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Green Line LRT

Centre City Multiple Account Evaluation **Summary Report**



May 2016

Green Line Centre City Multiple Account Evaluation Summary Report

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Green Line Centre City Multiple Account Evaluation Summary Report

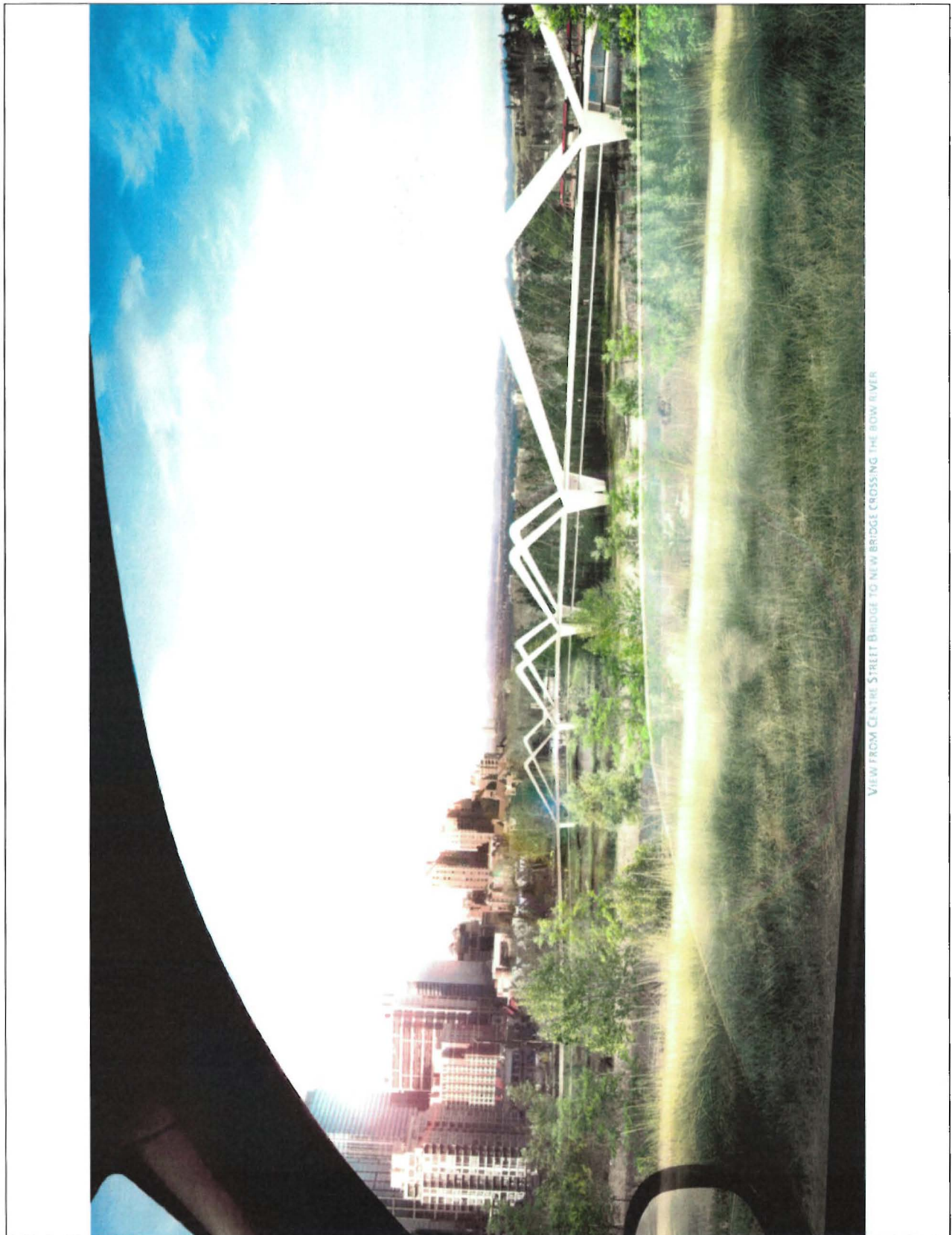
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VIEW FROM CENTRE STREET BRIDGE TO NEW BRIDGE CROSSING THE BOW RIVER

Executive Summary

MULTIPLE ACCOUNT EVALUATION

The five Centre City options were evaluated using a set of technical, financial, economic, environmental and community-focused criteria. A multiple account evaluation (MAE) process was developed to understand, evaluate and compare the relative benefits, opportunities, challenges and trade-offs between the options. The list of accounts and criteria used in the evaluation was reviewed and approved by Council prior to undertaking the evaluation, with each account weighted equally against the next.

One of the key questions for the Green Line project is how to best cross the Bow River and integrate the Green Line LRT in the Centre City. Five potential alignment options for the connection through the Centre City have been examined, as directed by City Council in 2015: using the Centre Street Bridge (Option A), a new bridge over the Bow River, and Prince's Island Park (Options B, C, and E), and a fully tunnelled option (Option D).

PUBLIC ENGAGEMENT

From 2015 November, through 2016 February, the Project Team met with community and business leaders, property owners, developers and the public to identify the opportunities, challenges and trade-offs that needed to be considered in the evaluation of the five options. Participants had an opportunity to learn about each option and to provide input on what needed to be considered.

In 2016 April, the Project Team reported back to stakeholders on the results of the comparative evaluation of the Centre City options and obtained additional input for further consideration and evaluation. Participants were presented with the evaluation process, examples of the look and feel associated with each option, and the benefits and challenges of each option.

An interactive graphic presentation of the evaluation results was installed at Olympic Plaza. Pop-up displays with information about the options were hosted at nine locations in the downtown, Beltline, and communities north of the Bow River. The City's online engage portal was promoted as a way to learn more about the options, provide input, and watch a video showing each of the options.

Public response to the evaluation criteria was generally positive, with the majority of participants supporting the evaluation framework. Numerous comments have been received about the holistic and comprehensive approach to the evaluation suggesting that it has accurately captured the interests of the community and businesses.

Public response to the highest ranking option, the fully tunnelled option (Option D), has been favourable. Comments collected throughout all events noted that a tunnelled alignment was preferable as it was viewed to cause the least amount of disruption to communities and the environment.

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HIGHEST RANKED ALIGNMENT – OPTION D

This option features a tunnel under the Bow River that continues underground in City Centre (see conceptual image below).

In this option a significant portion of the alignment and stations are underground in a deep tunnel. After leaving the Beltline, the LRT descends into tunnel south of the CPR tracks that continues north along 2 Street SW, under the Bow River, and surfaces north of approximately 20 Avenue N. Overall this option includes 3.4 kilometres of tunnel.

Below Grade Stations:

- 16 Avenue N Station
- 9 Avenue N Station
- 7 Avenue SW Station
- 2 Avenue SW Station

The Beltline alignment options along 10 Avenue S, 11 Avenue S, and 12 Avenue S are still under evaluation.



For Discussion Purposes Only

Green Line LRT

Centre City Alignment Option Evaluation Results Summary

Evaluation Accounts	Option A	Option B	Option C	Option D Highest Ranked	Option E
 Financial Capacity An affordable and cost effective service. Costs are achievable, sustainable in the long term and provide good value for money.					
 Community Well-being A safe and socially inclusive service that improves access to key community destinations and provides transportation choices for Calgarians.					
 Transportation A high priority transit service that attracts transit use, walking & cycling as preferred mobility choices for Calgarians. An integrated service that improves customer experience, meets future demand and strengthens the regional & local transit networks.					
 Urban + Neighbourhood Development A service that supports current and future land use, development along the corridor, and integrates with neighbouring communities.					
 Sustainable Environment A service that reduces greenhouse gases and minimizes impact to the existing natural environment.					
 Feasibility + Deliverability A service that can be constructed and operated without significant technical issues or constraints.					
 Stakeholders A service that reflects the values and priorities of communities.					
 OVERALL All Criteria	 	 		     	

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NEXT STEPS

Throughout the summer of 2016, Administration will work on refining cost estimates for all the options, including further analysis of the economic impacts and opportunities of each option, including integration with existing and proposed developments and cost refinement. Administration will then bring forward a recommendation to Council on the Centre City route in September 2016. After Council approval of the highest ranked option, the public engagement will continue with more certainty, the design will be refined and optimized, and risks and cost estimates will be advanced to provide additional information, and more certainty. The recommended option for the Centre City will not preclude any corridor options in the Beltline.

The Beltline corridor evaluation will also be completed in late fall of 2016, and the alignment (elevated, underground, or street level) will be determined in winter 2016. Once a corridor has been selected, the Green Line team will work towards integrating the Centre City and Beltline routes in the surrounding communities.

PROGRESS UPDATE

The following work has been completed to date on the Centre City.

- ✓ Continued engagement with key stakeholders including developers, community members, and transit users
- ✓ Technical refinement of route options recommended by Council in 2014
- ✓ Evaluation of Centre City route options through a Multiple Account Evaluation process (MAE)
- ✓ Development of options to integrate the LRT into the Beltline community
- ✓ Report back to Council on the recommended option for the Centre City

NEXT STEPS

- Functional design progression for the highest ranked option
- Validated cost and risk evaluation for the highest ranked option to increase cost certainty
- Evaluation of the options in the Beltline
- Report back to Committee in fall of 2016 with the recommended Centre City option
- Report back to Committee in late fall of 2016 with a recommended corridor to integrate the LRT into the Beltline community

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Green Line Centre City Multiple Account Evaluation Summary Report

1 WE ARE HERE

The Green Line is Calgary's next light rail transit (LRT) line. It will be 40 kilometres long and will nearly double the size of our current LRT network. The Green Line is more than just a transit project; it will improve the way we live, work, play and move in the city by helping to create sustainable, livable and vibrant communities.

End-to-end, the line will connect the Northern Hills communities in the north and Seton in the southeast to City Centre, and is estimated to serve 41 million passengers annually. The Green Line program is comprised of three segments: Green Line Southeast, Green Line Centre City and Green Line North. Green Line North is 15 kilometres long running from North Pointe to 4 Street SE through the Beltline, while the south leg is an additional 25 kilometres.

The Centre City will serve as the connection between the north central and southeast communities of the Green Line. The integration of the Green Line through the Centre City will provide a new north / south LRT route along 2 Street SW in the Downtown Core, with a connection to the existing Red and Blue LRT lines.

Assessing how to best cross the Bow River and integrate the Green Line in the Centre City is one of the key questions for the project. Five potential alignment options for the connection through the Centre City have been examined, an elevated option, a fully tunnelled option, a Centre Street Bridge option, an at-grade option and a hybrid option, as recommended by Council in 2015.

OUR CHALLENGE

In the Centre City there are several constraints and competing mobility priorities. Our challenge is to find the best way to cross the Bow River and connect the Green Line with communities in the Centre City.



FIGURE 1 GREEN LINE ALIGNMENT

Green Line Centre City Multiple Account Evaluation Summary Report

CONNECTING THE BELTLINE

Our assessment of the five options recommended by Council determined that special consideration is required for the Beltline. Several options for integrating within the Beltline include different configurations for the LA7 and road network on 10 Avenue S, 11 Avenue S, and 12 Avenue S east of 2 Street SW. The complexity of the options in the Beltline warrant a separate MAE that will be carried out to refine suitable options for the Beltline community as the Green Line story continues.

2015 MILESTONES

As the Green Line story has been unfolding, the team has met several key milestones noted below. An overall project timeline is also summarized on the following page.

- Engaged key stakeholders at several public events
- Completed the evaluation using the MAE process for the Centre City (excluding the Beltline)
- Undertook preliminary geotechnical and environmental investigations

In 2013, the Green Line team assessed approximately 20 alternatives for crossing the Bow River and integrating the Green Line into the Downtown Core. After evaluation, four options were presented to Council for additional study. In 2014, Council approved five options for additional study, and public engagement.

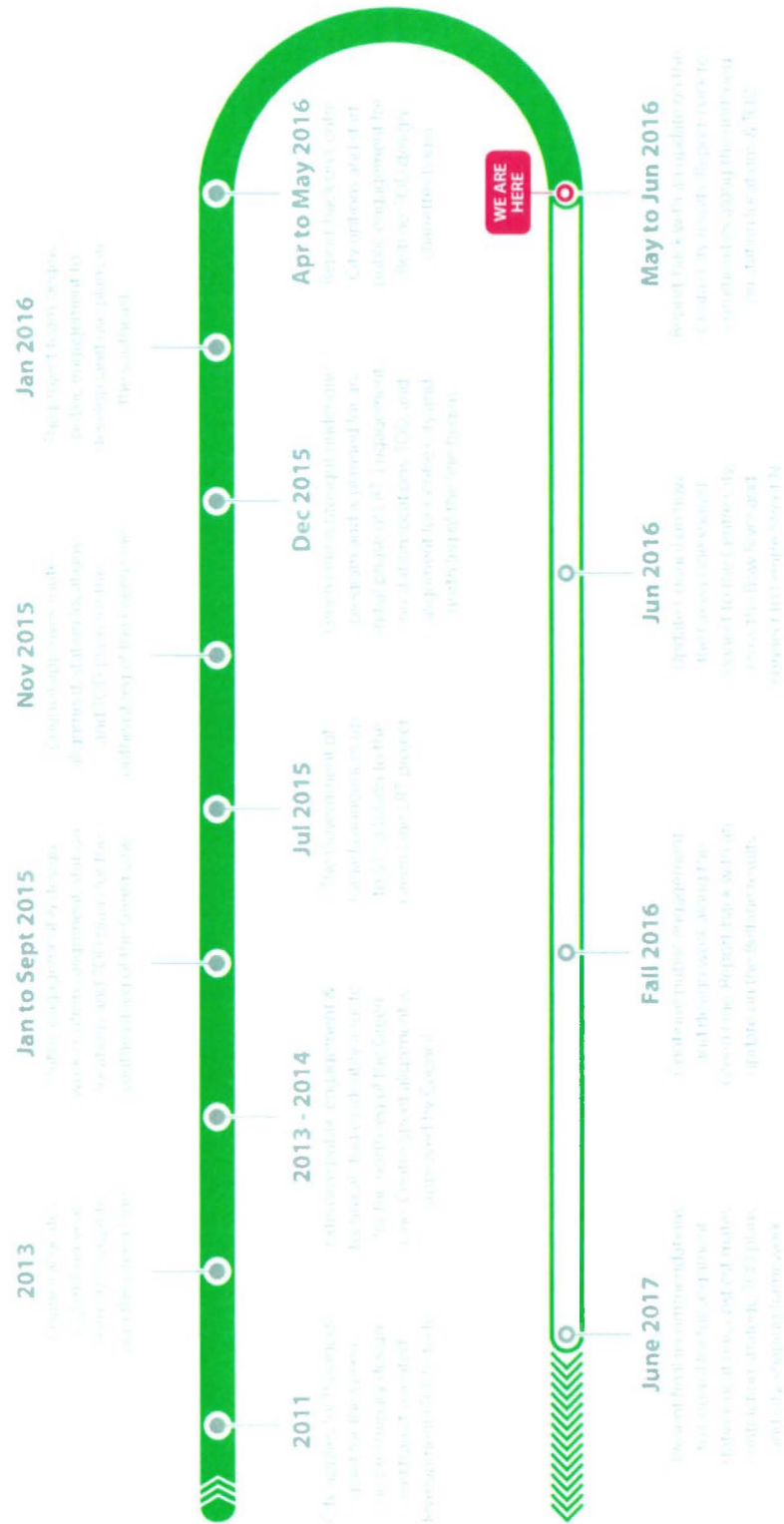
The five Centre City options were evaluated using a set of technical, financial, economic and community-focused criteria. A Multiple Account Evaluation (MAE) process was developed to understand, evaluate and compare the relative benefits, opportunities, challenges and trade-offs between the options. The list of accounts and criteria used in the evaluation was reviewed and approved by Council in 2015 December, prior to undertaking the evaluation, with each account weighted equally against the next.

