

Executive Summary

This Initial Business Case (IBC) was developed over a 12-month period, starting in April 2014 by a team of Metrolinx staff and consultants. It is the result of a collaborative effort including many departments and individuals within Metrolinx and the Ontario Ministry of Transportation (MTO).

This IBC is a response to the commitment made by the Province of Ontario in 2014 to implement a Regional Express Rail (RER) over a 10-year period. This document provides the evidence and business case to support this commitment, as well as developing the service concept and providing input to the phasing plan.

The IBC touches on virtually every aspect of the GO rail system and its conversion from a diesel-powered commuter railway to an electric regional express system that will provide faster, more frequent and all-day services across the Greater Toronto and Hamilton Area (GTHA).

In order to develop the appropriate solution for the GTHA at this early stage of program, five scenarios were developed and analyzed. The evaluation of all five scenarios is presented within this IBC.

While the recommended RER program aligns most closely with Scenario 5, it is informed by multiple considerations from a variety of scenarios to obtain an optimal result. Further analysis of infrastructure, systems, service design and other considerations is required over the life of the program. This analysis will result in additional modifications as appropriate.

The scenarios considered are as follows:

- **Scenario 1: Do Minimum** – Peak-focused limited capital with no electrification. This scenario becomes the base scenario against which the others are measured to determine relative performance.
- **Scenario 2: Two-Way All-Day** – Enhanced diesel service on all corridors with no electrification.
- **Scenario 3: 10-Year Plan** – Frequent service on most inner corridors with limited electrification.
- **Scenario 4: Full Build (Beyond 10-Year Plan)** – Frequent service on all inner corridors with full electrification.
- **Scenario 5: 10-Year Plan Optimized** – Frequent service on most inner corridors with significant electrification will be achieved under this scenario.

For each scenario, the service pattern, rolling stock, and required infrastructure are defined, with estimates of ridership, environmental considerations and impacts, and operating and capital costs. This information is used to calculate the financial and economic benefits. Best practices are applied in the development of alternative analyses and refinement of the program to achieve best possible value for resources invested. The RER Business Case Model (BCM) was developed specifically for this project to determine the best option for implementing RER across the whole GO Transit rail system as well as the impacts for each corridor.

This summary presents the key findings of a detailed evaluation of the RER project. It demonstrates how the recommended scenario was arrived at while allowing for further refinement to achieve even greater value.

The financial and economic results presented in this IBC are derived from the BCM's service plans, which identify train frequency, rolling stock type and train size, and the infrastructure required to support the plan. These plans were developed in order to determine capital and operating costs in each scenario. The costs are based on GO's recent construction and operating experience. Numerous assumptions that inform the calculations can be found in Appendix C. Some of the key assumptions in the BCM that impact the results are shown in Table 1.

Table 1: Key Economic, Cost and Policy Assumptions Included in the RER Business Case Model (BCM)

Item	Assumption
Project Life	60 years
Discount Rate	3.5% per year real discount rate
Implementation	All new services commence 2024 ¹
Underlying Demand Growth	2.3% per year on average (varies by route) to 2044. In all scenarios, peak capacity is added to maintain current average train loads
Fares	No changes to 2015 fare structures; no real increase in fares
Other Charges	Other charges are assumed for modelling purposes – these are represented by a potential parking charge implemented before the end of the RER program
Costs	No real increase in the costs of train crew labour, diesel fuel or electricity
Auto Operating Costs	\$0.63 per km, increasing at 0.7% per year to 2044
EA, Engineering and Design	15% of base capital costs
Infrastructure (Corridors)	Contingency - 50% of base capital costs Productivity and resource factor - 25% of base capital costs
Infrastructure (System Wide)	Contingency - 50% of base capital costs ²

For an extensive list of BCM assumptions see Appendix C. For definition of Productivity and Resource Factor see Appendix A.

¹ For the purposes of this IBC, 2024 has been modelled as the start date of service. It is recognized that service will in fact be introduced over several years, in some cases resulting in services being introduced earlier. This is a reasonable working assumption for the purpose of analysis and where services are introduced earlier than 2024, benefits will generally be greater. Therefore these are conservative working assumptions. Exact phasing and timing of implementation still TBD.

² In most cases see appendices for exact information and costing information. In all cases, capital cost contingencies are between 10% and 50%.

There is a compelling strategic case for RER. Evidence presented here indicates that RER would be an enhanced “backbone” of the regional transit system, by accommodating more medium and longer distance trips in the GTHA. Early research indicates that, together with some other key elements of the Regional Transportation Plan (The Big Move), such as integration with local transit and fare integration, there is the potential for further increased ridership, utilization of the system, and benefits to residents and businesses of the region. RER will attract substantial traffic off the GTHA’s highway and road system, and enable continued economic growth, not just in downtown Toronto but at nodes across the region. Some additional benefits that have not been quantified but are described qualitatively, such as reduced subway crowding and improved productivity, are discussed in this document. RER will encourage more efficient urban development, and make it feasible to travel across the region for work, study, or play without a car.

The five scenarios evaluated in this IBC represent different levels of capital investment³. The recommended RER program possesses a strong Financial Case (Figure 1) and Economic Case (Figure 2).

The program is deliverable over the 10-year period, and can be reliably and successfully operated in the years following, which indicates a strong Deliverability and Operations Case.

The five scenarios cover a wide range of investment options, including different service solutions on different corridors as follows:

³ Figures are Net Present Values discounted to January 1, 2015, in 2014 prices. They exclude inflation and financing charges. Figures are totals including works totalling \$2 billion previously committed by the Province. Figures include rolling stock and other expenditures required for traffic growth over the period to 2074, but do not include inflation. Thus, actual capital expenditures for the 10-year project period will be different.

Scenario 1 is the Do Minimum (DM) option used to evaluate all other scenarios on an incremental basis. Metrolinx would need to invest approximately \$5 billion mostly on trains, car parking, and safety systems to expand peak capacity to keep pace with growing demand, but without any expansion of all-day services. This scenario represents a lower level of investment and system improvement.

Scenario 2 is Two-Way All-Day (2WAD) service, which expands hourly 2WAD services to Hamilton, Meadowvale, Kitchener, Barrie, Richmond Hill and Unionville. Metrolinx would invest approximately \$10 billion, with most of the additional expenditure paying for double-tracking and associated infrastructure improvements.

Scenario 3 is the 10-Year Plan, i.e. the service and infrastructure that could be provided by 2024 within a \$12 billion budget. GO would operate all-day services every 15 minutes to Aldershot, Mt. Pleasant, Aurora, Unionville and Oshawa. Faster electric trains would replace diesels on the Lakeshore corridor between Oshawa and Aldershot. Other routes would continue to use diesels with peak-only services. Metrolinx can deliver this program by 2024 within a \$12 billion capital budget.

Scenario 4 is the Full Build envisioned for RER. All corridors including Milton and Richmond Hill would be electrified with frequent services using Electric Multiple Unit trains (EMUs), reducing journey times by up to 20%. Express diesels would link Hamilton to Union Station. Capital investment of approximately \$19 billion is required. This scenario is built on assumptions regarding the resolution of issues and limitations of corridor ownership, and geographical constraints (flooding), which have not been fully examined.

Scenario 5 is the 10-Year Plan Optimized, it represents significant progress towards implementing the service levels of Scenario 4. It goes beyond the investments and service included in Scenario 3 (10-Year Plan), with electrification also to Bramalea, Barrie, Stouffville and to Pearson

Airport. This scenario and the resulting recommended RER program has been defined to maximize return on investment while mitigating risks. Depending on resolving various challenges, it can be delivered over 10 years for approximately \$13.5 billion. It does not preclude, but rather prepares for, services to Milton and Kitchener to be eventually electrified and frequent all-day services introduced when agreement is reached on co-existence of GO and freight on these privately-owned corridors.

Scenario 5 (10-Year Plan Optimized) was developed in early 2015 as a solution that optimized the results from an analysis of scenarios one to four. It shows the optimal scenario that maximizes benefits while meeting all four business case tests (Strategic, Financial, Economic and Deliverability).

Under the recommended RER program, annual ridership will increase by two and a half times between the years 2014 and 2029 while annual operating costs will increase by much less than two and half times. GO already recovers approximately 80% of direct operating costs from fares. The analysis undertaken to date indicates that RER would generate a surplus on an operating basis (not counting capital), which would pay back some of the additional investment required for tracks electrification, new trains and other equipment. System-wide transport benefits exceed costs by a ratio of 3:1. On the Lakeshore corridors, the Benefit:Cost Ratio (BCR) is very high, almost 7:1 while on other electrified corridors it is ranges from 2:1 to 4:1.

Over 60 years, a high proportion of all costs are paid back from fare revenues. By 2029, hundreds of thousands of trips would be taken off the regional road system every day, compared with Scenario 1 (Do Minimum). In this document, Scenario 5 (10-Year Plan Optimized) shows a net cost of approximately \$9 billion over 20 years. A map showing the extent of electrified RER is shown in Figure 3. Discussions will need to continue with Canadian National Railway Company (CN) and Canadian Pacific Railway

(CPR) on this program, particularly as it relates to the sections of track the railways own and operate.

The capital cost estimates include significant but necessary contingencies for capital and operating cost estimates given the early design phase status for RER. Underlying ridership demand is assumed to grow at approximately 2.3% per year, in line with GO's recent historic rate of 3% to 4% (comprised of both the underlying growth and growth associated with service improvements).

The cost estimates include approximately \$750 million for construction of approximately 15,000 additional parking spaces, which may not be necessary if service integration and fare integration with local transit services can be improved.

RER is complementary to many other transit programs and projects being implemented as part of Metrolinx's Regional Transportation Plan (RTP). In particular, it should improve the utilization and performance (i.e. ridership and therefore benefits realized) of the Eglinton Crosstown Light Rail Transit (LRT), York VIVA Bus Rapid Transit (BRT) and Mississauga Transitway BRT, all now under construction, and the planned Hurontario-Main LRT. The RTP sets out many of the complementary measures and projects that are needed to support RER and maximize the impact of its investments.

It should be noted that SmartTrack, the City of Toronto's proposal for faster, more frequent service, including additional stations and enhanced local transit integration on parts of the RER network in the City of Toronto, Markham and Mississauga, is highly aligned with RER and will be considered by the Province as it proceeds with RER. An analysis by the City of Toronto, with input from the Toronto Transit Commission (TTC) and Metrolinx, is looking at the costs and benefits of SmartTrack improvements such as even more frequent service, new stations, and regional rapid transit serving the Airport Corporate Centre (ACC). More information is

expected by mid-2015, including a business case from the City of Toronto on ACC service options. Business case analysis will be considered in subsequent RER business case updates. SmartTrack would be enabled by improvements to the Stouffville, Lakeshore East, Lakeshore West and Kitchener RER corridors. As more is known about the SmartTrack proposal, it may be considered in future business case updates.

With this investment, Metrolinx is building the foundation for a virtuous cycle of increased transit ridership and even greater increases in service in the future, perhaps requiring further incremental investment. With improved service and fare integration, RER may help to reduce crowding on the subway, and could defer the timing of the need for the proposed Downtown Relief Line and impact ridership on the Scarborough Subway. Metrolinx is working with the City of Toronto and the TTC to ascertain the level of that impact.

RER is an enormous project, but delivery is relatively lower risk relative to large underground subway projects. Virtually all of the works are within existing rail corridors, so environmental and community impacts are limited mostly to noise and vibration. RER will use proven technology that is working around the world. The entire program can be implemented over 10 years.

In order to achieve the maximum benefits from RER, Metrolinx will:

- Advance discussions with CN and CPR, to develop strategies to upgrade CN- and CPR-owned corridors to accommodate increased GO rail services on the Milton, Kitchener and Richmond Hill corridors.
- Work with Transport Canada and other railway operators to review standards and practices, so RER can be built using modern, proven technology.

- Work with local municipalities, transit operators, developers and other stakeholders to improve integration of stations with local communities. In some locations, additional stations may be built.
- Explore the introduction of parking charges at GO stations to encourage ride-sharing and support development of all-day feeder transit services that are an essential element of the RER strategy. Parking charges can finance approximately \$4 billion of the new infrastructure.
- Advance fare integration with the TTC and all regional transit operators. This could increase ridership and revenues, while potentially lowering fares for many trips and improving social equity.
- Work with the Ministry of the Environment and Climate Change (MOECC) to adopt noise-related and other policies and practices appropriate for electric rail services.

Metrolinx will continue to test fleet, service and infrastructure options, balancing value for money against affordability constraints, and taking account of phasing issues. Findings will be presented in subsequent updates to this IBC.

This IBC was prepared by Metrolinx, an agency of the Government of Ontario, and created to improve the coordination and integration of all modes of transportation in the GTHA. Metrolinx staff was assisted in preparing and validating this IBC by:

- Hatch Mott Macdonald (HMM), an engineering consulting and project management firm based in Mississauga, Ontario. HMM has designed much of the passenger and freight rail infrastructure across the GTHA, and has experience building electrified RER systems around the world.

- First Class Partnerships (FCP), rail strategy consultants based in London, United Kingdom. FCPR advises public and private-sector train operators and governments on railway investment, restructuring and development. FCPR has experience preparing rail franchise bids in the U.K., Denmark, Sweden, Australia and Germany with values of several billion dollars, and is now providing leadership to the U.K. government's rail executive within the Department for Transport.
- Volterra, an economics consultancy also based in London which advised on wider economic benefits for the \$25 billion London Crossrail (RER) project.
- The Institute of Transport Studies (ITS), an institute within the University of Leeds, and a world leader in transport economics, transport planning and transport appraisal. In 2013, ITS completed an international review of frameworks in 2013 entitled "International Comparisons of Transport Appraisal Practice." This study reviewed developments in the state of economic evaluation and the role of business cases within decision making. ITS was commissioned by Metrolinx to peer review the Metrolinx Business Case Framework. The ITS review of the Metrolinx framework concluded that the Metrolinx approach is compatible with the best international practice in this area. ITS also recommended further work to ensure strong linkages between business case evidence and decisions. Metrolinx has embraced this recommendation and is seeking to inform project and program decisions using business cases. Metrolinx plans to continue to fully integrate business case considerations within GO RER program governance and decisions going forward.

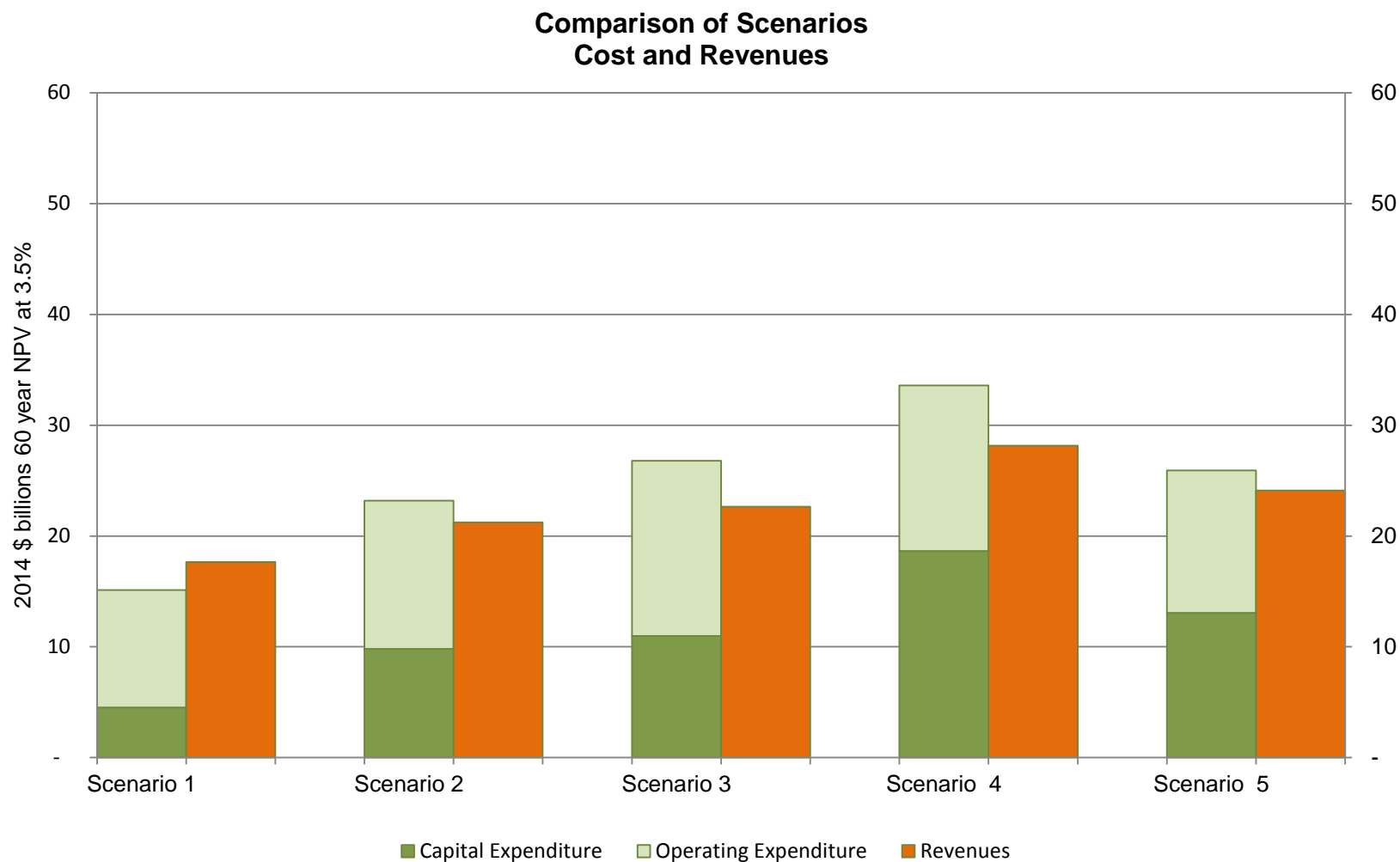


Figure 1: Financial Case – Costs and Revenues (60 Year Net Present Value)

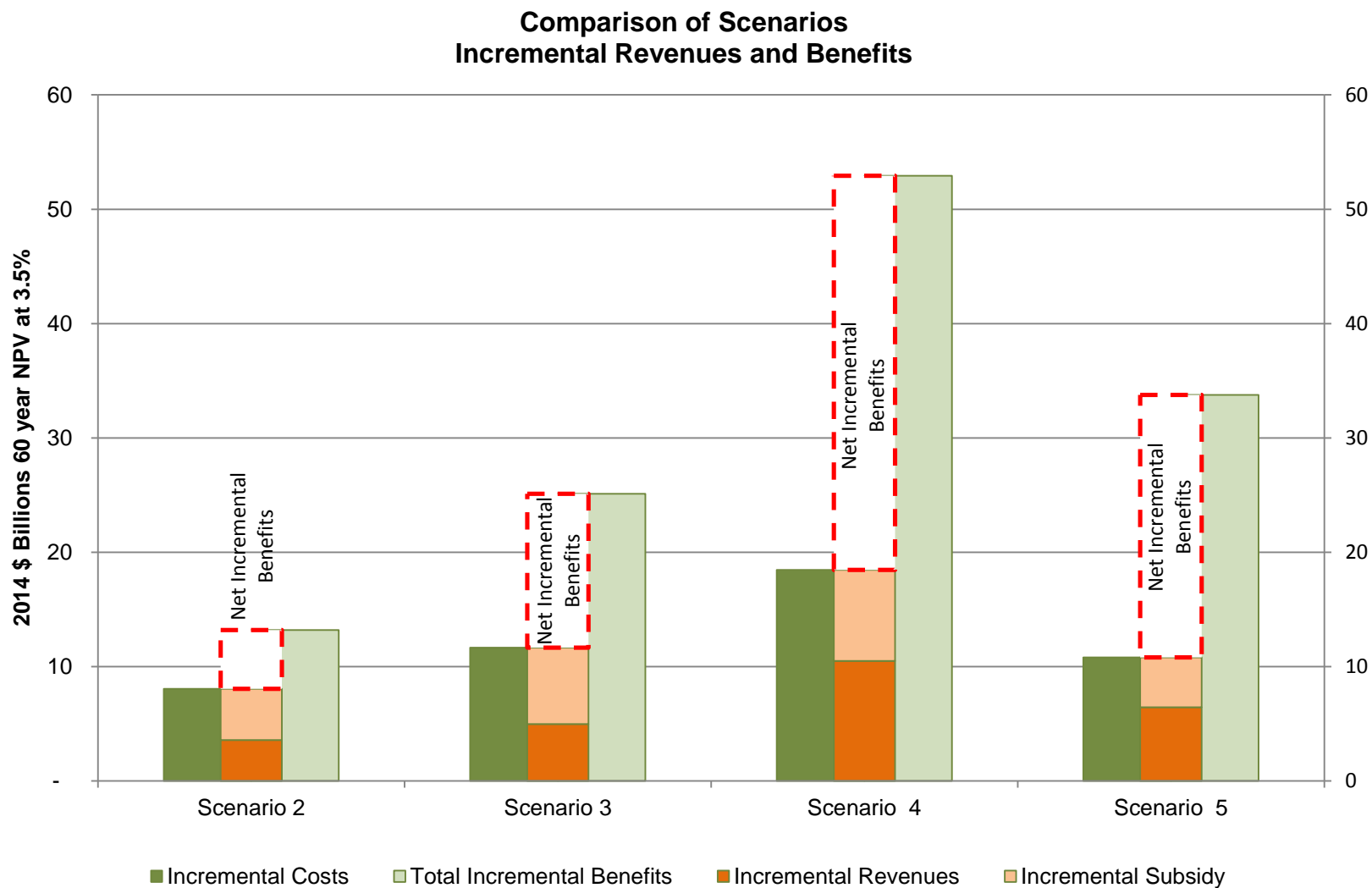
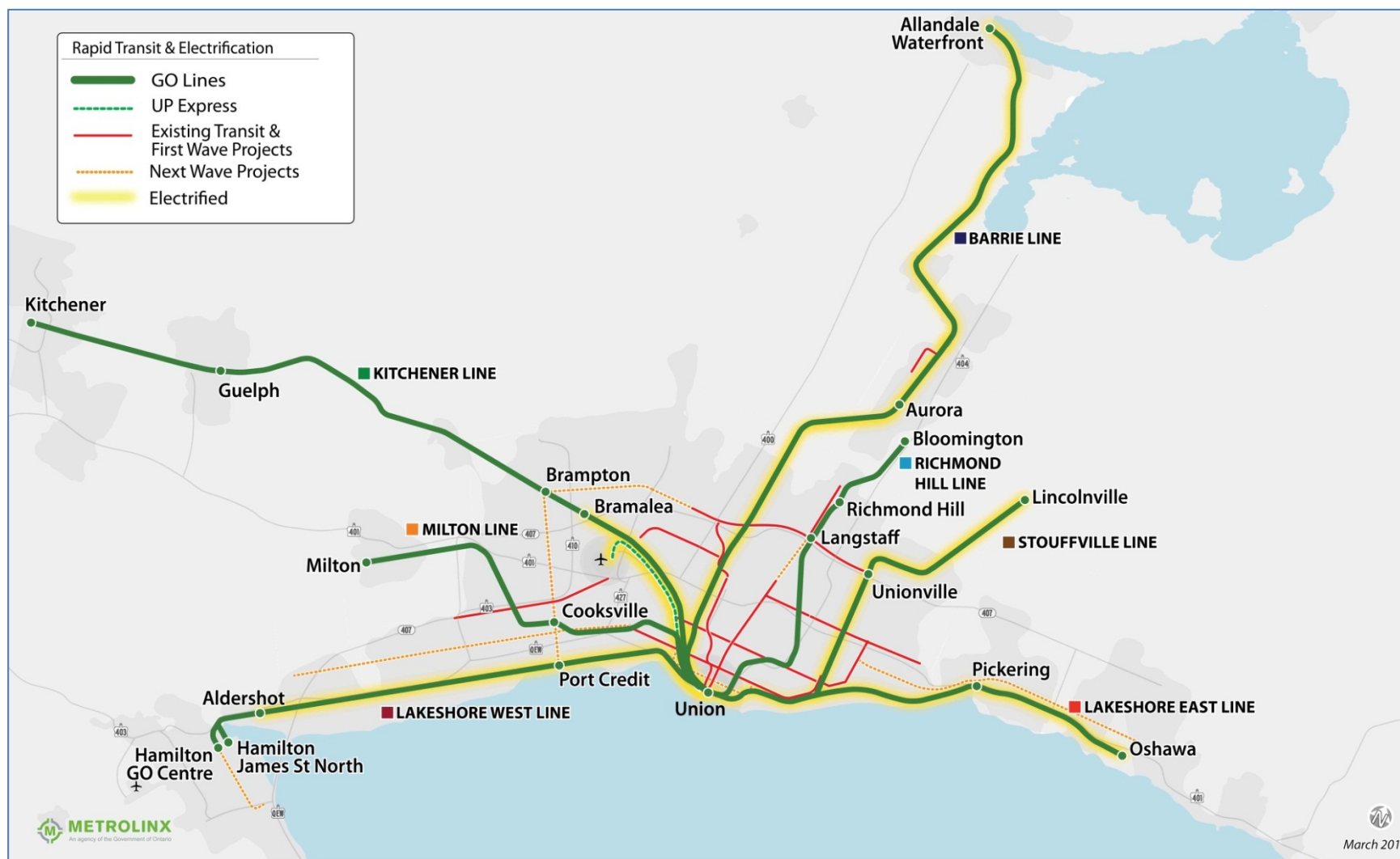


Figure 2: Economic Case – Incremental Revenues and Benefits (60-Year Net Present Value)



Glossary of Terms

Acronym/Terms	Description
2WAD	Two-Way All-Day
ACC	Airport Corporate Centre
AFP	Alternative Finance and Procurement
AREMA	American Railway Engineering and Maintenance-of-Way Association
BCF	Business Case Framework
BCM	Business Case Model
BCR	Benefit:Cost Ratio
BRT	Bus Rapid Transit
CAC	Criteria Area Contaminants
CAPEX	Capital Expenditure
CBD	Central Business District
CBTC	Communications-Based Train Control
CN	Canadian National Railway Company
CPR	Canadian Pacific Railway
CRBM	Commuter Rail Business Model
CRC	Criteria Area Contaminants
CSA	Customer Service Ambassador
CTC	Centralized Train Control
CTO	Commuter Train Operator
DDM	Direct Demand Model
DMU	Diesel Multiple Unit
EA	Environmental Assessment
EMU	Electric Multiple Unit
EN	European Norm (standard)
ERMF	East Rail Maintenance Facility
ETC	Enhanced Train Control
FBR	Farebox Recovery
FCP	First Class Partnerships
FRA	(U.S.) Federal Railroad Administration
GGH	Greater Golden Horseshoe
GGHM	Greater Golden Horseshoe Model
GHG	Greenhouse Gases
GJT	Generalized Journey Time

Acronym/Terms	Description
GO	GO Transit
GPRS	Go Passenger Rail Survey
GTA	Greater Toronto Area
GTHA	Greater Toronto and Hamilton Area
HMM	Hatch Mott MacDonald
HOV	High-Occupancy Vehicle
HSR	High-Speed Rail
IBC	Initial Business Case
LRT	Light Rail Transit
MOECC	Ministry of the Environment and Climate Change
MTO	Ontario Ministry of Transportation
NPV	Net Present Value
OPEX	Operating Expenditure
P3	Private-Public Partnership
PD1	Planning District 1, City of Toronto
PDFH	Passenger Demand Forecast Handbook
PTC	Positive Train Control
QCTO	Qualified Commuter Train Operator
RER	Regional Express Rail
RTP	Regional Transportation Plan (aka “the Big Move”)
TOC	Train Operating Companies
TOD	Transit-Oriented Development
tph	Trains Per Hour
TTC	Toronto Transit Commission
UPX	Union Pearson Express, sometimes referred to as UP.
USRC	Union Station Rail Corridor
VOT	Value of Time
WRMF	Willowbrook Rail Maintenance Facility

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1. The Strategic Case – The Vision of Regional Express Rail – Summary Report

1.1 The Challenge – Unblocking a Congested Region

The Greater Toronto and Hamilton Area (GTHA), and the surrounding Greater Golden Horseshoe (GGH), is now home to a population of almost nine million. This region is often ranked as one of the world's top 10 city regions,⁴ and is a global centre for business, culture, education and industry. In the past half century, the population of the region has more than doubled, and is expected to grow to almost 12 million by 2031.⁵ People come from all over the world to enjoy the range of opportunities that this region has to offer.

The GTHA has grown into a world city because it offers a wider range of opportunities than other communities. The vitality of the region is the product of both its size and the infrastructure that allows it to function efficiently.

Much of the region's transport infrastructure was built half a century ago, and was designed to meet expected traffic growth for 50 years. Now the highways, such as Highway 401 (see Figure 4), and subways are congested, not just in peak hours but increasingly throughout the day. Without more capacity and faster and more reliable transport, the GTHA region's vitality and status as a world city may suffer.

In the 1960s⁶, approximately half of all work trips in the region were made by public transport. Now, most trips other than to downtown Toronto are made by car. Commute times have grown, and many people now spend more than two hours each day driving to and from work, school and other activities. There has been sporadic investment in extending the subway, and GO train services have been expanded onto seven routes. GO now carries almost as many peak trips as the subway, but GO rail services are mostly useful for peak period trips into downtown Toronto. For trips to other places across the region, driving a car on the highway is the option of choice to the majority of commuters.

In 2006, congestion was estimated to cost the GTHA at least \$6 billion and perhaps as much as \$11 billion per year. With the continuation of trends and policies from the last quarter century, congestion will continue to worsen. GO rail services will carry commuters into downtown Toronto, but without all-day services, most contra-peak and orbital commuting will be by car. In this scenario, employment outside the Toronto downtown will likely grow slowly, because employers will only be able to draw on relatively local labour markets. As Toronto's reputation as a good place to live and work suffers, the region will be less attractive to new industries, which may choose to locate in cities with better transportation. Toronto's economic vitality will diminish and regional prosperity will be lower than it would be otherwise. Doing nothing is not an attractive option.

⁴ The Toronto Region often places in top 10 city-rankings for a combination of livability and economic competitiveness reasons. The Economist, Boston Consulting Group, and Forbes, among other groups, have ranked Toronto in the global top 10 for livability and/or competitiveness.

⁵ See Growth Plan for the Greater Golden Horseshoe (office consolidation 2013)
<https://www.placestogrow.ca/content/ggh/2013-06-10-Growth-Plan-for-the-GGH-EN.pdf>

⁶ According to the TTC Annual Report 1967, ridership in 1967 was 314,413,486, or about one million passenger trips per weekday. Population of the service area, then known as "Metropolitan Toronto," which is now the City of Toronto, was 2,089,729 in the 1971 census (source: Statistics Canada). On the basis that about half of the population was not employed, it is reasonable to assume that about half of all work trips were made by public transport



Figure 4: Highway 401

Source: Metrolinx

When Highway 401 was widened to 12 lanes in the 1960s, it was expected to meet the region's needs for 50 years. It is now congested throughout the day.

If the GTHA is to retain its reputation as a place with a good quality of life, people must be able to get from Markham to Mississauga, from Streetsville to Scarborough, or from King City to King West, in a reasonable time, reliably, when they want to travel. Improved transport is required so the GTHA can continue to function as an integrated urban region, and so everyone can share in the range of opportunities that are available.



Figure 5: Aerial View of Yonge and St. Clair Avenue

Source: Toronto Transit Commission (TTC)

Older suburbs are dense and transit friendly. Even new suburbs in the "905" have a high proportion of town house and high-rise apartment towers.

1.2 The Regional Context

At first glance, the GTHA may appear to be a sprawling low-density region, with a car culture similar to many others in North America. But in fact, there are key differences.

Toronto's downtown never declined in the way that some U.S. city centres did. The radial highway system has very limited capacity, and the majority of commuters into Toronto's Central Business District (CBD) use public transit.

The older suburbs, in parts of Toronto developed before 1950, are well served by buses and streetcars, and generate transit ridership many times higher than in U.S. cities.

Even newer suburbs are, on average, quite dense, with a high proportion of town houses and apartment towers. A continuous secondary road system has made it possible to extend bus services to within walking distance of almost all neighbourhoods. However, transit ridership is much lower than in the older parts of the City of Toronto, in part because jobs are widely dispersed, and transit does not currently serve long-distance trips that are not destined to downtown Toronto as effectively as it could. The GTHA has a growth plan (Places to Grow) and Greenbelt (the Greenbelt Act, 2005). During each of the last two decades, the GTHA population grew by 1.1 million. However, the expansion of available urban land was 24% in the first period but only 7% in the second, indicating that more growth is being accommodated as infill, and that the new development is also at higher densities.⁷

In the post-war period, when many cities were building expressways, Toronto was building and expanding its subway, along with the

construction of its early, but comparatively limited urban expressway system. Since the 1960s, subway expansion has slowed, but GO has developed over this period of time to become one of North America's largest commuter rail and bus systems. GO now carries almost 90,000 daily commuters into downtown Toronto, to a single hub station conveniently located immediately in the heart of its downtown, while thousands more commuters are carried on bus routes across the region. Toronto's patterns of development make it very much oriented to a good regional transit system.



Figure 6: GO Train 1967

Source: Metrolinx

GO started in 1967, and has grown into one of North America's largest commuter rail systems.

⁷ See Neptis Foundation Rethinking Sprawl, July 2014, <http://www.neptis.org/publications/rethinking-sprawl>

1.3 The Transformation to Regional Express Rail

The GO rail network today primarily serves the downtown commuter travel market, with trains bringing commuters to the downtown on weekday mornings and then returning those same commuters to the suburbs in the evenings. Off-peak rail service is provided on the Lakeshore corridors and was expanded to a half-hourly frequency in 2013. However, most off-peak and contra-peak travel is accommodated on the GO bus network.

This IBC describes the transformation over the next decade of five of the seven GO rail corridors into a service that operates all day, all week, and in both directions. It will provide \turn up and go\ levels of service (defined as a train every 15 minutes or better, and which does not typically require customers to consult a timetable). Many trains will be electric, bringing enhanced speed and operational efficiency.

This program is envisaged to significantly change existing GO service over the next 10 years; the cumulative impact on the way people can travel across the region will be transformational.

In particular, over the next decade, Metrolinx will transform the GO rail network into an RER system. This will include:

- Adding tracks and expanding stations for 2WAD services.
- Electrification of much of the rail network.
- Acquiring electric locomotives and EMUs.
- Installing new train control systems to enable higher frequency services.
- Operating all-day services every 15 minutes on many of the corridors it owns and expanding services to many cities within the region.

RER is a proven solution to the passenger transport challenges of a large region like the GTHA. Buses, LRT and subways all have roles to play, but

without the \backbone\ of a fast, high-capacity RER system to complement the existing subway system, transit is not usually attractive for longer, non-radial and off-peak trips.

RER systems have been developed over the years in more than 50 city-regions globally. RER is the backbone that, together with local transit, enables trips across a large region that are competitive with travelling by car in speed, comfort and convenience. Typical RER systems:

- Use electric trains, with rapid acceleration and top speeds of 120 to 200 kilometres per hour. Many use double-deck or bi-level trains. Almost all have level-loading or near-level loading, from platform to train. All have control systems that enable frequent services to operate safely.
- Offer frequent all-day services, with trains every 10-15 minutes all day from \suburban\ areas up to 40 kilometres from the CBD, and every 15-30-60 minutes from communities up to 100 kilometres away. Services can be more frequent in peak hours, or as required to carry traffic. On some routes, there is a mix of express and local trains.
- Operate on surface corridors where available, but run in tunnels or on elevated structures where necessary. Alignments are almost always exclusive and not shared with road traffic, and level crossings are minimized.
- Have fares integrated and optimized with other transit services. Some regions operate a single electronic purse, such as PRESTO, but most go further and operate an integrated tariff with zonal fares and free transfers between modes (as on the TTC between buses and subways). Some operate more sophisticated market pricing, with peak and off-peak fares, higher fares for faster modes, and daily capping of the total fare that can be paid by customers.



Figure 7: Sydney's City Rail

Source: <http://sydneyexpert.com/my-multi-travel-tickets/>

Sydney Trains operates over more than 900 kilometres of electrified network serving Australia's largest city region. Despite higher car ownership than in Canada, the system attracts almost one million riders each weekday.

RER is branded with different names in different cities. Paris and Geneva have developed Réseau Express Régional (meaning Regional Express Network). Many German-speaking cities have developed S-Bahn (Stadtschnellbahn meaning fast citytrain), Copenhagen has the S-Tog, and Sydney has City Rail while Melbourne has M-Train. London has different brands for groups of lines, such as the Overground, Thameslink and Crossrail. But, they all have the same characteristics described above.

The GO rail network offers the potential for creating an RER system across the GTHA, scaled to the region. The seven corridors of the GO rail network are an invaluable asset. They make it possible to build an RER network that will connect the entire GTHA much as the subway connects the older parts of the City of Toronto, but without the need for expensive tunnels or large-scale property acquisition.

Several U.S. cities have electric commuter rail systems, but like GO today, they usually do not have frequent all-day services and often have poor fare integration with other modes.

With electric locomotives replacing diesels with the existing bi-level cars, along with other changes to track, signalling and operating procedures, peak trip times would be reduced by approximately 8%. Where off-peak and other services are operated with new EMUs, trip times would be between 5% and 20% faster.

Diesel locomotives with bi-levels (see Figure 8) may continue to operate longer-distance services that extend onto CN or CPR tracks, where there will likely be significant challenges and expense to increase service and electrify.

Metrolinx may also develop new stations where justified by potential traffic demand, to support new development and improve interchange with other transit services. However, for the purpose of this IBC, there is not currently sufficient information to determine where new stations may be located and therefore no new stations have been assumed. Additional work is being undertaken by Metrolinx on the potential addition of new stations, including work with the City of Toronto related to the SmartTrack initiative. This work will be presented in updated business case information when ready. Each station should be assessed on a case-by-case basis using business case analysis methodologies.

Table 2: More than 50 Cities that have Implemented RER

ASIA	
Hong Kong, China	Nagoya, Japan
Fukuoka, Japan	Osaka, Japan
Hiroshima, Japan	Tokyo, Japan
Kobe, Japan	Yokohama, Japan
Kyoto, Japan	
EUROPE	
Vienna, Austria	Milan, Italy
Brussels, Belgium	Amsterdam, Netherlands
Copenhagen, Denmark	Rotterdam, Netherlands
Tallinn, Estonia	Oslo, Norway
Paris, France	Lisbon, Portugal
Berlin, Germany	Barcelona, Spain
Cologne - Bonn, Germany	Madrid, Spain
Dortmund, Germany	Stockholm, Sweden
Dusseldorf, Germany	Basel, Switzerland
Essen, Germany	Geneva, Switzerland
Frankfurt, Germany	Zurich, Switzerland
Hamburg, Germany	Istanbul, Turkey
Hanover, Germany	Birmingham, United Kingdom
Leipzig, Germany	
Mannheim, Germany	Glasgow, United Kingdom
Munich, Germany	Liverpool, United Kingdom
Stuttgart, Germany	London, United Kingdom
Dublin, Ireland	
NORTH AMERICA	
Mexico City, Mexico	
SOUTH AMERICA	
Buenos Aires, Argentina	São Paulo, Brazil
Rio de Janeiro, Brazil	
AUSTRALIA	
Brisbane, Australia	Sydney, Australia
Melbourne, Australia	Auckland, New Zealand

Together with improvements to local and regional transit, investments in complementary subway, LRT, BRT, and mobility hub programs and projects underway as part of the RTP, RER will make transit once again a more attractive mode for a wide range of intra-regional trips. It will enable continued growth and prosperity across the GTHA region. People in all parts of the region will be able to travel to most other parts of the region on transit, with journey times, comfort and cost that are competitive with using a private car. Employers will be able to draw on the workforce of the entire region, and educational and cultural centres will serve the entire region, whether they are located in downtown Toronto or at another node.

RER will also enable development of the GTHA as a more sustainable and socially cohesive city. By supporting more compact development, RER will complement the growth plan, helping to protect agricultural land and protected areas including the Greenbelt, Niagara Escarpment and conservation areas.

While GO now owns most of its own infrastructure, implementing RER on the Kitchener and Milton corridors, and on the Lakeshore corridor beyond Burlington, will depend on agreement with CN and CPR to reduce conflicts between increased passenger services and freight rail services. Full delivery of the RER concept on these routes will rely upon successful negotiation and agreement with CN and CPR.

On the Richmond Hill corridor, plans need to be developed for addressing flooding issues in the Don River valley, as well as discussions with CN for the part of the line that operates on its tracks.



1: Current GO Train Fleet



2: Future 12-car EMU



3: Future 8-car EMU



4: Future 4-car EMU

Figure 8: Current and Future Fleet Options

Currently GO operates all rail services with 10 or 12-car trains powered by diesel locomotives (Image 1) which are an efficient way to move large numbers of peak commuters. RER will operate a mixed fleet including 12-car EMUs (Image 2) and 8-car EMUs (Image 3) with the ability to split into shorter train sets. EMUs cost less to operate than 12-car diesel trains and have faster acceleration. They can be split into smaller 4-car trains (Image 4) during periods of lighter demand for example at the weekend, yielding even greater cost savings. GO's existing fleet of unpowered bi-level cars will still be used to operate many peak services, but will be mostly powered by electric locomotives (not shown above). Journey times can be reduced significantly with electric traction depending on the route, stopping pattern and equipment.

1.4 How Metrolinx uses Business Cases to Select, Evaluate and Specify Large Projects like GO RER

The Metrolinx Business Case Framework (BCF) is a single, high-level process that can be applied universally to all Metrolinx investments. The framework's objective is to provide proportionate but not prescriptive information to decision makers in a timely and consistent format. It is based on recent advances in international best practices.

Business case analysis includes both quantitative and qualitative impact information that comprehensively indicates the expected performance of a proposed investment by addressing the following issues:

- Is the investment supported by an explanation of how it fits with strategic objectives (**The Strategic Case**)?
- Does the investment demonstrate value for money measured in economic terms and is it affordable? (**The Economic Case and the Financial Case**).
- How will the project be procured, delivered and operated? (**The Delivery and Operations Case**).

The following diagram describes conceptually the architecture of the Metrolinx Business Case Framework.

Business case development is a continuous and iterative process. It follows the following eight-step process:

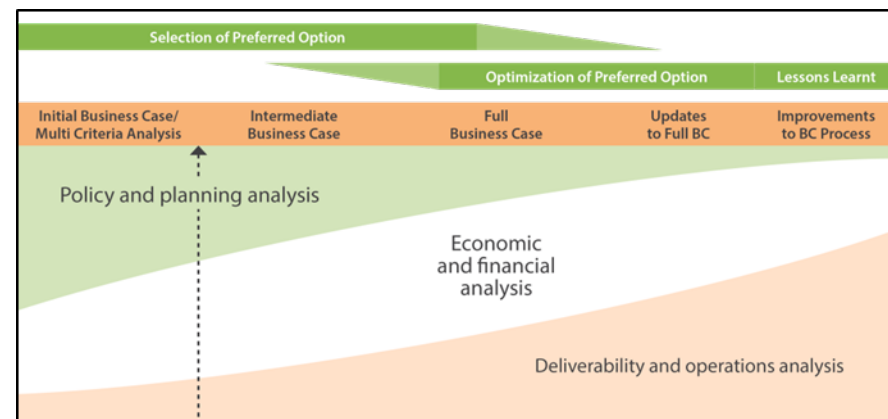


Figure 9: The Business Case Lifecycle

- **Step 1** – define a problem statement
- **Step 2** – define objectives and outputs against which the intervention can be measured and monitored
- **Step 3** – define a base case
- **Step 4** – define a baseline future-year transportation network
- **Step 5** – develop options
- **Step 6a** – assess contribution to strategic objectives
- **Step 6b** – assess deliverability and operational solutions
- **Step 6c** – assess lifecycle costs and benefits at current prices
- **Step 7** – assemble the business case evidence
- **Step 8** – continuously refine and develop the business case

1.5 Why Five Scenarios

This IBC is used to scope the RER program by defining, analyzing and reporting the feasibility, costs and benefits of various scenarios of GO RER service and infrastructure. This process helps in selecting a recommended scenario, which cannot be determined until an appropriate number of scenarios are analysed. In the RER business case, Scenario 1 (Do Minimum) is the base case which assumes a continuation of today's peak-focused service patterns and diesel technology. All other scenarios are compared to this base case. Scenario 2 (Two-Way All-Day) and Scenario 3 (10-Year Plan) consider more frequent all-day service, looking at the costs and benefits of all-diesel and some limited electrification. Scenario 4 (Full Build) is a "maximum-build" scenario, with frequent all-day service and electrification on all lines. These four scenarios were analysed so that different levels of service and infrastructure could be assessed and compared to understand how service and infrastructure would achieve strategic objectives, how much they would cost to build and operate, how effective they would be at generating benefits, all while considering deliverability constraints. Scenario 5 (10-Year Plan Optimized) was then developed to achieve better results with available funds and a 10-year build period for delivery. The final recommended RER program will provide further refinements and incorporate elements of other additional scenarios to maximize benefits. This program includes electrification and frequent service on most inner corridors, while ensuring that actions are not taken that could make it harder to deliver the vision of electric RER on all corridors in the future.

Ideally, any large capital program should undergo this kind of alternatives or scenarios analysis to understand where the opportunities are and design a high-performing program. This kind of alternatives analysis will be applied as the service concept is further refined to test different options and help select the best possible performing system.

The next iterations of the business case will include further optimization and improved estimation of key metrics and interdependencies, including ridership, service and fare integration. As the quality and depth of the evidence improves, greater certainty will increase the performance of the program once it is operational, while managing and decreasing outstanding risk to the program.

1.6 Why RER

GO RER will enable the GTHA to continue to grow, supported by accessing capacity provided by an improved transit and transportation system. The Transportation Tomorrow Survey shows the growth in demand from 1986 to 2011 on various transport modes.

Since 1986, highways into the Toronto downtown have been at capacity during the morning peak period, meaning that the majority of growth in travel has been accommodated by transit⁸ — TTC and GO — as shown in Figure 10.

Between 2006 and 2011, morning peak period GO Transit trips into the downtown increased by 35%, a rate similar to the TTC's growth of 39%. Yet with subways and streetcars at capacity, no new room on the highways and continued growth of rush-hour trips into the downtown, increasing GO Transit service to Union Station represents the most viable solution to facilitate job growth in the region's core.

⁸ There has also been a noticeable increase in AM peak-period active transportation trips destined for downtown Toronto. Between 1986 and 2011, active transportation trips increased by 27,500. Between 2006 and 2011, AM peak active transportation trips grew by over 13,000. This increase could reflect the condominium boom that has occurred, reducing trip distances for those employed in downtown Toronto. Data sourced from Transportation Tomorrow Survey 2011.

Trips to Downtown Toronto, 6. a.m. - 9 a.m.

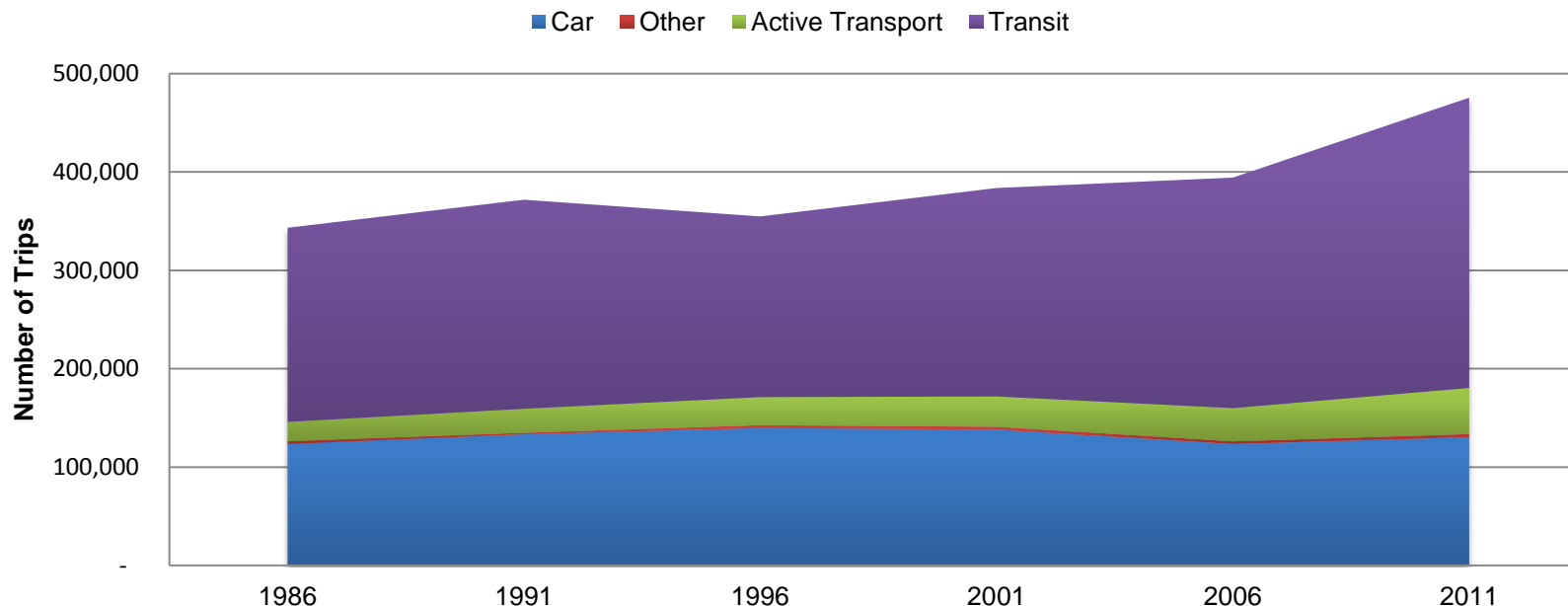


Figure 10: Trips to Downtown Toronto, 6 a.m. - 9 a.m.

Downtown Toronto is the cultural and activity hub of a region of 9 million people. It is already a successful transit hub not just for commuting but for all types of travel. Outside of the morning peak period, more than one third of all weekday trips into the downtown core are made on transit, as shown in Figure 11. Yet driving during these times is also increasing. Between 2006 and 2011, average daily car trips to the downtown outside the morning peak period grew by 16,000, compared with less than 4,000 by GO Rail. Meanwhile, over 55,000 new trips were made by walking, cycling and TTC.

As congestion on the Gardiner Expressway and Don Valley Parkway has spread from peak period to all times of the day, new off-peak options for longer distance, regional travel into downtown is necessary to maintain and improve regional access to downtown Toronto's services and cultural offerings. RER is the most efficient and effective way to keep the region connected to its core.

Trips to Downtown Toronto, Before 6 a.m. and After 9 a.m.

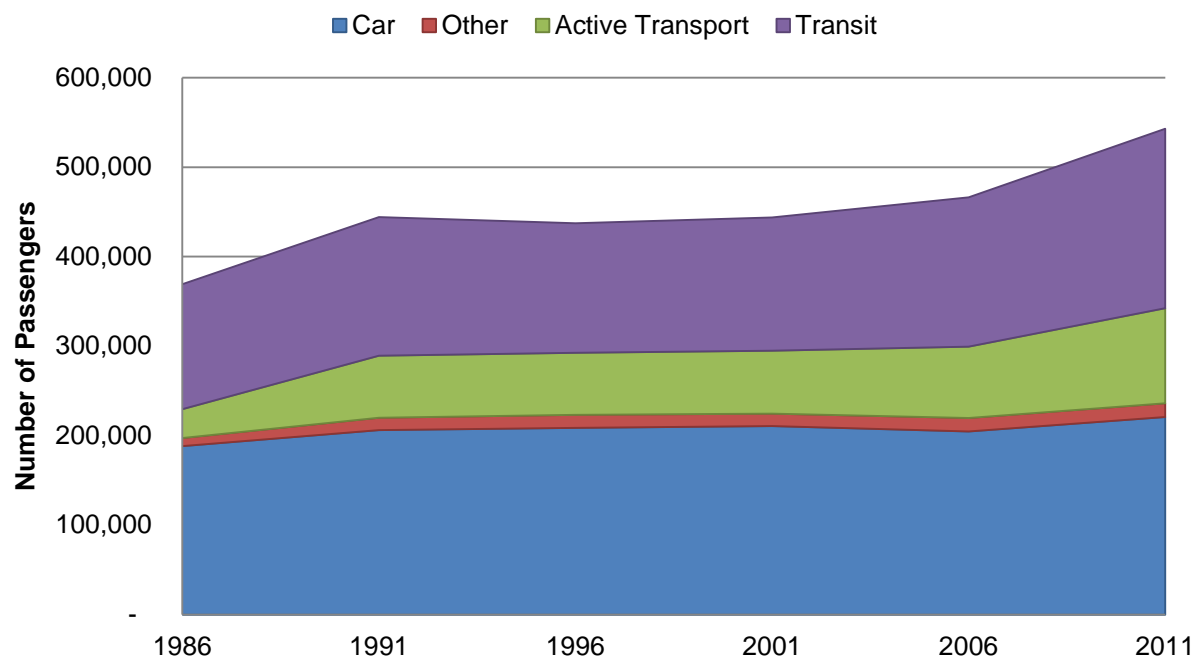


Figure 11: Trips to Downtown Toronto, Before 6 a.m. and After 9 a.m.

Outside the downtown core, rush hour trips into suburban municipalities outside Toronto have skyrocketed since 1986, reflecting significant population and job growth, as shown in Figure 12. Morning peak period trips to destinations in Durham, York, Peel, Halton and Hamilton have grown from just over 870,000 in 1986 to 1,960,000 in 2011 — a trip growth rate more than double the regional average.

Since 1986, 90% of new peak period trips (970,000 trips) to suburban municipalities outside Toronto have been made by car, with transit serving just 3% of the growth in travel. Highways have provided suburban residents access to jobs across the region at reasonable travel times; with congestion, these travel times threaten to limit access. GO RER provides a new regional travel option for these travellers, whether it is a suburb-to-suburb commute or a recreational weekend trip with the family.

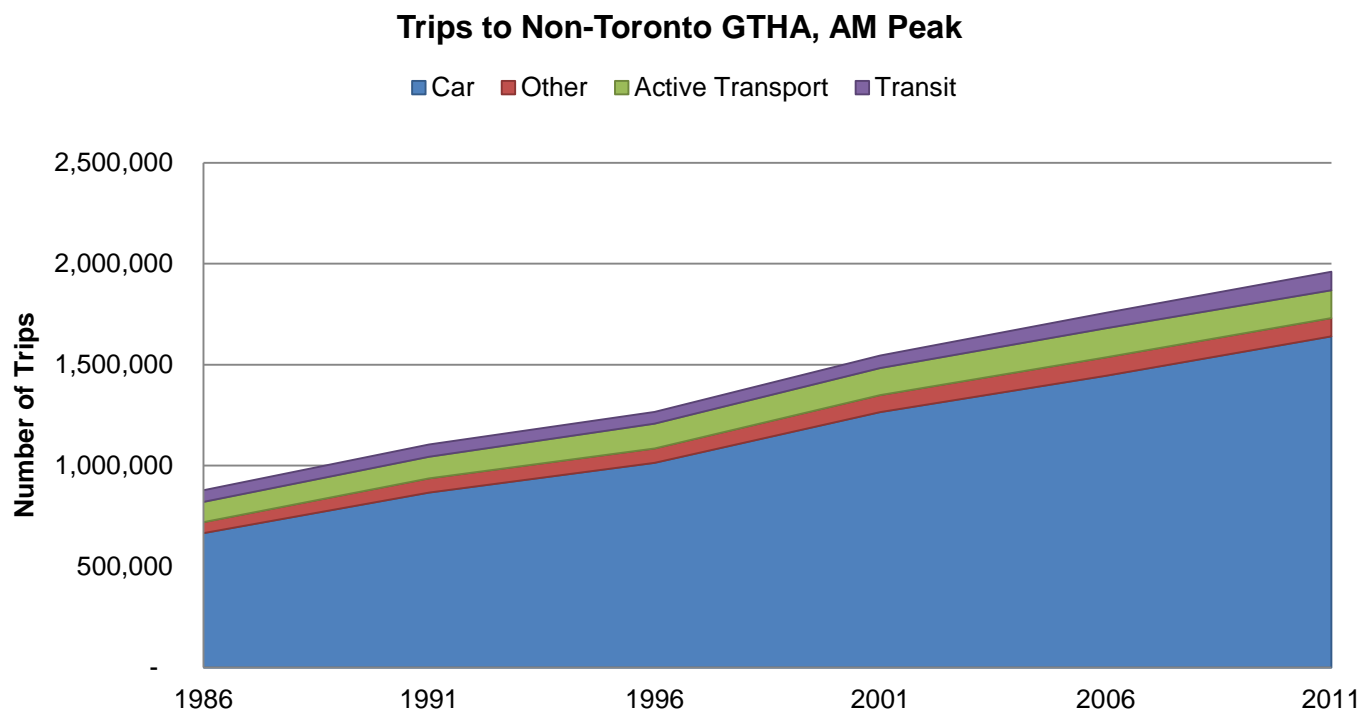


Figure 12: Trips to Non-Toronto GTHA, AM Peak

Residential and employment growth in the Toronto downtown continues to grow, and reshape the travel patterns and needs of the Toronto downtown core. Between 2006 and 2011, trips leaving the Toronto downtown core in the morning peak period grew by over 22,000, as shown in Figure 13. Yet, there is an almost even distribution between trips starting in the core during the morning peak period that are made by transit, driving or walking/cycling.

