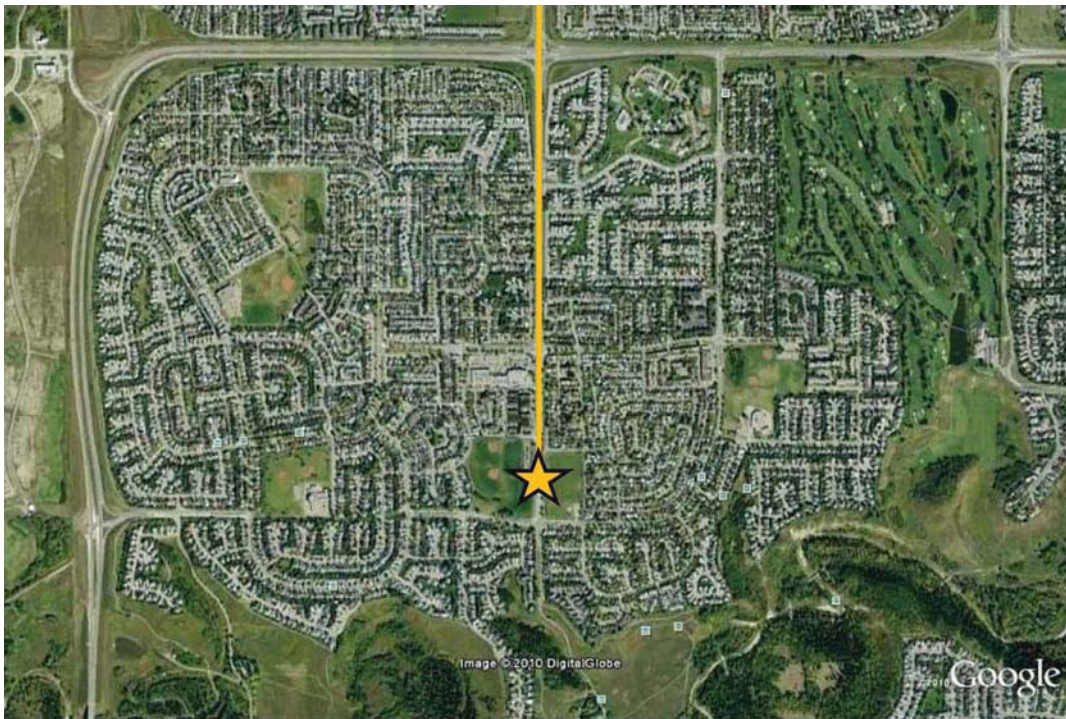


Figure 1: SW BRT Woodbine Terminal and Context

The terminal station proposed here would need further discussion with the public and various City departments. The intent is to identify the likely location where buses would hold for their return trip to the downtown. Once a location is selected design would need to be undertaken to determine the best arrangement of the elements and supporting amenities. The terminal station will also need to be strategically placed to allow for convenient transfers from local routes in the community.

The five options, shown on Figure 2, are:

- Option 1 – Community Loop
- Option 2 – North Parking Lot Loop
- Option 3 – Southeast Park Loop
- Option 4 – Southwest Park Loop
- Option 5 – Roundabout at 24 Street SW and Woodpark Boulevard SW



Figure 2: Options for Terminal Station Operations

Option 1 – Community Loop

This option allows all bus operation to continue on existing roadways with the stop on northbound 24 Street being the only infrastructure investment. This minimal cost option would operate:

- eastbound on the four blocks of Woodview Drive SW from 24 Street to Woodpark Boulevard SW,
- southbound then westbound on Woodpark Boulevard to 24 Street, and
- northbound to the terminal station on the east side of 24 Street.

This option would require introducing bus service onto the four blocks of Woodview Drive SW from 24 Street to Woodpark Boulevard SW. Buses currently operate on the rest of the

routing. The option provides the highest level of community coverage. Transfers between routes would occur at designated stops along the loop.

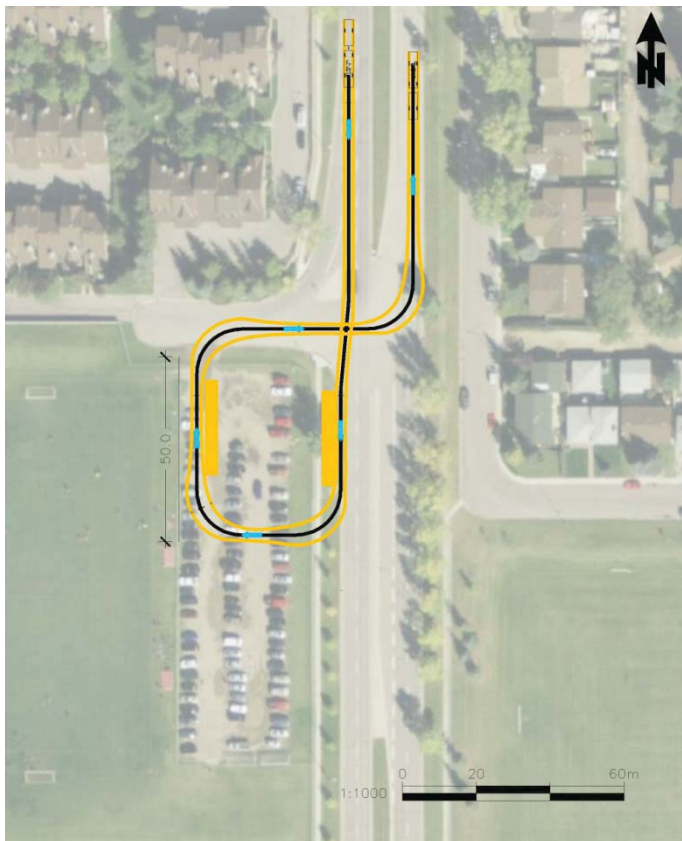
The terminal station could be located on the east side of 24 Street adjacent to the park. This station could be used by routes travelling north on 24 Street, and can be placed in any location north of Woodview Drive SW and south of Woodvale Crescent SW.

This option leaves the greatest flexibility for future route changes and service extensions as there is no off-street infrastructure required which would be abandoned or underused in future. Local connections can be made at stops along the community loop.

Option 2 – North Parking Lot Loop

This option is the shortest, with buses operating on 24 Street to the north end of the park. The channelized right-turn lane would be used by the buses, which would then enter a turn-around loop, turning left to return northbound on 24 Street. The access to the park would be shared with vehicles accessing the parking lot. The land needed for the loop would require that the parking area be reduced in size or expanded to the south.

The terminal station would be located on the south side of the loop adjacent in the park. Alternately it could be located on the east side of 24 Street in the median between 24 Street and Woodvale Crescent SW.



Traffic operations would need to be reviewed as the potential location for the bus left turn lane overlaps with the northbound left turn into the park and adjacent residential neighbourhood. With peak period 5-minute service planned, primarily at times when the park access is not heavily used, the situation can be managed.

The loop could provide a bus stop on the west side of 24 St SW, increasing the impact on the adjacent parking lot. Alternately the bus stop could be located on the curb side of northbound 24 St SW just north of the loop.

The station can be used by some buses in the local area, but is not ideally located to serve other routes without introducing a loop in the routing.

