Report

Mass Transit Planning for 1.25 Million Population

Mass Transit Component of Mobility Network Assessment

Prepared for City of Edmonton
by IBI Group
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Prepared by IBI Group

BY

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Glossary and Abbreviations

AM	The early morning (7am to 8am) weekday peak hour.
BNR	Bus Network Redesign
BRT	Bus Rapid Transit
CBD	Central Business District (Edmonton City Centre Node)
CL	Capital Line (LRT)
EIA	Edmonton International Airport
ETS	Edmonton Transit Service
HOV	High Occupancy Vehicles (can include carpools, transit and taxis)
IRTMP	Integrated Regional Transportation Master Plan (developed for the Edmonton Region with City participation)
LRT	Light Rail Transit
MD	The typical midday (9 am to 3:30pm) weekday time period. Statistics are usually for one hour.
ML	Metro Line
MTN	Mass Transit Network
PM	The late afternoon (4:30pm to 5:30pm) weekday peak hour.
RTSC	Regional Transit Services Commission
ROW	Right-of-Way
WEM	West Edmonton Mall (in the context of this report, the Transit Centre and future LRT stop)
VL/VLSE	Valley Line/Valley Line Southeast

Airport Connection	Airport service within the City-wide network with direct connection to the Centre City node with connections at key nodes along the way
Corridor	A place for movement, living and commerce that is anchored by key mobility networks and well connected to surrounding communities.
Design Capacity for LRT	High Floor LRT (Capital and Metro Line): 150 passengers per car, and 750 passengers per 5-car train. With the Capital Line running at 5 min headway and Metro Line running at 10 min headway during the morning peak hour (for the 1.25 Million horizon), the total capacities will be 9,000 passengers per hour per direction (pphpd) for the Capital line and 4,500 passengers per hour per direction (pphpd) for the Metro Line. Low Floor LRT (Valley Line): 225 passengers per car, and 450 passengers per 2-car train. With 5 min headway during the morning peak hour, the total capacity for Valley Line will be 5,400 passengers per hour per direction.
District	A grouping of neighbourhoods with diverse amenities that support living more locally.
Edmonton Metropolitan Region	The geographical area that is home to more than one million people, has a diversified economy, and surrounds several municipalities and three first nations 24 municipalities and three First Nations. The City of Edmonton is continuously working with its regional partners to help the Region thrive and prosper while also addressing the challenges of rapid growth.
Future Growth Area	Lands south of 41st Avenue SW for which substantial completion of developing areas is required before authorizing the preparation of statutory plans.
Mobility Hub	A place for trip origins, destinations, and transfer points to allow people to seamlessly move from one travel option to another as needed. Mobility hubs are typically located in nodes and centred at cross sections of mass transit routes to create connections within Edmonton and the region.
Networks	Networks are spatial representation of physical or conceptual elements that link together or are related.
Nodes	Centres of activity of different shapes and sizes that feature a variety of housing types, gathering places, a mixture of land uses and varying tenures and affordability. There are three types:
Passenger Boardings	The number of passengers that get onto (board) transit vehicles. It is a measure of how many people use a transit route or transit system.
Passenger Volumes	The number of passengers on board a transit vehicle at a specific point on the route. At any given time, this is how many people boarded the vehicle since the start of the route, minus the number who have already left the vehicle at an earlier stop.
Peak Hour Passenger Volumes	The total number of passengers travelling in the peak direction on one or more transit routes, operating in the same direction, during a one-hour period. This value is the sum of the passenger loads on the individual vehicles during that hour. It indicates how busy the route (or corridor) is during the time period.
Critical/Maximum Load Point	This is the location or segment of a route where the highest passenger loads are experienced in one direction during the time period in question. It is also referred to as the maximum passenger load or volume. This number is often compared with the capacity of a transit route to assess if the right amount of service is being provided.
Passenger Loads	Synonymous for passenger volumes.
Directional Peak Load	This is the passenger load at the critical load point, only counting the peak (higher value) direction.
Peak Hour Capacity	This is the theoretical number of passengers that can be carried on a transit route or transit mode past a single point or location, in one hour. It is a function of vehicle space

	× number of vehicles per hour. The peak capacity assumes that vehicles arrive as scheduled and counts all passenger spaces (seated or standing) that are provided in the peak direction of a transit service. It is challenging to achieve peak capacity because passengers are not evenly distributed throughout transit vehicles, and when vehicles are fuller, slower passenger alighting and boarding can end up delaying service.
Service Planning Capacity	This is a lower threshold for transit route capacity where the density of standing passengers is lower than the design load for that type of vehicle. It implies greater ease of passengers circulating on board, alighting and boarding the vehicle. This planning capacity is used to estimate how many vehicles a transit route should be allocated, with a safety margin built in for extra demand.
Transit Facilities	A location where residents can access public transit. Includes bus stops, train stations and transit centres.
Transit Vehicle Capacity	This is the number of passengers a transit vehicle can carry if full. It counts the seats on a transit vehicle plus an estimated number of people standing, assuming ‘x’ people per square metre of floor space in the vehicle. Since the ‘x’ value for number of people depends on operational needs and practices, there can be a range for this capacity value. (Please see Peak Hour Capacity and Service Planning Capacity)

Executive Summary

The City of Edmonton recently approved The City Plan, a long-term plan developed for the future growth of the city to 2 million people. The City Plan contains policies and outlines the systems and networks including a set of planning and design, mobility, and growth management systems. An Ultimate Mass Transit Network was defined, which included several major elements:

- Continued expansion of the 'conventional' bus network to serve all areas of the city;
- Frequent bus services operating on major arterials and passing through the central neighbourhoods of the city;
- Limited-stop (or rapid) bus services operating in mixed traffic but at higher speeds than conventional routes;
- Semi-exclusive transit routes where the service operates in dedicated lanes in the middle or alongside major corridors. These also operate with more limited stops and the separation from other traffic, allows these routes to run faster and more frequently across the city.
- Exclusive ROW routes, which includes existing and future LRT lines. While some sections of the LRT operate in semi-exclusive sections, all parts of the LRT benefit from signal priority and pre-emption to allow for high frequency, longer vehicles, and high capacities.
- The long-term vision also includes a connector from the airport to downtown, either by rail or semi-exclusive bus.
- Regional services were assumed to ensure connectivity with the Edmonton Metropolitan Region; the long-term form of these services rests with the Regional Transit Services Commission.

The elements of the ultimate mass transit network for 2 Million population were the starting point in defining network options for 1.25 Million, nominally 10-15 years in the future.

Future Base and Options A/B

Major considerations in defining the future base transit network (Base) and two evaluation options (A and B) included:

- Continued expansion of the LRT network as committed, and of the bus system into growth areas;
- The expected staging of population and employment growth;
- Interpolation of additions in service between today and the ultimate mass transit network;
- The operational and physical constraints, challenges and opportunities for transit identified by stakeholders.

These were evaluated using the travel demand model as the principal tool, along with GIS analysis of corridor characteristics. An evaluation was carried out to assess which routes from these future options appeared to be stronger choices for implementation in the 10-15-year time frame. This largely links back to the land uses and destinations being served and the resulting ridership on transit. There is also a logic in building up the transit network where parallel routes can offer alternative paths for passengers, and relieve pressures on more crowded parts of the transit system.

When comparing the more robust mass transit option with the 1.25 million base network, the results of the technical analysis project an increase in mode share. The resulting 9.3% weekday transit split considers all trips in Edmonton. The increase from the transit share of 8.2 percent recorded in the 2015 household travel survey should be analyzed in the context of a much higher population basis for the future mode share results. The number of transit riders will not only have kept pace with growth of the city but is also forecast to make additional gains.

Recommended Interim Network for 1.25 Million population

Based on the performance of the mass transit routes modelled and the success factors considered for mass transit, the following elements are **recommended for an interim 1.25 million population mass transit network**:

- The Heritage Valley Major Node extension of Capital Line is more likely to occur, ahead of the Metro Line extension beyond Blatchford due to the expected development to occur at this Major Node.
- Several infill LRT stations are possible as development opportunities arise. Business cases should be created to validate their potential. are needed as opportunities arise.
- B1 (part BRT/ part rapid bus) replaces and expands on existing routes, operating from Century Park to Campbell Road connecting Whyte Avenue, the Centre City Node with the north and south sections of the city and Castle Downs
- B2 (part BRT/ part rapid bus) will connect from West Edmonton Mall to Bonnie Doon through the University of Alberta and Whyte Avenue. The balance of service levels and stopping patterns on B2 and existing routes warrant further study.
- B4 and B5 will initially begin service as rapid bus - to build demand.
- Terwillegar Bus Lanes will be implemented and converted to the “BRT” B6 with a rapid bus extension to University station. This will help avoid a forced transfer and provides additional capacity parallel to the peak load point on the LRT network.
- RapidBus routes R3, R12, E2 (110X); and R6 are recommended to provide a consistent spacing across the city of limited-stop bus routes. The higher achievable speeds attract additional future passengers. R9 and R109 are recommended to provide peak rapid service and connections to LRT from outlying development.
- Initiation of the Airport Connection using Hwy QE2 and follow the B1 routing.

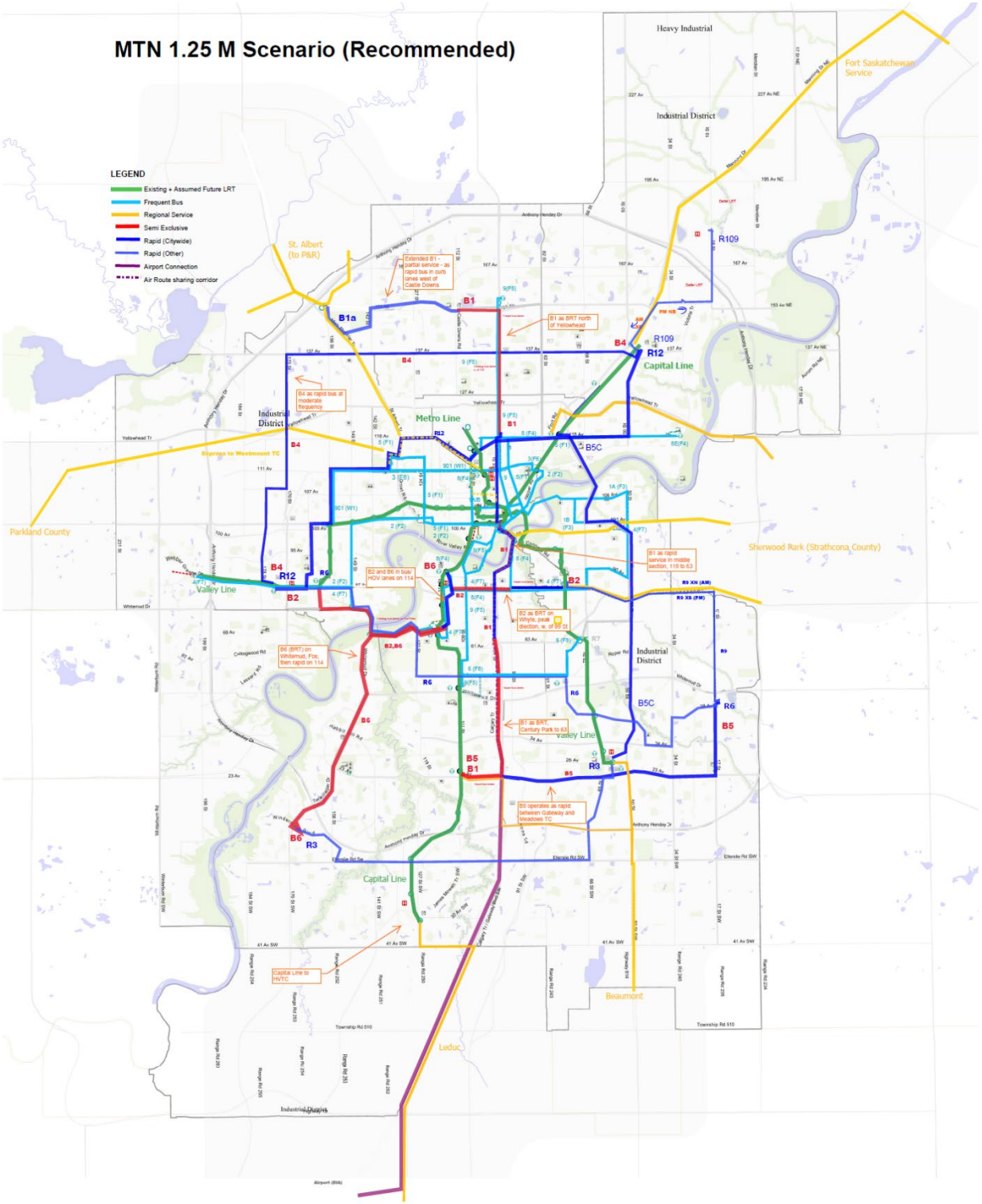
Exhibit ES.1 illustrates the recommended network.

The **order of magnitude costs** to construct these lines and procure vehicles are estimated at $595 Million in current dollars, when comparing the recommended network to the future base. This includes $325 Million for LRT expansion, $220 Million for BRT and $50 Million for rapid bus. These are planning-level costs and in particular the BRT and rapid bus costs are subject to a -50%/+100% uncertainty depending on the project scopes that get developed.

This figure does not include the costs of the future base. The background growth to 1.25 Million population will require additional buses, stops, garages and other amenities. The committed construction of the Valley Line, Terwillegar bus lanes, and the pending extensions of the Metro Line and Capital Line (by two stops apiece) are also excluded from the costs cited above.

Next steps to implement the network will include additional route-level planning and evaluation to further define the services, updating and expansion of design standards to encompass new forms of transit, and monitoring how other initiatives such as SmartFare and Transit Priority Measures could complement this. More broadly, the planning for these routes needs to be linked to land use planning and staging, including the planning and implementation of **Mobility Hubs** at key locations around the **Mass Transit Network**.

Exhibit ES.1: Mass Transit – Recommended Elements – 1.25 Million Population Horizon



Introduction

The City of Edmonton recently approved The City Plan, a long-term plan developed for the future growth of the city to 2 million people. The City Plan contains policies and outlines the systems and networks including a set of planning and design, mobility, and growth management systems. This includes high level direction on the form that municipal infrastructure and services will take. As the city physically grows, this increases the needs for community connections, jobs, housing, amenities and services such as transit. The plan broadly defines built physical spaces, options for how to get around, new connections to support businesses, and more lifestyle choice.

The mass transit study was one of several studies looking ahead at the "2 million people" horizon and working towards building a future vision. The strategic outcomes of The City Plan and of the ultimate mass transit network were developed in parallel, and each will support the other.

What Is Mass Transit?

A broad family of strategic public transit services that carry higher volumes of passengers within urbanized areas, such as the Edmonton Metropolitan Region.

Includes rapid and/or frequent transit for faster trips of varying lengths within the urban area to cross the city and provide reliable local connections.

Also includes regional scale services for longer trips within the city, and to and from surrounding areas.

As the next step in advancing the network envisioned in The City Plan, work has been carried out to develop options that build incrementally towards the 2-Million-person horizon, considering two interim stages: 1.5 Million population, and 1.25 Million population. These have nominal date ranges of 2045/2050 and 2030/2035 respectively, but it is the matching of transit services to the growth horizon that is important. The nominal dates are 'shorthand' for when the future population (and associated employment) thresholds could be reached, and it is against those targets that the transit analysis has been carried out for the interim stages.

The City of Edmonton is contributing to the Edmonton Metropolitan Regional Board's Integrated Regional Transportation Master Plan (IRTMP), which was also under study in 2020-2021. To ensure some consistency between base assumptions, this study developed a proposed Mass Transit Network for the 1.5 Million horizon by working back from the ultimate network envisioned for 2 Million, and assuming approximately half the investments in service and infrastructure would be achieved by that time. This considered the broad implementation phasing of the land uses in The City Plan to help guide where most of the new mass transit would be focused.

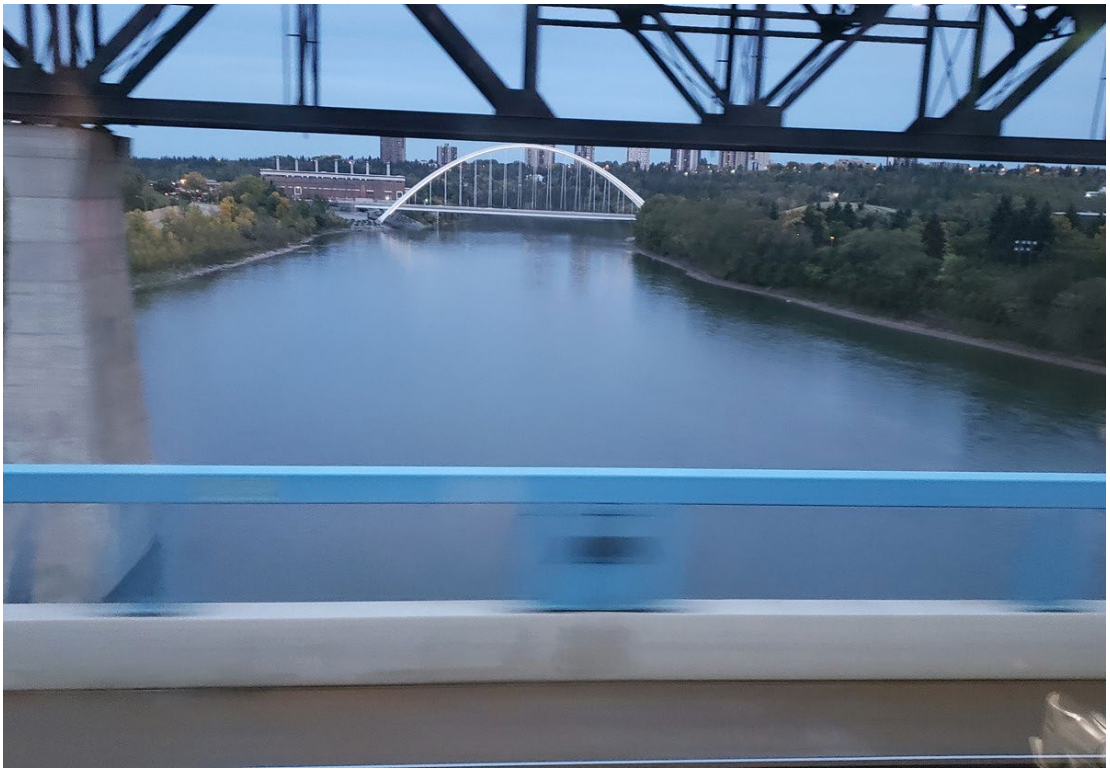
Within that context, a review of opportunities and constraints for mass transit projects was carried out to identify where there were near- to medium-term issues to be explored while developing options for the 1.25 Million horizon. These issues touched on LRT extensions, planned and proposed rapid bus services, general expansion of transit service coverage as the city grows, and the potential to increase service rail and bus service frequency within the financial and technical capabilities of the system.

The assessment of transit services in this technical report compares a future Base scenario and two options where additional mass transit services are overlaid, with differences in the combinations of routes that were included. The results of the evaluation are being used to inform an initial recommendation for the interim Mass Transit Network for the 1.25 Million population horizon.

The remaining sections of this report explain:

- the development of the mass transit network, the categories of mass transit service, and the considerations in defining modelling options.
- the overall performance of the options in attracting passengers, and the associated fleet requirements
- route-specific comparisons of performance to determine which elements are the most promising for implementation during the planning horizon;
- A description of the recommended interim network, including a discussion of each of the major elements;
- Implementation considerations, including service design and creation of mobility hubs.

It is intended that these routes (as well as local transit, first-km and last-km services, and mobility hubs) will provide high quality, reliable and efficient service allowing Edmonton residents to live and move within their community and connect to other communities thereby transforming Edmonton into a true community of communities.



High-Level and Walterdale Bridges, as seen from the Capital Line LRT crossing of the North Saskatchewan River. These all have a role in the future Mass Transit Network.

2. Mass Transit Options Development

The development of the ultimate mass transit network was carried out in parallel and in conjunction with The City Plan. The study process, major assumptions related to the transit networks, and the proposed network are described in the following sections. This includes maps and descriptions of the proposed routes forming the longer-term mass transit network, and several options defined for interim stages.

2.1. Development of the Mass Transit Network for 2 Million Population

The mass transit scenarios were developed through an iterative and consultative process, with the following main steps in compiling and applying the relevant input:

- The ***Mass Transit Backgrounder*** provided background on the current context and some of the future (Bus Network Redesign, LRT Network Expansion) plans already in place for Edmonton's transit network. It also looked at how different travel markets respond to the transit service on offer, and reviewed several cities in Edmonton's peer group to draw out lessons about coordinated transit and land use planning.
- The ***City Plan Mass Transit Scenario Analysis*** documented the transit-focused evaluation results for the refined versions of a future base (referred to as Business As Planned for 2065) and evaluation concept cities I, II and III. The intent of the evaluation was not to choose a scenario, but to identify which network elements worked together better than others, and the reasons why – such as how they connected and how they interfaced with the land use.
- Since the analysis results were driven more by the service assumptions rather than the technology used for modelling purposes for routes, the recommendations are mostly technology-neutral, except for approved and committed LRT extensions.

The ***Mass Transit Network*** report, issued February 2020, documents the proposed long-range network, and forms the basis for the current work presented in this report. The City Mass Transit Plan reports have links to the documents provided in Appendix B.

For the purposes of the ongoing study, some assumptions regarding technology type and specific route alignment on corridors were made to carry out the technical analysis. **It is critical to recognize that these assumptions should not be interpreted as final decisions on technology, alignment or station locations**. Furthermore, the network was not aligned with preliminary discussions around a proposed Regional Transit Services Commission (RTSC) network although similar desire lines have been identified by both studies.

Exhibit 2.1 shows the structure of the network, including the rail elements (LRT in green), semi-exclusive transit (shown in red), Airport Connection (in purple) and routes operating in mixed traffic (rapid bus in dark blue, frequent bus in light blue, and major regional routes in yellow). The following are the main highlights of the network:

- **Frequent**. These include 'F' routes carried forward from the future base, with some refinements to service levels. Buses in these routes operate in mixed traffic, make all local stops, and operate at least once every ten minutes in the AM and PM peak and 15 minutes in the midday and early evening. The mass transit network includes more emphasis on denser areas, and several brand-new routes were added to intensify central area service. This approach was based on peer examples in other cities where the spacing of the frequent network was as close as 400 metres in denser areas. The routes encompassed mainly the central areas of the city.

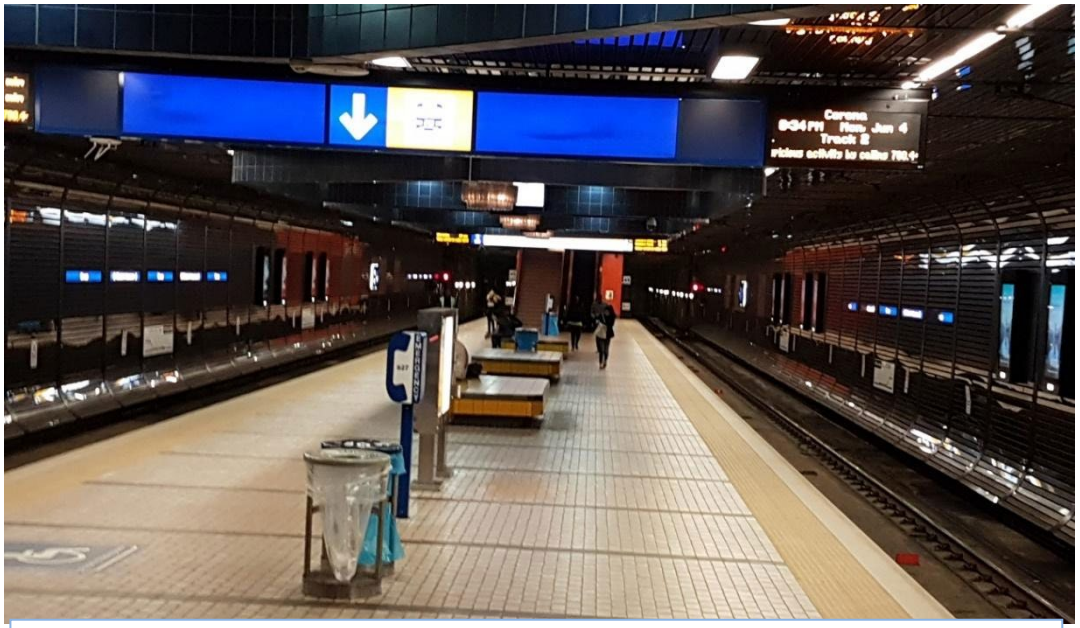
- **Limited Stops**. These are limited stop routes, serving transit facilities, mass transit stations, activity nodes and other transfer points. They function as feeder routes but also support corridors. Buses on these routes are often larger and while they may operate in mixed traffic they run faster than typical buses because of the stop spacing. They are also sometimes sped up by providing transit priority measures (including HOV lanes, dedicated transit lanes, queue jumping) in busy corridors where these routes operate.
- With the introduction of electronic fare collection to the ETS (SmartFare), all-door boarding will be theoretically possible on all transit routes, assuming each bus doorway would be equipped. Many transit operators around the world have tested their own local set of policies and customer service approaches to this option, often with a pilot phase followed by selective deployment. This usually occurs on higher-volume bus routes (and rail-based services if not already in practice). Limited stop and semi-exclusive bus operations usually benefit more from allowing use of all doors to reduce dwell times at busier stops. Over time, ETS may elect to apply this on other or all routes as well.
- **Semi-exclusive** - The network includes five semi-exclusive transit routes (red on the map). The transit vehicles on these routes can operate at the full posted speed of the corridor between traffic signals, as they run in dedicated/segregated lanes (or on tracks), and are not in mixed traffic. They do cross other traffic at intersections; however, these services are often sped along by transit priority measures and by having off-vehicle fare payment at the platform, to reduce dwell times. The latter may be facilitated with the introduction of Smart Fare. The mass transit network includes the following semi-exclusive routes:
  - A north-south route running between Castle Downs and Century Park District Nodes. This would use dedicated ROW (except for strategic segments where Bus/HOV lanes could be more appropriate) and would include a new direct connection (bridge) across the river between Downtown and Whyte Avenue.
  - An east-west route operating between West Edmonton Mall/Misericordia Major Node and Bonnie Doon District Node. This would include a new direct connection (bridge) across the river west of the University.
  - Three routes using a mix of dedicated and shared lanes in the north and west (B4), south (B5), and southwest (B6) parts of the city. Each of these connects to the other mass transit lines (such as the LRT lines) in at least two places. Where these operate in shared lanes, the design would be context-sensitive, and transit priority measures would be applied to produce fast travel speeds.
- **Exclusive ROW** – The network includes four exclusive transit routes encompassing mainly current and proposed LRT alignments and extensions (green) and a proposed airport connector (purple). Transit vehicles may operate at the full posted speed of the corridor between traffic signals, as they run in dedicated lanes or on tracks and are not in mixed traffic. A combination of infrastructure upgrades (grade separation) and technology (pre-emptive and priority signalling) are used to cross at traffic intersections. These services have off-vehicle fare payment at the platform, to reduce dwell times. The mass transit network includes the following exclusive ROW (as defined in this report) routes:
  - Capital Line LRT operating from Heritage Valley Major Node to the Edmonton Energy and Technology Park.
  - Valley Line LRT operating from Lewis Farms to Ellerslie.
  - Metro Line LRT operating between Campbell Road (St. Albert Park and Ride) and South Campus. The mass transit network assumes measures such as

grade separation are in place to permit 24 trains per hour, per direction, to cross University Avenue. (This extension adds service capacity at the busiest point in the LRT system and is discussed later in the report)

- **The Airport Connection** is assumed to operate between a grade-separated station downtown – with walk connections to mass transit lines nearby – and an elevated station at the airport terminal entrance. This line is proposed to ultimately follow the CP railway corridor and remain east of Calgary Trail/Gateway Boulevard until near the Airport. Intermediate stations would allow for connections to other bus routes. Of special note, stations would be included at 23 Avenue and Whyte Avenue. (Alternatively, this service may evolve into a semi-express
- **Regional bus services** were carried over from the future base, representing future versions of existing services. Three new express services have also been defined based on future demand patterns. Two connect the Sherwood Park and Bremner areas to Exhibition District Node and Gorman; and a third running on 50 Street, connecting Exhibition District Node and Beaumont. Several other regional connections to Stony Plain/Spruce Grove, Fort Saskatchewan, St. Albert and Leduc have also been identified.

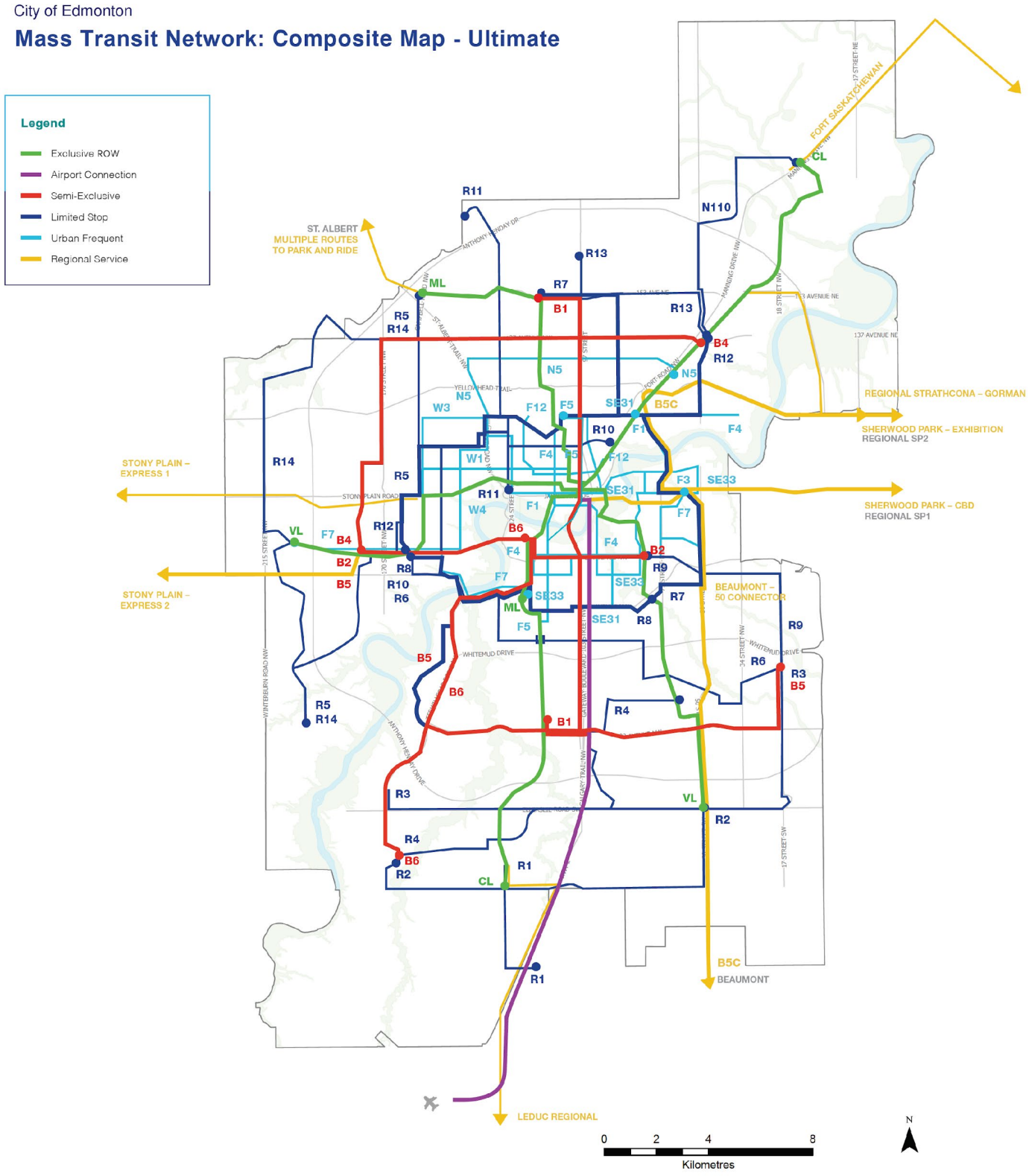
In addition to the services identified in the ultimate mass transit network, local and other regional transit services within Edmonton and in the surrounding municipalities were considered as part of this study. These were carried over from a future base scenario, with some adjustments to service levels to meet projected future demands. Routes in this group would provide first-last mile and connective functions to local destinations that are not situated in the major nodes and corridors and therefore not part of the mass transit network.

Please note that the route naming system used for the planning of the **Ultimate Mass Transit Network** uses conventions from the planning and consultation stages of the Bus Network Redesign (e.g. F1, N1, E1). This continues through the report for ease of comparing proposed transit routes at different future planning horizons. Since a numbering system has recently been created by ETS for the routes in the Fall 2021 service plan, those ETS route numbers are cross-referenced in later sections of this report.



Platform at Corona LRT station, on the Capital and Metro Lines.

Exhibit 2.1: Map of Edmonton Mass Transit Network (MTN) for 2 Million Population



2.2. Interim 1.5 Million Network Assumptions

While the focus of this report is the network analysis for the 1.25 Million population horizon, defining a reasonable network assumption for 1.5 Million was an important building block, as it represents a potential “halfway point” between the near-term (2021) network and the Ultimate Mass Transit Network for 2 Million residents.

With the understanding that approximately half of the infrastructure and service levels would be in place, there were several major inputs considered in developing the network. These included:

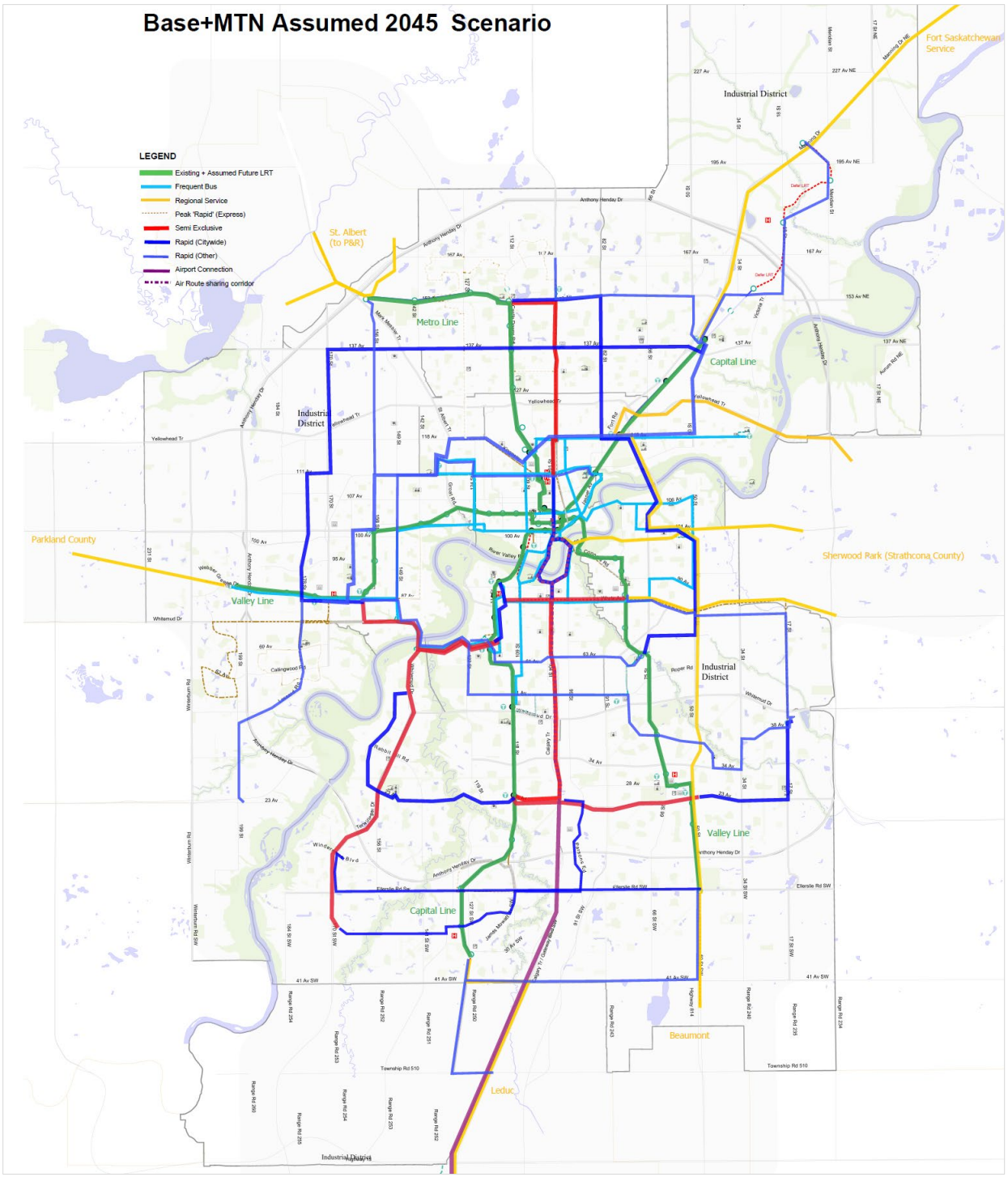
- City Plan interim growth targets at 1.5M population horizon, as allocated to modelling zones;
- The City Plan Implementation Staging;
- Hypothetical demand estimates (testing the Ultimate Mass Transit Network against the 1.5 M population to see where demand emerges sooner); and
- Potential to phase in service types and increase frequency over time.