Transit and walking/cycling are growing at the fastest rate and if the Toronto downtown is to continue its growth, its access to the region must be improved. GO RER, with its focus around Union Station, is best positioned to provide that access.

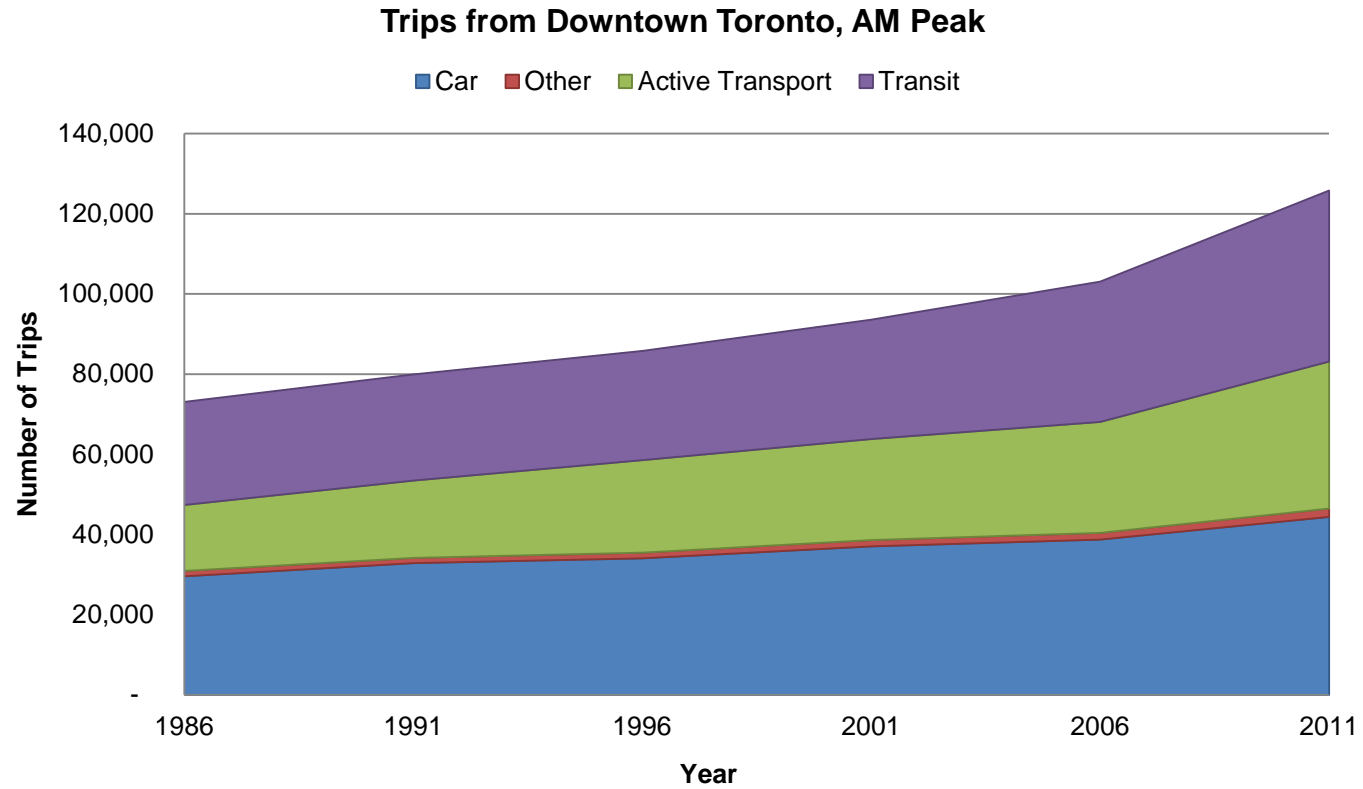


Figure 13: Trips from Downtown Toronto, AM Peak

1.7 Electric vs. Diesel

The first electric railway opened in 1883 (the Volks Tourist Railway on the Brighton seafront in the U.K.). Ever since that time, electric traction has increasingly become the default source of power for the world's more intensively used rail systems. Although the spread of electric railways globally was initially driven by necessity (in particular, rail systems that operate primarily underground and for which steam traction was particularly poorly suited, for example the Deux Montagnes line in Montreal), electrification has also been driven by the opportunity to capture financial efficiencies and drive economic optimization. Specifically, it has been the global experience that once a threshold level of intensity of operation has been reached, the capital cost of electrification becomes outweighed by operational efficiencies and broader economic benefits to society.

Until recently, diesel traction has been the appropriate mode of traction for the GO rail operation. However, the service enhancements envisaged in the near future will take GO rail beyond the threshold of service intensity appropriate for electrification. Continued use of diesel traction will become a source of financial and economic inefficiency. This conclusion is consistent with the findings of the Metrolinx Electrification Study, which was completed in 2010 and which envisaged a level of off-peak service equivalent to approximately one train per hour on most corridors and in most directions. The level of off-peak service anticipated within GO RER contained within this IBC has four trains per hour — approximately four times more intense a service than studied within the Electrification Study. Therefore, the case for electrification, given the level of service now anticipated within the recommended RER program, is stronger than previously anticipated.

Figure 14 illustrates the operating costs of alternative types of train configuration.

Further detail regarding the capital and operating costs of diesel and electric traction is contained within subsequent chapters and appendices. A sensitivity test has been completed assessing the incremental economic case of operating all the electric services proposed in Scenario 5 (10-Year Plan Optimized) with diesel power.

The results of this test show that the BCR of an all-diesel service would be much lower, 1.8:1 compared with 3:1 with electrification. Although capital expenditure would be less, operating costs would be higher. Ridership, revenues and transport benefits would be lower, because trips would take longer.

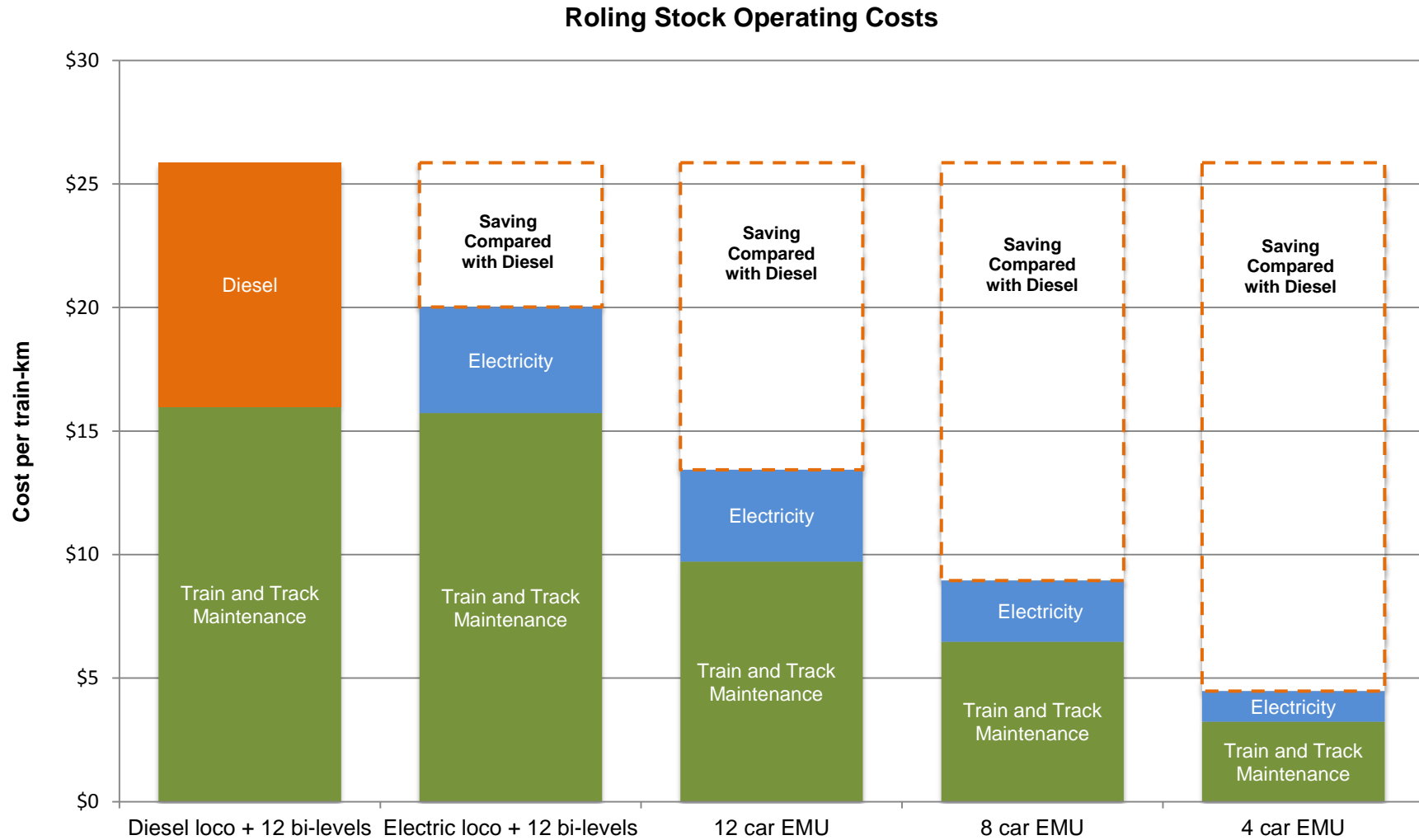


Figure 14: Rolling Stock Operating Costs

1.8 How RER Pays its Way

The recommended RER program is estimated to cost approximately \$13.5 billion to construct and approximately \$500 million each year to operate. The Province will need to finance the capital cost and continue to support GO's regional bus operations. Initial indications are that all of the operating costs and a significant share of the capital costs of RER will be repaid over time from passenger revenues. This conclusion is consistent with the experience of other RER systems in city and regions with population densities, car ownership and road systems similar to the GTHA.

The remaining net capital subsidy is justified by the benefits that society will realize from enhanced mobility. In the long term, greater tax revenues will be realized from higher productivity of the region as a result of the RER investment.

GO's current rail service already recovers approximately 80% of direct operating costs from fares.⁹ This is very good performance in the North American context, but some RER systems in Europe, South America and Asia generate revenues that cover more than 150% of direct operating costs. (See examples provided in Appendix E.) The operating surpluses can pay back a share of capital costs.

Figure 15 shows the growth of peak and off-peak ridership for each corridor in Scenario 5 (10-Year Plan Optimized) from 2014 to 2029. Figure 16 shows a comparison between revenues and operating costs for commuter rail and RER in Scenario 5 (10-Year Plan Optimized). Figure 16 also includes amounts for potential parking revenues should GO adopt a pay-for-parking policy.

While GO's service would triple over the years 2014 to 2029, operating costs will not rise at the same rate. It costs less on a net basis to operate an EMU compared to a 12-car diesel because EMU trains can be sized to meet demand more easily, will attract more off-peak riders with their faster acceleration and provide shorter journey times.

⁹ This is the average for the existing GO rail network. New all-day services introduced on an ad hoc basis and using diesel traction are likely to recover a much lower share of incremental costs.

Ridership: 2014 to 2029 (Scenario 5 – Optimized)

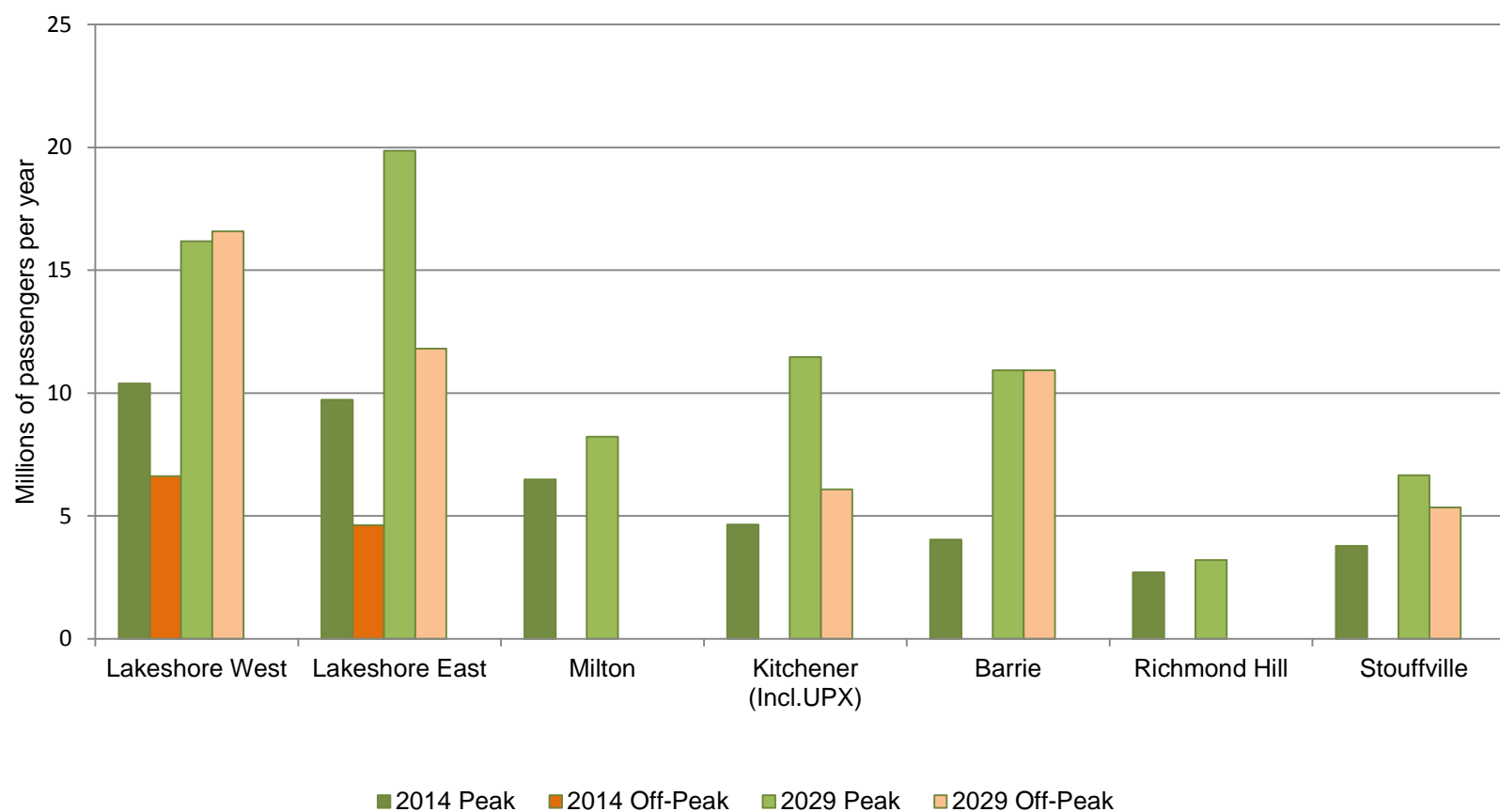
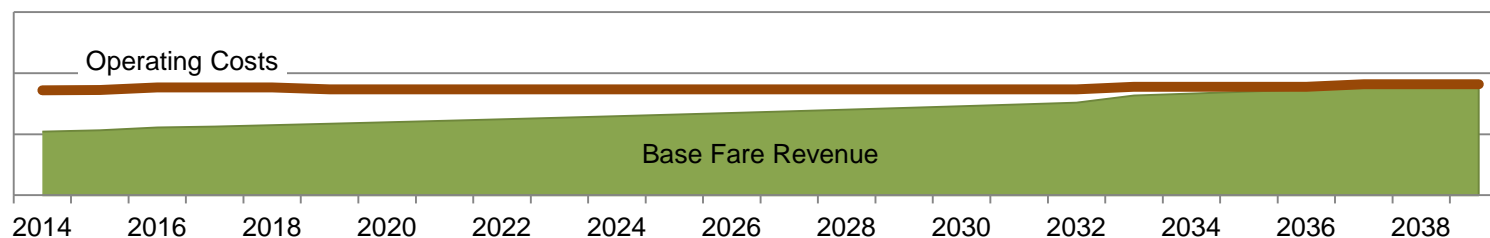


Figure 15: Ridership in Different Years, Peak and Off-Peak, Indicating Forecasted Growth (Scenario 5 (10-Year Plan Optimized))

Note: Off-peak ridership for 2014 on the Milton, Kitchener, Barrie, Richmond Hill and Stouffville corridors is for train-bus services.

Scenario 1 – Commuter Rail (2014 - 2039)



Scenario 5 – Regional Express Rail (2014 - 2039)

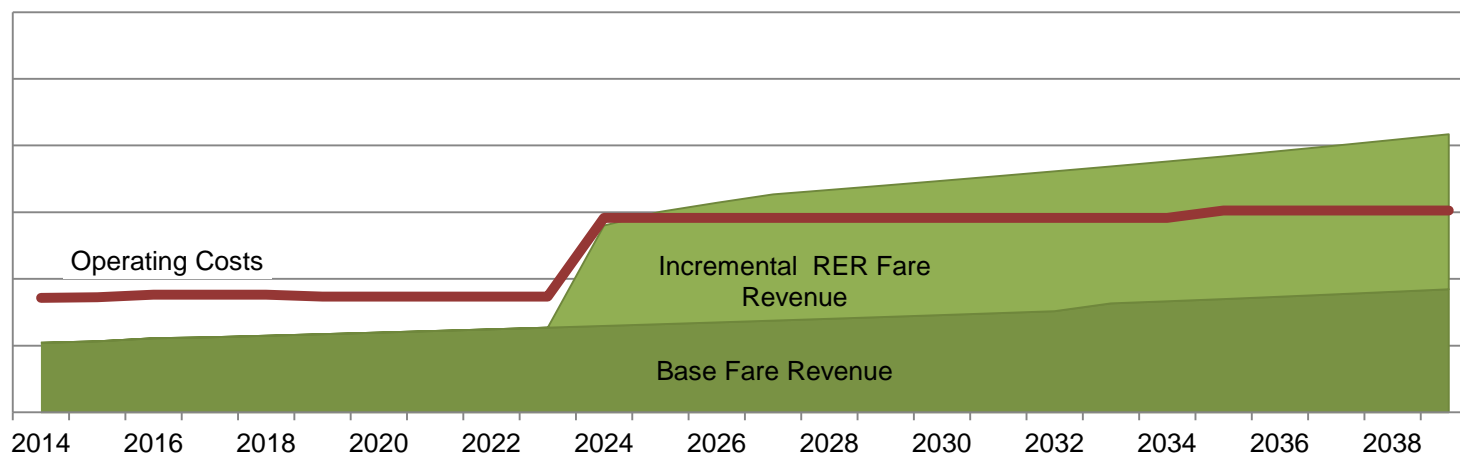


Figure 16: Revenues and Operating Costs – Prototypical RER Corridor

This chart shows the revenue and operating cost impacts of RER on the Stouffville corridor, which is prototypical of GO's seven corridors. Continuing GO's current Commuter Rail Business Model (CRBM), revenues rise slightly above operating costs after 2030 and begin to produce a modest surplus. With RER, ridership and revenues triple. Operating costs only double, generating large operating surpluses which can pay back much of the capital cost required to deliver it. If GO also begins to charge for parking, as on the TTC and almost all other RER systems, it can generate even larger surpluses.

1.9 How much Regional Express Rail and Where?



Figure 17: Swiss RER (Zurich S-Bahn)

Source: Metrolinx

Zurich's S-Bahn in Switzerland is an excellent example of RER that is fast, frequent and attractive. It contributes significantly to the mobility of people and business in that particular region.

Consistent with international best-practices, Metrolinx has evaluated the costs and benefits of different levels of infrastructure and service, including different all-day and weekend service levels on each GO rail corridor. This evaluation allows comparison of different options so that the highest performing, greatest value-for-money option can be recommended and selected. The options considered for each scenario on all corridors include:

- Commuter rail, with peak-period, peak direction services, as is currently offered on the Milton, Kitchener, Barrie, Richmond Hill and Stouffville corridors.
- Two-Way All-Day service, with diesel powered trains operating all-day every hour or, as currently offered, every half hour on the Lakeshore corridor.
- Diesel RER (RER-D), with diesel-powered trains operating all-day, every 15 minutes.
- Electric RER (RER-E), with electric trains all day, every 15 minutes.

In this IBC, corridor options have been evaluated using an integrated spreadsheet model. Train service plans were developed for each corridor, for the peak, contra-peak, off-peak and weekends. Required rolling stock, infrastructure and other capital investment was identified, with cost estimates. The model generates capital and operating cost estimates, together with estimates of ridership, revenues and benefits, over a 60-year period. Future costs and benefits are discounted to 2014 at 3.5%.

As infrastructure and service concepts are designed and refined, business case analysis will be used to test alternatives, further enhancing the financial and economic performance of the system.

In addition to the definition of train services and infrastructure, more than 100 other cost and economic assumptions are reflected in the model. Key assumptions are set out in Appendix C.

Explanation of the basis of the assumptions is set out in the relevant sections of this IBC. The model can be used to perform a sensitivity analysis of assumptions. A sensitivity analysis of some key economic assumptions is presented in Appendix E.

Although different service levels may be appropriate for different corridors, there are many interactions and synergies between the corridors, so the RER program also needs to be evaluated as a single system. In theory, there are thousands of possible combinations.

To enable an understanding of the strategic choices, the five scenarios were defined, testing a range of service levels and therefore different levels of capital investment. Table 3 shows the definition of each scenario for each corridor. Table 4 through Table 7 show the options tested on each of the seven rail corridors.

For full details of services, infrastructure and capital costs, please see Appendix A and Appendix B. For detailed financial and economic results of the analysis for all corridors in all scenarios, please see Appendix C. The extent of services for the recommended RER program are shown in Figure 18 and Figure 19. The existing peak service would remain on all corridors, with trains added to meet growth and demand. Where corridors are electrified, diesel locomotives would be replaced with electric locomotives. Additional services, as required to meet peak demand growth beyond the capacity added to operate frequent all-day services, is assumed to be operated with bi-level coaches powered by electric locomotives.

The case for electrification with EMUs on the Lakeshore West and Lakeshore East corridors is clear (see Table 4). The BCR is very high, more than 7:1. Operating surpluses will pay back close to the entire \$3.4 billion capital investment within 20 years and generate a net positive financial return of more than \$3.5 billion over 60 years. Both corridors have similar revenues but the Lakeshore West has higher operating costs. This is because it includes an hourly all-day service to Hamilton. This service is assumed to be operated with diesel locomotives because of the challenges of electrifying parts of the CN and CPR main lines.

While capital costs are lower in Scenario 3 (10-Year Plan) with use of electric locomotives and GO's existing bi-levels, operating costs are higher, in part because with slower trips, more trains are required to operate the same off-peak service frequency. The faster acceleration of EMUs allows operational savings that can help to pay back the additional investment.

It is important to note that the BCR, as shown, are calculated by dividing the incremental benefits of a given scenario by the incremental costs of a given scenario. For example, the BCR of Scenario 5 is the benefits of Scenario 5 (10-Year Plan Optimized) divided by the cost of Scenario 5 less the costs of Scenario 1.

Table 3: Definition of Scenarios

	Scenario 1 (Do Minimum)	Scenario 2 (Two-Way All-Day)	Scenario 3 (10-Year Plan)	Scenario 4 (Full Build)	Scenario 5 (10-Year Plan Optimized)	Other Options Tested
Lakeshore	Existing half hourly all day Aldershot - Oshawa (diesel) Peak services Hamilton - Union (diesel)	Half hourly all day Aldershot - Oshawa (diesel) Hourly all-day Hamilton - Union (diesel, express from Oakville)	Every 15 minutes Aldershot - Oshawa (electric locomotives) Hourly all-day Hamilton - Union (diesel, express from Oakville)	Every 15 minutes Aldershot - Oshawa (EMU) Hourly all-day Hamilton - Union (diesel, express from Oakville)	Every 15 minutes Aldershot - Oshawa (EMU) Hourly all-day from Hamilton - Union (diesel, express from Oakville)	
Milton	Existing peak only service (diesel)	Hourly all-day service to Meadowvale (diesel)	Existing peak only service (diesel)	Every 15 minutes all-day from Milton (EMU)	Existing peak only service (diesel)	
Kitchener	Existing peak only service (diesel) UP Express (DMU)	Hourly all-day service (diesel) UP Express (DMU)	Every 15 minutes all day from Mt. Pleasant (diesel) UP Express (DMU)	Every 15 minutes all day from Mt. Pleasant (EMU) Half hourly from Kitchener (EMU, Express from Bramalea) UP Express (EMU)	Every 15 minutes all day from Bramalea (EMU) UP Express (EMU)	Hourly all day from Kitchener (diesel, express from Bramalea) increment to Scenario 3 and Scenario 5
Barrie	Existing peak-only service (diesel)	Hourly all-day service (diesel)	Every 15 minutes all day from Aurora (diesel). One in four trains extended to Barrie	Every 15 minutes all day from East Gwillimbury (EMU). Hourly all day from Barrie (EMU, express from Aurora)	Every 15 minutes all day from Aurora (EMU). Hourly all day from Barrie (EMU, express from Aurora)	Hourly all day from Barrie as extension of stopping service instead of express increment to Scenario 4
Richmond Hill	Existing peak-only service (diesel)	Hourly all-day service to Richmond Hill (diesel)	Existing peak-only service (diesel)	Every 15 minutes all day from Richmond Hill (EMU).	Existing peak-only service (diesel)	
Stouffville	Existing peak-only service (diesel)	Hourly all-day service (diesel)	Every 15 minutes all day from Unionville (diesel). One in four trains extended to Mt. Joy	Every 15 minutes all day from Unionville (EMU). One in four trains extended to Mt. Joy	Every 15 minutes all day from Unionville (EMU). One in four trains extended to Mt. Joy	

Note: Milton peak-only service has been modelled for Scenario 3 (10-Year Plan) and Scenario 5 (10-Year Plan Optimized) due to the limitations imposed by the freight service operators. Richmond Hill peak-only service (per existing) has been modelled due to the unknown flood mitigation costs of operating within the Don Valley.

Note 2: Other service patterns, such as higher frequency service and alternate stopping patterns, will be analyzed and presented in future business case updates when more information is available.

Table 4: Option/Increments Tested for the Lakeshore Corridor

2014 \$ Millions NPV Included in Scenarios	Lakeshore West				Lakeshore East			Lakeshore (combined)
	1	2	3	4, 5*	1, 2	3	4, 5*	4, 5*
Service Pattern								
Peak Service – As Existing Plus	Capacity added to match demand	Capacity added to match demand	Capacity added to match demand	Capacity added to match demand	Capacity added to match demand	Capacity added to match demand	Capacity added to match demand	Capacity added to match demand
All-Day Service – Inner	Existing half-hourly all-day Aldershot – Oshawa (diesel)	Half-hourly all-day Aldershot – Oshawa (diesel)	Every 15 minutes Aldershot – Oshawa (electric locomotives)	Every 15 minutes Aldershot – Oshawa (EMU)	Existing half-hourly all-day Aldershot – Oshawa (diesel)	Every 15 minutes Aldershot – Oshawa (electric locomotives)	Every 15 minutes Aldershot – Oshawa (EMU)	Every 15 minutes Aldershot – Oshawa (EMU)
All-Day Service – Outer	Peak services Hamilton – Union (diesel)	Hourly all-day Hamilton (diesel, express from Oakville)	Hourly all-day Hamilton (diesel, express from Oakville)	Hourly all-day Hamilton (diesel, express from Oakville)	Not applicable	Not applicable	Not applicable	Hourly all-day Hamilton (diesel, express from Oakville)
Ridership								
2029 Ridership (millions)	21	26	30	33	23	30	32	64
2014-2029 Ridership growth	24%	51%	77%	93%	62%	108%	121%	
2030 Off-Peak to Peak ratio	1:1.6	1:1.3	1:1.0	1:1.0	1:2.1	1:1.8	1:1.7	-
Financial								
Revenue (\$ m)	4,453	4,998	5,522	5,821	4,902	5,723	5,969	11,790
Operating Cost (\$ m)	2,423	2,877	3,279	2,827	2,310	2,525	2,120	4,948
Capital Investment (\$ m)	497	661	1,437	1,427	1,147	1,811	1,938	3,365
TOTAL COST (\$ m)	2,920	3,538	4,715	4,254	3,457	4,336	4,058	8,312
Incremental costs		618	1,796	1,334		879	601	1,935
60-Year Surplus (subsidy)	1,533	1,460	806	1,567	1,444	1,387	1,911	3,478
20-Year Surplus (subsidy)	368	214	(543)	(266)	(104)	(562)	(474)	(740)
Economic								
Transport Benefits (\$ m)	-	2,987	5,855	7,427	-	4,831	6,377	13,803
Incremental Costs		618	1,796	1,334		879	601	
Net Benefits (\$ m)	-	2,369	4,060	6,092	-	3,952	5,776	11,868
Narrow Benefit:Cost Ratio		25.1	4.9	-	-	53.1	-	-
Benefit: Cost Ratio		4.8	3.3	5.6		5.5	10.6	7.1
Conclusion	Do Minimum (Base Case)	Very Good	Very Good	Very Good	Do Minimum (Base Case)	Very Good	Very Good	Very Good

*Figures are for Scenario 5: figures for Scenario 4 will vary only slightly due to network effect. For more details of service plans, capital costs, infrastructure requirements, financial and economic results, refer to Appendix A, Appendix B and Appendix C. BCR ratios as shown are calculated as an increment over Scenario 1 (Do Minimum).

On the Milton corridor (Table 6), in Scenario 2 (Two-Way All-Day), the option was tested to add a third track to allow all-day service to Meadowvale. Such a move would be contingent on an agreement with the owner of the corridor, CPR. Costs appear to exceed benefits, although by a small margin.

Compared with Scenario 2 (Two-Way All-Day), net benefits are approximately 20 times greater in Scenario 4 (Full Build), with a frequent service every 15 minutes using faster EMUs. However, implementation of this scenario would be contingent upon agreement with CPR with respect to infrastructure needs and the electrification of the freight rail corridor. If a suitable agreement cannot be reached, the best solution is to continue operating only peak commuter rail service on the Milton corridor and this Do Minimum option is included in Scenario 5 (10-Year Plan Optimized).

On the Kitchener corridor (see Table 6), there is a very good case for frequent all-day services to Mt. Pleasant with diesel locomotives, as tested in Scenario 3 (10-Year Plan), or to Bramalea with EMUs as tested in Scenario 5 (10-Year Plan Optimized). The feasibility to increase service levels and electrify the line beyond Bramalea would be contingent upon an agreement with CN.

Infrastructure improvements and electrification of the Kitchener corridor to Bramalea would be supportive and represent progress toward achieving the SmartTrack concept.

If electrification is not possible beyond Bramalea due to freight ownership and operation on the corridor, it may be possible to operate an hourly all-day diesel service serving all stations to Kitchener. The incremental capital cost is approximately \$600 million. This option could be partially repaid from fares over 60 years.

UP Express Service would be electrified in Scenario 4 (Full Build) and Scenario 5 (10-Year Plan Optimized). The best financial and economic case for UP Express electrification is as part of the wider electrification of the Lakeshore and Kitchener corridors.

Table 5: Options/Increments Tested for the Milton Corridor

2014 \$ Millions NPV	Milton		
Included in Scenarios	1, 3, 5*	2	4
Service Pattern			
Peak Service – As Existing Plus	Capacity constrained	Capacity added to match demand	Capacity added to match demand
All-Day Service – Inner	Peak-only service	Hourly all-day Meadowvale (diesel)	Every 15 minutes Milton (EMU)
All-Day Service – Outer	Not applicable	Not applicable	Not applicable
Ridership			
2029 Ridership (millions)	8	13	24
2014-2029 Ridership growth	27%	104%	276%
2030 Off-peak to Peak ratio	1:3.7	1:1.9	1:1.0
Financial			
Revenue (\$ m)	1,810	2,385	3,611
Operating Cost (\$ m)	1,080	1,431	1,599
Capital Investment (\$ m)	329	984	2,216
TOTAL COST (\$ m)	1,409	2,415	3,816
Incremental costs		1,006	2,407
60-Year Surplus (subsidy)	401	(30)	(205)
20-Year Surplus (subsidy)	(15)	(578)	(1,468)
Economic			
Transport Benefits (\$ m)	-	1,267	8,058
Incremental Costs		1,006	2,407
Net Benefits (\$ m)	-	261	5,651
Narrow Benefit: Cost Ratio	-	0.2	7.2
Benefit: Cost Ratio		1.3	3.3
Conclusion	Do Minimum (Base Case)	Fair	Very Good

*Figures are for Scenario 1; figures for Scenario 3 and Scenario 5 will vary only slightly due to network effect. For more details of service plans, capital costs, infrastructure requirements, financial and economic results, refer to Appendix A, Appendix B and Appendix C. The BCR, as shown, are calculated as an increment over Scenario 1 Do Minimum. Figures in parentheses are negative numbers. They are shown in red text and highlighted in pink for clarity. For definition of Narrow Benefit:Cost Ratio, see Section 4.5.

Table 6: Options/Increments Tested for the Kitchener Corridor

2014 \$ millions NPV Included in Scenarios	Kitchener (including UPX)							Increment of 5(a) over 5
Service Pattern	1	2	3	3 (a)	4	5	5 (a)	
Peak Service – As existing plus	Capacity constrained beyond Bramalea; UPX every 15 minutes (DMU)	Capacity added to match demand; UPX every 15 minutes (DMU)	Capacity constrained beyond Bramalea; UPX every 15 minutes (DMU)	Capacity added to match demand; UPX every 15 minutes (DMU)	Capacity added to match demand; UPX every 15 minutes (EMU)	Capacity constrained beyond Bramalea; UPX every 15 minutes (EMU)	Capacity added to match demand; UPX every 15 minutes (EMU)	
All-Day Service – Inner	Peak-only service; UPX every 15 minutes (DMU)	Hourly all day (diesel); UPX every 15 minutes (DMU)	Every 15 minutes Mount Pleasant (diesel); UPX every 15 minutes (DMU)	Every 15 minutes Mount Pleasant (diesel); UPX every 15 minutes (DMU)	Every 15 minutes Mount Pleasant (EMU); UPX every 15 minutes (EMU)	Every 15 minutes Bramalea (EMU); UPX every 15 minutes (EMU)	Every 15 minutes Bramalea (EMU); UPX every 15 minutes (EMU)	
All-Day Service – Outer	Peak-only service	Hourly all-day Kitchener (diesel)	Peak-only service	Hourly all-day Kitchener Express from Bramalea (diesel);	Half Hourly all-day Kitchener EMU Express from Bramalea	Peak-only service	Hourly all-day Kitchener Express from Bramalea (diesel)	
Ridership								
2029 ridership (millions)	10	15	18	20	25	18	23	-
2014-2029 ridership growth	105%	214%	288%	330%	448%	278%	393%	-
2030 Off-Peak to Peak ratio	1:3.3	1:1.5	1:1.3	1:1.0	1:1.0	1:1.9	1:1.0	-
Financial								
Revenue (\$ m)	2,820	3,566	3,983	4,258	5,066	3,972	4,740	768
Operating Cost (\$ m)	1,878	2,638	3,292	4,372	3,280	2,414	2,998	584
Capital Investment (\$ m)	558	2,301	2,047	2,767	4,131	2,513	3,221	708
TOTAL COST (\$ m)	2,437	4,938	5,340	7,139	7,412	4,928	6,219	-
Incremental costs	-	2,502	2,903	4,702	4,975	2,491	3,782	1,291
60-Year Surplus (subsidy)	383	(1,373)	(1,356)	(2,881)	(2,346)	(956)	(1,479)	(524)
20-Year Surplus (subsidy)	(175)	(1,969)	(1,892)	(2,941)	(3,508)	(1,886)	(2,594)	(707)
Economic								
Transport Benefits (\$ m)	-	2,171	4,826	6,375	9,955	4,560	8,919	4,359
Incremental costs	-	2,502	2,903	4,702	4,975	2,491	3,782	1,291
Net Benefits (\$ m)	-	(330)	1,923	1,673	4,980	2,069	5,136	3,068
Narrow Benefit:Cost Ratio	-	0.4	1.5	1.1	2.1	1.8	2.8	-
Benefit: Cost Ratio	-	0.9	1.7	1.4	2.0	1.8	2.4	3.4
Conclusion	Do Minimum (Base Case)	Poor	Good	Fair	Good	Good	Good	Very Good

For more details of service plans, capital costs, infrastructure requirements, financial and economic results, refer to Appendix A, Appendix B and Appendix C. The BCR, as shown, are calculated as an increment over Scenario 1 Do Minimum. Figures in parentheses are negative numbers. They are shown in red text and highlighted in pink for clarity. For definition of Narrow Benefit:Cost Ratio see Section 4.5.

On the Barrie (Table 7) and Stouffville (Table 8) corridors, upgrading with high-frequency diesel trains has been evaluated in Scenario 3 (10-Year Plan). In both corridors, benefits exceed costs. However, revenues from a fully-electrified RER service are much higher while operating costs are lower. Net Benefits of electrified RER are approximately twice as high, with BCR of approximately 4:0 for electrified RER on Barrie and 2:4 on Stouffville. Infrastructure improvements and electrification of the Stouffville corridor (which includes key segments of the Lakeshore East corridor) would be supportive and represent progress toward achieving the SmartTrack concept.

CRBM has been used to test the option to extend 15-minute all-day services to Aurora or East Gwillimbury, the latter also serving Newmarket. Initial analysis suggests the additional revenue and benefits of extending the frequent all-day service would offset the additional capital and operating costs. While the BCR is slightly lower, the net benefits are marginally higher in Scenario 4 (Full Build) which includes the extended service. Further study is required to better understand the costs and benefits of extending RER service into Newmarket. Scenario 5 (10-Year Plan Optimized) assumes frequent 15-minute all-day service to Aurora, with hourly EMU services to Allandale Waterfront (Barrie).

Separate analysis has shown that if the Barrie service were to be operated “express,” (likely from Aurora which would have five trains each hour to and from Union Station — one express and four all-stops), net benefits and the BCR can be improved. This is because the trains from Barrie in the peak period will be full by the time they get to Aurora. Most passengers are destined for downtown Toronto, so the inconvenience of a transfer to a local train for a few passengers destined to stations before Union Station is worth it to the many who will benefit from the faster journey times. Express trains, if scheduled correctly, could potentially fit in between the local

stopping trains, so that express and local services could be accommodated on a two-track corridor.

There is a good business case to electrify the entire Stouffville corridor to Lincolnville (Table 8). Scenario 5 (10-Year Plan Optimized) assumes: double track, 15-minute service to Unionville; hourly, all-day service to Mount Joy; and peak-period service to and from Lincolnville, assuming a single track beyond Unionville. Double tracking beyond Unionville would have significant local impacts as well as substantial costs, and there is no clear business case at this time to support this change. Unionville station is part of the Markham mobility hub and Urban Growth Centre, and will have good connections to York Viva BRT. It is a logical place to stop a high-frequency RER service. Further analysis is underway to determine whether it may be feasible to operate better than hourly all-day service to Markham or Mt. Joy over the single-track line as an extension of the Unionville service. There are reliable two-way services operating on short sections of single-track line on RER systems in other jurisdictions. More work is required to see if these operating practices can be applied to generate good ridership and benefit at a manageable cost on the Stouffville corridor.

Richmond Hill (Table 7) shows a good case for electrified RER; however no provision has been made for the significant costs of flood protection necessary in the lower Don Valley. Upgrading the line to electrified RER may well be worthwhile. However, further study is required to consider whether other options — such as a more limited upgrade combined with extension of the Yonge Subway — might give better value for money. There are other potential alignments that use parts of the Richmond Hill corridor, which are not explored in this document.

Table 7: Options/Increments Tested for the Barrie and Richmond Hill Corridors

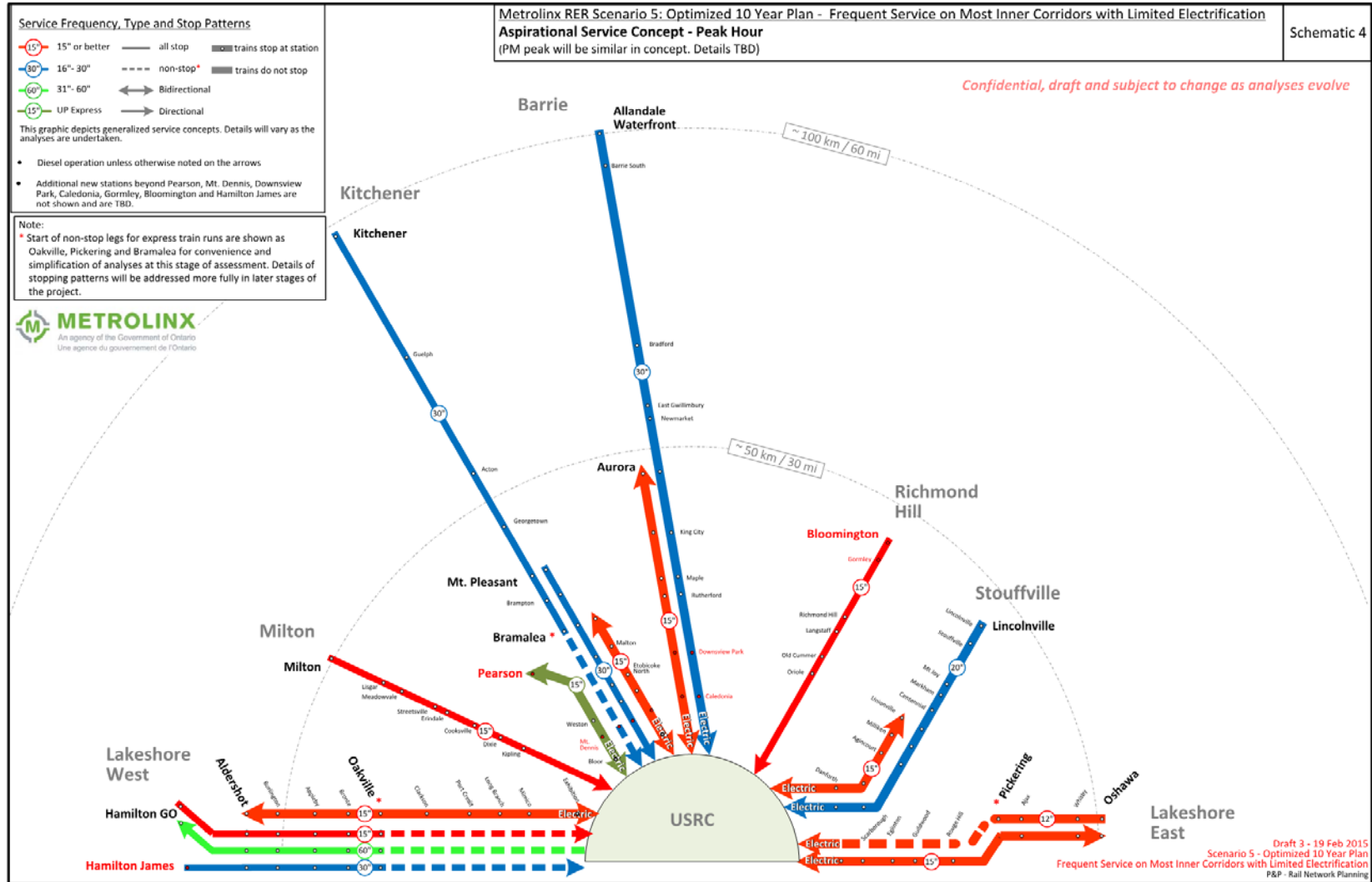
2014 \$ Millions NPV Included in Scenarios	Barrie					Richmond Hill		
	1	2	3	4	5	1, 3, 5*	2	4
Service Pattern								
Peak Service – As Existing Plus	Capacity added to match demand	Capacity added to match demand	Capacity added to match demand	Capacity added to match demand	Capacity added to match demand	Capacity added to match demand	Capacity added to match demand	Capacity added to match demand
All-Day Service – Inner	Peak-only service	Hourly all stations Barrie (diesel)	Every 15 minutes Aurora (diesel)	Every 15 minutes East Gwillimbury (EMU)	Every 15 minutes Aurora (EMU)	Peak-only service	Hourly all stations (diesel)	Every 15 minutes EMU
All-Day Service – Outer	Peak-only service	Peak-only service	Hourly Barrie (diesel); Extension of Aurora service	Hourly all-day Barrie (EMU); Express from Aurora	Hourly all-day Barrie (EMU); Express from Aurora	Not applicable	Not applicable	Not applicable
Ridership								
2029 Ridership (millions)	8	13	17	23	22	3	6	10
2014-2029 Ridership growth	91%	234%	319%	475%	442%	18%	120%	260%
2030 Off-Peak to Peak ratio	1:5.0	1:1.7	1:1.1	1:1.0	1:1.0	1:14.4	1:1.7	1:1.2
Financial								
Revenue (\$ m)	2,018	2,909	3,327	4,281	4,102	597	854	1,204
Operating Cost (\$ m)	1,234	1,885	2,971	2,482	2,341	800	1,081	1,314
Capital Investment (\$ m)	796	2,086	1,982	3,063	2,650	71	342	1,366
TOTAL COST (\$ m)	2,030	3,972	4,954	5,545	4,991	871	1,422	2,680
Incremental costs		1,942	2,924	3,515	2,961		551	1,809
60-Year Surplus (subsidy)	(12)	(1,063)	(1,627)	(1,264)	(889)	(274)	(568)	(1,476)
20-Year Surplus (subsidy)	(491)	(1,770)	(2,028)	(2,580)	(2,179)	(236)	(521)	(1,496)
Economic								
Transport Benefits (\$ m)	-	3,617	6,652	12,524	11,780	-	1,086	3,539
Incremental Costs		1,942	2,924	3,515	2,961		551	1,809
Net Benefits (\$ m)	-	1,675	3,728	9,008	8,819	-	535	1,730
Narrow Benefit:Cost Ratio	-	1.1	1.9	5.1	7.0	-	1.7	1.8
Benefit: Cost Ratio		1.9	2.3	3.6	4.0		2.0	2.0
Conclusion	Do Minimum (Base Case)	Good	Good	Very Good	Very Good	Do Minimum (Base Case)	Good	Good

Figures are for Scenario 1; figures for Scenario 3 and Scenario 5 will vary only slightly due to network effect. For more details of service plans, capital costs, infrastructure requirements, financial and economic results, refer to Appendix A, Appendix B and Appendix C. The BCR, as shown, are calculated as an increment over Scenario 1 Do Minimum. Figures in parentheses are negative numbers. They are shown in red text and highlighted in pink for clarity. For definition of Narrow Benefit:Cost Ratio, see Section 4.5.

Table 8: Options/Increments Tested for the Stouffville Corridor

2014 \$ Millions NPV	Stouffville			
Included in Scenarios	1	2	3	4, 5*
Service Pattern				
Peak Service – As existing plus	Capacity added to match demand	Capacity added to match demand	Capacity added to match demand	Capacity added to match demand
All-Day Service – Inner	Peak-only service	Hourly all stations (diesel) from Mount Joy	Every 15 minutes Unionville (diesel)	Every 15 minutes Unionville (EMU)
All-Day Service – Outer	Peak-only service	Hourly all stations (diesel) from Mount Joy	One train per hour extended to Mount Joy	One train per hour extended to Mount Joy
Ridership				
2029 Ridership (millions)	5	8	11	12
2014-2029 Ridership Growth	33%	124%	182%	229%
2030 Off-peak to Peak ratio	1:5.1	1:1.9	1:1.4	1:1.2
Financial				
Revenue (\$ m)	1,059	1,448	1,685	1,888
Operating Cost (\$ m)	890	1,167	1,872	1,299
Capital Investment (\$ m)	156	1,016	1,159	1,319
TOTAL COST (\$ m)	1,046	2,183	3,031	2,619
Incremental costs		1,137	1,985	1,573
60-Year Surplus (subsidy)	13	(735)	(1,346)	(731)
20-Year Surplus (subsidy)	(126)	(937)	(1,323)	(1,214)
Economic				
Transport Benefits (\$ m)	-	1,085	2,952	3,830
Incremental Costs		1,137	1,985	1,573
Net Benefits (\$ m)	-	(52)	966	2,257
Narrow Benefit: Cost Ratio	-	0.3	1.2	2.7
Benefit: Cost Ratio		1.0	1.5	2.4
Conclusion	Do Minimum (Base Case)	Fair	Good	Good

*Figures are for Scenario 4; figures for Scenario 5 will vary only slightly due to network effect. For more details of service plans, capital costs, infrastructure requirements, financial and economic results, refer to Appendix A, Appendix B and Appendix C. The BCR, as shown, are calculated as an increment over Scenario 1 Do Minimum. Figures in parentheses are negative numbers. They are shown in red text and highlighted in pink for clarity. For definition of Narrow Benefit:Cost Ratio, see Section 4.5.



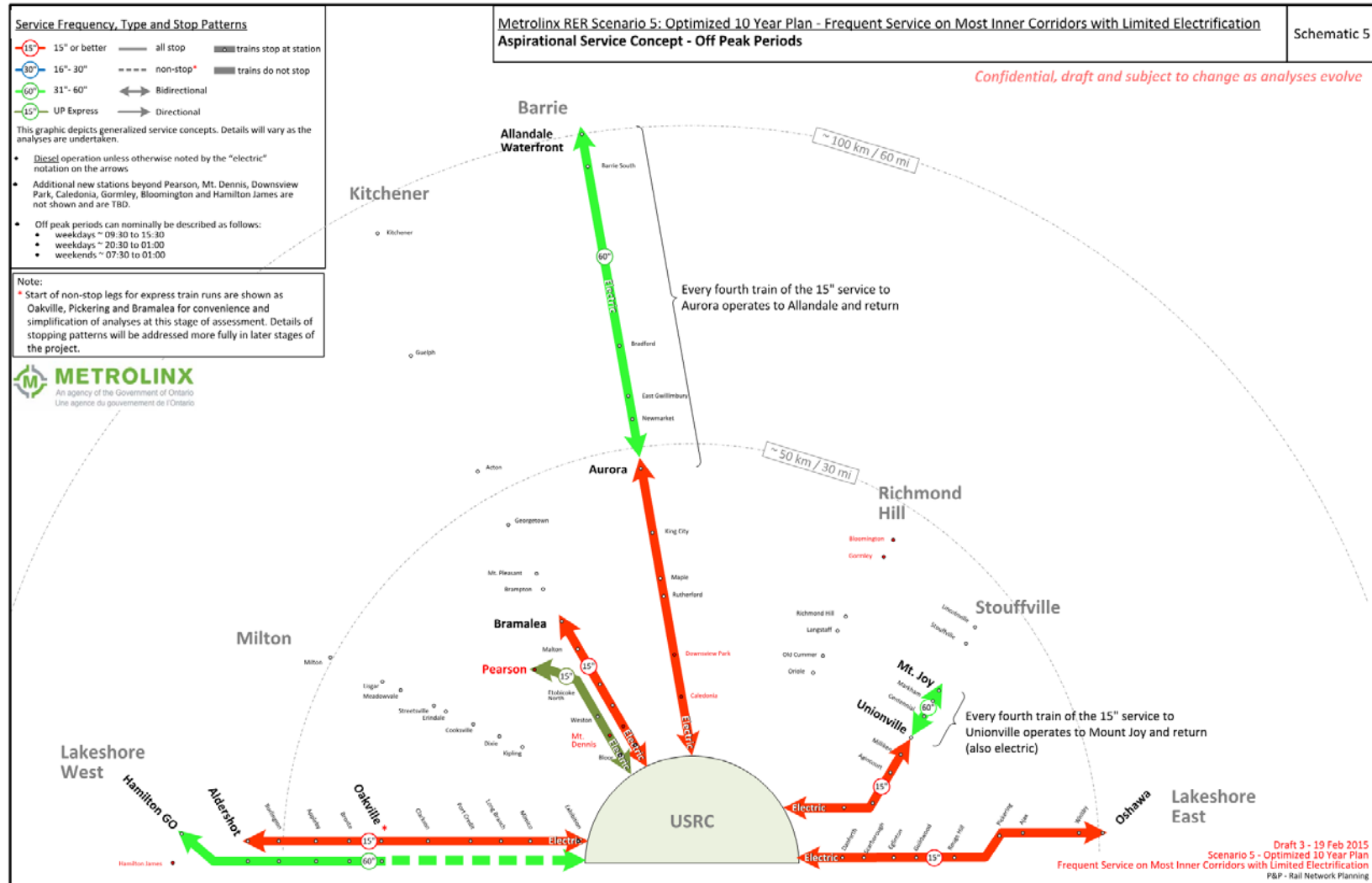


Figure 19: Recommended RER – Off-Peak Periods

1.10 Evaluation of Scenarios

Figure 20 shows graphically the total costs, revenues and benefits over 60 years discounted at 3.5%¹⁰ for each scenario. A summary of the financial and economic results are shown in Table 9.

Revenues include passenger and parking revenues. In all scenarios, passenger revenues exceed operating costs in all years from 2024 based on the assumptions made in the BCRM.

See Table 9 for definition of total transport benefits. The incremental costs as shown in in Table 9 are calculated by subtracting the total cost of Scenario 1 (Do Minimum) from the total cost of each scenario. Net benefits shown are the difference between the total transport benefits and the incremental cost.

While total benefits and revenues are greatest in Scenario 4 (Full Build), the scenario requires a negotiated solution with CN and CPR to deliver additional service and electrification. Net benefits, the excess of benefits over costs, are also greatest in Scenario 4 (Full Build). However, Scenario 5 (10-Year Plan Optimized) delivers approximately three-quarters of the benefits for three-quarters of the capital investment, and can be delivered within 10 years. It does not preclude future implementation of the full RER concept on all corridors. These advantages from Scenario 5 are retained in the recommended RER program.

The results indicate a strong case for implementation of RER on the GO rail network.

Other charges, here represented by parking charges, if introduced would generate approximately \$4 billion over time, substantially reducing the capital subsidy requirement. Charging for parking would encourage spaces to be used more effectively and increase the financial viability of local bus services. The net effect of charging for parking, carefully implemented, can be to increase ridership because customers who may switch access modes even occasionally will leave space for off-peak, mid-day customers who normally would have no access to a parking spot.

Capital costs will need to be incurred up front, while operating surpluses will be greatest in the later years. Indications are that over the 20 years to 2034, the cost to government of Scenario 5 (10-Year Plan Optimized) will be approximately \$9 billion.