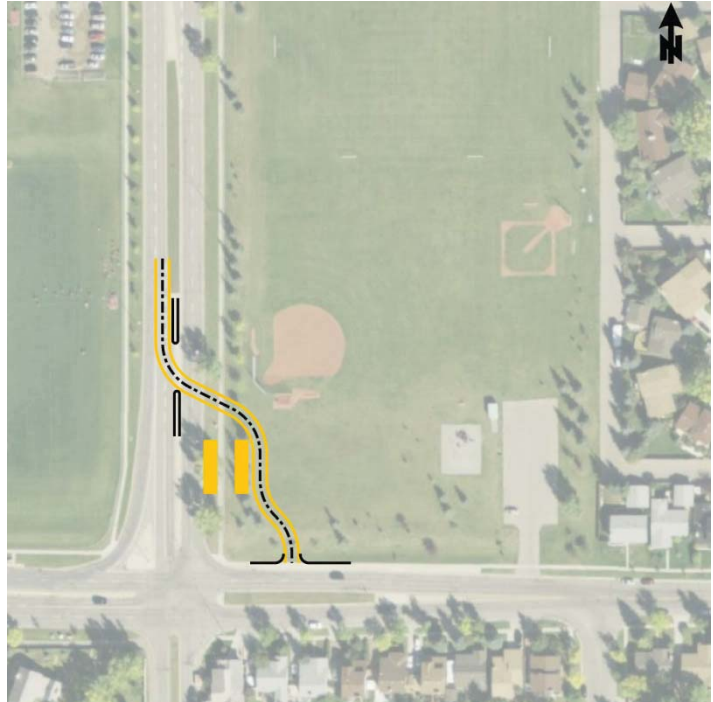
Option 3 – Southeast Park Loop

The Southeast Park Loop would be located in the south end of the park at the corner of 24 Street and Woodpark Boulevard SW. Buses would require a break in the median to turn into the exclusive turn-around area.

The terminal station would be located in the centre of the loop. If the station is matched with an on-street stop the terminal could serve the dedicated BRT route and other areas routes, however this requires a larger station and places the on-street station in an awkward location for other routes to access the station.

The open area to the east could be considered for neighbourhood Park and Ride activity and increase parking for park access. A more significant terminal station facility could be provided on this site.

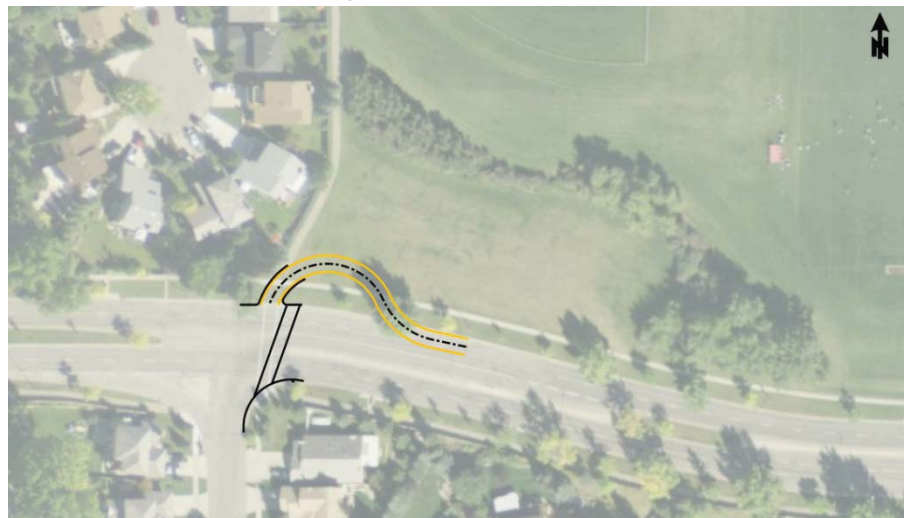
A bus stop could be provided inside the loop or on the curb side of northbound 24 St SW. The off-street stop would remove additional green space, but allow buses laying over to be boarded by passengers.



Option 4 – Southwest Park Loop

The turn-around loop would be located in the far southwest corner of the park. Buses would travel south on 24 Street and turn west onto Woodpark Boulevard SW. Towards the west end of the park, buses would enter into the bus-only loop. The terminal station would be located adjacent to the loop. A dedicated left turn out of the loop and onto eastbound Woodpark Boulevard SW would need to be provided, including a break in the median.

Ideally the exit would be lined up with Woodacres Drive SW, which would require minor changes to the intersection and



potentially a shift of the pedestrian crossing to the west side of the intersection. The station can be located in the park without changing the adjacent paved pathway connecting through the park to Woodfield Drive.

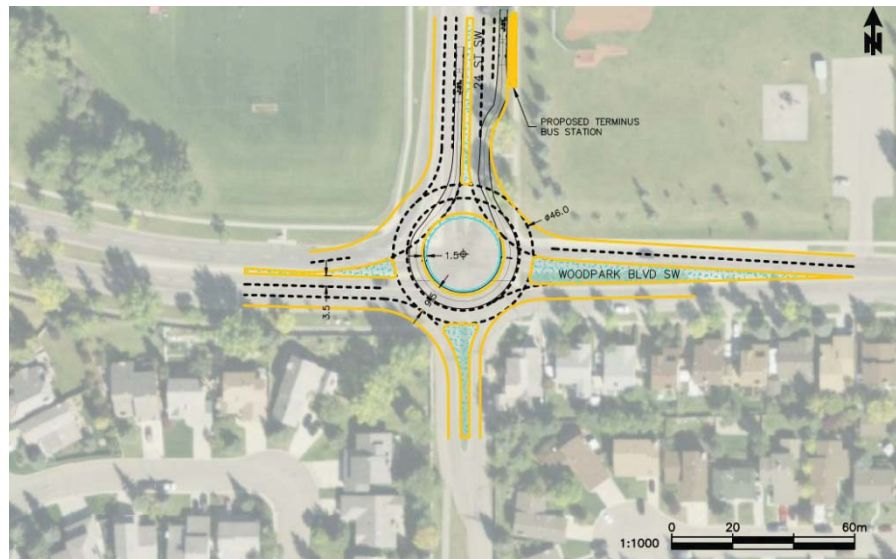
No stop would be provided at the loop. Buses would return to 24 St SW where the terminal stop would be located on the northbound curb side.

While this option is physically achievable it presents challenges for local road and pedestrian operations and would not provide a terminal station easily accessed by other local bus routes.

Option 5 – Roundabout at 24 Street SW and Woodpark Boulevard SW

The existing four-legged intersection would be converted to a roundabout to provide the turning radius for buses to enter from the north and exit back to the north. Buses travelling south would enter the roundabout and complete a full circle before returning north on 24 Street SW. The terminal stop could be located immediately north of the roundabout or at one of the locations described above for Option 2.

The physical space for the roundabout can be provided by encroaching on the open space north of Woodpark Boulevard SW. The operation of the roundabout and the effectiveness of the facility have not been reviewed as part of this analysis.



While this configuration is physically achievable the operational impact of the roundabout would need to be confirmed.

Conclusions

A number of potential routing and terminal station options are available for the south end of the BRT. Of the five options, Option 1 (Community Loop) and Option 3 (Southeast Park Loop) can be implemented with few issues and minimal infrastructure. The stations are also accessible to other local routes that may be created to take advantage of the BRT infrastructure.

Option 1 (Community Loop) requires introducing bus service on four blocks of Woodview Drive SW which do not have transit service today. The loop however could have additional

stops which would increase coverage and ridership. This option has the lowest required investment and the greatest future flexibility.

Option 3 (Southeast Park Loop) requires additional investment to create the loop, but offers much the same level of operational flexibility.

It is recommended that both of these options be carried forward into the next design stage to determine the most advantageous option to serve the areas adjacent to the park.