The evaluation of the criteria for the Centre City options is one important piece of a larger evaluation process. Additional factors that will support a final recommendation include:

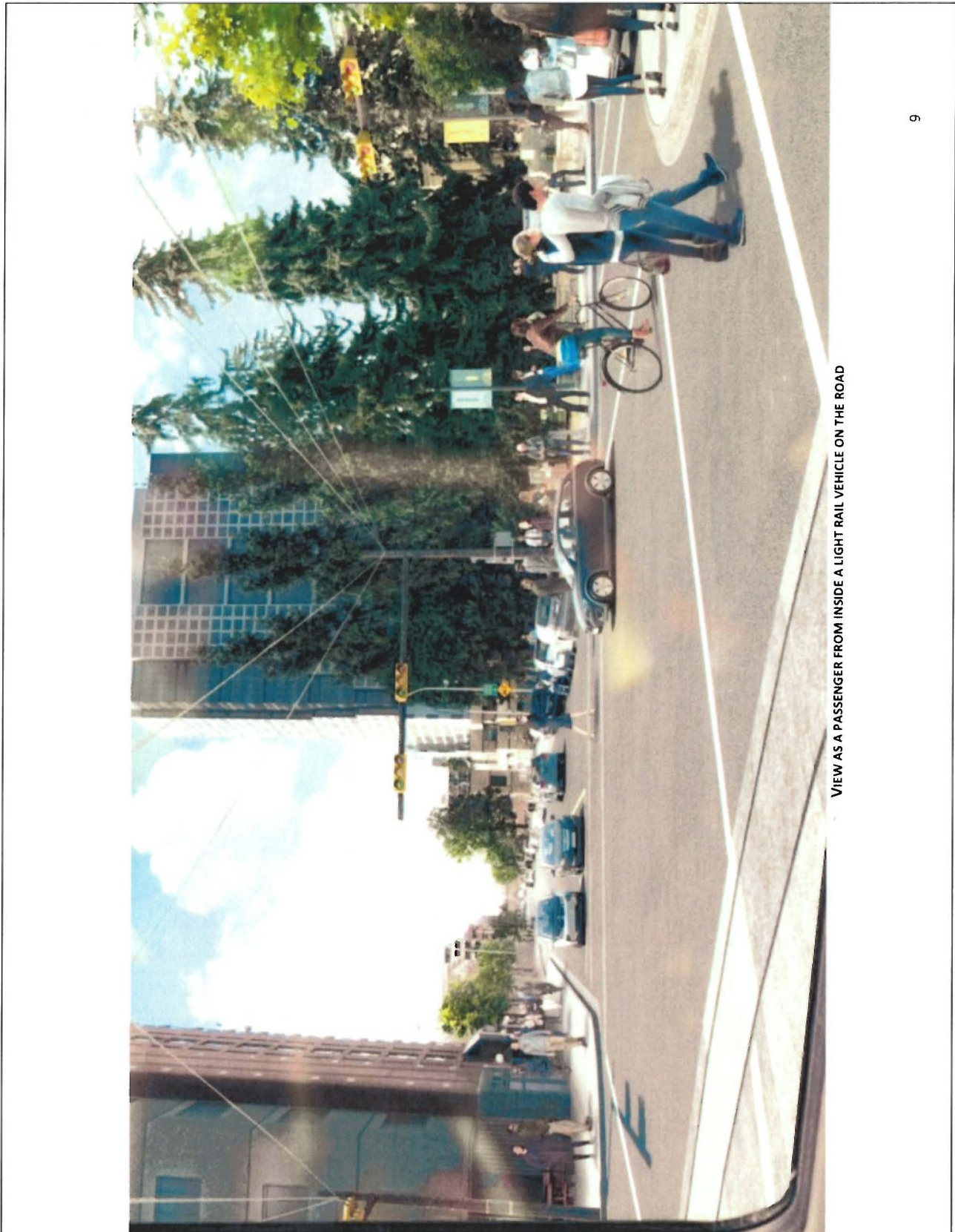
- Feedback from the public, downtown stakeholders and surrounding communities.
- Assessment of economic impacts and opportunities.

Green Line Centre City Multiple Account Evaluation Summary Report

Green Line LRT: Project timeline



Green Line Centre City Multiple Account Evaluation Summary Report



Green Line Centre City Multiple Account Evaluation Summary Report

2 STUDY AREA

The study area for the Centre City evaluation extends from 4 Street SE to 24 Avenue N on Centre Street as shown in Figure 2. The alignment along Centre Street north of the Bow River was previously approved by Council in the 2014 study. As the alignment heads south into the downtown, it shifts west onto 2 Street SW and turns east south of the Canadian Pacific Railway (CPR) tracks into the Beltline. As previously noted there are several options for the Beltline including 10 Avenue S, 11 Avenue S, and 12 Avenue S which will be studied in a separate MAE.

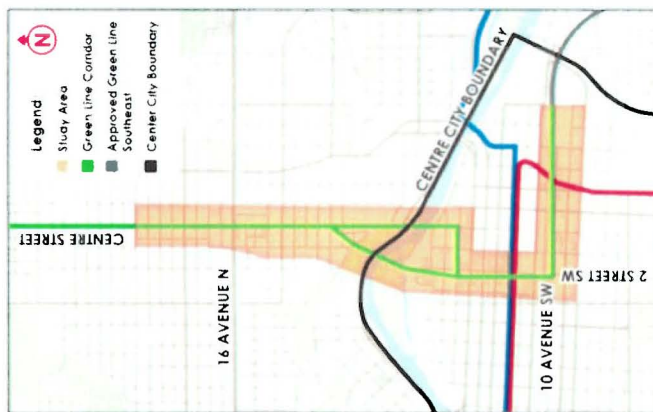


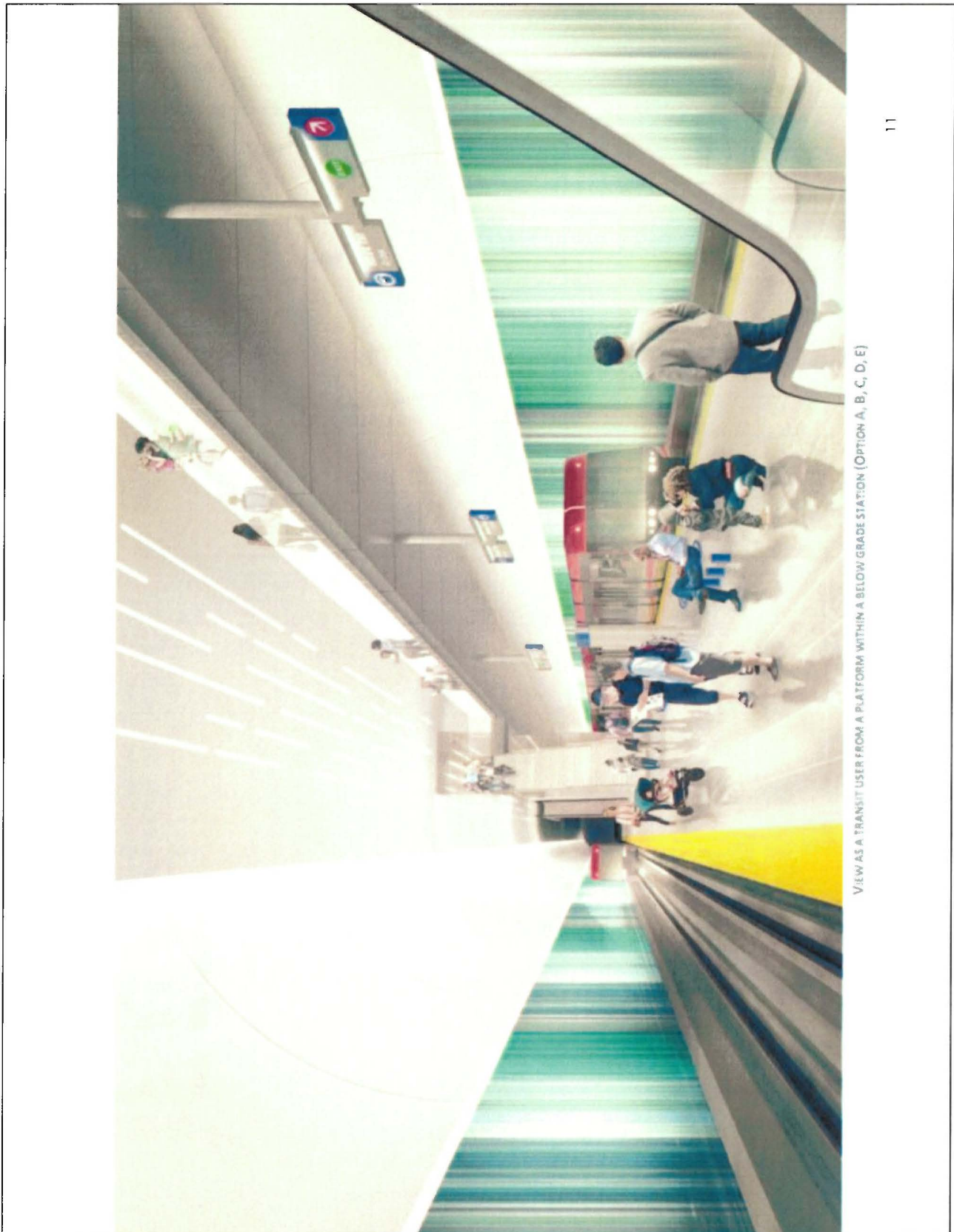
FIGURE 2 CENTRE CITY STUDY AREA

Figure 3 shows the boundary of the Centre City from 17 Avenue S to the Bow River and from the Elbow River to 14 Street SW. For the purposes of the evaluation of the Centre City, the study area was extended to include a section of Centre Street N up to 24 Avenue N (as shown in Figure 2). This is largely due to the influence that the river crossing configuration has on Centre Street north of the Bow River. For example, in options where a new bridge crossing is proposed over Prince's Island park the vertical alignment of the bridge dictates if the station proposed at 9 Avenue N is underground or on surface. The details of the options will be further outlined in Section 3.



FIGURE 3 CENTRE CITY COMMUNITIES

Green Line Centre City Multiple Account Evaluation Summary Report



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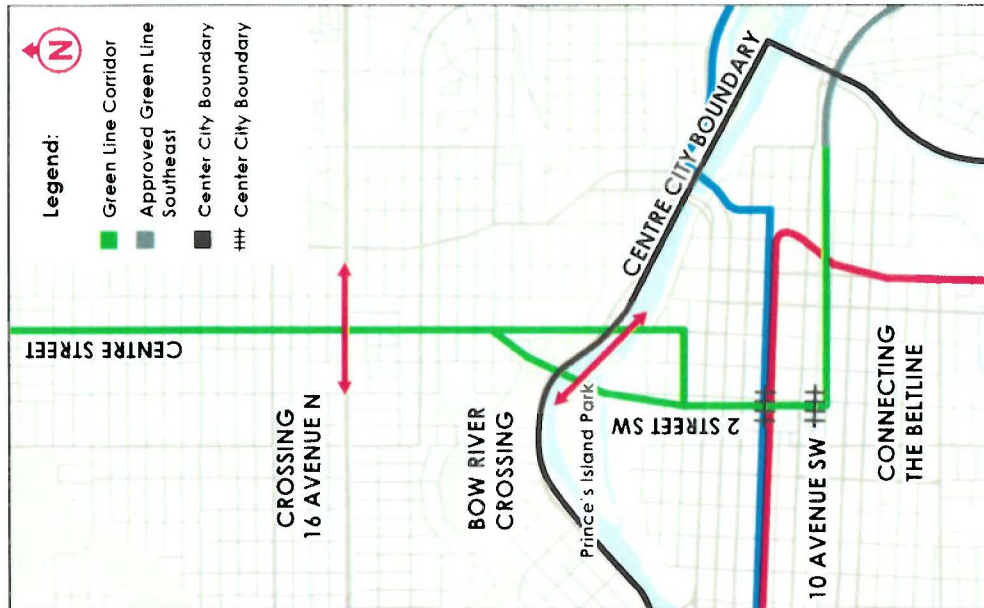


FIGURE 4 CENTRE CITY CONSTRAINTS

3 CENTRE CITY OPTIONS

Each route has different opportunities, and constraints. Some of the challenges include:

- Crossing the Canadian Pacific Railway (CPR) tracks
- Crossing the LRT tracks on 7 Avenue S that serve the Red and Blue Lines
- Crossing the future Red Line tunnel under 8 Avenue S
- Crossing busy east-west downtown avenues (4 Avenue, 5 Avenue, and 6 Avenue)
- Environmental impacts in the Bow River valley
- 16 Avenue N/Trans-Canada Highway crossing
- Future crossing of the Red Line tunnel

In these locations, it was necessary to grade separate in all options to minimize the disruption to the surrounding urban fabric of communities in the Centre City and along Centre Street N.