Total benefits in Scenario 5 (10-Year Plan Optimized), including time savings to transit riders and to motorists on less congested highways, are estimated to be worth approximately \$33 billion. Net benefits are \$23 billion. Total capital investment required, including rolling stock and allowing contingencies appropriate for a project at this stage of development, is approximately \$13.5 billion. These figures are consistent in the recommended RER program.

¹⁰ Note that transport benefits are calculated in comparison with the Do Minimum (Scenario 1), therefore no benefits are shown for that scenario.

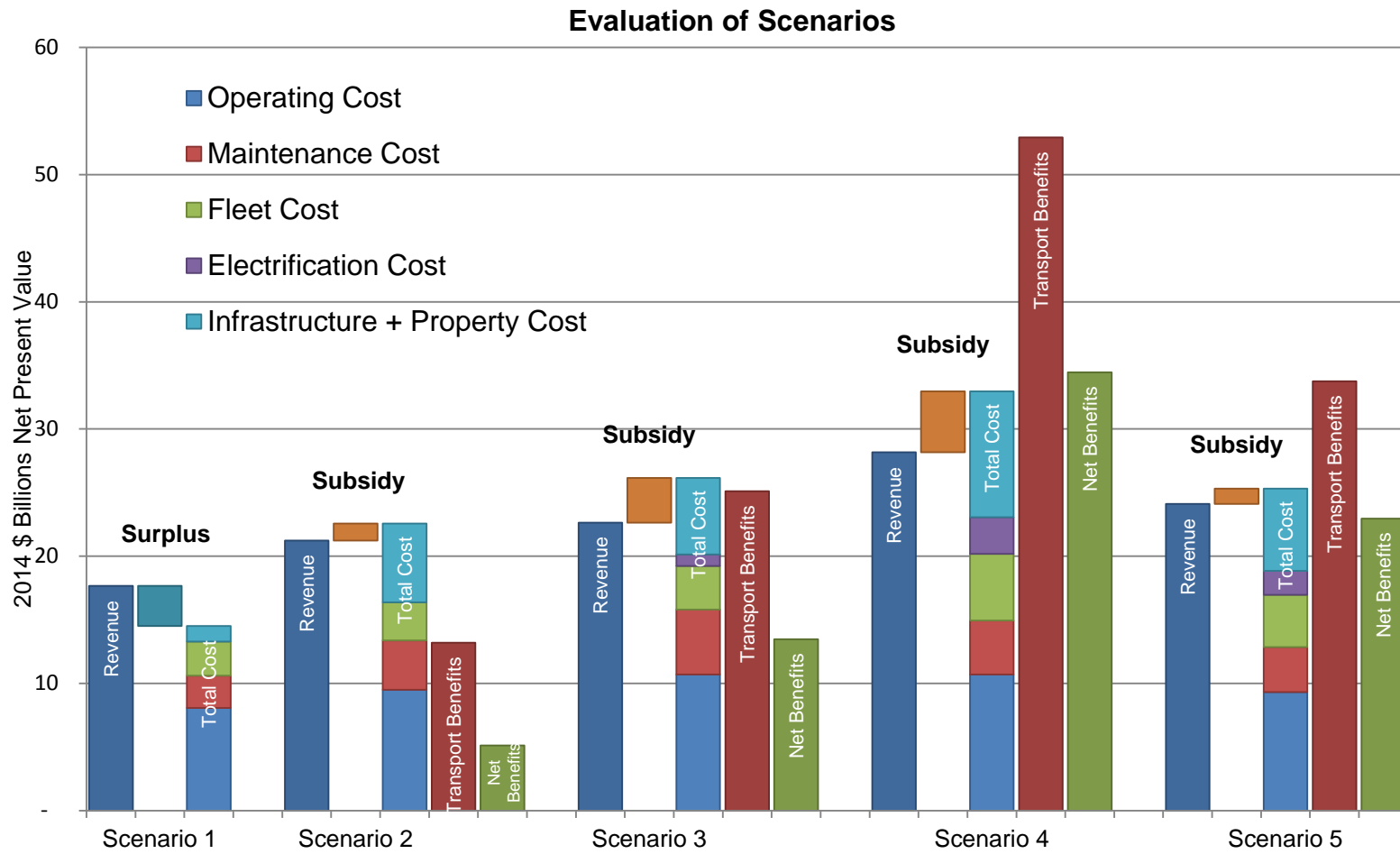


Figure 20: Costs and Benefits of the Five Scenarios

Revenues shown in this figure include both passenger and parking revenues.

Table 9: Summary Financial and Economic Evaluation of Scenarios¹¹

2014 \$ Millions Net Present Value	Scenario 1 (Do Minimum)	Scenario 2 (Two-Way All-Day)	Scenario 3 (10-Year Plan)	Scenario 4 (Full Build)	Scenario 5 (10-Year Plan Optimized)
Financial					
Total Revenue	17,658	21,236	22,647	28,164	24,159
Total Operating Cost	10,616	13,372	15,819	14,945	12,882
Farebox Recovery	166%	159%	143%	188%	188%
Operating Subsidy or Surplus	7,042	7,864	6,828	13,219	11,277
Infrastructure	589	5,066	4,093	7,381	4,093
Electrification CAPEX	-	-	895	2,887	1,882
Property	-	248	221	372	221
Car parking	624	624	624	624	624
Fleet	2,675	3,009	3,440	5,238	4,107
Other network CAPEX	628	871	1,708	2,137	2,137
Total Capital Expenditure	4,516	9,817	10,980	18,637	13,063
TOTAL COST	(15,132)	(23,189)	(26,799)	(33,583)	(25,945)
Surplus (Subsidy) 60-Year NPV	2,526	(1,953)	(4,153)	(5,418)	(1,786)
Surplus (Subsidy) 20-Year NPV	(1,507)	(6,846)	(8,693)	(13,970)	(9,016)
Economic					
Existing Transit User Time Savings		2,234	4,839	9,802	7,725
New Transit User Time Savings		799	6,117	12,821	6,904
Peak Period Road User Time Savings		860	1,161	3,488	2,148
Off-Peak Road User Time Savings		417	586	1,090	696
Auto Operating Cost Reduction		8,020	11,207	23,236	14,713
Safety Benefits		859	1,200	2,479	1,565
TOTAL TRANSPORT BENEFITS		13,188	25,110	52,916	33,751
Incremental Cost compared with Scenario 1		(8,057)	(11,667)	(18,451)	(10,813)
Net benefits		5,131	13,443	34,465	22,938
TRANSPORT BENEFIT : COST RATIO		1.6	2.2	2.9	3.1

Note that if parking revenues are excluded, the Farebox Recovery ratio reduces by 23% to 33%, depending on the scenario. A sensitivity analysis is included in Appendix E. For a breakdown of operating costs, see Figure 50.

¹¹ For more details of service plans, capital costs, infrastructure requirements, financial and economic results, refer to Appendix A, Appendix B and Appendix C. The BCR, as shown, are calculated as an increment over Scenario 1 Do Minimum. Figures in parentheses are negative numbers. They are shown in red text and highlighted in pink for clarity.

1.11 What are the Alternatives?

Most large city regions in Europe, Australasia, Japan, and developed cities in South America, Asia and Africa, have evolved some form of RER to meet urban population and employment travel needs.

Many U.S. cities have attempted to expand their freeway (highway) systems to meet growing travel demand. Places like Houston, Los Angeles and Chicago have five to 10 times as much radial freeway capacity as Toronto and two to five times as much orbital capacity. But even using demand management techniques, they have been unable to stop the growth in congestion. Moreover, the freeway “solution” is damaging to the environment, and leaves a large part of the population without access to a car isolated and excluded. It is difficult to imagine how the GTHA could double or triple the capacity of its highway system. See Figure 21.

Some city regions have successfully implemented BRT systems. These systems have much lower capital costs, but also typically offer lower capacity and speed. As cities become larger, some develop rail systems that offer higher capacity, and faster and more comfortable journeys. These systems are therefore more effective at competing with driving a car on the highway. Ottawa is an example of a very successful and extensive BRT system which is now being converted to a rail system in order to further increase capacity for Ottawa commuters. The York Region Viva BRT significantly shortens journey times and improves reliability for bus services. It will play an important role in both carrying local trips and feeding traffic onto RER while supporting York Region’s vision for development in the Highway 7 and Yonge Street corridors; however it is not fast enough to attract long trips off the highway network.



Figure 21: Highway 401

Source: Metrolinx

To get the same additional capacity as RER, the GTA would need to add another 12-lane freeway, like the 401, across the region. It would cost billions of dollars and have massive environmental impacts.

Some cities in Europe and Asia have implemented demand management strategies, with taxes on fuel, restrictions on parking, car ownership and use, and road tolls. All of these strategies can help to encourage more efficient use of limited road space and encourage greater use of transit. However, all cities that have implemented such programs, notably London, Singapore, Oslo and Stockholm, have also made large investments in RER and local transit. Simply managing demand is not seen as a way to support the continued growth and prosperity of a city region; capacity and connectivity must be continuously improved, especially in a fast-growing region like the GTHA, if it is to remain competitive with other cities and regions.

1.12 What does RER do for Regional Accessibility?

RER could dramatically reduce travel times for longer journeys across the region. Journey times (including the time people either wait or adjust their personal schedules to accommodate train schedules) could be reduced significantly if train frequency were reduced to 15 minutes rather than hourly or 30 minutes. Higher frequencies will be achieved on most corridors at all times, when operated with electric trains and with associated improvements to tracks, stations, control systems and operating practices.. The benefit will be even more substantial for journeys involving transfer between two or more train trips. Many cross-regional trips will become viable by transit for the first time, for example Unionville to Oakville, or Richmond Hill to Hamilton (see Figure 22). On many routes, the transit travel time will be faster than the trip time by car during peak periods. While driving will still be faster for most journeys when roads are not congested, transit times will still be attractive, taking account of the increased reliability, reduced stress and ability to make more productive use of time.

RER, together with connecting LRT, BRT, subways and buses will serve all developed areas in the GTHA, linking it also with Guelph, Kitchener, Aurora/Newmarket and Barrie. See Figure 23.

RER will support fast, convenient and attractive train service to help people get to and from many of the growth centres identified in Places to Grow, the regional land-use strategy. RER will deliver transportation speed and capacity to many of the nodes of people and jobs in the region (see Figure 24).

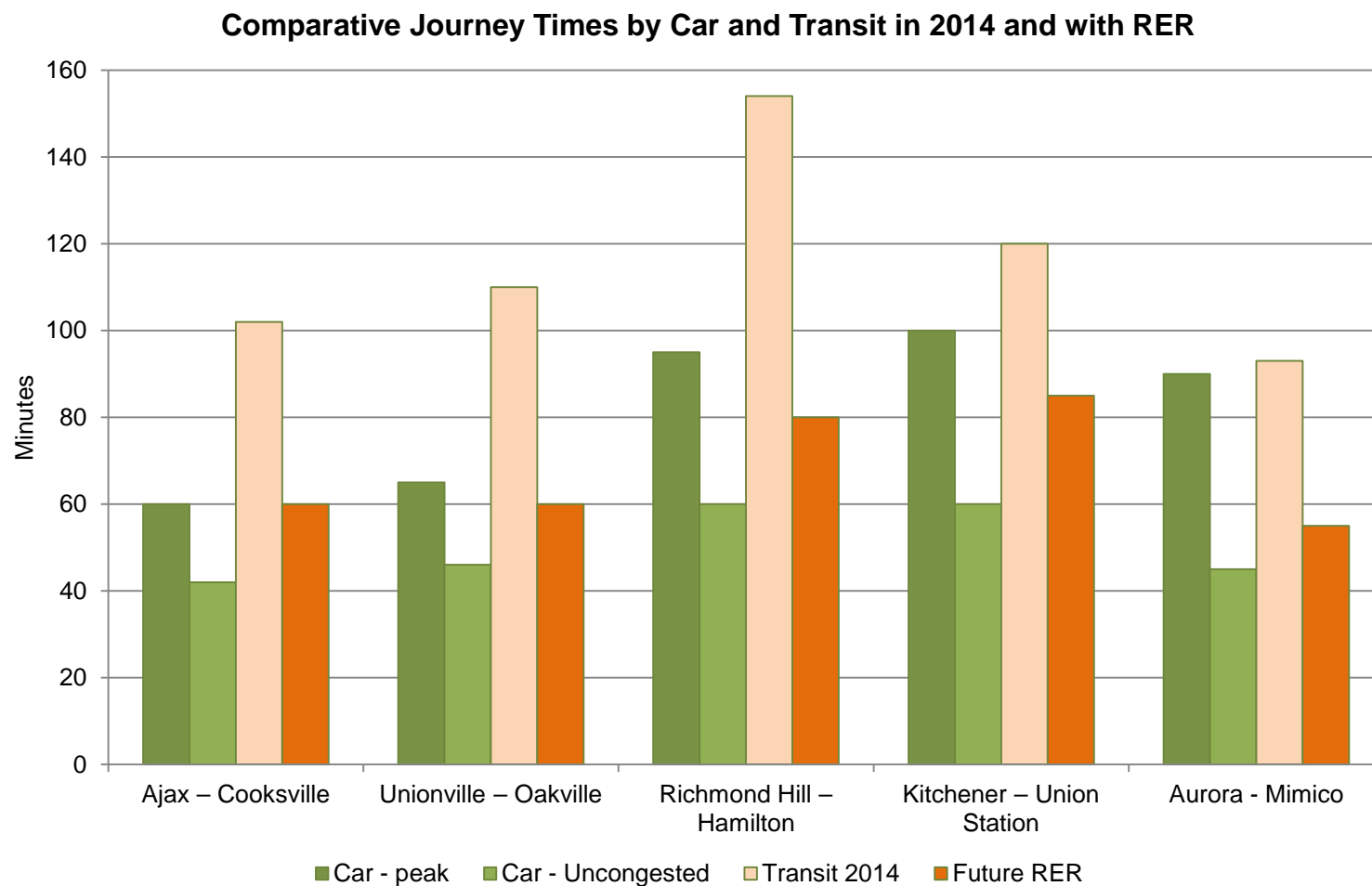


Figure 22: Comparative Journey Times by Car and Transit, in 2014 and with RER

RER will dramatically reduce transit travel times across the region. Many longer journeys will have a viable transit option for the first time, which in many cases will be faster as well as much less stressful than driving on congested roads.

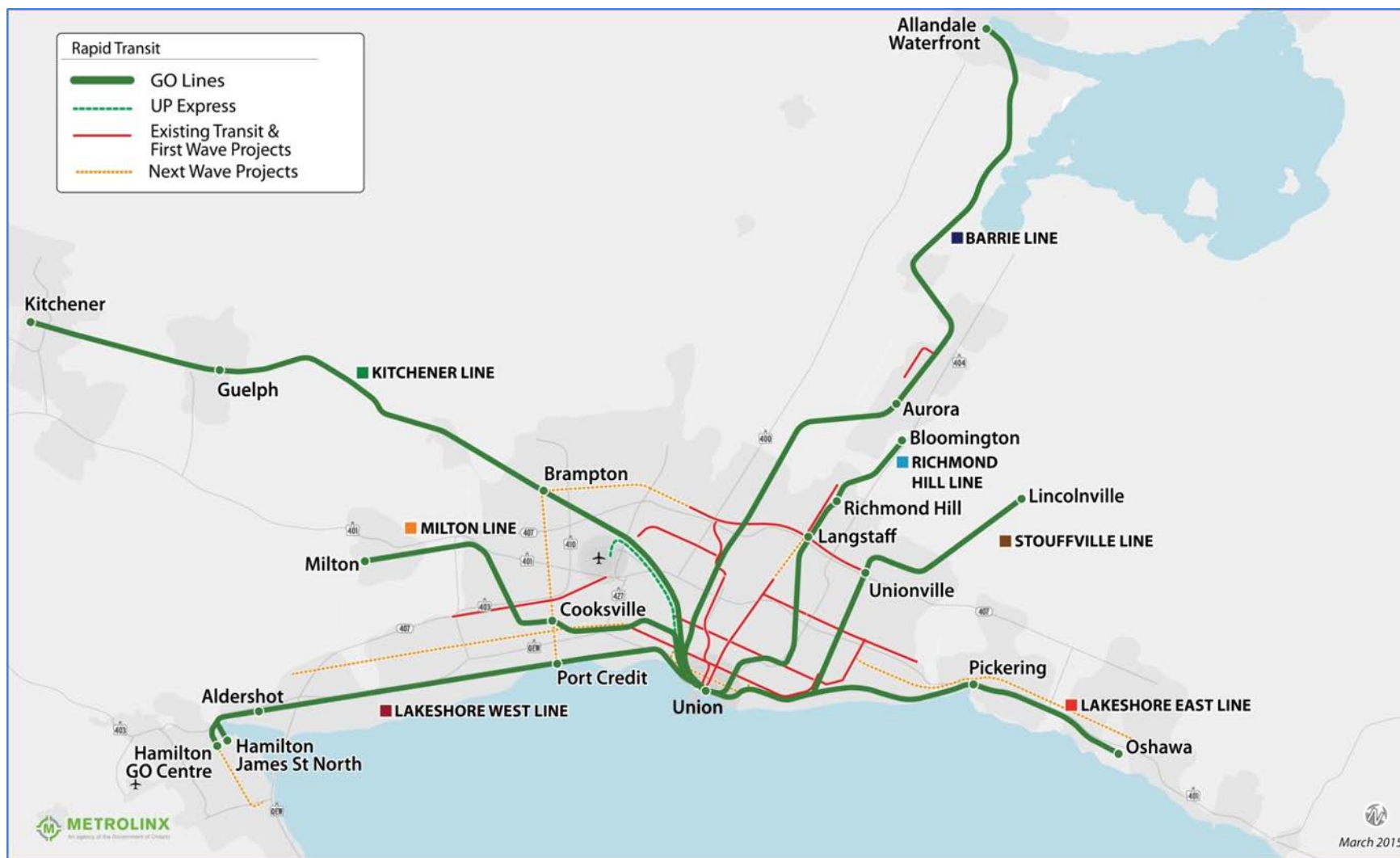


Figure 23: RER and Higher Order Transit

RER together with connecting LRT, BRT subways and buses, will serve all developed areas in the GTHA, linking it also with Guelph, Kitchener, Aurora/Newmarket and Barrie.



Figure 24: Urban Growth Centres

RER will connect many of the growth centres identified in "Places to Grow."

1.13 The Value RER Contributes to the Region

Estimates have been made of two categories of economic benefits for all scenarios.

Conventional transport benefits mostly reflect differences in journey times and other transport costs, for an assumed future pattern of land use and trips, in comparison with Scenario 1 (Do Minimum). Conventional transport benefits also include savings to the emergency services and health services from accident reduction. These benefits, over-and above the costs that can be recovered by fares, are one of the main reasons governments subsidize capital investment in public transport as they also do for highways.

As shown in Figure 25, in Scenario 3 (10-Year Plan), Scenario 4 (Full Build) and Scenario 5 (10-Year Plan Optimized), transport benefits far exceed total costs (including both capital and operating costs). In Scenario 2 (2WAD), Scenario 3, Scenario 4 and Scenario 5, transport benefits exceed the incremental subsidy requirement over the project life by a large margin. Passengers pay most of the total costs in Scenario 4 (Full Build) and Scenario 5 (10-Year Plan Optimized), with the net subsidies roughly equal to road user and safety benefits.

The cost of RER to the taxpayer will be substantially less than realistic alternatives, including highway expansion. This could ease pressure on the province to expand highways and roads, because RER will attract many trips that would otherwise be made by car. However, no explicit benefit from this is included in the IBC analysis.

Incremental Subsidy, Fares and Benefits

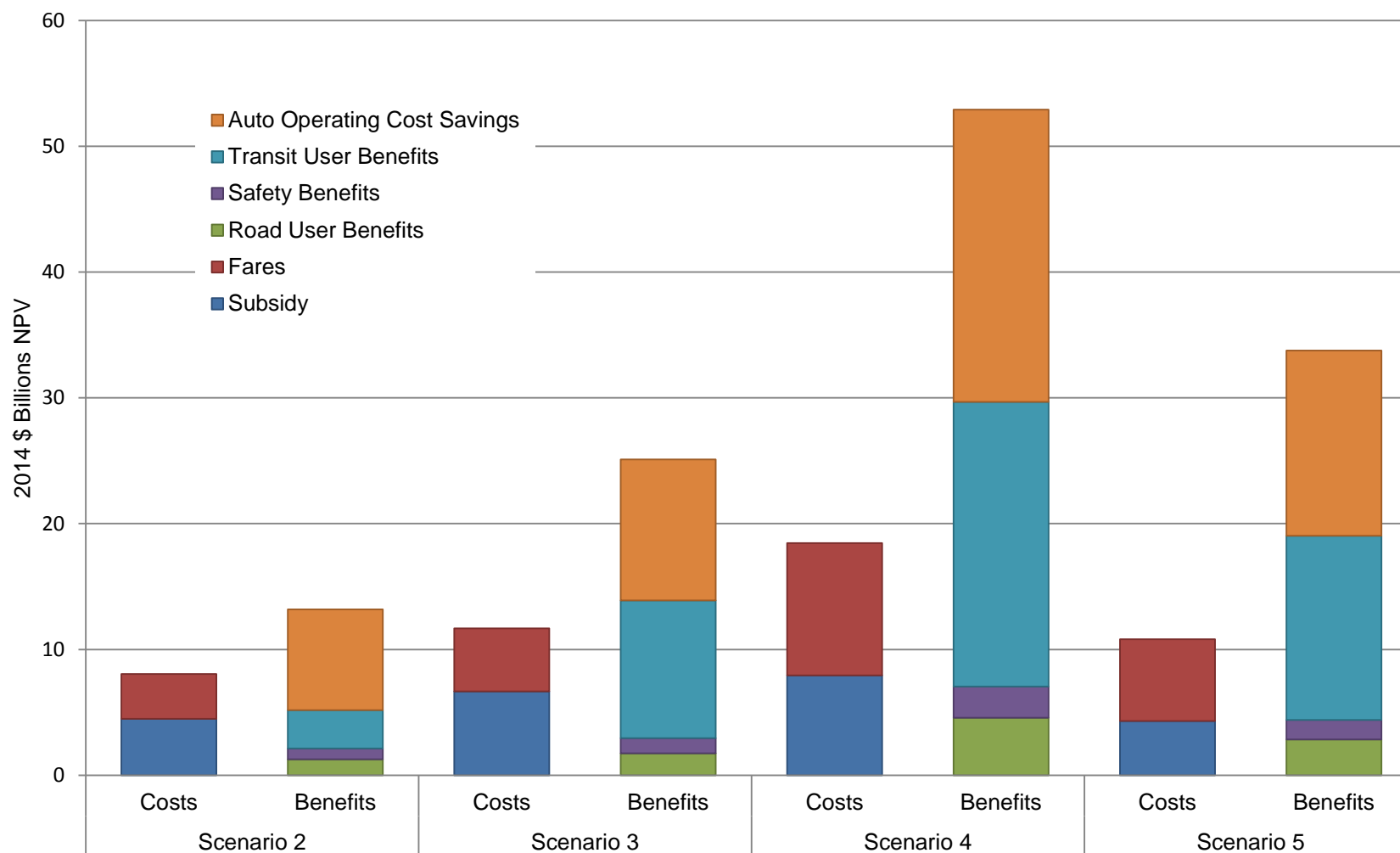


Figure 25: Incremental Subsidy, Fares and Benefits

The analysis presented in the IBC does not fully reflect the land use shaping benefits that may be realized as a result of RER. Wider economic benefits reflect the more general effect of efficient transport on the growth and prosperity of a city and region. Efficient transport is essential to making a city and region function as a single economic entity rather than merely a conglomeration of developments. As the region has grown, the highway system has become increasingly congested. While it is possible for people living in Oshawa or Halton Hills to commute to downtown Toronto, it is much more difficult for a student living in Scarborough to attend classes at the University of Toronto at Mississauga, or for a software engineer living in Mississauga to work for a company in Markham.

While many people try to live near their work, often personal reasons, family commitments or changing jobs make this impossible.

RER will transform travel across the region, allowing people to move more easily between homes, jobs, recreation, leisure and services, so that it operates as a single city-region. It will be possible to live in Waterloo and do business in Markham, without spending four hours each day behind the steering wheel. Research has shown that better matching people, jobs and other activities brings significant economic benefits. Research prepared for Metrolinx¹² suggests that these wider economic benefits could increase the wealth of the GTHA by up to a further \$2.4 billion over the 60-year period analysed in this report. This includes agglomeration benefits which accrue from improved accessibility between people and firms, and firms and other firms. Wider economic benefits are further addressed in Appendix G. Further analysis of the wider economic benefits may be undertaken in conjunction with updated ridership forecasts.

¹² AECOM report, Agglomeration Benefits of Metrolinx Rapid Transit Project Scenarios, AECOM, 2013
http://www.metrolinx.com/en/regionalplanning/funding/Benefits_of_Metrolinx_Rapid_Transit_Project_Scenarios_EN.pdf

Metrolinx will be working with a wide range of local and regional stakeholders to maximize the social and economic benefits of RER.

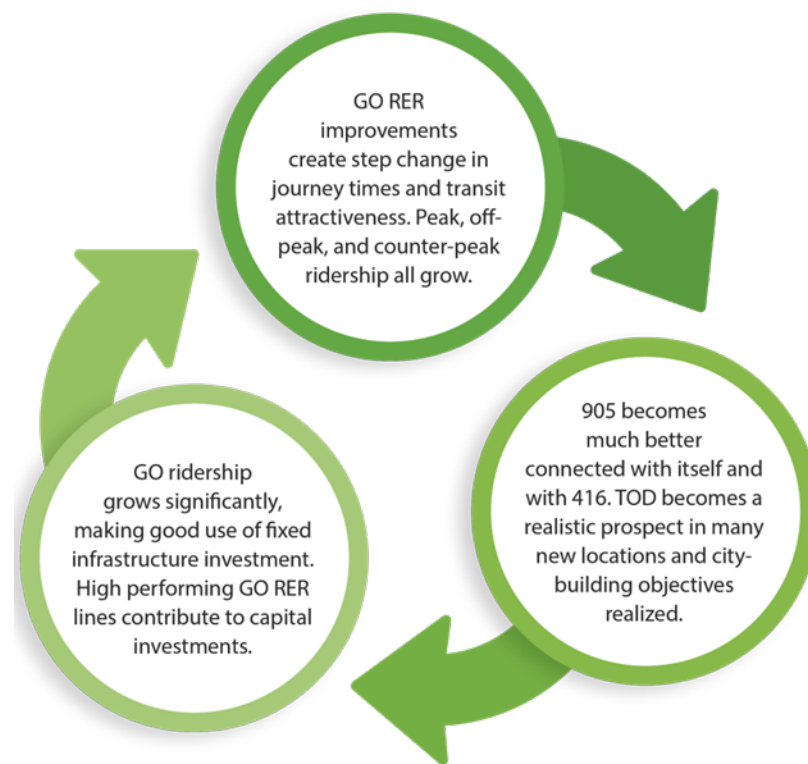


Figure 26: Improvements Cycle

RER creates a "virtuous circle," with improved rail services encouraging Transit-Oriented Development (TOD) around stations, much as the Yonge Subway did in Toronto in the 1960s. RER generates more ridership and revenues, which help pay for the system.

1.14 Building and Operating a Regional Express Rail System

The construction and installation of infrastructure for RER builds on Metrolinx's demonstrated expertise in many of the works that must be implemented. These works include adding tracks and station platforms, enlarging parking lots, building grade separations (e.g., bridges) across roads and railways, and modifications to layover and maintenance facilities. Metrolinx already has a number of projects underway that will contribute to delivering RER. Metrolinx has completed preliminary design work for electrifying UP Express and is building expertise in other elements of RER technology.

Metrolinx is considering a range of options to deliver and operate the RER system, including both in-house program and service management, and Alternative Finance and Procurement (AFP) methods, with private-sector partners taking a wider range of system integration and performance risk. GO currently contracts with Bombardier to maintain and operate all trains.

Metrolinx has a growing experience in public-private partnerships. The UP Express, East Rail Maintenance Facility, and the Eglinton Crosstown all have elements of public-private partnerships. Metrolinx supports more use of these delivery models in the future, where value for money can be demonstrated.



Figure 27: Double Deck EMU Operating on the Zurich S-Bahn

Source:

http://www.stadlerrail.com/media/uploads/factsheets/KISS_DOSBBRE0810e.pdf

The Zurich S-Bahn is a 380 km RER network, serving a rich city and region with approximately one-quarter the population of the GTHA. It attracts almost 500,000 passengers each day. Services and fares are integrated with light rail, buses and inter-city trains.

1.15 How RER Works with the rest of Metrolinx's Plan

Metrolinx's Regional Transportation Plan (the RTP – also known as “The Big Move”) is the Greater Toronto and Hamilton Area's multi-modal long-range regional transportation plan. Since it was put forward in 2008, it has provided strategic vision for planning, designing and building a regional transportation network, transforming how people move around the region and how healthier, more sustainable places to live and work will be created through ten strategies.

Together, the strategies provide direction on achieving the vision of the plan, and are supported by specific actions and policies to guide decision-making. A number of actions and policies have been implemented, including major investments to expand rapid transit infrastructure through projects such as the Eglinton Crosstown, Union Pearson Express and the Mississauga Transitway. RER builds on the vision of express rail in the RTP, forming the backbone of transit expansion, serving regional trips and connecting mobility hubs with all-day fast and frequent train service. Implementation of the RTP is further supported by work from partners across the GTHA to improve traveller information, expand cycling and walking networks, revitalize Union Station, and implement Smart Commute and other TDM programs.

Investment in transit infrastructure, and expansion of the existing network, will have a transformational impact on the GTHA's transportation system. The RTP sets the foundations for RER, while setting out many of the complementary measures that are needed to support RER and maximize the impact of investments.

RER will increase ridership, and thereby strengthen the case for many of the RTP programs, which will in turn feed passengers onto it. These include the Mississauga Transitway BRT, the York VIVA BRT and Eglinton Crosstown LRT which are now under construction. Ridership on the RER, and the BRT and LRT programs, can be expected to increase if good

interchanges, and integrated fares and services are offered. Additional ridership should also be generated on the Hurontario-Main, Hamilton, Sheppard East, Finch West, Durham, Mississauga Dundas and Brampton Queen Street major projects. These can be complementary to RER.

RER is likely to carry some passengers who might otherwise use the Scarborough Subway extension and Downtown Relief line. These major projects will serve overlapping, although not identical, markets. For many passengers, the Stouffville and Lakeshore East corridors will offer faster journey times and a higher level of comfort. Capacity on the RER corridor can be increased if required by adding trains. Work is underway to determine how the RER will affect ridership on the Scarborough and Downtown Relief subway projects.

Metrolinx has initiated work to update its Rail Parking and Station Access Plan recognizing the advent of RER. Previous work, which assumed only a limited all-day service on the GO rail network, needs to be comprehensively reviewed and revised.

Metrolinx has also begun detailed studies of options for reconfiguring the Union Station Rail Corridor (USRC), including tracks and platforms to support RER. For more information, see Section 5.9.

Metrolinx has initiated discussions with stakeholders and commenced analysis in support of further integration and optimization of the region's transit fare pricing.

Metrolinx, in conjunction with the City of Toronto, is currently evaluating the implications of overlaying the service and infrastructure envisaged in the SmartTrack proposal. These could include additional stations, higher frequency of service, and a new branch between Mount Dennis and the Airport Corporate Centre.



Figure 28: Five-Year Plan for Regional Rapid Transit

Source: *The Big Move*, Metrolinx

1.16 What Happens Next

This IBC provides a basis for deciding the general scope and phasing of the RER investment.

The analysis presented in this IBC indicates that, on all corridors, the greatest net benefits are likely to be obtained with the electrified RER service level, with the capital costs of electrification offset by lower operating costs and higher revenues. Hourly or half-hourly two-way all-day services are appropriate for outer sections of some lines.

Considering the strategic, financial, economic and deliverability cases, the conclusions of this IBC are that Scenario 5 (10-Year Plan Optimized) achieves many strategic objectives, is affordable, delivers very good value and is deliverable within 10 years. It is a significant step toward eventual implementation of Scenario 4 (Full Build). For these reasons, the recommended RER program most closely aligns with Scenario 5.

Metrolinx will also continue discussions with CN and CPR on how RER can be implemented in co-existence with freight services with the lowest overall costs and impacts. Depending on the outcome, the deliverability of infrastructure and electrification on the Milton, Kitchener, Barrie and Richmond Hill corridors may be materially improved.

Even as work begins on implementing the RER 10-year plan, Metrolinx should carry on studying ways to optimize services and infrastructure, adjusting train lengths, frequencies and service patterns. This is a process that will continue after RER is in service, as the service evolves and adapts to serve the growing and changing region. Every corridor is different and has unique challenges and opportunities.

Metrolinx will work with VIA Rail Canada and MTO to ensure RER plans are integrated with the development of the VIA network and any emergent plans for high-speed rail in the region. MTO is currently advancing an Environmental Assessment study for high-speed rail service that will link

Pearson International Airport to Waterloo Region, London and Windsor. Future decisions on high-speed rail will consider the ongoing implementation of RER within the GTHA. This consideration will ensure that any potential synergies or interfaces between these projects are captured.

Metrolinx will also be working with local municipalities to integrate RER with local transit and land use plans to improve pedestrian and bicycle access to stations. Initial work by Metrolinx, as shown in Appendix K, shows analysis regarding station access. Metrolinx and local municipalities will work together to optimize station access.

2. The Evaluation Framework

2.1 Metrolinx Guiding Principles

Metrolinx uses five guiding principles (Table 10) in its rigorous Benefit:Cost Analysis. This IBC specifically addresses these principles.

Table 10: Summary of Metrolinx Guiding Principles

Metrolinx Guiding Principle	As reflected in this IBC
Principle 1 – Regional or Metropolitan Focus — We need a Regional Transportation Plan (RTP) and investment strategy that reflect the way most of us live our lives and perform business. One that reflects where we routinely cross local community and municipal boundaries to support a dynamic regional economy, labour market, and institutional and social networks across the GTHA.	RER will be the backbone of the GTHA transit system. The majority of trips on the GO rail system cross intra-regional boundaries and this is expected to be the case with RER.
Principle 2 – Invest where it Matters Most — All Metrolinx investments should be aligned with the RTP and subject to a fair, easy to understand and rigorous benefits case screening process where economic, environmental and social needs and impacts are taken into direct account.	This IBC has been prepared to evaluate the costs and benefits of RER, and to present them in a format that can enlighten public discussions and serve as a tool for continuous improvement in the project as it progresses through the development process.
Principle 3 – Prudent Financial Management — We believe that the investments should be affordable and that a financial plan should be in place to show how the investments will be funded.	This IBC sets out the costs and revenues for the proposed RER system and shows clearly the share of costs that can be recovered from passengers and other beneficiaries, and the total and net effects on public finances.
Principle 4 – A System that Works and is Accountable — Metrolinx is a regional authority and is accountable to the Government of Ontario, as well as the residents in the GTHA. Our pledge is to post regular reports on exactly how we are progressing toward achieving our plans.	This IBC is being published on the Metrolinx website and is the first of many reports that will explain the RER project.
Principle 5 – Risk Management and Project Implementation Discipline — We will not make a single investment until we are satisfied that risks will be managed, projects will be delivered on time and on budget, and there will be no surprises.	This IBC describes, in general terms, the technical approach to implementing RER, and how the project makes use of existing corridors and proven technology to reduce cost and delivery risk. The IBC also includes sensitivity analysis to show how the costs and benefits of the program may change if exogenous trends including, for example, population growth, incomes, energy prices, or pricing policies are different than assumed. An implicit assumption for any program of this scale, at this level of conceptual design, is that program management practices including program controls, approval and decision making processes, etc. will be in place and operationalized correctly.

2.2 The Investment Lifecycle

The RER project has moved quickly from concept to implementation. This is because Metrolinx was already implementing a subset of RER (two-way all-day) and the IBC is very strong. With an overall BCR of around 3:1 and urgent needs to address growing all-day congestion on the road system, there is a good case for fast-tracking the program development process. At the same time, care must be taken to ensure that valuable opportunities are not foreclosed, both on the Lakeshore corridors and on the other routes which will share key assets and infrastructure.

Figure 29 shows conceptually the different stages of business case development. Investment interventions evolve over time. For a large and complex project such as RER, a phased approach to the delivery of the business case will ensure that business case considerations are progressively elaborated over time, while allowing necessary and robust investments to proceed without delay. This IBC provides a firm basis to begin implementing RER. It is based on initial cost, revenue and benefit forecasts with conservative assumptions that are appropriate for the level of work that has been completed. Further work will continue over the next year, and into the future, evaluating service and investment opportunities as the RER system grows and develops. RER encompasses many projects, from various stages of conception to construction. The business case is being embedded in scope management and controls processes to ensure the program evolves, and is delivered in such a way, that it achieves excellent outcomes and continues to represent a good financial investment.

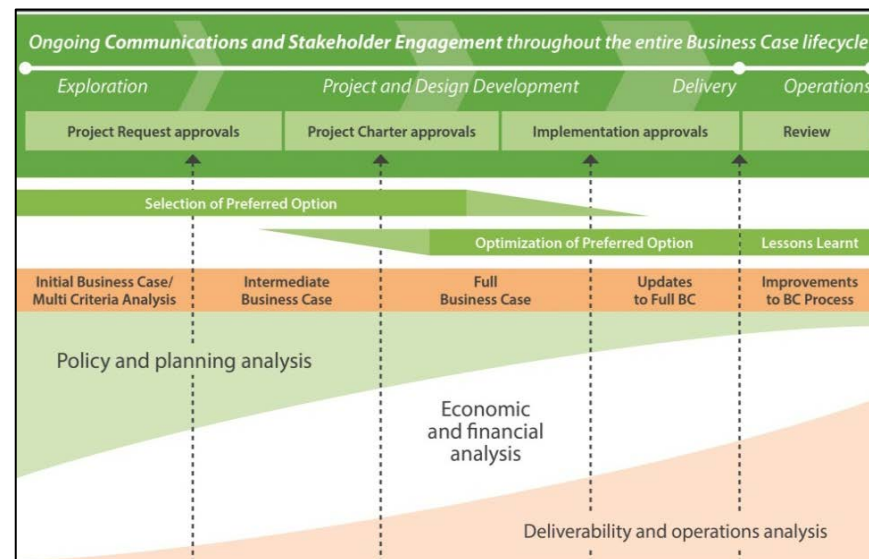


Figure 29: The Project and Business Case Lifecycle

As a program, RER would lie to the left of the diagram in Figure 29, indicating its early conceptual level of development. Some elements of RER are more advanced as, for example, work has already been done on segments of rail corridor improvement and therefore some project components could be considered to lie more in the middle of the development lifecycle described in Figure 29.

2.3 Baseline Parameters

2.3.1 Population, Land Use and Employment

The GTHA area has experienced significant growth over the past half century, and this is expected to continue. Together with the outer ring which includes Waterloo, Barrie and Niagara, population is now more than 9 million, and is expected to reach 11.4 million by 2031.¹³ The maps shown in Figure 32 illustrate the growth in office development within the region over the last 60 years.

Population and employment forecasts for each region are set out in Table 11. Although one of the principal objectives of RER is to strengthen population and especially employment in the vicinity of rail stations (downtown Toronto and centres of other GTHA communities), the BCRM does not currently assume higher employment levels in these areas. This is to ensure that the business case is prudent and built on reasonably conservative assumptions. In reality, while growth is plausible without effective infrastructure, it may not happen to the same degree. RER will support the employment and growth envisioned by the Growth Plan.

The growth around stations on each corridor is being examined using various transit, ridership and land use models; this work will inform future updates to the IBC.

Appendix K shows the initial analysis which is underway. The ridership indicated has been derived from the direct demand model embedded within the business case model.

The City of Toronto is currently considering higher employment numbers in downtown Toronto for planning purposes. These higher numbers were not used in this IBC, but given the high level of service RER provides to downtown Toronto, higher downtown employment numbers would likely strengthen the case for the capacity and access provided by RER.

¹³ Places to Grow - Growth Plan for the Greater Golden Horseshoe, 2006.

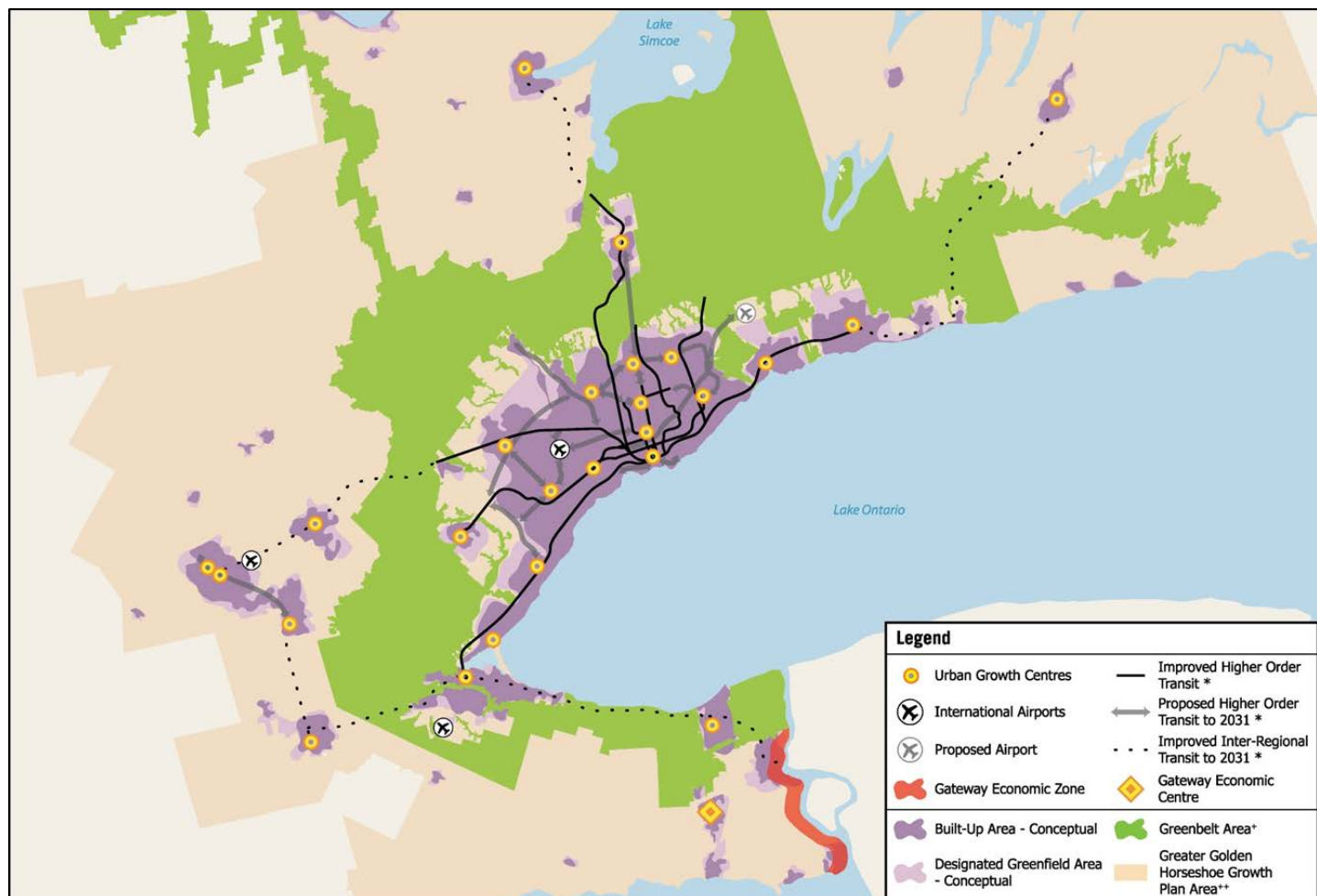


Figure 30: Moving People – Transit

Source: Places to Grow – Growth Plan for the Greater Golden Horseshoe, 2006. (<https://www.placestogrow.ca/content/ggh/2013-06-10-Growth-Plan-for-the-GGH-EN.pdf>)

This figure shows the built up areas, the Greenbelt, and the seven rail corridors serving the GGH. Since publication in 2006, GO rail services have been extended to Barrie and Kitchener, with weekend services to Niagara during the summer.

Table 11: Population and Employment Growth Assumptions by Region¹⁴

	Population		Employment	
	2006	2031	2006	2031
Toronto PD1 (CBD)	187,500	310,700	482,800	557,100
PD2-16	2,422,900	2,764,500	966,200	1,102,900
Toronto Total	2,610,400	3,075,200	1,448,900	1,660,000
Durham	584,300	909,400	207,000	336,800
York	931,800	1,507,600	456,300	780,100
Peel	1,212,800	1,640,000	589,400	875,300
Halton	458,000	780,100	213,900	390,000
Hamilton	523,700	659,700	219,800	301,000
Subtotal GTHA	6,321,100	8,571,900	3,135,500	4,343,200
Outer Ring GGH	2,125,500	2,835,800	944,800	1,234,000
Total GGH	8,446,600	11,407,800	4,080,300	5,577,200

¹⁴ As prepared by Metrolinx Strategic Policy & Systems planning staff. The growth is generally aligned with the Growth Plan 2031A totals, except where noted.

2.3.2 Underlying Growth Rates

This section describes how ridership growth rates have been developed for the purpose of the IBC analysis.

Ridership on the GO rail system has grown at an average annual rate of approximately 3.6% over the 12 years to 2013, and slightly faster annual compound rate of approximately 4.4% over the five years 2007 to 2012.¹⁵ This ridership reflects mostly underlying demand growth, but also the growing congestion on the roads, offset partly by GO service expansion. GO ridership has grown faster than population and employment because, with the highway system close to capacity, rail transit becomes relatively more attractive. As there is very little planned expansion of road capacity within the built-up parts of the GTHA, particularly where congestion is most acute, and population and job centres are located, GO ridership growth will almost certainly continue and may even accelerate, even without development of RER. See Table 12 for Historic Growth and Assumed Underlying Demand Growth.

MTO has developed the Greater Golden Horseshoe Model (GGHM), a classic 4-stage multi-modal transport model. Key inputs are estimates of population and employment, how they are distributed across the region, and the assumed current and future transport networks. Metrolinx has used the GGHM to estimate demand for GO rail services in the Do Minimum scenario. This analysis suggests underlying growth going forward, averaging overall 2.3% per year for the reasons underlined below.¹⁶

¹⁵ According to the GO Transit Annual Report 2004-2005, 2004 rail ridership was 38,201,500 with revenues of \$196.2 m, implying an average fare of \$5.13. According to the GO Year in Review 2011-12, ridership grew to 47,102,100 in 2011. This growth corresponds to an average compound rate of 3%

¹⁶ For full details of the GGHM model assumptions see GO Rail 2031 Ridership Forecasts - Regional Express Rail – 10-Year Scenario 3 service scenario, Metrolinx Strategic Policy & Systems Planning, updated GGHM ridership forecast, revision 0.2, Feb. 17, 2015.

The historic data reflects both rising underlying demand, and improvements and expansion of GO services. It is not possible to disaggregate these two factors.

Table 12: Historic Growth and Assumed Underlying Demand Growth

Annual Growth	2001-2013 Average	RER Do Minimum Business Case
Lakeshore West	1.7%	1.5%
Lakeshore East	1.4%	2.7%
Milton	4.7%	1.3%
Kitchener	4.4%	3.2%
Barrie	10.5%	4.0%
Richmond Hill	3.4%	1.3%
Stouffville	8.5%	2.1%
TOTAL GO Rail	3.6%	2.3%

The GGHM was used to determine the forecast ridership growth on a corridor-by-corridor basis in the Do Minimum base case. The DDM was used to generate incremental ridership in each of the scenarios where faster and more frequent service is proposed, in addition to base level ridership growth. These numbers show the base case growth used in this IBC.

There are several reasons the GGHM forecasts may understate underlying demand growth for GO rail services even in Scenario 1 (Do Minimum):

- GGHM includes a finite increase in parking spaces at GO stations, while no improvements are assumed to the feeder bus system.

- The assumed land use pattern is based on local plans as of 2013. These take account of the potential higher density development at suburban nodes and urban growth centres. However, the precise location of growth and intensification is very important when considering transit use — with significantly higher transit use to and from land use in the immediate vicinity of transit stations. The incremental impact of RER on future year land use intensification cannot be fully reflected within the GGHM or other similar modelling systems. Additional forecasting work is required.

The GGHM forecasts provide a useful guide to the variations in growth rates between the corridors. In developing the BCM's assumptions and results, the growth rates for each corridor predicted by the GGHM have been used. This implies an annual average compound rate of 2.3%, well below the historic rate and therefore inherently conservative. There are many other possible changes, including fare and service integration, which could lead to higher growth in transit ridership even without development of RER.

It is important to note that the GGHM has been used as the basis for estimating the Do Minimum growth rate for each corridor. However, the actual RER forecasts used in this IBC have been developed using the DDM (an incremental model).

The DDM is described in the following section. Detailed tables of inputs and outputs are listed in Appendix D.

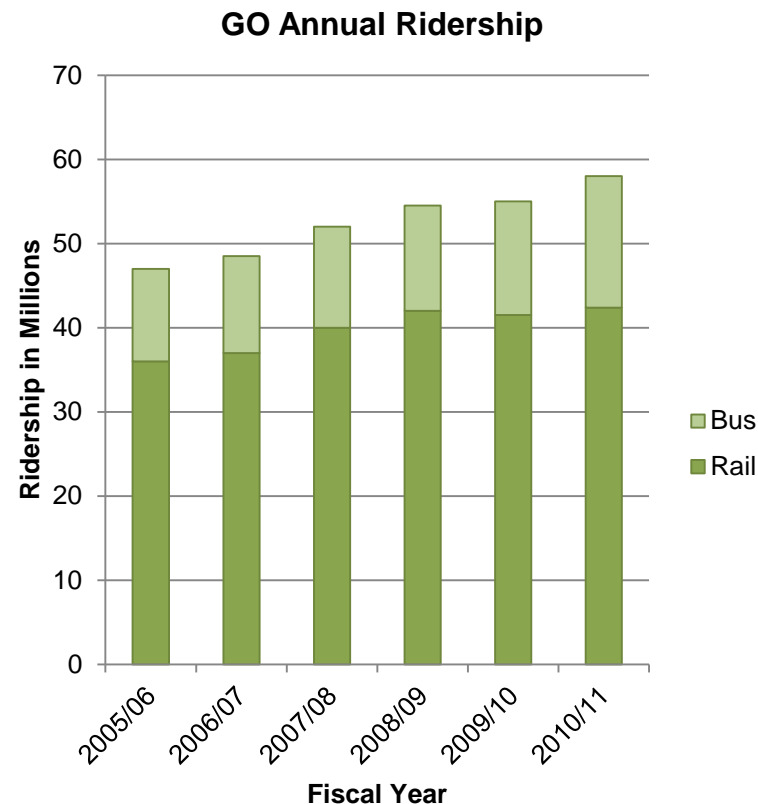


Figure 31: GO Annual Ridership

Source: Metrolinx Financial Statement 2011.

GO Ridership is growing at 3% or more each year, well above the rate of general population growth in the GTHA.

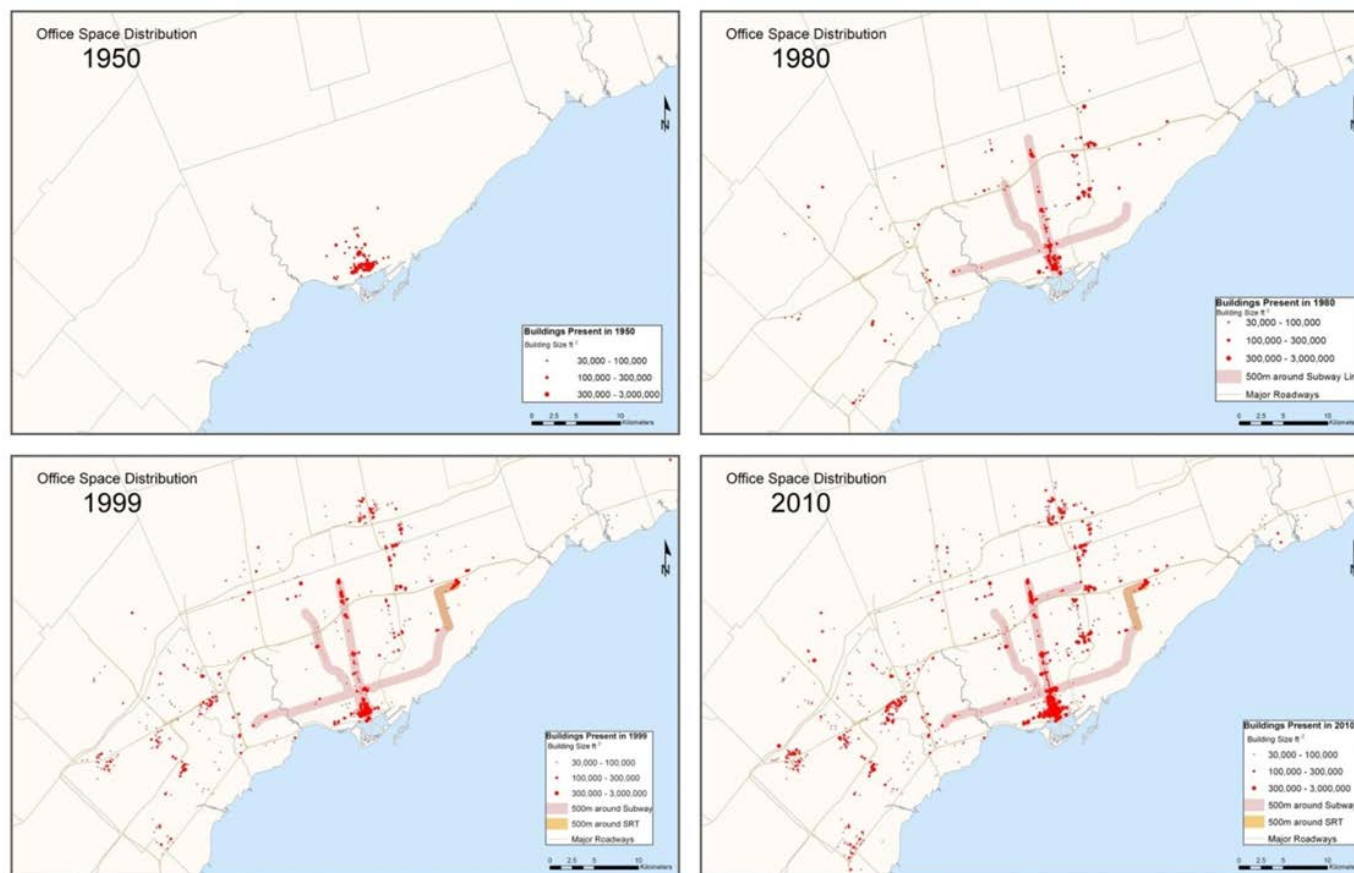


Figure 32: Spread of Employment across the GTHA 1950 - 2010

These maps show the growth of office employment across the GTA since 1950. Until the 1960s, this growth was concentrated in and around the Toronto Central Business District. By 1980, many office jobs were located in the suburbs, along the Yonge Subway but also along the Don Valley Parkway. By 1999, there were office clusters in North York, Mississauga and York Region. These clusters generate contra-peak car commuting such that there is significant congestion now in both directions on radial roads and expressways. Note that office development generally did not follow the Bloor Danforth or Spadina Subways, while the Toronto CBD has continued to grow. It will be important that much of the future office space land be on higher-order transit to facilitate better access to employment than a congested highway system facilitates. Further work is needed to understand where and how jobs can more effectively support, and be supported by, higher order transit. [Maps reproduced with permission of the Canadian Urban Institute.]

2.4 The Financial and Economic Model

The RER BCM was developed specifically for this project to evaluate the financial and economic performance of different possible scenarios for developing the GO rail system. Figure 33 illustrates the modular construction of the model. To the extent possible:

- The model reflects the structure of costs and understanding of passenger behaviour.
- Unit rates and total rates of growth, including costs, revenues and productivity factors, have been calibrated against actual experience, either on GO or comparable operators.
- Infrastructure capital costs are based on recent GO project costs.
- The model can be used to test different service options and policies.
- The model is transparent and users are able to vary assumptions to test functionality and sensitivity.