Southwest Bus Rapid Transit (SWBRT) – City of Calgary Order of Magnitude Cost Estimate

This memorandum summarizes the order of magnitude cost estimate developed for capital cost of Southwest Bus Rapid Transit (SWBRT) project. The proposed SWBRT route is approximately 20 km long (one-way) and involves a dedicated busway for an approximate length of 3.3 km and operates on the existing travel lanes or paved shoulder for the remainder of the route. The route is planned to service 35 bus stations that includes two bus stations for northbound and southbound service at fourteen locations, one terminal station in Woodbine and six bus stations within the downtown core. The major capital cost elements included in the estimate are:

- A dedicated new busway along the west edge of the 14 Street SW from Southland Drive SW to 75 Avenue SW,
- Re-alignment of a portion of the 14 Street Roadway to accommodate the busway within the existing ROW,
- An underpass structure for busway at 90 Avenue SW / 14 Street SW Intersection,
- Pathway connecting pedestrian crossing over 14 Street SW (located on North of Anderson Road) to Heritage Drive SW,
- 14 Street intersection modifications, and
- Bus stations.

It is to be noted that the SWBRT study is currently at a conceptual stage. While this level of study is adequate for the feasibility and functional assessment of a project, a more detailed engineering study and refinement of the project is required in order to ensure the accuracy of the cost estimates. Consequently, the cost estimate prepared at this stage must rely on a number of assumptions and the accuracy is generally in the order of $\pm 40\%$.

Listed below are the major assumptions/exclusions applicable to this cost estimate:

- Property acquisition, easements are not included in the estimate
- Environmental, ecological compensation costs are not included
- Geotechnical data including soil characteristics, surface & sub surface soil conditions, groundwater conditions are not available, and no geotechnical constraints are assumed for the new busway
- Construction staging, construction traffic control costs are not included
- Underpass bridge and pedestrian crossing structures are estimated at square meter of deck surface area

- Retaining wall cost is estimated at square meter of retained surface area
- Utility impact assessments have not been completed and a lump sum amount of \$500,000 is estimated to cover all underground utility relocations
- Existing drainage system on 14 Street is assumed to be able to handle the additional run-off from the new busway. However, a detailed assessment of the existing drainage system, including downstream capacity, will be required during the preliminary engineering and detailed design phases of this project in order to ensure that there is sufficient capacity in the existing storm sewer to convey the additional drainage resulting from the busway, as well as to confirm that no detention pond will be required.

The approach taken to estimate the construction cost included determination of the approximate quantity for major cost items based on the current conceptual plan for SWBRT and applying the appropriate unit costs. The items that could not be quantified due to the lack of necessary information are estimated on a lump sum basis. The unit costs used in the estimate represent current (2010) industry prices in Alberta. A summary of the estimated costs broken down into five segments are presented in the table below. The description of items included in the cost estimate for each of these segments are discussed in the subsequent paragraphs and the detailed cost estimate sheet including unit cost data are attached at the end of this memorandum.

SWBRT Segments	Estimated Construction Cost	Estimated Contingency 25%	Estimated Total Cost
24 Street Segment	\$1,924,118	\$481,030	\$2,405,148
Southland Drive Segment	\$1,099,295	\$274,824	\$1,374,119
14 Street Segment	\$15,214,268	\$3,803,567	\$19,017,835
Crowchild Trail Segment	\$3,547,885	\$886,971	\$4,434,856
Downtown Segment	\$1,890,647	\$472,662	\$2,363,309
TOTAL SWBRT	\$23,676,213	\$5,919,054	\$29,595,267
Preliminary & Detailed Engineering		15%	\$4,439,290
Construction Engineering & Mgmt		10%	\$2,959,527
ESTIMATED TOTAL CAPITAL COST (Excluding GST)			\$36,994,084

24 STREET SW SEGMENT

The SWBRT will share the existing travel lanes of 24 Street SW from the terminal station at Woodbine Park to Southland Drive. The cost estimate assumes no additional work on this road segment. The cost estimate includes the following items for this segment:

- Terminal station: The estimate assumes the North parking lot loop option for the terminal station. It allows for 4,000 sqm of paving for bus circulation and additional \$250,000 for intersection modification/widening for bus entry/egress on 24 Street SW.
- Bus station: The estimate assumes five bus stations in this segment, which include northbound and southbound bus stations at two locations on 24 Street SW and a terminal station. The engineering design of each of these individual bus stations has not been completed, and the estimate includes following items for each bus station.
 - 50m long bus bay,
 - Concrete platform (18mx3.3m),
 - Bus shelter,
 - Passenger information facilities,
 - Two ticket vending machines,
 - Illumination, and
 - Concrete walkways (100m) for pedestrian connectivity.

SOUTHLAND DRIVE SW SEGMENT

Similar to the 24 Street SW segment, the SWBRT will continue sharing the existing travel lanes of Southland Drive SW from 24 Street SW to just west of 14 Street SW where it will enter into the proposed dedicated busway. Thus, the cost estimate for this segment include only for the items associated with bus station, as follows:

- Bus station: There are four bus-stations (two stations in each direction) within this segment. The estimate assumes same cost elements for each bus station as listed previously for 24 Street SW segment bus station.

14 STREET SW SEGMENT

For this segment, the proposed BRT will run on a new dedicated busway, approximately 3.3 km long constructed along the west side of 14th Street from Southland Drive SW to Rockyview Hospital and will utilize existing ramps connecting 14th Street SW and Glenmore Trail. The cost estimate for this segment of BRT is based on the conceptual design dated November 2010.

Major cost components within this segment are:

- Construction of a 2-lane busway pavement consisting of 300mm SGBC, 300mm GBC, and 200mm ACP with concrete curb & gutter on both sides, and concrete barrier separating the busway from the adjacent 14 Street SW traffic.

- Realignment of 670m of 14 Street SW roadway between Heritage Drive SW and 75 Avenue SW
- Realignment of southbound 14 Street SW by reducing the median width for a length of 400m on north of Southland Drive Intersection in order to avoid impact to the property and sound attenuation wall on the west side of 14 Street SW
- A structure (30mx10m) for busway underpass at 90 Avenue including ramps to connect busway with 90 Avenue.
- Pedestrian pathway (2.5m wide) connecting pedestrian overpass North of Anderson Road to Heritage Drive
- Removal and reconstruction of the median pier and deck for the pedestrian crossing over 14 Street SW south of 75 Avenue SW
- Relocation of existing Glenmore Landing entrance
- Intersection modifications at 90 Avenue Intersection and Heritage Drive Intersection
- Retaining walls for underpass ramps at 90 Avenue and for busway near Southland Drive Intersection
- Drainage and utility works that include adjustment of catch basins, inlets and manholes, new catch basins and leads connecting drainage from busway to the existing 14 Street SW storm sewer trunk, and \$250,000 for pump station at the 90 Avenue /14 Street intersection.
- Relocation of light and power poles, signage and fencing.
- Six bus stations, three on each direction consisting of a (18mx3.3m) concrete bus platform, a bus shelter, passenger information facility, two ticket vending machines, sidewalks and illumination.
- The estimate allows for \$500,000 for landscaping, \$500,000 for miscellaneous utility relocations.

CROWCHILD TRAIL SEGMENT

This segment of the proposed SWBRT extends from 14 Street SW to Bow Trail SW. In this segment, the BRT is proposed to operate on the existing travel lanes or paved shoulders. Thus, the cost estimate assumes no additional works other than pavement markings for this segment except at bus stations where the pavement will be widened to allow for BRT buses to pull over and stop without restricting through traffic movement.

- Bus Stations: There are a total of twelve bus stations (six on each direction) in this segment. Since engineering design of individual stations has not been completed, the cost estimate assumes the same cost elements as listed previously for all bus stations within this segment.

- The cost estimate also allows for installation of stairs/ramp for pedestrian access to/from 17 Avenue SW to the NB bus station and improvement to the existing stairs to the southbound bus station.

