steer davies gleave

Réseau Électrique Métropolitain (REM)

REM Forecasting Report
February 2017

CDPQ Infra Inc.

Our reference: 22951103
Client reference: BC-A06438

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1 Introduction

1.1 Steer Davies Gleave was appointed by CDPQ Infra Inc. to develop investment grade forecasts for the Réseau Électrique Métropolitain system (REM), a 67 kilometre light rail network in Metropolitan Montréal.

1.2 This report represents the study's major deliverable and is supported by the Data Collection Report dated August 2016.

1.3 This report describes the REM specification, the existing in-scope demand, the methodological approach, data collection, demand forecasting framework and ridership forecasts. This forecasting work was summarized in a preliminary report dated November 2016. A number of project changes (including 3 additional REM stations, revised travel times and headways amongst others) means that additional analysis was undertaken and this is included in the work reported in this report. Summary of mode constant changes and forecasting differences resulting from these changes are included in Appendix E and F.

The Project

1.4 REM will be a fully automated transportation system, 67 km long, which will provide access to 27 stations. REM will transform the transit offer in the Metropolitan Montréal Area, by providing a new efficient, frequent and reliable service between the South Shore, Downtown Montréal and the West Island and Aéroport Pierre-Elliott-Trudeau.

1.5 REM will also have a key "urban" role in Downtown Montréal. Its 3 interchange stations with the Blue, Green and Orange Métro Lines will make REM an integral component of Montréal's urban transit network. For example, passengers on the Métro Blue Line with a destination in Downtown will now have an alternative to the circuitous Métro Orange Line.

1.6 Moreover, the definition of the project does not only include the REM network but will be complemented with a bus and rail service reorganization and a Park & Ride network, which will fully integrate the REM with the rest of the transit and road network, significantly increasing its attractiveness.

Steer Davies Gleave

1.7 Steer Davies Gleave has over 400 staff worldwide and is one of world's largest independent transport consultancies. The firm is almost 40 years old with our head office in London and offices worldwide, including Toronto and Vancouver in Canada and offices in the USA, Latin America, Europe, and India.

1.8 With over 400 consultants worldwide, Steer Davies Gleave has an unparalleled breadth of specialist expertise available to clients including qualified planners, modellers, engineers, economists, designers, operations experts, business strategy and finance analysts, researchers, specialists in marketing, communication and public relations, software developers, and social scientists. We have experience across all the transportation modes in the movement of people and goods.

1.9 Steer Davies Gleave has extensive experience developing and auditing demand and revenue forecasts for all transit modes and for a range of public and private sector clients with our forecasts having supported the investment of billions of dollars in transit systems.

1.10 We have developed forecasts for a number of LRT systems in Canada, including Hamilton, Mississauga, Surrey BC, and the Edmonton Valley line. We have worked in Montréal since 2007 on a variety of projects and clients including Aerotrain, Champlain Bridge Replacement, and the A25 and A30 highway projects.

Report Structure

1.11 Following this introduction, this report includes the following:

- Section 2 describes the proposed REM project and plans for reorganising the bus and rail services in the REM corridor including proposed Park & Ride sites at REM stations;
- Section 3 presents the current transport situation in Montréal and defines the 3 in-scope markets for REM: South Shore/A10 Corridor; West Island/Deux-Montagnes Line and Airport Corridor;
- Section 4 explains our modelling approach, the existing models and bespoke models prepared for this study;
- Section 5 describes how we constructed the 2015 base year demand for the existing in-scope ridership, historic growth of public transport ridership in Montréal and future demand growth models;
- Section 6 presents the model calibration, that is, how well the model simulates reality in terms of demand by transport mode and travel times in 2015;
- Section 7 shows the REM sponsor case forecasts for 2015 (assuming REM was in place today), and for years 2021 and 2031; and
- Section 8 defines the Low and High scenarios and the forecasts.

1.12 This report is supported by a number of appendices providing further details on the future road network proposals, Stated Preference[1] (SP) research and model calibration of bus services.

[1] Stated Preference (SP) surveys are widely used in travel behaviour research to identify behavioural responses to choice situations which are not revealed in the market. In this case, the introduction of REM is a “new” transit mode for Metropolitan Montréal.

Disclaimer

This document is solely for the benefit of CDPQ Infra Inc. ("the Client"). No other person or entity may rely upon this document without the prior written consent of Steer Davies Gleave ("the Company") which may be granted or withheld in the Company's sole discretion.

This document contains projected information and data (financial and otherwise), and other forward-looking information, that may or may not occur or prove to be accurate. Such projected and forward-looking information is based on current expectations and projections about future events, many of which are beyond the control of the Company, the Client or any other participant in the Project, and such projections and forward-looking information can be affected by inaccurate assumptions. The projections and forward-looking information were prepared in good faith, but no assurance can be given as to the accuracy or adequacy of such projections and forward-looking information, or the assumptions underlying such projections and forward-looking information.

This document speaks only as of the date thereof and the Company does not undertake any responsibility for updating this document for any reason, including as a result of new information, future events or otherwise.

2 Project Definition

2.1 This section of the report describes the full specification of the project, including the characteristics of the REM, the Park & Ride network and the bus and rail restructuring.

Stations and Alignment

2.2 REM will transform the transit offer in the Metropolitain Montréal Area, by providing a new efficient, frequent and reliable service between the South Shore, Downtown Montréal and the West Island and Montréal-Trudeau Aéroport (referred to as the Aéroport Pierre-Elliott-Trudeau). REM will also become a key component of Downtown Montréal's urban transit network, integrated with the Métro network and providing access to major destinations including Gare Centrale, McGill University and Édouard-Montpetit (close to Université de Montréal campus).

2.3 The project will be complemented with a bus and rail reorganization and a Park & Ride network, which will fully integrate the REM with the rest of the transit and road network. REM will be a fully automated transportation system, 67 km long, which will provide access to 27 stations. Figure 2-1 shows the extent of the REM network.

Figure 2-1: REM Network

Source: CDPQ Infra Inc.

2.4 With a frequent and reliable service running from 5:00 am to 1:00 am, 20 hours a day, every day, REM will provide a significantly enhanced travel experience for commuters and non-commuters in Metropolitan Montréal.

2.5 In the West Island, REM will provide services to those stations currently served by the Deux-Montagnes AMT line and it will substantially increase rail coverage with new stations in the South Shore, Sainte-Anne-de-Bellevue and Aéroport Pierre-Elliott-Trudeau. On the South Shore, REM will provide services to major interchange stations with the South Shore bus network and Park & Ride[2] facilities. In the Downtown area, REM will serve major destinations (McGill, Édouard-Montpetit, Gare Centrale and Bassin Peel) and will connect with the Métro Orange, Green, and Blue lines.

2.6 Dedicated tracks will allow for quick and uninterrupted travel and passengers will enjoy substantial travel time savings. The travel times between stations are shown in Table 2-1.

[2] A Park & Ride facility is a publically accessible car parking lot located close to a transit stop or station. Often used by commuters, Park & Ride lots allow users to drive for a portion of their journey then continue to their destination (or vice versa) by using transit.

Table 2-1: REM Stations and Travel Times

Station	Station	Distance (m)	Travel time (mins(1))	Speed (km/h)
DEUX-MONTAGNES				
Gare Centrale	McGill	506	01:30	20
McGill	Édouard-Montpetit	3,174	03:13	59
Édouard-Montpetit	Canora	1,730	02:12	47
Canora	Mont-Royal	820	01:33	32
Mont-Royal	Correspondance A40	1,470	01:58	45
Correspondance A40	Montpellier	940	01:37	35
Montpellier	Du Ruisseau	1,460	01:58	45
Du Ruisseau	Bois-Franc	1,720	02:05	50
Bois-Franc	Sunnybrooke	6,390	05:04	76
Sunnybrooke	Roxboro-Pierrefonds	2,170	02:25	54
Roxboro-Pierrefonds	Île-Bigras	3,450	03:11	65
Île-Bigras	Sainte-Dorothée	930	01:36	35
Sainte-Dorothée	Grand-Moulin	2,700	02:43	60
Grand-Moulin	Deux-Montagnes	2,200	02:26	54
Total		**29,660**	**33:31**	**53**
RIVE-SUD				
Gare Centrale	Bassin Peel	1,400	01:58	43
Bassin Peel	Île-des-Sœurs	3,600	03:43	58
Île-des-Sœurs	Panama	5,410	04:37	70
Panama	Du Quartier	3,670	03:22	65
Du Quartier	Rive-Sud	1,440	01:32	56
Total		**15,520**	**15:12**	**61**
SAINTE-ANNE-DE-BELLEVUE				
Bois-Franc	Autoroute 13	4,440	04:01	66
Autoroute 13	Des Sources	3,780	03:20	68
Des Sources	Pointe-Claire	4,130	03:49	65
Pointe-Claire	Kirkland	2,580	02:44	57
Kirkland	Sainte-Anne-de-Bellevue	4,280	03:46	68
Total (from Gare Centrale)		**31,030**	**33:46**	**55**
AÉROPORT PIERRE-ELLIOTT-TRUDEAU				
Autoroute 13	Technoparc Saint-Laurent	2,500	02:52	52
Technoparc Saint-Laurent	Aéroport Pierre-Elliott-Trudeau	2,780	03:01	55
Total (from Gare Centrale)		**21,540**	**26:00**	**50**

(1) Dwell time assumed is 30 seconds for all stations except for Gare Centrale and Panama where it is 40 seconds

Source: CDPQ Infra Inc.

2.7 REM will provide enhanced frequencies to the Deux-Montagnes corridor (services every 12 minutes) compared to the existing AMT rail service, with frequencies of 20 minutes in the peak and hourly in the Interpeak period and on weekends. It will also introduce very frequent services to the South Shore area (every 2 minutes and 40 seconds) replacing the existing express bus services on the Champlain Bridge. It will also include new rail services to the Aéroport Pierre-Elliott-Trudeau and Sainte-Anne-de-Bellevue (every 12 minutes, respectively), which will provide an alternative to the existing express bus services and other local services feeding the Métro Orange Line. Table 2-2 shows the key frequency assumptions.

Table 2-2: REM Operating Assumptions

Route	Headway (mins)		Travel time (mins)
	AM Peak (6am-9am)	Interpeak (9am-3pm)	
Deux-Montagnes to Rive-Sud	12	15	48:43
Roxboro-Pierrefonds to Rive-Sud	12	-	38:47
Sainte-Anne-de-Bellevue to Rive-Sud	12	15	48:58
Aéroport Pierre-Elliott-Trudeau to Rive-Sud	12	15*	41:12
Correspondance A40 to Rive-Sud**	20	-	25:38
Peak Headways per period	**2 mins 40 sec. From Correspondance A40 to Rive-Sud**	**5 mins From Gare Centrale to Rive-Sud**	-

** Interpeak service from Aéroport Pierre-Elliott-Trudeau is express from Bois-Franc to Gare Centrale*

*** Additional service from Correspondance A40 in the AM peak to cover the demand disembarking from the Mascouche Line service*

Source: CDPQ Infra Inc.

2.8 As a result of this operating plan, the headway from Bois-Franc to Correspondance A40 is 3 minutes in the AM Peak and this improves further to 2 minutes 40 seconds between Correspondance A40 and Rive-Sud. In the Interpeak period the peak headway is 7 minutes and 30 seconds from Bois-Franc to Gare Centrale and this decreases to 5 minutes between Gare Centrale and Rive-Sud. Therefore, the REM network will provide a new, direct and frequent transit alternative to users with an origin or a destination within the 2 branches of the “U-shaped” Orange Line as shown in Figure 2-2, and connections to the Métro Blue line at Édouard-Montpetit and Métro Green line at McGill.

Figure 2-2: REM and Montréal's Downtown Transit Network

Source: CDPQ Infra Inc.

2.9 In summary, REM will not only provide an additional service along important transport corridors in the Metropolitan area (Deux-Montagnes, Rive-Sud, Sainte-Anne-de-Bellevue and Aéroport Pierre-Elliott-Trudeau), but it will also provide new alternatives and connectivity to the Métro network (with connections to the Orange, Green, and Blue lines) and provide Montréal's first north-south, high frequency, rapid transit corridor in the Downtown area, linking Bassin Peel, downtown, McGill, and the Université de Montréal area.

Park & Ride Network

2.10 Another change brought about as a result of the introduction of the REM network is changes to Park & Ride provision. Table 2-3 provides a summary of the current and future Park & Ride provision for stations that will form part of the REM network.

Table 2-3: Park & Ride Assumptions

Station	Current Capacity	REM Capacity
Gare Centrale	-	-
McGill	-	-
Édouard-Montpetit	-	-
Canora	-	-
Mont-Royal	-	-
Correspondance A40	-	-
Montpellier	-	-
Du Ruisseau	1,063	1,060
Bois-Franc	742	740
Sunnybrooke	515	400
Roxboro-Pierrefonds	918	1,040
Île-Bigras	65	45
Sainte-Dorothée	1,101	975
Grand-Moulin	304	230
Deux-Montagnes	1,256	1,160
Bassin Peel	-	-
Île-des-Sœurs	-	-
Panama	962	700
Du Quartier	-	-
Rive-Sud	-	3,000
Autoroute 13	-	500
Des Sources	-	500
Pointe-Claire	-	700
Kirkland	-	500
Sainte-Anne-De-Bellevue	-	2,000
Technoparc Saint-Laurent	-	-
Aéroport Pierre-Elliott-Trudeau	-	-
TOTAL	**6,926**	**13,550**

Source: CDPQ Infra Inc. and AMT 2015 annual report

Rail Network Reorganization

2.11 The introduction of REM will result in the following changes to the rail network:

- Deux-Montagnes existing rail service will cease to operate and will be replaced by the REM
- Mascouche Line will be terminated at Correspondance A40 station and will cease to provide services to Gare Centrale. An additional REM service from A40 has been introduced in the operating plan in order to cover this demand and ensure full integration and capacity of the system (see Table 2-2).

Bus Network Reorganization

The bus network assumptions presented in this report are preliminary and based on draft assumptions regarding the routeing and frequencies of services. As the REM project progresses, further bus network analysis and optimisation will be required.

2.12 The introduction of REM will be complemented with a full reorganization of the transit network in the South Shore/A10 Corridor, and the West Island/Deux-Montagnes Corridors. A preliminary bus reorganization plan has been defined by the Société de Transport de Montréal (STM), and was used by the Agence Métropolitaine de Transport (AMT), along with those of the Société de Transport de Laval (STL), the Réseau de Transport de Longueuil (RTL), and other Autorités Organisatrices de Transport (AOTs) in order to conduct simulations and in context of the Transition Committee. The intent of the plan is to optimize the system by avoiding duplication of services and increasing the network coverage and service levels.

2.13 This section summarizes the future bus network reorganization assumptions.

South Shore/A10 Corridor

2.14 The South Shore bus network reorganization is based on assumptions developed by AMT in February 2016. The main objective of the reorganization is to truncate all express bus services that currently cross the Champlain Bridge, in order not to duplicate services and eliminate bus traffic on the Bridge. The approach adopted by AMT was to terminate these services at the most accessible REM station.

2.15 Since February 2016, the definition of the REM alignment and the location of some of the stations have been optimized. At the time of writing this report, AMT has not been able to account for the optimized REM network; therefore, adjustments to the original AMT assumptions will have to be undertaken.

2.16 The key assumptions include:

- ***Station Assumptions***
  - Our approach has been to maintain AMT assumptions, unless the terminal station has been modified with the updated scope of REM. Table 2-4 summarises the key changes in stations since February 2016, which has been the basis for our adjustments.

Table 2-4: REM Station Changes

Initial REM Assumptions (Basis for AMT Restructuring Proposal)	Current REM Design
Grande-Allée	Rive-Sud
Du Quartier	Du Quartier
Chevrier	Chevrier (potential) - not included in scope
Panama	Panama
Île-des-Sœurs	Île-des-Sœurs
Saint-Patrick	Du Havre (potential) - not included in-scope
Griffintown	Griffintown (potential) - not included in-scope
De la Cathédrale	Gare Centrale

Note: Stations might not be at exactly the same location.

  - When no information was available for a specific service between the South Shore and Downtown, it has been assumed that the service will be truncated, terminating at the closest REM station[3].
- ***Level of service***
  - There are gaps in the AMT plan with regards to the level of service during the Interpeak period. It has been assumed that headways will remain as current.

West Island/Deux-Montagnes Line

2.17 Assumptions regarding the West Island bus network reorganization are based on the preliminary assumptions and subject to further discussion and analysis with STM. The approach was to develop a new feeder bus system for the West Island that avoids duplication of services and is better integrated with the REM.

2.18 A summary of Steer Davies Gleave's bus network reorganization assumptions are provided below:

- **Route assumptions:**
  - Most routes are maintained with some alignment modifications that better serve existing communities and feed the REM service.
  - In the preliminary scenario, certain lines will be abolished, modified, or created. These new services directly feed REM stations.
- **Level of service:**
  - For most of the remaining services, levels of service during peak periods increase and stay relatively the same during the Interpeak.
  - Levels of service for the new routes during the AM Peak period used in the preliminary scenario are similar to current express services headways.

[3] This assumption might impact parking demand and number of bus terminals required for each station.

2.19 STM also operates the 747 Express Airport Shuttle. However, STM has not provided assumptions for the level of service when the REM starts operation, which will have a significant impact in ridership on the Aéroport Pierre-Elliott-Trudeau branch. For the base case, as requested by the client, it was assumed that this service will be terminated when REM starts operating.

Fare Assumptions

2.20 It is expected that the current fare structure will remain in place and the REM will be fully integrated into Metropolitan Montréal's transit fare structure.

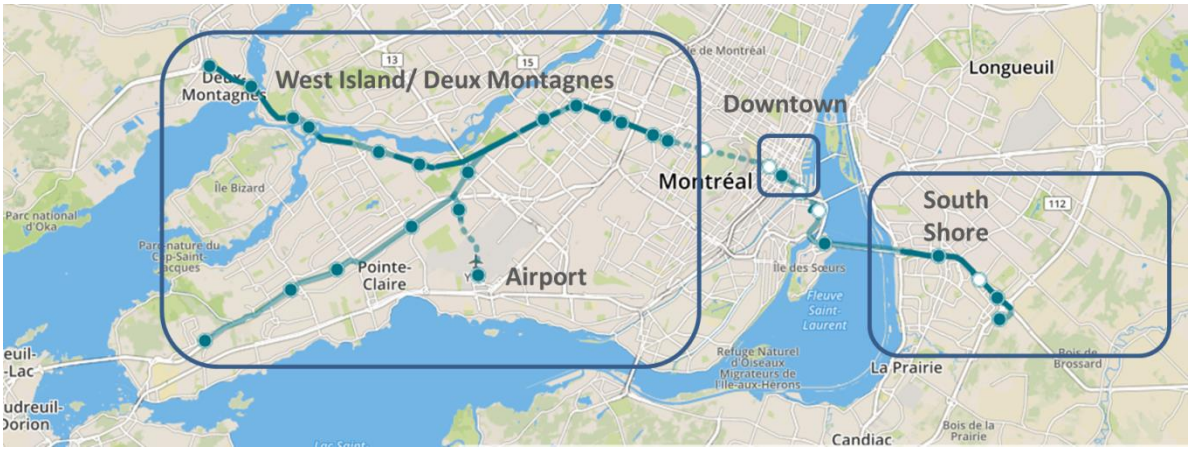
2.21 The only major modification would be related to the REM airport branch, where fares have been assumed to be $5 higher compared to the current 747 Express Airport Shuttle average fare.

3 Current situation

Background

3.1 The REM project will transform the transit offer in the Metropolitan Montréal area, by providing a new efficient, frequent and reliable service between the South Shore, Downtown Montréal, the West Island, Deux-Montagnes and the Aéroport Pierre-Elliott-Trudeau.

Figure 3-1: REM Project



3.2 Although REM will be fully integrated, it will service different markets:

- **South Shore/A10**: clearly dominated by a commuting demand which is very high in the AM Peak in the Montréal direction. This demand is currently served by express bus services that cross the Champlain Bridge using dedicated bus lanes.
- **West Island/Deux-Montagnes Line**: similar to the above, this is a very strong commuting market. However, this demand is served by a variety of services, including rail services and express and local bus services that feed the Orange Line into Montréal.
- **Airport**: very specific demand driven by the Aéroport Pierre-Elliott-Trudeau activity, with a flatter daily profile and peak in the afternoon between 3pm and 6pm.
- **Downtown**: internal demand in downtown area, currently served primarily by Métro lines and STM bus services.

3.3 This section describes the characteristics of each of these markets, the existing demand patterns for transit and auto, how this demand is currently served by the transport network and current transit fares. We discuss each market separately by auto and transit mode in the following sections.

South Shore/A10 Market

Introduction

3.4 The REM will provide a frequent and reliable rail link between the South Shore and Downtown Montréal (as well as the rest of the West Island corridor and the airport corridor).

3.5 The South Shore is the general term for the suburbs of Montréal located on the southern shore of the Saint Lawrence River opposite the Island of Montréal. It includes 26 municipalities and covers 1640.05km^2. With a total population of 919,000 residents, the South Shore represents 23% of the population in the Metropolitan Montréal region. Nearly half of the population of the South Shore is located in Longueuil agglomeration which includes the cities of Longueuil, Brossard, Boucherville, Saint-Bruno-de-Montarville and Saint-Lambert. According to the most recent estimates from the Institut de la Statistique du Québec, the demographic growth rate in the South Shore is greater than on the Island of Montréal. The population is expected to gain 127,950 new residents by 2031[4].

3.6 In 2011, 298,200 jobs (16% of the employment of the Metropolitan Montréal region) were located in the South Shore while more than two thirds of the total employment (1.86 million) is located on the Island of Montréal. With more than 250,000 jobs within less than 18km^2, Downtown Montréal is the biggest employment hub of the region and the Province[5].

3.7 As a result, there is a very strong commuter-driven demand between the South Shore and the Montréal Downtown area, with high peaks in the AM Peak towards Montréal and in the PM peak towards the South Shore.

3.8 Given the natural barrier of the Saint Lawrence River, the river crossing alternatives are limited and, as a result, the South Shore/A10 is one of the highest demand corridors in Metropolitan Montréal for auto and transit users. We describe the existing auto and transit users and current transport provision in the following sections.

Auto Users

3.9 There are limited crossings across the Saint Lawrence River, which results in bottlenecks to access Downtown Montréal at these locations, especially during the peak periods.

3.10 Figure 3-2 shows the most important five crossings from the South Shore.

[4] Communauté métropolitaine de Montréal. 2016. *Portrait of Greater Montréal*. Issue N°5, p.41.
[5] Ville de Montréal. 2013. *Analyse économique: L'emploi à Montréal de 1981 à 2011*, p.2

Figure 3-2: Saint Lawrence River Crossings

Source: Steer Davies Gleave

3.11 The Champlain Bridge carries approximately 28% of the total traffic crossing to/from the South Shore. Although there is a strong component of commuting traffic heading to Downtown Montréal during the AM Peak period, Table 3-1 also shows significant demand levels in the Interpeak period.

Table 3-1: 2013 Saint Lawrence River Crossing Traffic Volumes

Screenline Num.	Name	Direction	6am-9am (3 hours)	9am-3pm (6 hours)
1	Louis Hippolyte Lafontaine Bridge-Tunnel (A25)	To Montréal	13,364	19,939
		From Montréal	11,450	20,830
2	Jacques Cartier Bridge (R134)	To Montréal	12,757	13,863
		From Montréal	5,530	12,663
3	Victoria Bridge (R112)	To Montréal	6,765	4,043
		From Montréal	-	3,697
4	Champlain Bridge (A10)	To Montréal	17,046	17,956
		From Montréal	6,750	18,003
5	Honoré Mercier Bridge (R138)	To Montréal	7,285	9,040
		From Montréal	3,152	8,803
	TOTAL	**To Montréal**	**57,217**	**64,841**
		From Montréal	**26,882**	**63,996**

Source: MTMDET and Steer Davies Gleave analysis

Transit Users

3.12 Transit options are also limited to the crossings along the Saint Lawrence River. The key existing transit options are shown in Figure 3-3 and summarized below:

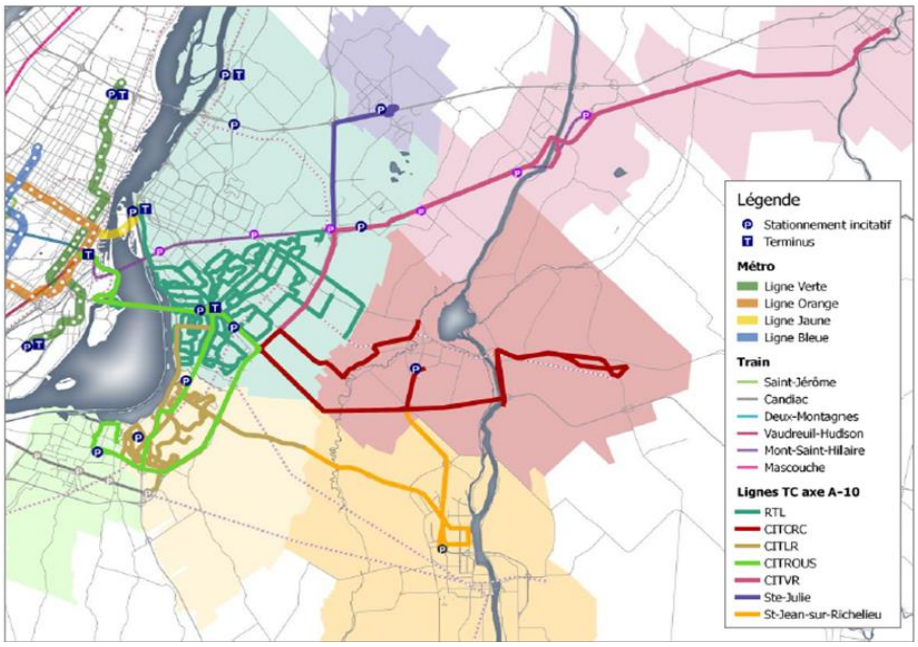
- ***Bus services***
  - ***South Shore/A10***: Is the key transit corridor to access Montréal island by bus, with more than 48 bus routes providing services from the South Shore to Downtown Montréal (Terminus Downtown).
  - ***Bus services on other links***: There are other bus routes that use alternative crossings. However, these routes service areas away from the REM area of influence and present a lower level of service:
    - Honoré Mercier Bridge : 1 route (CIT Roussillon : route 200)
    - Jacques Cartier Bridge: 3 routes (RTL: route 86, 87 and 170)
    - Louis-Hippolyte LaFontaine Bridge-Tunnel : 1 route (RTL: route 61)
    - Victoria Bridge: 1 route (RTL: route 55)
- ***Metro Yellow line***: Provides a reliable transit service between Longueuil and Downtown Montréal. Travel time between Longueuil–Université de Sherbrooke station and Berri-UQAM station is 9 minutes, whereas travel time to Bonaventure station is approximately 17 minutes. The Line has a frequency of 5 minutes during the AM Peak period.
- ***Mont-Saint-Hilaire:*** This AMT commuter rail line provides a direct service to Downtown Montréal (Gare Centrale) from Mont-Saint-Hilaire. Six of the seven stations are located on the South Shore. Travel time from Mont-Saint-Hilaire to Gare Centrale is 50 minutes, whereas travel time from Saint-Lambert station, which is the last station before Montréal, is 11 minutes. This commuter rail service runs every 25 to 30 minutes in the AM Peak period.

Figure 3-3: Saint Lawrence River Crossing Transit Alternatives

South Shore/A10 corridor

3.13 The transit demand in the **South Shore/A10 corridor** is currently served by 48 bus routes operated by different transit service providers. These routes provide direct access to Downtown Montréal from different areas within the South Shore. The operator with greatest demand is RTL (shown in dark green in Figure 3-4) that provides services to Longueuil.

Figure 3-4: Current Transit Network (South Shore)



Source: Agence Métropolitaine de Transport

3.14 These 48 routes provide a combined frequency over the Champlain Bridge of approximately 200 services in the AM Peak hour. However, this frequency drops to approximately 21 services in the Interpeak period (9am–3pm), which clearly shows that the service is driven by the commuter needs of residents of the South Shore.

3.15 These express bus services provide competitive travel times in the peaks (despite high levels of congestion on Champlain Bridge) as transit services use segregated bus lanes across the bridge. As a result, travel times only increase from 19 minutes in the Interpeak direction to 24 minutes in the peak direction.

3.16 The competitiveness and convenience of the South Shore/A10 transit corridor has encouraged the use of transit, presenting very high transit market share compared to other corridors. Table 3-2 presents the demand in the corridor per transit agency and for those bus routes that cross the bridge to access Downtown Montréal.

Table 3-2: South Shore/A10 Corridor Demand (October Weekday in 2015)

Transit agency	Peak (6am-9am)	Interpeak (9am-3pm)
RTL	9,557	**6,399**
AMT	2,768	**783**
Ville de Saint-Jean-sur-Richelieu	1,336	**958**
CIT Le Richelain	2,025	**476**
CIT Vallée-du-Richelieu	149	**64**
CIT Chambly-Richelieu-Carignan	1,577	**286**
CIT Roussillon	875	**214**
OMIT Sainte-Julie	481	**20**
TOTAL	**18,768**	**9,200**

Source: Steer Davies Gleave analysis based on data from RTL, AMT, Ville de Saint-Jean-sur-Richelieu, Gestrans and OMIT Sainte-Julie

3.17 Within the South Shore/A10 transit corridor, Park & Ride facilities are provided at the critical transit interchange stations. Currently Panama and Chevrier stations have a total capacity of 3,275 spaces (see Table 3-3). These facilities are currently free of charge and are typically at full capacity from early in the AM Peak which suggests that there is unsatisfied demand due to parking capacity constraints.

Table 3-3: South Shore Park & Ride Spaces and Occupancy (2015)

Location	Size	Occupancy
Panama	962	100%
Chevrier	2,313	89%
Total	**3,275**	**92%**

Source: Agence Métropolitaine de transport 2015. Rapport annuel de 2015

West Island/Deux-Montagnes Line Market

Introduction

3.18 The REM will provide a frequent and reliable rail link between the West Island/Deux-Montagnes Line and Downtown Montréal (as well as the South Shore/A10). It will not only improve the service currently provided by the Deux-Montagnes Line, but it will also extend its alignment to the Pointe-Claire and Sainte-Anne-de-Bellevue areas.

3.19 The West Island is the unofficial name given to the cities, towns and boroughs at the western end of the Island of Montréal. In 2011, the total population of the West Island was approximately 236,000 residents[6]. The second biggest employment hub (Saint-Laurent/Dorval) in Greater Montréal is located on the West Island. This hub counts more than 190,000 jobs and is home to the Aéroport Pierre-Elliott-Trudeau, John Abbott College, Cégep Gérald-Godin, the Macdonald Campus of McGill University, the Fairview Pointe-Claire and Galeries des Sources malls, STM Fairview bus terminal, as well as Montréal's largest park, the Cap-Saint-Jacques nature park.

3.20 The Deux-Montagnes line crosses part of the West Island, Laval, and ends in the North Shore in Deux-Montagnes. Residential areas along the Deux-Montagnes line, especially on the North Shore are amongst the fastest growing in terms of population in the region. In 2011, the North Shore had 208,400 jobs which equates to 11.6% of the total employment in the Metropolitan Montréal region[7].

3.21 As a result, there is a very strong commuter-driven demand between the West Island/Deux-Montagnes corridor and the Downtown Montréal area, with high peaks in the AM Peak towards Montréal and in the PM peak in the reverse direction.

Auto Users

3.22 The REM Line will operate in parallel to the A40 for a great part of its alignment, although the A20 could also provide an alternative route for some destinations.

3.23 In order to understand the auto demand in the West Island/Deux-Montagnes Line corridor, two screenlines have been created that include the Autoroute Du Souvenir (commonly called A20) and Autoroute Félix-Leclerc (A40):

- Screenline 1 is located between Pointe-Claire and Des Sources stations along Autoroute Félix-Leclerc and Autoroute du Souvenir.
- Screenline 2 is positioned between Des Sources and Autoroute 13 stations.

3.24 Total traffic volumes from the two screenlines by direction are detailed in Table 3-4. The location of the screenlines is shown in Figure 3-5.

[6] Communauté métropolitaine de Montréal. 2016. *Portrait of Greater Montréal*. Issue N°5, p.41. This excludes the Saint-Laurent borough and the borough to its northern and eastern end.

[7] Ville de Montréal. 2013. *Analyse économique: L'emploi à Montréal de 1981 à 2011*, p.2

Figure 3-5: West Island Auto Screenlines

3.25 Traffic volumes peak between 6am and 9am heading into the Montréal area, as a result of the high proportion of commuting traffic. Screenline 2, which lies closer to Downtown Montréal displays significantly higher traffic volumes (approximately twice as high) as Screenline 1.

Table 3-4: West Island Corridor Traffic Demand (2013)

Direction	Screenline 1		Screenline 2	
	6am-9am	9am-3pm	6am-9am	9am-3pm
To Montréal	21,893	26,476	43,385	55,860
Towards West	10,489	23,818	19,424	42,008

Source: MTMDET

Transit Users

3.26 The West Island of Montréal covers a very large area. To cater for this demand, there is an extensive transit network of commuting rail (Deux-Montagnes Line and Vaudreuil-Hudson Line) and bus services that provide access to Downtown Montréal either directly or via the Orange Line.

Rail Network

3.27 The West Island/Deux-Montagnes Line Corridor is currently served by two rail commuting services and one Métro Line as shown in Figure 3-6.

- ***Deux-Montagne Line*** is currently owned and operated by AMT. Although services are relatively fast, the frequencies are poor with three services per hour in the peak and less than one service per hour in the Interpeak period.
- ***Vaudreuil-Hudson Line*** provides services in the southern part of the West Island/Deux-Montagnes Line Corridor. At present, the Vaudreuil-Hudson Line operates at or near capacity during peak hours and offers very limited service during Interpeak hours. In addition to a relatively early termination of service in the evening, current priority of freight transport over commuter traffic limits expansion of services along the southern rail corridor.

3.28 The ***Métro Orange Line*** is a key component of the existing transit network, since many of the express and local buses in the West Island terminate at an Métro Orange Line station which provides access to Downtown Montréal and the Métro network. The Métro Orange Line provides services every 4 minutes during the morning peak period (every 8 minutes during the Interpeak period) and travel times are relatively long due to the high number of stations (average speed of 40km/h). Moreover, the eastern branch of the service is currently congested in the peak hour.

3.29 Although they do not operate directly in the West Island/Deux-Montagnes Line Corridor, the following rail services are also relevant to the study since they can feed demand to REM.

- The ***Mascouche Line***, which currently provides direct access to the Gare Centrale using the Mount Royal tunnel, will terminate in the future at a station near the Autoroute 40 and is expected to feed demand to the REM network. This service started operations in 2014, currently has 13 stops and offers 8 services in each direction on weekdays, mainly during the peak hour.
- The ***Saint-Jérôme Line***, which currently terminates at Lucien L'Allier, could also potentially feed demand to the REM network if it is integrated. The current Mount Royal tunnel and Gare Centrale conditions do not allow the Saint-Jérôme Line to use the tunnel and it has to detour 20 minutes via Lachine. However, this rail line provides three connections with the Métro network: De La Concorde station in Laval (Orange Line), Parc (Blue Line) and Lucien L'Allier (Métro Orange Line). The frequency of service is every 25-45 minutes during the peak hour and one service every two hours outside of the peak hour, of which five services continue to, or begin at, the Lucien-L'Allier station. All other trips begin or end at the Parc Métro station.

3.30 Figure 3-6 shows the rail and Métro line alignments and stations on the West Island/Deux-Montagnes Line Corridor.

Figure 3-6: Rail and Métro Network in the West Island/Deux-Montagnes Line Corridor

3.31 Currently, the Deux-Montagnes Line (DM) has the highest ridership, with almost 32,000 daily riders. Table 3-5 shows that most of the rail services have a strong component of commuting demand demonstrated by the majority of demand travelling in the peak periods.

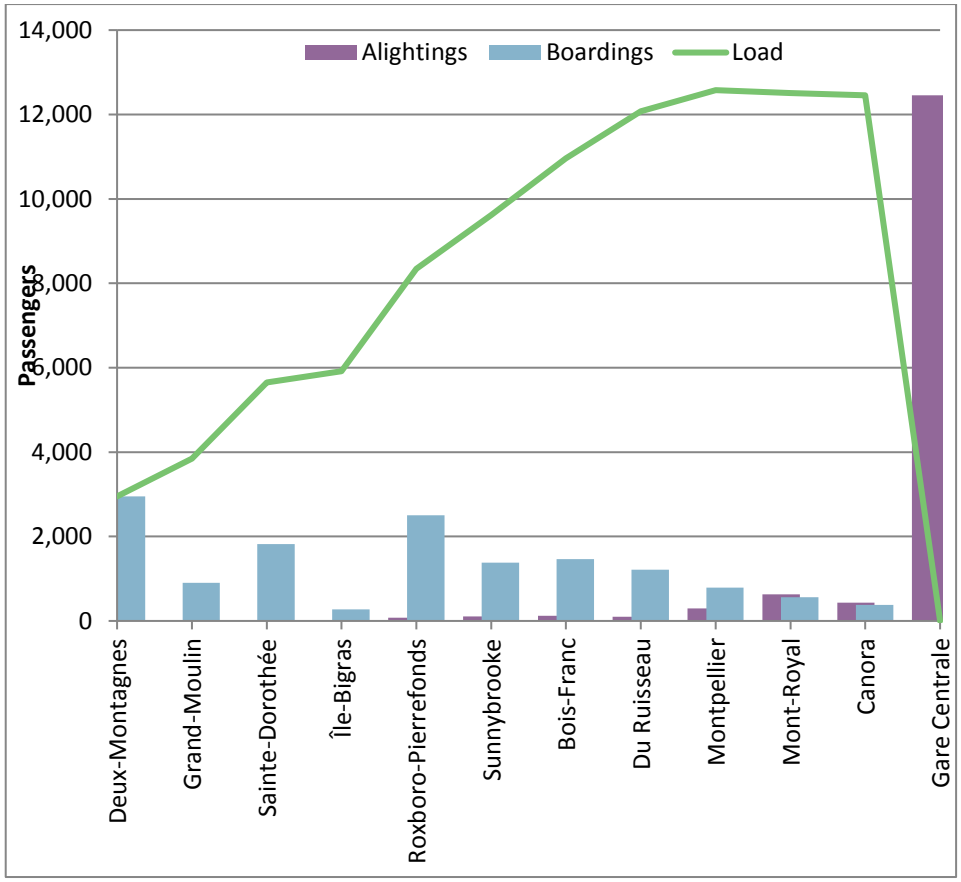
Table 3-5: AMT Average Ridership (2015)

AMT commuter rail	6am-9am	9am-3pm	Daily
Deux-Montagnes Line	14,371	4,580	31,835
Vaudreuil-Hudson Line	8,450	1,238	17,588
Mascouche Line	2,421	199	4,905
Saint-Jérôme Line	6,792	1,068	13,709

Source: Agence Métropolitaine de Transport

3.32 Figure 3-7 shows the boardings and alightings of the DM Line per station for the AM Peak. Figure 3-7 shows the majority of demand alights at Gare Centrale with very limited activity at intermediate stations. The peak load is around 12,000 passengers in the AM Peak hour.

Figure 3-7: Deux-Montagnes Line AM Peak Profile (Sept 11th 2014) – To Downtown Montréal



Source: AMT

Bus Network

3.33 STM is the main bus service provider in the western part of the Island of Montréal. It operates 53 in-scope bus services, which cover both express and local services. Frequencies vary depending on the route.

3.34 Table 3-6 presents the demand for each type of bus route and for an average weekday in October 2015. The express routes have higher demand in the peak period, as expected, while the non-express routes have higher demand in the Interpeak period due to shorter trips on these services.

Table 3-6: West Island/Deux-Montagnes Line Bus Demand (October 2015 weekday)

	Peak (6am-9am)	Interpeak (9am-3pm)	Daily
Express routes in scope	12,580	10,611	41,404
Non-express routes in scope	42,392	50,902	174,782
747 Express Airport Shuttle*	493	1,730	5,304
Total	**55,465**	**63,243**	**221,490**

Source: STM and Steer Davies Gleave analysis
* This bus is the express service to the Aéroport Pierre-Elliott-Trudeau

3.35 The express routes currently provide longer distance services with a lower number of stops. Some routes terminate at an interchange station, mainly with the Métro Orange Line or at Terminus Fairview. Table 3-7 shows the demand for each of the express routes in the West Island/Deux-Montagnes Line corridor, as well as their key connections with other rail modes to access Downtown Montréal. Some of the areas served by these routes in the future will be covered by the REM network or they will feed passengers to REM stations with minor modifications to their layout:

Table 3-7: Express Service Demand in the West Island of Montréal (October 15 weekday)

Express Routes in Scope	Current Connections with the Métro and AMT network	Assumed Connections with REM	AM Peak (6am-9am)	Interpeak (9am-3pm)	Daily Demand
401	None	None	106	-	277
405	None	None	609	1,004	2,495
407*	Roxboro-Pierrefonds (DM)	Roxboro-Pierrefonds & Pointe-Claire	185	-	414
409	Du Collège (OL)	None	650	147	1,442
411	Lionel-Groulx (OL)	None	516	395	1,333
419*	None	Sainte-Anne-de-Bellevue, Kirkland & Pointe-Claire	495	815	1,929
425	None	None	258	377	1,053
460*	Du Collège Sud (OL)	Technoparc Saint-Laurent	3,049	411	7,192
468	Roxboro-Pierrefonds (DM)	None	811	1,018	2,715
470*	Côte-Vertu (OL)	Pointe-Claire & Des Sources	2,241	3,267	10,701
475	Côte-Vertu (OL)	None	235	24	374
485	Lionel-Groulx (OL)	None	548	723	2,090
491*	Lionel-Groulx (OL)	None	798	512	2,106
495*	None	Aéroport Pierre-Elliott-Trudeau	697	874	2,977
496*	Lionel-Groulx (OL)	Aéroport Pierre-Elliott-Trudeau	1,380	1,045	4,306
Total			**12,578**	**10,612**	**41,404**

Note: Routes without asterisks would not be in service in 2021. They would be replaced by 14 new services serving REM stations. OL = Métro Orange Line, DM = Deux-Montagnes Line (AMT)

Park & Ride Facilities

3.36 In the West Island/Deux-Montagnes Line Corridor, many of the rail stations currently have Park & Ride facilities. Stations on the Deux-Montagnes Line provide a total capacity of 5,964 spaces (see Table 3-8). These facilities are currently free of charge and are typically at full capacity from the early peak hour period (average occupancy of 91%), which suggests that there is unsatisfied demand due to the capacity constraints of the car parks.

Table 3-8: West Island/Deux-Montagnes Park & Ride sites

Deux-Montagnes Line	Size	Occupancy
Du Ruisseau	1,063	82%
Bois-Franc	742	91%
Sunnybrooke	515	98%
Roxboro–Pierrefonds	918	92%
Île-Bigras	65	99%
Sainte-Dorothée	1,101	92%
Grand-Moulin	304	96%
Deux-Montagnes	1,256	92%
Total	**5,964**	**91%**

Source: AMT Annual Report

Aéroport Pierre-Elliott-Trudeau Market

Introduction

3.37 The REM will provide frequent and reliable access to/from Aéroport Pierre-Elliott-Trudeau for air passengers and staff travelling from the South Shore, Downtown Montréal, the West Island and Deux-Montagnes. At the moment, the majority of people drive and park at the airport. There is also a significant number of people who are driven to the airport either by a friend/family member or in a taxi.

3.38 The only current public transport option is the 747 Express Airport Shuttle operated by STM. The 747 Express Airport Shuttle service runs 24 hours a day, 7 days a week, between Aéroport Pierre-Elliott-Trudeau and Berri-UQAM Métro station, east of Downtown Montréal. Frequencies vary through the day, from one bus every 7-10 minutes to two buses per hour. The 747 Express Airport Shuttle route is shown in Figure 3-8.

3.39 The total end to end travel time ranges from 45 minutes to 60 minutes, depending on traffic conditions. Travel times vary particularly on the A20 and on René-Lévesque, the main road through Downtown Montréal.

Figure 3-8: 747 Express Airport Shuttle Route Alignment and Stations

Source: STM Website (http://www.stm.info/en/info/networks/bus/shuttle/more-about-747-aeroport-p-e-trudeau-centre-ville-shuttle)

Demand

3.40 Demand for travel to the Aéroport Pierre-Elliott-Trudeau includes:

- Aéroport Pierre-Elliott-Trudeau passenger demand; and
- Aéroport Pierre-Elliott-Trudeau staff demand.

3.41 Aéroport Pierre-Elliott-Trudeau passenger demand is based on the actual number of air passengers flying into or out of Aéroport Pierre-Elliott-Trudeau using information directly from Aéroports de Montréal (ADM).

3.42 This demand has been estimated differently from the rest of the transit network demand in order to include passengers who currently travel by car (either Park & Fly, Kiss & Fly or take a taxi). We consider that for the airport, these car drivers/passengers are “in-scope” to possibly switch to REM, as well as bus users who are considered to be the primary target for REM.

3.43 The total passenger demand for the airport is estimated to be 15.5 million passengers in 2015. This includes:

- 5.87 million passengers on Domestic flights
- 3.70 million passengers on Transborder flights
- 5.93 million passengers on International flights

3.44 Clearly not all airport passengers could use REM for their journey to/from the Aéroport Pierre-Elliott-Trudeau. Some passengers were excluded from our analysis for the following reasons:

- Passengers who are using Aéroport Pierre-Elliott-Trudeau to connect to another flight and do not leave the airport (18%).
- Passengers who were arriving/leaving the Aéroport Pierre-Elliott-Trudeau while REM is not in operation (e.g. in the middle of the night) (7%).

3.45 Airport staff demand has also been calculated using information from ADM; there were around 27,000 employees in the airport and its hinterland in 2015. ADM also provided details of roles and working patterns, which showed that in 2015, 41% of staff worked “normal hours”, 46% worked long shifts and 13% were pilots or cabin crew.

3.46 In order to convert the number of employees into the number of trips to/from Aéroport Pierre-Elliott-Trudeau, we made the following assumptions:

- Each airport employee works 46 weeks per year.
- Employees who work normal working hours travel to or from the airport 10 times a week.
- Employees who work long shifts travel to or from the airport 6 times a week.
- Pilots and cabin crew travel to or from the airport twice a week.

3.47 Based on this, we estimated employees in the airport area made 8.8 million trips to/from the Aéroport Pierre-Elliott-Trudeau in 2015. As with airport passengers, we also excluded airport staff who:

- Travelled to/from the Aéroport Pierre-Elliott-Trudeau outside REM operating hours (7%)
- Live outside the Montréal area (3%)

3.48 In order to improve the mode choice preferences by market segment in the model, we have developed a number of market segmentations of the air passenger and airport staff demand. The market segmentations have been generally estimated from ADM surveys.