Exhibit 2.2 illustrates the 1.5 Million network, representing an initial projection of which new transit services would be implemented by a 2045/2050 time frame. This is significant for the 1.25 Million network since any routes not assumed for 1.5 Million are less likely to be included in the 1.25 Million network.

Some of the major assumptions reflected on the map include:

- Metro Line extended northwest to Campbell Road;
- Valley Line completed;
- Capital Line extended southwest to the Heritage Valley Major Node. A future extension to Allard/Desrochers is assumed to depend on growth sometime after the 1.5 Million threshold. The planned extension northeast to Energy Park is also deferred, since much of the development (including parts of Horse Hills) that would support such an extension is now planned to occur post-1.5 Million.
- Frequent bus services carried forward from today; with additional routes outside the specific category also increasing in frequency where warranted by density and demand;
- Regional services being provided by the RTSC and/or surrounding municipalities, depending on how those services are structured in the future. (Any decision on this is outside the scope of this current study.)
- Implementation of major north-south (B1) and east-west (B2) semi-exclusive transit routes to add capacity to the network. Due to uncertainty over feasibility and timing of new river crossings, these routes would borrow from existing crossing capacity.
- An Airport Connector service from downtown, but likely as a highway-based connection, or if rail, using existing rail corridors and deferring construction of a new river crossing;
- Completion of the Terwillegar bus lanes and operation (as B6) from the southwest corner of the city to the University Station area;
- Operation of an east-west crosstown B5 service, with the busiest portion on semi-exclusive right of way. The rest of B5, and the B4 crosstown route in the north and west parts of the city, would operate as rapid bus with conversion to follow later.
- Many of the proposed rapid bus lines in the ultimate network would start operations, but at frequencies matching demand at the 1.5 Million population threshold. In more mature areas these services would operate more frequently and in newer areas the emphasis would be on introducing a fast variant of bus service at a more modest frequency to begin with.

Exhibit 2.2: Edmonton Assumed Interim Transit Scenario – 1.5 Million Population Stage



2.3. City Plan Interim Target Growth Distributions for 1.25 Million Horizon

Exhibits 2.3 and 2.4 illustrate the target distributions of total population and employment by model zone, as allocated for an interim growth target of 1.25 Million population in the city, and employment of approximately 700,000. The City Plan's anticipated growth at this horizon is estimated to have 65% of new dwelling units in the developing area with 35% in existing areas.

The areas with existing and planned development are the focus for the transit service proposals in the rest of Section 2. Most elements of the longer-term network south of 41 Av SW or in the Horse Hills and Riverbend areas are not required within the shorter timeframe.

Exhibit 2.3: Edmonton City Plan Target - Total Population Distribution for 1.25 Million Population Horizon

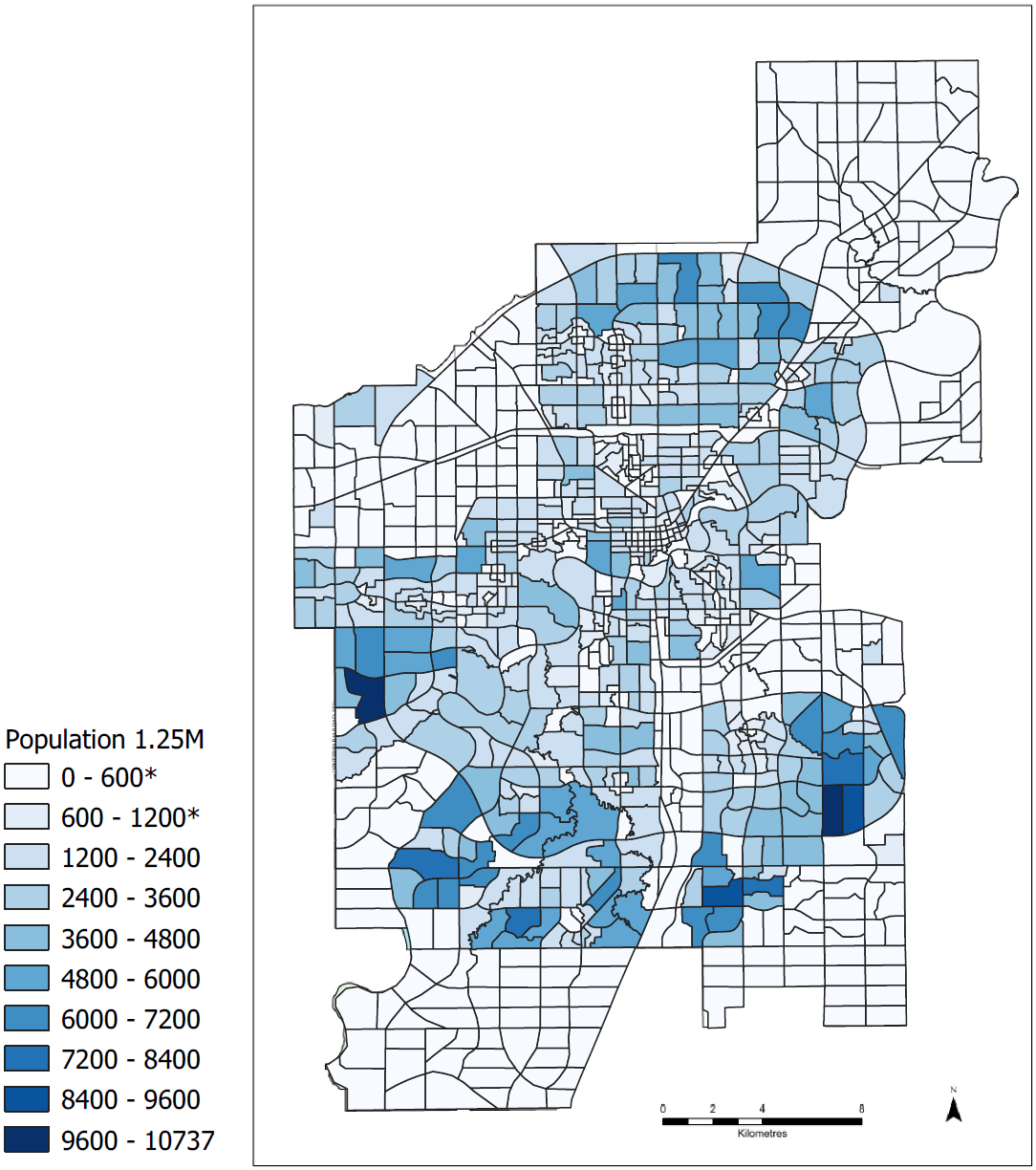
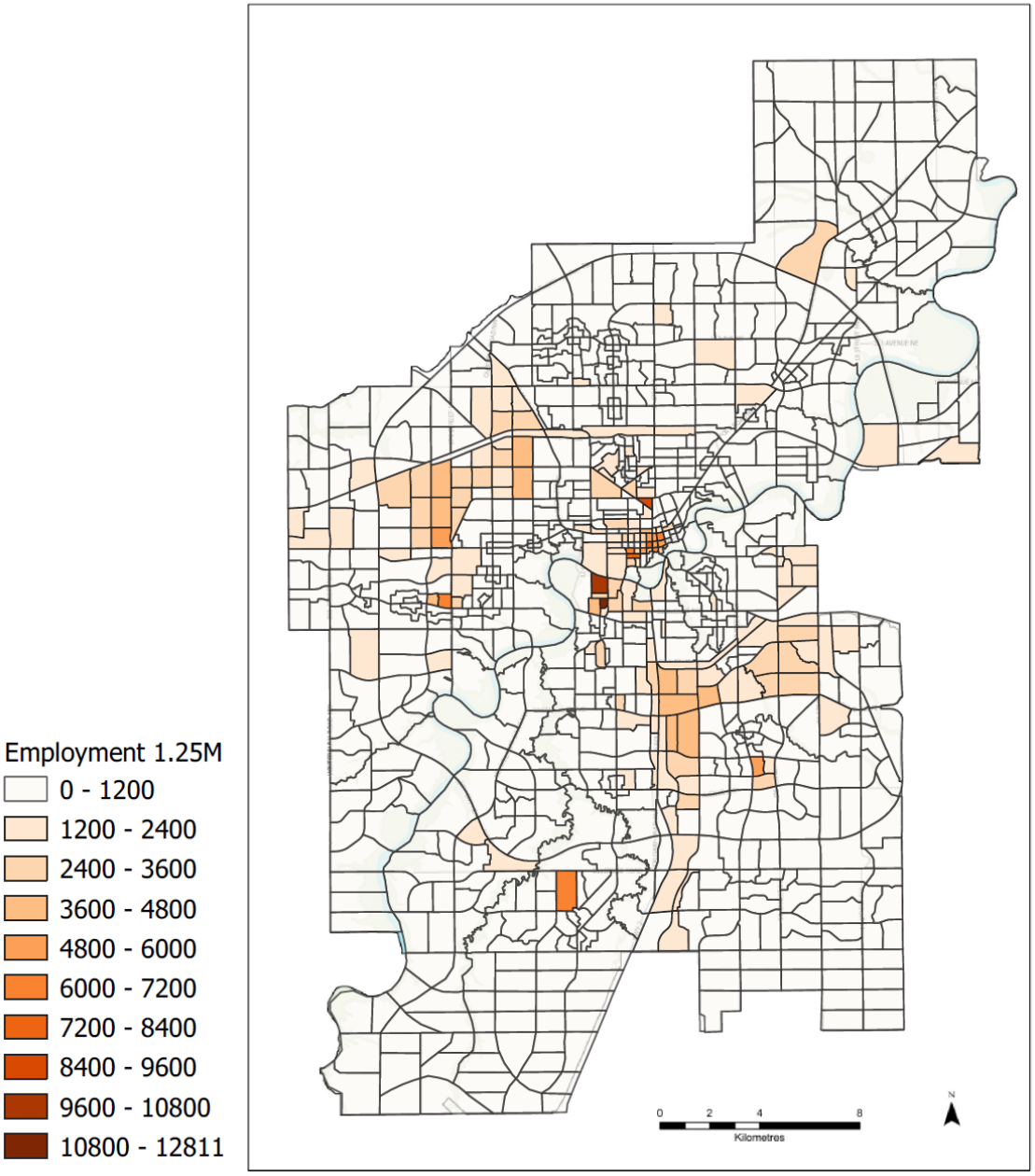


Exhibit 2.4: Edmonton City Plan Target - Total Employment Distribution for 1.25 Million Population



A caution: Due to the modelling zones being of unequal sizes, the colour scale represents absolutes per zone rather than density. Therefore, some neighbourhoods comprised of many smaller zones on the map are more built up (particularly for population) than the colours suggest. Refer to Appendix A for a dot density map, which demonstrates that most large outer zones are of similar density to many established areas – for this planning horizon.

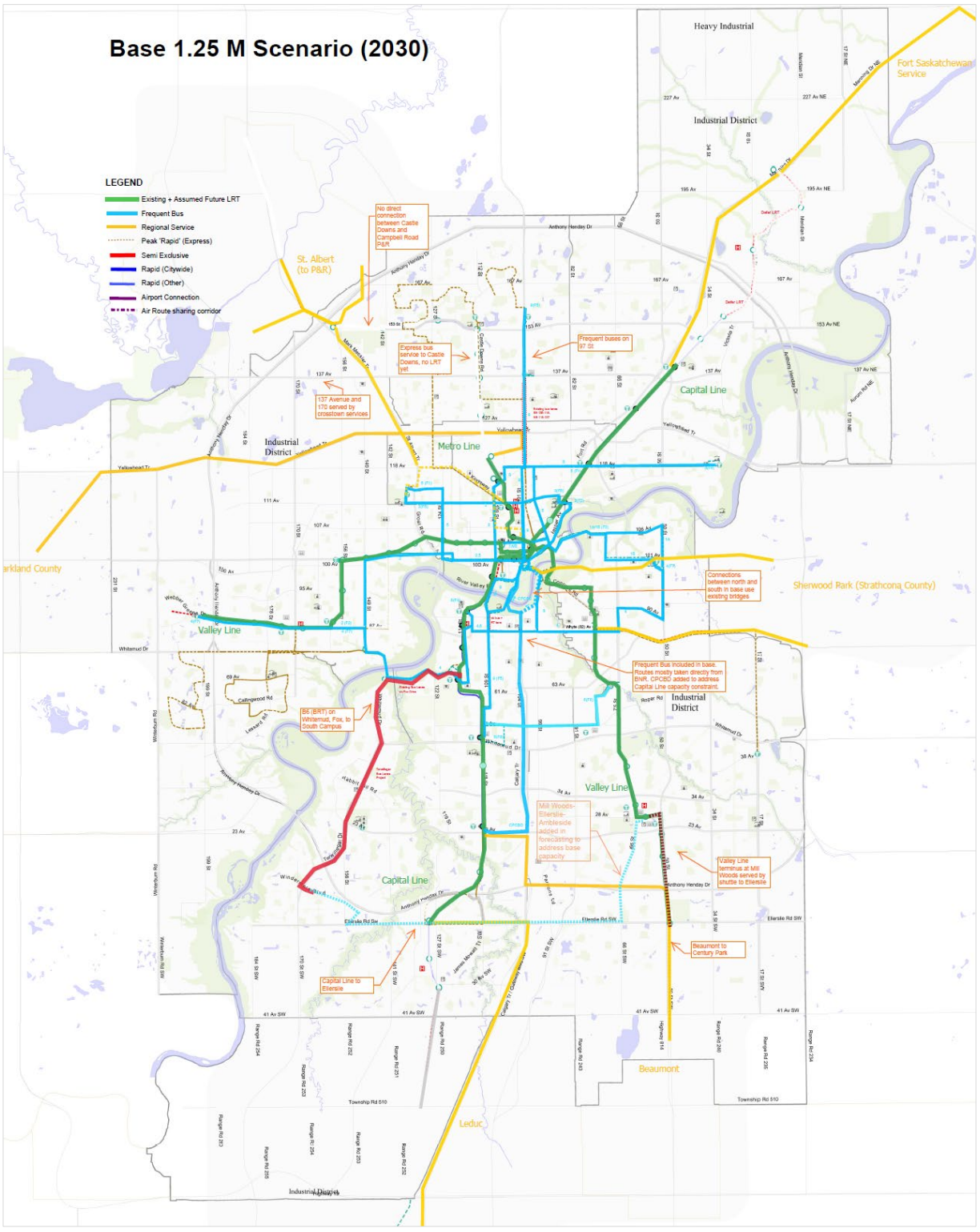
2.4. Base Scenario for the 1.25 Population Horizon

The 1.25 million (2030 for modelling purposes) Baseline includes:

- The **Bus Network Redesign** (BNR) network is included, plus future extensions of service into anticipated growth areas up to 1.25 Million. Consistent with 2021 plans, this future version of the BNR system also includes several types of services: Frequent, Crosstown, Rapid (all-day and peak-only), Local and Circulator routes.
- The Frequent services from 2021 (F1 to F9, also referred to as ETS routes 1A through 9) continue in the future base. Some of these services are assumed to operate every 20 minutes in the off-peak, and it would be expected by future horizons that these would be 15 minutes or better. Peak service is typically every 15 minutes or better.
- The all-day rapid services in the BNR (E1 and E2, or ETS routes 110X and 120X), continue into the 2030 base. These routes connect downtown to Eaux Claires (via 101 and 97 Street) and a second route from downtown to the Castle Downs area (via 109 Street, then 97 Street). The segment of 97 Street north of 118 Avenue has peak-period bus lanes in place. Peak-only rapid services were as defined by ETS, and connect outlying parts of the city with downtown or intermediate LRT stations.
- Terwillegar bus lanes (providing an early version of proposed route B6, on a semi-exclusive alignment). In the base scenario, a pair of bus routes operates between Ambleside and South Campus Station, and use the bus lanes on Fox Drive.
- Modifications to some bus service headways for Edmonton routes were modelled to provide a better demand to capacity balance (based on unconstrained demand versus constrained capacity of the assumed LRT and bus services).
- Several routes were added to the model to address capacity pinch points in the system identified through demand model tests by forecasting staff. The addition of these routes to the base assumption was confirmed with the project team. These included:
    - A frequent shuttle between the Mill Woods LRT /TC and a planned park and ride at 50 St and Ellerslie SE.
    - Frequent service on Ellerslie Road between Mill Woods, the Heritage Valley park and ride/LRT at Ellerslie SW, and Ambleside.
    - Peak-only relief service from Century Park to downtown using Gateway Boulevard/ Calgary Trail and the existing river crossings.
- **LRT network** expansion is assumed to continue, with service as follows:
    - Capital Line LRT extended from Century Park to Ellerslie SW
    - Metro Line LRT extended from NAIT to Blatchford
    - Valley Line LRT operating from Lewis Farms to Mill Woods.
- **Regional services** based in the surrounding municipalities, including St. Albert, Fort Saskatchewan, Sherwood Park, Beaumont, Leduc County (Nisku), Devon, Leduc, Parkland County, Stony Plain and Spruce Grove. In all future scenarios, the assumed regional routes are subject to change once the RTSC agrees on and adopts a future service plan.

Exhibit 2.5 shows the assumed LRT (dark green), regional routes (yellow), frequent bus (turquoise), and peak rapid express routes (brown) that form the backbone of the future base transit network. In addition, the entire built-up area of Edmonton (by ~2030) and the surrounding municipalities is served by local routes and regional connections. These routes were considered as part of the modelling analysis but are not shown in detail by the exhibit.

Exhibit 2.5: Edmonton Future Base Transit Scenario for 1.25 Million



2.5. Opportunities and Constraints

The Edmonton Transit Service (ETS) and LRT Expansion & Renewal departments were consulted to gain an understanding of the near- to medium-term opportunities and constraints for the transit system. The intent was to confirm what proposals and plans were already in place to expand service, and how the mass transit elements might form a part of those plans. In several areas, there were questions as to what order certain elements would be implemented, due to financial and technical constraints.

Capital Line Extent

In 2020, Council directed staff to prepare a business case for the extension of the Capital Line south from Century Park to the Ellerslie (SW) Park and Ride location. This is included in the Baseline and both options. A further extension to Heritage Valley Major Node, which would also include a station at the SW Hospital, is under consideration and could potentially be implemented in the next 10 to 15 years.

There is some impetus to extend beyond Ellerslie to the SW Hospital by 1.25 million, since it is expected to open by then. A more logical interim extension would take the line to Heritage Valley Major Node, which would provide a better location for a transit centre, and would support surrounding development. Funding has not been confirmed for this extension. The ultimate terminus of the Capital Line is at Allard/Desrochers, which will be triggered by future development of lands south of 41 Avenue SW, expected to occur by the 1.5 Million growth horizon (or later).

Extensions northeast to Gorman and beyond are not as high on the LRT priority list and not expected by the 1.25 Million horizon; this is also consistent with planned land development in the northeast being at a slower pace than the southwest.

Any Capital Line extension may produce two pressures on the system: 1) equitable distribution of investment throughout the city; 2) peak demands along the Capital Line, specifically on the segment of the line between South Campus and Health Sciences stations. There will be a need to further evaluate the best solution to Capital Line capacity issues – refer also to the discussion of capacity issues on the following pages.

Capital Line Infill Stations

There has been past discussion of interim ‘infill’ stations being constructed along the existing Capital Line to provide better access to areas that may start to develop in the planning horizon and are worth testing now to gain insight. Examples of these stations include the 92 Street area (midway between Churchill and Stadium stations) and at 40 Ave NW (the ‘Harry Ainlay’ location between Southgate and Century Park). There may also be interest in other locations at a future time, such as a ‘south Exhibition lands’ station; if this were to proceed, the concept would be developed in accordance with Exhibition Lands Planning Framework.

Metro Line Extent

Over the longer term, construction of the Metro Line northwest to Campbell Road is one of the priorities for LRT implementation, once funding becomes available. The line is assumed to be completed at some time prior to the 1.5 Million horizon. Council has identified this line as the next priority following the extension of Capital Line south.

Currently, the next major LRT project is the westward extension of the Valley Line, which has commenced the design and construction stage. The Valley Line West is assumed to be completed by the time of the 1.25 Million growth horizon. It was assumed to be less likely that the Metro Line could also be completed all the way to its planned terminus (at Campbell Road) within 10 to 15 years.

Phase 1 construction to build a new station at Blatchford and construction of the permanent NAIT station have commenced. Therefore, the next extension of Metro Line would be a new

bridge over the Yellowhead Trail and CN Calder railway yard as part of Phase 2, which would take the Metro Line as far as Castle Downs. This has been identified as a next priority for LRT extension by Edmonton City Council. This bridge was estimated to have a capital cost of over $200 Million, and a detailed design and final agreement with CN would be required to proceed. The third phase will extend the line to Campbell Road.

Valley Line Extent

The SE portion of this route is planned to open in 2021, as far as Mill Woods. Proposed extensions beyond this to Ellerslie Road are at the concept level only and not identified as a higher priority at this time. As noted above, the western extension of Valley Line to Lewis Farms is the next major LRT project. Design is currently underway with construction expected to soon.

Capacity Constraints on LRT

The LRT system's capacity depends on several factors including the size of the vehicles, and the frequency at which they can operate. In turn, the practical size and frequency of trains usually depends on the size of the stations, the power and signal systems, and safety considerations.

Platform lengths at the stations limit the length of high-floor LRT trains on the Capital and Metro Lines. Extending tunnel stations would be particularly expensive and a more practical way to increase capacity would be to tighten the frequency between trains on the combined routes.

Within the tunnel, the primary constraint is at the junction point of the two routes immediately north of Churchill Station, due to safety requirements for separation between trains. It is expected that more trains per hour will be operable in the future with signalling, communications and control upgrades.

The governing limitation on LRT capacity is currently at the grade crossings, where it is considered impractical to operate more than 12 trains per hour in each direction. Otherwise, impacts to other traffic and pedestrians would exceed local acceptance. Operational review is required to test near-term approaches that might trade off operating speeds and dwell times to make a higher frequency practical. A longer-term approach would be to grade separate any critical locations to permit more trains per hour. The location at University Avenue/114 Street is the most significant currently, as it is the peak load point on the LRT network and the place most in need of more capacity, which depends on headway and train size. In the future, trains on the Metro Line will be the same as the Capital Line (5 cars) and headway will remain as the limiting factor.

The assumed design capacities (refer to glossary) are 9,000 per direction for the Capital Line; 4,500 for the Metro Line; and 5,400 for the Valley Line.

Bus Fleet Reallocation and Expansion

Current planning indicates that over the next 10 to 15 years, approximately half of all fleet purchases will be replacing older vehicles, while the other half will be to address headway maintenance and allow for service expansion. Some near-term pressure on the size of fleet will be alleviated by reallocating service to the Bus Network Redesign (BNR) structure when VLSE starts operating in 2021.

An expanding fleet needs new bus garages, with a new garage planned for 2026-7 to accommodate 350 buses. The next garage after that would be needed in 2033, which coincides approximately with the 1.25 Million population horizon. Allocations of buses are expected to be shuffled among existing and new garages, so there is room for growth in each area of the city.

Terwillegar/Whitemud Bus Lanes

Terwillegar is a related project that is proposed to transition towards BRT. The alignment was initially assumed to be a combination of Whitemud/122 Street and Fox Drive, possibly one-way

on each leg. However, with recent funding announcements, these assumptions may need to be revisited and an alignment using only Fox Drive is more likely.

2.6. Mass Transit Options for 1.25 Million Horizon

Options A and B overlay elements of the emerging Mass Transit routes on top of the 2030 base, with some variations in the specific elements to test the response to different infrastructure and service investments. The rationale for these major elements follows these summary listings and reference maps.

2.6.1. Option A

- BNR bus route structure
- Route B6 (the Terwillegar BRT), extended from South Campus to University LRT station.
- Capital Line LRT further extended beyond Ellerslie Road to Heritage Valley Major Node
- Introduction of routes B1, B2, B4, and part of B5, mostly as rapid bus, but with several segments using dedicated lanes
- New rapid bus services B5C, R3, R6, R7, R12, and R109
- A 'ridership builder' local connector (RB2), anchored by the Heritage Valley LRT station at one end, and the Mill Woods LRT station at the other end.

Exhibit 2.6 shows the route structure for the major elements of Mass Transit 'Option A' for the proposed 1.25 Million horizon, referred to as a nominal '2030' modelling horizon.

2.6.2. Option B

- BNR bus route structure
- Route B6, extended from South Campus to University
- Metro Line LRT further extended to Castle Downs (testing the Metro Line Phase 2 extension to assess its effects)
- Infill stations tested on Capital Line; without any extension of the line
- Introduction of routes B1, B2, the short version of B5, and a greater amount of dedicated bus lanes than in Option A
- A shorter version of route B4
- New rapid bus services B5C, R3, R9, and R12
- A 'ridership builder' local connector (RB5), anchored by the Lewis Farms LRT station at one end, and the West Edmonton Mall LRT station at the other end.

Exhibit 2.7 shows the route structure for the major elements of Mass Transit 'Option B'.

Exhibit 2.6: Edmonton Future Mass Transit for 1.25 Million Horizon – Option A

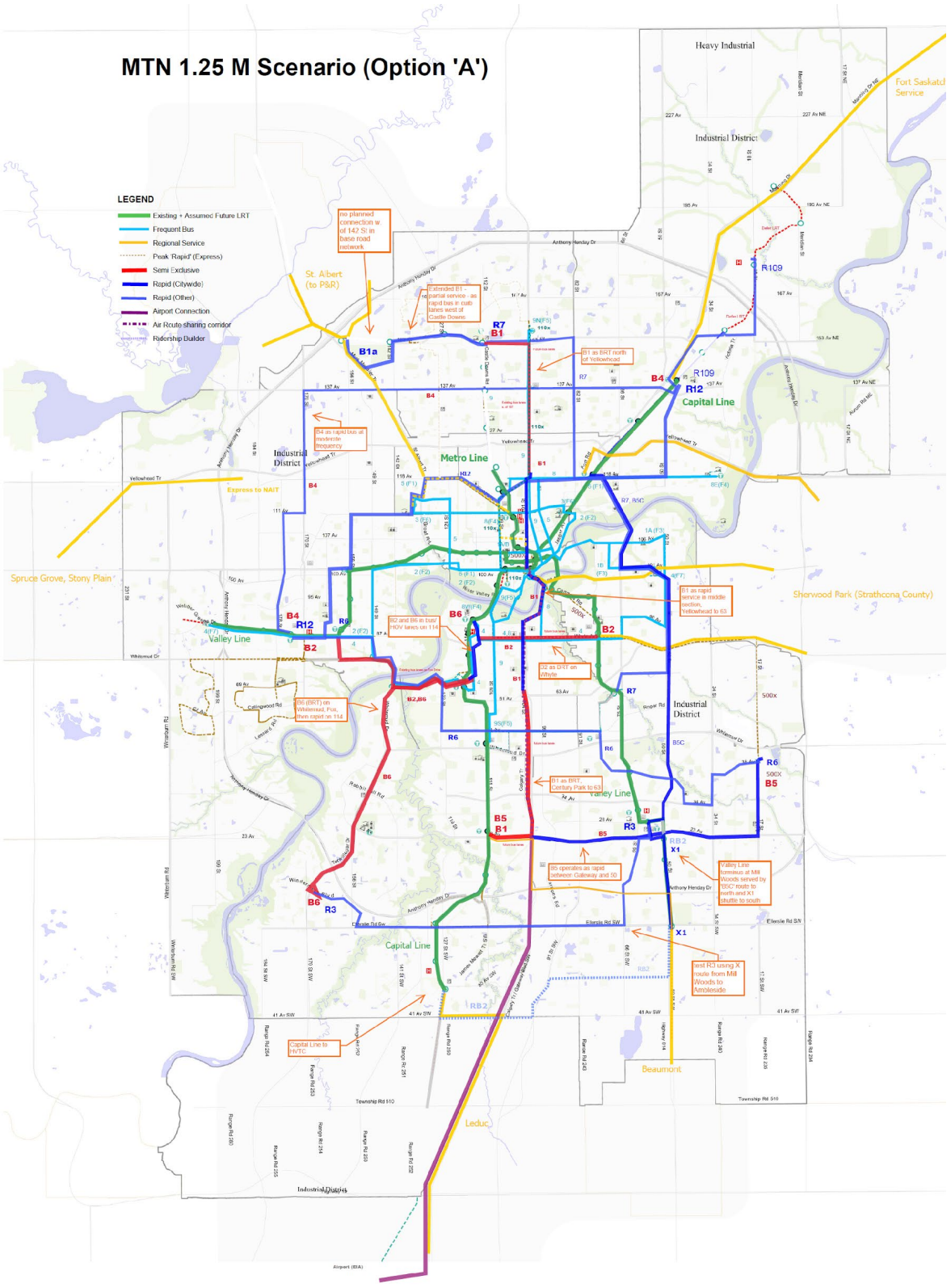
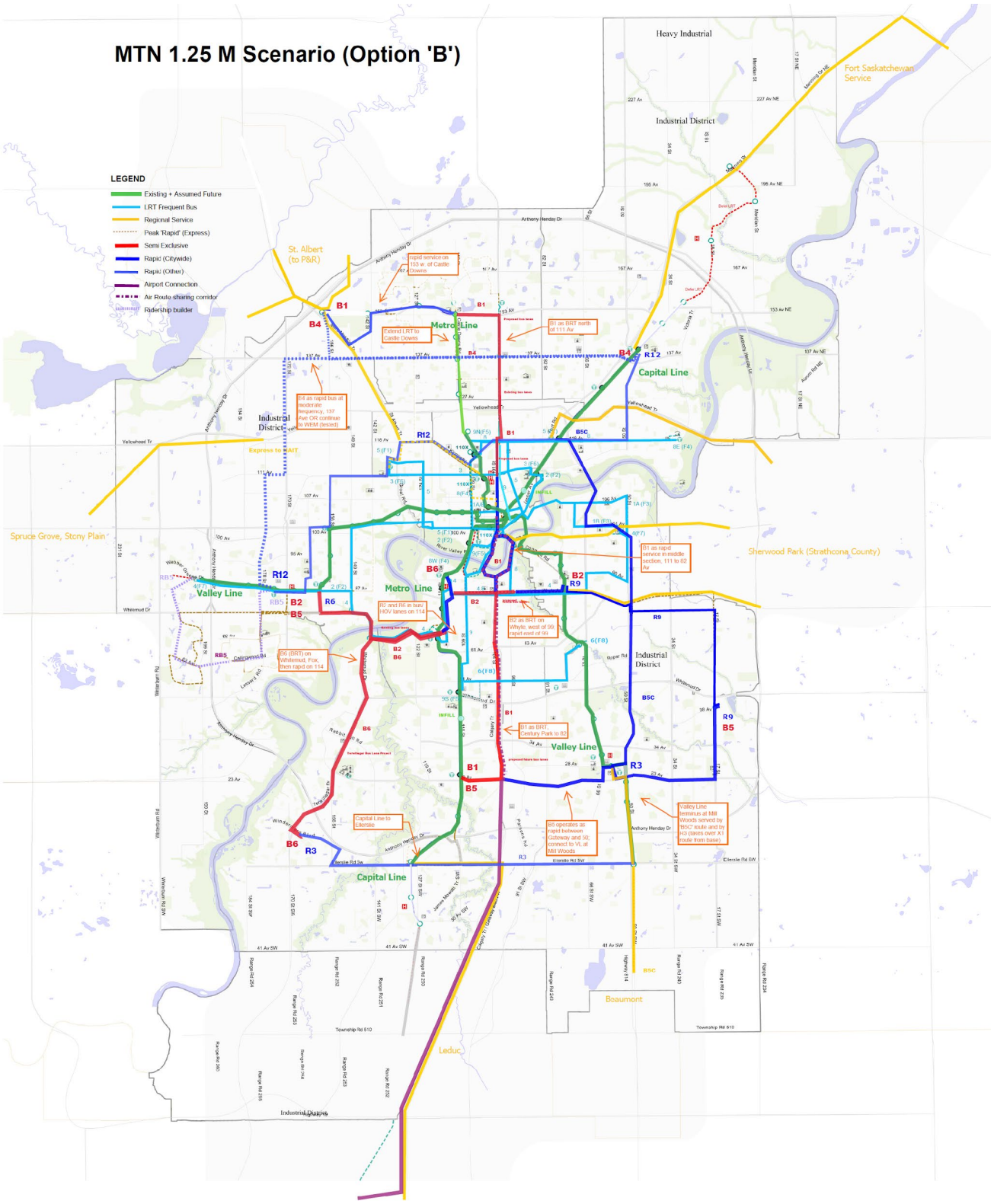


Exhibit 2.7: Edmonton Future Mass Transit for 1.25 Million Horizon – Option B



2.6.3. Options Being Tested by the 2030 modelling Base, Options A and B

The differences between Options A and B and from the 2030 modelling baseline reflect several factors:

- The expected staging of population and employment growth;
- Interpolation of additions in service between today and the 1.5 Million horizon that was previously defined;
- The constraints, challenges and opportunities identified by stakeholders;
- Opportunities to test different combinations of routes to see what the costs and benefits are projected to be. This will allow the team to propose a hybrid of the Base, Option A and B as the staging recommendation once analysis has been carried out.

The following points provide an overview of the rationale for Options A and B.

Capital Line Extent. An extension of the Capital Line south from Century Park to the Ellerslie (SW) Park and Ride location is included in the Baseline and both options. A further extension to Heritage Valley Major Node, which would also include a station at the SW Hospital, is under consideration and could potentially be implemented in the next 10 to 15 years. This potential extension is included within Option A. It is not included in Option B, which addresses other potential LRT modifications.

Capital Line Infill Stations. Examples of these stations include the 92 Street area and at 40 Ave NW. Given that Option A already includes an extension of the line, the effect of adding these stations is expected to be more apparent if analyzed as part of Option B.

Metro Line Extent. The baseline and both options include an extension to Blatchford and construction of the permanent NAIT station. The next logical extension would be a new bridge over the Yellowhead Trail and CN Calder railway yard. Similar to the 2030 base, Option A will terminate at Blatchford. Option B will test an extension as far as Castle Downs/153 Avenue as a potential next segment.

> The 153 Avenue corridor would be served by rapid bus services prior to completion of the Metro Line. For passengers at Campbell Road, both Options A and B would provide B1 connecting service, with a higher frequency provided by Option B in anticipation of greater demand (since it would also be possible to transfer to the Metro Line at Castle Downs).

LRT Frequencies and Capacities. The Capital and Metro Lines will continue to deploy high-floor LRT, which has longer trains, and a higher per-train capacity. The Capital Line is assumed to operate every 5 minutes in both directions during peak periods. Due to existing operational challenges – including overlapping use of alignment between Churchill and Health Sciences - and lower passenger loads, the Metro Line is assumed to operate every 10 minutes during the peak. By the 1.25 Million horizon, the Capital Line and Metro Line are assumed to have five (5) cars per train.

The Valley Line will use low-floor LRT that can be more directly integrated in urban streets, and will have shorter trains. It is also assumed to operate every 5 minutes during peak periods. Valley Line trains are assumed to operate with two (2) cars per train.

The off-peak frequencies are less than the peak: 10 minutes for Capital Line and Valley Line, and 15 minutes for Metro Line.

Semi-Exclusive Routes. The grouping of routes B1 through B6 fall into this category. For the planning horizon, only partial implementation of semi-exclusive right of way is assumed, with differences between all three scenarios.

- **B6**. This route includes the planned bus lanes on Terwillegar and consequently, a shortened variant of this route, running from Ambleside to South Campus, is effectively included in the baseline. For both Options A and B, the route is extended north to University LRT station using 114 and 112 Avenues without dedicated lanes (operating in mixed traffic for this time horizon).

- **B1.** This route extends from Century Park to the Campbell Road, with the segment west of Castle Downs operated as rapid bus. The route includes semi-exclusive lanes along its route to the north and south of the city centre. In Option A, these lanes are less extensive and would operate north of 118 Avenue and south of 61 Avenue. In Option B, they would be north of 111 Avenue and south of 82 Avenue, providing additional speed benefits. Both options expand on the existing bus lanes between 118 Avenue and 137 Avenue on 97 Street.

- The crossing of the North Saskatchewan River uses existing bridges. In Option A, NB and SB buses would use the Low Level Bridge. In Option B, NB will operate via Walterdale while SB will use Low Level. The distances are similar but allow a different combination of bus stops to be compared.