DOWNTOWN SEGMENT

This segment includes the north turnaround loop for the SW BRT extending from Crowchild Trail SW to downtown. In this segment, the proposed SWBRT will utilize the existing travel lanes of Bow Trail SW, 9 Avenue SW, 1 Street SE and 6 Avenue SW, and no additional work on pavement is assumed in the cost estimate.

- Bus Station: Out of the total of eight bus stations in this segment, six are within the downtown core area where road widening will not be possible due to ROW constraint.

For these six downtown core stations, the estimate allows for the following items:

- Replacement of concrete sidewalks,
- Installation of passenger information facilities,
- Two ticket vending machines, and
- Light standards for illumination.

And for the remaining two stations located on 16 Street, the cost estimate also allows for following additional items:

- A bus bay and
- Walkways for pedestrian connections.

Attachments:

1. SWBRT – Order of Magnitude Cost Estimate
2. Unit Cost Data and Derived Unit Prices of Major Elements

City of Calgary
 Southwest Bus Rapid Transit
 Order of magnitude Cost Estimate - Jan 2011

WBS	Description	Unit	Estimated Quantity					Estimated Unit Cost	Extended Cost
			Length	Width	Thk	number	Quantity		
SEGMENT 1. 24TH ST									
1 Bus Stations - Five \$ 1,374,118.75									
1.1	Removals	m2	100	7		5	3,500	\$ 10.00	\$ 35,000.00
1.2	Asphalt Pavement for Busbay	m2	100	3.5		5	1,750	\$ 74.13	\$ 129,718.75
1.3	Curb & Gutter	m	100			5	500	\$ 100.00	\$ 50,000.00
1.4	Concrete Platform	m2	18	3.3		5	297	\$ 200.00	\$ 59,400.00
1.5	Bus Shelter	ea				5	5	\$ 150,000.00	\$ 750,000.00
1.6	Passenger Information	ea				10	10	\$ 10,000.00	\$ 100,000.00
1.7	TVM (Including conduit & power)	ea				10	10	\$ 5,000.00	\$ 50,000.00
1.8	Ped Walkways Connections	m2	100	1.5		5	750	\$ 100.00	\$ 75,000.00
1.9	Illumination	ls				5	5	\$ 25,000.00	\$ 125,000.00
2 Woodbine Park Terminal Station \$ 550,000.00									
2.1	Paving for Bus Circulation	m2	100	40			4,000	\$ 75.00	\$ 300,000.00
2.2	24th Street access/egress Modification	ls				1	1	\$ 250,000.00	\$ 250,000.00
SUBTOTAL - SEGMENT 1								\$	1,924,118.75
SEGMENT 2. SOUTHLAND DRIVE									
1 Bus Stations - Four \$ 1,099,295.00									
1.1	Removals	m2	100	7		4	2,800	\$ 10.00	\$ 28,000.00
1.2	Asphalt Pavement for Busbay	m2	100	3.5		4	1,400	\$ 74.13	\$ 103,775.00
1.3	Curb & Gutter	m	100			4	400	\$ 100.00	\$ 40,000.00
1.4	Concrete Platform	m2	18	3.3		4	238	\$ 200.00	\$ 47,520.00
1.5	Bus Shelter	ea				4	4	\$ 150,000.00	\$ 600,000.00
1.6	Passenger Information	ea				8	8	\$ 10,000.00	\$ 80,000.00
1.7	TVM (Including conduit & power)	ea				8	8	\$ 5,000.00	\$ 40,000.00
1.8	Ped Walkways Connections	m2	100	1.5		4	600	\$ 100.00	\$ 60,000.00
1.9	Illumination	ls				4	4	\$ 25,000.00	\$ 100,000.00
SUBTOTAL - SEGMENT 2								\$	1,099,295.00
SEGMENT 3. 14TH STREET SEGMENT									
1 Demolitions & Removals \$ 220,156.25									
1.1	Clearing & Grubbing	ls				1	1	\$ 50,000.00	\$ 50,000.00
1.2	Earth Excavation & Disposal	m3					17,016	\$ 10.00	\$ 170,156.25
2 Busway \$ 2,847,721.61									
2.1	New Pavement for Busway - Southland Dr to Rockyview Hospi	m	2155				2,155	\$ 1,147.78	\$ 2,473,455.13
2.2	Busway Connecting Ramps at 90 Ave	m2	305	5			1,525	\$ 143.47	\$ 218,794.61
2.3	Connecting Road Glenmore ramp to RV Hospital Road	m2	200	5			1,000	\$ 143.47	\$ 143,471.88
2.3	Signage	ea				6	6	\$ 2,000.00	\$ 12,000.00
3 14 St Realignment \$ 3,168,413.00									
3.1	Realigned Pavement - Heritage Dr to 75 Ave	m	670				670	\$ 3,579.90	\$ 2,398,533.00
3.2	Realigned SB Pavement - N of Southland Dr to S of 90 Ave	m	400				400	\$ 1,924.70	\$ 769,880.00
4 Bus Stations - Six \$ 1,391,280.00									
4.1	Concrete Platform	m2	18	3.3		6	356	\$ 200.00	\$ 71,280.00
4.2	Bus Shelter	ea				6	6	\$ 150,000.00	\$ 900,000.00
4.3	Passenger Information	ea				12	12	\$ 10,000.00	\$ 120,000.00
4.4	TVM (Including conduit & power)	ea				12	12	\$ 5,000.00	\$ 60,000.00
4.5	Ped Walkways connections	m2	100	1.5		6	900	\$ 100.00	\$ 90,000.00
4.6	Illumination	ls				6	6	\$ 25,000.00	\$ 150,000.00
5 Structures \$ 4,183,500.00									
5.1	90 Ave Underpass Structure	m2 (deck)	30	10			300	\$ 4,000.00	\$ 1,200,000.00
5.2	Ped Crossing-S of 75 Ave.(Replacement of med pier & deck)	m2 (deck)	48	2.25			108	\$ 4,500.00	\$ 486,000.00
5.3	90 Ave Underpass Retaining Walls	m					1,050	\$ 1,350.00	\$ 1,417,500.00
5.4	Southland Dr. Retaining Wall	m	400	2			800	\$ 1,350.00	\$ 1,080,000.00
6 Drainage \$ 542,500.00									
6.1	Catch Basin Adjustments	ea				25	25	\$ 1,500.00	\$ 37,500.00
6.2	Manhole Adjustments	ea				15	15	\$ 2,000.00	\$ 30,000.00
6.3	Stormsewer adjustments	ls				1	1	\$ 150,000.00	\$ 150,000.00
6.4	Sanitary Sewer Adjustments	ls				1	1	\$ 75,000.00	\$ 75,000.00
6.5	Pump Station at 90 Ave/14th St Int.	ls				1	1	\$ 250,000.00	\$ 250,000.00

