steer davies gleave

Transport Collectif sur l'axe A10/centre-ville de Montréal

Report
December 2015

CDPQ Infra

Our ref: 22876101
Client ref:

331 **DA17**

Projet de réseau électrique métropolitain de transport collectif

6211-14-009

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1 Introduction

Background

1.1 Steer Davies Gleave was appointed by CDPQ infrastructure to develop preliminary demand forecasts for the new LRT on the A10/Downtown Montreal corridor. The main objective of this study is to inform the initial dimensioning of the transit system in order to proceed with the technical engineering work.

1.2 The assignment encompassed 2 objectives:

- Review, analyse and assess previous studies; and
- Develop preliminary forecasts

1.3 The development of preliminary forecasts has been carried out based on information that has been produced by third parties and that Steer Davies Gleave has not been able to validate extensively at this first stage (e.g. transit and auto travel times, access times, average tariffs, etc.). These items would need to be assessed in detail in the development of investment-grade forecasts.

Report Structure

1.4 Following this introductory section the report includes:

- Chapter 2 covers the review of the previous analysis
- Chapter 3 includes the description of the existing demand and the key market segments in the corridor
- Chapter 4 summarizes the different growth assumptions in the corridor
- Chapter 5 describes the LRT service and its competitiveness with the other modes; integration with the feeder buses and auto traffic impacts
- Chapter 6 describes the methodology adopted to estimate the capture of the LRT from transit and car, and the key assumptions that have been adopted
- Chapter 7 defines the hypothesis adopted to develop the dimensioning base case and the preliminary forecasts, including station boardings for the AM peak period, maximum load section in AM peak period, daily demand and annual demand and sensitivity analsysis
- Chapter 8 describes the main conclusions of the study and the next steps for the next phase.

2 Review of Previous Studies

Introduction

2.1 In the last few years, numerous studies have been carried out about the feasibility of the LRT in the A10/Downtown Montreal corridor. Our first objective was to review these studies and apply this previous work and analysis to the development of preliminary demand forecasts for the dimensioning phase.

2.2 CDPQ Infra provided Steer Davies Gleave with an extensive list of documents, including some of the most recent and studies that have been carried out since June 2012 (last one dated September 2015).The documents included:

- Mise à jour des ètudes d'achalandage en transport collectif dans le corridor A-10 / Centre-Ville: Étude des besoins, AMT, June 2012
- Études préparatoires d'un système de transport collectif pour le corridor A10/Centre-ville de Montréal, AECOM, March 2013
- Système de transport collectif dans l'axe A10/Montréal: Étude des besoins, CIMA+, June 2013
- Projet de SLR dans le corridor A-10/Centre Ville: Validation de l'ordre de grandeur d'achalandage, AMT, December 2013
- Projet de SLR dans le corridor A-10/Centre Ville: Activité 3.2 Intrants pour l'analyse multidomaines, AMT, June 2014
- Projet de SLR dans le corridor A-10/Centre Ville: Études Transport Comité Directeur, AMT, October 2014
- Projet de SLR dans le corridor A-10/Centre Ville: Note Technique 3.3 - Révision des besoins aux stations, AMT, October 2014
- Projet de SLR dans le corridor A-10/Centre Ville: Rapport Synthèse -Validation de l'ordre de grandeur d'achalandage, AMT, December 2014
- Projet de SLR dans le corridor A-10/Centre Ville: Note Technique - Appréciation de l'impact potential du péage sur les réseaux de transport, AMT, December 2014
- Système léger sur rail (SLR) entre la Rive-Sud et le centre-ville de Montréal: Études pour préparer le DO, STM, March 2015
- Système de transport collectif dans l'axe A10/Montréal: Étude des besoins, AMT, April 2015
- Système de transport collectif dans l'axe A10/Montréal: Étude des besoins, AMT, June 2015
- Projet de SLR dans le corridor A-10/Centre Ville: Analyse des options de système TC performant, AMT, August 215
- Système de transport collectif dans l'axe A10/Montréal: Avant-projet préliminaire –métro léger, AMT, September 2015

2.3 Steer Davies Gleave has reviewed these studies, focusing mainly on the key assumptions and methodology:

- Demand data sources (bus ridership, boarding/alighting, OD matrices, etc)
- Ad-hoc surveys and key results (Revealed preferences, Stated Preferences)
- Methodology and Modelling tools
- Main assumptions on:
  - Transit Network restructuring
  - Tariff assumptions
  - Development growth in the corridor- Transit Oriented Development
- Resulting Demand Forecasts

2.4 In this section of the report we include a summary of our assessment and views on; the quality of the data sources (AMT sources and ad hoc market research), the methodology and tools used, the main assumptions and the ridership forecasts.

General approach

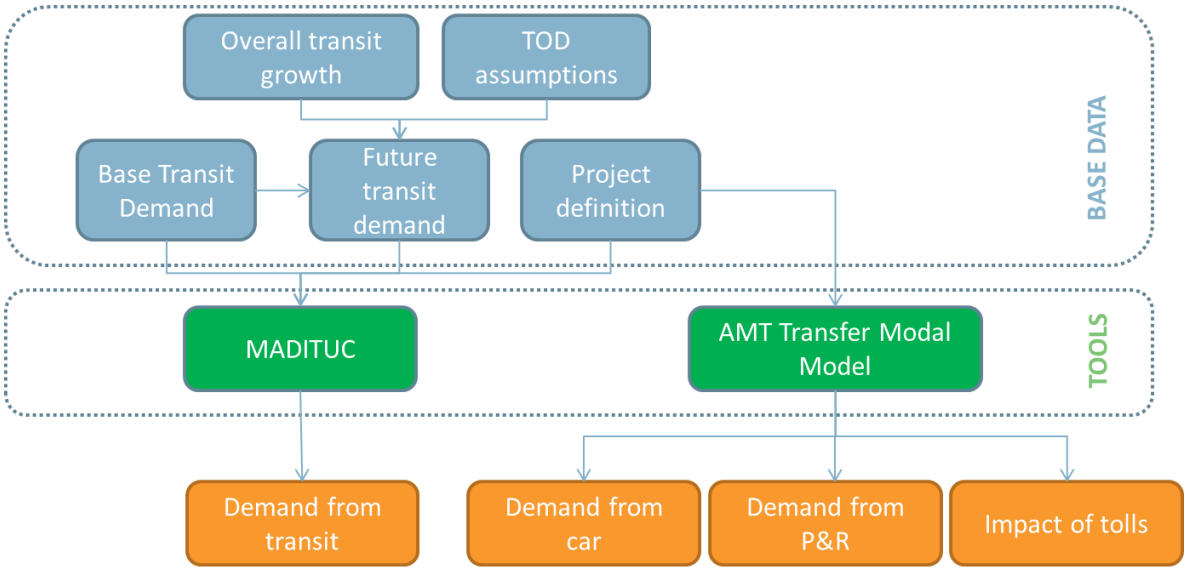
2.5 The previous studies present very different ridership forecasts. However, they adopt a very similar methodology and the differences are due to different assumptions on the way the forecasts are presented (they use different forecast years, some include unidirectional /bidirectional demand, etc)

2.6 The methodology adopted, common to all studies, includes the following steps:

- Definition of Base assumptions related to:
  - Transit Demand
    - Existing demand
    - Future demand: based expected transit growth and Transit Oriented Development (TOD) scenarios
  - LRT competitiveness compared to alternative modes:
    - LRT service characteristics
    - Existing Bus network restructuring
    - Road travel costs: especially related to tolling the bridge
- LRT capture modelling:
  - Capture from transit: using Madituc model
  - Capture from Car: using an AMT transfer model.

2.7 The methodology is summarised in Figure 1 and detailed further in the next chapters.

Figure 1: AMT Project Methodology



Base Assumptions

2.8 Although all studies generally adopt a similar methodology, the ridership outcomes vary substantially depending on the assumptions adopted. These are described below.

Demand data

2.9 Current and future demand in the area of influence is what determines the "potential market" for the LRT, and therefore it is critical for estimating LRT ridership forecast. It is important to establish, not only the existing demand, but also the expected growth in the corridor.

- ***Base demand***
  - All studies use the 2008 OD survey data as their base source for characterizing existing demand. Their analysis in mainly focused on the AM peak period (6am-9am).
  - A new 2013 OD Survey has recently been made available. A comparison carried out by AMT between bus demand counts and the 2013 OD survey suggests that the latter overestimates demand on transit services over the bridge by 10%. However, the counts were carried out only during one day, and therefore the sample may not be considered to be representative.
- ***Background Demand Growth***
  - Background demand growth in most studies has been based on Ministère des Transports du Québec (MTQ) growth forecasts (described in chapter 4). These forecasts assume the following growth:
    - Until 2031: 0.75% per annum
    - 2031-2061: 0.3% per annum

- ***Transit-Oriented Development (TOD)***
    - Some of the studies have assumed that transit growth in the corridor will be greater than forecasted by MTQ, based on the assumption that the LRT will be a catalyst for new development in the corridor. The TOD growth assumptions have ranged between 3 and 19% of total demand, and has one of the key differentials for the different ridership forecasts across the studies

Project definition

2.10 The definition of the project is what determines the competitiveness of the LRT compared with the competing modes (either transit or car), and therefore the likely capture of demand. It is critical to define accurately not only the characteristics of the LRT service, but also the competing modes, especially related to the transit alternatives and potential competition

- ***LRT service***
    - The studies include various assumptions regarding LRT travel times, alignment, station locations and park and ride facilities. However these are typically minor variations that do not have any major impact on the overall LRT demand.
    - All studies assume that the LRT will be fully integrated in the tariff system, and LRT tariff will be the same as the Metro.
- ***Transit network restructuring***
    - All studies assumed a comprehensive transit network restructuring with the elimination of bus routes on the Champlain Bridge and converting the routes to feeder routes into the various LRT stations in the South Shore- This is a critical assumption
- ***Road network***
    - Most studies assume no toll on the Champlain Bridge.
    - Only the AECOM study (March 2013) tested sensitivities to tolls, and these same results have been used for all the other studies.

Methodology- demand capture tools

Transit Capture

2.11 LRT capture from transit has been estimated for the AM peak period (6-9am) using the MADITUC model. This is an assignment model that distributes transit demand between different transit modes based on their competitiveness (travel times and cost).

2.12 However, MADITUC doesn't assume any loss or gain of demand to other modes, as a result of changes in travel times or fares of transit compared to car travel.

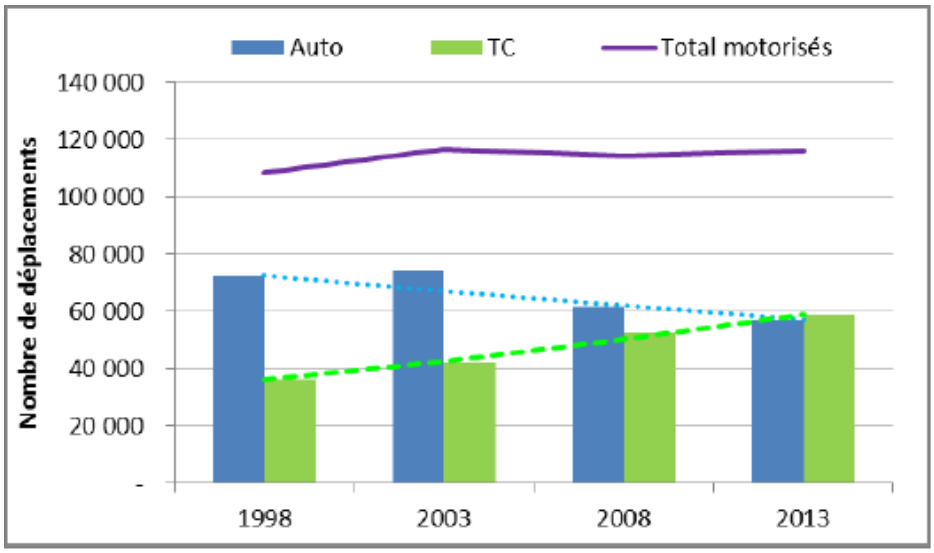
2.13 Since all studies assume that bus services will be eliminated on the bridge and the LRT will have the same tariff and a clear competitive advantage over alternate transit modes, the model estimates that almost 100% of total existing transit demand in the corridor will be captured by the LRT. As a result, the demand is not very sensitive to changes in alignment, travel times or frequencies.

2.14 For this type of projects, mode share surveys (SP) are typically carried out to test user preference to LRT compared to other modes (in this case to bus and car). This has not been carried out in any of the previous studies. However, it would be very important to assess especially if LRT fares are increased over existing transit fares.

Car Capture

2.15 Half of the trips towards Montreal from the Rive Sud are currently using transit. As shown in Figure 2, transit market has increased considerably over the last 15 years.