Distribution of demand

3.49 The airport model includes a number of different levels of segmentation. This allows us to have different profiles for different types of people. The profiles determine how likely someone is to switch to REM given their current travel time (which includes walk time, wait time, in vehicle travel time and fare (if they use public transport).

3.50 Our segmentation is explained below:

- Spatial segmentation: We developed a zoning system of 68 zones across Montréal and distributed airport passengers and staff so that each person travels between the airport and one of these zones. Our segregation varies for:
  - Airport passenger residents: based on the demand distribution in the EMME[8] traffic model
  - Airport passenger non-residents: based on the Steer Davies Gleave 2016 airport survey
  - Airport staff: based on the ADM 2008 staff survey
- Passenger type segmentation based on the ADM surface access survey. This includes:
  - Splitting passengers by their current mode of transport to/from the Aéroport Pierre-Elliott-Trudeau (including bus, taxi, Car Park & Fly and Car Kiss & Fly)
  - Residents of Montréal and non-residents

[8] EMME is a travel demand modelling software package produced by INRO Software. The forecasts in this report have been completed using a custom-built travel demand forecasting model that uses EMME software.

- Purpose of travel: Business and non-business
- Whether passengers are travelling alone or in a group
- Time of travel: AM Peak (3 hours 6am-9am) and Interpeak (6 hours 9am to 3pm)[9]

- Staff type segmentation based on the 2008 ADM staff survey. This includes:
  - Splitting staff numbers by their current mode of transport to/from the Aéroport Pierre-Elliott-Trudeau (including bus and car Park & Fly)
  - Time of travel: AM Peak and Interpeak[9]

3.51 Table 3-9 provides a summary of total airport passengers demand by market segment in the AM Peak and Interpeak periods.

Table 3-9: 2015 In-Scope Airport Passenger Demand– AM Peak and Interpeak

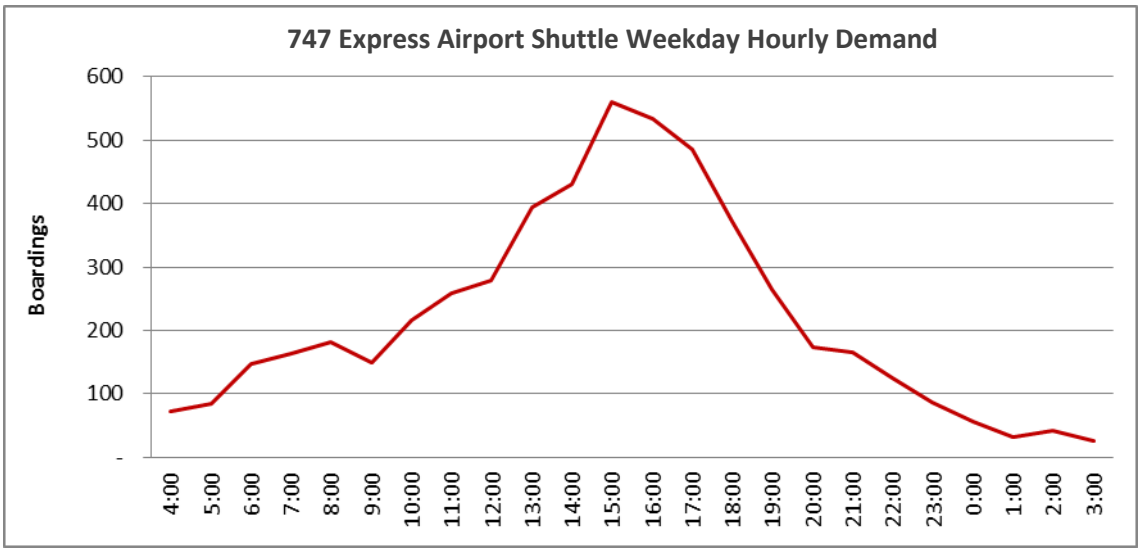
		Bus		Taxi	Car Park & Fly		Car Kiss & Fly
		747 Passengers	Airport Staff Local Bus	Passengers	Passengers	Airport Staff	Passengers
Time of Day	AM Peak (6am-9am)	493	122	1,362	889	1,095	1,973
	Interpeak (9am-3pm)	1,730	122	3,234	1,685	1,095	4,456
Journey purpose	Business	509	-	1,824	1,007	-	922
	Non Business	1,714	-	2,772	1,567	-	5,507
	Airport staff	-	122	-	-	1,095	-
Residency	Non-resident	342	37	966	105	-	686
	Resident	1,881	207	3,630	2,469	2,190	5,743
Group size	Alone	1,917	210	2,868	1,167	2,190	3,743
	In a group	306	34	1,728	1,407	-	2,687
Total		**2,223**	**244**	**4,596**	**2,574**	**2,190**	**6,429**

[9] Only AM peak and Interpeak travel modelled in detail. The PM peak is included in our expansion factors of the AM and Interpeak results

Existing 747 Express Airport Shuttle Demand

3.52 The main transit access to the Aéroport Pierre-Elliott-Trudeau is the 747 Airport Express Shuttle service. This service registered an average daily demand of 5,300 passengers for an average weekday in October 2015 (493 passengers in the AM Peak and 1,730 in the Interpeak). The peak demand for this service occurs between 2pm and 5pm, which partially overlaps with the commuting PM peak. Figure 3-9 shows the hourly profile of the service.

Figure 3-9: 747 Express Airport Shuttle Weekday Hourly Demand Profile



Source: STM

3.53 As shown in Table 3-10, the hourly demand in the AM Peak period is much lower than the Interpeak hour demand.

Table 3-10: 747 Express Airport Shuttle Service Demand (October 2015 Weekday)

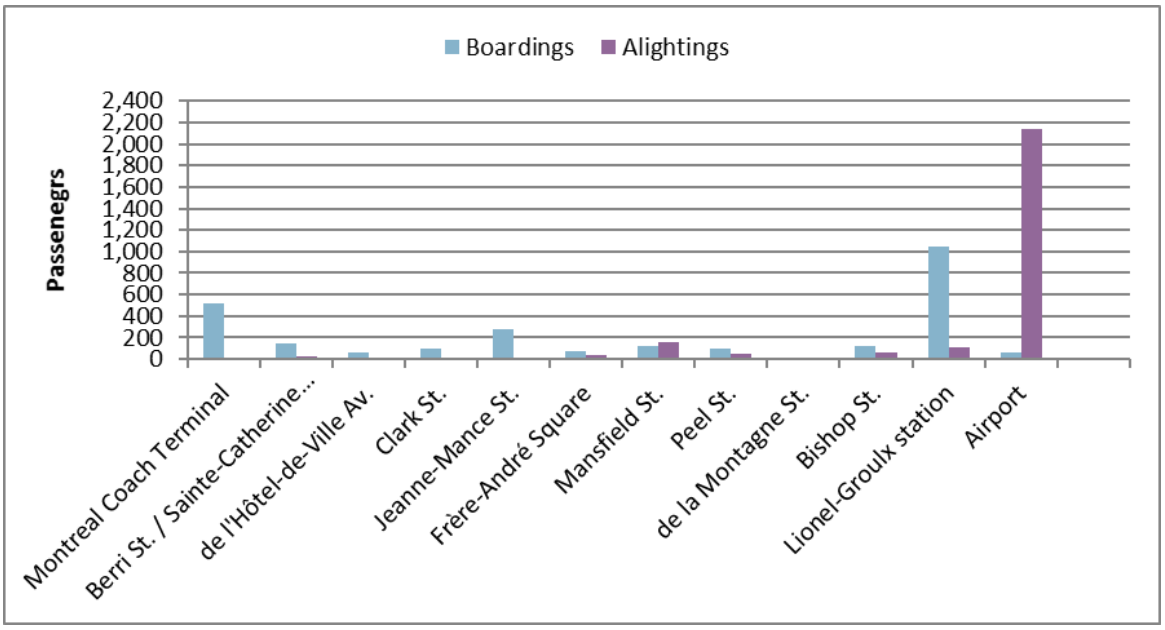
Route	AM Peak (6am-9am)	Interpeak (9am-3pm)
747	493	1,730

Source: STM

3.54 Figure 3-10 shows the boardings and alightings of the 747 Express Airport Shuttle service per stops and direction. Most users board at Lionel-Groulx Métro station. It is observed that very few people board or alight in the heart of downtown on René-Lévesque.

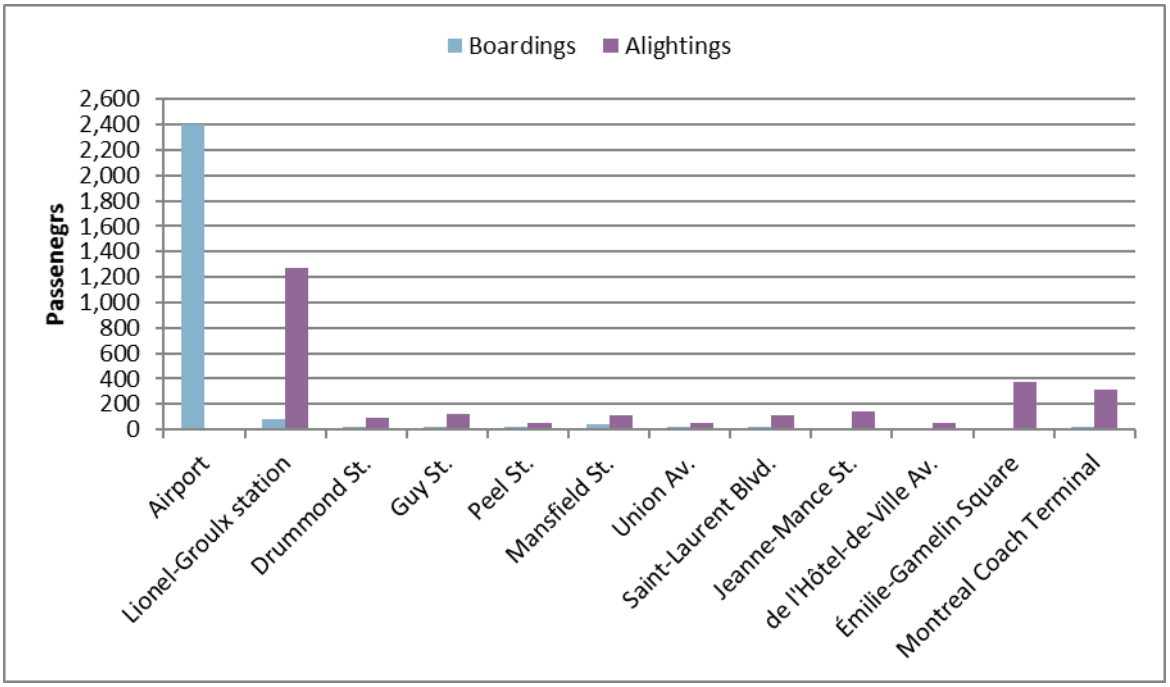
Figure 3-10: Average 747 Express Airport Shuttle Service Daily Boardings and Alightings (March-June 2015)

Westbound (to Aéroport Pierre-Elliott-Trudeau)



Source: STM, Steer Davies Gleave analysis

Eastbound (from Aéroport Pierre-Elliott-Trudeau)



Source: STM, Steer Davies Gleave analysis

Downtown Montréal Market

Introduction

3.55 For the purpose of this study, the downtown market covers the area south of the Métro Blue Line, between the western and eastern branches of Métro Orange Line and north of the Saint Lawrence River as shown in Figure 3-11. Downtown is the central business district and heart of Montréal.

Figure 3-11: Downtown Area

3.56 Downtown Montréal is the main employment hub of the metropolitan area. With more than 250,000 jobs and the highest employment density in Québec, the Downtown far outweighs other employment concentrations in the region and in the province as a whole. In the Montréal region, one in five jobs is located downtown[10]. In addition, most international conventions, headquarters of international organizations and consulates are located downtown.

3.57 Downtown Montréal is also Québec's main educational, artistic and cultural hub. A large proportion of Québec's most popular venues and tourist attractions are located Downtown (Old Port, Old Montréal, Quartier des spectacles). Downtown Montréal is also home to three major universities and multiple colleges and CEGEP. These include:

- Université du Québec à Montréal (UQAM) (about 66,000 students)

[10] Statistics Canada. 2011. *National Household Survey customized by place of work*, presented in *Downtown Strategy-Building on momentum* (Retrieved online on 15 January 2017)

http://ocpm.qc.ca/sites/ocpm.qc.ca/files/document_consultation/vmvma-16-026_strategie_centre-ville_final.pdf

- McGill University (about 40,000 students)
- Concordia University (about 44,000 students)
- Cégep du Vieux-Montréal (about 6,100 students)

3.58 Université de Montréal's main campus (about 55,000 students) is located on the northern slope of Mount Royal and is one of the main destinations of the downtown area.

Transit Demand

3.59 The downtown area is a densely populated area. To cater to the internal transit demand of this area, and the inter-urban demand from elsewhere in the region, there is an extensive network of Métro lines and bus services that provide access to the main points of interest.

Métro Demand

3.60 The Montréal Métro system consists of four lines operated by the Société de Transport de Montréal (STM) identified by their colour. All lines serve the downtown area.

- **Métro Orange Line** measures 30 km in length and has 31 stations. The line runs in a "U"-shape from Côte-Vertu in northwestern Montréal to Montmorency in Laval to the northeast of Montréal. The lower part of the 'U' crosses downtown from west to east. The busiest section of the line is between Jean-Talon and Bonaventure stations.
- **Métro Green Line** is a key component of the transit network. This 22.1 km line offers an efficient east-west transit service. The line runs through the heart of downtown. Trains on this section can become extremely congested during rush hour, with significant passenger numbers between McGill and Berri-UQAM stations. In Downtown, the Métro Green Line runs parallel to the Métro Orange Line and has two direct interchanges with the Orange Line (at Lionel-Groulx and Berri-UQAM stations) and one interchange with the Yellow Line (Berri-UQAM station).
- **Métro Blue Line** measures 9.7 km and runs mainly on an east-west axis north of Mount Royal. The main source of the line's demand is the Université de Montréal, Notre-Dame-de-Grâce and the dense residential areas beyond the west end of the line. The line connects with both Métro Orange Line branches at Snowdon and Jean-Talon stations.
- **Métro Yellow Line** is the shortest line on the network (4.25 km) and only has three stations. This line links Longueuil on the South-Shore to Berri-UQAM station.

3.61 The Métro Orange Line is the busiest line of the entire network. In 2015, passenger demand on the line was near to 114.1 million, while 98.5 million rode the Green Line, 25.6 million the Blue Line and 10.8 million the Yellow Line. Table 3-11 shows the average daily demand for each line in October 2015.

Table 3-11: Metro Daily Demand (October 2015)

Métro Line	Average Daily Demand
Orange Line	343,700
Green Line	286,500
Blue Line	79,100
Yellow Line	32,100
TOTAL	**741,400**

Source: Société de Transport de Montréal
Daily demand refers to 7 day average demand (including weekend)

3.62 STM only provided Métro stations boardings and no alighting data was available. Considering the importance of the new REM stations at Édouard-Montpetit and McGill, passenger counts were undertaken at McGill, Université de Montréal and Édouard-Montpetit Métro stations in December 2016 to better understand the transit demand in the areas surrounding the stations. Table 3-12 presents the transit demand observed at these stations (converted to average 2015 weekday data).

Table 3-12: Metro Station Weekday Demand (2015)

Station	AM Peak (6am-9am)		Interpeak (9am-3pm)	
	Boardings	Alightings	Boardings	Alightings
McGill	916	15,423	7,690	14,765
Université de Montréal	435	7,010	3,003	6,490
Édouard-Montpetit	313	1,924	1,596	2,594

3.63 With an average of 36,500 boardings per day (7 day week including weekends), McGill station is the second busiest station on the network after Berri-UQAM (38,600). Université de Montréal (13,500) is the 27th busiest station while Édouard-Montpetit (5,400) is the 54th. All seven downtown stations are among the top ten most used.

Bus Demand

3.64 Downtown is currently served by more than 60 bus routes which are operated by STM. Most routes provide access to Downtown from the north and west. No route serves Downtown exclusively.

Figure 3-12: Downtown STM Bus and Métro Network (2015)

Source: *Société de Transport de Montréal*

3.65 There are four bus routes that would be in competition with the McGill to Édouard-Montpetit segment of REM. These include:

- Bus route 165 – Côte-des-Neiges (north-south service)
- Bus route 80 – Du Parc (north-south service)
- Bus route 435 – Express Du Parc/Côte-des-Neiges (north-south service)
- Bus route 51 – Édouard-Montpetit (east-west service)

3.66 These bus services allow transit users to travel from downtown Montréal to Université de Montréal. Route 165 runs along Chemin de la Côte-des-Neiges on the west side of Mont-Royal, while route 80 operates along Avenue Du Parc on the eastern side. Route 435 is an express bus service, running during peak periods, along these two same roads in a "U" shape. Finally, route 51 runs along Édouard-Montpetit Boulevard where many of the Université de Montréal buildings are located; route 51 also connects with routes 165, 80, and 435. These bus services operate on roads parallel to the future REM alignment. Travel times from downtown to Université de Montréal on these routes are between 28 and 40 minutes. Table 3-13 presents the bus ridership for downtown services; routes 165, 80, 435 and 51 are among the highest in the network in terms of ridership. With the addition of REM, the ridership on these routes will decrease significantly.

Table 3-13: Downtown Bus Route Ridership (2015)

STM Bus Route	AM Peak (6am-9am)	Interpeak (9am-3pm)	Daily Demand
15	35	314	733
24*	5,060	7,550	21,182
51	6,945	10,103	28,587
55	2,969	4,795	13,415
61*	891	828	2,805
74*	39	17	170

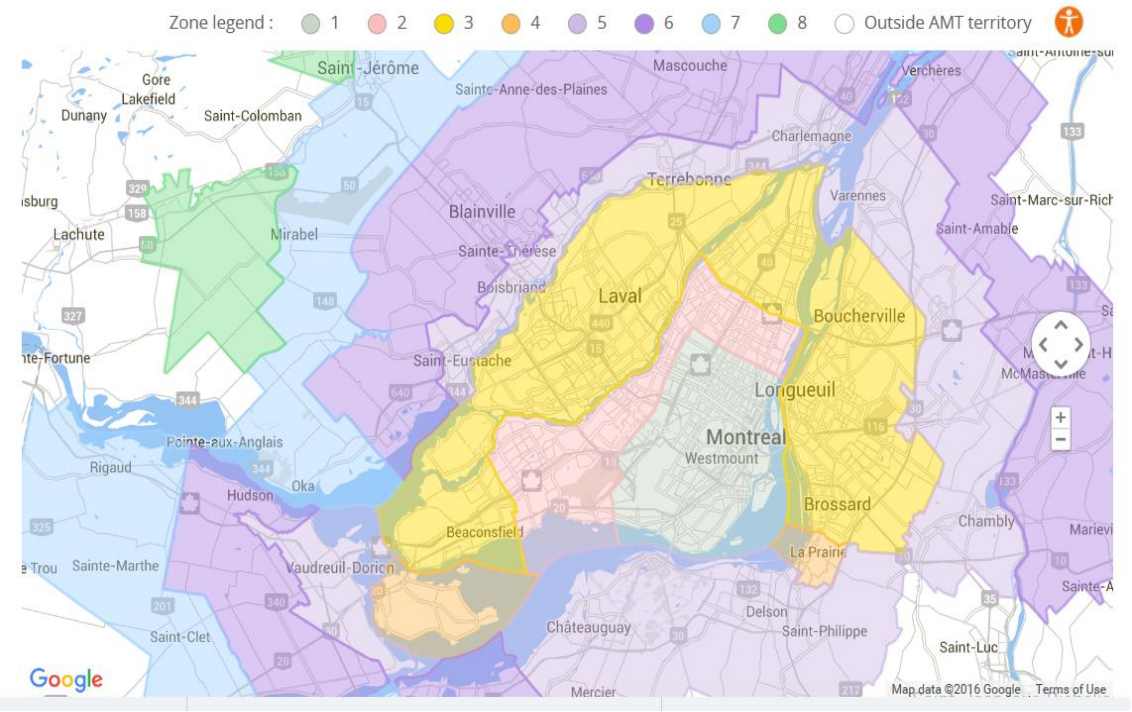
STM Bus Route	AM Peak (6am-9am)	Interpeak (9am-3pm)	Daily Demand
80	**2,864**	**6,107**	**17,193**
92	405	784	2,037
107*	1,027	847	3,046
119	539	685	1,710
125	269	737	2,175
129*	**2,254**	**2,282**	**6,901**
160	1,325	1,721	5,459
161	4,419	6,463	19,544
165*	**4,618**	**11,282**	**26,389**
166	597	839	2,641
168	1,864	1,558	6,334
178	317	86	732
410	175	-	1,092
420*	445	298	1,026
427	1,985	-	3,169
430	132	175	1,083
435*	3,792	1,651	10,961
715	122	372	810
715	122	372	810
TOTAL	**43,211**	**59,865**	**180,003**

*Note: * indicates whether the route could have a direct connection to a REM stations. **Bold** numbers indicate competitive bus services to REM i.e. routes between Downtown and Université de Montréal area.*
Source: Société de Transport de Montréal.

Existing Fares

3.67 The REM area of influence is covered by the AMT TRAM integrated ticketing structure, which allows passengers to use the whole transit network in the Montréal Region. AMT fares are classified according to a zoning system of 8 zones. Figure 3-13 shows the fare zone map.

Figure 3-13: AMT Fare Zone Map (August 2016)



Source: AMT/Google

3.68 AMT has a wide range of products and concessions, with fares differentiated by[11]:

- **Zones**: Fares differ depending on the origin and destination of the trip according to the 8 zone system;
- **Type of user**: Fares are split into regular (*ordinaire*), reduced (*réduit*) and student (*étudiant*);
- **Mode**: There are different products available depending on the mode used; TRAM (Commuter rail, bus and Métro) and TRAIN (Commuter rail only); and
- **Products**: Tickets are available for different frequency users; monthly (*mensuel*), 6-ticket booklets (*carnet*) and individual tickets (*billet*).

3.69

3.70 Table 3-14 shows the average fare estimated for each of the in-scope zones for adults and Table 3-15 shows the average fare for students.

[11] https://www.amt.qc.ca/fr/titres-tarifs/titres-Métropolitains

Table 3-14: Average Fare – AMT Adults (2015 $)

ADULT Zone	TRAM Fare SINGLE TICKET	TRAM Fare 6-TICKET BOOKLET	TRAM Fare MONTHLY FARE (*)	TRAIN Fare SINGLE TICKET	TRAIN Fare 6-TICKET BOOKLET	TRAIN Fare MONTHLY FARE	AVERAGE ADULT (**)
1	$4.43	$2.83	$1.92	$3.91	$2.51	$1.75	**$2.01**
2	$5.44	$3.30	$2.33	$4.40	$3.01	$2.06	**$2.38**
3	$6.37	$3.96	$2.77	$5.38	$3.56	$2.45	**$2.77**
4	-	-	$2.95	$5.91	$3.84	$2.67	**$3.02**
5	-	-	$3.45	$6.89	$4.48	$3.09	**$3.47**
6	-	-	$4.12	$8.38	$5.44	$3.71	**$4.14**
7	-	-	$4.82	$9.57	$6.16	$4.20	**$5.19**

Table 3-15: Average Fare – AMT Students (2015 $)

STUDENT Zone	TRAM Fare SINGLE TICKET	TRAM Fare 6-TICKET BOOKLET	TRAM Fare MONTHLY FARE (*)	TRAIN Fare SINGLE TICKET	TRAIN Fare 6-TICKET BOOKLET	TRAIN Fare MONTHLY FARE	AVERAGE STUDENT (**)
1	-	-	$1.67	-	-	$1.42	**$1.66**
2	-	-	$1.97	-	-	$1.67	**$1.95**
3	-	-	$2.34	-	-	$2.00	**$2.34**
4	-	-	$2.52	-	-	$2.15	**$2.52**
5	-	-	$2.93	-	-	$2.50	**$2.92**
6	-	-	$3.50	-	-	$2.98	**$3.49**
7	-	-	$4.02	-	-	$3.41	**$4.00**

** Monthly average fare by trip is based on the assumption of an average usage of 44 trips/ month*

*** There are only monthly passes with student discount*

Not possible to differentiate between zones 7 and 8 in the model network, so for the purposes of this analysis they are combined

Source: AMT data and Steer Davies Gleave analysis

3.71 On the **South Shore/A10,** more than 50% of the total transit demand that cross the Champlain Bridge has an origin or destination within AMT fare zone 3. However, for other areas, in addition to AMT products, there are a number of agencies that also provide products for users that only use that specific transit agency service (products are not integrated with AMT or STM services) including:

- CIT Chambly-Richelieu-Carignan (CITCRC)
- CIT Vallée-du-Richelieu (CITVR)
- OMIT Sainte-Julie (OMITSJU)
- CIT Roussillon (CITROUS)
- CIT Le Richelain (CITLR)

3.72 For those areas, the weighted average fare by trip has been estimated based on the distribution of demand per ticket type as shown in Table 3-16.

Table 3-16: Average Fare per Trip – CIT (2015 $)

AV FARE	CIT Chambly-Richelieu-Carignan		CIT Vallée-du-Richelieu		OMIT Sainte-Julie		CIT Roussillon		CIT Le Richelain	
Zone	ADULT	STUDENT	ADULT	STUDENT	ADULT	STUDENT	ADULT	STUDENT	ADULT	STUDENT
4									$2.65	$2.24
5	$3.23	$2.78	$3.71	$2.78	$3.42	$2.78	$2.90	$2.58	$2.71	$2.29
6	$3.48	$3.28	$4.25	$3.28	$3.69	$3.27	$3.04	$2.99	$2.75	$2.60

Source: CITs data and Steer Davies Gleave analysis

3.73 In the Montréal Island area, STM fares apply exclusively to users of the STM transit services (bus and Métro on the Montréal Island) and fares are different to those for AMT. The main characteristics of STM fares are:

- **Flat fee**: Montréal Island represents one fare zone, while AMT has 3 fare zones on the island;
- **Type of user**: Fares are split into regular (*ordinaire*) and reduced (*réduit*). Student specific fares are not available and are included within the reduced fares;
- **Mode:** Tickets can be used on bus or Métro (and allow transfers between them); and
- **Products**: Tickets are available for different frequency users; monthly (*mensuel*), weekly (*hebdo*), 3 days (*3 jours*), 1 day (*1 jour*), evening (*soirée illimitée*), weekend (*week-end illimité*) and 1, 2 and 10 ticket booklets.

3.74 In order to estimate the number of trips and average fare for adults and students, the following assumptions have been adopted:

- Trips for monthly pass holders: 48 trips/month (it is a less commuter-oriented service than AMT and therefore a higher number of monthly trips assumed)
- Trips for weekly pass holders: 12 trips/week
- Trips using the 747 Express Airport Shuttle service have been excluded
- Number of student trips within the "discounted" trips: 65% of monthly pass holders
  This assumption has been based on the observed AMT distribution between students and other discounted monthly pass holders

3.75 Table 3-17 shows the average fare estimated for the whole Montréal Island and by ticket type.

Table 3-17: Average Fare per Trip – STM (2015 $)

Fare	Monthly	Weekly	Single	2 trips	10 trips	TOTAL
Adult	$1.58	$2.10	$3.21	$2.93	$2.35	**$1.93**
Student	$1.02	$1.29	-	-	-	**$1.03**

3.76 It is worth noting that 78% of demand currently uses monthly or weekly passes, with a higher use of single tickets and carnets on AMT, probably related to the higher use of the service by infrequent users such as tourists.

3.77 The STM 747 Express Airport Shuttle service is the only service that has a different fare structure. The average fare is $3.15, which has been calculated based on ticket type sales and usage data provided by STM as shown in Table 3-18.

Table 3-18: 747 Express Airport Shuttle Service Estimated Average Fare

Ticket Type	Ticket Sales ($)	Sales Breakdown	Trips per Ticket type	Fare	Average Fare per Trip
747 Express Airport Shuttle Ticket	78,104	5.4%	1.10	$9.00	$8.18
1 Day	469,272	32.4%	1.72	$9.00	$5.23
3 Days	96,596	6.7%	6.73	$18.00	$2.67
Unlimited Weekend	17,541	1.2%	5.22	$12.00	$2.30
Regular Monthly	552,714	38.2%	48.43	$77.00	$1.59
Reduced Monthly	159,386	11.0%	44.24	$45.00	$1.02
Regular Weekly	68,083	4.7%	12.75	$23.75	$1.86
Reduced Weekly	1,855	0.1%	11.43	$14.00	$1.22
Free/Other	3,975	0.3%	-	$-	-
TOTAL	**1,447,525**	**100%**	**-**	**$-**	**$3.15**

Source: STM

4 Modelling approach

Introduction

4.1 REM will completely transform the transit offer in the Metropolitan Montréal area. The new system will be complemented by the following interventions:

- Restructuring of the ***bus network***: With the elimination of the express routes directly competing with REM, the transit agencies will introduce a frequent and improved bus feeder network that will substantially reduce the access and egress time to REM stations.
- Restructuring of ***rail services***: REM will substitute the existing Deux-Montagnes commuter rail service, providing an improved service in terms of frequency and travel time. The Mascouche Line will be truncated to feed the REM.
- Improvement of the ***interchange facilities*** to fully integrate the REM with the rest of the transit network and with new Park & Ride facilities.

4.2 As a result, the project as a whole, is expected to have an important impact on:

- ***Corridor demand*** (South Shore/A10 and West Island/Deux-Montagnes Line): Existing transit and auto travellers within the area of influence of the REM – mainly residents; commuters in the peak periods and non-commuters in the Interpeak periods.
- ***Airport demand:*** Demand to and from the Aéroport Pierre-Elliott-Trudeau, currently using: transit, auto, taxi, Park & Fly and Kiss & Fly, etc. This includes both airport passengers and staff.

Model Overview

4.3 For this study, we have designed a demand model structure to provide the most practical framework to address the different markets. This has been achieved by optimizing the use of existing information and modelling work, and complementing it with additional data collection and the development of new modelling features.

4.4 In order to assess the critical markets, different models have been developed. The models are fully integrated and consistent:

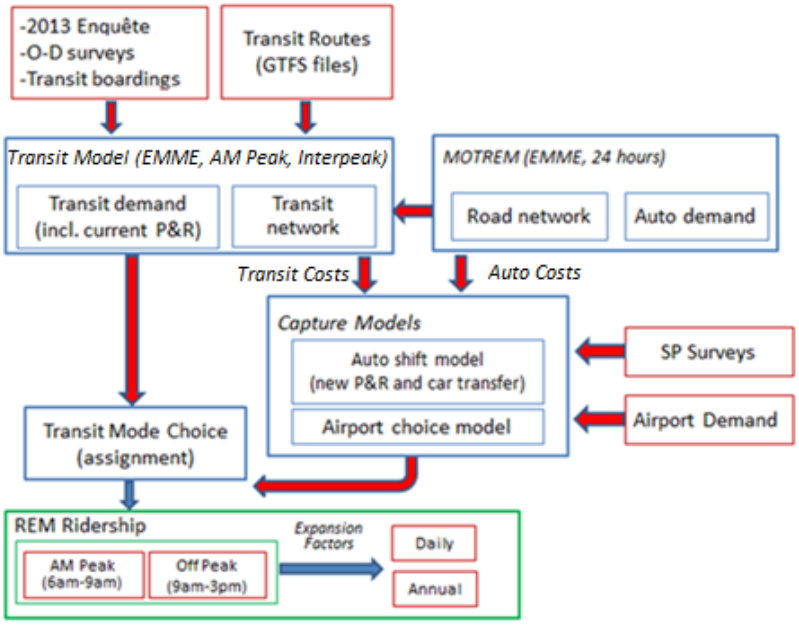
- ***Corridor demand choice model:*** In order to estimate REM future demand and capture from alternative modes for the “corridor” demand, two separate models have been developed.
  - ***Auto shift model***: Estimates the demand that shifts from auto to transit and REM given the future improved competitiveness of the transit modes compared to auto. This includes two sub-models:

  - Shift from auto to REM with Park & Ride access (bi-modal)
  - Shift from auto to REM with transit/walking access
- ***Transit mode choice model*** estimates the redistribution of demand between the different transit modes (bus, rail, métro and REM) given the current and future competitiveness for each of the modes.

4.5 In addition, the **Airport demand choice model** estimates airport demand mode choice using a broader variety of competing modes including bus, taxi, Car Park & Fly and Car Kiss & Fly.

4.6 An overview of the forecasting model framework is shown in Figure 4-1.

Figure 4-1: Corridor Demand Choice Model Overview



Note: General Transit Feed Specification (GTFS) refer to publicly available transit schedules and routes.

4.7 To support all models, a road and transit network in EMME has been developed including the following features:

- Base year (2015) and two future years (2021 and 2031)
- Two time periods
  - AM Peak: 6am to 9am
  - Interpeak: 9am to 3pm

4.8 REM demand estimates from the Auto Shift Model and Airport Demand Choice Model have been consolidated into the assignment model, in order to calculate total REM demand by station, section loads, etc.

4.9 The following sections describe the network development in more detail and the approach adopted for the corridor demand choice model.

Network Development

Overview

4.10 In order to forecast the future demand for the REM, a number of models have been developed to estimate the redistribution of the existing and future demand, within the different modes available. The redistribution is based on the attractiveness of each option.

4.11 Given the complexity of the road and transit network in Metropolitan Montréal, it was considered that a network (assignment) model was required to represent more accurately the complex interaction between the different modes. This has been built in the EMME software package.

4.12 Although different models and approaches have been adopted to estimate different types of demand (corridor and Aéroport Pierre-Elliott-Trudeau demand), all models have based the calculation of generalized costs[12] on the travel times and fares extracted from the network model.

4.13 The Montréal road and transit network is complex and developing a new auto and transit model would be a challenging task that could take many months. Therefore we have relied upon existing models (road network only) which have been adapted and complemented with additional features to represent the transit network characteristics with a particular focus on the REM corridors.

4.14 The following sections describe the existing model sources and the additional work carried out to develop an auto and transit model for the study area. A network model has been developed for an average fall weekday and includes the AM Peak (defined as 6am-9am) and Interpeak (defined as 9am-3pm) with those time periods reflecting the differences between commuter and non-commuter demand.

4.15 Development of the PM peak model is a considerable undertaking with a limited 'return'. Extensive analysis on expansion factors presented in Table 4.13 and 4.14 accounts for the PM demand impact on the daily estimates.

4.16 The network model includes a road and a transit network, which are described below.

Road Network

4.17 In order to characterize the existing road network, the team has used the MOTREM model, a road transportation model developed for the Montréal region, using the EMME software platform. MOTREM is owned and maintained by MTQ and it was provided to CDPQ Infra Inc. for the purposes of this study.

4.18 This model has then been upgraded in order to include “bus only lane” links, which are extremely important to define the road characteristics for transit services. This is especially relevant for South Shore/A10 users.

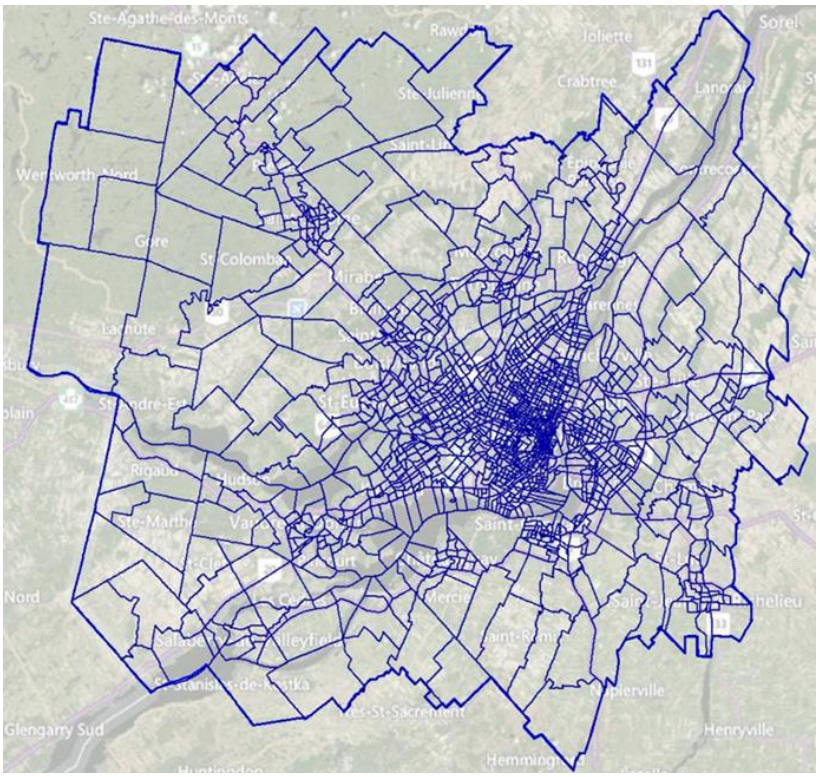
[12] The generalized cost is the total sum of the monetary and non-monetary costs associated with an origin-to-destination a journey. “Costs” could include time, road tolls, transit fares, and other penalties.

MOTREM

4.19 The MOTREM model includes a very detailed representation of the existing and future road network and produces auto traffic simulations for a range of years (2008, 2016, 2021 and 2031). This model estimates the demand for a typical weekday in the fall, across a 24-hour time period.

4.20 MOTREM is disaggregated geographically into 1,766 traffic zones. Figure 4-2 shows the detailed zoning system covered in the model.

Figure 4-2: MOTREM Zoning System

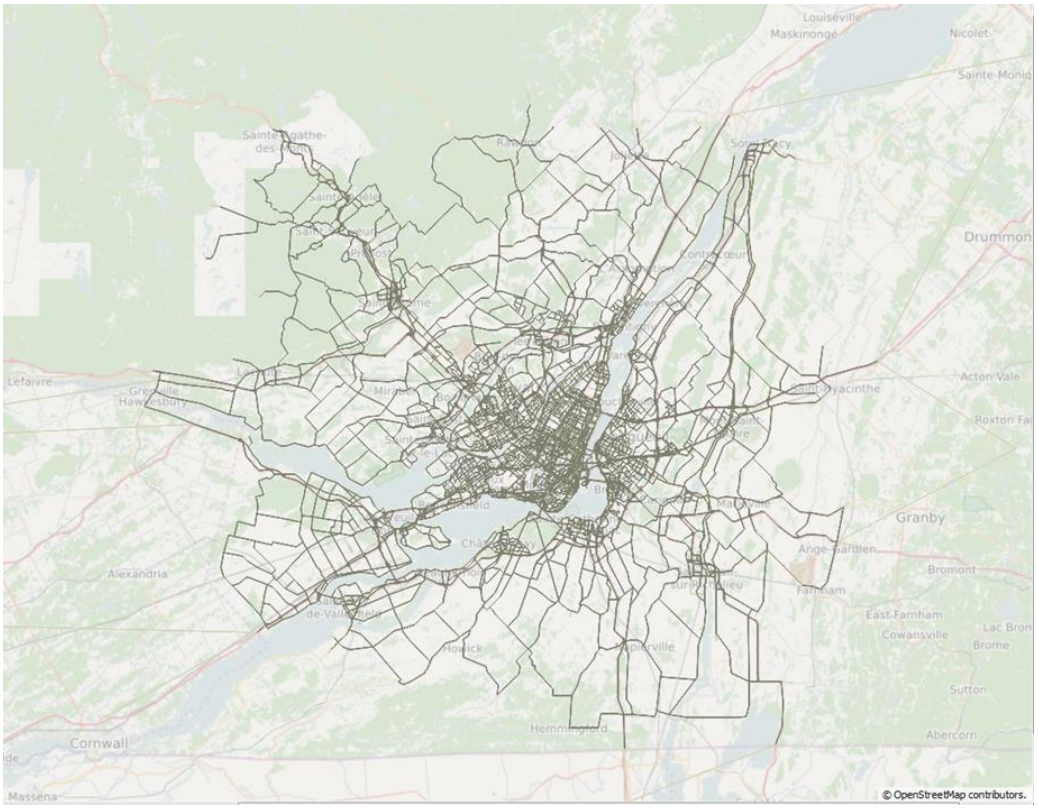


4.21 MOTREM includes auto origin-destination (OD) demand matrices for the zones identified above for the base and future years (2008, 2016, 2021 and 2031). The demand matrices are split into four vehicle types: cars, commercial cars, light goods vehicles and heavy good vehicles.

4.22 The model road network is represented as nodes, links and zones. Links contain network information such as the number of lanes per direction and the volume delay function (vdf). This function estimates the average speed on that particular link depending on the volume of traffic and could be different depending on the road characteristics, maximum speed limit, etc.

4.23 Figure 4-3 shows the extent of the road network in MOTREM.

Figure 4-3: MOTREM Road Network



4.24 The model assigns demand to each route depending on the Generalized Costs associated with each alternative. The MOTREM model was calibrated to a 2008 base year, using the demand OD matrices available from the 2008 Enquête OD survey, and traffic screenline counts for different vehicle types.

4.25 MOTREM assigns auto and goods vehicle demand to the road network via a series of iterations designed to reach convergence or equilibrium based on the Generalized Costs which account for travel time, operating costs and tolls (on the A25 and A30 and not very relevant to REM).

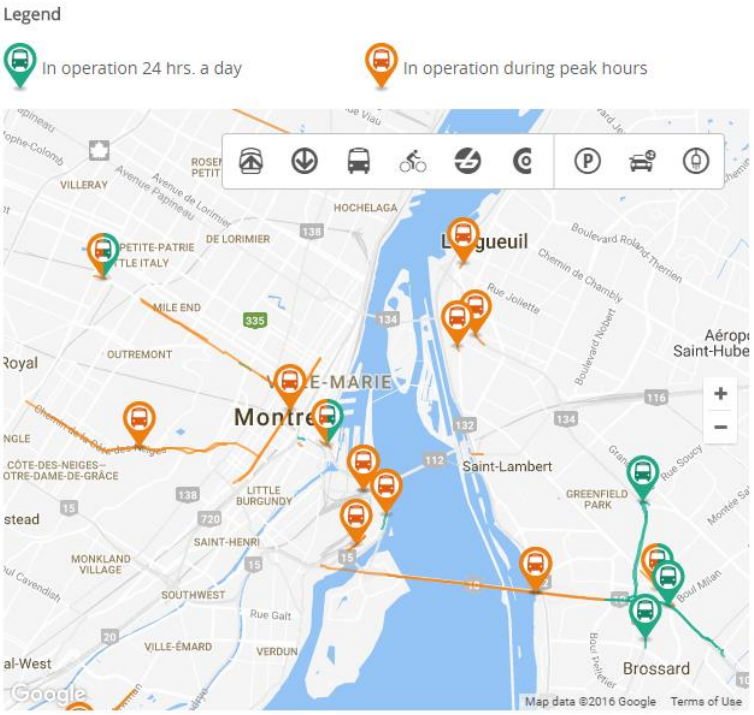
Bus Only Lanes

4.26 MOTREM is not a transit model and therefore does not include bus lanes i.e. Champlain Bridge is represented as 3 lanes to Montréal and two lanes to the South Shore direction in the AM Peak period for example and the bus lane is not included.

4.27 Since bus lanes are critical for the existing transit network, especially for demand from the South Shore/A10 corridor, selected bus only lanes have been included in the model and shown in Figure 4-4[13].

[13] https://www.amt.qc.ca/en/trip-planner/bus/reserved-lanes

Figure 4-4: Bus Only Lanes



Source: AMT

Future Road network

4.28 MOTREM includes a number of future road network improvements which are detailed in Appendix A.

4.29 Of particular interest to this project are the following:

- Champlain Bridge replacement[14]: Construction of new 6 lane bridge across the Saint Lawrence River and access roads to replace existing bridge (currently under construction)
- Turcot Interchange[15]: Reconstruction of the interchange for Highways 15, 20 and 720. This includes the introduction of reserved bus lanes along Highway 20 (between the St-Pierre and Turcot Interchanges), inside lane of the Ville-Marie in the eastbound direction and the new Pullman Boulevard.

Transit Network

4.30 Since MOTREM only represents the road network relevant to auto users, it has been necessary to incorporate all the transit network links (rail and Métro) and transit services.

[14] http://www.newchamplain.ca

[15] https://www.turcot.transports.gouv.qc.ca/en/Pages/default.aspx

Transit Links

4.31 The current MOTREM model includes a range of modes (link characteristics). These have been maintained in order to retain consistency with MOTREM work done to date. Note that MOTREM includes transit mode variables already even though it is a road-traffic based model (it is presumably a long term aim of MTQ to develop a transit model component of MOTREM).

4.32 Table 4-1 details the various modes included. Note that the only addition that we have incorporated in MOTREM is the inclusion of REM as a specific mode to ensure it can be coded separately and extract relevant statistics more efficiently.

Table 4-1: Model Link Modes

MOTREM Mode	MOTREM Description	MOTREM Type	Comment
a	Automobile	Auto	Main mode for autos and buses
z	CamLourd	Aux. auto	Mode to allow Heavy Truck link bans
y	CamLeger	Aux. auto	Mode to allow Light Truck link bans
v	AutoPrive	Aux. auto	Mode to allow Private Car link bans
w	AutoComm	Aux. auto	Mode to allow Commercial Veh. link bans
m	Métro	Transit	Métro transit mode
t	Train	Transit	AMT Commuter Rail transit mode
l	Bus-stl	Transit	RTL bus transit mode
s	Bus-strsm	Transit	STL bus transit mode
b	Bus-stcum	Transit	STM bus transit mode
c	Bus-cit	Transit	CIT bus transit mode
i	Inter-urbn	Transit	Other bus transit mode
r	**REM**	**Transit**	**REM (new mode)**
p	Pieton	Aux. transit	Pedestrian
x	Transfert	Aux. transit	Pedestrian transfer link

Transit Links Coding

4.33 Rail and Métro lines have been coded as separate links and stations have been “connected” to the street network as required.

4.34 Bus routes have been coded using, as a base, the road network represented in MOTREM. Transit service route GTFS files were downloaded from the different transit agencies in the Montréal region and imported as transit routes to EMME.