WBS	Description	Unit	Estimated Quantity					Estimated Unit Cost	Extended Cost
			Length	Width	Thk	number	Quantity		
7 Utility Relocations									
								\$ 625,000.00	
	7.1 Light Poles	ea				40	40	\$ 2,500.00 \$ 100,000.00	
	7.2 Power Poles & Lines	ea				5	5	\$ 5,000.00 \$ 25,000.00	
	7.3 Miscellaneous Utility Relocations	ls				1	1	\$ 500,000.00 \$ 500,000.00	
8 90 Avenue Intersection Modifications									
								\$ 132,896.88	
	8.1 Demolition & removals	m2	305	4			1,220	\$ 10.00 \$ 12,200.00	
	8.2 New Pavement	m2	775				775	\$ 74.13 \$ 57,446.88	
	8.3 Curb & Gutter	lm	400				400	\$ 100.00 \$ 40,000.00	
	8.4 Conc. Sidewalk/Island	m2	155	1.5			233	\$ 100.00 \$ 23,250.00	
9 Glenmore Landing Access Relocation									
								\$ 103,887.50	
	9.1 Demolition & removals	m2	1000				1,000	\$ 10.00 \$ 10,000.00	
	9.2 New Pavement	m2	700				700	\$ 74.13 \$ 51,887.50	
	9.3 Curb & Gutter	lm	270				270	\$ 100.00 \$ 27,000.00	
	9.4 Conc. Sidewalk/Island	m2	100	1.5			150	\$ 100.00 \$ 15,000.00	
10 Heritage Drive Intersection Modifications									
								\$ 266,412.50	
	10.1 Demolition & removals	m2	400				400	\$ 10.00 \$ 4,000.00	
	10.2 New Pavement	m2	100				100	\$ 74.13 \$ 7,412.50	
	10.3 Curb & Gutter	lm	100				100	\$ 100.00 \$ 10,000.00	
	10.4 Conc. Sidewalk/Island	m2	450				450	\$ 100.00 \$ 45,000.00	
	10.5 Traffic Signal Modifications	ls				1	1	\$ 200,000.00 \$ 200,000.00	
11 Landscaping									
		LS				1	1	\$ 500,000.00 \$ 500,000.00	
12 Miscellaneous									
								\$ 1,232,500.00	
	12.1 Pathway - Heritage Dr to Ped Overpass North of Anderson Rd.	m2	3000	2.5			7,500	\$ 75.00 \$ 562,500.00	
	12.1 CPR - Model Train Relocations	ea	1				1	\$ 50,000.00 \$ 50,000.00	
	12.2 Signage Relocations - Two Post	ea	8				8	\$ 5,000.00 \$ 40,000.00	
	12.3 Fence Relocation	m	1000				1,000	\$ 50.00 \$ 50,000.00	
	12.4 Relocation of Sound Attenuation Wall	m	360				360	\$ 500.00 \$ 180,000.00	
	12.5 Guardrail Relocation	m	500				500	\$ 500.00 \$ 250,000.00	
	12.6 Pavement Markings	LS				1	1	\$ 100,000.00 \$ 100,000.00	
SUBTOTAL - SEGMENT 3								\$ 15,214,267.73	
SEGMENT 4. CROWCHILD TRAIL SEGMENT									
1 Bus Stations - Twelve									
								\$ 3,297,885.00	
	1.1 Removals	m2	100	7		12	8,400	\$ 10.00 \$ 84,000.00	
	1.2 Asphalt Pavement for Busbay	m2	100	3.5		12	4,200	\$ 74.13 \$ 311,325.00	
	1.3 Curb & Gutter	m	100			12	1,200	\$ 100.00 \$ 120,000.00	
	1.4 Concrete Platform	m2	18	3.3		12	713	\$ 200.00 \$ 142,560.00	
	1.5 Bus Shelter	ea				12	12	\$ 150,000.00 \$ 1,800,000.00	
	1.6 Passenger Information	ea				24	24	\$ 10,000.00 \$ 240,000.00	
	1.7 TVM (Including conduit & power)	ea				24	24	\$ 5,000.00 \$ 120,000.00	
	1.8 Ped Walkways Connections	m2	100	1.5		12	1,800	\$ 100.00 \$ 180,000.00	
	1.9 Illumination	ls				12	12	\$ 25,000.00 \$ 300,000.00	
2 Crowchild /17 Ave Bus Stations									
								\$ 250,000.00	
	2.1 Ped Access Ramp/Staircase - NB Bus Station	m2	150	2			300	\$ 500.00 \$ 150,000.00	
	2.2 Improvements on existing ped Stairs - SB Bus Station	ls				1	1	\$ 100,000.00 \$ 100,000.00	
SUBTOTAL - SEGMENT 4								\$ 3,547,885.00	
SEGMENT 5: DOWNTOWN SEGMENT									
1 Downtown Core Bus Stations -Six									
								\$ 1,341,000.00	
	1.1 Removals	m2	25	4		6	600	\$ 10.00 \$ 6,000.00	
	1.2 Curb & Gutter	m	25			6	150	\$ 100.00 \$ 15,000.00	
	1.3 Concrete Sidewalks/Platform	m2	25	3		6	450	\$ 200.00 \$ 90,000.00	
	1.4 Bus Shelter	ea				6	6	\$ 150,000.00 \$ 900,000.00	
	1.5 Passenger Information	ea				12	12	\$ 10,000.00 \$ 120,000.00	
	1.6 TVM (Including conduit & power)	ea				12	12	\$ 5,000.00 \$ 60,000.00	
	1.7 Illumination	ls				6	6	\$ 25,000.00 \$ 150,000.00	

WBS	Description	Unit	Estimated Quantity					Estimated Unit Cost	Extended Cost
			Length	Width	Thk	number	Quantity		
1 16th Street Bus Stations - Two								\$ 549,647.50	
1.1	Removals	m2	100	7		2	1,400	\$ 10.00	\$ 14,000.00
1.2	Asphalt Pavement for Busbay	m2	100	3.5		2	700	\$ 74.13	\$ 51,887.50
1.3	Curb & Gutter	m	100			2	200	\$ 100.00	\$ 20,000.00
1.4	Concrete Platform	m2	18	3.3		2	119	\$ 200.00	\$ 23,760.00
1.5	Bus Shelter	ea				2	2	\$ 150,000.00	\$ 300,000.00
1.6	Passenger Information	ea				4	4	\$ 10,000.00	\$ 40,000.00
1.7	TVM (Including conduit & power)	ea				4	4	\$ 5,000.00	\$ 20,000.00
1.8	Ped Walkways Connections	m2	100	1.5		2	300	\$ 100.00	\$ 30,000.00
1.9	Illumination	ls				2	2	\$ 25,000.00	\$ 50,000.00
SUBTOTAL - SEGMENT 5								\$ 1,890,647.50	
TOTAL SWBRT - SEGMENT 1 TO 5								\$ 23,676,213.98	
CONTINGENCY								25%	\$ 5,919,053.50
ESTIMATED TOTAL CONSTRUCTION COST FOR SWBRT								\$ 29,595,267.48	
PROFESSIONAL SERVICES COST									
PRELIMINARY & DETAILED ENGINEERING								15%	\$ 4,439,290.12
CONSTRUCTION ENGINEERING & MANAGEMENT								10%	\$ 2,959,526.75
GRAND TOTAL - SWBRT PROJECT CAPITAL COST								\$ 36,994,084.35	

Notes/Assumptions:

- Quantity estimate is based on the conceptual plan - 14 St SW Recommended.dwg dated October 2010.
- Estimate assumes re-alignment of 14 St from Heritage Dr. to 75 Ave and re-alignment of SB 14 St for 400m segment between Southland Dr and 90 Ave.
- Property requirement, easement etc. are NOT included in the estimate.
- Unit prices represent the prevailing industry and construction prices in Alberta for 2010 and do not include GST.
- Construction staging, traffic control costs are NOT included in the cost estimate
- Pavement structure for Busway is assumed to consist of 300mm of SGBC, 300mm of GBC and 200mm of ACP with concrete curb & gutter on both sides and concrete barrier separating the opposing traffic.
- The estimate assumes relocation of median pier and replacement of deck for the ped crossing located on south of 75 Ave; and utilization of existing end piers and ramps.
- The estimate assumes North parking lot loop option for terminal station and allows for paving required for bus circulation.

