METROLINX

April 2018

Technical Report:
GO Expansion New Stations Modelling Backgrounder

April 2018 New Stations Modelling Backgrounder

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1. Introduction

1.1 Purpose

The New Stations Modelling Backgrounder is a supplement to the overall Technical Report that summarizes the results of the *GO Expansion RER New Stations Business Case Analysis* (Attachment A). The Backgrounder under this cover summarizes the overall modelling approach, while also providing more technical details about the analysis inputs, assumptions, and tools that were used support the analysis. This includes a description of the core travel demand forecasting tool, network and land use input assumptions, economic and financial analysis parameters, and the approach used to model express running services, level boarding, and fare integration. Please refer to the *GO Expansion RER New Stations Business Case Analysis* (Attachment A) Technical Report for details on the overall business case analysis results.

This Backgrounder also provides more information about how the New Stations Business Case analysis fits into the on-going and future infrastructure and service planning work that is supporting the GO Expansion program.

1.2 The Business Case Life Cycle

Following the New Stations Preliminary Design Business Cases (PDBCs), the next step in Metrolinx's project life cycle is the Design and Procurement Preparation stage, which includes the preparation of a Full Business Case (**Figure 1**). A Full Business Case incorporates the latest information on the project and allows decision makers to validate and confirm a specific option for procurement. The new stations will be integrated into the GO Expansion Full Business Case currently being developed. The Full Business Case considers the entire GO Expansion program, and will measure the how the different components of the program, such as service enhancements, electrification, investments in new and existing stations and other potential improvements (e.g., level boarding) come together to deliver ridership, benefits, and overall economic performance.

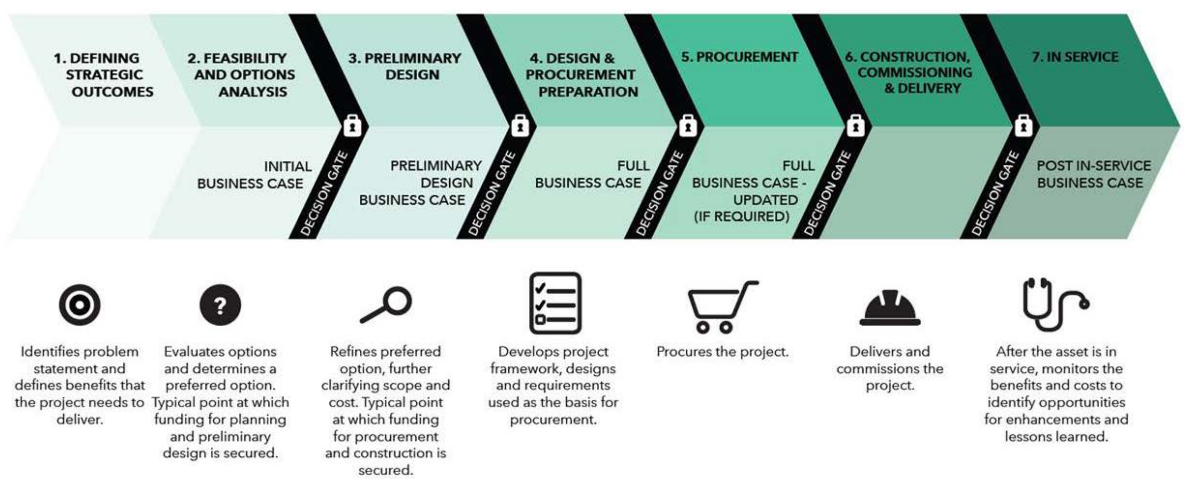

Figure 1: Business Case Analysis in the Project Lifecycle

As part of preparing for procurement, Infrastructure Ontario (IO) and Metrolinx took the first step to select a team to deliver the new stations. The Request for Qualifications (RFQ) to build the new RER and SmartTrack Stations[1] was issued on March 29th, 2018.

[1] *http://www.infrastructureontario.ca/Request-for-Qualifications-Issued-RER-Stations-and-Off-Corridor-Program/*

2. New Stations Business Case Analysis

The overall methodology and approach to modelling for the business case analysis is consistent with the approach used in undertaking the 2016 New Station Initial Business Cases (IBC's) and has been independently peer-reviewed and validated. In particular, the current business case analysis measures and captures the same key benefits (e.g. new station users benefit from the station) and impacts (e.g. delays to upstream riders due to the station). The current business case analysis for new stations take advantage of updated input information, including GO rail service assumptions, land use, connecting rapid transit infrastructure, and a refined approach to ridership forecasting and modelling. The analysis also takes a long-term view by considering the opening day infrastructure and service, together with system-wide initiatives that are anticipated to come online over the lifecycle of a station investment.

2.1 Analysis Methodology

The economic and financial cases for each new station depend on forecasts of how travellers will respond to the presence of a new station. Stations can support increased system ridership by providing a new access opportunity that may be closer to household locations and employment, school, or other travel destinations. Individuals who use the new station benefit by saving time relative to their previous travel option – travelling farther to another GO station, or using a different transport mode such as subway, bus, or auto. Some existing GO passengers that do not use the station, on the other hand, can be delayed if they travel on a train that now stops at the new station. Examining travel time savings, delays, and modal shifts is the focal point of the technical analysis that supports the economic and financial case for each station.

As summarized in **Figure 2**, the following key benefits and impacts are identified for each station:

Benefits

- Travel Time Savings for New Station Users
    - The new station provides a new connection that can provide a faster route between a rider's origin and destination. This includes riders that previously did not use GO Rail and existing GO Rail riders that would choose to switch to the new station. New station users save time and these travel time savings are monetized in the economic analysis.
- Auto Usage Decrease
    - A proportion of the new GO Rail users at the new station would have previously used the automobile for their trip. This type of modal switch results in a reduction in automobile vehicle kilometres travelled (VKT), which has environmental, safety, congestion, and auto operating cost reduction benefits. These benefits are monetized in the economic analysis.

Impacts

- Delays to Upstream Passengers
    - Most upstream riders continue to use GO Rail even if they happen to be delayed by the new station (extra travel time required for the train to slow down, stop and get back up to speed). These travel time delays are monetized in the economic analysis and measured against the time savings benefits to new station users. The extent of the impact depends on the new station's location on the GO Rail network; stations located closer to Union carry more passengers and tend to impact more upstream riders.