4.35 Table 4-2 summarizes the total transit routes downloaded as GTFS files by agency and coded into EMME.

Table 4-2: Transit Services Coded

Agency	Services included
AMT Bus	2
CIT Le Richelain	36
CIT Chambly-Richelieu-Carignan	33
CIT du Haut-Saint-Laurent	7
CIT Roussillon	16
CIT Vallée-du-Richelieu	46
La MRC Deux-Montagnes	4
Réseau de Transport de Laval	195
Ville de Saint-Jean-sur-Richelieu	16
Société de Transport de Laval	93
Socitété de Transport de Montréal	387
OMIT Sainte-Julie	17
TOTAL	**852**

4.36 Figure 4-5 shows a plot with the routes included in the model and Figure 4-6 shows the transit services by mode.

Figure 4-5: Transit Services Coded by Agency

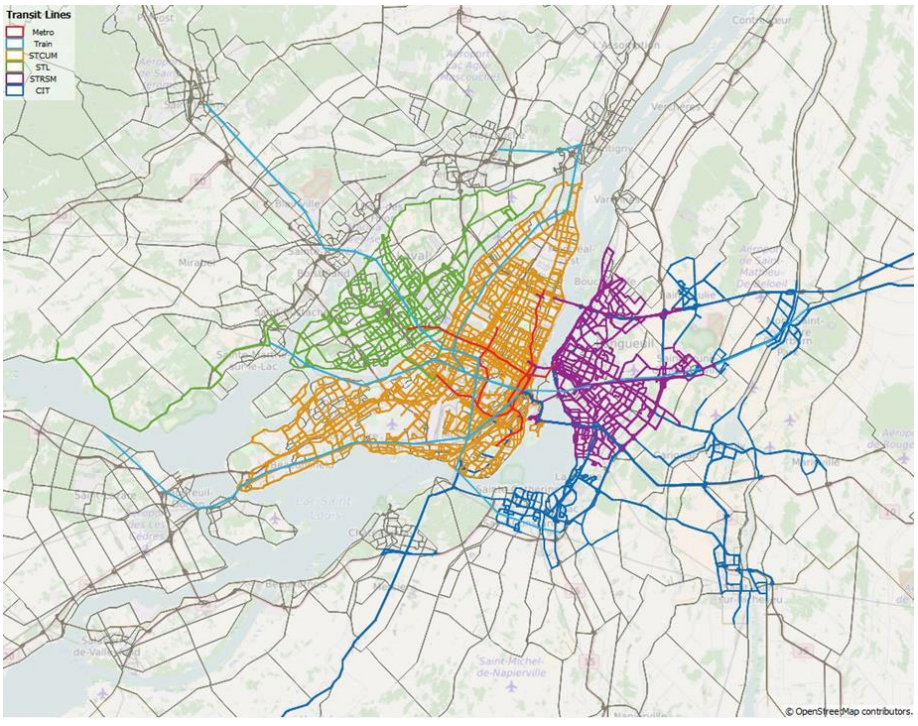
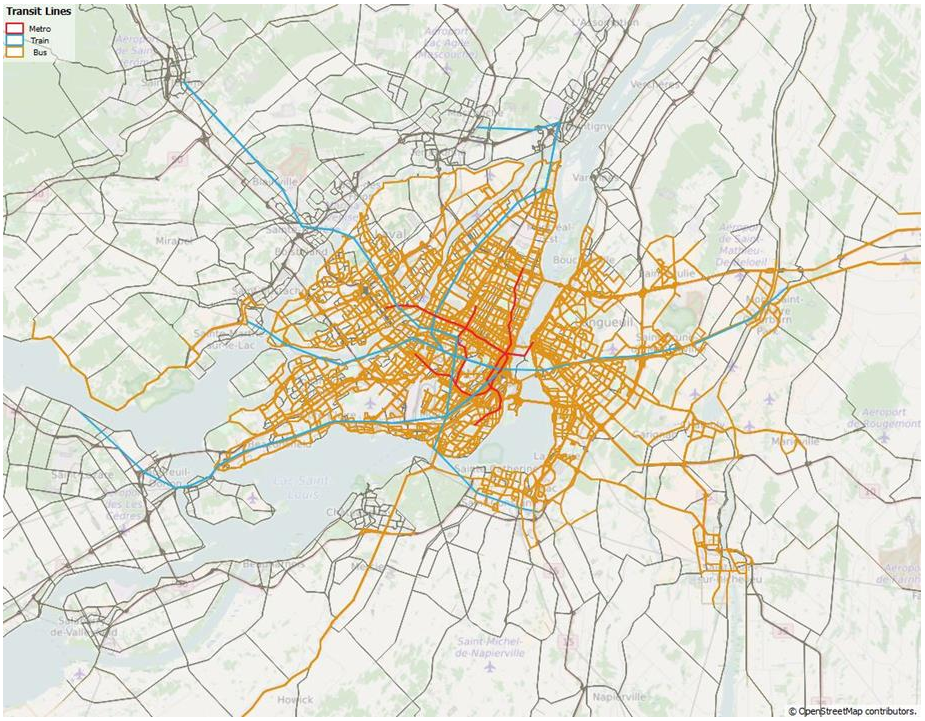


Figure 4-6: Transit Services Coded by Mode



Future transit network

4.37 No changes have been made to the transit network with the exception of ensuring buses are using the new bus lanes on the Turcot Interchange.

Corridor Demand Choice Model

Introduction

4.38 In order to predict REM ridership, estimates of future demand and capture from alternative modes for the REM "corridor" were required. Two separate choice models have been developed.

- ***Auto shift model***: Estimates the demand that shifts from auto to REM
- ***Transit mode choice model***: Estimates the redistribution of demand between the different transit modes (bus, rail, Métro and REM).

Auto shift model

4.39 The auto shift model is integrated within the Network Model (EMME) and estimates the demand that would be captured from auto in the AM Peak and Interpeak periods based on:

- The *in-scope market*: Estimation of the auto traveler demand in the corridor (described in Section 3)
- The *key benefits of REM* compared to auto: This is measured in terms of Generalized Costs for each particular OD (including time and monetary costs) and period, and is covered in the following sub-sections

- The *auto shift model*: Is an incremental binary logit model, where the demand captured by REM is estimated based on the incremental Generalized Costs for auto and transit compared to the existing situation

4.40 This model has been developed in the EMME platform (using macros) to ensure consistent car and transit assumptions are applied. The Generalized Cost (including total travel time and cost) for the auto alternative is compared with the best transit alternative Generalized Cost, and this is applied for each origin-destination pair for each time period.

4.41 It is worth noting that the REM option for auto users presents two potential alternatives:

- REM with Park & Ride access (bi-modal)
- REM with transit/walking access

Transit mode choice model

4.42 The transit mode choice model is also integrated within the Network Model (EMME) and estimates the demand that REM could capture from other transit modes based on:

- The *in-scope market*: estimation of the transit traveller demand in the corridor (Section 3)
- The *key benefits of REM* compared to other transit modes: this is measured in terms of Generalized Costs per time period (see following sub-sections)

4.43 The transit mode choice model is a mode choice and assignment model in EMME where the total transit demand for each OD pair is assigned to a transit network which represents all the major transit alternatives (Commuter rail, Métro lines and bus services) and combinations of these modes.

4.44 Since the transit capture is expected to be the most relevant component in the REM demand, the transit mode choice has been based on a more detailed segmentation not only by OD pair, but also by type of user, which has been classified by trip purpose (work, student and other).

Generalized Cost

4.45 The mode choice model assigns the demand to the different mode alternatives based on the Generalized Costs associated to each of them. The Generalized Cost does not relate strictly to monetary cost, but instead incorporates a wide array of journey attributes (such as in-vehicle travel times, access times and costs, transfers, wait times, etc.) all of which are combined with different weighting factors depending on user preferences.

4.46 The key attributes for ***transit users*** include:

- **Fare of the trip** (in 2015 Canadian Dollars): This represents the monetary component of the cost, and includes the average fare paid by each type of user (adult/student) from origin to destination.
- **In-vehicle travel time** (in minutes): Represents the time spent in the specific mode or combination of modes (if it is a multimodal trip). This is estimated using the Network Model for the AM Peak and Interpeak periods.
- **Access/egress time** (in minutes): Includes the access time (walking/bus) from the origin of the trip to the main mode station/stop. Access time is perceived by users at a higher rate than in-

vehicle time, and therefore Generalized Costs typically include a "penalty" multiplier factor compared to in-vehicle travel time (Section 5)

- **Wait time** (in minutes): Depends on the frequency of the service and estimated as half of the headway. The uncertainty related to wait time also results in a penalty multiplier factor compared to in-vehicle travel time.
- **Transfer time** (in minutes): Estimated time transferring between stops/stations when a combination of modes is used. Transfers are also penalised by users and an additional transfer time penalty is included (Section 5).
- **Perceived quality of the service** (mode penalty)**:** There are intrinsic and intangible benefits perceived by passengers between rail-based modes and conventional bus related to the quality and reliability of the service. These benefits are generally included in the Generalized Cost as a time penalty/bonus depending on the perceived value of the users. For example, at equal travel time and cost, transit users typically prefer riding in a train compared to a bus.

4.47 The attributes included to estimate the Generalized Costs of ***Park & Ride users*** are the same parameters as those described for transit users, but they also include the auto travel times and costs associated with accessing the Park & Ride station. The monetary costs include fuel and parking costs (if applicable).

4.48 The attributes used to estimate the Generalized Costs of ***Auto users*** include travel time, fuel, parking and tolls (currently A25 and A30 are tolled in the region and outside the REM study area).

4.49 Given that some of the Generalized Cost components are measured in time and others in monetary values, the ***value of time*** (VoT) is used to homogenize the different costs in the same units (minutes or CAD$). 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.

4.50 The Generalized Cost is a combination of travel time and costs associated with each mode and these are described below. The behavioural parameters associated to the Generalized Cost calculation have also been addressed in this section.

Travel Time Attributes

In-vehicle Travel Time

4.51 Auto in-vehicle travel times are estimated in the Network Model based on the estimated demand on each particular link and the road link attributes (number of lanes per direction and volume delay function).

4.52 Transit travel times are estimated from the Transit Mode Choice Model (EMME) by applying a Transit Time Function (ttf) to links to ensure transit travel times account for the type of transit service provided (commuter, express, local) and the road type the service operates on (transit only, mixed traffic).

4.53 Table 4-3 summarizes the various ttfs applied in the Network Model. These were estimated based on the scheduled bus travel times and auto travel times to ensure an accurate representation of travel times was obtained.

Table 4-3: Network Model Transit Time Functions (ttf)

Transit service	Transit Time Function (ttf)
All road transit links in Downtown Montréal	ttf = 1.10 * timau *where timau represent car travel time*
Local transit links outside Downtown Montréal	ttf = 1.17 * timau *where timau represents car travel time*
Express bus services	ttf = 1.09 * timau *where timau represents car travel time*
Champlain Bridge bus lane	ttf = us2 *where us2 represents bus travel time*
Other bus only lanes	ttf = average speed to ttfs
Rail and Métro	Based on scheduled travel time

Transit Wait Times

4.54 Wait times are an important component of the Generalized Cost calculation and typically penalize users compared to the in-vehicle time. The values estimated are presented later in this section and these are applied to the wait times (half the headway) estimated in the Transit Mode Choice Model (EMME).

Transit Station Access and Interchange times

4.55 Access time to stations and transfer times between stations or between modes are also important components of the Generalized Cost calculation, since it is typically heavily penalized by users.

4.56 A site visit was carried out during the second week of August 2016 to measure the main interchange and street access locations. 32 stations and corresponding platform and street accesses were surveyed with a total of 350 measurements. These included the following:

- 23 Métro stations
- 8 AMT rail stations
- 11 of the main interchange locations

4.57 The survey involved registering walking time to each location. This was translated into walking distance in order to be coded into the EMME Transit Mode Choice Model. The following assumptions were adopted:

- Walking speed
  - Average walking speed estimated at 1.12 m/s
- Access times
  - Walking times were measured from the street access door to the entrance of the platform
  - Where available, the surveyor stood (and not walked) on escalators
- Transfer times
  - Transfer times between two lines were calculated from the exit of one platform to the entrance of the other platform
- Commuter rail interchange stations

- Access times and transfer times between rail lines at Gare Centrale, Lucien L'Allier and Vendôme were based on an average travel time on all possible platforms because commuter rail lines do not have a designated platform and arrival and departure platforms change frequently.

4.58 For stations where no travel times were recorded, an average street access distance of 100 metres (90 seconds) was applied based on the average of the measurements obtained during the survey. These estimates were revised and updated as required during the calibration process presented in Section 6.

Monetary Cost Attributes

Auto and Park & Ride costs

4.59 Monetary costs for auto and Park & Ride users include operating costs, parking and toll costs (if applicable, currently applied on the A25 and A30).

Transit Costs

4.60 Another key component to the Generalized Cost calculation is the monetary cost associated with the transit trip. The complexity of estimating this parameter relates to the availability of a wide range of ticket products and concessions which result in different trip unit fares i.e. frequent users use monthly cards with reduced unit fares and fare discounts are applied to student or seniors.

4.61 For the purposes of simplicity and applicability to the transit mode choice model (EMME) we have estimated a weighted average transit fare matrix for each user type (student and adult) covering all the zones in the model (a total of 1,766 zones).

4.62 In order to estimate this matrix, we have analysed in detail the different ticket types and fares available in the study area, and what is the market share of those for the key market segments (student and regular). This has been discussed in Section 3.

4.63 This section includes the assumptions adopted based on the analysis of the demand and revenue datasets provided by AMT, STM, RTL and CIT/OMIT transit agencies.

4.64 The model has been developed for two type of users; adults and students (adults include regular fares while reduced fares include seniors, children, etc.).Table 4-4 and Table 4-5 summarize the fare assumptions adopted for each market.

- ***STM Montréal Island trips***: The average fare estimated for the whole Montréal Island and by ticket type based on the analysis of STM current fares:
  - $1.93 for Adults
  - $1.03 for Students
- ***CIT trips (South Shore/A10)***: Table 4-4 shows the average fare estimated for each CIT and by ticket type.

Table 4-4: Average Fares – CITs (2015 $)

AVG. FARE	CITCRC		CITVR		OMITSJU		CITROUS		CITLR	
Zone	ADULT	STUDENT	ADULT	STUDENT	ADULT	STUDENT	ADULT	STUDENT	ADULT	STUDENT
4									$2.65	$2.24
5	$3.23	$2.78	$3.71	$2.78	$3.42	$2.78	$2.90	$2.58	$2.71	$2.30
6	$3.48	$3.28	$4.25	$3.28	$3.69	$3.27	$3.04	$2.99	$2.75	$2.60

- ***Ville de Saint-Jean-sur-Richelieu:*** also provides services to the South Shore and Montréal Island. Ticket sales and revenue was analyzed and the following fares were estimated for trips to Montréal:
  - $4.93 for adult
  - $3.28 for student
- ***RTL***: fare for internal trips in Longueuil was based on the average fare extracted from the ticket sales and revenue information. This was estimated as $1.99 for regular and $1.14 for students.
- ***Airport***: fare data from STM showed that just under 40% of 747 Express Airport Shuttle passengers paid the "full" cash fare ($9 in 2013). A weighted fare average per trip of $3.15 was estimated for 747 Express Airport Shuttle users.
- ***Rest of Trips***: For the rest of the trips, the average fare has been estimated based on the existing average fare for the in-scope AMT zones as shown in Table 4-5.

Table 4-5: Average Fare – AMT (2015 $)

ZONE	AVERAGE ADULT	AVERAGE STUDENT
1	$2.01	$1.66
2	$2.38	$1.95
3	$2.77	$2.34
4	$3.02	$2.52
5	$3.47	$2.92
6	$4.14	$3.49
7	$5.19	$4.00

Not possible to differentiate between zones 7 and 8 in the model network, so for the purposes of this analysis they are combined

4.65 The fares estimated above have been used as a base to define the 2015 average transit fare matrix. The calculation of the fare OD matrix was based on the zone location and the number of zones travelled between each OD pair.

4.66 On Montréal Island, STM and AMT services have different fares. To reflect the differential fares between STM and AMT commuter rail services, the following approach was adopted in modelling terms (only applied for ODs in Montréal Island):

- A "base" fare matrix was created based on the STM fares for adult and students (see paragraph 4.64).

- An "incremental fare" was introduced in the model to represent the additional cost of commuter rail trips on Montréal Island. Table 4-6 shows the differential.

Table 4-6: AMT and STM Fare Differential

Montréal Island AMT Fare Zone	STM Adult Fare	AMT Adult Fare
1	$1.94	$2.01
2	$1.94	$2.38
3	$1.94	$2.77

Generalized Cost Parameters

Stated Preference Surveys

4.67 In order to assess the specific model parameters (values of times, weights and mode preference) associated with the different users in the corridor, a number of Stated Preference (SP) surveys were carried out by Steer Davies Gleave in May and June 2016.

4.68 Respondents were presented with 8 cards with different hypothetical scenarios where REM was compared to other modes. These scenarios were designed for each individual respondent based on their existing trip patterns (origin-destination, mode used and existing trip travel time). The behaviour parameters and value of time for each type of user were estimated based on the responses to these scenarios.

4.69 The analysis of the survey presented in Table 4-7: Shows that 60% of the respondents "traded" during the SP exercise. For example, they chose their current mode at least once and they chose the new REM service at least once out of the 8 choices. However, 40% of respondents always chose the same mode (23% always chose their existing mode and 16% always chose REM).

Table 4-7: Corridor SP Traders Summary

Trading	Car	Park & Ride	Transit	Total
Traders[(1)]	67%	59%	57%	60%
Always REM	12%	18%	18%	16%
Always Current Mode	20%	24%	25%	23%

[(1)] Traders chose their current mode at least once and chose the new REM service at least once out of the 8 choice exercises.

4.90 The overall analysis suggests a resistance to change from the existing mode to REM as evidenced by the higher proportion of Current Mode non-traders (23%). Although this resistance is typically observed for auto users around the world, the analysis also showed a resistance for existing transit users to remain on their existing transit modes. This is somewhat surprising for existing bus users, where the REM service will provide an improved level of service in terms of quality (smooth

ride in a clearly identified network with multi-door loading/unloading) and reliability (service operates completely segregated from car traffic) on a service much more akin to a Métro or rail service.

4.91 Table 4-8 shows the behaviour parameters extracted from the SP analysis:

- Value of Time (VoT): Shows how much an individual is prepared to pay in order to save an hour of journey time and it is applied to convert fares and other costs into travel time. This has been estimated for work and non-work users separately.
- Access and Wait time factors: Represent the perceived penalty for the time spent to access and to wait for the main mode compared to the in-vehicle time. This is included as a multiplier to the estimated access/wait times.
- Transfer penalty: Additional time added to the Generalized Cost calculation as a penalty for the transfer. This penalty is added for each transfer required for the full trip.
- Mode constant: Additional time added to the Generalized Cost calculation to represent passenger's quality and reliability perceptions of different modes.

Table 4-8: Corridor SP Results

Parameter	Transit Users	Car Users
VoT Work	$7.37	$14.85
VoT Non-Work	$7.91	$14.85
Access Time Factor	1.6	2.7
Wait Time Factor	1.6	1.8
Transfer Penalty	+4 min	
Mode Penalties	REM vs Rail/Métro: +11 min REM vs Bus: +6min	REM with transit access (vs Car): +21 min REM with Park & Ride (vs Car): +4 min

4.92 Table 4-8 shows some preference of existing transit modes to their current mode compared to REM. Typically for a system like REM (guided rail and completely segregated from traffic), we would expect REM to be as attractive as Métro or rail and therefore all sharing the same mode constant. Furthermore, we would expect REM to be perceived as "better" than bus which is not as comfortable and subject to traffic unreliability. However, the Transit Users SP results are showing the opposite trend, with an estimated penalty for using the REM of 6 minutes compared to the bus i.e. a 20-minute travel time trip between bus and REM would be perceived by bus passengers as 6 minutes faster than by REM.

4.93 On the other hand, a model developed only with "traders" (eliminating both "always current mode" and "always REM" non-traders) results in a REM mode constant in line with expectations with an estimated penalty to the bus of 5 minutes compared to the REM and indifference between rail, Métro and REM at equal time and costs. This tends to indicate the existence of a bias in the SP responses.

4.94 There are a number of possible reasons for this response to REM including:

- Misunderstanding of the REM project and potential association with a service of lower service quality and reliability (streetcar)
- Resistance to change and to the elimination of direct express routes to their final destination

4.95 It is unclear how each of these possible reasons contributed to the selection of the bus versus REM in the Corridor SP results. In light of our professional experience and extensive past LRT and rapid transit work in Canada and around the world, we believe the trader model shows a more realistic estimation for the REM characteristics.

4.96 Table 4-8 also displays a low VoT for Park & Ride users, especially when compared to pure transit users. We believe the pure transit users VoT model shows a more realistic and more conservative estimate of the Park & Ride VoT.

4.97 The VoT and modal constant assessments and adjustments made are discussed below.

Value of Time Assessment

4.98 The value of time is an important parameter of the Generalized Cost, since it converts the various cost components into a unified time value to be compared across alternative modes. The higher the value of time, the more users are willing to pay to save time.

4.99 In order to assess the reasonableness of the estimated VoT, it is common practice to compare it to half the hourly wage rate. In this case it is $10.40 (half the Québec hourly wage of $20.80/hour estimated from Statistics Canada data).

4.100 On this basis:

- Auto users ($14.85) values of time seem to be within the higher range, which is consistent with a typical higher income level. Moreover, it is very similar to the MOTREM assumption of $14/hour.
- Transit users ($7.37-$7.91) values are however within the lower range of what would be expected for Transit and Park & Ride users. However, these values seem to be consistent with previous SP surveys carried out in Montréal which have resulted in relatively low VoT values.

Modal Constant Assessment

4.101 The modal constant is another particularly important component of the Generalized Cost, since it determines the mode preference of users given similar travel time and cost conditions.

4.102 The results obtained from the SP surveys show a consistent preference of rail modes versus bus (on-street bus mode constant has a 5-minute penalty compared to Métro and rail modes) and in line with expectations. However, the Stated Preference survey (when using the entire sample) is showing biased results against REM.

4.103 The model developed only with “traders” (eliminating both current mode and REM non-traders) results in a REM mode constant in line with the expectation that REM is perceived as favorable as commuter rail and Métro, and a 5-minute penalty for bus users when compared to REM. We believe the trader model shows a more realistic estimation for the REM characteristics with similar quality and reliability characteristics to the existing rail and Métro services, and therefore we expect a similar mode constant.

4.104 While this assumption is reasonable, it is important to test these mode constants to understand their impact and to compare them with evidence observed in other studies/applications. Appendix B describes our review of literature and applications to similar projects.

4.105 The final values applied are detailed in the model calibration section (Section 6). However, the uncertainty of this parameter should be taken into account when developing the Sponsor Case and carrying out the risk assessment and defining sensitivity analysis as described in Section 7.

Airport Model

Model Overview

4.106 The Airport model is a standalone spreadsheet model, which estimates the level of demand that will switch to REM to access Aéroport Pierre-Elliott-Trudeau from each of the existing modes (bus, car Park & Fly, car Kiss & Fly and taxi). Note: Airport staff are only assumed to use local bus (not 747 Airport Shuttle Express) and car Park & Fly currently.

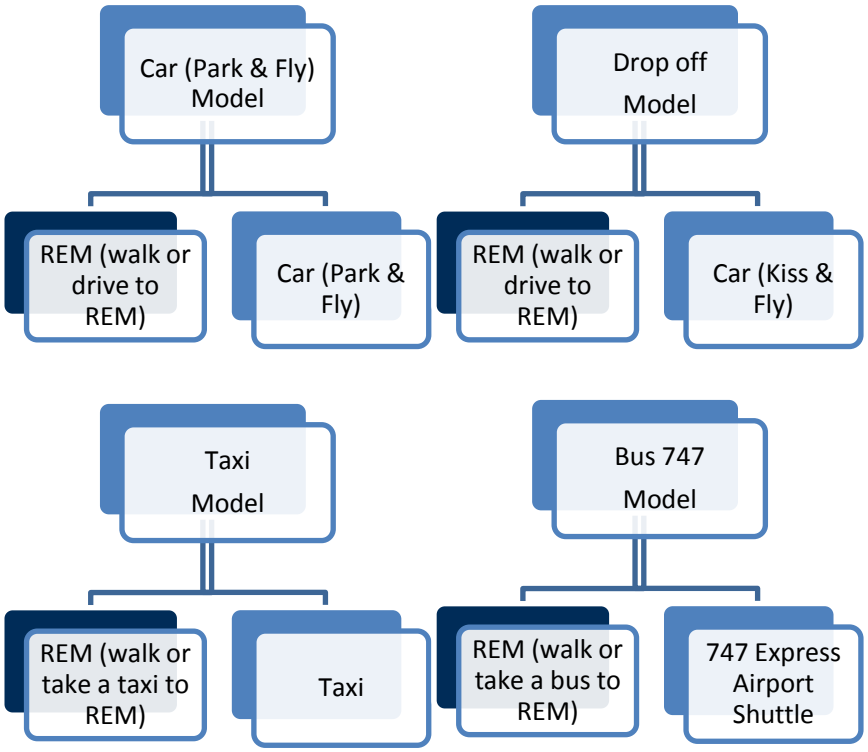
4.107 REM capture is calculated by comparing the Generalized Cost for travel using the existing mode with the Generalized Cost for travel using REM. Generalized Cost includes:

- Walk time
- Wait time (which for transit includes any interchange time)
- In-vehicle time
- Mode constants
- Fare or parking charge

4.108 Airport passenger and staff demand has been estimated and distributed by market segment using the assumptions in Section 3, (see Table 3-9 for the distribution of in-scope demand by market segment). A binary choice model is then used to understand how each market segment reacts to the change in Generalized Cost when comparing their existing mode to REM.

4.109 The greater the Generalized Cost advantage of REM compared with the existing mode, the more capture is likely to be abstracted.

Figure 4-7: Air Passengers Mode Choice Model Logit Model Structure



4.110 REM capture is calculated for an average hour in the AM Peak (6am-9am) and an average hour in the Interpeak (9am-3pm).

Generalized Cost Components

4.111 Table 4-9 shows the Generalized Cost components for each mode and their source.

Table 4-9: Generalized Cost Components for Existing Modes

Component	Mode	Value	Source
Walk Time	Bus	Varies for each trip	Estimated in Transit Mode Choice model
	Taxi	0 minutes	
	Car (Park & Fly)	10 minutes	Based on data on car parks on ADM website.
	Car (Kiss & Fly)	0 minutes	
Wait Time	Bus	Varies for each trip	Estimated in Transit Mode Choice model
	Taxi	5 minutes	Assumed wait time
	Car (Park & Fly)	10 minutes	Based on data on car parks on ADM website.
	Car (Kiss & Fly)	0 minutes	Assumed no wait time
In-vehicle Time	Bus	Varies for each trip	Estimated in Transit Mode Choice model
	Taxi		
	Car (Park & Fly)	Same times for all of these modes	Estimated in Network Model
	Car (Kiss & Fly)		
Mode constants	Bus	$25	Assumed for airport staff
	Taxi Car (Park & Fly) Car (Kiss & Fly)	Business/non-resident -$3.12 Non-Business/non-resident -$8.90 Business/resident -$3.12 Non-Business/resident -$8.90	Based on SP survey (see description below)
Fare or parking charge	Bus	Varies for each trip	Estimated in Transit Mode Choice model
	Taxi	$40 fixed downtown fare $17 + $4.86 per km	Based on *Steer Davies Gleave* online research of standard taxi fares in Montréal
	Car (Park & Fly)	$140 parking charge for passengers $- for staff	Passenger charge based on an assumed average 9 nights stay at the Aéroport Pierre-Elliott-Trudeau (using 2016 SP survey data) and average $16 per night from *Steer Davies Gleave* online research of Aéroport Pierre-Elliott-Trudeau car park charges.
	Car (Kiss & Fly)	$-	Assumed no charge for drop off at the Aéroport Pierre-Elliott-Trudeau.

4.112 Components are weighted according to their relative importance. For example, time spent walking or waiting is usually perceived as more than time spent travelling in a vehicle. These weights have been estimated from our Stated Preference work and benchmarked against experience elsewhere. Given that some of the Generalized Cost components are measured in monetary values, a value of time (which varies for each mode and market segment) is used to convert these in to time values.

4.113 The auto and transit travel time and cost components used to generate Generalized Costs have been estimated from the Network Model. This allows us to maintain consistency between the two models and ensure that any REM configuration or service changes can be reflected in the Airport model.

Generalized Cost Parameters

4.114 In order to assess the specific model parameters (values of times, weights and mode preference) associated with the different type of Airport users, Stated Preference interviews were undertaken with passengers in the departure lounge of Aéroport Pierre-Elliott-Trudeau in July 2016[16].

4.115 Respondents were presented with eight cards with different hypothetical scenarios where REM was compared to the current mode used to access the Aéroport Pierre-Elliott-Trudeau (Park & Fly, Dropped-off, Taxi or 747 Express Airport Shuttle). These scenarios were designed for each individual respondent based on their existing trip patterns (Origin/Destination, mode used and existing trip travel time). The behaviour parameters and value of time for each type of user were estimated based on their responses to these scenarios.

4.116 The analysis of the Airport survey sample showed that, overall 62% of the respondents chose the hypothetical scenario ("traded") during the SP exercise. However, 38% of respondents always chose the same mode (26% always chose their current mode and 12% always chose REM).

4.117 Respondents who used auto-based modes (Park & Fly, Kiss & Fly and taxi) have a higher share of respondents who always chose their existing mode (41%, 28% and 26% respectively) compared with 747 Express Airport Shuttle users who were less likely to remain loyal to their current mode (only 3% of bus respondents always chose to stay on the bus).

Table 4-10: Airport SP Traders Summary

Tradings	Car Park & Fly	Car Kiss & Fly	Taxi	747	Total air travelers	Airport Staff
Traders	51%	58%	66%	77%	**62%**	**58%**
Always REM	8%	14%	8%	20%	**12%**	**1%**
Always Current Mode	41%	28%	26%	3%	**26%**	**41%**

4.128 The analysis suggests:

- **Auto-based modes** have an intrinsic predisposition against the REM with a resistance to change from their existing mode. This is evidenced by the high level of non-traders in favour of the Current Mode. This resistance is typically observed for auto users around the word and is an expected result.
- **Existing bus users** are more likely to favor REM, perceiving a benefit from an improved level of service in terms of quality (smooth ride in a clearly identified network with multi-door

[16] Summer is not an ideal time to undertake research. However, choosing summer is unlikely to affect passengers' willingness to pay values, which is more affected by the mixture of journey purposes of the passengers interviewed.

loading/unloading) and reliability (service operates completely segregated from car traffic) for a service much more akin to a Métro or rail service. It is therefore reassuring to see that 747 Express Airport Shuttle users have an intrinsic predisposition in favor of the REM.

4.129 Table 4-11 shows the behaviour parameters used in the model:

Table 4-11: Airport Factors Results Summary

Parameter	Car Park & Fly	Car Kiss & Fly	Taxi	747	Airport Staff
VoT Business(1)	$166.6	$37.5	$52.80	$13	$65.0
VoT Non-Business(1)	$58.3	$33.3	$28.10		
Access Time Factor	1.0	1.3/1.4 (Business/Non business)	2.8	1.0	1.0
Wait Time Factor	1.0	2.6/2.9 (Business/Non business)	5.6	4.4	1.0
In Vehicle Time Factor	1.0	1.0	1.0	1.1	Bus (1.1)
Transfer Penalty (mins)	0.0	0.0	0.0	7.5	Bus (7.5)

(1) VoT is for Business and Non-business separately for Park & Fly, kiss & Fly, Taxi and Staff. 747 Express Airport Shuttle splits the markets into AM Peak and Interpeak, and does not distinguish business and non-business trips.

4.130 While the value of times obtained from the SPs are very high, experience in other jurisdictions shows that these values for air travelers are typically much higher than those observed for other trip purposes (i.e. commuter travel). For example, the US Department of Transport[17] guidelines provide an average value of time of $44/$60 (in 2012 USD) for all purpose and business air travel ($56/$72 in 2016 USD).

4.131 While the average VoT values for air travelers seem to be within acceptable ranges, the ***Park & Fly*** values appear to be extremely high, especially for business users ($166.60 per hour). It is also worth noting that a similar effect is observed with ***airport staff*** that are currently using the airport parking facilities.

4.132 However, business travelers and airport staff are reimbursed for the parking costs and therefore there is a resulting bias against any other mode, with a very high component of non-traders who always chose the car or taxi, no matter how attractive the new transit system is (41% of surveys).

4.133 This reflects a clear resistance of existing car users (both air travelers and airport staff) to shift modes unless they are asked to pay for a parking fee.

4.134 ***Drop off and taxi users*** present a high value of time, as well as a penalty for access and wait time, which is in-line to what is expected.

[17] https://www.transportation.gov/sites/dot.gov/files/docs/USDOT%20VOT%20Guidance%202014.pdf

4.135 *747* Express Airport Shuttle users present a value of time which is almost double to that observed for the transit system. This is in-line with what is expected, given the different trip purpose and different type of users. It also reflects the preference of users to REM, although it has been reflected in a higher value of time.

4.136 As discussed, the Stated Preference parameters are a result of preferences stated by the users of each mode, which could be biased. The application process of these variables is an iterative process, where the different parameters are adjusted in order to better reflect the expected diversion propensity of current demand by mode.

4.137 As mentioned above, the uncertainty of these parameters has been taken into account when developing the risk assessment and defining sensitivity analysis and high and low case scenarios.

Expansion Factors

4.138 The demand modelling has been carried out for the AM Peak period (6am-9am) and the Interpeak period (9am-3pm). In order to translate into daily and annual ridership, we have estimated the following factors:

- Weekday factor: Translates AM Peak and Interpeak demand into an average week day, using the following:
  - AM Peak (6am-9am) to Peak (6am-9am & 3pm-6pm) factor
  - Interpeak (9am-3pm) to Off Peak (before 6am, 9am-3pm, & after 6pm) factor
- Annual factor: Translates average weekday demand into annual demand.

Corridor Expansion Factors

4.139 In order to estimate the potential annualization factors to apply to the REM forecasts, Steer Davies Gleave has reviewed the most recent factors for the most relevant services in the corridor.

4.140 The estimated existing weekday and annual expansion factors are shown in Table 4-12.

Table 4-12: Expansion Factor Analysis

Mode	AMT Rail	AM PEAK TO PEAK	INTERPEAK TO OFF PEAK	WEEKDAY TO ANNUAL	% PEAK
RAIL	Deux-Montagnes Line	1.88	-	241	85%
	Vaudreuil-Hudson Line	1.92	-	214	92%
	Saint-Jérôme Line	1.86	-	213	92%
Mode	**West Island Bus**	**AM PEAK TO PEAK**	**INTERPEAK TO OFF PEAK**	**WEEKDAY TO ANNUAL**	**% PEAK**
STM	Non-express routes	2.13	1.66	277	52%
	Express routes	**1.95**	**1.59**	**273**	**59%**
Mode	**Métro**	**AM PEAK TO PEAK**	**INTERPEAK TO OFF PEAK**	**WEEKDAY TO ANNUAL**	**% PEAK**
MÉTRO	Green Line	2.50	1.86	313	49%
	Orange Line	2.18	1.78	293	52%
	Yellow Line	1.54	1.77	320	55%
	Blue Line	2.43	1.73	306	49%
	Total	**2.27**	**1.81**	**-**	**51%**
Mode	**Line**	**AM PEAK TO PEAK**	**INTERPEAK TO OFF PEAK**	**WEEKDAY TO ANNUAL**	**% PEAK**
EXPRESS BUSES (SOUTH SHORE/A10 corridor)	RTL	1.98	1.55	284	66%
	AMT	1.83	1.70	239	79%
	Ville de Saint-Jean-sur-Richelieu	2.09	1.58	287	65%
	CITs	1.90	2.15	192	81%
	Total	**1.94**	**1.63**	**258**	**70%**

Source: AMT, STM and CITs data

Note that data used to estimate Metro's 'Weekday to Annual' factor will differ from data in Table 3-11 as that refers to average weekly data (includes weekends)

West Island/Deux-Montagnes Line Corridor

4.141 The expansion factor on the Deux-Montagnes Line, as in the other rail lines, is currently very low. This reflects the commuting nature of the corridors, which are mainly used for trips to work. Furthermore, the service provision in the non-peak hours and weekends is limited (60 minute headways on Deux-Montagnes Line).

4.142 The bus demand observed in the DM corridor has a higher daily factor than rail, related in part to the higher frequency of Interpeak services. However, it is also worth noting, that Interpeak demand is partly comprised of shorter distance trips related to local access (shopping, errands, etc.) that will not be captured by the DM rail service.

4.143 Most of the demand for REM in West Island/Deux-Montagnes Line corridor will be captured from the Deux-Montagnes Line, express bus services and local bus services feeding the Orange Line. Therefore, a combination of the three has been taken into account in order to estimate expansion factors.

Table 4-13: West Island/Deux-Montagnes Line Expansion Factor Analysis

	AM PEAK TO PEAK	INTERPEAK TO OFF PEAK	WEEKDAY TO ANNUAL	% PEAK
DM	1.88		241	85%
Express routes	1.95	1.59	273	59%
Orange Line	2.18	1.78	293	52%
ESTIMATED REM	**1.94**	**1.63**	*	*

** The % of the peak periods compared to the total weekday demand will vary in each case*

Note that 'Weekday to Annual' factor

South Shore/A10 Corridor

4.144 The expansion factors on the express bus routes are higher, especially on the RTL services that provide a higher level of service in the Interpeak periods. Since most of the REM demand in this corridor will be captured from the existing bus demand, we have estimated similar expansion factors to those observed on the express bus services today.

Table 4-14: South Shore/A10 Corridor Expansion Factor Analysis

Line	AM PEAK TO PEAK	INTERPEAK TO OFF PEAK	WEEKDAY TO ANNUAL	% PEAK
RTL	1.98	1.55	284	66%
AMT	1.83	1.70	239	79%
Ville de Saint-Jean-sur-Richelieu	2.09	1.58	287	65%
CITs	1.90	2.15	192	81%
Total	**1.94**	**1.63**	**258**	**70%**
ESTIMATED REM	**1.94**	**1.63**		

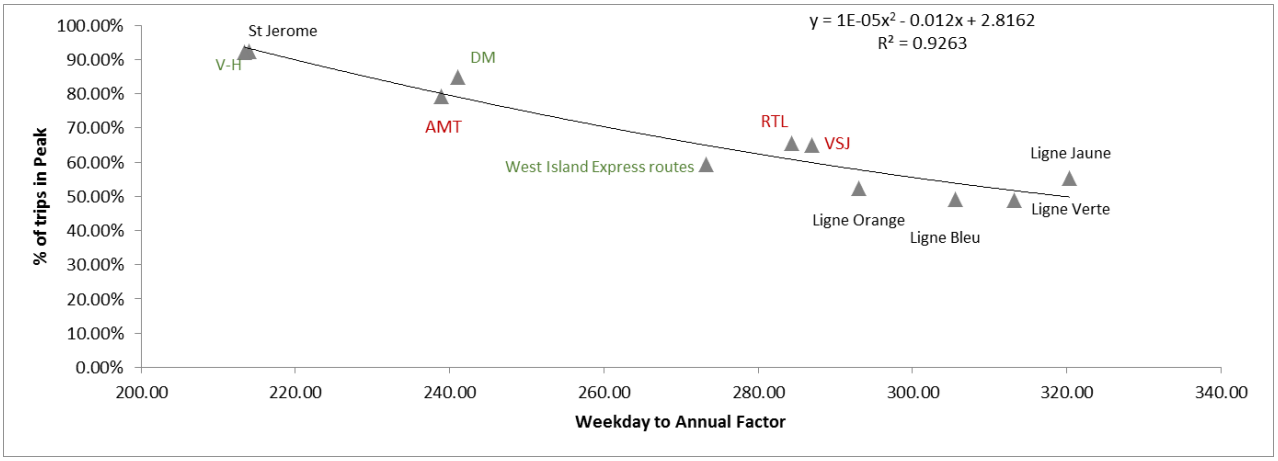
Annual factor

4.145 The annual factor reflects the multiplier that should be applied to convert weekday demand into annual demand. This incorporates weekend, public holidays and seasonality (with commuter service demand reducing over the Christmas and summer holidays).

4.146 The very low annual expansion factors on the Deux-Montagne Line and some of the bus express services (Express 90 Chevrier, etc.) reflect, in part, the low service provision of those services in the Interpeak periods and during weekends and holidays. However, it is also worth noting, that Interpeak demand is mostly comprised of local short distance trips related to shopping, errands, etc., that are less likely to be captured by REM due to the larger distance between stations.

4.147 There is normally a correlation between the level of service provision/demand in the Peak period of a weekday and that over the weekend and low season. Figure 4-8 plots the correlation between the percentage of demand in the peak periods over the average weekday, and the annual factor for some of the key services in the corridor. The correlation was applied to estimate the REM expansion factor.

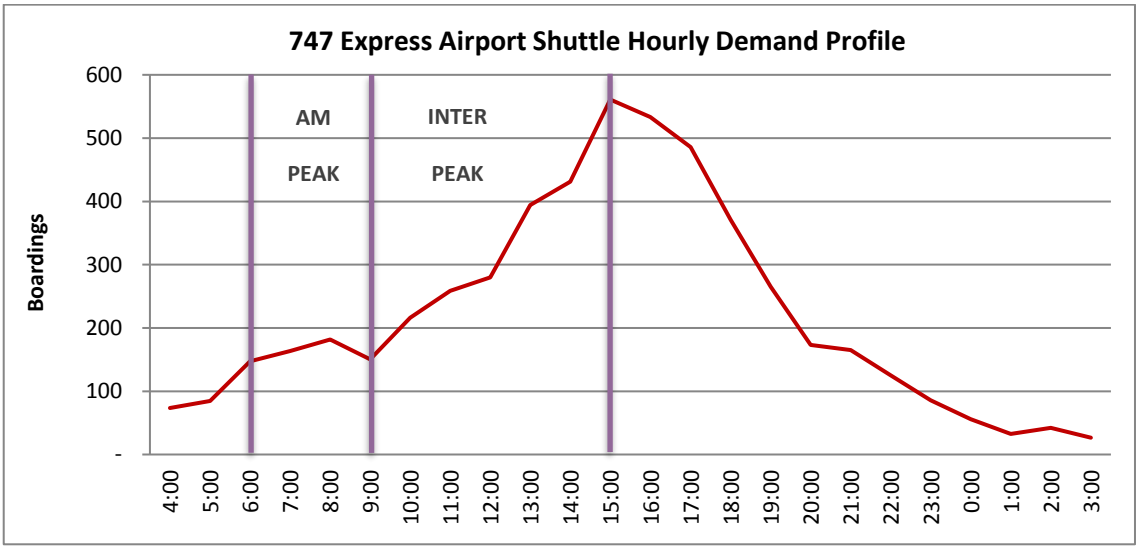
Figure 4-8: Weekday to Annual Expansion Analysis



Aéroport Pierre-Elliott-Trudeau

4.148 The 747 Express Airport Shuttle service has a very different hourly profile, since it reflects the airport demand based on flight schedules, instead of commuting demand. Figure 4-9 shows that the actual peak period for the 747 Express Airport Shuttle service is between 3pm and 4pm on a weekday.

Figure 4-9: 747 Express Airport Shuttle Hourly Demand Profile



4.149 Based on the 747 Express Airport Shuttle data above, the following expansion factors have been estimated for the 747 Express Airport Shuttle:

- AM Peak + Interpeak to weekday: 2.38
- Daily to annual: 277

Ramp Up

4.150 Ramp up is the reduction in potential ridership during the first years of operation as users gradually become fully aware of the alignment, service patterns and benefits of the new system. The extent of the ramp up depends on the type of user captured and is unique to every transport infrastructure project.

4.151 While users from the existing transit system are expected to transfer almost immediately if the existing rail/bus routes are removed, shifts from competing transit modes or from car will take longer to occur.

4.152 Table 4-15 shows some examples of ramp up rates for LRT systems and it also includes an estimation of the ramp up when the 747 Express Airport Shuttle was introduced.

Table 4-15: Transit Ramp Up Examples

	London, UK (Croydon)	Nottingham Line 1, UK	Manchester Métrolink, UK	Tren Urbano, Puerto Rico	747 Express Airport Shuttle
Year 1	74%	83%	60%	75%	80%
Year 2	83%	96%	84%	83%	90%
Year 3	85%	99%	92%	89%	95%
Year 4	90%	100%	94%	100%	100%
Year 5	100%	100%	100%	100%	100%

4.153 We have applied the following ramp up factors for the REM system.

Table 4-16: REM Ramp Up Factors

Year	West-Island/Deux-Montagnes Line Corridor		Airport Corridor		South Shore/A10 Corridor	
	Existing DM	New	Existing	New	Existing Express (eliminated)	New
2021	100%	60%	80%	60%	90%	60%
2022	100%	80%	90%	80%	95%	80%
2023	100%	90%	95%	90%	100%	90%
2024	100%	100%	100%	100%	100%	100%

5 Demand Development

5.1 The existing and future demand is incorporated in the model in the form of an OD matrix, which defines the demand between each origin and destination, and in some cases segregated by type of user. Different sources have been used in order to define the base matrices, which in some cases have been complemented with data collection (described in the Data Collection report).

2015 Demand Base Year

Auto Demand

5.2 The MOTREM model auto demand OD matrix was used as the basis to estimate auto demand. MOTREM was calibrated to the 2013 Enquête OD survey, traffic counts, and matrix developed for 2016, summarized in Table 5-1.