The model includes service definitions and infrastructure specifications for each of the five scenarios, with provision for further sensitivity testing.

As is good practice when developing a complex model of this type, the model is modular, with outputs from one module feeding in a defined way into other modules. Altogether there are 14 modules. See Figure 33.

The model evaluates each scenario over 60 years, from January 1, 2015 to December 31, 2074. All monetary values are in 2014 Canadian dollars. Except where otherwise indicated, future values are presented as net present value (NPV), using a real discount rate of 3.5% per year.

The model has provision for escalation of many costs and for some other key assumptions, including train crew wage rates, diesel fuel, traction electricity, cost of driving, value of time (VOT) and average GO rail fares. In the evaluation of the five scenarios, no real escalation has been assumed, with two exceptions:

- Auto operating costs are assumed to rise at 0.7% per year in real (not nominal) values
- VOT is assumed to increase at 1.6% per year (in real (not nominal) values).

The financial case, including cost and revenue assumptions and forecasts, is set out in Section 3.

Transport and other economic benefit assumptions and forecasts are set out in Section 4.

Table 13: Key Economic, Cost and Policy Assumptions Included in the RER Business Case Model

Item	Assumption
Project Life	60 years
Discount Rate	3.5% per year real discount rate
Implementation	All new services commence 2024
Underlying Demand Growth	2.3% per year on average (varies by route) to 2044. In all scenarios peak capacity is added to maintain current average train loads
Fares	No changes to 2015 fare structures; no real increase in fares (i.e. no fare increases ever)
Other Charges	Other charges are assumed, represented by a potential parking charge implemented before the end of the RER program
Costs	No real increase in train crew labour, diesel fuel or electricity costs
Auto Operating Costs	\$0.63 per kilometre, increasing at 0.7% per year to 2044
Environmental Assessment, Engineering and Design	15% of base capital costs
Infrastructure (Corridors)	Contingency – 50% of base capital costs Productivity and resource factor – 25% of base capital costs
Infrastructure (System-Wide components)	Contingency – 50% of base capital costs

For an extensive list of model assumptions, see Appendix C.

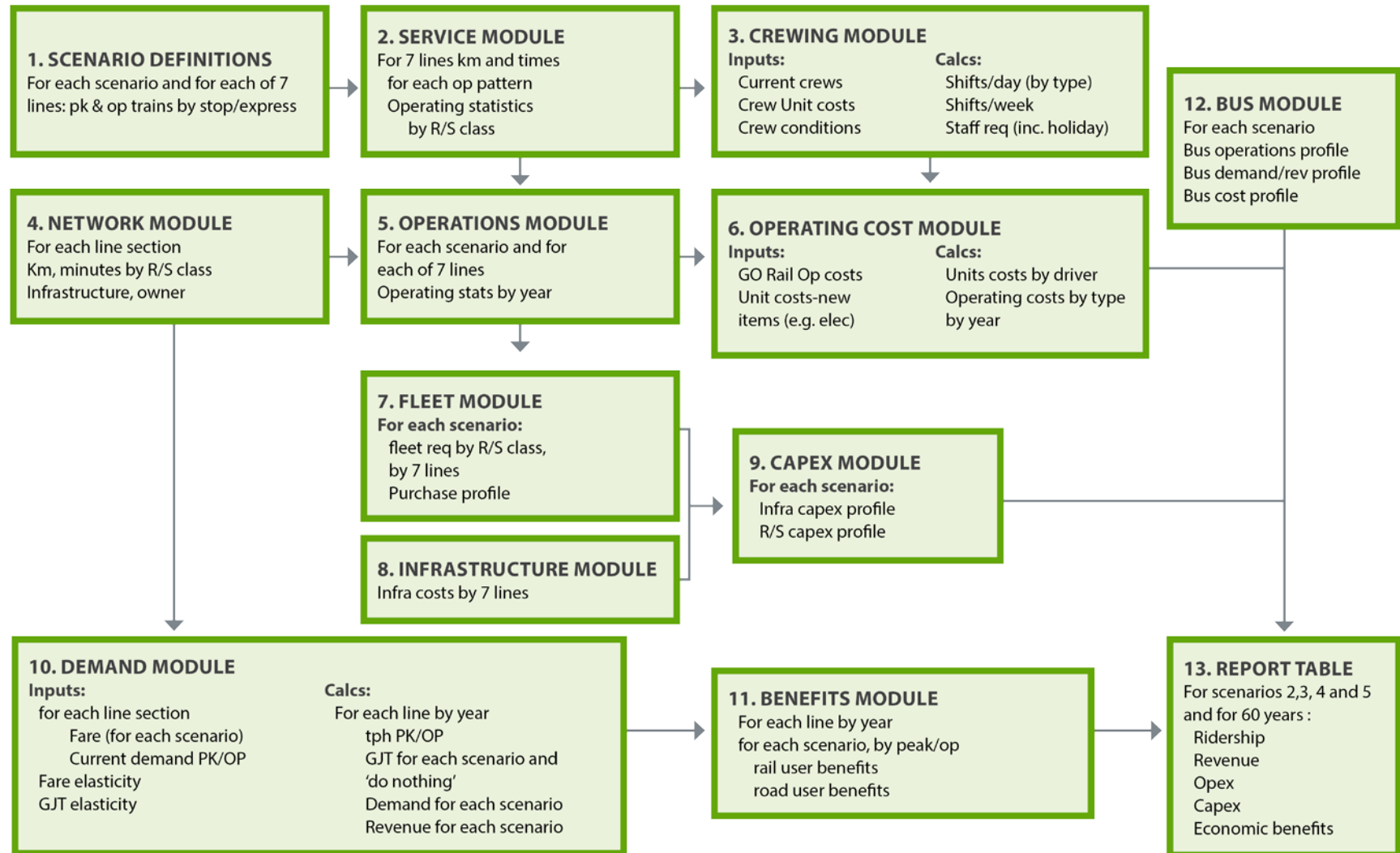


Figure 33: Spreadsheet Model Structure

2.5 Investment Scenarios

In developing a business case, it is good practice to identify a range of realistic investment scenarios. These are then evaluated against each other and against a Do Minimum scenario. Policy makers can then choose between the scenarios. Normally, they will seek to choose the program that generates the maximum net benefits. However they will also consider:

- Capital requirements and affordability considerations, which may be significant. Affordability is impacted by other considerations, like the ability to finance, and other priorities outside of the investment decision under consideration.
- The share of costs which is recovered from beneficiaries and the share that must be borne by taxpayers.
- Wider economic benefits, relating to the impact of the broader performance of the regional economy.

Four main service levels have been defined, ranging from commuter rail to electrified RER. See Table 14. These service levels were used as inputs to create the five scenarios for evaluation, with different levels of capital investment ranging from a narrow Do Minimum (Scenario 1) to an ambitious Scenario 4 (Full Build) with electrified RER on all routes. Scenario 5 (10-Year Plan Optimized) optimizes cost and risks, capturing many of the benefits but with lower capital costs, and assumes the existing interface arrangements with rail freight on the Kitchener and Milton corridors are maintained while discussions continue with CN and CPR over potential service levels and electrification. It is considered to be deliverable over 10 years, without precluding further investment to achieve the benefits of Scenario 4 (Full Build).

The scenarios considered are as follows:

- **Scenario 1: Do Minimum** – Peak-focused limited capital with no electrification.
- **Scenario 2: Two-Way All-Day** – Enhanced diesel service on all corridors with no electrification.
- **Scenario 3: 10-Year Plan** – Frequent service on most inner corridors with limited electrification.
- **Scenario 4: Full Build** (Beyond 10-Year Plan) – Frequent service on all inner corridors with full electrification.
- **Scenario 5: Optimized** (10-Year Plan Optimized) – Frequent service on most inner corridors with limited electrification.

The five scenarios have been defined to help understand the effect of different levels of investment, and technical strategies, on operating costs, ridership, revenues and benefits.

To the extent reasonably possible, an attempt has been made to optimize each scenario within the relevant capital constraint, based on professional judgment and on international experience.

The following sections give a high-level specification for each scenario as well as for some further options to be evaluated. A further detail of service specification, rolling stock and infrastructure for each corridor in each scenario is described in Appendix A.

Table 14: Defined Service Levels

	Commuter Rail	Two-Way All-Day	Diesel RER	Electric RER
Peak service	Typically four to 10 trains to carry demand	Same as CR	Same as CR; additional trains to provide four trains per hour service	Same as diesel RER
Contra-peak service	No service	Hourly	Four trains per hour	Same as Diesel RER
Off peak and weekend service	No service	Hourly	Four trains per hour	Same as diesel RER
Trains	12-car diesel loco powered	12-car diesel loco powered	12 car diesel loco powered	4-car EMUs and 12-car electric locos in peak

2.5.1 Scenario 1 (Do Minimum)

This is defined as the minimum investment, with peak trains added to match growth in peak demand but with no enhancement of off-peak services. All capacity increases are met by adding 12-car bi-level trains with diesel locomotives. Some consequent investment in station and layover capacity is required. Expansion of car parking is also assumed, with 15,000 new spaces added to GO's current 65,000 spaces. It is also assumed that GO implements Positive Train Control, as is mandatory on U.S. and European commuter rail systems.

2.5.2 Scenario 2 (Two-Way All-Day)

This is essentially the 10-year investment strategy as was approved in 2012 with the addition of some measure of enhanced train control, which is assumed to be desirable if not mandatory within the first 10 years of the program.

Hourly services would operate all-day each-way between Union and Hamilton (express from Oakville), Meadowvale, Kitchener, Barrie, Richmond Hill and Mt. Joy.

In addition to the investments in the Scenario (1Do Minimum), extensive double tracking and station reconstruction would be required, as well as construction of road-rail grade separations and the rail-rail grade separation of the Davenport and Doncaster diamonds.

2.5.3 Scenario 3 (10-Year Plan)

This scenario includes everything in Scenario 1 (Do Minimum) plus:

- Electrified RER on the Lakeshore from Aldershot to Oshawa with four trains per hour.
- Frequent all-day diesel RER services to Mt. Pleasant, Aurora and Unionville.
- Hourly services from Hamilton; express from Oakville.
- Hourly service from Barrie and Mt. Joy.

To minimize capital expenditure (CAPEX), it was assumed that RER on the Lakeshore corridors would be operated with electric locomotives and bi-level coaches with the exception of Hamilton services, which would use diesel locomotives. All other routes would use only diesel locomotives. To minimize operating costs, match capacity with demand and achieve faster acceleration, various strategies were considered to operate shorter trains outside peak hours. Operational complexities ruled out splitting and joining of trains, so it was assumed that all-day services would, in most cases, be operated with 8-car trains which could also operate shoulder-peak and contra-peak trips.

The Milton and Richmond Hill corridors, and the Kitchener corridor beyond Mt. Pleasant, would remain as commuter rail, with no mid-day or weekend service as in Scenario 1 (Do Minimum).

Infrastructure would include: electrification between Aldershot and Oshawa; additional track and grade separations, and station reconstruction on the lines to Mt. Pleasant, Aurora, and Unionville; a fourth track on the Lakeshore East (Scarborough Junction-Union and Guildwood-Pickering); and passing tracks between Aurora and Allandale.

It is assumed that GO will continue to share the CN main line between Bramalea and Georgetown, and the CPR main line from West Toronto to Milton.

A summary description, and financial and economic evaluation of Scenario 3 (10-Year Plan), by corridor, is set out in Table 15. For further detail, see Appendix A, B, and Appendix C.

As an option to consider the costs and benefits of an alternate infrastructure and service specification on the Kitchener corridor, additional infrastructure including a rail-rail grade separation, passing tracks and additional station platforms would be constructed between Mt. Pleasant and Kitchener to enable an hourly diesel all-day service to Kitchener. This service would run express from Bramalea to Union. Scenario 3 did not include this option.

2.5.4 Scenario 4 (Full Build)

This scenario represents a fully built-out RER service on all corridors and it includes electrified RER with four EMU trains per hour (tph) to Aldershot, Milton, Mt. Pleasant, East Gwillimbury, Richmond Hill, Unionville and Oshawa. Express service operate to Hamilton (one tph diesel), Kitchener (two tph EMU) and Barrie (one tph EMU), while one stopping EMU per hour is extended to Mt. Joy. Off-peak services on all electrified routes are operated with 4-car and 8-car EMUs. UP Express is also electrified in this

scenario. Full delivery of this RER concept will rely upon successful negotiation and agreement with CN and CPR.

2.5.5 Scenario 5 (10-Year Plan Optimized)

All day EMU services would operate every 15 minutes to Aldershot, Bramalea, Aurora, Unionville and Oshawa, with hourly services to Hamilton (diesel, express Oakville-Union), Barrie (EMU, express Aurora-Union),¹⁷ and Mount Joy (EMU, as an extension of one in four Unionville trains). Milton and Richmond Hill would remain peak-only diesel corridors.

A summary description, and financial and economic evaluation of Scenario 5 (10-Year Plan Optimized), by corridor, is set out in Table 16.¹⁸

As an option to consider the costs and benefits of an alternate infrastructure and service specification on the Kitchener corridor, additional infrastructure would be constructed between Bramalea and Kitchener to enable an hourly diesel all-day service to Kitchener. This service would run express from Bramalea to Union. Scenario 5 (10-Year Plan Optimized) did not include this option. As an option to consider the costs and benefits of an alternate infrastructure and service specification on the Kitchener corridor, additional infrastructure would be constructed between Bramalea and Kitchener to enable an hourly diesel all-day service to Kitchener. This service would run express from Bramalea to Union. Scenario 5 (10-Year Plan Optimized) did not include this option.

¹⁷ The service concept with express services from beyond Aurora is presented here. An alternate service pattern would see all stopping services on the Barrie corridor. More work is required to confirm that the Barrie line and Union Station rail corridor infrastructure can support such a service pattern. Further information about exact service specification on all corridors will be provided in future business case information

¹⁸ Small differences in ridership, costs and benefits between Table 16 and Table 17, with the corridor tables in Section One, and with the detailed tables in Appendix C are due to rounding and network effects.

Table 15: Scenario 3 (10-Year Plan) Summary of Services, Costs and Benefits

2014 \$ Millions NPV Scenario 3 10-Year Plan	Lakeshore West	Lakeshore East	Milton	Kitchener	Barrie	Richmond Hill	Stouffville	System Wide	Total GO Rail
	Electrification with Electric Locos; Diesel to Hamilton	Electrification with Electric Locos	Do Minimum - Peak only as existing	Diesel RER from Mt Pleasant. Peak only from Kitchener	Diesel RER to Aurora; hourly all-day to Barrie	Do Minimum - Peak only commuter rail as existing	Diesel RER to Unionville; Peak only to Lincolnville		
Peak Service – As existing plus	Capacity added to match demand	Capacity added to match demand	Capacity constrained	Capacity constrained beyond Bramalea; UPX every 15 minutes (DMU)	Capacity added to match demand	Capacity added to match demand	Capacity added to match demand	-	-
All-Day Service – Inner	Every 15 minutes Aldershot-Oshawa (electric locomotives)	Every 15 minutes Aldershot-Oshawa (electric locomotives)	Peak-only service	Every 15 minutes Mount Pleasant (diesel); UPX every 15 minutes (DMU)	Every 15 minutes Aurora (diesel)	Peak-only service	Every 15 minutes Unionville (diesel)	-	-
All-Day Service – Outer	Hourly all-day Hamilton (diesel); Express from Oakville	Not applicable	Not applicable	Peak-only service	Hourly Barrie (diesel); Extension of Aurora service	Not applicable	One train per hour extended to Mount Joy	-	-
2029 ridership (millions)	30	30	8	18	17	3	11	-	117
2014-2029 ridership growth	77%	108%	27%	288%	319%	18%	182%	0%	121%
2030 Off-Peak to Peak ratio	1:10	1:1.8	N/A	1:1.3	1:1.1	N/A	1:1.4	-	1:1.6
Financial									
Revenue (\$ m)	5,522	5,723	1,810	3,983	3,327	597	1,685	-	22,647
Operating Cost (\$ m)	3,279	2,525	1,079	3,292	2,971	800	1,872	-	15,819
Infrastructure CAPEX	344	365	4	1,338	1,263	-	779	-	4,093
Electrification CAPEX	470	425	-	-	-	-	-	-	895
Property	19	36	-	77	66	-	23	-	221
Parking	58	90	63	176	205	22	10	-	624
Fleet	546	894	262	457	448	49	348	436	3,440
Other network CAPEX	-	-	-	-	-	-	-	1,708	1,708
Capital Investment (\$ m)	1,437	1,811	329	2,047	1,982	71	1,159	2,144	10,980
TOTAL COST (\$ m)	4,715	4,336	1,408	5,340	4,954	871	3,031	2,144	26,799
60-Year Surplus (subsidy)	806	1,387	402	(1,356)	(1,627)	(274)	(1,346)	(2,144)	(4,153)
20-Year Surplus (subsidy)	(543)	(562)	(10)	(1,892)	(2,028)	(234)	(1,323)	(2,100)	(8,693)
Economic									
Transport Benefits (\$ m)	5,855	4,831	(5)	4,826	6,652	-	2,952	-	25,110
Incremental Cost	(1,796)	(879)	0	(2,903)	(2,924)	-	(1,985)	(1,182)	(11,667)
Net Benefits (\$ m)	4,060	3,952	(5)	1,923	3,728	-	966	(1,182)	13,443
TRANSPORT BCR	3.3	5.5	-	1.7	2.3	-	1.5	-	2.2

For more details of service plans, capital costs, infrastructure requirements, financial and economic results, refer to Appendix A, Appendix B and Appendix C. The BCR, as shown, are calculated as an Increment over the Scenario 1 Do Minimum. Figures in parentheses are negative numbers. They are shown in red text and highlighted in pink for clarity.

Table 16: Scenario 5 (10-Year Plan Optimized) Summary of Services, Costs and Benefits

2014 \$ millions NPV Scenario 5 (10-Year Plan Optimized)	Lakeshore West Electrification with EMUs; Diesel to Hamilton	Lakeshore East Electrification with EMUs	Milton Do Minimum – Peak only as existing	Kitchener EMUs to Bramalea; Peak- only diesel to Kitchener	Barrie Electrification with EMUs	Richmond Hill Do Minimum – Peak-only commuter rail as existing	Stouffville Electrification with EMUs	System Wide	Total GO Rail
Peak Service – As existing plus	Capacity added to match demand	Capacity added to match demand	Capacity constrained	Capacity constrained beyond Bramalea; UPX every 15 minutes (EMU)	Capacity added to match demand	Capacity added to match demand	Capacity added to match demand		
All-Day Service – Inner	Every 15 minutes Aldershot – Oshawa (EMU)	Every 15 minutes Aldershot – Oshawa (EMU)	Peak-only service	Every 15 minutes Bramalea (EMU); UPX every 15 minutes (EMU)	Every 15 minutes Aurora (EMU)	Peak-only service	Every 15 minutes Unionville (EMU)		
All-Day Service – Outer	Hourly all-day Hamilton (diesel); Express from Oakville	Not applicable	Not applicable	Peak-only service	Hourly all day Barrie (EMU); Express from Aurora	Not applicable	One train per hour extended to Mount Joy		
Ridership	33	32	8	18	22	3	12		127
2014-2029 ridership growth	93%	121%	27%	278%	442%	18%	217%		140%
2030 Off-Peak to Peak ratio	1: 10	1: 1.7	N/A	1: 1.9	1: 10	N/A	1: 1.2	-	1: 1.5
Financial									
Revenue (\$ m)	5,821	5,969	1,810	3,972	4,102	597	1,888	-	24,159
Operating Cost (\$ m)	2,827	2,120	1,079	2,414	2,341	800	1,299	-	12,882
Infrastructure CAPEX	344	365	4	1,338	1,263	-	779	-	4,093
Electrification CAPEX	470	425	-	331	468	-	188	-	1,882
Property	19	36	-	77	66	-	23	-	221
Parking	58	90	63	176	205	22	10	-	624
Fleet	536	1,021	262	592	648	49	320	679	4,107
Other network CAPEX	-	-	-	-	-	-	-	2,137	2,137
Capital Investment (\$ m)	1,427	1,938	329	2,513	2,650	71	1,319	2,816	13,063
TOTAL COST (\$ m)	4,254	4,058	1,408	4,928	4,991	871	2,619	2,816	25,945
60-Year Surplus (subsidy)	1,567	1,911	402	(956)	(889)	(274)	(731)	(2,816)	(1,786)
20-Year Surplus (subsidy)	(266)	(474)	(10)	(1,886)	(2,179)	(234)	(1,214)	(2,753)	(9,016)
Economic									
Transport Benefits (\$ m)	7,427	6,377	(5)	4,560	11,780	-	3,613	-	33,751
Incremental Cost	(1,334)	(601)	0	(2,491)	(2,961)	-	(1,573)	(1,854)	(10,813)
Net Benefits (\$ m)	6,092	5,776	(5)	2,069	8,819	-	2,040	(1,854)	22,938
TRANSPORT BCR	5.6	10.6	-	1.8	4.0	-	2.3	-	3.1

For more details of service plans, capital costs, infrastructure requirements, financial and economic results, refer to Appendix A, Appendix B and Appendix C. The BCR, as shown, are calculated as an increment over the Scenario 1 Do Minimum. Figures in parentheses are negative numbers. They are shown in red text and highlighted in pink for clarity.

2.5.6 SmartTrack

The City of Toronto SmartTrack plan consists of 53 kilometres of all-day two-way frequent service building on RER within Kitchener, Stouffville, Lakeshore East and Union Station GO rail corridors, and a new heavy rail corridor along Eglinton Avenue West to the ACC. The SmartTrack proposal includes 22 station stops (of which 13 are new), electrification of the entire route and completion within seven years.

At its meeting on February 10, 2015, Toronto City Council considered the report on the SmartTrack Work Plan. SmartTrack leverages the Province's commitment to improving regional rail and deliver RER over the next 10 years by Metrolinx and identifies a possible Toronto contribution of up to \$2.5 billion for the SmartTrack project.

Toronto City Council has requested the Province and Metrolinx work with the City on the SmartTrack plan, and includes the following elements in the design and review of RER on the Stouffville/Lakeshore East GO corridor from Unionville to Union Station, and on the Kitchener corridor from Mount Dennis to Union Station:

- Service frequency of better than 15 minutes.
- All-stop service in both directions.
- Accelerated electrification of the entire SmartTrack line.
- Transit service integration.
- Integrated fares between GO Transit and the TTC.
- Seven additional stations on the Stouffville GO/Lakeshore East GO corridor.

- Four additional stations, including one south of Bloor Street between Queen Street and Dundas Street West, plus the already planned new station at Mount Dennis on the Kitchener GO corridor.

Toronto City Council has also directed that the City, in partnership with Metrolinx and the TTC, study the feasibility of SmartTrack in the Eglinton Avenue West corridor, from Mount Dennis station to the ACC with at least three stations, and to include an additional option to continue SmartTrack north from the Mount Dennis station, into the airport area and connect to the ACC.

Metrolinx staff are working closely with City and TTC staff on the RER/SmartTrack work including: Kitchener GO and Stouffville/Lakeshore East GO RER/SmartTrack service concept, infrastructure plan and business case analysis; Eglinton West Corridor feasibility study findings, including options for rapid transit on the Eglinton West Corridor; high-level cost estimates and planning analysis for all three corridors; capital cost sharing and City financing strategy; a plan for undertaking additional Environmental Assessments (EAs) that may be required on all corridors; and an update on public consultation activities.

A report to Toronto City Council on these issues will be submitted by City staff in fall 2015 and is expected to include a business case for SmartTrack.

2.5.6.1 SmartTrack and RER

Union Station corridors have a high degree of congruence with the RER. However, SmartTrack is only part of much longer corridors and a broader network. SmartTrack elements such as stations, higher frequency and Eglinton West to ACC, will be evaluated in the context of the performance and function of the full network.

The Scenario 5 service concept (10-Year Plan Optimized) provides for a minimum, 15-minute, 2WAD service on the Stouffville, Lakeshore East,

Lakeshore West and Kitchener corridors within the City of Toronto, consistent with the City of Toronto's SmartTrack plan.

On the Kitchener line, 15-minute all-stop, 2WAD service will be provided from Bramalea to Union Station.

On the Stouffville Line, from Unionville to Union Station 15 minute all-stop, 2WAD service will be provided. In addition, the Lakeshore East service will provide 15-minute all-stop, 2WAD service adding to the level of service on SmartTrack from Scarborough Junction to Union Station.

It should be noted that the optimized service concept of the five scenarios presented here provides: 15-minute level service on the Lakeshore East and West lines; on the Barrie line from Aurora; on the Kitchener line from Bramalea; and on the Stouffville line from Unionville.

2.5.6.2 New Stations

RER provides the opportunity to consider new stations and expansion of stations on the network. Consideration of new stations will include land use intensification and local transit integration that could increase transit and/or RER ridership. However, new stations may also increase travel time on the entire corridor, possibly discouraging riders from further up the corridor and reducing the overall effectiveness of the service. The number of new stations per corridor may be limited in order to maintain optimal travel times and maximum benefit for the entire corridor. Metrolinx staff is working with City staff and other municipalities on new station locations. Stations should be, and will be considered on, a case-by-case basis, with business case analysis considering strategic, financial, economic and deliverability considerations ahead of investment decisions. Station proposals should be considered in concert with municipal development and service planning work, and analysis of development potential for transit oriented development, with particular care taken to optimize the financial contributions from large development sites that may benefit significantly

from the accessibility value created by a new station. New stations are also potential opportunities to strengthen and/or improve local transit integration — which can be a valuable source of ridership and incremental fare revenues for both RER and the local transit service(s). Initial work is yet to be completed in this area.

2.5.6.3 Eglinton Corridor

The City and Metrolinx were co-proponents of the EA and plan for the Eglinton Crosstown LRT from Kennedy Station to Pearson International Airport, approved in 2010. The Eglinton Crosstown LRT from Kennedy Station to Mount Dennis is now under construction by Metrolinx. In 2013, Metrolinx amended the EA to include an interchange station between the Eglinton Crosstown LRT, the Kitchener GO line and UP Express. The extension of the Eglinton Crosstown LRT west to the Airport was proposed and there is an EA approved. The project is unfunded and the business case analysis available on the Metrolinx website indicates the EA-approved alignment should be investigated for optimization alternatives.

The SmartTrack plan includes a new, separate heavy rail corridor in the Eglinton West corridor to provide a continuous RER/SmartTrack service from the Kitchener corridor, through the Mount Dennis area and west to ACC. This Eglinton corridor is not a part of the existing GO rail network or RER plan.

The Eglinton corridor part of the SmartTrack plan would have significant implications for the Scenario 5 RER service concept on the Kitchener corridor. Accommodating the RER service levels on the Kitchener GO corridor, along with UP Express and VIA service and further south with the Barrie service, will put significant pressure on the approach to Union Station and could require additional infrastructure to accommodate SmartTrack and maintain the planned levels of service for the other rail services. Please refer to Section 5.9 on USRC.

The feasibility study being undertaken by the City and Metrolinx will include assessment of SmartTrack and other rapid transit options in the Eglinton West corridor including extension of the Eglinton Crosstown LRT and will address the technical feasibility, community impacts, and cost implications of a heavy rail line including:

- Availability of right-of-way.
- Feasibility of any required tunnels and bridges.
- Station locations.
- Crossings, grade separations.
- Operational and infrastructure implications on the Kitchener GO rail corridor, including the interchange between corridors.
- Transit network connectivity and access to service.

Public consultation in the study area will be undertaken in late spring/early summer 2015.

The study will identify the feasibility of the different types of transit service possible in the Eglinton West corridor, and the associated business case analysis will help determine how best to provide transit access from downtown Toronto to the ACC.

2.5.6.4 Through Service at Union Station

The RER service concept presented in this report requires more extensive analysis to determine how the service will work through Union Station. The potential for interlining and connecting corridors using services via Union Station is being investigated as part of the work required to make efficient use of Union Station. Multiple combinations will be looked at to consider strategic, financial, economic and deliverability considerations for different options. See Section 5.9.

2.5.6.5 Electrification

The Scenario 5 RER service concept includes electrification of the Stouffville, Kitchener, Barrie, Lakeshore East and Lakeshore West corridors within the City of Toronto over the 10-year plan. Metrolinx has initiated a network-wide environmental assessment for the electrification of GO Transit services, including the SmartTrack components of RER.

2.5.6.6 Fare Integration

Metrolinx has identified fare integration as a key success factor for the RER program. City Council has included integrated fares between GO Transit and the TTC as one of the elements of SmartTrack to be considered. Metrolinx is analyzing options for fare integration with TTC, other local services providers and GO Transit, and expects to provide recommendations to the Metrolinx Board by the end of 2015 based on business case analysis of fare options.

2.5.6.7 Completion of SmartTrack

The City of Toronto has set out an objective to deliver SmartTrack within seven years. Additional work is underway with the City of Toronto and the

TTC to examine major elements of the SmartTrack program. This work needs to be completed and reported back to City Council in the fall of 2015. Concurrently, Metrolinx is developing a phasing plan for the RER program as a whole. Work will be required to integrate the phasing of SmartTrack with the overall RER program, subject to Provincial decision-making processes. Both the RER and SmartTrack programs set out ambitious objectives in terms of the delivery of results. Achieving these objectives will require efficient and effective administration of the programs by Metrolinx, the City of Toronto, other municipalities, the Province and other agencies.

2.6 Option for Further Study

Many options have been identified for further study and more will be identified as the project proceeds. These options will be evaluated using the BCM as an increment or decrement to the RER program, to determine the costs and benefits. Consideration of these and other options may provide the opportunity for additional optimization of the RER program as its delivery is advanced. It is this consistent, constant and iterative process of seeking better options for infrastructure and service design that leads to greater value for money when leading public and private sector organizations are planning and implementing transportation services.

2.6.1 Service Options

Some possible options are listed in Table 17.

Table 17: Service Options

Corridor	Option
Lakeshore West	Electrification to Hamilton GO (Hunter), with 2 tph or 4 tph EMU express service. May require additional track, tunnel and grade separation at Hamilton Junction. Creative solutions may exist which will allow for more affordable implementation. Optimizations of the stopping pattern for the diesel express service between Hamilton and Union Station.
Milton	RER service to Meadowvale, with hourly diesel service to Milton sharing CPR line. Could avoid cost of 4-tracking the CPR Meadowvale-Milton corridor.
Kitchener	Brampton and Kitchener corridor markets require analysis of optimal speed, stopping patterns, frequency of service, enhancements to track capacity and specification, including relationship to potential high-speed rail. "Left turn" Kitchener corridor branching options, as suggested by SmartTrack, should be considered as one kind of option to achieve rapid transit service to ACC and Pearson International Airport.
Barrie	Double-tracking could be extended beyond Aurora to Newmarket and/or East Gwillimbury, with frequent all-day RER service. Initial analysis suggests incremental capital and operating costs will be offset by benefits, but further work is required to explore how RER, together with improvements to local transit and denser development especially around Newmarket station, could improve the IBC. Further analysis is required to determine if a two-way service can operate with a short single-track "gauntlet section."
Richmond Hill	Electrified commuter rail or 2WAD service should be evaluated in conjunction with Yonge Subway extension and potential future branches. There are additional alternate alignments that could be looked at, including use of the Don Branch and Leaside sub-division, to create new lines and services for markets.
Stouffville	Double tracking beyond Unionville would enable frequent all-day RER services to be extended to Markham or Mt. Joy. Further analysis is required to determine if a two-way service can operate with a short single-track "gauntlet section."
Lakeshore East	Two-tier all-day service, with express and local trains on the Lakeshore East corridor, as is planned for the Lakeshore West corridor. This service might be combined with potential further eastern extension.

2.6.2 Fleet Strategy Options

The business case might be improved further with variations on the fleet strategy. Options to test include:

- Retain surplus bi-level cars and store to meet future growth. Surplus bi-level cars and diesels could be used to operate possible service extensions.
- Acquire new EMUs rather than bi-levels and electric locos to meet peak growth beyond 2024. Over time, the entire system could then be operated entirely with EMUs, offering faster peak journey times.
- Operate some corridors entirely with shorter trains (6 or 8-car EMUs) to better match demand and to enable different berthing options at Union Station.

Further study is required, but is unlikely to change the main conclusions of this IBC analysis. A detailed fleet strategy will be prepared as part of the optimization of the RER program.

2.6.3 Station Options

Several new stations are under development and many more have been proposed. The case for each station will be examined separately. Metrolinx is in the process of undertaking work to look at new station site opportunities. New stations present the opportunity for land value capture activities, which can lead to a combination of funding contributions, private sector value creation, additional ridership, and more optimal sharing of risk — both short and long term. The analysis presented here has assumed no new stations in this IBC, but that is not meant to convey that no new stations are possible. Future business case updates will include consideration of new stations once sufficient information for any new station(s) is available.

Successful new station(s) will require collaboration between municipal planning, property owners, developers and Metrolinx.

2.6.4 Non-Fare Revenue

Incremental non-fare revenue associated with land value capture, enhanced retail, and other customer amenities and commercial activity will be possible with the increased ridership and activity on the GO system as a result of RER. Metrolinx is pursuing non-fare revenue opportunities. For the purposes of this IBC, such non-fare revenues beyond those already included in Metrolinx's business practices have not been included. Future business cases may consider and present non-fare revenue as an incremental financial opportunity as part of a refined RER program.

2.6.5 Phasing Options

This IBC is prepared on the working assumption that all corridors are upgraded simultaneously with all new services commencing January 1, 2024. This position reflects a simplifying assumption for evaluation purposes only. Once the appropriate service level is defined for each corridor, Metrolinx will consider:

- The appropriate number of stages for implementation, including elements delivered on a network basis and elements delivered on a corridor basis. Practical considerations will include spending constraints, management and industry capacity.
- Whether to introduce increased services early, with diesels. While this will deliver benefits sooner, it will add to costs and may significantly complicate the eventual implementation of full RER.

2.7 Policies and Practices

In order to provide a robust evaluation of RER, the following working assumptions have been made in all scenarios in the IBC, as noted. See Table 18.

Table 18: Policies, Practices and Working Assumptions for RER Business Case

Current Policy and Practice	Working Assumption and Comments
<p>FARES: Currently there are more than 10 different fare structures applied on transit across the GTHA.</p> <p>GO administers co-fare arrangements with some municipal operators and there are various arrangements for cross-boundary trips. However, trips involving use of more than one operator almost always cost more, yet are slower and less convenient, than trips on a single operator. Both ridership and revenues are lower than they would be if an integrated fares structured was in place.</p>	<p>No change to current (March 2015) fare levels or fare structures, and no new fare integration.</p> <p>Comments: With the introduction of PRESTO on the TTC, Metrolinx is pursuing a strategy to introduce an integrated and optimized fares structure. These changes, if implemented, would almost certainly strengthen the case for RER.</p> <p>Alternate fare models are being developed for testing to be presented as a sensitivity analysis in future business case updates.</p>
<p>PARKING CAPITAL INVESTMENT: Metrolinx funds parking construction from its general capital budget. It costs approximately \$50,000 to provide one additional parking space in a structure. Taking account of finance and operating costs, it costs GO approximately \$10 per day (capital costs, cost of capital, and maintenance and operation costs) to provide each parking space in a structure.</p> <p>Where possible, surface parking will be pursued because surface parking is much more affordable than structured parking. On most RER systems, users are charged for car parking, and in many cases the provision of parking is left to third parties, including local government or even private companies.</p>	<p>Capital expenditure of \$740 million is assumed in all scenarios to develop approximately 15,000 new parking spaces.¹⁹ Any further new parking, if required, is assumed to be provided at a price reflecting full cost recovery. This approach could be done by Metrolinx, through a P3 structure, as part of station area development, or by a third party.</p>

¹⁹ Note that, as with most capital investments in the program, a smaller figure is show in detailed tables. This is because the money will be spent in the future, and is presented as a Present Value discounted back to 2014.

Current Policy and Practice	Working Assumption and Comments
<p>OTHER CHARGES: Currently GO does not charge for parking, although a proportion of parking spaces are reserved at a charge of \$90 per month with a 6-month minimum rental. This rental corresponds to a charge of approximately \$4.25 per day. Reserved spaces are allocated to a specific user and so are not available for use by others. This practice results in some spaces going un-used.</p>	<p>Other revenue that could be developed is represented in the model using GO parking charges. This assumption has the effect of raising revenues by approximately \$4 billion NPV in all four scenarios. While it would slightly reduce peak demand, it would ensure availability of parking for off-peak passengers. Analysis has shown that if properly implemented, pay-parking at GO stations could increase transit ridership by encouraging more efficient decisions by GO system users. Parking revenues are shown separately in this IBC. They affect the financial case, but have only a small and indirect impact on the economic case, as they are mostly a transfer.</p>
<p>DEMAND MANAGEMENT: Road user charges, fuel taxes and parking restrictions.</p>	<p>No changes are assumed from current policies.</p>
<p>TRAIN CREW SIZE: Currently, GO operates all services with 3-person crews, except on the Milton corridor where 2-person crews are used.</p>	<p>For the purposes of assumptions for the financial model, it is assumed that GO moves toward 2-person crews on trains by 2019. Alternative crew scenarios will be evaluated in future versions of the business case.</p>
<p>UNION STATION RE-SIGNALING: This project is funded and underway.</p>	<p>Completed as planned.</p>
<p>UNION STATION IMPROVEMENTS: Some expansion of Union Station platform and passenger facilities will be required to accommodate the growth in the number of peak passengers. A number of options are under consideration at this time.</p>	<p>Capital expenditure ranging from around \$300 million in the Do Minimum scenario to \$882 million in Scenario 3 (10-Year Plan), Scenario 4 (Full Build) and Scenario 5 (10-Year Plan Optimized) is assumed. Appendix A.²⁰</p>

²⁰ Unless noted otherwise, costs include engineering, contingency, and resource and productivity factor.

Current Policy and Practice	Working Assumption and Comments
<p>TRAIN CONTROL: Enhanced Train Control (ETC) is a prudent and necessary investment given the level of services now being operated. This may be of a type of train control, such as Positive Train Control (PTC) and Communication-Based Train Control (CBTC).</p> <p>It is noted that CBTC includes the functionality of PTC, but also regulates and automatically operates trains so they can operate more closely and more efficiently.</p>	<p>In all scenarios, allowance is made for installation of ETC (and associated costs) to varying extents within the five scenarios.</p> <p>It is noted that PTC is not yet a legal requirement in Canada but it is mandated in the U.S., and many RER systems in other countries have a train control system with similar functionality. PTC's effect on capacity is not yet known; it should be noted that CBTC is the working assumption for the Scenario 5 (10-Year Plan Optimized) RER program.</p>
<p>UNION PEARSON EXPRESS: This project is almost complete.</p>	<p>In all scenarios, assume UP Express is implemented as planned and operates as a free-standing business. In Scenario 1 (Do Minimum), Scenario 2 (Two-Way All-Day) and Scenario 3 (10-Year Plan), it is assumed that UP Express will operate with DMUs. Implementation of EMUs for UP Express (requiring electrification of a portion of the Kitchener and Lakeshore West corridors) is assumed in Scenario 4 (Full Build) and Scenario 5 (10-Year Plan Optimized). The case for electrification of UP Express is most strong as a part of wider RER electrification.</p>
<p>DWELL TIMES: GO might reduce costs and increase revenues by shortening dwell times. Faster journeys would help to attract new passengers.</p>	<p>Scenario 1 (Do Minimum) and Scenario 2 (Two-Way All-Day): no change to dwell or schedule recovery times.</p> <p>Scenario 3 (10-Year Plan), Scenario 4 (Full Build) and Scenario 5 (10-Year Plan Optimized): shorter dwell times and reduced schedule times are assumed for EMUs. It is confirmed that the improved acceleration of electric traction could improve journey times by up to approximately 20%, with some additional reduction possible if faster boarding and alighting, and/or faster door open/close protocols, and/or reduced recovery times could be introduced. A working assumption has been made that EMU operation would allow a nominal 4% improvement in journey times due to shorter dwell times. This assumption will be the subject of further verification and refinement.</p>

Current Policy and Practice	Working Assumption and Comments
<p>LINE SPEED IMPROVEMENTS: There are opportunities to shorten journey times through improvements to track and alignment. Many would not have been worthwhile for peak only-commuter services, but with frequent all-day services, they could prove cost effective. In some locations, line speed improvements can actually reduce the need for double tracking.</p>	<p>No improvements assumed. Some potential improvements are identified in Section 5.12.</p> <p>Early analysis indicates that in some sections of the network, line speed efficiencies may be the best way to achieve service enhancement and attract ridership. Line speed enhancements will be considered and reported on future business case updates. For more information on potential speed improvements refer to Table 34.</p>
<p>TRAIN LENGTHS: GO could operate shorter trains during mid-day, evenings and on weekends, when passenger demand does not require full 12-car trains. This change would reduce rail car-kilometre and allow slightly faster run times. While there are operational complexities, GO is now experimenting with running shorter trains on a few test services.</p>	<p>Scenario 1 (Do Minimum) and Scenario 2 (Two-Way All-Day): all services will be operated with 10 or 12 cars.</p> <p>Scenario 3 (10-Year Plan), Scenario 4 (Full Build) and Scenario 5 (10-Year Plan Optimized): EMUs will be configured as 8 or 12-car trains to operate all day services. Train lengths (either diesel or electric) will be shortened or lengthened during the day only at layover or maintenance facilities as required to meet the service plan.</p>
<p>LEVEL CROSSINGS: GO currently has over 180 level crossings, and typically replaces one or two each year, often sharing the cost with local municipalities. As more trains will operate in Scenario 2 (Two-Way All-Day), Scenario 3 (10-Year Plan) and Scenario 4 (Full Build), greater expenditure in road-rail grade separations may be required.</p>	<p>An allowance, from a costing perspective, has been made for grade separations of 13 level crossings in this IBC. The exact number of grade separations for planning purposes is to be determined. This is considered a conservative assumption for the purpose of analysis at this time.</p>

Current Policy and Practice	Working Assumption and Comments
<p>ADDITIONAL STATIONS: There are some new stations being added as part of committed projects, including West Harbour (formerly known as James St. North) Mount Dennis, Caledonia, Downsview Park and Gormley.</p>	<p>Additional work is required to determine the number and location of new stations. No new stations are assumed to be built in any of the scenarios. The case for each new station will be examined as a separate project.</p> <p>Comment: In some cases, new stations may bring sufficient levels of ridership to warrant their construction. In other cases, new stations will not generate sufficient ridership to warrant their construction, maintenance, and the cost to other riders of lengthened trip times as a result of additional stations adding dwell, acceleration and braking times to GO service timetables. New stations create opportunities for co-funding, joint development, and/or land value capture activities in partnership with the private sector. Land value capture can reduce the net cost of RER infrastructure to government, transfer risk and create incentives for the private sector to collaborate with Metrolinx for the benefit of greater ridership and system attractiveness, and greater total value created.</p>

2.8 Passive Provision and Future Proofing

In designing and implementing RER, Metrolinx must make many decisions that will affect the potential cost to expand capacity and introduce other types of services. Often, passive provision can be made at little or no cost. But for some elements of the RER system, there is a price for providing spare capacity and flexibility. It only makes sense to provide capacity for future needs if there is reasonable certainty that it will in time be used, and if the cost to provide it now is sufficiently lower than the cost to provide it in the future.

The business case assumes the following:

- **Train Size:** All facilities are built for use by bi-level trains, up to 12-cars long.
- **Platform Height:** Raising platforms to allow level loading with EMUs should be explored. New bi-level EMUs can be designed for level boarding as on the Toronto subway. This allows passengers with wheelchairs, strollers and other mobility devices to load at any door, and can also make boarding of all passengers faster and safer. Minor platform height adjustment will be required, and perhaps other measures, to ensure compatibility with existing GO bi-level equipment which will continue in service. The Zurich S-Bahn is an established and successful system with bi-level EMU coaches where boarding occurs from the lowest levels of the train cars, achieving level boarding with an excellent standard of accessibility.
- **Control Systems:** ETC systems such as CBTC, or similar technology, are employed where required, providing ample capacity for future growth and schedule-recovery capability in the event of service disruptions. Metrolinx is exploring the feasibility of introducing such a system so that the performance needed can be achieved on the GO rail network.
- **Fleet Size and Storage:** In Scenario 4 (Full Build), the GO rail fleet triples in size by 2074 to approximately 1,800 cars and locomotives, or approximately 150 trains. Space for overnight storage at or near the end-of-line terminals is being identified and protected for up to 100 trains, approximately three times the current provision and enough to accommodate expected growth until 2074. Space is also being identified and protected for mid-day storage near downtown Toronto for up to 80 trains. Space is also being identified and protected to expand train maintenance facilities to service this fleet.
- **Other Passenger Rail Services:** When designing track and station layouts, provision should be made for existing VIA Rail, Amtrak and freight services.
- **Electrification:** Overhead electrification should be designed with provision to intensify services to five-minute headways on all routes, and three-minute headways where two or more routes would operate over the same track. This allows for future growth, but will also be useful to allow closer spacing of trains when recovering from service disruptions.
- **Union Station Rail Corridor (USRC):** Work is underway to look at a variety of different strategies that may enable higher performance of trains and better services for people, while accommodating the required passenger through-put

2.9 Forecasting Demand

2.9.1 Objectives and Methods

Attracting new riders onto transit and off the region's overcrowded roads is one of the main objectives of developing RER.

Forecasting transit ridership involves predicting travelers' choices, including unique trips at different times of the day and with unique requirements. As shown in Figure 34, demand forecasting and service planning for a new transport investment is usually an iterative process. A scheme and service level is conceived, and then ridership is estimated using a travel demand model. Often several iterations are required to define an optimized scheme, with train frequencies and train sizes matching peak demand, and finding a solution with benefits in excess of costs.

The travel demand and service definition process for RER is somewhat different. The entire GO rail system is already operating, with a highly efficient business model, using large trains that carry commuters in comfort into downtown Toronto.

Peak demand has grown, in recent years by more than 3% per year (see Table 12). This growth is a combination of underlying growth and demand responses to service improvements. It is anticipated that underlying growth will continue in the future at a rate of more than 2% per year.

Four service levels have been defined and tested: commuter rail, hourly 2WAD, 15-minute diesel RER (RER-D) and 15-minute electric RER (RER-E). To identify which level of investment is appropriate, it is necessary to estimate the ridership that will be attracted by each of the four service levels on all the relevant corridors.

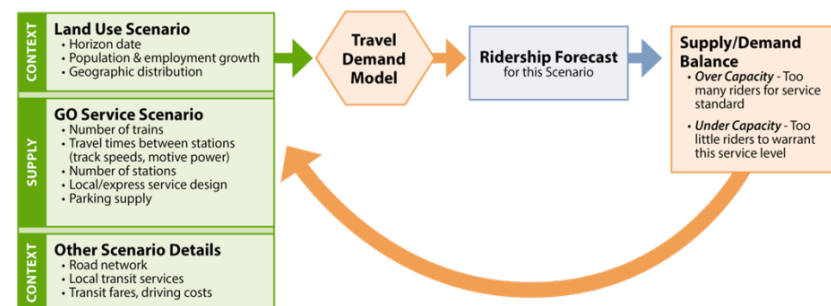


Figure 34: Classic Iterative Demand Forecasting Process

In developing the business case for RER, ridership forecast outputs are required for two distinct purposes:

- Estimates of peak demand on each route to determine the train and track capacity that must be provided.
- Estimates of total all-day traffic, including off-peak traffic and contra-peak traffic, to determine the total revenue and benefits.

It is important to understand the total off-peak and contra-peak traffic, but less important to estimate the pattern of this demand, as trains and tracks must provide capacity for the peak anyway. Off-peak loadings will fluctuate through the day, and at different locations on the corridor.

Metrolinx is using a range of forecasting methods as described below and is continuing to refine its forecasts as work progresses.

2.9.2 Peak Demand

GO's peak traffic has grown as services and car parking have been added over the past half century, in response to employment growth in downtown Toronto, and population growth in other parts of the GTHA and surrounding communities.

Peak period demand growth assumptions for the Do Minimum (Scenario 1) are described in section Underlying Growth Rates. These assumptions depend mostly on growth in underlying population and employment. The GTHA has experienced population growth averaging approximately 2% per year over the last half century and GO peak ridership has generally grown somewhat faster, given that with a congested road system, GO rail attracts a growing share of the travelling market.

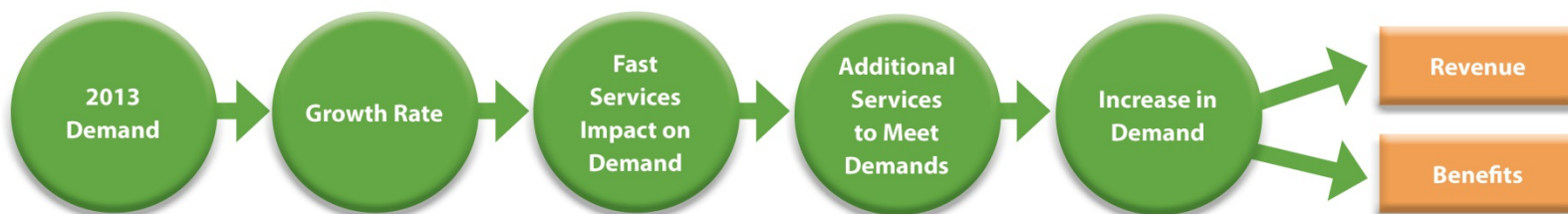
Peak period Do Minimum growth assumptions, as set out in Section 2.3.2, are derived using the GGHM, a classic four-stage network model based on extensive data and research.

Current four-stage models used at Metrolinx are peak only. Work is underway to develop a four-stage model for the GTHA that can forecast off-peak travel. This model is still in development and will be used for RER forecasting when available.

Four-stage models are widely accepted as giving accurate forecasts of peak demand on different routes and modes, provided of course that the underlying population and employment growth forecasts are accurate. If the GTHA grows faster or slower than expected, and if employment and labour force participation are different than assumed, peak traffic on RER will also be different.

It is inherent in such models that the changes to the transport system do not change the overall levels of population and economic activity in any part of the region; they redistribute trips linking people to jobs and other activities, but do not alter the total number. Travel is not an end in itself; if RER is successful in attracting trips off the overcrowded roads, it will facilitate the economic growth of the region, attracting more and potentially higher-paying jobs, and making all parts of the region accessible to a wider range of educational, cultural and leisure activities. By implication, any classic four-stage model will under-estimate total demand if major transport improvements enhance the competitiveness of a region. As a consequence, the estimates of underlying peak demand should be inherently conservative.

PEAK



OFF PEAK

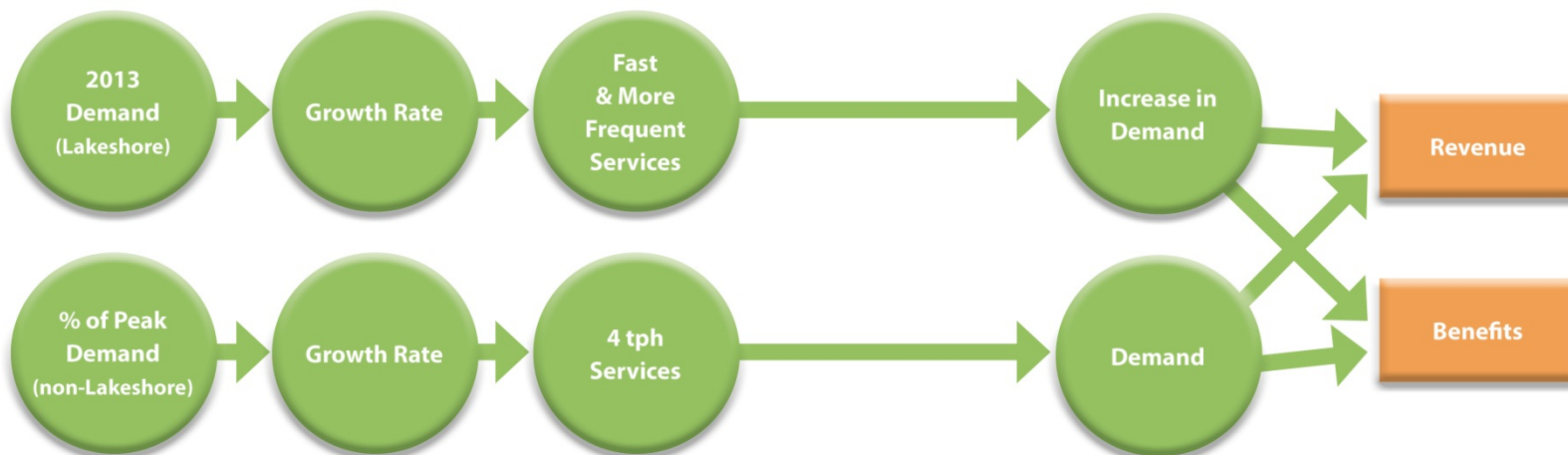


Figure 35: GO Direct Demand Forecasting Methodology –
This is consistent with standard practice direct-demand forecasting models.

2.9.3 Forecasting Off-Peak Demand

Conventional traffic models are designed to forecast peak traffic volumes, so roads and railways can be correctly sized to meet demand. Forecasting the precise level of contra-peak and off-peak ridership is more difficult for several reasons. Off-peak trips are for a wide variety of purposes and not dominated by commuting to work. Many trips are “linked,” combining multiple purposes, sometimes with a car transporting both the driver and a passenger, perhaps to different destinations. Trips are not the same every weekday. Roads are less congested and driving is an attractive alternative even for radial trips and transit services are generally not as good, indeed on many GO routes there is currently no off-peak rail service. There is good evidence to suggest that off-peak demand is more sensitive to service frequency, speed, price and quality changes.

Forecasting the precise level of off-peak demand is also less important from an infrastructure and service definition perspective. Tracks and trains need to carry the peak, so will usually have ample capacity in the off-peak and contra-peak. For a contra-peak commuter, there is value in knowing there will almost always be a choice of seats on the train. Metrolinx does need to know the total off-peak and contra-peak traffic that RER can attract, and the revenue and benefits that it will generate. This can be estimated with some confidence by reference to international experience, and the off-peak demand that is attracted by the existing all-day service on the Lakeshore corridors. Future off-peak demand for RER on the Lakeshore corridors is estimated using elasticities, as described below, and reflecting service enhancements compared with the current trip times and frequencies.

Recognizing the difficulties of estimating off-peak demand through the day, total off-peak demand is usually estimated by factoring estimates of peak demand. Off-peak demand for RER services is therefore estimated on each corridor based on evidence of the ratio of peak to off-peak demand

on similar corridors with comparable markets and services. Essentially, it is assumed that there will be similar ratios between peak and off-peak travel, on corridors of similar development and density characteristics, if a similar service is offered.

Forecasts have also been benchmarked against experience of RER in other cities and regions, and on the Toronto subway.

The University of Toronto Travel Modelling Group, with funding from MTO, Metrolinx and several of the regional municipalities, has been working to develop a four-stage “activity-based” model to forecast peak and off-peak travel across the GTHA. This model has been under development for several years, when it becomes functional, Metrolinx will use it to validate assessments. The City of Toronto is intending to use it in evaluation of SmartTrack.

The City of Toronto and other municipalities, along with Metrolinx, are undertaking work to better understand the potential for contra-peak travel to employment and activity clusters in Mississauga, Markham and elsewhere in the region. The modelling results presented in this IBC do not assume any contra-peak ridership as a result of economic development in those areas, and therefore ridership, as presented here, could be considered conservative.

Ridership resulting from suburban employment that is connected to RER in a way that encourages ridership beyond the levels presented here will result in revenue at little or no additional cost; the trains in most cases are already modelled to be running to accommodate the peak-oriented downtown Toronto-bound ridership market. A key variable is how effectively can suburban jobs be connected to RER, and will RER, combined with those connecting facilities, be attractive enough to encourage new ridership.

