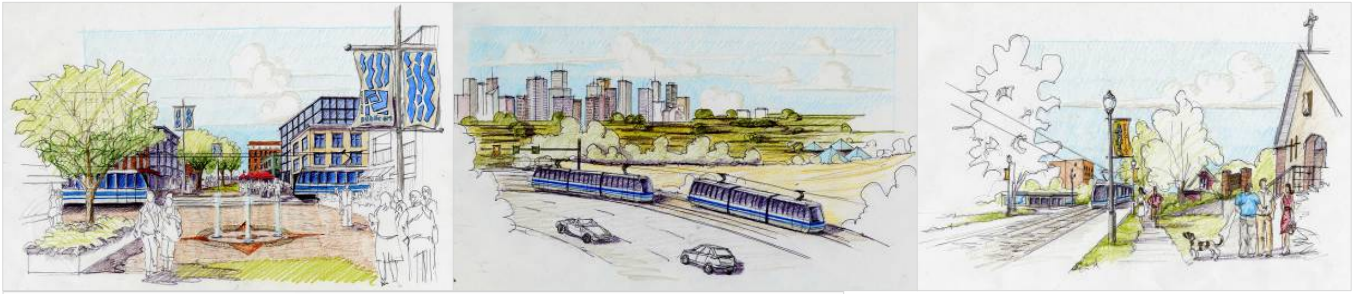
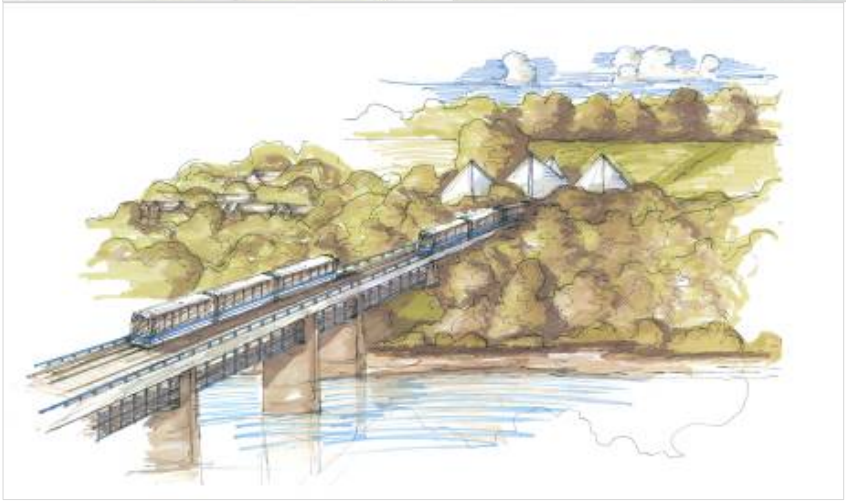
ATTACHMENT 1

Southeast Light Rail Transit Downtown to Mill Woods Concept Planning Report





Prepared for

THE CITY OF Edmonton

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Prepared by

CH2MHILL

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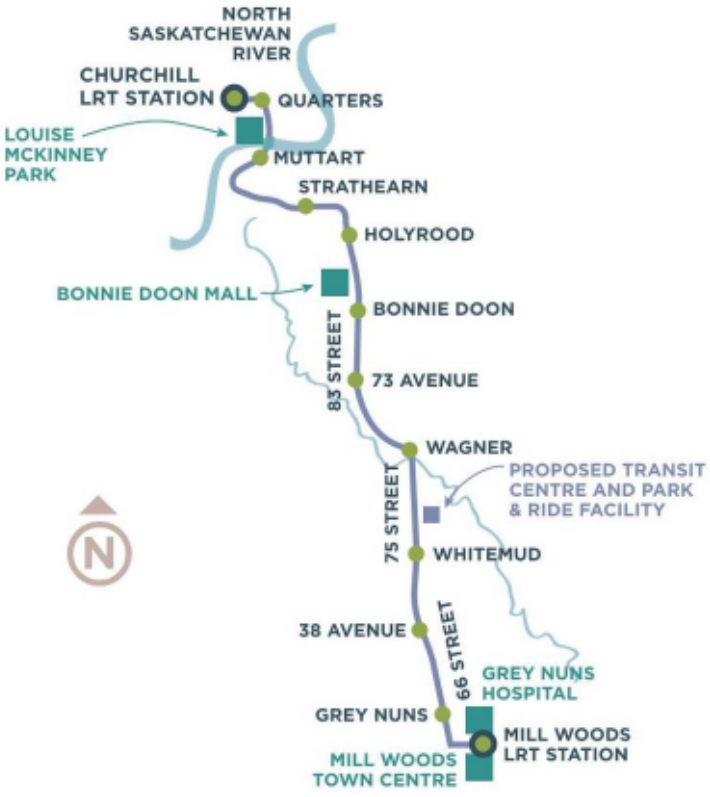
SECTION 1

Introduction

1.1 Purpose of the Report

This report summarizes the results of the conceptual engineering work carried out for the proposed Southeast Light Rail Transit (SE LRT) recommended alignment that connects downtown Edmonton to Mill Woods Town Centre neighbourhood. Via 12-km of track and 10 stations, this line traverses the southeast part of Edmonton by connecting the Quarters Redevelopment area, Bonnie Doon Shopping Centre, Grey Nuns Hospital and Mill Woods Town Centre.



An urban-style approach will be applied to this system, which will run primarily at grade and operate in a dedicated guideway adjacent to traffic. In an effort to limit property acquisition, certain sections of the corridors will have traffic lanes removed in order to accommodate the LRT. The principles of LRT operations are based on line of sight operations in the urban areas and with LRT having traffic signal priority through intersections. The speed of the LRT will be limited to roadway traffic speeds to allow the system to fit and operate safely in narrow rights-of-way and pedestrian-oriented areas.