The area that varied significantly across all options was the Bow River crossing which dictated the alignment possibilities from approximately 3 Avenue SW to 12 Avenue N. Figure 4 shows where these constraints are within the study area and also highlights where the options have the greatest difference in their alignments.

The following section outlines the options. Due to the similarities between the options, a comparison of the number of underground stations and length of tunneling required for each option is also included to better represent the differences between the options.

A CHALLENGING URBAN CONTEXT

Due to the constraints within the Centre City, such as the major east-west road connections and Canadian Pacific Railway, within the Centre City, all of the options feature a grade separation of the LRT at 16 Avenue N to optimize transit and traffic operations, and at the CPR tracks between 9 and 10 Avenue S.

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3.1 OPTION A

This option features a surface running connection from Crescent Heights to the downtown using the existing Centre Street bridge. This option only includes one station downtown, because it is not technically feasible to have a station in Chinatown.

From the north, the LRT is surface running on Centre Street then descends under 16 Avenue N where there is an underground station. The LRT ascends out of the tunnel at approximately 12 Avenue N, and stops at a surface station around 9 Avenue N. The LRT continues on surface, using the existing Centre Street bridge, before making tight turns at 3 Avenue SW, and descending into a tunnel on 2 Street SW. There is no opportunity for a station in the Chinatown community due to technical constraints. There is an underground station at 7 Avenue SW to connect to the existing Red and Blue Lines. The LRT continues under the CPR tracks to connect to any of the Beltline options currently being considered. Overall, this option includes 1.6 kilometres of tunnel.

Surface Stations:

- 9 Avenue N Station

Underground Stations:

- 7 Avenue SW Station
- 16 Avenue N Station



3.2 OPTION B

This option features a shallow tunnel from approximately 20 Avenue N to the Bow River and a new bridge over Prince's Island Park.

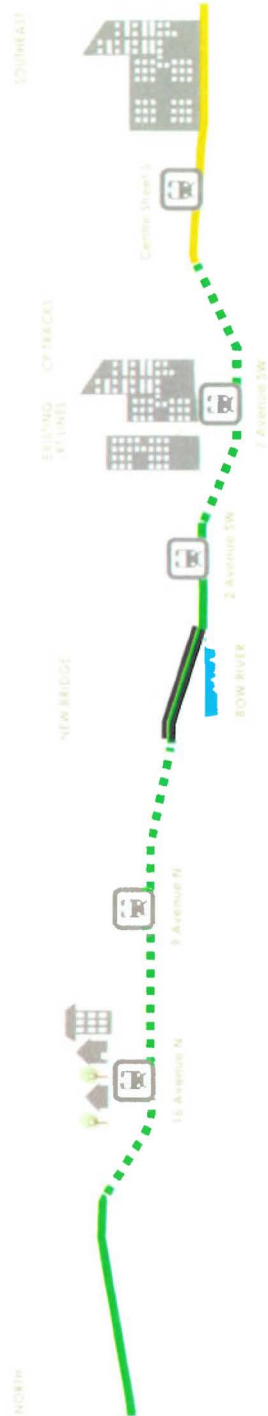
From the north, the LRT is surface running then descends under 16 Avenue N where there is an underground station. The LRT continues underground with a second underground station at 9 Avenue N. In the tunnel the LRT turn towards the McHugh Bluffs and transitions from the tunnel to a new bridge crossing the Bow River and Prince's Island Park. The LRT descends to 2 Street SW on the surface with a surface station at 2 Avenue SW. The LRT then descends into a second tunnel south to the CPR tracks with an underground station at 7 Avenue SW connecting the Red and Blue Lines. The LRT continues under the CPR tracks to connect to any of the Beltline options currently being considered. Overall this option includes 2.3 kilometres of tunnel.

Surface Stations:

- 2 Avenue SW Station

Underground Stations:

- 7 Avenue SW Station
- 9 Avenue N Station
- 16 Avenue N Station



3.3 OPTION C

This option features a shallow tunnel from approximately 20 Avenue N to the Bow River and an elevated guideway in downtown.

From the north, the LRT is surface running on Centre Street then descends into a tunnel under 16 Avenue N where there is an underground station. The LRT continues underground with a second underground station at 9 Avenue N. In the tunnel the LRT turn towards the McHugh Bluffs and transitions from the tunnel to a new bridge crossing the Bow River and Prince's Island Park. The LRT continues elevated through the downtown along 2 Street SW with elevated stations at 2 Avenue SW and 7 Avenue SW connecting the Red and Blue Lines. The LRT continues over the CPR tracks to connect to the 10 Avenue S Beltline option. Overall this option includes 1.6 kilometres of tunnel.

Elevated Stations:

- 7 Avenue SW Station
- 2 Avenue SW Station

Underground Stations:

- 9 Avenue N Station
- 16 Avenue N Station



3.4 OPTION D

This option features a tunnel under the Bow River and is underground in the downtown. This option best address the trade-offs presented in the evaluation criteria, and aligns with the themes shared by the public.

From the north, the LRT is surface running then descends under 16 Avenue N where there is an underground station. The LRT continues underground with a second underground station at 9 Avenue N. In the tunnel the LRT turn towards the McHugh Bluffs and continues in a tunnel under the Bow River. The LRT remains in a tunnel in the downtown along 2 Street SW with underground stations at 2 Avenue SW and 7 Avenue SW. The underground 7 Avenue SW station connects to the Red and Blue Lines. The LRT continues under the CPR tracks to connect to any of the Bellline options currently being considered. Overall this option includes 3.3 kilometres of tunnel.

Underground Stations:

- 7 Avenue SW Station
- 2 Avenue SW Station
- 9 Avenue N Station
- 16 Avenue N Station



3.5 OPTION E

This option is a hybrid of Option A and B and features a new bridge over the Bow River.

From the north, the LRT is surface running then descends under 16 Avenue N where there is an underground station. The LRT ascends out of the tunnel at approximately 12 Avenue N, and stops at a surface station around 9 Avenue N. The LRT continues on surface and turns onto a new bridge over the Bow River and Prince's Island Park. The LRT transitions from the new bridge to surface running into the downtown with a stop at 2 Avenue SW. The LRT then descends into a second tunnel south to the CPR tracks with an underground station at 7 Avenue SW connecting the Red and Blue Lines. The LRT continues under the CPR tracks to connect to any of the Beltline options currently being considered. Overall this option includes 1.5 kilometres of tunnel.

Surface Stations:

- 2 Avenue SW Station
- 9 Avenue N Station

Underground Stations:

- 7 Avenue SW Station
- 16 Avenue N Station



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4 PUBLIC ENGAGEMENT

The Centre City engagement strategy focused on stakeholder input regarding community expectations, issues, concerns and interests in the alignment options. Stakeholders included business and community leaders, area residents, downtown employees and Calgarians from other areas of the city.

Stakeholder engagement began in late 2015, and continued to May 2016. The stages of engagement are shown in Figure 5, and included workshops, presentations, open house events, meetings and on-line engagement opportunities. Options for the Centre City had also previously been identified in the 2013/2014 Corridor Study, and provided a starting point for Phase 1 of this engagement stream.

Table 1 identifies the main activities and events that provided the public with an opportunity for input to the evaluation framework and criteria for the Centre City options. On-line engagement is becoming increasingly popular for the Green Line project with the number of visits increasing as more people become aware of the Green Line and the Centre City options. Approximately 40% of the Engage website visits are to the Centre City page. The Engage Portal will continue to be used and promoted to encourage engagement on the options for Green Line in the Centre City and the Beltline.

Additional information on the phases of the engagement process is outlined in the following section.

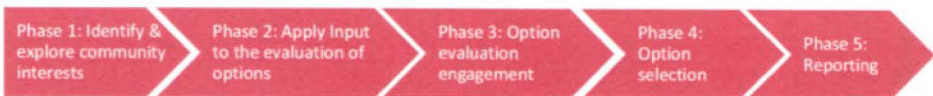


FIGURE 5 ENGAGEMENT PROCESS

Table 1 Centre City Engagement Summary

Date	Event	Attendees
2015 Nov 24	Crescent Heights/Chinatown/Eau Claire Community Association	15
2015 Dec 08	Centre City Business/Community Leaders	50
2016 Jan 06	Hillhurst-Sunnyside/Crescent Heights/Eau Claire	20
2016 Jan 20	Baconfest	100
2016 Feb 02	Open House #1 - Telus Convention Centre	100
2016 Feb 03	Open House #2 - St. Henry School	100
2016 Feb 09	Open House #3 - Rosedale School	180
2016 Feb 10	Open House #4 - Mount View School	160
2016 Feb 16	Open House #5 - Thorncliffe School	250
2016 Feb 20	Chinatown community event	130
2016 Mar 10	Tuxedo Park AGM	50
2016 Mar 16	Station Area Workshop #1	70
2016 Apr 18	Centre City Business/Community Leaders	30
2016 Apr 18 - Apr 28	Olympic Plaza Centre City MAE and lunch hour events	1190
2016 Apr 18 - May 6	Beltline and Centre City MAE pop-up events	
2016 April 18 - May 6	Beltline and Centre City MAE online engagement via the engage portal	2660
2016 May 25	Beltline Neighbourhoods Association AGM	50
2016 May 25	Beltline development industry	5
2016 May 26	City-shaping speaker series	30
2016 June 1	Beltline Information Session	110
	TOTAL Number of Participants	5300

Green Line Centre City Multiple Account Evaluation Summary Report

PHASE 1 - IDENTIFY AND EXPLORE COMMUNITY INTERESTS

The objective of Phase 1 was to obtain input from stakeholders on the criteria for evaluating the Centre City options. Stakeholder input was incorporated into the evaluation criteria.

From 2015 November through 2016 February, the project team met with community and business leaders, property owners and developers, and the public to identify the opportunities, challenges and trade-offs. Participants had an opportunity to learn about each option and to provide input on what needed to be considered in the evaluation. Input received from stakeholders was combined into the following themes:

- **Connectivity**
Promote connections to and from community destinations and downtown retail, tie in with public transit, and minimize conflicts with existing forms of mobility/transportation options. Participants also noted that the LRT alignment should not divide a community at street level. The elevated alignment option was considered a key challenge in the Centre City, potentially constraining connectivity and other forms of mobility.
- **Travel Time**
Evaluate options for fast and efficient travel times, such that the LRT is an attractive option for users and encourages ridership.
- **Accessibility**
Barrier free and easily accessible for seniors, people with disabilities and all Canadians.
- **Safety**
Promote safe behaviour for people accessing and using the LRT and crime prevention.

- **Transit Oriented Development (TOD) and Urban Realm Benefits**
Consider options that allows for TOD and improvements to public spaces and art. This also includes addressing affordable housing needs in communities. Stations should be designed to create a 'sense of place' in the community. They should attract people and 'animate' the downtown and Beltline.
- **Environmental Considerations**
Minimize impact on the environment, including natural areas and views particularly around Prince's Island Park. Promote benefits such as energy efficiency, reduced greenhouse gas emissions and reduced traffic congestion.
- **Traffic Implications**
Address impact on traffic flow in and around communities, access restrictions (residential and business), parking by people accessing the LRT and loss of parking for businesses along Centre Street.

The concept of low floor LRT was well received in the community. Participants were more supportive of an underground option in the Centre City, and less supportive of an elevated guideway through the downtown because of the impact to buildings, the +15 network, and visual impacts. Many participants also expressed concern about the potential impact of a bridge across Prince's Island, and the visual impact to the Bow River valley. Participants from the Chinese Community, who attended the February 20, 2016 presentations, commented that at grade options (e.g., Option A) would have a significant impact on Chinatown and the safety of pedestrians. A number of participants commented that they favoured Option D, the underground option, over the surface or the bridge options.

PHASE 2 - OPTION EVALUATION

The objective for Phase 2 was to first incorporate public input from Phase 1 into the framework for evaluating the Centre City options, and then to conduct the evaluation to show how each of the options met the criteria in the framework. This process was largely an internal planning process, but included internal engagement with City staff technical experts representing many business units. This Phase provided the information to take forward once again to the public for their information and input in Phase 3.

PHASE 3 - OPTION EVALUATION ENGAGEMENT – THE CENTRE CITY EXPERIENCE

The objective of Phase 3 was to report back the results of the comparative evaluation of the Centre City options and to obtain further feedback on any gaps in the analysis. Participants emerged with an understanding of how options were evaluated, the 'experience' associated with each option, along with specific benefits and challenges.

Graphic animation and the use of Google Cardboard 3D imagery were developed to provide participants with the experience associated with each option. Animation video and imagery was used at public events and pop up displays enabling participants to see and understand how different options would fit into the community. This allowed all participants to share a similar understanding and experience for each of the five options, promoting input based on a common understanding of the options. Additional information on this approach is provided in the next section.

To obtain input on the evaluation, a second business and community leader workshop was held, along with an interactive graphic presentation of the options evaluation at Olympic Plaza. Pop-up displays with information about the options were held at nine locations in the Centre City, and The City's Engage website was promoted as a way to learn more about the options and to provide input.

PHASE 3 ENGAGEMENT RESULTS

Public response to the evaluation process and criteria used was positive, with the majority of participants supporting the evaluation framework. Numerous comments were received about the holistic and comprehensive approach to the evaluation suggesting that it has accurately captured the interests of the community and businesses identified in Phase 1.

NEXT STEPS

Further consultations are being planned with community and business organizations in the Centre City to obtain further input on the option evaluations and to identify any additional considerations.

PHASE 4 - OPTION SELECTION

The objective of Phase 4 is to present the comparative evaluation of the Centre City options to City Council. The outcome is that Calgarians will understand why a preferred option is selected, and the benefits it provides to the City.

Community outreach and a communications program will be implemented to ensure businesses, employees and residents in the Centre City are well informed about the option evaluation and why the preferred option has been selected. This will include communicating the results of the evaluation using social media and the project website.