Several precursor rapid/express routes assumed in the 2030 base are modified for Options A and B. These changes include the replacement of 120X and CPCBD (Century Park-downtown peak-only) routes by the B1 route.

- **B2**. This route would operate between West Edmonton Mall and Bonnie Doon LRT station. In both options, it would use the bus lanes on Fox Drive, sharing this section with B6. Option A includes semi-exclusive treatment on 82 Avenue from 112 Street to Bonnie Doon, while Option B tests a shorter extent, from 112 Street to 99 Street, since 82 Avenue becomes more residential to the east.

- **B4**. This route runs from Clareview to West Edmonton Mall in Option A. Option B shortens the route and serves the busier part of the line on 137 Avenue only, and terminates at Campbell Road. In the 2030 horizon, this route uses existing lanes with some priority assumed, but is not a semi-exclusive operation.

- **B5**. Due to higher demands on the eastern portion of this route, an initial segment from Century Park to Maple TC is included in both Options A and B. The segment from Calgary Trail to 111 Street, shared with B1, would be semi-exclusive. The future western part of the B5 route (from 87 Avenue to Century Park) is also served by a crosstown route, which will have its frequency slightly increased to address peak demand.

Rapid Bus. The set of routes proposed for implementation focuses on those serving growth areas and corridors designated for investment in the 1 to 1.25 Million planning horizon. Details of the routes are indicated on the maps and summary table. In general, the frequency assumed in 2030 is less than the ultimate, since population and employment along most routes will be at an interim state, beginning to increase but not at the so-called 2065 levels.

- **R3** is included in Options A and B, and replace a frequent service identified in the refined base network, due to high demand on Ellerslie Avenue. Option A tests a direct replacement of the route from Mill Woods to Ambleside, which follows part of 66 Street.

In Option B, R3 follows 50 Street, also replacing some of the shuttle service between Mill Woods LRT and the Ellerslie SE Park and Ride. These two variations in R3 will have different operating costs and boardings.

- **R6** is a crosstown service from Meadowlark to Maple, including service on 51 Avenue. It is introduced as a medium frequency rapid bus to build ridership, in Option A.

- **R7** is another crosstown service, connecting Castle Downs, Exhibition LRT station, Capilano and Davies LRT station. It is being tested as an element of Option A. (It is not included in Option B, which instead sees LRT service to Castle Downs, and assumes more frequent service on route B5C on 50 Street as an alternative).

- **R9** provides a connection from Maple TC to Bonnie Doon LRT, with intermediate stops in the employment district. It is included as an element in Option B. The level of service on a parallel express route (500 X) is adjusted for Option B. 2030 Base and Option A assume route 500X only with no R9.

- **R12** operates between Clareview TC and West Edmonton TC, with connections to Exhibition LRT, NAIT, Westmount, and West Jasper Place. This route demonstrated some of the highest rapid bus demand in the ultimate City Plan network, and the interim 1.5 Million network, and so it is also included in Options A and B.

- **R109** is included in Option A in a truncated form to provide a connection from Clareview to the future Gorman station and Alberta Hospital station locations. This route is expected to become more significant by 1.5 Million, and it is included in Option A only, to assess its potential demand.

- **B5C – Edmonton Portion**. Options A and B include implementation of the B5C service from Mill Woods to Exhibition LRT via 50 Street, operating much like a rapid bus. The frequency of this assumed service is less for Option A, due to overlap with part of R7.

- In two emerging areas where future rapid buses are planned in later planning horizons, the ridership builder routes RB2 and RB5 (identified previously) are being tested to see how much demand there is by the 1.25 Million horizon. These are being operated similar to local routes for the 2030 scenarios.

Airport Connector. This service is included in both Options A and B, but with variations in travel time. It is assumed to follow Highway QE2 and then use the same route as B1 between 23 Avenue NE and downtown. The differences in the assumed extent of bus lanes for B1 would also affect the travel time of the AC service in Options A and B.

Frequent Bus. The frequent bus services largely come directly from the BNR and on the map and tables, the functional name used (e.g. F1, F4) is also accompanied by the proposed route numbering that ETS plans to use when the route restructuring is implemented in 2021. In Options A and B, some of the frequent routes carry forward as assumed in the base (e.g. 1A, 1B, 2), where no semi-exclusive or rapid service is being introduced. Other routes (e.g. 4, 5, 6) assume a modest reduction in local service frequency in Options A and B, where some of the demand would be picked up by proposed new routes in the same corridors.

Regional Bus. These are largely carried forward from the revised ‘2030’ base without further modification. A previous memo identified the refinements made to ensure the current RTSC proposals for regional coverage were reasonably reflected in the travel model.

2.6.4. Bus Lanes and Transit Priority

The semi-exclusive routes noted above proposed to evolve over time, with some segments operating in mixed traffic with spot treatments to address delays, segments with dedicated bus lanes in peak periods, and other areas where the transit service would eventually be segregated except at intersections. For the early horizon of 1.25 Million, portions of B1, B2, B4, B5 and B6 will operate more like rapid bus, with limited stops and some strategic use of transit priority at delay locations. There are also areas in the 2030 Base, Options A and B where existing (2020) bus lanes continue to operate and new ones are assumed or proposed.

The bus lane elements in the **Future Base Scenario** include:

- Peak direction bus lanes on 97 Street between 118 Avenue and Yellowhead, SB from 135 to 125, and NB at 137 into Northgate TC. There is also a peak direction lane reversal south of Yellowhead Trail. (Used by BNR routes and by B1 in options A and B)
- A combination of NB bus lanes on 109 Street operating in peaks and all day. (Used by BNR routes)
- Bus lanes on Fox Drive and connecting through to South Campus. (used by BNR routes, the SWBRT in the base scenario, and B2 and B6 in Options A and B)
- Peak period bus lanes on Jasper Avenue between ~120 Street and ~110 Street.
- Bus lanes on Whitemud and Terwillegar Drive between Fox Drive and Windermere Blvd (used by the SWBRT in the base scenario and by B6 in Options A and B).
- Several dedicated bus lanes on various downtown blocks – because of high volumes of buses stopping – and at approaches to various transit centres around the city.

These elements are the starting point for Options A and B. **Both options include**:

- Peak direction, peak period lanes extended on 97 Street to Eaux Claires TC, converted from existing lanes;
- Bus lanes added to 153 Avenue from just east of 97 Street to Castle Downs;
- NB bus lane converted from an existing lane on Gateway Boulevard, from 23 Avenue to 63 Avenue;
- SB bus lane conversion on Calgary Trail from 63 Avenue to 23 Avenue;
- Peak direction, peak period bus lane on 82 (Whyte) Avenue from 99 Street to 112 Street;
- Peak direction, peak period bus lane on Whitemud from 159 Street to Fox Drive; and
- Peak direction, peak period bus lane on 23 Avenue from Calgary Trail to 111 Street.

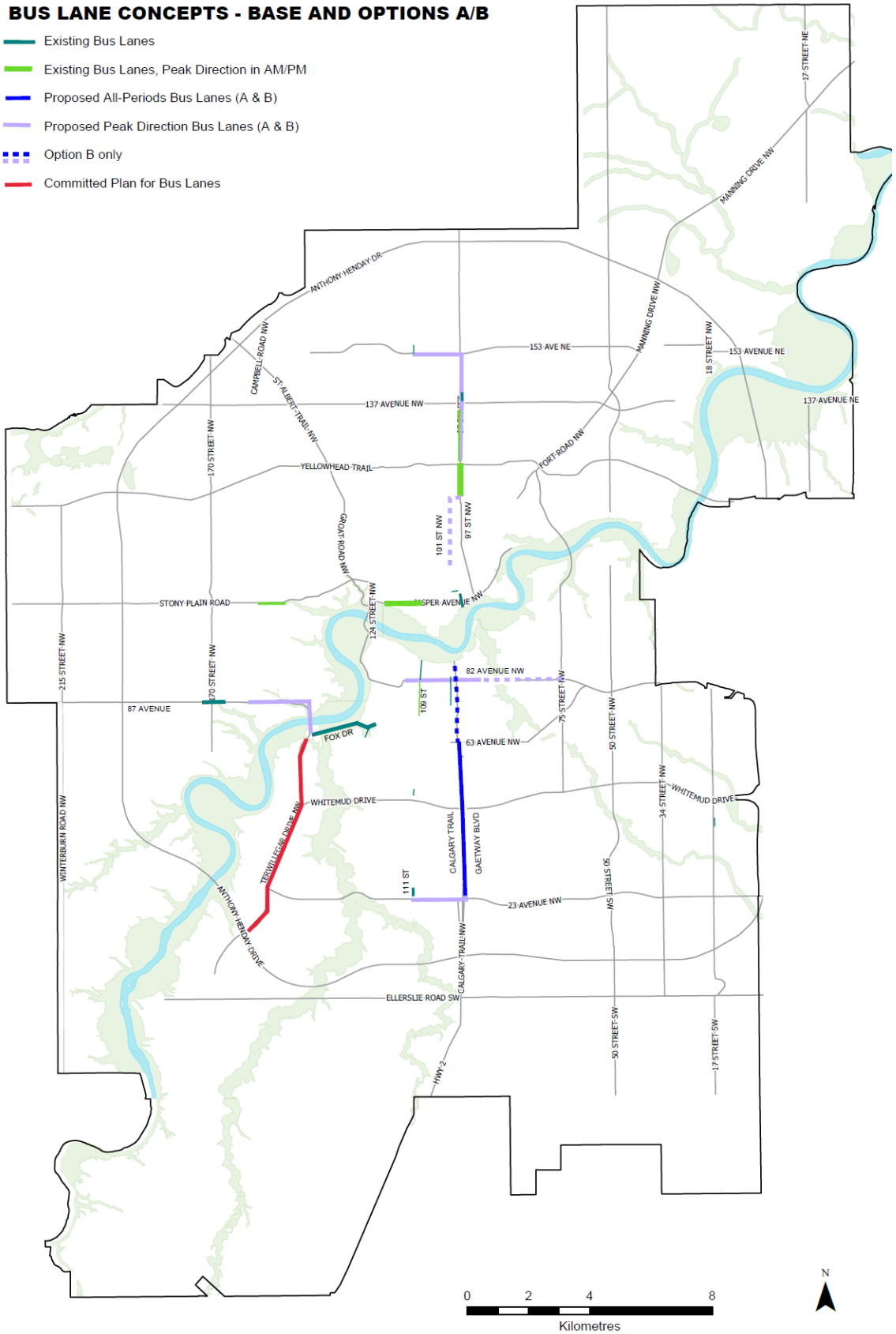
Bus lanes tested in the model generally assumed reallocation of existing street space rather than widening.

Option B extends several bus lanes further:

- Peak direction, peak period lanes on 101 Street, converted from existing lanes, from 118 Avenue to south of 111 Avenue;
- Peak direction, peak period bus lane on 82 (Whyte) Avenue from Bonnie Doon to 112 Street;
- Extended NB bus lane converted from an existing lane on Gateway Boulevard, from 23 Avenue to 83 Avenue; and
- Extended SB bus lane conversion on 104 Street and Calgary Trail from 83 Avenue to 23 Avenue.

The existing bus lanes and those proposed lanes tested in the model are illustrated conceptually in Exhibit 2.8.

Exhibit 2.8: Future Mass Transit for 1.25 Million Horizon – Proposed Bus Lanes



3. Network Options Performance

The ultimate mass transit network was developed in conjunction with the Edmonton City Plan, and as such, was intended to enhance future transit network performance in addition to several broader goals. These include supporting future land use plans and policies by serving and shaping travel demand, acting as a catalyst for development at nodes and corridors, and helping the city to be more sustainable (financially, environmentally and socially). The evaluation of interim options for 1.25 Million scenarios has been carried out to help prioritize elements of an incremental build-up of that long-term network.

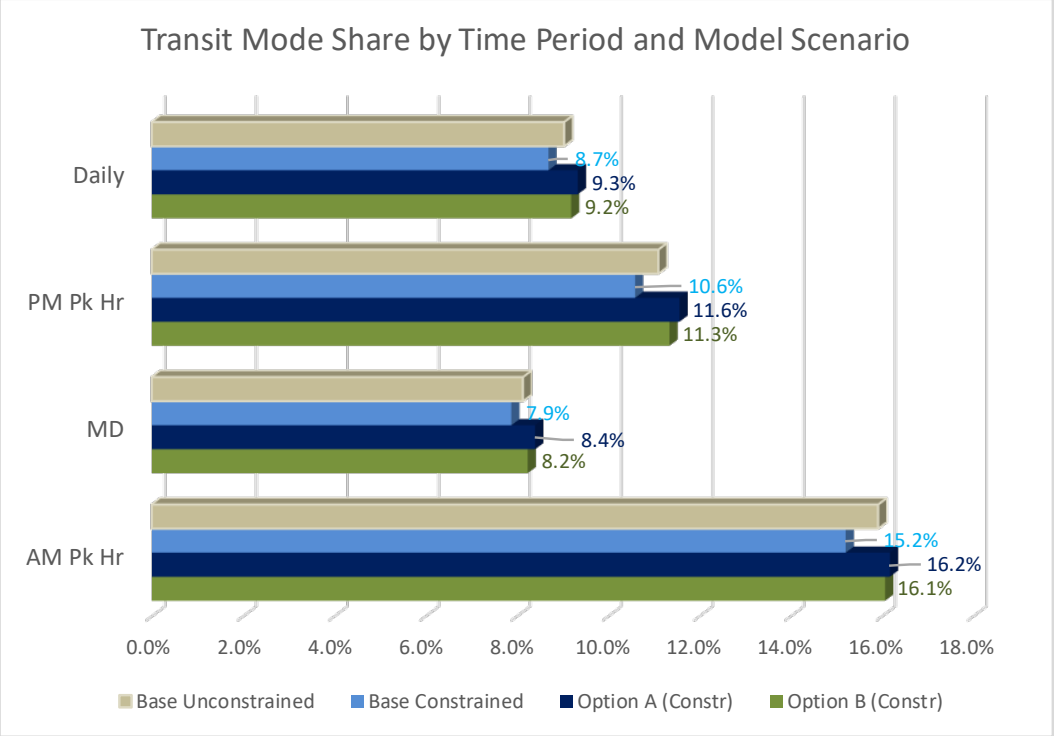
It is important to note that the demand modelling has been carried out using the City's calibrated travel demand model, which is partially based on the 2015 Household Travel Survey and on network-level counts of traffic and transit passengers. These trends were representative through to early 2020, prior to the pandemic. There is some uncertainty about the timing of future travel demand since there may be lasting legacy effects of the past year.

3.1. Transit Mode Share Comparison

The mass transit options are built upon the Base scenario with the objective of aligning with the land use patterns proposed for 2030 modelling base analysis. It is important to improve performance of the interim 1.25 M network options during the AM peak for work and school commute trips, in the midday for personal business, shopping and recreational travel, and in the PM peak for a broad combination of different trip purposes.

Exhibit 3.1 summarizes the mode choice results for the 2030 modelled horizon (used as the approximate time horizon to reach 1.25 million people) for two variations of the Base scenario, in addition to mass transit options A and B.

Exhibit 3.1: 2030 (1.25 M Population) Transit Mode Shares – Base Scenarios, Options A and B



The 'unconstrained' Base reflects potential demand for transit, whereas the 'capacity constrained' scenario reflects additional time transit passengers would require waiting for additional transit vehicles or taking different routes where on some routes, space becomes limited. This produces a lower level of ridership. Options A and B use the same constrained capacity, so the transit mode choice increases are relative to the Base constrained.

These results all reflect the mode choice for residents of Edmonton, as output by the regional demand model. Option A outperforms B, but this was expected as it contained a larger extent of mass transit routes. Both options increase transit mode choice relative to the constrained future base, because they add capacity and speed between key origins and destinations.

Transit Mode Share Compared to Recent Performance

The projected increases in future mode share include a 1% increase in each of the peak periods and 0.6% over the course of a full day when comparing the most robust mass transit option with the future base network. These percentages are for ALL trips in Edmonton. Focusing just on the implications for transit, these projected AM and PM increases would result in nearly one-tenth (9-10%) *more transit passengers* on ETS.

When comparing these results to recent transit usage (8.2 % in the 2015 travel survey), it is important to remember that the higher mode share is also based on a much higher population. Therefore, the mode share gains in the analysis indicate that the number of transit riders will not only have kept pace with growth of the city (nearly 30%) but also forecast to make additional gains, resulting in 50% more transit riders between 2015 and the 1.25 Million horizon

Mode Choice by Time Period

Exhibits 3.2 through 3.4 show the percentages of travel choice for transit and other modes of personal travel, for the AM peak hour, the average midday, and the PM peak hour. The auto mode share is expressed in terms of drivers and passengers. The transit share is split into 'walk access' (people board at a nearby stop or station, reached on foot) and Park and Ride/Kiss and Ride access (passengers drive to a parking lot near a transit stop or station, or are dropped off/picked up by someone).

- In the AM peak, the mass transit options can build on the base scenario, increasing mode share for transit from 15.2% to 16.2% (Option A) or 16.1% (Option B). This is the percentage of AM trips by city residents that select transit as the primary mode. The transit shares are highest in the AM peak because the focus of AM travel is work and school-related, which lend themselves well to transit.

Exhibit 3.2: 2030 (1.25 M Pop) AM Peak Mode Shares – Constrained Base Scenario, Options A and B

AM Peak Hr (7-8)	Driver%	Passenger%	Walk Access Transit%	PNR/KNR%	School Bus%	Walk%	Bike%
Base Constrained	58.7%	15.9%	12.3%	2.9%	2.9%	5.5%	1.9%
Option A	57.8%	15.8%	**13.2%**	**3.0%**	2.8%	5.6%	1.9%
Option B	57.9%	15.8%	13.1%	3.0%	2.8%	5.6%	2.0%

- In the MD typical hour, transit mode choice increases from 7.8% to 8.4%/8.2% for trips in Options A and B respectively. This increase reflects higher speeds provided by the additional services, which help to attract additional passengers relative to the Base. These trips appear to be drawn away from auto drivers and passengers.

Exhibit 3.3: 2030 (1.25 M Pop) MD Peak Mode Shares – Constrained Base Scenario, Options A and B

Midday 9 - 3:30	Driver%	Passenger%	Walk Access Transit%	PNR/KNR%	School Bus%	Walk%	Bike%
Base Constr	54.3%	21.0%	7.4%	0.4%	1.1%	14.3%	1.4%
Option A	53.9%	20.9%	**8.0%**	**0.4%**	1.1%	14.3%	1.4%
Option B	54.1%	20.9%	7.8%	0.4%	1.1%	14.3%	1.4%

- In the PM peak, transit mode choice increases from 10.6% in the Base to 11.6% in Option A and 11.4% in Option B. These all fall into a lower percentage range than in the AM, due to the number and complexity of trips being higher in the PM. The reverse commute from the AM is part of the PM pattern, but there are additional discretionary trips such as personal business and shopping, and commute times in the afternoon and evening are more dispersed due to school ending at a generally different time from the end of the working day. Auto passenger and walk trips both increase as a percentage of PM peak trips compared to the AM.

Exhibit 3.4: 2030 (1.25 M Pop) PM Peak Mode Shares – Constrained Base Scenario, Options A and B

PM Peak Hr (4:30-5:30)	Driver%	Passenger%	Walk Access Transit%	PNR/KNR%	School Bus%	Walk%	Bike%
Base Constr	59.1%	18.5%	9.1%	1.5%	0.03%	9.8%	2.0%
Option A	58.3%	18.4%	**10.0%**	**1.6%**	0.04%	9.8%	1.9%
Option B	58.4%	18.5%	9.8%	1.6%	0.03%	9.8%	2.0%

3.2. Fleet Requirements

Based on the estimated running times for the range of transit services, and the service frequencies at different time periods, one may estimate the number of buses and LRT trains in operation. ETS uses the AM peak to define the service fleet requirements for most routes, which combines the morning commute demand with school trips, resulting in the largest number of buses in service. Community circulator routes are an exception to this, and run more frequently in the midday.

Exhibit 3.5 shows the calculation for the size of the bus fleet based on the combined AM/MD peak vehicles, as described above. The numbers of buses vary between the base and options due to new services being added, and to replacement or reduction of some base services by the new routes. For the two options, the incremental number of buses is 60 to 95 vehicles more than the future base fleet.

Exhibit 3.5: Transit Vehicle Fleet - Buses - Constrained Base Scenario, Options A and B

SCENARIO	BASIC BUS REQT (AM PEAK)*	COMMUNITY BUSES (MIDDAY)	RED ('BRT')	TOTAL BUSES IN PEAK SERVICE**	TOTAL BUS FLEET	SPARES
BASE	832	12	15***	**859**	**1075**	216
OPT. A	848	12	74	**934**	**1170**	236
OPT. B	824	12	71	**907**	**1135**	228

Notes:
* AM Peak number = regular buses in peak service, 10% allowance for extra buses for school-related peak loads (this is in addition to the regular service one would estimate based on travel times divided by nominal headway), and rapid bus fleet.
**Includes buses estimated from modelled run times and headways, allowance for school services, and shuttle services (which are higher midday).
***SW 'BRT' using Terwillegar and Fox Drive bus lanes, is in the base network and counted as BRT.

In Exhibit 3.6, the numbers of LRT indicated are trains in service, then the totals with spares, and the resulting number of individual LRVs. For planning purposes, and for setting capacity in the demand model, 5-car high-floor LRT and 2-car low-floor LRT is assumed. A spare ratio of 25% was assumed for LRVs.

The high-floor numbers increase slightly for Options A and B due to the proposed alignment extensions being assessed in each. For the two options, approximately 15 high-floor LRT cars and no additional low-floor cars are assumed relative to the future base network.

Exhibit 3.6: Transit Vehicle Fleet - LRVs - Constrained Base Scenario, Options A and B

SCENARIO	HIGH FLOOR LRT	WITH SPARES	HIGH FLOOR CARS	LOW FLOOR LRT	WITH SPARES	LOW FLOOR CARS
BASE	20	25	**125**	27	34	**68**
OPT. A	22	28	**140**	27	**34**	**68**
OPT. B	22	28	**140**	27	**34**	**68**

4. Performance of Network Element Options

In this section, the performance of the individual network elements is presented in order to identify key areas of interest within the network. This section builds upon the broader network considerations discussed in Section 3.

4.1. Measures/Definitions

The following measures are used in this section to better articulate the performance of individual routes and normalize them against each other.

- Average Hourly Boardings – AM and PM peak hour passengers getting onto a route, added in both directions, expressed as a per-hour average. It is a measure of how many people **use** (demand) a transit route or transit system.
- AM + PM Boardings per km – Total passengers boarding a route in the AM and PM peak hours, divided by the length of a round trip on that route (this distance is also known as the total directional route-km). This measures the **attractiveness** of a route and its assumed stops. It is divided by distance to allow us to compare routes with different lengths. This value is sensitive to land uses, destinations, and service assumptions.
- Boardings per service hour. This measures how many passengers board a route, divided by the amount of service being provided over a period. The total service hours on a transit route is the sum across all vehicles operating on that route. If 'N' buses each operate for a full hour on one route, then 'N' service hours have been provided. This is also a measure of attractiveness because it relates boardings to the amount of service. Boardings/hour is the main productivity measure in many Transit Service Standards, including ETS. This measure can be sensitive to stop spacing, and as such it is most applicable comparing transit routes within the same category, for time series monitoring, and system-wide statistics.
- Hourly Volume – Number of passengers on board transit vehicles, passing a location in a one-hour period, in one direction, on one or more routes. Maximum volume is the highest of these values along a route or corridor. This measures how **full** the service gets, which is both a measure of its attraction and an indicator how much service is needed to meet the maximum demand.

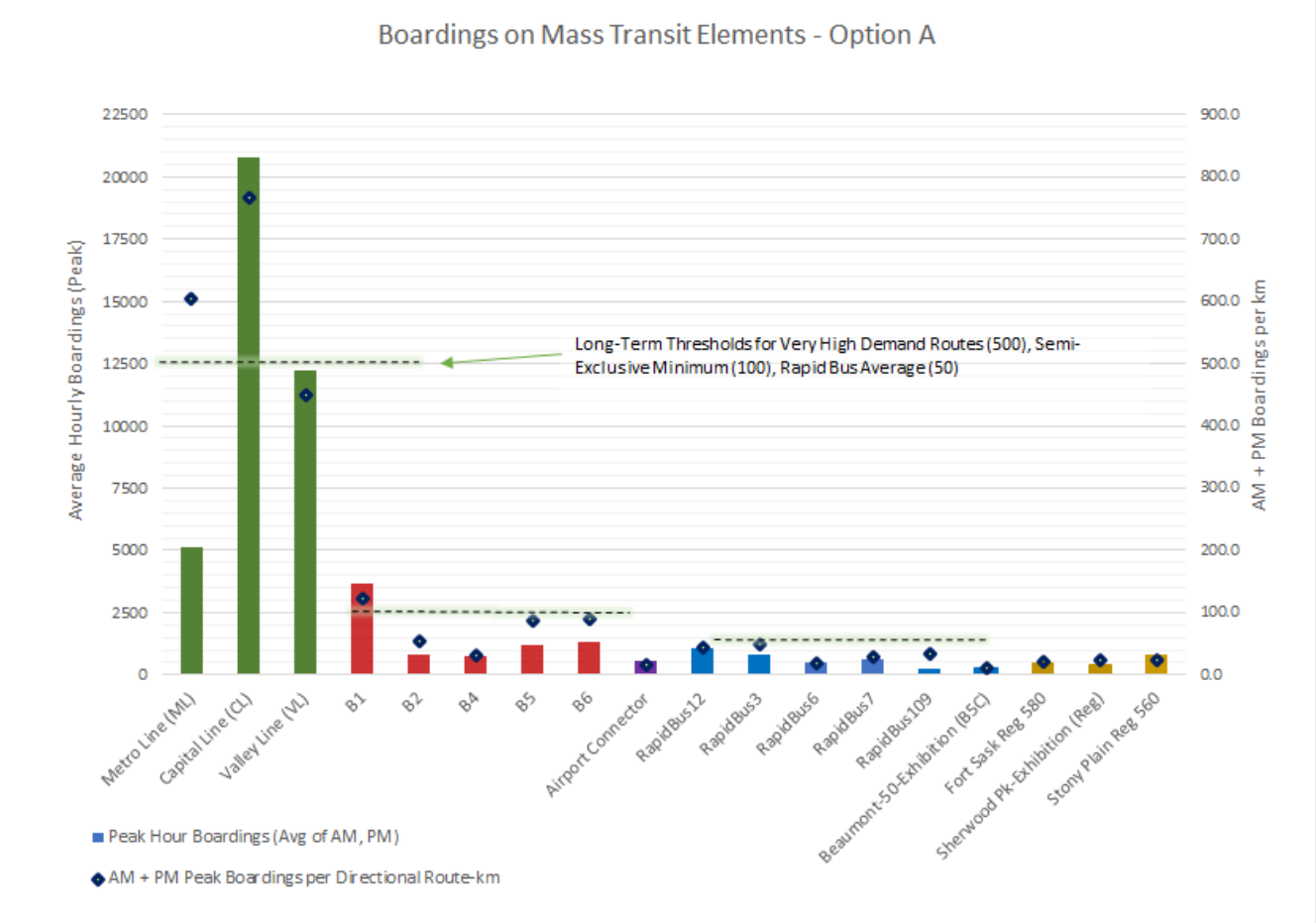
4.2. Exclusive, Semi-Exclusive and Rapid Routes

4.2.1. Boardings

Exhibit 4.1 summarizes the resulting average hourly boardings for the AM and PM peaks (coloured bars) and the AM + PM boardings per-km number (diamond shapes on the chart) for the major mass transit elements being tested in Option A.

The number of boardings has been colour-coded to roughly correspond with the maps in Section 2. Elements of the City-wide routes include exclusive ROW rail services (LRT lines in green, Airport Connector in Purple), semi-exclusive ROW transit (shown in red-orange), and routes operating in mixed traffic (rapid bus in dark blue, and major regional routes in tan-yellow).

Exhibit 4.1: Boardings on Selected Mass Transit Elements, Option A



- The first four routes in the chart all stand out with high numbers of passenger boardings indicating that these lines are most responsive to the demand generated by the mass transit network. These lines serve major travel demands and connect several of the highest-density employment areas in the city, which explains the popularity of these routes.

- The Metro Line, Capital Line, and Valley Line all include exclusive river crossings, either existing or under construction. This contributes to their capacity and speed advantages that attract passengers.
- For comparison purposes, the per-km threshold of 500 passengers is shown against the LRT routes. This threshold is comparable to the busiest surface route in Greater Vancouver, the 99 B-Line, a frequent limited bus between the SkyTrain rapid transit system and the University of British Columbia. This line represents a high level of passenger activity and requires substantial capacity – in fact part of the route is being replaced by rail in the next 5-6 years. The Capital and Metro lines will be reaching this type of threshold by the 1.25 Million population horizon.
- B1, and B2 propose new river crossings in the ultimate state, but these crossings are deferred beyond 1.25 million. The results above reflect B1 and B2 following existing routes as an interim approach to delivering service. In the case of B1, the effect of the detour and the less extensive bus lanes slows service and suppresses potential ridership, but B1 is still faster than most bus routes.
- B2 in its interim state follows Fox Drive and Whitemud, which places it in competition with peak express and all-day frequent buses for passengers. Its less direct interim routing depends on transit priority and bus lanes to gain some travel time advantages.
- The second per-km threshold of 100 passenger boardings is the suggested minimum to meet bus rapid transit service levels. This was established through comparison with peer services. For example, two of the Metro Vancouver rapid bus routes (R5 and R1, formerly the 95 and 96 B-Lines) currently achieve 130-170 peak boardings (two peak hours) per directional kilometre of route.
- B1 is projected to meet this demand threshold by the planning horizon, with B5 and B6 being close behind. Each of these routes is a combination of semi-exclusive and rapid service, on direct paths between nodes, and consequently they perform well against the per-km measure.
- Routes B4 operates as a rapid bus and at a somewhat lower frequency than the other ‘B’ routes in the interim network, and as such its performance is more in line with a starter rapid bus service.
- Other mass transit services are not expected to attract as many passengers since they serve less dense corridors and do not align with as many major activity nodes. For comparison purposes, the suggested threshold shown in the chart is 50 passengers per km.
- The Airport Connection and the regional routes are longer and with fewer stops. This type of service is usually evaluated as to how full the individual vehicles are, and how long the average passenger trips are on the service. Because the number of stops is usually fewer, the number of boardings per km will naturally be lower.

Exhibit 4.2 provides the same information, but for the set of routes included in Option B. There are several differences from Option A to point out:

- The Metro Line (ML) has more boardings in this option, since it includes the extension to Castle Downs. The number of passengers per km drops slightly as the extension includes a gap between stations that brings down the line's average.
- The Capital Line (CL) has fewer boardings in this option, which is a combination of two factors. The line does not include the HVTC extension but does add two infill stations that attract modest ridership. This has the effect of increasing the number of passengers per km despite the lower number of boardings overall.
- The set of rapid bus routes is slightly different, reflecting a different set of routes being tested. *Refer to the following pages for more discussion of the rapid bus routes across the two options where they were tested*.

Exhibit 4.2: Boardings on Selected Mass Transit Elements, Option B

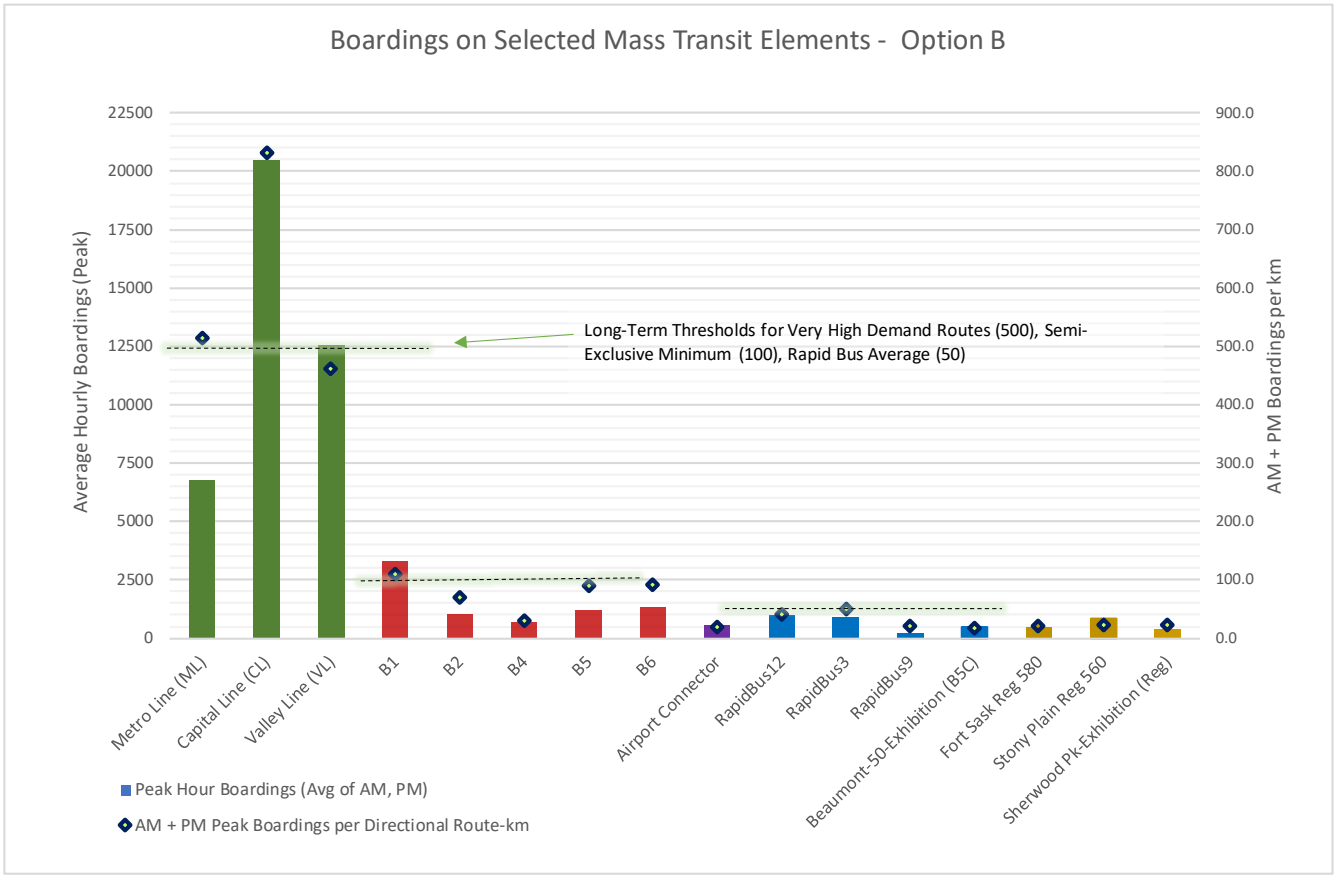
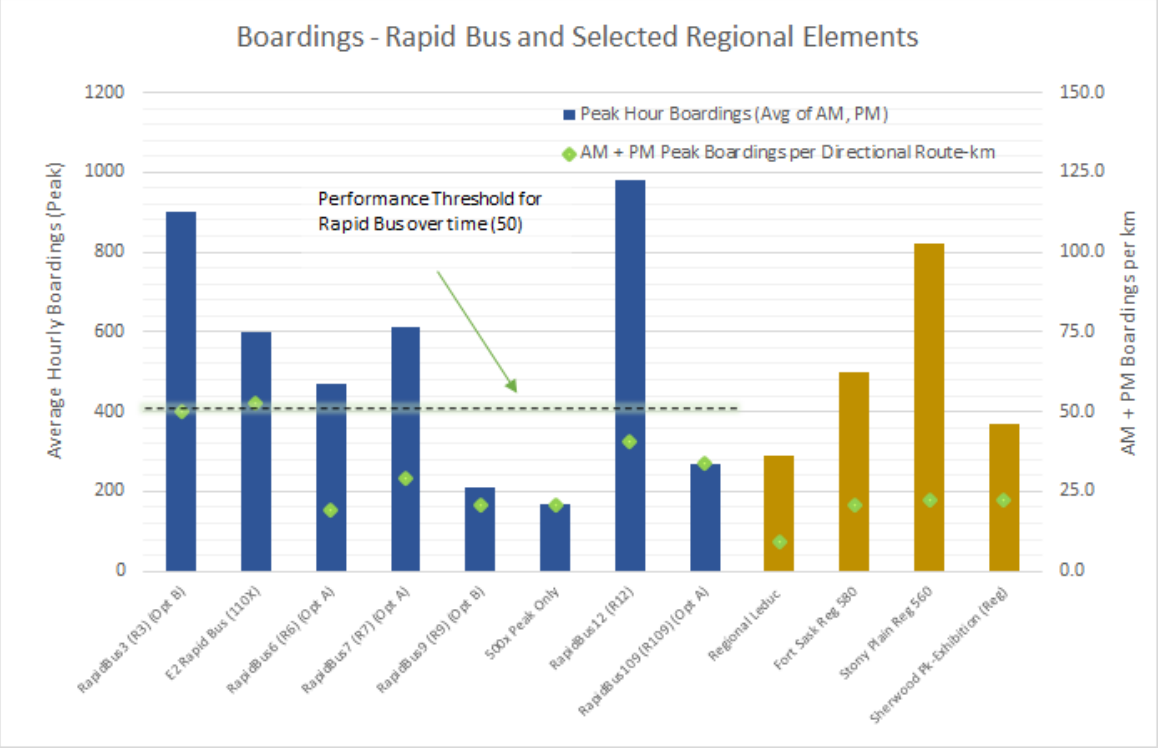


Exhibit 4.3 summarizes the average number of hourly boardings for the AM and PM peaks (coloured bars) and the per-km number of peak boardings for the rapid bus elements and several of the regional routes.