Table 5-1: MOTREM Demand Total (2016)

	AM Peak (6am-9am)	Interpeak (9am-3pm)	24 Hours
Auto	1,166,657	1,350,718	4,800,628
Auto Commercial	146,799	664,107	1,057,953
Light Goods Vehicles	61,210	141,535	308,561
Heavy Goods Vehicles	20,272	55,763	127,309
TOTAL	**1,394,938**	**2,212,122**	**6,294,451**

5.3 The MOTREM auto demand was reviewed and auto calibration is presented in Section 6.

Transit Demand

5.4 The transit demand matrix was developed using the following data sources:

- 2013 Enquête OD survey
- 2015 AMT on-board survey
- 2016 Steer Davies Gleave on-board survey
- 2015 bus boarding data

2013 Enquête OD Survey

5.5 The survey covers almost 79,000 households and provides origin-destination data for the AM Peak period and 24 hours for all modes of transportation. The expanded matrix, based on estimated population in 2013 is shown in Table 5-2. Note the following:

- Interpeak demand is not estimated specifically as part of the 2013 Enquête OD survey process

- Trucks were not included in the 2013 Enquête OD survey
- Differences with Table 5-1 as result of MOTREM calibration and adjustments

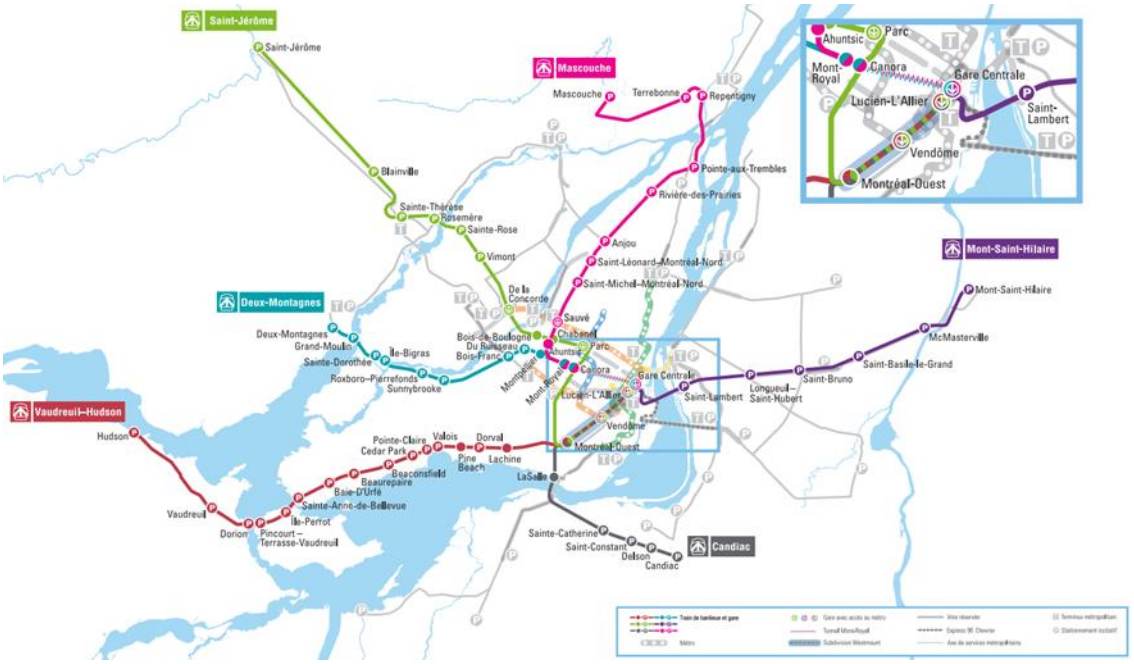
Table 5-2: 2013 Enquête OD Survey – Trips by Mode

Mode	AM Peak	24 Hour
Auto (driver)	1,140,253	5,069,864
Auto-passenger	251,262	1,216,957
Auto subtotal	*1,391,515*	*6,286,821*
Transit	399,677	1,363,795
Park & Ride	44,856	123,397
Auto-passenger + transit (kiss & ride)	23,694	55,536
Transit subtotal	*468,227*	*1,542,728*
Total	**1,859,742**	**7,829,549**

2015 AMT On-board Survey

5.6 AMT undertakes on-board OD surveys at regular intervals on the six commuter rail lines and the Express 90 Chevrier bus service. AMT provided origin-destination data for all rail lines and the Express 90 Chevrier. These were carried out in September 2015 in the AM Peak and were collected via postcards which passengers returned as they alighted from the train. Figure 5-1 shows the AMT train network.

Figure 5-1: AMT Rail Network



5.7 The train survey was conducted in the AM Peak period and the bus survey was conducted all day. Passengers were asked about their origin and destination in addition to access and egress mode, ticket type used and socio-economic background. The observations were expanded by the number

of passengers (boarding) and the boarding station. Table 5-3 shows a summary of the survey sample.

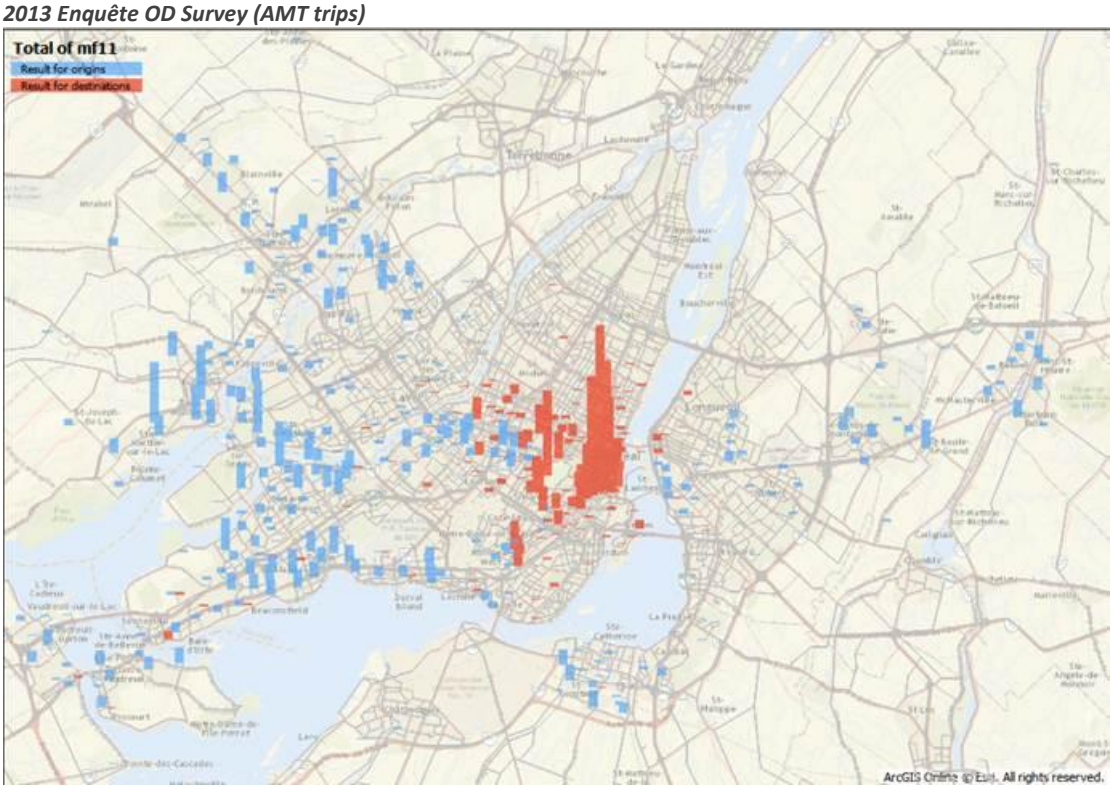
Table 5-3: 2015 AMT – Survey Sample

Line	Date	Responses	Passenger counts	Initial Passenger Sample	Valid responses	Revised Passenger Sample
Deux-Montagnes Line	Sep 2015	8,030	14,186	57%	7,482	53%
Vaudreuil-Hudson Line	Sep 2015	5,610	8,285	68%	5,217	63%
Mascouche Line	Sep 2015	2,649	3,388	78%	2,470	73%
Saint-Jérôme Line	Sep 2015	4,821	6,788	71%	4,558	67%
Express 90 Chevrier	Nov 2015	2,106	3,424	62%	1,893	55%
Mont-Saint-Hilaire Line	Sep 2015	3,729	4,739	79%	3,544	75%
Candiac Line	Sep 2015	1,938	2,412	80%	1,795	74%
TOTAL		**28,883**	**43,222**	**67%**	**26,959**	**62%**

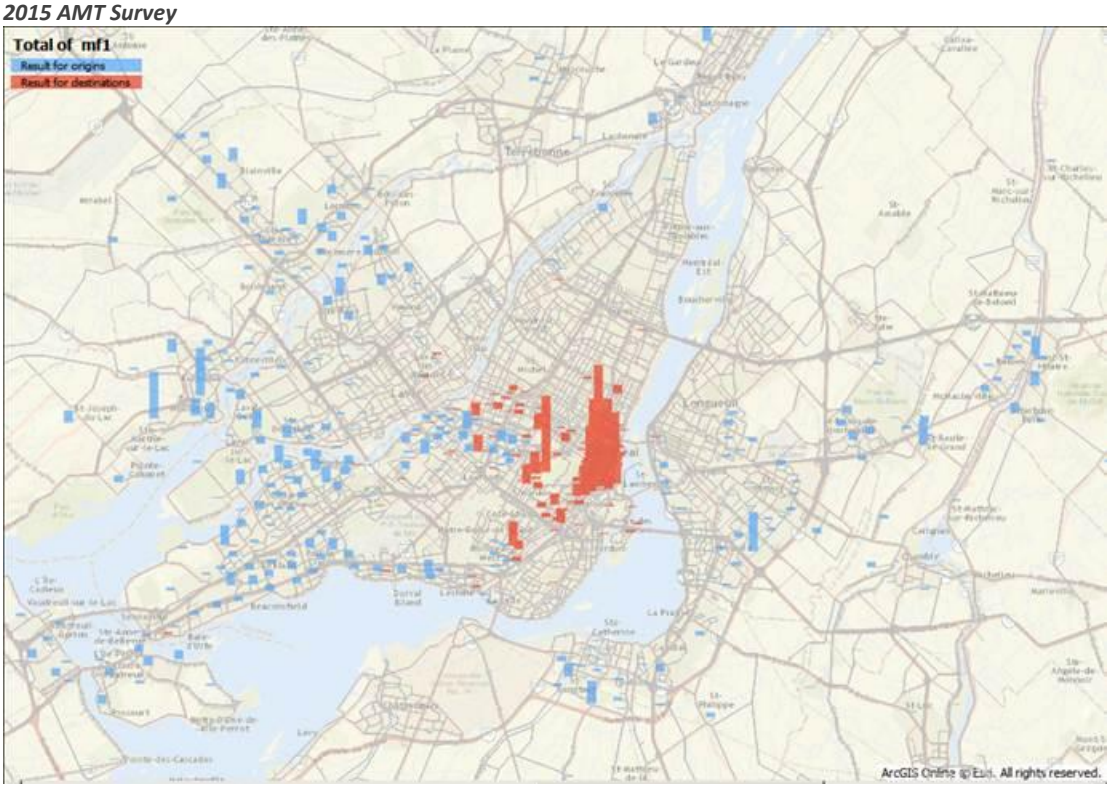
5.8 The overall survey sample was very high (62%) considering it relied on passengers returning the survey form. Figure 5-2 shows a comparison between the AM Peak AMT trips from the 2013 Enquête OD survey and the 2015 AMT survey.

Figure 5-2: 2013 Enquête OD Survey and 2015 AMT Survey Comparison (AM Peak)

2013 Enquête OD Survey (AMT trips)



2015 AMT Survey



5.9 The survey data shows the 2013 Enquête OD survey has more AMT trips than the 2015 AMT survey (51,000 vs 40,000) with both datasets having similar trip patterns.

5.10 An important proportion of trips to the train station are by car (car-driver access mode). Table 5-4 shows the number and proportion of car-driver access mode trips. Note that the AMT survey did not specify whether the car driver access was to an "official" Park & Ride site or drivers parked on the surrounding streets around the station.

Table 5-4: AMT Car Driver Access Mode Trips (AM Peak)

Variable	Trips	%
Car-driver Access Mode	22,066	55%
All Other Modes	17,875	45%
Total Trips	**39,941**	**100%**

2016 Steer Davies Gleave *on-board bus survey*

5.11 Steer Davies Gleave conducted an on-board OD survey on some of the West Island/Deux-Montagnes Line and South Shore/A10 bus services in May and June 2016 in the AM Peak and Interpeak periods (described in the Data Collection Report). The bus OD matrix was estimated based on:

- OD surveys expanded; and
- Additional transit demand to account for services, direction of travel and other areas not included on the survey. This demand was based on the 2013 Enquête OD survey and 2015 bus boarding data.

Table 5-5 summarises the estimated totals of bus trips in the study area by time period.

Table 5-5: Bus Trip Totals

Period	Steer Davies Gleave OD Survey Boardings	Total Boardings
AM Peak (6am-9am)	28,618	76,413
Interpeak (9am-3pm)	17,982	68,273

Demand Development

Data sources

5.12 Demand matrices were developed by combining data from the sources indicated above and following an extensive process to review and check the accuracy and validity of each data source. The matrices were developed into:

- 3 demand segments (Work, Student and Other)
- 2 time periods: AM Peak from 6am-9am and Interpeak from 9am-3pm

5.13 Table 5-6 summarizes the data sources by mode and period.

Table 5-6: Matrix Data Source Summary

Mode	Period	Direction	Source
AMT Rail	AM Peak	All	2015 AMT OD survey
	Interpeak	All	2013 Enquête OD survey
Express 90 Chevrier	AM Peak	To Montréal	2015 AMT OD survey
		To Chevrier	2013 Enquête OD survey
	Interpeak	To Montréal	2015 AMT OD survey
		To Chevrier	2013 Enquête OD survey
West Island/Deux-Montagnes Line and South Shore/A10 in-scope buses	AM Peak and Interpeak	All	2016 Steer Davies Gleave OD surveys and 2013 Enquête OD survey
Métro and other	AM Peak and Interpeak	All	2013 Enquête OD survey

5.14 The parking location was used as the origin from the AMT OD survey with a car driver access mode i.e. a Park & Ride trip.

Initial Demand

5.15 Table 5-7 shows the initial demand totals estimated by Steer Davies Gleave and compares them to the 2013 Enquête OD survey results. The following figures show the trip pattern for each matrix.

Table 5-7: Initial and AMT 2013 Enquête OD Survey Transit Demand Comparison

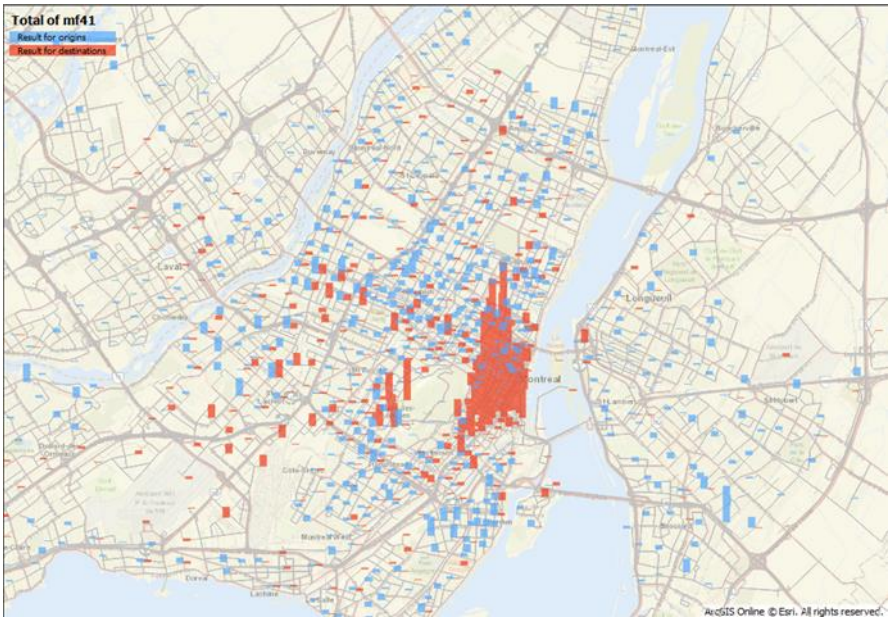
Period	Purpose	Initial (A)	2013 Enquête OD Survey (B)	Difference (A-B)	((A-B)/A)%
AM Peak	Work	220,470	265,899	(45,429)	-21%
	Study	137,483	173,582	(36,099)	-26%
	Other	24,982	28,746	(3,764)	-15%
	Total	**382,935**	**468,227**	**(85,292)**	**-22%**
Interpeak	Work	72,120	53,978	18,142	25%
	Study	80,811	65,236	15,575	19%
	Other	254,724	204,182	50,542	20%
	Total	**407,656**	**323,396**	**84,259**	**21%**

5.16 Table 5-7 shows that the initial 2015 demand estimates have reduced considerably the number of AM Peak trips in the 2013 Enquête OD survey while the opposite is the case in the Interpeak. This is a common occurrence with household surveys which are generally developed on a 24-hour basis and where respondents include their AM Peak trips (more regular and predictable) but can under-report non-peak trips which are more infrequent and therefore not reported.

5.17 Figure 5-3 to Figure 5-8 show the trip patterns for the initial estimated demand. Note that this demand was refined in the calibration process to ensure that road and transit flows on the network reflected observed boardings and peak loads and therefore further adjustments were carried out as reported in Section 6.

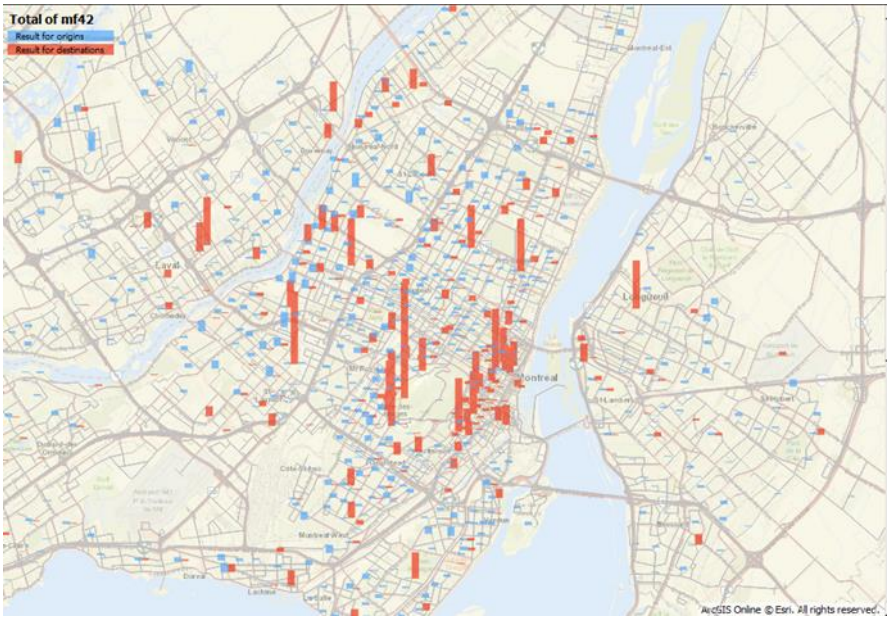
5.18 Figure 5-3 shows how the trip pattern for the AM Peak work trips displays a large number of trips with destination in downtown Montréal.

Figure 5-3: Work Trip Distribution (AM Peak)



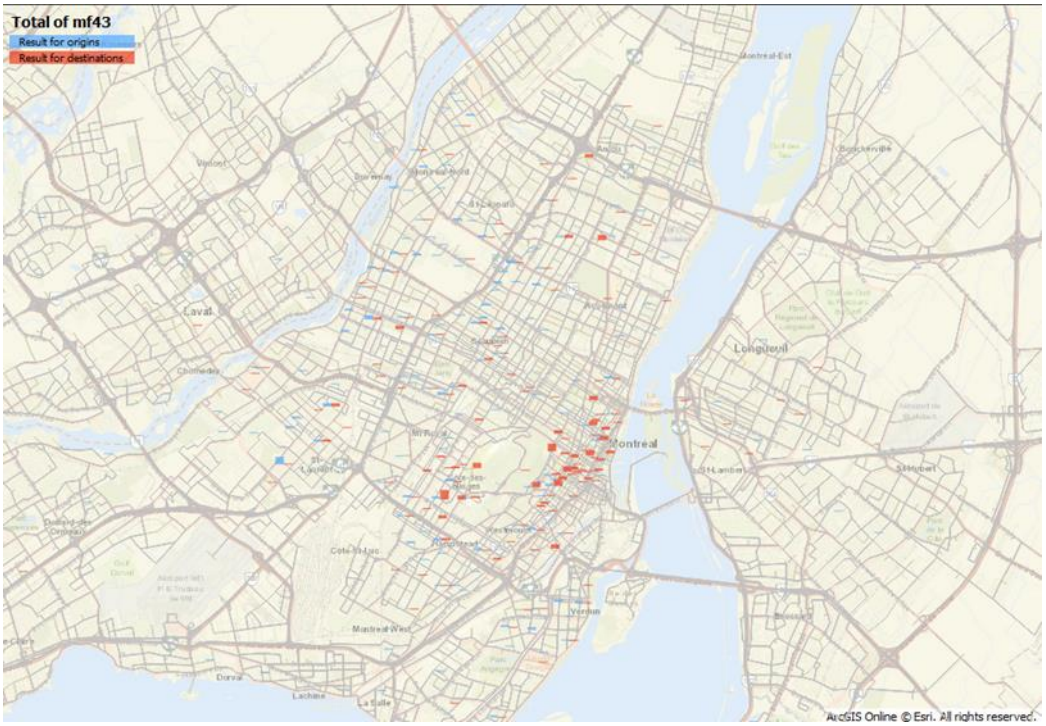
5.19 Study trips shown in Figure 5-4 display a much more diverse trip pattern and are linked to the location of the various universities and colleges e.g. Université de Montréal, west of Mont-Royal.

Figure 5-4: Study Trip Distribution (AM Peak)



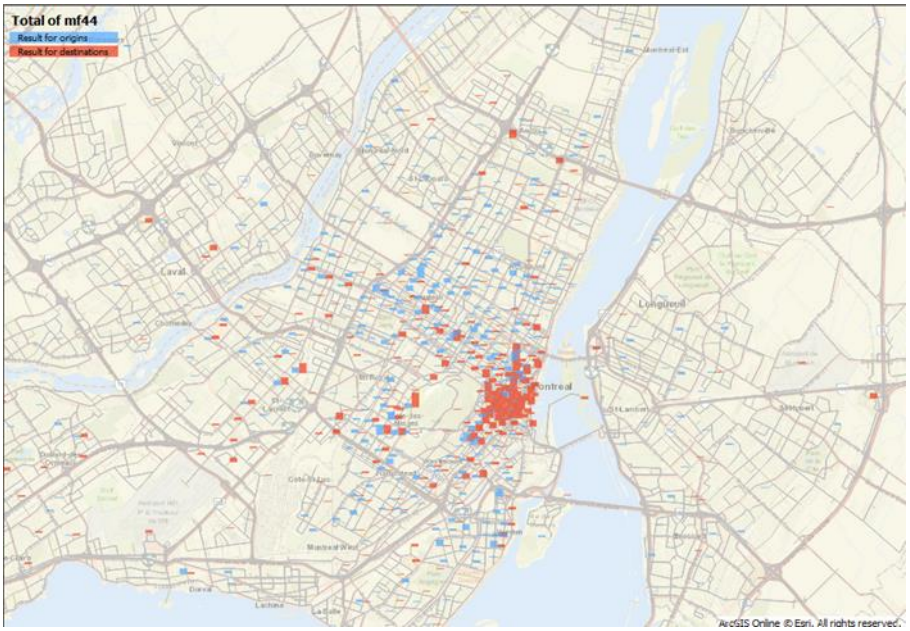
5.20 Other AM Peak trips are considerably less than Work and Study trips in volume and show a wide geographical distribution as shown in Figure 5-5.

Figure 5-5: Other Trip Distribution (AM Peak)



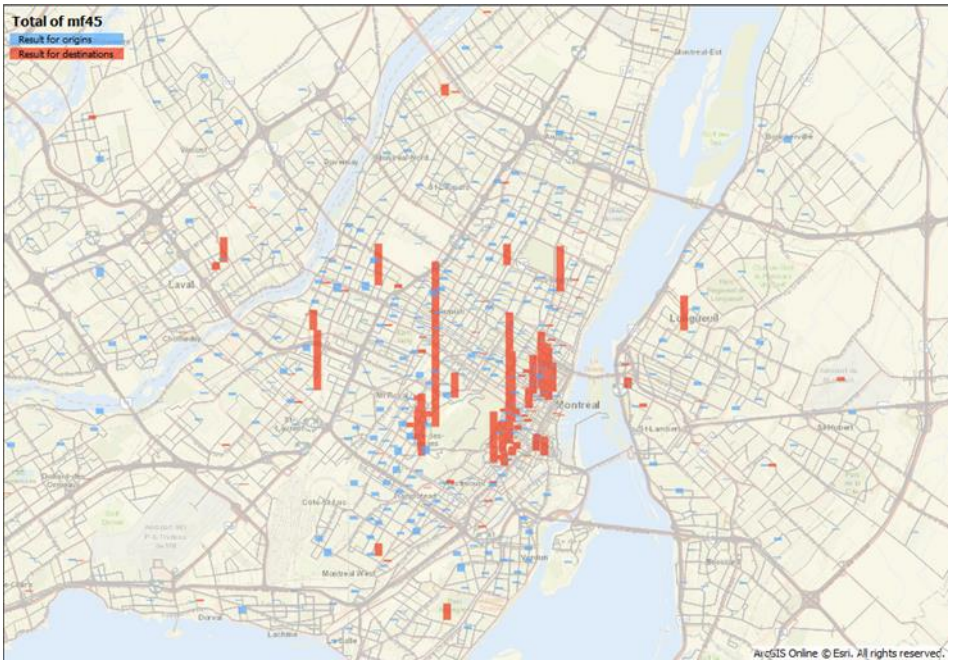
5.21 The Interpeak Work trip patterns are still concentrated in the Downtown area but show a more dispersed distribution than in the AM Peak as shown in Figure 5-6.

Figure 5-6: Work Trip Distribution (Interpeak)



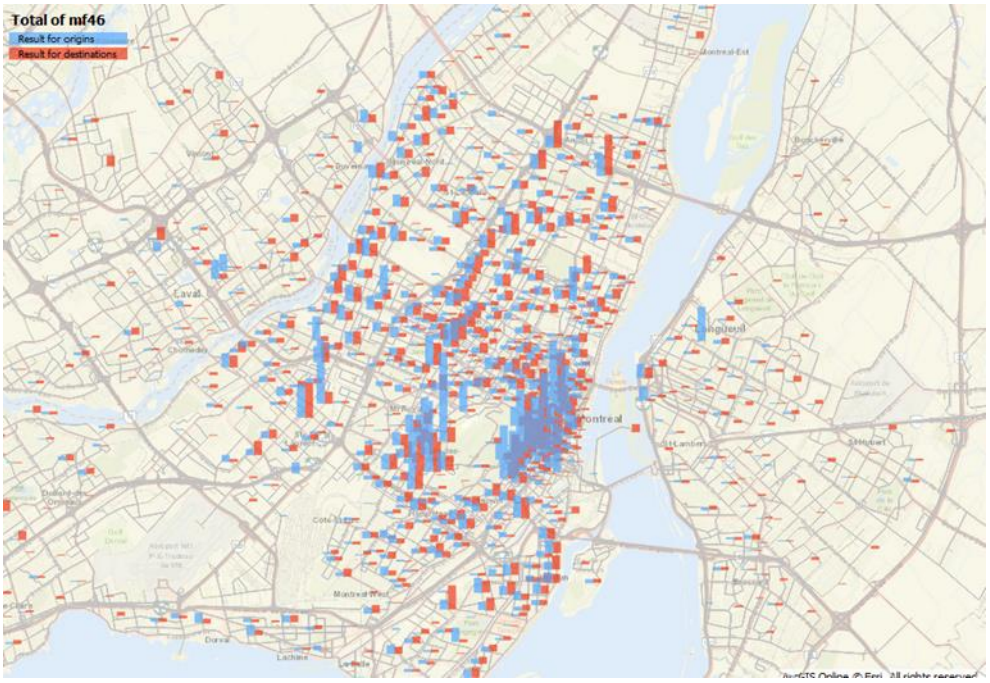
5.22 Figure 5-7 shows that Interpeak Study trips show a higher concentration of destinations at university locations than the AM Peak, likely as a result of high schools generating limited demand after the AM Peak.

Figure 5-7: Study Trip Distribution (Interpeak)



5.23 Figure 5-8 shows the largest geographical spread of origins and destinations for Other trips, in-line with the variety of trip purposes and the non-work nature of Interpeak trip-making.

Figure 5-8: Other Trip Distribution (Interpeak)



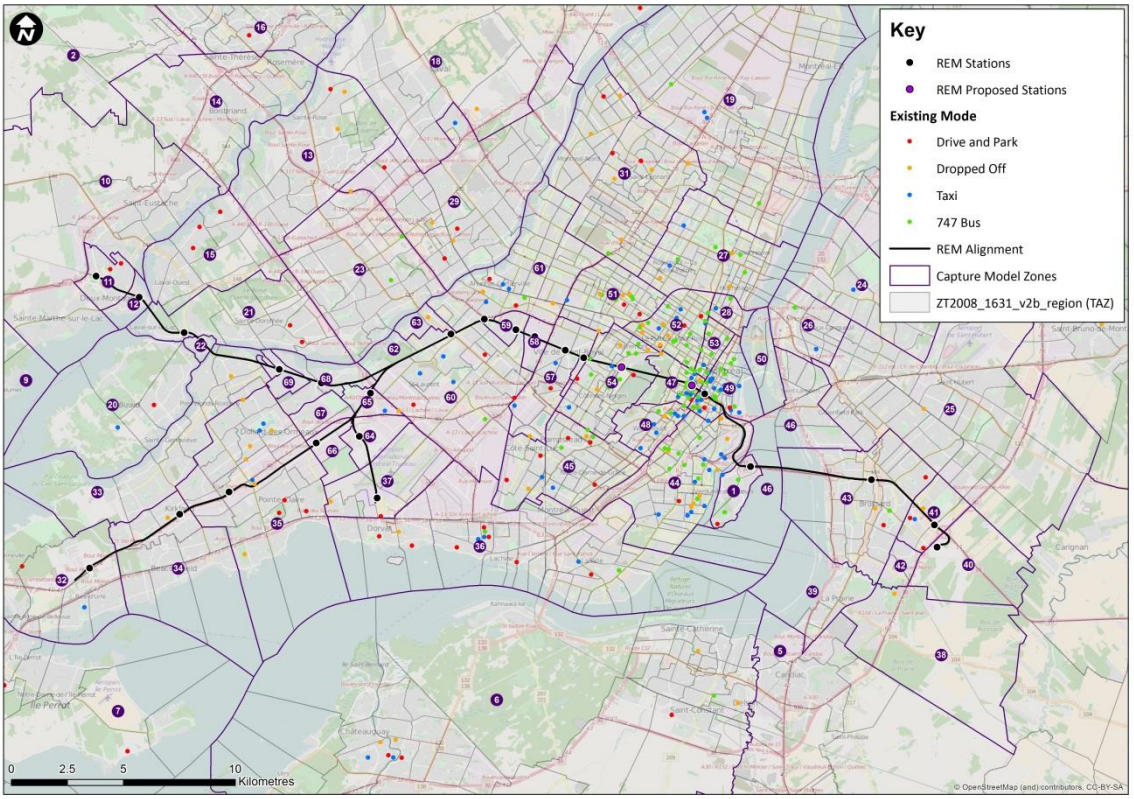
Airport demand

5.24 The Airport demand has been assessed separately from the rest of the demand, since the Household Surveys (2013 Enquête OD survey) do not capture the airport market. The 2013

Enquête OD survey is based on surveys to Montréal residents and focuses on day-to-day trips as described earlier in this section.

5.25 The spatial distribution of Montréal resident air passenger trips was distributed according to an aggregated version of the Network EMME Transit Mode Choice Model zones. There are 68 zones in the Airport model (Figure 5-9) where each station is assigned to an individual zone. The spatial distribution of non-resident air passenger trips was taken from the Steer Davies Gleave airport SP survey.

Figure 5-9: Airport Model Zoning System



5.26 The EMME demand distribution resulted in some gaps in the distribution. Where the equivalent area in the ADM surface access surveys was found to be non-zero, demand has been "in filled"[18].

5.27 The distribution of staff demand has been taken from the ADM staff survey of 2008. This survey contains staff postcodes, which have been mapped to the Airport model zoning system. This

[18] Zones with zero demand have been compared in the ADM surface access data with their contiguous neighbours to establish their relative importance. Using this we have estimated a relative importance factor for the "zero zone" which has been applied to the distribution in our Aéroport Pierre-Eliot-Trudeau model. As a final step, the whole EMME based demand matrix has been re-scaled to maintain its overall size and to ensure that some zones do not become unduly represented.

distribution has then been applied directly to the total annual staff trips. 3% of staff trips were found to be from areas outside of our zoning system and have thus been excluded.

Demand Growth

5.28 In this section, Steer Davies Gleave has analysed how auto and transit demand has grown in the past, both in the West Island/Deux-Montagnes Lines and South Shore/A10 corridors.

5.29 This section also includes the development of models to estimate future growth based on observed historic trends and their correlation with the key socio-economic variables, in order to estimate future matrices.

West Island/Deux-Montagnes Line Transit Growth

Historical Growth

5.30 Steer Davies Gleave has analysed how transit demand has grown in the West Island/Deux-Montagnes Line corridor since 2007. This has been based on historical ridership on the West Island bus routes, Deux-Montagnes Line (DM) and Vaudreuil-Hudson Line (V-H) rail lines and Métro Orange Line. The data is shown in Table 5-8.

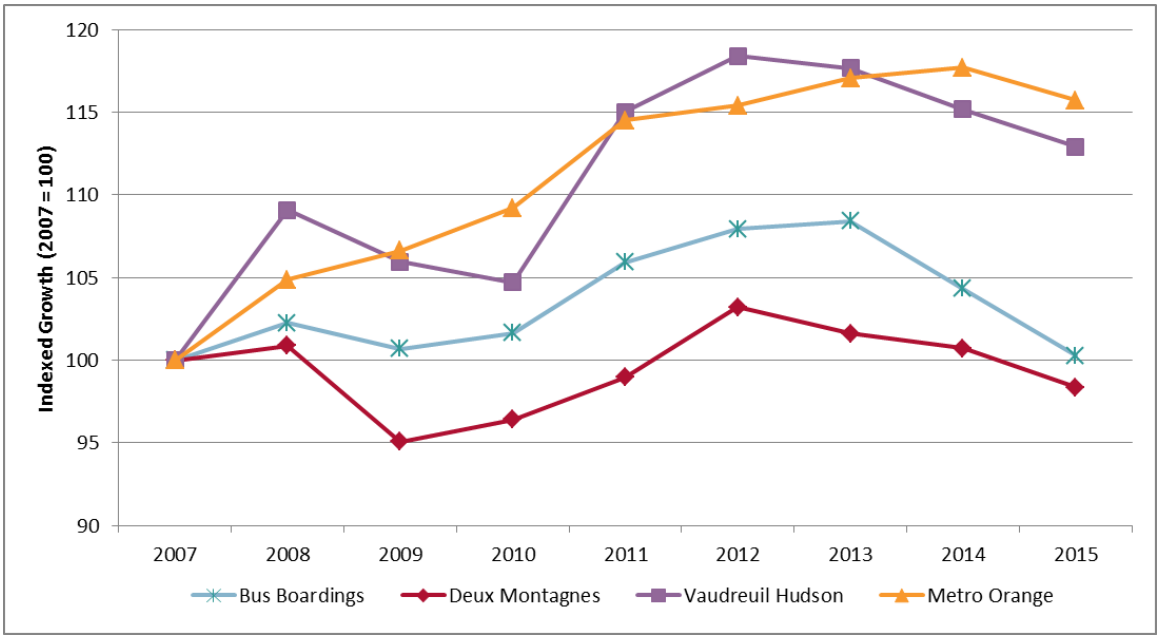
Table 5-8: Historical Transit Demand (Annual)

	Deux-Montagnes Line	Vaudreuil-Hudson Line	Bus	Orange Line
2007	7,620,800	3,267,900	62,726,469	98,587,989
2008	7,687,200	3,565,000	64,145,817	103,377,436
2009	7,245,600	3,462,600	63,151,709	105,113,052
2010	7,347,200	3,421,700	63,758,197	107,681,830
2011	7,543,300	3,759,000	66,432,141	112,882,353
2012	7,864,800	3,869,500	67,711,050	113,768,470
2013	7,744,800	3,845,300	68,011,631	115,415,163
2014	7,675,000	3,763,500	65,443,879	116,033,440
2015	7,495,900	3,689,800	62,906,809	114,098,821

Source: AMT and STM

5.31 Figure 5-10 shows the data presented as growth from 2007. This shows quite a variable growth pattern with the 2008-09 recession clearly identified with a reduction in demand across all services (with the exception of the Orange Line).

Figure 5-10: West Island/Deux-Montagnes Line Historical Ridership Growth



Source: AMT and STM

5.32 Figure 5-11 shows a consistent pattern between transit growth on the Deux-Montagnes Line and West Island buses and the employment growth in Montréal until 2013. However, the correlation breaks in 2014, with a much higher than expected reduction in transit boardings thereafter.

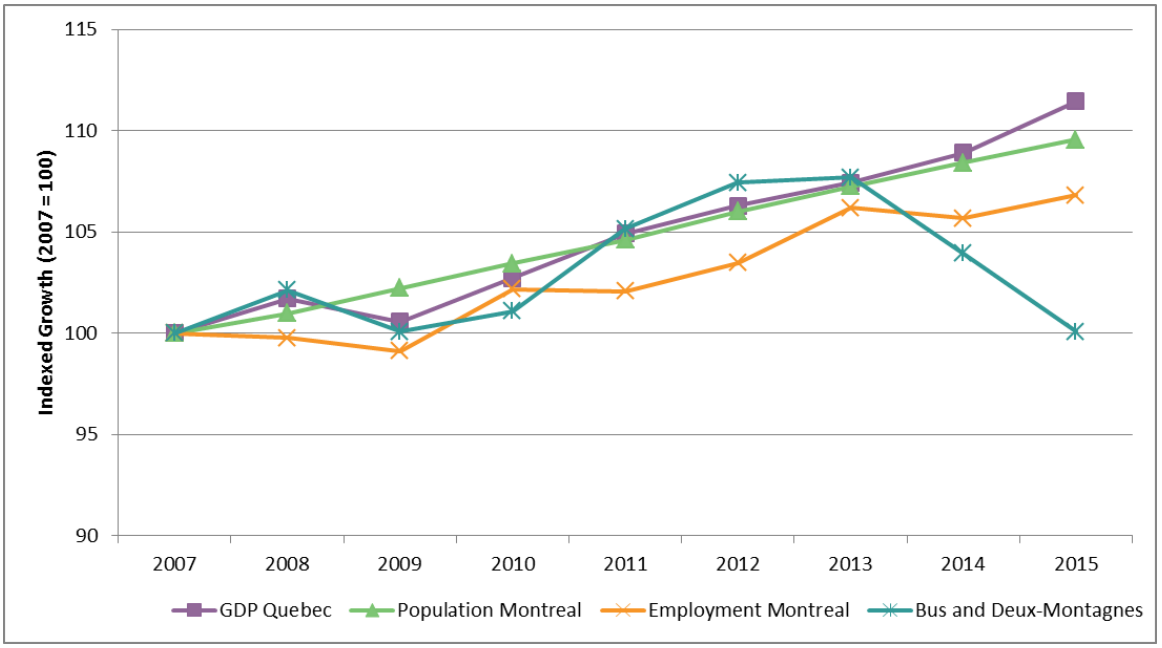
5.33 STM in their annual report has identified a number of potential factors for this reduction including[19]:

- An increase in the number of active trips (walking and cycling)
- An increase in new mobility options (car sharing etc.)
- Decline in the cost of gas
- Difficult winter conditions

5.34 This represents a potential risk area for the forecasts and alternative transit growth scenarios should be considered when reviewing REM forecasts.

[19] STM 2015 Annual Report

Figure 5-11: West Island/Deux-Montagnes Line Transit Ridership and Socio-economic Growth



Source: AMT, STM and Statistics Canada

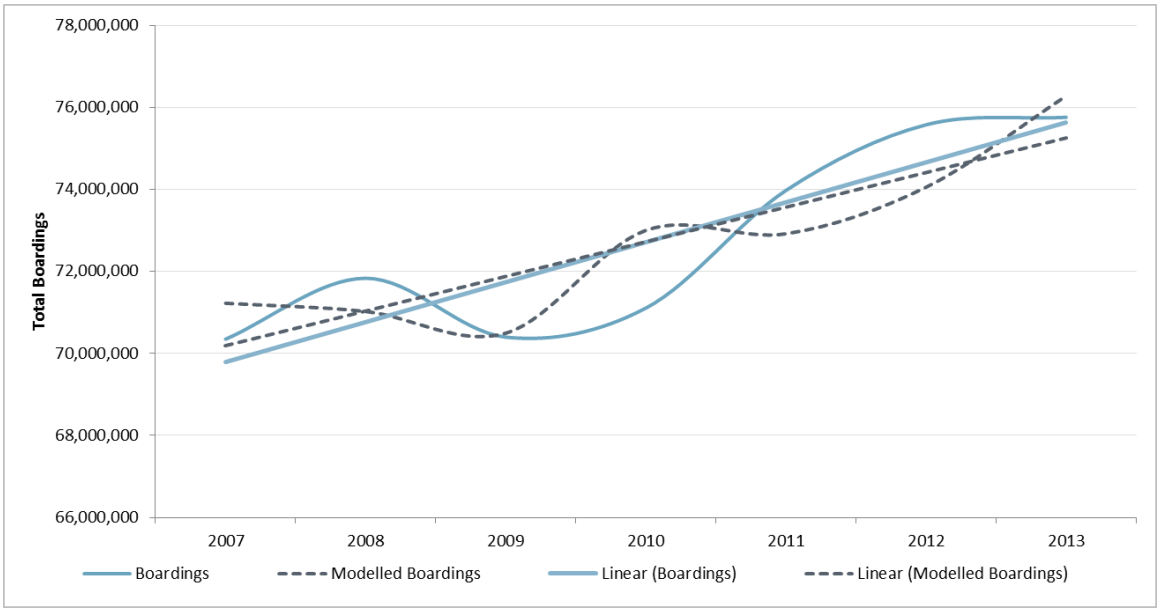
Growth Model

5.35 Based on the relationship observed between transit boardings and the socio-economic indicators, a regression model was developed. In order to select the best indicators of transit ridership, several statistical analyses were compared including Québec GDP and Metropolitan Montréal's population and employment statistics.

5.36 The analysis showed that the highest explanatory variable was employment in Metropolitan Montréal. Note that the ridership decline in 2014 and 2015 is challenging to model, considering all the socio-economic variables examined increased and the model was therefore developed by using data up to 2013 data only.

5.37 The R^2 value of the modelled versus observed ridership based on these parameters was estimated to be 0.74, which indicates an acceptable correlation of these parameters to transit demand. Figure 5-12 shows the comparison of observed and modelled boardings for reference and the considerable year-to-year variations. We have also presented the growth as linear between 2007 and 2013 and this shows a close growth match.

Figure 5-12: West Island/Deux-Montagnes Growth Model Results



Source: Steer Davies Gleave and Statistics Canada

South Shore/A10 Corridor Transit Growth

Historical growth

5.38 Steer Davies Gleave has analysed how transit demand has grown since 2005 in the corridor based on historical ridership in the A-10 corridor and Métro Yellow Line. Table 5-9 shows the historical boardings for each of the service providers in the A-10 corridor.

Table 5-9: South Shore/A10 Corridor Historical Transit Demand (Annual passengers)

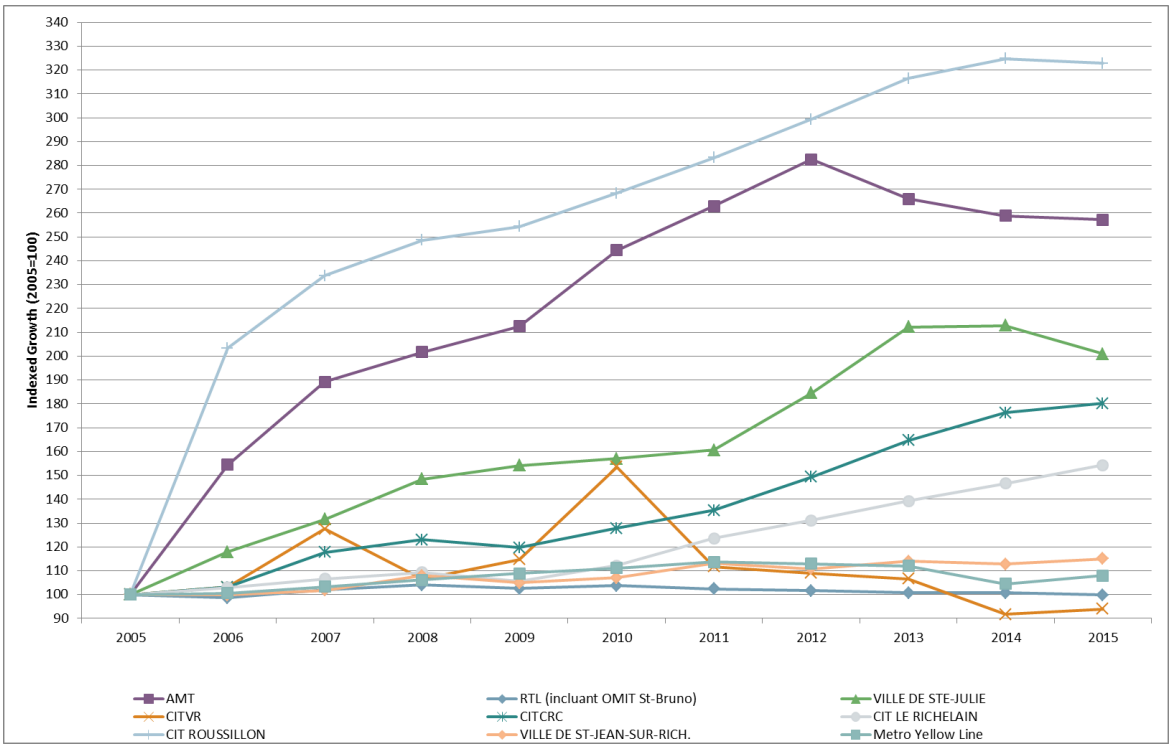
	AMT	RTL	OMIT Sainte-Julie	CIT Vallé- du-Richelieu	CIT Chambly-Richelieu-Carignan	CIT Le Richelain	CIT Roussillon	Ville de Saint-Jean-sur-Richelieu	Métro Yellow Line	Total
2005	593,062	6,224,758	172,998	67,960	550,281	753,206	185,019	1,071,772	10,066,518	19,685,574
2006	916,148	6,139,549	204,059	70,122	567,481	776,123	376,358	1,069,337	10,127,509	20,246,686
2007	1,122,160	6,345,889	227,607	86,713	648,065	803,367	432,361	1,090,937	10,399,207	21,156,306
2008	1,195,941	6,480,234	256,849	72,324	676,836	823,849	460,163	1,157,501	10,681,822	21,805,519
2009	1,260,126	6,381,705	266,713	78,007	658,508	796,242	470,628	1,125,371	10,963,981	22,001,281
2010	1,449,774	6,462,624	271,631	104,343	703,337	844,584	496,450	1,147,555	11,182,389	22,662,687
2011	1,559,593	6,376,363	277,884	75,887	745,051	931,249	524,036	1,211,282	11,447,724	23,149,069
2012	1,675,488	6,325,821	319,382	74,132	821,812	988,197	553,906	1,187,341	11,374,094	23,320,173
2013	1,577,400	6,275,680	367,077	72,418	906,482	1,048,628	585,479	1,221,997	11,276,937	23,332,098
2014	1,535,500	6,275,687	368,085	62,358	970,384	1,104,991	600,959	1,208,283	10,519,144	22,645,391
2015	1,525,800	6,218,338	347,693	63,874	991,891	1,162,551	597,182	1,233,393	10,868,701	23,009,423

**The historical demand and the demand presented in this report do not necessarily match because the annual data provided by the various transit agencies includes all their services whereas the demand estimated by Steer Davies Gleave for the South Shore/A10 corridor is only for the routes in scope.*

Source: AMT, RTL and CITs

5.39 Figure 5-13 shows graphically the boarding data in Table 5-9 since 2005.

Figure 5-13: South Shore/A10 Historical Ridership Growth



Source: AMT, RTL and CITs

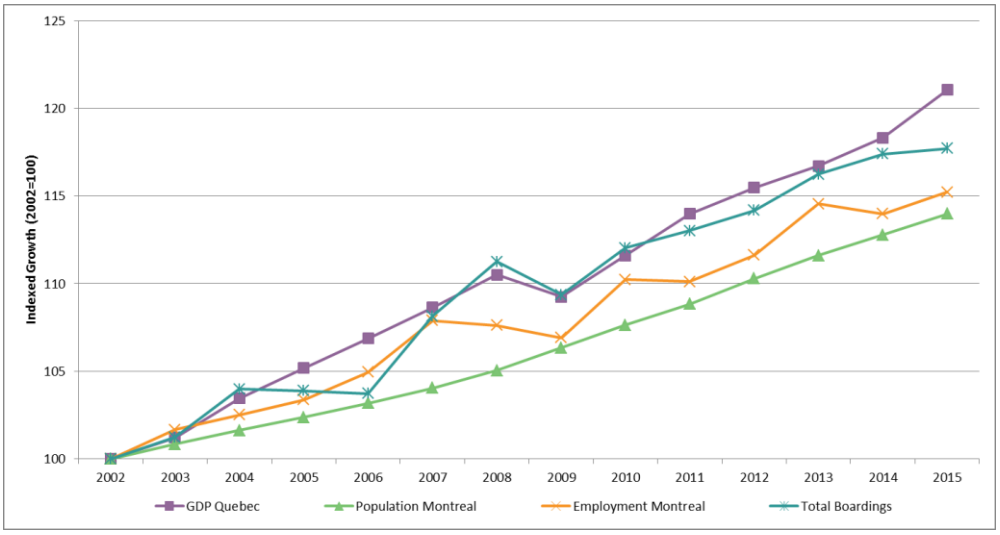
5.40 The data presents some surprising behaviour:

- Very large ridership increases for AMT (basically the Express 90 Chevrier) and CIT Roussillon between 2005 and 2006, which is likely a result of significant improvements in service. Since the purpose of this analysis is to develop a long term econometric analysis, these changes in service provision will distort the results and those two observations have been removed from further analysis.
- The Métro Yellow Line was also closed for extensive re-construction over weekends in 2014 resulting in a considerable reduction in boardings[20].
- In a similar pattern to the West Island/Deux-Montagnes Line transit services, the data shows boarding reductions over the last few years for a number of services (AMT, Sainte-Julie, and Vallé de Richelieu).