City of Calgary
 Southwest Bus Rapid Transit (SWBRT)
 Order of magnitude Cost Estimate - Jan 2011

UNIT COST DATA (2010)

Item	Unit	Unit Cost	Item	Unit	Unit Cost
Topsoil Stripping & Removal	m2	\$ 5.00	Underpass Structure	m2 (Deck)	\$ 4,000.00
Earth Excavation and Removal	m3	\$ 10.00	Ret. Walls	m2	\$ 1,350.00
Concrete Removal	m2	\$ 10.00	Concrete Platform	m2	\$ 200.00
Pavement Removal	m2	\$ 10.00	Bus Shelter	ea	\$ 150,000.00
Subgrade Preparation	m2	\$ 5.00	TVM	ea	\$ 5,000.00
SGBC	m3	\$ 15.00	Conc. Sidewalks	m2	\$ 100.00
GBC	t	\$ 15.00	Curb & Gutter	lm	\$ 100.00
ACP	t	\$ 100.00	Conc. Barrier - Divider	lm	\$ 250.00

DERIVED UNIT COSTS FOR MAJOR COST ELEMENTS

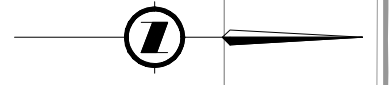
1 New Busway									
Items	Unit	L	B	T	Factor	Quantity	Unit Price	Amount	
Topsoil Stripping & Removal	m2	1	15			1	15 \$ 5.00	\$ 75.00	
Earth Excavation and Removal	m3	1	10.2	0.8		1	8.16 \$ 10.00	\$ 81.60	
SGBC	m3	1	10.2	0.3		1	3.06 \$ 15.00	\$ 45.90	
GBC	t	1	10.2	0.3	2.25	6.885	\$ 15.00	\$ 103.28	
ACP	t	1	8	0.2	2.45	3.92	\$ 100.00	\$ 392.00	
Curb & Gutter	lm	2				2	\$ 100.00	\$ 200.00	
Conc. Barrier - Divider	lm	1				1	\$ 250.00	\$ 250.00	
Cost Per m of Busway								\$ 1,147.78	
Cost Per Sqm of Busway								\$ 143.47	

2 Modification on Existing Pavement									
Items	Unit	L	B	T	Factor	Quantity	Unit Price	Amount	
Pavement Removal	m2	1	1			1	\$ 15.00	\$ 15.00	
GBC	t	1	1	0.3	2.25	0.675	\$ 15.00	\$ 10.13	
ACP	t	1	1	0.2	2.45	0.49	\$ 100.00	\$ 49.00	
Cost Per Sqm of AC Pavement Modification								\$ 74.13	

3 14 St Realignment - Heritage Dr to 75 Avenue - 660m									
Items	Unit	L	B	T	Factor	Quantity	Unit Price	Amount	
Concrete Removal	m2	1	4			1	\$ 10.00	\$ 40.00	
Pavement Removal	m2	1	30			1	\$ 10.00	\$ 300.00	
Topsoil Stripping & removal	m2	1	15			1	\$ 5.00	\$ 75.00	
Earth Excavation & removal	m3	1	10.2	0.8		1	\$ 8.16	\$ 81.60	
Subgrade Preparation	m2	1	10.2			1	\$ 5.00	\$ 51.00	
SBGC	m3	1	15.2	0.3		1	\$ 4.56	\$ 68.40	
GBC	t	1	15.2	0.3	2.25	10.26	\$ 15.00	\$ 153.90	
ACP	t	1	40	0.2	2.45	19.6	\$ 100.00	\$ 1,960.00	
Curb & Gutter	lm	6				6	\$ 100.00	\$ 600.00	
Conc. Barrier - Divider	lm	1				1	\$ 250.00	\$ 250.00	
Cost Per m of Re-aligned Roadway								\$ 3,579.90	

4 14 St Realignment - N of Southland Dr to S of 90 Ave - 400m									
Items	Unit	L	B	T	Factor	Quantity	Unit Price	Amount	
Concrete Removal	m2	1	2			1	\$ 10.00	\$ 20.00	
Pavement Removal	m2	1	8			1	\$ 10.00	\$ 80.00	
Earth Excavation & removal	m3	1	10.2	0.8		1	\$ 8.16	\$ 81.60	
Topsoil Stripping & removal	m2	1	15			1	\$ 5.00	\$ 75.00	
Subgrade Preparation	m2	1	10.2			1	\$ 5.00	\$ 51.00	
SBGC	m3	1	15.2	0.3		1	\$ 4.56	\$ 68.40	
GBC	t	1	15.2	0.3	2.25	10.26	\$ 15.00	\$ 153.90	
ACP	t	1	15.2	0.2	2.45	7.448	\$ 100.00	\$ 744.80	
Curb & Gutter	lm	4				4	\$ 100.00	\$ 400.00	
Conc. Barrier - Divider	lm	1				1	\$ 250.00	\$ 250.00	
Cost Per m of Re-aligned Roadway								\$ 1,924.70	

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NOTE:
CONCEPT PLAN ONLY,
SUBJECT TO REVISION.