This system will place an emphasis on aesthetics and suitability within the surrounding area; integration with transit, pedestrian, and cyclist connections; and operations that fit safely with reduced right-of-way and fewer barriers, gates, and bells in comparison with the existing Edmonton LRT system. Station infrastructure will be simple in scale and focused on integration with the neighbourhood. As this extension does not directly interline with the existing Edmonton LRT, transfers between systems will be possible through close walking connections from the new stations to the existing stations.

1.2 Policy and Direction

The City's Strategic Vision, *The Way Ahead*, identifies strategic goals to be accomplished over a 10-year plan that provides guidance for the long term development of a sustainable City. Supplemented by the Municipal Development Plan (MDP) *The Way We Grow* and the Transportation Master Plan (TMP) *The Way We Move*, the policy documents provide the framework for developing a sustainable and livable city and outline the importance of LRT as a key tool in creating compact urban centres, offering premium transit service and promoting a mode shift to transit.

As an extension of the TMP, *The LRT Network Plan* defines the type of LRT system that best meets Edmonton's long term objectives, identifies the number and destination of LRT expansions, and suggests technology and system style. Specifically, the Network Plan recommends that low-floor technology vehicles be used for lines that do not interline with the existing system along with smaller scale stations spaced more closely: such a system enhances opportunities to serve multiple activity centres and integrates better into mature communities.

In line with these policies, the SE LRT recommended corridor was approved by City Council in December 2009, with a recommendation to commence an additional concept engineering study to evaluate a preferred alignment, and assess associated costs, traffic management, and other impacts.

SECTION 2

Southeast LRT Expansion Concept Planning Study

In February 2010, CH2M HILL Canada Limited (CH2M HILL) was directed by the City of Edmonton (the City) to undertake the planning concept engineering for the Southeast and West LRT, from downtown to Mill Woods Town Centre and from downtown to Lewis Estates, respectively, in order to identify a preferred alignment for these projects. The alignment decisions resulted from technical considerations, financial implications, public and stakeholder input, and the LRT Network Plan.

2.1 Alignment and Stations

2.1.1 Consistent Approach to Corridor

The introduction and implementation of this new LRT system into a built-up urban landscape requires that careful consideration be given when making decisions about the placement of LRT track within the selected corridor. Consistency in locating and introducing the LRT alignment is critical. Such consistency results in a new transportation mode that is understood, recognized, and, hence, completely integrated and accepted by transportation network users.

In the instance of the LRT for southeast Edmonton, several decision points along the corridor helped guide recommendations along the alignment. These decision points, along with several issues regarding integration into the existing urban fabric, needed to be addressed in a consistent manner. The recognition of this consistent approach allows the public to adjust to and accept the new LRT routes more easily over a short period of time.

Trade-offs

With specific direction from the City to use existing transportation corridors and minimize land-taking, the alignment, access control and station location decisions became a function of trade-offs between property, traffic lanes, and LRT right-of-way (ROW) requirements. This approach was a significant consideration in the concept engineering phase and was applied as consistently as possible through the corridors.

Existing transportation corridors ranged in width from 20 to 60 metres (m), and every effort was made to consistently balance the trade-offs. Where the ROW was limited, both the LRT and roadway minimum desired widths were applied relatively equally, with considerations given to incident management and other operational concerns. Where these minimums could not be achieved, property was identified for acquisition to accommodate the recommended alignments, station placements, and access for pedestrians, bicycles, and vehicles.

Key Stakeholder Input

During the planning process of this substantial transportation project, extensive consultation with public and key stakeholders was completed to evaluate alignment alternatives within

the approved corridor. Specialists in many fields, as well as members of the key internal city departments, were engaged through the alignment selection process to identify potential opportunities and challenges. These were evaluated and often incorporated into the alignment recommendations. Public outreach, involvement, and feedback are described in Section 2.8. The internal city department comments are summarized as follows:

- Transportation Operations: Traffic Engineering – Preservation and consistency of access control and network capacity; consideration of implications to the signalling system of an LRT priority approach; incident management; and neighbourhood short-cutting
- Transportation Operations: Roadway Maintenance – Maximizing the width of the single-lane roadway; accounting for snow and ice control, roadway repair and maintenance, and incident management
- Edmonton Transit: Light Rail Transit Operations – Ease and reliability of operations; incident management; speed of operation; interface with traffic signal systems; and rail geometry
- Edmonton Transit: Service Development – Impacts to the existing service; provision of effective and efficient transfer points associated with the new LRT service
- Capital Construction: LRT Design and Construction, LRT Expansion – Constructability and consistency in approach to the design and construction
- Planning and Development – Integration with existing and future land uses and station area planning
- Parks and Recreation– Consultative utilization of space, staging areas, and river valley; minimize impact to existing parks and green space

2.1.2 Generalized Approaches

The following section covers the general overall design concept approach for the entire length of the corridor used to determine the recommended alignment.

Centre-running

Centre-running alignment, where the LRT vehicles run in the center of the existing roadway, is a very important overall governing concept adopted as a basis for alignment selection. This concept is most appropriate to use in developed urban areas with a highly distributed road network where lanes of traffic in both directions are required. This concept is founded on accepted principles in similar applications, where LRT is placed within existing transportation corridors and provides good urban fit. Experience has shown that is that a center-running alignment balances the impacts and benefits of access control and manages the proximity of LRT to private property and amenities, rather than being on one side or the other. It also provides for a physical separation of pedestrians and train operations by providing pedestrian facilities, like sidewalks and trails, and by having vehicular traffic separate the trains from pedestrians and cyclists.

The alternative side-running approach, where the LRT vehicles run on one side of the existing street, disproportionately impacts the side of the road on which the alignment is

placed by forcing cul-de-sacs at the ends of many of the intersecting streets and requiring provision of a dedicated right-turn bay and signal in order to cross the tracks safely. The side-running LRT can best be applied in more suburban areas where the neighbourhood access is already consolidated into a few, largely spaced, signalized intersections and ROW widths are generally larger. Side-running is also preferred to provide better integration to major activity centers and transit centers.