4.1 CENTRE CITY EXPERIENCE

Throughout the early phases of the engagement process, stakeholders indicated that the technical schematics shown in Section 3 required additional explanation to highlight the impact of the options in the Calgary context. Additionally, individuals had different perceptions of what the five options would look like. As a result of this feedback, and as previously outlined in Phase 3 of the Centre City engagement process, an animation video was developed in order to translate technical information into a form that can depict the human experience, and demonstrate how Calgarians interact with each of the options. Three different perspectives were produced for each of the five options to demonstrate what they would look like if you were a:

- Person using public transit
- Person walking
- Person in a vehicle

Specific locations along the alignment were used to depict the three perspectives. The views selected include the following:

- Along 2 Street SW to depict the perspective from the transit user above the road, and pedestrians and motorists below the guideway at street level
- In the Beltline to depict the LRT on surface from the transit user, pedestrian, and motorist perspectives
- On Centre Street & 9 Avenue N to depict the LRT on surface from the transit user, pedestrian, and motorist perspectives
- On Centre Street & 9 Avenue N to depict the LRT underground from the transit user, pedestrian, and motorist perspectives
- At McHugh Bluffs to depict the new bridge over the Bow River, and Prince's Island, with new views introduced for the transit user, pedestrian, and motorist perspectives

The locations selected were only sample locations that were chosen to depict the most striking elements of the options that were evaluated

2 Street SW Elevated Option



View for Person Using Transit

View for Person in Vehicle



View for Person Walking

Beltline Surface Option

View for Person Walking



View for Person Using Transit



View for Person in Vehicle

View for Person in Vehicle



View for Person Walking



View for Person Using Transit



Centre Street & 9 Avenue N Surface Option

Centre Street & 9 Avenue N

Tunnel Option

View for Person Using Transit



View for Person Using Transit

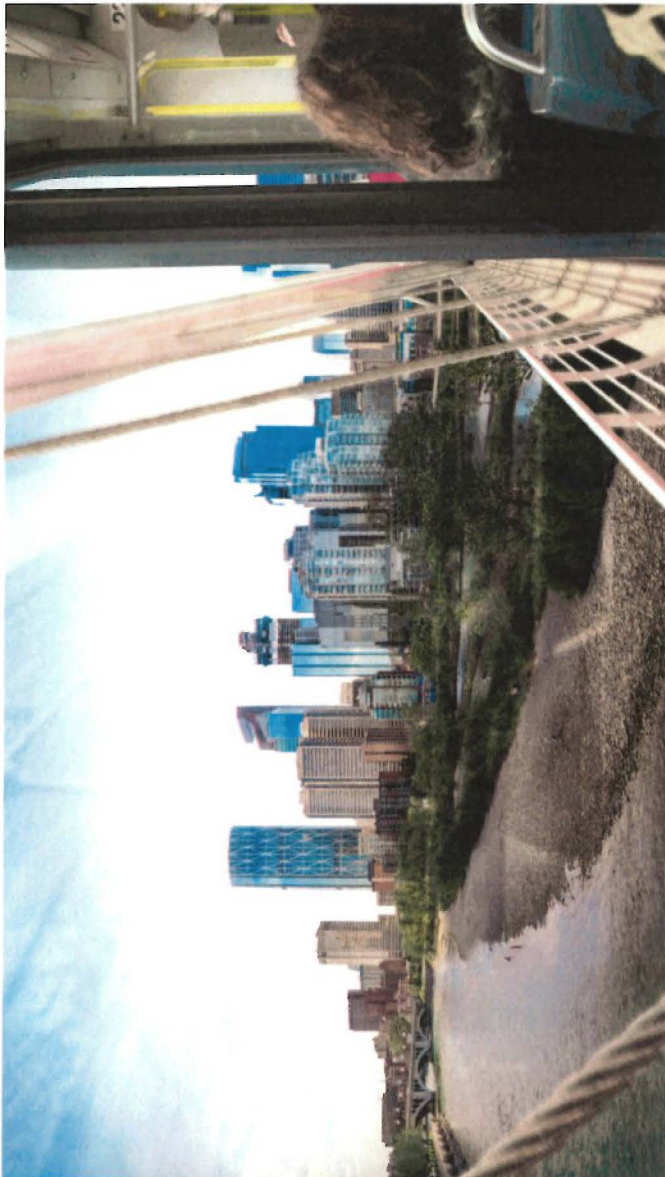
View for Person Walking



View for Person in Vehicle

New Bridge Over the Bow River

View for Person Using Transit



View for Person Walking



View for Person in Vehicle



5 ECONOMIC DEVELOPMENT

Downtown is more than just the critical link for transportation connectivity, it is Calgary's economic engine. This is where the headquarters of global corporations locate, where business activity occurs throughout an ever-growing neighbourhood of skyscrapers, and where over 120,000 Calgarians travel to work every day. Integration of the Green Line into this dense urban core must give particular consideration to the opportunities the downtown environment presents for all Calgarians and potential negative impacts. In order to continue to attract corporations and their employees in a competitive, global marketplace, Calgary's Downtown must continue to develop into a place of attractive business, recreation and residential destinations.

An underground alignment offers the most flexibility and long-term development potential for all aspects of Calgary's Downtown. It maintains and enhances Grade A office real estate locations, while not disrupting the critical movement around, and in/out of Downtown for all modes.

6 THE EVALUATION PROCESS (MULTIPLE ACCOUNT EVALUATION)

The Centre City options were evaluated using a set of technical, financial, and community-focused accounts that were developed ensuring alignment with the overall project objectives. This section outlines a summary of the evaluation results, with a detailed scoring table included in Appendix A. The account categories developed were based on the City's targets outlined in the 2020 Sustainability Direction, and reflect the project vision to leverage city-shaping opportunities, and public input. The accounts and project objectives are shown in Figure 6.

Within each account, criteria and metrics were defined to measure which option best meets the project objectives and best aligns with The City's Sustainability Direction, and long-term priorities. The criteria are summarized in Figure 7 on the following page. All of the accounts were weighed equally in order to minimize subjective value judgment in the evaluation process. For example, cost is equal in weight to community impacts.

The accounts were reviewed and approved by Council in December 2015. Additional details on the criteria included within each account are shown on the following page.



FIGURE 6 ACCOUNTS & PROJECT OBJECTIVES

FIGURE 7 EVALUATION ACCOUNTS AND CRITERIA





Financial Capacity

*An affordable and cost effective service.
Costs are achievable, sustainable in the long
term & provide good value for money.*

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Green Line Centre City Multiple Account Evaluation Summary Report

6.1 FINANCIAL CAPACITY

GOAL

To deliver an LRT project that is affordable and provides cost effective service. Costs are achievable, sustainable in the long term and provide good value for money.

EVALUATION CRITERIA & METRICS

CAPITAL COST: Considers the full costs to construct the LRT based on the latest cost estimates.

Cost estimates were developed based on unit quantities derived from functional design alignment plans and profiles. The unit price for these quantities were derived from a cost database developed from similar transit projects throughout North America. Premiums were added to major visible infrastructure to address publicly expected aesthetics. This is the difference between functional level of infrastructure and architecturally enhanced infrastructure.

- Elevated guideway
- Architectural enhancements
- Architecturally enhanced bridge over the Bow River

LAND IMPACT: Considers the amount of land required to be purchased to accommodate the LRT infrastructure.

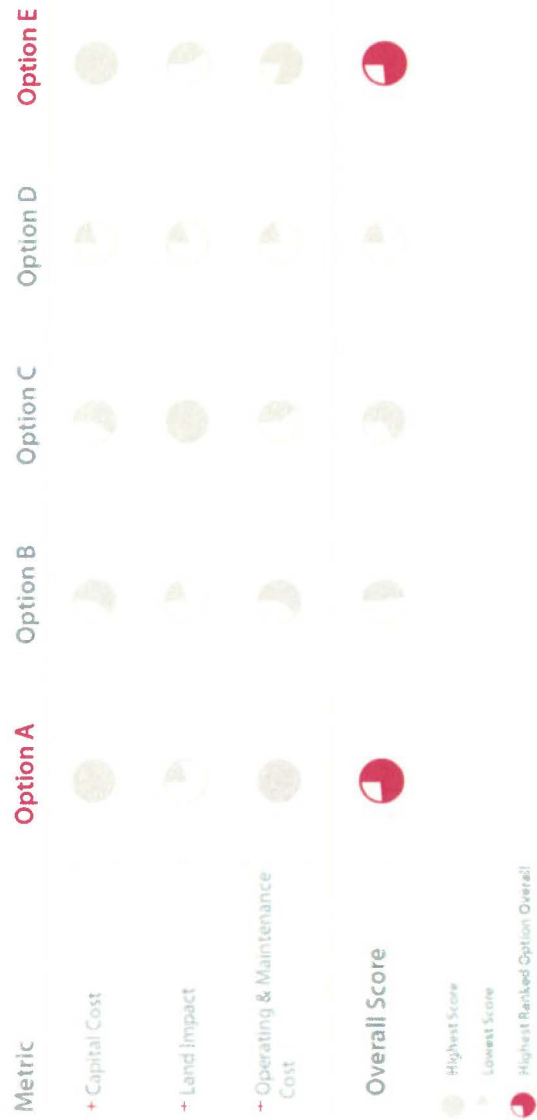
Land impact is the amount of property required for LRT alignment and station entrances on a parcel by parcel basis measured from the property line. The balance of parcels was taken into consideration for redevelopment purposes. If a remaining parcel was too small to be redeveloped the entire parcel was assumed to be taken. The amount of land was used to determine the anticipated land cost for acquisition. In general, if access to a property was irreparably impacted, it was assumed as a full land acquisition.

OPERATING & MAINTENANCE COST: Considers the overall life cycle costs to operate and maintain the LRT infrastructure.

Each alignment option was ranked based on the costs associated with operating and maintaining that particular alignment. A subjective weighting was used relative to the operation and maintenance costs, with tunnels and underground stations requiring the highest costs. Elevated guideways/bridges were ranked mid range due to infrastructure costs while surface alignments were ranked with the lowest operation and maintenance costs.

Green Line Centre City Multiple Account Evaluation Summary Report

The chart below summarizes the evaluation results for Financial Capacity:



Green Line Centre City Multiple Account Evaluation Summary Report

FINANCIAL CAPACITY RESULTS

CAPITAL COST

Options A and E were ranked the highest overall as they would run primarily at surface, and would therefore be the least expensive. An LRT alignment that is on the surface requires less infrastructure than an alignment that is tunnelled or elevated.

LAND IMPACT

Option C scored highly on land impact as it is elevated in the City Centre and tunnelled north of the river. It is the option that has the least impact on properties in the City Centre. Additional land purchases would not be required to accommodate the LRT.

OPERATING & MAINTENANCE COST

Option A scored highest on operating & maintenance costs as it would be the least expensive option to operate and maintain due to the fact that it includes surface operations, but also includes tunnelled sections. Alignments that are either tunnelled or elevated have more operational (higher security requirements) and maintenance (elevators, escalators) costs due to the significant infrastructure associated with those types of alignment profiles.

Financial Capacity/Sustainable Corporation - Overall Results

An overall average of ranking scores in the Financial Capacity/Sustainable Corporation account shows that Option A and E rank highest. These options offer the best chance to fulfill the account goal of delivering an LRT project that is affordable and provides cost effective service.



Community Well-being

*A safe & socially inclusive service that improves
access to key community destinations &
provides transportation choices to Calgarians.*

Green Line Centre City Multiple Account Evaluation Summary Report

6.2 COMMUNITY WELL-BEING

GOAL

To provide a safe and socially inclusive service that improves access to key community destinations and provides transportation choices for Calgarians.

EVALUATION CRITERIA & METRICS

Community Cohesion: *Considers the opportunities for integrating LRT stations within existing neighbourhoods while minimizing visual and physical barriers*

Within this evaluation criterion there were three different metrics that were studied:

- **Access to sky** - The amount of sky visible to a person on the street would be highest with the LRT in a tunnel and lowest with the LRT elevated. As a result, alignments with the greatest amount of tunnel would be scored highest.
- **Physical Disruptions** - Ramps and portals (the open entry where the LRT descends or ascends from a tunnel) introduce a high level of disruption to communities by creating a permanent physical barrier. Options were compared by the amount of portal and ramp area in each. Alignments with the least amount of portal and/or ramp infrastructure were ranked the highest.
- **Views and Privacy** - View protection and residential & commercial privacy is determined by the amount of LRT alignment that obstructs views or interferes with privacy. Alignments with the shortest length of elevated guideway and ramp adjacent to residences and businesses were ranked the highest.

Impact to Recreational Users: *Considers potential construction impacts on community events, festivals and amenities*

Within the City Centre there is a wide range of community events held over the course of a year. Prince's Island is one location that has the largest number of high profile community events and festivals scheduled year round. An LRT alignment that preserves these community events would be considered the most desirable and score the highest.

Safety, Security & Emergency Access: *Consideration of perceived safety and security of the LRT service, including how emergency services could access different parts of the system*

Within this evaluation criterion there were two different metrics that were studied:

- **Crime Prevention Through Environmental Design (CPTED)** - Scoring for safety & security was based on the "CPTED for Transit Users" principals. Alignments with stations at grade scored highest when all of the above CPTED principals were met.
- **Emergency Access** - Surface alignments scored highest for this metric, as they allow emergency access freely along the alignment, while elevated or tunnelled alignments have constraints to emergencies between two underground or elevated stations.

Accessibility: *Consideration of a service that would be accessible to all users.*

Due to the different level grade separation between the options in the Centre City, ease of access for all users was considered. Although based on perception, options with shorter distances for transit users to access station platforms are considered more favourable and were ranked higher.

Green Line Centre City Multiple Account Evaluation Summary Report

The chart below summarizes the evaluation results for Community Well-being:



Green Line Centre City Multiple Account Evaluation Summary Report

COMMUNITY WELL-BEING RESULTS

COMMUNITY COHESION

On average Option D scored highest based on the following metrics:

- **Access to Sky** – Option D scored highest in this metric as it has a significant portion of its alignment in tunnel and would provide the most access to sky to a transit user standing at grade within the LRT alignment
- **Physical Disruptions** – All options include ramps and/or portals causing disruption along the alignment. Option C scored highest in this metric as it had the smallest measured area of portal/ramps within the alignment. Option D was ranked second highest.
- **Views and Privacy** – access to views and residential and commercial privacy is maintained within an Option that has the smallest length of guideway and ramps adjacent to both residences and businesses. A tunnelled option, such as Option D, allows for the greatest amount of privacy for residences and commercial properties and provides the greatest access to views.