- Auto Usage Increase
  - A small proportion of upstream GO Rail riders may switch to other modes (i.e. subway, bus, or auto) due to the delay from the new station. The number of individuals that shift to another mode depends on how competitive GO Rail travel times are in comparison to other transit options and auto travel. The number of upstream riders that switch to the automobile would cause an increase in VKT, which has environmental, safety, congestion and auto operating cost impacts. These VKT increases offset the VKT reductions associated with auto usage decreases from new station users.

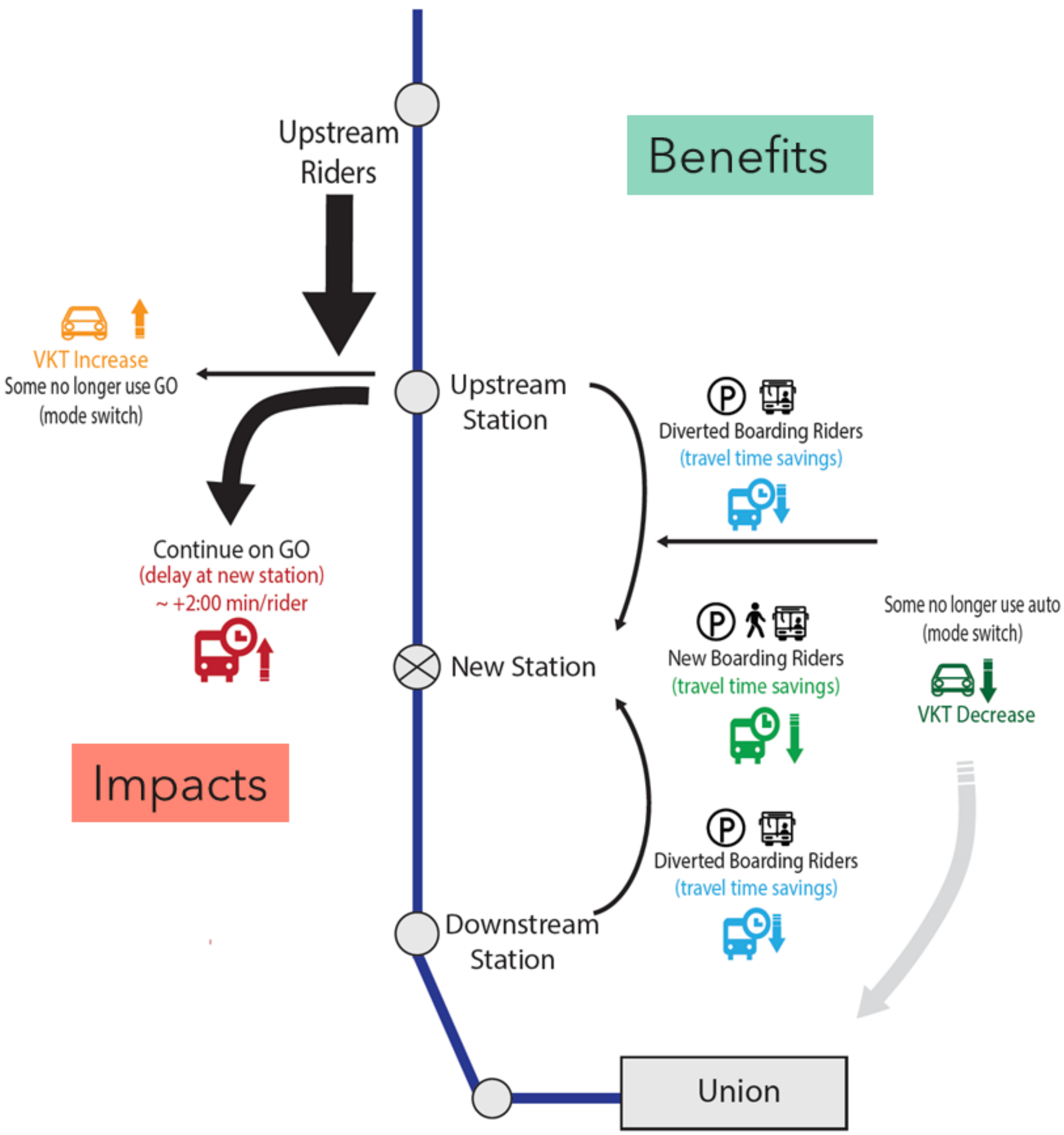

Figure 2: New Station Benefit and Impact Analysis

3. Three Key Advancements

As the GO RER program has advanced, opportunities for Metrolinx to optimize investments and improve overall network efficiency continue to be studied. The current business case analysis (both PDBC and IBC levels) takes into consideration a lifecycle (60-year) view of stations, assessing station performance outcomes for opening day infrastructure and services, as well as initiatives that are anticipated to come online over the lifecycle of a station. The following three system-wide initiatives have been considered in the current business case analysis as they have the potential to significantly benefit overall network performance:

- Express Running Services
- Level Boarding
- Fare Integration

Each of these inputs applies to the entire network, and as such, the business case for each station is evaluated under the assumption that these key advancements are in place. The question being posed through the PDBC is *How would the station perform if express service, level boarding, and fare integration were in place?* This also means that system-level and programmatic costs and benefits are allocated to the overall program and not to the individual station.