2.9.4 Forecasting Demand with Elasticity Methods

Reductions in journey times and increased frequencies will bring ridership growth, over and above the growth in underlying demand. GO's DDM uses "elasticities," factors derived from quantitative research, to estimate the effect (sensitivity) of increasing frequencies and reducing journey times.

The RER DDM has been integrated, with some changes, into the RER BCM, so that changes to train services automatically generate changes in revenues and benefits as well as costs. See Figure 35 for the GO direct demand methodology. For the Lakeshore corridor, the forecasts are based on current demand, adjusted for underlying demand as described above, with further changes in peak and off-peak demand reflecting service changes.

The RER model reflects GO's own experience, particularly from the 2013 doubling of off-peak services on the Lakeshore corridor, to validate the elasticities. It has also drawn on extensive international experience. The model uses various formulae and elasticity values to estimate the change in demand. The general model structure is shown in Figure 35. For full details of elasticity assumptions, annualization factors and other aspects of the Direct Demand Model, see Appendix C. Table 19 shows approximate values of changes in demand, as predicted using elasticities.

On the other corridors there is currently no off-peak or contra-peak rail service. Current train-bus ridership ranges from 10% of peak ridership on the Richmond Hill corridor, where the subway provides competition for many trips, and where many stations are not served at all, up to approximately 20% on the Kitchener and Barrie corridors. RER will bring a fundamental change in service on these corridors. Train-bus services mostly run every half hour, and on some routes can actually be faster than a train. Buses can provide similar comfort to a train; however they are vulnerable to road delays. In particular, morning peak departures may be late where they are operated following on an inbound journey. They also

do not always serve trips between stations because many train-bus services run express to Union Station.

Table 19: Impact of Key Elasticity Assumptions

Service Enhancement	Approximate Impact on Demand
10% reduction in peak journey time	7% growth at 4 tph
10% reduction in off-peak journey time	10% growth at 4 tph; 8% at 2 tph
Increasing off-peak frequency from one to two trains per hour	52% growth in off-peak demand
Increasing off-peak frequency from two to four trains per hour	30% growth in off-peak demand
Parking charge of \$5	1.2% reduction in rail demand at the station.
10% increase in peak fares	2.5% reduction in peak demand, 7% peak revenue uplift
20% reduction in off-peak fares	13% increase in off-peak demand, 10% reduction in off-peak revenue

Off-peak ridership on the other routes is therefore estimated by analogy. The Kitchener and Milton corridors are assumed to have the same peak: all-day ratios as the Lakeshore West corridor, while the Barrie, Richmond Hill and Stouffville corridors are assumed to be similar to the average of the combined Lakeshore East and West. Off-peak ridership is assumed to build up to the full predicted level over four years within the model. These rates are based on actual GO experience on the Lakeshore corridors and international experience.

With the faster, more frequent service provided using EMUs, off-peak and weekend ridership on the Lakeshore West corridor, currently approximately 39% of total ridership, grows to equal peak ridership although spread

over more hours. On the Lakeshore East corridor, off-peak and weekend ridership grows to approximately 37% of total ridership. On Richmond Hill, which has competition from the Yonge Subway for many trips, 2029 off-peak and weekend is expected to reach 45% of total ridership, with Stouffville at the same level. Off-peak and weekend ridership on Kitchener, Barrie and Milton will be higher, approximately the same as peak ridership (see Table 20).

Table 20 shows figures for Scenario 4 (Full Build) on all corridors. Table 21 shows figures for Scenario 5 (10-Year Plan Optimized), where ridership will be less on the Milton, Kitchener and Richmond Hill corridors.

Table 20: Peak and Off-peak Ridership in Millions per year – Scenario 4 (Full Build)

Scenario 4	Lakeshore West	Lakeshore East	Milton	Kitchener (including UPX)	Barrie	Richmond Hill	Stouffville	GO Rail Total
2014 Ridership								
Peak	10	10	6	5	4	3	4	42
Off-Peak	7	5	-	-	-	-	-	11
Total	17	14	6	5	4	3	4	53
2029 Ridership								
Peak	17	21	12	13	12	5	7	86
Off-Peak	17	12	12	13	12	4	6	76
Total	34	33	24	25	23	10	12	162
Off-peak Ridership (% of Total Ridership)								
2014	39%	32%	0%	0%	0%	0%	0%	21%
2029	51%	37%	49%	51%	50%	45%	45%	41%
2014-2029 Ridership Growth								
Peak	62%	112%	92%	170%	189%	99%	82%	107%
Off-Peak	160%	165%	-	-	-	-	-	429%
Total	100%	129%	276%	448%	475%	260%	229%	206%

Note 2014 off-peak ridership does not include train-bus ridership.

Table 21: Peak and Off-peak Ridership in Millions per year – Scenario 5 (10-Year Plan Optimized)

Scenario 5	Lakeshore West	Lakeshore East	Milton	Kitchener (including UPX)	Barrie	Richmond Hill	Stouffville	GO Rail Total
2014 Ridership								
Peak	10	10	6	5	4	3	4	42
Off-Peak	7	5	-	-	-	-	-	11
Total	17	14	6	5	4	3	4	53
2029 Ridership								
Peak	16	20	8	11	11	3	7	77
Off-Peak	17	12	-	6	11	-	5	51
Total	33	32	8	18	22	3	12	127
Off-peak Ridership (% of Total Ridership)								
2014	39%	32%	0%	0%	0%	0%	0%	21%
2029	51%	37%	0%	35%	50%	0%	45%	40%
2014-2029 Ridership Growth								
Peak	56%	104%	27%	147%	171%	18%	76%	83%
Off-Peak	151%	155%	-	-	-	-	-	352%
Total	93%	121%	27%	278%	442%	18%	217%	140%

2.9.5 Benchmarking Demand

In many ways, RER will transform not just the service that is offered by GO, but in time, the region around it and where people live and work. Elasticity models are intended for small service changes, while conventional four-stage models generally assume a “fixed” pattern of development, with or without the improvement.

An alternative approach to estimating ridership on RER is to compare the GTHA with similar city regions that have implemented it. Clearly, there will be differences not just in city size, but also the pattern and density of development, the extent of competing and complementary roads and transit services, and even factors such as climate. Several cities and systems have been considered and some conclusions drawn, which can be used to benchmark RER ridership. For each city, a comparison with the GTHA in size, structure and competing modes, and what lessons can be drawn, has been made. Specifically, the analysis considers annual RER ridership per person, and the proportion of RER trips that are off-peak, including contra-peak and weekends, in comparison with the peak period and peak direction commuting trips. The common experience of the many regions that have implemented RER can give confidence that the GTHA could achieve similar outcomes.

2.9.5.1 Toronto Subway

Perhaps the most useful benchmark is Toronto itself, where the TTC has operated a frequent two-way all-day service on the subway since 1954 and GO has been operating half-hourly all-day services on the Lakeshore since 2013.

The TTC publishes platform boarding counts for each station, by time band. System-wide ridership counts are impacted by the downtown, where there are many short trips.

The analysis is therefore focused on selected stations which have some of the characteristics of GO stations.²¹

Table 22 shows that off-peak demand at subway stations, even at quite suburban locations with very little walk-in traffic, far exceeds peak ridership .

Table 22: Ridership at Selected TTC Subway Stations

Station	All Day	Mid-day	PM Peak (15:00 hrs. to 19:00 hrs.)	Off-Peak, Contra - Peak, Weekends / All Day
Finch	49,078	10,408	42%	58%
Kennedy	34,817	6,565	38%	62%
Kipling	27,671	4,364	32%	68%
Wilson	12,150	2,128	35%	65%
York Mills	14,732	2,109	29%	71%
Eglinton	40,593	5,889	29%	71%
St Clair	20,634	3,250	32%	68%

Source: TTC Subway 2012 Station Platform Usage Report.

Note – TTC’s AM Peak is 7 a.m. - 9.30 a.m., and PM Peak is 3 p.m. - 7 p.m.

2.9.5.2 GO Lakeshore Corridors

In June 2013, GO increased its two-way all-day service on the Lakeshore corridors from hourly to half hourly. According to GO’s cordon counts²² of September 2013, off-peak, contra-peak and weekend ridership together equalled approximately 41% of total ridership on the Lakeshore West and

²¹ TTC Subway 2012 Subway Platform Usage Counts.

²² RER BCM assumes a three-hour peak period (AM peak = 6:30a.m. - 9:30 a.m., PM peak = 4:30 – 7:30) and 14.5 hour off-peak period.

32% on the Lakeshore East. These figures are based on train counts made only three months after the doubling of the off-peak frequency to 2 tph.

They showed a 28% increase in the level of demand compared with the previous year, when the service was hourly. Experience in other regions indicates that it takes time for demand to build up following a major improvement in service pattern, and it is likely that demand will continue to grow, with perhaps only half the eventual growth in demand having been achieved within the first three months. The conclusions will be reviewed when more recent counts are available.

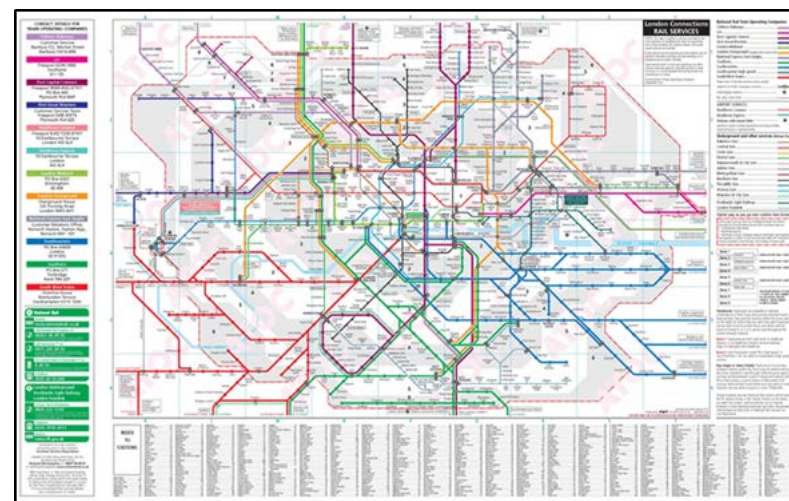
It is important to note that the ratio of existing off-peak to peak ridership will be depressed, because off-peak service currently operates only every half hour, but also because all services are operated as all-stop diesel services whereas in the peaks there are also some express trains. So the average trip actually takes longer in the off-peak. In the peak hours, many passengers are able to take advantage of express trains, but in the off-peak these do not operate. By increasing demand in the peak, express trains have the effect of further depressing the off-peak to peak ratio. Faster and more frequent EMU off-peak services will attract more riders. A further factor that may depress current off-peak ridership is the limited availability of parking at most GO stations after the morning peak.

2.9.5.3 *London, U.K.*

In London, the city and region has a population approximately double the GTHA, spread 360° around a dense core. Like Toronto, it has a dense city centre with congested streets and a very limited radial expressway system. Unlike Toronto, it has had frequent radial electric rail services, on 40 routes, in a network that has developed progressively since the 1920s into a RER (although it is not called this). London has several other policies that affect the relative attractiveness of transit for radial commuting, but also for non-radial and off-peak trips:

- Provision of car parking in the city centre has been severely restricted since the 1960s.
- High fuel taxes are charged, although the effect of this is mitigated by the use of smaller cars.
- For the last decade, a daily congestion charge has been levied, although this only applies in a small area.
- Fully integrated and “smart” fares encourage orbital and cross-regional commuting by transit.

Figure 36: RER-Type Services of London’s Network



Data has been obtained for train loadings for one train service into London that serves one of the least affluent areas of southeast England; the majority of commuters are support staff rather than managers or professionals. This route has fast EMU services every 20 minutes, all day. The data shows that on an average weekday, the off-peak demand represents 48% of peak demand. It is estimated that daily weekend demand averages approximately the same level as off-peak weekday demand (although spread over a longer period of time). Thus, total off-peak demand is approximately 67% of peak demand. Off-peak and weekend ridership is substantially higher on other routes, serving more affluent markets with more development that attracts off-peak and contra-peak passengers. The 67% rate thus sets a lower bound of expected off-peak ridership, compared with peak period, peak direction commuting. It should be noted that the Lakeshore West corridor already seems to exceed this ratio, with the current half hourly service.

2.9.5.4 Sydney, Australia

In many ways, Sydney is a very comparable city to Toronto. Sydney is smaller, with a regional population of approximately 4.8 million. Like Toronto, it is essentially a 180° city with a downtown near the shore with offices, apartment towers and sprawling residential development mostly along the shore and inland. Transport in both cities is mostly by car, but as in Toronto, public transit is the main mode for access to the CBD.

Sydney Trains performs the role of both GO rail and the Toronto subway. There are frequent 2WAD services extending over a large network. Nearer the city centre, trains run every 5-10 minutes, while further out, headways extend to 15 or 30 minutes. All services operate with bi-level EMUs.

Sydney does not have a subway system but does have ferries and buses. Since 1992, train fares have been integrated with ferries, and public and private bus routes. Off-peak fares are approximately two-thirds of the peak fare.



Figure 37: Sydney has Network of RER Trains

Source: <http://www.airportlink.com.au/network-map.php>

Sydney Trains operate on a network greater than 900 kilometres, with 176 stations and five main lines radiating from the Sydney CBD. There is a loop under the city centre, used by three routes. Some trains run through the CBD and across the Harbour Bridge; one line runs through to Bondi Junction. Much of the network was built in the 1930s. A tunnel under the airport, with three new stations, built with private finance, opened in 2000, together with a branch to the Olympic Park.

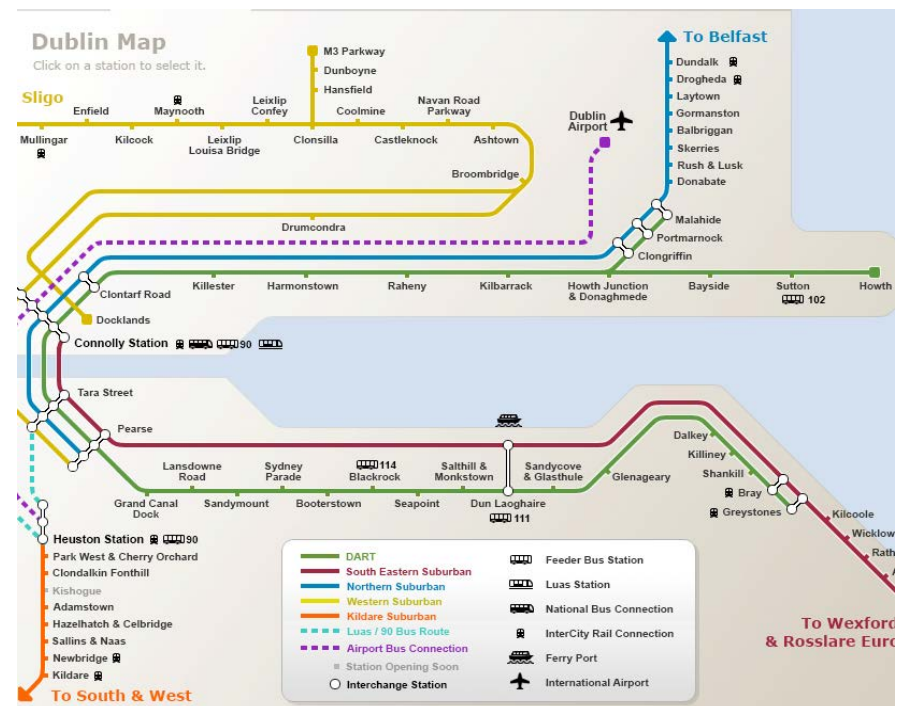
Sydney has a very limited radial expressway (highway) system, like Toronto. But unlike Toronto, most expressways also have tolls. Sydney train publishes boarding data for all stations by time band. To estimate the off-peak to peak ratio, demand has been excluded at stations within the CBD. Excluding contra-peak demand, off-peak weekday demand is 45% of total demand, and when allowance is made for weekends, the off-peak: total ratio increases to 53%. This percentage will include traffic from stations close to the city centre which, in Toronto, would be served by the subway.

2.9.5.5 Dublin, Ireland

Dublin is a much smaller city than Toronto, with: less than one-third the population; a dense low-rise city centre; and sprawling residential suburbs with a mix of single-family homes and apartment blocks. Automobile ownership is high and there is severe traffic congestion. Dublin has no subway, although two surface light rail lines, which run on-street in the city centre, have recently been built.

The electrified DART system was created in the 1980s by electrifying the north-south railway line. Irish railways also operate some diesel commuter routes. As in Toronto, there is incomplete integration of fares, although a smartcard is being introduced.

Initially, DART focused on serving peak commuter markets, but in 2003 introduced a 15-minute “clock face” all-day service. Ridership grew at approximately 10% per year until the 2008 financial crisis. Car parking charges were introduced in 2006, which brought some complaints but helped ensure spaces are available for off-peak travelers. Review of 2013 train count data indicates 63% of ridership is off-peak or contra-peak.



Dublin has a single electrified RER line, DART, and four routes with less frequent DMU services.

Figure 38: Dublin Map

Source: http://en.wikipedia.org/wiki/Dublin_Suburban_Rail

2.9.5.6 Berlin, Germany

Like Toronto, Berlin is a sprawling city in a cold climate. It has wide streets and a freeway system roughly comparable in extent to Toronto. There is a mix of high-rise and low-rise apartments, but also large areas of detached single-family homes. Population is approximately half of the GTHA and the economy has grown slowly since re-unification. Auto ownership is high.

Berlin has three extensive rail systems. The subway is similar to Toronto's, with shallow stations built mostly under or along city streets, with closely spaced stations. Some sections are elevated. The S-Bahn network is mostly surface or elevated, with two main lines crossing the city and a ring line. There are also regional trains on a wider network serving the state of Brandenburg. There is also an extensive light rail (tram) system, running mostly on-street and mostly in the east side of the city (East Berlin).

Analysis of 28 suburban S-Bahn stations shows that only approximately 40% of trips are in the peak hours and peak direction. Approximately 20% are contra-peak, with the remainder of 40% being off-peak, for a total of 60% off-peak ridership.

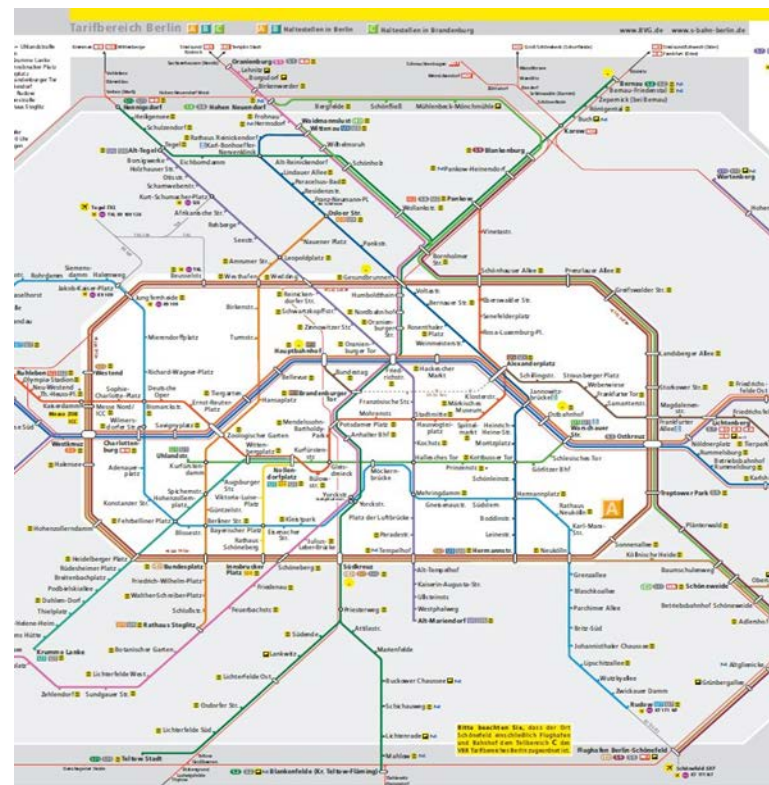


Figure 39: Berlin RER (S- Bahn) and Subway (U- Bahn) Map

Source: [http://commons.wikimedia.org/wiki/File:Berlin_-_S-Bahn_and_U-Bahn_Map_\(1998\)_6570985235.jpg](http://commons.wikimedia.org/wiki/File:Berlin_-_S-Bahn_and_U-Bahn_Map_(1998)_6570985235.jpg)

2.9.6 Comparative Characteristics of RER System

Table 23 shows ridership patterns and other characteristics of some RER systems. The evidence supports the view that contra-peak, off-peak and weekend ridership can be expected to rise to a level similar to, or even greater than, peak period, peak direction ridership.

Table 23: Characteristics of some other RER Systems

	Route km	Stations with All-Day Service	Service Area Population (millions)	Annual Trips (millions)	Trips/Capita	Fully Integrated fares	Typical Station Car Parking Charges Per Day (Cdn. \$)	Train Size (Cars Peak and Off-Peak)	Crew Per Train
Berlin									
Berlin U-Bahn (subway)	152	170	3.6	507	141	Yes	Yes	-	1
Berlin S-Bahn (RER)	332	166	3.6	395	110	Yes	Yes	-	1
Berlin Total	484	336	3.6	902	251	-	-	-	-
Dublin									
Dublin DART	53	31	1.8	15	8	Yes	\$5.70	6 - 8 peak, 4 off-peak	1
London									
London Underground and DLR	402	270	8.2	1,265	154	-	-	-	1
London RER	3,000	930	20	900	45	Yes	\$3 to \$10 peak, \$2 to \$6 off-peak	-	1 or 2
London and Southeast Total	3,402	1200	20	2,165	108	-	-	-	-
Sydney									
Sydney Trains	775	176	4.8	281	59	Yes	-	-	2
GTHA									
Toronto Subway and RT	69	69	2.6	300	115	No	\$3 to \$5	6 all day	2
GTHA GO	450	20	7.1	54	8	No	Free	12 all day	3
GTHA TOTAL 2014	519	89	7.1	354	50	-	-	-	-
Toronto GO RER (2029 forecast or assumed)	450	63	9	160	18	TBD	\$5 to \$10	12 peak, 4 off-peak	2

2.9.7 Station Access

First mile and last mile considerations at all stations are an important component of the GO RER business case. Initial work has been undertaken in line with local and international best practice to create an initial transportation assessment for each station.

This understanding of how customers get to and from GO RER stations will support the development of appropriate station facilities design and also support local area planning initiatives and requirements. It also validates the ridership forecasts in the sense that station-by-station forecasts must be “sense checked” to ensure they are compatible with local land-use and transportation networks.

The basis of the analysis is as follows:

- First, an understanding of the existing volume of use and mode of access/egress is developed.
- Second, a future-year baseline scenario is developed that reflects the expected future situation in the event that the GO RER program is not introduced. This scenario assumes background levels of ridership growth, and development to the local built form and transportation networks that would occur regardless of GO RER.
- Third, a future year with RER scenario is developed. This scenario assumes the incremental impacts of GO RER; for example, the additional ridership, the land uses catalyzed by GO RER, and the developments to local transportation networks.

By comparing the two future-year scenarios, it is possible to identify the specific impact of GO RER with respect to the full suite of station access considerations.

So far, the focus of the initial analysis has been primarily on building an understanding of the existing conditions. Future work will address the two future-year scenarios, and better disaggregate our understanding of access and egress considerations by time of day and day of week. Work completed so far, as well as more detail regarding the approach, is presented in Appendix K.

The table and figures below present the aggregate network-level picture of the initial assessment of GO RER stations. Table 24 presents the typical weekday ridership forecast with GO RER. Figure 41 identifies population and employment changes expected around GO Stations. Figure 40 presents today’s station access and egress mode shares. Further information of this type for each station and corridor can be found in Appendix K.

Table 24: Typical Weekday Ridership by Time of Day and Direction in 2013 and 2031 (Initial Forecast with GO RER Scenario 5:10-Year Plan Optimized for all Stations not Including Union Station)

		2013	2031 Scenario 5
Boardings	AM peak	87,800	158,100
	Contra-Peak	700	5,400
	Off-Peak	10,100	72,100
Alightings	AM peak	2,900	5,400
	Contra-Peak	2,200	13,300
	Off-Peak	14,300	100,500

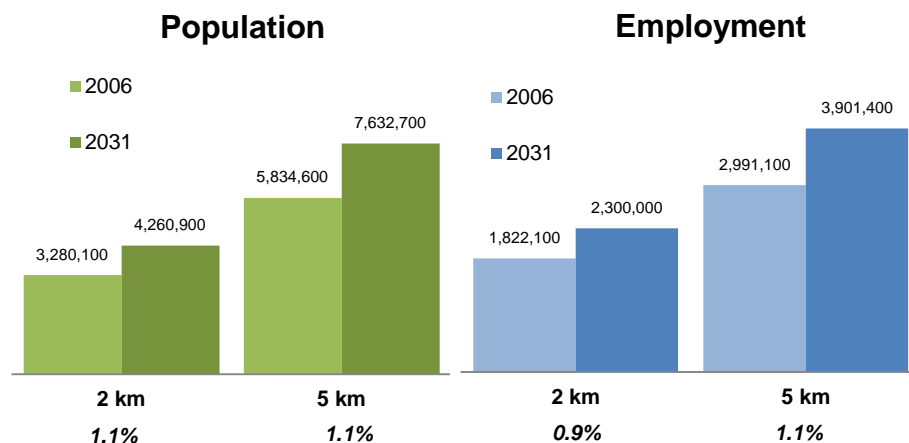


Figure 40: Population and Employment Change Expected in 2 km and 5 km Catchment Areas between 2006 and 2031

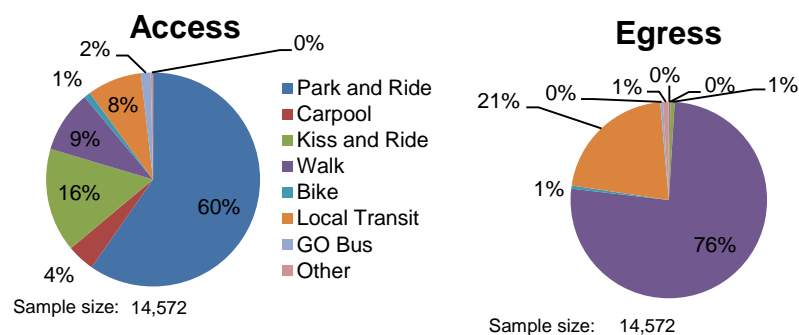


Figure 41: Station Access and Egress Mode Shares, 2013 GO Passenger Rail Survey

2.9.7.1 Station Access and Egress Considerations

To fully realize the potential for ridership increases forecast with GO RER, the station access needs of current and future riders will need to be effectively addressed. To this end, work is underway to analyze the station access needs for all existing GO stations with the station-level details of information compiled to date included in Appendix K. This analysis builds on station access modelling completed as part of the 2013 GO Rail Parking and Station Access Plan, which took into account a portion of the forecast RER ridership growth, but did not consider the Scenario 5 RER service concept as presented in this IBC. Station analysis should evaluate the impact of the following factors on station access in greater detail:

- 1. Parking Demand Management and Paid Parking:** Research indicates that managing parking demand through the introduction of pay parking and other measures could have a positive impact in the growth of more efficient auto modes (carpooling, drop-off) and non-auto modes (local transit, walking and cycling). This growth in other modes through parking demand management may be essential to addressing the station access needs for GO RER.
- 2. Station Area Intensification:** The extent to which this growth will be shaped and catalyzed by RER requires study. Analysis is underway to refine development projections within a reasonable walking distance of each train station. Additional analysis will evaluate development projections along local transit corridors that feed GO stations to determine further increases to GO bus and local transit riders.

3. **GO Bus and Local Transit Improvements:** Local transit ridership analysis, completed as part of the 2013 GO Rail Parking and Station Access Plan, indicates strong transit performance at many key GO Rail stations. However, there are opportunities to enhance local transit networks to increase station access mode for many GO passengers. In addition to addressing opportunities, GO Bus and local transit service levels will need to grow with GO RER service increases to ensure broader access and use of local transit as a station access mode, particularly in the off-peak period. Future planning work is required. Work is therefore underway to identify costs and timelines associated with improvements to local transit services. This work will include the potential impact on the financial performance of the municipal service providers.
4. **Passenger Drop-off Changes:** Today, passenger drop-offs represent the second largest access mode share (16%), after park and rides (60%). While it is predicted that this access mode share will grow, little is known at this time about this access market. A study is currently being devised by Metrolinx to better understand the passenger drop-off market.
5. **Station Area Improvements:** Analysis shows that current transportation and parking facilities at many stations are at, or near, capacity. Growth in use of all station access modes will require careful evaluation of each station's configuration and facilities to ensure that they can address future needs. Additionally, special consideration should be paid to improvements that promote cycling and walking access. To this end, new and updated master planning with associated transportation and facilities assessments will likely be needed for a number of stations.
6. **New and Emerging First and Last Mile Options:** There is little doubt that the transportation market is undergoing a shift with the continued spread of mobile communications technologies. In spring 2015, a smart-phone enabled, demand-responsive shuttle service called Dynamic Transit will come online in Milton. The service is intended to be a first-mile feeder service to GO Transit, supplementing the fixed local transit routes. This type of service can eventually roll out across the network, and can act as a last-mile service to better connect stations to surrounding employment areas. While the Dynamic Transit pilot remains in its early stages, a detailed assessment of the program will be conducted with the goal of understanding the benefits such a program could have on station access and egress capacities.
7. **Off-Peak Market:** Off-peak station access needs were evaluated by using the 2013 GO Rail Passenger Survey data on current off-peak riders on the Lakeshore GO Rail corridors. This data indicates that off-peak riders are more likely to walk, get dropped off, or use local transit when compared with peak riders. Further analysis is anticipated to understand the off-peak market.
8. **Contra-Peak and Outbound Markets:** GO RER will provide for contra-peak and outbound service to new markets which today do not have the benefit of frequent train service. The full benefits of GO RER service will be felt if station configuration is conducive to contra-peak and outbound ridership. Today, 91% of all GO train commuters are going to and from Union Station. In the future, GO stations throughout the region are expected to become destinations for contra-peak and outbound trips. Two factors to consider are: improving the connectivity between stations and surrounding commercial, office and other intensified land uses; and focusing on new employment growth at and around GO Stations. The extent to which this is achievable, and the steps required to optimize outcomes will be assessed as a part of future work being planned by Metrolinx and stakeholders.

Transportation assessments are required at each GO RER station to ensure station configuration is consistent with expected access and egress flows. Work presented within Appendix E is initial work and will form the foundation upon which more detailed understanding of access and egress patterns will be developed. This bottom-up understanding will help inform the development of a top-down program-wide station access and egress strategy. It should also assist in the development of a land use intensification strategy at GO RER stations.

2.9.8 Other Considerations

There are several factors that will affect ridership. The effect of potential parking charges has been reflected in the RER BCM, but others, such as synergies with other RTP projects, fare integration and “smarter” fares are not. These are discussed in the following paragraphs.

2.9.8.1 Synergies with other RTP Projects

Several other committed transport improvements, in particular the Eglinton Crosstown LRT, the VIVA and Mississauga Transitway BRTs, and York University-Vaughan Subway extension, will feed local traffic onto the RER system.

2.9.8.2 Integrated and Optimized Fares

There are 10 public transit agencies in the GTHA. Currently each has its own, separate policies for fares and each has its own fare structure. This means, for example, that people who travel from a local bus in one city, to a GO train, and then to the subway in Toronto need to pay three different fares or have three different transit passes for their trip. Other jurisdictions in Canada and around the world have integrated their transit fare systems to offer a more consistent and seamless service. The RTP has identified the implementation of an integrated transit fare system. The launch of the Presto farecard provides a common payment platform in the GTHA and will provide an opportunity to integrate fares across the region.

Fare integration is a critical component of RER.

The RER BCM has some capability to test changes to the level and structure of fares, although no changes to the current fare structure have been assumed in any of the five scenarios presented in this document. For simplicity, and because the analysis is focused on the 10-year implementation of RER service, no real increases to fares (i.e. fares increase at the rate of inflation) have been assumed in the reported modelling. The modelling presented in this initial business case assumes the fare structure of GO today continues into the future.

However, it is very much worthwhile — and important — to discuss the additional opportunity of integrated and optimized fares that the introduction of GO RER creates. The introduction of RER carrying more passengers, and creating more travellers at all times of the day, creates an even stronger case for optimized fares, fare policies and fare integration. Optimized and further integrated fares will attract additional ridership, revenue and benefits to the public that are currently not being reported in the modelling in this document.

GO currently operates with a zone fare structure but with no variation by time of day or direction. Metrolinx experience indicates that overall GO fares elasticity is relatively low, but off-peak fare elasticity is almost certainly higher, based on experience in comparable cities. International experience also suggests that:

- Revenues can be increased by raising peak fares and that few riders would be lost.
- Off-peak ridership can be increased, by offering less expensive off-peak fares. Ridership growth as a result of lower off-peak ridership may be enough to generate a net increase in revenues.

Many RER systems offer off-peak fares that are 25% to 50% below the peak fares. Experience on other RER systems suggests that raising the peak fare while dropping off-peak fares could increase total GO revenues while also increasing ridership and benefits. Moreover, encouraging even a small share of peak commuters to travel outside peak hours could reduce the required capital investment in rolling stock. Each peak seat on the GO system requires a capital expenditure of approximately \$20,000 in rolling stock, and potentially a further \$50,000 or more in parking, train storage facilities and station capacity.

As part of the fare integration policy work, it will be important to model various pricing models that include consideration of: (a) Simplicity: fare policies that are easy to understand and harmonized rules and definitions that offer an attractive customer experience; (b) Value: fares that reflect the journey travelled and the quality of service provided; and (c) Commonality: One fare structure for all agencies with common fare products and common fare payment methods to make the system easy to use for customers and attract further ridership.

As part of the modelling work that needs to be undertaken to bring forward recommendations, there are opportunities to use elasticity values generated from GO data and other data, and model what the outcomes of raising peak fares (illustrative purpose only — 10%). It is estimated that raising peak fares while cutting off-peak fares by 25% (illustrative only) could generate \$500 million net present value in Scenario 4 (Full Build), and only marginally less revenue increases in Scenario 5 (10-Year Plan Optimized). The analysis at this time is preliminary; it does not reflect the opportunity for testing modification to the GO existing structure of zone fares, integration with GO and local buses, discounts for frequent users and concessions for specific classes of passengers. It is therefore believed to be conservative. The introduction of optimized pricing through fare integration and fare policy to take advantage of RER service is expected.

Such improvements could involve more integrated fares products, differentiated peak and off-peak fares, and daily and weekly capping with potentially different caps by mode. These potential changes could all help to realize an increase of both revenues and ridership on the RER system, and, for that matter, the wider regional transit systems. Better financial performance and significant public benefits could be realized.

As of early March 2015, fare integration planning and policy work had achieved a review of integrated fare system features in other jurisdictions, principles and vision statements, and high-level policy options. Future work, not yet completed, includes a business case analysis of different fare structures for the GTHA. Further information will be available in summer 2015.

For further discussion of how optimized fares could increase revenues and ridership on the RER system and on transit across the GTHA, see Appendix E.

2.9.8.3 Car Parking Charges

For a discussion of the revenues that could be raised by parking charges, see Section 3.5.

2.9.9 Conclusions

As shown in Figure 43, GO rail ridership will grow approximately 50% by 2029, to 75 million trips, even in the Do Minimum scenario. Figure 44 shows ridership growth from 2014 to 2029 by corridor.

As discussed in Section 2.9.5, benchmarking of RER systems in broadly similar city regions, and indeed on the TTC and the Lakeshore corridors, shows that off-peak ridership, which includes contra-peak, evening and weekend traffic as well as mid-day traffic, typically equals or exceeds peak period, peak direction traffic. It will take time for travel patterns to change, and indeed for land use patterns to change, but there is no reason to believe that GO stations in Peel Region or York Region cannot achieve the same peak/off-peak proportions as subway stations in North York or Scarborough.

As shown in Figure 42, forecast GO rail ridership will grow to 6 billion trip kilometres by 2029. Although this result is approximately three times current traffic, it will only be approximately 15% of all longer trip-kilometre across the GTHA.²³ Given the high-quality service RER will offer across the region, this figure suggests that the forecasts are achievable and indeed may be conservative.

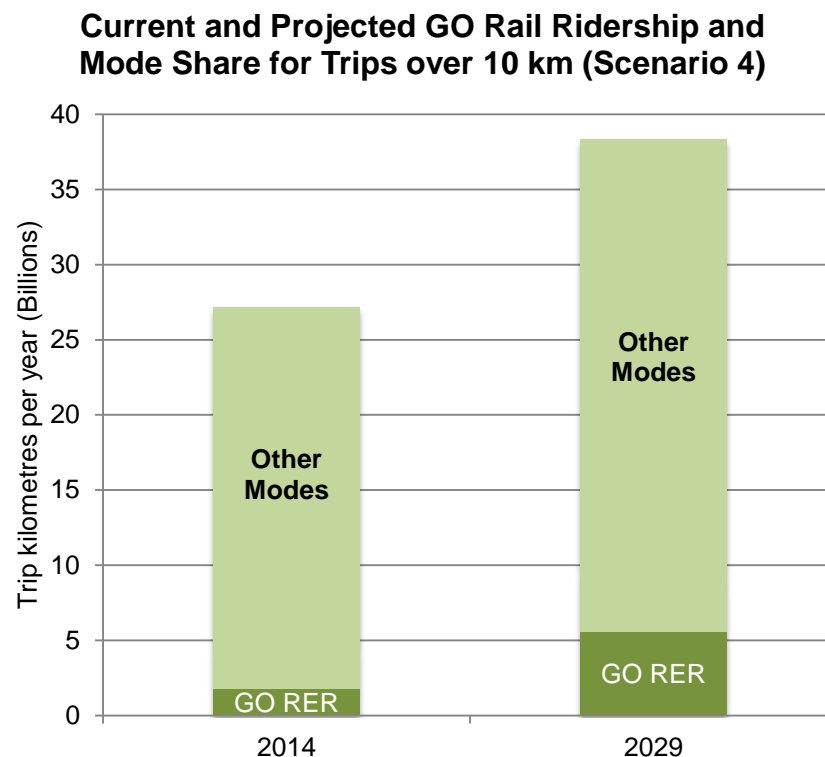


Figure 42: Current and Project GO Rail Ridership and Mode Share

²³ For this analysis, longer trips are defined as trips of more than 10 kilometres. Data on existing and projected trips is from the Transportation Tomorrow survey and the GGHM.

Ridership Growth in Five Scenarios

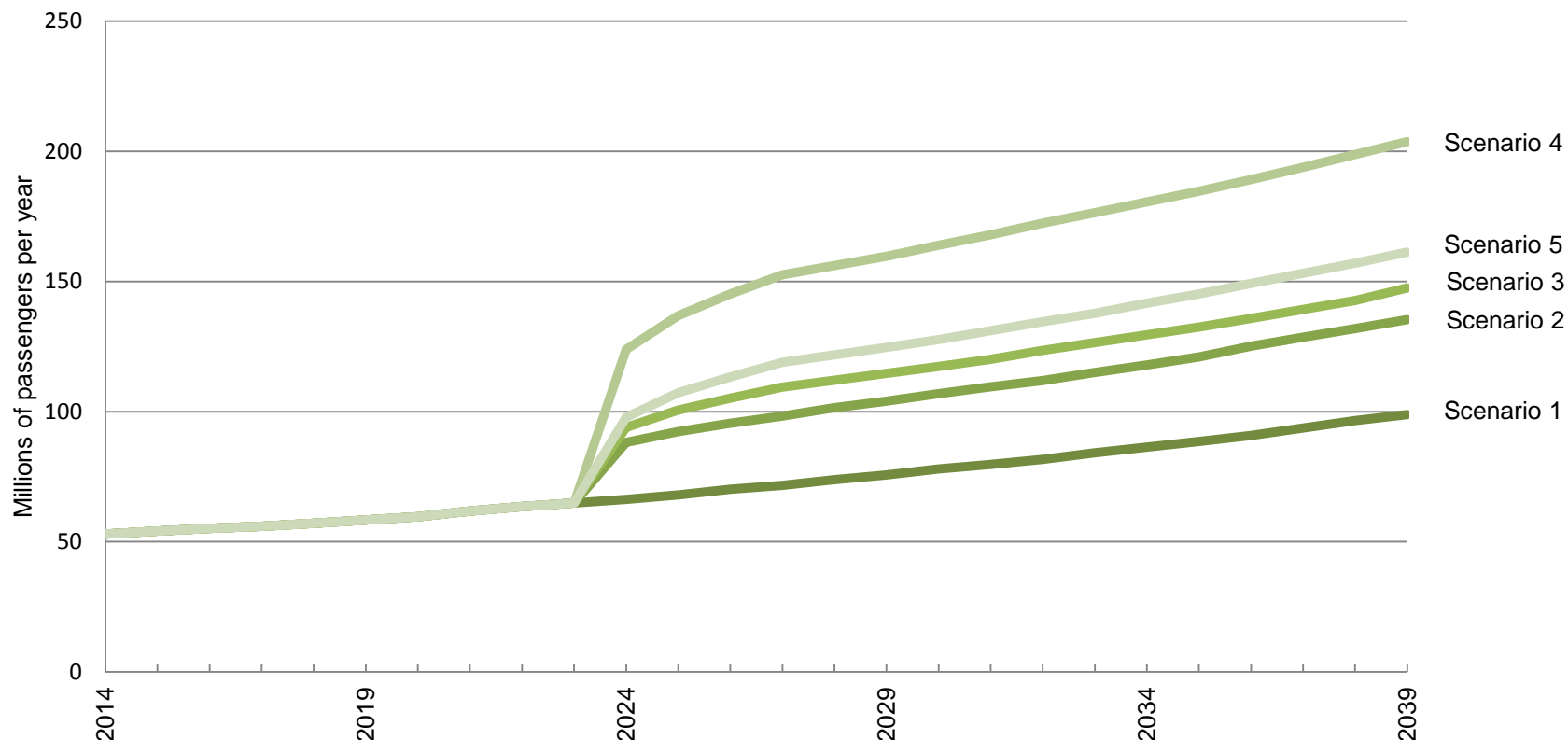


Figure 43: Ridership Growth in Five Scenarios

In the Do Minimum (Scenario 1), GO ridership will grow 50% by 2029. In Scenario 4 (Full Build), with electrified RER services on all routes ridership will be twice as high, exceeding 200 million by 2035. Note that RER services are assumed to enter service in one year, in 2024, in current modelling. Services will be introduced over the 10-year program, which will result in actual ridership growth appearing earlier, and growing more gradually, than indicated here.

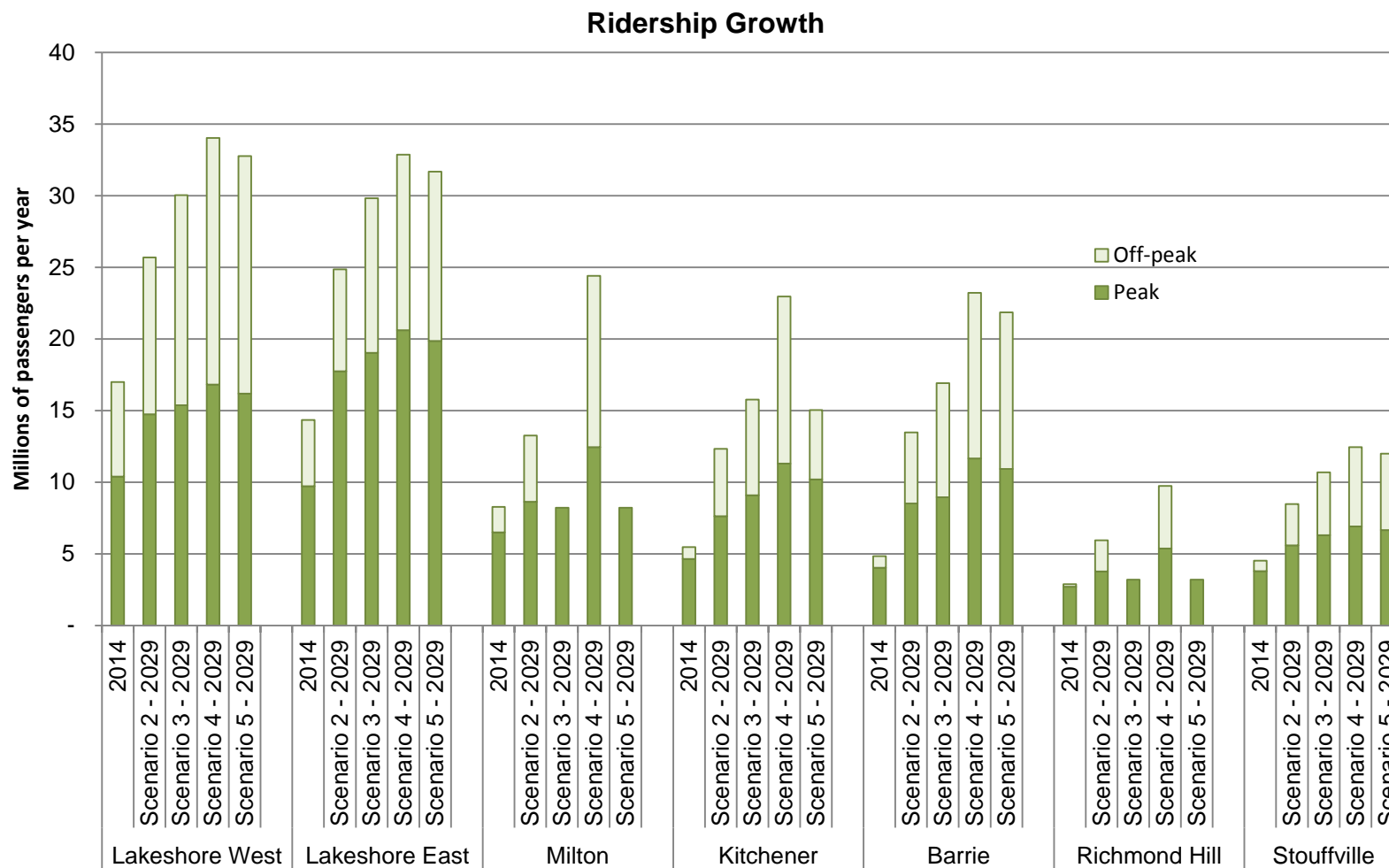


Figure 44: Ridership Growth

Note that in Scenarios 3 (10-Year Plan) and 5 (10-Year Plan Optimized), ridership on the Milton and Richmond Hill corridors only grows slightly, because there are only limited service and capacity improvements. Peak capacity is constrained on the Milton corridor. Note also that 2014 off-peak ridership on non-Lakeshore corridors includes GO Train-Bus ridership, which is not shown for 2029.

2.9.10 Off-peak Train Size Recommendations

Normal practice among RER operators is to size the off-peak fleet so that passengers can expect to have a choice of seats for most of their journey.

In Scenario 5 (10-Year Plan Optimized), by 2029, off-peak traffic on the Lakeshore West corridor will be approximately 2.5 to 3 times the current level. This estimate implies a requirement to provide mid-day capacity of approximately 2,500 - 3,000 passengers per hour, per direction. Mid-day loads on the other routes are predicted at this time to be approximately half as much.

In Scenario 3 (10-Year Plan), off-peak services on the Lakeshore corridors are assumed to be operated with 8-car bi-level trains. Including the hourly express service from Hamilton, capacity on Lakeshore West would be approximately 6,000 passengers, more than twice the required capacity. Traffic will be lower, and capacity higher, on the routes from Kitchener, Stouffville and Barrie, which would operate with 12-car diesel trains. Capacity on the Lakeshore East corridor will be 4,800 per hour, also well in excess of expected demand.

In Scenario 5 (10-Year Plan Optimized), 4-car EMUs should provide ample off-peak capacity on all routes. However, in the RER Business Case Model, some off-peak trips are assumed to be operated with 8-car EMUs. While EMUs can be split and joined much more easily than GO's existing locomotive-powered trains, it is assumed that for operational reasons GO may wish to avoid the need to split EMUs in Union Station. This means that there will be additional shoulder-peak and contra-peak capacity, on some services.

There will always be uncertainty approximating the pattern of off-peak ridership, and there is little point buying expensive rolling stock that may only be required occasionally. Metrolinx may, initially, purchase 4-car EMUs, with provision to lengthen to 6-cars if required. If initial off-peak

traffic is higher than expected, GO can always keep more locomotive-powered trains in service during the day, which it will likely do anyway for special events.

Potentially, routes other than the Lakeshore corridors could be operated initially with 2 or 3-car EMUs, reducing the initial capital outlay. Further study is required.

2.10 Social Inclusiveness

RER will open new opportunities to people who by reason of income, physical condition or preference do not have access to a car. Currently, longer trips to and from places not served by the subway or the Lakeshore corridors are often slow, difficult and expensive. RER will be fast, frequent and accessible. If implemented together with integrated and optimized fares, it could also be very affordable, especially outside peak times. GO will open new employment, education, cultural and leisure opportunities especially to lower income, elderly, children and teenagers in suburban communities. (See Figure 45)

Transit offers an alternative to the private automobile. Owning a car is expensive, typically approximately \$5,000 per year before paying for gasoline, and around \$10,000 per year all-in.²⁴ However, once the car is bought and insured, the marginal cost to drive it can be quite low, actually less than transit fares for short trips, especially with children, and for trips to suburban destinations where parking is free. Persons living in auto-oriented suburban areas depend on cars for transportation, despite the financial burden. Auto-dependence limits travel opportunities for those who are too young, too old or otherwise unable to drive. Offering a competitive

²⁴ Canadian Automobile Association, *Driving Costs*, 2013. Source: http://www.caa.ca/wp-content/uploads/2012/06/CAA_Driving_Cost_English_2013_web.pdf

transit alternative can allow families to own one less vehicle and can open up travel options for people who depend on transit.

There are clear spatial disparities across the region in terms of transit access. Experts are in agreement that a very important measure and differentiator between socio-economic groups is income. Figure 47 begins to indicate the spatial distribution of income earners in the region and suggests that GO RER can play a significant role in enhancing access to lower income communities in some instances.

As a proof point, emerging Lakeshore passenger data indicates that weekend riders are less likely to drive to the station, and have a household income that is lower, than typical weekday peak passengers. This result indicates that GO Lakeshore service, even at 30-minute frequency, is a valuable and reasonably affordable option for occasional travel. Furthermore, access to the extensive medical facilities in downtown Toronto at all times of the day will be valuable to many travelers of all ages.

Much of the urban form in the GTHA is designed around the automobile. Toronto suburbs are unique in the North American context in having a mixture of relatively dense single-family housing combined with many apartment towers. RER has the potential to improve social inclusiveness in the region by facilitating improved local and longer-distance transit access in suburban areas. It does this by offering a service that is faster and more frequent than current transit, and is competitive with the car for many trips.

RER, together with other local and regional transit lines, will support regional intensification and the emergence of a polycentric metropolis. However, the success of RER also depends on improving walking and cycling connections to stations, and offering fares that are attractive and integrated with local transit. If well implemented, RER has the potential to reduce spatial and social disparities across the region.

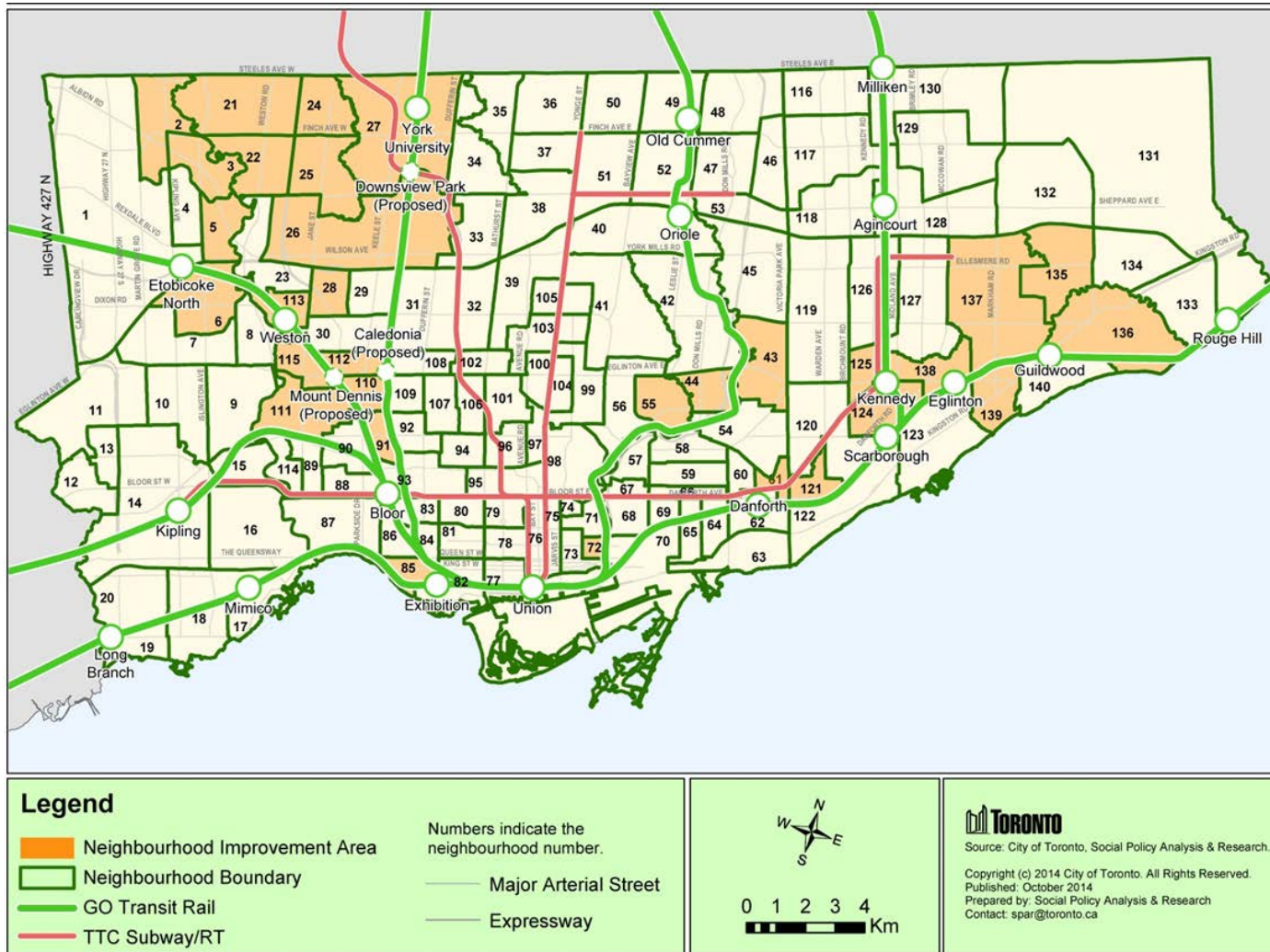


Figure 45: Toronto Neighbourhood Improvement Areas

Source: City of Toronto, Modified by Metrolinx

RER will serve many of Toronto's priority neighbourhoods, including many not on the subway system.