- Of the rapid bus routes, R12 (West Edmonton Mall/WEM - Clareview via Westmount, NAIT and 118 Ave) has the highest number of boardings. This is in part due to the route's length and its boardings per km are only third-highest in the category. A review of the passenger volumes shows relatively consistent peak loads along the length of the route, suggesting that many R12 passengers are travelling to the ends of the route and major transfer points along the line.
- Routes R3 serves the Ellerslie Road corridor, connecting to the Valley Line, Capital Line, and B6. It acts as both a crosstown trip option and provides access to north-south rapid transit from the southeast and southwest growth communities.
- Route E2 (ETS #110X) is a limited stop service on 97 Street between Eaux Claires and NAIT, and then continues downtown via 109 Street. It offers complementary service to B1 and is recommended to continue.

Exhibit 4.3: Boardings on Rapid Bus and Selected Regional Elements



A common transit industry metric for monitoring service performance is the number of boardings per hour of service. For most transit agencies, this is a useful way to manage service on a specific route and set financial priorities between similar types of routes, as it indicates how many passengers board each bus that is operating, in this case during the peak hours.

Exhibit 4.4 compares the LRT routes with the semi-exclusive and rapid routes in terms of boardings per hour, and boardings per route-km. The ranking of routes one would get is not the same between these measures. Boardings per hour on the LRT is naturally higher, reflecting service speeds, and the capacity of LRT being much higher. The Metro Line and Capital Line use high-floor trains of five cars, while the Valley Line uses low-floor cars in sets of two per train. The LRT indicator reflects train hours rather than car-hours.

Among the 'B' routes, B5 and B6 are the best performers in the service hour measure, which partly derives from their attractiveness along the route, and operations at fairly high speeds, which makes them efficient routes.

Exhibit 4.4: Boardings per km and per Service Hour, Selected Mass Transit Elements

Line Name (both Options unless indicated)	**Peak Hour Boardings (Avg of AM, PM)**	AM + PM Peak Boardings per Directional Route-km	Total Service Hours AM+PM	**Boardings Per Service Hour, Peak**
Metro Line (A)	5,120	604	6.4	**1600**
Capital Line (A)	20,770	768	32.2	**1290**
Valley Line	12,240	450	51.8	**473**
B1	3,680	123	79.3	93
B2	790	54	24.3	65
B4	750	31	15.9	94
B5	1,190	88	19.2	124
B6	1,310	89	24.4	107
Airport Connector	540	17	20.3	53
RapidBus12	1,070	44	39.6	54
RapidBus3	820	48	23.3	70
RapidBus6 (A)	470	19	15.1	62
RapidBus7 (A)	610	29	17.1	71
RapidBus9 (B)	*210*	*21*	7.46	56
RapidBus109 (A)	270	34	3.8	142
Beaumont-50-Coliseum (A)	290	11	18.6	31
Beaumont-50-Coliseum (B)	*460*	*18*	*18.6*	*49*

Note: In Option A, parts of RapidBus7 and Beaumont-50 overlap.

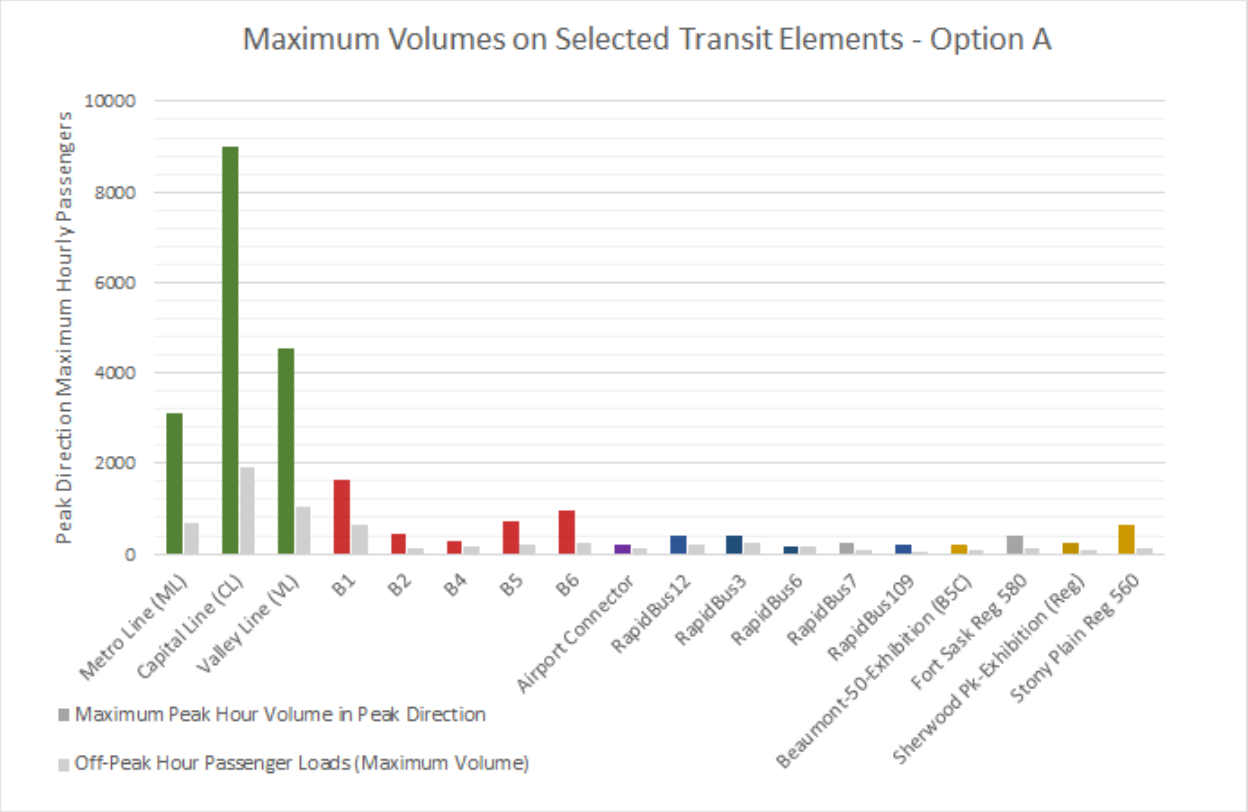
Boardings per service hour can vary greatly between different types of service, as shown above in the chart, and factors such as stop spacing, level of overlap with other routes, speed, and amount of service provided all factor into the response. The 'speed' is a measure of the running speed plus the time to access and wait for the service. This makes more frequent services very attractive to passengers, yielding the results as shown above where LRT and then the semi-exclusive 'B' routes perform well.

4.2.2. Peak Passenger Volumes (Passenger Load)

Exhibit 4.5 illustrates the maximum passenger volumes at the peak demand location on each route. It also shows the typical one-hour midday demand for each route in grey. For most of the routes, this value is less than half the peak hour which leads to service frequency being consequently much lower than in the peak, to better match service provided to demand.

- The maximum volume on the Capital Line is capacity-constrained to approximately 9,000 passengers, and this value is reached in the peak periods in the Base scenario and both of Options A and B. (Details for each line are included in Appendix A.8)
- Since it operates at half the frequency of the Capital Line, the Metro Line's capacity limit in the mode would be ~4,500 per direction, which it does not reach. Its peak load point is between MacEwan and Churchill Stations.
- While the B1 route was introduced in part to help address Capital Line capacity limits, its busiest point in Option A is north of 118 Avenue. The 97 Street segment has been identified by previous and recent studies (including the 2011 IRTMP and 2020 RTSC Business Case Analysis) as an important corridor for transit investment.

Exhibit 4.5: Maximum Volumes on Mass Transit Elements – Option A



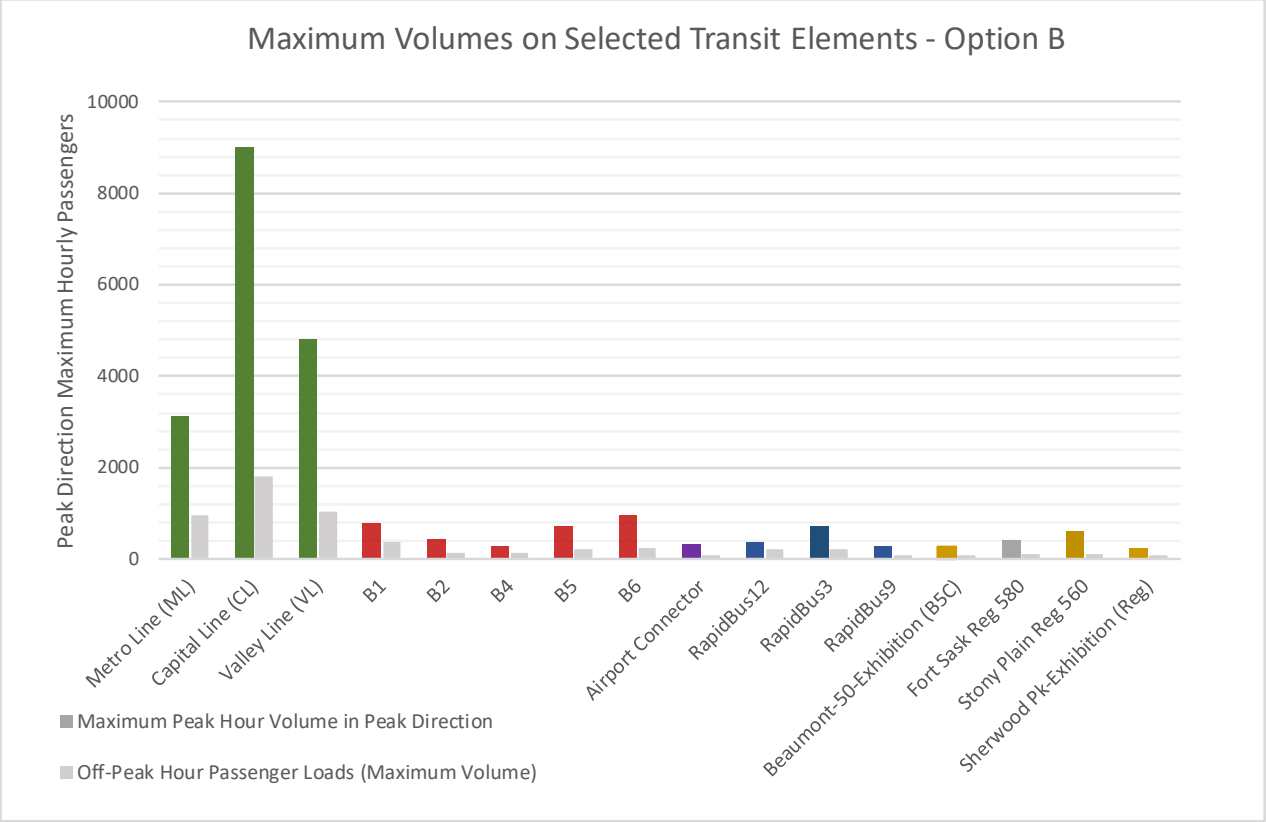
The maximum passenger volumes provide some of the guidance as to how much service would be needed on each route, in terms of frequency and vehicle capacity. Values of 2,000 passengers or fewer could be accommodated by articulated transit buses (or standard size buses) operating at a sufficiently high frequency and with support from transit priority measures.

The other aspect in defining these services is that some routes, especially in the off-peak, would not be expected to be as full, and would be operating at a policy headway to maintain convenience and make the service competitive in terms of overall trip times.

Exhibit 4.6 presents similar information for Option B. There are some notable differences to point out:

- Despite the ML extension in Option B, the peak load point downtown has similar volumes as Option A.
- The Capital Line hits the capacity limit in this option even without the extension. Additional passengers board at the infill stations, and marginally more people can fill up the capacity at stations closer to the peak demand point.
- Valley Line peak loads are slightly higher, in part due to feeder connections being tested as part of Option B.

Exhibit 4.6: Maximum Volumes on Mass Transit Elements – Option B



4.3. Frequent Routes

Exhibit 4.7 shows boardings for the Frequent routes as modelled in Option A. Many of these routes operate along primary and secondary corridors and pass through the Centre City node of The City Plan, which also explains their popularity. The routes are indicated by their functional code from the Bus Network Redesign (the same codes were used in the Mass Transit Network report). The ETS route numbers are also indicated for reference; this is what the public will see as the network identifiers.

Several routes stand out:

- Routes F5 (ETS #9) and F7 (ETS #4) are the busiest by number of boardings. F5 serves 112 Street south of downtown and 97 Street north of downtown. F7 serves 87 Avenue and Whyte Avenue, overlapping for much of its length with B2.
- The most productive route per km is F6 (ETS #3), which operates on 111 Avenue.
- F2 is not as busy a route by either measure, and it competes for passengers with the parallel Valley Line west. This appears to make it a less attractive route in the future.

Exhibit 4.7: Boardings on District Routes – Frequent Bus – Option A

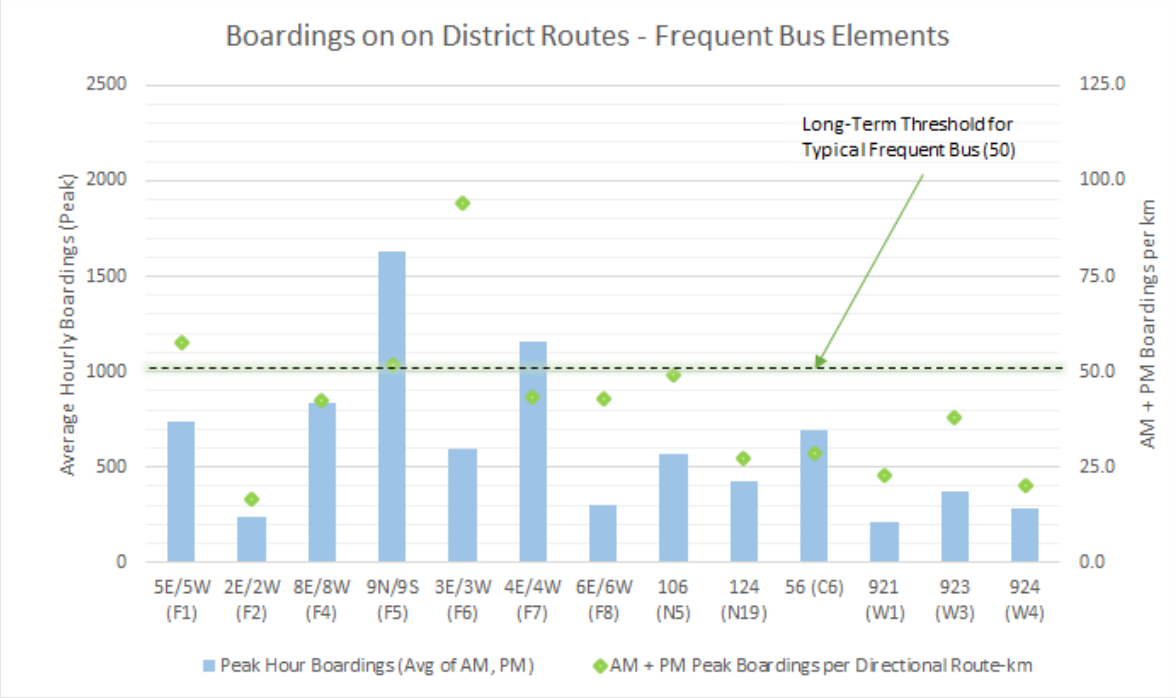
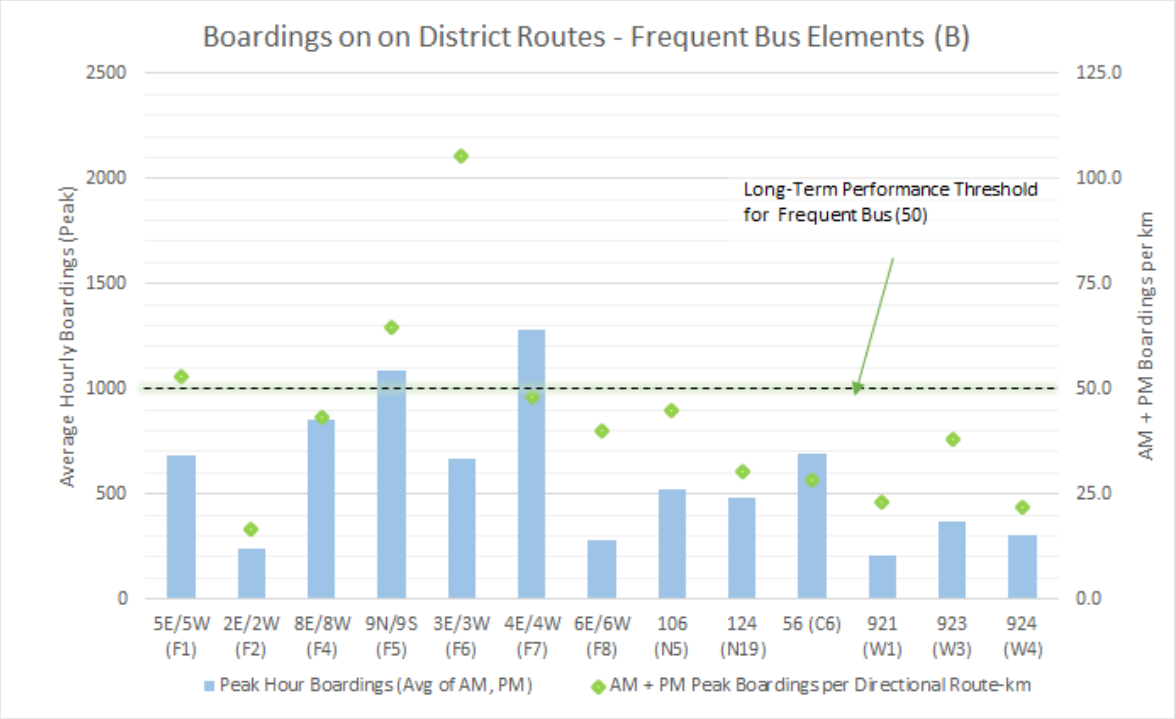


Exhibit 4.8 provides a comparison of frequent routes for Option B. The most significant difference is that F5 (ETS #9) sees fewer passengers, and this appears to be related to the Metro Line being extended north of the Yellowhead. This reduction in local demand in the face of ML and B1 competing for the same passengers also manifested itself in the demand forecasts for the Ultimate Mass Transit Network.

Exhibit 4.8: Boardings on District Routes – Frequent Bus – Option B



4.4. Trade-Offs between Mass Transit Service Options

This section focuses on locations where significant mass transit services were introduced relative to the Base Scenario, in one or both options, and illustrates the specific outcomes for those parts of the transit network.

4.4.1. Capital Line Extension

Exhibit 4.9 demonstrates the outcome of the Capital Line extension to Heritage Valley Major Node.

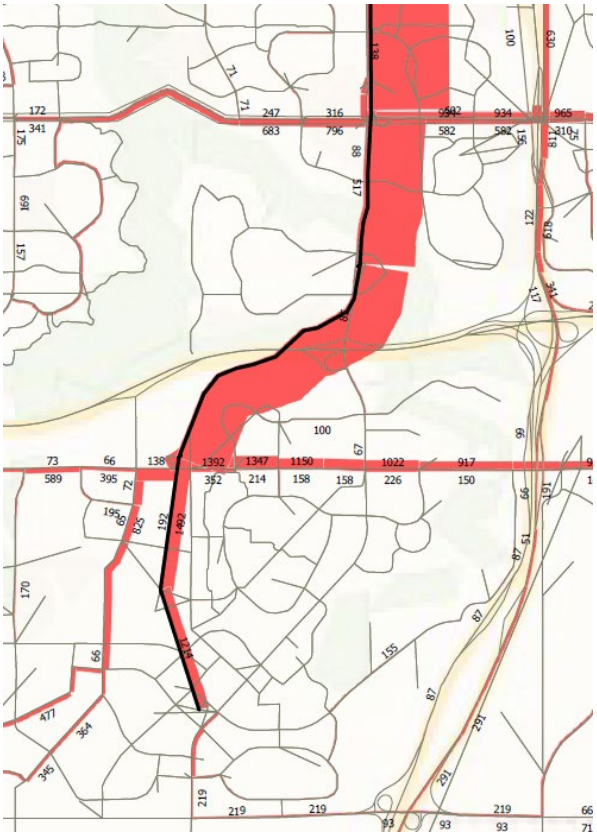
- During the AM peak, the Capital Line gains 1575 boardings
- Given that the length of the extension is 2.4 km, the extension attracts 650 passengers per km

The introduction of this extension increases transit ridership from this area. However, since the Capital Line is already capacity constrained in the future base, additional passengers boarding at any new stations would displace later passengers, unless the other passengers had other transit alternatives. The capacity limitation is reached for the AM northbound between McKernan/Belgravia and Health Sciences station. Past the peak point, the passenger load on the line is lower and passengers there are not displaced by adding demand.

This is where the other added transit services offered in Option A yield a benefit, by providing other routes in the north-south direction. These services include B6 (for passengers from the southwest) and B1 (for passengers heading north of Century Park towards Whyte Avenue or the City Centre). The parallel B6 service between South Campus and University stations also helps provide extra transit capacity between those LRT stations. The reverse occurs in the PM peak

where the LRT sees its maximum loads south of Health Sciences and continuing until South Campus. Refer to Appendix A (Exhibit A.8) for illustrations of projected passenger activity.

Exhibit 4.9: AM Peak Passengers Volumes – Capital Line Extension, Option A



4.4.2. Peak Loads on the Capital Line and Parallel services

The Capital Line already experiences heavy passenger loads during part of the AM and PM peak hours, with the highest volume of passengers observed south of Health Sciences station. This is expected to increase in the future as growth occurs in the south and southwest corners of the city, and the Capital Line is extended beyond Century Park, first to Ellerslie and then to the Heritage Valley Major Node. The 2030 base and Option B assumed a southwest terminus at Ellerslie Road SW park and ride, whereas Option A included a two-stop extension to Heritage Valley Major Node.

In parallel, the Terwillegar corridor connects to developed and developing communities in the southwest part of the city. The 2030 base includes a 'SWBRT' route, which in Options A and B was extended to University Station and renamed B6.

Exhibit 4.10 shows the effects of providing additional options north-south to complement the Capital Line:

- In both cases, the Capital Line reaches the modelling limit of 9,000 peak direction passengers. (Earlier modelling of the future base indicated that some passengers would shift to parallel transit routes, use autos, or some trips would not be made)
- In the Base, the SWBRT and the limited stop service added to Calgary Trail carry 900 additional peak direction passengers.

- In Option A, the combination of B1, B6 and the Airport Connector carry some 2,200 peak direction passengers. The additional routes and enhanced services clearly tap into a pent-up travel market that the Capital Line alone cannot address.

Exhibit 4.10: Peak AM Northbound Passengers on Mass Transit Lines Parallel to Capital Line

Route(s)	base	opt. a
Terwillegar Corridor (SWBRT / B6)	640	960
Capital Line LRT	9,000	9,000
Calgary Trail/Gateway (CPCBD / B1)	260	1,020
Airport Connector	--	220
Sum	**9,900**	**11,200**

4.4.3. Metro Line Extension

Option B included a test of the effects of an extension of Metro Line as far as Castle Downs station at 153 Avenue. This is illustrated in the transit volume plot in Exhibit 4.11.

Exhibit 4.11: Metro Line Extension and Connecting Services, Option B

Approximately 1700-1800 peak hour boardings are added in the AM and PM, taking into consideration the number of northbound and southbound passengers on the leg north of

Blatchford Station. For extension of 4.6 km, this amounts to over 360 passengers added per km of new construction. An important consideration for this option is the long bridge required to connect Blatchford to the stations north of Yellowhead Trail.

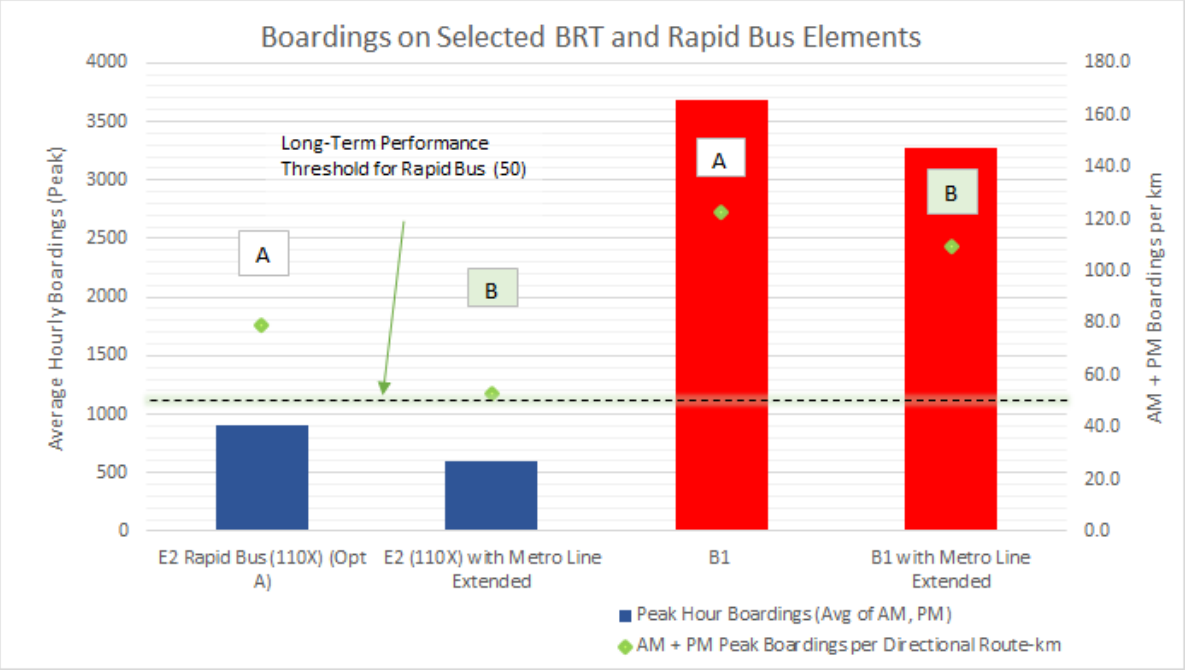
4.4.4. North of Centre City Node

As previously noted, Option B includes extension of the Metro Line to Castle Downs. This carries over 1700 passengers in the peak direction and produces 360 passengers per km. The Base Scenario and Option A exclude the Metro extension beyond Blatchford station.

Exhibit 4.12 shows the effects of the ML extension on the other key mass transit elements:

- The 110X limited stop bus drops 300 boardings, and the B1 drops nearly 400 boardings. Overall, the network gains approximately 1000 peak direction passengers from the ML extension. (This does not factor in the drop in riders on F5 also identified in Option B).
- The number of passengers per km on 110X and B1 decreases in Option B, but in either case, these are productive and attractive routes.

Exhibit 4.12: Peak Passengers to and from the North



Additional information on the demand profile for routes B1, E2 (110X) and F5 (ETS #9) is included in the Appendices. In Option A, routes 110X and 9 carry significant numbers of passengers as a complement to the B1 route, with a large number of passengers bound to and from the Eaux Claires Transit Centre.

4.4.5. Whyte Avenue

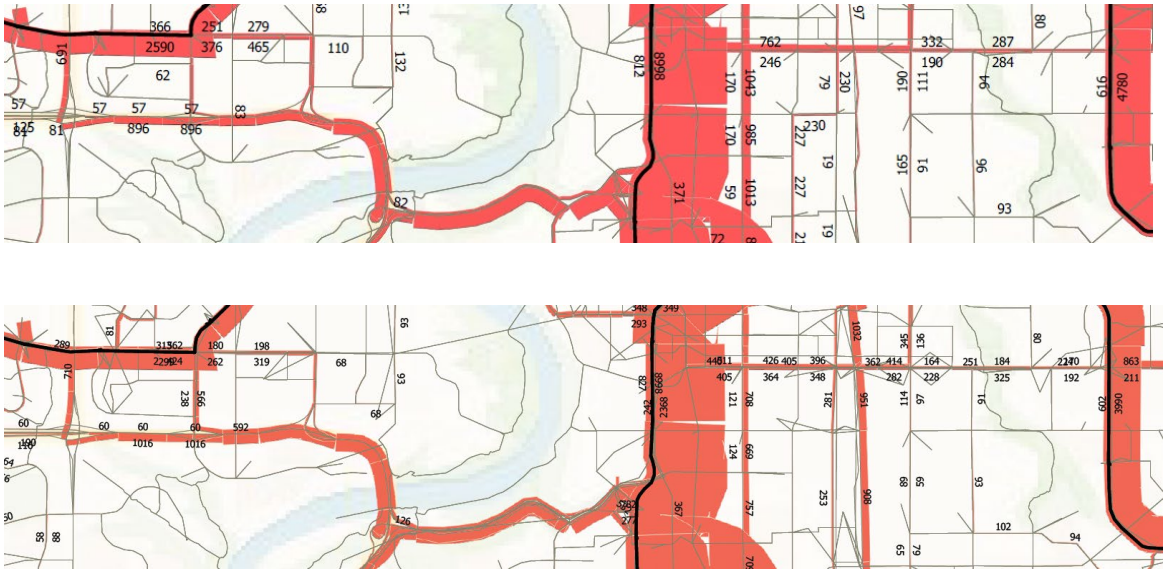
Shifting our attention to the east-west direction, one of the busiest travel corridor outside Centre City is the Whyte Avenue corridor. Options for this corridor have been reviewed in past studies and several different transit service options were considered in the scenario evaluation of this study. A semi-exclusive transit service complemented by frequent transit with closer stop spacing was identified as the best option for this corridor.

Exhibit 4.13 illustrates the differences between the base scenario and Option A, which includes B2. The interim version of B2 uses peak-direction, peak period bus lanes on Whyte Avenue as an initial step to improve travel time and reliability. With a future river crossing deferred for B2, the route would follow Fox Drive and Whitemud to connect to 87 Avenue.

- In the Base Scenario, during the AM Peak, peak loads are 760 WB and 250 EB passengers. This depends primarily on two frequent routes (F4 and F7), each operating at least every 10 minutes in the peak.
- In Option A, which includes B2, peak loads increase to 830 WB and 360 EB. There are increases in both directions and capacity for additional growth is added by the B2 service offering.
- Another benefit would be that the bus lanes in the peak direction could also benefit the F4 and F7, which was not explicitly assumed in the demand modelling.
- This corridor has a fairly high amount of passenger turnover, with passengers making short to medium length trips. This mix of activity is not as strongly reflected by the volume plot.

Based on a review of the passenger patterns, it would be recommended to assess the trade-offs between direct routing on B2, and detouring the route into University Station, and potentially South Campus.

Exhibit 4.13: Peak AM Passengers on Whyte Avenue, Base and Option A



Additional information on the demand profile for routes B2, F4 and F7 is included in the Appendices.

4.5. Additional Comparisons

GIS analysis was carried out for the major mass transit corridors being proposed to help evaluate which routes to prioritize. This information is a factor in the ridership results, but the conclusions one might draw are different, as the demand forecasts consider speed and network effects in addition to demographics.

4.5.1. LRT Station Catchments

Since Options A and B each consider LRT service expansion and test potential infill stations, the catchment of these potential new stations has been compared with some examples that would be present in the Base scenario. Several are already existing stations.

Exhibit 4.14 tabulates the results for 800-m radius catchment areas for stations, considering population and employment. The analysis takes an area-based average from the transportation zones around the stations and prorates how many residents and jobs might be within the radius. True results would vary since not all zones are uniformly developed.

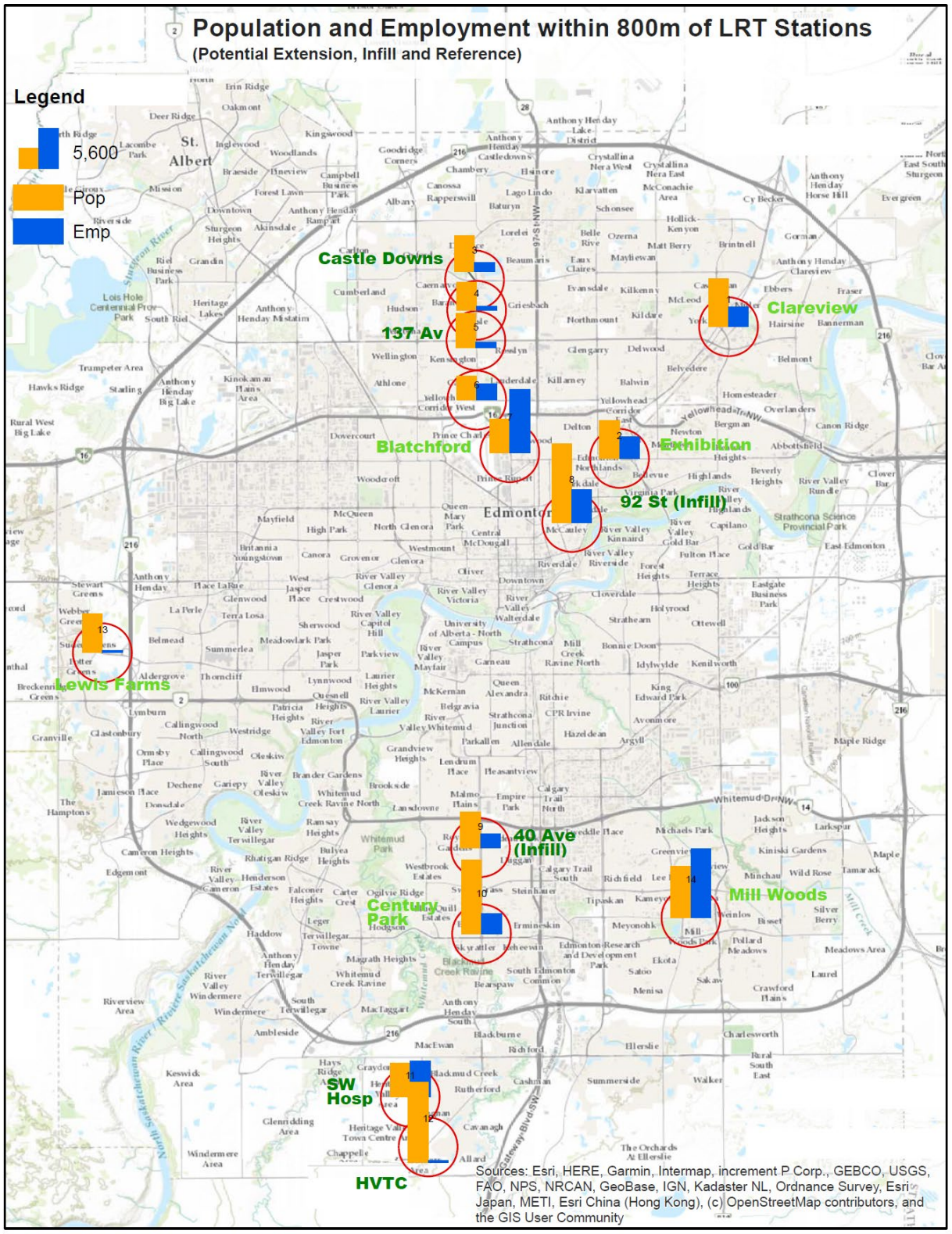
Nearly all the stations in this table have reasonable populations and most have nearby employment that would make them a potential destination for some transit passengers. Just based on these results, one might anticipate that the SW Hospital and Heritage Valley Town Centre stations will be strong performers in the future. It also suggests that the 92 Street station site might be worth pursuing provided that good connections and development plans around the station would support a business case to advance with that location.