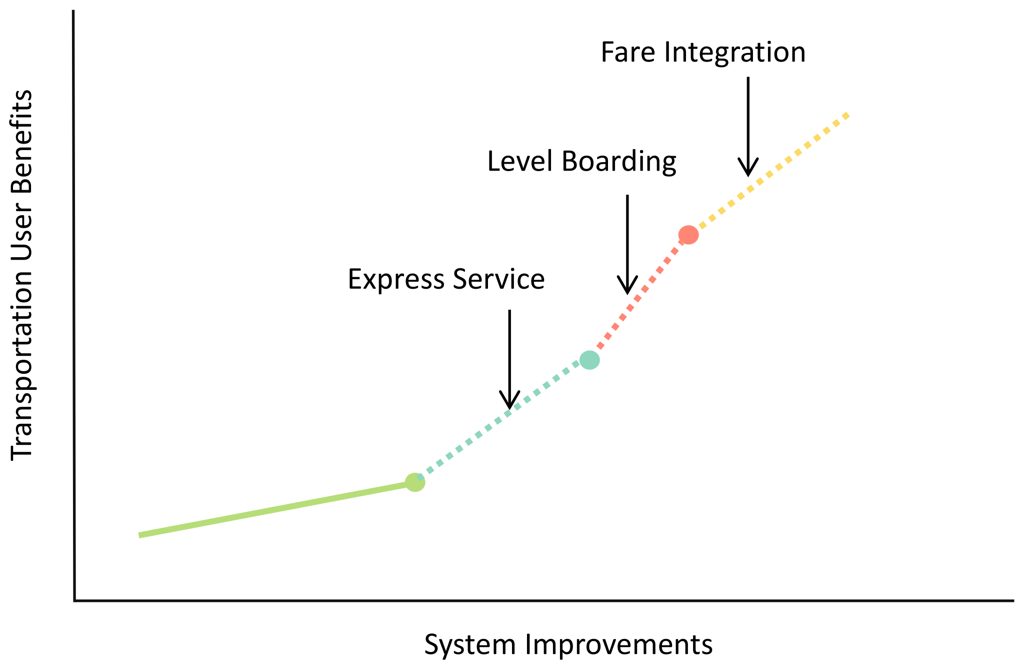

Figure 3: Cumulative Benefits of Potential System Improvement Scenarios (illusrative, not to scale)

Results suggest that the transportation user benefits trend upwards as these advancements are included in the analysis (see **Figure 3** above). Reducing upstream impacts (via express service levels) result in significant positive trends for some of the Barrie and Stouffville Stations, reduced dwell times (via level boarding) results in a positive trend at all stations, and the removal of differences in fare as a barrier to travel (via fare integration) results in a positive ridership trend for Toronto stations.

Each of these advancements and the approach to modelling each one is discussed in more detail in the sections below.

3.1 Modelling Future Service Patterns

Connecting Forecasting, Service Levels and Infrastructure Planning

Ridership forecasting and the associated economic analysis for new stations are connected to the infrastructure and service planning process for the overall GO Expansion program. As illustrated in **Figure 4**, these planning activities are inherently related and must be jointly considered:

- Ridership depends on provided rail service levels
- Service planning and fleet capacity requirements depend on ridership
- Infrastructure requirements depend on the service levels that need to be achieved

Train services are delivered by optimizing train fleet, infrastructure capability, and service timetable planning decisions. Each element can be adjusted independently to yield a different level of train service. There is not a single answer and these factors need to be optimized together in order to achieve the best solution.

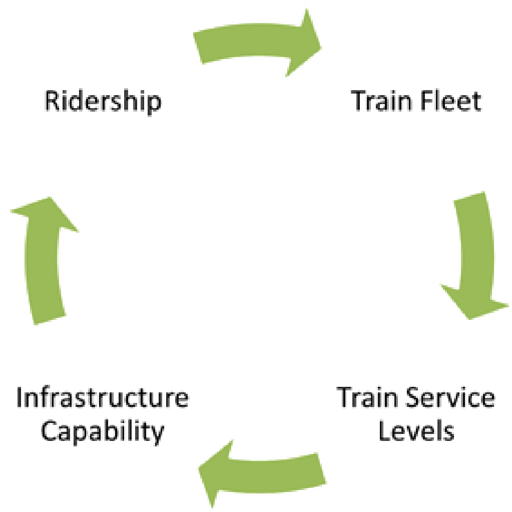

Figure 4: Delivering Train Services

Modelled Service Levels for the Business Case

A forward looking conceptual service concept was assumed for new stations modelling purposes. This service concept reflected information available at the time of analysis and consciously adopted a long-term view of how the service may be delivered and optimized by the system operator once the GO Expansion is up and running and in a mature state. This modelling was done to understand how stations could perform with additional express services that may be introduced over the lifecycle of the station asset. These services were recognized as one potential method of reducing train journey times for riders that travel through the new stations.

The new station modelling assumes the implementation of the GO Expansion program, including electrification and 15-minute or better all-day two-way service on the most heavily travelled sections of the Lakeshore East and West, Stouffville, Kitchener, and Barrie Lines. The GO Expansion service concept for the Kitchener and Lakeshore East and West corridors has always been envisioned to include express running services and this was reflected in the 2016 IBCs for new stations. The modeling for the PDBC and updated IBC analysis has added the consideration of potential express service options to the Stouffville and Barrie corridors.

Express (limited stop) and tiered service patterns typically have trains serving outer stations that then run non-stop past inner stations which are served by other "all-stop" trains. Express running services are an important part of the existing and future GO service offering. The primary purpose of these types of services is to provide competitive travel times for upstream riders while also managing train capacity levels (e.g. seat availability).

The business case modelling for new stations assumed the following forward-looking express or inner/outer service options.

- **Barrie corridor**: Outer service stopping at all stations between Allandale Waterfront and Aurora; trains will also stop at Downsview Park and Spadina stations, otherwise, express to Union Station. Inner services will serve all stations between Union Station and Aurora

- **Stouffville corridor**: All-stop peak direction outer service between Lincolnville and Unionville stations; trains will also stop at Kennedy and East Harbour stations, otherwise, express to Union Station. Inner services will stop at all stations between Unionville and Union Station.
- **Lakeshore West corridor**: Alternating trains with bi-directional 15-minute service on the corridor with stops at Mimico and Park Lawn stations. Mimico and Park Lawn stations would therefore receive 30 minutes service inbound and outbound all day.

The service level that was assumed at each station for modelling purposes is summarized in more detail in **Table 1** of the Appendix. The table presents the number of AM peak trains that were assumed to stop at each station (frequency) and the resulting average number of minutes between trains (headway).

The modelling assumptions in **Table 1** *of the Appendix do not represent a service plan*. The full service plan for GO Expansion will be defined by bidders as part of the procurement process, described below.

GO Expansion Service Plan Next Steps

On April 3, 2018, Infrastructure Ontario and Metrolinx also issued a Request for Qualifications for the GO Expansion project[2]. The RFQ is the first step in the procurement process to select a team to deliver GO Expansion, including design, build, finance, operate, and maintain. The project is being delivered as a Design Build Finance Operate Maintain (DBFOM) contract using Infrastructure Ontario's Alternative Financing and Procurement (AFP) model. A key feature of this choice of procurement method is that bidders will be responsible for planning, designing, building, and operating the train services that are required to meet Metrolinx defined output requirements.