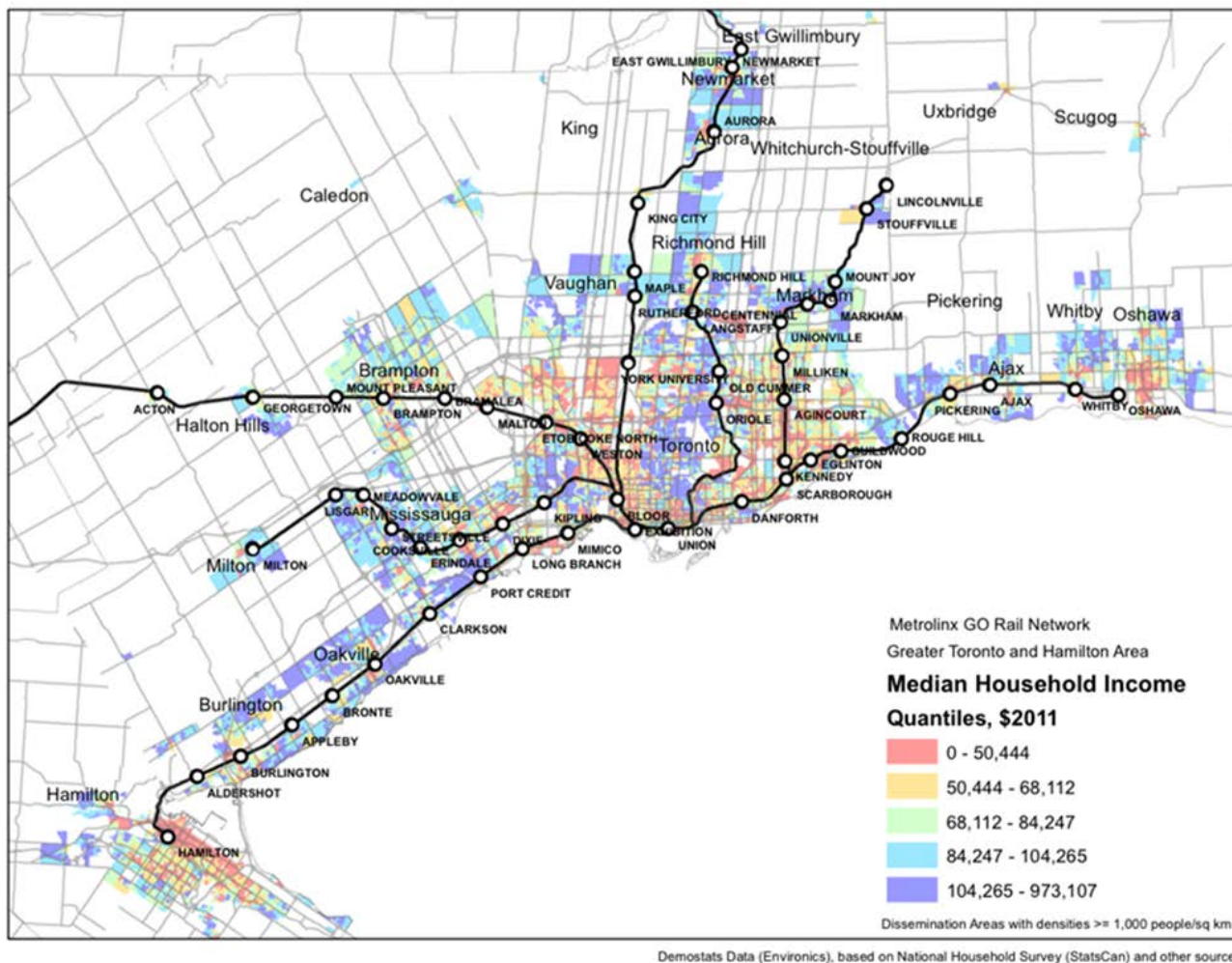


Figure 46: GTHA Median Household Incomes

This map shows how RER will serve virtually all developed parts of the GTHA, including neighbourhoods of high, middle and low income.

2.11 Environmental Impacts

RER will enable more sustainable life choices. Residents and visitors will be able to live, work, study and play all across the GTHA without needing to own and operate as many cars. RER will attract approximately half a million trips each day that would probably otherwise be made by car. It will provide a transit backbone across the region that will help to support other sustainable transit projects, including LRT, BRT, improved pedestrian and cycling facilities, and Transit Oriented Development (TOD). Over time, it will help parts of the region become much more pedestrian and transit-friendly than they are today.

RER will be powered with electricity which can be generated from sustainable, non-polluting sources. RER trains can be equipped with regenerative braking so that power is returned to the system as trains stop.

2.11.1 Greenhouse Gas and Criteria Area Contaminant Emissions

Overall, RER is expected to reduce Greenhouse Gases (GHG) and Criteria Air Contaminants (CAC).

There are potentially three areas of GHG impact associated with the GO RER. Refer to Section 4.3 for economic evaluation.

2.11.1.1 *The Switch from Diesel to Electric Traction on much of the GO Rail System*

With a fully operational GO rail system (Scenario 5), the reduction of CO₂ emissions per annum is calculated to be 84,000 tonnes. This figure is based on changes in train kilometres, vehicle type and energy source. This reduction is assessed to have an economic benefit of between \$54 million and \$219 million net present value over the 60-year appraisal life of the

program.²⁵ Metrolinx is working with MTO and MOECC, and will undertake further analysis to better quantify GHG benefits associated with the RER initiative.

2.11.1.2 *Impacts on Automobile Vehicle Travel and Urban Shaping*

GO RER can reduce automobile vehicle kilometres travelled by encouraging people to switch from driving to taking the train. GO RER is expected to provide transit alternatives for many trips that are only possible by auto at the moment. It also has the potential to support the creation of a more dense and energy-efficient urban form. It may provide an opportunity to influence positive future outcomes in terms of the development of local transit networks, the promotion of TOD, and the development of shuttle, share taxi and other local transit options. Intensified land use in and around stations, and new TOD, could further support reductions in the emission of climate change gases.

However, some of the highway capacity released by GO RER may be filled by the release of suppressed demand for highway travel. In addition, GO RER may also create the option for some people to move to more dispersed “905” communities, creating a net increase in their household auto vehicle kilometres travelled. Finally, auto travel may increasingly electrify and become otherwise more fuel efficient; the extent to which that trend will occur is difficult to predict.

The overall story is complex, nuanced and the subject of alternative outcomes dependent on the success (or otherwise) of supporting policy measures. At this stage, although Metrolinx anticipates the overall impacts of GO RER on both vehicle kilometres travelled and urban shaping will be

²⁵ Calculation assumes the social cost of carbon is valued in the range \$38 to \$155. Source: Environment Canada (2015)

substantially positive, more work is required to quantify and verify this assertion.

2.11.1.3 Embedded Carbon

Analysis has not been completed to assess the extent to which embedded GHG emissions will be generated in the construction of the GO RER infrastructure. In addition, the extent to which embedded GHG emissions would be generated in the delivery of alternative transportation solutions for the region would also require consideration.

CACs will not change to the same extent when switching from diesel to electric. GO has already committed to Tier 4 Diesel Engines, which greatly reduce CAC emissions. There is the potential for sizeable CAC impacts from changes in automobile vehicle kilometres travelled, but these changes have not been measured.

2.11.2 Other Environmental and Community Impacts

While most work will be within existing rail corridors, some property will need to be acquired and there may be impacts on local environments and habitats.

Metrolinx has recently completed EAs for:

- Additional track Scarborough Junction-Unionville.
- UP Express electrification (much of which will also apply to Kitchener corridor electrification).
- Additional track York University-Rutherford.
- Metrolinx is initiating EAs for projects that include:
 - ♦ Davenport Diamond Grade Separation.
 - ♦ Train storage facility in Brampton.
 - ♦ Grade-separations, Stouffville corridor.

- ♦ Others as the program evolves.

Metrolinx expects to prepare a single EA for the overall network-wide electrification program.

2.11.3 Conservation and Recreation Destinations

The GO RER system, together with regional and local bus services, will greatly improve access to natural and recreation areas including Conservation Areas, the Rouge River Valley, points of access to the Lake Ontario waterfront, and other natural trail and recreation systems that help make the GTHA an attractive place to live in and visit, as well as to work (see Figure 47). Fast, quiet electric trains, combined with local transit or shuttles, can be a low-impact and convenient way for people to access these areas of natural beauty, with less impact than extensive road systems and car parking facilities.

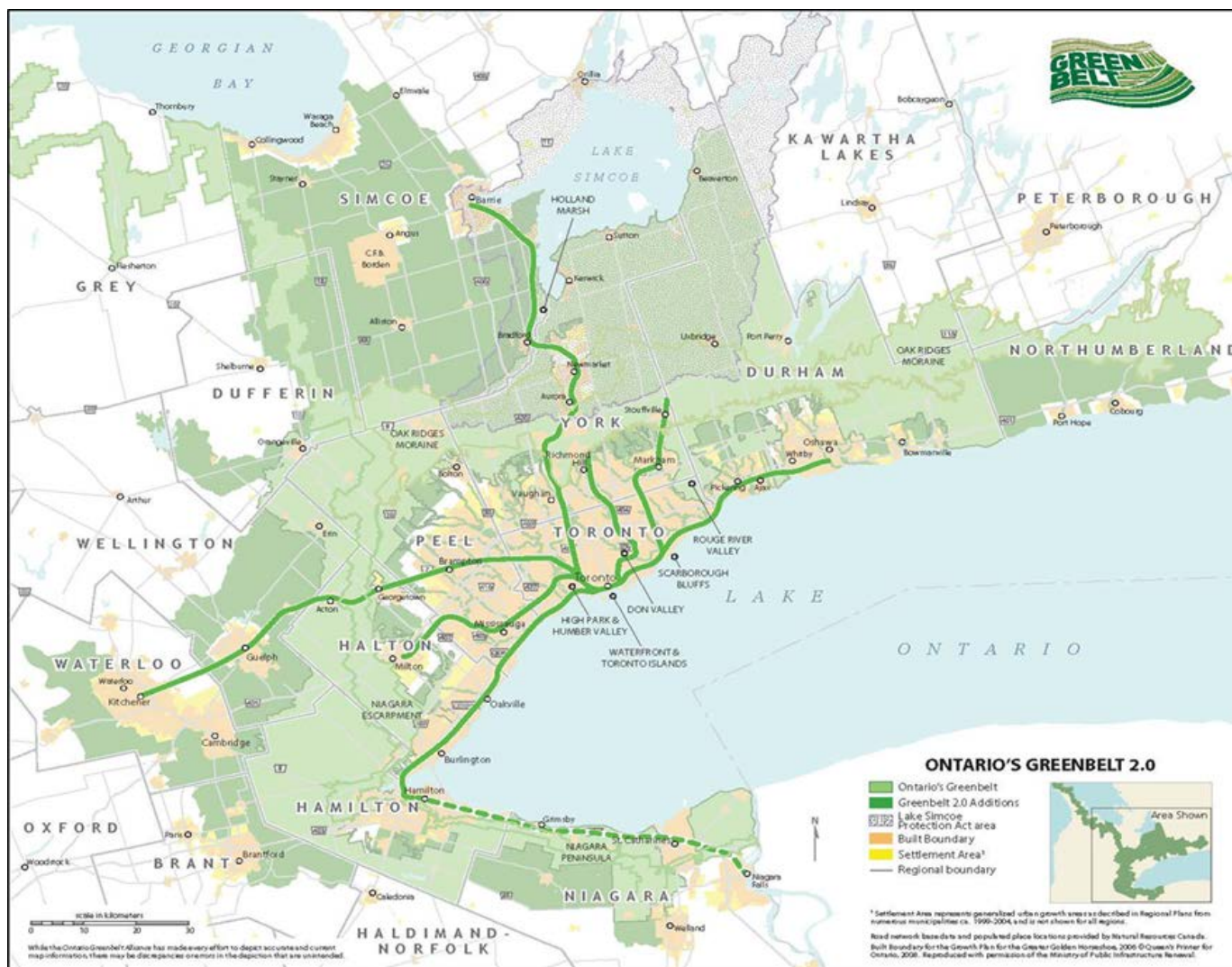


Figure 47: GO Rail Network Connects to Key Conservation and Recreation Destinations

2.12 Relationship to Other Infrastructure Projects

Upgrading the GO rail system to offer 2WAD services, but at hourly frequencies, was envisaged to be part of the next wave. Electrification had been studied but remained a long-term aspiration.

The decision of the Ontario Government to fund the upgrading of the GO rail system to electrified RER, and to do so within 10 years, is a game changer. It will take many months to update transport planning work on the many projects and programs comprising the RTP, to take account of the effects of RER. This work is now being done as part of the legislated review of the RTP.

However, it is already clear that RER will increase ridership, and thereby could strengthen the case for some of the RTP programs and projects:

- The Mississauga Transitway BRT and York VIVA BRT major projects will feed passengers onto RER at several stations. While BRT is inherently flexible, some modifications may be required to provide better interchanges where these BRT projects cross or come close to RER lines. GO and VIVA already have interchanges at Langstaff and Unionville. Consideration could be given to developing an interchange between the Barrie GO rail corridor and VIVA.
- The Eglinton Crosstown LRT will cross four RER corridors, and ridership on both RER and the LRT should increase if good interchanges and integrated fares are offered. GO already serves Kennedy and a station at Mount Dennis is planned. An interchange with the Barrie corridor is planned at Caledonia. Interchange with the Richmond Hill corridor is difficult because of the topography. Business Case work done on the Eglinton Crosstown and posted on the Metrolinx website indicates the potential role for Eglinton to attract more trips if sufficient speeds are achieved. RER could further support these trips.

- The Hurontario-Main LRT will complement RER, with interchanges at Port Credit, Cooksville and Brampton. Development of RER will strengthen the business case for the Hurontario-Main LRT project.
- Other next wave projects should be evaluated in light of the RER program.

RER will also strengthen the case for local transit improvements, potentially transforming the economics of local bus services just as the subway has done in the City of Toronto. RER will also generate substantial bicycle and pedestrian traffic, and support the case for investment in improved routes for walking and cycling.

2.13 Relationship to Local Transit

The GTHA is already served with extensive municipal bus systems (see Figure 48). Most routes already operate at least every half hour. Buses serve mostly local trips, to employment, school, shopping, hospitals and recreation centres. GO already offers co-fares with most municipal bus operators (except for the TTC). However use is limited because, on routes other than the Lakeshore corridors, GO only operates trains in the peak hour and in the peak direction. With introduction of frequent 2WAD services, RER will create a new market for municipal bus operators, generating feeder trips to stations that in some cases can be carried at little or no extra cost because the capacity on buses is already being provided. In many cases, it may make sense to modify bus routes and timetables, and increase frequencies, so as to operate services that meet each train, and municipalities may choose to do so. With GO RER, municipal operators may be able to increase daytime frequencies on some routes at a moderate additional cost because vehicles and drivers are already required to serve the peaks. The additional ridership and fare revenue opportunity, along with the added cost of providing higher service levels, will need to be considered on a case-by-case basis.

While in some cases, additional local services will be required that will generate a need for subsidy, in other cases, additional riders will be carried with capacity that already exists, improving the financial position of local transit services. In summary, increases in service will generate new costs, but increases in ridership may increase revenues and should increase the productivity of local transit. Further study of local transit service integration is underway by Metrolinx.

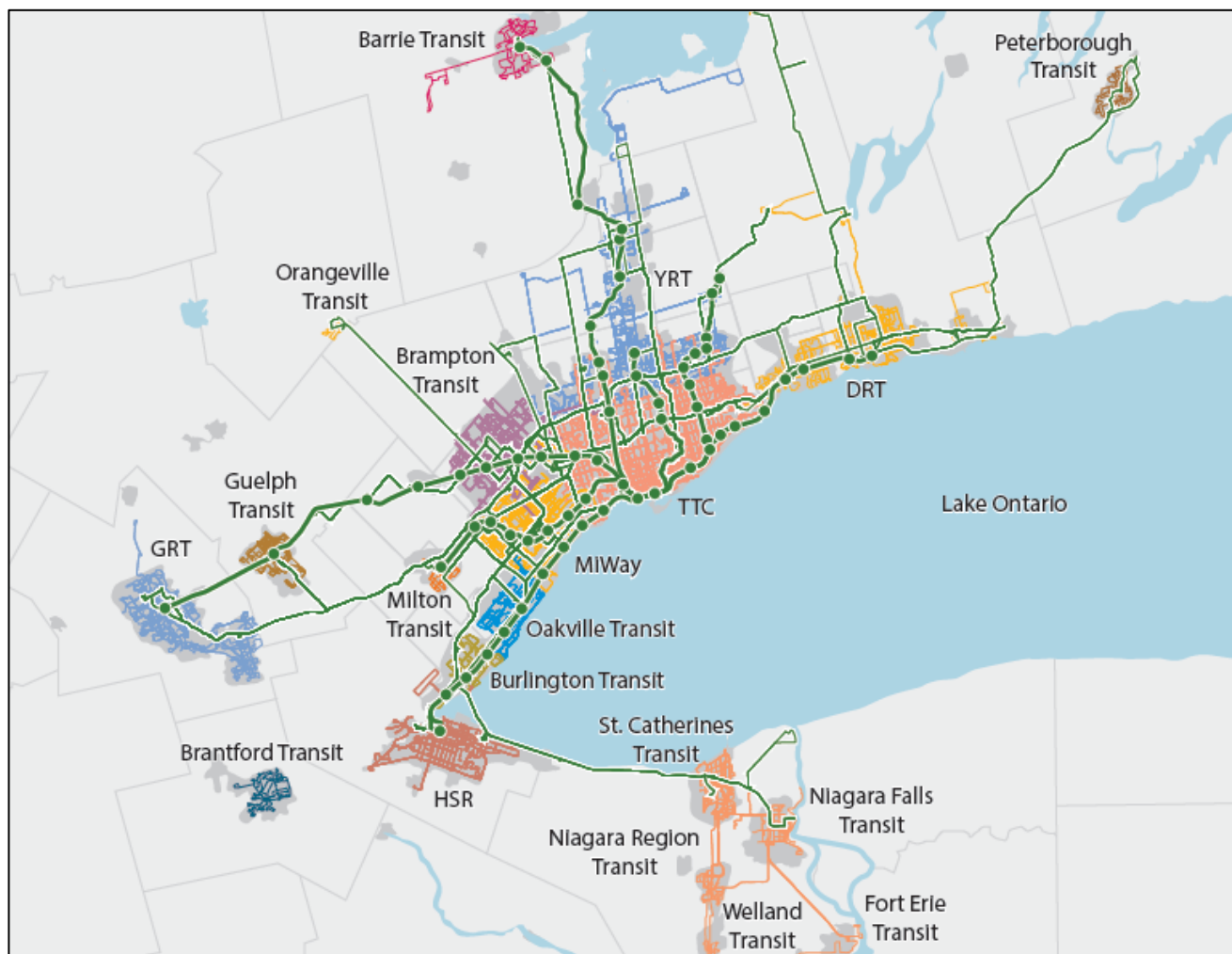


Figure 48: GO RER Network and Municipal Bus Routes

There is already a web of bus routes across virtually all urbanized parts of the GTHA.

2.14 Complementary and Alternative Strategies

There are many theoretical solutions to the GTHA's transport problems that can be proposed.

Based on real-world experience, practical solutions to the transport challenges faced by a large region such as the GTHA comprise a multitude of small and large interventions that cumulatively add up to more than the sum of their parts. RER will form a transit backbone across the GTHA. The following sections describe other region-wide and transformative interventions that could support RER.

2.14.1 Highway Expansion

While the GTHA has some large highways, it has very little radial expressway capacity and relatively limited orbital capacity. Compared with the GTHA, Houston, Chicago and San Francisco have four to eight times as many radial freeway (highway) lanes into the CBD, and two or three times as many orbital lanes. The GO system already provides peak commuting capacity roughly equivalent to 40 expressway lanes, 20 in and 20 out, which is comparable to Chicago, San Francisco and Boston.

RER will provide a roughly equivalent capacity for orbital or "quasi-orbital" trips, for example Oakville to Markham, which currently can only be practically made by car. RER can eventually attract around a half million new trips, which otherwise would be made by car. A similar increase in capacity might be achieved by adding three lanes each way (six in total) from Oakville to Pickering. However, adding lanes to existing highway would be very expensive and would bring significant environmental disruption, both directly and indirectly.

This alternative strategy is identified for completeness. It is not recommended. The net financial costs would certainly be higher, while the transport benefits would be less. A road-based approach to urban transport was rejected in Toronto decades ago.

3. The Financial Case

3.1 General Assumptions and Detailed Results

An integrated GO RER BCM has been used to evaluate the financial and economic case. All costs, revenues, and benefits are estimated for 60 years and discounted at 3.5% real. Except where otherwise noted, figures are presented as NPV.

3.2 Estimated Capital Costs

Table 25 presents a summary of estimated CAPEX for each of the five scenarios. More detailed estimates are provided in Table 27. Table 25 presents the assumptions for fleet requirement. Appendix A provides a further cost breakdown by 24 categories for each corridor in each scenario.

Table 25: Capital Costs for the Five Scenarios

Real 2014 \$ Millions	Scenario 1 (Do Minimum)	Scenario 2 (Two-Way All-Day)	Scenario 3 (10-Year Plan)	Scenario 4 (Full Build)	Scenario 5 (10-Year Plan Optimized)
Corridor					
Stations	270	1,333	1,324	1,858	1,324
Track	215	2,318	1,919	3,770	1,919
Noise Mitigation and Fencing	48	509	410	962	410
Signalling	23	253	205	463	205
Road/Rail Crossings	151	822	822	961	822
Rail/Rail Crossings	-	853	228	853	228
Other Infrastructure	-	10	10	10	10
Subtotal Civil Infrastructure	707	6,096	4,917	8,875	4,917
Overhead	-	-	360	1,307	839
Signals EMI Immunization	-	-	400	1,131	703
Traction Power Substations	-	-	192	444	303
Station Modifications	-	-	87	296	205
Bridge Modifications	-	-	23	104	40
Other Electrification	-	-	-	120	120
Subtotal Electrification Infrastructure	-	-	1,062	3,402	2,211
Property		315	281	472	281
Total Corridor (Civil + Electrification+ Property + Rolling Stock)	707	6,411	6,260	12,749	7,409
Total System-Wide	1,483	1,772	2,806	3,339	3,339
Fleet	757	842	1,899	3,571	2,583
GRAND TOTAL	2,947	9,025	10,965	19,659	13,330

Table 26: Fleet Requirements to 2031, Excluding UP Express

	Current Fleet Including Committed Purchases	Required 2014	Required 2023	Required 2025 Scenario 5 (10-Year Plan Optimized)	Required 2030 Scenario 5 (10-Year Plan Optimized)
Diesel Loco	77	53	73	43	44
Electric Loco	0	0	0	35	44
Coach	554	442	591	536	627
Accessible	66	55	67	72	81
Cab Car	123	51	69	75	84
TOTAL Bi-Level Cars	743	548	727	683	792
4-car EMU Set	0	0	0	84	84

In Scenario 4 (Full Build) and Scenario 5 (10-Year Plan Optimized), GO would have approximately 60 surplus diesel locomotives and approximately 200 surplus bi-level cars. Phase-in planning to optimize fleet purchase and utilization is being done and will be reported in the future. Note: UP Express fleet is not included here. Note: Fleet requirements in 2031 will be different than fleet requirements in 2024, as growth in passenger demand is forecast to require additional service beyond 2024.

Table 27: System-Wide Capital Costs

Real 2014 \$ Millions	Scenario 1 (Do Minimum)	Scenario 2 (Two-Way All- Day)	Scenario 3 (10-Year Plan)	Scenario 4 (Full Build)	Scenario 5 (10-Year Plan Optimized)
Union Station Rail Corridor	293	582	882	882	882
Storage Facilities and End of Line Maintenance	0	0	344	577	577
Traction Power (Electric)	0	0	90	90	90
Dispatching Office	250	250	250	250	250
Parking	740	740	740	740	740
Enhanced Train Control	200	200	500	800	800
SYSTEMWIDE TOTAL	1,483	1,772	2,806	3,339	3,339

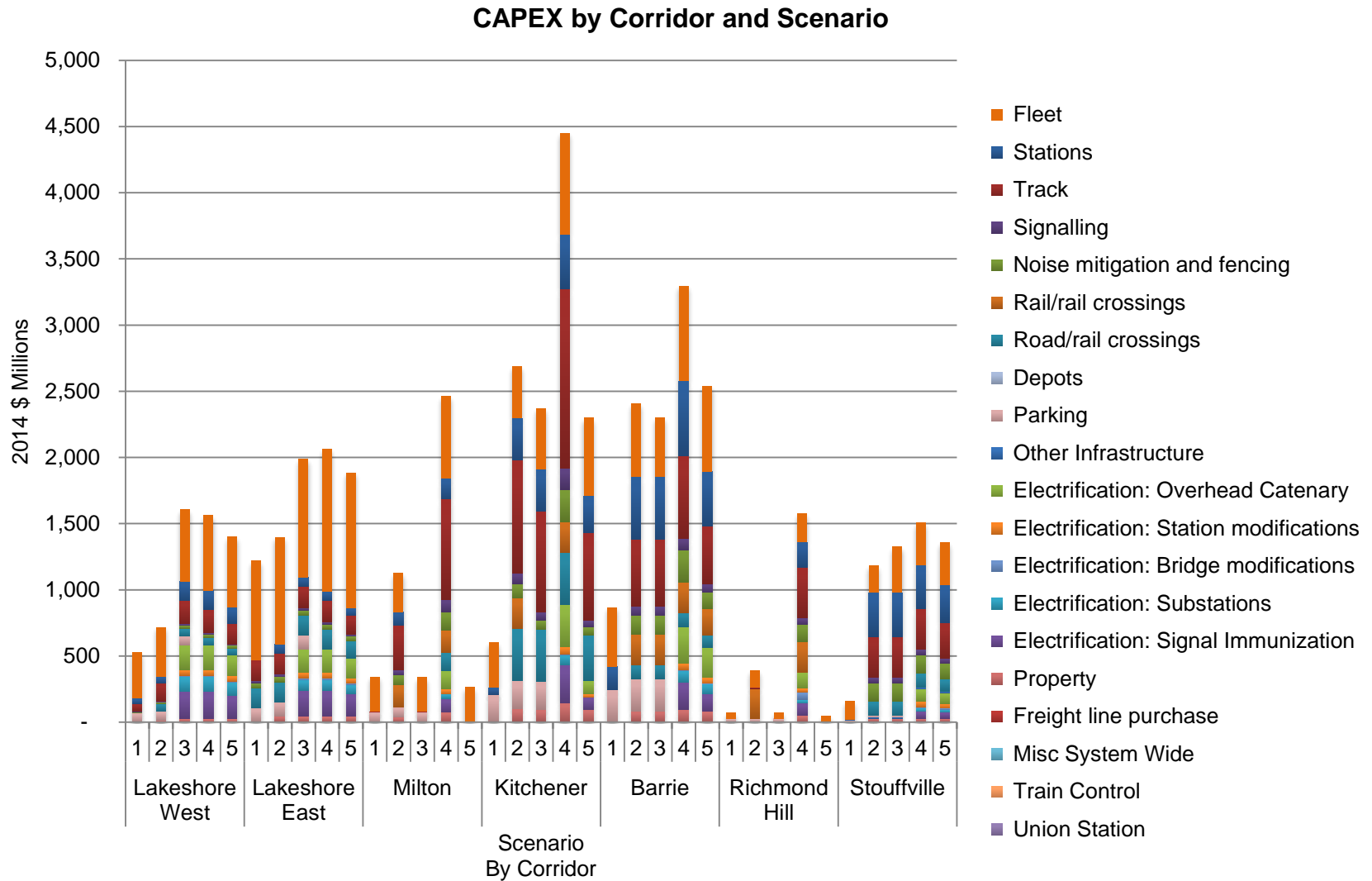


Figure 49: Capital Expenditure by Corridor and Scenario

Note: in Table 25, the figures are not discounted to 2014, but are given in 2014 prices. The nominal amounts may be higher when actually spent due to inflation. The economic value as of January 1, 2014, and figures shown in other tables that are shown as Present Values, will be less.

In Table 25, the figures only include rolling stock expenditure to 2024 with conversion of the relevant corridors to electrification. The totals thus represent the amounts in 2014 Canadian dollars that must be spent to implement each scenario over the next decade. Approximately a further \$2 billion expenditure for rolling stock after 2024 is included in all scenarios to carry underlying peak traffic growth to 2074. These post 2024 expenditures are included in the 60-year projections, and most other figures and tables in this IBC.

Capital costs for each corridor are presented graphically in Figure 49. Note that this graphic includes rolling stock CAPEX to 2074. Assumptions and detailed results for each scenario and each corridor from the RER BCM are set out in Appendix C.

3.2.1 Basis of Cost Estimate

Capital cost estimates are based wherever possible on GO's recent project experience. This is the case mostly with track, stations, civil infrastructure (such as bridges), retaining walls, noise walls, road-rail and rail-rail grade separations, conventional CTC signalling, diesel locomotives, unpowered bi-level cars and property acquisition. Electrification, electric rolling stock, and advanced train control prices are based on a range of industry sources, both published and confidential. Infrastructure costs include engineering costs and contingencies (see details provided in Section 5.11).

Future cost-estimating work should identify appropriate contingencies relative to cost certainty and risk for the various program elements. This work will be pursued as the program develops. Costs to and from various sources, such as overhead and other groupings, have been allocated with

best available information and best professional judgment where appropriate. All allocation rates are deemed to be fair and reasonable, will not reasonably change the conclusions of the analysis, and may change as future information and program details are worked out.

3.2.2 Specification and Attribution of Costs

Care has been taken to allocate costs correctly by corridor, such as allocating the fourth track along the Union to Scarborough to Stouffville corridor. Although physically on the Lakeshore East corridor, the requirement for this investment is actually triggered by the Stouffville service. Therefore, it is attributed to the Stouffville corridor. Similarly, in Scenario 4 (Full Build) and Scenario 5 (10-Year Plan Optimized), costs to electrify the line from Union Station to Bramalea are carried by the Kitchener corridor, with UP Express only triggering additional maintenance facility costs and the costs to electrify the branch into the airport.

In Scenarios 4 (Full Build) and 5 (10-Year Plan Optimized), UP Express is allocated only incremental costs for electrification. Costs to electrify Union Station are allocated entirely to the Lakeshore, with costs to electrify from the USRC to Woodbine allocated to the Kitchener corridor.

Provision should be made when developing RER for future improvements to intercity services, which may include high-speed rail. At this point, no specific costs have been identified for this provision. Specific costs, if identified, should be allocated to high-speed rail or other rail projects, not RER. Further study is required, especially on the Lakeshore and Kitchener corridors where future inter-city and high-speed rail work is likely.

Some costs, such as Union Station works and a new system-wide train control system, cannot be objectively apportioned to individual corridors. These costs are included in the total GO rail system costs but not in any individual line. Conversely, there are fleet synergies between the lines which are reflected in the evaluation of the entire GO rail system. The estimated net benefits and benefit:cost ratios for each corridor are believed to accurately represent the incremental costs of upgrading the relevant corridor, but the net benefits and benefit:cost ratios for upgrading the entire GO rail system will therefore be slightly different. This fact does not seem to be a matter for concern, as the Lakeshore corridors perform very strongly and can, on their own, easily carry the system-wide costs.

For further discussion of control system issues, see Section 5.6.

Cost to renew the signalling at Union Station, for which a contract has recently been awarded, is not included in the RER BCM because it is a committed project and will occur as a baseline investment in all scenarios.

3.2.3 Fleet Capital Cost Optimization

In the RER BCM, capital costs for new rolling stock, and conservative estimates of what GO might receive on disposal of surplus rolling stock, are calculated based on unit prices as discussed in Section 5.3. There has been no attempt in the information presented here to optimize the strategy for acquiring and disposing of rolling stock; work is starting in this area and will be available in the future. For the purposes of analysis here, GO is assumed to continue purchasing diesel locomotives and unpowered bi-level cars to meet growing peak demand, even in the scenarios where lines are then electrified and some of this equipment is surplus and is assumed to be sold at a reduced price.

GO has recently contracted with Bombardier to supply a further 146 cars, at an average cost of \$3.4 million per car. This brings the total fleet to 743 cars, of which GO would normally expect 694 or 93% to be available for service. In the projections, it is assumed GO purchases more cars to carry demand growth to 2023, even though it then has, in Scenario 5 (10-Year Plan Optimized), approximately 200 surplus cars. The financial projections are based on the assumption that GO sells surplus bi-level cars immediately, at a low price of \$1 million, even though it will begin again buying new cars within a few years to meet growing peak demand, and will be back up to a fleet of 672 cars by around 2030. These assumptions are expected to generate high, and thus conservative, cost estimates.

The financial projections also assume that all EMUs are purchased as 4-car units, although in fact, 3-car units may be adequate for off-peak demand on the Stouffville and Richmond Hill corridors.

When the initial RER program is approved, the fleet strategy can also be optimized. In the context of alternative fleet overhaul and attrition strategies, Metrolinx might consider:

- Procuring EMUs early, rather than keep buying unpowered bi-levels, and might lease rather than buy some diesel locomotives.
- Storing some bi-level cars, to meet growing demand a few years later.
- Leasing surplus cars to other operators. There are now 13 operators across North America using more or less identical cars.
- Procuring fewer EMUs, and operating some RER service with electric locomotives and short trains.
- Using surplus diesel locomotives and unpowered bi-levels to operate new services.

- Procuring some 3-car EMUs, with potential to be lengthened to 4, 5 or 6-cars in future.
- The projections are therefore conservative with respect to Scenario 3 (10-Year Plan), Scenario 4 (Full Build) and Scenario 5 (10-Year Plan Optimized) for these reasons.

3.2.4 System-Wide Elements

Some elements of the RER system cannot be allocated to specific services or corridors. Specifically, expansion of Union Station and the approach corridors to provide additional capacity, upgrading of the signalling system to provide PTC and ETC functionality, and costs related to expansion and electrification of the East and Willowbrook Rail Maintenance Facilities are best considered as system-wide elements although scale of investment relates to the fleet, and electrification on each corridor. Estimated capital costs are set out in Table 27.

3.2.5 Capital Renewals

Allowance has been made in the RER BCM for periodic overhaul of rolling stock, which GO treats as a capital expenditure. For details, see Section 3.3. However, there is no provision for replacement. With periodic refurbishment, and with the type of conditions experienced in Ontario, rolling stock can provide good service for many years.

No explicit residual values are included in the economic model. Operating costs, revenues and benefits are appraised over a 60-year period. Therefore, there is also no provision for fleet refurbishment in the last 30 years of the evaluation period.

3.2.6 Operating and Maintenance Costs

Rail operating costs are estimated primarily on the basis of train kilometres and train hours. The model has been calibrated against current GO operating costs, as determined from GO management accounts. Figure 50 provides a breakdown of annual operating and maintenance costs in 2029 for each scenario.

It is notable that the “Other Operations Cost” category represents approximately 40% of the total operations costs in all scenarios. The “Other” costs include dispatching, wayside power, headquarters and maintenance facilities, layovers, and berths and administration.

3.2.7 Train Crew Costs

For the purposes of this business case, two-person crews are assumed on all routes from 2019.

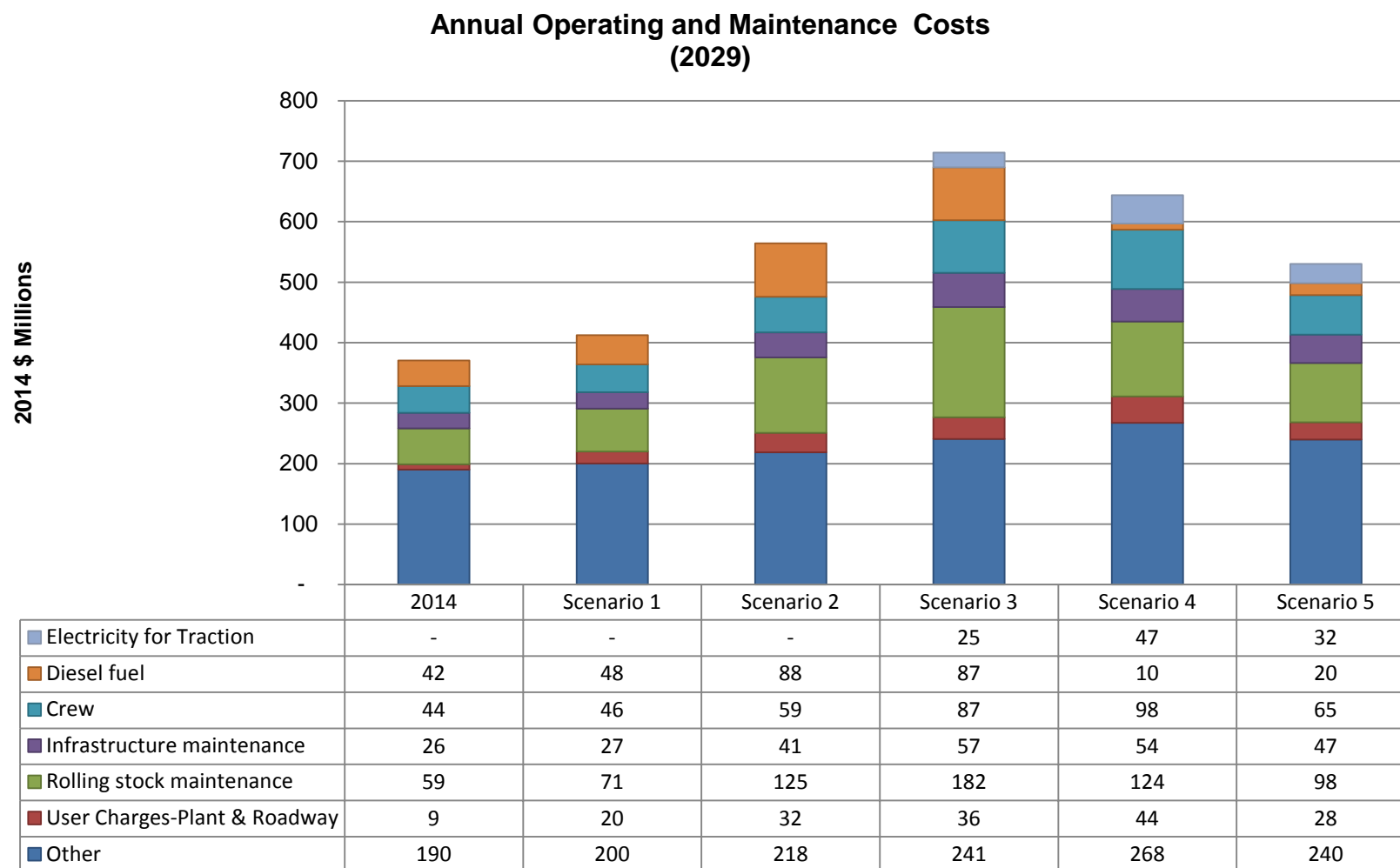


Figure 50: Annual Operating and Maintenance Costs for 2014 and for each Scenario in 2029

Note: Operating costs are actually less for Scenario 4 (Full Build) than Scenario 3 (10-Year Plan) even though it includes frequent all-day services on the Milton and Richmond Hill corridors. This is because: electricity is less expensive than diesel (per train kilometre, off-peak trains can be shorter, electric trains require simpler maintenance, and crew are used more productively because trains are faster. See 5.13.2 for a description of other costs.

3.2.8 Rolling Stock Maintenance

Rolling stock maintenance costs for diesel locomotives and bi-level trains are estimated per vehicle kilometre, based on GO's current costs. Maintenance costs for electric locomotives and for EMUs are based on international experience. Care has been taken to estimate relative costs, recognizing that labour cost and other inputs will be different in Ontario. The cost to maintain a 12-car diesel train is approximately \$11 per kilometre, compared with \$2.72 per kilometre to maintain a 4-car EMU because EMUs can run in smaller trains which better match demand and are less expensive overall for off-peak services. For further details of rolling stock maintenance costs, see Section 5.13.3.

3.2.9 Infrastructure Maintenance Costs

Infrastructure maintenance costs are estimated in two parts. Variable costs, reflecting use-related wear and tear, are estimated per vehicle kilometre. For each scenario, and for the current service plan, the variable costs are calculated based on planned use of each kind of train. This component of cost explains approximately half of GO's current infrastructure maintenance costs.

The balance of GO's existing infrastructure maintenance costs are treated as fixed, but they will increase as the infrastructure is expanded. Some infrastructure will need little or no maintenance over the 50 years from 2024 to 2074. Annual fixed infrastructure maintenance costs are assumed to increase by 1% of the incremental track capital expenditure, 1% of incremental signalling capital expenditure and 2% of overhead line capital expenditure. For further discussion, see Section 5.13.4.

3.2.10 Fuel and Power Costs

Fuel costs are calculated per diesel train kilometre. The rate has been calibrated against existing GO fuel costs and services. Electricity costs per kilometre for electric locomotives powering bi-levels, and for EMUs, are based on a range of sources.

Electricity costs are approximately one-third of diesel fuel costs for similar service patterns, in part because EMUs will usually operate in shorter trains.

Both diesel and electricity prices are likely to change over time, as they have in the past. However, there is no consensus as to whether, overall, fuel and electricity prices will rise or fall. Therefore, no real increase or decrease in these costs is assumed in the RER BCM.

If fuel prices do increase in real terms, this increase should strengthen the case for electrified RER and the converse is also true. While a portion of electricity in Ontario is generated from fossil fuels, generally electricity prices can be expected to fluctuate much less than diesel fuel prices. As electric trains use less power, electrified RER is therefore less susceptible in principle to fuel-energy price fluctuations.

For a fuller discussion of energy and fuel costs, and how they are estimated, see Section 5.13.1.

3.3 GO Overheads, Customer Services and Bus Costs

Costs and revenues for GO bus and rail are calibrated to data shown in the 2013-14 Metrolinx Annual Report. The breakdown of costs that are directly attributable to bus or rail services are based on analysis of management accounts. This leaves corporate and other costs, including station operations, fare retailing, marketing and service planning, which at this point can only be apportioned between the two modes. It is assumed that 75% of these costs can be attributed to rail, apportioned equally to the seven corridors. The balance of approximately \$50 million is attributed to GO bus operations.

Most of these costs are fixed. Many GO stations are currently staffed even when trains are not running, because stations are also served by buses. See Section 5.13.4.

Costs and revenues of the GO bus system are included in the projections for each scenario, so as to reflect the total financial impact on GO. An assumed average fare of \$5.00 is used to derive ridership from annual bus revenue. Note that bus revenue is itself an apportioned share of total commuter revenue. GO operates a zone fare system and, although transfer rates are lower than on TTC, it is still not possible to precisely distinguish bus and rail revenue. For further details of bus cost rate assumptions, see Section 5.13.5.

In the Do Minimum (Scenario 1), it is assumed that there will be no changes to GO bus services.

In Scenario 3 (10-Year Plan), Scenario 4 (Full Build) and Scenario 5 (10-Year Plan Optimized), it is assumed that off-peak and contra-peak train-bus services are discontinued wherever 2WAD rail services are introduced. Some train-bus services would continue to operate very early and very late services, as they do now on the Lakeshore corridor. Bus-kilometres are assumed to be reduced by approximately 15% when RER is implemented,

and operating costs to decline proportionately. In the model, this reduction is assumed to take place on January 1, 2024, although in fact it might be spread over several years.

Underlying demand for bus services is assumed to increase by 1.5% per year, less than the 2.5% assumed rate of underlying demand growth on the rail system.

The revenues generated by existing GO train-bus passengers will shift to rail. There should also be a network effect, with an increase in ridership on GO's routes, many of which will now feed RER routes. No allowances are made for any increase in capacity or costs. Generally, frequent 2WAD rail services would also be expected to increase 2WAD feeder bus traffic, so the additional traffic would fill spaces on mid-day buses which are not usually full.

This traffic increase is estimated as a multiple of the rail network effect, with an assumed multiple of one, so Scenario 4 (Full Build) generates a 10% increase in GO bus ridership and revenues, offsetting some of the 22% lost to rail.

3.4 Rail Revenues

Incremental rail revenues have been estimated from 2013 and 2014 ridership and revenues, and the expected effects of the 5% (nominal) fare increase approved in December 2014 and implemented in February 2015. Considering underlying consumer price inflation of approximately 2%, and the price elasticity of demand, the net effect is to increase future revenues by approximately 2%.

The current fare structures across the GTHA have evolved over many decades. There is good reason to believe that an integrated and optimized fare structure would further increase revenues and ridership, while actually also reducing fares to less affluent passengers and thereby improving equity. In other words, more ridership, more revenue, at a lower cost per trip.

Issues in the current structure, and suggested solutions based on international experience, are set out in Appendix E. Note: The solutions have not been reflected in the RER BCM. Generally, the proposed solutions would increase total revenues, although in some cases, by increasing passenger numbers while reducing average yields (revenue per passenger).

3.5 Parking Costs and Revenues

Only a relatively small number of GO passengers live within walking distance of their “home” station and local transit service may currently be inadequate for customers, which results in demand for parking spaces. Providing additional parking is expensive and has impacts on the properties around the station. New parking must be coordinated with growing service levels and effectively integrated with the surrounding neighbourhoods. Metrolinx recognizes that a strategic parking management approach is needed. The mobility hub guidelines state that Metrolinx will:

1. Assess commuter parking needs on a corridor or system basis and locate and design parking to maximize development and ridership potential at transit stations.
2. Limit commuter parking expansion by prioritizing feeder transit services to mobility hub stations.
3. Implement commuter parking pricing with incentives for carpooling and alternative fuel vehicles.

In June 2013, Metrolinx released the GO Transit Rail Parking and Station Access Plan. The plan recommended a series of guidelines and principles that should inform plans for parking expansion and other measures to

facilitate access to the GO system. The Plan did not recommend the immediate application of fare and parking pricing to change travel behaviour, although it acknowledged the need for active management of demand and more efficient use of existing parking across the network. Since that time, the Metrolinx Investment Strategy recommended pay parking, and the report of the Commission on the Reform of Ontario's Public Services chaired by Don Drummond, *“Public Services for Ontarians: A Path to Sustainability and Excellence”*, recommended the implementation of paid parking.

Today, GO's practice is to offer free parking at all stations, other than the few (e.g. Kipling) where parking is operated by TTC. GO also rents out reserved spaces for \$90 per month, which corresponds to approximately \$4.50 per weekday.

GO has had a de facto policy of adding capacity where possible to meet demand, and has recently built several multi-story parking structures at an average cost of approximately \$50,000 per net new space (taking account of existing spaces lost for construction). Today, GO has about 65,000 parking spaces. It is anticipated that there will be a continued need for parking. The GO Rail Parking Plan will be reviewed in light of RER, which will make alternate access modes and alternate land uses around stations economic, that were previously not seen as likely or possible when the GO Rail Parking plan was developed on very different assumptions about rail service improvements.

For the purposes of financial modelling in this IBC, fares have been assumed to be flat-lined in real terms. Since fares for GO passengers have increased in real terms every year for the last several years, so this assumption is a departure from the practice of GO increasing fares by a small real amount on an annual basis. While fare increases can help cover the cost of providing services, it also must cover the cost of providing parking, even though approximately a third of current GO customers do not use parking facilities. As more GO services are provided and the cost of building and providing additional parking goes up, it is reasonable to find additional sources of revenue. It is common practice for RER systems, and mature commuter rail systems in the United States, to charge customers for parking. Analysis indicates that adjusting the allocation of revenue

among train fares and pay parking, if implemented, could lead to an increase in ridership. This is because it is important to encourage people to get a ride to the station, take the bus, carpool, or find an alternative way to get to the station, even if only occasionally. This creates valuable space for others to access the system, particularly those who wish to use the system off-peak, when ordinarily today there would be no available parking at most GO stations because the parking lot is full in the morning. In other words, even a very marginal shift upwards in the average number of people accessing the station per vehicle parked for the day will result in a ridership increase. Encouraging those who might easily shift to alternate access modes to get to the station, even if only part of the time, could provide parking for those who would take the GO train only if a parking spot were available. Encouraging both of these actions to occur, across a large number of parking spaces, it can have a significant effect. As described elsewhere in this IBC, increased transit ridership has significant benefits, and finding ways to help people access the system will help RER create the benefits of increased transit ridership.

For the purpose of this IBC, revenue figures have been reported that show anticipated GO rail fare revenue and potential parking revenue separately. This is so that it is clear what additional revenue could be expected if pay parking is assumed to be a good proxy for additional revenue. In practice, this additional revenue could be collected through a number of different means, over and above fares that are assumed to remain flat (ie not go up at all in real terms over time). Revenues from parking or other means could be more than \$100 million per year from 2020, which works out to approximately \$3.8 billion NPV. This means that the revenues from parking could offset \$3.8 billion of infrastructure, or roughly the cost of electrification of the system in Scenario 5 (10-Year Plan Optimized). For the purposes of calculations and presenting the information, it is assumed that there will be no additional operating costs needed to collect the additional revenue. This is considered a reasonable assumption because of the high level of revenue collection technology already assumed to be deployed in the RER IBC for scenario 5.

The capital cost associated with revenue collection has been assumed to be included in the capital costs of new parking space construction, which is

an insignificant cost compared to the significant hard infrastructure costs associated with expanded parking at GO stations.

To show how parking or other additional revenues are incremental to the business case, these revenues (listed as parking charges) are shown separately in tables and graphs in this report. However as the total cost of a trip to users who park and ride includes both fare and parking charges, the introduction of optimized fares and parking charges should be considered together. It is possible that the introduction of parking charges together with adjustments to fares may be the most practical and attractive way to charge customers for their trip. Adjusting fares appropriately could lead to further increased ridership and revenue and further work to understand the optimal pricing structure for RER is expected to be undertaken as the Initial Business Case for the RER program is further refined and optimized.

3.6 Other Income

Metrolinx receives income from various other options including rentals from station retailers and advertising revenue. This income may increase as passenger numbers at GO stations also increase. Additional station retailing is likely to be viable as stations are used by large numbers of passengers throughout the day, instead of only during peak hours, as is currently the case. In the RER BCM, no increase in rental and advertising income is assumed. This is a conservative assumption.

Metrolinx is looking at ways of generating revenues from development on its station lands and/or neighboring partners. In 2013, it released a discussion paper on land value capture, and where neighbouring property owners are interested, there have been discussions looking at ways of co-funding infrastructure to generate additional ridership and have the private sector contribute where there is distinct benefit. If implemented correctly, land value capture can generate some revenue to pay for station and other infrastructure. In this IBC, no revenues from these sources have been assumed in order to be conservative. In financial budgeting, land value

capture and other income are referred to as non-fare revenue. Assuming no growth in non-fare revenue, given the opportunity presented by the Metrolinx asset base and the potential opportunities afforded by RER, is considered a conservative assumption.

Metrolinx also receives income from other rail operators, including CN, CPR, VIA and Amtrak, for use of its track, Union Station, and some other facilities and services. Generally, charges are use-related, for example per train mile for access over the network to rail sidings. The charges also generally reflect costs to Metrolinx. With electrification and implementation of CBTC, it may be attractive to create alternate haulage and switching arrangements over the GO network to take full advantage of the CBTC safety and capacity enhancements by limiting unequipped trains from operating. If high-speed rail is developed, Metrolinx will be able to charge other operators for use of the overhead electrification system. In total, the income from other rail operators is not material to GO's overall financial position. In this IBC, no change to income from other rail operators is assumed in all scenarios.

3.7 Financial Effects on Other Transit Operators

The RER BCM includes estimates of the number of trips that would be attracted to RER and the economic benefits of these trips. The incremental revenues to GO are estimated on the basis of the existing GO fare structure. Some of these trips, especially within Toronto, will be diverted off existing bus, LRT and subway services.

Although there has been no attempt to estimate the financial impacts of RER on other regional transit operators in this IBC, experience in other city regions suggests they should be very positive. However, the financial effects will depend on the fare structure and effective service integration.

RER will provide a fast higher-order transit system enabling longer-distance trips that will attract many new trips onto local transit, which provide the first mile and last mile. This traffic will be new to transit, comprising either trips diverted off roads or newly generated. As discussed in Appendix E, there are revenue-apportionment methods in Western Europe that provide good incentives and rewards to both surface and rail operators, and which are considered by industry experts to lead to greater efficiencies and better outcomes.

3.8 Sensitivity Analysis – Financial Assumptions

A sensitivity analysis of key financial assumptions is presented in Appendix F.

3.9 Summary Financial Case

Table 28 shows summary financial results for the five scenarios. Scenario 4 (Full Build) and Scenario 5 (10-Year Plan Optimized) have the highest fare-box recovery ratios, but also require the greatest capital investment. While capital costs are higher than in Scenario 3 (10-Year Plan), they are substantially offset by lower operating costs and higher revenues.

Table 28: Summary of Scenarios – Financial

2014 \$ Millions Net Present Value	Scenario 1 (Do Minimum)	Scenario 2 (Two-Way All-Day)	Scenario 3 (10-Year Plan)	Scenario 4 (Full Build)	Scenario 5 (10-Year Plan Optimized)
2014-2029 Ridership Growth	47%	96%	116%	201%	135%
2030 Off-Peak to Peak Ratio	1:3.7	1:1.8	1:1.6	1:1.1	1:1.5
2029 Ridership (millions)	78	106	117	162	128
Passenger Revenue	13,955	17,534	18,944	24,462	20,456
Parking Revenue	3,703	3,703	3,703	3,703	3,703
Total Revenue	17,658	21,236	22,647	28,164	24,159
Crew	1,234	1,443	1,924	2,274	1,725
Fuel	1,273	1,967	1,885	498	691
Electricity for Traction	-	-	442	843	559
Rolling Stock Maintenance	1,864	2,804	3,754	2,796	2,337
Infrastructure Maintenance	685	1,061	1,336	1,456	1,217
User Charges-Plant & Roadway	492	713	768	904	644
Other	5,067	5,384	5,710	6,174	5,710
Total Operating Cost	10,616	13,372	15,819	14,945	12,882
Farebox Recovery (FBR)	166%	159%	143%	188%	188%
Operating Subsidy or Surplus	7,042	7,864	6,828	13,219	11,277
Infrastructure	589	5,066	4,093	7,381	4,093
Electrification CAPEX	-	-	895	2,887	1,882
Property	-	248	221	372	221
Car Parking	624	624	624	624	624
Fleet	2,675	3,009	3,440	5,238	4,107
Other Network CAPEX	628	871	1,708	2,137	2,137
Total Capital Expenditure	4,516	9,817	10,980	18,637	13,063
TOTAL COST	15,132	23,189	26,799	33,583	25,945
Surplus (Subsidy) 60-Year NPV	2,526	(1,953)	(4,153)	(5,418)	(1,786)
Surplus (Subsidy) 20-Year NPV	(1,507)	(6,846)	(8,693)	(13,970)	(9,016)

Note: If parking revenues are excluded, the FBR ratio reduces by 23% to 33%, depending on the scenario. A sensitivity analysis is included in Appendix F.