Figure 2: A10 Daily Corridor Trips by Car and Transit



Source: Projet de SLR dans le corridor A-10/Centre Ville: Analyse des options de système TC performant, AMT, August 215

2.16 The AECOM study (2013) developed a car shift model. However no detail has been made available on the car capture methodology or assumptions and therefore Steer Davies Gleave is not able at this stage to provide an opinion on these assumptions. According to this study:

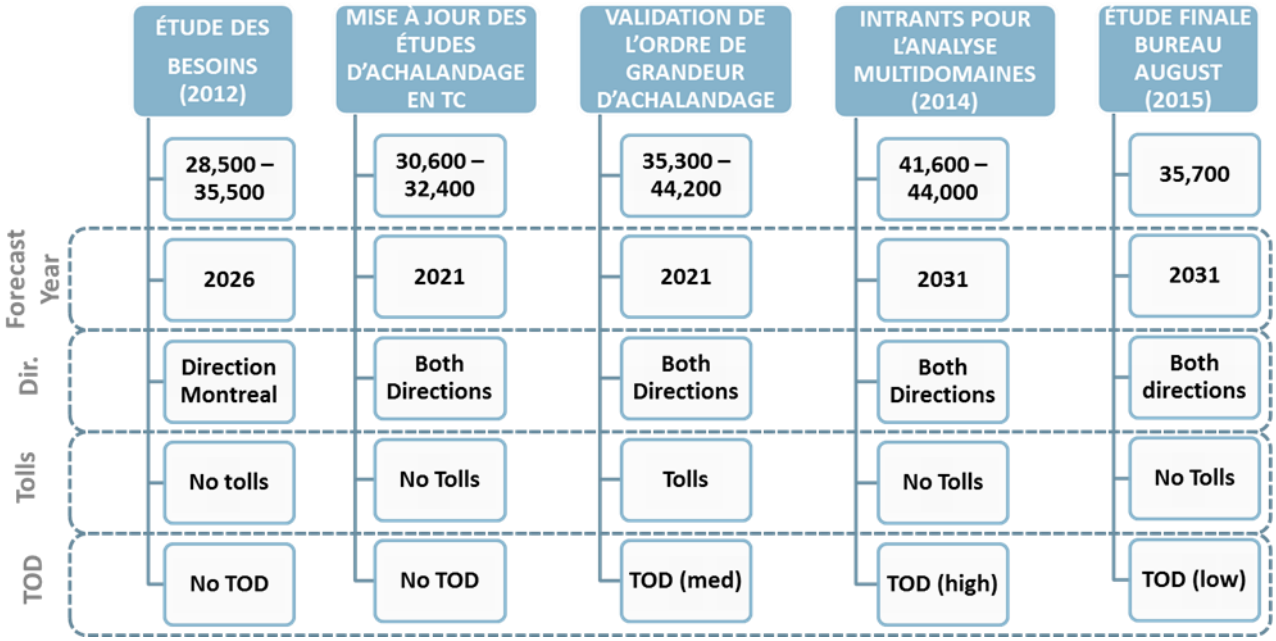
- The improvement in transit travel time as a result of the LRT would result on a mode shift of 1,000-2,000 trips.
- The impact of tolls in the Bridge was estimated to be between 2,200 to 5,400 additional passengers (approximately 10% to 20% demand increase).
- Additional P&R facilities would result in additional 700-1,300 trips.

2.17 This was the only study that has analysed mode shift, and these results have been carried over to the rest of the studies.

Demand Forecasts

2.18 Figure 3 presents a summary of the various demand forecasts developed and the assumptions behind each forecast.

Figure 3: Previous Studies – Demand Forecast Summary



2.19 The key differences are related to:

- Different results being presented:
  - Different forecast year (2021, 2026 or 2031)
  - Different aggregation: ridership in Montreal direction vs both directions
- Different assumptions
  - Especially related to the TOD impact on demand growth, forecast range from 3% to 20% of total demand

3 Existing Demand

Background

3.1 Estimating accurately existing demand is critical, since this information provides the basis for the LRT forecasts. Steer Davies Gleave has reviewed the following sources:

- **2008 and 2013 OD surveys**: trips between each origin and destination classified by:
  - Periods: AM peak and daily.
  - Modes: transit and car demand.
- **2013 Transit Passenger counts** in downtown terminal (one weekday in October 2013) classified by:
  - Periods: AM and PM peak.
  - Boardings and alightings by station.
- **Annual demand** on bus routes crossing St-Lawrence bridges by transit provider (AMT, RTL and CITs)

Existing Service and Demand

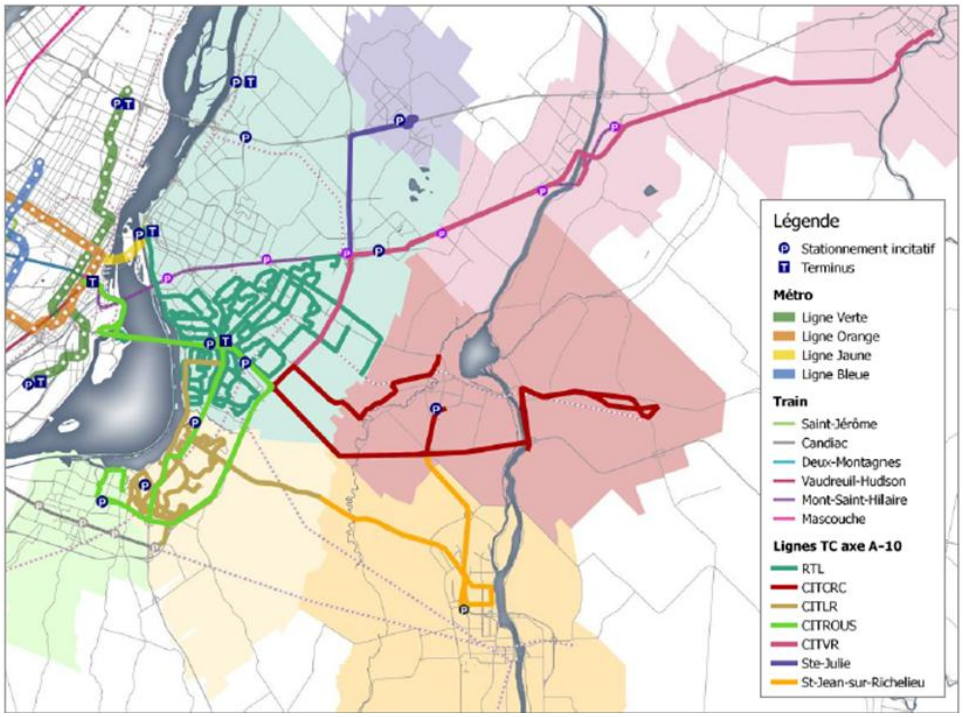
3.2 The existing demand in the corridor is comprised of two very different markets:

- Demand between Rive-Sud and Montreal; and
- Demand internal to Montreal

Demand between Rive-Sud and Montreal

3.3 This demand is served by 48 bus routes with a joint frequency of approximately 200 services in the AM peak hour. Most of these services (27 routes) and 57% of demand are RTL routes.

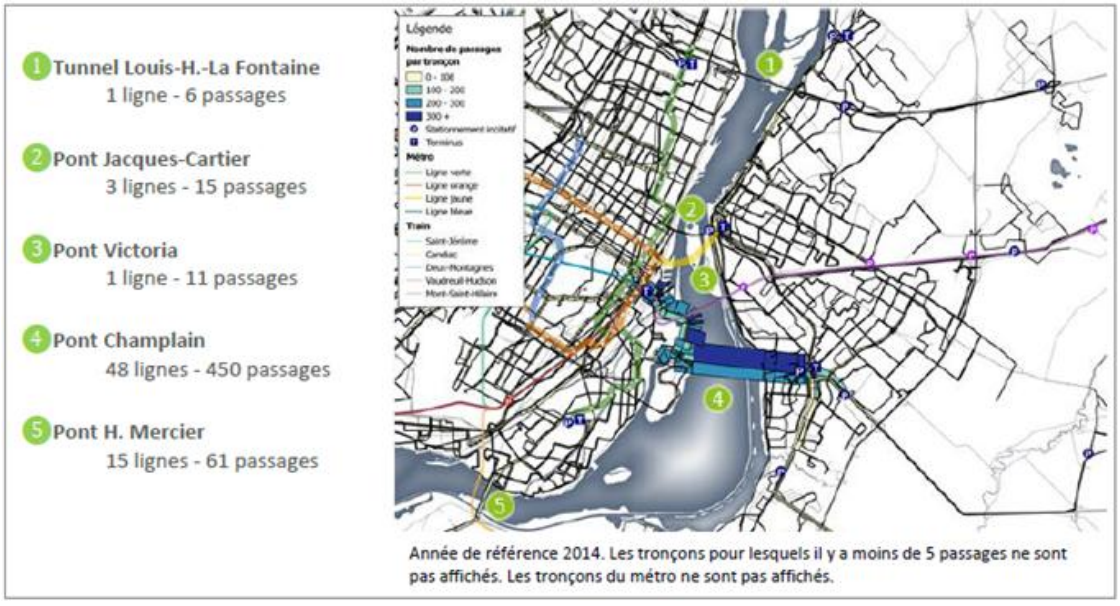
Figure 4: Current Transit Network (Rive-Sud)



Source: AMT

3.4 Although the A10 is the key transit corridor, there are other options to access Montreal island, which could be an attractive alternative depending on the origin of the trip.

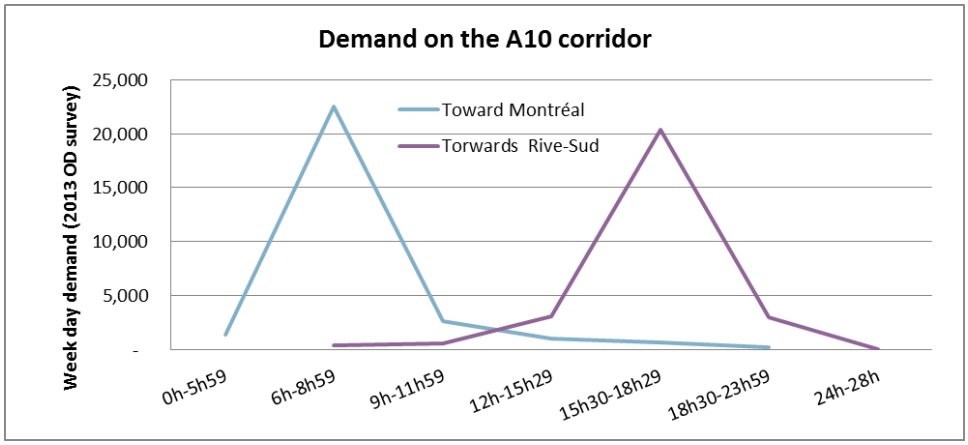
Figure 5: Alternative Options to A10 Corridor



Source: AMT

3.5 The A10 is a high demand corridor with an average weekday ridership of 54,700 trips with approximately 22,500 in the AM peak (6-9 AM) towards Montreal. Figure 6 shows that most of the demand seems to be work/commuter related, with 79% of the trips originating in Rive Sud heading to Montreal between 6am and 9am.

Figure 6: A10 Corridor Demand (2013)



Source: 2013 OD Survey ("REP2_A10_jour")

3.6 Figure 7 shows the AM peak hour towards Montreal is 7:30-8:30am accounting for 43% of total am period demand. The 15 minute peak is between 8:00 and 8:15 AM registering around 12% of the total peak period ridership (se Figure 8).

Figure 7: Peak Period Demand Distribution- 30 Minutes

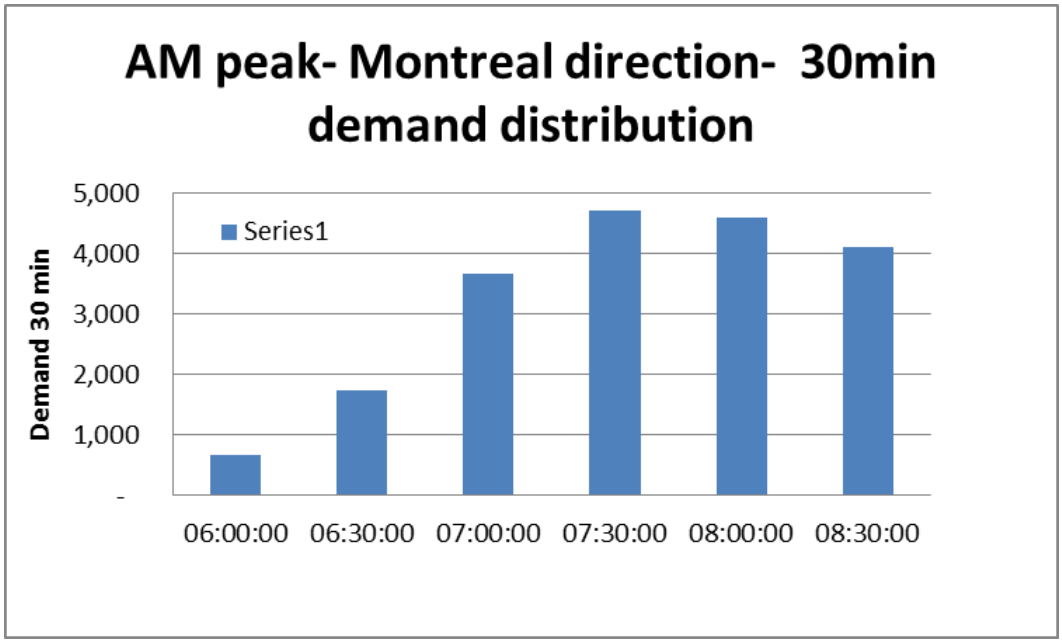
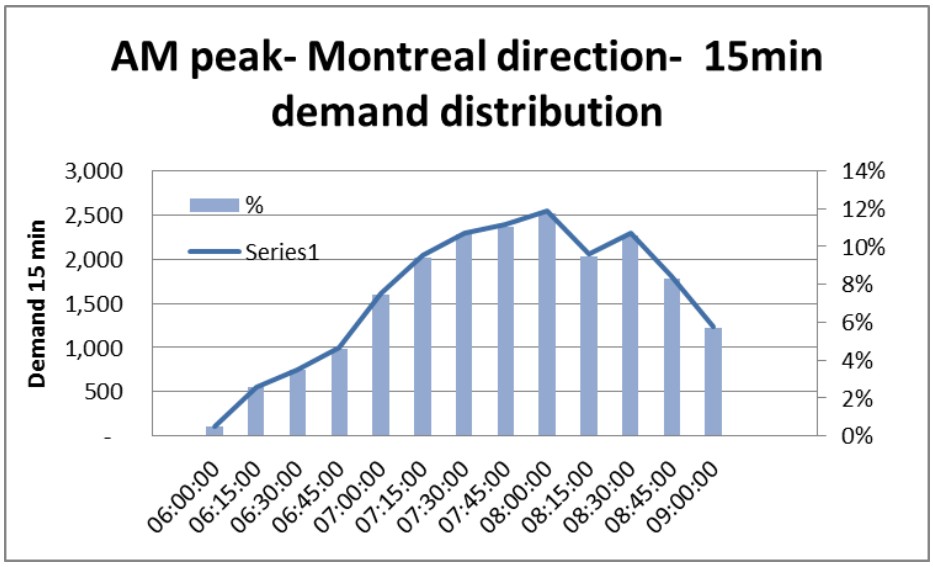