Consistency of LRT placement within any given corridor is a major safety consideration. Meeting driver expectations regarding the location of trains within the right-of-way will best be supported by maximizing the consistent location within the ROW. Deviations are to be minimized in order to eliminate driver surprise, particularly given Edmonton's long, dark nights and inclement weather Consistent alignment also allows for easier operations and better passenger ride quality and comfort. The design challenge is to minimize the number of alignment shifts within the corridor while optimizing the alignment location for individual segments.

Station Configurations

Serving land uses along the lines and balancing overall spacing of stations was a key objective of the corridor selection phase. During concept engineering, the configuration of stations was selected to minimize property requirements and minimize impact to traffic operations. Side platforms are recommended to maintain a consistent track-centre spacing in the corridor, thereby limiting or minimizing any land-taking and also permitting left-hand traffic turning-lanes in the shadow of the stations at intersections where a staggered configuration is appropriate. Centre-platform stations are generally reserved used for large activity centres, for elevated stations, and where the ROW can accommodate the required associated track flaring.

Access Management

Public input consistent identified a need for reasonable vehicular access into and out of neighbourhoods and opportunities for pedestrian crossings. Alignment, adjustments have been incorporated to improve the approach for both vehicles and pedestrians. In the more mature areas of the City, the robust road network grid system will further mitigate this issue and serve accessibility needs to most every location along the corridors selected. In the City's newer suburban areas, the generalized approach was to consolidate the curvilinear local road networks to collector roads and then to arterial road connections. This consolidated road hierarchy approach, along with ample ROW in the newer neighbourhoods, provided the design team with the room to accommodate all movements at the current intersections in these neighbourhoods, essentially having no impact on access.

Vehicular, pedestrian, and cyclist crossings of the LRT would be permitted only at signalized locations. The generalized approach was to provide right-in/right-out (RIRO) intersections at every opportunity. All directional crossings would be limited to major intersections: if these were too widely spaced in a given neighbourhood, provisions would be made for intermediate signalized crossings and left-turn-out opportunities.

Existing pedestrian/cyclist crossings were noted, and pedestrian-only crossings were established at locations that best matched the existing pedestrian/cyclist corridors.

Signalized pedestrian crossings were also permitted at the ends of station platforms where only a single traffic lane needed to be crossed.

A way-finding signage program will also be required along some segments of the corridors to address some of the access issues as they relate to businesses and neighbourhoods. The individual traveler's changes to route planning and the natural traffic redistribution are expected to settle quickly into a new access regime once the LRT is commissioned.

2.1.3 Touchstones

Several touchstone locations along the corridor provided clear starting points for the location of the alignment within the corridors. Once the touchstones were verified and firm decisions made at these locations, selection of the alignment placement between these locations was selected to ensure City-wide consistency in our approach.

In general, these touchstones are as follows:

- *Connors Road* – Remaining north of Connors Road in order to target 95 Avenue and avoiding the major commuter route with reversible lanes
- *Bonnie Doon Traffic Circle* – Reconfiguring the traffic circle and respecting the strong traffic movements by remaining on east side of intersection
- *Bonnie Doon Mall* – Incorporating LRT into potential future plans of the mall by placing LRT on west side of 83 Street
- *Whyte Avenue/83 Street* - Respecting the strong traffic movements by keeping LRT on west side of intersection
- *Railway Crossings* – Accounting for the grade-separation needed over freight rail corridors
- *75 Street* – Accounting for the grade-separation needed over the Inner Ring Road
- *Whitemud Drive Park and Ride* –Integrating strongly into transit centre and park and ride facilities by having alignment on east side of 75 Street
- *Mill Woods Town Centre* – Integrating strongly into transit centre by providing a south-running alignment on 28 Avenue

2.1.4 Recommended Alignment Overview

The recommended SE LRT alignment as detailed in Figure 1 to 15 is a continuation of the new proposed downtown LRT and West LRT alignments that are currently under consideration.

The Quarters

Leaving the downtown LRT corridor and the Quarters station, the SE LRT alignment would enter into a portal in the downtown along the south side of 102 Avenue just east of 96 Street. With the width requirements for the portal, property acquisition is required to provide one lane of traffic in each direction. The horizontal geometry at the tunnel entrance section require significant land-takings on the south side of 102 Avenue approaching Jasper Avenue. Additionally, land or easement on the south side of Jasper Avenue west of 95 Street will be required and may be provided in conjunction with future Quarters redevelopment plans.

The tunnel would continue south under 95 Street to a portal on the eastern edge of Louise McKinney Park. The portal will be high on the bank of the river and the LRT will immediately transition onto a structure to cross over the Park. The new structure will accommodate a pedestrian crossing at approximately the same elevation it is today.

Muttart Conservatory and Muttart Station

The structure will continue over the North Saskatchewan River above the flood plain on the south shore and then over 98 Avenue. The alignment would touch down along the east side of the service road, just west of the Muttart Conservatory where the Muttart Station would be located. The station will serve the activity centre and special events in the area. Signalized access across the tracks will provide for access to Muttart Greenhouses. The alignment would then continue adjacent to the north edge of Connors Road, while maintaining the existing traffic lanes on this commuter corridor, requiring property from the bordering Edmonton Ski Club. The pedestrian bridge that connects the trail system will be rebuilt in approximately the same area and the existing trail system connections will be maintained.

Strathearn and Holyrood Communities and Strathearn and Holyrood Stations

At the top of Connors Hill, several properties will be required in order to transition the alignment into the centre of 95 Avenue through a signalized intersection. The alignment then continues east on 95 Avenue, with one lane of traffic on either side of the LRT guideway, until reaching Strathearn Station. This station is located between 89 Street and 88 Street and serves the mature neighbourhood and the future Strathearn Heights high density redevelopment. Signalized intersections at 92 Street, 87 Street, and 85 Street allow for neighbourhood circulation.