Train service requirements are expected to be defined in the Request for Proposals (RFP) that will set out the train service needs, run times, and capacities that are to be achieved through the concession period. Bidders will be responsible for proposing the infrastructure that needs to be built, the type and number of trains, and develop detailed train service timetables that meet the mandated requirements. This will constitute the full service plan for the GO Expansion program. Over the life of the DBFOM contract, Metrolinx will continue to update the service output requirements based on emerging demand patterns, policy decisions, and customer requirements. The successful proponent will be expected to continue to respond to these changes through further optimizations to the overall fleet, infrastructure, and timetable solution.

The GO Expansion Full Business Case, identified in **Section 1.2**, will provide the next opportunity to examine service assumptions and evaluate the benefits of the overall GO Expansion network.

3.2 Modelling Level Boarding

Metrolinx is currently preparing an Initial Business Case (IBC) for level boarding across the GO rail network. Level boarding will provide significant accessibility benefits for customers while also reducing station run-in and dwell-times. The total run-in and dwell time at stations built for level boarding is expected to be reduced by approximately 30 seconds per station. Dwell times will be reduced since riders will be able to board and alight more easily and efficiently with level boarding in place. Dwell times will be further reduced since it will not be necessary to deploy the accessibility ramp at stations with level boarding, although use of the accessibility ramps will need to continue during a transition period at stations not equipped for level boarding, until they are modified. All new stations are anticipated to be built with level boarding from the outset.

[2] *http://www.infrastructureontario.ca/Request-for-Qualifications-Issued-RER-GO-Regional-Express-Rail-Corridor/*

As part of the new station analysis, level boarding is assumed to reduce each new station's overall delay by 30 seconds. This reduces the impact on upstream riders, taking the incremental travel time impact at most stations down from 2 minutes to about 1.5 minutes. The modelled incremental travel time impact of each station is presented in **Table 2** of the Appendix.

3.3 Modelling Fare Integration

The business cases also considered a forward-looking fare scenario that tested the impact of removing differences in fare as a barrier to travel between GO and TTC. More simply, this means that the business cases consider the ridership that could be achievable if fare did not factor into a transit rider's choice between transit options in Toronto.

The modelled fare integration scenario represents a future state where customers move seamlessly between services and do not need to worry about the logo or colour of the bus or train that gets them to where they need to go. This was achieved, conceptually, by modelling a scenario where there is no difference in cost to take the TTC, GO, or use both. A specific dollar amount or fare structure assumption was not necessary to support the modelling scenario that was adopted to represent Fare Integration. The analysis removed the fare barrier by giving forecast TTC transit riders in Toronto the ability to choose GO if it is a more convenient, faster option for all or part of their trip. No additional modal shift to transit from auto or walk was considered in the analysis.

Reduced fare barriers have a positive impact on the business cases through increased ridership, particularly in markets where municipal transit services provide a competitive alternative to GO and the existing fare differential with GO is large. For these reasons, the focus of the fare analysis and associated ridership impacts is therefore on stations within the City of Toronto.

4. Travel Demand Modelling

As discussed in **Section 2**, the technical business case analysis has its foundations in the assessment of the transportation user benefits and impacts that occur when a new station is introduced. The balance and trade-offs between the travel time savings experienced by new station users, delays experienced by upstream riders, and shifts in automobile usage is central to the business case analysis for new stations.

The Greater Golden Horseshoe regional travel demand model (GGHM) version 3 has been used as the starting point for ridership forecasting, modal shift, and travel time savings analysis that underpins the business case for each new station. This Section provides an overview of the GGHMv3 tool and a summary of how the tool was applied to isolate the transportation user benefits and impacts associated with each new station.

4.1 Greater Golden Horseshoe Model (GGHM) Version 3

The Greater Golden Horseshoe Model (GGHM) Version 3 is a four-stage regional travel demand model that includes standard practice Trip Generation, Trip Distribution, Mode Choice, and Trip Assignment components. The model generates forecasts for a typical weekday during the AM peak period, which is defined as all trips that start between 6:30 and 9:30 am. The model generates forecasts of overall trip making by mode by considering the distribution and intensity of population and employment growth across the GGH (input to the model at traffic zone level – see **Section 5.1** for more details) and weighing the relative attractiveness of each available transport mode based on congested auto travel times and provided transit service levels and times. A detailed GGH-wide network model is used to represent the regional automobile and transit network (including GO rail, subway, municipal buses, streetcars, GO bus, etc.). The network model includes a representation of the level of service, travel times, and generalized costs associated with each mode.

All travel demand forecasts for the new stations analysis have been generated for the 2031 AM peak period using 2031 land use inputs. **Figure 5** provides an overview of the key model inputs and outputs that are relevant to the GGHM analysis that was conducted for new stations.

The GGHM has a history of being successfully applied and proven as a credible tool, starting with the Big Move Regional Transportation Plan (RTP) through to more recent applications supporting rapid transit project assessments and the GO Expansion program. The GGH model is also being used to generate key ridership growth inputs to the overall Full Business Case for GO Expansion; the direct use of the GGHM ensures greater consistency between these two related work streams.