Figure 8: AM Peak Period Demand Distribution



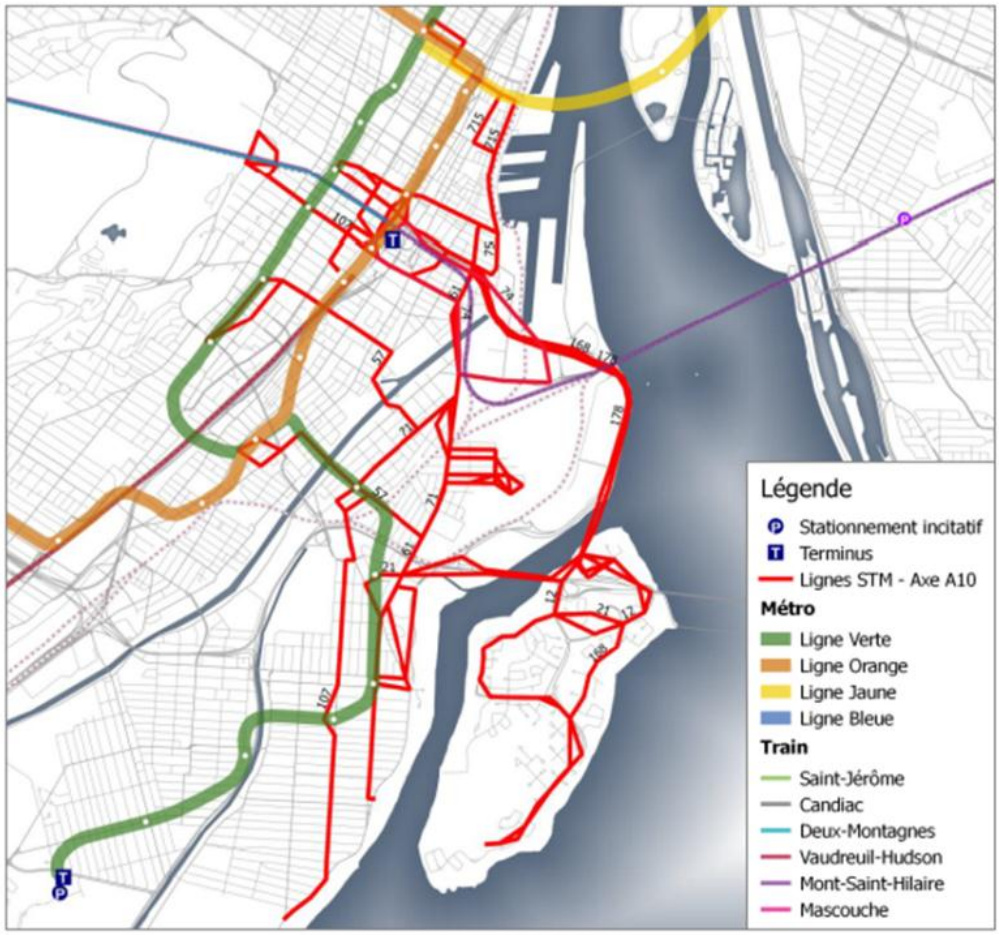
Source: 2013 OD Survey ("REP1_Releve- TCV_TauxOcc.xls")

Montreal Internal Trips

3.7 The A10 corridor also provides service to the demand between the Île-des-Sœurs, Saint-Patrick, Griffintown and Montreal. This market is currently mainly served by the STM bus network:

- Lines 168 and 178 connect Île-des-Sœurs with downtown Montreal through the Bonaventure corridor, and
- The rest of the STM bus network and the Metro orange and green lines provide service to the rest of the area

Figure 9: STM Bus Network (Montreal Island)



Source: AMT

3.8 The demand and service information provided by AMT for this market has not been as extensive as for the Rive Sud market. For 2031 it has been estimated based on the 2031 BAU scenario.

Existing Demand Summary

3.9 Based on the 2013 OD survey data and the data provided by AMT, Table 1 shows the existing demand has been estimated in the corridor.

Table 1: Corridor Demand Estimates (2013)

Current Ridership	Bus Network (Champlain Bridge)*	Transit Network (STM)**
Rive Sud Users	**22,501**	**-**
Montreal Direction	22,501	-
Rive Sud Direction	-	-
Montreal Users	**400**	**7,527**
Montreal Direction	-	6,037
Rive Sud Direction	400	1,490
Total	**22,901**	**7,527**
Montreal Direction	22,501	6,037
Rive Sud Direction	400	1,490

** Note: Based on EOD 2013 (validée)- Source AMT (REP2_A10_jour)*

*** Note: 2013 demand has not be provided for 2013- it has been estimated based on AMT forecasts for 2031 BAU scenario, discounting AMT estimated growth.*

3.10 Comparison between 2013 OD surveys and bus demand counts carried out by AMT suggest that the surveys might be overestimating 10% of demand over the bridge. However, it is worth noting that passenger counts were only carried out during one day, and therefore the sample is likely not to be representative.

3.11 Therefore, for the dimensioning base case, we have adopted the 2013 OD survey data as the reference data for existing demand.

4 Demand Growth

Background

4.1 Future transit demand in the corridor will depend on the following factors:

- **Background demand growth in the corridor** as a result of economic, population and employment growth in the area; and
- **Transit market share growth**: as a result of the competitiveness of the transit system compared to the auto. This is highly dependent on road congestion and pricing, as well as improvement on the transit network.

4.2 In order to assess the background demand growth, Steer Davies Gleave has analysed:

- Historic transit growth in the study area, and
- Growth forecasts produced by MTQ and AMT.

Historical Transit Growth and Trends

Historical growth

4.3 Steer Davies Gleave has analysed how transit demand has grown in the last decade (2002-2012), based on historical ridership in the A10 corridor provided by AMT. Table 2 shows the demand growth for each of the service providers in the A10 corridor.

Table 2: A10 Corridor Historical Transit Demand (Annual)

	AMT	RTL	VILLE DE STE-JULIE	CITVR	CITCRC	CIT LE RICHELAIN	CIT ROUSSILLON	CITHSL	CITSO	VILLE DE ST-JEAN-SUR-RICH.	TOTAL
2002	484,403	5,947,826	116,025	340,105	423,257	674,877	393,582	85,846	232,903	748,033	8,643,706
2003	524,331	6,174,935	176,606	77,174	459,174	687,600	385,621	98,823	277,725	841,169	8,802,279
2004	593,062	6,224,758	172,998	67,960	550,281	753,206	185,019	116,605	340,106	912,755	8,866,977
2005	593,062	6,224,758	172,998	67,960	550,281	753,206	185,019	116,605	340,106	912,755	8,866,977
2006	916,148	6,139,549	204,059	70,122	567,481	776,123	376,358	128,473	398,253	880,940	9,014,633
2007	1,122,160	6,345,889	227,607	86,713	648,065	803,367	432,361	145,004	416,830	907,039	9,451,041
2008	1,195,941	6,480,234	256,849	72,324	676,836	823,849	460,163	134,478	436,991	872,346	9,642,601
2009	1,260,126	6,381,705	266,713	78,007	658,508	796,242	470,628	150,486	427,319	849,322	9,501,125
2010	1,449,774	6,462,624	271,631	104,343	703,337	844,584	496,450	157,437	459,811	916,144	9,799,113
2011	1,559,593	6,376,363	277,884	75,887	745,051	931,249	524,036	158,938	484,683	978,434	9,908,904
2012	1,675,488	6,325,821	319,382	74,132	821,812	988,197	553,906	155,866	551,512	1,007,788	10,091,038

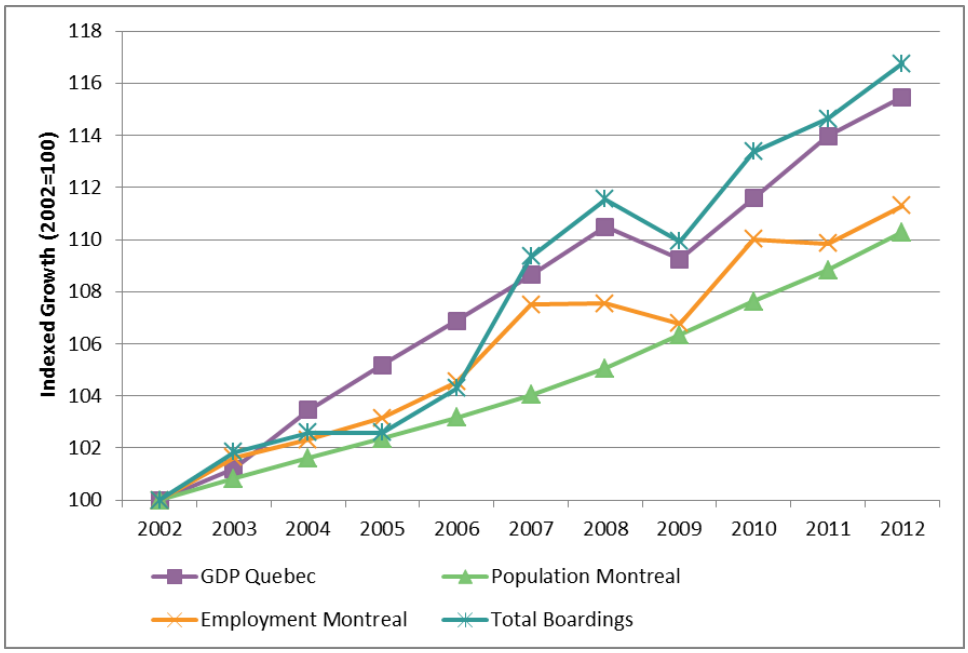
Source: AMT

4.4 Historical boardings were compared to the socioeconomic growth in the region. However, some of the data above was excluded from the analysis for the following reasons:

- CITHSL and CITSO: the majority of their services use the Honoré-Mercier Bridge rather than the Champlain Bridge.
- AMT boardings: This includes primarily the Chevrier Express (route 90), where very large ridership growth was observed from 2005 to 2006 as a result of a significant improvement on service (almost doubling of ridership). Since the purpose of this analysis is to develop a long term econometric analysis these changes in service provision would distort the results.

4.5 Figure 10 shows how ridership and econometric variables are highly correlated (including the economic downturn of 2008-2009 resulted in a matching decline in total boardings).

Figure 10: Boardings and Socioeconomic Parameters Growth



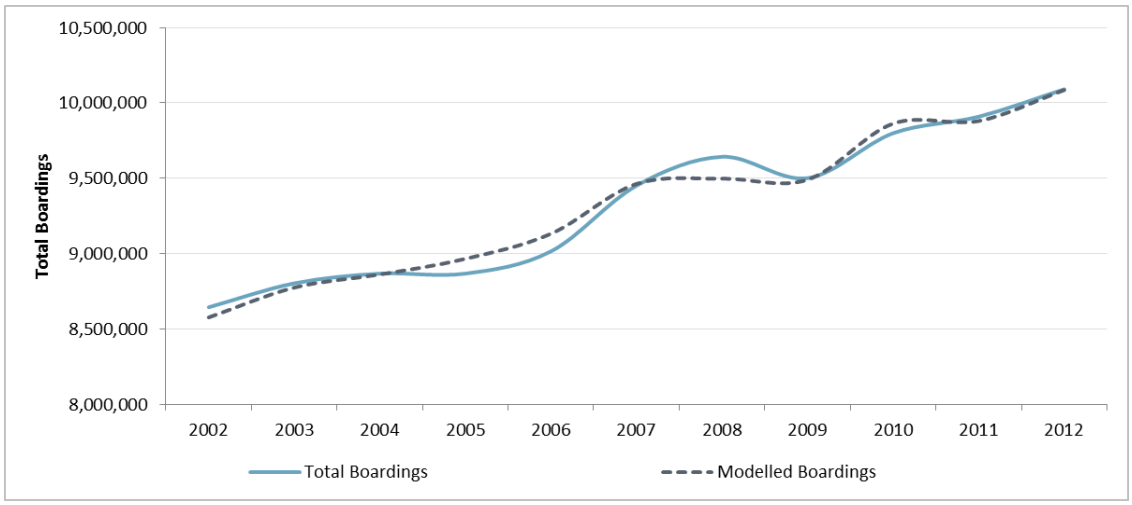
Source: AMT and Statistics Canada

Growth Model

4.6 Based on the relationship observed between boardings and socioeconomic indicators, a simple regression model has been developed. In order to select the best indicators of transit ridership, a series statistical analyses have been undertaken, which suggest that the Quebec GDP, population and employment of Montreal have the highest explanatory power in forecasting ridership.

4.7 The R^2 of the modelled versus observed ridership based on these parameters was estimated to be 0.98, which indicates a close correlation of these parameters to transit demand. Figure 11 shows the comparison of observed and modelled boardings for reference.