5.41 Figure 5-14 shows a close correlation between boardings (for buses) and the various socio-economic parameters.

[20] https://www.stm.info/fr/presse/communiques/2013/travaux-sur-la-ligne-jaune-du-Métro-en-2014---25-fins-de-semaine-de-fermeture-a-prevoir

Figure 5-14: South Shore/A10 boardings and Socio-economic Parameters Growth



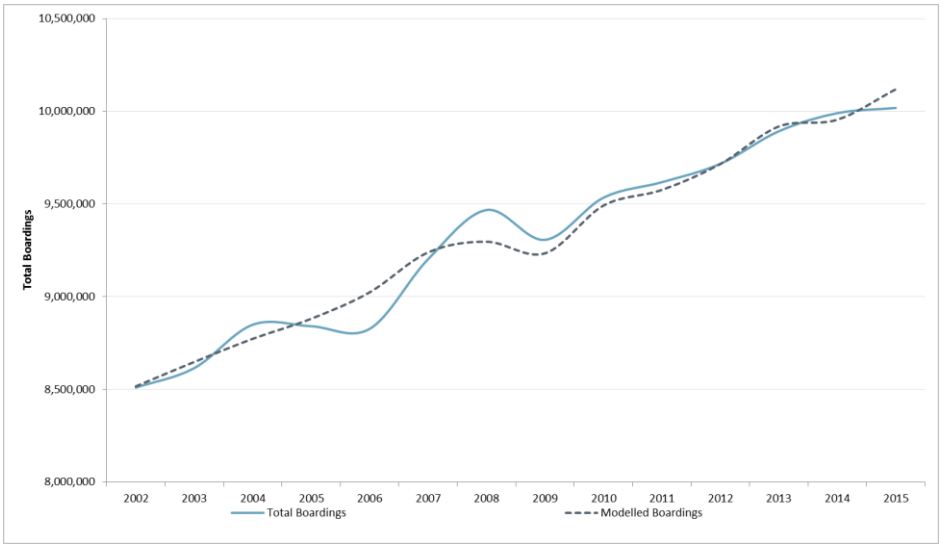
Source: AMT, RTL, CITs and Statistics Canada

Growth Model

5.42 As with West Island/Deux-Montagnes Line passenger travel, a regression model has been developed between historical boardings and socio-economic indicators. Québec GDP and Greater Montréal's population and employment provided the best fit and the R^2 of the modelled versus observed ridership based on these parameters was estimated to be 0.97, which indicates a very close correlation of these parameters to transit demand.

5.43 Figure 5-15 shows the comparison of observed and modelled boardings for reference.

Figure 5-15: South Shore/A10 Growth Model Calibration



Source: Steer Davies Gleave and Statistics Canada

Airport Demand Growth

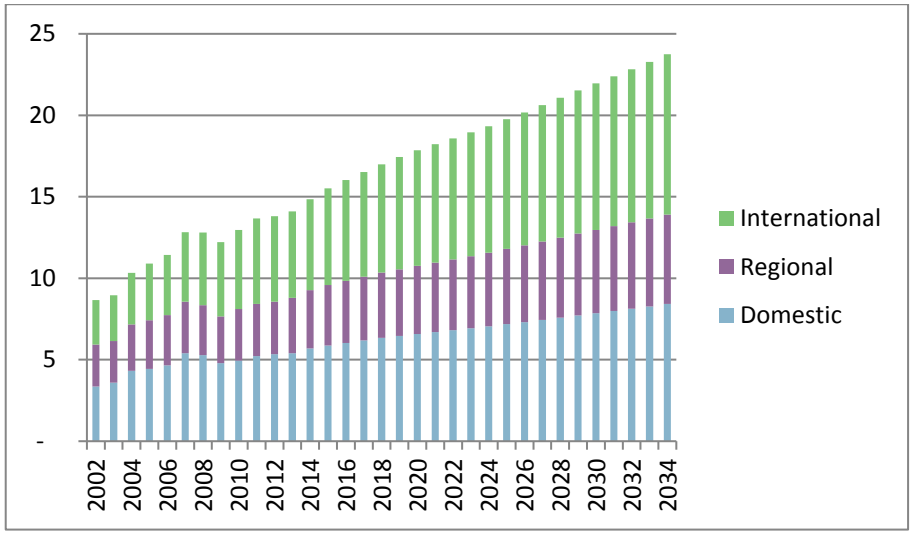
5.44 The Airport demand growth has been based on the forecasts provided by ADM as shown in Table 5-10 and Figure 5-16.

Table 5-10: Airport Growth Forecast (Per Year)

ADM	2015-2020	2020-2034
Domestic	2.3%	1.8%
Regional	2.4%	2.0%
International	3.7%	2.3%
Total	2.9%	2.1%

Source: ADM

Figure 5-16: ADM Airport Growth Forecast (Passenger Millions)

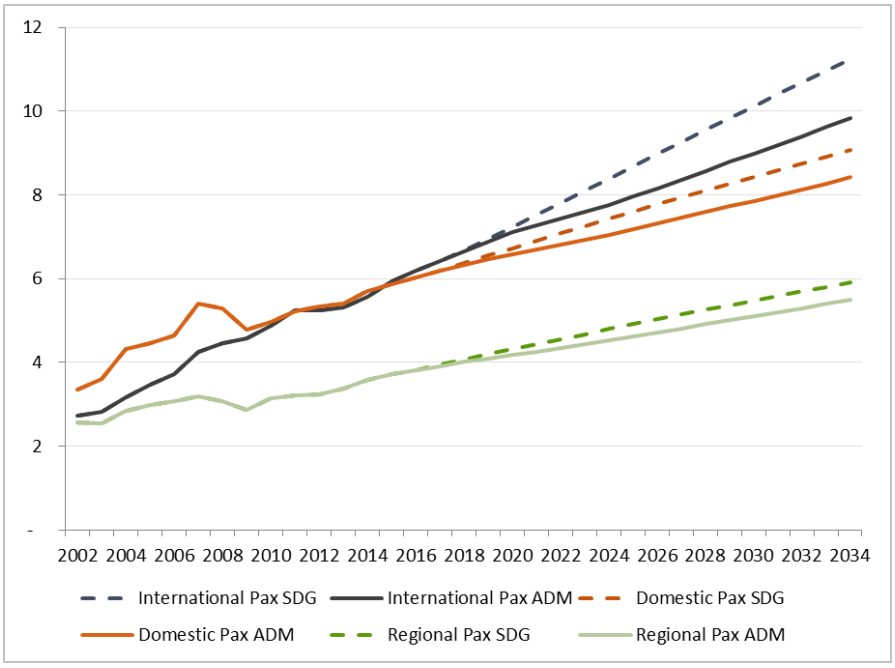


5.45 In order to validate this growth and provide reassurance of these estimates, Steer Davies Gleave carried out a simple GDP-driven forecast. The methodology and assumptions adopted to develop these models were as follows:

- 2016 has been used as the base year and demand based on ADM's Business Plan (September 2015).
- Growth models have been estimated for each traffic segment using regression analysis based on historic data.
  - Regional traffic forecasts (US only) have been correlated to a combination of Canada GDP (for outbound traffic) and US GDP (for inbound traffic)
  - For international traffic we have used a combination of Canada GDP (for outbound traffic) and a mix of Europe/LATAM and AsiaPac GDPs (for inbound traffic)
- GDP forecasts have been obtained from reliable sources: Global Insight Oct 15 for long term forecast and short term updates from April 16 IMF updates.

5.46 The following figure shows the growth estimates of ADM for each market segment compared to the GDP elasticity model developed.

Figure 5-17: Comparison of ADM Forecasts and GDP-Elasticity Model



5.47 The result of this analysis estimates CAGRs that are 30% higher than forecasted by ADM. However, it needs to be highlighted this is a high level and unconstrained assessment, which does not take into account the maturity or saturation of the Airport.

5.48 The ADM forecasts of future passenger demand were applied in the Airport model.

Future Transit Matrix Development

Corridor Transit Growth

5.49 A transit growth base case scenario was developed using the regression models described above based on the identified key demand drivers - the independent variables.

5.50 Socio-economic growth forecasts have been collected from different reliable sources and summarized in Table 5-11.

Table 5-11: Socio-economic Variables and Forecasts

Annual Growth	2016	2017	2018	2019	2020	2021	2021-2031
GDP	2.2%	1.8%	1.9%	2.0%	2.0%	1.9%	1.4%
Population	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.7%
Employment	0.8%	1.1%	1.0%	0.9%	0.8%	0.8%	0.6%

Sources: Québec GDP (Moody's), Montréal population (Institute de la Statistique du Québec Référence case), Montréal employment (Moodys)

5.51 The application of the input parameters identified in Table 5-11 results in the following transit growth estimates as shown in Table 5-12.

Table 5-12: Transit Ridership Growth Estimates

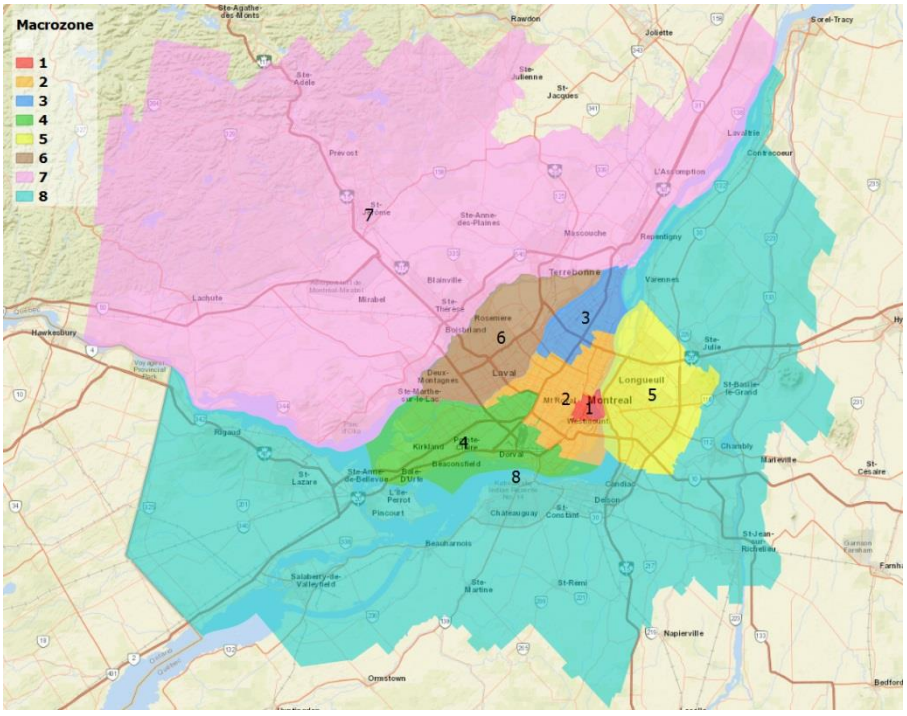
CAGR	2015-2021	2021-2031
South Shore/A10 corridor	1.4%	0.9%
West Island/Deux-Montagnes Line corridor	1.0%	0.7%

Future Transit Matrix Development

5.52 These growth forecasts represent an estimate of overall average growth in the corridor. However, growth per origin and destination will vary based on more localized growth patterns.

5.53 In order to estimate specific growth per OD, we have used the distribution of demand growth estimated by MTQ for the auto OD matrices[21]. This distribution represents an in-depth analysis of land use and population changes across Metropolitan Montréal and has been presented in terms of the macro-zones shown geographically in Figure 5-18.

Figure 5-18: Macro-zones of Metropolitan Montréal



5.54 Demand growth for the "Work" trip purpose by macro-zone for 2021 is shown in Table 5-13 and Table 5-14.

[21] Demand growth patterns of auto matrices except for the declining of trips to downtown and surroundings (macro zones 1 and 2) was considered as increasing in transit

Table 5-13: Transit Demand Growth for 2015 to 2021, Work Trip Purpose, AM Peak

	1 Downtown	2	3	4 West Island	5 South Shore	6 Laval	7	8 South Shore
1 Downtown	1.17%	1.12%	1.12%	0.75%	1.31%	1.12%	1.12%	
2 Central Island	1.16%	1.21%	1.14%	0.95%	1.30%	1.14%	1.12%	1.31%
3 East Island	1.18%	1.20%	1.26%	0.92%	1.31%	1.12%	1.12%	
4 West Island	0.83%	0.93%	0.93%	1.04%	1.51%	0.94%	1.25%	1.31%
5 South Shore	1.20%	1.32%	1.14%	1.26%	1.42%	1.31%		1.31%
6 Laval	0.95%	1.07%	1.00%	0.80%	1.27%	1.34%	1.10%	
7 North Shore	0.82%	0.87%	1.03%	1.28%	0.81%	1.40%	1.18%	
8 South Shore	1.11%	1.16%	1.11%	1.19%	0.73%	0.39%	1.22%	1.66%

Source: Steer Davies Gleave and MTQ

Table 5-14: Transit Demand Growth for 2015 to 2021, Work Trip Purpose, Interpeak

	1 Downtown	2	3	4 West Island	5 South Shore	6 Laval	7	8 South Shore
1 Downtown	1.15%	1.18%	1.15%	0.98%	1.34%	1.15%		1.34%
2 Central Island	1.19%	1.23%	1.04%	1.01%	1.34%	1.18%	1.15%	1.34%
3 East Island	1.15%	1.19%	1.17%	0.98%		1.47%	1.15%	
4 West Island	0.99%	1.00%	0.98%	0.99%		2.65%	0.98%	1.34%
5 South Shore	1.38%	1.32%	1.34%	1.34%	1.35%			1.34%
6 Laval	1.15%	1.15%	1.15%	0.98%		1.75%		
7 North Shore	1.15%	1.25%	1.15%				1.32%	
8 South Shore	1.37%	2.23%	1.34%	1.34%	1.53%			1.66%

Source: Steer Davies Gleave and MTQ

5.55 Total transit demand growth by macro-zone for 2031 is shown in Table 5-15 and Table 5-16.

Table 5-15: Total Transit Demand Growth for 2021 to 2031, AM Peak

	1 Downtown	2	3	4 West Island	5 South Shore	6 Laval	7	8 South Shore
1 Downtown	0.91%	0.88%	0.87%	0.71%	1.02%	0.89%	0.87%	1.02%
2 Central Island	0.91%	0.95%	0.89%	0.77%	1.03%	0.89%	0.89%	1.02%
3 East Island	0.92%	0.93%	0.95%	0.75%	1.04%	0.88%	0.90%	
4 West Island	0.69%	0.76%	0.76%	0.87%	1.08%	0.68%	0.50%	1.05%
5 South Shore	0.94%	1.04%	0.95%	1.01%	1.09%	1.02%	1.02%	1.04%
6 Laval	0.78%	0.88%	0.89%	0.85%	1.03%	1.09%	0.86%	
7 North Shore	0.67%	0.70%	0.84%	0.77%	0.76%	0.88%	1.18%	1.05%
8 South Shore	0.92%	0.92%	0.92%	0.97%	0.94%	0.97%	0.96%	1.17%

Source: Steer Davies Gleave and MTQ

Table 5-16: Total Transit Demand Growth for 2021 to 2031, Interpeak

	1 Downtown	2	3	4 West Island	5 South Shore	6 Laval	7	8 South Shore
1 Downtown	0.90%	0.90%	0.86%	0.75%	1.06%	0.85%	0.86%	1.06%
2 Central Island	0.93%	1.01%	0.89%	0.79%	1.06%	0.88%	0.86%	1.06%
3 East Island	0.88%	0.94%	0.93%	0.75%	1.04%	0.71%	0.87%	1.06%
4 West Island	0.82%	0.84%	0.75%	0.84%	1.06%	0.89%	1.04%	1.07%
5 South Shore	1.05%	1.06%	1.06%	1.05%	1.16%	1.06%		0.96%
6 Laval	0.92%	0.89%	0.88%	0.72%	1.06%	1.10%	0.96%	
7 North Shore	0.88%	0.88%	0.88%	0.82%	1.06%	0.80%	1.13%	
8 South Shore	1.05%	1.08%	1.01%	1.04%	1.02%			0.75%

Source: Steer Davies Gleave and MTQ

Auto Future Matrix Development

5.56 Future auto matrices have been based on MTQ's forecast growth as contained in MOTREM. This distribution represents an in-depth analysis of land use and population changes across Metropolitan Montréal.

6 Model Calibration

Introduction

6.1 Calibration refers to the process undertaken to optimize the model performance by comparing the observed against modelled travel data to ensure the model represents current travel demand patterns in Metropolitan Montréal accurately. The calibration process is iterative and involves a review of network coding, demand levels and mode constants. This section presents the model calibration undertaken and includes:

- Auto traffic flow
- Rail loadings
- West Island transit boardings
- Saint Lawrence transit screenline

6.2 One of the results of the calibration was a review and update of the mode constants resulting from the Stated Preference surveys (presented in Section 4). The use of the SP parameters resulted in modelled results that were substantially higher than observed in bus boardings and bus transfers. This could also be related to a representation of bus accessibility in the model that favours the use of bus due to easy access to bus stops.

6.3 In order to represent more accurately the demand and transfers observed in the existing bus, rail and Métro network, the bus was penalized with increased mode constant and transfer penalties.

6.4 The changes included:

- Modal Constant
  - Rail/Métro: 0 minutes
  - Bus: 7.5 minutes
- Transfer Penalty
  - To rail modes: 4-minute transfer penalty (as per SP survey)
  - To bus: 7-minute transfer penalty

6.5 The mode constant values are within the values presented in the review contained in Appendix B and are based on similar differences between bus and REM presented in the traders-only SP analysis.

Traffic Model

6.6 MOTREM is a 24-hour traffic forecasting model. However, the focus of our work has been on the AM Peak (6am-9am) and Interpeak (9am-3pm) periods and these were calibrated to a 2015 fall weekday base year.

6.7 The calibration was carried out for the two screenlines shown in Figure 6-1 and

6.8 Figure **6-2**. This allows us to understand the main auto demand on the REM corridors across each major screenline.

Figure 6-1: Saint Lawrence River Crossing Auto Screenlines

Figure 6-2: West Island Auto Screenlines

6.9 Table 6-1 to Table 6-4 show the resulting AM Peak and Interpeak auto traffic flow calibration. Note that calibration to individual road links can be challenging. We captured the overall traffic crossing the various screenlines to ensure a good match between modelled and observed total flows across screenlines and time periods (between -17% and +14% is the range of differences for the screenline totals by direction).

Table 6-1: Bridge Crossing Screenline (AM Peak)

Location	Direction	Observed Counts	Modelled Counts	Difference	% Difference
Champlain Bridge	To Montréal	18,275	17,558	-717	-4%
Champlain Bridge	From Montréal	7,961	7,255	-706	-9%
Honoré Mercier Bridge	To Montréal	9,801	10,273	472	5%
Honoré Mercier Bridge	From Montréal	3,735	4,496	762	20%
Victoria Bridge	To Montréal	7,120	7,472	352	5%
Victoria Bridge	From Montréal	One way only		-	-
Jacques Cartier Bridge	To Montréal	13,276	16,307	3,031	23%
Jacques Cartier Bridge	From Montréal	5,847	7,197	1,350	23%
Louis-Hippolyte Lafontaine Bridge-Tunnel	To Montréal	14,652	14,978	327	2%
Louis-Hippolyte Lafontaine Bridge-Tunnel	From Montréal	13,124	13,217	92	1%
Subtotal	*To Montréal*	*63,123*	*66,588*	*3,465*	*5%*
Subtotal	*From Montréal*	*30,668*	*32,166*	*1,498*	*5%*
TOTAL		**93,791**	**98,754**	**4,963**	**5%**

Totals may vary due to rounding

Table 6-2: Bridge Crossing Screenline (Interpeak)

Location	Direction	Observed Counts	Modelled Counts	Difference	% Difference
Champlain Bridge	To Montréal	20,807	18,397	-2,410	-12%
Champlain Bridge	From Montréal	20,584	21,231	647	3%
Honoré Mercier Bridge	To Montréal	11,882	12,164	282	2%
Honoré Mercier Bridge	From Montréal	11,280	14,795	3,515	31%
Victoria Bridge	To Montréal	3,815	2,028	-1,787	-47%
Victoria Bridge	From Montréal	3,887	1,148	-2,739	-70%
Jacques Cartier Bridge	To Montréal	14,664	16,110	1,446	10%
Jacques Cartier Bridge	From Montréal	13,594	20,169	6,575	48%
Louis-Hippolyte Lafontaine Bridge-Tunnel	To Montréal	20,366	19,059	-1,308	-6%
Louis-Hippolyte Lafontaine Bridge-Tunnel	From Montréal	20,799	22,959	2,160	10%
Subtotal	*To Montréal*	71,534	67,757	-3,777	-5%
Subtotal	*From Montréal*	70,144	80,303	10,159	14%
TOTAL		**141,678**	**148,060**	**6,382**	**5%**

Totals may vary due to rounding

Table 6-3: West Island Screenline (AM Peak)

Location	Direction	Observed Counts	Modelled Counts	Difference	% Diff
Pointe-Claire	EB1	11,316	14,374	3,058	27%
Pointe-Claire	EB2	10,741	12,046	1,305	12%
Pointe-Claire	WB	10,567	8,504	-2,064	-20%
Des Sources	WB1	7,357	6,226	-1,131	-15%
Des Sources	WB2	12,213	10,346	-1,867	-15%
Des Sources	EB1	12,718	13,686	967	8%
Des Sources	EB2	12,721	12,855	134	1%
Des Sources	EB3	18,270	14,872	-3,398	-19%
Subtotal	To Montréal	65,766	67,833	2,067	3%
Subtotal	From Montréal	30,137	25,076	-5,061	-17%
TOTAL		**95,903**	**92,909**	**-2,995**	**-3%**

Totals may vary due to rounding

Table 6-4: West Island Screenline (Interpeak)

Location	Direction	Observed Counts	Modelled Counts	Difference	% Diff
Pointe-Claire	EB1	15,522	15,157	-365	-2%
Pointe-Claire	EB2	10,954	10,433	-521	-5%
Pointe-Claire	WB	23,818	23,302	-516	-2%
Des Sources	WB1	14,942	12,661	-2,281	-15%
Des Sources	WB2	27,066	28,511	1,445	5%
Des Sources	EB1	28,229	11,486	-16,743	-59%
Des Sources	EB2	13,734	11,486	-2,248	-16%
Des Sources	EB3	13,897	24,891	10,994	79%
Subtotal	To Montréal	82,336	73,452	-8,884	-11%
Subtotal	From Montréal	65,826	64,474	-1,352	-2%
TOTAL		**148,162**	**137,926**	**-10,236**	**-7%**

Totals may vary due to rounding

6.10 Note that as a result of the analysis and calibration shown above, there were some adjustments made to the overall MOTREM demand and this is shown in Table 6-5.

Table 6-5: Auto Demand Total – After Calibration

	AM Peak (6am-9am)	Interpeak (9am-3pm)
Auto	1,123,178	1,350,718
Auto Commercial	146,799	664,107
Light Goods Vehicles	60,591	141,535
Heavy Goods Vehicles	19,610	55,763
TOTAL	**1,350,178**	**2,212,122**

Transit Model

Rail Loadings

6.11 AMT provided the loading profiles for all the rail lines in Montréal as shown in Figure 5-1.

6.12 A comparison of modelled versus observed rail loadings for each line is shown in Figure 6-3 to Figure 6-8. Note that the loading profile calibration focused on the AM Peak direction towards Montréal as this is when the largest proportion of the rail demand is present (which then returns from Montréal in the evening). The demand levels on services from Montréal are either very low or there are no services (Candiac Line and Mont-Saint-Hilaire Line).

Figure 6-3: Deux-Montagnes Line Load Profile – AM Peak towards Montréal

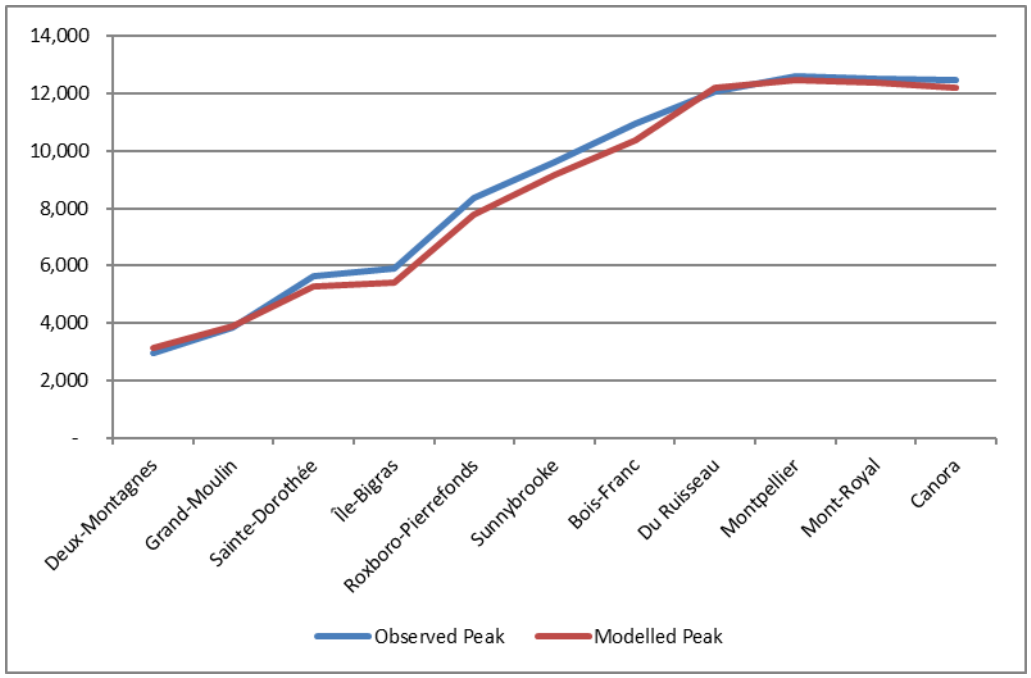


Figure 6-4: Mascouche Line Load Profile – AM Peak towards Montréal

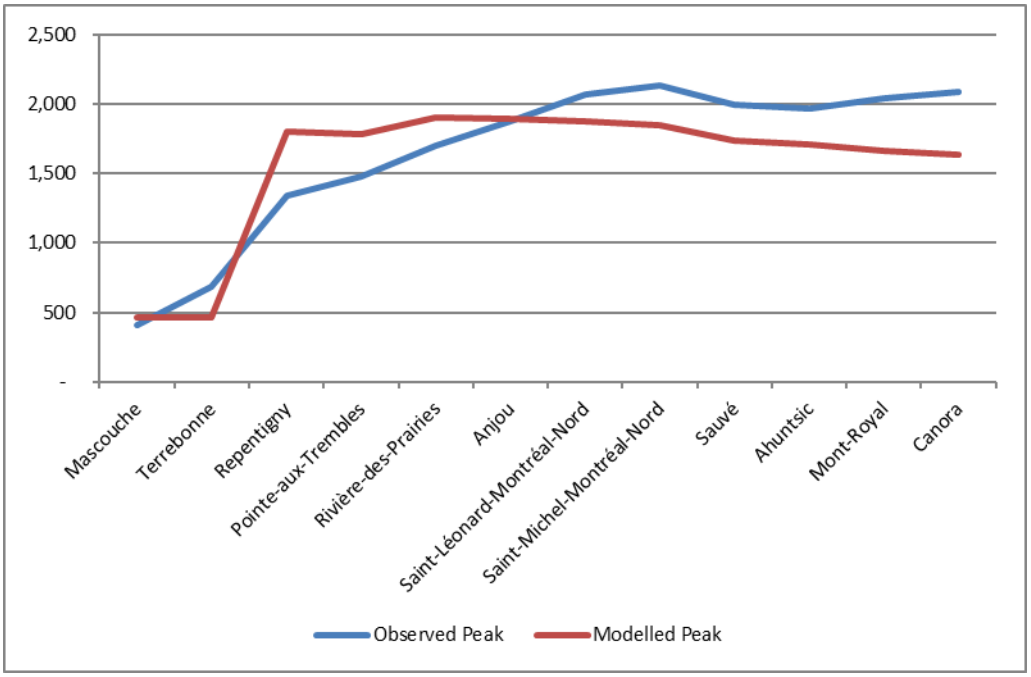


Figure 6-5: Saint-Jérôme Line Load Profile – AM Peak towards Montréal

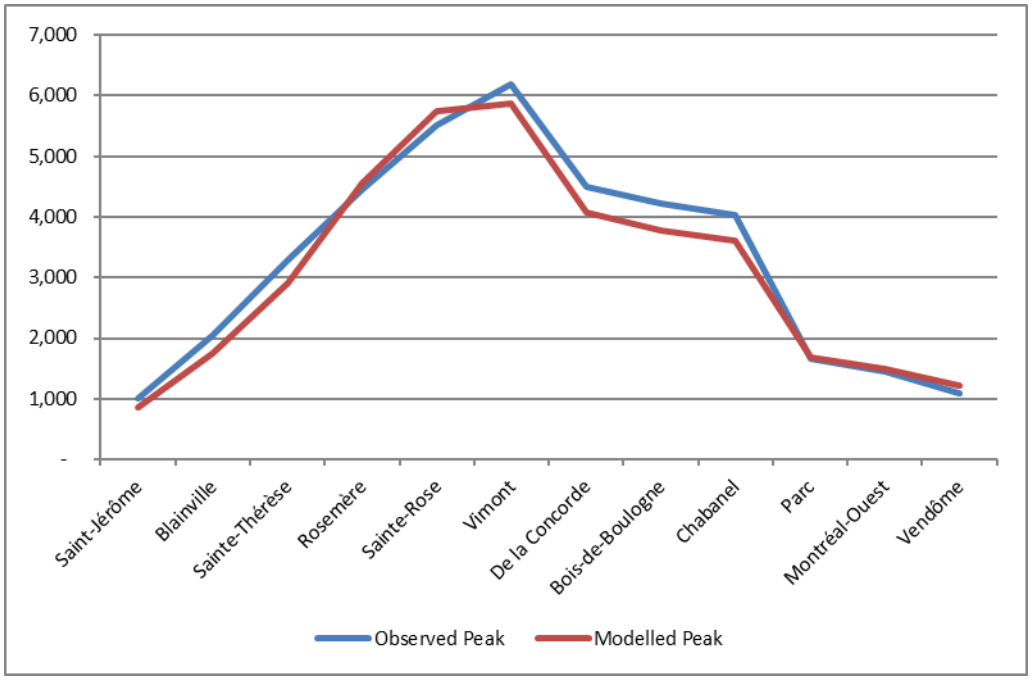


Figure 6-6: Vaudreuil-Hudson Line Load Profile – AM Peak towards Montréal

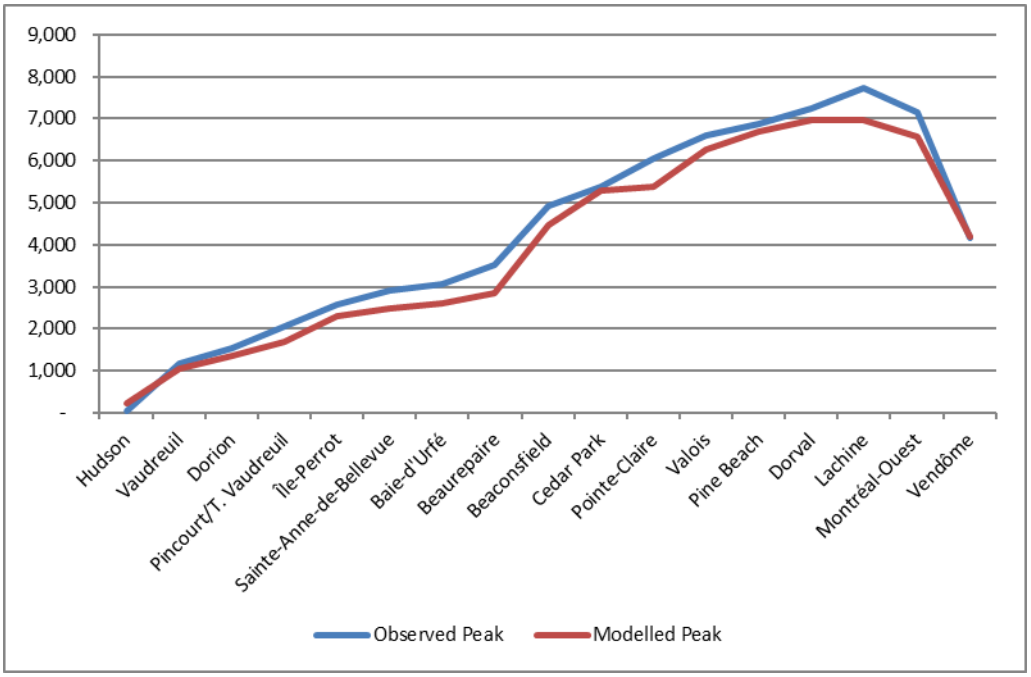


Figure 6-7: Candiac Line Load Profile – AM Peak towards Montréal

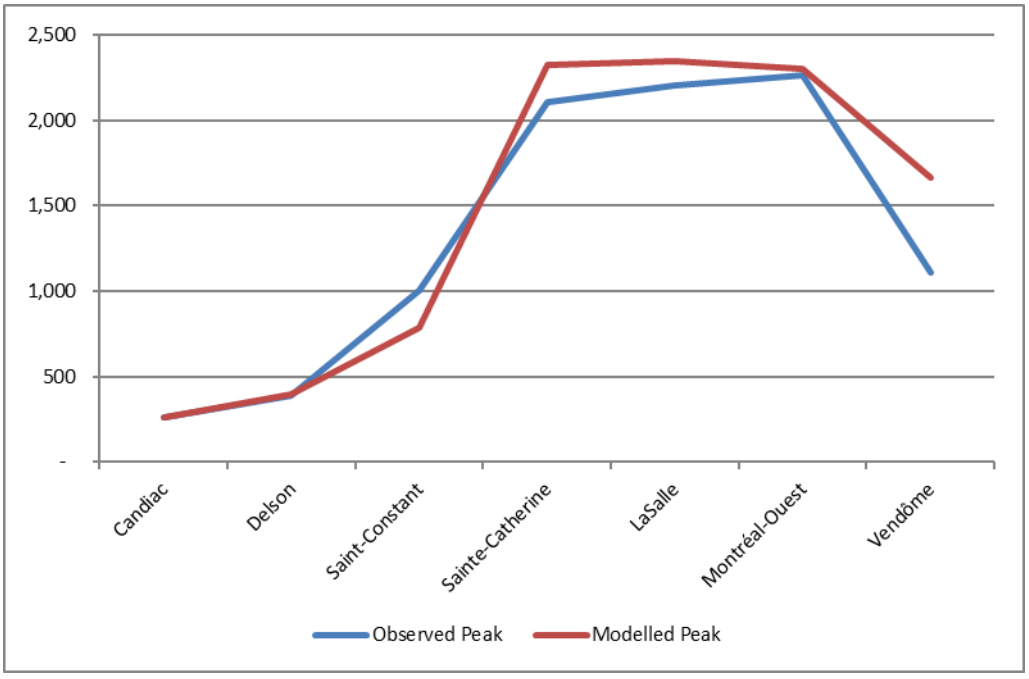
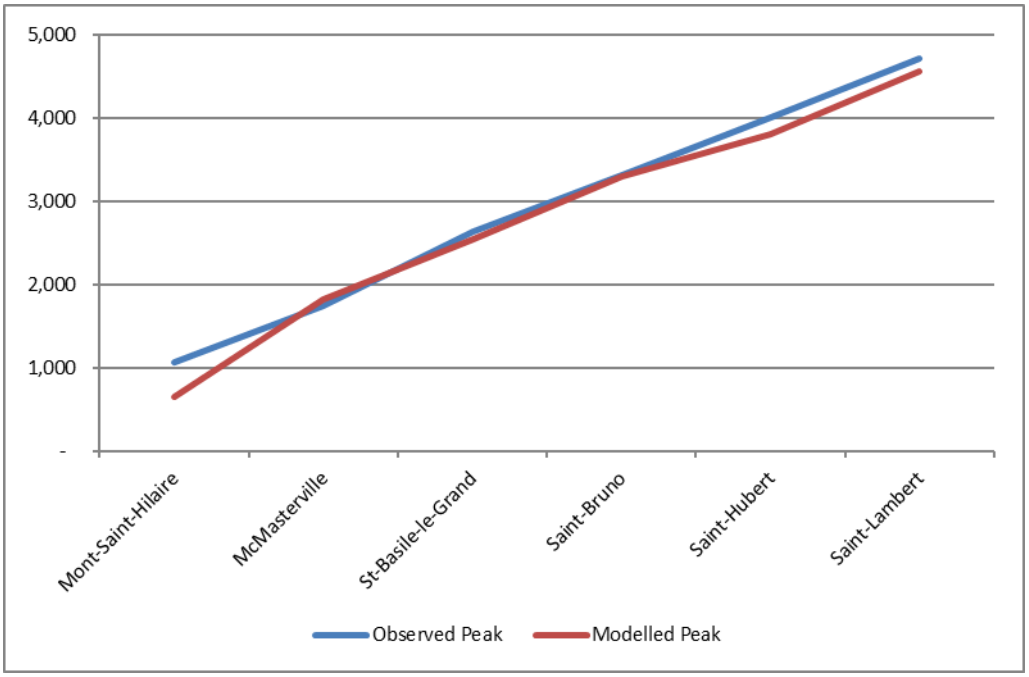


Figure 6-8: Mont-Saint-Hilaire Line Load Profile – AM Peak towards Montréal



6.13 The AM Peak profile figures show the model provides an accurate representation of rail boardings and peak loads across all lines. Figure 6-9 to Figure 6-14 present the Interpeak for a number of lines. Note that a large number of Interpeak routes provide a very low service provision leading to very low demand levels and no attempt has been made to calibrate such low demand levels e.g. peak load on Mascouche line is 23 passengers inbound and 159 outbound.