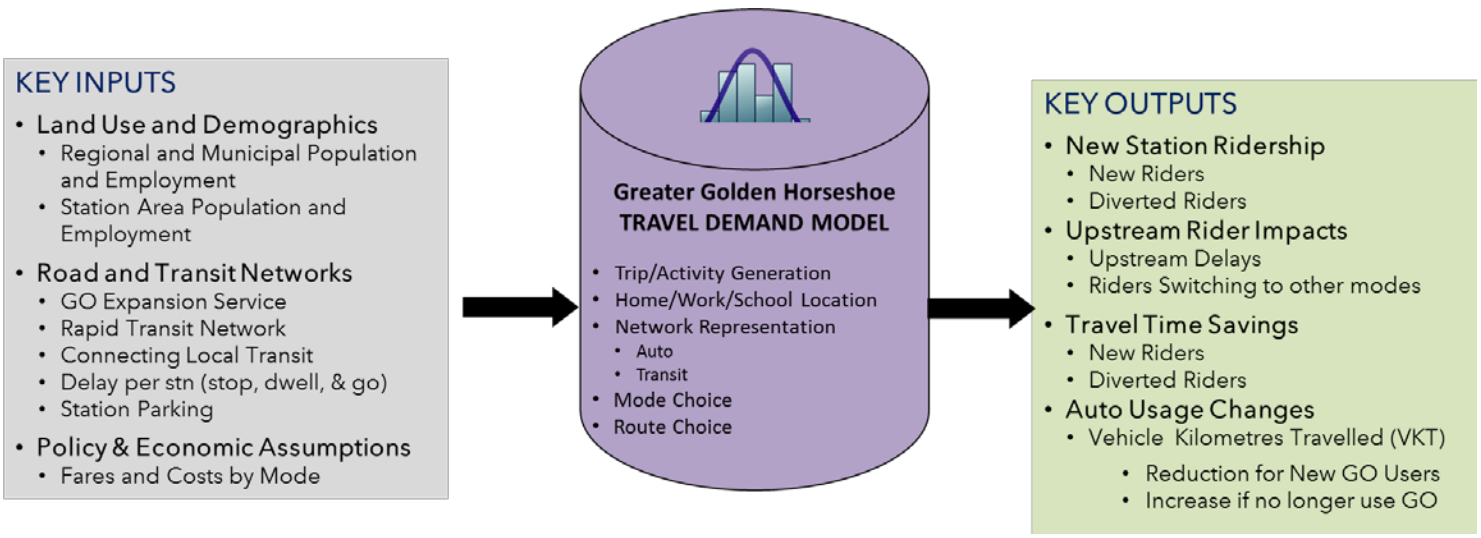

Figure 5: Greater Golden Horseshoe Model: Key Inputs and Outputs

4.2 Model Application Process and Run Structure

The primary question being posed by the business case analysis is: *How would each station perform if it were added to the GO Expansion program?* The business case is concerned with measuring the incremental impact of adding each station, not of the overall GO Expansion program itself. This requires an assessment of how many riders would benefit and how many would be impacted (and by how much) by the addition of the station. The GGHM was first used to examine a "No New Stations" network scenario that includes the overall GO Expansion program and the surrounding / connecting rapid transit network but none of the 17 proposed new stations. Next, 17 separate "With Station" runs were undertaken and compared to the "No New Stations" baseline in order to analyze the incremental transit ridership, transit travel time, and auto usage impacts. As highlighted in **Figure 6**, this approach allowed for the analysis to isolate the benefits and impacts that were associated with each of the 17 individual new stations.

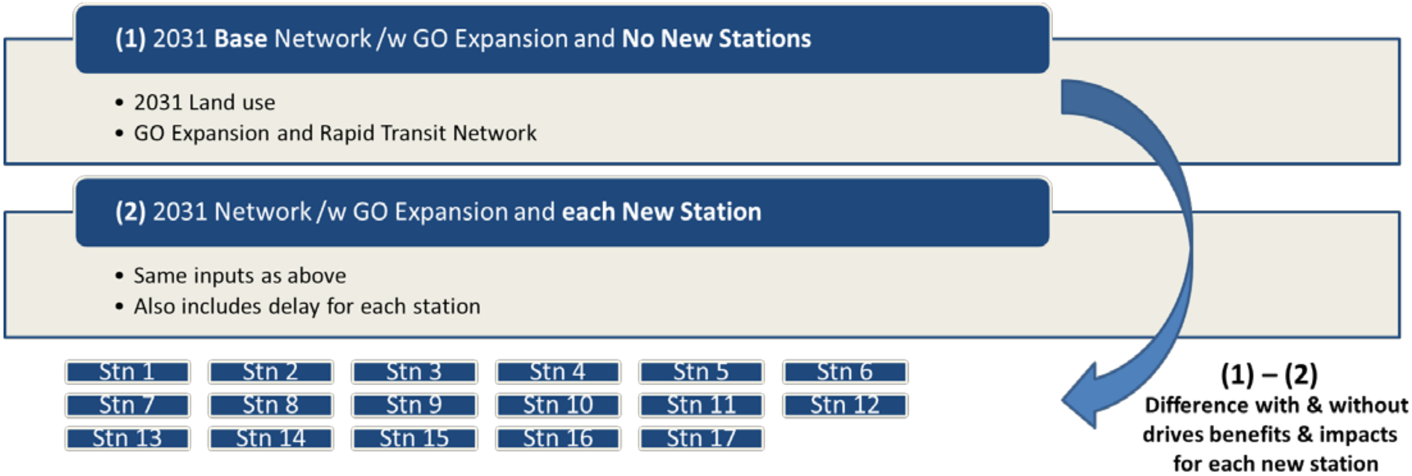

Figure 6: Model Run Structure

Land use inputs were held constant in the "No New Stations" and in the 17 "With Station" runs in order to provide a consistent base of comparison between scenarios. Trip distribution was also held constant between runs in order to better isolate transportation user benefits and to limit model variability or noise between runs. An additional run with all of the 17 proposed stations in place was also used to test and confirm the level of interaction between adjacent stations.

All model outputs were reviewed using professional judgement and compared against benchmarks for reasonableness. Recognizing that the level of detail in the traffic zone system and the transportation network varies at each station site, modelled travel time savings estimates were closely reviewed and compared to detailed sector-based calculations for downtown stations that were conducted at the IBC stage of analysis. This is particularly important in areas where major employment sites and non-residential activity generators are located within walking distance of each station site.

5. Demand Model Inputs and Assumptions

5.1 Land Use

The forecasted growth in population and employment across the region is a fundamental input to the GGH model's projections of future trip making and transit ridership. Over 3,000 traffic zones are used by the model to capture both the intensity and distribution of population and employment growth across the GGH. This allows the model to capture the impacts of proposed growth in the vicinity of station sites and broader growth in surrounding areas. This component allows the analysis for the PDBC's and updated IBC's to consider the impacts of proposed development on station ridership.

Population and employment inputs at the traffic zone level relied on municipally-derived forecasts for 2031 as a starting point. New information was provided by municipalities and directly translated for input to the model, including Kirby and Hwy 7 / Concord station area development provided by the City of Vaughan and citywide traffic zone level forecasts provided by the City of Toronto (including zones near station areas and the rest of the city). Please refer to **Table 3** in the Appendix for a summary of the assumed density levels within a 10 minute walk of each station site (assumed as 800m radius).

Where explicit information was not provided, the model's population and employment forecasts were reviewed against the IBC's assessment of the development potential and intensification for surrounding areas (i.e. anticipated density within 800m of the station site). Modelled traffic zone level forecasts were updated to reflect the high-end of the IBC's density range where applicable.

As previously noted in **Section 4.2**, the same land use (population and employment by zone) has been assumed to be in place both in the Base "No New Stations" and the "With Station" scenarios.