IMPACT TO RECREATIONAL USERS

Option D scored highest for having the least amount of impact to recreational users as it is tunnelled below the river and would have minimal impact to Prince's Island Park and its users. The alternative options A, B, C, and E were not well received because of the perceived specific impact to Prince's Island Park with a new bridge structure overhead.

SAFETY, SECURITY & EMERGENCY ACCESS

Within Safety, Security & Emergency Access there were two metrics that were scored to produce an overall highest score for both Option A and E

- **CPTED** – Options A and E have the highest number of stations at grade and thus scored highest when all of the above CPTED principals were considered
- **Emergency Access** – Options A and E have the highest total length of at-grade guideway and the highest number of at-grade stations thus providing for the best emergency response times

ACCESSIBILITY

Option E ranked the highest as it has the highest number of surface stations. Although Option A is also surface running, the loss of the Chinatown results in longer distances for transit users to travel from the north side of Downtown to the nearest station, 7 Avenue SW, which is underground.

RESULTS - Community Well-being

An overall average of ranking scores in the Community Well-being account shows that Option D ranks highest. This option offers the best chance to fulfill the objective of providing a safe and socially inclusive service that improves access to key community destinations and provides transportation choices for Calgarians.



Transportation

A high priority transit service that attracts transit use, walking & cycling as preferred mobility choices for Calgarians.

Green Line Centre City Multiple Account Evaluation Summary Report

6.3 TRANSPORTATION

GOAL

To provide a high priority transit service that attracts transit use, walking & cycling as preferred mobility choices for Calgarians. An integrated service that improves customer experience, meets future demand and strengthens the regional & local transit networks.

EVALUATION CRITERIA & METRICS

RIDE TIME FOR LRT: Consideration for the length of travel time for each alignment.

The alignment with the lowest travel time will score the highest on this criterion.

TRANSPORTATION NETWORK RELIABILITY: Consideration of impacts to traffic, and demand on the overall transportation network.

Within this criterion there were two different metrics that were studied:

- **Travel Lanes Lost**—Highest rank for this metric is given to the alignment that has the lowest total for travel lanes lost.
- **Vehicular Movements Lost**—The fewest vehicular movements lost per alignment will score highest on this metric.

INTEGRATION OF EXISTING & FUTURE TRANSIT SERVICE AND CUSTOMERS: Considers opportunities to strengthen regional and local transit networks by providing convenient connections to existing and future rapid transit routes.

The alignment that provides the lowest distance travelled between the proposed 7 Avenue SW Station to the existing Red Line, Blue Line and the proposed 8 Avenue subway for the Red Line scores highest on this metric.

LRT SERVICE RELIABILITY: Includes an evaluation of factors that could influence the reliability of the LRT service, such as interaction with vehicle traffic, pedestrian crossings, or incidents that can disrupt transit service.

The alignment with the lowest total number of conflicts points between LRV and pedestrians/ vehicles at crossings and intersections will achieve the score highest for this evaluation metric.

RIDERSHIP: Consideration of future growth and projected ridership for each option.

Within this criterion there were two different metrics that were studied:

- **Number of Stations**—The highest number of stations per alignment will achieve the highest score.
- **Catchment Area**—The larger the employment and population total for a catchment area the higher the alignment will score.

COMPLETE STREETS: MULTI-MODES, CONNECTIVITY & ACCESSIBILITY:

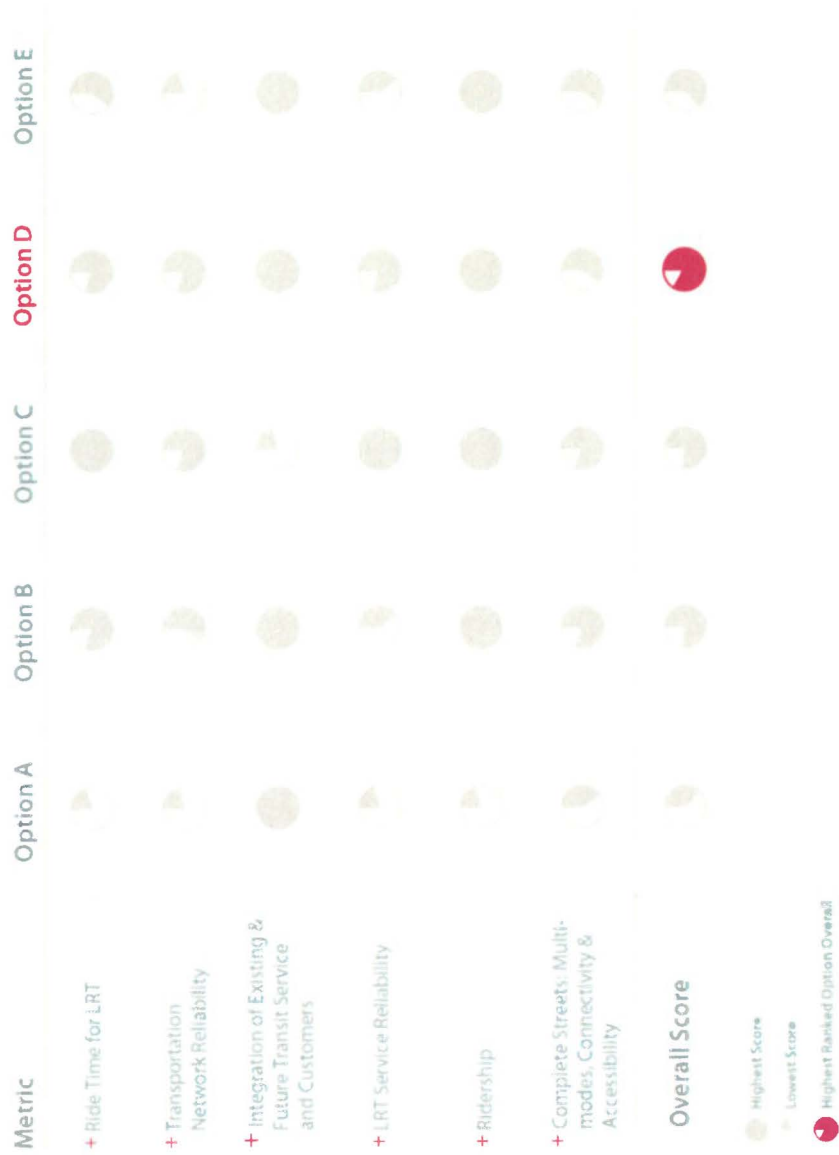
Consideration for opportunities to align with transportation policy documents by supporting active transportation such as cycling or pedestrian facilities along the route.

Within this criterion there were three different metrics that were studied:

- **New Bike Facilities**—The alignment that achieves the longest length of new bike facility will score highest on this metric.
- **Improved Public Realm**—The alignment achieving the most new or improved public realm will score highest in this metric.
- **Supporting Active Transportation**—The alignment that has the lowest total of movements for bicyclists and pedestrians lost at all intersections will score highest on this metric.

Green Line Centre City Multiple Account Evaluation Summary Report

The chart below summarizes the evaluation results for Transportation:



TRANSPORTATION RESULTS

RIDE TIME FOR LRT

Option C scored highest for ride time as it is the alignment that would provide transit riders with the fastest time from 20 Avenue N to 4 Street SE. This run time is achieved having the majority of the alignment in tunnel or elevated which allows the LRT to run uninterrupted stopping only at stations.

TRANSPORTATION NETWORK RELIABILITY

There are two metrics that were evaluated to achieve an overall score for this criterion. Options C and D scored the highest based on these two metrics.

- **Travel Lanes Lost** - Option D scored highest on this metric as a significant amount of the alignment is in tunnel and thus has little effect on the travel lanes at grade.
- **Vehicular Movements Lost** - Option C has the lowest net number of vehicular movements lost per alignment.

INTEGRATION WITH EXISTING & FUTURE TRANSIT SERVICE AND CUSTOMERS

Options A, B, D, and E all scored highly in providing reasonable distances for transfers between proposed Green Line stations and existing LRT stations.

LRT SERVICE RELIABILITY

Option C scored highest on service reliability because of the total length of guideway that is physically separated (by elevation) from pedestrians/vehicles.

RIDERSHIP

There are two metrics that were scored to achieve an overall score for ridership. Options B, C, D, and E scored the highest based on these two metrics.

- **Number of Stations** - Options B, C, D, and E have the greatest number of stations in the City Centre and scored the highest on this metric.
- **Catchment Area** - Options B, C, D, and E had the largest total catchment area and scored the highest on this metric.

COMPLETE STREETS: MULTI-MODES, CONNECTIVITY AND ACCESSIBILITY

There were three metrics that were utilized to achieve an overall score for Complete Streets. Options B and C scored the highest based on these three metrics.

- **New Bike Facilities** - Options B, C and E would provide the longest length of new bike facility and scored highest on this metric.
- **Improved Public Realm** - Option D provided the highest square meters of new or improved public realm scored the highest on this metric.
- **Supporting Active Transportation** - Options A, B, C and D best supported active transportation by maintaining crossings for pedestrians and cyclists at all intersections.

RESULTS - Transportation

Overall, Option D ranked the highest in this account as it has the most grade separation while also integrating with the existing and future LRT lines. Although Option C is largely grade separated, it is challenging to integrate with the existing and future LRT service on 7 Avenue SW. In general, options that maintain more grade separation provide more reliable transit service, faster ride times, and minimize disruption to the surrounding transportation network including complete streets.



Urban + Neighbourhood Development

*A service that supports current & future land use,
development along the corridor, and integrates with
neighbouring communities.*

Green Line Centre City Multiple Account Evaluation Summary Report

6.4 URBAN DEVELOPMENT / URBAN REALM

GOAL

To provide a service that supports current and future land use, development along the corridor, and integrates with neighboring communities.

EVALUATION CRITERIA & METRICS

TRANSIT ORIENTED DEVELOPMENT & DEVELOPMENT POTENTIAL:
Consideration of how well stations locations and the route alignment integrate into existing land uses and provide opportunities for future development

The measure of success of an LRT alignment is how it is able to shape a city and provide for future development along its corridor and is measured by the alignment's ability to spur development. Within this evaluation criterion there were two different metrics that were studied:

- **TOD Integration Potential** – Each alignment was scored based on its ability to spur development in the direct area of the stations
- **Development Influence area for TOD** - The higher the number of stations per alignment the higher the score for that option
- **Access Agreements Required** - Access agreements may be required for station head access or physical siting of the station head

STREETSCAPE & PUBLIC REALM *Evaluation of potential ways to improve the street environment and create high quality public spaces.*

The potential for streetscape and public realm improvements was focused at the station locations, as they have the highest amount of activity that

can contribute to improved streetscape and public realm. Within this evaluation criterion there were two different metrics that were studied:

- **Legibility of Stations** – The ability to locate stations and to improve public realm. Underground options ranked lowest as the alignment is out of sight
- **Challenges of Integration** – Ensuring that integrating LRT into the public realm is seamless. Elevated options will rank the lowest

IMPACT ON PARKING *Consideration of public and private parking availability and access.*

Within the Centre City parking impacts are a major consideration. This criterion measures the impact to existing parking. Within this evaluation criterion there were two different metrics that were studied:

- **Public Parking Removed** – The options that are able to preserve the highest number of on street parking stalls would score the highest
- **Private Parking Access Restrictions** – The option with the lowest number of parking accesses modified or retrofitted scored the highest

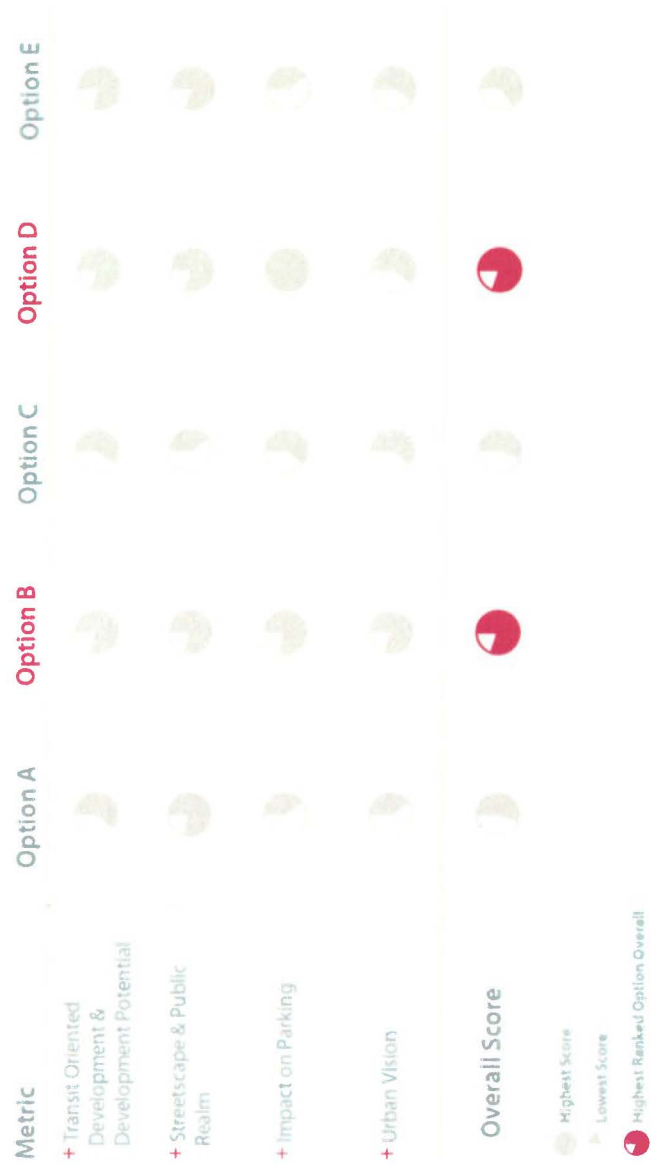
URBAN VISION: *Consideration of opportunities to provide high quality architectural design*

Some of the options in the Centre City have the potential to greatly change iconic views of the Bow River valley and to integrate signature architecture into the Centre City. Two different metrics that were studied:

- **Effort to Meet Signature Design** – The level of effort to meet signature design is higher for elevated options and as a result was ranked lower
- **Opportunity for Signature Design** – Typically any option that incorporates a new bridge crossing was seen as a potential benefit to the City.