Figure 11: Growth Model Calibration



Source: Steer Davies Gleave and Statistics Canada

Future Growth

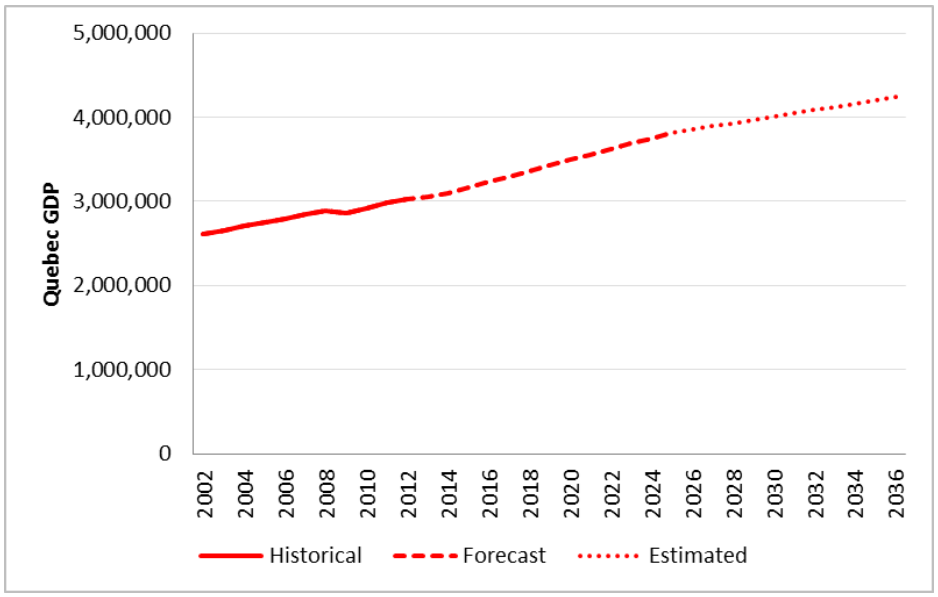
4.8 Steer Davies Gleave developed a transit trend scenario using forecast information for the various variables, which was collected from different sources and summarized in Table 3. The specific assumptions for each variable are presented in Figure 12 to Figure 14.

Table 3: Socioeconomic Variables and Forecasts

Annual Growth	2017	2018	2019	2020	2021	From 2022	From 2027	From 2031
GDP	1.8%	1.9%	2.0%	2.0%	1.9%	1.8%	1.0%	1.0%
Population	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%	0.7%	0.6%
Employment	1.5%	1.3%	1.2%	1.2%	1.2%	1.1%	0.9%	0.8%

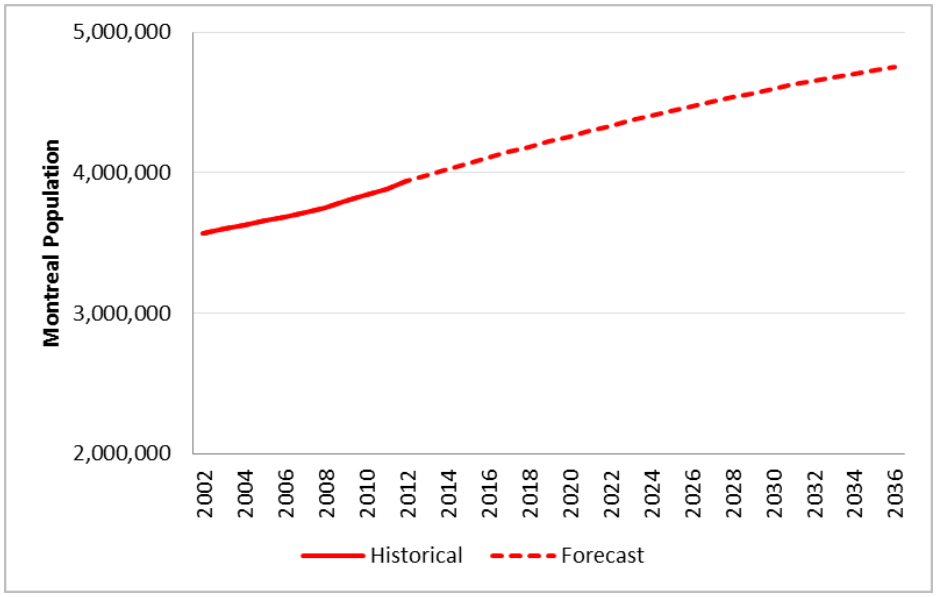
Sources:
Quebec GDP: Moody's
Montreal population: Institute de la Statistique du Quebec (Référence)
Montreal employment: Conference Board of Canada

Figure 12: Quebec GDP



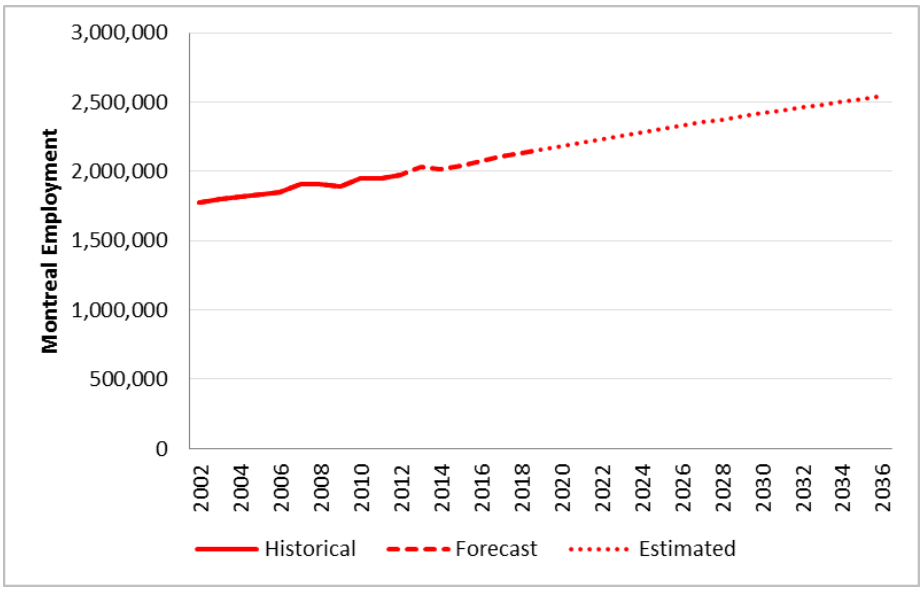
Source: Statistics Canada (Historical), Moody's (Forecast) and Steer Davies Gleave (Estimated)

Figure 13: Montreal Population



Source: Statistics Canada (Historical), Institute de la Statistique du Quebec (Forecast)

Figure 14: Montreal Employment



Source: Statistics Canada (Historical), Conference Board of Canada (Forecast) and Steer Davies Gleave (Estimated)

4.9 The application of those input parameters results in the ridership growth shown in Table 4:

Table 4: Champlain Bridge Transit Ridership Growth

	2013-2021	2021-2031	From 2031
Annual growth	1.5%	1.3%	1.0%

Other growth assumptions

MTQ Assumptions

4.10 MTQ develops transit and car demand growth forecasts, which incorporate population projections taking into account the observed growth trends on the OD surveys. The overall population growth is aligned regionally with the ISQ (Institute de la Statistique du Quebec) but is applied to each zone based on urban development trends. MTQ forecasts also reflect trends on car ownership, transit and active mode market share, etc.

4.11 The estimated forecasts for the corridor were as follows:

- Until 2031: 0.75%
- 2031-2061: 0.3%

TOD Assumptions

4.12 The MTQ growth is based on urban development trends, however, they do not take into account the potential intensification along the corridor as a result of the implementation of the LRT system.

4.13 In order to assess the potential growth as a result of intensification, AMT appointed two companies to develop urban studies; one in 2013 and another more recently in 2015. This

latest study assumed that regional growth will be slightly redistributed to focus in specific areas along the corridor.

4.14 As a result, the estimated annual transit growth was increased to 1.2% p.a. between 2008 and 2031.

Conclusions on growth assumptions

4.15 Growth assumptions developed by MTQ seem to be very conservative compared to the observed ridership growth in the corridor over the last decade.

4.16 AMT growth assumptions, take into account some TOD growth, and it is more in line with the growth trends observed in the past.

4.17 It is worth noting that transit market share has grown considerably over the last decade and a slowdown might be possible. However, for the dimensioning base case we have adopted the observed transit trends as reference growth.

5 Definition of the Project

5.1 In order to assess LRT ridership, it is critical to define accurately the “base” characteristics of the project, since this will determine the competitiveness of the LRT compared to other modes.

5.2 The definition of the project includes not only the LRT characteristics, but also those of competing modes; other transit and road.

LRT System

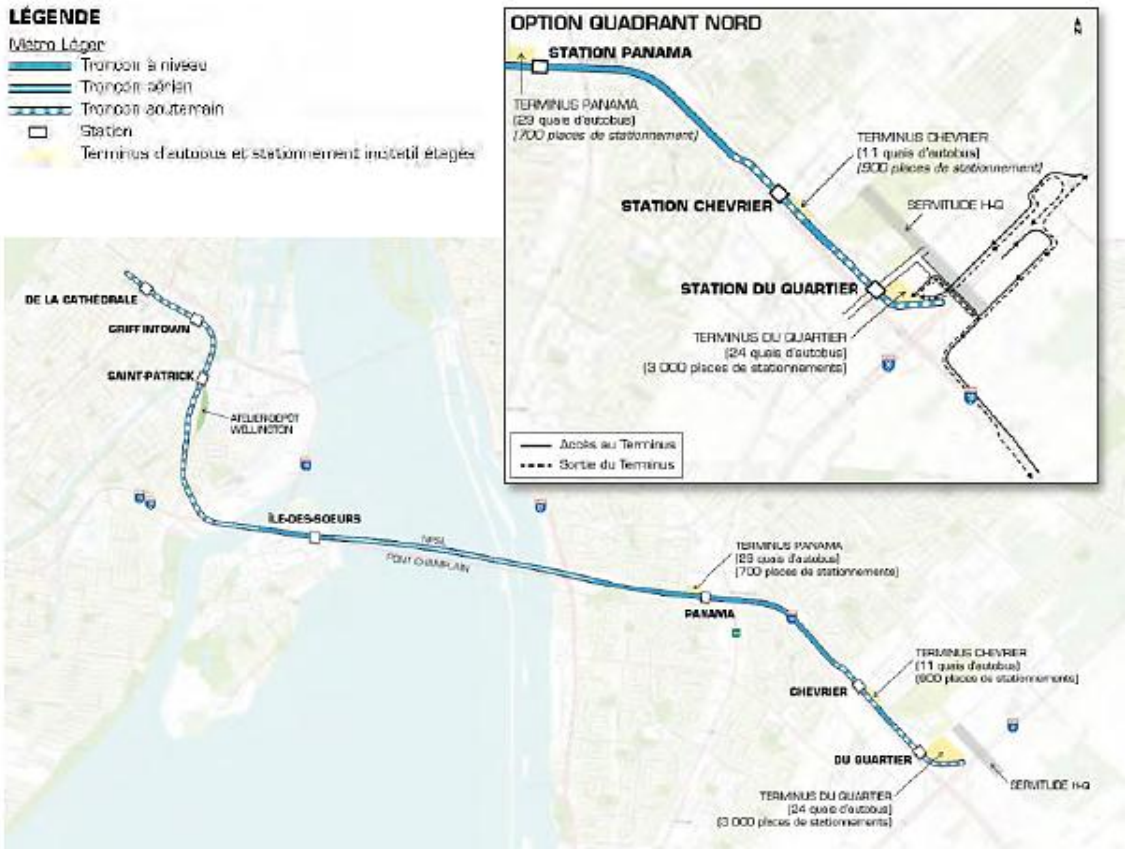
Alignment and Stations

5.3 The final alignment and station location has not been finalised. However, for the purpose of this study the following seven stations have been assumed (agreed with CDPQ infra):

- Montreal:
  - De la Cathédrale,
  - Griffintown, and
  - Saint-Patrick;
- Île-des-Sœurs; and
- Rive-Sud:
  - Panama,
  - Chevrier, and
  - Terminale.

5.4 The following figure shows the assumed alignment:

Figure 15: LRT Alignment



Travel Times

5.5 The travel times between each Origin and Destinatin have been provided by AMT based on the MADITUC model results at the Sector Municipaux (SM) level. Travel time for the whole line has been determined to be about **15 minutes**.

Frequencies

5.6 This study used an AM Peak (6am-9am) frequency of **2 min. 40 s.**

Integration with Metro Network

5.7 According to the AMT report, the LRT Montreal terminal (De la Cathédrale) will result in an additional **2.2 minutes** of walking time to reach the existing Metro interchange station (Bonaventure). This results in a total walk time of **4.2 minutes** for the transfer, which will have a negative impact to users with Metro transfers. At this stage, we haven't been able to assess this impact; it will be important to consider and analyse in next stages.