5.2 Changes to GO Ridership

Each new station provides a new access opportunity that has the potential to attract new riders to the GO network. These are riders that would have used another mode of transport to get to their destination if the new station were not in place. The GGH model was used to directly estimate the number of station users that would be new to GO. These users were identified by isolating origin-destination pairs where the total demand for GO increases with the station in place. The model run without the station in place ("No New Stations") was compared to the results of the model run with the station place ("With Station") in order to determine the net change in GO demand. The forecasted number of daily trips made by riders that are new to GO at each new station is provided in **Table 4** of the Appendix.

Although the new station provides a new access opportunity, it increases travel times for upstream riders that now have to stop at the station. The delay associated with stopping and travelling through a new station is small for most longer-distance trips (e.g. a 1.5 minute delay is less than a 5% increase in travel time for a 40 minute trip). Although this is a small increase in travel time, a small number of riders may consider switching to alternate modes in response to the delay, primarily switching to auto or other transit modes. The number of users that would consider switching largely depends on whether alternative modes provide competitive travel times relative to GO, which can vary significantly by station location. For example, although the auto network is congested in peak periods, the TTC subway can be a competitive option for travel to downtown for trips that start in southern York Region either via walk/transit access or Park-and-Ride (PNR).

GGH model forecasts have also been used to directly estimate the number of upstream riders that would divert to other modes. The network-based GGH model has the advantage of being able to directly consider the attractiveness (e.g. auto congestion) and availability (e.g. presence of rapid transit options) of competing transportation modes. **Table 4**, in the Appendix, presents the number of net new GO trips that are forecasted to be attracted to each new station. The net new GO trips accounts for the small number of riders that would no longer use GO due to the longer journey times that are caused by stopping at the new station.

5.3 Travel Time Savings

The trade-offs between the travel time saved by new station users and the travel time increases experienced by upstream users are a fundamental input to the economic analysis for each station. Although upstream delays are generally small in magnitude per rider, significant overall impacts can be incurred if the new station delays many upstream riders that travel through the station. Upstream impacts are generally more significant for stations that are located closer to Union station and hence have more riders on-board. New stations that are located near line termini and/or are on lines with express services that do not stop at the new station have the potential to impact the least number of upstream riders.

For upstream users, the travel time increases are estimated by combining the GGH model forecasted volume through the station (i.e. upstream volume minus alighting demand) with the incremental journey time increase caused by each station, which is approximately 1.5 minutes at most stations with level boarding. Former GO riders that switched to another mode, on the other hand, incur half of the station delay through the application of the standard practice economic "rule of half"; this reflects the fact that the precise amount of delay that induced the riders to switch is not known.

For new station users, travel time savings were tracked in the GGHM across each of the six (6) user categories presented in **Figure 7** below.

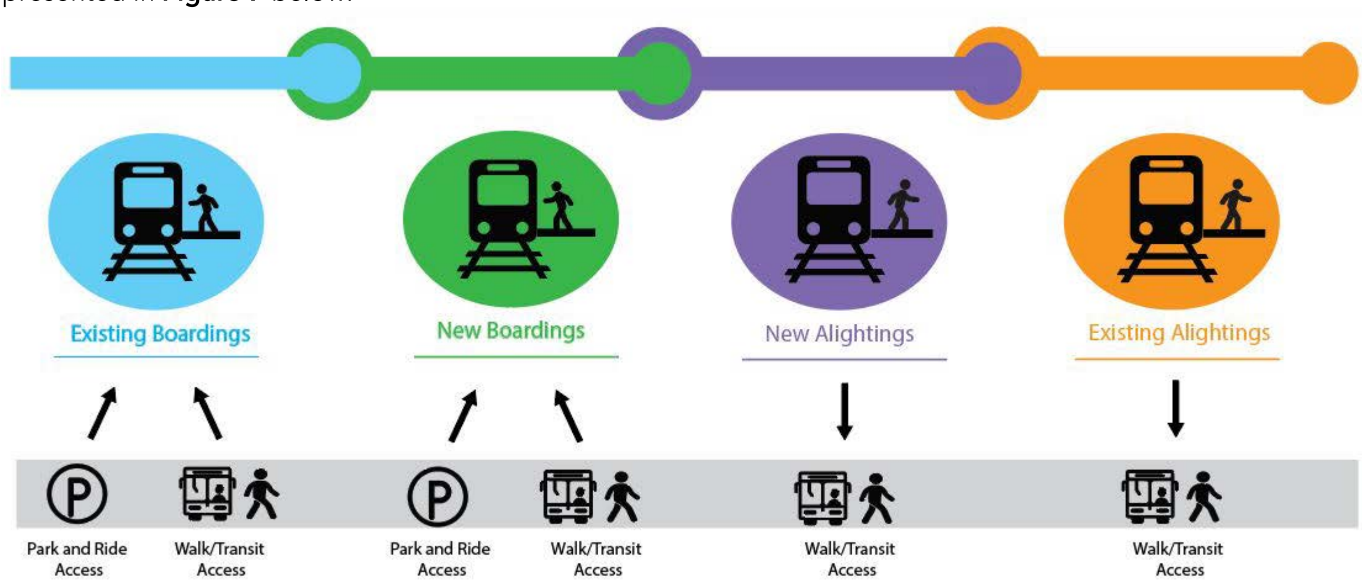

Figure 7: Station User Categories for Travel Time Savings Analysis

The GGH model's mode choice component stratifies GO Rail demand by access mode: Park-and-Ride / Kiss-and-Ride (PNR) and Walk/Transit. Walk/Transit is the only mode provided as an option for station egress in the AM peak period, regardless of the access mode that is used.

Unlike upstream users, new station user travel time savings are more complex and are very dependent on the local geography / urban form and the configuration of the local area transit network. Travel time savings estimates rely on GGHM estimates of demand and travel time savings by trip origin-destination pair. Consistent with the approach used to estimate new overall users to GO, the increase in demand and time savings by each of the two access modes were tracked at the origin-destination level and isolated to identify the time savings that would be associated with the station. This allowed for the calculation of the time saved for each of the 6 station user categories shown in **Figure 7**.

Travel time savings for walk/transit access and egress (~10-20 or more minutes) are generally expected to be higher than that of auto PNR access time savings (~2-5 minutes) since travel tends to be more time consuming and less flexible via walk/transit. In the economic analysis, existing GO users benefit from the entirety of the calculated time savings, while new users benefit from half of the calculated time savings per the "rule of half."