Exhibit 4.14: Population and Employment within 800m of Selected LRT Stations

Station	Pop	Emp	Notes
Precedent Stations - included in Base			
Clareview	6,700	2,750	2021 end of CL
Exhibition	5,350	3,000	
Century Park	10,300	2,800	2021 end of CL
Mill Woods	7,150	9,650	2021 end of VL
Lewis Farms	5,500	300	future west end of VL
Blatchford	4,700	8,850	future north end of ML
Extension Stations			
Castle Downs	5,000	1,350	ML Ext. in Opt. B
145 Av	3,850	600	ML Ext. in Opt. B
137 Av	4,850	800	ML Ext. in Opt. B
132 Av	3,350	2,300	ML Ext. in Opt. B
SW Hospital	4,750	5,100	CL Ext. in Opt. A
HVTC	11,200	200	CL Ext. in Opt. A
Potential Infill Stations			
92 St	11,050	4,600	On CL in Opt. B
40 Av NW	5,000	1,900	On CL in Opt. B

Exhibit 4.15 is a map showing these stations, to provide some geographic context for the results.

Exhibit 4.15: Map - Population and Employment within 800m of Selected LRT Stations



4.5.2. Mass Transit Corridor Catchments

For the semi-exclusive and rapid bus routes, a 400-metre catchment around the path of each route was used as an approximation of the area served by each route. For several of the longer routes, segments were used in this analysis to differentiate between different parts of each corridor.

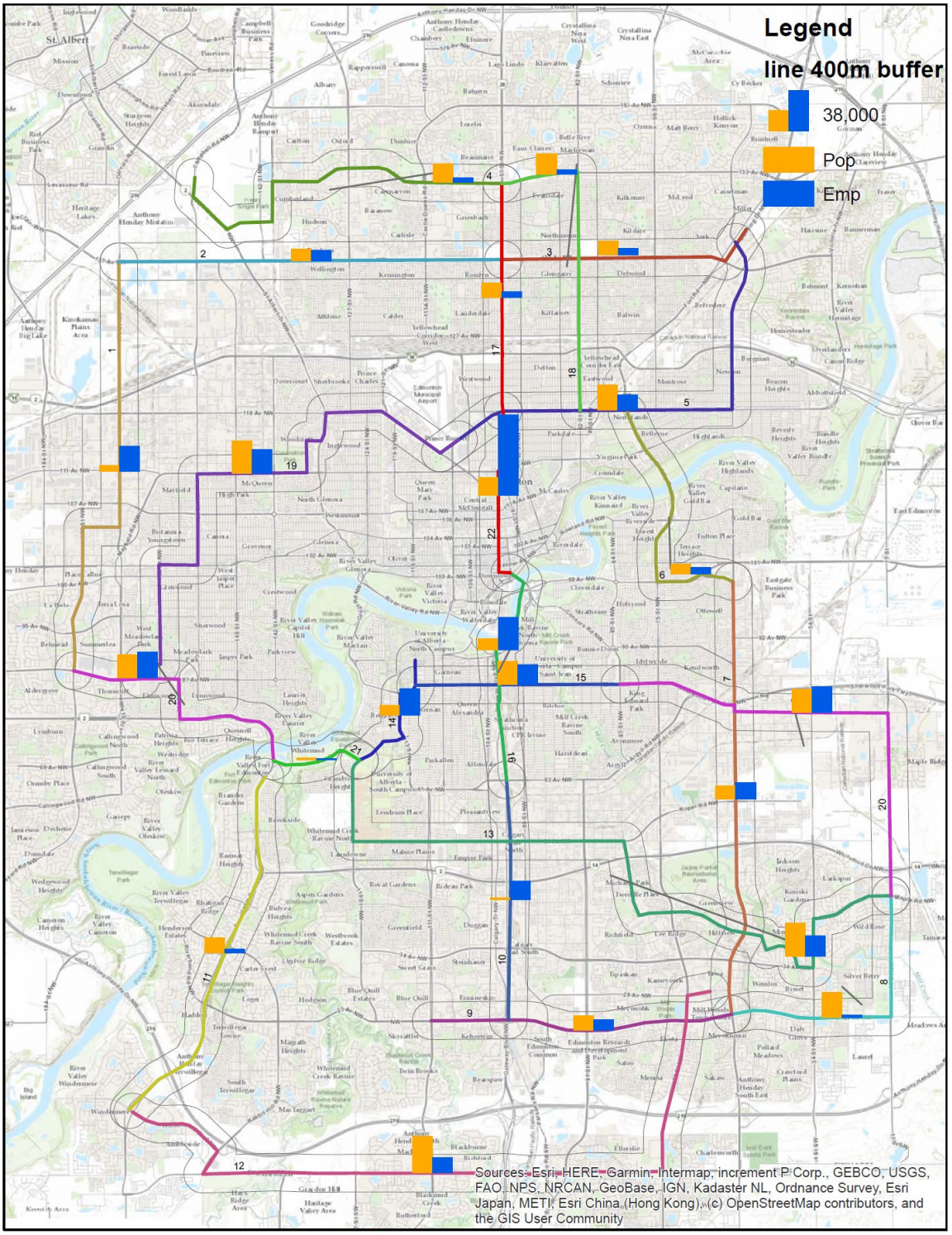
Exhibit 4.16 is a tabulation of the results for the 2030 modelling horizon. The corridor names are approximations and indicate which routes were being evaluated with each segment. Since these numbers are absolutes, they reflect land use patterns as well as the extent of each corridor. Exhibit 4.17 is a map showing the segments to aid in interpretation.

One surprising observation was that corridor 11 (Terwillegar) is not a standout from the perspective of land use, and its performance is related to its speed and the set of origins and destinations it connects.

Exhibit 4.16: Population and Employment within 400m of Mass Transit Corridors

	Estimated Statistics for 400 m Buffer around Transit Lines		
Map #	Location/Corridor	Population	Employment
1	WEM TO 153 (B4)	5,400	23,900
2	137 WEST OF 97 (B4)	10,900	9,900
3	137 EAST OF 97 (B4)	13,800	6,600
4	153 Av (B1a)	17,700	4,600
5	EAST of NAIT (R12)	24,100	14,700
6	WAYNE GRETKY (R7, B5C)	9,300	6,200
7	50 St N. of MILL WOODS (B5C)	12,900	16,000
8	EAST OF MILL WOODS (B5)	24,100	2,600
9	23 Av, W. of MILL WOODS (B5)	14,000	10,600
10	23 Av TO 63 Av (B1/B1A)	2,400	17,900
11	TERWILLEGAR (B6)	15,000	3,800
12	ELLERSLIE RD (R3)	35,300	14,700
13	FOX DRIVE to MEADOWS (R6)	32,200	20,100
14	UNIVERSITY-S.CAMPUS (B2/B6)	9,300	25,400
15	WHYTE, W. of BONNIE DOON (B2)	22,300	19,400
16	63 TO N. Sask. River (B1/B1A)	11,000	31,300
17	97 NORTH OF 118 (B1/B1A)	13,600	5,700
18	82 St (R7)	20,000	4,500
19	WEST OF NAIT (R12)	30,800	22,900
20	WEM TO FOX DRIVE (B2)	22,500	24,700
21	FOX DRIVE (B2/B6/R6)	1,700	1,000
22	101 STREET/DOWNTOWN (B1/B1A)	17,200	76,700

Exhibit 4.17: Map - Population and Employment within 400m of Mass Transit Corridors



5. Recommendations for Mass Transit Planning at 1.25 Million

This section provides an initial recommendation for mass transit priorities leading up to the 1.25 Million population horizon. It includes an overview of the network and a discussion of each of the major elements, including what areas they serve, the rationale for the route, and implementation considerations (where applicable).

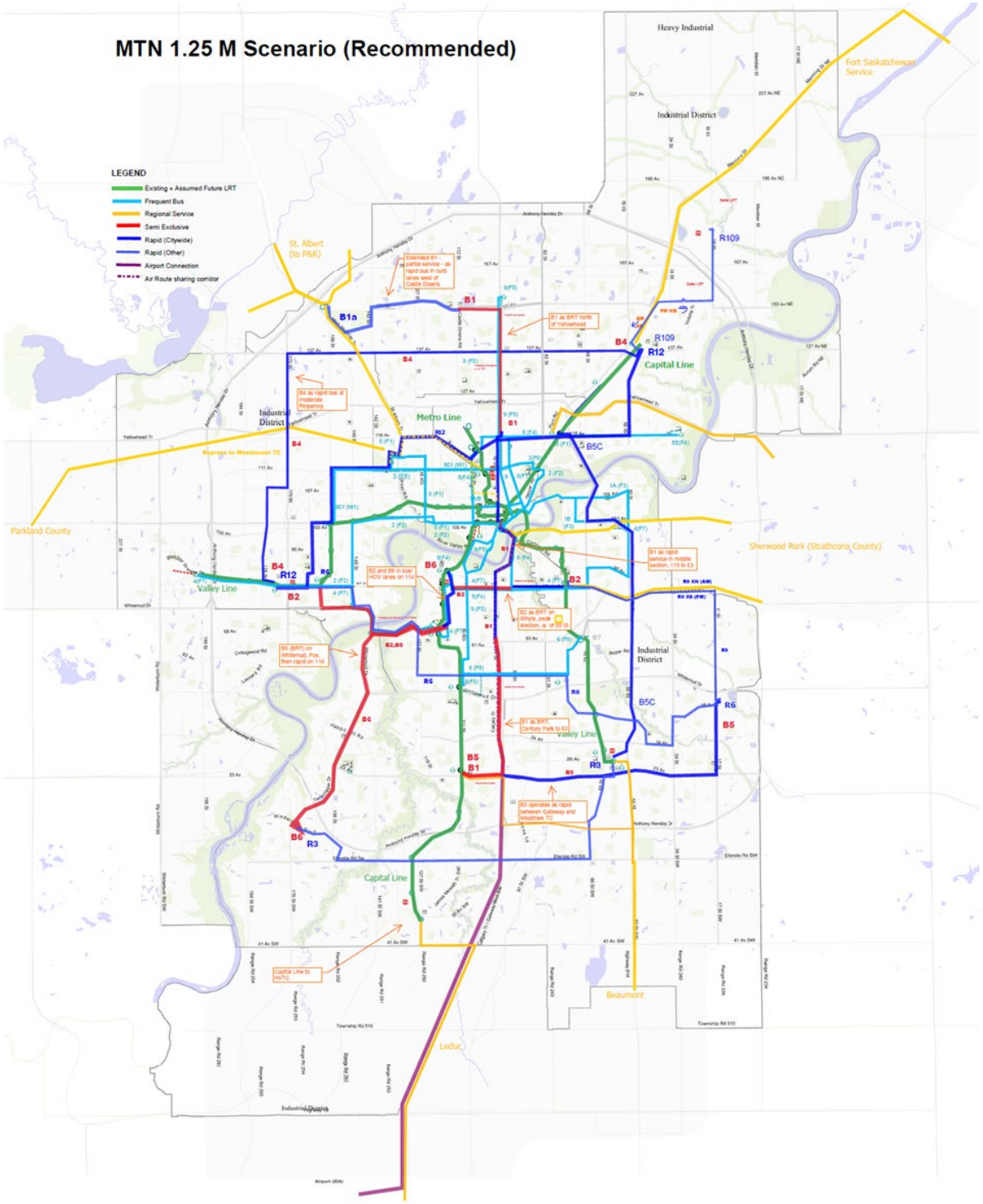
5.1. Most Promising Elements

Based on the performance indicators and success factors for mass transit, the following elements are included in the recommended interim network for the 1.25 Million population horizon:

- The Heritage Valley Major Node extension of Capital Line is more likely to occur, ahead of the Metro Line extension beyond Blatchford, due to the expected development to occur at this Major Node.
- Several infill LRT stations are possible as development opportunities arise. Business cases should be created to validate their potential as opportunities arise.
- B1 (part BRT/ part rapid bus) replaces and expands on existing routes, operating from Century Park to Campbell Road connecting Whyte Avenue, the Centre City Node with the north and south sections of the city and Castle Downs
- B2 (part BRT/ part rapid bus) will connect from West Edmonton Mall to Bonnie Doon through the University of Alberta and Whyte Avenue. The balance of service levels and stopping patterns on B2 and existing routes warrant further study.
- B4 and B5 will initially begin service as rapid bus - to build demand.
- Terwillegar Bus Lanes will be implemented and converted to the “BRT” B6 with a rapid bus extension to University station. This will help avoid a forced transfer and provides additional capacity parallel to the peak load point on the LRT network.
- RapidBus routes R3, R12, E2 (110X); and R6 are recommended to provide a consistent spacing across the city of limited-stop bus routes. The higher achievable speeds attract additional future passengers.
- R9 and R109 are recommended to provide peak rapid service and connections to LRT from outlying development.
- Initiation of the Airport Connection using Hwy QE2 and follow the B1 routing.

Details of the individual routes are discussed in the following pages. Exhibit 5.1 illustrates the resulting network. Maps of the same network subdivided by the Citywide and District components (based on their categorization in the Ultimate MTN) are included in Appendix A.

Exhibit 5.1: Mass Transit Recommendations – 1.25 Million Population Horizon



5.1.1. Light Rail Transit (Citywide)

Exhibit 5.2 focuses on the subset of routes within the interim network that are categorized as Citywide in the Ultimate Network.

Capital Line (LRT): Clareview – Heritage Valley Major Node

The Capital Line (CL) will ultimately connect North-South from Edmonton Energy & Technology Park to the Heritage Valley Major Node. Along that route, it will serve the following nodes: Horse Hill, Clareview, Exhibition, Stadium, Centre City, University/Garneau, Southgate, Century Park, Heritage Valley and several important corridors. The line is recommended to retain its current northeast terminus at Clareview until at least 1.25 million horizon, given that only modest development is envisioned to the northeast. A peak-period bus route (see RapidBus109) is proposed to serve the area in the meantime.

This line currently has the highest peak passenger volumes and is expected to grow, with peak volumes occurring south of Health Sciences. This section will be capacity constrained until post-1.25 million horizon, as operating more than 12 trains per direction is not feasible at the existing level crossings. The mass transit network will include pre-1.25 million alternatives, including the B1, B2 and B6 routes (described in the next section) and an Airport Connection which all demonstrate positive results in ridership uptake and relief for the Capital Line.

Metro Line (LRT): Blatchford – Health Sciences

The Metro Line (ML) will ultimately connect north-south from Campbell Road to South Campus through the following nodes and corridors: Castle Downs, 137 Avenue, Blatchford-NAIT-Kingsway, Centre City and University/Garneau utilizing an exclusive ROW (as defined in this study).

For the 1.25 Million horizon, the current phase under construction will replace the temporary NAIT station and extend the line to Blatchford. A second phase of construction, likely to occur post-1.25 million, would follow a new bridge over the Yellowhead Trail and CN rail yards, and add four new stations, ending at Castle Downs station until a third phase to Campbell Road is constructed.

To the south the proposed longer-term service will be South Campus station, to provide capacity relief for the Capital Line. However, due to significant challenges in grade separating at University Avenue/114 St, the interim terminus for the Metro Line will be at Health Sciences station. It is anticipated that the implementation of other capacity relief measures (such as route B6) could provide future flexibility (post-1.25 million) to address this location.

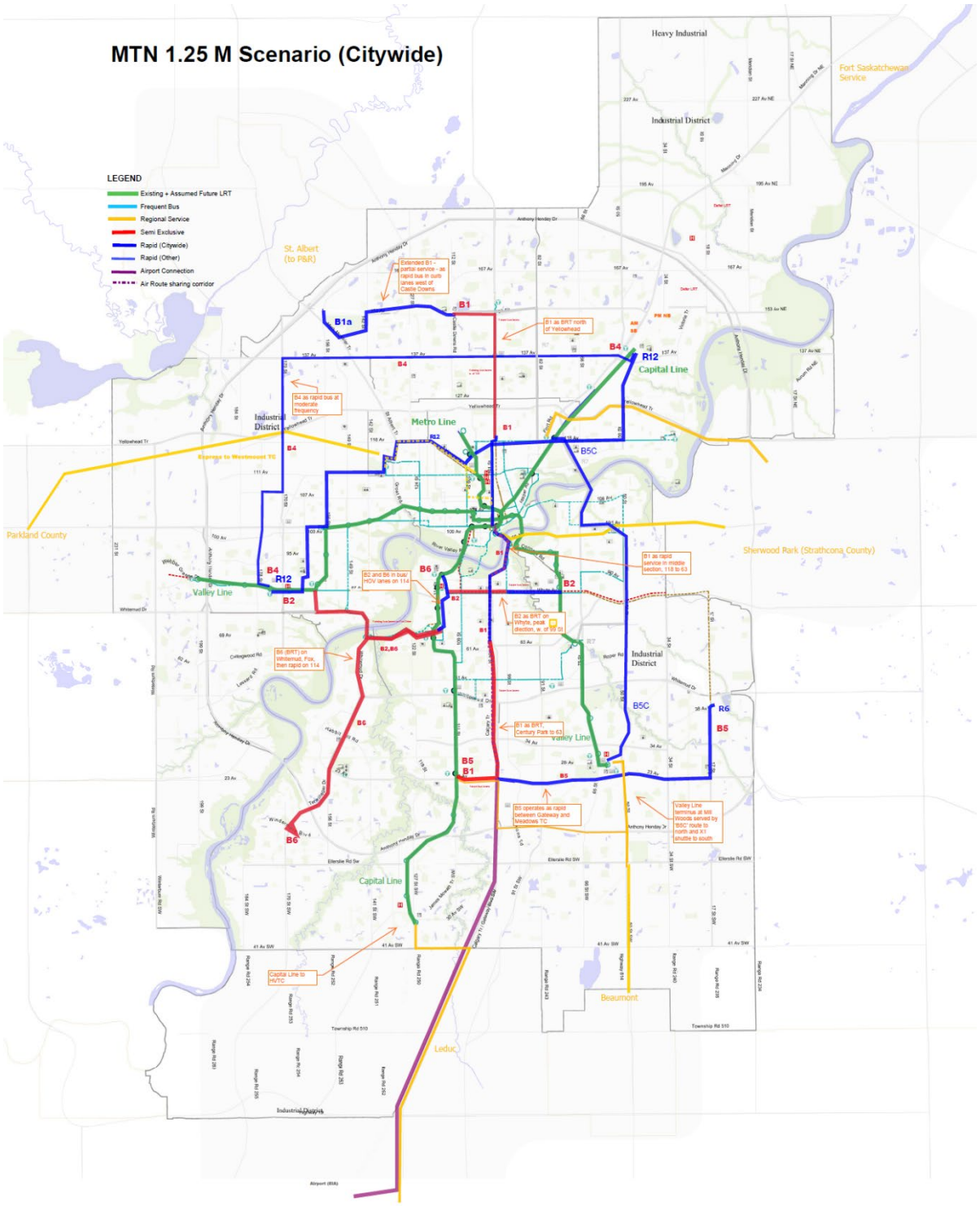
Valley Line (LRT): Lewis Farms – Mill Woods Node

The Valley Line (VL) will connect West to Southeast from Lewis Farms to Ellerslie Road (Charlesworth District Node). Along the way, it will serve the following nodes and corridors: Charlesworth, Mill Woods, Bonnie Doon, Centre City, Stony Plain Road, Meadowlark, West Edmonton Mall/Misericordia.

This LRT line will be using low-floor technology and will be more integrated into the urban fabric of the areas it serves, in particular the street-level segments on 102 and 104 Avenue in the Centre City. An initial segment from 102 Avenue to Mill Woods will enter service later in 2021, and construction of the west segment to Lewis Farms is now in the procurement stage.

Any extension beyond Mill Woods is expected to occur post-1.25 million. At or near the future site of Ellerslie SE/Charlesworth Station, a park and ride facility is planned, with an express shuttle connecting it to Mill Woods.

Exhibit 5.2: Citywide Mass Transit at 1.25 Million Population Horizon



5.1.2. Semi-Exclusive Services (Citywide)

Each of the non-LRT services introduces bus services on various forms of right of way with different levels of priority. In most cases, these routes provide an alternative form of transit service on routes that would already have service by extending the principles of the Transit Strategy and the Bus Network Redesign. However, the new mass transit routes offer speeds, directness, and coverage different from the other forms of bus service, which would make more frequent stops.

When the mass transit routes are implemented, ETS will find there are advantages to re-balancing the levels of service between the different routes to optimize how passenger needs are met. Based on other Canadian cities where the two forms of bus transit run in parallel, the semi-exclusive and rapid services typically capture 60-80% of the passenger demand and the other services can thereby operate at reduced frequencies, depending on the type of corridor.

B1 Route (BRT): Campbell Road – Castle Downs District Node – Century Park District Node

B1 is a proposed semi-exclusive transit route that will operate north-south from the Castle Downs district node to the Century Park district node in its ultimate configuration. This route will serve the following nodes and corridors: Northgate/Northtown, 97 Street, Centre City, Whyte Avenue, Gateway/Calgary Trail. The route would primarily utilize 97 St, 101 Street and Gateway Boulevard/Calgary Trail.

The B1 service would stop every 1 to 1.5 km along its route and provide connections to numerous other elements of the mass transit network as well as the underlying network of other bus transit services. This adds significant north-south high-capacity frequent service to denser parts of the urban area. In the section north of 118 Avenue, B1 would operate in parallel with another rapid service, E2 (ETS #110X), which would provide additional capacity on this busy section of the transit network. E2 was assumed to connect to Eaux Claires Transit Centre while B1 stopped nearby at 153 Avenue and 97 Street. These assumptions should be revisited to determine the optimal stopping pattern for the services in the 97 Street corridor.

In its early stages of implementation, a ‘B1A’ extended service would continue onwards as a rapid bus using the mixed traffic lanes of 153 Avenue, making limited stops until a terminus at Campbell Road. This will provide service in northwest Edmonton and connect to numerous regional routes at the St. Albert transit facility. By the 1.5 Million horizon, once the Metro Line is extended west past Castle Downs, route B1 would be shortened and Castle Downs would become its north terminus.

In its interim state, this route will make use of dedicated bus lanes covering the maximum extent feasible. For 1.25 million, it is proposed that the bus lanes extend:

- North-south on 97 Street during peak periods in the peak direction (as a minimum);
- North-south on Calgary Trail and Gateway Boulevard, once implementation has been worked out for stop locations and operations at connecting streets and major commercial driveways;
- East-west on 153 Avenue to connect to Castle Downs hub, during peaks, and similarly east-west on 23 Avenue to connect to Century Park.

In addition to these areas where bus lanes are proposed, transit priority measures may also be considered where warranted to mitigate speed and reliability issues, in particular for limited-stop buses to avoid long queues and delays at signals with lengthy peak-period cycle lengths. This guidance would apply to all other routes in the semi-exclusive family in addition to transit hot-spots identified through travel time performance monitoring by ETS.

This route proposes a dedicated river crossing in the long term (by 2065); however, for the 1.25 Million horizon it is assumed that route B1 would repurpose some of the capacity on existing

bridges to carry the route between the downtown hub and the Whyte Avenue district. Near-term options include the Low Level and Walterdale Bridges and connecting streets. The details of this section of the route will require more detailed analysis and will also reflect other projects in the vicinity, such as River Crossing.

B2 Route (BRT): WEM/Misericordia Major Node – Bonnie Doon District Node

B2 is a proposed route crossing east-west from WEM/Misericordia Major Node to Bonnie Doon District node. B2 will serve the following nodes and corridors: Meadowlark, University/Garneau, Whyte Ave/99 Street and Gateway/Calgary Trail.

The interim route for B2 defers consideration of a new river crossing to post-1.25 million2030, and instead follows a less direct route via Whitemud Drive and Fox Drive. Long-term demand will warrant future exploration of the river crossing connection, not only determining potential financial costs but also social and environmental costs associated with this option.

B2 will operate semi-exclusively using peak-period, peak direction bus and HOV lanes on Whitemud Drive, Fox Drive, and Whyte Avenue west of 99 Street.

B5 Route (BRT): Century Park – Meadows North District Node

B5 is a proposed route making limited stops, operating in a primarily east-west orientation across the southern part of Edmonton. Longer-term, it is proposed that the route would operate from WEM/Misericordia and Meadowlark and then south and east to the Meadows North node. The interim version of the route includes only the eastern portion, where passenger demand is projected to emerge sooner. The proposed interim route, using 23 Avenue NW, will serve Century Park, South Common - Research Park, Mill woods, and Meadows South. The western portions of the ultimate B5 service will initially be addressed by similar crosstown bus routes.

This route will initially operate as a mix of semi-exclusive (west of Calgary Trail) and rapid bus, and transition over time towards more semi-exclusive alignment as demand increases.

B6 Route (BRT): University/Garneau Major Node – Windermere Hub

B6 is a proposed route servicing south-west Edmonton, using dedicated lanes on the Terwillegar Expressway to serve stations at major cross streets. The map shows an assumed route via Fox Drive and an extension of service via 114 Street to University LRT station. This extension is assumed to operate in mixed traffic given the physical constraints present on these streets. Spot improvements to signal timing along 114 or 112 Streets may be able to provide some transit priority; however, the details would also depend on adjacent LRT operations and how that interfaces with the traffic signals.

As indicated in public presentations for the Terwillegar Project, the initial “southwest BRT” was assumed to follow Fox Drive and Whitemud westbound/south, while coming north it would use 122 Street. This is nearly identical to B6, except for the section between the University and South Campus stations.

A direct connection to University station was found to increase the attractiveness of this route, by avoiding a forced transfer at South Campus station, in a section of the Capital Line where peak direction capacity is more limited.

5.1.3. Airport Connector

Airport Connector: Centre City (Downtown) – Edmonton International Airport

This proposed Citywide route would provide regional and intercity travel to the Airport, connecting with other services including the Metro Line, Capital Line, Valley Line and other City-wide routes (B1, B2, R8, B5, and R3).

The interim proposal for this route is to provide coverage by extending bus services using the B1 corridor between approximately 104 Ave (downtown) and 23 Ave NW. Because this route

extends well beyond the city to EIA, there may arise challenges with operational reliability. In addition, operating bus service with stops along the Queen Elizabeth Highway may also require a provincial partnership.

5.1.4. Rapid Bus

Citywide Elements

B4 Route (BRT): Clareview Major Node – WEM/Misericordia Major Node

B4 is a proposed route operating crosstown from WEM/Misericordia Major Node to Clareview Major Node, connecting the following nodes and corridors: Londonderry, Northgate/Northtown, 137 Avenue. It will travel through northern and western Edmonton, primarily on 137 Avenue (east-west) and a combination of 170 and 178 Street (north-south). Initially, this route will operate in mixed traffic with strategically located transit priority features. Over time, it is expected to transition towards using semi-exclusive lanes in more congested portions.

RapidBus12 (R12): WEM/Misericordia Node– Clareview Major Node

R12 is a proposed rapid transit route operating east-west with limited stops between Meadowlark district node and Clareview major node. The route travels primarily along 118 Avenue, with a north-south section on 163 Street. This route has strong ties to land use, with ten nodes and corridors along its proposed route including the following: 124 Street, Blatchford-NAIT-Kingsway, 97 Street, 118 Street, and Exhibition.

In addition to the corridors being served and the support it will provide for intensification along 118 Avenue, and Kingsway near Blatchford, this route has an important role providing connections to other mass transit routes at transit centres and LRT stations. This includes two locations along the Valley Line, once on the Metro Line, and twice on the Capital Line. In addition, it also provides service to Westmount Transit Centre.

B5C (50 Street-Exhibition): Mill Woods Node – Exhibition District Node

Over the long term, this route is identified as a regional connection due to the southern portion operating in the City of Beaumont. Trips from Beaumont are partially oriented towards the southern end of the Valley Line, but many also continue north along 50 Street. The primary markets served by this route are crosstown travel to and from the Exhibition district node and trips to and from employment areas along 50 Street and in Capilano. The interim B5C route will focus on providing rapid crosstown service between Mill Woods and Exhibition (Coliseum LRT station). Service south of Mill Woods on 50 Street is planned to be provided by a limited-stop shuttle (in lieu of route B5C) to a future park and ride facility at Ellerslie Rd SE.

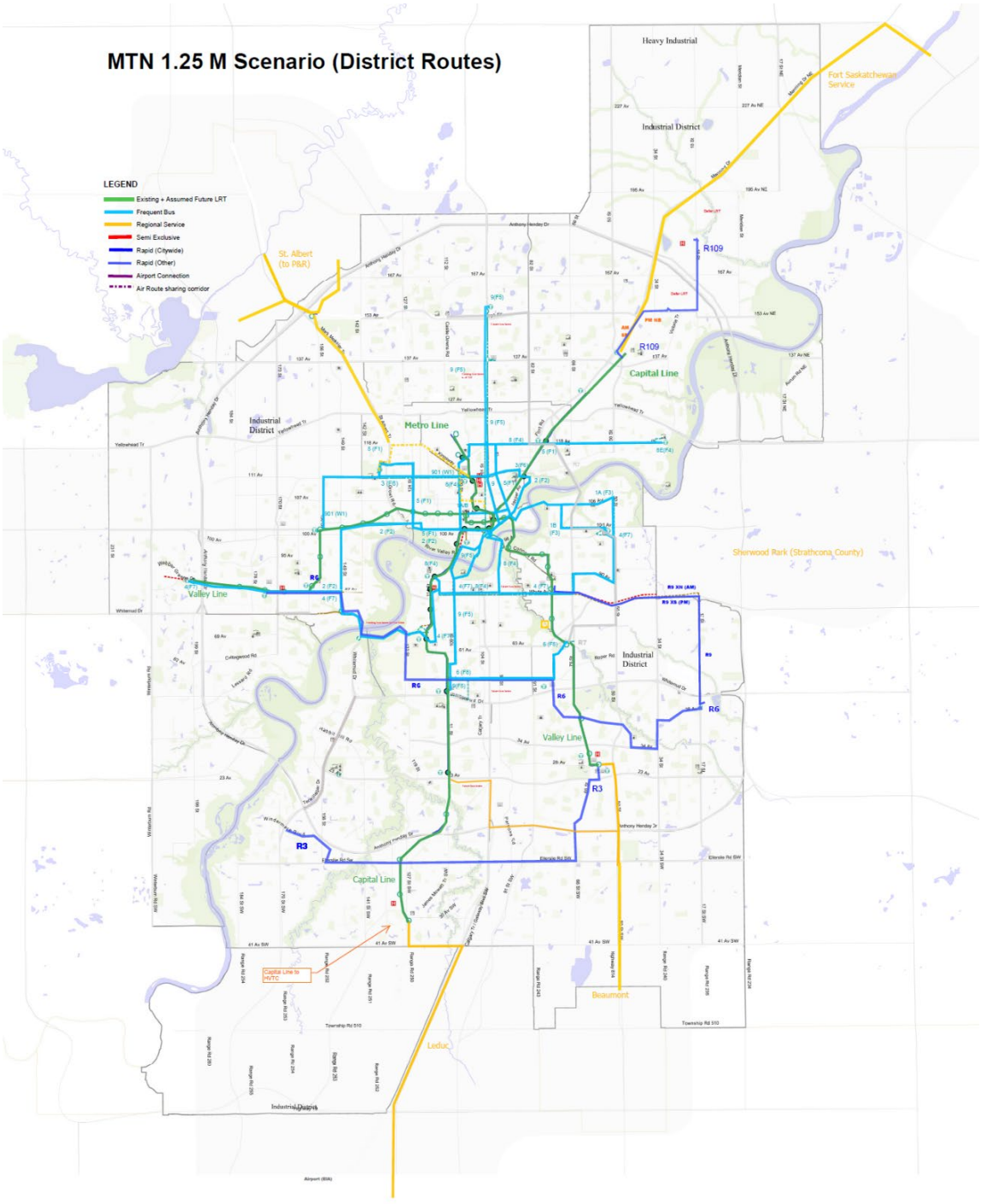
District Elements

Exhibit 5.3 is a map of the recommended interim network, focusing on the district routes. (The LRT lines are included for geographic reference since many of theses routes terminate at transit centres adjacent to stations.)

RapidBus3 (R3): Windermere District Node – Mill Woods Node

R3 is a proposed rapid route operating west-east between Windermere and Mill Woods, which will extend in the future to the Meadows district nodes. It will connect several development nodes as well as the Ellerslie Road corridor in the southern part of the city. Further into the future, there could also be potential for this route to be extended via mixed traffic to the Riverview area west of the river, depending on how travel patterns evolve.

Exhibit 5.3: Mass Transit at 1.25 Million Population Horizon – District Routes



RapidBus6 (R6): WEM/Misericordia Node –Meadows North District Node

The R6 is a proposed rapid route going east-west between WEM/Misericordia Node and Meadows North District Node primarily along Whitemud Drive, 51 Avenue, and 38 Avenue. Design for this service will consider its potential relationship with crosstown service on Whitemud Drive and with local services in the eastern part of Mill Woods.

RapidBus9 (R9): Bonnie Doon District Node – Meadows North District Node

R9 is a proposed east-west rapid route between Bonnie Doon district node and Meadows North district node primarily along 82 Avenue, 76 Avenue, and 17 Street. It would provide key linkages to the B2, Valley Line, B5C, R3, and B5 routes.

This route initially serves commute trips in two directions during peak periods. There is also a parallel peak express route (500X) that skips the 76 Avenue corridor; there are opportunities for these two services to be scheduled to provide alternating service along the two routes, since they both pass through Bonnie Doon station and the transit centre in Meadows.

Rapid Bus 109 (R109): Edmonton Energy Park Area – Clareview Major Node

Route R109 is a proposed rapid bus connection into the northeast residential and employment districts, with termini proposed at the Clareview major node and serving Alberta Hospital. The northern terminus may be a temporary on-street layover or could continue towards Edmonton Energy Park. Much of this route's initial projected demand relates to a transitional park and ride opportunity at the future Gorman station site. This route is intended to operate – in peak periods at a minimum – until the Capital Line is extended northeast, well after the 1.25 million horizon.

5.1.5. Frequent Routes (District Services)

The names of the urban frequent are indication of where they are located within the city. Routes passing through the centre of the city have the 'F' designation carried over from the upcoming BNR, while N, SE, SW, and W routes extend into city quadrants. The near-term numbering of these routes (the ETS designation appearing on buses) is also identified.

- **F1 Route: Westmount District Node – Exhibition District Node (ETS #5)**. The proposed F1 east-west route connects the Westmount and Exhibition district nodes travelling mainly along 124 Street, Jasper Avenue, 97 Street, and 118 Avenue.
- **F2 Route: Stadium LRT-WEM/Misericordia Major Node (ETS #2).** F2 is a proposed route operating crosstown from Stadium LRT to WEM/Misericordia Major Node to, connecting the following traveling along Jasper Avenue, 102 Avenue, 142 Street and 87 Street.
- **F3 Route: Centre City – Capilano District Node (ETS #1A/1B)**. The F3 east-west route connects Centre City to Capilano district node travelling mainly along Jasper and 98 Avenue.
- **F4 Route: University Major Node – 118 Avenue Primary Corridor (ETS #8)**. The proposed F4 is an S-shaped route to connect University Station and the east limit of 118 Avenue primary corridor travelling mainly along 82 Avenue, 99 Street, Jasper Avenue, 109 Street, and 118 Avenue and it expected to serve nodes and corridors well.
- **F5 Route: Eaux Claires – Southgate District Node (ETS #9)**. BNR line F5 is a north-south route travelling mainly along 97 Street, 101 Street, 105 Street/109 Street. It will provide linkages to the Capital Line, B2, Metro, Valley, B1, R8, and R12.
- **F6 Route: Westmount – Stadium LRT (ETS #3)**. This line will operate on 111 Avenue, providing frequent local service immediately north of the downtown core.
- **F7 Route: Lewis Farms – Capilano District Node (ETS #4)**. The proposed F7 east-west transit service between Lewis Farms and Capilano travels mainly along 87 Street,

Whitemud, Fox Drive, 114 Street, and 82 Avenue. Despite competing with other mass transit network services (such as B2) along much of its length, this route is attractive to passengers. It serves several higher-density areas, and since its stop spacing is closer than B2, it provides a complementary service.

- **F8 Route: Southgate District Node – Davies LRT (ETS #6)**. This line will operate on 51 Avenue, providing a connection between Capital Line LRT, B1 and Valley Line LRT, as well as service along a secondary corridor.
- **W1 Route: Stony Plain Road Primary Corridor – Centre City (ETS #901).** The W1 proposed east-west line connects Jasper Place within the Stony Plain Road primary corridor and Centre City travelling mainly along 107 Avenue. It would provide linkages to the Valley Line, R12, Metro Line and B1.

5.1.6. Other ETS Services

The Bus Network Redesign (BNR) carried out as part of the Transit Strategy (2017) includes restructuring of the network to address customer service objectives, and to reshape the system around the introduction of Valley Line SE LRT later in 2021.

The same principles were carried forward by ETS and planning staff to define the underlying transit services for the 1.25 Million population horizon, and this set of routes is included in the transit plan. Where there is some duplication of service, or a mix of local and rapid services in the same corridors, future headways would be adjusted to optimize how demand is served and the transit fleet deployed.