Green Line Centre City Multiple Account Evaluation Summary Report

The chart below summarizes the evaluation results Urban Development/Urban Realm:



Green Line Centre City Multiple Account Evaluation Summary Report

URBAN DEVELOPMENT / URBAN REALM RESULTS

TOD AND DEVELOPMENT POTENTIAL

There were three metrics that were utilized to achieve an overall score for TOD and Development Potential. Options B and D scored the highest on how well they integrated into existing land uses and provide for future development based on these three metrics.

- **TOD Integration Potential** – Option D provides the best TOD integration potential scoring highest on this metric. TOD potential is measure by how well the proposed alignment integrates into the surrounding existing land uses and provides the most opportunity for future development.
- **Development Influence Area for TOD** – Options B, C and D that have the greatest amount of underutilized sites within a 600m radius of proposed stations and all scored highest on this metric.
- **Access Agreements Required** – As the designs evolved typically all primary access for the LRT were made in the public realm or through land acquisition. As a result, all of the options ranked the same for this metric.

STREETSCAPE AND PUBLIC REALM

There were two metrics that were utilized to achieve an overall score for Streetscape and Public Realm. Options A, B, D and E scored equally based on these two metrics.

- **Legibility of Stations** – Options A and E scored highest on this metric as they include the most at grade stations which have the highest legibility and as a result the highest potential to improve streetscape and public realm.
- **Challenges of Integration into Existing and Future Urban Realm** – Options A, B, D, and E ranked the highest for this metric as they have stations that are at grade or underground which have higher potential for seamless integration into the existing and future urban realm.

IMPACT ON PARKING

There were two metrics that were utilized to achieve an overall score for Impact to Parking. Option D scored highest based on these two metrics.

- **Public Parking Removed** – Option D was able to preserve the highest number of parking stalls and thus scored highest on this metric.
- **Private Parking Access Restrictions** – Options that have the least number of parking lot accesses modified or retrofitted scored highest on this metric. Option C ranked the highest as the LRT elevated guideway allows for the majority of accesses to be maintained with slight modifications to traffic flow.

URBAN VISION

There were two metrics that were utilized to achieve an overall score for Urban Vision. On average, Options B scored highest based on these two metrics.

- **Effort to Meet Signature Design** – Option D ranked the highest as it has the least amount of anticipated effort in order to meet signature design.
- **Opportunity for Signature Design** – Option C ranked the highest as it provides the opportunity for a new bridge over the Bow River and also provides for opportunity to integrate signature design on the elevated guideway along 2 Street SW.

RESULTS - Urban Development/Urban Realm

An overall average of ranking scores in the Urban Development / Urban Realm account shows that Option B and D rank highest. These options offer the best chance to fulfill the project objective by providing stations that support current and future land use and development along the corridor, and that integrate well with neighbouring communities.



Sustainable Development

*A service that promotes sustainable development by
reducing greenhouse gases & minimizes impact to the
existing natural environment.*

6.5 SUSTAINABLE DEVELOPMENT

GOAL

To provide a service that promotes development by reducing greenhouse gases and minimizes impact to the existing natural environment.

EVALUATION CRITERIA & METRICS

IMPACT ON EXISTING NATURAL ENVIRONMENT: Consideration of the impact on biodiversity and natural environment, both during and after the construction.

Through consultation with City of Calgary Parks Ecologists and Planners key natural areas within the downtown alignment were identified. These are the Prince's Island managed parkland and associated naturalized storm water pond, the Bow River and McHugh Bluff Park Environmental Reserve. The evaluation focused on the impacts of the options on these three key areas. Within this evaluation criterion the following metrics were studied:

- **Permanent Impact to Environment** – Alignments that had minimal negligible permanent impacts to the environmental elements within the key natural areas would score highest.
- **Construction Impacts to Environment** – Alignments that had minimal negligible impacts to the environmental elements within the key natural areas during the construction period would score highest.
- **Wildlife Impacts** – Alignments that had minimal impact to existing wildlife and wildlife habitat would score the highest.

ENVIRONMENTAL SOIL CONDITIONS & CONTAMINATION: Consideration of a number of contaminated sites that may be disturbed during construction.

A high level modified Phase 1 Environment Site Assessment was done for the Centre City study area. Within this evaluation criterion there were two different metrics that were studied:

- **Number of Contaminated Sites** – Number of properties within 100 m of the alignment (including stations) which were identified in the Modified Phase 1 ESA as having moderate or high risk of environmental impact.
- **Level of Remediation** – High, Moderate or Low Risk to be determined based on professional judgment and review of historical data.

FLOOD RISK: Consideration of the impact of extreme weather conditions and climate change on the LRT infrastructure.

All of the Centre City options will be exposed to the risk of flooding impacts as portions of each alignment option is located within the flood inundation zone for the 1:100 year design flood event. Flooding of a tunnel section will have greater consequences than flooding of an elevated guideway section. The alignment option with the lowest risk was the most favourable and was ranked the highest.

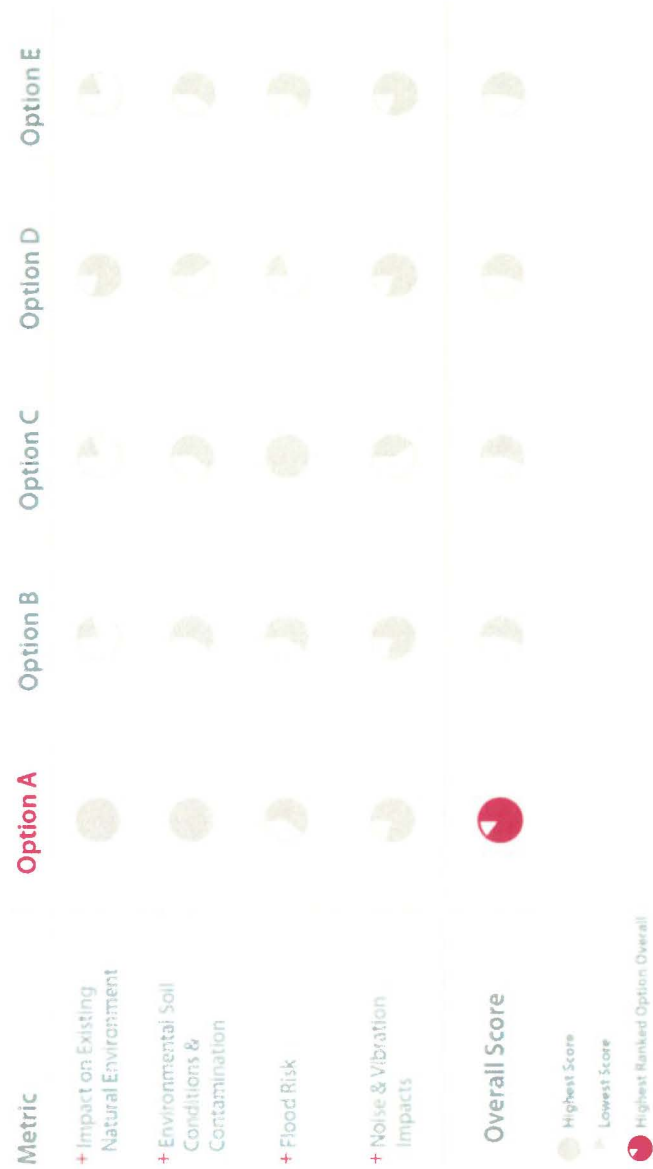
NOISE & VIBRATION: Consideration of noise and vibration on residents and businesses in the area during LRT operations.

Each alignment was assessed for the impacts of noise and vibration on residents and businesses within the area during the operation of the LRT system. Within this evaluation criterion there were two different metrics that were studied:

- **Noise Impacts** – Each alignment condition was ranked based on an anticipated level of impact of the noise. Three different levels of noise impact were developed based on the condition for each option. Lower noise impacts were ranked more favourable.
- **Sensitivity Receptors** – The total number of high sensitivity receptors (i.e. doctors' offices) were counted along the alignment. The alignment with the fewest receptors scored highest in this metric.

Green Line Centre City Multiple Account Evaluation Summary Report

The chart below summarizes the evaluation results for Sustainable Environment.



Green Line Centre City Multiple Account Evaluation Summary Report

SUSTAINABLE ENVIRONMENT RESULTS IMPACT ON NATURAL ENVIRONMENT There were three metrics that were utilized to achieve an overall score for Impact on Natural Environment. Option A scored highest based on these three metrics: • Permanent Impacts to Environment – Options A and D have the least permanent impact on environmental sites/water bodies and scored the highest on this metric. • Construction Impacts to Environment – Option A had the least impact on environmental sites/water bodies during construction since it utilizes the existing Centre Street Bridge and scored the highest on this metric. • Wildlife Impacts – Options A and D had the least impact on wildlife and their habitats during and after construction scored highest on this metric. ENVIRONMENTAL SOIL CONDITIONS AND CONTAMINATION There were two metrics that were utilized to achieve an overall score for Environmental Soil Conditions and Contamination. Option A scored highest based on these two metrics: • Contaminated Sites – Option A had the lowest number of contaminated sites that may be disturbed within the public right of way and scored highest on this metric. • Level of Remediation – Option A had the lowest level of proposed remediation within the public right of way and scored highest on this metric.	FLOOD RISK Option C scored highest for risk of flood due to its ability to adapt to extreme weather conditions (i.e. flooding) and climate change. An elevated guideway avoids flooding while alignments at grade or in tunnel may flood with extreme weather if they were identified as being within a floodplain. NOISE AND VIBRATION IMPACTS There were two metrics that were utilized to achieve an overall score for Noise and Vibration Impacts. Options A, B, D and E scored highest based on these two metrics: • Noise Impacts – Option D ranked the highest as the LRT in a tunnel is anticipated to have the lowest noise impacts on the Centre City alignment. • Sensitivity Receptors – All options were ranked the same as the alignment is largely the same between all the options and impacts the same number of high sensitivity receptors (dental offices, doctors' offices, medical labs and veterinary clinics) within 50m of the alignment scored the highest in this metric. RESULTS – Sustainable Environment An overall average of ranking of the Sustainable Development account shows that Option A ranks highest. This option offers the best opportunity to fulfill the project objective by providing an alignment that would minimize the impact to the existing natural environment.
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Feasibility + Deliverability

A service that can be constructed & operated without significant technical issues or constraints.

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Green Line Centre City Multiple Account Evaluation Summary Report

6.6 FEASIBILITY / DELIVERABILITY

GOAL

To provide an LRT project that can be constructed and operated without significant technical issues or constraints

EVALUATION CRITERIA & METRICS

CONSTRUCTABILITY: *Consideration of technical constraints such as existing utilities, ground conditions, system wide challenges, and the risk related to each*

The construction risk was assessed for to each type of guideway Tunnel guideway was assumed to have the highest risk with at grade guideway the lowest risk. Based on the length of the alignment that is at grade, underground, or elevated, the option with the lowest anticipated risk scored the highest in for this evaluation criterion

CONSTRUCTION IMPACTS: *Consideration of traffic impacts and disruptions to the surrounding community during construction activities*

Preliminary assessment of staging and laydown area requirements for each Centre City alignment option was assessed based on the amount of anticipated surface disruption. The option with the lowest staging/laydown area requirements was ranked as most favourable

IMPACTS TO RESIDENCES & BUSINESSES: *Consideration of impacts to neighbourhoods, business operations and traffic flow during construction*

Construction impacts to neighbourhoods and existing business operations, as well as changes to access and circulation during the construction period will be different for each alignment option

Within this evaluation criterion there were two different metrics that were studied

- **Construction Disruption to Residences and Businesses –** Tunnels and a bridge over the river were both assumed to have no impact on residences & businesses. Tunnel portals and underground stations are assumed to have the highest impact and are ranked lowest.
- **Accesses for Residences and Businesses –** The integration of the LRT may introduce new accesses that benefit nearby residences and businesses but may also replace or remove previous accesses. The higher the number of accesses indicates more benefits to the nearby businesses and residences and is rated higher.

ARCHAEOLOGICAL & HERITAGE IMPACTS: *Consideration of potential impacts on land or buildings with historical or architectural significance.*

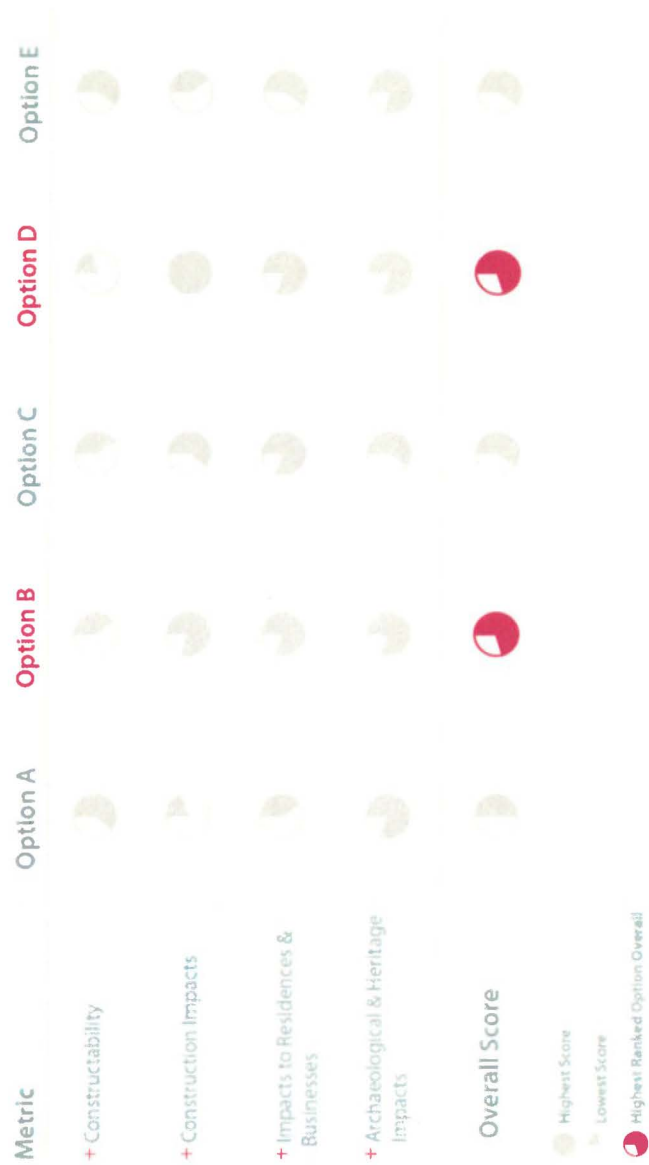
As referenced in the Heritage Buildings and Sites document, historical sites are classified as either "Evaluated Historic Resource" or "Legally Protected/Federally Recognized". "Legally Protected/Federally Recognized" properties are weighted more heavily than others. The number and type of impacts on properties with local/regional heritage value, architectural merit or community facilities or known archaeological sites, as a result of construction or operation of the LRT were considered for this criterion

The metrics that were studied for this criterion include:

- **Historic Sites Impacted –**The alignment option with the lowest number of historical sites with frontage onto the LRT alignment scored highest for this metric.
- **Level of Impact to Historic Sites –** Other factors (such as proximity) may affect the visual presence these resources have in the public realm. The alignment option that has the least impact to historic sites scored highest on this metric.
- **Number of Archaeological/Paleontological Sites –**The alignment with the lowest number of sites impacted scored the highest in this metric.