The tracks would turn south onto the east side of 85 Street while maintaining the service road on the east side of 85 Street and reducing the four-lane collector road to two lanes. The reduced lane configuration is capable of accommodating the projected traffic volumes and required neighbourhood access, while providing a more desirable pedestrian space through wider sidewalks and boulevards. The Holyrood Station would be located just south of 93 Avenue to serve the mature neighbourhood as well as a potential higher density redevelopment of the Holyrood Apartment site. Signalization of 93 Avenue and 85 Street will maintain access into Holyrood neighbourhood.

Bonnie Doon Shopping Centre and Bonnie Doon Station

The east side-running alignment along 85 Street best serves the effective management of the predominant traffic volumes through the new, reconfigured traffic circle intersection. A reconfigured intersection is proposed at this location to accommodate the traffic and LRT interface. This configuration locates the LRT east of the new intersection in order to best facilitate the predominant of northbound to westbound and eastbound to southbound traffic movements.

As the LRT proceeds south of the traffic circle within the existing four-lane configuration, it transitions to the west side of 83 Street at a new signalized intersection just north of 86 Avenue that aligns with future access into the Bonnie Doon Campus Park. The Bonnie Doon Station is located just south of 84 Avenue to provide direct access to the mall, to allow space for required track work to cross 82 Avenue, and to leave future opportunity for a connection

with the Downtown Circulator. Signalization at 84 Avenue will provide safe crossing of LRT ROW and access into the shopping centre.

Avonmore and King Edward Park Communities and 73 Avenue Station

The alignment on 83 Street continues south, transitioning from the west side of 83 Street to the centre through the intersection of 82 Avenue and 83 Street. The traffic lanes are reduced south of 82 Avenue from a four-lane arterial road to a two-lane configuration, in order to minimize property acquisition along the narrow ROW from 82 Avenue and 76 Avenue. Traffic analysis indicates that the reduction in lane capacity can be accommodated on the parallel north-south corridors of 99 Street, 75 Street, and 50 Street.

The alignment south of 76 Street continues in the centre of the roadway with one lane of traffic, parking, and wide boulevards on either side. A station is located at 73 Avenue to serve the surrounding mature neighbourhoods. Two mid-block crossing signals are provided at 76 Avenue and 73 Avenue to maintain community connectivity. Property acquisition is required around 76 Avenue.

Argyll Road Area and Wagner Station

As the alignment continues south the corridor crosses over the Canadian Pacific Railway (CPR) tracks immediately south of Argyll Road. The clearance elevation over the railway and the gradient limitations of the LRT are such that the elevated structure must commence near 69 A Avenue in order to be high enough to clear Argyll Road first before crossing the rail tracks. Therefore, Argyll Road is grade-separated due to the CPR tracks. The LRT ramps down parallel to Wagner Road, and crosses Davies Road at grade onto the Auction Site, which the City is pursing as an opportunistic purchase. Wagner Station is located on this parcel to serve the neighbouring school and area businesses, and also encourages redevelopment potential. Leaving the station, the alignment then enters a portal and a cut-and-cover underpass that together allow the LRT to cross under both 75 Street and a Canadian National Railway (CNR) freight corridor and resurfaces on the east side of 75 Street.

Whitemud Drive and Whitemud Station, Transit Centre and Park & Ride

In order to provide full integration with the Park and Ride and Transit Centre and to the proposed vehicle maintenance facility (VMF) immediately north of the Whitemud Drive Park and Ride and east of 75 Street, the LRT re-surfaces on the east side of 75 Street just north of McIntyre Road. The alignment crosses McIntyre Road, Roper Road, and 51 Avenue at grade through signalized intersections that provide safe crossing of LRT tracks and business access to the industrial neighbourhoods.

In order to provide access to the VMF site which will be oriented at a right angle to the alignment, a third track will be required in order to provide efficient train access to the facility. This will require additional land along the east side of 75 Street, from Roper Road to the Park and Ride facility.

The Park and Ride facility on the east side of 75 Street will require some significant roadway improvements in order to adequately accommodate the vehicular and bus/train interfaces at a congested expressway intersection. The most notable improvements will be upgrading 51 Avenue to allow patrons the option of using the 50 Street interchange with Whitemud

Drive as an option to the 75/66 Street interchange immediately adjacent to the Park and Ride site.

Mill Woods Community and Millbourne, Grey Nuns and Mill Woods Stations

The alignment continues on the east side of the corridor as 75 Street transitions to 66 Street over Whitemud Drive. Since the terminus at Mill Woods Town Centre is on the east side of 66 Street, the alignment remains on the east side of 66 Street all the way to 28 Avenue. The curvilinear roadway layout was designed to provide access onto 66 Street at well spaced intervals. This, together with an exceptionally wide ROW allows for side-running LRT with minimal access impacts and design issues. The Millbourne Station will be located just north of 38 Avenue to serve the residential community and the Grey Nuns Station just north of 31 Avenue to also serve the surrounding communities as well as the hospital and neighbouring businesses. Intersections at 38 Avenue, 36A Avenue, 34 Avenue, 31 Avenue, and 28 Avenue will be signalized and provide full access into bordering neighbourhoods. There is also another signalized intersection just north of 28 Avenue to accommodate business access.

Detailed evaluation of alternatives led to the selection of the LRT terminus at 28 Avenue, with a station centrally located to serve Mill Woods Town Centre, Grey Nuns Hospital, and the neighbouring higher density developments, with the potential for long term connection to the south.

With that terminus in consideration, the alignment will turn east from 66 Street onto the south side of 28 Avenue with two lanes of traffic on the north side. The Mill Woods Station will be located west of Hewes Way. The existing transit centre would be relocated to south of the station to provide direct pedestrian access between bus and LRT.