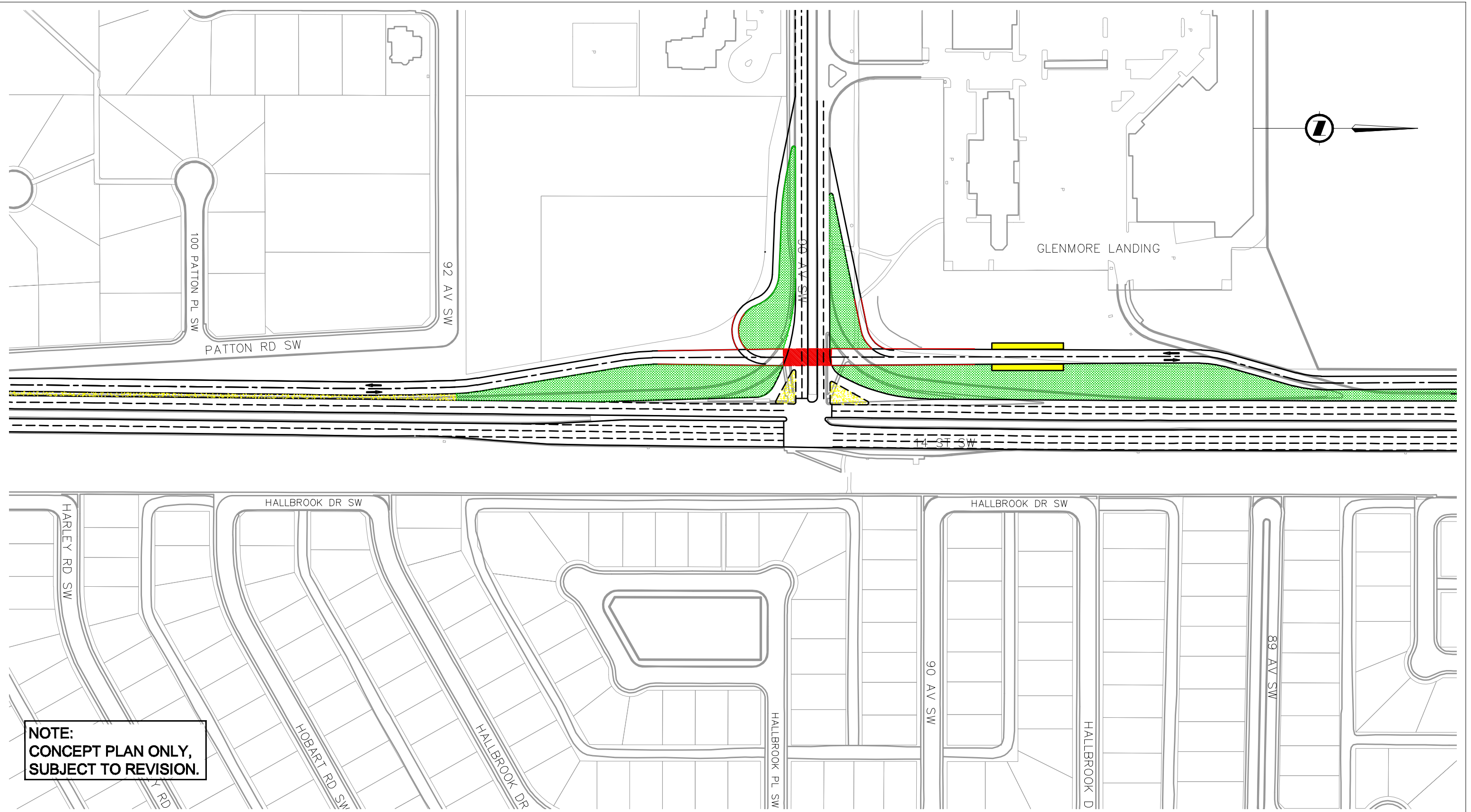
OCTOBER, 2010

CALGARY SW BRT 14 ST SW DRAFT PLAN (SOUTHLAND DR SW)

SCALE 1:2000
 20m 0 40m



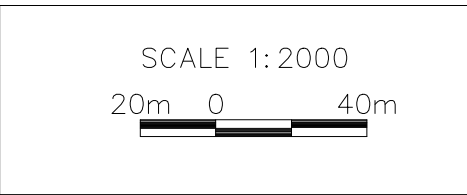
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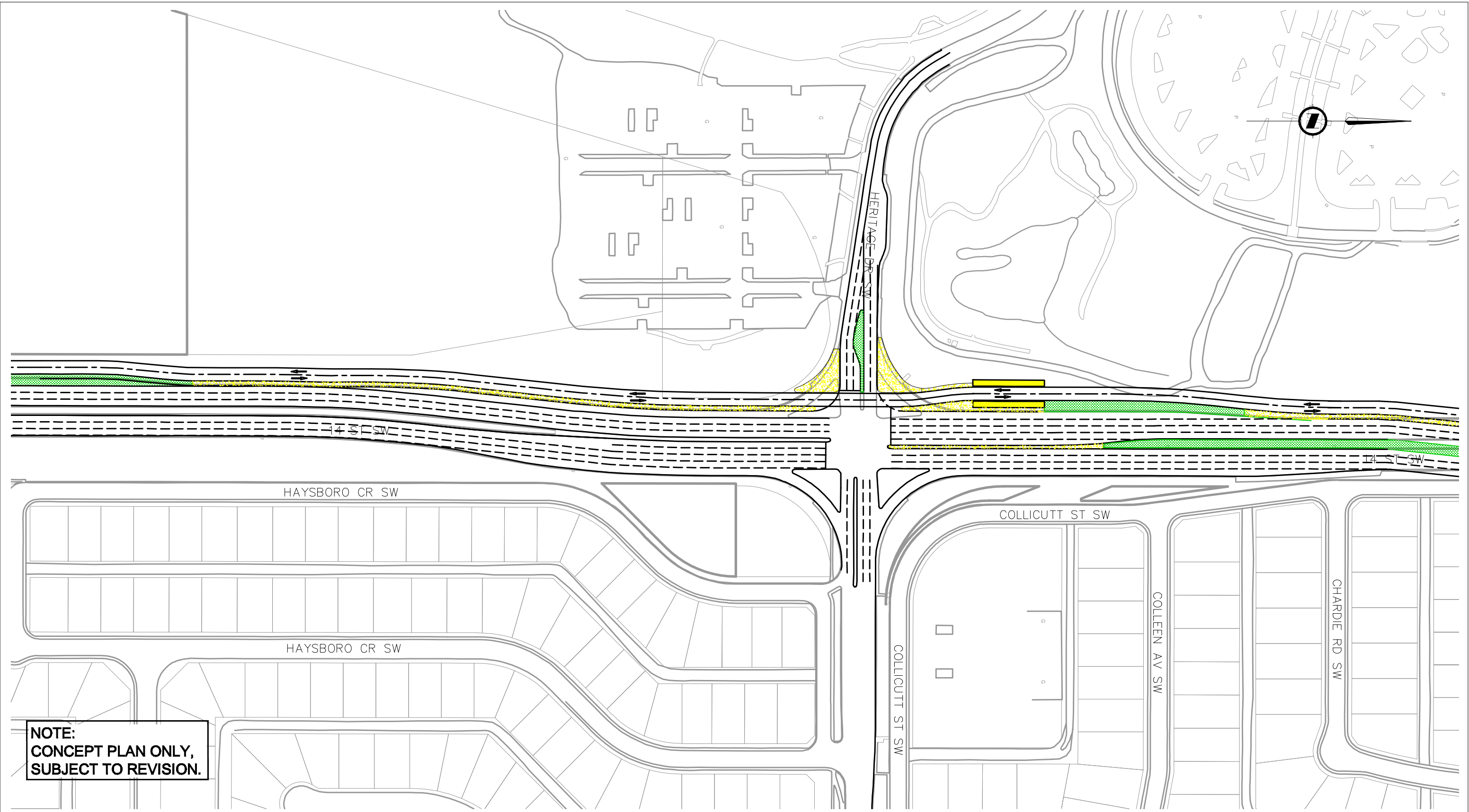
NOTE:
CONCEPT PLAN ONLY,
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OCTOBER, 2010

CALGARY SW BRT 14 ST SW DRAFT PLAN (90 AVE SW)