5.4 Auto Usage Changes

Auto usage changes, particularly the change in vehicle kilometres travelled (VKT), are an important component of the economic analysis of stations. Each VKT that is reduced as a result of the new station is monetized based on its ability to reduce auto congestion, reduce auto operating costs, reduce environmental impacts, and improve safety. The GGH model was used to track network level VKT changes across each of the following categories:

- **VKT Reductions for users New to GO**: A proportion of the new riders to GO would have previously driven to their destination. A net reduction in VKT is therefore expected for new users. The GGH model was used to estimate the VKT reductions and auto diversion rate for new boarding and alighting riders.

- **VKT Increases for users that Switched to Other Modes**: A proportion of the riders that switched from GO to another mode will now drive to their destination. A new increase in VKT is therefore expected for riders that no longer use GO. The GGH model was used to estimate the VKT increase and auto diversion rate for former GO riders that choose to switch to another mode.

- **VKT Reductions for Park and Ride Users**: The new station can also provide PNR users with a closer access station or encourage some PNR users to switch to the walk/transit access mode. Both of these changes in PNR access behaviour would result in a reduction in auto VKT. This type of VKT reduction was not considered in the 2016 IBC since it is difficult to estimate without the direct use of a network model. For the PDBCs and updated IBCs, the GGH model was used to estimate the VKT reductions associated with PNR access.

5.5 Daily Ridership

As previously discussed in **Section 4.1**, the Greater Golden Horseshoe Model's ridership forecasts are generated for the 3-hour 2031 AM peak period. Therefore, post-model factors are used to generate the daily and annual forecast inputs that are necessary for economic analysis. For most stations an AM peak to daily factor of 2.8-2.9 has been adopted which reflects existing patterns on the GO rail network, specifically the Lakeshore corridors which currently have 30-minute all-day service.

Given that the Fare Integration scenario represents a significant shift away from the status quo to a future where travel between TTC and GO is seamless and where GO Expansion provides frequent service in Toronto, it is reasonable to expected that the future looking GO system will start to behave more like the TTC subway system within Toronto. In light of these considerations, an AM peak period to daily factor of 3.85 was adopted under Fare Integration for Toronto stations. This factor was derived from system wide figures in the 2015 TTC Subway

Platform counts. The forecast breakdown of the 2031 AM peak period boardings and alightings and the total daily boardings and alightings by station is presented in **Table 5** of the Appendix.

6. Financial and Economic Model Inputs and Assumptions

Metrolinx is committed to the on-going review of economic guidance parameters for alignment with best practice thinking from around the world and the most up-to-date information for the local region. To this end, Metrolinx recently released the full version of the Draft Metrolinx Business Case Guidance in March 2018[3], which provides detailed information on how to lead the development of a business case, including recommended analytical methods and parameters. While the New Stations analysis was undertaken in parallel to and finalized prior to the release of the draft guidance, a conscious effort was made to align the analysis with the emerging guidance. The Full Business Case for the overall GO Expansion program will also be similarly aligned with the Business Case Guidance.

In addition to the transportation user benefits and ridership forecasts that were discussed in previous sections, the economic and financial analysis also makes use of anticipated station related costs (incremental capital and operating costs) as a key input to the analysis. One key difference between the IBC and PDBC level of analysis is the level of design detail that informs the scope and cost estimates. The PDBC level of business case analysis reflects additional design details and Class-3 cost estimates that provide greater cost certainty. In the business cases analysis, cost estimates for the economic case exclude the cost of property. This is because property is expected to have residual value of at least equal to the initial property cost when considering inflation.

Table 6 in the Appendix summarizes the key financial and economic case input assumptions that were used in the analysis.

[3] *http://www.metrolinx.com/en/regionalplanning/projectevaluation/benefitscases/benefits_case_analyses.aspx*

Appendix I: Technical Tables

Table 1: Modelled 2031 Service Levels: AM Peak Trains Serving Each Station (Inbound to Union)

		Modelled Frequency (number of trains per hour)	**Modelled Headway** (minutes between trains)
Preliminary Design BC	**Smart Track Stations**		
	East Harbour (Don Yard/Unilever)	11	5.5
	Finch	4	15
	Gerrard-Carlaw	8	7.5
	Lawrence-Kennedy	4	15
	King Liberty (Liberty Village)	6	10
	St. Clair - Old Weston	6	10
	Other GO Expansion Stations		
	Bloor-Lansdowne	4	15
	Spadina-Front	6	10
	Breslau	2	30
	Innisfil	2	30
	Kirby	4	15
	Mulock	2	30
Updated Initial BC	**Stations in City of Toronto**		
	Ellesmere	4	15
	Park Lawn	2	30
	St. Clair West (Barrie Line)	4	15
	Stations Outside City of Toronto		
	Highway 7-Concord	4	15
	Whites	4	15

Note: ***This is not a service plan***. *These service levels have been assumed for modelling purposes only. These assumptions have been used to understand how stations could perform over a 60 year life-cycle with additional express services*. The full service plan for GO Expansion will be defined by bidders as part of the DBFOM procurement process. *See Section 3.1 for details*.

Table 2: Incemental Travel Time Impact by Station (with Level Boarding)

		Travel Time Impact (min)
Preliminary Design BC	**Smart Track Stations**	
	East Harbour (Don Yard/Unilever)	1.3
	Finch-Kennedy	1.3
	Gerrard-Carlaw	1.3
	Lawrence-Kennedy	1.3
	King Liberty (Liberty Village)	1.3
	St. Clair-Old Weston	1.3
	Other GO Expansion Stations	
	Bloor-Lansdowne	1.3
	Spadina-Front	2.5
	Breslau	1.5
	Innisfil	1.5
	Kirby	1.5
	Mulock	1.5
Updated Initial BC	**Stations in City of Toronto**	
	Ellesmere	1.3
	Park Lawn	1.5
	St. Clair West (Barrie Line)	1.3
	Stations Outside City of Toronto	
	Highway 7-Concord	1.5
	Whites Road	1.5