2.2 LRT Operations

2.2.1 LRT Operating Protocol

In any LRT system involving trains running at-grade through signalized intersections, the degree of priority given to the trains compared to that given vehicular traffic is critical in determining how the intersections will operate, measured by the level of service and amount of delay experienced by each mode. Efficiently accommodating competing needs (those of LRT trains and passengers with those of vehicular traffic and its passengers and goods), is not a simple matter. Some factors that come into play when considering the various trade-offs in this matter include the following:

- *Vehicle operating characteristics of LRT vehicles:* Greater deceleration and acceleration distances than other vehicle.
- *Schedule reliability:* Efficient operation of an LRT system requires more service reliability and schedule/travel time consistency than other vehicles using the road network.
- *Signal control technology:* The need to efficiently deal with frequent passage of LRT trains through or adjacent to busy, urban signalized Will require use of one of the newer generations of traffic signal controllers with capability to accommodate the interaction between LRT movement and vehicular traffic. More sophisticated interaction capability between traffic signal and rail signal systems is also becoming more common.

- *Environmental and sustainability perspectives:* A number of environmental and societal factors are considered pertinent to balance increased vehicle emissions associated with delays to traffic against the need to provide significant priority to LRT vehicles.

The recommended protocol for the SE LRT uses an integrated traffic signal control system for both the train and vehicular traffic. The signal concept for LRT priority involves operating the trains as close as possible to the traffic signal system green phase to minimize the delay to trains while minimizing impacts on movement of vehicular traffic. Such a system would seek to have peak direction trains (for example, downtown-bound in the morning peak period) travel through key intersections during the green phase for the parallel traffic flow. To accomplish this, it is envisioned that a communication system between the LRT trains and the traffic signals at major intersections will provide feedback to Light Rail Vehicle (LRV) operators to either extend or truncate their dwell times at stations in order to best hit the green signal phase at the critical intersection(s) in the next segment of track. Trains travelling in the non-peak direction may not receive as much priority as peak direction trains, and this must be accounted for in the system's operational planning. This will generally require upgrades or replacement of the existing traffic signal control system.

2.2.2 Track Geometry

The trackway geometry was developed for both operator and passenger comfort,, minimizing and flattening curves to manage travel times and noise, and reduce wear and tear .The trade-off between these objectives and property SE LRT ROW requirements was considered carefully.

2.3 Traffic Management

This project represents a substantial length of new LRT to be implemented, most of it running at-grade within or alongside existing roadways. There will inevitably be traffic-related impacts, including the following:

- *Overall road network impacts*: Roadway capacity reduced where traffic lanes are to be removed, and "off route" impacts to roads in the general vicinity of the new LRT resulting from traffic that will divert away from the LRT route.
- *Traffic operations impacts*: At intersections where trains pass through, as well as at some "off route" intersections that will be affected by diverted traffic
- *Neighbourhood accessibility impacts*: Resulting from the necessary full or partial closure of some intersections along the LRT corridor

This section provides a conceptual overview of each of these traffic management issues. Further analysis is required during preliminary and detailed design stages to fully address these issues, as well as traffic management during construction. Following construction, there will be a need for ongoing monitoring of traffic conditions, to identify and implement solutions to traffic-related concerns. This may include accommodating diverted traffic along parallel arterial routes, or addressing neighbourhood shortcutting concerns.

Overall Road Network Capacity

A basic premise of development of the SE LRT project to date has been the Council directive that elimination of travel lanes can be considered as a way to create space within a road ROW to accommodate LRT, in order to reduce or eliminate property acquisition. However, reduction of lanes inevitably raises concerns about displacement of traffic. The existing road network within the SE LRT study area is relatively "robust" with, in most cases, a number of routes being available for drivers to choose from, particularly in the peak commuter flow directions. This network resiliency is a vital factor in the implementation of the SE LRT system as currently proposed.

In the SE LRT study area, the only routes from which lanes will be removed are 85 Street (from 95 Avenue to 90 Avenue) and 83 Street (from 82 Avenue to Argyll Road). Parallel routes with spare capacity to accommodate some traffic displaced from these two roads include 99 Street, 75 Street (a portion of the inner ring road), and 50 Street.

The City examined general traffic redistribution to the broader arterial roadway network and determined it to be robust enough to accommodate the redistribution of traffic from the corridors directly impacted by the new LRT. The City provided turning movements and volumes of this redistribution to the study team to assist in determining the generalized traffic capacity and lane requirements at major intersections.

2.3.2 Traffic Operations

With the "urban-style" LRT technology proposed for the new SE line, trains will be more integrated into the traffic realm (compared to the existing LRT in Edmonton). They will still operate in a dedicated ROW, typically in the centre of the road, with small curbs between trains and adjacent traffic lanes, and with no crossing gates and bells at intersections (except where needed to address specific safety concerns). As discussed in Section 2.2.1, from a traffic control perspective, the intent is that an integrated signal system will control both vehicle traffic and LRT, with special signal displays for the LRT. There will be two different scenarios with respect to train-vehicle priority:

- At select locations, trains will receive full priority when approaching a signalized intersection, with the signal phasing/timing being adjusted as necessary to accommodate the passage of the train with no reduction in speed. This mode of operation is desirable from an LRT operations perspective, and is generally appropriate at intersections with relatively minor side streets, and where traffic capacity conditions allow for the resultant overall decrease in intersection capacity.
- At certain critical intersections (in terms of cross street classification, and/or intersection capacity conditions), it will be desirable and necessary to use the traffic/train signal control system(s) to adjust the timing of arrival of trains at the intersection so as to minimize the impacts of the train passage on traffic operations. Rather than holding trains at stations, the system would also have the option of rearranging the order in which the various signal phases are displayed, to either advance or delay the display of the "main street green" signal phase to allow the train to pass through, while still ensuring that the signal phases serving other movements are also displayed during the signal cycle.