Figure 6-9: Deux-Montagnes Line Load Profile – Interpeak towards Montréal

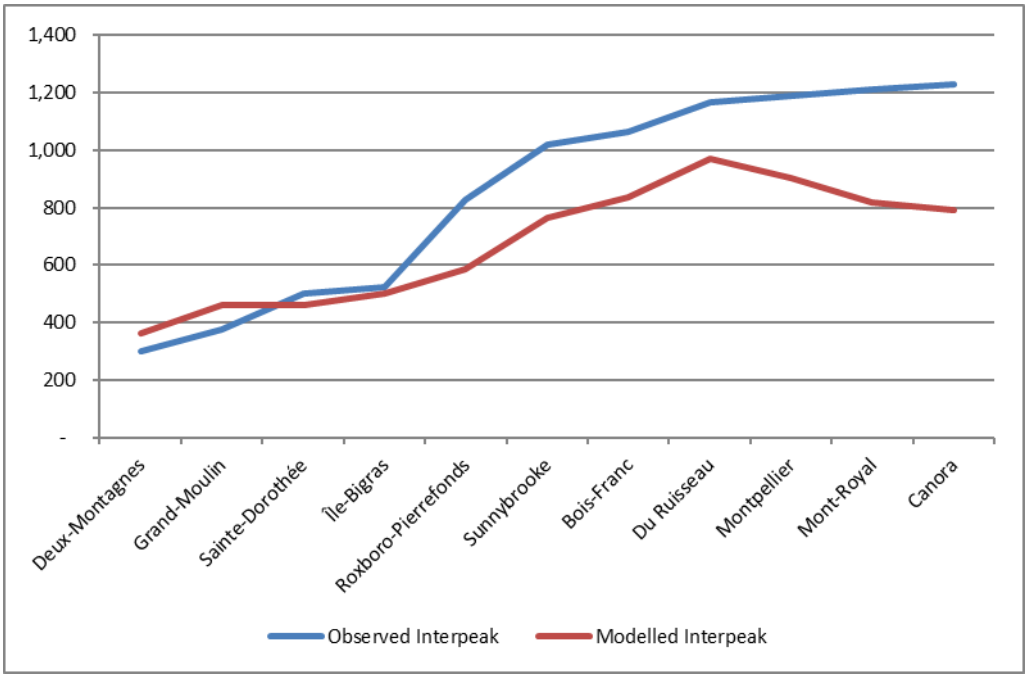


Figure 6-10: Deux-Montagnes Line Load Profile – Interpeak from Montréal

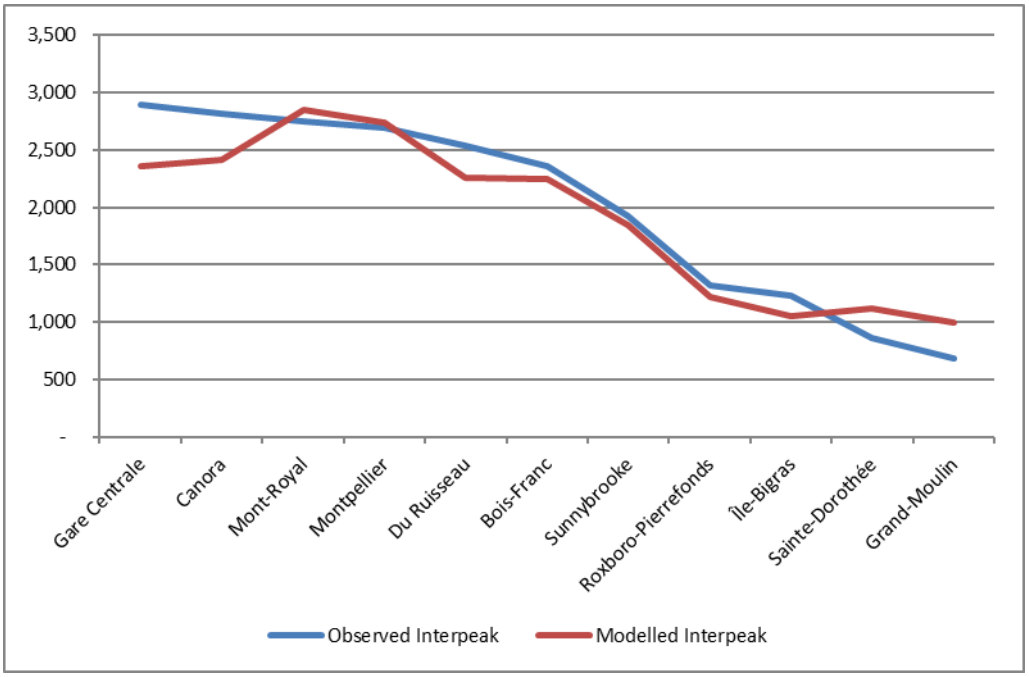


Figure 6-11: Vaudreuil-Hudson Line Load Profile – Interpeak towards Montréal

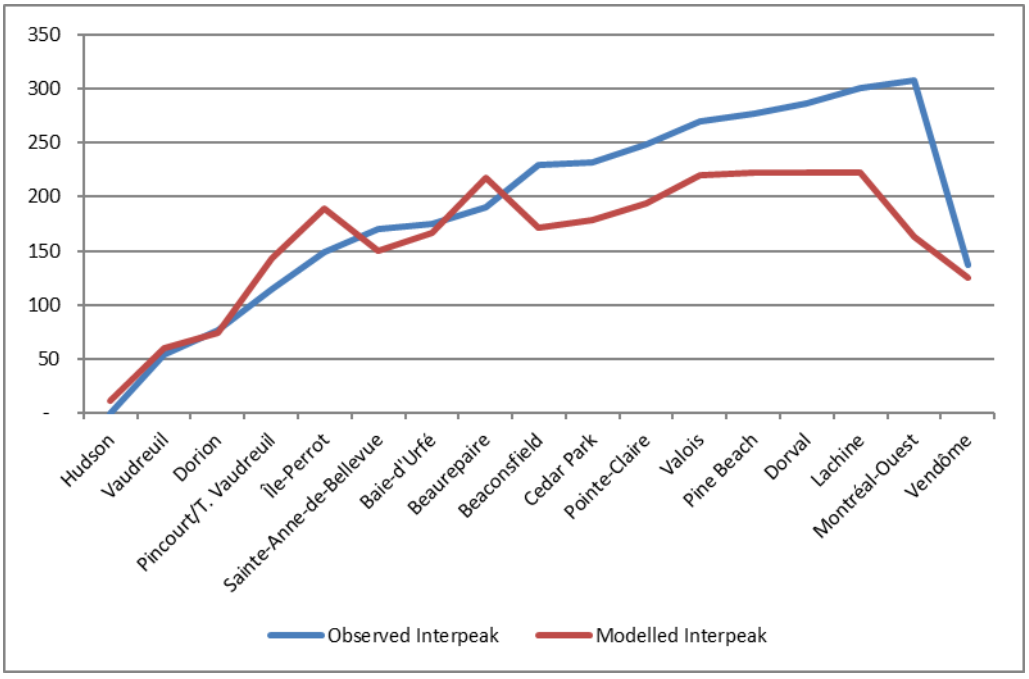


Figure 6-12: Vaudreuil-Hudson Line Load Profile – Interpeak from Montréal

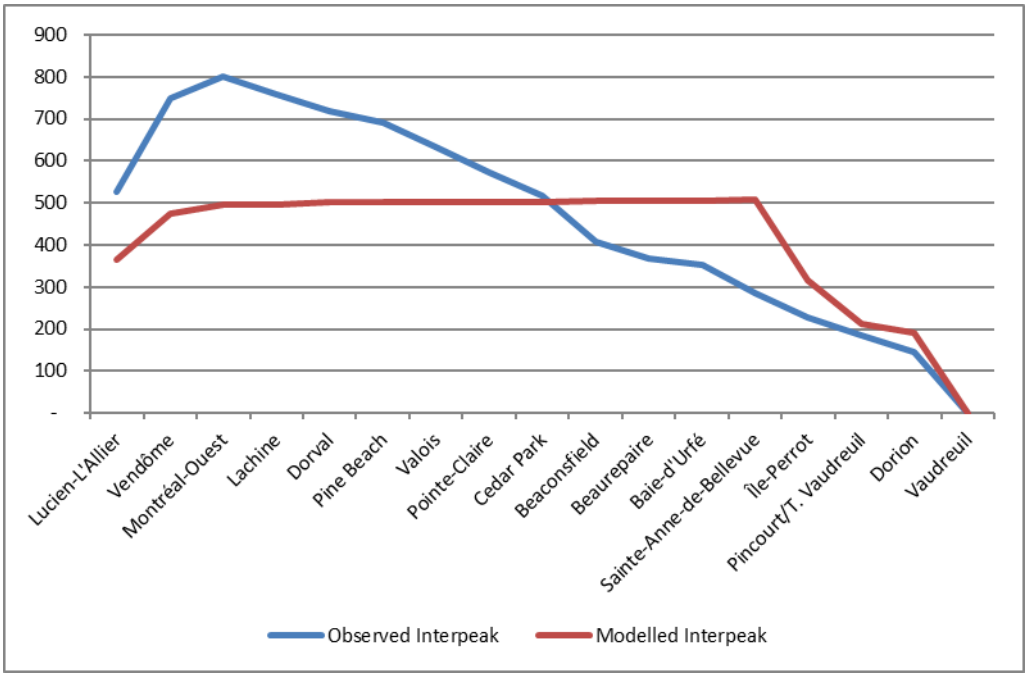


Figure 6-13: Saint-Jérôme Line Load Profile – Interpeak towards Montréal

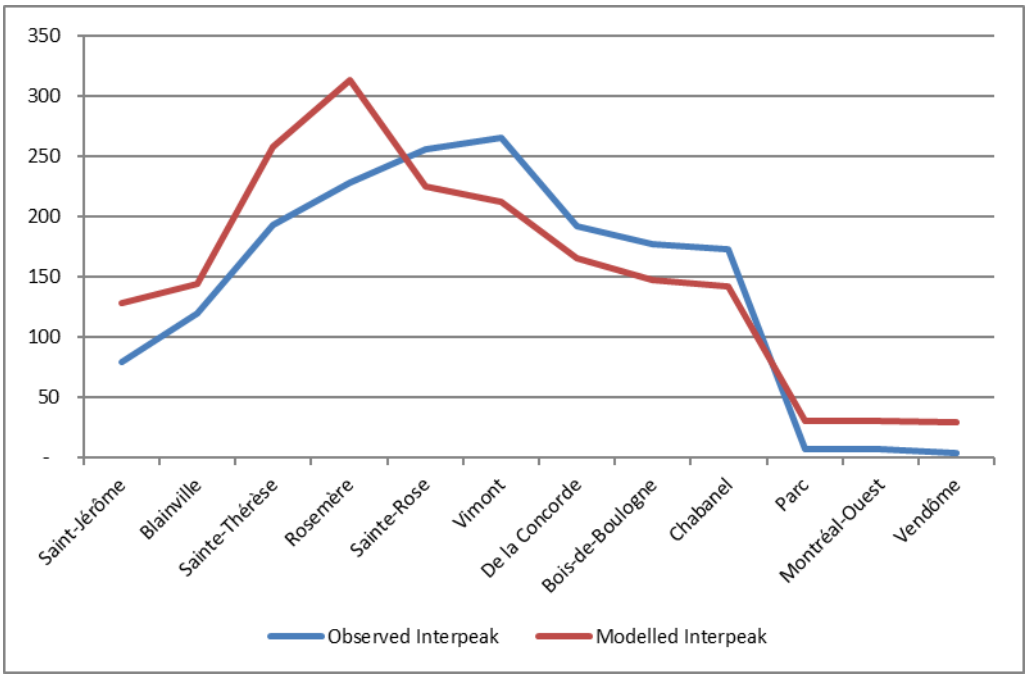
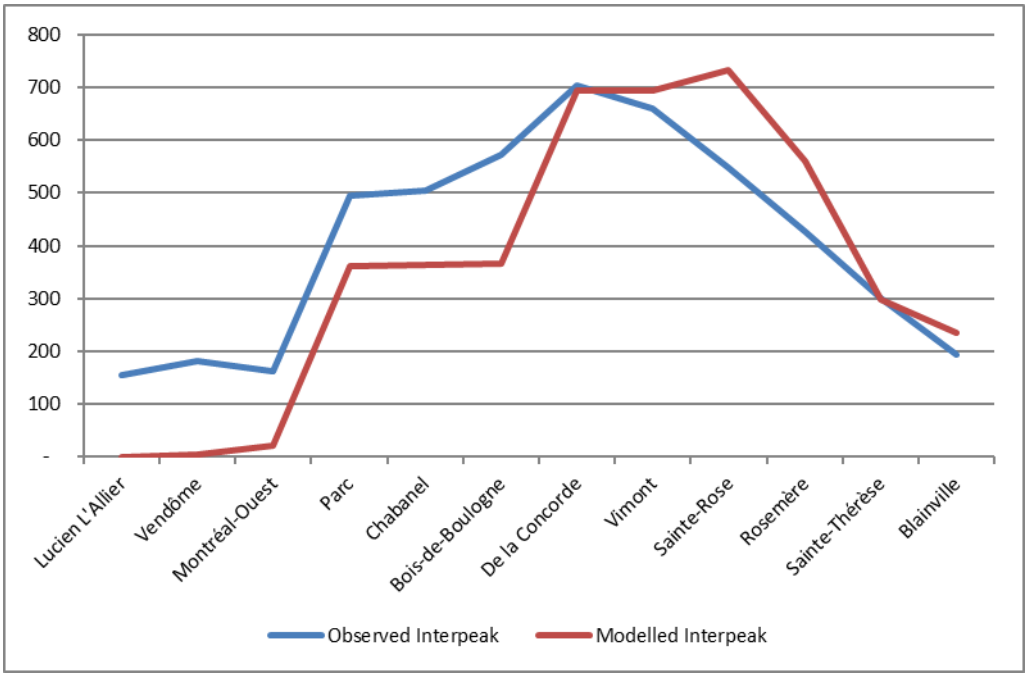


Figure 6-14: Saint-Jérôme Line Load Profile – Interpeak from Montréal



West Island/Deux-Montagnes Line Transit Boardings

6.14 A summary of AM Peak rail, Métro and bus boardings for the West Island /Deux-Montagnes Line Corridor is included in

6.15 Table **6-6**. Note that Métro peak loads or alightings were not available.

Table 6-6: Transit Boarding Calibration – Average AM Peak Hour

Line	Modelled	Observed	Difference	Percentage	GEH[22]
Métro Blue Line	5,490	5,177	313	6%	4
Métro Green Line	18,940	19,581	-641	-3%	5
Métro Orange Line	28,939	28,693	246	1%	1
Métro Yellow Line	4,053	3,964	89	2%	1
Candiac Line IN	867	804	63	8%	2
Deux-Montagnes Line IN	4,620	4,746	-126	-3%	2
Deux-Montagnes Line OUT	*34*	*45*	*-10*	*-23%*	*2*
Mont-Saint-Hilaire Line IN	1,542	1,572	-30	-2%	1
Mascouche Line IN	646	800	-154	-19%	6
Mascouche Line OUT	*0*	*7*	*-7*	*-100%*	*4*
Saint-Jérôme Line IN	1,990	2,229	-239	-11%	5
Saint-Jérôme Line OUT	*38*	*35*	*3*	*10%*	*1*
Vaudreuil-Hudson Line IN	2,417	2,742	-325	-12%	6
Vaudreuil-Hudson Line OUT	*18*	*75*	*-57*	*-76%*	*8*
West Island bus routes[23]	14,570	14,104	466	3%	4
West Island express bus routes	4,703	4,655	47	1%	1
Downtown Bus Routes	13,466	13,328	-138	1%	1

-Non-peak direction AMT rail data (the OUT services) are included for reference. Limited calibration undertaken due to the very low demand levels observed on those particular services resulting from very low services being provided (in italics)
-Observed Métro line boardings refer to stations with no transfers, as no data available on the split between Métro boardings by line at transfer stations
-Totals may vary due to rounding

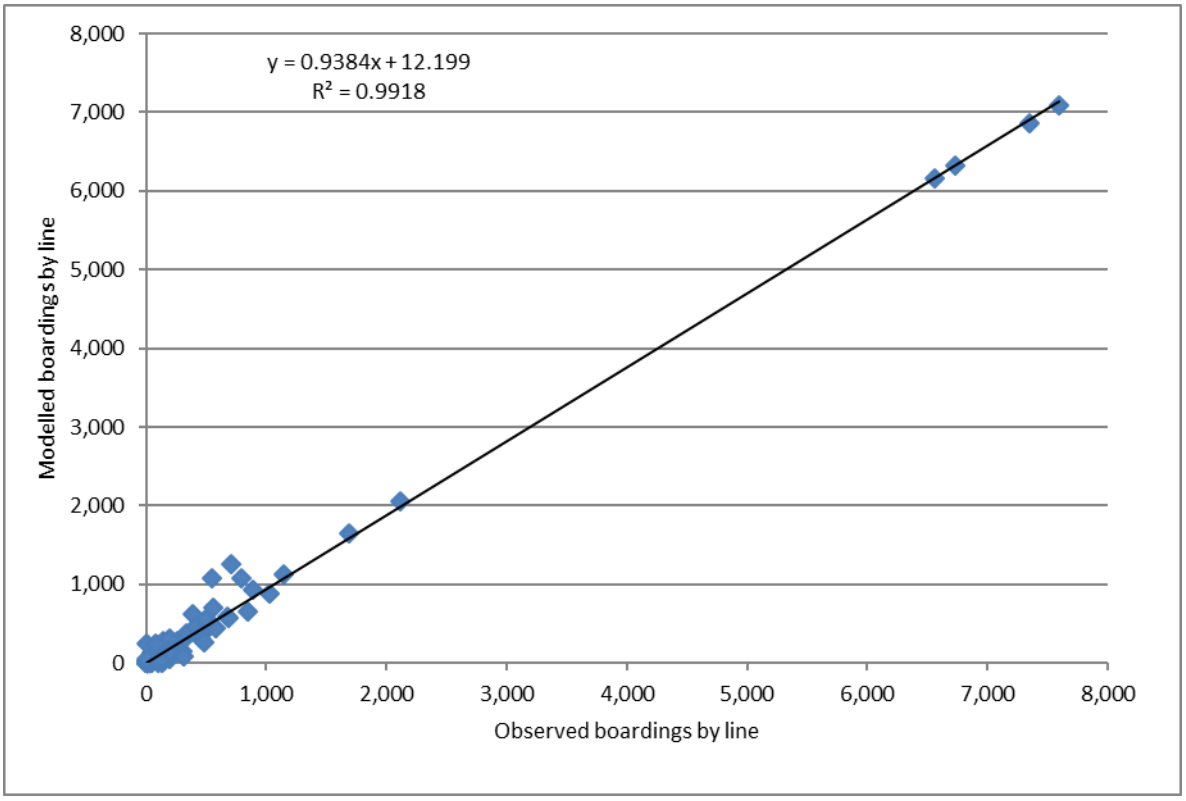
6.16 A scatter plot comparing modelled and observed results presented in Table 6-6 is shown in Figure 6-15.

[22] The GEH statistic compares two sets of volumes. Values closer to zero indicate a best fit.

$$GEH = \sqrt{\frac{2(M-C)^2}{M+C}}$$

[23] List of routes provided in Appendix C

Figure 6-15: Transit Boarding Calibration – AM Peak Average Hour



6.17 The same statistics are included for an average Interpeak hour and shown in Table 6-6 and Figure 6-16.

Table 6-7: Transit Boarding Calibration – Average Interpeak Hour

Line	Modelled	Observed	Difference	Percentage	GEH
Métro Blue Line	3,696	3,808	-113	-3%	2
Métro Green Line	12,494	13,285	-792	-6%	7
Métro Orange Line	13,941	14,935	-994	-7%	8
Métro Yellow Line	1,127	1,145	-18	-2%	1
Deux-Montagnes Line IN	194	234	-40	-17%	3
Deux-Montagnes Line OUT	531	529	2	0%	0
Mascouche Line IN	*8*	*5*	*3*	*70%*	*1*
Mascouche Line OUT	*5*	*29*	*-24*	*-84%*	*6*
Saint-Jérôme Line IN	*71*	*47*	*25*	*53%*	*3*
Saint-Jérôme Line OUT	137	131	6	4%	0
Vaudreuil-Hudson Line IN	*59*	*62*	*-3*	*-5%*	*0*
Vaudreuil-Hudson Line OUT	*85*	*144*	*-59*	*-41%*	*6*
West Island bus routes[24]	7,306	7,518	-213	-3%	2
West Island express bus routes	1,553	1,725	-172	-10%	4
Downtown bus routes	10,552	9,132	1,422	16%	14

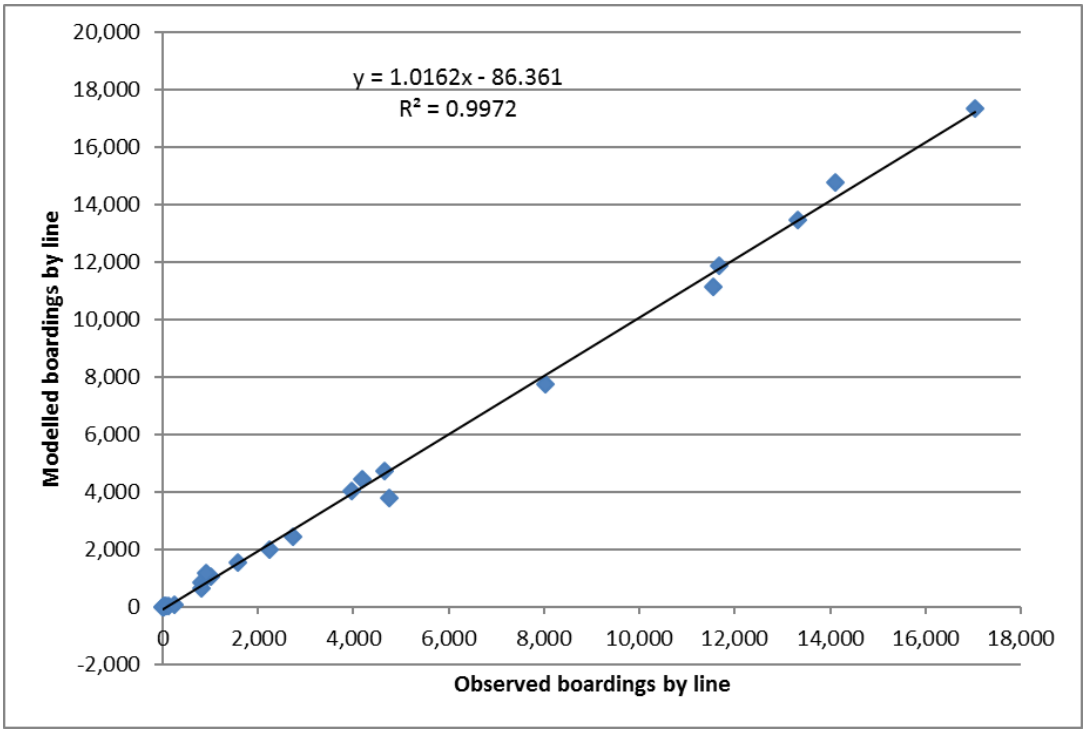
-All AMT rail services are included for reference. Limited calibration undertaken due to low demand level services resulting from very low service frequencies provided (in italics)

-Observed Métro line boardings refer to stations with no transfers, as no data available on the split between Métro boardings by line at transfer stations

-Totals may vary due to rounding

[24] List of routes provided in Appendix C

Figure 6-16: Transit Boarding Calibration – Interpeak Average Hour



Métro Station Calibration

6.18 As indicated previously no Metro alighting data was available. We undertook a number of surveys at McGill, Université de Montréal and Édouard-Montpetit Métro stations to collect this information and results were presented in Section 3.

6.19 Table 6-8 and Table 6-9 present the calibration of these 3 stations. The tables show a close match between modelled and observed volumes, with the exception of AM Peak boardings at McGill which are over-estimated.

Table 6-8: AM Peak Metro Station Calibration (2015)

Hourly	Modelled	Observed	Difference	Percentage	GEH
BOARDINGS					
Université de Montréal	125	145	-20	-14%	2
Édouard-Montpetit	77	104	-37	-26%	3
McGill	609	305	303	99%	14
ALIGHTINGS					
Université de Montréal	2,421	2,337	84	4%	2
Édouard-Montpetit	711	641	69	11%	3
McGill	5,379	5,379	238	5%	3

Table 6-9: Interpeak Metro Station Calibration (2015)

Hourly	Modelled	Observed	Difference	Percentage	GEH
BOARDINGS					
Université de Montréal	497	501	-4	-1%	0
Édouard-Montpetit	234	266	-32	-12%	2
McGill	1,119	1,282	-163	-13%	5
ALIGHTINGS					
Université de Montréal	965	1,082	-116	-11%	4
Édouard-Montpetit	385	432	-48	-11%	2
McGill	2,325	2,461	-136	-6%	3

Saint Lawrence River Transit Screenline

6.20 The Saint Lawrence River screenline includes the Champlain Bridge transit services. We have estimated the peak load crossing the river from the following data sources:

- Métro Yellow Line peak load from the number of boardings at Longueuil station (first station on the line) provided by STM for an average day in 2015
- Saint-Hilaire Line peak load between Saint-Lambert and Lucien L'Allier
- Estimation of Champlain Bridge transit load

6.21 The estimation of transit passages over the Champlain Bridge was challenging due to the number of potential data sources available. Table 6-10 summarizes the various data sources consulted and it shows the high level of divergence between the estimates. For the purposes of our calibration we have assumed the Terminus Centre Ville estimates as they:

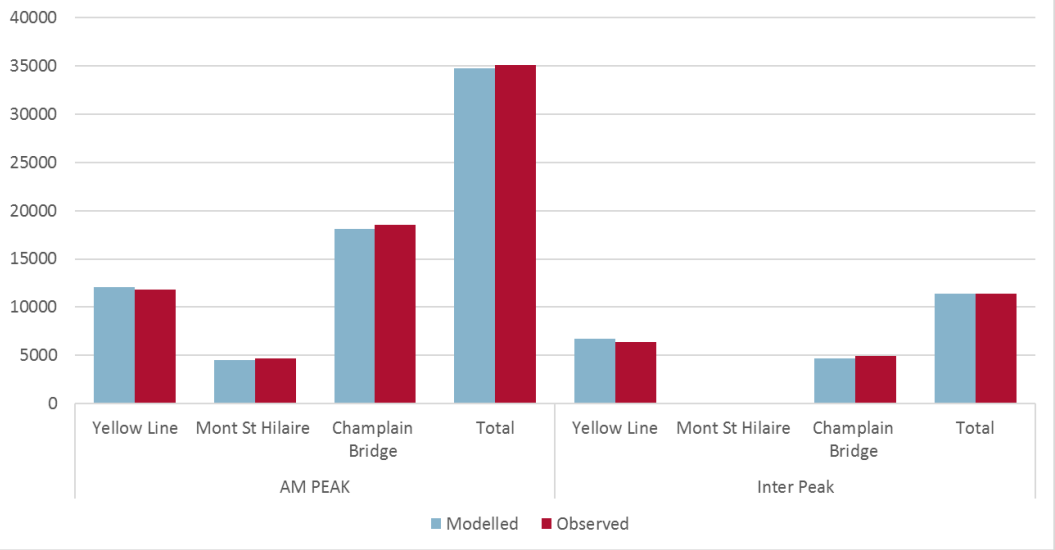
- Represent a number of years rather than one year only
- Acknowledge issues with the other 2 methods of estimation

Table 6-10: Champlain Bridge Transit Estimates – AM Peak (6am-9am)

Source	Estimate	Comment
2013 Enquête OD Survey	22,500	Acknowledged by AMT as potentially high due to Terminus Centre Ville surveys
Terminus Centre-Ville surveys	18,532	Average of one day counts from 2011 to 2015[25] Does not include CIT du Haut-Saint-Laurent and CIT Sud-Ouest passengers as they use the Honoré Mercier Bridge It might include some boardings in stops in Montréal Island (trips did not cross the Saint Laurent)
2015 transit count estimate	18,287	Includes all bus boardings on bus services crossing the Champlain Bridge. However, not all boardings will cross the river (although the majority do)

6.22 The South Shore/A10 screenline comparison is displayed in Figure 6-17 and it shows the model is predicting total transit demand across the Saint Lawrence accurately (within 5%) for the AM Peak and Interpeak periods, and just as importantly, with the correct assignment to each transit link across the river.

Figure 6-17: South Shore/A10 Transit Calibration



** Champlain Bridge observed demand includes all boardings on Saint Lawrence services*

Calibrated Transit Demand

6.23 The calibration of the various transit services presented above required the review and adjustment of transit services, travel times, mode constants and network coding (station connections, transfer distances, etc.) and a number of demand matrix adjustments. The final 2015 transit demand is presented in Table 6-11.

[25] Passenger counts of 19,473 (in 2011), 18,800 (in 2012), 18,771 (in 2013), 16,834 (in 2014) and 18,780 (in 2015).

Table 6-11: 2015 Transit Demand Total – After Calibration

Period	Purpose	Initial (A) – see Table 5-7	Final (B)	Difference (A-B)	((A-B)/A)%
AM Peak	Work	220,470	193,556	-26,914	-12.21%
	Study	137,483	116,224	-21,259	-15.46%
	Other	24,982	21,822	-3159.8	-12.65%
	Total	382,935	331,602	-51,333	-13.41%
Interpeak	Work	72,120	69,225	-2,895	-4.01%
	Study	80,811	66,260	-14,551	-18.01%
	Other	254,724	232,730	-21,994	-8.63%
	Total	407,656	368,215	-39,441	-9.68%

6.24 The growth factors presented in Table 5-13 to Table 5-16 were applied to the 2015 final calibrated matrix and the totals are shown below.

Table 6-12: Transit Demand Matrices by Forecast Year

Period	Purpose	2015	2021	2031
AM Peak	Work	193,556	206,694	222,689
AM Peak	Study	116,224	124,542	134,368
AM Peak	Other	21,822	23,376	25,242
AM Peak Total		**328,069**	**331,602**	**354,612**
Interpeak	Work	69,225	74,914	81,429
Interpeak	Study	66,260	71,070	76,900
Interpeak	Other	232,730	249,427	269,525
Interpeak Total		**367,560**	**368,215**	**395,411**

Airport Model

6.25 The Airport model is a spreadsheet-based logit model which takes time and cost inputs from the EMME Transit Mode Choice Model and Network Model. The Airport model itself contains a set of binary or pair-wise choices between the current mode of travel and REM. The model then forecasts the likely take up of REM in the future according to the assumptions made on the level of service on both REM and the existing current modes.

6.26 As such, the calibration is less “formal” than with a traditional network based model. Indeed, pair-wise choices mean that there is no requirement to replicate the current situation. Instead the effort goes into establishing the size and market segmentation of the base demand, as has been described in Section 5.

6.27 Calibration type tasks are then more focused on checking the sensitivity of the model to a range of factors including:

- Stress testing the model to cases where REM has very low or zero fares compared with cases when the fare is relatively high to understand the likely range of capture
- Checking implied fare and journey time elasticities are appropriate

- Understanding the impact of the behavioural parameters and testing the model sensitivity to these
- Checking that the logit curve is not forecasting high levels of diversion from current modes when the generalized time advantage is small and making suitable adjustments.

7 REM Sponsor Case Forecasts

Sponsor Case Definition

7.1 REM competitiveness and resulting ridership forecasts will depend to a large extent on the various forecasting assumptions undertaken. These relate not only to the REM service itself, but also to the bus and rail network services and fares.

7.2 Table 7-1 describes the Sponsor Case Project Definition. This reflects the Sponsor assumptions of the most likely scenario, given the current engineering and operations analysis to date as well as discussions with a range of organizations (AMT, STM, Aéroports de Montréal) regarding bus restructuring and fare integration.

Table 7-1: Sponsor Case Project Definition

	Description	Assumption
Travel times[26]	Deux-Montagnes to Rive-Sud	48:43
	Roxboro-Pierrefonds to Rive-Sud	38:47
	Sainte-Anne-de-Bellevue to Rive-Sud	48:58
	Aéroport Pierre-Elliott-Trudeau to Rive-Sud	41:12
	Correspondance A40 to Rive-Sud	25:38
Headways (AM Peak)	Deux-Montagnes to Rive-Sud	12
	Roxboro-Pierrefonds to Rive-Sud	12
	Sainte-Anne-de-Bellevue to Rive-Sud	12
	Aéroport Pierre-Elliott-Trudeau to Rive-Sud	12
	Correspondance A40 to Rive-Sud	20
Headways (Interpeak)	Deux-Montagnes to Rive-Sud	15
	Roxboro-Pierrefonds to Rive-Sud	-
	Sainte-Anne-de-Bellevue to Rive-Sud	15
	Aéroport Pierre-Elliott-Trudeau to Rive-Sud	15
	Correspondance A40 to Rive-Sud	-
Fares	As per current AMT fares	$2.01 to $5.19 (adult) $1.66-$4.00 (student)

[26] Include dwell times

	Description	Assumption
Fare, Airport	Current average airport fare ($3.15) with $5 premium	$8.15
Bus Re-Structuring	South Shore services re-directed to REM stations STM West Island bus network reconfigured	-
747 Express Airport Shuttle	Eliminated from service	-

7.3 In addition to REM and the bus service and fare assumptions identified above, there are a number of other model assumptions included in the Sponsor Case and these are detailed in Table 7-2.

Table 7-2: Sponsor Case Model Assumptions

Model Assumptions	Sponsor Case
Users' perception of REM	REM mode constant cannot be calibrated, but as mentioned in Section 4, given the reliability and quality of the system, it is expected that the mode constant should be similar to that observed to rail and Métro (0 minutes). However, given the uncertainty and the bias observed in the survey results, for the Sponsor Case we have assumed a mode constant penalty of 2 minutes against rail and Métro. Impact of mode constant penalty of 1 minute and 3 minutes on REM demand are presented in Appendix D.
Corridor growth (see Table 5-13 to Table 5-16)	CAGR: 2015-2021 / 2021-2031 South Shore/A10: 1.4% / 0.9% West Island/DM: 1.0% / 0.7%
Aéroport Pierre-Elliott-Trudeau Growth	CAGR: 2015-2020 / 2020-2034 Aéroport Pierre-Elliott-Trudeau: 2.9% / 2.1%
Expansion Factor (see Figure 4-8)	Varies depending on the AM Peak and Interpeak demand breakdown.
Ramp up	See below

Year	West-Island/Deux-Montagnes Line Corridor		Airport Corridor		South Shore/A10 Corridor	
	Existing DM	New	Existing 747	New	Existing Express (truncated)	New
2021	100%	60%	80%	60%	90%	60%
2022	100%	80%	90%	80%	95%	80%
2023	100%	90%	95%	90%	100%	90%
2024	100%	100%	100%	100%	100%	100%

Sponsor Case Forecast Review (2015)

7.4 REM is expected to start operation in 2021 (February 2017 Report's base case assumption). However, it is good practice to understand the impacts of REM in the base year (2015) to compare demand levels directly with the current situation and therefore assess and understand the robustness of the results.

7.5 This section presents the results of the analysis of this hypothetical scenario in which REM's Sponsor Case Definition is applied to the base year (2015) models.

Demand Captured by Market and Mode

7.6 REM will provide the Metropolitan Montréal region with a new, fast and reliable transit service with an enhanced level of service in the peak and Interpeak periods. As a result, it is expected that the new mode will capture demand not only from existing transit users, but also from other competing transit modes. Table 7-3 shows the total REM demand and where the trips have transferred from.

Table 7-3: REM Demand Captured by Market

	AM Peak		Interpeak		AM Peak + Interpeak	
	Passengers	Percentage	Passengers	Percentage	Passengers	Percentage
Airport Capture	927	2%	2,384	9%	3,311	4%
Auto Capture	3,467	6%		0%	3,467	4%
Transit Capture	50,688	92%	24,296	91%	74,984	92%
TOTAL	**55,082**	**100%**	**26,680**	**100%**	**81,762**	**100%**

7.7 The table shows clearly that the majority of the REM demand is transferring from other transit modes (more than 90%) and the rest is made of airport (56% of which is also transit demand transferred from the 747 Express Airport Shuttle) and auto capture. Each of these markets are described below.

Airport Capture

7.8 The airport demand captured from existing competing modes has been estimated with the Airport model. Table 7-4 shows the majority of the demand is captured from the 747 Express Airport Shuttle and a considerable proportion (30%) is expected to shift from taxi and car Park & Fly passengers.

Table 7-4: REM Airport Demand Capture (2015)

AM Peak+ Interpeak	Bus		Taxi	Car Park & Fly		Car Kiss & Fly	Total
	747 passengers	Airport staff Local Bus	Passen-gers	Passen-gers	Airport Staff	Passengers	
Existing Demand	2,223	243	4,597	2,574	2,190	6,429	18,257
Demand which transfers to REM	1,859	26	761	331	5	331	3,312
REM Capture	**84%**	**11%**	**17%**	**13%**	**0%**	**5%**	**18%**

7.9 As shown in Table 7-5, it is expected that over 56% of REM demand will be existing transit demand that will shift from the 747 Airport Express Shuttle when the service ceases operation.

Table 7-5: REM Airport Demand Split

AM Peak and Interpeak	Passengers	Proportion
Existing 747	1,859	56%
Other modes	1,454	44%
Total	**3,313**	**100%**

Auto Capture

7.10 Mode transfer from car to REM has been estimated with the auto shift model which estimates the user choice between auto, REM with transit access and REM with Park & Ride access. While the model shows a higher demand for Park & Ride access, this demand is constrained by the capacity of existing facilities in most of the corridor. The only exceptions are the new or extended facilities in the South Shore/A10 area and in some locations in the West Island (mostly along the Sainte-Anne-de-Bellevue Corridor). Table 7-6 shows the car shift demand estimates.

Table 7-6: REM Car Shift Capture (2015)

	AM Peak Boardings
South Shore/A10	360
West Island	1,740
Park & ride access	**2,100**
South Shore/A10	*540*
West Island	*820*
Transit access	**1,360**
TOTAL	**3,460**

Transit Capture

7.11 As indicated previously, most of the REM demand is captured from existing transit services. This is particularly the case from those services that are replaced (for example the Deux-Montagnes Line) or truncated (South Shore/A10 express bus services) in order to be fully integrate with the REM. Table 7-7: shows that the demand currently using the A10 and Deux-Montagnes Line services represents over 60% of the total transit demand shifting to REM.

Table 7-7: REM Transit Demand Shift Capture (2015)

	AM peak	Interpeak	AM Peak + Interpeak
A10 Express services*	16,458	8,262	24,721
Deux-Montagnes**	14,371	4,802	19,173
Other	19,858	11,232	31,091
REM Transit Capture* **	**50,688**	**24,296**	**74,984**
% Existing A10 and DM	61%	54%	59%

** Observed Data-Estimated number of passengers crossing Champlain Bridge (includes boardings at Gare Centrale)*
*** Observed Data-Number of boardings on DM (includes boardings at Gare Centrale)*
**** REM Modelled data-excludes car mode shift and demand from airport (including 747 Express Airport Shuttle)*

7.12 In summary, Table 7-8 shows the estimated number of boardings in the AM and Interpeak periods should the REM have been implemented in 2015. The number of boardings have been aggregated for all the stations located in the South Shore/A10 and West Island/Deux-Montagnes corridors. Gare Centrale has been included separately.

Table 7-8: 2015 AM Peak and Interpeak REM Boardings

REM section	AM Peak	Interpeak
South Shore/A10 stations*	22,425	6,129
West Island/Deux-Montagnes stations*	32,097	17,623
Gare Centrale	561	2,928
Total	**55,082**	**26,680**

** Data does not include boardings at Gare Centrale*

7.13 In summary:

- The South Shore/A10 corridor incremental demand is more moderate and in part driven by the additional Park & Ride capacity.
- However, it is the West Island/Deux-Montagnes corridor where the REM captures more additional demand, not only from car Park & Ride users, but mainly from transit users.

Additional transit demand capture

7.14 Table 7-3 showed that REM will attract around 55,100 boardings in the AM Peak and almost 26,700 in the Interpeak. Nearly 60% of that demand is expected to shift from existing services running on the Deux-Montagne Line or express buses in the South Shore/A10 corridor. This section describes the nature of the additional transit demand and has been split into the West Island/Deux-Montagne and South Shore/A10 corridors.

West Island/Deux-Montagne corridor: AM Peak capture (to Gare Centrale)

7.15 Table 7-9: shows the number of AM Peak boardings on the West Island/Deux-Montagnes Line corridor and the increase in REM demand over the existing Deux-Montagne Line demand. This demand will include capture from transit (bus, rail and Métro), Park & Ride and airport demand and represents a considerable proportion of the total REM demand.

Table 7-9: West Island/Deux-Montagnes Line Boardings (to Gare Centrale, 2015)

Station	AM Peak			Interpeak		
	DM Modelled	REM Sponsor Case	Difference	DM Modelled	REM Sponsor Case	Difference
Technoparc Saint-Laurent	-	6	6	-	6	6
Aéroport Pierre-Elliott-Trudeau	-	606	606	-	1,069	1,069
Autoroute 13	-	320	320	-	112	112
Des Sources	-	729	729	-	861	861
Pointe-Claire	-	2,190	2,190	-	1,026	1,026
Kirkland	-	1,201	1,201	-	126	126
Sainte-Anne-De-Bellevue	-	1,001	1,001	-	319	319
Deux-Montagnes	2,912	3,234	322	366	501	135
Grand-Moulin	767	760	-7	95	96	1
Sainte-Dorothée	1,415	1,596	181	120	82	-38
Île-Bigras	234	480	246	42	106	64
Roxboro–Pierrefonds	2,582	3,221	639	210	249	39
Sunnybrooke	1,643	1,665	22	179	223	44
Bois-Franc	1,869	3,840	1,971	186	2,330	2,144
Du Ruisseau	1,009	2,169	1,160	164	576	412
Montpellier	811	2,302	1,491	81	924	843
Mont-Royal	611	859	248	475	1,424	949
Correspondance A40	-	1,420	1,420	-	162	162
Canora	302	1,023	721	77	640	563
Édouard-Montpetit	-	2,090	2,090	-	1,909	1,909
McGill	-	1,386	1,386	-	4,882	4,882
TOTAL	**14,200**	**32,100**		**2,000**	**17,600**	

** Forecasts include transit capture, Park & Ride capture and Aéroport Pierre-Elliott-Trudeau demand.*

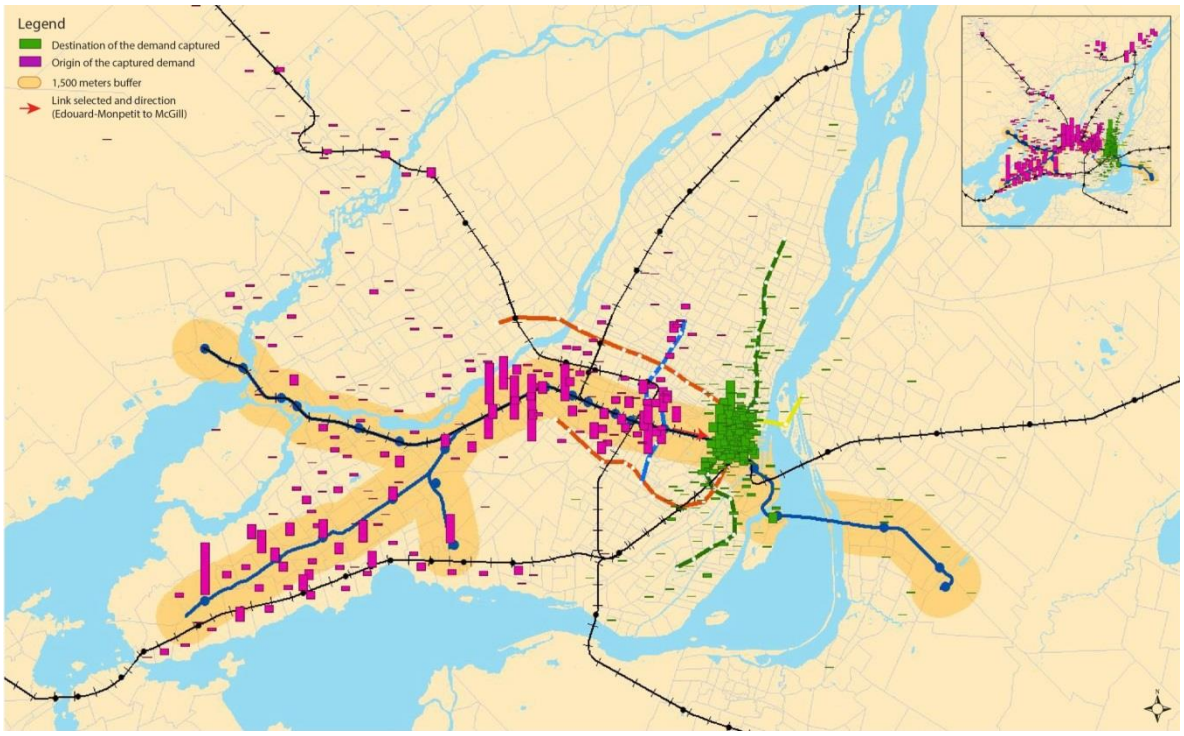
7.16 Excluding the demand captured from the new Park & Ride facilities, the stations that register the highest growth are those located in the 'core' section where all the three branches converge (from Bois-Franc to Canora Stations). This is the section where REM provides very high frequencies (2 minutes and 40 seconds between Correspondance A40) and fast travel times compared to other transit alternatives and this makes REM very competitive compared to other options increasing capture from other transit modes between Bois-Franc and Canora stations.

7.17 Most of the additional trips during the AM Peak period are commuting trips to Downtown Montréal. Some of these (around 1,700 trips) are expected to shift from car and will be using the new car Park & Ride facilities to access REM. However, the majority of the additional demand is formed from existing transit users that currently access Downtown Montréal by a combination of express bus service and the Métro Orange line.

7.18 Further analysis was carried out to understand more clearly the origin and destination of these additional trips (this was carried out with a select link analysis in EMME) for all the trips that cross the Mont-Royal Tunnel in the AM Peak period and in the Montréal direction (between Édouard-

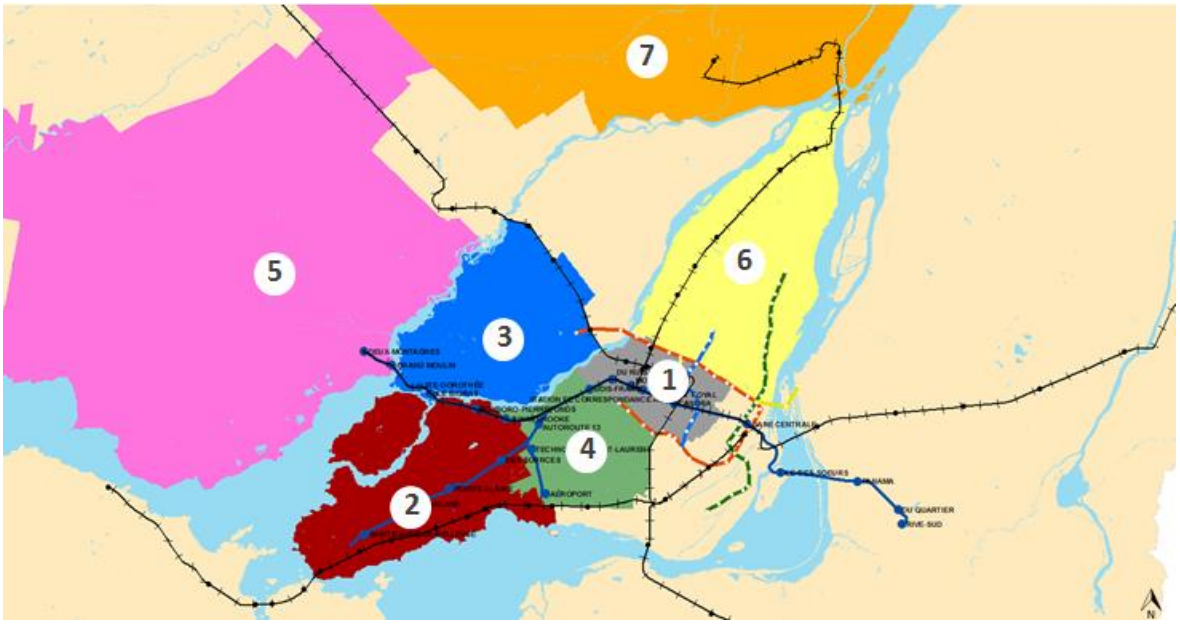
Montpetit and McGill stations). Figure 7-1: shows that most of the destinations are concentrated in the Downtown area, and most of the origins (54%) are located within 1.5km of the REM alignment.

Figure 7-1: AM Peak Origin and Destination of Mont-Royal Tunnel Captured Demand (to Gare Centrale, 2015)



7.19 To facilitate the analysis, the data has been aggregated into 7 areas identified in Figure 7-2.

Figure 7-2. Zone Analysis Definition – West Island/Deux-Montagnes Line Corridor



7.20 Table 7-10 shows the split of the additional demand using the Mont-Royal Tunnel in the AM Peak period.

Table 7-10: AM Peak Mont-Royal Tunnel Additional Demand Origin (to Gare Centrale, 2015)

Area	Trips	Proportion
1	2,686	28%
2	2,901	30%
3	434	5%
4	1,924	20%
5	28	0%
6	303	3%
7	1,027	11%
Other	329	3%
TOTAL	**9,630**	**100%**

7.21 The table shows :

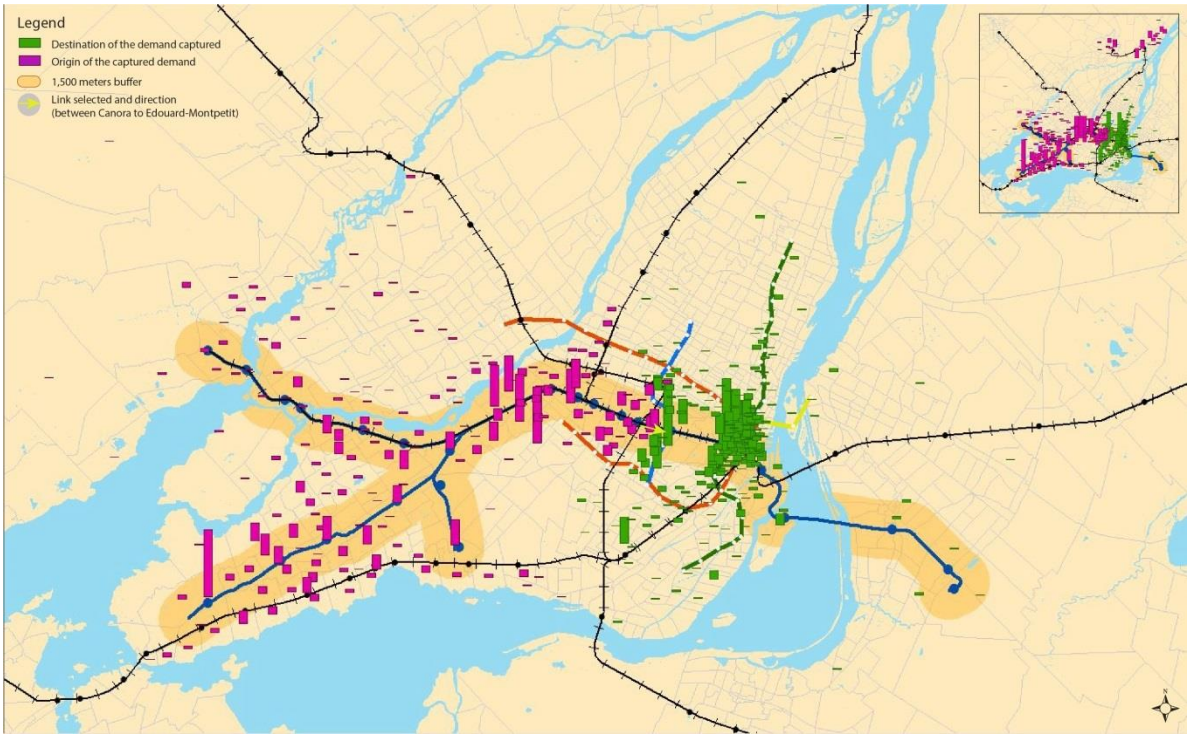
- 30% of the additional REM demand has its origin in the Sainte-Anne-de-Bellevue branch (zone 2) as a result of the introduction of a new rail service offering a high speed and a 12-minute headway service direct to Downtown
- 28% has its origin in the area between the western and eastern branches of the Métro Orange Line (zone 1).
- 20% of the additional demand originates from the airport branch and Métro Orange Line (zone 4)

7.22 Although a great part of the additional demand will be commuting trips to Downtown, REM will attract a significant number of trips to access key educational and health centres in the Greater

Montréal Area. The implementation of REM will provide a very competitive alternative to access the Université de Montréal, the Hôpital Sainte-Justine and other colleges in the area.