Table 3: Station Area Land Use - 2031 Population and Employment within 800m

		Population	Employment	Density (People + Jobs / ha)
Preliminary Design BC	**Smart Track Stations**			
	East Harbour (Don Yard/Unilever)	13,000	51,000	320
	Finch-Kennedy	7,000	3,000	50
	Gerrard-Carlaw	19,000	7,000	130
	Lawrence-Kennedy	12,000	6,000	90
	King Liberty (Liberty Village)	25,000	28,000	260
	St. Clair-Old Weston	15,000	4,000	90
	Other GO Expansion Stations			
	Bloor-Lansdowne	23,000	5,000	140
	Spadina-Front	60,000	56,000	580
	Breslau	300	200	3
	Innisfil	11,000	1,000	60
	Kirby	9,000	2,000	50
	Mulock	6,000	2,000	40
Updated Initial BC	**Stations in City of Toronto**			
	Ellesmere	8,000	9,000	80
	Park Lawn	14,000	7,000	110
	St. Clair West (Barrie Line)	17,000	2,000	90
	Stations Outside City of Toronto			
	Highway 7-Concord	4,000	17,000	110
	Whites Road	7,000	2,000	40

Note: Model assessment includes population and employment by traffic zone for the entire Greater Golden Horseshoe for 2031. Station area land use is shown to illustrate localized development levels assumed in the model.

Table 4: New Stations Ridership Breakdown – 2031 Daily Trips by New GO Riders

		Daily Trips by New GO Riders (ons + offs)	Daily Trips by Net New GO Riders (ons + offs)	Total Daily Trips (ons + offs)
Preliminary Design BC	**Smart Track Stations**			
	East Harbour (Don Yard/Unilever)	10,200	8,000	68,100
	Finch-Kennedy	1,700	1,400	4,200
	Gerrard-Carlaw	7,900	6,900	13,500
	Lawrence-Kennedy	5,400	4,600	9,200
	King Liberty (Liberty Village)	5,600	4,400	19,600
	St. Clair-Old Weston	4,100	3,600	8,900
	Other GO Expansion Stations			
	Bloor-Lansdowne	1,900	1,500	8,500
	Spadina-Front	10,000	8,000	39,300
	Breslau	800	800	3,100
	Innisfil	700	600	2,800
	Kirby	1,900	1,800	10,600
	Mulock	400	100	4,200
Updated Initial BC	**Stations in City of Toronto**			
	Ellesmere	2,900	2,100	4,600
	Park Lawn	2,000	300	10,000
	St. Clair West (Barrie Line)	4,600	4,000	6,200
	Stations Outside City of Toronto			
	Highway 7-Concord	1,300	1,000	5,500
	Whites Road	700	300	3,500

Note: New GO Riders are defined as new station users that choose to switch to use GO when the new station is in place. The remaining trips at each station are made by riders that would have otherwise used another GO station. In addition to the new GO riders that are attracted to each new station, Net New GO Riders also considers the small numbers of upstream riders that choose to no longer use the system due to the longer journey times that are caused by stopping at the new station.

Table 5: Ridership by Station – 2031 Boardings (ons) and Alightings (offs)

		2031 AM Peak Period Boardings	2031 AM Peak Period Alightings	2031 Daily Trips (boardings + alightings)
Preliminary Design BC	**Smart Track Stations**			
	East Harbour (Don Yard/Unilever)	1,600	16,100	68,100
	Finch-Kennedy	900	200	4,200
	Gerrard-Carlaw	1,900	1,600	13,500
	Lawrence-Kennedy	1,700	700	9,200
	King Liberty (Liberty Village)	2,400	2,700	19,600
	St. Clair-Old Weston	1,500	800	8,900
	Other GO Expansion Stations			
	Bloor-Lansdowne	1,300	900	8,500
	Spadina-Front	3,200	7,000	39,300
	Breslau	1,100	20	3,100
	Innisfil	1,000	20	2,800
	Kirby	3,800	100	10,600
	Mulock	1,500	20	4,200
Updated Initial BC	**Stations in City of Toronto**			
	Ellesmere	600	600	4,600
	Park Lawn	1,700	900	10,000
	St. Clair West (Barrie Line)	900	700	6,200
	Stations Outside City of Toronto			
	Highway 7-Concord	1,400	500	5,500
	Whites Road	1,100	30	3,500

Table 6: Financial and Economic Analysis Assumptions

Model Input Assumptions	Metric	Notes
Project Evaluation Period (Years)	60	Analysis period ends in 2083
Year of Cost Estimates	2022	Per cost estimate
Annual inflation rate – General Price Level	2%	See Metrolinx Business Case Guidance
Annual Inflation Rate – Construction Spending	3%	Per cost estimate
Ridership Daily Factor (from Peak Period)	2.8-3.85	Varies by station service level and context
Ridership Annualization Factor (days/year)	280	Annualizes weekday forecasts
Discount Rate, Nominal (%)	5.5%	See Metrolinx Business Case Guidance
Construction Period (start and end dates)	2021-2023	Construction timeline
Discount Rate, Real (%)	3.5%	See Metrolinx Business Case Guidance
Value of Time ($/hr) (2017$)	$17.95	See Metrolinx Business Case Guidance
Value of Time Annual Growth Rate, Real (%)	1.6%, capped in 2047	See Metrolinx Business Case Guidance
Auto Operating Cost ($/VKT) (2017$)	$0.66	See Metrolinx Business Case Guidance
Auto Operating Cost Growth Rate, Real (%)	0.7%, capped in 2047	See Metrolinx Business Case Guidance
Decongestion on Road Network ($/VKT) (2017$)	$0.18 (peak) $0.02 (off-peak)	See Metrolinx Business Case Guidance
Decongestion on Road Network Growth Rate, Real (%)	0%	See Metrolinx Business Case Guidance
Accident Reduction Benefit ($/VKT) (2017$)	$0.08	See Metrolinx Business Case Guidance
Greenhouse Gas Emission (GHG) Costs in CO2e ($/VKT) (2017$)	$0.01	See Metrolinx Business Case Guidance
Greater Golden Horseshoe Model (GGHM) Forecast Year	2031	GGHM forecasts for 2031 AM peak period
Ridership annual growth rate - Lakeshore W (%)	1.9% to 2047	GGHM background growth rate
Ridership annual growth rate – Kitchener (%)	2.9% to 2047	GGHM background growth rate
Ridership annual growth rate – Barrie (%)	4.0% to 2047	GGHM background growth rate
Ridership annual growth rate – Stouffville (%)	2.9% to 2047	GGHM background growth rate
Ridership annual growth rate - Lakeshore E (%)	1.8% to 2047	GGHM background growth rate