In addition to the signalized intersections along the SE LRT route, a number of "off route" locations have been identified as sites where traffic signals may be required to address the shifting of traffic away from the LRT route roads. For the most part, these new sets of traffic signals need not be installed prior to or concurrent with construction of the LRT. It is recommended that such locations be monitored after LRT construction, with signals installed only when warrants are met. At some key locations, where traffic diversion related to the LRT is expected to be significant, it is recommended that signals be installed as part of the LRT construction. There may also be locations at which signalization will be required primarily as a part of the traffic management planning for accommodating traffic during construction. Construction related impacts and mitigation measures are not addressed in this study.

2.3.3 Access Management

The "access management" required for this project focuses primarily on addressing neighbourhood accessibility needs along the new LRT routes. Implementation of an at-grade LRT system will result in full or partial closure of some accesses that currently connect with roads forming the LRT route. Such closures impact the movement of vehicles into and out of adjacent neighbourhoods and other types of development along the corridor. Also impacted are locations at which pedestrians can cross the LRT route.

The corridor selection and conceptual engineering work to date provides a comprehensive approach to access management focused on traffic safety and operational requirements, built upon the following key assumptions:

- All vehicle movements crossing LRT tracks must occur under signal control. In most cases, full signalization of an intersection is desirable, allowing for all vehicle movements and for pedestrian crossings.
- In some situations, such as driveways accommodating only right-in/right-out movements with side-running LRT, signal control is still required to manage the movement of the vehicles across the tracks, but in these cases the signals will not need to control the through movements on the main street.
- All left-turn movements crossing the LRT tracks must occur with "protective" signal phasing, i.e. with a left-turn arrow phase controlling the movement (left turns move only when the arrow is displayed). To avoid situations where a queue of vehicles waiting for their left-turn arrow phase blocks through vehicles from being able to proceed through the intersection, all left-turn movements crossing the tracks are provided with dedicated left-turn storage bays. This is a critical criterion, as there are some locations at which traffic signals are required but ROW restrictions limit the ability to provide for left-turn storage bays for the turns crossing the tracks from the main street.
- Pedestrian crossings of the LRT can be dealt with in several different ways, with specific details to be determined during the preliminary and detailed design stages of the project. Examples include the following:
  - Pedestrian movements are accommodated at a normal, signal-controlled intersection.
  - A partial set of pedestrian-activated traffic signals, linked to the traffic/LRT control system, either at an intersection (with limited vehicular movements) or at a midblock

location, are provided solely for the purpose of accommodating pedestrian crossings of the LRT alignment. These would be configured to ensure that a "Walk" signal is displayed only when there is no train coming and when traffic can be interrupted without significantly impacting vehicle flow.

– Uncontrolled pedestrian crossings of the LRT can be provided in some circumstances. Options include what are referred to as "Z" crossings (in which the path provided for pedestrians' forces them to be looking in the direction of an approaching train as they cross each side of the tracks). Other forms of pedestrian crossing can also be considered, employing a variety of different signage and/or train-actuated warning devices.

In establishing the recommended access management plans, provision of direct neighbourhood connections to and from the LRT alignment was the primary objective. In some cases, however, indirect routing of vehicles will be required because of the need to limit the number of signalized intersections along the LRT route. For example, in situations where left-turn movements into a neighbourhood are not accommodated, drivers may need to make three right turns to get to a signalized intersection where they will be able to make a through movement across the tracks.

Provision of indirect access for residential areas was considered to be more acceptable than it would be for access to and from a commercial area. This recognizes the high degree of familiarity that residents would have with access options for their neighbourhood. Conversely, commercial developments rely on easy and direct access for patrons.

2.4 Utilities and Drainage

The proposed SE LRT project will generate numerous wide-ranging impacts to the existing utilities. Existing municipal services within the corridor include major trunk sewers and watermains, local sewers and watermains, telecommunication duct banks, and oil and gas pipelines. Together with associated service and access manholes, individual building services and surface catchbasins and leads.

Storm water runoff and the increased impervious areas along the corridor, as well as in the tunnel sections in the Quarters and Wagner areas, will impact drainage system capacity, storage, and discharge. Existing drainage systems will have to be assessed for these effects.

At this level of study, some utilities and service locations require further investigation. Verifying locations and identifying mitigations in the next stage of engineering will help optimize the construction cost and identify schedule implications.

2.5 Geotechnical, Environmental, and Historical Resources

During the corridor selection and alignment selection phases, geotechnical, environmental and historical impact assessments were conducted in order to establish any fatal flaws within the corridor or the alignment. The assessments were limited to a desktop evaluation of previously published data and reports. No geotechnical drilling investigation of the recommended alignment was performed.

The review identified that the majority of subsurface along the SE corridor consists of glaciolacustrine deposits of bedded sands, silts, and clays; and glacial till, consisting of a silty clay matrix containing sand layers, cobbles, and boulders. Clay shale and sandstone bedrock, containing coal seams and bentonite layers, can be found at various depths along the alignment.

A few areas of specific geotechnical interest are the north and south slopes of the River Valley. Bank instability and resulting landslides have been well documented around Grierson Hill just west of the recommended alignment on the north slope. The recommended alignment for the tunnel and North Saskatchewan River crossing (in the vicinity of the existing pedestrian bridge) are located at the eastern flank of the slide area and are believed to be in a relatively more stable area and less affected by the slide movements. On the south side of the River Valley, the slopes below Connor's Road consist mainly of grassed parkland. Portions of these slopes appear to have been filled and graded in the past. There are no visual signs of slope instability on the south valley slopes either above or below the roadway, and no documentation of any major past instabilities was found.

A Phase I Environmental Site Assessment (ESA) was not carried out for this level of engineering. However, a desk-top environmental review was undertaken and identified several locations which have the potential to impact the quality of soil and groundwater of sites along the corridor.

A Historical Resources Overview (HRO) of the SE LRT alignment included primarily archaeological and palaeontological sites, Aboriginal traditional use sites of a historic resource nature, and historic structures. Approximately two historical sites have been identified: one along Davies Road; and one further south around 30 Avenue, adjacent to the alignment.