Bus Network Restructuring

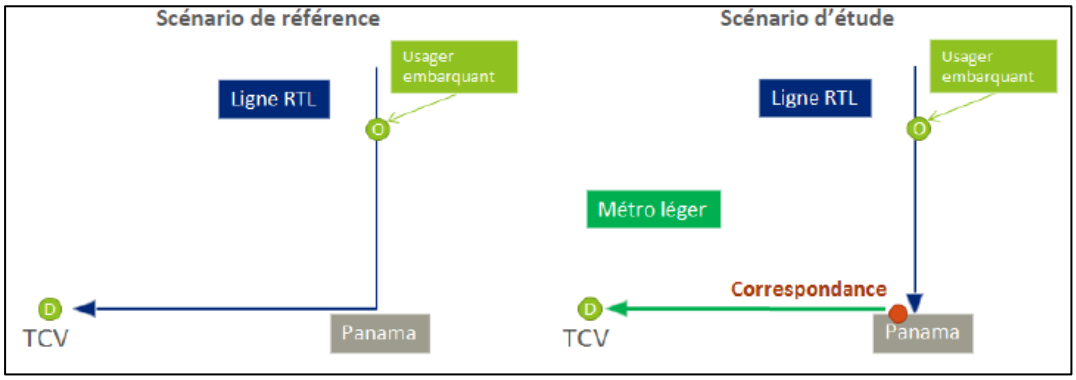
5.8 The AMT report states that the bus network will be restructured to feed demand into the LRT system. Bus routes will be organized to feed those LRT stations that are closer geographically or in terms of travel times. And bus feeder travel times and frequencies will be maintained unless it is justified by very low demand levels.

5.9 This restructuring will result in additional transfers, however, this negative impact is in most cases has been assumed to be offset by improved travel times.

Réseau de Transport de Longueil (RTL)

5.10 RTL users account for 57% of the total demand across the bridge. Most of the trips, currently go directly from their origin to Montreal. However, with the introduction of the LRT, they will have to transfer to an LRT station.

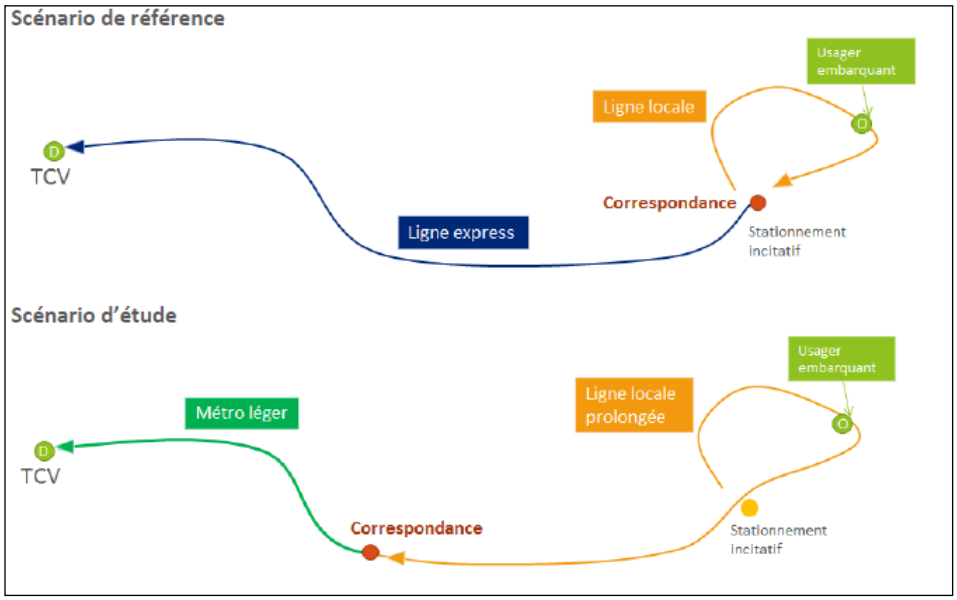
Figure 16: RTL Reconfiguration



CIT Roussillon, CIT Le Richelain, and CIT Chambly-Richelieu-Carignan

5.11 Most of these trips currently need to transfer to an express bus line. The bus restructuring will extend the existing lines to connect directly to an LRT station.

Figure 17: Reconfiguration for Certain CIT Bus Routes



CIT Vallée-de-Richelieu, City of Sainte-Julie, City of Saint-Jean-sur-Richelieu, and AMT (90 Chevrier Express)

5.12 These services will mostly maintain their existing transfer stations.

Société de Transport de Montréal (STM)

5.13 Some routes will be reorganized to interchange with the LRT system and some parallel routes will reduce their existing frequencies.

Road Network

Tolling

5.14 The new Champlain Bridge is expected to be toll-free with no charges to the users[1]. However, in the feasibility studies different assumptions were assessed where a toll was introduced as follows (for autos):

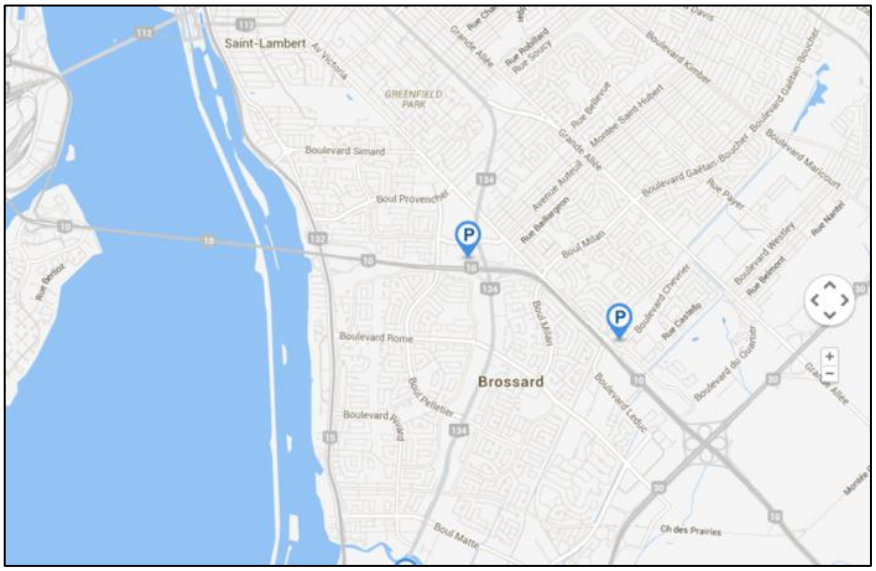
- flat fee of $2.00 ($2012); and a
- peak fee of $2.44 and a off-peak fee of $1.84.

5.15 The introduction of tolls will increase the cost of using the car and therefore will make the LRT more competitive, increasing its demand. Sensitivities have been carried out to test this impact.

Park and Ride

5.16 The current A10 corridor is served by two Park and Ride sites at Panama (962 parking spaces) and Chevrier (2,313 spaces) for a total of 3,275 spaces. According to AMT these are currently 100% utilized.

Figure 18: Current Park and Ride Locations



5.17 We understand that the latest plans are to increase total capacity to 4,600 spaces with 700 spaces at Panama, 900 spaces at Chevrier and 3,000 at the terminal (location to be confirmed).

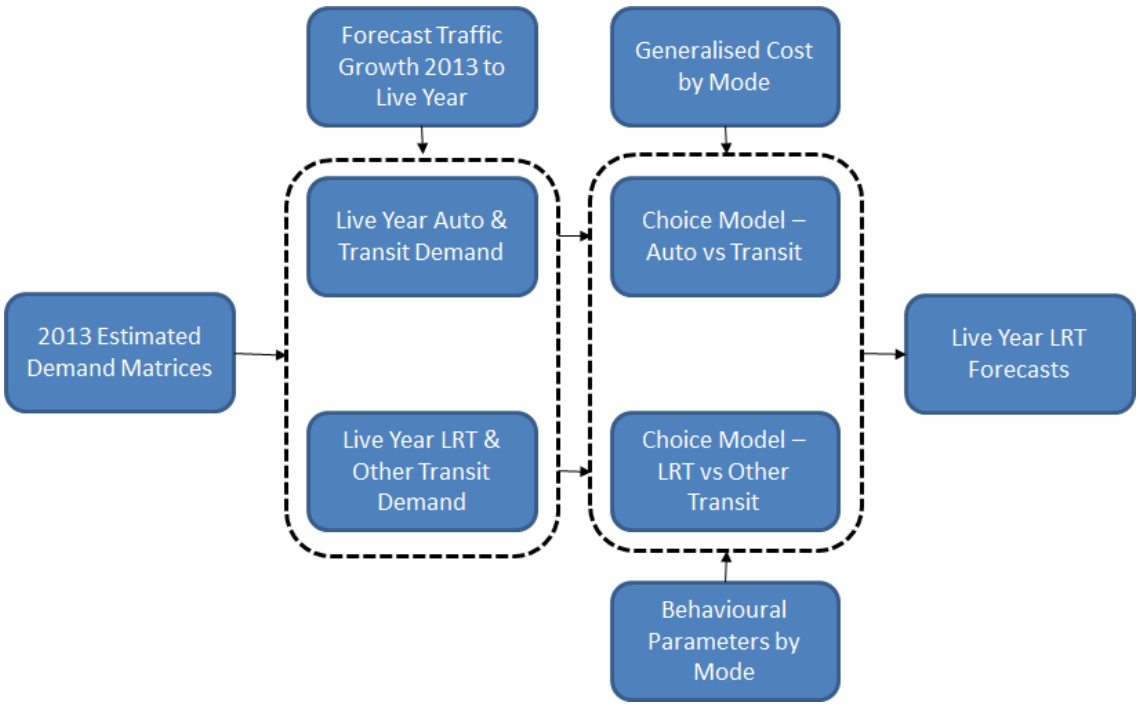
[1] Confirmed by December 2, 2015 announcement by Quebec Transport Minister Robert Poëti

6 Methodology

Overview

6.1 The figure below summarizes the modeling methodology used to estimate traffic on the LRT:

Figure 19: Overview of Model Methodology



6.2 Estimated 2013 demand matrices have been scaled to the year of analysis (live year) according to the forecast impacts on ridership of macroeconomic factors. The distribution of demand by origin-destination (OD) pair has been kept constant.

6.3 Calibrated choice models are then applied taking as inputs the new generalised costs of each mode for the base case scenario and key behavioural parameters affecting mode choice (for example value of time) to produce forecasts of LRT demand for the live year.

Choice Model

6.4 Discrete choice models are statistical formulations which attempt to assign a probabilistic value to the event of an individual choosing one alternative over another; in the case of transport, this relates the probability of an individual choosing one mode of transport over another.

6.5 The most common type of discrete choice model used to evaluate such cases, and that utilised within our Forecasting Model, is a discrete logit model. A discrete logit model works on the basis of the utility of the two options, or the overall 'Generalised Cost' of choosing each individual mode.

6.6 Cost here does not relate to strictly monetary cost. Instead it incorporates a wide array of journey attributes all of which combine to provide the overall Generalised Cost of the journey. Examples of such attributes include the relative journey time, wait time, number of interchanges required as well as the actual monetary cost.

6.7 Once a Generalised Cost has been constructed for each of the two alternative modes, the following formulation is used to calculate the relative probability of an individual choosing one mode over the other:

$$P_i = \frac{exp(\beta G_i)}{exp(\beta G_i) + exp(\beta G_j)}$$

Where:

P_i = The probability of an individual choosing to travel by mode *i*

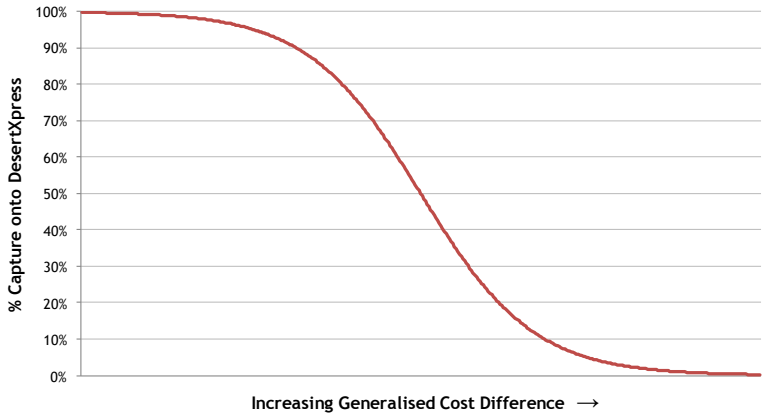
G_i = The Generalised Cost for an individual travelling by mode i

B = A scaling parameter

exp = The exponential function

6.8 What this function yields is an S-shaped curve as demonstrated in the figure below, whereby at an equal Generalised Cost between modes, 50% of demand will choose to travel on each. As the Generalised Cost for the first mode increases (i.e. this mode becomes a less attractive option to travel by), the proportion of demand travelling on each switches in favour of the second mode. The curve tails off however meaning further incremental increases in cost do not result in the same number of people switching away from the mode. In this way, the formulation accounts for the fact that even at a very high difference in Generalised Cost between modes, a small minority of demand is still likely to travel via the higher cost option.

Figure 20: Logit Curve Example



Source: Steer Davies Gleave

6.9 In our model, two separate discrete logit models are applied:

- Auto vs Transit; and
- LRT vs Other Transit.

Model Assumptions

Generalised Costs Calculation

6.10 The discrete logit model works on the basis of the utility of the different options, based on the overall 'Generalised Cost' of choosing each individual mode.