Green Line Centre City Multiple Account Evaluation Summary Report

The chart below summarizes the evaluation results for Feasibility/Deliverability.



Green Line Centre City Multiple Account Evaluation Summary Report

FEASIBILITY / DELIVERABILITY RESULTS

CONSTRUCTABILITY

While all options have risks in construction delivery, **Options A and E** scored highest within this evaluation criterion. It was assumed that options that have the greatest length of tunnel, river bridges and elevated guideway would have the greatest amount of construction delivery risk. **Options A and E** have the greatest length of at-grade alignment associated with them thus the lowest delivery risk.

CONSTRUCTION IMPACTS

Option D ranked highest with respect to construction impacts to the environment surrounding the alignment. Construction staging/laydown areas are minimized with an option that has a large portion of the alignment in tunnel.

IMPACTS TO RESIDENCES AND BUSINESSES

There were two metrics that were utilized to achieve an overall score for impacts to Residences and Business. **Option B, C and D** scored highest based on these two metrics.

- **Construction Disruption to Residences and Businesses – Option D** scored highest on this metric with **Option B** and **C** following closely behind. **Option D** scored slightly higher because a large portion of the alignment is in tunnel causing the least amount of construction disruption to both residences and businesses.
- **Access to Residences and Businesses – All options** scored the same in terms of disruption to accesses to residences and businesses. After data collection it was assumed that this metric was not a differentiator.

ARCHAEOLOGICAL/HERITAGE IMPACTS

There were three metrics that were utilized to achieve an overall score for Archaeological/Heritage Impacts. **Options A, B, D and E** scored highest based on these three metrics.

- **Historic Sites Impacted – All options** scored the same in terms of the number of historical sites impacted due to the similarities in the alignments. As a result, this metric was not a differentiator.
- **Level of Impact to Historic Sites – Options A, B, D, and E** scored the same in terms of level of impact to historic sites. **Option C** scored lowest on this metric as the elevated guideway was seen as having the highest level of impact to historical sites by obstructing potential views.
- **Number of Archaeological/Paleontological Sites – Options A and D** scored highest on this metric as they both have the lowest potential to encounter archaeological or paleontological sites within the Bow River valley.

RESULTS – Feasibility / Deliverability

Option B & D ranked the highest as they have the least impact to businesses & residences, and minimize the construction impacts on the street. As a result, these options best meet the project objective of providing an option that can be delivered. However, it is important to note that **all options have significant construction risks and technical constraints** in order to construct the LRT in the complex urban environment of the downtown core.



Stakeholders

A service that reflects the values & priorities of communities.

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6.7 STAKEHOLDERS

GOAL

To provide a service that reflects the values and priorities of the communities it runs through.

EVALUATION CRITERIA & METRICS

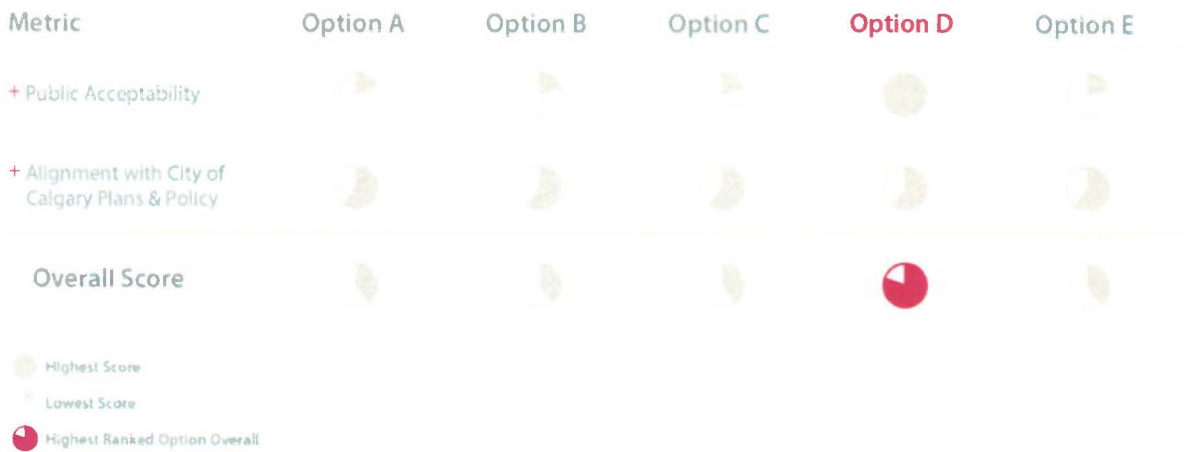
PUBLIC ACCEPTABILITY: *Consideration of public input gathered on the City Centre options*

Between December 2015 and February 2016 public input was gathered about community and business priorities and values in the Centre City. The process for the engagement is outlined in Section 4. The input gathered throughout this process was included as a criterion for the evaluation process to provide a means for including stakeholder feedback as part of the trade off analysis.

ALIGNMENT WITH CITY OF CALGARY PLANS & POLICIES: *Consideration for how the options align with existing plans and policies and the potential of each option to help achieve those goals*

Alignment with existing policy documents is a requirement of all the options to ensure that the direction intended to shape the future of Calgary outlined in the Municipal Development Plan (MDP), Calgary Transportation Plan (CTP), Complete Streets, and Route Ahead are considered.

The chart below summarizes the evaluation results for Stakeholders:



STAKEHOLDER RESULTS

PUBLIC ACCEPTABILITY

Based on the feedback received throughout the engagement process, Option D was ranked the highest. This is consistent with feedback received throughout the various stages of the Green Line North project. Option D received the most positive feedback as many people believed the underground option would provide the most opportunity for future development to occur in downtown. Many of the values identified in the engagement events indicated that Calgarians felt it was important to maintain traffic, pedestrian and cyclist connections in the downtown core.

There was also a strong desire to preserve Prince's Island Park as it is today, without the addition of a new bridge. Some people indicated that street-level LRT would provide opportunities to improve sidewalks and pedestrian amenities. Concerns regarding the visual impact of an elevated LRT guideway in the Centre City were expressed.

ALIGNMENT WITH CITY OF CALGARY PLANS & POLICIES

In general, all of the options assessed meet the requirements of the City plans & policies.

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6.8 EVALUATION SUMMARY

Based on the details of the evaluation, there are several challenges and trade offs that exist between all of the options as they all include some length of tunnelling south of 24 Avenue N and ties the LRT into an challenging urban environment

Table 2 shows a graphical summary that highlights the options that rank the highest across all accounts. In summary, **Option D, fully tunnelled**, ranks the highest in five accounts with the highest overall score

TABLE 2 MAE SUMMARY

Centre City Alignment Option Evaluation Results Summary

Evaluation Accounts	Option A	Option B	Option C	Option D	Option E
 Financial Capacity					
 Community Well-being					
 Transportation					
 Urban + Neighbourhood Development					
 Sustainable Environment					
 Feasibility + Deliverability					
 Stakeholders					
 OVERALL	 	 		    	

7 HIGHEST RANKED ALIGNMENT

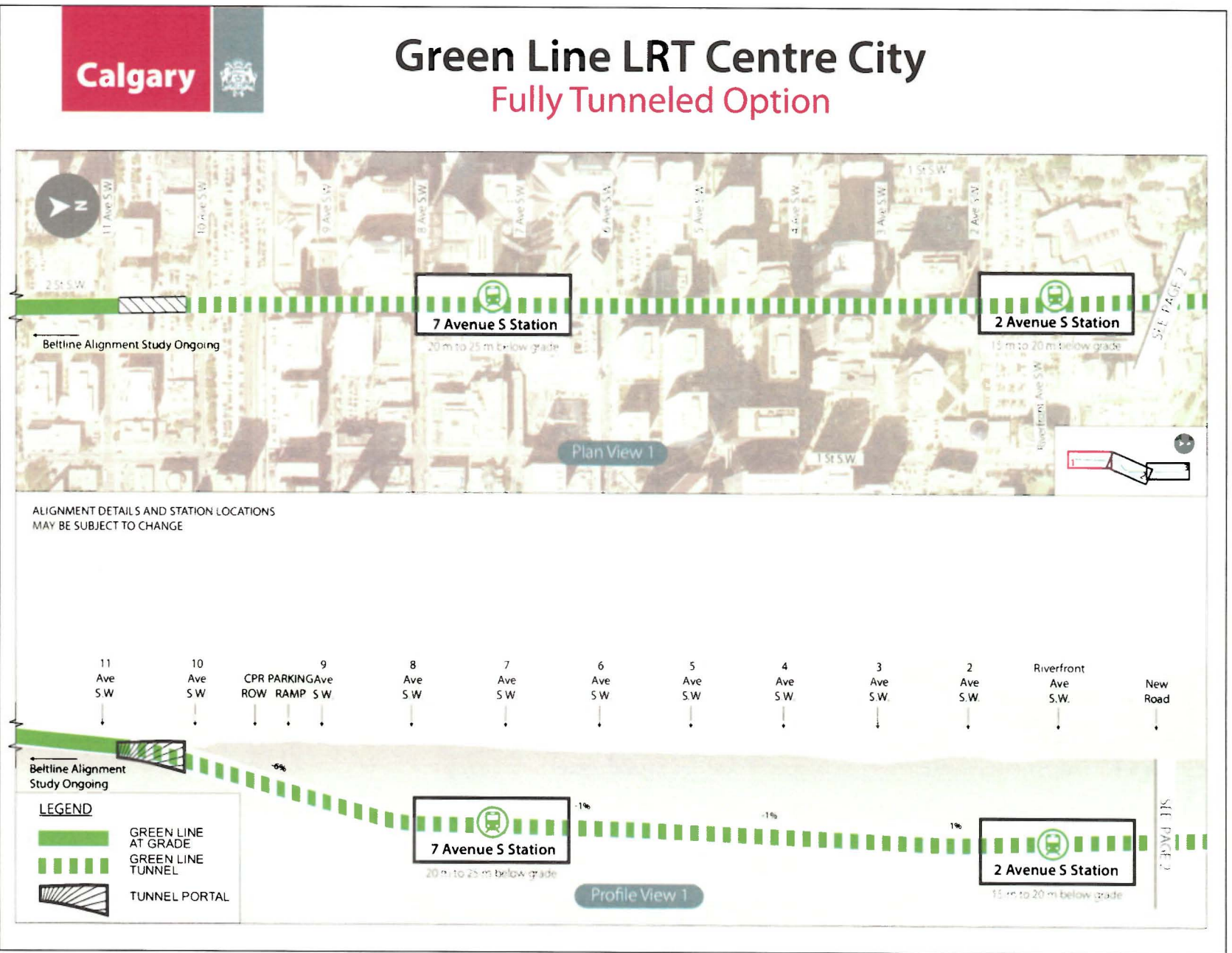
The highest ranked alignment, **Option D, fully tunnelled**, is shown in the following figures. The LRT would be tunnelled from 24 Avenue N and Centre Street south to the CPR tracks. Pending the results of the Beltline evaluation, this option would tie into any of the Beltline options at 2 Street SW south of the CPR tracks.

DOWNTOWN

With the LRT tunnelled, impacts on the downtown along 2 Street SW would be localized to station areas which are proposed in the area around 2 Avenue SW and 7 Avenue SW. The 7 Avenue SW station provides opportunity for a connection to the existing Red and Blue Lines as well as the future tunnel below 8 Avenue SW.