2.6 Noise and Vibration

In the process of consultation with the public, noise and vibration impacts were raised as a concern for residences and businesses located along the transportation corridors traversed by the SE LRT. In an effort to address these issues, noise monitoring measured the existing noise levels; these levels were then compared with levels projected for the year 2041 traffic volumes and LRT combined. The results of the baseline noise monitoring indicated sound levels ranging from 51.3 to above 65.0 dBA $_{Leq24}$ as measured in the rear outdoor amenity area. At all locations, the noise climate was dominated by either local traffic on the main or adjacent roads. The monitoring indicated the noise climate was generally broadband in nature, with no tonal components and no dominant stationary sources.

Segments of the alignments that may require noise attenuation are at the top of Connors Road on the south side; along 83 Street between 82 Avenue and 76 Avenue; and at a few residences around 66 Street and 34 Avenue that do not have existing fencing between the structure and the roads. The mitigation will be subject to the City Urban Noise Policy and applied where technically, administratively, and economically practical, with an objective of achieving a noise level as low as 60 dBA $_{Leq24}$.

The vibration study for SE LRT will be undertaken in the next stage of design.

2.7 Property Acquisition

As expressed earlier in this report, minimizing land-taking was one of the guiding principles for the design of the urban LRT system. However, there were several instances where, despite this guiding principle, land had to be acquired to fit the system into the urban fabric. Typically, land would be required to help accommodate the following:

- insufficient ROW available to fit the critical elements
- insufficient space at station locations
- turning movements at intersections
- smoothed curvature of the track at tight turns
- systems infrastructure such as sub-stations and maintenance facilities

The approach used in handling property acquisition wherever property was required, first examined the potential for a partial taking or sliver as opposed to taking the entire property. Where it was determined that the sliver required was large or that the building on the property was impacted, the entire parcel was identified for taking. Additionally, when land-taking was confirmed to be necessary for the project, construction lay-down or staging-area opportunities were contemplated for those parcels to assist in the construction of the adjacent segment. In the next phase of engineering, additional lay down space will likely need to be identified and secured. The potential property requirements are indentified in the red shading in Figures 1 to 14.

2.8 Stakeholder Consultation

Building on consultation and outreach carried out at the earlier corridor planning phase, the City conducted a comprehensive public consultation process through concept engineering. Public input shaped the outcome of the project as alignment, station and access alternatives were identified, evaluated and incorporated into the final concept recommendation.

The public consultation process included individual stakeholder surveys, on-line comment opportunities, public workshops, public open houses and public information sessions. Public input provided was a key consideration by the project team when developing their recommendation.

2.9 Cost Estimating

A cost estimate has been prepared for the conceptual plan. Cost estimating techniques, commensurate with the level of engineering design to date, were used to develop the estimate. The cost estimate is based on the following:

- Recent costs for similar, competitively tendered work carried out in the City (such as structures, tunneling, and roadworks)

- Industry rates for comparable projects from multiple sources, including LRT projects elsewhere in North America
- Unit rate-based build-up of costs

To this total estimated capital cost is applied an "Incremental Risk Pricing Adjustment", to harmonize the parametric-based capital cost estimate with the risk-adjusted estimate developed as part of the probabilistic risk analysis undertaken by the project's Financial Advisor. On this basis, and at this level of conceptual design development, total estimated capital cost is $1.52 billion (2010 dollars). Exhibit 2-1 provides a breakdown of the cost by major cost elements.

EXHIBIT 2-1
Southeast LRT Capital Cost Concept Level Estimate

Capital Cost Category		**Millions**
Construction		$1,025
Roadwork & Trackwork	*$ 365*	
Structures	*$ 215*	
Signals & Systems	*$ 150*	
Maintenance Facility	*$ 240*	
Stations	*$ 55*	
Vehicles		$ 260
Land		$ 90
Engineering & Construction Administration		$ 140
Total 2010/11 Real Dollars (Billions)		**$ 1.52**
Total Inflated to 2016 Dollars (Billions)		**$ 1.78**

SECTION 3

Special Study Areas

Consultation has been an essential part of the Concept Planning for the recommended alignment of the SE LRT. Throughout this year, the general public, business groups, special interest groups, community associations, and City Stakeholder groups have been engaged through various workshops, meetings, events, and online surveys and questionnaires. The collected input has been influential in shaping the alignment recommendation.

Through the consultation process, a few areas were identified to be of particular interest, importance, and concern. These areas are discussed as follows.

3.1 Connors Road

The LRT alignment along Connors Road through the River Valley is constrained on the north side by the Edmonton Ski Club and on the south side by Connors Road. The alignment curves as gently as possible to optimize LRT operations, and follows the north side of Connors Road as closely as possible to minimize the impacts to the Ski Club. This alignment also protects the integrity of the Connors Road corridor, which is one of a limited number of key commuter corridors into downtown from the City's southeast neighbourhoods and Strathcona County east of Edmonton.

It will be necessary to widen the existing road ROW on the north side of Connors Road by up to 15 m to accommodate the LRT. This will require a retained fill section ranging from about 1 to 5 m high for an approximate length of 120 m. There are no visual signs of slope instability on the south valley slopes, either above or below the roadway, and no documentation of any major past instabilities in this area of the south river valley slopes.

Currently, there is limited geotechnical information on the soil and groundwater conditions to quantitatively assess the potential impact of the SE LRT grade construction on the slope stability. However, based on a preliminary geotechnical assessment, widening of the ROW with appropriate slope retaining structures is technically feasible.

Going forward, consideration will be given to partial relocation of the existing Connors Road southwards to reduce the potential amount of retaining slope required on the north side of the roadway. This may potentially reduce the overall impact to the Ski Club.