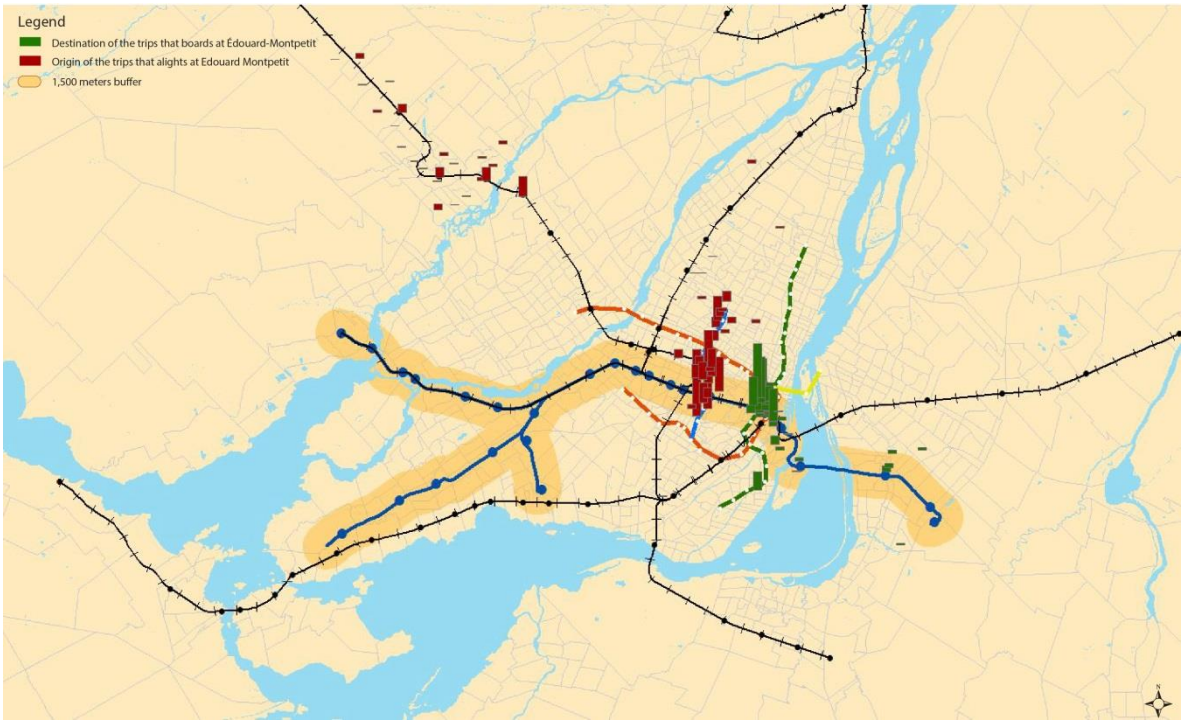
7.23 A second select link analysis was performed to evaluate the demand alighting at Édouard-Montpetit station. As presented in Figure 7-3, a lot of people alight at this station and walk to their final destination. However, many people transfer to the Métro Blue Line before reaching their final destination.

Figure 7-3: AM Peak Origin and Destination of Édouard-Montpetit Alightings (to Gare Centrale, 2015)



7.24 Figure 7-4 presents in red the origin of the trips boarding at Édouard-Montpetit during the morning peak period and their destination in green.

Figure 7-4: AM Peak Origin and Destination of Édouard-Montpetit Boardings



South Shore/A10 corridor: AM Peak capture (to Gare Centrale)

7.25 The introduction of REM and the comprehensive bus reorganization on the South Shore will also increase the number of REM boardings over existing transit demand by over 7,700 passengers during the AM Peak period.

7.26 Almost 35% of this increase is due to the new Park & Ride facility at Rive-Sud station (with 3,000 spaces) while the analysis shows that most of the transit demand shift is originating from the Longueuil and Brossard areas (82%, which include the Park & Ride demand).

7.27 Figure 7-5 presents the origins and destinations of the additional demand carried by REM that crosses the Champlain Bridge in the AM Peak. While a considerable number of the trips go to Downtown, the trip destinations are spread throughout the Island of Montréal. The REM provides a more direct and frequent link from the South Shore to the Downtown and to the Université de Montréal's sector.

Figure 7-5: AM Peak Origin and Destination of Champlain Bridge Trips (to Gare Centrale, 2015)

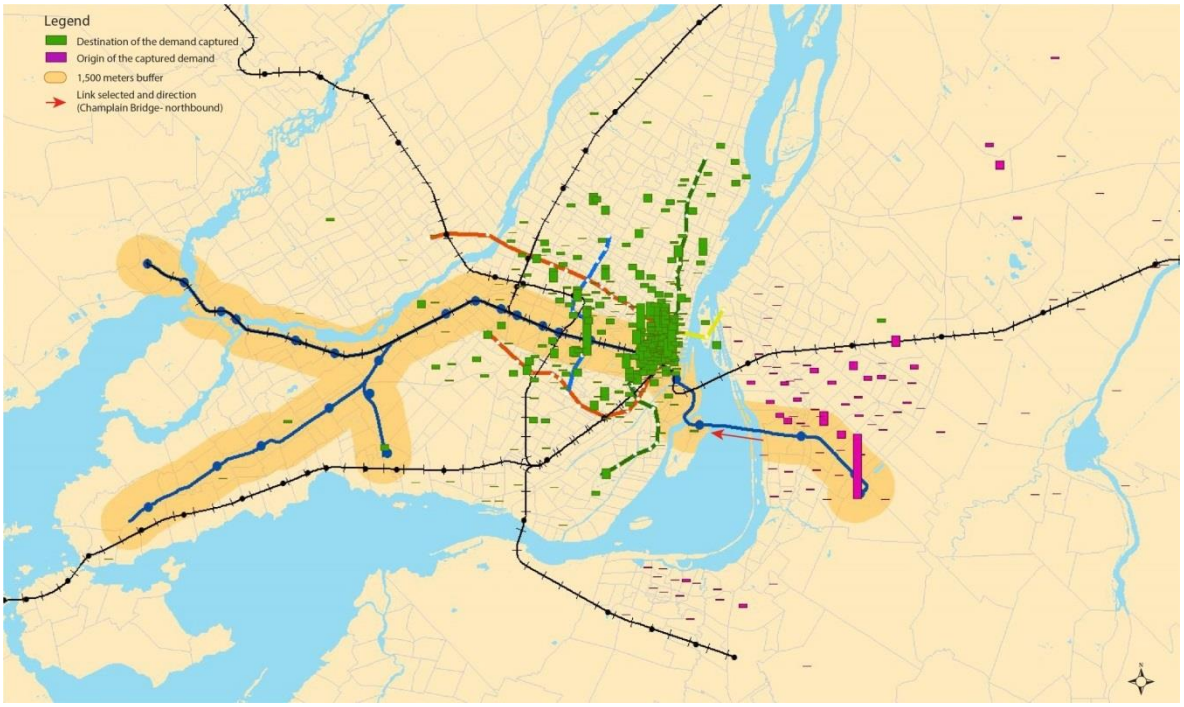


Table 7-11: Champlain Bridge Captured Demand Origin (to Gare Centrale, 2015)

Area	Trips	Proportion
Longueuil	2,144	39%
Brossard	1,915	35%
Candiac	160	3%
La Prairie	6	0%
Sainte-Catherine, Saint-Constant, and Delson	203	4%
Carigan and Chambly	11	0%
Sainte-Amable and Sainte-Julie	541	10%
Saint-Jean-sur-Richelieu	1	0%
Saint-Lambert	252	5%
Other	225	4%
TOTAL	**5,458**	**100%**

Sponsor Case Forecasts (2021 and 2031)

Peak and Interpeak Forecasts

7.28 The 2021 and 2031 REM demand has been estimated using the same methodology as the 2015 estimation presented above. The main differences are that demand has been increased to account for socio-economic growth in the region together with road and transit network changes identified in sections 4.28 and 4.29. A similar pattern to the capture rates and type of trips identified in the 2015 analysis was observed.

7.29 Table 7-12: shows the AM and Interpeak REM demand captured from transit for 2021 and 2031. It shows that REM growth rates are in line with the overall demand growth identified in Section 5, with growth slightly higher in the Interpeak period.

Table 7-12: AM Peak and Interpeak REM Boardings

Period	REM Section	Demand by period			CAGR	
		2015	2021	2031	2015-2021	2021-2031
AM Peak	South Shore/A10 Stations	22,425	24,121	26,155	1.22%	0.81%
	West Island/Deux-Montagnes Stations	32,097	33,798	36,060	0.86%	0.65%
	Gare Centrale	561	596	637	1.01%	0.67%
	Total	**55,082**	**58,515**	**62,852**	**1.01%**	**0.72%**
Interpeak	South Shore/A10 Stations	6,129	6,652	7,220	1.37%	0.82%
	West Island/Deux-Montagnes Stations	17,623	19,162	20,649	1.41%	0.75%
	Gare Centrale	2,928	3,102	3,309	0.97%	0.65%
	Total	**26,680**	**28,916**	**31,178**	**1.35%**	**0.76%**

7.30 The airport demand is highlighted below. A similar pattern to the 2015 analysis was observed with passengers transferring from the 747 Express Airport Shuttle representing the bulk of the demand generated for the airport station.

Table 7-13: REM Capture – Airport Demand (2021 and 2031)

AM Peak + Interpeak	747 Express Airport Shuttle Passengers	Taxi	Car (Park & Fly)	Car (Kiss & Fly)	Total
2021	2,295	679	316	199	3,488
2031	2,789	823	376	236	4,224

7.31 The resulting boardings and alightings for each station for 2021 and 2031 (AM and Interpeak) are shown below.

Table 7-14: AM and Interpeak Station Boardings and Alightings (2021 and 2031)

	2021				2031			
	AM Peak Boardings	AM Peak Alightings	Interpeak Boardings	Interpeak Alightings	AM Peak Boardings	AM Peak Alightings	Interpeak Boardings	Interpeak Alightings
Bassin Peel	28	1,452	439	622	30	1,556	450	664
Île-des-Sœurs	286	522	21	91	306	560	24	100
Panama	14,049	303	3,412	1,964	15,298	337	3,749	2,152
Du Quartier	4,665	245	752	519	4,916	257	805	558
Rive-Sud	5,094	0	2,027	130	5,606	0	2,191	144
Technoparc Saint-Laurent	7	190	6	123	8	204	6	131
Aéroport Pierre-Elliott-Trudeau	718	659	1,225	1,618	851	872	1,474	1,959
Autoroute 13	339	424	123	151	445	536	137	167
Des Sources	765	293	917	706	823	311	987	751
Pointe-Claire	2,321	687	1,092	682	2,463	732	1,170	737
Kirkland	1,262	0	134	0	1,421	0	144	0
Sainte-Anne-de-Bellevue	1,048	39	337	35	1,114	42	358	37
Deux-Montagnes	3,326	94	543	1,161	3,483	100	599	1,260
Grand-Moulin	779	5	102	129	803	5	109	137
Ste-Dorothée	1,619	55	87	934	1,646	60	92	995
Île-Bigras	511	22	116	213	548	25	130	230
Roxboro-Pierrefonds	3,367	176	261	1,063	3,536	190	276	1,124
Sunnybrooke	1,743	89	236	757	1,823	94	251	787
Bois-Franc	4,083	1,021	2,515	1,563	4,361	1,113	2,732	1,757
Du Ruisseau	2,193	478	582	727	2,222	518	528	742
Montpellier	2,461	1,826	991	1,175	2,654	1,969	1,027	1,268
Mont-Royal	920	927	1,518	944	1,006	996	1,582	1,012
Correspondance A40	1,544	866	175	156	1,682	936	190	170
Canora	1,090	985	678	304	1,180	1,058	731	338
Édouard-Montpetit	2,217	5,001	2,046	2,280	2,382	5,387	2,173	2,443
McGill	1,483	15,005	5,480	5,358	1,606	15,982	5,953	5,583
Gare Centrale	596	27,151	3,102	5,511	637	29,011	3,309	5,931
TOTAL	**58,515**	**58,515**	**28,916**	**28,916**	**62,852**	**62,852**	**31,178**	**31,178**

Totals may vary due to rounding

7.32 The peak loads for 2021 and 2031 and in both the AM and Interpeak periods are observed on the link between Correspondence A40 and Mont-Royal. The link loads are summarized in Table 7-15.

Table 7-15: REM Section Load Flows

	2021		2031	
	AM Peak	Interpeak	AM Peak	Interpeak
Rive-Sud - Du Quartier	5,094	2,027	5,606	2,191
Du Quartier - Panama	9,759	2,779	10,522	2,997
Panama - Île des-Sœurs	23,744	6,019	25,753	6,558
Île-des-Sœurs - Bassin Peel	23,899	6,028	25,919	6,571
Bassin Peel - Gare Centrale	23,035	6,202	24,990	6,752
Autoroute 13 - Technoparc Saint-Laurent	835	1,730	1,060	2,079
Technoparc Saint-Laurent - Aéroport Pierre-Elliott-Trudeau	659	1,618	872	1,959
Bois-Franc - Autoroute 13	1,946	3,157	2,159	3,603
Autoroute 13 - Des Sources	898	1,411	956	1,513
Des Sources - Pointe-Claire	726	717	774	774
Pointe-Claire - Kirkland	39	35	42	37
Kirkland - Sainte-Anne-De-Bellevue	39	35	42	37
Gare Centrale - McGill	8,851	4,714	9,591	5,074
McGill - Édouard-Montpetit	5,142	8,271	5,589	8,912
Édouard-Montpetit - Canora	3,175	8,347	3,461	8,989
Canora - Mont-Royal	3,103	8,434	3,385	9,084
Mont-Royal - Correspondance A40	2,856	8,545	3,115	9,194
Correspondance A40 - Montpellier	2,508	8,495	2,738	9,143
Montpellier - Du Ruisseau	2,071	7,890	2,276	8,515
Du Ruisseau - Bois-Franc	2,091	7,163	2,301	7,773
Bois-Franc - Sunnybrooke	294	4,182	318	4,454
Sunnybrooke - Roxboro-Pierrefonds	262	3,427	285	3,669
Roxboro-Pierrefonds - Île-Bigras	175	2,383	190	2,566
Île-Bigras - Ste-Dorothée	153	2,208	164	2,376
Ste-Dorothée-Grand-Moulin	98	1,290	106	1,397
Grand-Moulin - Deux-Montagnes	94	1,161	100	1,260
Gare Centrale – Bassin Peel	1,436	2,877	1,545	3,151
Bassin Peel - Île-des-Sœurs	875	2,520	948	2,756
Île-des-Sœurs - Panama	484	2,441	528	2,667
Panama - Du Quartier	245	650	257	703
Du Quartier - Rive-Sud	0	130	0	144
Aéroport Pierre-Elliott-Trudeau - Technoparc Saint-Laurent	718	1,225	851	1,474
Technoparc Saint-Laurent - Autoroute 13	711	1,221	843	1,469
Sainte-Anne-De-Bellevue - Kirkland	1,048	337	1,114	358
Kirkland - Pointe-Claire	2,310	471	2,535	502
Pointe-Claire - Des Sources	4,631	1,563	4,998	1,672
Des Sources - Autoroute 13	5,275	2,468	5,692	2,646
Autoroute 13 - Bois-Franc	6,114	3,676	6,587	4,096
Deux-Montagnes - Grand-Moulin	3,326	543	3,483	599

	2021		2031	
	AM Peak	Interpeak	AM Peak	Interpeak
Grand-Moulin - Ste-Dorothée	4,105	645	4,286	708
Ste-Dorothée - Île-Bigras	5,723	715	5,932	783
Île-Bigras - Roxboro-Pierrefonds	6,235	793	6,480	873
Roxboro-Pierrefonds - Sunnybrooke	9,512	1,035	9,922	1,128
Sunnybrooke - Bois-Franc	11,197	1,269	11,684	1,377
Bois-Franc - Du Ruisseau	20,225	5,720	21,343	6,164
Du Ruisseau - Montpellier	21,920	6,302	23,021	6,692
Montpellier - Correspondance A40	22,991	6,725	24,169	7,080
Correspondance A40 - Mont-Royal	24,018	6,793	25,292	7,150
Mont-Royal - Canora	24,259	7,256	25,573	7,611
Canora- Édouard-Montpetit	24,436	7,542	25,771	7,909
Édouard-Montpetit-McGill	23,620	7,233	24,894	7,562
McGill-Gare Centrale	13,807	3,798	14,520	4,094

Daily and Annual Forecasts

Daily and Annual expansion factors

7.33 The model estimates boardings by station and loadings per line section and direction for the AM Peak (6am-9am) and the Interpeak (9am-3pm) periods. In order to translate this into weekday and annual figures, expansion factors have been applied as discussed in Section 5 of this report.

7.34 The weekday factors have been based on those observed in the existing services in the corridors. Estimated factors for both corridors (South Shore/A10 and Deux-Montagne/West Island) are very similar, and therefore we have used the same weekday factors for all the stations in the corridors, with the exception of the airport demand. The estimated resulting weighted average for the total boardings in the corridors are:

- AM Peak (6am-9am) to Peak (6am-9am & 3pm-6pm) factor: 1.95
- Interpeak (9am-3pm) to Off Peak (before 6am, 9am-3pm, & after 6pm) factor: 1.64

7.35 For estimating annual demand, we have analyzed the observed annual factors in the various corridors and have developed a formula that estimates annual factors based on the weight of the peak demand on an average weekday (see Figure 4-8). We have applied this approach to estimate the annual demand for each REM station based on the AM Peak and Interpeak demand forecasted from the Transit Mode Choice Model.

7.36 Table 7-16 shows the (weighted) annual factors for the stations located in the different corridors. Note that Gare Centrale is not included in the analysis and has been estimated based on the REM weighted average. The Airport factor has been estimated independently as the travel patterns are quite different to regular commuters and students.

Table 7-16: Annual Factor Estimate (2021)

	Annual Factor	Peak Proportion
South Shore/A10	247	77%
Deux-Montagnes/West Island	263	70%
Sainte-Anne-de-Bellevue	263	70%
Aéroport Pierre-Elliott-Trudeau	277	
REM Weighted Average	**260**	

7.37 Note the following impacts:

- Better service in the Interpeak: The proportion of demand in the Interpeak has increased at most stations as a result of the much improved level of service. This results in higher capture from other transit services in the Interpeak and therefore a lower weight of the peak period (from the current 85% peak factor in Deux-Montagnes Line compared to estimated 70% with REM). As a result, a higher annual factor is estimated, which is consistent with the estimated capture from express buses and the Métro Orange Line.
- Impact of Park & Ride: Demand in the AM Peak increases in some stations with the introduction of Park & Ride facilities. This results in a higher weight in the peak period and a small reduction in the annual factor.

Daily and Annual Ridership Forecasts

7.38 We have applied the expansion factors presented previously to the AM Peak and Interpeak boardings extracted from the Transit Mode Choice Model and these are presented in Table 7-17.

Table 7-17: REM Daily and Annual Boardings (No Ramp Up)

	Daily		Annual	
	2021	2031	2021	2031
Bassin Peel	2,301	2,446	643,961	681,266
Île-des-Sœurs	875	941	193,128	208,082
Panama	18,303	19,975	4,525,585	4,945,106
Du Quartier	5,798	6,130	1,361,283	1,442,288
Rive-Sud	6,699	7,341	1,690,109	1,846,841
Technoparc Saint-Laurent	296	318	75,373	81,050
Aéroport Pierre-Elliott-Trudeau	4,606	5,648	1,275,913	1,564,506
Autoroute 13	964	1,199	236,716	288,131
Des Sources	2,349	2,516	820,635	878,667
Pointe-Claire	4,364	4,654	1,170,956	1,251,941
Kirkland	1,333	1,495	288,581	322,831
Sainte-Anne-De-Bellevue	1,359	1,443	331,359	351,941
Deux-Montagnes	4,705	4,991	1,221,885	1,305,696
Grand-Moulin	949	985	226,460	236,285
Ste-Dorothée	2,455	2,541	663,249	693,035
Île-Bigras	786	850	212,845	231,041
Roxboro-Pierrefonds	4,517	4,755	1,116,463	1,176,370
Sunnybrooke	2,586	2,705	682,340	713,647
Bois-Franc	8,274	8,968	2,374,394	2,589,817
Du Ruisseau	3,658	3,693	946,796	946,496
Montpellier	5,924	6,355	1,542,224	1,649,128
Mont-Royal	3,798	4,056	1,258,623	1,331,542
Correspondance A40	2,607	2,833	574,627	624,742
Canora	2,814	3,043	723,907	784,052
Édouard-Montpetit	10,527	11,299	2,834,121	3,036,463
McGill	24,826	26,462	6,815,345	7,260,882
Gare Centrale	33,934	36,289	8,159,512	8,730,753
TOTAL	**161,606**	**173,931**	**41,966,392**	**45,172,601**

Totals may vary due to rounding

7.39 With the ridership data extracted from the Transit Mode Choice model we can then estimate the passenger kilometres on REM by factoring individual link loads by the corresponding distance. The passenger kilometres estimates are shown in Table 7-18. The highest passenger kilometres are observed on links with high ridership and long length. These include Gare Centrale to Canora (5.4 kilometres), Bois Franc to Sunnybrooke (6.4 kilometres), Île-des-Sœurs to Gare Centrale (5.4 kilometres) and Panama to Île-des-Sœurs (5.4 kilometres).

Table 7-18: REM Annual Passenger Kilometres (no Ramp Up)

	2021	2031
Rive-Sud - Du Quartier	5,039,887	5,527,928
Du Quartier - Panama	23,960,203	25,850,916
Panama - Île-des-Sœurs	85,902,826	93,388,342
Île-des-Sœurs - Bassin Peel	58,295,968	63,370,265
Bassin Peel - Gare Centrale	22,772,363	24,751,685
Autoroute 13 - Technoparc Saint-Laurent	5,102,737	6,197,468
Technoparc Saint-Laurent - Aéroport Pierre-Elliott-Trudeau	5,308,061	6,501,575
Bois-Franc - Autoroute 13	31,061,741	34,277,337
Autoroute 13 - Des Sources	18,071,290	19,448,820
Des Sources - Pointe-Claire	15,222,471	16,398,773
Pointe-Claire - Kirkland	3,627,212	3,964,062
Kirkland - Sainte-Anne-De-Bellevue	3,037,866	3,230,393
Gare Centrale - McGill	7,643,396	8,165,523
McGill - Édouard-Montpetit	67,220,549	71,372,296
Édouard-Montpetit - Canora	35,913,339	38,116,522
Canora - Mont-Royal	16,849,558	17,881,602
Mont-Royal - Correspondance A40	29,622,288	31,425,658
Correspondance A40 - Montpellier	18,240,108	19,331,876
Montpellier - Du Ruisseau	26,575,176	28,201,656
Du Ruisseau - Bois-Franc	28,889,602	30,849,913
Bois-Franc - Sunnybrooke	52,042,647	54,786,616
Sunnybrooke - Roxboro-Pierrefonds	14,871,152	15,671,303
Roxboro-Pierrefonds - Île-Bigras	15,872,536	16,729,230
Île-Bigras - Ste-Dorothée	3,926,914	4,128,442
Ste-Dorothée - Grand-Moulin	7,975,467	8,437,813
Grand-Moulin - Deux-Montagnes	5,408,274	5,741,992
TOTAL	**608,453,632**	**653,748,003**

Totals may vary due to rounding

Annual Profiles

7.40 We have developed annual demand and passenger kilometres profiles for every year from 2021 to 2041. These have been based on the following assumptions:

- Forecasts between 2021 and 2031 have been interpolated
- Forecasts from 2031 to 2041 have been extrapolated based on observed growth between 2016 and 2031 and reduced to reflect long term forecasting uncertainty and lack of long term socio-economic data

Ramp up

7.41 The ramp up has been applied to each of the initial years of operation according to Table 4-16 (base assumptions). The application has been based on the estimation of the split between existing demand and new demand as different ramp up rates applied to reflect the fact that existing users are more likely to adopt and use the REM at a faster rate.

7.42 We have included as existing demand those users that are currently using a transit service in the corridors that are either going to be eliminated or truncated in order to feed the REM system. Table 7-19 shows the estimated existing demand for the Sponsor Case.

Table 7-19: Existing Demand Estimates

Corridor	Total Corridor Demand (Observed)	In-Scope	Existing	Boardings (Assumed Half of Existing)
South Shore	13,052,269	90%*	11,747,042	5,873,521
Deux-Montagnes	7,495,900	100%	7,495,900	3,747,950
Airport	1,471,637	84%**	1,250,891	625,446

** Estimated that 90% of the boardings on the South Shore express buses cross the Champlain Bridge to access Montréal Island*

*** Estimated that only 84% of the 747 Express Airport Shuttle demand will shift to REM*

7.43 The application of the assumptions shown above result in the estimated ramp up factors for the Sponsors Case shown in Table 7-20.

Table 7-20: Sponsors Case Overall Ramp Up Factors

	2021	2022	2023	2024
Annual Demand	74%	87%	94%	100%
Annual Passenger-Km	74%	87%	94%	100%

Ridership and Passenger Kilometres profile

7.44 Table 7-21 shows a summary of the ridership and passenger kilometres totals for 2021, 2026 and 2031 with the ramp up applied.

Table 7-21: REM Ridership and Passenger Kilometres Summary (with ramp up)

	2021	2026	2031
Daily			
Boardings	119,467	167,637	173,931
Passenger kilometres	1,743,484	2,428,409	2,517,174
Annual			
Boardings	30,961,199	43,535,017	45,172,601
Passenger kilometres	452,753,922	630,655,913	653,748,003

7.45 Figure 7-6 and Figure 7-7 show the resulting ridership and passenger kilometres forecast profiles accounting for ramp up which explains the high growth in the 2021 to 2024 period when the ramp up is applied as the REM starts operations and it becomes an integral part of Montréal's transit network.

Figure 7-6: Annual Ridership Profile (with ramp up)

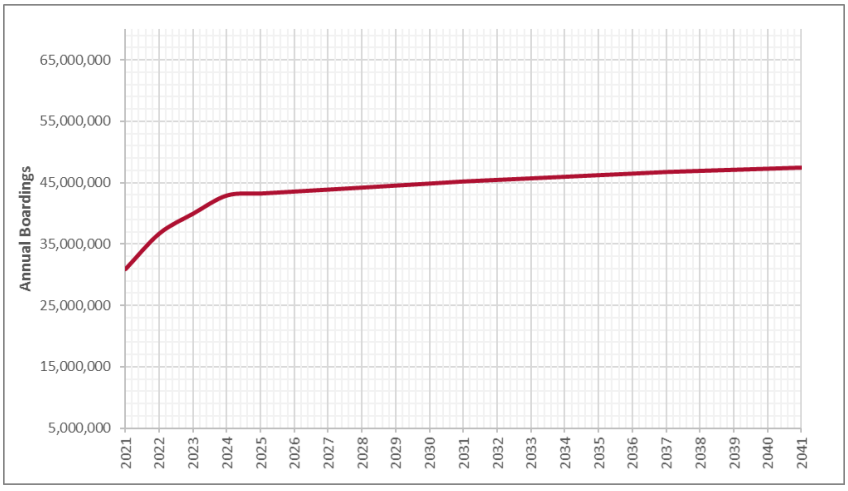
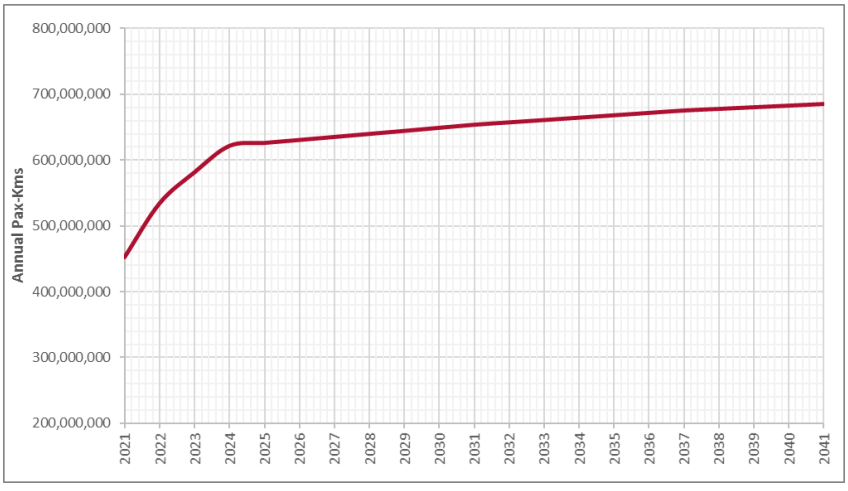


Figure 7-7: Annual Passenger Kilometres Profile (with ramp up)



8 Sensitivity Tests

Identified risks

8.1 REM is a transformational project that has been a priority project (separately as Champlain LRT, Train de l'Ouest and Aerotrain projects) for a long time. However, its development has stalled due to funding constraints.

8.2 The Sponsor Case reflects the sponsor assumptions of the most likely scenario, given the current engineering and operations analysis to date and latest discussions with a range of organizations. It also includes the consultant base assumptions for the model parameters and expected transit growth. However, there are a number of risks in any transit project and these need to be clearly identified to understand their potential ridership and operational impact. These include:

- Transit network: transit agencies (AMT, STM and CITs) are cooperating with CDPQ Infra Inc. to develop an integrated transit network. However, there is a risk on the level of transit integration and/or level of service to be implemented.
- Fare: there is some uncertainty with regards to the fare that will be charged on REM. The Sponsor Case assumes the REM fare will be similar to the current fare structure in Metropolitan Montréal. However, if different fares are assumed, for example if STM fares are applicable at REM stations on Montréal Island, REM fares will reduce overall and result in an increase in REM ridership at the expense of express buses and Métro lines.
- Demand growth: there are some concerns with regards to the recent decline in transit ridership observed in the last couple of years (especially on STM bus services). This may be a temporary effect (particularly cold recent winters, employment reductions and low gas prices) or a more fundamental shift resulting from competition from alternative modes (car sharing, cycling) or changes in travel patterns (working from home, online shopping, etc).
- Model parameters: this study has included a substantial data collection exercise and development of a demand forecasting model. However, every model requires a number of assumptions related to the behaviour of passengers, how they value the different travel components and passengers' perception of REM compared to other modes (bus, rail and Métro).

Sensitivity Tests

8.3 In order to assess the extent of the impact of these risks, a number of sensitivities have been carried out. The sensitivities were undertaken for Transit Mode Choice and the Airport models separately due to the different characteristics of both markets.

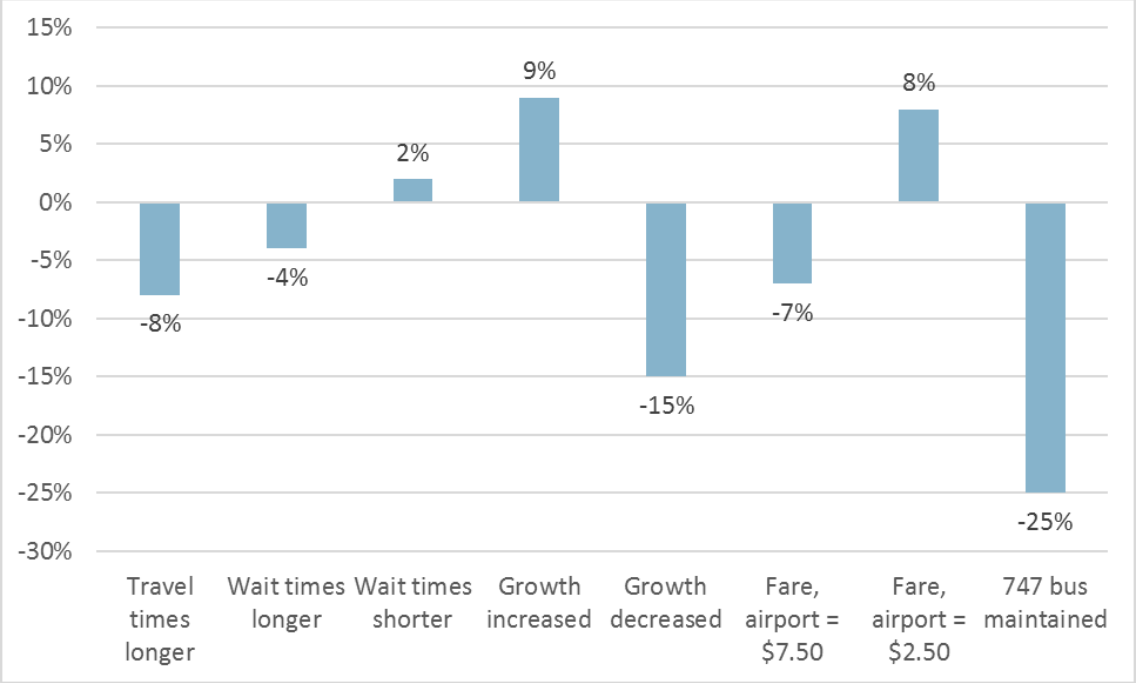
8.4 Table 8-1Table 8-2: presents the assumptions that have been adopted for the Sponsor Case, and High and Low sensitivities to those variables.

Table 8-1: Sensitivity Tests

	Sponsor Case	Sensitivity Low	Sensitivity High
REM Service			
Travel times longer	Average speed of 57kph	Average speed 49kph (15% slower)	-
Wait times longer/ shorter	AM: 12 mins OP: 15 mins	AM: 18 mins OP: 20 mins	AM: 12 mins OP: 10 mins
Users' Perception of REM			
REM users' mode constant vs Metro/Rail	2 mins	4 mins	0 mins
Growth	As modelled	-50% of modelled	+30% of modelled
Airport			
Fare Airport	$5	$7.50	$2.50
747 Express Airport Shuttle	No service	Same as current	No service

8.5 Figure 8-1 shows the impact of the sensitivities on the predicted airport demand.

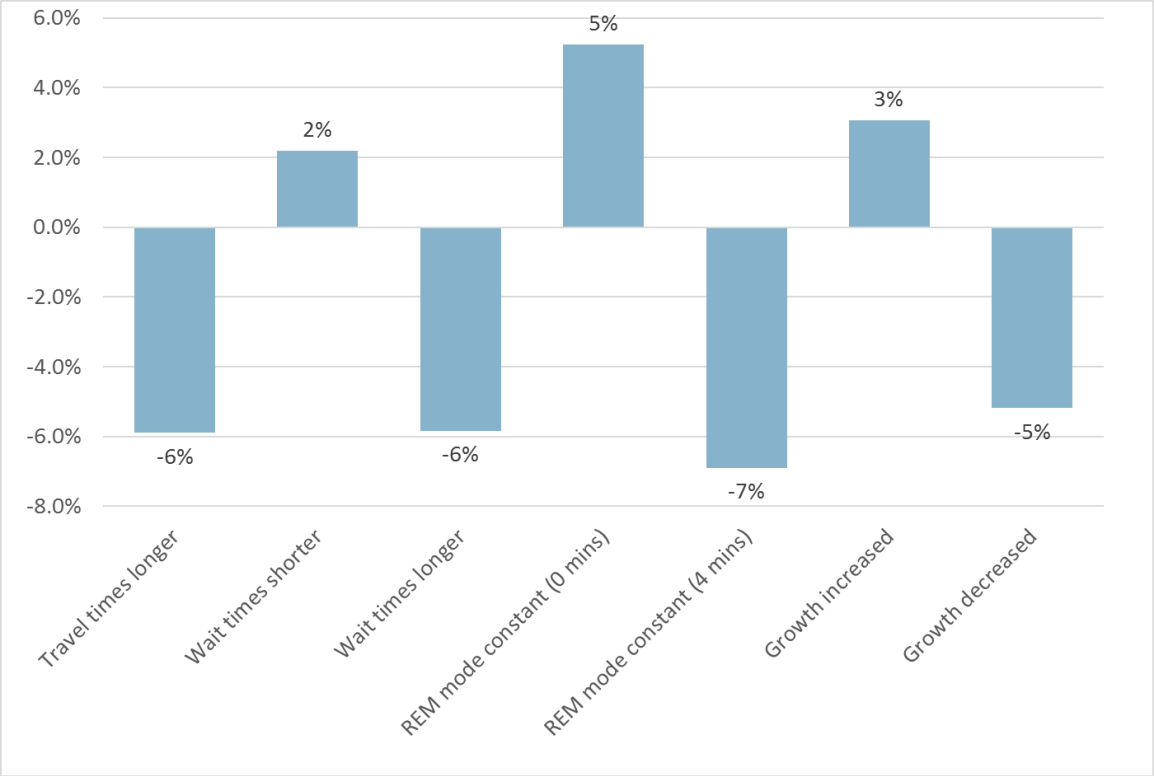
Figure 8-1: REM Airport Station Ridership Sensitivity Tests (2031)



8.6 The figure shows clearly that the existence of the 747 Express Airport Shuttle has the largest impact on REM ridership.

8.7 Tests were also carried out on transit demand using the Transit Mode Choice Model. The results are shown in Figure 8-2.

Figure 8-2: REM Transit Ridership Sensitivity Tests (2031)



8.8 Compared to the removal of the 747 Express Airport Shuttle for the airport demand tests, the impact of the various variables is generally less dramatic. However, it affects a larger number of trips.

Low and High Case Definition

8.9 Following the various sensitivity tests indicated above, we developed Low and High cases to understand the combined effect of various assumptions and to aid understanding of the range in ridership forecasts around the Sponsor Case.

8.10 Table 8-2: presents the assumptions adopted for the Sponsor Case, compared to the High and Low Cases. Each case includes the combination of all the different assumptions adopted for each variable.

Table 8-2: Sensitivity Test Definition

	Description	Sponsor Case	Low Case	High Case
Travel times	Deux-Montagnes to Rive-Sud	48:43	56:01	Same as sponsor
	Roxboro-Pierrefonds to Rive-Sud	38:47	44:36	Same as sponsor
	Sainte-Anne-de-Bellevue to Rive-Sud	48:58	56:19	Same as sponsor
	Aéroport Pierre-Elliott-Trudeau to Rive-Sud	41:12	47:23	Same as sponsor
	Correspondance A40 to Rive-Sud	25:38	29:29	Same as sponsor
Fares	South Shore fares	As per current fares	Same as sponsor	Same as sponsor
Fares	West Island fares	As per current fares (REM as AMT in Montréal Island)	Same as sponsor	STM fares on REM in Montréal Island
Fare, Airport	Current average airport fare ($3.15) with premium	$8.15 ($5 premium)	Same as sponsor	$5.65 ($2.50 premium)
Bus Restructuring	South Shore services	South Shore services re-directed to REM stations	Same as sponsor	Same as sponsor
Bus Restructuring	STM West Island services	Bus network reconfigured	Bus network reconfigured with 20% decrease in frequency (if wait time is 10 mins or lower no decrease applied)	Bus network reconfigured with 10% increase in frequency
747 Express Airport Shuttle	Eliminated from service	Removed	Remains as current	Same a sponsor
REM perception	REM mode constant vs Metro/Rail	2 minutes	4 minutes	0 minutes
Growth		As modelled	-50% of modelled	+30% of modelled
Ramp up		See Table 8-3 below	See Table 8-3 below	See Table 8-3 below
Car shift		Auto Shift Model	30% reduction	30% increase

Table 8-3: Ramp Up Assumptions – Low and High Case

Year	West-Island/Deux-Montagnes Line Corridor		Airport Corridor		South Shore/A10 Corridor	
	Existing Deux-Montagnes Rail	New	Existing	New	Existing Express (Eliminated)	New
SPONSOR CASE						
2021	100%	60%	80%	60%	90%	60%
2022	100%	80%	90%	80%	95%	80%
2023	100%	90%	95%	90%	100%	90%
2024	100%	100%	100%	100%	100%	100%
2025	100%	100%	100%	100%	100%	100%
LOW CASE						
2021	100%	55%	55%	55%	85%	55%
2022	100%	75%	75%	75%	90%	75%
2023	100%	85%	85%	85%	95%	85%
2024	100%	95%	95%	95%	100%	95%
2025	100%	100%	100%	100%	100%	100%
HIGH CASE						
2021	100%	70%	85%	70%	95%	70%
2022	100%	85%	95%	85%	100%	85%
2023	100%	90%	100%	90%	100%	90%
2024	100%	100%	100%	100%	100%	100%
2025	100%	100%	100%	100%	100%	100%

Ridership Forecasts

8.11 Table 8-4 shows the 2021 annual station boardings for the Low and High Case compared to the Sponsor Case scenario.

8.12 There are large differences across the various stations which result from the considerable number of variables changed and their different impact by trip origin and destination. The large reduction in the boardings at Aéroport Pierre-Elliott-Trudeau is the result of maintaining the 747 Express Airport Shuttle route with the existing level of service which becomes a direct competitor to REM.

Table 8-4: REM Station Annual Boardings – Low and High Cases (2021)

	Sponsor Case	Low Case	High Case	Difference (Low vs Sponsor)	Difference (High vs Sponsor)
Bassin Peel	643,961	539,788	985,487	-16%	53%
Île-des-Sœurs	193,128	181,379	205,877	-6%	7%
Panama	4,525,585	4,198,067	4,721,877	-7%	4%
Du Quartier	1,361,283	1,311,166	1,384,022	-4%	2%
Rive-Sud	1,690,109	1,581,553	1,757,760	-6%	4%
Technoparc Saint-Laurent	75,373	62,388	86,955	-17%	15%
Aéroport Pierre-Elliott-Trudeau	1,275,913	851,000	1,559,975	-33%	22%
Autoroute 13	236,716	144,546	409,112	-39%	73%
Des Sources	820,635	680,039	915,171	-17%	12%
Pointe-Claire	1,170,956	788,832	1,351,834	-33%	15%
Kirkland	288,581	190,642	362,750	-34%	26%
Sainte-Anne-De-Bellevue	331,359	251,531	407,747	-24%	23%
Deux-Montagnes	1,221,885	1,192,105	1,284,532	-2%	5%
Grand-Moulin	226,460	222,448	229,210	-2%	1%
Ste-Dorothée	663,249	390,755	713,787	-41%	8%
Île-Bigras	212,845	160,146	239,345	-25%	12%
Roxboro-Pierrefonds	1,116,463	997,877	1,338,591	-11%	20%
Sunnybrooke	682,340	606,801	779,221	-11%	14%
Bois-Franc	2,374,394	1,837,887	3,208,165	-23%	35%
Du Ruisseau	946,796	800,401	986,106	-15%	4%
Montpellier	1,542,224	1,078,872	1,799,393	-30%	17%
Mont-Royal	1,258,623	1,007,708	1,436,714	-20%	14%
Correspondance A40	574,627	476,119	649,425	-17%	13%
Canora	723,907	501,180	1,036,461	-31%	43%
Édouard-Montpetit	2,834,121	2,060,630	3,653,285	-27%	29%
McGill	6,815,345	5,262,411	7,890,284	-23%	16%
Gare Centrale	8,159,512	7,114,464	8,847,206	-13%	8%

8.13 The full profile for ridership and passenger kilometres for the Low and High cases are shown in Figure 8-3 and Figure 8-4. Note that ramp up has been applied to these forecasts and hence the steep growth during the first few years of REM operations.

Figure 8-3: Annual Boardings – Low and High Cases (with Ramp Up)

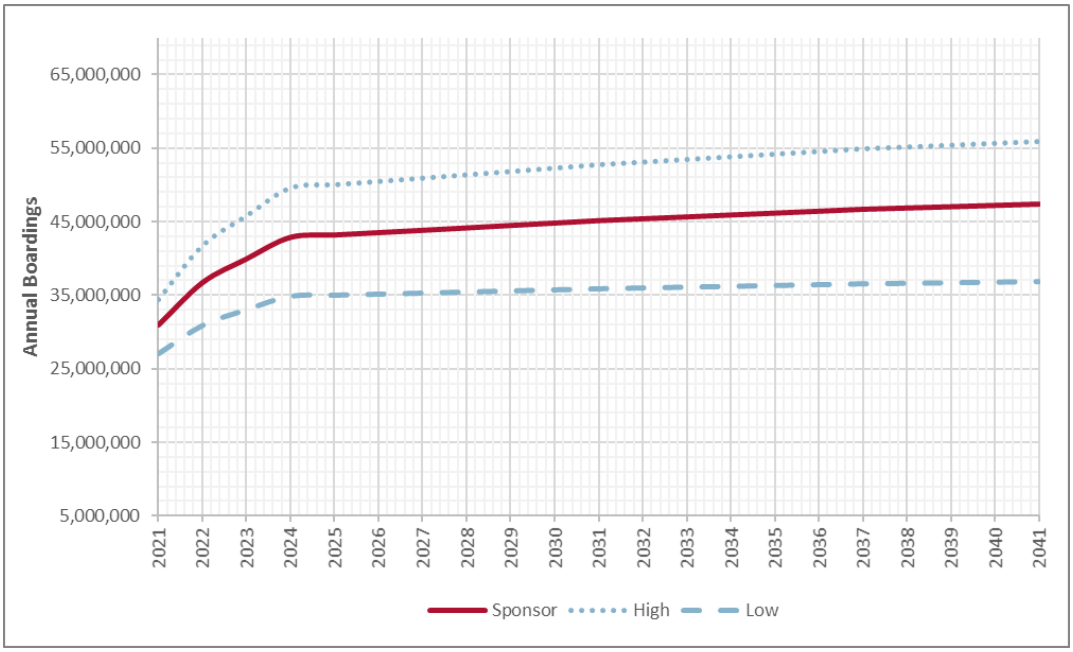
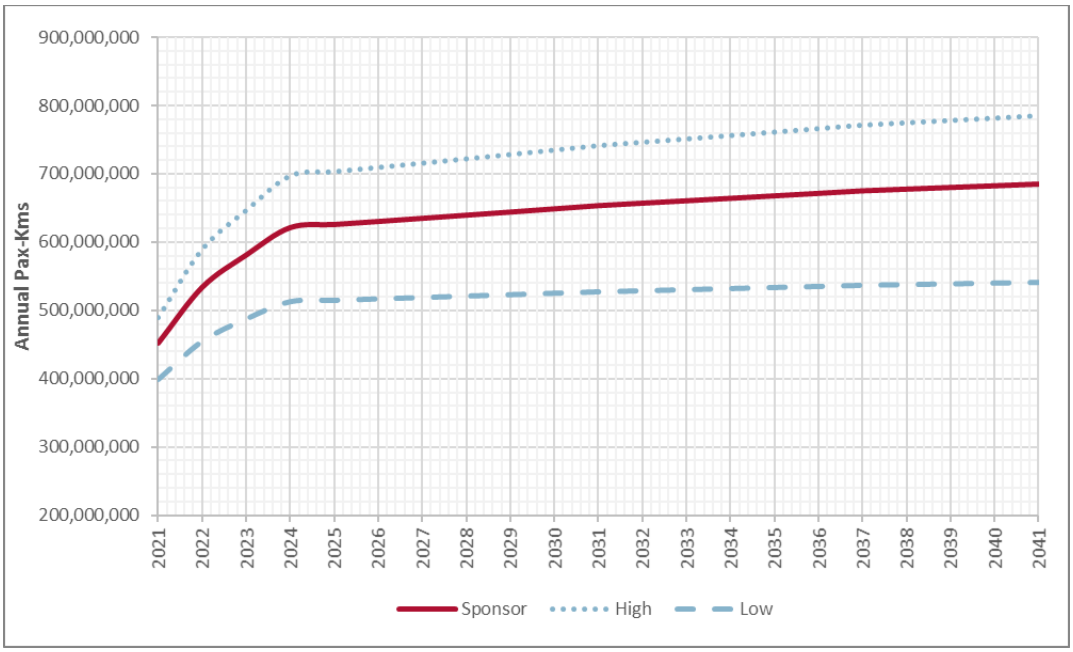


Figure 8-4: Annual Passenger Kilometre – Low and High Case (with Ramp Up)



8.14 Table 8-5 compares the results for 2021 and 2031. The larger difference observed in 2021 is due to the ramp up impact. Note that the change in boardings and passenger kilometres are closely aligned.