NORTH OF THE BOW RIVER

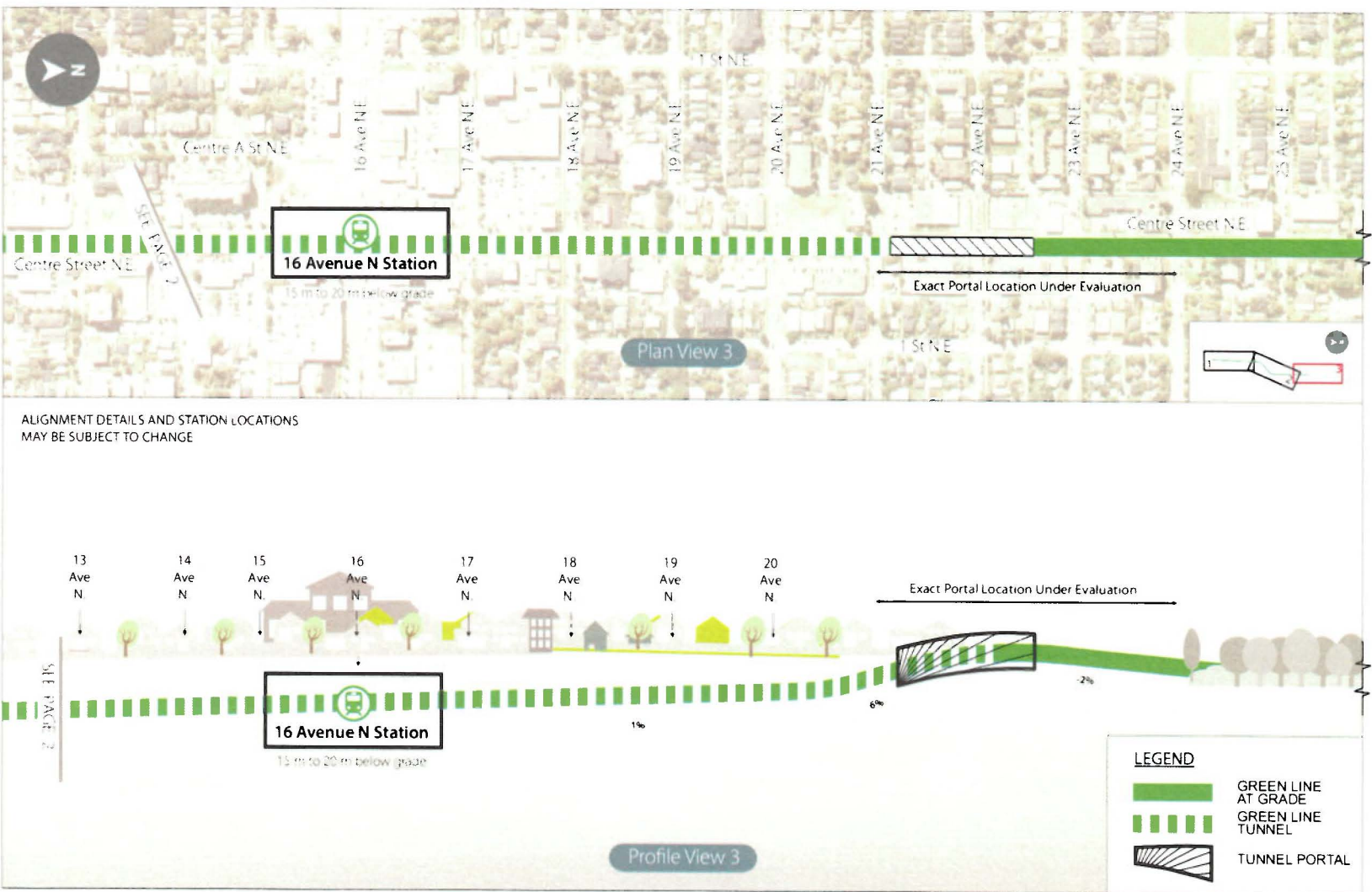
Along Centre Street, north of the Bow River, impacts would be localized to portal areas around 20 Avenue to 24 Avenue N and station areas proposed in the area around 9 Avenue N and 16 Avenue N. The LRT underground along Centre Street allows for additional space on the road surface to be allocated to other modes and users.





Green Line LRT Centre City Fully Tunneled Option

Calgary



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7.1 COSTS

Estimating Approach

Comparative cost estimates were developed based on conceptual designs for each of the Centre City alignment options. The cost estimates were prepared in conformance with the City of Calgary Cost Estimating and Contingency Standard.

The City of Calgary Cost Estimating and Contingency Standard follows a modified form of the ASTM Cost Estimate Classification System (E2516-11). This system identifies five categories for capital project estimates based on the estimating method, supporting information and expected level of variance associated with the estimate. The estimate classes are as follows:

- Class 5 estimate – Order of Magnitude
- Class 4 estimate – Conceptual/Functional Design
- Class 3 estimate – Preliminary Design
- Class 2 estimate – Detailed Design
- Class 1 estimate – Final Design/Pre-Tender

The following table provides a summary of the basis of estimate, level of expected variance, and typical purpose and use for estimates prepared within each class.

PROJECT CONTINGENCY

A 40% contingency is recommended for the current estimate. Including a 40% contingency for projects with significant underground works is consistent at this stage of project development and is consistent with industry practice for projects with a significant tunnel and underground construction component.

Class	Description
Class 5 - Order of Magnitude Design	• Generally prepared based on very limited information and often based on judgment and/or experience. • Expected variance is -50% to +100%. • Developed to understand the magnitude of the costs involved in achieving the project.
Class 4 - Conceptual/ Functional Design	• Generally prepared based on conceptual or feasibility studies, considering project options and known constraints. • Expected variance is -40% to +75%. • Developed to aid in defining the detailed project scope.
Class 3 - Preliminary Design	• Generally prepared based on preliminary design information. At this stage project assumptions and constraints have been defined and detailed design is underway. • Expected variance is -30% to +50%. • Developed to verify project scope and establish the basis for project cost/schedule control.
Class 2 - Detailed Design	• Generally prepared based on detailed design information. At this stage detailed design has advanced. • Expected variance is -15% to +20%. • Developed to verify project scope and establish the basis for project cost/schedule control.
Class 1 - Final Design/ Pre-Tender	• Generally prepared based on final design information. At this stage detailed design is complete. • Expected variance is -10% to +10%. • Developed based on finalized project scope, to confirm the sufficiency of funding for the project prior to tender and/or project execution. • Provide the basis/background necessary for detailed negotiation and cost reconciliation with any bidder and/or contractor.

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The cost estimates for the Centre City options were prepared as **Class 4 Estimates** based on the City of Calgary Cost Estimating and Contingency Standard. Combinations of elemental and comparative approaches were used in developing the estimate for each alignment option in this project.

Estimating for the Centre City alternatives was based primarily on quantity take offs from conceptual drawings combined with either representative costs from similar projects or bottom up crew based estimate, (Elemental Estimate approach). Comparative estimating was used where there was insufficient information to support an elemental estimate. For these, costs were pro-rated for similar activities and components from similar projects.

CENTRE CITY OPTION COSTS

The estimated Class 4 cost for each alignment option has been developed and will be validated further prior to public presentation.

Option A and E are identified as having the lowest cost for construction, resulting from having the lowest length of tunnel and only two underground stations at 7 Avenue SW and 16 Avenue N. In contrast

Option D is fully tunnelled and has four underground stations.

8 WHERE WE ARE GOING

Moving forward, further refinement will be done for the highest ranked option, pending Council approval. In order to fully assess the impact of the option on the Centre City area the design will be progressed to validate and increase certainty of costs and risks. The recommended option for the Centre City will not preclude any corridor options in the Beltline.

The Beltline corridor evaluation will also be completed in late fall of 2016, and the alignment (elevated, underground, or street level) will be determined in winter 2016. Once a corridor has been selected, the Green Line team will work towards integrating the Centre City and Beltline routes in the surrounding communities.

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APPENDIX A

Green Line Centre City Multiple Account Evaluation Summary Report

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APPENDIX A

Green Line North LRT
Centre City Multiple Account Evaluation Scoring Results

Major Accounts	Project Objective	IO #	Evaluation Criteria	Expanded Description	Representative Metric	Option A Existing Centre Street Bridge	Option B New Bridge & Shallow Tunnel	Option C New Bridge, Shallow Tunnel & Elevated Structure	Option D Tunnel to 24 Avenue	Option E Hybrid
Financial Capacity / Sustainable Corporation	1. Affordable and accessible transit services that can be used by all residents and visitors	1	Capital Cost	Considers the full costs to construct the LRT system, including the land acquisition costs.	\$ Million	5	3	3	1	5
	2. Safe and accessible transit services that can be used by all residents and visitors	2	Land Costs	Considers the amount of land required to be purchased to accommodate the LRT system.	Number of Disparities	1	1	5	1	2
	3. Operational and Maintenance Costs	3	Operational and Maintenance Costs	Considers the total life cycle costs to operate and maintain the LRT infrastructure.	Qualitative	5	1	2	1	4
	4. Financial Capacity / Sustainable Corporation TOTAL					11	5	10	3	11
Community Well Being	1. Safe and accessible transit services that can be used by all residents and visitors	1	Community Well Being	Considers the impact of the LRT system on the community, including the impact on the environment, the impact on the economy, and the impact on the quality of life.	1. Impact on the environment	3	4	2	3	4
	2. Safe and accessible transit services that can be used by all residents and visitors	2	Community Well Being	Considers the impact of the LRT system on the community, including the impact on the environment, the impact on the economy, and the impact on the quality of life.	2. Impact on the economy	2	1	5	4	1
	3. Safe and accessible transit services that can be used by all residents and visitors	3	Community Well Being	Considers the impact of the LRT system on the community, including the impact on the environment, the impact on the economy, and the impact on the quality of life.	3. Impact on the quality of life	1	3	1	3	2
	4. Safe and accessible transit services that can be used by all residents and visitors	4	Community Well Being	Considers the impact of the LRT system on the community, including the impact on the environment, the impact on the economy, and the impact on the quality of life.	4. Impact on the quality of life	1	3	2	3	2
	5. Safe and accessible transit services that can be used by all residents and visitors	5	Community Well Being	Considers the impact of the LRT system on the community, including the impact on the environment, the impact on the economy, and the impact on the quality of life.	5. Impact on the quality of life	4	1	1	5	1
	6. Safe and accessible transit services that can be used by all residents and visitors	6	Community Well Being	Considers the impact of the LRT system on the community, including the impact on the environment, the impact on the economy, and the impact on the quality of life.	6. Impact on the quality of life	5	3	2	3	5
	7. Safe and accessible transit services that can be used by all residents and visitors	7	Community Well Being	Considers the impact of the LRT system on the community, including the impact on the environment, the impact on the economy, and the impact on the quality of life.	7. Impact on the quality of life	5	3	1	3	5
Community Well Being TOTAL						11	10	8	2	5
Community Well Being TOTAL						11	10	8	2	5

Green Line North LRT
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Green Line North LRT
Centre City Multiple Account Evaluation Scoring Results

Major Accounts	Project Objective	ID #	Evaluation Criteria	Expanded Description	Representative Metric	Option A Existing Centre Street Bridge	Option B New Bridge & Shallow Tunnel	Option C New Bridge & Shallow Tunnel & Elevated Structure	Option D Tunnel to J4 Avenue	Option E Hybrid	
Sustainable Environment	A sustainable project will reduce CO2 emissions while not impacting water conservation and environmental	18	Impact on Existing Natural Environment	Consideration of the impact of the project on existing natural environment, both during and after construction	1. Extent of development in areas of environmental sensitivity (water bodies, wetlands, etc.)	3	3	3	3	3	
			Creation of New Natural Environment	1. Extent of impact on environmentally sensitive areas (water bodies, wetlands, etc.)	3	3	3	3	3		
				Creation of New Natural Environment	1. Extent of impact on environmentally sensitive areas (water bodies, wetlands, etc.)	3	3	3	3	3	
					Creation of New Natural Environment	1. Extent of impact on environmentally sensitive areas (water bodies, wetlands, etc.)	3	3	3	3	3
						Creation of New Natural Environment	1. Extent of impact on environmentally sensitive areas (water bodies, wetlands, etc.)	3	3	3	3
Sustainable Environment Totals							12	12	12	12	12

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Green Line North LRT
Centre City Multiple Account Evaluation Scoring Results

Major Accounts	Project Objective	ID #	Evaluation Criteria	Expanded Description	Representative Metric	Option A Existing Centre Street Bridge	Option B New Bridge & Shallow Tunnel	Option C New Bridge, Shallow Tunnel & Elevated Structure	Option D Tunnel to 24 Avenue	Option E Hybrid
Feasibility / Deliverability	An independent engineering consultant will prepare a feasibility study for the project.	21	Complexity	Consideration of technical constraints such as existing utilities, ground conditions, water, and challenges and the risk associated with them.	Risk premium to project, in and out	1	1	2	1	1
			Construction Methods	Construction of a new bridge, tunnel, and the associated risk to the north-south corridor during construction activities.	Area of Right-of-Way (ARW) required	1	4	3	5	2
	Integration of existing and new infrastructure and transportation.	22	Integration of Existing and New Infrastructure	Consideration of impacts to neighbourhoods, businesses, and existing infrastructure during construction.	1. Severity of impacts to neighbourhoods, businesses, and existing infrastructure during construction. 2. Number of impacted areas, including: a. Number of impacts to neighbourhoods. b. Number of impacts to businesses. c. Number of impacts to existing infrastructure. d. Number of impacts to existing infrastructure.	1	4	4	3	2
			Construction Methods	Construction of a new bridge, tunnel, and the associated risk to the north-south corridor during construction activities.	Area of Right-of-Way (ARW) required	1	4	3	5	2
	Construction of a new bridge, tunnel, and the associated risk to the north-south corridor during construction activities.	23	Construction of a new bridge, tunnel, and the associated risk to the north-south corridor during construction activities.	Construction of a new bridge, tunnel, and the associated risk to the north-south corridor during construction activities.	Area of Right-of-Way (ARW) required	1	4	3	5	2
Stakeholders	An independent engineering consultant will prepare a feasibility study for the project.	24	Complexity	Consideration of technical constraints such as existing utilities, ground conditions, water, and challenges and the risk associated with them.	Risk premium to project, in and out	1	1	2	1	1
			Construction Methods	Construction of a new bridge, tunnel, and the associated risk to the north-south corridor during construction activities.	Area of Right-of-Way (ARW) required	1	4	3	5	2
	Integration of existing and new infrastructure and transportation.	25	Integration of Existing and New Infrastructure	Consideration of impacts to neighbourhoods, businesses, and existing infrastructure during construction.	1. Severity of impacts to neighbourhoods, businesses, and existing infrastructure during construction. 2. Number of impacted areas, including: a. Number of impacts to neighbourhoods. b. Number of impacts to businesses. c. Number of impacts to existing infrastructure. d. Number of impacts to existing infrastructure.	1	4	4	3	2
			Construction Methods	Construction of a new bridge, tunnel, and the associated risk to the north-south corridor during construction activities.	Area of Right-of-Way (ARW) required	1	4	3	5	2
	Construction of a new bridge, tunnel, and the associated risk to the north-south corridor during construction activities.	26	Construction of a new bridge, tunnel, and the associated risk to the north-south corridor during construction activities.	Construction of a new bridge, tunnel, and the associated risk to the north-south corridor during construction activities.	Area of Right-of-Way (ARW) required	1	4	3	5	2
Feasibility / Deliverability TOTAL						10	14	11	14	11
Stakeholders						2	3	3	3	3
Overall TOTAL						77	85	80	92	83