5.1.7. Regional Service Assumptions

Regional services are subject to decisions made by the regions and municipalities in the Edmonton Metropolitan Region. For the analyses in this report, the set of services currently provided to and from surrounding cities is included in the demand model, including refinements to include proposals from the RTSC business case. Some of the regional proposals included significant portions of routes within Edmonton, and these are represented either as regional routes in the current analysis, or by proposed semi-exclusive and rapid routes that had already been identified during The City Plan Mass Transit Study.

Significant connections include:

- St. Albert routes connecting into Edmonton. Local routes were assumed to terminate at Campbell Road, and express routes at West Edmonton Mall, University of Alberta, NAIT, and downtown;
- Service between Fort Saskatchewan and the Capital Line NE;
- Services between Strathcona County and Edmonton, including continuation of existing express routes to University of Alberta, downtown and NAIT, and potential future connections to the Capital Line outside of downtown to the northeast;
- Beaumont and Leduc tot Valley Line and Capital Line LRT stations;
- Services from Parkland County, Spruce Grove and Stony Plain, with express services being considered to Metro Line or to Westmount TC, and shorter distance services from locations such as Big Lake and Acheson connecting to Valley Line stations.

The exact routing and the operations of these routes in the future are outside the scope of this current study.

5.2. Summary of Routes

Exhibit 5.4 presents a rolled-up summary of the mass transit routes in the LRT, semi-exclusive, rapid bus and airport connector categories. The table includes information on the round-trip distance, the one-way length of the route, and how much of each falls into different categories of Right of Way. These distances are based on the interim stages of each route as presented in the map (Exhibit 5.1). Refer also to Appendix A for additional maps of this interim network.

Exhibit 5.4: Characteristics of Mass Transit Elements – 1.25 Million Population Horizon

Line Name	Principal Alignment(s)	Endpoints	*Directional Route-km*	*One-way distance*	LRT (km)	Semi-Exclusive Bus (km)	Mixed Bus (km)
Citywide Transit Routes (at Interim 1.25 Million Horizon)							
Metro Line		Blatchford – Health Sciences	16.9	8.5	8.47		
Capital Line		Clareview – Heritage Valley District Node	54.1	27.1	27.1		
Valley Line		Lewis Farms - Mill Woods Node	54.4	27.2	27.2		
B1	153 Av, 97 St, Calgary Tr, Gateway	Campbell Rd - Castle Downs Node - Century Park Node	60.0	30.0		16.0	14.0
B2	Whyte Av, 87 Av	WEM/Misericordia Node – Bonnie Doon Node	29.1	14.6		4.3	10.3
B4	137 Av, 170 St	Clareview Node - WEM/Misericordia Node	48.3	24.2			24.2
B5	23 Av. 17 St	Century Park – Meadows North Node	27.0	13.5		1.8	11.7
B6	Terwillegar Expressway	University/Garneau Node – Windermere Hub	29.3	14.7		10.3	4.4
Airport Connector	Hwy QE2, Calgary Tr, Gateway	Centre City – Edmonton International Airport	63.0	31.5		5.1	26.4
RapidBus12 (R12)	118 Av, Kingsway, 111 Av, 163 St	WEM/Misericordia Node – Clareview Node	48.3	24.1			24.1
B5C (50 Street-Exhibition)	50 St (north of 23 Av)	Mill Woods Node – Exhibition Node	30.0	15.0			15.0
District Transit Routes (at Interim 1.25 Million Horizon)							
RapidBus3 (R3)	Ellerslie Rd	Windermere Node – Mill Woods Node	34.3	17.1			17.1
RapidBus6 (R6)	51 Av	WEM/Misericordia Node –Meadows North Node	53.6	26.8			26.8
RapidBus9 (R9)	76 Av	Bonnie Doon District Node – Meadows North Node	20.1	10.1			10.1
RapidBus109 (R109)	153 Av, 18 St	Edmonton Energy Park Area – Clareview Node	15.9	8.0			8.0
Approximate Network Extents		***Overlaps between routes***			***4.0***	***9.0***	***5.0***
for Exclusive, Semi-Excl., and Rapid		***Net distance for network elements (km)***			***59***	***29***	***189***

Exhibit 5.4, continued

Line Name	Principal Alignment(s)	Endpoints	*Directional Route-km*	*One-way distance*	LRT (km)	Semi-Exclusive Bus (km)	Mixed Bus (km)
Frequent Routes (part of District Network)							
5 (F1)	124 St, Jasper Av, 97 St, 118 Av NW	Westmount Node-Coliseum	25.6	12.8			12.8
2(F2)	Jasper Av, 102 Av, 142 St, 87 Av	Stadium - WEM/Misericordia	29	14.5			14.5
1A/1B (F3)	504 Av, 106Av, 76 St, 101 Av, 50 St	Capilano-Downtown	16.5	8.3			8.3
8 (F4)	112 St, 82 Av, 99 St/ Scona, Jasper, 109 St	University Stn - Abbottsfield	39.5	19.7			19.7
9 (F5)	97 St, 101 St, Bellamy Hill, 105 St/109 St	Eaux Claires - Southgate	31.5	15.8			15.8
3 (F6)	111 St	Westmount-Stadium	12.7	6.4			6.4
4 (F7)	87 St, Whitemud, Fox Dr, 114 St, 82 Av	Lewis Farms - Capilano	53.3	26.7			26.7
6 (F8)	51 Av	Southgate - Davies	14	7			7
901 (W1)	107 Av	Jasper Place - Downtown/ 101 Street	18.3	9.2			9.2
		Total Frequent routes, km (includes some overlaps)					**120**

5.3. Order of Magnitude Costs

The capital costs for the recommended network have been estimated to determine the incremental costs beyond the future base, which already includes existing and planned services for the City of Edmonton.

The costs in Exhibit 5.5 are based on typical unit rates for transit construction and on the incremental quantities of infrastructure and transit vehicles implied by the recommended interim network. Major items are as follows:

- Expansion of the Capital Line LRT south to Heritage Valley Major Node. The estimate shown was previously provided by city staff, and is based on an extension by two stations;
- Bus lane modifications and BRT stop/station installations along the portions of routes B1, B2 and B5 proposed to advance towards semi-exclusive operations;
- Articulated vehicles for the semi-exclusive/BRT routes, including the portions initially operating in mixed traffic;
- An allowance for rapid bus stops to be installed along all planned 'R' routes, including the portions of the B1, B2 and B5 that will operate in mixed traffic. This allowance is to provide for expansion of bus stops or installation of new stops, to allow the limited stop routes their own space adjacent to any local services.
- Additional transit buses to operate the net increase in bus service associated with the rapid bus routes (based on Section 3.2). The rapid routes fully or partially replace some future base service, so this increase assumes reallocation of buses;
- The increased bus fleets for the addition of BRT and rapid services will be factored into planning for bus garages by ETS. This cost would be in addition to what is shown in the exhibit.

Exhibit 5.5: Order of Magnitude Capital Costs (Increment over Future Base)

Proposed Element	Cost - Conceptual
LRT Extension of Capital Line, including vehicles[1]	$ 325,000,000
BRT vehicles, stations, and initial lane conversions[2]	$ 220,000,000
Rapid Bus stops and additional buses[2]	$ 50,000,000
Incremental Cost over Future Base	**$ 595,000,000**

Note 1: LRT costs for Capital Line South from Report: CR_8337, Att. 3.

Note 2: BRT and rapid bus costs are conceptual, subject to a -50%/+100% cost range due to potential for changes as the project is developed.

These costs do not include the entire interim network for 1.25 Million, which is largely comprised of existing and planned services. Some have committed funding and others are related to planned growth of the city.

Future Base Items Excluded from Mass Transit Incremental Cost

Major items in the future base, and therefore not counted in the mass transit costs, include:

- LRT services that either exist, have construction underway, or have committed funding. These include:
  - Existing Capital Line from Clareview to Century Park;
  - Extension of Capital Line to Ellerslie Road SW;

  - Valley Line, eastern and western segments, from Mill Woods to Lewis Farms;
  - the existing Metro Line to NAIT;
  - Metro Line extension now under construction to Blatchford Gate.
  - LRVs to operate these services at a 5-minute peak headway, plus spare vehicles. This would include new vehicles and replacements for aging vehicles.
- The southwest BRT service on Terwillegar Expressway to South Campus, including dedicated lanes and buses to operate the route;
- Planned future bus services, including:
  - 2021 implementation of the Bus Network Redesign, including frequent routes, rapid routes, peak rapid/express, crosstown, local and community shuttles.
  - Expansion of bus service into growth areas between 2021 and the 1.25 Million population horizon. This would represent approximately 25% more buses in service than today, and installation of new bus stops.
  - Ongoing bus fleet renewal, replacement, and technological innovation.
  - As noted above, expansion of the bus fleet is accommodated by new bus garage facilities, and these are outside the costs shown above.
- Changes related to regional services in the future.

5.4. Success Factors

As a foundation to the definition of future transit network options for this study, a review of several peer agencies and background industry technical reports was conducted, with the results documented in the *Mass Transit Backgrounder*. The key lessons from this review were applied during the entire study, and many of the key elements of a successful mass transit network were demonstrated in the Ultimate Mass Transit Network defined for the 2 Million population horizon, as documented in Section 2.1.

Given that the **1.25 Million horizon** is an **interim state**, some of the measures of success are less complete for the partially implemented Mass Transit Network. However, since the developed portion of Edmonton will have a smaller footprint, a smaller network will still meet many of the requirements.

The following factors are common to other transit networks (or strong-performing portions of networks) across North America:

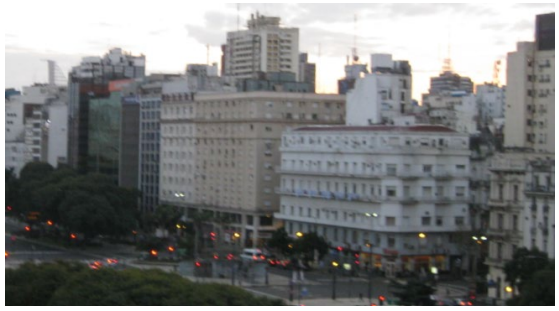
- Supportive urban form and densities (measured as number of people and jobs located near rapid transit stations);
- Length of exclusive right-of-way transit available, and the strongly related travel time competitiveness with the car; and
- Frequent Transit Network (FTN) coverage.

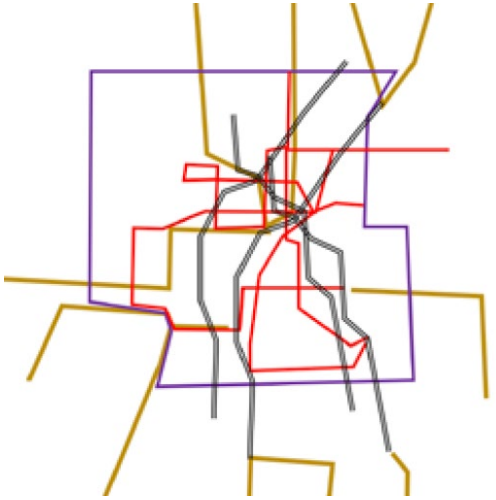
Exhibit 5.6 recaps the summary of key measures of success and major lessons learned identified through the peer review. Most of these measures relate directly to the mass transit and the land use around mass transit station locations. Measures such as these were applied to define network elements for the evaluation scenarios in the previous stage of the study, and the implementation options evaluated in this current report.

As identified in the following pages, the interim mass transit network begins to address all the factors that were previously defined as key descriptors of a successful mass transit network. The success factors were an input to the definition of the interim network scenarios, and the factors were also a key consideration in selecting the elements carried forward from that evaluation.

Exhibit 5.6: Key Measures of Success for Mass Transit

Number of residents and jobs located near mass transit stations	Length of exclusive and semi-exclusive right-of-way transit available	Frequent Transit Network (FTN) coverage
This promotes the network serving more passengers, and supporting land use objectives in The City Plan Most City-wide and District routes, including the LRT, connect to major nodes and primary corridors in The City Plan land use concept. The focus of the interim network is on adding service to nodes and corridors where investment is planned to stimulate development, and in growth areas around and within the current built-up footprint of the City.	Reflects speed and reliability for transit dependent and choice riders; *also supports travel time* The proposed mass transit network includes planned extensions of the Valley Line to Lewis Farms and proposed LRT extensions to Heritage Valley Major Node. It also includes and semi-exclusive transit routes B1, B2, B5 (east portion) and B6. These will increase the length of exclusive and semi exclusive ROW of Edmonton's mass transit network from 24 km now (37 km when Valley Line Southeast opens) to over 90 km for the interim network.	Connectivity beyond basic rapid transit, integration of services All parts of the city will have at least one transit route with frequent service within 1km, due to the grid structure of the mass transit network Core areas of the city will be served by a variety of exclusive, semi-exclusive, rapid and frequent routes offering more localized service. Outer parts of the City, including growth areas to the southwest, southeast and west, will gain new rapid bus routes as a starting point for mass transit.





Images are examples illustrating the concepts.

Travel time competitiveness with the car

Support mode share and sustainability objectives

Higher mode shares result in most parts of the city, including harder-to-serve employment areas, due to introduction of higher-speed semi-exclusive routes and a network of rapid and frequent routes.

The projected all-day mode share with the proposed interim network will be 9.3%, an increase from the recent 8.3% (based on the most recent travel survey in 2015).

Just maintaining the past transit share requires investment keeping pace (or more) with population; generating a future increase comes from some trip types becoming more attractive by transit than currently.

Multiple anchor destinations along mass transit

Increases ridership and spreads demand across more of the day

The mass transit network achieves this through expansion of service types and additional capacity options between major origins and destinations.

The anchor destinations include Centre City node, University/Garneau, Mill Woods, Heritage Valley, West Edmonton Mall /Misericordia, Blatchford-NAIT-Kingsway and Clareview Major Nodes and all of these are served by various mass transit routes.

Parking cost/availability at destination(s)

Higher parking prices are a stronger deterrent to drive-alone travel than fuel or the ‘sunk costs’ of auto ownership.

While general parking policy goes beyond the scope of the mass transit strategy, new park and ride would be focused at ends of the rapid transit lines to create a catchment area feeding into transit. In other locations, parking would be tied in with development objectives, with mobility hubs providing parking where consistent with their function, and then redeveloping some or all parking as more travel shifts to other transit routes and relies less on parking supply.

Speed, reliability and capacity measures

Operating transit in mixed traffic tends to reach a capacity limitation sooner, often due to platform (sidewalk) space at stations. In addition, the speed and reliability of mixed operations can reduce how many transit vehicles can operate along the route during peak hour. The impacts on travel speed therefore have a knock-on effect on capacity.

Implementing exclusive and semi-exclusive ROW with priority measures help to sustain higher-capacity service. The mass transit network includes extensions of the Capital, Metro and Valley Lines, and proposed new semi-exclusive routes B1, B2, B4, B5 and B6 (some of which may be BRT routes). In addition, priority measures for other routes, such as the 'R' series of limited stop Rapid routes, helps distribute this benefit around the city.

Limited stop buses

A highly flexible form of mass transit, with some limitations due to operations in traffic; nevertheless, these routes can be highly productive, especially when linked to a major destination.

In addition to the 'B' series of routes that may be bus or rail, the 'R' rapid bus routes form a grid with services between major nodes and providing a two-way grid of crosstown connections.

The interim network focuses on areas where higher demand and land use support warranted implementation of service. This network includes approximately half of the ultimate route coverage and frequency.

Operations in different parallel corridors

This approach helps match the demand more effectively with capacity, with the added benefit of providing limited stop service to other passengers.

Analysis of the interim horizon focused on capacity-constrained modelling which caps transit volumes on each route.

Many of the major nodes and transit terminals are served by multiple routes in the mass transit network, in addition to local bus routes.
A specific case where parallel services are critical is the north-south travel to areas between downtown and the airport. While the Capital Line is planned to be extended to Heritage Valley Major Node, new Airport Connector routes and B1 (stopping 1-1.5 km) help to serve the employment areas parallel to 111 Street and offload some of the potential excess demand from the Capital Line. Similar offloading can be expected from the B6 route.

6. Developing the Network

The mass transit network will require implementation that stages the network, so it is developed in response to existing transit demand and capturing future ridership demand. It is also critical that the network be developed in manner the helps support components of The City Plan, in particular the land use concept. Finally, the next steps for this study and beyond are outlined to conclude this chapter.

6.1. Concept Staging

The Ultimate Mass Transit Network defined in conjunction with The City Plan represented the transit services available over a long-term horizon for a city with 2 million residents. This doubling in size will take several decades. As the city grows, the population increase will also mean that more public funding is available for transit operations. The extent of the transit system will gradually increase over time, through introduction of new types of service, new routes, and increased frequency. Staging is typically carried out under the guidance of shorter-term strategic and investment plans focusing on 4-year and 10-year time periods.

The COVID-19 pandemic has had a marked influence on travel patterns in the short term (2020-2021), and due diligence through monitoring of ridership recovery and the emergence of any new patterns will no doubt influence the first few years of this plan. That is part of the reason the 1.25 Million horizon has been given a range of 10 to 15 years in the future.

The mass transit network is expected to be deployed over time, with several opportunities and constraints factoring into the staging.

Existing ridership demand and desired lines can provide a starting point for developing and expanding Edmonton's current mass transit network (mainly dominated by LRT). The result will be building the network logically through extensions or new mass transit lines (where the infrastructure/technology allows for exclusive or semi-exclusive ROW) connecting to current demand and to where already existing services exist (ideally coalescing around at least one mobility hub location). Additionally, the potential to capture future ridership (through future land development, or direct/fast connections) should be considered as the mass transit network is developed.

- The interim network proposed in Section 5 assumes extension of the Valley Line to Lewis Farms, and of the Capital Line to Ellerslie Road SW. It proposes a further extension to Heritage Valley Town Centre.
- The proposed interim network consolidates and extends the Terwillegar Bus Lanes project past South Campus to University Station, thereby adding capacity parallel to the Capital Line at its peak demand point and making the route (B6) itself more attractive by offering direct service.
- The north-south B1 service provides service into northwest Edmonton in advance of the future extension of the Metro Line, and south of downtown, this new route adds future capacity and opens new transit travel markets.

There will be a need to further evaluate the best solution to Capital Line capacity issues. Additional routes such as B1 and B6 can also mitigate capacity issues in the south which may be an effective way to address the LRT 'pinch point' that occurs in the peak hour between Health Sciences and South Campus stations. Solutions may include combinations of measures directly related to the Capital Line operations, and introduction of other services.

The rationale for projects can and should be linked to city building opportunities. The City Plan land use concept proposes its own staging plan for different types of development, and the deployment of transit infrastructure and services can provide support and be a catalyst for the land use initiatives and transit-oriented development.

- East-west corridors such as Whyte Avenue (B2) and 118 Avenue (R12) are supported by implementation of new semi-exclusive and rapid routes.

Financial resources available during a given period mean that certain projects will be prioritized while others are deferred until more funding becomes available.

- The implementation of B1 on 97 Street and 153 Avenue provides a lower-cost and easier to implement building block for eventual extension of the Metro Line north from Blatchford. The ML extension requires a costly bridge to carry the LRT over the Yellowhead and CN yards, and this also introduces a long gap between feasible station locations.
- Some of the longer-term rapid bus services within the existing built area of Edmonton have been deferred to post-1.25 million, focusing investment on higher ridership and more strategic corridors to start with. Some of these corridors, such as 111 Avenue, are projected to achieve high demand in the future as infill development occurs, and in the meantime can be served by planned services such as F6 (ETS route 3).

Some forms of capital construction can be converted from one mode to another, but this will have significant capital cost and design implications. (I.e. new bridges or tunnels built for transit). Designing and building for multiple modes can introduce extra design features, requirements and costs which become 'throw away' after the transition. Furthermore, upgrading to new infrastructure requirements requires shut down or diversion to existing services causing disruption to mobility options.

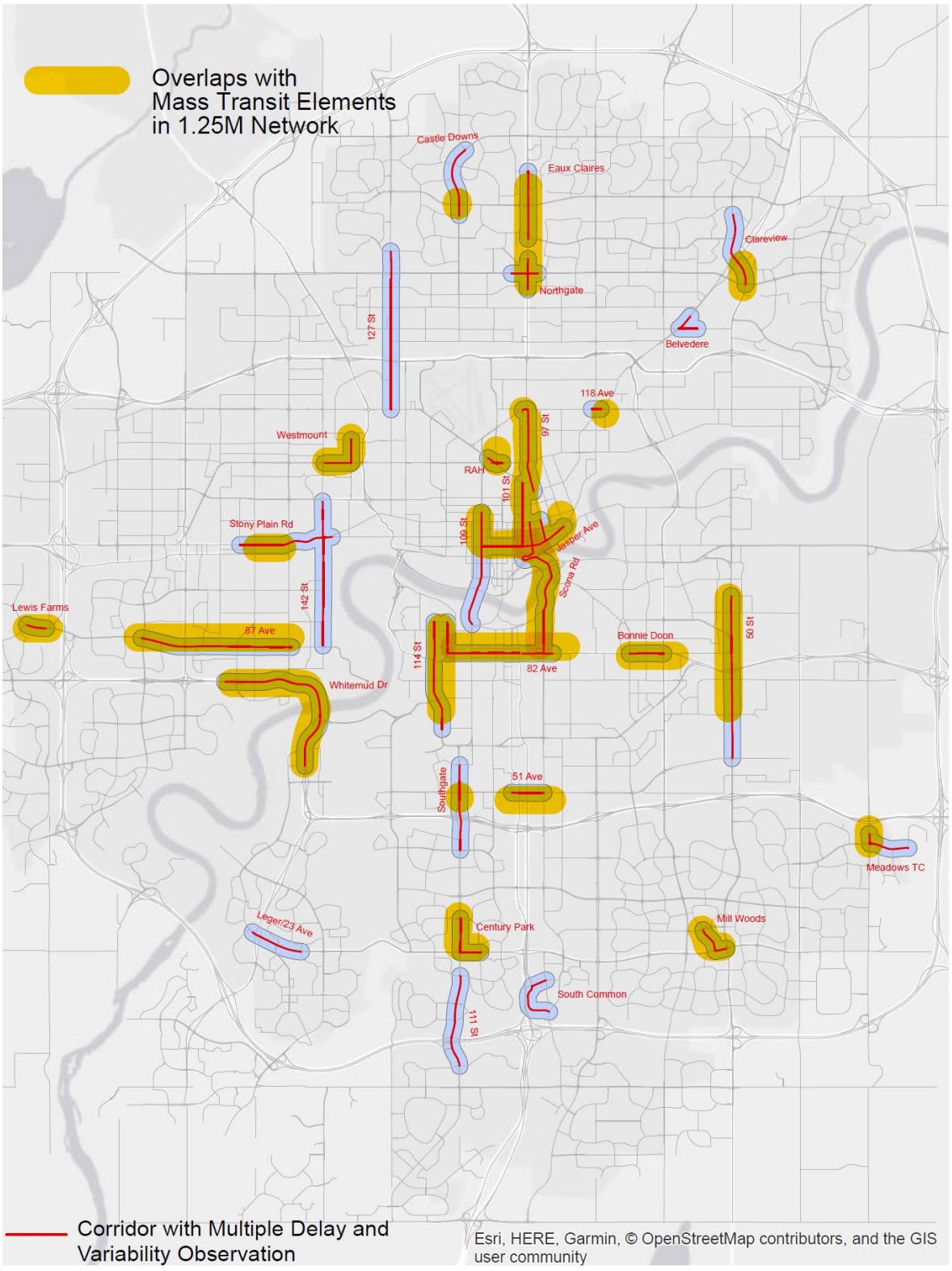
- Addition of more frequent Metro Line and Capital Line service through the downtown tunnel and across the grade crossings south of Health Sciences is currently constrained by several technical factors. The frequencies of each route during the peak are capped, with 18 trains per hour per direction assumed in the tunnel, and no more than 12 per hour at the grade crossings.
- Addressing these constraints may become more feasible once other mass transit options are available, so that construction to upgrade these lines can take place (replacement of signals and other upgrades to LRT typically require reduced service or bus bridging around the site to carry out upgrades). The interim network includes new routes that could form part of the building block to this enhancement strategy such as the incorporation of the south leg of B1 into semi-exclusive route and extension of B6 to University major node. With these routes in place, the transitional upgrades might then become feasible post-1.25 million.

Some services may be introduced in a less capital-intensive form sooner (for example a rapid or limited stop bus) and then be converted in part or in full to semi-exclusive or exclusive transit as needs arise.

- This approach has been taken with partial implementation of bus lanes assumed on B1, B2, and B5.

There will also be opportunities to implement Transit Priority Measures (TPM) at hot spots – either existing or emerging. These TPMs may include physical measures, as well as lane management/regulatory and signal operations modifications. Many corridors across the city could potentially warrant TPM implementation, including sections of 97 Street, 101 Street, and longer sections of arterials approaching key mobility hubs (such as Century Park and Mill Woods.) Exhibit 6.1 shows the overlap between mass transit elements and potential TPM implementation corridors.

Exhibit 6.1: Potential Locations for Transit Priority (Within 10-15 Years)

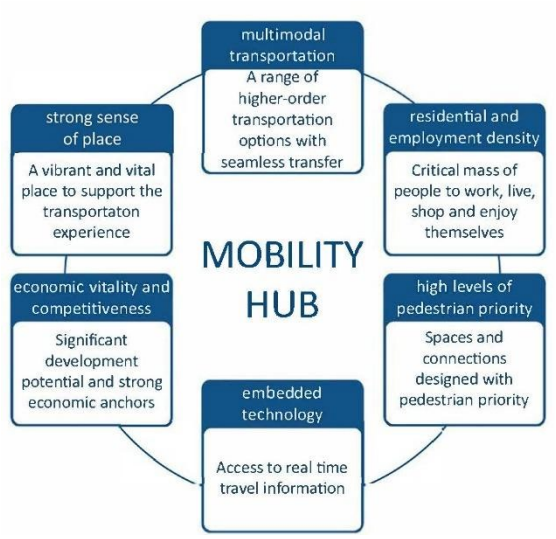


6.2. Mobility Hubs

The mass transit network recommendations for 1.25 million can be further refined by identifying intermodal transit hub locations, based on transportation and land use considerations that will emerge during the first quarter of development towards the ultimate 2 million. These intermodal sites are referred to as mobility hubs and are an important form of investment in transit infrastructure and help to support and incentivize large scale transit-oriented development. They tie important pieces of the proposed land use and transit strategies together.

A mobility hub is more than just a transit station. Mobility hubs consist of major transit stations and the surrounding area. They serve a critical function in the regional transportation system as the origin, destination, or transfer point for a significant portion of trips. They are places of connectivity where different modes of transportation – from walking to riding transit – come together seamlessly and where there is a concentration of working, living, shopping and/or playing. They are an important form of investment in transit infrastructure and help to support and incentivize large scale transit-oriented development. They tie important pieces of the proposed land use and transit strategies together. The key elements of a successful mobility hub are illustrated in Exhibit 6.2.

Exhibit 6.2: Mobility Hub Elements



Mobility hubs vary in size, but generally comprise the transit station and surrounding area that can be comfortably accessed by foot, approximately an 800-metre radius. However, the actual hub boundary should be determined based on the specific physical characteristics, neighbourhood context, and planning framework of the area. Of the mobility hub concept locations nominated for the Edmonton area, there is a range between existing sites and those that are envisioned after rapid transit investment. Many existing sites offer little more than vast parking lots, while others are easily accessible by many modes and are already vibrant places of activity and destinations in themselves.

Mobility Hubs are strategically located in nodes or can be centred on a mass transit station. They serve as critical places for trip origins, destinations and transfer points. Furthermore, they create connectivity to different modes, supporting a mobility system that allows people to seamlessly move from one travel option to another and to conveniently fulfill their daily needs. This is where different modes of transportation come together including walking, biking, transit and shared mobility options to create connections within Edmonton and to the region. Existing

examples of possible emerging mobility hubs where key connections between routes are made could include Century Park and West Edmonton Mall.

The provision of a safe transportation system is a cornerstone of The City Plan. Given the fact that most transit users are pedestrians during the first, last and transfer components of their trips, pedestrian safety is a major concern. These users need safe and efficient routes when accessing stations and while making multi-modal transfers. They rely on existing active transportation networks.

Selection of these functional types of mobility hubs was made based on identifying key City Plan nodes and key transportation intersection points that were candidates to fit the primary function for each of these types of mobility hubs:

- **Entry hubs**: Typically situated at or near the end of the high-capacity mass transit lines;
- **Transfer hubs:** Areas of significant network transfer points that combine higher volumes of passengers with a proposed land use node or location along a designated development corridor.
- **Destination hubs:** Identified as the Major Nodes from The City Plan Concept, since these are planned to act as both employment centres (destinations) and as origins and transfer points for people movement.

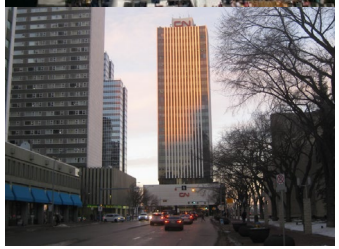
Exhibit 6.3 describes the characteristics of the mobility hub locations and provides high-level guidance as to the typical features of each hub. The locations of the hubs in each category are also listed for reference. It should be recognized that each mobility hub location may serve more than one function. Therefore, the typologies assigned to each location serve as preliminary identification of each mobility hub's primary function. It is expected that further study and planning will identify and incorporate other secondary functions of each mobility hub in parallel to land use planning for infill development.

Planning Steps

Common early steps to plan for and start to implement Mobility Hubs include the following suggestions:

1. Reviewing the existing planning context for the location, including regional, municipal and neighbourhoods plans. This assists in determining what elements of a hub would align with existing plans and community values. Where plans are due for a refresh, this presents an opportunity to incorporate stakeholder and community input into the process as the mobility hub is introduced as a concept.
2. Carrying out an inventory of study area infrastructure and land parcels to identify available capacity, constraints and opportunities. These steps are important where the vision for the hub is to encourage or help support redevelopment or infill, consistent with the vision in The City Plan for the study area. Since some mobility hubs are constructed adjacent to or jointly with developments, it is important to understand how feasible development would be, what form it might take, and when it may be triggered.
3. Defining guiding principles for the hub, such as what specific objectives it will have, and how it relates to the surrounding community.
4. Developing options and selecting a concept plan. Again, with input from community stakeholders, a recommended built form, and proposed infrastructure and streetscape modifications are developed. A staging plan that includes lead and supporting partners is also drafted to help carry forward momentum. Partnerships are typically needed in the areas of planning, services and elements, land development and funding.

Exhibit 6.3: Proposed Mobility Hub Typologies and Design Guidance – for the Edmonton Mass Transit Study

Typology	Examples	Description
Entry Hubs 	Ellerslie District Windermere	• Typically situated at or near the end of the high-capacity mass transit lines. • Existing development forms and transportation network generally auto oriented. • Growing market for mixed use development with significant developable land available including high development potential.
Transfer Hubs  	Whyte Avenue Century Park Jasper Place Bonnie Doon Castle Downs	• Areas of significant network transfer points that combine higher volumes of passengers with a proposed land use node or location along a designated development corridor. • Major and local centres with a mix of uses and moderate to high densities. • Some developable land availability. Development opportunities primarily through infill.
Destination Hubs  	Downtown City Centre University of Alberta West Edmonton Mall	• Identified as the Major Nodes from The City Plan Concept. • Regional centre with mature mix and scale of development, multiple destinations, and high densities. • Universities, Colleges, Airports in varying urban contexts. • Large trip generators. • Good pedestrian environment with well connected, walkable street network. • Limited developable land availability. Development opportunities primarily through infill.

The proposed locations of mobility hubs in the City of Edmonton are identified on Exhibit 6.4. A general explanation of what could take place at these hubs follows.

Entry Hubs

- The NW Metro Line hub will form around the future extension of the Metro Line to the Campbell Road station. The City of St. Albert owns land near the future station and in 2020 opened the Naki Transit Centre, which includes a bus terminal and large park and ride lot. The City of Edmonton will want to include mobility hub considerations in the station area planning for this location, in advance of construction, which is expected post-1.25 million.
- Horse Hills is deferred to post-1.5 million since much of the development in that part of the city is not staged to occur until then, which would become a trigger for Capital Line extension.
- A hub at Lewis Farms should be under consideration as soon as possible, building on the existing transit centre and responding to any opportunities related to the construction of Valley Line West, which will commence imminently.
- Windermere Centre hub requires decisions to be made around the optimal location for the major transit exchange in this corner of the city. The current Ambleside location may see many of the functions shift to a larger transit centre in Glenridding. Once this has been resolved, planning of the joint hub and transit centre should begin, given that the area around this hub is projected to see significant residential growth and high transit mode shares. The B6 route would be modified as necessary to serve the major hub.
- The ‘New Southwest Node’ on SW 41 Avenue will be triggered by plans to extend the Capital Line to its terminus in the Heritage Valley Major Node. Based on the recommendations of this report, that extension will take place once development of lands south of SW 41 begins in earnest, which is likely after the initial 10-15-year window.
- Ellerslie District hub is planned to include a park and ride and be connected by frequent limited-stop bus service to Mill Woods LRT station and Transit Centre. The initial hub should consider street-facing land uses. The park and ride would feature transitional surface parking set back from the arterial streets, and ideally this will be laid out in modules of s suitable size for staged redevelopment in the medium to longer-term.

Transfer Hubs

- Castle Downs: In keeping with the recommendation to initiate B1 service through Castle Downs, this hub would initially focus on the operations of the new route, and how this would be integrated with the transit centre in this area. The planning process for the transit infrastructure and adjacent land uses would also need to consider staging considerations for the future extension of the Metro Line.
- Exhibition: This hub has the potential to build from the existing transit centre at Coliseum LRT and feed into planning processes related to the Exhibition lands. Several of the new mass transit routes will connect or terminate at this hub.
- Jasper Place: This location represents an opportunity to link existing commercial areas and the transit exchange in the area with the Valley Line. Planning here may need several smaller stages to advance as the area is constrained and the streets where the LRT is being constructed will not lend themselves directly to high numbers of connecting buses.
- South Campus: New mass transit services will either pass close to or connect directly to the LRT station and some reconfiguration of stops may be required to optimize operations. Given that University of Alberta regularly undertakes planning initiatives, a

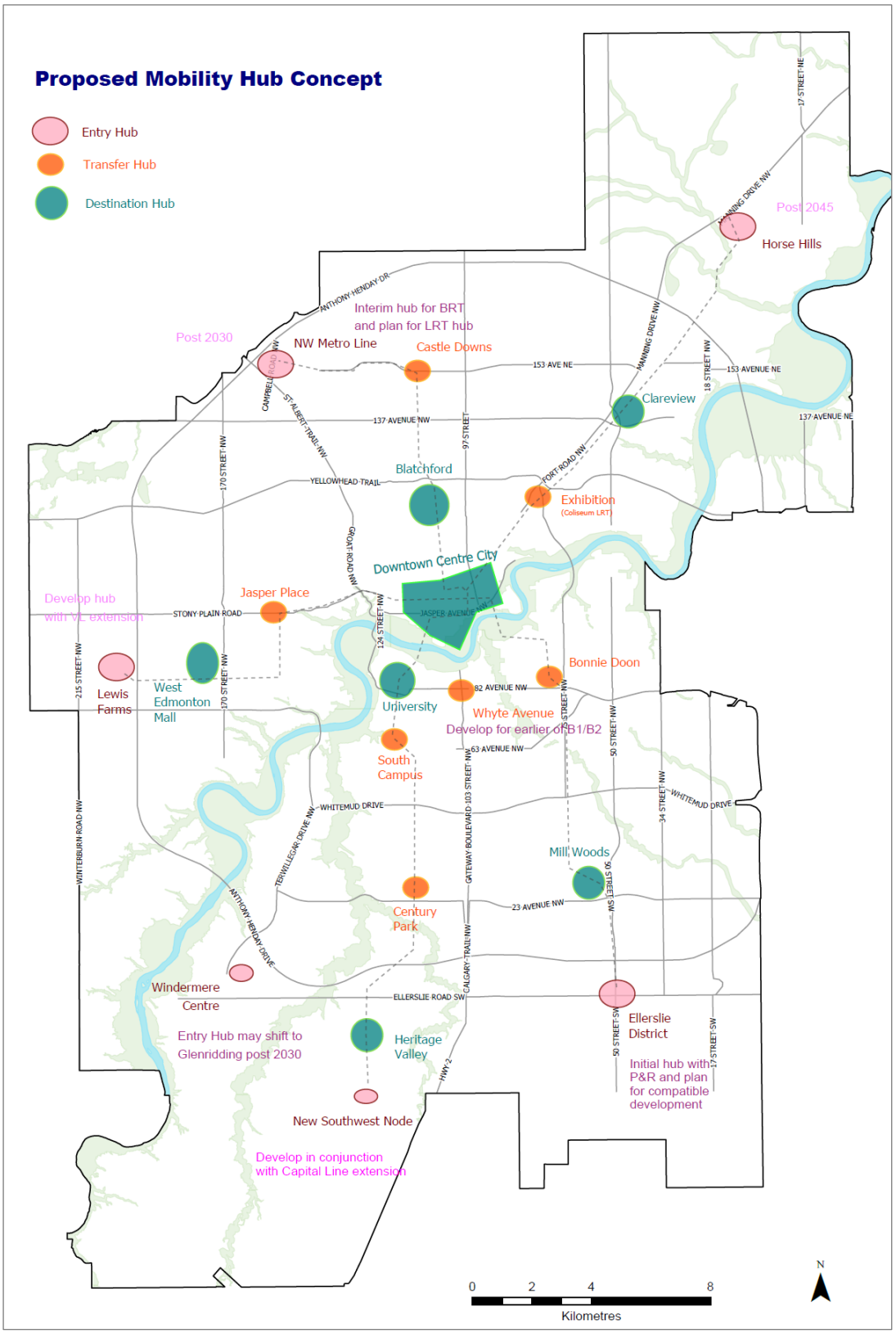
review of transit needs and transit-friendly development opportunities around this hub should feed into that process.