Scenario 1 (Do Minimum) & Incremental Scenario 5 (10-Year Plan Optimized) Cash Flows

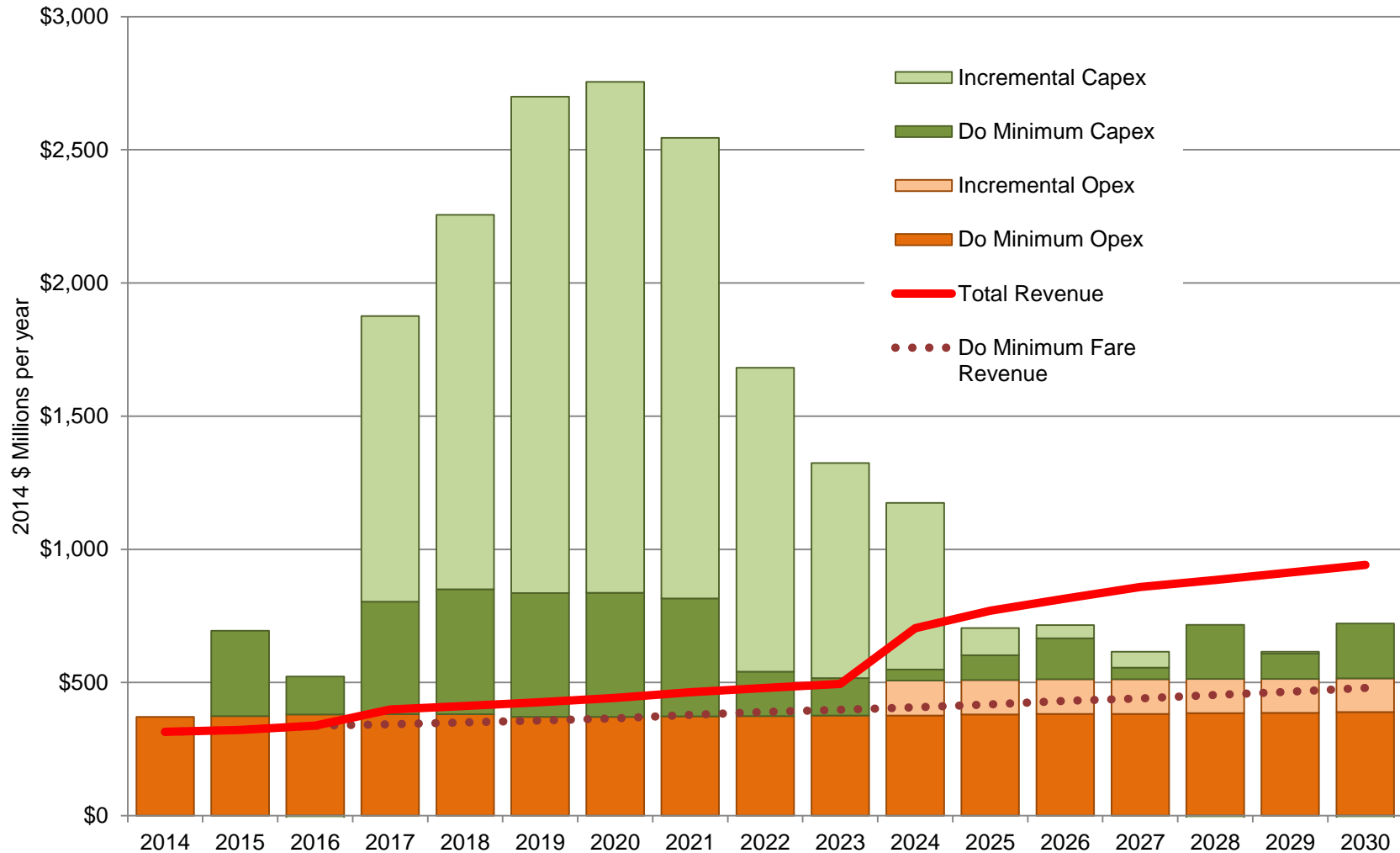


Figure 51: Scenario 1 (Do Minimum) and Incremental Scenario 5 (10-Year Plan Optimized) Cash Flows

4. The Economic Case

As indicated in Section 1.1, a spreadsheet model was used to evaluate the financial and economic case. All costs, revenues and benefits are estimated for 60 years and discounted at 3.5% real.

Detailed results for each scenario and each corridor are presented in Appendix C.

4.1 Understanding Benefit:Cost Analysis

The economic and financial model adds up all quantified costs and benefits of a proposal, converted into NPV in 2014 dollars. All benefit and cost figures are calculated as increments against an agreed Do Minimum also often called the base case. The increment is the scheme or investment that is being considered.

Most of the benefits are estimated based on the ridership that is forecast on RER. Note that increments are for future years, with and without RER, not between today and the future.

The model generates two key measures: net benefits and BCRs.

Net benefits tells us whether a scheme is actually worthwhile as a whole, and if it is, by how much. If benefits are greater than costs, then net benefits are greater than zero, and the scheme is worthwhile. The larger the net benefits, the more worthwhile the scheme.

BCR shows how much confidence is required in the accuracy of the cost and revenue estimates. If the BCR is, for example, 3:1, then decision makers can have a high level of confidence that a scheme is worthwhile. The actual costs would have to be three times higher, or revenues or other benefits one-third of what is expected, before the scheme would prove not to be worthwhile. But if the estimated BCR is close to 1:1, then any cost overrun or ridership shortfall could bring it below 1:1, making the scheme

as proposed not worthwhile. In such a case, net benefits would also of course be negative.

There are various ways of calculating BCRs. The standard method in Ontario (and generally the rest of North America) is to treat auto cost savings as a benefit, and so part of the numerator of the BCR. In some other jurisdictions, auto cost savings are deducted from the denominator. This makes no difference to the net benefits but can substantially change the BCR. In the U.K., auto cost savings are often not included in the analysis; instead, incremental fare revenues are estimated as a proxy and deducted from the denominator. There is no single way to do BCRs, but it is important when comparing project BCRs, or considering thresholds for what is an acceptable project, that they are prepared and compared on a consistent basis.

4.2 Transport Benefits

Transport user benefits comprise:

- Time savings to existing and new transit users.
- Auto cost savings to drivers switching to transit.
- Quality benefits such as improved comfort, convenience and reliability for transit users.
- Safety benefits, primarily reduced accident costs.
- Crowding benefits to transit users.
- Road-user benefits, cost and time savings to motorists from reduced congestion.

Further details of the demand and benefits estimation methodology are set out in Appendix D.

4.2.1 User Time Savings

Time savings to existing and new transit users are calculated at a standard rate of \$20.64 per hour. This amount is 25% higher than the equivalent for road users(\$16.51), reflecting the typically higher incomes of city centre workers who will continue to dominate GO rail ridership. Existing transit ridership is based on the GGHM forecasts, while incremental ridership is based on the DDM forecasts, as described in Section 2.9. The calculations actually use Generalized Journey Time (GJT), with various adjustments. For example there is a higher weighting of two for time spent waiting than actually in a vehicle. This weighting factor is based on experience in Canada and other countries.

The projections assume a 1.6% per year real increase in the VOT.

It has been suggested that zero VOT growth in real terms should be assumed. In addition, it has also been suggested that the VOT applicable to off-peak passengers should be 10% less than that applied to peak-period passengers. There are counter arguments that suggest the user time savings have been substantially under-estimated. (For example, to name four areas of conservatism within the forecast of benefits:1) the potential impacts of greater fares and service integration have not been included; 2) the value of reliability and quality improvements implicit in the use of electric traction have not been included; 3) modest assumptions regarding the potential for land use shaping by GO RER have been used; and 4) very modest assumptions regarding the potential to capture new travel markets have also been used.) All these issues will be reviewed and developed as the project progresses, and are expected to result in a far more optimistic assessment of transportation user benefits. However, assuming the more pessimistic assumption that VOT does not grow in real terms and off-peak values of time are less than those in the peak period, Scenario 5 (10-Year Plan Optimized) continues to be a very strong

performer in economic benefit:cost terms with an economic benefit cost of 2.5 to 1 instead of 3 to 1.

4.2.2 Auto Costs Savings

Reduced auto costs, the money saved by people who switch to transit, is calculated at \$ 0.63 per kilometre. Fifty per cent of new transit riders are assumed to be diverted from cars and this is a conservative assumption, as the majority of longer distance trips across the GTHA, currently more than 90%, are made by car. Some new transit trips will be attracted to RER that would otherwise be made as a passenger or not made at all, and some will be otherwise made by local transit, so the proportion should certainly be less than 100%. Motoring costs are assumed to increase at 0.7% per year, in real terms.

4.2.3 Quality Benefits

Comfort, convenience and reliability, sometimes called quality benefits, are difficult to quantify, but are usually turned into an effective time saving and then a monetary value. Reliability benefits were used in the business case for the Eglinton Crosstown, but are not at this point being used in calculation of the business case for RER.

4.2.4 Safety Benefits

Accident cost savings are estimated to be reduced at the rate of \$0.08 per car kilometre diverted onto RER.

4.2.5 Subway Crowding Relief

Subway congestion is severe on the Yonge Subway, especially southbound in the morning peak. While there are a number of limiting factors to increasing peak capacity, the ultimate limiting factor for the TTC in operating more trains through Bloor station will be because of the large numbers of passengers transferring from the Bloor-Danforth line, and the consequent extended dwell times. Metrolinx and the Province have already funded significant portions of the Automatic Train Operation (ATO) project

in 2008 that the TTC is responsible for installing on Line 1 (Yonge Line). Automatic train operation will increase the number of trains that can move through crowded Yonge-Bloor station in the peak hour. GO already operates peak-hour services from York Region, Durham Region and Scarborough, which attract some riders who might otherwise use the subway. It is evident that many more riders might use GO if: there was better integration of fares and services with TTC; GO services were faster and more frequent; and stations had better connections to TTC buses and the rest of the TTC network.

As part of the Metrolinx Yonge Relief Network Study, Metrolinx is studying the potential for RER to divert riders off the subway. The results of this work will be reported separately and included in future iterations of the RER business case when available. For now, the value of this crowding relief, while acknowledged, has not been included in the numbers presented in this IBC.

4.2.6 Sensitivity Analysis – Economic Assumptions

A sensitivity analysis of some assumptions is provided in Appendix E.

4.2.7 Highway Congestion Relief

Time savings to road users who continue to drive will accrue because of reduced congestion. These time savings translate into small savings per trip, although will affect many thousands of motorists.

Experience is that development of an RER system will slow the growth of road traffic and road congestion. The effect is unlikely to be noticeable in the peak hours because there are probably substantial suppressed demand trips that are not being made at all, or are being shifted to off-peak hours, because of the severe congestion on the GTHA road network. However, with a significant share of longer-distance regional trips (trips over 10 kilometres and weighted by trip length) being shifted off the roads and onto RER, the rate at which congestion worsens should be less, and

there may even be some narrowing of the peak. While the RER is unlikely to visibly decongest the GTHA road system, capacity that is protected or created as a result of RER compared with the Do Minimum scenario is capacity that can be used by people who want to make trips. Therefore, the value attributed in the economic model is appropriate and meaningful.

Benefits to road users from reduced traffic congestion are included in the business case as an economic benefit. For further details, see Appendix C.

There is substantial evidence that improved regional transit, including improved rail and bus services, together with fare integration and a broader policy environment, has led to a net reduction in car use in Greater London. While transit has always dominated commuting into central London, as indeed it does into downtown Toronto, transit's share of trips has declined in outer London over the past decade, where cars are the dominant mode and the central area cordon charge would have little effect. Over the recent period, total car kilometre in outer London has declined by approximately 5%, all the more remarkable given that London's population is increasing at a rate of approximately 100,000 people per year. This result indicates that car use per capita must be falling faster than absolute car use. Figure 52 and Figure 54 indicate these patterns.

Motorized trip rates in the 416 are similar to outer London, with approximately two-thirds of trips by car and one-third by transit. However, car trip rates are approximately 50% higher in the 905. (Source: Transportation Tomorrow Survey 2011.) If Toronto, which is often thought of as a car-oriented suburban environment, has similar car use rates as that of outer London, can Toronto also realize improved transit mode share?

Personal Trip Rates by Residency of Inner and Outer London and Main Mode of Transport

Source: Transport for London Travel Report 5, 2012, Figure 2.10

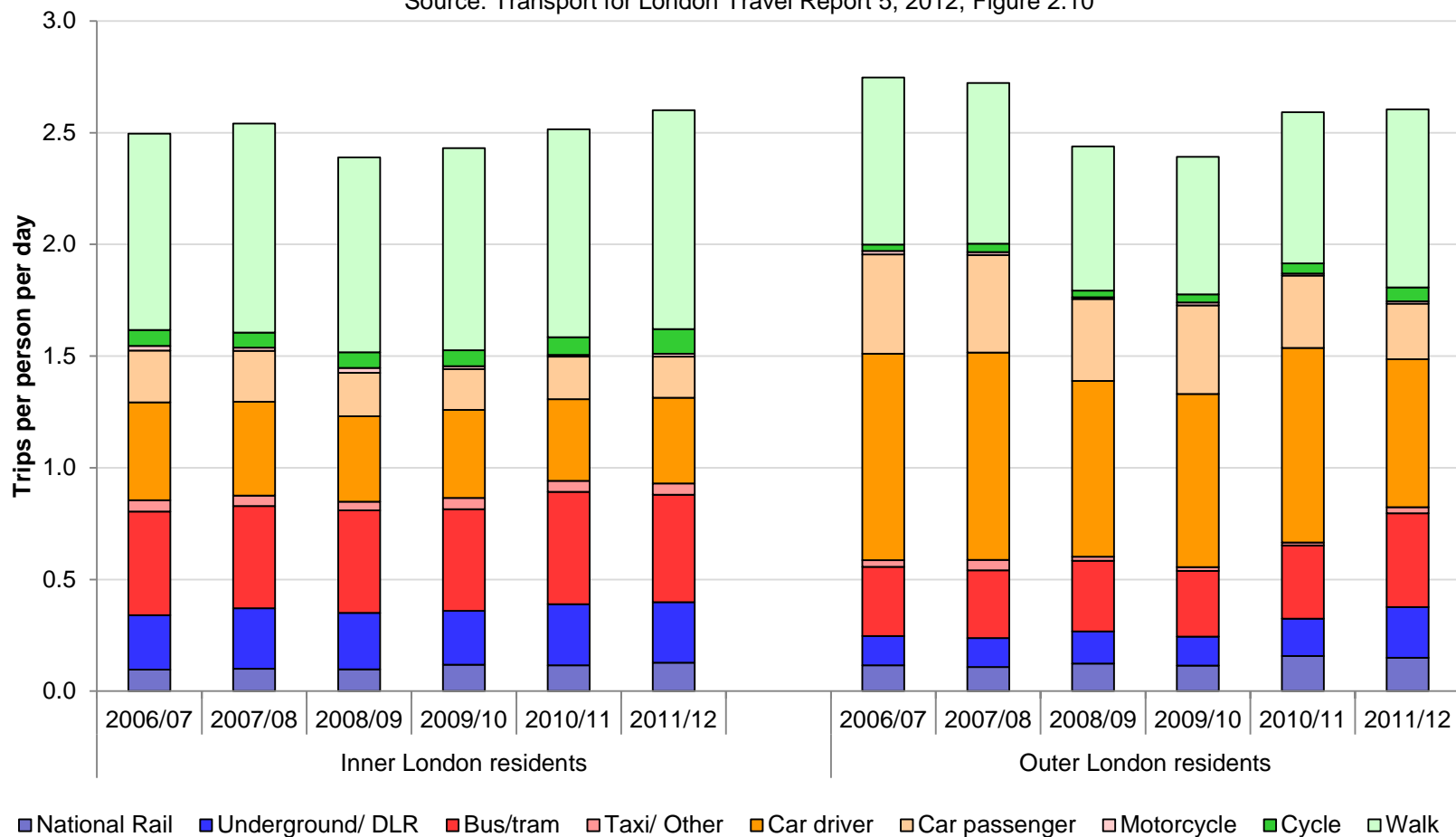


Figure 52: Personal Trip Rates by Inner and Outer London Residents and Main Mode of Transport 2006 - 2011

Personal Trip Rates by Area of Residence and Main Mode of Transport

Source: Transportation Tomorrow Survey 2011

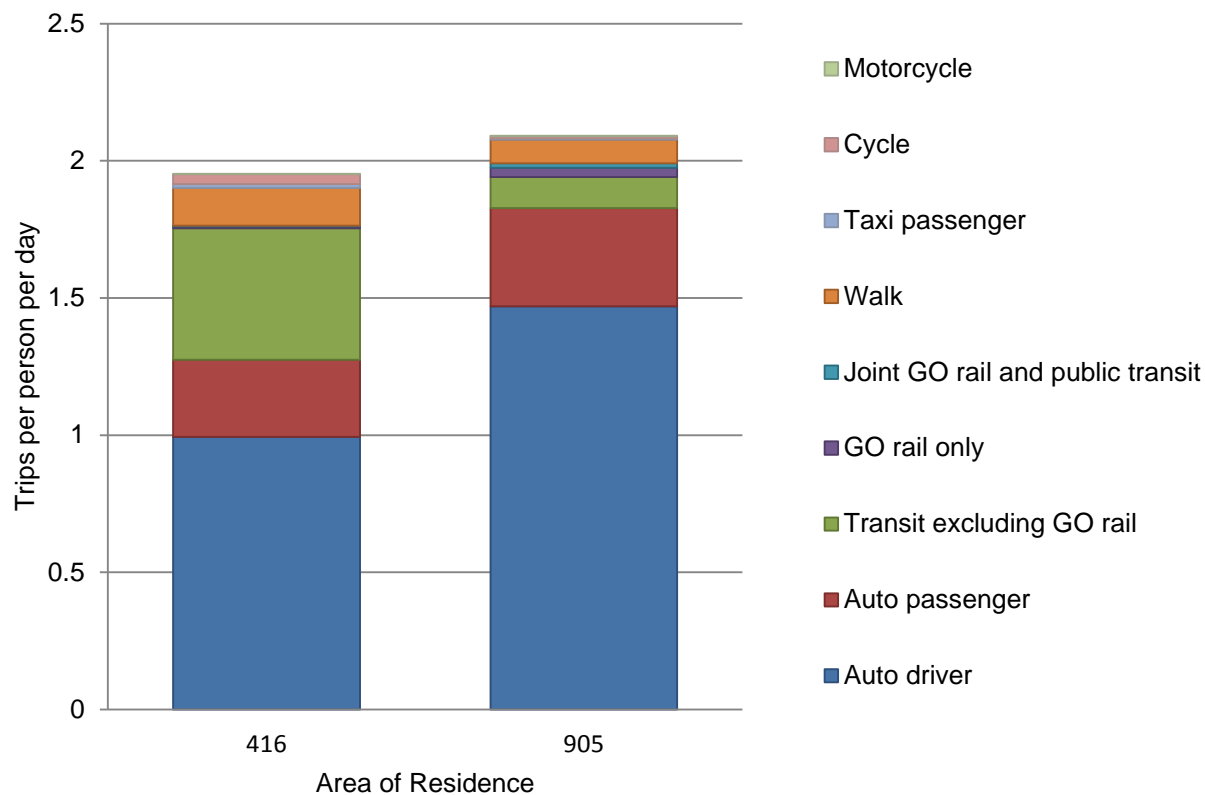


Figure 53: Personal Trip Rates for City of Toronto (416) and Other GTHA (905) Residents, by Mode, 2011

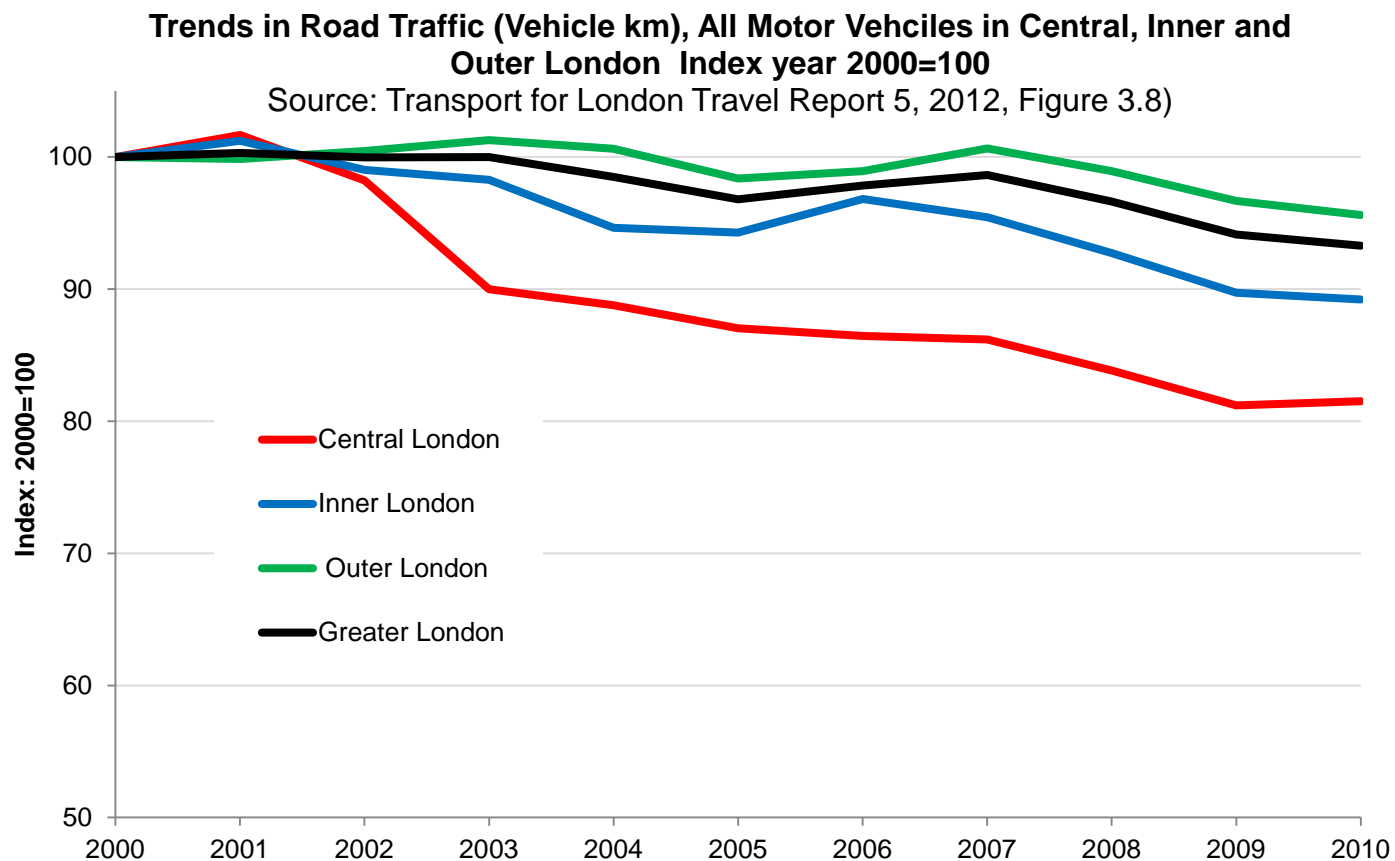


Figure 54: Trends in Road Traffic (Vehicle km), all Motor Vehicles in Central, Inner and Outer London

Note: Road traffic has declined, not just in central London where the congestion charge was introduced, but also in inner and outer London. The only explanation seems to be improvements to public transport as the road system and road costs have not changed substantially.

4.3 Economic Evaluation of Environmental Benefits

Overall, the RER is expected to reduce Greenhouse Gas (GHG) and Criteria Area Contaminants (CAC).

There are potentially three areas of GHG and CAC impact associated with the GO RER. Refer to Section 2.11.1 for more information.

1. The switch from diesel to electric traction on much of the GO rail system.

This reduction is assessed to have an economic benefit of between \$54 million and \$219 million NPV over the 60-year appraisal life of the program.²⁶

2. Impacts on Automobile Vehicle Travel and Urban Shaping.

Assuming an average value of \$40 per tonne, incremental CO₂ reduction resulting from diversion of car trips could be worth approximately \$1 billion NPV over 60 years in Scenario 4 (Full Build). The benefit in the Scenario 5 plan (10-Year Plan Optimized) would be approximately \$650 million.

3. Embedded Carbon.

There is the potential for sizeable CAC impacts from changes in automobile vehicle kilometres travelled, but these changes have not been measured.

4.4 Economic Impact and Wider Economic Benefits

An initial analysis suggests that in Scenario 5 (10-Year Plan Optimized) — assuming no new policies to encourage land-use changes due to RER — wider economic benefits will be worth approximately \$1.2 billion NPV, or approximately 18% of the value of new transit user time savings. With

stronger policies to encourage development around RER stations, the value of these economic benefits could be doubled or tripled. See Appendix G for a discussion of wider economic benefits and how their value for the RER system may be estimated.

The initial work indicates that the land use impacts of RER — which are not predicted at this time but could be substantial — could be a big driver of additional wider economic benefits. Metrolinx mobility hub guidelines envisages active work to facilitate station-oriented development in which people can live and work with great mobility opportunity as a result of the new RER system. Additional development that will occur just outside the station area, but will still be highly accessible to RER stations will also realize, and contribute to, wider economic benefits. There is a substantial amount of work required to fully value these effects and Metrolinx intends to work with partners in academia and other sectors to better understand and report this benefit.

Wider economic benefits include economic development, land use and tax impacts. While construction and operation of the RER will increase tax payments superficially to all three levels of government, to a substantial extent this will be offset by reductions in payments relating to other activity, for example reduced road construction and reduced car expenses. Development around RER stations will be in place of density development at other locations, although typically at higher densities.

²⁶ Calculation assumes the social cost of carbon is valued in the range \$38 to \$155. Source: Environment Canada (2015).

4.5 Summary Economic Case

Summary economic benefits for the four scenarios, incremental to the Do Minimum (Scenario 1), are presented in Table 29. The evaluation shows clearly that net economic benefits increase with greater capital investment in the scenarios as defined. Significantly, Benefit:Cost ratios also increase, indicating that the incremental investment even on the margin is giving good value for money, and that the point of diminishing returns has not yet been reached. The analysis suggests that further capital investment may bring even greater economic benefits as is often the case with railway projects, where investment tends to be unevenly applied, but once a large initial investment is made, additional smaller investments can bring high returns.

While Scenarios 2 (Two-Way All-Day) and 3 (10-Year Plan) appear attractive with a BCR greater than 1:1 on most corridors, the additional capital costs to implement electrified RER with EMUs is far outweighed by the incremental benefits, both to passengers and reductions in operating costs. On some corridors the incremental revenues and operating cost savings actually offset the capital costs, without even considering transport benefits. The incremental BCR comparing Scenarios 3 (10-Year Plan) and 4 (Full Build) are very high.

Experience in other regions is that once the initial cost of upgrading one part of the system to electrified RER is made, the incremental cost of adding branches is relatively modest, and often outweighed by incremental benefits.

The Narrow Benefit:Cost Ratio is, broadly, consistent with U.K. government practice. Benefits, the numerator of the BCR, only includes time savings to passengers not captured by fares and savings to road users. No account is taken of avoided auto costs for persons who switch from car to transit. Instead, the denominator includes net costs, but is reduced by incremental passenger revenues.

The Transport Benefit:Cost Ratio is consistent with usual practice in Ontario, and generally, North America. The numerator includes time savings to passengers and auto operating cost savings for persons switching to transit. The denominator includes net costs. No specific consideration is taken of fare revenues, as these are a transfer and not a true cost to society (because a transit rider paying a government agency is a transfer and collectively, transit riders, government agencies and everybody else are part of society).

The “Full Benefit:Cost Ratio” also takes account of wider economic benefits, and the economic value of environmental and social benefits, together with transport benefits calculated as described above.

Table 29: Incremental Economic Analysis of Scenarios 2 (2WAD) – Scenario 5 (10-Year Plan Optimized) Compared with Scenario 1 (Do Minimum)

2014 \$ Million Net Present Value	Scenario 2 (Two-Way All-Day)	Scenario 3 (10-Year Plan)	Scenario 4 (Full Build)	Scenario 5 (10-Year Plan Optimized)
Revenue	3,578	4,989	10,506	6,501
Operating Costs	(2,756)	(5,203)	(4,330)	(2,266)
Capital Costs	(5,301)	(6,464)	(14,121)	(8,547)
Total Cost	(8,057)	(11,667)	(18,451)	(10,813)
Surplus (Subsidy) 60 yr. NPV	(4,479)	(6,679)	(7,945)	(4,313)
Surplus (Subsidy) 20 yr. NPV	(5,339)	(7,186)	(12,464)	(7,510)
Existing Transit User Time Savings	2,234	4,839	9,802	7,725
New Transit User Time Savings	799	6,117	12,821	6,904
Peak Period Road User Time Savings	860	1,161	3,488	2,148
Off-Peak Road User Time Savings	417	586	1,090	696
Auto Operating Cost Reduction	8,020	11,207	23,236	14,713
Safety Benefits	859	1,200	2,479	1,565
Total Transport Benefits	13,188	25,110	52,916	33,751
Road and Transit User Benefits	5,168	13,904	29,681	19,038
Narrow Benefit:Cost Ratio	(1.2)	(2.1)	(3.7)	(4.4)
Net Benefits	5,131	13,443	34,465	22,938
TRANSPORT BENEFIT:COST RATIO	1.6	2.2	2.9	3.1
Wider Economic Benefits	144	1,101	2,308	1,243
Green House Gas Reductions	356	498	1,033	654
Net Benefits (Full)	5,631	15,042	37,806	24,834
FULL BENEFIT:COST RATIO	1.7	2.3	3.0	3.3

- Safety Benefits
- Auto Operating Cost Reduction
- Off-peak road time savings
- Peak road time savings
- New Transit User Time Savings
- Existing Transit User Time Savings

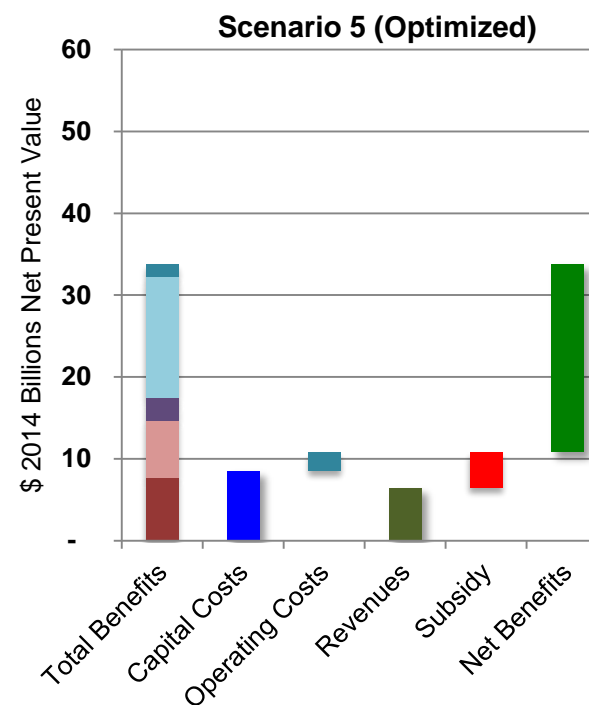
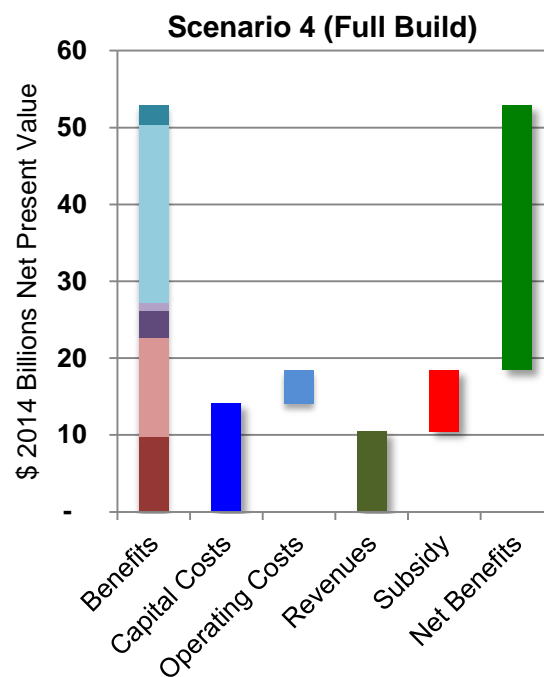


Figure 55: Economic and Financial Evaluation of Scenarios 4 (Full Build) and Scenario 5 (10-Year Plan Optimized) as Increments over the Do Minimum (Scenario 1)

5. The Deliverability and Operations Case

5.1 Technology Objectives, Constraints and Solutions

RER technology varies from region to region, usually because of legacy technology choices that are expensive and disruptive to change.²⁷ RER will in many respects be a new system, and therefore can adopt international best practice in many areas, limited only by the:

- Requirement to maintain GO services and capacity for peak commuters during implementation. GO might divert some services, e.g., Barrie or Stouffville trains, might run via the York subdivision and Richmond Hill corridor to Union, as is done now when services are disrupted. However, with 10,000 or more peak passengers on each branch, it may not be feasible to shut down entire lines, as was done on the Montréal Deux Montagnes line when it was electrified.
- Financial case for using the existing fleet of passenger cars, which likely cannot be sold at an attractive price. GO might sell 10 or 20 each year to other cities, but it would take decades to dispose of the entire fleet.
- Continued operation of freight services over some lines. Metrolinx is working to segregate freight and passenger trains. With a few exceptions, freight traffic to industrial customers on GO's network may be limited to night-time hours when passenger services are not operating.

- Regulatory constraints. GO is regulated by Transport Canada where it operates over CN and CPR, and voluntarily accepts the same regulation over the network that it owns.

This IBC is prepared on the basis of working technical assumptions as set out in Table 30. Many of the technical assumptions are self-evidently optimal, but some may be subject further study.

²⁷ For example, Toronto's subway uses a non-standard track gauge which essentially makes it impossible to run subway service over surface tracks shared with GO, and other passenger and freight operators.

Table 30: Technical Parameters and Working Assumptions

Technical Parameter and Considerations	Working Assumption and Options for Further Study Comments
TECHNICAL STANDARDS AND PERFORMANCE	
Technical Standards: GO currently voluntarily complies with US FRA and American Railway Engineering and Maintenance-of-Way Association (AREMA) standards which are optimized for mixed operation with freight.	<p>It is assumed for the purpose of this IBC that GO: 1) adopts international (UIC and EN) technical standards; 2) this approach is accepted by Transport Canada under the Alternate Practice policy; and 3) by CN and CPR where they interact with RER services.</p> <p>Operating rule changes would need to be discussed and confirmed with Transport Canada and other bodies.</p> <p>This discussion with Transport Canada is particularly important with respect to rolling stock, train control and electrification costs.</p>
Power and Signalling Systems: 25 kV AC overhead power and CBTC or similar communications based signalling are now accepted international standards.	<p>Assume 25 kVAC power.</p> <p>Enhanced train control system.</p>
Maximum Speed: 160 kilometres per hour is the norm for RER systems, although some shorter routes with closely-spaced stations operate at 120 kilometres per hour. Some longer distance services operate at 200 kilometres per hour. Existing GO trains are limited to approximately 150 kilometres per hour.	<p>Existing line speeds are assumed with a top speed for the technology of 160 kilometres per hour maximum, achievable on all routes subject to alignment and other constraints. Future options for consideration include evaluation of the case for 200 kilometres per hour or faster running on Niagara, Kitchener and Barrie routes, potentially in conjunction with HSR (which may be faster than 200 kilometres per hour).</p>
Locomotive-Powered or EMUs: Virtually all RER systems use EMUs where they are acquiring new equipment. Some use locomotives to propel unpowered older cars, usually in short trains of four to six cars. Modern systems use locomotives to haul short trains of four or six cars, sometimes linking trains to create sets with multiple locomotives. This operational strategy enhances acceleration, reduces journey times, and increases ridership and revenue.	<p>Assume EMUs for all off-peak services, except for service to Hamilton which will use diesel power.</p> <p>Use electric locos to power existing unpowered bi-level fleet to operate peak services on all routes.</p> <p>Retain diesel locomotives to operate services to Hamilton GO (Hunter), where electrification is problematic. Evaluate alternative of electrification to Hamilton James.</p> <p>Evaluate case for operating some off-peak services with electric locos and short sets of unpowered bi-levels. As described in Table 3, Milton, Richmond Hill and Kitchener services beyond Bramalea will use diesel locomotives for traction power.</p>

Technical Parameter and Considerations	Working Assumption and Options for Further Study Comments
Acceleration: Modern EMUs can have up to half of all axles powered and can deliver acceleration limited only by passenger comfort and safety.	Assume acceleration and braking performance similar to other RER systems.
Mixed Fleet Performance: Issues/considerations may arise from scheduling/operating trains with different performance characteristics. Mixed fleets are very common on RER systems because different trains do different things well.	<p>Working Assumption: Mixed fleet is assumed in Scenarios 3 (10-Year Plan), 4 (Full Build) and 5 (10-Year Plan Optimized).</p> <p>Comment: While there will inevitably be some increase in operational complexity, this complexity will likely be offset by capital and operating cost savings, and revenue benefits. Smaller EMUs with faster acceleration are optimal for all day services, and offer a lower cost per seat for lower, mid-day volumes. Electric-locomotive powered bi-levels offer a lower cost per seat, when operated in big trains which are ideal for peak commuter trips. Diesel locomotives are required for services onto CN and CPR lines to Hamilton and potentially Kitchener.</p> <p>Further Study: Related issues will be worked through in future iterations of the RER business case.</p>
TRAIN SIZE AND STATION INTERFACE	
Platform and Maximum Train Length: GO rail stations are all built for 12- car (300 m+) trains. Very few RER systems have trains that are longer, although some long-distance and high-speed railways operate with 400 m passenger trains.	<p>Assume 12-car (300 m+) platform length.</p> <p>Consider shorter trains if required to allow double-berthing at Union Station.</p> <p>Consider shorter trains for operation of new branches e.g., ACC, which will reduce station costs but may consume too much scarce track capacity through Union Station.</p>
Platform Height: GO operates a low-platform system with raised mini-platforms enabling wheelchair loading. Since most routes are used by freight trains, there is a large gap between the platform and the train, and an attendant is required to assist with loading.	<p>Assume continued use of low platforms.</p> <p>Consider: 1) migrating toward full-length higher platforms, at the same height as the mini-platforms, for faster loading and shorter dwell times, and 2) purchasing new rolling stock with door and threshold designs, and with a threshold extension, as operating in Zurich that would allow unassisted boarding by – users who require step free access. See Figure 58. Zurich S-Bahn, serving a cold climate city and region, demonstrates excellent unassisted disabled passenger accessibility using new rolling stock mixed with old rolling stock.</p>

Technical Parameter and Considerations	Working Assumption and Options for Further Study Comments
Single or Bi-level Trains: Bi-level trains cost less per seat than single-deck trains and are used on most systems where there are clearances, and where traffic volumes support them. GO already operates bi-level trains and there seems to be no reason to revert to single-deck trains.	Assume bi-level trains.
EMU Length: Bi-level EMUs are normally four to eight cars long, although they can be as short as two cars.	Assume four-car EMUs are used initially, coupled into eight-car and 12-car trains during peak hours. Provide for future lengthening to six-car units as ridership grows.
Door Widths, Seating and Standing: GO's existing fleet is designed to provide every passenger with a seat. Doors are relatively narrow, and there is little space intended for standing. At peak times, some passengers sit on the stairs. Wider doors, and a larger standing area with hand-holds, would allow faster loading and should be more appropriate.	Assume upper deck and mezzanines have comfortable seating appropriate for longer trips as on the current fleet. Further study is required to determine if the lower deck should have wider doors and more standing area with hand-holds, recognizing that RER may attract shorter trips than GO does currently. New standards of passenger comfort for these short trips may prove to be acceptable while generating greater system productivity and higher net benefits. The extent to which the boarding/alighting component of station dwell times can be reduced will be evaluated in subsequent stages of program development.
OTHER ISSUES	
Use of DMUs: Some commuter lines in the U.S., and regional lines in lower density areas in Europe and Japan use DMUs. There are DMU designs compatible with low platform loading and speeds of at least 150 kilometres per hour, but the cost per seat is approximately twice as much as for bi-level EMUs.	Not assumed. DMUs could in theory be used on the Hamilton service as an alternative to using diesel locomotives and on the Barrie service as an alternative to electrification beyond Aurora. However, no promising solution has been identified mostly due to the high cost of low-floor DMUs per seat compared with continued use of GO's existing fleet. DMUs have not been identified or recommended for use in the RER program.
Use of Hybrid and Dual- Mode Traction:	Dual-mode locomotives have been considered and discounted as a rolling stock option. This assumption will be kept under review to ensure it remains the most appropriate assumption.
Single-Person Operation:	Not assumed. Will require a solution to enable unassisted disabled passenger access.

5.2 Technical Standards

Until recently, North American passenger rail operators were required to comply with US FRA and AREMA standards. However, in recent few years, the U.S. Federal Railroad Administration has begun to accept that European and international standards can be more appropriate for passenger railways, reducing costs while actually increasing passenger safety. The vehicles that could potentially work with some specialized features specific to their context are referred to as alternate compliance vehicles.

For the purposes of the IBC, it is assumed that international standards will be applicable to fleet procurement. This assumption will be a focus for future work. In the event that existing standards remain applicable, the financial performance of Scenario 5 (10-Year Plan Optimized) would be somewhat reduced.

5.3 Rolling Stock

5.3.1 Train Configuration

The five scenarios assume various train configurations.

GO already operates trains with unpowered bi-level coaches, including an accessibility car and a cab car, and a diesel locomotive. Mostly, GO operates with 12-car trains, limited by platform lengths, but a few services use shorter trains. While there are logistical issues to address, it is understood that GO is considering operation of shorter trains on weekends.

In Scenario 1 (Do Minimum) and Scenario 2 (Two-Way All-Day), it is assumed that, from 2015, GO operates weekend services on the Lakeshore corridor with six-car trains.

In Scenarios 2 (Two-Way All-Day), 3 (10-Year Plan), 4 (Full Build) and 5 (10-Year Plan Optimized) various off-peak and weekend services operate on the other corridors. Wherever practical, these services are assumed to

operate with six-car or eight-car trains, thereby reducing operating costs. In many cases, these trains will have sufficient capacity to operate a shoulder-peak service.

In Scenario 3 (10-Year Plan), diesel locomotives would be replaced with electric locomotives on the Lakeshore East and Lakeshore West corridors with the exception of the Hamilton services which will use diesel locomotives. There are several possible options, trading off capital costs, operating costs, train performance, operating costs and revenues. Four options have been identified:

1. Operate all weekday off-peak services with 12-car trains (E1BL12). This option is operationally the simplest, but entails excess car-kilometres and substantially reduced acceleration compared with EMUs.
2. Operate all weekday off-peak services with eight-car trains (E1BL8). This second option is also operationally simple, but reduces the car-kilometres and allows improved acceleration, although still not as fast as with EMUs. It also implies more train movements in the peak hour through Union Station, as three eight-car trains would have the capacity of two 12-car trains.
3. Operate off-peak with six cars and a locomotive (E1BL6), joining together into trains with two locomotives and two sets of six bi-level cars. This option is operationally the most challenging, as trains would need to be split and joined during the day.
4. Operate peak trains with one locomotive and 12 bi-level cars, but uncouple six cars at a terminal at the end of the morning peak and collect them again for the evening peak. This would also be operationally complex. Cars left at terminals would need to be connected to wayside power for heating and air conditioning. GO

would also need to have additional accessibility cars, so that both short and long trains would have one in the right place.

In theory, all options are possible. Option 2) appears to have the highest net benefits (by a small margin) as well as being operationally simple, and has been used in Scenario 3 (10-Year Plan).

In Scenario 4 (Full Build), GO would also operate EMUs, which are assumed to be four or eight-cars long.

5.3.2 Rolling Stock Options

Scenarios 1 (Do Minimum) and 2 (Two-Way All-Day) assume continued operation with GO's existing fleet of MPXpress Diesel-Electric locomotives and unpowered Bombardier bi-Level coaches, or similar.

In Scenarios 3 (10-Year Plan), Lakeshore corridor services are electrified using electric locomotives, with the exception of Hamilton services, which retain diesel service, as do all other corridors.

In Scenarios 4 (Full Build) and 5 (10-Year Plan Optimized) most diesel locomotives are replaced with electric locomotives, with many services operated using bi-level EMU trains.

Summary data for representative rolling stock is presented in Table 31. This summary data is drawn from manufacturers' data and other industry sources. It has not been independently verified. Prices are based on published contract awards and usually exclude other expenses that will be incurred by Metrolinx, depending on the procurement process that is adopted.

Note that the capital cost per seat is approximately twice as much for EMUs as for unpowered cars powered by locomotives. However, the difference is reduced by the faster acceleration and shorter journey times, allowing greater productivity of a given fleet. Train and track maintenance costs are also approximately one-third less for EMUs per seat-kilometre.

Where trains typically run less than half-full, as they do on GO's Lakeshore services outside peak hours, the savings will be much larger because the average load factor can be much higher with shorter trains. GO's current operating model makes sense because most trains only make a single trip morning and evening. There is no productivity benefit from faster journeys, and the savings from lower track and train maintenance will not usually offset the capital costs of infrastructure electrification. However, for frequent all-day services, the higher capital costs of EMUs are usually offset by the commercial benefits. Note that the table does not consider labour (train crew) and dispatching costs, which may also be less expensive with EMUs depending on policies and practices.

Metrolinx is currently conducting a market sounding to better understand the range of vehicle options that could be available.

Table 31: Rolling Stock Summary Data²⁸

	MPXpress Diesel + 12 Bombardier Bi-Level	Bombardier TRAXX P160 AC + 12 Bombardier Bi-Level	Bombardier TRAXX P160 AC + 6 Bombardier Bi-Level	Stadler KISS 4-Car EMU	Bombardier 4-Car Twindexx EMU
Typical Journey Time Savings – Express	Base	10%	13%	20%	14%
Typical Journey Time Savings – Stopping	Base	15%	17%	24%	28%
Cars per train	12	12	6	4	4
Seats per Car	1,850	1,850	925	340	340
Number of Cars per Consist	12	12	6	6	4
CAPITAL COSTS (millions)					
Per Car	3.1	3.1	3.1	5.5	5.5
Per Locomotive	7.0	6.0	6.0		
Per Set	45	44	25	22	22
Per Seat	24,151	23,611	26,854	64,706	64,706
Per Seat Adjusted for Productivity (Express)	24,151	22,430	25,109	58,365	60,176
Per Seat Adjusted for Productivity (Stopping)	24,151	21,840	24,571	57,019	55,647
MAINTENANCE AND ENERGY COSTS (\$)					
Train and Track per km	15.99	15.73	8.88	3.24	3.24
Fuel and Electricity per km	9.88	4.29	4.29	1.24	1.24
Total per Train	25.86	20.02	13.17	4.48	4.48
Total per 1,000 seat km	13.98	10.82	14.23	13.18	13.18
Adjusted for Speed (Express)	13.98	9.74	12.38	10.59	11.33
Adjusted for Speed (Stopping)	13.98	9.20	11.81	10.05	9.49

Source: Manufacturer's data sheets; RER BCM analysis.

²⁸ Adjusted cost per seat is calculated by reducing cost proportional to journey time savings assuming half stopping and half express use

Table 32: Assumed Journey Time Savings for Different Types of Trains

Description	Assumed Journey Time Savings		Stopping	Express	Improved Dwell Times Using In-Cab CCTV
	Stopping	Express	Improved Acceleration	Improved Acceleration & Ability to Achieve Line Speed	
1 Diesel Loco and 12 Bi-Levels	0%	0%	0%	0%	0%
1 Diesel Loco and 6 Bi-Levels	10%	8%	10%	8%	0%
1 Electric Loco and 12 Bi-Levels	15%	10%	15%	10%	0%
4-Car Bi-Level EMU	20%	20%	19%	15%	4%
8-Car Bi-Level EMU	20%	20%	19%	15%	4%
2 Diesel Locos and 12 Bi-Levels	10%	8%	10%	8%	0%
1 Electric Loco and 6 Bi-Levels	17%	13%	17%	13%	0%
12-Car Bi-Level EMU	20%	20%	19%	15%	4%
2 Electric Loco and 12 Bi-Levels	17%	13%	17%	13%	0%
1 Electric Loco and 4 Bi-Levels	17%	13%	17%	13%	0%
2 Electric Loco and 8 Bi-Levels	17%	13%	17%	13%	0%
1 Diesel Loco and 8 Bi-Levels	0%	0%	0%	0%	0%
1 Electric Loco and 8 Bi-Levels	16%	12%	16%	12%	0%

Journey time savings are estimated for each type and use, based on international experience. Note that no allowance has been made for savings from removing line speed restrictions, which may require additional expenditure to improve track and structures.

5.3.2.1 Locomotive and Unpowered Coaches

The MPXpress diesel locomotive is used by GO and by many other North American commuter rail operators. GO's locomotives can pull up to 12 bi-level coaches. Each locomotive costs approximately \$7.8 million. This price is approximately 50% higher than the price for freight diesel locomotives because there are additional requirements for high output and hotel power, but also because there is only one manufacturer that has developed the product for this relatively small market.

There is a wide range of electric locomotives available that could be suitable for the GO RER system. The Metrolinx 2010 Electrification Study indicated a capital cost of \$9.2 million per electric locomotive which reflects prices in the small and relatively closed U.S. market (as a result of BuyAmerica Act and other policies). The projections assume a cost of \$6 million, which is the typical price of electric passenger locomotives such as the TRAXX used in Europe.²⁹

In Scenario 3 (10-Year Plan), Scenario 4 (Full Build) and Scenario 5 (10-Year Plan Optimized), GO may have surplus diesel locomotives and bi-level coaches in 2024. In preparing the financial projections, it is assumed, conservatively, that surplus coaches are sold for \$1 million and locomotives could be sold for \$3 million in their current condition, probably to another commuter rail operator with similar requirements. This assumption is reasonable to use at this time given that a phasing plan to introduce new equipment into the GO fleet and minimize the sale of surplus assets still needs to be developed by Metrolinx.

²⁹ According to Railway Gazette International April 2014, German leasing company Paribus-DIF-Netz-West-Lokomotiven has acquired 15 Bombardier Traxx multi-system locomotives for "around €60m" or about CAN\$5.6m per locomotive. As Metrolinx gets closer to a purchase decision, it is expected that additional market information will become available.

In order to make use of existing rolling stock, some RER operators form their existing hauled bi-level stock into shorter formations. German railways even operate some services with two locomotives powering four bi-level coaches. This configuration provides a performance capability similar to an EMU. However, operating costs and track maintenance costs will probably be higher because of the additional weight of the locomotives. While in principle these short consists can be coupled into longer trains at peak hours, platform space will be taken up by locomotives, limiting train capacity. In Switzerland, longer trains for the peak period are created by coupling train-sets of one locomotive and three passenger cars to create longer trains consisting of six passenger cars and two locomotives.

Figure 56: The Zurich S-Bahn



Source: Metrolinx.

Train shown is six passenger cars with one locomotive at the front and one locomotive in the middle, enabling the train to be broken into smaller trains for off-peak service.

5.3.2.2 Multiple Units

While there are hundreds of multiple-unit designs available, the potential range narrows rapidly after taking account of the specific requirements of the GO RER system. Figure 57 shows a decision tree for the selection of suitable diesel and electrical multiple units. The decision tree is intended to show feasibility, and does not include the next step, which would be an analysis of costs and benefits.

5.3.2.3 Diesel Multiple Units, Dual-Mode Locomotives and Hybrids

Consideration has been given to use of DMUs on the RER system but, at this stage, no promising option has been identified. In all scenarios, 12-car diesel-hauled trains are required to provide peak capacity into Union Station. Consequently, there are in all scenarios surplus trains to operate the off-peak service, and no scenario has been devised where DMUs would be cheaper than simply operating diesel trains. The main reason is capital cost to operate over the RER system. DMUs will need to be low-floor, so as to allow efficient loading at the same platforms. Low-floor DMUs with performance similar to EMUs are available but the cost per seat is very high, approximately twice as high as for an EMU. DMUs seem to be attractive on systems with very low-peak volumes, but on GO this is not the case. Even the off-peak services to Unionville, Barrie and Kitchener would require six-car single deck DMUs, off-peak and for these loads, which can be handled less expensively either in a four-car EMU or a 10 or 12-car diesel.

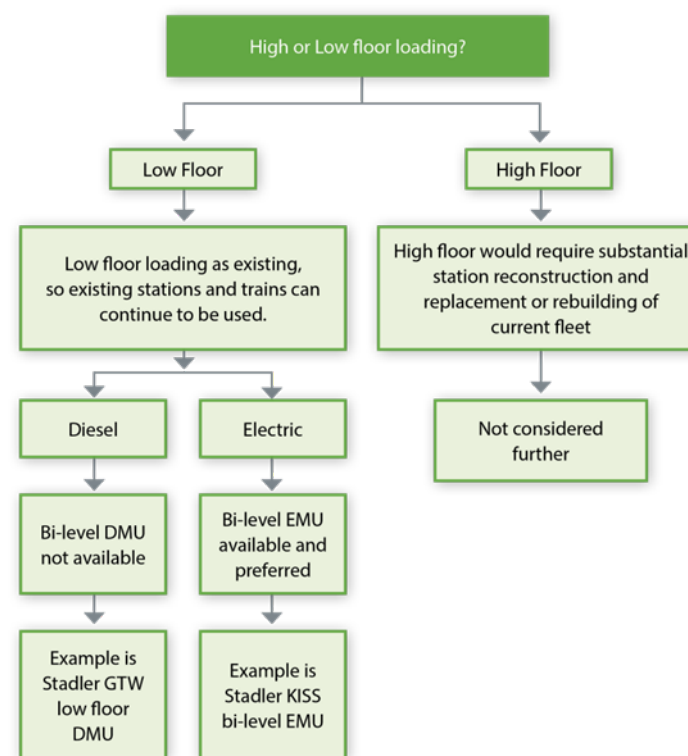


Figure 57: Multiple Unit Rolling Stock Decision Tree

Since railway tracks in Europe are typically closer together, and bridges are lower; most bi-level EMU designs are built with a tapered upper deck. Metrolinx will need to consider the benefits of providing more space inside the cars as this may increase cost or delivery risks. The volume of cars required by Metrolinx for the GO RER may make it feasible and attractive for a manufacturer to modify an existing design. Benefit:Cost analysis should be conducted on various solutions that may be available.

5.3.2.4 Electric Multiple Units

EMUs have been available in bi-level versions for more than half a century.³⁰ However, until recently, bi-level EMUs mostly operated on systems using DC power distribution because it was difficult to provide space in a bi-level car for the transformer required to step high voltage AC power down to a voltage that could be controlled to drive traction motors. For this reason, on many older systems in “AC territory,” such as the Rhine-Ruhr S-Bahn (RER) system, bi-level coaches are powered by electric locomotives.

With the advent of high-voltage power electronics, and smaller transformers, AC-powered bi-level trains are now available and in wide use. Bombardier and Alstom have built various designs of bi-level EMUs for the Paris RER. Stadler has built bi-level EMUs for RER systems in

Zurich, Bern, Geneva and Luxembourg. The Stadler KISS bi-level has also been sold to Russia for two airport express services, and to WestBahn, a private inter-city train company operating in Austria. Bombardier is supplying its Twindexx in both EMU and unpowered versions for various RER (S-Bahn) services in Germany. Siemens and Alstom are two other manufacturers with experience building bi-level EMUs.

Although EMU cars typically cost more than unpowered cars, the average cost per passenger space is broadly similar after taking account of the cost of locomotives, and the higher utilization that is possible.³¹

It is difficult to objectively compare the costs of different types of trains, because capacity, usable space and performance differ.

- Space in the end cars of EMU sets is lost due to the energy-absorbing end structure, the driving cab and for electrical equipment.
- Total passenger space on cars is less because the upper deck is a smaller proportion of the car length, and the car is slightly narrower, especially on the upper deck, to fit within the smaller European loading gauge.
- Space for seats is less, but standee space greater because the cars typically have wider doors. This, combined with in-cab CCTV, enables faster loading and shorter dwell times, which in turn raises fleet productivity.

³⁰ DC technology was developed in the 1920s and requires wayside substations every few kilometres alongside the line to provide power that can be used on the train more or less directly to drive the motors. High voltage AC technology was developed in the 1950s. It is able to provide much more power to trains, allowing faster acceleration, and with far fewer wayside grid connections and feeder stations. Transmission losses are lower and the potential for regenerative braking is increased. Modern Smart 25kV configurations can also receive feeds from renewable sources (where they exist) reducing the amount of electricity required through the meter. However, a transformer is required on board each train set to convert the high voltage power to lower voltages which can drive the motors. Typically, one transformer is provided on every four to six cars to drive motors on some or all of the cars. Older RER systems with bi-levels (Sydney, Melbourne, Netherlands) use DC traction provided at voltages of 600V to 3,000V through overhead wires or a third rail. Newer systems, unless required to inter-operate with older systems, almost always use 25 kV AC. The Paris RER has a mix of 1500V DC and 25 kVAC lines, while London has a mix of 700V DC and 25 kVAC lines. Germany and Sweden use 15 kVAC

³¹ Stadler recently supplied 19 six-car double-deck EMUs for the Zürich S-Bahn (RER) network. The Zurich EMU is rated at 4,000 kW, with 6,000 kW available during acceleration, about four times the power of the GO bi-level configured as a 12-car train with a single MPXpress. The 114 cars cost SFr 397 million, equivalent to SFr21 million or about \$24 million Cdn. per six-car EMU. Allowing for spares and other costs, a six-car EMU should cost about \$28 million Cdn., and a four-car set about \$20 million Cdn. Bombardier announced a contract in February 2013 to supply 12 four-car bi-level EMUs for the S-Bahn in Würzburg, Germany. Bombardier quoted a price of \$145 million U.S., or about \$12 million per EMU. These cars were purchased as part of a larger order negotiated in 2008. The cars are built in Germany and Sweden.