6.11 The generalised costs are calculated based on the estimated travel time and the cost of travel, which is translated in time using behavioural parameters (Value of Time). This chapter describes the assumptions adopted to estimate generalised time for each option

Road Generalised Costs

6.12 Car trip generalised costs are estimated based on the travel times and the operating costs.

- Travel Times
  - OD travel times have been provided by MTQ based on the Motrem model results at the Sector Municipaux (SM) level - see Appendix A.
- Fuel Costs
  - Average monthly fuel prices were obtained from Statistics Canada for the Montreal Census Metropolitan Area (CMA). The monthly data was converted to annual for the 2013 base year and estimated at $1.37/litre. This value has been kept constant (in real terms), since it has been assumed that potential increases in fuel would be offset by improved car efficiency.
- Vehicle Operating Costs (VOC)
  - VOC for the 2013 base year are available from the Canadian Auto Association's (CAA) annual driving cost survey. The VOC from CAA is split into fuel, maintenance, and tires. The fuel (gasoline) costs are based on a national average and this was increased by approximately 10% to account for Montreal's relatively higher gas prices. The average fuel cost was determined to be 11.7 ¢/km and the total average VOC (including maintenance and tires) was determined to be 17.0 ¢/km.
  - Only the fuel cost element is used within our forecasting model. This is general practice within most transportation models since research has shown that people tend not to consider indirect costs such as maintenance and tires when making their choice of travel mode.
- Car Availability
  - Car availability was estimated at 85% of households having access to a personal vehicle (Source: 2010 provincial data).

Transit Generalised Costs

6.13 Transit trips generalised costs are estimated based on the travel times and the tariff.

- Travel Times
  - OD travel times have been provided from the MADITUC model. These times have been provided at an aggregate level and include not only actual journey time, but also all access/egress time, wait time and interchange penalties where a transfer is required.
  - For the entire OD matrix, the weighted average travel time for LRT is 50.0 minutes, and for Other Transit is 58.5 minutes.

- Tariff
    - Note that there are two fares used for this study, especially for the calibration of the model and definition of business as usual:
        - Average tariff for services using the Champlain Bridge (various CIT, RTL, and AMT buses), and
        - Average tariff for trips within the Montreal island (STM).
    - The tariff for the Champlain Bridge services was calculated as an average of the fares for each of the different transit agencies using it weighted by the transit demand across the bridge. These values were only available for 2015 and shown in Table 5.

Table 5: Weighted Average Tariff ($2015 CAD)

	Recettes moyennes (avant partage)
AMT	$2.66
CIT CRC	$3.65
CIT HR	$4.30
CIT LR	$3.24
CIT Le Roussillon	$3.29
CIT VR	$4.49
RTL	$2.75
Sainte-Julie	$4.03
Total	**$3.02**

Source: AMT

    - 2015 tariffs were converted to 2013 values based on known tariff changes and relative changes to the Montreal Consumer Price Index (CPI) from 2013-2014 which was also assumed for 2014-2015.
    - STM tariff was provided by AMT using a similar approach for trips internal to Montreal where STM is the only operator.
    - This resulted in average 2013 tariffs of $2.88 (Champlain Bridge) and $1.40 (Montreal).

Behavioural Parameters

- Value of Time
    - The value of time provides an indication of how much an individual is prepared to pay in order to save a given amount of journey time. Table 6 summarizes the values used within each of the choice models:

Table 6: Value of Time ($/hour)

VoT Group[2]	Auto vs Transit	LRT vs Other Transit
Quartile 1	$3.20	$2.60
Quartile 2	$6.40	$5.20
Quartile 3	$10.20	$8.30
Quartile 4	$12.70	$10.40
Overall Average	$8.10	$6.60

Source: SDG Assumptions

Other assumptions

Transit Demand Assignment to Stations

6.14 The choice model estimates the demand that would be captured by the LRT for each origin and destination, at Sector Municipaux (SM) level.

6.15 In order to assign accurately the demand from each SM to a specific station, it would be necessary to understand in more detail the feeder route that would be used to access the LRT and the demand associated with it.

6.16 For this phase of the project, we have allocated the demand to each LRT station based on the estimated level of transit provision at each SM by service provider, and the expected allocation of service provider to each LRT station. Table 7 highlights the assumptions applied to the Rive Sud demand.

Table 7: Rive Sud Demand Station Allocation

	AMT	RTL	CITLR	CITROUS	CITCRC	St Jean	CITVR	St Julie	Other CIT	TOTAL
Bus Services	**1**	**35**	**13**	**9**	**8**	**3**	**1**	**1**	**3**	**74**
Panama		26	8	2		1				37
Chevrier	1	4								5
Terminale		5	5	7	8	2	1	1	3	32
Bus Service Split										
Panama		74%	62%	22%		33%				-
Chevrier	100%	11%								-
Terminale		14%	38%	78%	100%	67%	100%	100%	100%	-

Source: AMT

6.17 A table summarizing the application of the resulting splits to the SMs is included in Appendix B.

[2] Each quartile represents 25% of the population in-scope for each choice model

Park & Ride Assumptions

6.18 An additional 1,325 P&R spaces are assumed to be available once the LRT is operational. The location of these is outlined in Table 8.

Table 8: P&R Assumptions

Location	Existing	Additional	Total	% Cars
Panama	962	-262	700	15%
Chevrier	2,313	-1,413	900	20%
Terminale	-	3,000	3,000	65%
Total	**3,275**	**1,325**	**4,600**	**100%**

Source: AMT 2014 Annual Report

6.19 Of these additional spaces, 1,000 (75%) are assumed to be occupied within the base case. Since it has been assumed an average occupation rate of 1.3, this results in potential additional demand of 1,300 users.

Expansion Factor Assumptions

6.20 The demand modelling has been carried out for the AM peak period (6am-9am). In order to translate peak period demand into daily and annual ridership, we have reviewed the following sources, each of which results in different expansion factors as shown in Table 9:

- 2013 AMT ridership OD data (REP2_A10_jour_2013EOD.xls)
- 2013 OD survey
- 2013 STM annual report

Table 9: Expansion Factors

Source	Daily	Annual
AMT data of 2013 OD (REP2_A10_jour_2013EOD.xls)	2.4	
2013 OD (weighted average of 521 LRT OD users)	3.6	
STM (2013 STM annual report)		320

6.21 Table 10 shows the daily and annual expansion factors provided by AMT for the lines in the corridor.

Table 10: Daily and Annual Expansion Factors

	Daily	Annual
AMT	2.50	250
CIT C.-R.-Carignan	2.50	250
CIT Haut-Richelieu	2.50	250
CIT Le Richelain	2.50	250
CIT Le Roussillon	2.50	250
CIT Vallée-du-Richelieu	2.50	250
RTL	3.00	275
Sainte-Julie	2.50	250
Weighted average	**2.80**	**265**

Source: AMT

6.22 According to the data provided by AMT for the corridor, the existing expansion factors are low; 2.5/3.0 from AM period to weekday and 250/275 for weekday to annual ridership. This reflects the commuting nature of the corridor, which is mainly used for trips to work, and there is limited demand during the off peak hours.

6.23 This is accentuated by the fact that off peak level of service is reduced (e.g. Chrevier Express has services every 10-15 min in weekday peak while only every hour on Sundays). However, with the introduction of the LRT and the improved level of service during the off peak periods, we would expect that ridership in the off peak will increase.

6.24 For the dimensioning base case, we have assumed the weighted average expansion factors provided by AMT for the corridor. However, we have run different sensitivities to assess its impact. Table 11 summarizes three scenarios (low, central, and high)

Table 11: Summary of Expansion Factors

	AM Peak Period to Weekday	Weekday to Annual	AM Peak Period to Annual
Low	2.5	250	625
Central	2.8	265	741
High	3.0	298	893

Key modelling issues

- Steer Davies Gleave has not been provided the detail of the network restructuring. Therefore, our model calibration and the assessment of the LRT option has been based on the travel times provided by AMT and MTQ for; the LRT, the car and the second best transit alternative for each Origin and Destination – we have not been able to assess the accuracy of this information.
- The allocation of trips to LRT stations has also been estimated based on splits of service provider. However, more detailed information and analysis would be required in order to estimate trip distribution accurately.
- Travel times provided by AMT for some alternatives do not correspond with their mode assignment market shares (e.g. some ODs have similar LRT travel times as the second best transit option, however the LRT capture is negligible). We have not been able to assess the other potential impacts that could result in this mode share. Therefore, for the purpose of this analysis we had to eliminate this demand from our model calibration
- The model estimates that the user tariff will be similar to what they currently pay ($2.88). However, the new network will rely on transit integration and interchange between service providers. Therefore, this (user) tariff might have to be distributed/shared between different service providers.
- We have not been able to assess the impact of the worse connectivity between the De la Cathédrale terminal and Bonaventure Metro station. We understand an additional penalty has been included in the overall travel times (Madituc travel times) however, a detailed analysis will be required in the next stage to assess this impact.
- Madituc only develops am peak period outputs. There is uncertainty around the potential LRT capture rate during the off peak periods. In order to assess this more accurately, an off peak model should be developed during the investment grade study.

7 Preliminary Forecasts

LRT Base Case

7.1 The base case scenario has been defined for dimensioning purposes and therefore it is not a conservative case as it would be defined for a base lenders case.

7.2 The analysis has mainly focused on the most loaded period and direction (AM peak towards Montreal) which will drive the dimensioning requirements of the system. However, assumptions have been undertaken to provide daily and annual demand.

Assumptions

The assumptions adopted for the dimensioning base case have been as follows:

- ***2013 corridor base demand***: based on the 2013 surveys and shown below

Table 12: 2013 Corridor Transit Ridership

Current ridership	Bus network- Bridge*	Transit network- STM**
Rive Sud users	**22,501**	
Montreal direction	22,501	-
Rive Sud direction	-	-
Montreal users	**400**	**7,527**
Montreal direction	-	6,037
Rive Sud direction	400	1,490
Total	**22,901**	**7,527**
Montreal direction	22,501	6,037
Rive Sud direction	400	1,490

- ***Transit Growth***: has been based on the transit 'trend' scenario
  - 2013-2021: 1.5% CAGR
  - 2021-2031: 1.3% CAGR
  - 2031-2041: 1% CAGR
- ***LRT tariff*** (integrated with bus network)
  - All users: $2.88
- **LRT service and bus restructuring** as defined in Chapter 5
- ***No toll*** in Champlain Bridge
- ***P&R facilities*** available as described in chapter 5

Outputs

Summary

7.3 Under this scenario and based on the travel times provided by AMT, it is estimated that most of the existing transit demand on the Champlain Bridge will be captured by the LRT. Few ODs will chose other alternatives and new trips will be captured from other transit modes, but with a resulting net increase of 5% demand captured from transit, compared to the Business as Usual. Demand from transit will account for 94% of the total demand.

7.4 The improvement in transit travel times will result in some car shift, however, this is estimated to be very small since the expected travel time improvements are not significant (especially taking into account the interchange time). Therefore, most of the car shift is estimated to be the result of the additional P&R facilities. In total, capture from car has be estimated to be around 6% of the total demand.

7.5 The capture both from transit and especially from car in the Montreal area is estimated to be much lower, due to the increased tariff compared with the current bus system ($2.88 versus $1.4) and the availability of multiple transit options.

7.6 Table 13 shows the estimated capture from each of the market segments.

Table 13: Demand Captured from Auto and Transit

	From Car/P&R	From Transit	Total
Montreal area	-	3,000	3,000
Rive-Sud Montreal	2,000	30,200	32,200
Rive-Sud area	100	700	800
Total	**2,100**	**33,900**	**36,000**

Station Boardings- AM Peak Period

7.7 **Table 14** and **Figure 21** and **Figure 22** show the station boardings for the reference years.

Table 14: Station Boardings, AM Peak Period (Base Case)

	2021	2031	2041
Terminale	9,900	11,100	12,200
Chevrier	2,300	2,600	2,900
Panama	15,800	17,900	19,800
Île-des-Sœurs	700	900	900
Saint-Patrick	700	700	800
Griffintown	400	500	600
De la Cathédrale	2,000	2,200	2,500
Total	**31,800**	**36,000**	**39,700**

Figure 21: Station Boardings, AM Peak Period, To Montreal (2041 Base Case)

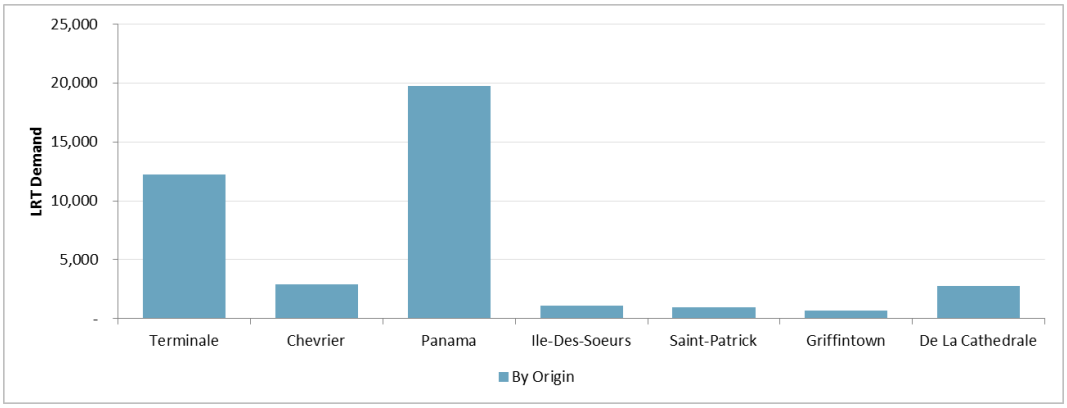
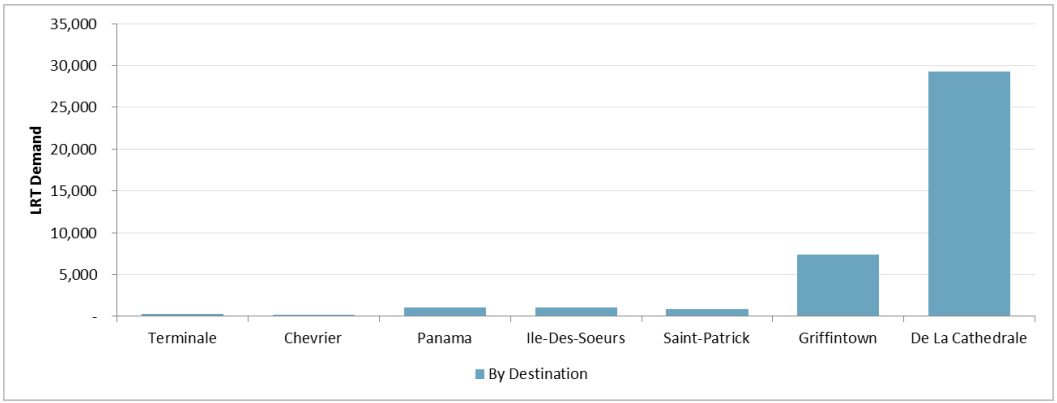


Figure 22: Station Alightings, AM Peak Period, To Rive-Sud (2041 Base Case)



7.8 Most of the demand in the peak period boards in the Rive Sud area and alights in Downtown Montreal. Most of the boardings take place in the Panama stations, where most of the feeder buses have been allocated, and in the terminal with both; feeder buses and major P&R capacity.