- Whyte Avenue: This future hub is already served east-west by several frequent bus routes. It will become a transfer point once the B1 service is implemented. As part of the planning for those stops, which may be split northbound/southbound onto different streets, active modes connections, public spaces and development plans in nearby parts of Whyte Avenue will need to be included in planning for this connection.
- Century Park: This is an existing LRT station and bus transit center that will remain important even after the Capital Line is extended farther south. There will be need here to re-organize the bus operations to accommodate new routes such as B1 and B5. In addition to these needs, there may be opportunities at such time the site undergoes renovation or redevelopment.
- Bonnie Doon. This near-future LRT station will be a terminal point for the B2 route, and potentially an intercept point for some regional services. Again, over time this area may evolve in response to the additional transit services.
- In addition to the hubs noted on the map, there are existing locations where transit centres are adjacent to commercial areas (such as Northgate and Southgate), and efforts to enhance the integration and urban design of these locations may take place as needs and opportunities arise at those locations.

Destination Hubs

- These include Centre City Node, Blatchford, Clareview, Mill Woods, Heritage Valley and West Edmonton Mall Major Nodes.
- These areas have already undergone planning processes, and so more of the focus in defining mobility hub features will be to determine the major passenger destinations, flows to/from/between transit services, and how the active modes network and public spaces in these hub areas will function together.
- Each of these should undergo review of the station areas and transit centres within them in conjunction with planning around transit service expansion, including new LRT, BRT and rapid routes.

Exhibit 6.4: Proposed Mobility Hubs – Edmonton Mass Transit Study



6.3. Next Steps

This report documents the ultimate mass transit network and a proposed interim network for a 1.25 Million population horizon. The next technical step is to integrate these findings with the other aspects of the **Mobility Network Assessment** to define transportation project priorities across multiple modes. These will be guided by community needs and opportunities, as well as the logistics of implementing infrastructure and services.

Another branch of technical analysis will be to assess the **operational feasibility** of elements of the mass transit network, to evaluate if and how they could be implemented. The increases in service frequency and new types of service point to several challenges that will need to be addressed through future study. These include:

- Increasing the capacity of certain parts of the LRT network to interline the Capital and Metro Lines at higher frequencies, and finding the best way to address the capacity constraint at University Avenue;
- Operating frequent and rapid buses at high frequencies, typically in mixed traffic and with constraints on 'platform' space in the public right of way. This will need to consider transit priority measures and curb management;

This type of work is usually collaborative and would draw upon the local knowledge base for the transit system, bring in lessons learned from applicable case studies, and evaluate potential solutions, potentially through modelling simulation.

Design Guidelines and Standards for the new and evolving types of transit service will need to be developed to inform planning and design of future services. This may take several forms but typically starts with confirming the 'function and feel' of transit infrastructure and services, with technical and stakeholder input informing this. Design standards can then be developed by merging best practice from existing standards, with emerging urban design principles, and the guidelines developed for transit infrastructure, vehicles and operations. It will also be important to align these guidelines and standards to City Policy (both short term and long term) and in particular land use development policy to ensure the integration with land use policies.

Bus Rapid Transit (with fully-segregated or dedicated lanes) types of service would be "new" to Edmonton and some elements would warrant development of guidelines and standards to support and inform future project development. This would also be applicable to mobility hubs and large-scale mass transit stations not designed specifically for rail technology.

Early Implementation can take several forms. The Bus Network Redesign is already approved and many of the early versions of future routes included in the mass transit network will be in service in the city before the end of 2021.

The rapid bus and semi-exclusive services, including the look and application of Bus Rapid Transit (BRT), bus only or HOV lanes (painted and segregated) and transit priority measures, will be new to Edmontonians. Therefore, purposeful and coordinated efforts to define these concepts in the Edmonton setting will be critical for the success of implementing the mass transit network. It is common in the industry to select a priority corridor, work with stakeholders to develop, design and implement 'quick wins' improvements (for example, confirming and implementing bus stop locations for a rapid bus service) and deploying a demonstration/pilot version of the service.

Appendix A – Additional Mass Transit Reference Exhibits

Categories of Mass Transit Modes

Nodes and Corridors Reference Maps

Volume Plots for AM Peak – Options A and B

Additional Model Outputs (Transit Volumes)

Categories of Mass Transit Modes

In addition to building on the future base network, the mass transit network provides as opportunity to bring together and categorize different mass transit modes. Exhibit A.1 outlines the types of services that are included in the mass transit network, and explains their role or the primary market that they cater too as well as some examples of each type of service. Most of the services can be provided by more than one technology option (primarily rail and bus variations).

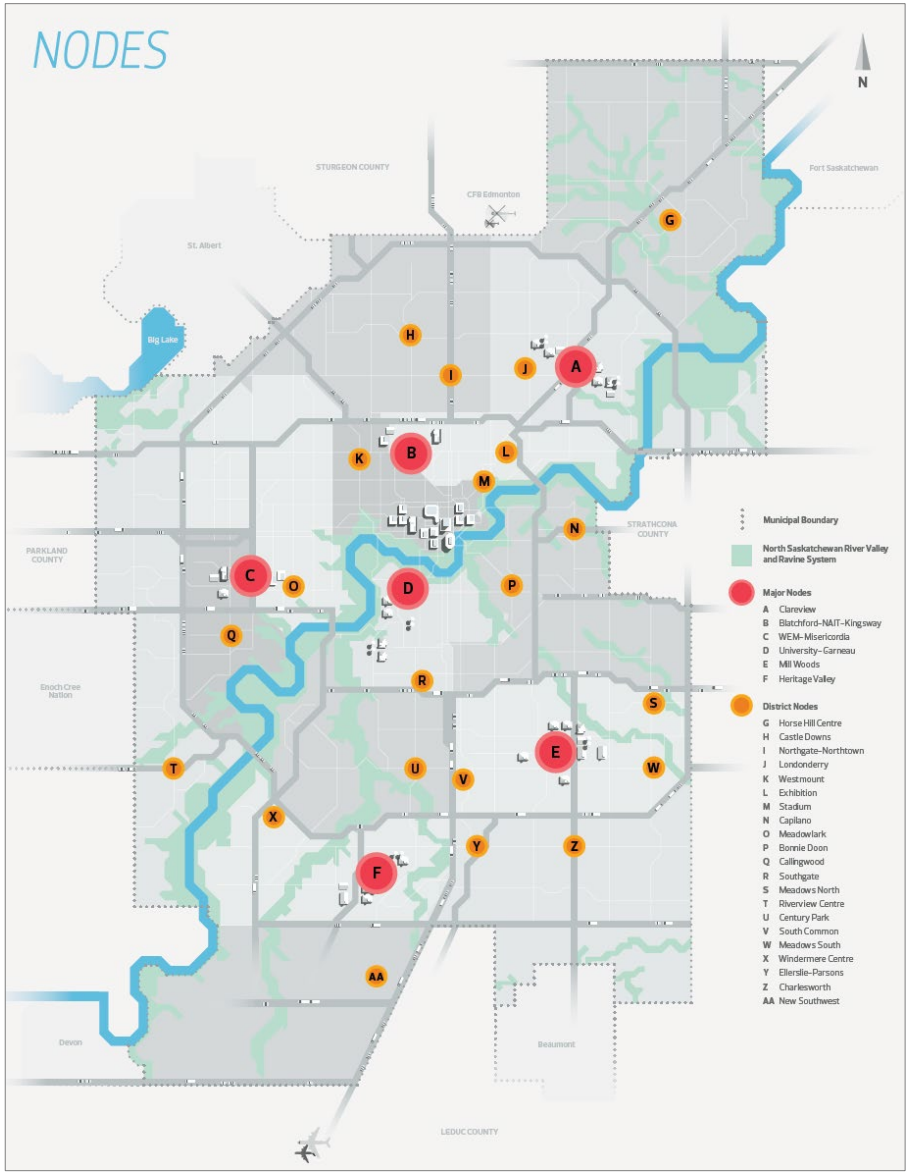
The exhibit also identifies:

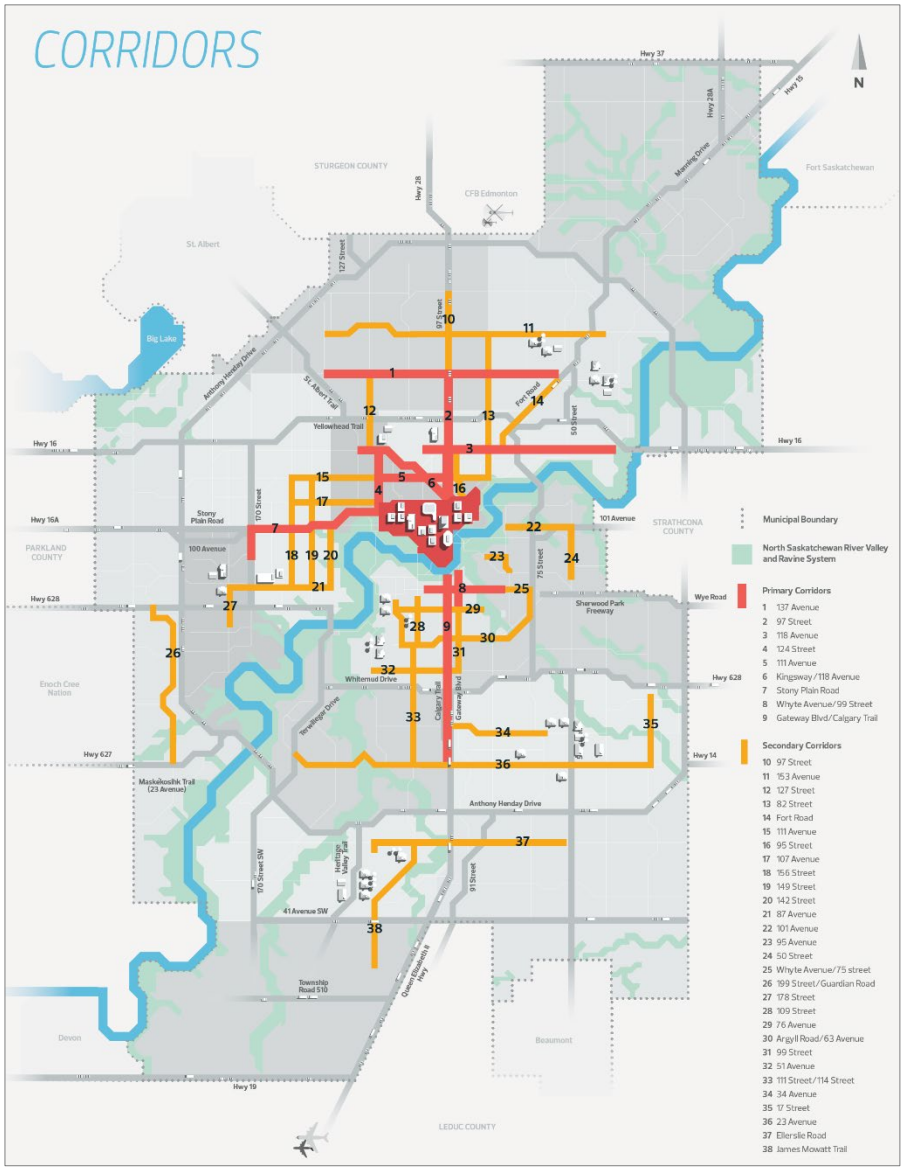
- The range of typical operations usually seen with the different modes of transit operation for the regional, rapid and urban forms of mass transit. These are expressed in terms of stop spacing and frequency;
- The lengths of typical trips supported by the different forms of mass transit;
- The typical densities served and connected by the different forms of transit. This provides some guidance as to where the different forms of transit would usually find success in attracting enough passengers;
- Typical benefits and challenges associated with implementation and operation of each type of service. These are based on general practice in North America.

Exhibit A.1: Mass Transit Modes, Technology Examples and Service Characteristics

Mode	Primary Trip Markets	Technology Examples	Typical Services	Trip Length (km)	Density (people + jobs/ha)	Benefits	Challenges
Regional Transit (Link Cities Together)							
All Day	• Long commuter trips • Long off-peak discretionary trips	• Passenger train • Highway coach (Bus)	• Peak headway, 5 to 15 minutes • 800 m to 4 km spacing	>15	Varies by context	• Competitive with auto for long trips • Better mitigates peak hour congestion	• ROW can be costly given long distances • Costly station parking & road improvements
Peak Only	• Long commuter trips	• As above, but only commuter services	• Peak headway, 10 to 20 minutes • 800 m to 4 km spacing	>15	Varies	• Better mitigates peak hour congestion Restricted service times lowers operating costs	• Does not serve non-work based trips well • Costly station parking & road improvements
Rapid Transit (Support Cross-City Travel and Higher Density Development)							
Exclusive ROW	• Long and intermediate distance trips, all times of day	• Subway • Automated Train or Bus • LRT or BRT in tunnel, trench or on structure • Signal Pre-emption or Priority System at intersections	• Peak headway, 3 to 6 minutes • 400 m to 2 km spacing	5-15	>200	• Very high capacity • Can encourage densification	• High capital costs • Space requirements
Semi-Exclusive ROW	• Long and intermediate distance trips, all times of day	• LRT or BRT in exclusive path, but with intersections • Integrated Transit Priority Measures (queue jumping, dedicated lanes, etc.)	• Peak headway, 3 to 10 minutes • 400-800 m stop spacing	5-15	100-200	• High capacity at lower costs than exclusive ROW • Can encourage densification	• Less reliable and potentially slower than exclusive ROW • Space requirements
Limited Stop	• Long and intermediate distance commuter trips	• Limited stop 'rapid' bus in bus lanes and mixed traffic • Optional Transit Priority Measures (queue jumping, dedicated lanes, etc.)	• Peak headway, 5 to 12 minutes • 400-800 m stop spacing.	5-15	50-100	• Reduced travel times attracts new riders • Low cost, flexible route designs	• Reliability concerns due to mixed traffic • Less impact on densification
Urban Mass Transit– (Convenient Access to Local Destinations)							
Frequent	• Long and intermediate distance commuter • Off-peak discretionary trips in major nodes and corridors	• Bus or streetcar/ tram in frequent/primary transit network	• Peak headway, 5 to 10 minutes • Spacing same as currently done, 100-200m.	<10	50-100	• Extend reach of rapid services	• Operating costs need to be justified by demand • Need many intersecting routes to work well

Exhibit A.2– Reference Maps – City Plan Nodes and Corridors





Source: City of Edmonton

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Exhibit A.3 – Combined Population and Employment Distribution at 1.25 Million Horizon

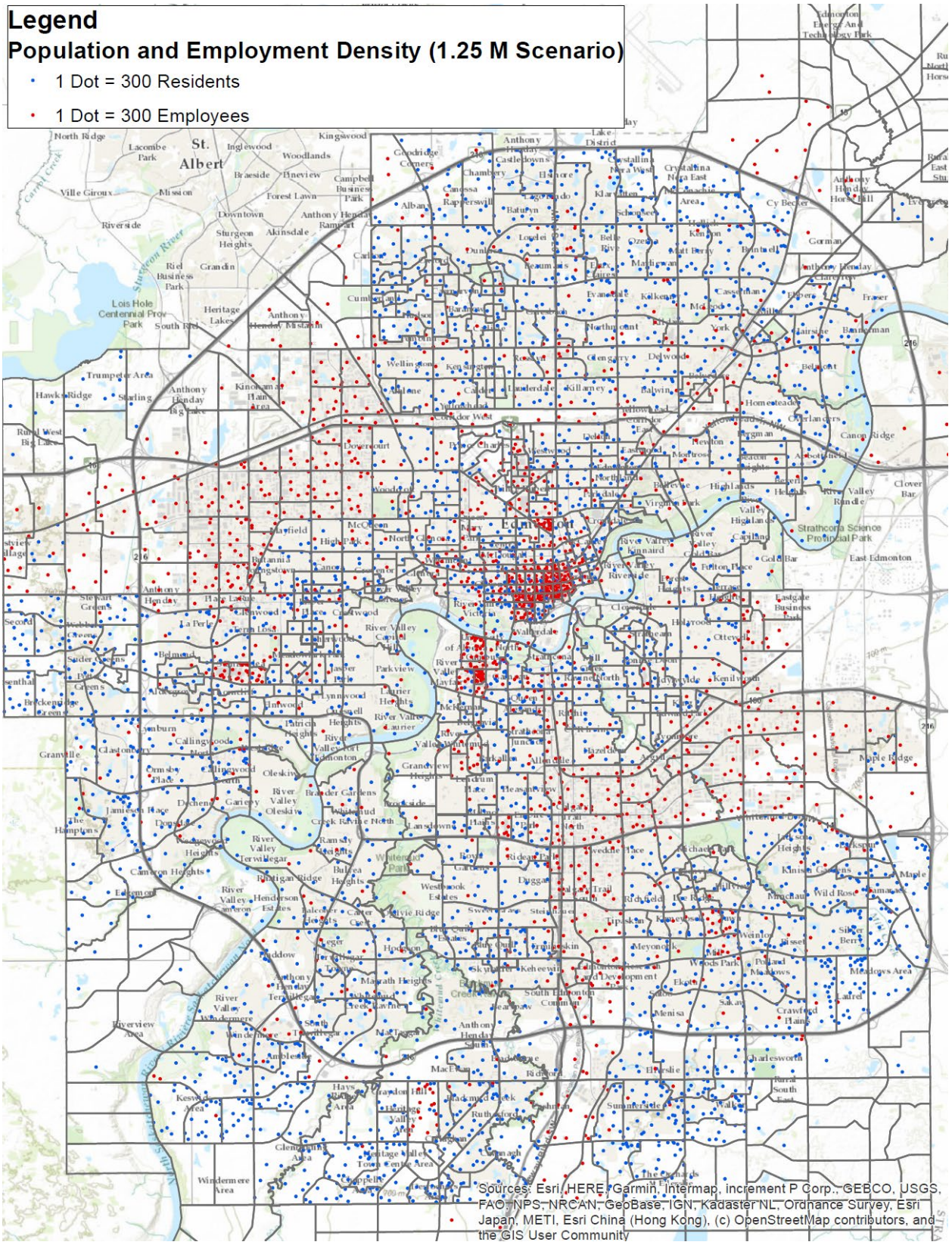
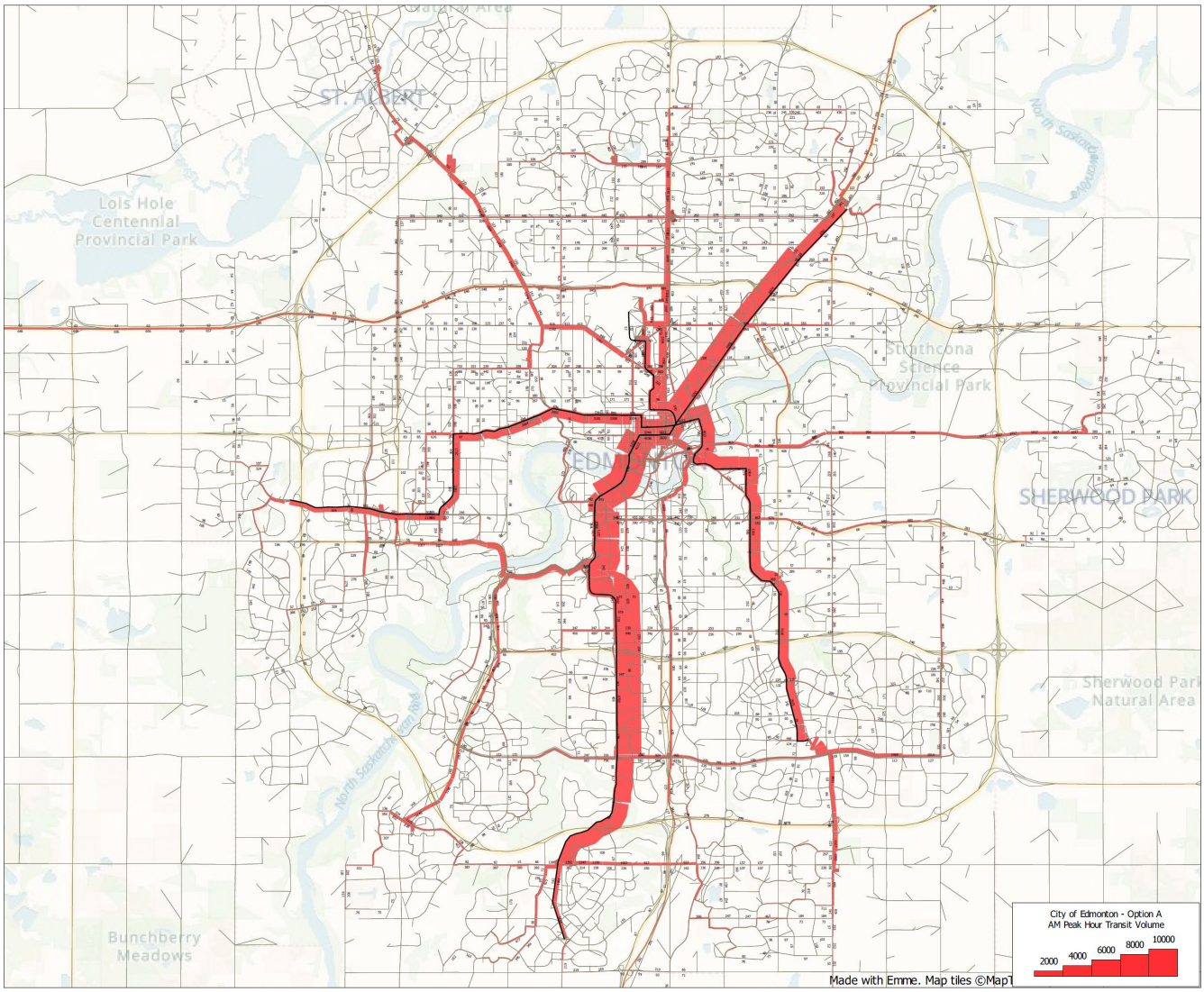
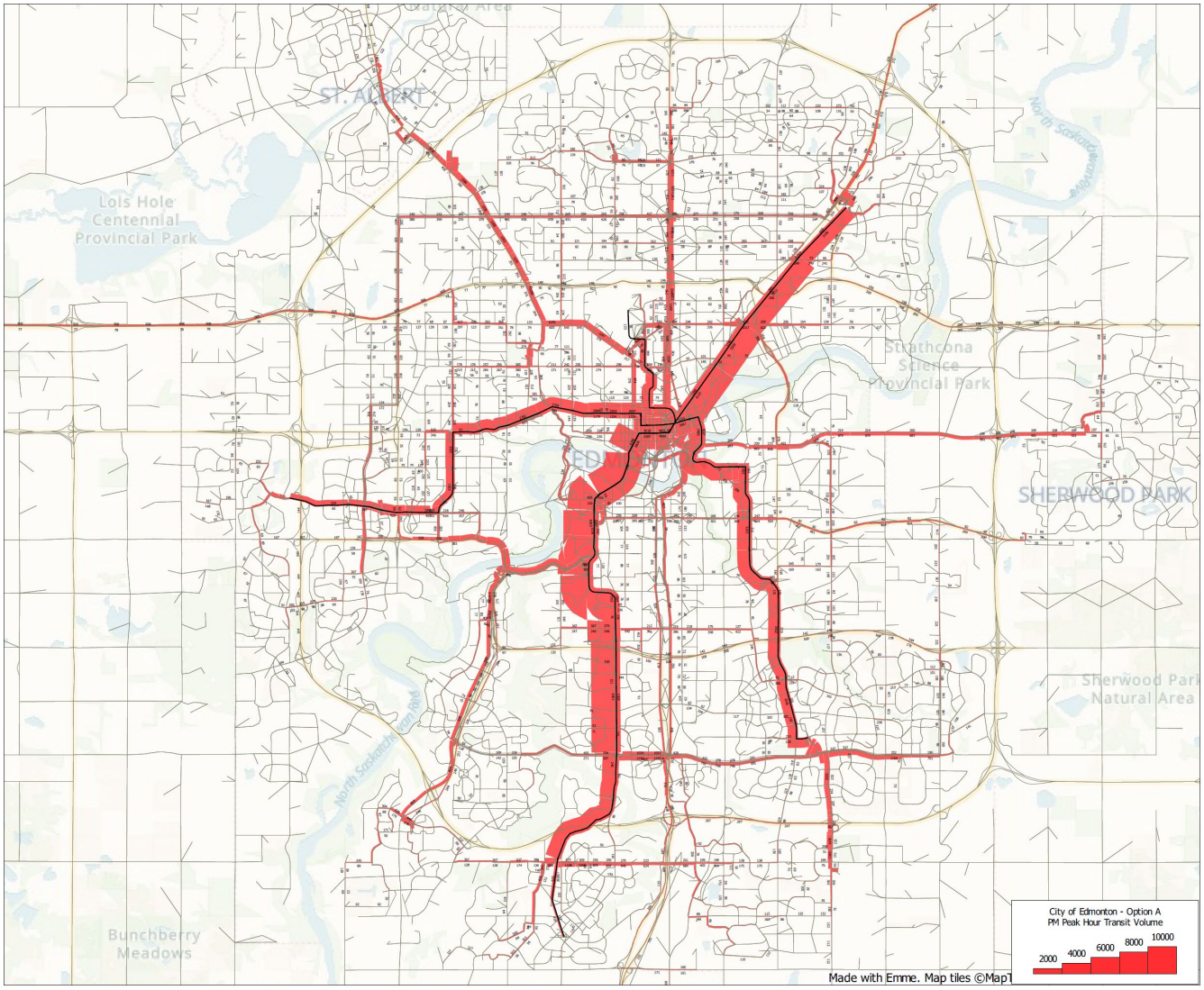


Exhibit A.4 – AM Peak Transit Assignment Result – Option A



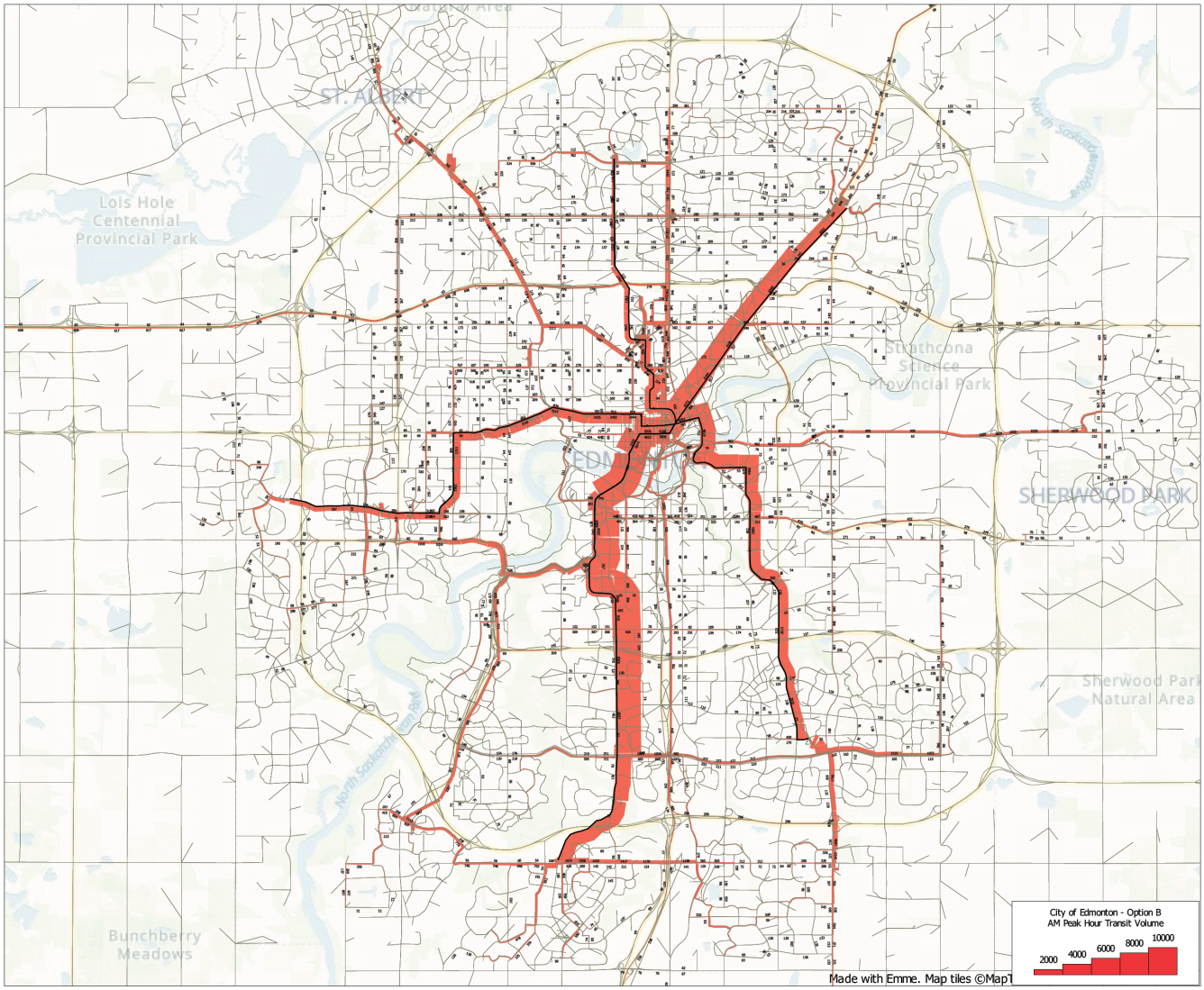
Source: IBI Group/City of Edmonton. EMME Transit Volume Plot.

Exhibit A.5 – PM Peak Transit Assignment Result – Option A



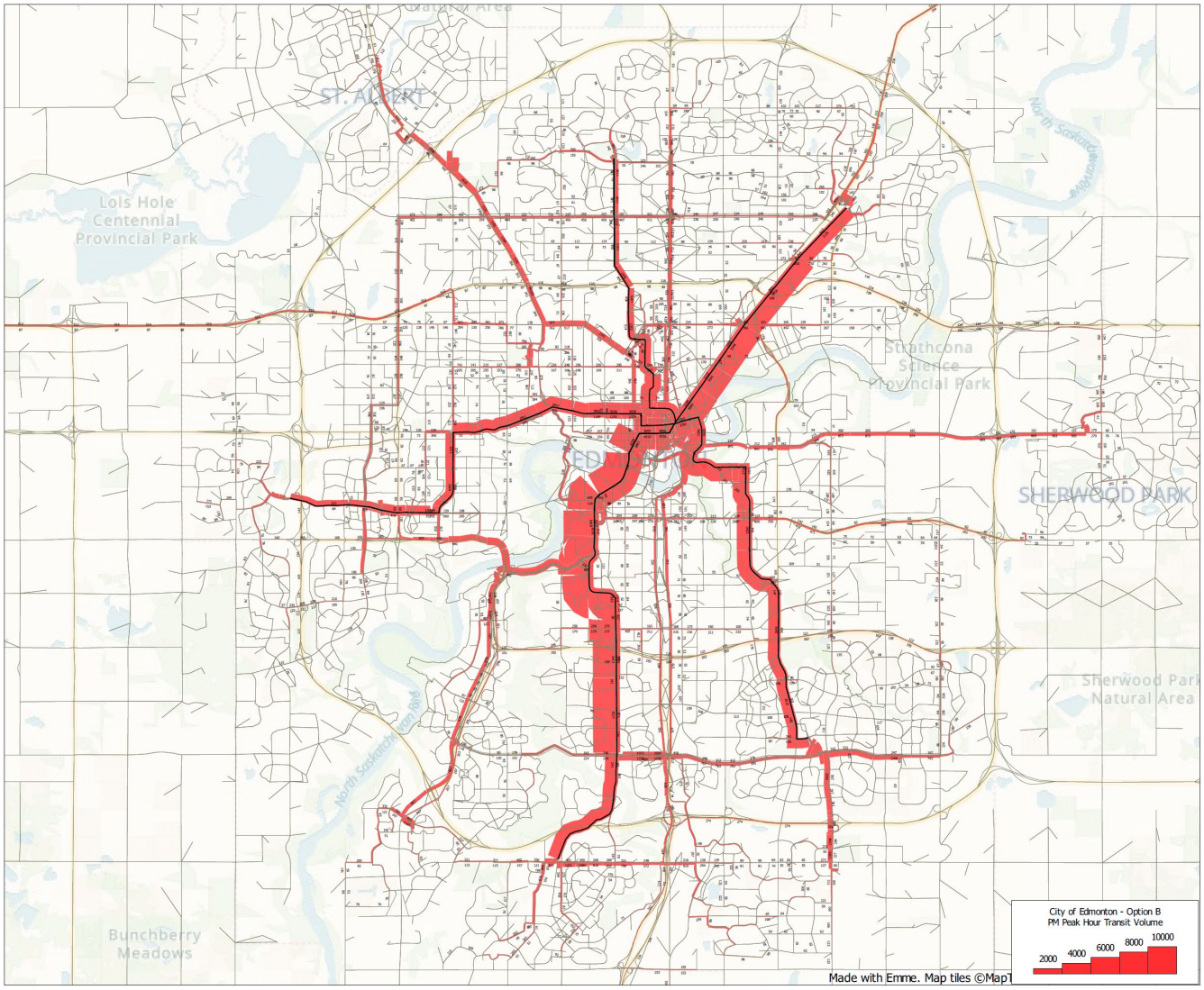
Source: IBI Group/City of Edmonton. EMME Transit Volume Plot.