- Some trains (e.g., Swiss) have first class accommodation.
- Many new EMUs have generous space for bicycles and luggage storage, and a wheelchair accessible toilet.



Figure 58: The Zurich S-Bahn bi-level cars, as shown, make use of doors on the lowest levels, allowing level boarding to meet accessibility needs

Stadler is supplying a slightly wider car for use on the Moscow Airport Express services, with 700 seats in each six-car set. Stadler has also supplied a four-car configuration for the Bern S-Bahn. This configuration is essentially the Zurich EMU, but with two middle cars omitted. The Waratah bi-level EMUs being supplied to Sydney Trains have a larger cross section similar to the Bombardier bi-levels. One can speculate that Stadler, or any of its competitors, could build an EMU to the North American loading gauge, providing perhaps 90% of the effective capacity of a six-car set of Bombardier bi-levels.

The Bombardier Twindexx can be equipped with active steerable axle trucks, which can enable it to run through curves at 15% higher speed. These are in operation in Europe and Israel, and could offer benefits particularly on the Barrie and Stouffville routes which have challenging track geometry.

New bi-Level EMUs can also be equipped with gap filling capability between train and platform, which could enable unassisted loading of wheelchairs at higher platforms, reducing dwell times. Potentially, this capability would allow one-person train operation (two-person operation is assumed in the financial projections). Further study is required to determine if this capability can be used on the RER network.

Modern EMUs offer much greater acceleration than is possible with trains powered by diesel locomotives, and top speeds of 200 kilometres per hour are readily achieved. Faster acceleration, combined with faster loading due to wide doors and the provision of in-cab CCTV, can reduce journey times as much as 28% on stopping services. Besides attracting more passengers, on all-day services this journey time reduction increases train productivity so that a smaller fleet is required. The net effect can be to lower the cost per EMU seat below that of a seat in a diesel powered bi-level train.

5.3.3 Rolling Stock Procurement Issues

5.3.3.1 Fleet Size and Manufacture

Passenger rail rolling stock is almost always built in fleets customized for a specific application. Although there are standard technical platforms, railways differ sufficiently in local technical and environmental requirements that it almost always makes sense to develop, or at least customize, designs for local requirements. In comparison with automobile manufacture or even aircraft, production runs are very small.

In Scenario 5 (10-Year Plan Optimized), approximately 140 EMU cars would be required for the Lakeshore route, and approximately 30 cars for each additional electrified route.

5.3.3.2 Procurement Time Line

Procurement of a new rolling stock fleet is assumed to take typically four to eight years, although Metrolinx is committed to expediting this process and it may be possible to reduce this timeframe. The process entails:

- Development of the customer requirements (car size, configuration of doors, seats).
- Defining detailed technical requirements.
- Defining procurement contracting structure and finance.
- Option of long-term maintenance contract with extended warranty.
- Tender preparation period.
- Tender evaluation, negotiation and award.
- Fundraising and financial close (if privately financed).
- Final design and approval.
- Establishment of manufacturing arrangements.

- Car manufacture.
- Testing and commissioning.

It is possible to get small fleets faster, if there is an existing off-the-shelf design, and if trains can be purchased as an add-on to an existing order. Additional time may be required if: 1) there is no off-the-shelf design; 2) the design is not already approved by regulatory authorities; 3) the customer wishes to facilitate local manufacture; or 4) AFP methods are to be used.

This suggests that if RER is to be in service by 2024, work should begin now defining requirements and agreeing the procurement structure and process.

5.3.3.3 Alternative financing and procurement

Historically, most railway operators built trains themselves or procured trains from one or two favoured suppliers. Experience of operators buying new or unfamiliar technology is very mixed, and a very high proportion of trains purchased using conventional supply contracts are delivered late and do not perform as anticipated, often with substantial cost implications.

Many public and private sector operators, especially in the U.K., are now purchasing new fleets under long-term train service contracts. The manufacturer teams up with a financial investor to provide “trains by the hour.” The operator agrees to pay fixed prices each day for delivery of the required fleet, with penalties and bonuses depending on actual performance. The train supplier takes the risk of train performance, train maintenance costs and train life.

Train service contracts have been used successfully for many complex fleets of trains. However, they can take longer to complete because of the need for service and maintenance contracts, and to put in place equity and debt funding.

This procurement structure was used first in 1995 by London Underground for the replacement fleet for the Northern Line, for 636 cars and was won by Alstom. Most private sector rail operators adopted similar contract structures, notably for: the Virgin Voyager high speed DMU, built by Bombardier; the Pendolino high speed EMU, built by Alstom; and several smaller fleets of Turbostars built by Bombardier. Similar structures are now being used by the U.K. Department for Transport to procure new high-speed inter-city trains such as the InterCity Express project, won by Hitachi) and the new 1,150 EMU fleet for Thameslink, won by Siemens. However, the approach can also drive higher long-term maintenance costs than can typically be achieved in-house by operators, particularly once new-build warranty periods end and risk of endemic new build issues has evaporated following several years successful operation.

Hybrid models are possible with private finance of trains together with responsibility for commissioning and operations for an initial period of perhaps 10 years. This model could transfer many of the technical risks of introduction technology to the private sector. Best value for the tax payer may be protected by including an option for operations and maintenance to be brought in-house or competitively tendered after the initial period.

5.4 Corridor Infrastructure

5.4.1 Stations

Many existing stations will require new platforms and therefore access tunnels over shelters. In some cases, stations will undergo significant change due to additional track or realignment station facilities space for bus interchange. Passenger pick up will also require modification to support increased ridership. Additional property may be required at many station locations. The potential to encourage higher density development around stations should be explored with local municipalities. Joint development and funding opportunities should be explored wherever

possible. Station designs should reflect good value for money and be appropriate for the context within which they are built.

Ontario weather requires heated platforms and enclosed shelters both on the platforms and approaching the street so that passengers can wait comfortably and exit the station easily.

Capital-cost assumptions for different types of stations are based on recent GO experience. Detailed designs need to be prepared.

5.4.2 Track and Structures

Additional tracks are required at various locations on each corridor. Typically passing tracks are required for hourly two-way service, while a full second track is required where trains operated every 15 minutes all day. A third or fourth track is required where there are express services or where tracks are shared between two or more services, or with inter-city or freight services.

Line speeds can be increased on many sections of track, in some places at relatively low cost. The business case will be best in Scenarios 3 (10-Year Plan), 4 (Full Build) and 5 (10-Year Plan Optimized) on routes with frequent all-day services, but each section must be evaluated individually. For further details and analysis, see Appendix H. An assessment is required of the existing track infrastructure to support the service levels over speed of trains proposed in Scenario 3 (10-Year Plan) and Scenario 4 (Full Build). The installation of new tracks may require EAs. Additional property may also be required. Metrolinx is proceeding with preliminary design of additional track work on all corridors, and the start of construction of an additional track on the Stouffville and section of the Barrie corridors is imminent.

There are sections of track which operate at speeds up to 160 kilometres per hour. Where they do not, there are three main reasons why: track curvature, structures and signalling. The type of track construction defined should be considered for speed potential, in some cases for operation above 160 kilometres per hour operation. At some locations, realignment may be possible within the existing rail corridor or with relatively modest property acquisition. Such opportunities will be explored in subsequent stages of project development. When implemented, an enhanced train control system may permit further speed improvements to be achieved. Higher speeds can in some cases reduce journey times and reduce the size of the fleet required to achieve a certain level of service. Higher speeds can therefore create additional capital and operating costs, but they may also lead to higher revenues and lower operating costs. The specification of speed, and potentially different specification of speeds in different parts of the network, should be considered in future design work.

Structures are mostly modern and built to the appropriate standards for freight but not always for higher speed passenger services. Where ties are directly fixed to viaducts, higher speeds might not be easily achieved.

Costs per track mile are based on recent GO experience.

5.4.3 Level Crossings

There are approximately 187 public level crossings, as well as 50 private and farm crossings, and 23 pedestrian crossings on the GO network. Some 344 crossings are already grade separated.

In preparing the business case, assumptions have been made in the number of grade crossings that may be required, as shown in Appendix A and Appendix B. Allowance has been made for a total of 10-13 road/rail grade separations. These numbers are subject to change, but are a good assumption for the purposes of the analysis presented in this IBC. Actual

locations will be selected during feasibility and design phases, and are subject to discussions with municipal stakeholders.

5.5 Electrification

Metrolinx has already completed preliminary design for electrification of the UP Express service, and is now retaining specialist consultants to prepare plans for system-wide electrification.

Metrolinx is proposing to have the first high-voltage electrified railway in Ontario, and there are many issues to address. For example:

- Feasible locations for connection to the electricity grid must be identified and impacts on the grid evaluated. The total power consumption of RER is small compared with the total supply in the GTHA, and should not trigger the need for more generating capacity, but RER will impose particular demands on the network because of the nature of its power needs.
- The Canadian Standards Association's guideline for bonding and grounding of conductive materials in the vicinity of RER appear to have been developed for relatively remote locations and may need to be revised to be suitable for denser urban environments.
- Overhead clearances requirements must be reviewed and a freight operations and deliveries strategy developed to minimize infrastructure costs. As required by Transport Canada, the overhead clearance requirements for single and double stack freight cars and GO bi-level cars is shown in Table 33.
- The electrification system must be designed with sufficient capacity for reasonable traffic growth. It must be maintainable in the Ontario climate.
- Transport Canada's standard for electrification heights are quite high relative to what may be needed; lower electrification heights consistent

with other electric railways, if implementable, could lower cost and increase performance of electric trains.

Table 33: Electrification Clearances

Height/Clearance (mm)	GO Bi-Level	Actual Double Stack	Transport Canada Double Stack
Contact Wire Height at Registration	5,900	7,182	7,550
Pantograph Uplift Clearance	300	300	300
Nominal Mid-Span Height	200	200	200
Electrical Passing Clearance	205	205	205
Total Structural Clearance	6,605	7,887	8,255

5.6 Enhanced Train Control Systems

In all scenarios, costs are included to install the functionality of conventional PTC signalling on new track on the relevant sections of line. It is noted that, although not yet a legal requirement in Canada, systems similar to PTC are installed on many RER systems, and are now required on passenger rail routes in the U.S.

Allowance has been made in the capital cost estimates to install PTC in Scenario 1 (Do Minimum) and Scenario 2 (Two-Way All-Day), and other means of enhanced train control (such as CBTC or other) to varying extents in Scenarios 3, 4 and 5.

Train control is a system-wide cost and is included only in the evaluation of the entire GO rail system. An ETC system, such as CBTC, is likely to cost approximately \$800 million whereas PTC is likely to cost approximately \$200 million.

At present, double-rail track circuits are used to detect broken rails. The actual rate of detection on the GO network is not known. In other countries, the successful detection of broken rails using track circuits can be around 50%. The serious accident in the U.K. in 2000 at Hatfield, near London, was caused by a broken rail (yet this was not detected by the track circuits failing). Most networks now deploy advanced ultrasonic testing as a more reliable and robust means of detecting rail flaws, rolling contact fatigue and latent defects before they manifest themselves as actual breaks. This detection enables significantly improved management of the rails and advance intervention prior to any rail breaks actually occurring.

Initial work at Metrolinx has identified that CBTC is the preferred train control system. Further work will lead to a further refined cost estimate. As work progresses on this topic, the business case will be updated.

5.7 Interface with Inter-city and Potential High-Speed Rail

GO currently shares tracks with VIA on the Lakeshore, Kitchener and Richmond Hill corridors (and a very small part of the Barrie corridor, at the south end of the Georgetown South Corridor), and with Amtrak on Lakeshore West. These same corridors can be shared with high-speed rail, if and when, it is implemented in Ontario.

Generally, provision for inter-city and high-speed rail requires suitable train paths, for trains operating non-stop into Union Station. Track must have suitable cant (banking or super-elevation) to allow fast running on curves. There must be a practical way to equip all inter-city trains with equipment to interface with the enhanced train control system.

VIA currently parks trains in Union Station for extended periods, and moves terminating trains to and from its yard in South Etobicoke for service and reversal. It is assumed that in the future, inter-city and HSR trains will operate mostly push-pull, with less need for movement to and from the

yard and reduced dwell time at Union Station. This change will reduce platform consumption by inter-city and HSR trains at Union Station, leaving more capacity for RER use.

There are many international precedents for inter-city, HSR and RER services sharing stations with similar traffic and footprint to Union Station. The way Union Station is currently used will have to change to maximize its productivity.

5.8 Interface with Freight

GO rail services co-exist with CN and CPR freight services on many sections of track. Expansion of GO services will require investment to enable the increase in frequency of passenger services to co-exist with freight services. Expansion of RER on all corridors is contingent on agreements with freight operators. Discussions are underway with CN and CPR.

5.8.1 Doncaster and Davenport Diamonds

The Barrie corridor crosses the CPR main line at Davenport, and the Richmond Hill corridor crosses the CN main line at Doncaster. At both locations, these are rail-rail level crossings, which operate on a first-come first-served basis. This method of operation only just works with the limited peak-only services that GO currently operates; rail-rail grade separations at both locations are considered essential to operate 2WAD services. The grade separation will require considerable capital expenditure and will impose impacts on the adjacent communities during the construction period.

In Scenarios 2 (Two-Way All-Day), 3 (10-Year Plan), 4 (Full Build) and 5 (10-Year Plan Optimized), costs of \$228 million for Davenport, inclusive of property, noise walls, track and signalling, are included. Arguably, these investments will also benefit CN and CPR as they too share in the delays that would otherwise occur. However, for the purposes of this business case, benefits to CN and CPR, and any possible sharing of costs, are ignored. It is possible that steeper grades could be achieved if freight operations were to be eliminated or modified because electric trains can manage steeper grades. In some cases, this efficiency could result in less costly and intrusive grade separation solutions, but such design solutions are subject to negotiations of operations with the freight operators.

5.8.2 Access Rights

Currently, CN has rights to operate freight, including double-stack trains, over most of the GO rail network. However, there are no double-stack terminals on the GO network. Maintaining the double-stack capability affects the cost of electrification as the additional clearance required between the vehicle and existing overhead bridges will likely require structural modifications in many cases to provide the required clearance.

CN also has broad rights to serve existing and new industrial customers over much of the GO rail network. For the purpose of the IBC, it is assumed that these rights will not interfere with the ability of GO to implement the proposed services considered here. This assumption must be validated through continued discussion with CN.

5.8.3 Enhanced Train Control and Freight Strategy to Minimize Capital Expenditure

GO operates over key sections of CN and CPR corridors in the region. Electrification of the corridors will cause electrical interference with wayside signals. Steps can be taken to immunize against such interference and enable safe operation of the wayside signalling equipment on electrified routes. However, such measures incur capital expenditure and may require

wholesale change of all equipment including track circuits. Where a modern communication-based system is used, cab signalling or CBTC, immune equipment would be installed from the outset. However, this solution would require onboard systems in trains operating over the equipped territory.

Examples of locations which should be considered for this strategy include between Aldershot and Oakville, Oakville and Mimico, and to and from MacMillan Yard. By adopting such a strategy, it may be possible to avoid the extensive costs of immunizing conventional signals due to electrification of the corridor.

5.8.4 CN and CPR Mainline Sections

GO operates over key sections of CN and CPR mainline tracks in the region. Development of RER services on the Milton line would require significant additional tracking of sections of the Milton corridor. There will be substantial extra costs to ensure electrification is high enough for double stack operation, which may also compromise full development of HSR on the Kitchener corridor.

CPR's requirements to allow electrification on the Milton corridor are potentially quite onerous and expensive to implement. Consequently, no upgrade of the corridor is assumed in Scenarios 3 (10-Year Plan) and Scenario 5 (10-Year Plan Optimized). In Scenario 2 (Two-Way All-Day), provision is made for a third track as far as Meadowvale, while in Scenario 4 (Full Build), provision is made to four-track the line from West Toronto Junction to Milton, subject to agreement with CPR.

Based on Metrolinx' initial analysis; costs would be at least \$1.5 billion for infrastructure to allow RER services on the Milton corridor plus the costs of electrification. As an alternative to four-tracking the Milton corridor, and to realize key benefits on the sections of the Kitchener corridor owned by CN,

Metrolinx has entered into discussions with both operators to seek alternatives.

5.9 Union Station and the Union Station Rail Corridor

Union Station is the heart of the GO network, and will continue to be the main destination for peak commuters from across the GTHA. It is anticipated it will also become a significant interchange point within the GO rail network and attract greater inbound flows of boarding passengers than is the case today. Also, there is the potential to attract more trips connecting places on either side of Union Station, which could be a benefit of running more trains through the station as opposed to terminating many train routes at Union Station, as is common practice today.

The USRC is approximately 6.4 kilometres long and stretches from the Don River in the east to Strachan Avenue in the west (41 kilometres of track, 256 switch machines). It has a complex network of tracks, interlockings and platforms that support operations in and out of Union Station; see Figure 59 for an aerial view of the USRC. The ladder tracks typically consist of double-slip switches. These tracks, combined with the strategically located lateral turnouts, provide for several thousand routing possibilities. Union Station has 12 tracks running through the train shed, two tracks outside the train shed configured as passenger tracks and two additional tracks outside of the train shed for freight detours and equipment moves. Twelve platforms service the 14 passenger tracks (configured mainly as island platforms giving 27 service platforms). The existing platforms can accommodate both the current 10-car and 12-car train configurations. Track 1 is configured for permit double berthing of one UP Express train and one 10-car GO train.

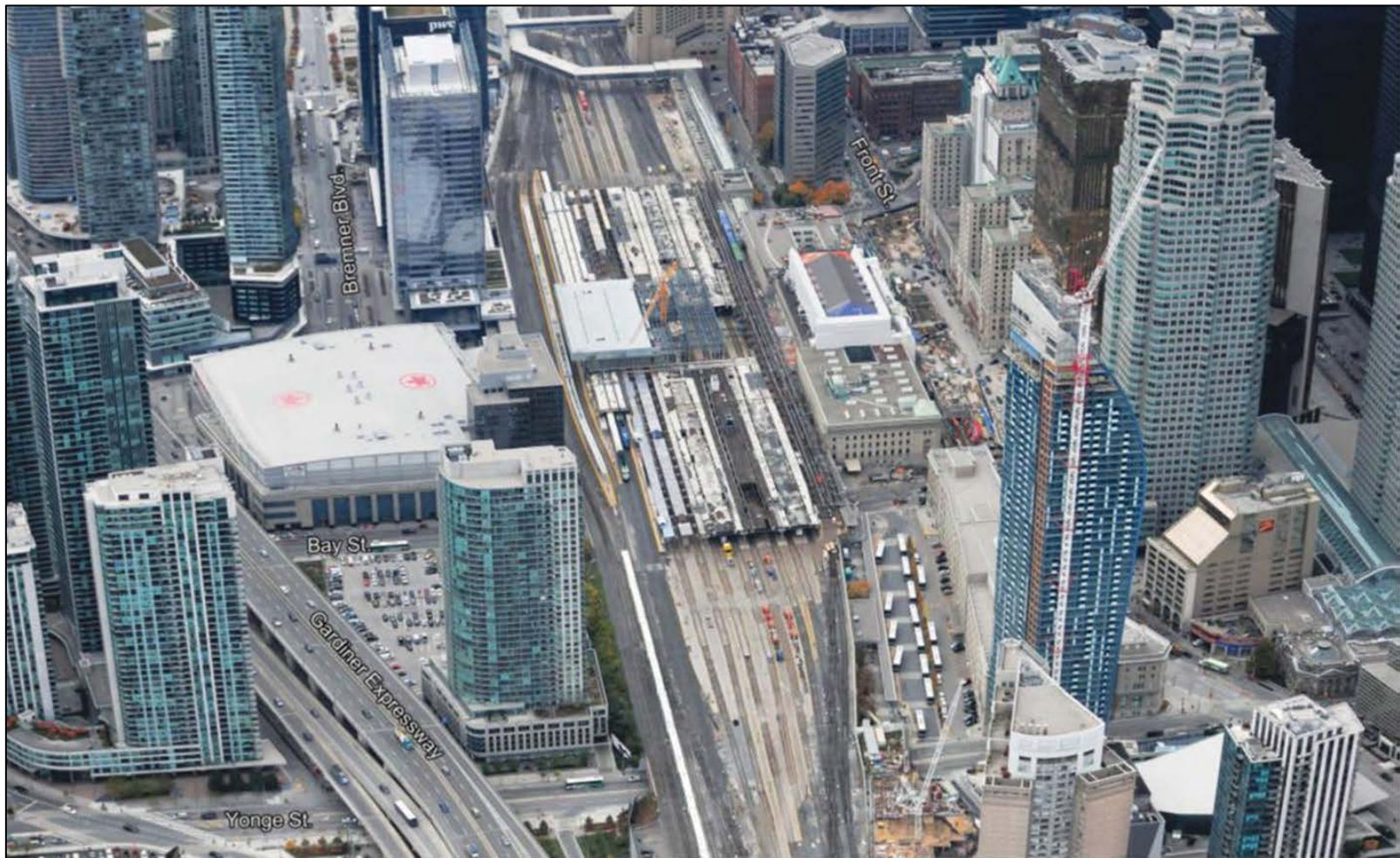


Figure 59: Union Station Rail Corridor Looking West

Union Station was designed originally for use mostly by long-distance passenger trains, with lower passenger volumes and lower frequency of services. The station has been adapted incrementally to serve GO, and to provide step-free access to all platforms. Much larger concourses are now being created as part of the Union Station revitalization project, and new stairs and elevators have been built to most platforms. However, the platforms remain very narrow with limited vertical circulation and barrier-free circulation capacity. The track layout in the corridor provides flexibility for trains from any route to operate into most platforms, but the consequence of using many of the turn-outs³² translates into slower approach speeds and congestion on the ladders³³ with conflicting moves.

On completion of the Signal Upgrade Program, train speeds will be on average 30 miles per hour on the west side of Union Station and 45 miles per hour on the east side, which suggests pursuit of solutions to increase train speeds, increase direct routing and increase overall available platform tracks. In summary, the main constraints to a higher flow of trains through Union Station relate to a combination of platform capacity and track capacity. Platform capacity is derived from the physical number of platforms, platform width, number of stairs and their width, and concourse capacity. Track capacity includes number of approach tracks, construction impacts, track speed, signal headways, train scheduling and routing. The dwell time includes: the ability to safely and quickly clear trains and platforms of alighting passenger loads; the time required to board passenger loads; and the time required to clear the train from the platform track to allow the next train to enter. The headways (i.e. time between trains) comprises line speed restrictions, the degree to which conflicting equipment moves cross the corridor and the ability to avoid the need to turn trains in platforms (a particular issue at Union Station as a result of the imbalance of train movements east and west). Capacity is comprised of many variables and is further summarized in Figure 60 below.

³² Turn-outs are known to some as “switches,” They are diverging tracks that allow a train to move from one track to another.

³³ Ladders are a series of connecting turn-outs. They allow trains to run diagonally across a corridor of many tracks in one movement. It is infrastructure that is the equivalent of allowing a train to change many lanes all in the same movement.

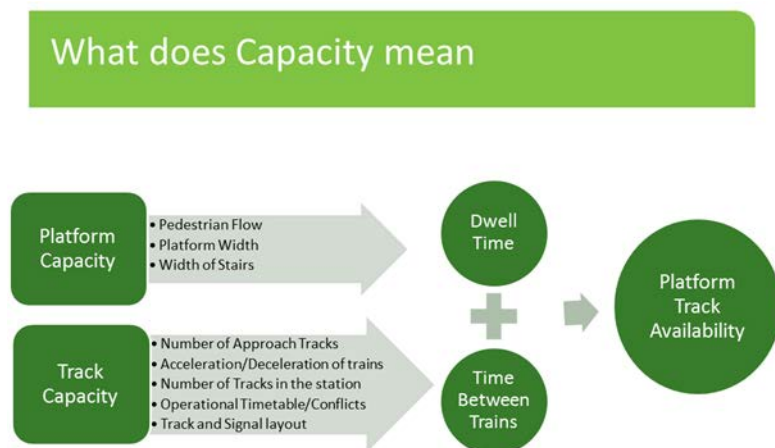


Figure 60: Capacity at Union Station

It is envisaged that approximately 50 GO trains will move through the USRC and stop at Union Station in the morning under Scenario 5 (10-Year Plan Optimized). This is an opening year volume of train movements which can be expected to grow as ridership builds. The current peak-hour arrivals peak at Union Station are in the order of 29 GO trains.

In summary, to increase the capacity of Union Station, each train will need to enter and exit the station more quickly, and load and unload passengers more quickly, while not preventing or slowing the movement of other trains moving along their paths on the tracks and turnouts.

There are a number of projects being considered that will constitute a USRC program to enable the number of trains RER will schedule to pass through and serve Union Station. The following projects are included in Scenario 5 (10-Year Plan Optimized) to ensure appropriate capacity is available to meet the 2024 demand for passenger and train movements. Further program elements are being considered to adequately protect for projected growth in ridership and train movements that will occur beyond 2024. The USRC program is being developed and will be refined in the short term to plan for phasing and finalizing track, tunnel and platform layouts, and design specifications. Projects will be developed and implemented as not to preclude future increases in capacity beyond 2024.

USRC West Side Enhancements

The USRC has nine approach tracks from Strachan Avenue to Union Station. However the B-Track terminates at Bathurst Yard and does not continue to Strachan Avenue. This termination limits the operational routes available for trains approaching the station and means the train's paths are restricted earlier. Enhancements on the west side would extend the approach tracks to facilitate increased train routing capacity in the USRC. The project would also improve the alignment of the tracks and increase speeds in the vicinity of Fort York which experience a restriction to approach speeds, slowing journey times for passengers and limiting the number of trains that can run on the tracks. The new track infrastructure would provide enhanced routes into Union Station and allow more train movements which would provide improved routing and train speeds. The Fort York interlocking is currently made up of slower speed crossovers that in the future RER scenario will become a limiting factor in the ability to sort trains for the best approach to Union Station. These slower speed crossovers will be replaced with higher speed, lower maintenance turnouts. In recent years, GO purchased the north and south connecting tracks. This project will realign tracks to achieve the best speeds and passenger ride

experience, thereby optimizing the use of the north and south connecting tracks. With the realignment of the tracks, an additional train storage location can be created to help support the peak service as well as service recovery. The signalling in this area will also be upgraded to facilitate the introduction of electrification.

USRC East Side Enhancements

The USRC has six approach tracks from the Don River to Union Station. This number limits the operational routes available for trains approaching the station. This project would add additional approach tracks, storage locations and potentially crossovers to facilitate increased train routing capacity in the USRC. The new track infrastructure would provide two new direct routes into Union Station and additional daytime storage tracks. A new Track E7 would originate directly from Track 13 (train shed) and connect into an extended Track E6, just west from the signal bridge west from the Don River Bridge (USRC east limit). A new Track E8 would be laid south of the new Track E7. It would originate directly from Track 14 (train shed) and span into the Harbour Lead Track and the west end of the Don Yard tracks. The train storage improvements include provision for four two-locomotive and 12-car consist layovers- designed on the parallel E7/E8 tracks, from Lower Jarvis Street to the Don Yard west end. The E7/E8 between the tracks accommodates new access roads to service the parked GO train consists. In addition one consist layover capacity track section was designed on the new E7 track, running parallel and north from the Don Yard tracks. The existing access road for the Don Yard Track 1 will be adjusted as needed.

Track 1 Extension

The introduction of the new UP Express service resulted in the building of a dedicated UP Express station and platform to accommodate the new trains on the historic Track 1 just west of the train shed. Track 1 is being used as a double berthing platform for UP Express and GO/VIA, increasing its utilization. The physical constraints of the track mean that only GO service with 10-car trains can be accommodated on Track 1 when the UP Express services is running. This restriction will be removed when the existing GO bus terminal is relocated in 2019, and the track and platform can be extended to accommodate a 12-car train length.

New Southern Platform

Currently there are 14 platform tracks and two passing tracks (Tracks 15 and 16) at Union Station. This project proposes to remove Track 15 and replace it with a new Island Platform (Platform 28/29) for use by GO. This platform will be wider than average platforms at Union Station thereby reducing dwell times related to platform crowding. Approach speeds for this platform will be higher than typical platform track approach speeds at Union Station. The combination of the wider platform and higher approach speeds could enable the platform to have higher capacity than any other platforms at Union Station. There is also sufficient space to allow for double berthing on this platform; this option to extend the platform is currently under review. This new Platform 28/29 would also enhance the capacity of Track 14 which currently only has pedestrian access from one side, thereby increasing the capacity of Track 14.

Operational Support Building

The introduction of increased service will significantly reduce the time available for maintenance. To facilitate the increased efficiencies needed by the maintenance teams, a best-in-class maintenance facility will be built in the USRC to accommodate the track, signalling and electrification teams.

Options for Further Study

The following options are being assessed as potential components for inclusion in the USRC capacity enhancement program to address increased capacity needs that will be required by RER in the years beyond 2024.

Double Berthing

Double berthing could further increase the capacity at Union Station while still maintaining a relatively central location for passengers to access Union Station and downtown Toronto's underground pedestrian walkway system, PATH. Double berthing could convert up to four platform tracks to accommodate two trains at a time, end to end, thus potentially increasing Union Station capacity. These extended platforms may allow increased capacity and operational flexibility for use as through moves with tight headways, through moves with separate arrivals and departures, or allow for back-to-back turn-around moves. The conversion would require the extension of platforms and the construction of new stairways, elevators and tunnels, thereby potentially improving passenger access to the station, including potential improved connectivity to Yonge and Lower Simcoe Streets. While there are significant challenges associated with double berthing, most notably ensuring acceptable access for passengers with restricted mobility (in particular, wheel chair users), the option remains under consideration at this time.

Satellite Stations

The potential to create satellite stations at either end of the USRC is under consideration. These stations could result in some transfer of passenger movements from Union Station and facilitate train flows through the corridor. In addition, satellite stations could allow operations to continue under a modified service in the event of potential weekend or holiday closures to accommodate major capital rehabilitation, construction or maintenance programs. Further work is underway to determine the feasibility and benefits of these potential stations in the vicinity of the Bathurst North Yard and Don Yard locations. Use by, and scheduling of, services will have a significant impact on ridership and benefits realized.

Track Rationalization/Platform Widening

Options to widen platforms through the rationalization of tracks within the Union Station facility are under consideration. This option could: eliminate, or at least reduce, platform pedestrian crowding constraints; improve barrier-free circulation; and in combination with appropriate line speed enhancements, could result in a far higher throughput of trains per track per hour than is currently operated or envisaged at Union Station. However, this option also represents a significant change in the way the Union Station facility is operated and further work is required to verify the feasibility of the concept.

New Tunnels or Elevated Options

The option to provide additional capacity by tunneling or building elevated platforms at Union Station is also under consideration at this stage. However, it has some very significant engineering challenges to overcome that may make it cost prohibitive in terms of the benefits it gains. West of Union Station there are three grade separated structures below the rail corridor and 15 overhead structures. East of Union Station there are

eight grade-separated structures below the rail corridor and three overhead structures.

The creation of the new concourses under Union Station means that any tunnel option would need to be very deep and to meet the required grade will require very long tunnels. Additionally, the roads under the tracks on the east side of the USRC push this tunnel even deeper reducing further the practicality of this option.

An alternative to tunneling is an elevated platform option. On the west side of the USRC there are too many elevated crossings to make this practical but it could be accomplished on the east side. However, it would be a very long elevated structure that would require a large number of supporting columns throughout the corridor; close to Union Station, it would also be difficult to link passengers back into the station.

Schedule Optimization

In addition to the planned and proposed infrastructure improvements, train scheduling and routing will be thoroughly evaluated in order to establish optimized schedules that minimize conflicts by: reducing the number of crossing moves; reducing peak period non-revenue equipment moves; maximizing direct routing to the appropriate platform; reducing turn-around moves; and establishing an overall systems approach that minimizes simultaneous arrivals/departures and creates an optimum balance of both train and pedestrian flow. Work is underway on this task and will continue over the following 18 months.

5.10 Maintenance Facility and Stabling

Increased train services will require additional facilities for mid-day and overnight storage, and for cleaning and maintenance. Some tasks (e.g., train car washing), may need to be transferred to suburban locations, as electric trains may not need to visit full-maintenance facilities as frequently as diesel trains. GO is already acquiring sites for facilities in suburban and end-of-route locations. Additional sites may need to be found close to Union Station for mid-day storage, if GO wishes to manage the costs of returning empty trains out of the city.

A new maintenance facility is currently envisaged for the UP Express at the Resources Road site and work is underway to create a preliminary design for this facility. However, the planning assumption regarding the extent of electrification envisaged under Scenario 5 (10-Year Plan Optimized) means that there may be alternative maintenance scenarios for electrified UP Express vehicles which could yield operating efficiencies. These options will be further reviewed as work to refine the program is undertaken.

For the East Rail Maintenance Facility (ERMF) in Scenarios 4 (Full Build) and 5 (10-Year Plan Optimized), there is an allowance for electrification of the ERMF, including specialist equipment to maintain electric locomotives and EMUs and completion of the new operations control centre. In Scenario 3 (10-Year Plan), there is allowance to maintain the electric locomotives only because there are no EMUs in this scenario.

For Willowbrook Rail Maintenance Facility (WRMF), in Scenarios 3 (10-Year Plan), 4 (Full Build) and 5 (10-Year Plan Optimized), there is an allowance for electrification. Once the overall RER program is agreed, further work is required to determine the optimum strategy for maintenance and train storage facilities. In Scenarios 4 and 5, there is an additional allowance for the electrification of a portion of WRMF including an assumption that Preventative Maintenance Bays 3 and 4 would be used to

service the UP Express EMUs; this assumption is captured in the cost estimates and IBC analysis.

Costs for electrification of maintenance facilities are captured in the system-wide cost component of the cost estimates provided in Appendix A.

5.11 Capital Cost Estimates

The capital costs have been estimated by Metrolinx largely based on cost estimates for similar works undertaken recently on the GO rail network. The cost estimates were supplied and input into the model as real 2014 dollar costs. The model converts all costs to economic net present values expressed in 2014 prices.

The capital costs (excluding rolling stock) include the following allowances:

- 15% Environmental Assessment, Engineering Design and Procurement (EDP). Note that an allowance of up to 22% may be required for some works.
- 50% Contingency. This contingency has been applied to all civil infrastructure and electrification base costs. This percentage is considered appropriate at this stage, recognizing that the scope of all works is not fully defined and in many cases only conceptual designs have been completed. With further design work, contingency could be reduced to 40% or less for works such as track, stations and level crossings where GO has extensive experience. A 50% contingency is reasonable for signalling and for electrification — the latter for which GO has limited experience.

- 25% Productivity and Resource Factor. This factor is applied to corridor infrastructure base costs to account for construction under increased rail traffic and ongoing service expansions throughout the 10 years, and includes consideration of limited specialized resources in the industry (particularly for electrification). This factor has not been applied to system-wide costs such as enhanced train control and maintenance facilities.

Adjusting the contingency and other factors will substantially improve the Financial Case for all scenarios, but especially for Scenario 3 (10-Year Plan), Scenario 4 (Full Build) and Scenario 5 (10-Year Plan Optimized) as these are the most capital-intensive. Adjustments will not be made until further design work has been completed (which would enable a higher confidence in the costs).

Whether the RER system is delivered within, below, or above the costs assumed in this Initial Business Case will depend on many factors, including site-specific issues which will only be determined with further engineering design and market conditions. However, there may be future opportunity to identify and implement more cost-effective technical solutions.

5.12 Reducing Journey Times

Reduction of journey times has been considered by comparing existing GO service running times with actual performance of EMU rolling stock on other RER systems.

Journey times drive train crew costs and passenger demand. Journey time savings are assumed to range from around 8% with electric locomotives, up to around 20% for EMUs on stopping services. These savings can also generate efficiencies in rolling stock and crew use if fewer train sets are required to operate a given number of services. In fact, journey time savings could be considerably greater, at least from current times. Some of the key factors influencing journey time reduction can be found in Table 34.

Table 34: Key Factors and Features Enabling Journey Time Reduction

Factor or Feature	Opportunity	Issues
Greater tractive power of 25 kV electric train compared with locomotive-powered train acceleration.	Greater acceleration enabling faster running over longer sections between stations. Potentially reduce section running times.	Attaining run-time improvements through higher acceleration may be constrained by crossing warning systems and various grade separations may be required to capture the full benefits.
Attainable speed capability will highlight penalty inflicted by low infrastructure speeds.	Selective line speed improvements may be possible. These may include bridge strengthening to remove speed restrictions or increased cant (banking).	Removal or reduction of speed restrictions may be possible with limited capital expenditure; requires case-by-case analysis. As a rule of thumb, revenue and economic benefits may justify approximately \$1 million CAPEX for each second of reduced one-way run time, although the value will often be less. The IBC analysis had not included any costs for these potential benefits.
Lighter EMU rolling stock.	Take advantage of higher line speeds. Possibility of differential higher line speeds for EMU derived from lighter axle weights.	Infrastructure/structures assessments likely to be required to determine scope/scale of opportunity.
Wider doors with increased standing area.	Faster loading and alighting, enabling shorter dwell times. Further work is required to determine the extent of dwell time reduction that could be realized by adopting wider doors and increased standing area.	Continued requirement for Customer Service Ambassador(CSA) to assist with wheelchair boarding; may be avoided with higher platforms and sliding thresholds as available on some Bombardier and Stadler EMUs, and practiced in mixed fleet such as Zurich S-Bahn.

Factor or Feature	Opportunity	Issues
On-board in-cab door CCTV.	Reduce station dwell times.	Transfer control to Commuter Train Operator (CTO) from CSA.
Radial steering bogies.	Increased curving speeds without requiring curve re-alignment.	Available, as on Bombardier Twindexx.
Union Station Rail Corridor and approaches.	Faster entry/egress speeds for trains. Reduced congestion/conflict in station/platform area. Reduced station dwells. Increased capacity. Reduced timetable allowances.	Track layout. Constrained speed through ladders due to track geometry. Constrained speed due to structural speed restriction. Platform width retards access/egress to/from trains with safety issues. Rationalize and speed up. Link services (e.g., Barrie to Stouffville) to alleviate/reduce need for conflicting movements.
Enhanced train control and signalling	Specify a technology and system that can facilitate higher speeds and faster junction/platform/track section re-occupation.	Need to ensure that all aspects of signalling recognize the attainable speed capability of electric operation and do not restrict it. Refined scheduling will be done to ensure capacity is optimized.
Junction remodelling and/or grade separation.	Can facilitate higher speeds and faster junction/platform re-occupation. Reduced timetable allowances.	Need to ensure that design recognizes the attainable speed capability of electric operation and does not restrict it.

5.13 Operations and Maintenance

Most operating cost rates are calculated from current GO costs, as determined from analysis of GO general ledger documents.

Costs are calculated based on the service levels as defined, driven by train crew hours, train kilometres, route kilometres, or vehicle kilometres as appropriate.

5.13.1 Energy and Fuel

Diesel fuel and traction electricity consumption and costs have been estimated based on data presented in the 2010 GO electrification study and actual GO experience.

Based on figures provided in the 2010 GO Electrification Study, costs have been estimated for current GO operations and compared with the actual costs as provided in GO management accounts, and found actual fuel costs in 2013 were 19% higher. Assuming a further 2% real increase in fuel and energy costs to 2014, fuel and energy cost rates are increased in total by 21%. This data suggests an average cost of \$9.03 per kilometre for 12-car diesel trains, and \$5.28 per kilometre for 6-car diesel trains. No short or long term real change in diesel fuel prices is assumed, although obviously in fact there will be many fluctuations.

Appendix 8C of the 2010 GO Electrification Study estimated traction electricity costs on a similar basis as for diesel fuel.³⁴ On this basis, electricity cost for 12-car trains with a locomotive is \$3.55 per kilometre, approximately half the fuel cost of a diesel. The more recent Metrolinx Lakeshore Express Rail Service Design Study suggests that EMUs will consume 10% more electricity, per ton-kilometre, because of faster

acceleration and braking. On this basis, energy cost is \$1.24 per kilometre for a 4-car EMU, \$2.48 for an 8-car unit and \$3.72 for a 12-car unit, slightly more than for a 12-car electric locomotive train.

Further study and simulation modelling can give more accurate estimates of energy consumption by time of day, and taking account of train loadings, gradients and the potential for regenerative braking as well as potential feeds from local renewable sources to reduce the net amount of power purchased.

As with diesel prices, no long-term change is assumed in electricity prices. Electricity is generated from a mix of energy sources and is inherently less vulnerable to short-term price fluctuations. This situation favours RER. It should also be noted that, while there is always going to be uncertainty about future electricity and diesel fuel costs, electrified RER is much more energy efficient and therefore less vulnerable to energy-cost increases compared with its main competitor — the private car. If fuel costs rise substantially, this change will only increase the relative competitiveness of RER.

5.13.2 Other Operating Costs

Payments to CN and CPR for track use and dispatching costs are calculated from existing charges, adjusted for train-kilometres.

In addition to its rail and bus operations, Metrolinx has \$200 million per year in corporate costs. These costs include administration, planning, retailing, marketing and facilities costs such as stations that are shared with bus operations. Costs of \$150 million have been allocated to rail and allocated equally across the seven routes such that each route incurs a fixed administration cost of \$21 million per year. A fine-tuning of these assumptions would not be expected to change the high-level conclusions and the assumptions are fair. A key takeaway is that there are fixed costs and variable costs. Costs which are fixed do not change as service levels

³⁴ Set Operations and Maintenance Costs, GO Electrification Study (2010). Appendix 8C. The actual figure given is \$0.00756 per ton-mile.

increase; costs which are variable will increase as service is increased. The cost model employed in this IBC uses a combination of fixed and variable costs to come up with a total cost estimate for each scenario.

Taking this apportionment into account, the GO rail farebox recovery, currently estimated at around 80%, could rise above 100% by 2020 if the introduction of parking charges and conversion to two-person train crews is implemented. Such additional revenues will help to offset capital costs. Note that although this forecast cost recovery ratio is exceptional for North American transit operators, it is in line with experience of many RER operators in Europe and Asia (please refer to Appendix E for further details).

5.13.3 Rolling Stock Maintenance and Refurbishment

Incremental rolling stock maintenance cost rates are based on Canadian and U.K. experience. Total maintenance costs for diesel trains are known from GO's existing contract with Bombardier. The breakdown between locomotives and bi-level coaches suggests that a diesel locomotive kilometre costs 1.3 times a bi-level coach kilometre. Using that ratio with the 2013-14 costs produced a rate of \$1.39 per diesel locomotive-kilometre and a rate of \$1.06 per kilometre for unpowered bi-level cars.

It is understood that the Bombardier contract includes train cleaning, but excludes periodic refurbishment which GO treats as a capital cost.

On this basis, maintenance costs are \$14.11 per kilometre for a 12-car diesel train, and \$7.75 for a six-car diesel train.

The U.K. experience is that maintenance costs for electric locomotives are approximately 25% less than for diesels, which is logical as a diesel locomotive is essentially an electric locomotive, minus a pantograph and transformer, plus a diesel generator. A figure of \$1.50 per kilometre for electric locomotive maintenance is used. This figure includes regular

maintenance, and inspection and the replacement of all mechanical components on a mileage-travelled basis.

The U.K. experience indicates a rate of \$0.30 per car-kilometre mile for balanced maintenance of a modern EMU. This rate includes daily cleaning, regular maintenance and inspection, and the replacement of all mechanical components on a mileage-travelled basis. It does not include any interior or exterior refurbishment. This figure needs to be increased for the additional cleaning required for double-deck vehicles and the effects of winter weather in Ontario. It is suggested that \$0.08 per car-kilometre is an appropriate figure to use for this rate. The winter weather will also require additional maintenance of brakes, air dryers, pantograph carbon strips and motors in cases of snow ingress. A figure of \$0.12 per vehicle mile has been assessed as required here. Recognizing the uncertainty inherent in these figures, a 36% contingency is included, bringing the maintenance cost to \$0.68 per car-kilometre or \$2.72 per kilometre for a four-car EMU.

GO bi-level cars are currently given a comprehensive non-mechanical refurbishment every 18 years at a cost of \$1 million per coach. This refurbishment is modelled as \$55,600 per coach per year. With more intensive use, refurbishment will be required more often to maintain the same level of passenger amenity. Refurbishment every –eight to 10 years is common on RER systems in Western Europe.

EMU cars, which will be used more intensively, will need refurbishment more frequently. It is assumed that one-eighth of the fleet is refurbished each year, at a cost of \$ 2 million per four-car EMU. Note that this is for interior and exterior refurbishment only. Mechanical rebuilding of the running gear and traction equipment is assumed to be included in the annual maintenance costs.

It is not expected that any of the fleet will need replacement within the 60-year project life, although obviously most will be very old by 2074. It is likely that the oldest bi-level cars, built in 1976, will be retired or sold in 2024. In fact, some of the older bi-level cars may need replacement. However, as there is also no assumed residual value in the total financial projections, this issue can be ignored and is a safe set of assumptions for modelling purposes.

5.13.4 Infrastructure Maintenance

Infrastructure maintenance is included in three parts.

Variable track maintenance costs relate to use, and are calculated per vehicle-kilometre based on rates as charged in the U.K. by Network Rail. These rates vary by type of vehicles and have been derived from extensive research. These rates show cost relative to one another and have been used to calibrate costs to known GO rail costs for MP40 and bi-levels. Assumed costs are \$0.89 per kilometre for a diesel locomotive, \$0.10 for an unpowered bi-level car, \$0.52 for an electric locomotive, and \$0.52 for a four-car EMU.

So-called fixed maintenance costs for the existing GO network are calculated by subtracting the estimated variable track costs for current (2014) GO operations from GO's total infrastructure maintenance costs. These costs are apportioned to each corridor on the basis of route kilometres. Infrastructure maintenance costs are understood also to include signalling maintenance.

Maintenance cost will increase as GO infrastructure is upgraded. The increase to fixed maintenance costs is estimated as a proportion of capital investment in track, treating this as a proxy for structures, drainage, and other that may also require maintenance. An increase of 1% of track capital investment is assumed. While this alone is obviously not sufficient to

maintain and renew the new infrastructure, it must be considered together with the increase in variable costs estimated as described above.

Similarly, an allowance has been made for an increase in annual signalling maintenance cost of 1% of the signalling capital investment. In fact, with installation of CBTC, signalling maintenance costs should be reduced if conventional signalling on significant parts of the network can be removed, as should be the case.

For electrification maintenance and renewals, there is an allowance of 2% per year of the capital cost of overhead line electrification on each corridor. The recent study of UP Express electrification, prepared for Metrolinx by Parsons Brinkerhoff, suggests cost of \$7 million per year, or 5% of the estimated \$144 million capital cost for the overhead line. In addition, Parsons Brinkerhoff also notes that major renewals will be required in years 15 and 20. Certainly further renewals will be required during the 60-year project evaluation period.

However, there can also be significant economies with electrification of several corridors.

Electric locomotives and EMUs are significantly lighter than diesel locomotives, and cause significantly less track and track bed wear. Past studies of all-day services and electrification seem to have not addressed track costs. Although the figures are not large, for completeness, they are included in the analysis.

GO now owns and maintains 80% of its network. Infrastructure maintenance costs totalled \$23.1 million in 2012-2013. GO currently operates approximately four million train-kilometres, so average cost per train mile is approximately \$5. However, most infrastructure maintenance costs are fixed, including clearing and maintenance of right-of-way, track bed and structures, regardless of the actual number or type of trains that operate. Estimates of the variable element of track maintenance costs are in the range of 10%-20%. On this basis, variable track costs are \$2.3 million to \$4.6 million, or approximately \$0.60 to \$1.20 for each train kilometre that GO operates.

Concern has been expressed that the introduction of all-day services will make routine maintenance more difficult. In many cases, this work will move to nights, albeit at a slight premium in wages. Canada has a very well-understood method of working on the track which will maximize productivity in planned night-time track occupations. Further work is required to understand the potential implications of a shift to greater reliance on night-shift work for maintenance crews.

Forecast total infrastructure maintenance costs were benchmarked against data for U.K. Network Rail, as published by the independent Office of Rail Regulation.³⁵ Infrastructure maintenance, including track, signalling, electrification and structures, averages £36,000 (\$65,000) in England, and approximately £21,000 (\$38,000) in Scotland and Wales, per track kilometre. Most of the track in England is electrified, while most in Scotland and all tracks in Wales are not. The GO system currently comprises approximately 650 track kilometres, which at \$38,000 per track kilometre would cost approximately \$25 million per year to maintain. This figure

closely matches GO's current actual infrastructure maintenance costs of \$25.7 million.

The full RER system will have approximately 1,200 track kilometres, almost all electrified. At a rate of \$38,000 per track kilometre, this will cost \$46 million per year to maintain. The maintenance costs as estimated with the BCM are \$66 million, approximately 40% more than is indicated by the U.K. benchmarks. This result indicates that the estimates are conservative.

5.13.5 Bus Costs

Bus costs are estimated only so that the effect of RER services displacing off-peak and weekend train-bus services can be reflected in the analysis.

No change is assumed in the bus operating costs rates, but a reduction in bus kilometres for the services that are replaced by all-day rail services is anticipated. GO bus operations provided estimates as to the variability of bus cost categories with respect to bus-kilometres. It also provided a figure for 2013-14 bus-kilometres. On this basis, GO's variable costs are estimated to be approximately \$2.55 per bus-kilometre. Train-bus services operate approximately 25% of GO's total 45 million bus-kilometres. Therefore, GO bus operating costs would fall by approximately \$28 million, more than the loss of revenue, as calculated from train-bus ridership numbers.

5.14 Environmental Impacts, Noise and Mitigation

Implementation of the various projects that constitute RER on all the GO rail corridors will require an EA. Preliminary design of each is included within the EA process. The status of the EA process for projects that make up the RER program is shown in Appendix I. Environmental impacts of a project, both during construction and eventual operation, are evaluated through the EA process. Metrolinx uses two approved methods to determine project impacts and associated mitigation measures, the GO

³⁵ The full data set is available at <http://orr.gov.uk/publications/reports/gb-rail-industry-financial-information-2012-13>

Class EA and the Transit Project Assessment Process, as described in O.Reg. 231/08.

This process includes studies to identify likely environmental impacts and to determine the need for mitigation measures to address these impacts. It also includes stakeholder consultation, including the public, to assist in identifying impacts. It is difficult to determine the site-specific impacts prior to study completion, but expected environmental impacts include those associated with:

- Noise and vibration (due to construction and operation of vehicles).
- Air quality (relating to vehicle emissions, dust, etc.).
- Built heritage (potential presence of heritage stations, buildings, bridges, culverts, landscapes).
- Archaeology.
- Natural heritage (e.g., species at risk, wetlands, in-water works, vegetation).
- Traffic plus changes to travel patterns as a result of the project (including and relating to disruption during construction, increased train crossings at-grade).
- Socio-economic impacts.

Regulatory processes are generally in place to ensure impacts are addressed. There are numerous mitigation measures available to address impacts. Some examples include noise walls, silt fences, dust suppression and environmental monitoring.

The nature of impacts varies with the type of infrastructure and the nearby receptors. Typically, the most disruptive infrastructure activities are rail-to-rail grade separations and rail-to-road grade separations. Property takings

are often required, impacting private landowners. There are disruptions due to utility relocations, traffic, noise and other potential impacts referenced above. Construction of new layovers can have similar impacts due to the areal scale of the facilities, and the impacts during both construction and operations. Corridor work including track, signals, alterations to bridges and structures also has impacts due to both construction and operating considerations.

Impacts are generally more pronounced in areas where there are sensitive receptors such as residential or institutional areas, natural features or heritage resources.

5.15 Station-Area Development Opportunities

These will be explained and developed through the program life cycle. There are significant opportunities in some locations to integrate development with stations and these will be pursued where possible. RER will enhance the opportunity to further improve mobility hubs such as Oakville (shown in Figure 61).



Figure 61: Oakville GO Station

5.16 Station Amenities

The opportunity for station amenities will be examined on a station-by-station basis as the project develops. There is work underway on a retail strategy and other elements that can contribute to an enhanced passenger experience.

6. Next Steps

6.1 Work Completed to Date and Work Ongoing

This IBC has confirmed earlier work that provided Metrolinx and the Province with sufficient confidence to commit to implement RER over the next 10 years. This section explains some of the activities that are now underway. It is not exhaustive.

- Following on earlier commitments to introduce 2WAD services, contracts are being tendered to begin double tracking a section of the Stouffville corridor. This work will be the first shovel in the ground for RER.

- Metrolinx is progressing with design and specification of the electrification system and rolling stock.
- Work continues to refine the BCM so that alternative technical and commercial solutions can be evaluated, to ensure the best value for money is obtained.
- Federal support for grade separation work is being pursued. There are other areas of the RER program that the federal government could also justify supporting, as part of its policies and programming going forward.
- Metrolinx is preparing a consultation and stakeholder management strategy for introducing RER.
- Together with MTO, a comprehensive communications strategy is being developed to explain the RER program to the public and to seek input into the program.
- Metrolinx and MTO are also working with regional municipalities and transit operators to improve fare integration, to improve fare integration, and to implement strategies for station area development and land use intensification.
- Metrolinx is working with the MOECC to review policies for noise walls, and other policies that may affect the financial and economic success of the RER program.
- Negotiations will continue with CN and CPR.
- Key properties that will enable implementation of RER are being identified and purchased.
- Discussions are underway with Transport Canada to establish the technical standards under which RER can be developed, efficiently, and ensure appropriate standards of safety.

- Metrolinx is taking steps to establish an RER implementation project team and is recruiting senior management. It is also considering various contracting strategies to design, build and operate RER. These strategies range from conventional procurement through to AFP structures.
- Metrolinx is currently developing a management and implementation plan.
- Metrolinx is developing an overall project schedule to ensure delivery of the agreed program within 10 years. Key objectives are to: mitigate delivery risks and disruption to existing services while gaining early experience with electrification; and smoothing capital expenditure and construction workload so as to minimize costs.
- EAs are being prepared for many other works required to implement RER.

7. Conclusion: Regional Express Rail – Turning Vision into Reality

RER will help the transit and transportation infrastructure of the GTHA catch up with the way this region has grown and changed over the past half-century. The GTHA is one of the leading urban regions of the world because of its size, geographic diversity, and economic and cultural dynamism. These strengths demand a transit and transportation infrastructure that helps people to build on the GTHA's strengths, and to take advantage of all that the region has to offer.

When GO Transit was established 48 years ago, it made a big difference for the region. It provided the means for people living throughout the GTHA to get to jobs in downtown Toronto in the morning and return home in the

evening. Now, the people of the GTHA need a transport system that is better able to take them where they want or need to go — not just to downtown Toronto and back — when they need to travel, and not just in peak periods. The people of the GTHA require transport that is faster and more reliable, available at all times and in all parts of the region.

This IBC describes how RER will transform five of the seven GO rail corridors into a service that operates all-day, every day, in both directions and with far greater frequency. It calls for the introduction of a large fleet of electric-powered trains, a technology that is faster and more efficient.

The IBC evaluates several plans for achieving RER, and explains why the recommended RER program at this time most closely aligns with Scenario 5 (10-Year Plan Optimized). It provides a strategic case explaining (among other things): the need for RER and its potential contribution to the region; where it should be introduced; how it should be operated; the value of introducing electric trains to the fleet; and where they should be introduced. The IBC also provides: an evaluation framework; a financial case estimating capital and operating costs compared with likely revenues; an economic case analysing the likely benefits of RER compared with the likely costs; and a deliverability and operations case, providing an overview of requirements for rolling stock, corridor infrastructure, electrification, enhanced train control systems and other key factors. Finally, the IBC reviews next steps.

The GTHA's need for RER is clear. The benefits for the people of the region will be great. The BCR is strong.

- This IBC makes it clear that RER would set GO rail on a new path, and it points the best way for getting there.