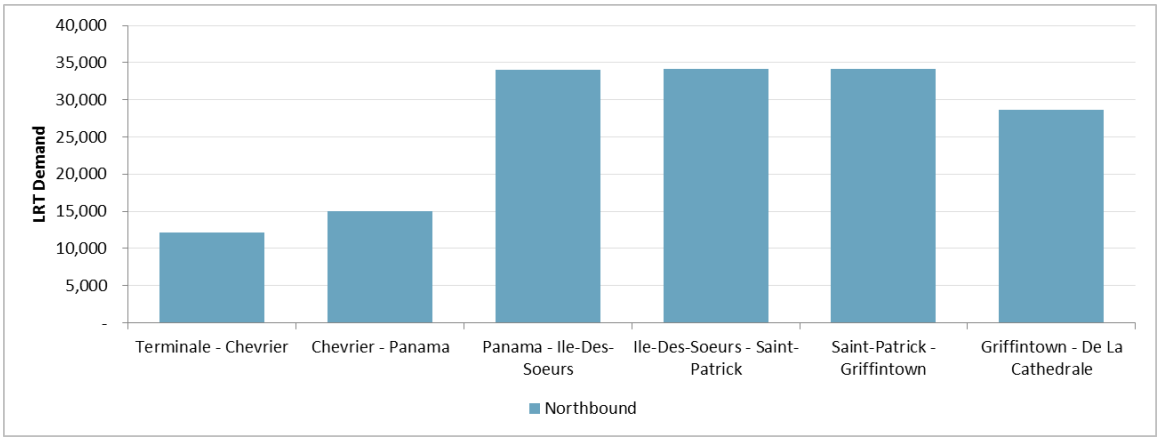
Most Loaded Section during AM Peak Period

7.9 The following table shows that the sections between Panama and Saint-Patrick are the most loaded on the network, with more than 34,000 passenger in the peak period in 2041 (note that the peak 15 minutes contains 12% of all demand observed in the peak period).

Table 15: Section Load, AM Peak Period, To Montreal (Base Case)

	2021	2031	2041
Terminale - Chevrier	9,900	11,100	12,200
Chevrier - Panama	12,100	13,700	15,000
Panama - Île-des-Sœurs	27,400	31,000	34,100
Île-des-Sœurs - Saint-Patrick	27,400	31,000	34,100
Saint-Patrick - Griffintown	27,400	30,900	34,100
Griffintown - De la Cathédrale	22,900	25,900	28,600

Figure 23: Section Load, AM Peak Period (2041 Base Case)



Daily demand

7.10 **Table 16** shows the estimated daily demand for the different expansion factor scenarios.

Table 16: Daily Demand (Base Case)

Scenario	2021	2031	2041
Low	79,500	90,000	99,100
Central	89,100	100,800	111,000
High	95,400	108,000	119,000

7.11 The potential daily demand range between the high and low scenarios and the base case forecasts are around +7%/ -11%.

Annual demand and revenue

7.12 **Table 17** shows the estimated annual demand for the different expansion factor scenarios.

Table 17: Annual Demand (Base Case)

Scenario	2021	2031	2041
Low	19,885,000	22,491,500	24,783,700
Central	23,607,500	26,702,000	29,423,200
High	28,443,500	32,171,900	35,450,600

7.13 The potential annual demand range between the high and low scenarios and the base case forecasts are around +20%/ -16%.

7.14 The annual revenue estimated is presented in **Table 18** for the different expansion factor scenarios and based on demand estimates presented above. Note the following assumptions regarding the revenue calculations:

- $2.88 tariff (2013 $) as estimated in paragraph 6.13 (trips within Montreal charged the same as trips crossing the St Lawrence)
- Assumed a split of 75% revenue allocated to LRT and 25% allocated to bus service connectors
- No real increase in tariffs i.e. remain linked to CPI increases

Table 18: Annual Revenue (Base Case, 2013 $)

Scenario	2021	2031	2041
TOTAL REVENUE			
Low	$57,269,000	$64,776,000	$71,377,000
Central	$67,989,000	$76,901,000	$84,739,000
High	$81,917,000	$92,655,000	$102,097,000
LRT ALLOCATION (75% of TOTAL)			
Low	$42,952,000	$48,582,000	$53,533,000
Central	$50,992,000	$57,676,000	$63,554,000
High	$61,438,000	$69,491,000	$76,573,000

Sensitivities

Assumptions

7.15 The following sensitivity analysis have been carried out:

- **Sensitivity to 2013 demand**
  - *S1 2013 Upside*: 2013 demand with OD distributions based upon 2013 counts as opposed to input matrices from the AMT model;
  - *S2 2013 Downside*: 2013 demand reduced by a factor of 10%. This adjustment is based on implied reductions from the passenger counts (1 day survey).
- **Sensitivity to growth**
  - *S3 Growth Upside*: More optimistic macroeconomic forecasts resulting in higher forecasts of underlying traffic growth using the trend transit growth model:
    - Base case:
      2013-2021: 1.5% pa
      2021-2031: 1.3% pa
      2031-2041: 1.0% pa
    - Upside case:
      2013-2021: 1.6% pa
      2021-2031: 1.7% pa
      2031-2041: 1.3% pa
  - *S4 Growth Downside*: More conservative traffic growth assumptions, based upon MTQ scenario:
    - Downside case:
      2013-2021: 0.7%
      2021-2031: 0.7%
      2031-2041: 0.3%

- **Sensitivity to tariff**
  - *S5 Montreal Tariff $1.40*: Tariff for all movements in Montreal (by LRT/other transit[3]) assumed to remain at $1.40 (in real terms);
  - *S6 Tariff +25%:* All tariffs for LRT/other transit increased by + 25% relative to the base case:
    - Base case:
      Average tariff $2.88 (2013 prices)
    - +25%:
      Average tariff $3.60 (2013 prices)
  - *S7 Tariff + 50%:* All tariffs for LRT/other transit increased by +50% relative to the base case:
    - +50%:
      Average tariff $4.32
- **Sensitivity to tolls**
  - *S8 Auto Toll $2.00*: tolls $2.00
  - *S9 Auto Toll $2.88*: tolls $2.40
- **Sensitivity to P&R**
  - *S10 100% P&R Inc. Occupancy*: A total of 1,325 P&R spaces are assumed to be added in the base case, with an average occupancy of spaces in the AM Peak Period of 75%. In this sensitivity occupancy of the new P&R spaces is assumed to be 100%.
  - *S11 0% P&R Inc. Occupancy*: In this sensitivity there are assumed to be no additional P&R spaces.
  - *S12 $6.00 Parking Fee*: In the base case, parking at P&R facilities is assumed to be free. In this sensitivity all sites are assumed to charge a daily fee of $6 to park.
  - *S13 $6.00 Parking Fee at Panama*: In this case, only the P&R facility at Panama (consisting of 700 spaces) is assumed to charge a daily fee of $6 to park; all other P&R facilities are assumed to be free.

Station Boarding Forecasts - AM Peak Period

7.16 The following tables show the impacts of the different sensitivities on the total number of boardings in 2031 and 2041, as compared to the base case.

Table 19: Station Boarding Sensitivity, AM Peak Period, 2031

2031	*Base*	S1 2013 Upside	S2 2013 Downside	S3 Growth Upside	S4 Growth Downside	S5 Montreal Tariff $1.40	S6 Tariff +25%
Terminale	*11,100*	13,500	10,100	11,600	10,000	11,100	9,400
Chevrier	*2,600*	2,500	2,300	2,700	2,300	2,600	2,200
Panama	*17,900*	18,800	16,200	18,800	16,000	17,900	15,100
Île-des-Sœurs	*900*	900	800	900	800	1,500	700
Saint-Patrick	*700*	700	700	800	700	1,100	600
Griffintown	*500*	400	500	500	400	700	400
De la Cathédrale	*2,200*	2,700	2,000	2,300	2,000	2,900	1,900
TOTAL	***36,000***	**39,600**	**32,500**	**37,700**	**32,100**	**37,800**	**30,500**
		10%	-10%	5%	-11%	5%	-15%

[3] It is assumed full tariff integration with the existing network.

2031	S7 Tariff +50%	S8 Auto Toll $2.00	S9 Auto Toll $2.88	S10 100% P&R Inc. Occupancy	S11 0% P&R Inc. Occupancy	S12 $6.00 Parking Fee	S13 $6.00 Parking Fee at Panama
Terminale	7,900	11,300	11,400	11,400	10,300	10,600	11,000
Chevrier	1,800	2,600	2,700	2,600	2,600	2,600	2,600
Panama	12,700	18,200	18,400	18,100	17,500	17,700	17,900
Île-des-Sœurs	600	900	900	900	900	900	900
Saint-Patrick	600	800	800	700	700	700	700
Griffintown	400	500	500	500	500	500	500
De la Cathédrale	1,600	2,200	2,200	2,200	2,200	2,200	2,200
TOTAL	**25,600**	**36,500**	**36,800**	**36,400**	**34,700**	**35,300**	**35,900**
	-29%	1%	2%	1%	-4%	-2%	0%

Table 20: Station Boarding Sensitivity, AM Peak Period, 2041

2041	*Base*	S1 2013 Upside	S2 2013 Downside	S3 Growth Upside	S4 Growth Downside	S5 Montreal Tariff $1.40	S6 Tariff +25%
Terminale	*12,200*	14,900	11,100	13,200	10,200	12,200	10,300
Chevrier	*2,900*	2,800	2,600	3,100	2,400	2,900	2,400
Panama	*19,800*	20,700	17,800	21,400	16,400	19,800	16,700
Île-des-Sœurs	*900*	1,000	800	1,000	800	1,600	800
Saint-Patrick	*800*	800	700	900	700	1,200	700
Griffintown	*600*	500	500	600	500	800	500
De la Cathédrale	*2,500*	2,900	2,200	2,700	2,000	3,200	2,100
TOTAL	***39,700***	**43,600**	**35,800**	**42,900**	**33,000**	**41,600**	**33,600**
		10%	-10%	8%	-17%	5%	-15%

2041	S7 Tariff +50%	S8 Auto Toll $2.00	S9 Auto Toll $2.88	S10 100% P&R Inc. Occupancy	S11 0% P&R Inc. Occupancy	S12 $6.00 Parking Fee	S13 $6.00 Parking Fee at Panama
Terminale	8,600	12,400	12,500	12,500	11,400	11,700	12,100
Chevrier	2,000	2,900	2,900	2,900	2,800	2,800	2,900
Panama	14,000	20,100	20,300	19,900	19,400	19,500	19,700
Île-des-Sœurs	700	1,000	1,000	900	900	900	900
Saint-Patrick	600	800	800	800	800	800	800
Griffintown	400	600	600	600	600	600	600
De la Cathédrale	1,800	2,500	2,500	2,500	2,500	2,500	2,500
TOTAL	**28,200**	**40,200**	**40,500**	**40,100**	**38,400**	**38,900**	**39,500**
	-29%	1%	2%	1%	-3%	-2%	-1%

Route Loadings - AM Peak Period

7.1 The following tables show the impacts of the different sensitivities on the total number of users in the most loaded section in 2031 and 2041, as compared to the base case.