Table 8-5: Low and High Case Ridership Comparison

	Boardings		Passenger Kilometres	
	2021 (With Ramp Up)	2031	2021 (With Ramp Up)	2031
Sponsor	-	-	-	-
Low	-13%	-20%	-12%	-19%
High	+10%	+17%	+8%	+13%

8.15 Finally, we have reviewed the peak loads for the various cases to understand the impact on REM operations. The peak loads are detailed in Table 8-6.

Table 8-6: Low and High Case Peak Loads

	AM Peak Load (No Ramp Up)		Difference from Sponsor Case	
	2021	2031	2021	2031
Sponsor	23,899	25,919	-	-
Low	22,400	23,394	-6%	-10%
High	24,675	27,315	+3%	+5%

8.16 Due to the existing transit system being close to capacity in the peak periods, particularly on the Deux-Montagnes Line and the Terminus Centre Ville (TCV) for buses originating from the South Shore, the potential for growth in demand on these transit services is limited. The mode shift calculated could therefore hypothetically be more important than the forecasted demand growth due to the introduction of REM, which will result in a considerable increase in transit capacity that could hypothetically transfer additional demand from auto-based transportation to transit. Figure 8-5 and Table 8.7 show the impact of a range of mode transfer scenarios.

Figure 8-5: REM AM Peak Boardings with Differing Mode Shift

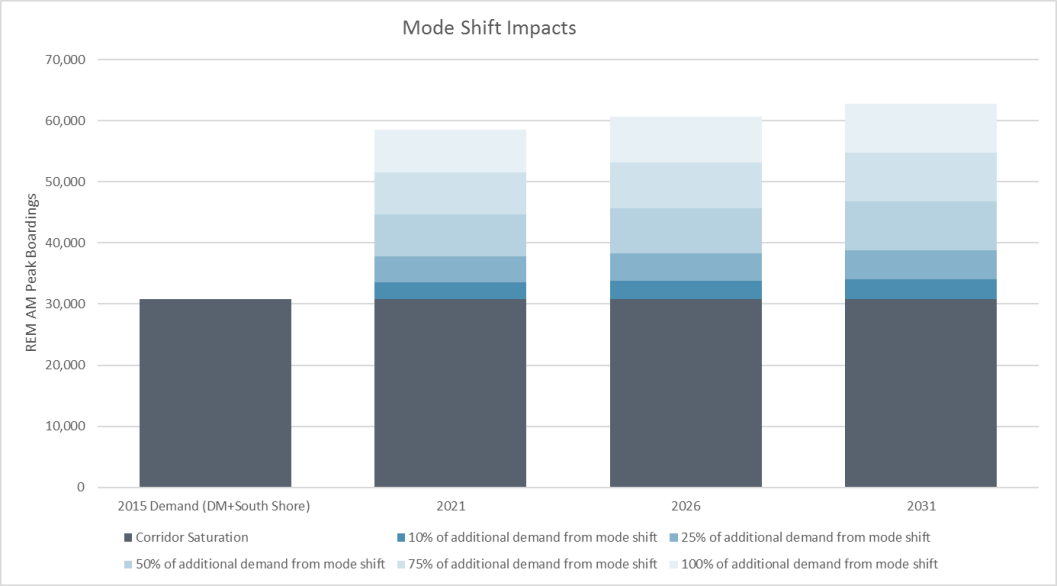


Table 8.7: REM AM Peak Boardings with Differing Mode Shift

	2015	2021	2026	2031
Demand (DM and South Shore)	30,829	30,829	30,829	30,829
10% of additional demand from mode shift		2,769	2,981	3,202
25% of additional demand from mode shift		4,153	4,471	4,803
50% of additional demand from mode shift		6,921	7,452	8,006
75% of additional demand from mode shift		6,921	7,452	8,006
100% of additional demand from mode shift		6,921	7,452	8,006
TOTAL	30,829	58,515	60,638	62,852

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Appendices

A Future Road Network Assumptions

Projects included (2016)			Project update (included in 2021)
No	Project name	Year	
171	Road 337: Widening to 2 lanes northbound between Rodrigue and Philippe Chartrand streets	2016	2018
172	Road 335: Redesign of the Industriel Boulevard intersection with Henry-Bessemer new ramp towards A640 West – Bois-de-Fillion	2016	2018
215	Redesign of Viau and St-Clément streets between Pierre-de-Coubertin and Notre-Dame streets	2016	
221	Redesign of Pie-IX/Henri-Bourassa intersection	2016	
225	Décarie Interchange redesign	2016	
290	Turcot Interchange phase I – Construction	2016	
291	Dorval Interchange phase I – End summer 2015	2016	
330	Redesign of the interchange between A20/A30	2016	2017
333	Additional ramp on A30 West towards road 116	2016	2018
334	A30 East and West: weaving widening between Road 116 and Clairevue Boulevard	2016	2018
501	A15: New interchange (entry/exit lane) Notre-Dame Street in Mirabel	2016	

Projects included (2021)			Project update (included in 2031)
No	Project name	Year	
294	Bonaventure project	2017	
331	Additional ramp on A30 West towards A20	2017	
296	New Champlain Bridge (December 2015 design)	2018	
335	A30 West: weaving widening between Grande-Allée street and A10	2018	
211	Boulevard Cavendish extension	2020	
222	Redesign of Pie-IX Bridge between Montreal and Laval	2020	2022
336	Completion of A35 between St-Sébastien and St-Armand	2020	
129	A640: New interchange with Urbanova – Terrebonne	2021	
133	A440: New overpass and ramps between A19 and A25	2021	
146	Completion of A19 between Laval and the North-Shore	2021	2031
170	Boulevard René-Laennec extension	2021	
212	Extension of L'Assomption and Souligny boulevards and new link with the Port of Montreal	2021	
216	Redesign of A25 and Port of Montreal access.	2021	
226	New urban boulevard between Gouin street and A40	2021	
293	Turcot Interchange phase II (design version 5.1)	2021	
332	A20/Road 132: New ramp F – Longueuil	2021	
601	Redesign of Charles Street between A15 and Sainte-Henriette road – Mirabel	2021	
608	Bypass road Saint-Lin – Laurentides region	2021	
610	Widening of Saint-Simon road between A20 and Saint-Canut boulevard	2021	
NA	Dorval Interchange phase II	2019	

Projects included (2031)			Project update
No	Project name	Year	
337	A10: Widening between A30 and A35	2025	
338	A20: Widening between Saint-Julie and Saint-Hyacinthe	2025	
339	A30: Widening between A10 and A20	2025	
134	Completion of Dagenais Boulevard (2 lanes per direction) between Des Laurentides and Industriel boulevards	2026	
292	Dorval Interchange phase II – final	2026	To be determined
606	New East-West link between road 333 et road 117 – Saint-Jérôme, Lafontaine neighbourhood	2026	
609	A13: Four lanes extension between A640 and Chemin de la Côte-Nord	2026	
604	A15: Additional third lanes (both direction) between Saint-Sauveur and Saint-Jérôme	2031	
607	A50: Doubling of traffic lanes between Mirabel and Lachute	2031	

Source: Ministère des Transports, de la Mobilité durable et de l'Électrification (MTMDE)

B Stated Preference Research Review

Quality and Reliability Assessment

Introduction

1.1 There are intrinsic and intangible benefits perceived by passengers between rail-based modes (such as REM) and conventional bus. These benefits are generally categorized as “quality and reliability benefits” and reflect a key component of mode choice.

1.2 Quality benefits arise from parameters associated with modelling “quality” aspects of the transit system and these include trip ambience (generally vehicle characteristics), ride quality and stop attributes.

1.3 Traditionally, “quality” is incorporated as part of a mode-specific perception factor which is applied in a model. The application of quality parameters in a model has traditionally been done either through a “fixed” mode constant (applied to in-vehicle travel time or a mode specific boarding penalty) or a “factor” on in-vehicle travel (IVT) time. The difference between the application of these parameters means that the impact of each factor will vary considerably based on trip length e.g. a short trip will be impacted by a ‘fixed’ variable more than an IVT “factor” while the opposite will be true for longer trips.

1.4 In practice the most accurate measure would likely be a mixture of both, with fixed constants reflecting stop related attributes (shelter, CCTV, real time information) and variable constants reflecting journey ambience (ride quality, climate control).

1.5 Mode-specific factors can be estimated through a variety of methods including as a calibration parameter (for existing transit networks), a review of values applied in other studies/models or based on stated preference surveys.

1.6 Finally, it is important to note that quality and reliability represent two different aspects of a trip but it can sometimes be challenging to distinguish between them, particularly when transit users are asked about a “new” transit mode in the region and have limited experience with it.

Quality Impact

1.7 Mode-specific perception factors can be applied at the mode-choice and/or assignment stages and are largely accepted in the transportation modelling community[1] [2] [3].

1.8 Currie[1] extensively examined how passengers valued trip attributes for on-street bus, BRT, LRT and heavy rail systems, compiling information from a range of studies and sources. The conclusion was that BRT, LRT and heavy rail are all favoured relative to conventional bus. Based on Currie’s analysis, BRT and LRT mode constants could be up to 20 minutes relative to conventional bus and heavy rail could be up to 33 minutes. These results, together with results of others studies are included in Table 1.

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1 G. Currie, "The Demand Performance of Bus Rapid Transit", Journal of Public Transportation, vol. 8, no. 1, pp. 41-55, 2005.

2 Department for Transport (UK), "Transport Analysis Guidance (TAG) UNIT M3.2", London, UK, 2014.

3 T. Litman, "Evaluating Public Transit Benefits and Costs," Victoria Public Transport Policy Institute, Victoria, BC, 2015

Table 1. Quality Benefit Estimates

Source	Location/ Case	Transit Modes		
		Bus Rapid Transit vs. On-Street Bus	Light Rail vs. On-Street Bus	Heavy Rail vs. On-Street Bus
Halcrow Fox (1995)[1]	Manchester/Car Available Passengers		20	
	Manchester/Car Not Available Passengers		0	
Bray (1995)/Transfund NZ (2000)[1]	Adelaide/All Trips	20		
Ableson (1995)/Fouracre et al. (1990)[1]	International/All Trips			4-6
Van Der Waard (1988)[1]	Holland/All Trips		2-3	2-3
Kilvington (1991)[1]	UK Several Studies/Car Available Passengers	9	15	12
Kilvington (1991)[1]	Dublin/Bus Users	12	16	16
London Railplan Review[1]	UK Several Studies/Bus Users	9	8	7
Prosser et al. (1997)[1]	Sydney/A.M. Peak		4	9
Wardman (1997)[2]	Study 19 (B) 1989			-56
	Study 19 (B) 1989			-27
	Study 7 (B) 1992			-5
	Study 4 (B) 1993			0
	Study 17 (B) 1987			0
	Study 8 (B) 1988			3
	Study 20 (B) 1989			4
	Study 20 (B) 1989			6
	Study 3 (B)			10
	Study 28 (B) 1989			11
	Study 28 (B) 1989			11
	Study 4 (B) 1993			22
	Study 23 (B) 1990			33
	Study 13 (B) 1991		1	
	Study 9 (B) 1989		10	
	Study 12(B) 1990		18	
Average of values		12	10	4
Range of values		9 to 20	2 to 20	-56 to 33

Leeds New Generation Transit, UK (2010)	2.8 to 5.6	
	20 (stop)	
Manchester Metrolink Revealed Preference, UK (2005) *CA=Car Available* *NCA=non Car Available*		15 to 19 (CA)
		5 to 6 (NCA)
Hurontario LRT (2013)		0.85 of bus time
Surrey LRT (2015)		4.5
Hamilton LRT (2015)		0.81 of bus time

1.18 Furthermore, the US's Federal Transit Administration also provides some guidance on the range of mode constants expected which are generally in line with the values presented in the table above. This is shown in Table 2[4].

Table 2. FTA Mode Constant Recommendations

Guideway attributes that are different from local bus	Maximum Alternative specific effects vs. local bus (mins)		Maximum Guideway - in-vehicle time factor
	Guideway only	Guideway + local bus	Any guideway
Guideway like characteristics	8	3	0.85
- *Reliability of vehicle arrival, travel time*	*4*	*2*	*0.90*
- *Branding/visibility/learnability*	*2*	*1*	*-*
- *Schedule-free service*	*2*	*0*	*-*
- *Ride quality*	*-*	*-*	*0.95*
Span of good service	3	0	-
Passenger facilities	4	3	-
- *Amenities at stops/stations*	*3*	*2*	-
- *Dynamic schedule information*	*1*	*1*	-
Vehicle amenities	-	-	0.95
Availability of seat	-	-	0.95
Maximum effect	15	6	0.75

Reliability Impact

1.19 It is common that the average travel time varies from hour to hour on any given day, and to a large extent the service timetable can reflect this. Passengers take this into account when planning their travel.

1.20 What passengers cannot predict is the day-to-day variation in travel times for making the same travel at the same time of day, and regularly arrive at their destination later or earlier than desired. This is clearly an inconvenience to passengers, and reliability is often a factor for users to choose to make the trip by car rather than transit.

1.21 In the context of this report, travel time reliability is defined as the variation in travel times that passengers cannot predict as measured by the standard deviation of travel time compared to the average travel time. As with the average travel time, this can vary by time of day.

[4] Travel Forecasting for New Starts, Federal Transit Administration, September 2007

1.22 Rail-based systems will generally improve both journey time reliability and headway reliability. While journey time benefits are captured within conventional modelling and evaluation (which are based on "average" journey times), reliability benefits are associated with the reduction in day-to-day journey time variability for similar times of travel.

1.23 Journey time variability is particularly important for transit riders who need to arrive at a given time (as would be the case for someone who needs to arrive at work on time or make on onward transport connection). In these cases, people often need to "factor in" additional time to ensure they compensate for unreliability.

1.24 Traditionally, the impacts of transit unreliability have not been explicitly accounted for in transport models and the benefits from improved reliability did not have a formal role in the evaluation of transit projects. However, the fact that travellers do respond to the level of reliability (and the existence of economic benefits or costs associated with this response) has recently been acknowledged by transportation planners and economists.

1.25 There has been significant research into reliability. In the UK this research has been used to develop an approach to value and monetize reliability benefits that form part of UK's TAG[5]. The approach used is to estimate the "average lateness" based on the standard deviation of arrival times (compared to the timetable or schedule), and to value this 'unreliability' by a higher perception factor based on research.

1.26 Given the availability of data, two key components of journey reliability can be measured:

- In-vehicle time variability – passengers experiencing unpredictable journey times; and
- Headway variability – passengers experiencing unpredictable wait times

1.27 Improvements in travel time reliability can also help deliver second order benefits (but are not generally accounted for). These include:

- Having variable travel times can lead to bunching of services, meaning:
  - Passengers experience longer average wait times than implied by the timetabled headway
  - Passengers experience higher levels of crowding, as passenger loads are not evenly spread between services
- Reliable travel times mean that the operating efficiency can be improved and the level of service capacity can be delivered more consistently.

1.28 A literature review of reliability inputs has confirmed that the average-lateness method is the preferred method for determining reliability benefits in benefits-cost-analyses[6]. Reliability effects of transit projects are captured in various forms of evaluation practices in the USA, UK, Australia, New Zealand, Sweden and the Netherlands[7].

1.29 However, this value can also be included in models as part of the mode constant.

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[5] Department for Transport (UK), "Transport Analysis Guidance (TAG) UNIT A1.3", London, UK, 2014.

[6] D. Carlos & L. Carrion, "Value of travel time reliability: A review of current evidence," Transportation Research Part A, no. 46, pp. 720-741, 2012.

[7] Transportation Economics Committee Wiki, "Reliability and BCA," [Online]. Available: http://bca.transportationeconomics.org/benefits/travel-time-reliability/reliabilityandbca. [Accessed 2015].

C Calibration Bus Services

List of In-scope Bus Routes

Transit agency	Route	Name
Downtown Routes		
STM	15	Sainte-Catherine
STM	24	Sherbrooke
STM	51	Édouard-Montpetit
STM	55	Boulevard Saint-Laurent
STM	61	Wellington
STM	74	Bridge
STM	80	Avenue du Parc
STM	107	Verdun
STM	129	Côte-Sainte-Catherine
STM	161	Van Horne
STM	165	Côte-des-Neiges
STM	166	Queen-Mary
STM	168	Cité-de-Havre
STM	410	Express Notre-Dame
STM	427	Express Saint-Joseph
STM	430	Express Pointe-aux-Trembles
STM	435	Express du Parc
West Island Express Bus Routes		
STM	401	Express Saint-Charles
STM	405	Express Bord-du-Lac
STM	407	Express Île-Bizard
STM	409	Express Des Sources
STM	411	Express Lionel-Groulx
STM	419	Express John Abbott
STM	425	Express Anse-à-l'Orme
STM	460	Express Métropolitaine
STM	468	Express Pierrefonds / Gouin
STM	470	Express Pierrefonds
STM	475	Express Dollard-des-Ormeaux
STM	485	Express Antoine-Faucon
STM	491	Express Lachine
STM	495	Express Lachine / LaSalle
STM	496	Express Victoria
STM	747	Aéroport P.-É.-Trudeau / Centre-ville
West Island Routes		
STM	64	Grenet
STM	68	Pierrefonds
STM	69	Gouin

Transit agency	Route	Name
STM	70	Bois-Franc
STM	72	Alfred-Nobel
STM	90	Saint-Jacques
STM	100	Crémazie
STM	110	Centrale
STM	115	Paré
STM	121	Sauvé / Côte-vertu
STM	128	Ville-Saint-Laurent
STM	164	Dudemaine
STM	170	Keller
STM	171	Henri-Bourassa
STM	174	Côte-Vertu-Ouest
STM	175	Griffith / Saint-François
STM	177	Thimens
STM	178	Pointe-Nord
STM	180	De Salaberry
STM	191	Broadway / Provost
STM	195	Sherbrooke / Notre-Dame
STM	196	Parc-Industriel-Lachine
STM	200	Sainte-Anne-de-Bellevue
STM	201	Saint-Charles / Saint-Jean
STM	202	Dawson
STM	203	Carson
STM	204	Cardinal
STM	205	Gouin
STM	206	Roger-Pilon
STM	207	Jacques-Bizard
STM	208	Brunswick
STM	209	Des Sources
STM	211	Bord-du-Lac
STM	213	Parc-Industriel-Saint-Laurent
STM	215	Henri-Bourassa
STM	216	Transcanadienne
STM	217	Anse-à-l'Orme
STM	219	Chemin Sainte-Marie
STM	225	Hymus
South Shore Services		
RTL	5	St-Hubert/Maisonneuve
RTL	15	Churchill
RTL	30	Secteurs P-V
RTL	31	Secteurs R-S-T/boul. St-Laurent

Transit agency	Route	Name
RTL	32	Secteur B/Mountainview
RTL	33	Secteurs M-N-O
RTL	34	Secteur A/Bellevue
RTL	35	Secteur L/DIX30/TCV
RTL	37	Simard/du Béarn
RTL	38	Boul. Chevrier/Secteur B
RTL	42	Gaétan Boucher/Parc de la Cité
RTL	44	Secteur M-N-O
RTL	45	Express Panama/TCV
RTL	46	Secteurs R-S-T
RTL	47	Secteurs R-S-T
RTL	49	Secteurs R-S
RTL	50	Prince-Charles
RTL	55	Victoria/Wellington
RTL	59	Gareau
RTL	60	Milan/Gaétan-Boucher/Promenandes St-Bruno
RTL	86	Samuel-De Champlain/De Montarville/Montréal
RTL	87	Marie-Victorin/du Fort St-Louis/Montréal
RTL	100	Chevrier / Panama / Île-des-Sœurs
RTL	115	Churchill
RTL	132	Parc de la Cité/Westley
RTL	135	Secteur L/DIX30/TCV
RTL	142	Gaétan Boucher/Pacific
RTL	144	des Prairies/Océanie/Naples/Malo
RTL	150	Orchard
AMT	90	Express Chevrier
Ville de Saint-Jean-sur-Richelieu	96	SJSR/TCV Montréal
OMIT Sainte-Julie	600	Express Montréal
CIT Le Richelain	121	La Prairie/Montréal
CIT Le Richelain	122	La Prairie/Montréal
CIT Le Richelain	123	La Prairie/Montréal
CIT Le Richelain	124	La Prairie/Montréal
CIT Le Richelain	132	Candiac/Montréal
CIT Le Richelain	133	Candiac/Montréal
CIT Le Richelain	321	La Prairie/Montréal (Express)
CIT Le Richelain	323	Candiac/Montréal (Express)
CIT Le Richelain	340	Candiac/Longueuil
CIT Le Richelain	341	Candiac/Longueuil
CIT Le Richelain	343	Candiac/Longueuil
CIT Vallée-du-Richelieu	300	Saint-Hyacinthe/Montréal
CIT Chambly-Richelieu-Carignan	400	Chambly - Montréal

Transit agency	Route	Name
CIT Chambly-Richelieu-Carignan	401	Chambly - Montréal
CIT Chambly-Richelieu-Carignan	500	Richelieu/Marieville/Montréal
CIT Chambly-Richelieu-Carignan	600	Carignan/Montréal
CIT Roussillon	100-115	Delson/Brossard/Montréal
CIT Roussillon	130	Delson/Brossard/Montréal

D REM Mode Constant Results

REM MODE CONSTANT = 1 MINUTE

Table D-1: AM Peak and Interpeak Station Boardings and Alightings (2021 and 2031, No Ramp Up)

REM MC=1	2021				2031			
	AM Peak Boardings	AM Peak Alightings	Interpeak Boardings	Interpeak Alightings	AM Peak Boardings	AM Peak Alightings	Interpeak Boardings	Interpeak Alightings
Bassin Peel	28	1,452	439	622	30	1,556	450	664
Île-des-Sœurs	286	522	21	91	306	560	24	100
Panama	14,049	303	3,412	1,964	15,298	337	3,749	2,152
Du Quartier	4,665	245	752	519	4,916	257	805	558
Rive-Sud	5,094	0	2,027	130	5,606	0	2,191	144
Technoparc Saint-Laurent	7	190	6	123	8	204	6	131
Aéroport Pierre-Elliott-Trudeau	718	659	1,225	1,618	851	872	1,474	1,959
Autoroute 13	339	424	123	151	445	536	137	167
Des Sources	765	293	917	706	823	311	987	751
Pointe-Claire	2,321	687	1,092	682	2,463	732	1,170	737
Kirkland	1,262	0	134	0	1,421	0	144	0
Sainte-Anne-De-Bellevue	1,048	39	337	35	1,114	42	358	37
Deux-Montagnes	3,326	94	543	1,161	3,483	100	599	1,260
Grand-Moulin	779	5	102	129	803	5	109	137
Ste-Dorothée	1,619	55	87	934	1,646	60	92	995
Île-Bigras	511	22	116	213	548	25	130	230
Roxboro-Pierrefonds	3,367	176	261	1,063	3,536	190	276	1,124
Sunnybrooke	1,743	89	236	757	1,823	94	251	787
Bois-Franc	4,083	1,021	2,515	1,563	4,361	1,113	2,732	1,757
Du Ruisseau	2,193	478	582	727	2,222	518	528	742
Montpellier	2,461	1,826	991	1,175	2,654	1,969	1,027	1,268
Mont-Royal	920	927	1,518	944	1,006	996	1,582	1,012
Correspondance A40	1,544	866	175	156	1,682	936	190	170
Canora	1,090	985	678	304	1,180	1,058	731	338
Édouard-Montpetit	2,217	5,001	2,046	2,280	2,382	5,387	2,173	2,443
McGill	1,483	15,005	5,480	5,358	1,606	15,982	5,953	5,583
Gare Centrale	596	27,151	3,102	5,511	637	29,011	3,309	5,931
Total	**58,515**	**58,515**	**28,916**	**28,916**	**62,852**	**62,852**	**31,178**	**31,178**

Note: Totals may vary due to rounding

Table D-2: REM Section Load Flows

REM MC=1 Section	2021		2031	
	AM Peak	Interpeak	AM Peak	Interpeak
Rive-Sud - Du Quartier	5,094	2,035	5,923	2,200
Du Quartier - Panama	9,761	2,789	10,854	3,008
Panama - Île-des-Sœurs	23,791	6,025	26,465	6,561
Île-des-Sœurs - Bassin Peel	23,946	6,034	26,634	6,574
Bassin Peel - Gare Centrale	23,125	6,230	25,719	6,770
Autoroute 13 - Technoparc Saint-Laurent	850	1,730	1,076	2,079
Technoparc Saint-Laurent - Aéroport Pierre-Elliott-Trudeau	674	1,618	888	1,959
Bois-Franc - Autoroute 13	2,068	3,195	2,293	3,629
Autoroute 13 - Des Sources	986	1,449	1,134	1,539
Des Sources - Pointe-Claire	777	755	912	800
Pointe-Claire - Kirkland	39	35	42	37
Kirkland-Sainte - Anne-De-Bellevue	39	35	42	37
Gare Centrale - McGill	8,921	4,742	10,025	5,095
McGill- Édouard-Montpetit	5,334	8,606	5,945	9,183
Édouard-Montpetit - Canora	3,345	8,642	3,678	9,225
Canora - Mont-Royal	3,231	8,730	3,526	9,320
Mont-Royal - Correspondance A40	3,007	8,751	3,277	9,337
Correspondance A40 - Montpellier	2,667	8,701	2,909	9,287
Montpellier - Du Ruisseau	2,213	8,066	2,433	8,627
Du Ruisseau - Bois-Franc	2,236	7,339	2,460	7,885
Bois-Franc - Sunnybrooke	319	4,200	345	4,473
Sunnybrooke - Roxboro-Pierrefonds	288	3,442	312	3,685
Roxboro-Pierrefonds - Île-Bigras	185	2,383	201	2,566
Île-Bigras - Ste-Dorothée	163	2,208	175	2,376
Ste-Dorothée - Grand-Moulin	98	1,290	106	1,397
Grand-Moulin - Deux-Montagnes	94	1,161	100	1,260
Gare Centrale - Bassin Peel	1,504	2,895	1,618	3,170
Bassin Peel - Île-des-Sœurs	875	2,538	948	2,776
Île-des-Sœurs - Panama	484	2,459	528	2,687
Panama-Du Quartier	245	650	257	703
Du Quartier - Rive-Sud	0	130	0	144
Aéroport Pierre-Elliott-Trudeau - Technoparc Saint-Laurent	758	1,225	980	1,474
Technoparc Saint-Laurent - Autoroute 13	752	1,221	972	1,469
Sainte-Anne-De-Bellevue - Kirkland	1,061	357	2,058	380
Kirkland - Pointe-Claire	2,418	493	3,838	523

REM MC=1 Section	2021		2031	
	AM Peak	Interpeak	AM Peak	Interpeak
Pointe-Claire - Des Sources	4,771	1,610	6,724	1,731
Des Sources - Autoroute 13	5,448	2,536	7,706	2,735
Autoroute 13 - Bois-Franc	6,318	3,748	8,856	4,190
Deux-Montagnes - Grand-Moulin	3,326	543	3,483	599
Grand-Moulin - Ste-Dorothée	4,105	645	4,286	708
Ste-Dorothée - Île-Bigras	5,730	715	5,939	783
Île-Bigras - Roxboro-Pierrefonds	6,253	793	6,500	873
Roxboro-Pierrefonds - Sunnybrooke	9,534	1,035	10,087	1,128
Sunnybrooke - Bois-Franc	11,219	1,269	11,877	1,377
Bois-Franc - Du Ruisseau	20,579	5,890	23,957	6,354
Du Ruisseau - Montpellier	22,280	6,471	25,589	6,882
Montpellier - Correspondance A40	23,460	6,871	26,848	7,248
Correspondance A40 - Mont-Royal	24,504	6,954	27,865	7,334
Mont-Royal - Canora	24,748	7,380	27,899	7,819
Canora - Édouard-Montpetit	24,982	7,725	27,843	8,100
Édouard-Montpetit - McGill	24,113	7,405	26,433	7,693
McGill- Gare Centrale	14,161	3,832	15,257	4,157

Note: Totals may vary due to rounding

REM MODE CONSTANT = 3 MINUTES

Table D-3: AM Peak and Interpeak Station Boardings and Alightings (2021 and 2031, No Ramp Up)

REM MC=3	2021				2031			
	AM Peak Boardings	AM Peak Alightings	Interpeak Boardings	Interpeak Alightings	AM Peak Boardings	AM Peak Alightings	Interpeak Boardings	Interpeak Alightings
Bassin Peel	6	1,429	270	622	7	1,531	269	663
Île-des-Sœurs	286	522	21	91	306	560	24	100
Panama	13,965	298	3,372	1,953	15,206	331	3,693	2,145
Du Quartier	4,634	245	744	519	4,882	257	797	558
Rive-Sud	5,082	0	2,027	130	5,593	0	2,191	144
Technoparc Saint-Laurent	7	164	7	123	8	176	7	131
Aéroport Pierre-Elliott-Trudeau	701	647	1,215	1,615	831	860	1,463	1,956
Autoroute 13	339	423	119	88	445	535	133	98
Des Sources	756	273	921	650	812	289	990	691
Pointe-Claire	2,230	663	941	651	2,369	707	1,016	666
Kirkland	1,227	0	130	0	1,384	0	139	0
Sainte-Anne-De-Bellevue	1,049	39	336	35	1,114	42	356	37
Deux-Montagnes	3,326	94	521	1,161	3,483	100	576	1,260
Grand-Moulin	779	5	102	129	803	5	109	137
Ste-Dorothée	1,607	55	87	361	1,633	60	92	321
Île-Bigras	479	22	116	213	514	25	130	230
Roxboro-Pierrefonds	3,352	167	261	1,063	3,521	178	276	1,124
Sunnybrooke	1,723	89	231	757	1,806	94	240	787
Bois-Franc	3,795	970	2,435	1,452	4,052	1,061	2,635	1,614
Du Ruisseau	2,137	475	497	727	2,162	515	502	742
Montpellier	2,308	1,784	888	1,139	2,491	1,923	914	1,186
Mont-Royal	873	922	1,479	869	955	991	1,576	931
Correspondance A40	1,527	749	160	122	1,664	810	174	134
Canora	1,008	975	672	238	1,091	1,048	632	267
Édouard-Montpetit	1,831	4,765	1,798	2,142	1,974	5,131	1,974	2,296
McGill	1,392	14,687	5,333	5,095	1,509	15,649	5,624	5,331
Gare Centrale	594	26,550	2,597	5,332	635	28,372	2,772	5,754
Total	**57,013**	**57,013**	**27,278**	**27,278**	**61,251**	**61,251**	**29,304**	**29,304**

Note: Totals may vary due to rounding

Table D-4: REM Section Load Flows

REM MC=3 Section	2021		2031	
	AM Peak	Interpeak	AM Peak	Interpeak
Rive-Sud - Du Quartier	5,082	2,027	5,593	2,191
Du Quartier - Panama	9,716	2,771	10,475	2,988
Panama - Île-des-Sœurs	23,619	5,978	25,617	6,501
Île-des-Sœurs - Bassin Peel	23,774	5,987	25,783	6,514
Bassin Peel - Gare Centrale	22,896	5,992	24,839	6,514
Autoroute 13 - Technoparc Saint-Laurent	797	1,727	1,020	2,075
Technoparc Saint-Laurent - Aéroport Pierre-Elliott-Trudeau	647	1,615	860	1,956
Bois-Franc - Autoroute 13	1,864	3,015	2,072	3,414
Autoroute 13 - Des Sources	854	1,325	909	1,382
Des Sources - Pointe-Claire	703	687	749	704
Pointe-Claire - Kirkland	39	35	42	37
Kirkland - Sainte-Anne-De-Bellevue	39	35	42	37
Gare Centrale - McGill	8,824	4,033	9,561	4,348
McGill - Édouard-Montpetit	5,053	7,443	5,494	7,857
Édouard-Montpetit - Canora	3,021	7,432	3,296	7,843
Canora - Mont-Royal	2,912	7,542	3,180	7,962
Mont-Royal - Correspondance A40	2,669	7,699	2,914	8,120
Correspondance A40 - Montpellier	2,436	7,676	2,661	8,099
Montpellier - Du Ruisseau	2,000	7,106	2,200	7,552
Du Ruisseau - Bois-Franc	2,021	6,379	2,226	6,810
Bois-Franc - Sunnybrooke	285	3,610	307	3,779
Sunnybrooke - Roxboro-Pierrefonds	253	2,854	274	2,994
Roxboro-Pierrefonds - Île-Bigras	175	1,811	190	1,891
Île-Bigras - Ste-Dorothée	153	1,636	164	1,701
Ste-Dorothée - Grand-Moulin	98	1,290	106	1,397
Grand-Moulin - Deux-Montagnes	94	1,161	100	1,260
Gare Centrale - Bassin Peel	1,417	2,873	1,524	3,151
Bassin Peel - Île-des-Sœurs	872	2,517	944	2,756
Île-des-Sœurs - Panama	480	2,437	524	2,667
Panama - Du Quartier	245	650	257	703
Du Quartier - Rive-Sud	0	130	0	144
Aéroport Pierre-Elliott-Trudeau - Technoparc Saint-Laurent	701	1,215	831	1,463
Technoparc Saint-Laurent - Autoroute 13	694	1,210	823	1,458
Sainte-Anne-De-Bellevue - Kirkland	1,049	336	1,114	356
Kirkland - Pointe-Claire	2,276	466	2,498	495

REM MC=3 Section	2021		2031	
	AM Peak	Interpeak	AM Peak	Interpeak
Pointe-Claire - Des Sources	4,506	1,406	4,867	1,511
Des Sources - Autoroute 13	5,141	2,315	5,550	2,489
Autoroute 13 - Bois-Franc	5,963	3,521	6,426	3,938
Deux-Montagnes - Grand-Moulin	3,326	521	3,483	576
Grand-Moulin - Ste-Dorothée	4,105	623	4,286	685
Ste-Dorothée - Île-Bigras	5,711	694	5,919	760
Île-Bigras - Roxboro-Pierrefonds	6,190	772	6,433	850
Roxboro-Pierrefonds - Sunnybrooke	9,453	1,013	9,859	1,105
Sunnybrooke - Bois-Franc	11,119	1,243	11,604	1,344
Bois-Franc - Du Ruisseau	19,778	5,501	20,868	5,919
Du Ruisseau - Montpellier	21,420	5,998	22,490	6,421
Montpellier - Correspondance A40	22,380	6,318	23,519	6,696
Correspondance A40 - Mont-Royal	23,391	6,378	24,626	6,758
Mont-Royal - Canora	23,585	6,831	24,856	7,244
Canora - Édouard-Montpetit	23,727	7,155	25,015	7,490
Édouard-Montpetit -McGill	22,826	6,821	24,057	7,183
McGill - Gare Centrale	13,300	3,649	13,983	3,967

Note: Totals may vary due to rounding

E REM Mode Constant Information

steer davies gleave

Memo

To	CPDQ Infra		
Cc			
From	Steer Davies Gleave		
Date	March 2017		
Project	REM Forecasting	Project No.	22951103

REM Mode Constant Summary

The mode constant determines the mode preference of users to different transit modes (Metro, rail, REM and bus) given similar travel times and cost conditions. This memo provides a summary of the mode constant estimation and assumptions. All the material in this memo is included in the February 2017 forecasting report.

Mode Constant Estimation

The Stated Preference (SP) surveys enable to gauge passenger perceptions to current and 'new' transit modes (such as REM) and is one of the many components in a ridership study. SP survey responses were not in line with our professional experience or with extensive experience worldwide showing that passengers prefer rail-based to bus-based transit systems as result of the higher reliability, comfort (a smoother ride) and station facilities (shelter, lighting, seats, passenger information) of rail-based systems. While attempts were made to represent REM accurately in the SP survey, it is a 'new' mode in the region and respondents may be biased in their response or have a misconception of REM's potential benefits and scope. A critical review of SP survey results is an inherent part of the development of demand forecasts to ensure results are robust and in line with professional experience and results from other studies and therefore adjustment/review of SP survey results is a relatively common occurrence.

Table 1 summarizes the mode constant values presented in the February 2017 report.

Table 1: Mode Constant Assumptions

	Minutes
Metro/Rail	0
Bus vs Metro/Rail	7.5
REM vs Metro/Rail	2

Further analysis on survey responses presented in the report showed the survey results of only selecting 'traders' (people that chose the REM at least 1 time in the survey) and how the REM perception was more in line with our professional experience showing the likelihood that REM is perceived similarly to commuter rail and Métro and a 5 minute penalty for bus users to account for the reliability, comfort and station facilities offered by rail-based systems. The final bus, rail and Metro mode constant values were estimated as part of the base model calibration process where the observed and modelled traffic data is compared to ensure that current transit demand patterns in Metropolitan Montreal are replicated accurately.

Mode Constant Benchmarking

Appendix B in the February 2017 report presented evidence on rail mode constants from other studies and jurisdictions and a summary is presented in table below.

Table 2: Mode Constant Benchmarking

Source	Description	Values
Currie (2005)	Peer review of 9 different studies worldwide comparing Bus Rapid Transit, Light Rail and Heavy Rail versus On-Street Bus	Light Rail preferred to On-Street bus by an average of 10 minutes (range between 2 and 20 minutes)
Federal Transit Administration (2007)	Transit forecasting advice for US federal funding applications	Rail based modes specific effect over local bus by up to 15 minutes
SDG experience	5 LRT studies in the UK and Canada	Consistent passenger preference of Light Rail versus On-Street Bus

Source: Appendix B of February 2017 REM Forecasting Report

The table shows there is no 'standard' or 'exact' value on what a rail-based mode constant should be, but shows there is overwhelming experience confirming passenger preference of rail-based versus bus-based systems.

F REM Forecasting Changes

steer davies gleave

Memo

To	CPDQ Infra		
Cc			
From	Steer Davies Gleave		
Date	March 2017		
Project	REM Ridership Forecasting	Project No.	22951103

REM Ridership Forecast Changes

Background

This memo details the changes between the November 2016 and February 2017 reports and the impact on the REM ridership forecasts.

Steer Davies Gleave was appointed by CDPQ Infra Inc. to develop investment grade ridership forecasts for the Réseau Electrique Métropolitain (REM), a 67 kilometres light rail network in Metropolitan Montréal. This work was summarized in a preliminary report dated November 2016. Prior to the announcement of 3 additional REM stations, Steer Davies Gleave also developed preliminary demand forecasts which included these additional stations. The main objective of that work was to inform the initial dimensioning of REM to proceed with the engineering work required. Preliminary results indicated an overall increase in annual ridership ranging between 10% and 15%.

Network changes have occurred since the November report including:

- Three additional REM stations at Bassin Peel, McGill and Édouard-Montpetit. Two of which are major trip generators (McGill and Édouard-Montpetit)
- Revised REM travel times
- Two new connections between REM and Montréal Métro (Blue and Green lines)
- Refinement of bus connectivity at some stations
- Included Park & Ride capacity constraints

As a result of the various changes indicated above, a review of the forecasting model was carried out in order to account for the revised network and enlarged in-scope demand and revised forecasts were developed and included in the February 2017 ridership report.

Worth highlighting REM's impact on transit ridership:

- An estimated 10% demand capture from passengers transferring from the Orange Line to REM in the AM peak and Interpeak periods
- An improved transit demand distribution in the downtown area between Édouard-Montpetit, McGill and Gare Centrale stations
- An improved transit service throughout the day, particularly in the Interpeak
- Providing a better access to the East of the Island as result of connectivity to Blue and Green Metro lines

Model Re-Calibration

In order to reflect the new scope accurately, new transit data was gathered and collected, and the transit mode choice forecasting model was recalibrated accordingly:

- The introduction of the 3 additional REM stations expanded the previous in-scope demand to areas and services that were not calibrated in detail in the original model (Downtown and Université de Montréal areas).
- The new calibration includes a more detailed review of the demand associated with bus and Métro services in the Downtown and Université de Montréal areas. Passenger counts were also undertaken to represent more accurately boarding and alighting at McGill (Green Line), Université de Montréal and Édouard-Montpetit (Blue Line) Métro stations.
- A more detailed review of the overall demand, particularly in the downtown area, showed that the model was overestimating bus boardings compared to Metro, and the model was not representing accurately the higher penalty that users allocate to bus due to service unreliability, especially when transferring to another bus service. Therefore, the recalibration process included adjustments to the bus mode constant to represent more accurately the overall network demand, and with an special focus in the downtown area (new in-scope demand).

Table 1 summarizes the mode constant changes.

Table 1: Mode Constant Adjustments

	November 2016	February 2017
Metro/Rail	0	0
Bus vs Metro/Rail	5	7.5
REM vs Metro/Rail	2	2

A memo summarizing the REM Mode Constant estimation is also available. Please refer to that document for further information.

Total Demand and Passenger-km Impact

Table 2 shows the impact on REM forecasts of the various model changes. There is an overall increase in daily and annual ridership (approximately 4 % and 6% in 2026 respectively). This demand includes:

- New demand captured by REM due to the improved accessibility to major destination centres; either University hubs or other destinations on the Blue and Green Metro lines. This is especially the case for South Shore trips.
- New demand generated between the REM and Metro connectors (McGill, Édouard-Montpetit, Gare Centrale).
- Lower demand in the South Shore due to Park & Ride capacity restrictions.

Table 2: February 2017 Ridership Summary

	2015 Current Ridership on existing networks *	2021 Projected ridership	2026 Projected ridership	2031 Projected ridership
AM Peak	43,902	58,515	60,638	62,852
Daily	119,688	161,606	167,637	173,931
Annual	30,730,985	41,966,392	43,535,017	45,172,601
Passenger-km	--	608,453,632	630,655,913	653,748,003

* Includes demand in the following services: 747, West Island Express Services, Deux-Montagnes, and A-10 bus services

Demand Impacts

The addition of the 3 stations not only results in an overall ridership increase, but also leads to a demand re-distribution between stations. Previously most of the demand from/to Downtown was concentrated in Gare Centrale station (and to lesser extent to Canora and Mont-Royal for access to universities) and now there is a major shift of demand to the new stations at McGill and Édouard-Montpetit. This is related to the major access benefits for users heading to the university hubs (Université de Montréal, HEC Montréal and École Polytechnique), transfers to the Blue and Green Metro lines and access to the northern section of the downtown core from McGill station.

The main differences between the November 2016 and February 2017 reports include:

- A large shift of demand from Gare Centrale, Canora, Correspondance A40 and Mont-Royal to the new stations at McGill and Édouard-Montpetit. The new stations provide direct connectivity to the Université de Montréal area, while in the November forecasts REM passengers needed to either walk a long distance or transfer to a bus. The new stations also improve substantially the access to other destinations along the Blue and Green Metro lines.
- Increased demand in South Shore stations due to the improved accessibility to universities and other destinations Downtown.
- The estimated demand in Rive-Sud station with Park & Ride access (in the AM peak) is lower than estimated in November 2016. While previous results showed total potential Park & Ride demand (for dimensioning purposes), the new results account for Park & Ride capacity constraints. This is consistent with a desire not to increase the interchange capacity other than for transit needs.
- Shift of demand (AM peak) between Bois-Franc and Du Ruisseau stations. This has been the result of demand adjustments and refinement of bus connectivity to each station.
- 2015 demand data used in the calibration of the Mascouche base model demand does not reflect the ramp up as the service opened in December 2014. Therefore, forecast boardings at Correspondence A40 station may be potentially underestimated although the impact on overall REM demand will be limited. Ridership data from AMT shows approximatively 80% of Mascouche Line alightings at Gare Centrale in the AM peak and the ridership projections show almost 80% of the Mascouche line users will transfer to the REM to get to Downtown Montreal.

- The slight decrease in demand observed between the two studies on Deux-Montagnes stations is the result of the new calibration, where the modelled demand for Deux-Montagnes is slightly lower than the observed demand. Note there is a considerable increase in ridership on the line with an increase by 2021 of 90% over 2015 demand levels for all Deux-Montagnes stations, including new stations at McGill, Édouard-Montpetit and Correspondence A40 (the increase is 54% when those stations are excluded).

Available Documents

REM Forecasting Summary Report (February 2017)

REM Forecasting Report (February 2017)

REM Mode Constant Summary Memo (March 2017)

CONTROL INFORMATION

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STEER DAVIES GLEAVE project/proposal number	Client contract/project number
22951103	BC-A06438

Author/originator	Reviewer/approver
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Version control/issue number	Date
v1.0	29-October-2016
v2.0	05-November-2016
v3.0	08-November-2016
V4.0	08-November-2016
V5.0 FINAL	09-November-2016
V5.0 Appendix D included (forecasting clarification)	22-November-2016
V6.0 DRAFT (re-calibrated model and 3 additional stations)	13-January-2017
V7.0 (re-calibrated model, full report edits and 3 stations)	19-January-2017
V8.0 (CDPQ comments, added Appendix D with MCs)	03-February-2017
V9.0 (Final CDPQ Comments)	07 February 2017
V10.0 (Final CDPQ Comments)	08 February 2017
V11.0 (Final CPDQ Comments)	February 2017