3.2 Strathearn Neighbourhood Access

The recommended alignment includes LRT running down the centre of 95 Avenue through the Strathearn community. Access to the Strathearn neighbourhood from 95 Avenue is important given the restricted accessibility of the area with the escarpment to the north and the impact of additional traffic generated from the planned Strathearn Heights redevelopment. Left turn access into the neighbourhood will be provided at 92 Street and 87 Street and a new right-in, right-out intersection will be provided at 88 Street as part of the redevelopment. This will supplemented by a new traffic signal at Strathearn Drive and 85

Street. An expected shift in transportation mode choice to transit, as well as traffic diverting to alternate routes available will also help address neighborhood access constraints.

3.3 Bonnie Doon Traffic Circle

The Bonnie Doon "traffic circle" serves five intersecting legs, including Connors Road, and is an important node within the SE LRT study area. This junction experiences high levels of congestion during peak periods and has been the subject of much study, including a detailed operational review completed in 2009. The study recommended upgrading the circle to a "modern roundabout" design to more efficiently handle traffic movements. However, the study did not account for any accommodation of an at-grade LRT crossing through this area.

The dominant traffic flows through the traffic circle are as follows:

- From northbound 83 Street (with a significant amount of this traffic being from 82 Avenue east) onto Connors Road towards downtown in the morning peak period
- From the downtown via Connors Road to southbound 83 Street (and ultimately with much of that flow destined to eastbound 82 Avenue) in the afternoon peak period

As part of the current study, several configuration options were reviewed, incorporating consideration for these dominant traffic flows while also providing accommodations for the new at-grade LRT crossing. Provision of a grade-separation for the LRT was not recommended as it would be inconsistent with the design premise that grade separations would only be provided at railway crossings, crossings of the Inner Ring Road, crossings of access-controlled freeways or where technically required to achieve the required vertical profile.

Replacement of the traffic circle with a single signalized intersection, and maintaining all existing traffic movements while introducing the LRT, was not considered feasible. While provision of two separate signalized intersections would allow for all movements to be maintained, there would be significant operational concerns as there is insufficient space available to provide adequate separation between the intersections.

The recommended solution involves one primary four-legged signalized intersection connecting Connors Road, 85 Street north, 90 Avenue east and 83 Street south. The south leg of 85 Street has been downgraded in this scenario to a right in - right out configuration. The only two movements to be maintained would be the right-turn movement from Connors Road onto southbound 85 Street, and, the northbound right-turn movement onto Connors Road primarily to allow for movement to the east via 90 Avenue. Further work is required to finalize details of access to and from the adjacent emergency services facilities on the south side of the primary intersection, between 83 Street and 85 Street.

An east-side LRT alignment crossing only the 90 Avenue leg of the intersection was recommended to minimize impact on the dominant commuter flows through the intersection. Initial analysis indicates that the recommended configuration will provide sufficient capacity to accommodate projected 2041 peak hour traffic movements.

3.4 83 Street Lane Configuration

The limited ROW available on 83 Street between 82 Avenue and 76 Avenue lead to the recommendation to eliminate a lane of traffic in each direction. This is consistent with project objectives to maximize the use of transportation corridors over property acquisition. There is insufficient ROW in this section to accommodate LRT while maintaining four lanes of traffic, without significant property acquisition. South of 76 Avenue, the 83 Street ROW is wide enough to accommodate four lanes of traffic and LRT, but the recommended alignment maintains the two lanes of traffic (one per direction) for corridor continuity and consistency. 83 Street between 82 Avenue and Argyll Road is not a high volumes arterial, and there is sufficient north-south arterial capacity in the area to accommodate the elimination two travel lanes, one in each direction.

3.5 Wagner Area Alignment

As discussed earlier, the LRT alignment is constrained by numerous factors in the vicinity of 75 Street and Wagner Road. The full operational freight rail corridor, the freight rail spur line, and the inner ring road are all located within 800 m and require grade-separation from the LRT guideway. To add to the complication, the area also requires an LRT station to service the nearby businesses and school. In utilizing this parcel, there are benefits from the LRT operations perspective as well as potential land-use and transit-oriented development (TOD) opportunities. In order to maneuver around this site, the LRT alignment required a tight radius turn at the Wagner Road and Davies Road intersection, as well as two winding turns in the cut-and-cover tunnel under CNR and 75 Street that reduced LRT speed and increased maintenance service and costs. The use of this site provides a more desirable track alignment with softer track curvature and introduces the prospect of using the site for a more desirable station area plan and potentially an integrated development.

3.6 Mill Woods Terminus Station

As previously mentioned, the Transportation System Bylaw defined the SE LRT corridor from the downtown to 31 Avenue; further study was required to determine the terminus point for the LRT. The evaluation focused on land use, how to most effectively serve the activity centres in the area, integration with the Mill Woods Transit Centre, social environment, feasibility and constructability, land impacts, and traffic impacts, as well as the long term plan for the line to extend beyond Mill Woods south of Ellerslie Road. The three corridors that were examined in detail were the Youville Drive corridor, that had the alignment head east onto 31 Avenue and then south on Youville Drive/Hewes Way; the 28 Avenue corridor, that continued down 66 Street and then proceeded east onto 28 Avenue; and the 66 street corridor, that headed straight south with the final station just north of 23 Avenue. The measure of balance between the impacts and benefits of each route resulted in the recommendation of the 28 Avenue corridor. While the Youville Drive Corridor performed best from the land use and social environment perspective, it had substantial property impacts and constructability challenges. Conversely, the 66 Street corridor had fewer land use and social environment benefits, but performed well in regards to feasibility and constructability and aligned best with potential future extensions further south. The analysis concluded that the 28 Avenue corridor has strong land use and social environment

results, reasonable configuration for future extensions, nominal construction and feasibility issues, minimal property impacts and was recommended as a balanced solution.

To provide strong integration with the Mill Woods transit centre and optimum pedestrian access to the station. The Mill Woods Station is recommended to be located on 28 Avenue west of Hewes Way, with the existing transit centre relocated south of the station to provide direct pedestrian access between bus and LRT, and to provide clear and unimpeded access to the shopping areas, hospital, and residential developments.