Table 21: Section Load Northbound Sensitivity, AM Peak Period, 2031

2031	*Base*	S1 2013 Upside	S2 2013 Downside	S3 Growth Upside	S4 Growth Downside	S5 Montreal Tariff $1.40	S6 Tariff +25%
Terminale - Chevrier	*11,100*	13,500	10,100	11,600	9,900	11,100	9,400
Chevrier - Panama	*13,700*	16,000	12,400	14,300	12,200	13,700	11,600
Panama - Île-des-Sœurs	*31,000*	34,200	28,000	32,500	27,600	31,000	26,100
Île-des-Sœurs - Saint-Patrick	*31,000*	34,700	28,000	32,500	27,600	31,600	26,100
Saint-Patrick - Griffintown	*30,900*	35,000	28,000	32,400	27,600	31,800	26,100
Griffintown - De la Cathédrale	*25,900*	28,900	23,400	27,200	23,100	26,800	21,900

2031	S7 Tariff +50%	S8 Auto Toll $2.00	S9 Auto Toll $2.88	S10 100% P&R Inc. Occupancy	S11 0% P&R Inc. Occupancy	S12 $6.00 Parking Fee	S13 $6.00 Parking Fee at Panama
Terminale - Chevrier	7,900	11,300	11,300	11,400	10,200	10,600	11,000
Chevrier - Panama	9,700	13,900	13,900	14,000	12,800	13,200	13,600
Panama - Île-des-Sœurs	21,800	31,300	31,400	31,400	29,700	30,300	30,900
Île-des-Sœurs - Saint-Patrick	21,900	31,300	31,400	31,400	29,700	30,300	30,900
Saint-Patrick - Griffintown	21,900	31,200	31,300	31,300	29,700	30,200	30,800
Griffintown - De la Cathédrale	18,300	26,200	26,200	26,300	24,900	25,300	25,800

Table 22: Section Load Northbound Sensitivity, AM Peak Period, 2041

2041	*Base*	S1 2013 Upside	S2 2013 Downside	S3 Growth Upside	S4 Growth Downside	S5 Montreal Tariff $1.40	S6 Tariff +25%
Terminale - Chevrier	*12,200*	14,900	11,000	13,100	10,200	12,200	10,300
Chevrier - Panama	*15,000*	17,600	13,600	16,200	12,600	15,000	12,700
Panama - Île-des-Sœurs	*34,100*	37,700	30,800	36,900	28,500	34,100	28,800
Île-des-Sœurs - Saint-Patrick	*34,100*	38,300	30,800	36,900	28,400	34,800	28,800
Saint-Patrick - Griffintown	*34,100*	38,600	30,800	36,800	28,400	35,100	28,700
Griffintown - De la Cathédrale	*28,600*	31,800	25,800	30,900	23,800	29,500	24,100

2041	S7 Tariff +50%	S8 Auto Toll $2.00	S9 Auto Toll $2.88	S10 100% P&R Inc. Occupancy	S11 0% P&R Inc. Occupancy	S12 $6.00 Parking Fee	S13 $6.00 Parking Fee at Panama
Terminale - Chevrier	8,600	12,400	12,400	12,500	11,300	11,700	12,100
Chevrier - Panama	10,600	15,200	15,300	15,300	14,100	14,500	14,900
Panama - Île-des-Sœurs	24,000	34,500	34,600	34,500	32,800	33,400	34,000
Île-des-Sœurs - Saint-Patrick	24,100	34,400	34,500	34,500	32,800	33,400	34,000
Saint-Patrick - Griffintown	24,000	34,400	34,500	34,500	32,800	33,300	33,900
Griffintown - De la Cathédrale	20,100	28,800	28,900	28,900	27,500	28,000	28,500

Sensitivity Summary

- **To existing demand (S1 and S2)**
  - Existing demand has been estimated based on the 2013 OD survey totals, which is believed to be 10% higher than passenger counts in the corridor. However, it is worth noting that the survey sample size of both; the passenger counts and the OD surveys are not large, and therefore there is a degree of uncertainty that could range between +10 and -10% of the base value.
- **To transit growth (S3 and S4)**
  - MTQ growth scenario is considered to be conservative, especially when analysing the transit historic growth in the corridor. Applying these forecasts would lead to reduction of 17% ridership by 2041 compared to the base case.
  - On the other hand, more optimistic macroeconomic forecasts, could lead to higher transit demand in the medium term that would result in ridership increases of 8% by 2041.
- **To tariff (S5, S6 and S7)**
  - The LRT ridership seems to be sensitive to increases in tariff. There are certain ODs where the difference in travel times compared to the second best transit option is around 10-15 minutes. And there are segments of the population with low values of time, who might shift to longer transit options to save costs. As a result, the models show a decrease in ridership of 15% for tariff increases of 25%, and a decrease in ridership of 29% when increasing tariff by 50%.
  - The base case assumes a flat tariff of $2.8 for every trip. Retaining the tariff on the Montreal section to the existing levels ($1.4) would increase the demand in that sector (although with a lower yield), increasing total ridership by 5%
- **To tolls (S8 and S9)**
  - The sensitivity to tolls is assumed to be very low. According to previous models developed in the corridor, the introduction of tolls in the Bridge would lead to a reduction of around 20% of the traffic, but only 10% of this (2% of total traffic) would shift to the LRT. The rest would chose other road alternatives.
  - As a result, the impact of tolls in demand is only around 2% of total demand.

- **To P&R**
  - The additional ridership as a result of the expanded P&R facilities account for around 4% of the total demand.
  - Including a parking fee would increase the travel cost for the P&R user by $6 (assumed to be $3 to represent a one way trip) and demand will reduce. However, the overall impact is less than 2% of total demand as the majority of the demand comes from transit services, there is limited P&R capacity and as seen in S8 and S9 the sensitivity to auto costs is low.
  - The P&R charge impact is largely reduced if that fee is only applied to the parking spaces in Panama Station (only 900 spaces).

8 Conclusions and Next Steps

Capture from transit

8.1 The base case scenario assumes that most of the demand from existing buses across the Bridge will transfer to the new LRT. Although this seems sensible under existing assumptions, there are a number of issues that need to be understood and addressed in further stages:

- The current bus network uses dedicated lanes in part of the route with high commercial speeds. Current frequencies are very high (200 services/peak hour across the bridge) and it is creating congestion issues around the Montreal terminal, therefore the role of the LRT will be critical to provide the required capacity to meet future demand.
  However, existing speeds and frequencies are high, and the benefit of the LRT in terms of travel times are not expected to be significant, and therefore additional capture from other transit modes would be limited.
- The main underlying assumption for the LRT future demand is the full *restructuring of the bus network*, which has been assumed to be redesigned to feed the LRT instead of competing with it. Any change on this assumption would have a significant impact on the LRT demand.
- The new transit network structure (with LRT) will result in a much *higher number of transfers*; trips that before could use a direct bus to downtown will now have to transfer to the LRT. The generalised travel times provided by AMT suggest that this transfer (negative) impact will be offset by improved speeds, and a positive net impact on ridership (+5%) has been estimated. However, the assumed LRT commercial speed and the integration with the bus network are critical to make sure that the LRT/local bus option is competitive. Therefore, this needs to be understood and addressed in more detail.
- Steer Davies Gleave has calibrated the transit choice model based on LRT and transit generalised times provided by AMT (Madituc). Further analysis would be required (in next stages) to make sure these *travel times are accurate and the transfer penalties* have been properly included (both in Rive Sud interchange stations, but also to Bonaventura Metro station)
- The calculation of generalised times and the logit model has been estimated based on behavioural parameters based on similar experience and third party data. This would need to be analysed further, in order to ensure that the choice model accurately represents the different users mode preference.
- The allocation of boardings to each station has been based on our understanding of the restructuring of the bus service (high level information provided by AMT). This needs to be further assessed based on a full understanding of the proposed transit network

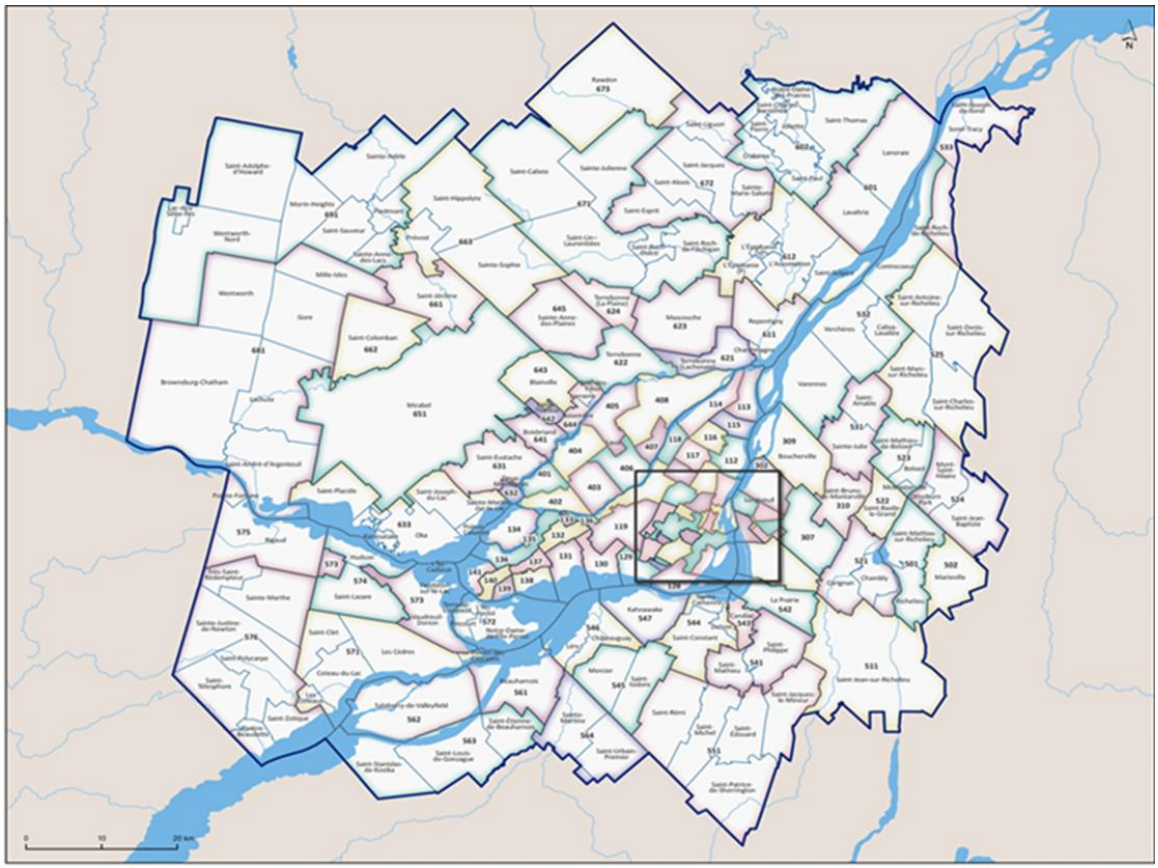
- The proposed scenario assumes that tariffs in the network are fully integrated. Therefore, a Rive Sud user will pay similarly to their existing tariff ($2.88), although now will be using two different services (local bus+ LRT). As a result, some type of revenue allocation will have to be agreed between different operators
- As agreed with CDPQ, the base scenario assumes that tariff will be flat for the whole length of the LRT ($2.88). Since exiting tariff on the Montreal area is lower, this reduces the capture of demand internal to the Montreal island.
- Steer Davies Gleave has found inconsistencies in some of the Madituc output data provided by AMT with regards to travel times and market shares in the Montreal market segment. This segment would need to be analysed in detail, since any additional demand would be critical for the capacity of the most loaded section.
- The model used for this study and in all previous studies estimate demand in the AM peak period. In order to estimate daily and annual demand, it would be necessary to estimate in more detail the attractiveness of the system during the off peak period.

Capture from car

- Given the expected minor improvements in transit travel times, the capture from car will be very limited and highly reliant on the availability of P&R facilities. However, this will be also dependent on the future congestion of the road network and the competitiveness of the integrated transit network.
- Car shift has been estimated based on a logit model, that has been developed and calibrated based on current car/transit market shares and generalised travel times provided by MTQ and AMT. This model and inputs need to be further reviewed and refined in next phases.

8.2 Both models have been based on behavioural parameters (VOT) and assumptions (travel times, bus restructuring) that have been either based on similar projects or provided by third parties. These assumptions are critical to determine the competitiveness and LRT future demand. Those would have to be assessed and analysed in detail in next phases of the project.

A Sector Municipaux (SM) Map



B Sector Municipaux (SM) to Rive Sud Station Allocation

SM	Name	Terminale	Chevrier	Panama
301	Longueuil : Vieux-Longueuil	14%	11%	74%
302	Longueuil : Longueuil Est	14%	11%	74%
303	Longueuil : De Lyon	14%	11%	74%
304	Saint-Lambert	14%	11%	74%
305	Longueuil : LeMoyne	14%	11%	74%
306	Longueuil : Greenfield Park	14%	11%	74%
307	Longueuil : Saint-Hubert	14%	11%	74%
308	Brossard	14%	11%	74%
309	Boucherville	14%	11%	74%
310	Saint-Bruno-de-Montarville	14%	11%	74%
501	Richelieu, Saint-Mathias-sur-Richelieu	100%		
502	Marieville	100%		
511	Saint-Jean-sur-Richelieu	67%		33%
521	Carignan, Chambly	100%		
522	Saint-Basile-le-Grand	100%		
523	Beloeil, Saint-Mathieu-de-Beloeil, McMasterville	100%		
524	Mont-Saint-Hilaire, Otterburn Park, Saint-Jean-Baptiste	100%		
525	St-Charles-sur-Richelieu, St-Marc-sur-Richelieu, St-Antoine-sur-Richelieu, St-Denis-sur-Richelieu	100%		
531	Saint-Amable, Sainte-Julie	100%		
532	Verchères, Calixa-Lavallée, Varennes, Contrecoeur	100%		
533	St-Joseph-de-Sorel, St-Roch-de-Richelieu, Sorel-Tracy	100%		
541	Saint-Philippe, Saint-Mathieu	38%		62%
542	La Prairie	38%		62%
543	Candiac	38%		62%
544	Sainte-Catherine, Saint-Constant, Delson	78%		22%
545	Mercier, Saint-Isidore	50%	50%	
546	Châteauguay, Léry	50%	50%	
547	Kahnawake	50%	50%	
551	Saint-Édouard, Saint-Michel, Saint-Rémi, Saint-Patrice-de-Sherrington, Saint-Jacques-le-Mineur	50%	50%	
561	Beauharnois	50%	50%	
562	Salaberry-de-Valleyfield	50%	50%	
563	Saint-Étienne-de-Beauharnois, Saint-Louis-de-Gonzague, Saint-Stanislas-de-Kostka	50%	50%	
564	Sainte-Martine, Saint-Urbain-Premier	50%	50%	

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SDG project/proposal number	Client contract/project number
22876101	

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Version control/issue number	Date
1.0	10-December-2015
2.0	29-December-2015