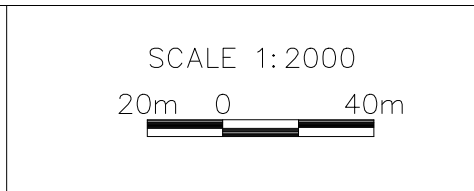
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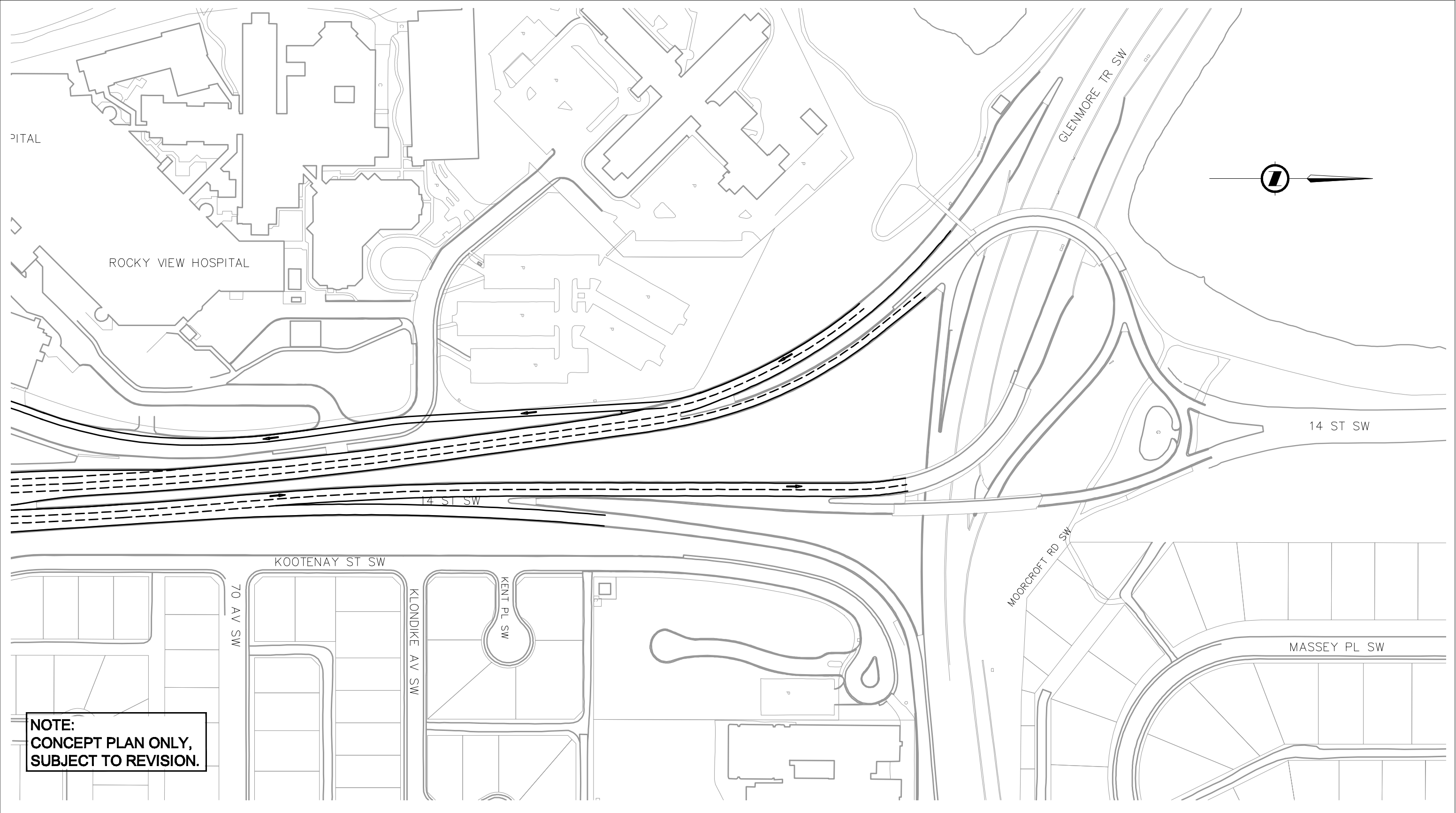
**NOTE:
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OCTOBER, 2010

CALGARY SW BRT 14 ST SW DRAFT PLAN (HERITAGE DR SW)



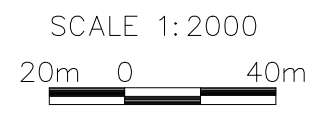
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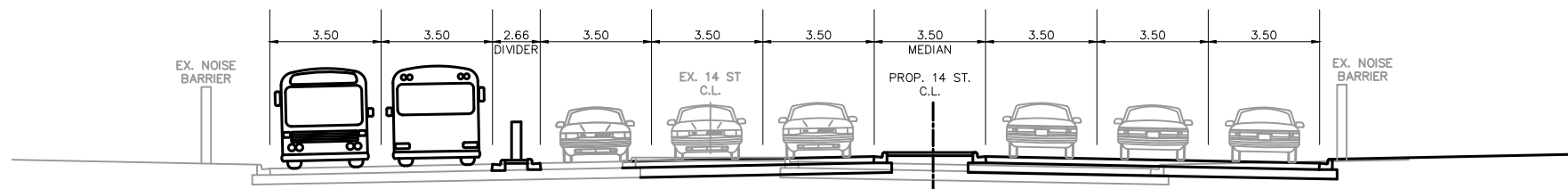
**NOTE:
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OCTOBER, 2010

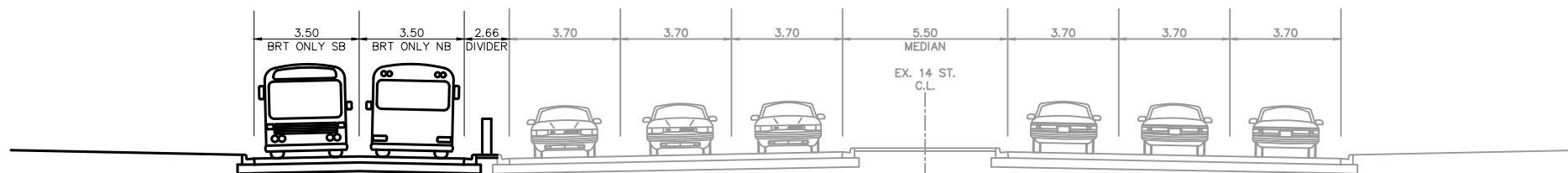
CALGARY SW BRT 14 ST SW DRAFT PLAN (NORTH END OF ROCKYVIEW HOSPITAL)



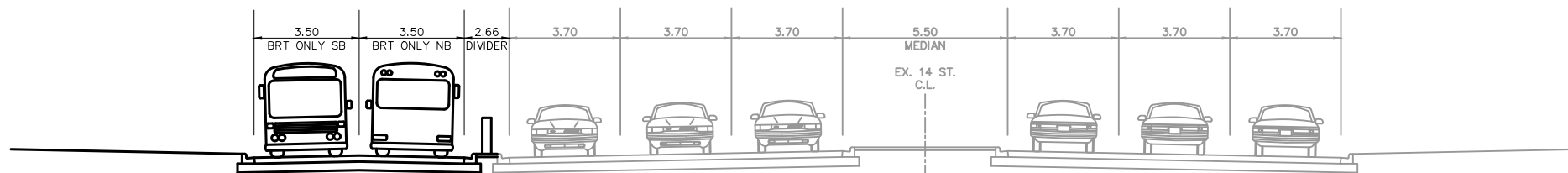
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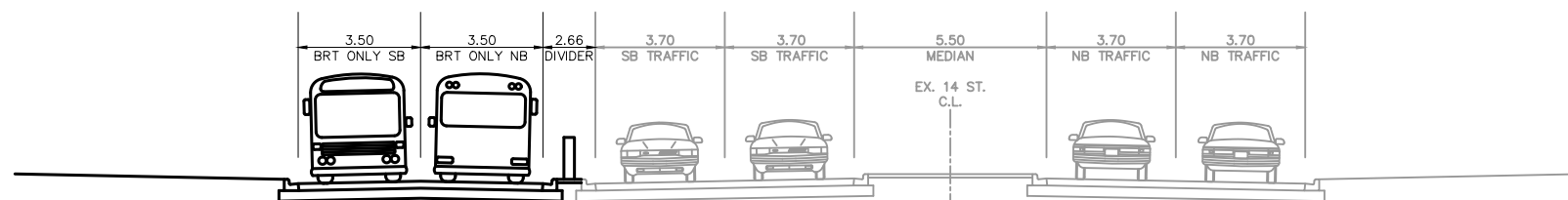
14 ST SW TYPICAL CROSS SECTION (HERITAGE DR SW TO ROCKYVIEW HOSPITAL, REALIGNMENT REQUIRED)



14 ST SW TYPICAL CROSS SECTION (HERITAGE DR SW TO ROCKYVIEW HOSPITAL, NO REALIGNMENT)



14 ST SW TYPICAL CROSS SECTION (90 AVE SW TO HERITAGE DR SW)



14 ST SW TYPICAL CROSS SECTION (SOUTHLAND DR SW TO 90 AVE SW)

NOTE:
CONCEPT PLAN ONLY,
SUBJECT TO REVISION.

OCTOBER, 2010

CALGARY SW BRT 14 ST SW DRAFT PLAN TYPICAL CROSS SECTIONS