Exhibit A.6 – AM Peak Transit Assignment Result – Option B



Source: IBI Group/City of Edmonton. EMME Transit Volume Plot

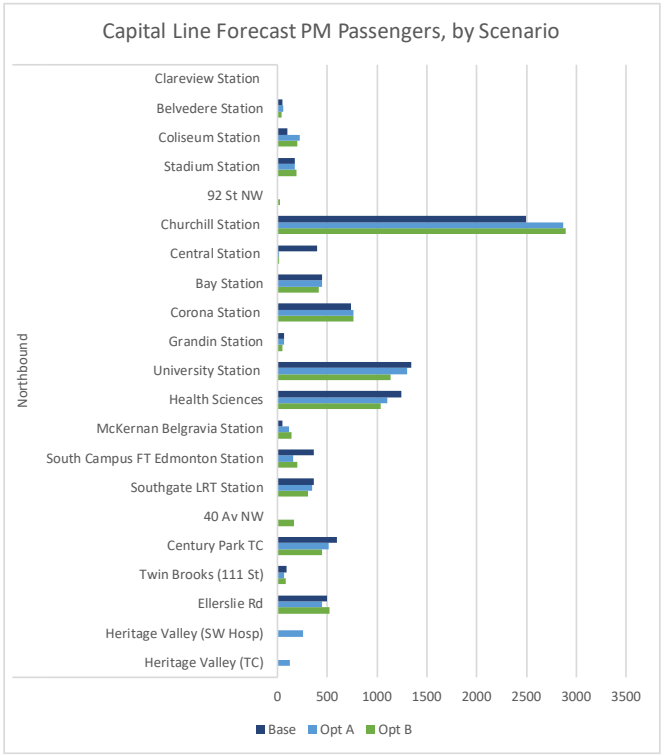
Exhibit A.7 – PM Peak Transit Assignment Result – Option B

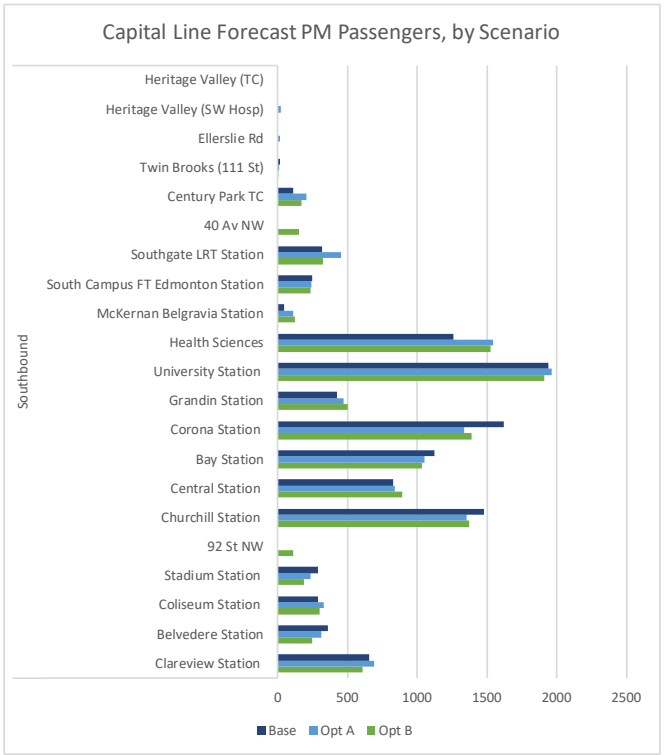


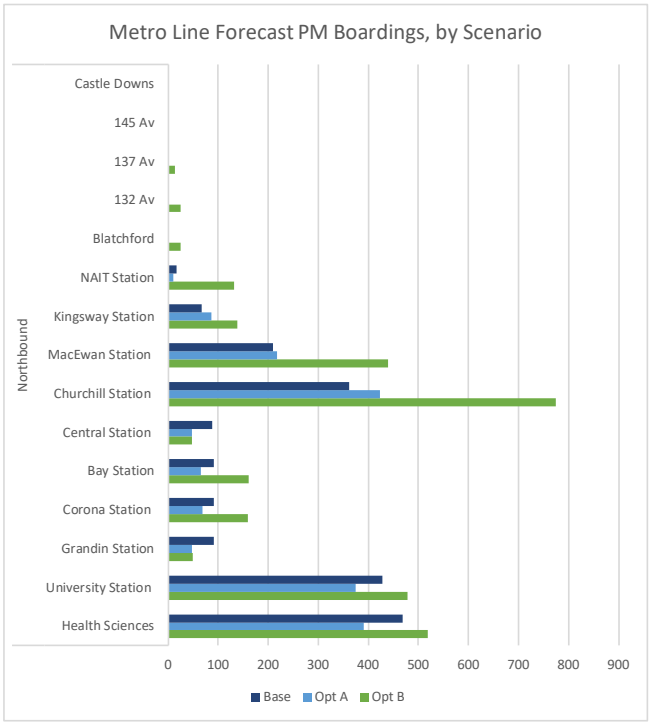
Source: City of Edmonton. EMME Transit Passenger Demand - Volume Plot.

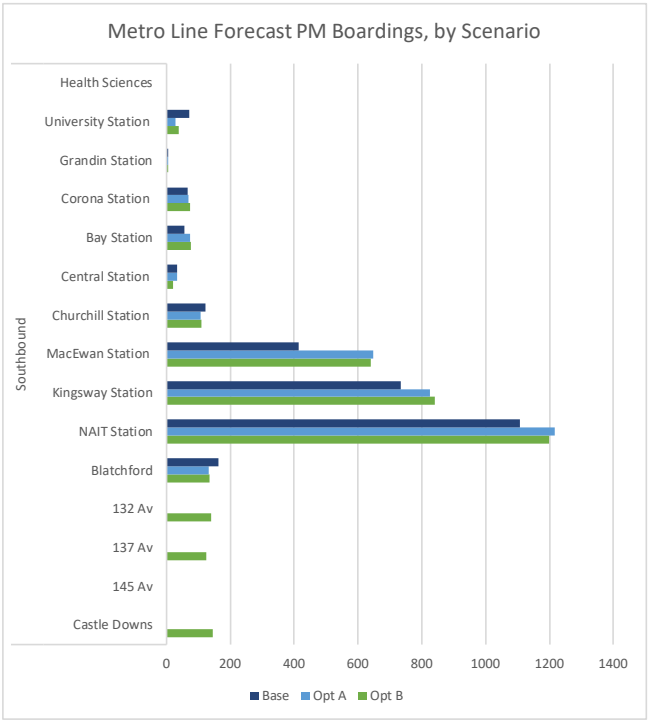
Exhibit A.8– Light Rail Transit Boarding Activity, by Scenario

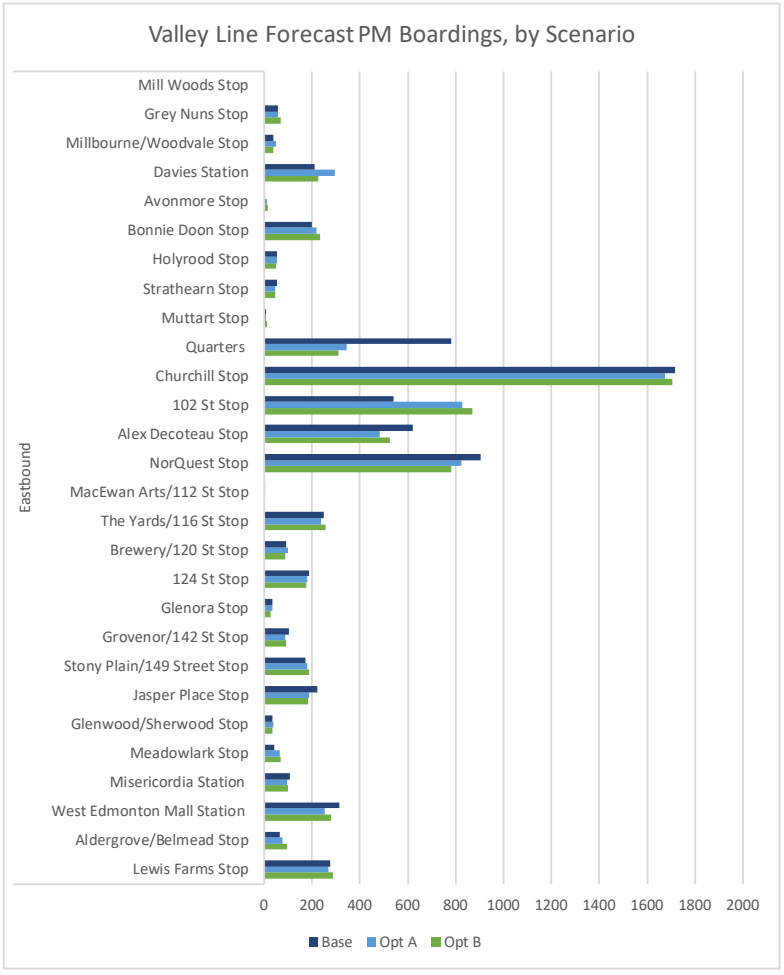
			Capital Line		Metro Line		Valley Line	
	Peak	Direction	Board	Alight	Board	Alight	Board	Alight
Comparing Options								
PM	**Base**	2-way	**20,014**	**20,015**	**4,680**	**4,679**	**13,130**	**13,130**
	Opt A	2-way	20,216	20,220	4,869	4,867	12,507	12,507
	Opt B	2-way	20,216	20,220	6,510	6,511	12,563	12,562
Option A	PM Peak	North	9,038	9,040	1,731	1,730		
		South	**11,178**	**11,180**	**3,138**	**3,137**		
		East					**6,703**	**6,704**
		West					5,804	5,803
		Total	20,216	20,220	4,869	4,867	12,507	12,507
	AM Peak	North	**11,327**	**11,326**	**3,836**	**3,836**		
		South	9,988	9,986	1,539	1,538		
		East					5,487	5,487
		West					**6,493**	**6,493**
		Total	21,315	21,312	5,375	5,374	11,980	11,980






Metro Line Forecast PM Boardings, by Scenario
Northbound
Castle Downs
145 Av
137 Av
132 Av
Blatchford
NAIT Station
Kingsway Station
MacEwan Station
Churchill Station
Central Station
Bay Station
Corona Station
Grandin Station
University Station
Health Sciences
0 100 200 300 400 500 600 700 800 900
Base Opt A Opt B


Metro Line Forecast PM Boardings, by Scenario
Southbound
Health Sciences
University Station
Grandin Station
Corona Station
Bay Station
Central Station
Churchill Station
MacEwan Station
Kingsway Station
NAIT Station
Blatchford
132 Av
137 Av
145 Av
Castle Downs
0 200 400 600 800 1000 1200 1400
Base Opt A Opt B


Valley Line Forecast PM Boardings, by Scenario
Eastbound
Mill Woods Stop
Grey Nuns Stop
Millbourne/Woodvale Stop
Davies Station
Avonmore Stop
Bonnie Doon Stop
Holyrood Stop
Strathearn Stop
Muttart Stop
Quarters
Churchill Stop
102 St Stop
Alex Decoteau Stop
NorQuest Stop
MacEwan Arts/112 St Stop
The Yards/116 St Stop
Brewery/120 St Stop
124 St Stop
Glenora Stop
Grovenor/142 St Stop
Stony Plain/149 Street Stop
Jasper Place Stop
Glenwood/Sherwood Stop
Meadowlark Stop
Misericordia Station
West Edmonton Mall Station
Aldergrove/Belmead Stop
Lewis Farms Stop
0 200 400 600 800 1000 1200 1400 1600 1800 2000
Base Opt A Opt B

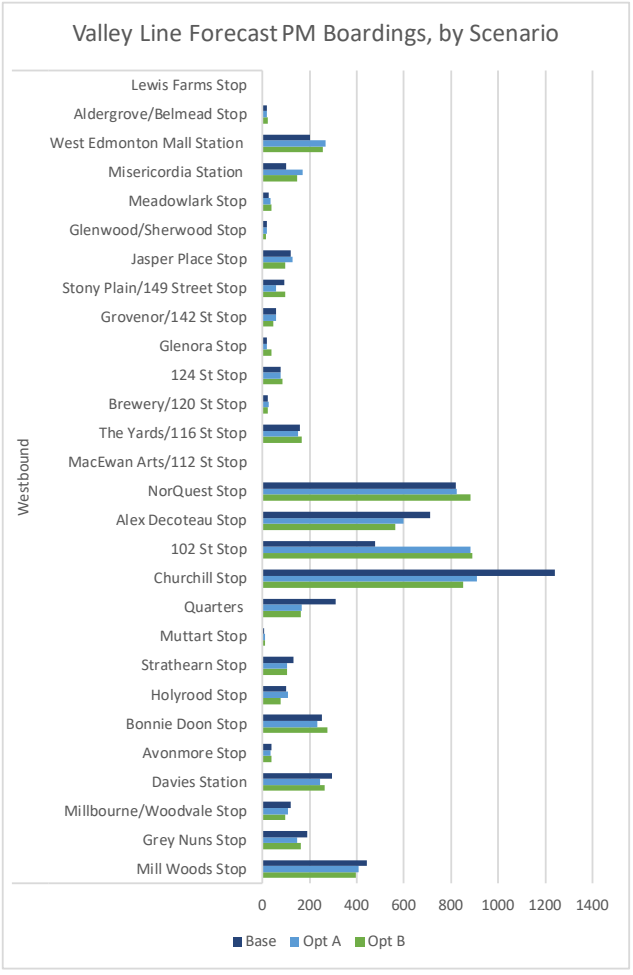
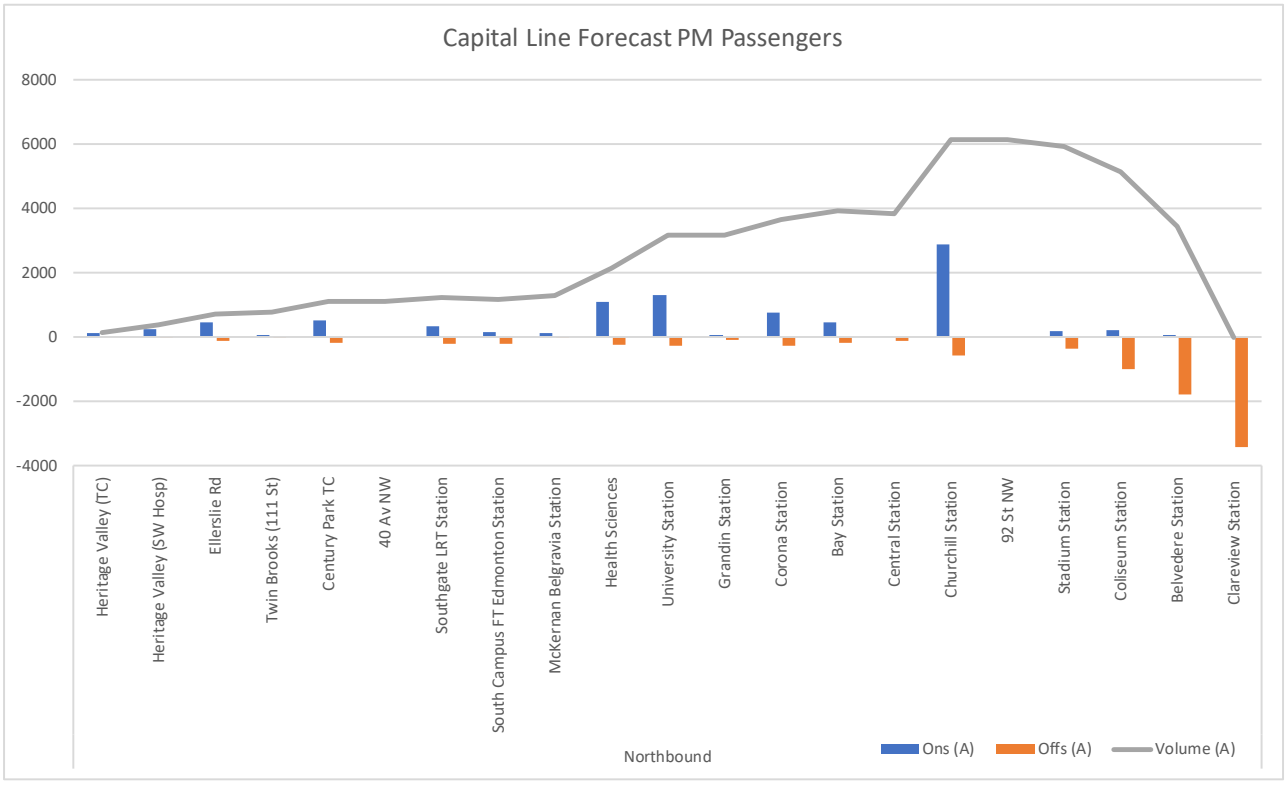
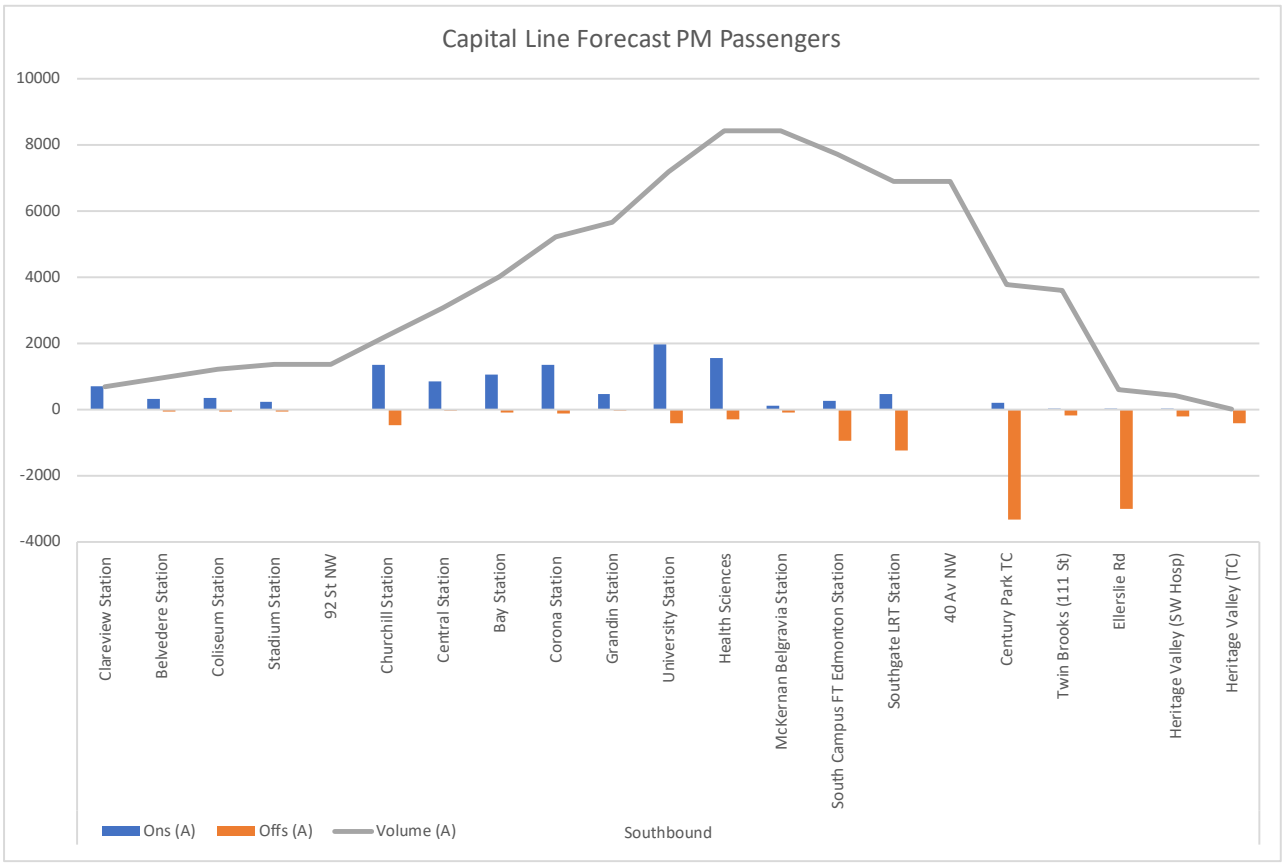
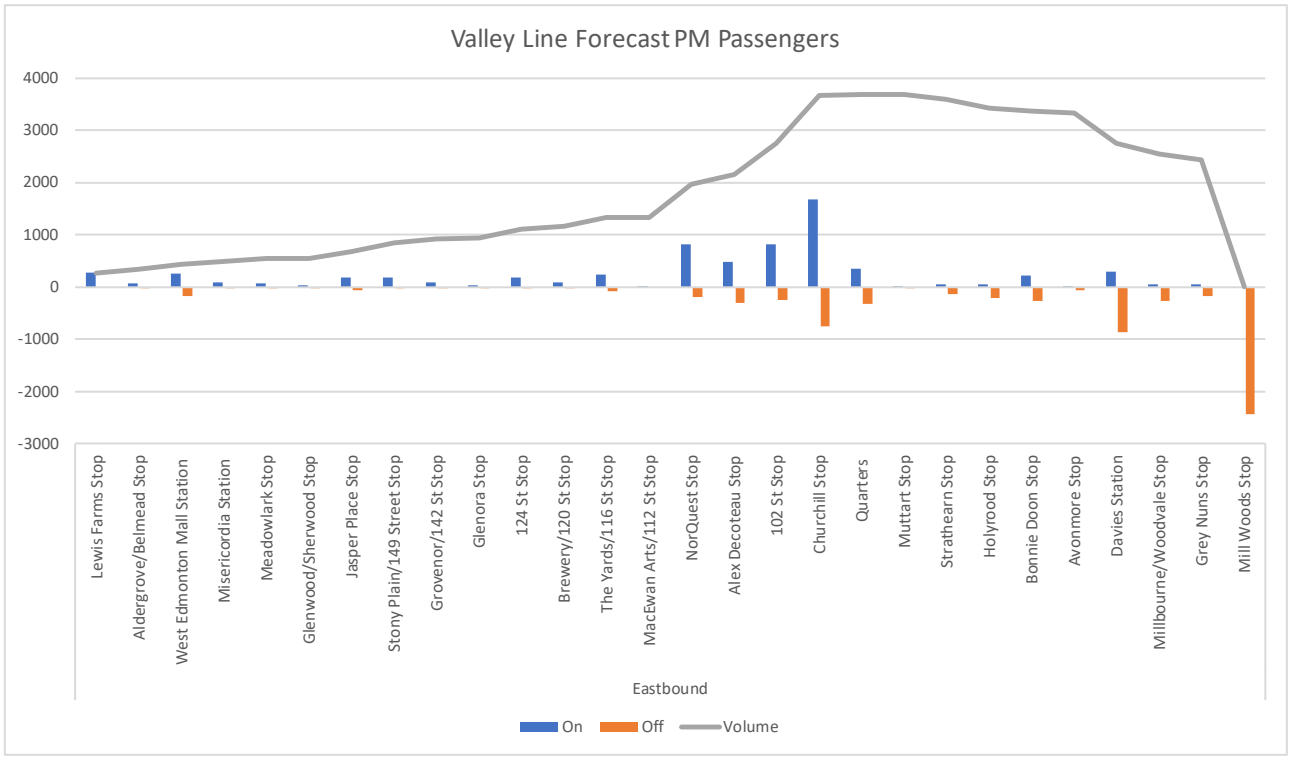
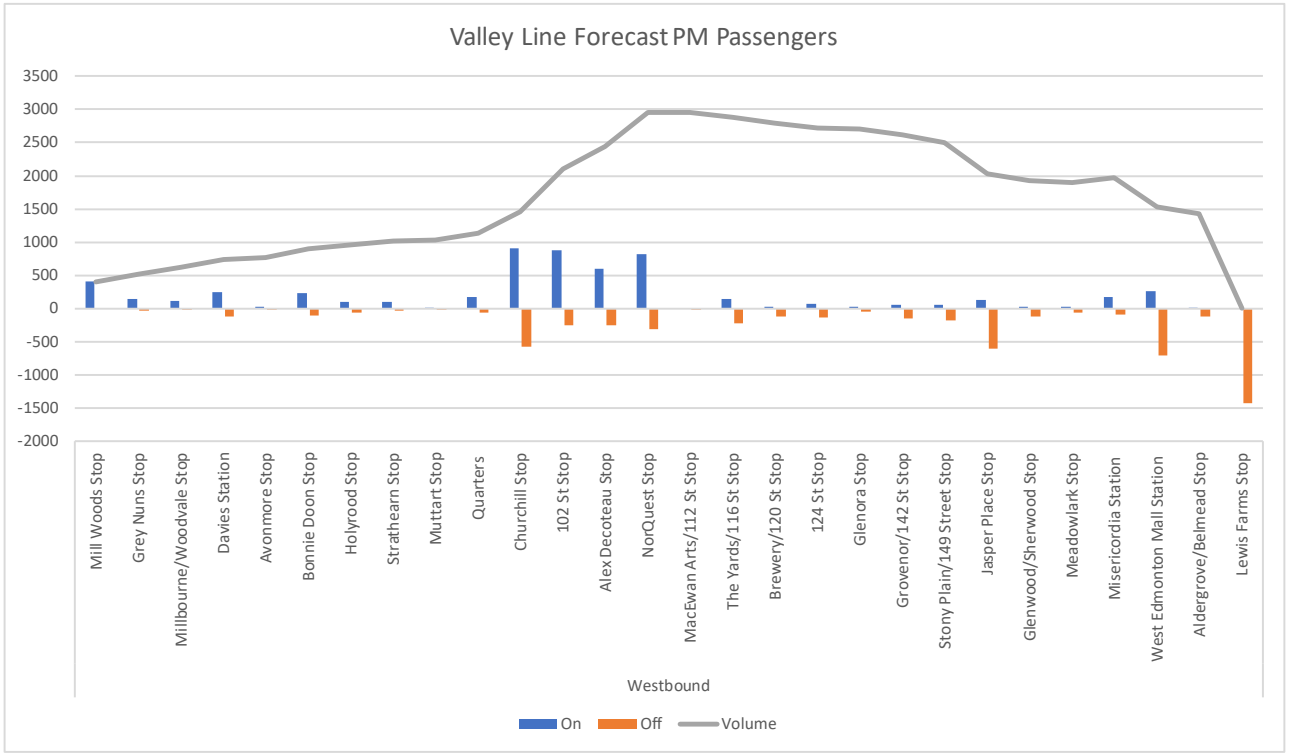

Valley Line Forecast PM Boardings, by Scenario
Westbound
Lewis Farms Stop
Aldergrove/Belmead Stop
West Edmonton Mall Station
Misericordia Station
Meadowlark Stop
Glenwood/Sherwood Stop
Jasper Place Stop
Stony Plain/149 Street Stop
Grovenor/142 St Stop
Glenora Stop
124 St Stop
Brewery/120 St Stop
The Yards/116 St Stop
MacEwan Arts/112 St Stop
NorQuest Stop
Alex Decoteau Stop
102 St Stop
Churchill Stop
Quarters
Muttart Stop
Strathearn Stop
Holyrood Stop
Bonnie Doon Stop
Avonmore Stop
Davies Station
Millbourne/Woodvale Stop
Grey Nuns Stop
Mill Woods Stop
0 200 400 600 800 1000 1200 1400
Base Opt A Opt B

Exhibit A.9– Light Rail Transit Passenger Profiles (PM Peak)






Valley Line Forecast PM Passengers
4000
3000
2000
1000
0
-1000
-2000
-3000
Lewis Farms Stop
Aldergrove/Belmead Stop
West Edmonton Mall Station
Misericordia Station
Meadowlark Stop
Glenwood/Sherwood Stop
Jasper Place Stop
Stony Plain/149 Street Stop
Grovenor/142 St Stop
Glenora Stop
124 St Stop
Brewery/120 St Stop
The Yards/116 St Stop
MacEwan Arts/112 St Stop
NorQuest Stop
Alex Decoteau Stop
102 St Stop
Churchill Stop
Quarters
Muttart Stop
Strathearn Stop
Holyrood Stop
Bonnie Doon Stop
Avonmore Stop
Davies Station
Millbourne/Woodvale Stop
Grey Nuns Stop
Mill Woods Stop
Eastbound
On
Off
Volume


Valley Line Forecast PM Passengers
3500
3000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
Mill Woods Stop
Grey Nuns Stop
Millbourne/Woodvale Stop
Davies Station
Avonmore Stop
Bonnie Doon Stop
Holyrood Stop
Strathearn Stop
Muttart Stop
Quarters
Churchill Stop
102 St Stop
Alex Decoteau Stop
NorQuest Stop
MacEwan Arts/112 St Stop
The Yards/116 St Stop
Brewery/120 St Stop
124 St Stop
Glenora Stop
Grovenor/142 St Stop
Stony Plain/149 Street Stop
Jasper Place Stop
Glenwood/Sherwood Stop
Meadowlark Stop
Misericordia Station
West Edmonton Mall Station
Aldergrove/Belmead Stop
Lewis Farms Stop
Westbound
On
Off
Volume

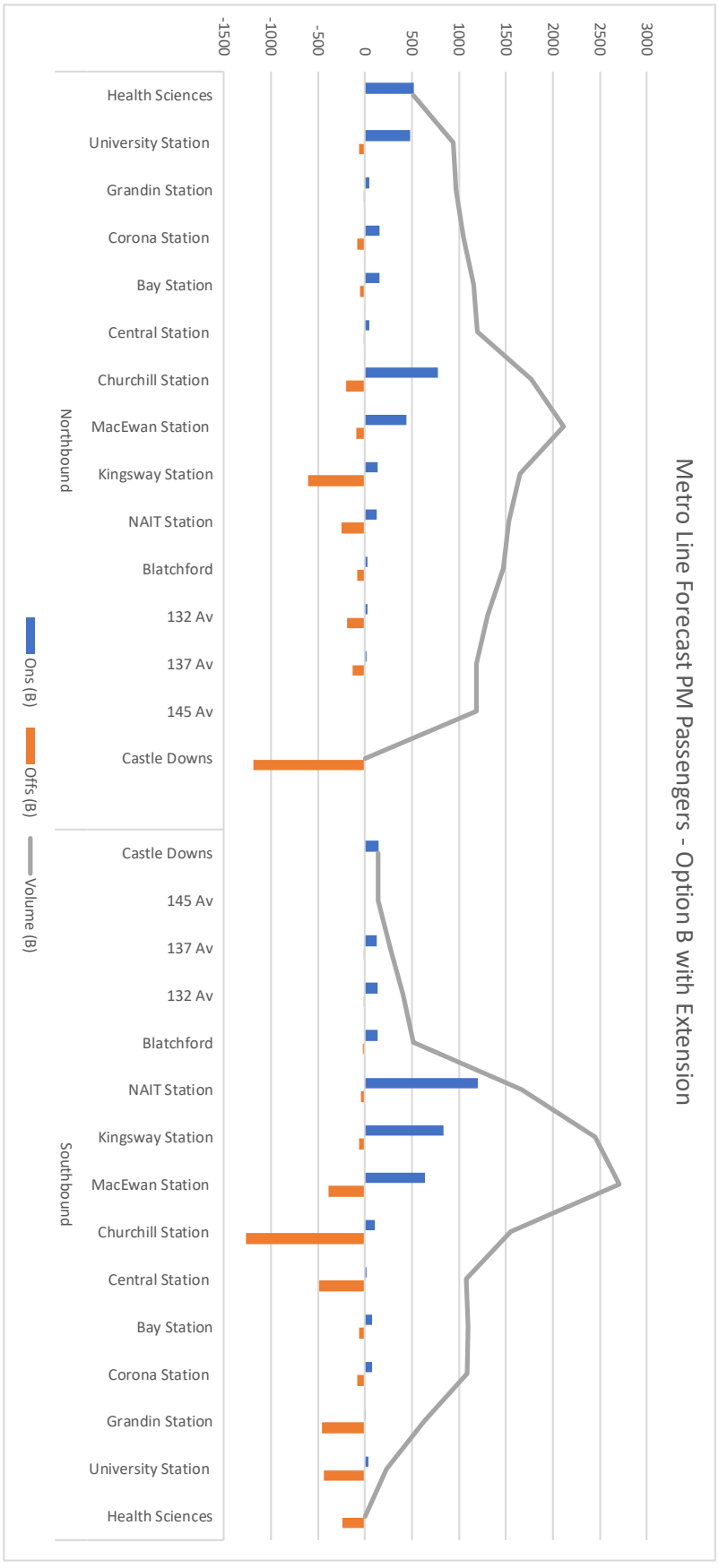

Metro Line Forecast PM Passengers - Option B with Extension
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000
Northbound
Health Sciences
University Station
Grandin Station
Corona Station
Bay Station
Central Station
Churchill Station
MacEwan Station
Kingsway Station
NAIT Station
Blatchford
132 Av
137 Av
145 Av
Castle Downs
Southbound
Castle Downs
145 Av
137 Av
132 Av
Blatchford
NAIT Station
Kingsway Station
MacEwan Station
Churchill Station
Central Station
Bay Station
Corona Station
Grandin Station
University Station
Health Sciences
Ons (B)
Offs (B)
Volume (B)

Exhibit A.10 – Bus Passenger Activity – 97 Street North of 118 Avenue

			B1/B1a		110X		9		Total	
Peak	Direction	Location	Board	Alight	Board	Alight	Board	Alight	Board	Alight
PM Peak	NB	97 Street & 118 Avenue	42	43	9	17	16	23	67	83
PM Peak	NB	97 Street & 127 Avenue/128 Ave	43	45			1	71	44	116
PM Peak	NB	97 Street & 132 Avenue	37	36	1	9	1	4	39	49
PM Peak	NB	97 Street & 137 Avenue/Northgate	98	113	54	139	62	73	214	325
PM Peak	NB	97 Street & 153 Avenue	100	536				18	100	554
PM Peak	NB	Eaux Claires TC			8	457	10	279	18	736
PM Peak	NB	Castle Downs Road & 153 Avenue	46	134					46	134
PM Peak	NB	Castle Downs Transit Centre	38	372					38	372
	NB PM Total		404	1279	72	622	90	468	**566**	**2369**
PM Peak	SB	Castle Downs Transit Centre	96	36					96	36
PM Peak	SB	Castle Downs Road & 153 Avenue	72	7					72	7
PM Peak	SB	Eaux Claires TC			105		174		279	0
PM Peak	SB	97 Street & 153 Avenue	18	37					18	37
PM Peak	SB	97 Street & 137 Avenue/Northgate	7	29	57	31	114	38	178	98
PM Peak	SB	97 Street & 132 Avenue	8	2	2	1	4	1	14	4
PM Peak	SB	97 Street & 127 Avenue/128 Ave	54	6			13	6	67	12
PM Peak	SB	97 Street & 118 Avenue	18	2	0	6	6	8	24	16
	SB PM Total		273	119	164	38	311	53	**748**	**210**

B1 operates from Campbell Rd to Century Park

110X operates Eaux Claires to Government Centre; ETS #9 operates Eaux Claires to Southgate

Exhibit A.11– Bus Passenger Activity – Whyte Avenue Corridor/U of Alberta area

Major Services on Whyte/82 Avenue - as modelled			B2		4		8		3-Route Total	
Peak	**Direction**	**Location**	**Board**	**Alight**	**Board**	**Alight**	**Board**	**Alight**	**Board**	**Alight**
PM Peak	EB	Fort Edmonton Park Road & Fox Drive		0	-	-			0	0
	EB	Belgravia Road & Fox Drive	28	1	-	1			28	2
	EB	116 Street & Belgravia Road			-	4			0	4
	EB	116 Street & 68 Avenue			-	-			0	0
	EB	South Campus Ft Edmonton Station			47	72			47	72
	EB	113 Street& 65 Avenue			2	43			2	43
	EB	114 Street & 71/72 Ave	3	3	-	1			3	4
	EB	114 Street & 76 Avenue	-	54	0	3			0	57
	EB	114 Street & 82 Avenue/University Dr	0	1	1	0			1	1
	EB	114 Street & 83 Avenue			0	28			0	28
	EB	114 Street & 85 Avenue			-	33			0	33
	EB	University Station			252	6	167	-	419	6
	EB	112 Street & 87 Avenue			0	31	0	17	0	48
	EB	112 Street & 84 Avenue			0	17	-	13	0	30
	EB	112 Street & 82 Avenue/Whyte Ave	129	10	0	1	0	4	129	15
	EB	109 Street & 82 Avenue/Whyte Ave	20	25	-	34	1	26	21	85
	EB	106 Street & 82 Avenue/Whyte Ave			10	46	6	34	16	80
	EB	104 Street & 82 Avenue/Whyte Ave	85	146	2	10	2	7	89	163
PM Peak	**EB Total**		**265**	**240**	**315**	**330**	**176**	**101**	**756**	**671**
PM Peak	WB	104 Street & 82 Avenue/Whyte Ave	33	2	13	6	8	4	54	12
	WB	106 Street & 82 Avenue/Whyte Ave			15	17	9	9	24	26
	WB	109 Street & 82 Avenue/Whyte Ave	17	8	8	3	4	2	29	13
	WB	111 Street & 82 Avenue/Whyte Ave		12	-	11	-	6	0	29
	WB	112 Street & 82 Avenue/Whyte Ave			-	22	-	5	0	27
	WB	112 Street & 84 Avenue			-	30			0	30
	WB	112 Street & 87 Avenue			-	44			0	44
	WB	University Station			133	10	-	5	133	15
	WB	114 Street & 85 Avenue			-	10	-	13	0	23
	WB	114 Street & 83 Avenue			1	0			1	0
	WB	114 Street & 82 Avenue/University Dr	-	1	-	-			0	1
	WB	114 Street & 76 Avenue	3	21	-	0			3	21
	WB	114 Street & 71/72 Ave		1	-	-			0	1
	WB	113 Street & 65 Avenue			4	8			4	8
	WB	113 Street & 65 Avenue			2	26			2	26
	WB	South Campus Ft Edmonton Station			100	9			100	9
	WB	Belgravia Road & Fox Drive	67	2					67	2
	WB	Fort Edmonton Park Road & Fox Drive	1	5	4	0			5	5
PM Peak	**WB Total**		**121**	**52**	**280**	**196**	**21**	**44**	**422**	**292**

EB	Subtotal - Fox Drive/114 Street/U of A	31	59	303	239	167	30	**501**	**328**
	Subtotal - Whyte Avenue (82)	234	181	12	91	9	71	**255**	**343**
								756	671

WB	Subtotal - Whyte Avenue (82)	50	22	36	59	21	26	**107**	**107**
	Subtotal - Fox Drive/114 Street/U of A	71	30	244	137	-	18	**315**	**185**
								422	292

B2 operates from West Edmonton Mall Station to Bonnie Doon Station
ETS #4 operates Lewis Farms to Capilano; ETS #8 operates University to Abbotsfield

Appendix B – Previous Mass Transit Study Reports

Mass Transit Backgrounder

https://www.edmonton.ca/city_government/documents/PDF/CityPlan_MassTransitBackgrounder.pdf

City Plan Mass Transit Scenario Analysis

https://www.edmonton.ca/city_government/documents/PDF/CityPlan-MassTransit_ScenarioAnalysis.pdf

Mass Transit Strategy

https://www.edmonton.ca/city_government/documents/PDF/CityPlan_Edmonton_Mass_Transit_Strategy.pdf