TORONTO REGION BOARD OF TRADE
WORLD TRADE CENTRE® TORONTO

# GETTING ON THE RIGHT TRACK

## Connecting Communities with Regional Rail

March 2021

In partnership with **Deloitte**

## Contents

# Executive Summary

The Toronto region benefits from an irreplaceable legacy of rail corridors radiating from Union Station. They are invaluable routes for linking together the region's residents and employers. They are burgeoning routes for off-peak travel. But we have not yet been able to harness their full potential. While GO Transit services have long transported tens of thousands of workers every weekday to their jobs in downtown Toronto, these corridors could be made useful for a far wider variety of trips. Realizing this potential is especially important in the wake of the COVID-19 pandemic, and the timing is right to consider their full potential as we begin to understand how the future of work is shifting commuter patterns. We can change the narrative on the business case for Regional Rail by including economic and sustainability objectives as part of the value proposition to government; and transforming the value proposition for customers; resulting in a bi-directional, all day regional rail service fully integrated with local transit, the rail corridors could become a regional transit backbone that would contribute to the economic success of the region. As the province moves ahead with GO expansion, this report builds on this work and lays out a comprehensive plan for the implementation of regional rail, highlighting best practices that have been used in successful implementations of regional rail around the world. Its guiding principles are two-way, all-day service; high frequency; seamless integration with local transit; a focus on equity; and integration with regional planning.

This is the second in a series of four frameworks that collectively lay out a strategy for an integrated, competitive transportation system for the Toronto Region that draws from global best practices. The third and fourth editions of this series will be published in the latter part of 2021.

**NOVEMBER 2020**
**Erasing the Invisible Line: Integrating the Toronto Region's Transit Networks**
Highlighting the importance of a unified fare structure and collaborative administration to break down barriers in the region, this report proposed the creation of a "Transit Federation" for the Toronto Region.

**MARCH 2021**
**Getting on the Right Track: Connecting Communities with Regional Rail**
Uncovering the enormous potential of regional rail in the Toronto Region, along with the global best practices that can be used to improve its value and effectiveness.

**SUMMER 2021**
**Solving the Last Mile**
Looking at the importance of frequent and reliable local transit service needed to get people to and from their homes and destinations, this report will look at how to close the gap around the often overlooked "last mile" of transportation.

**FALL 2021**
**Building Infrastructure**
This report will examine how the Toronto Region will have to deliver timely and cost-effective infrastructure, if it is to keep up with its global peers and maximize the value of investment.

# Introduction

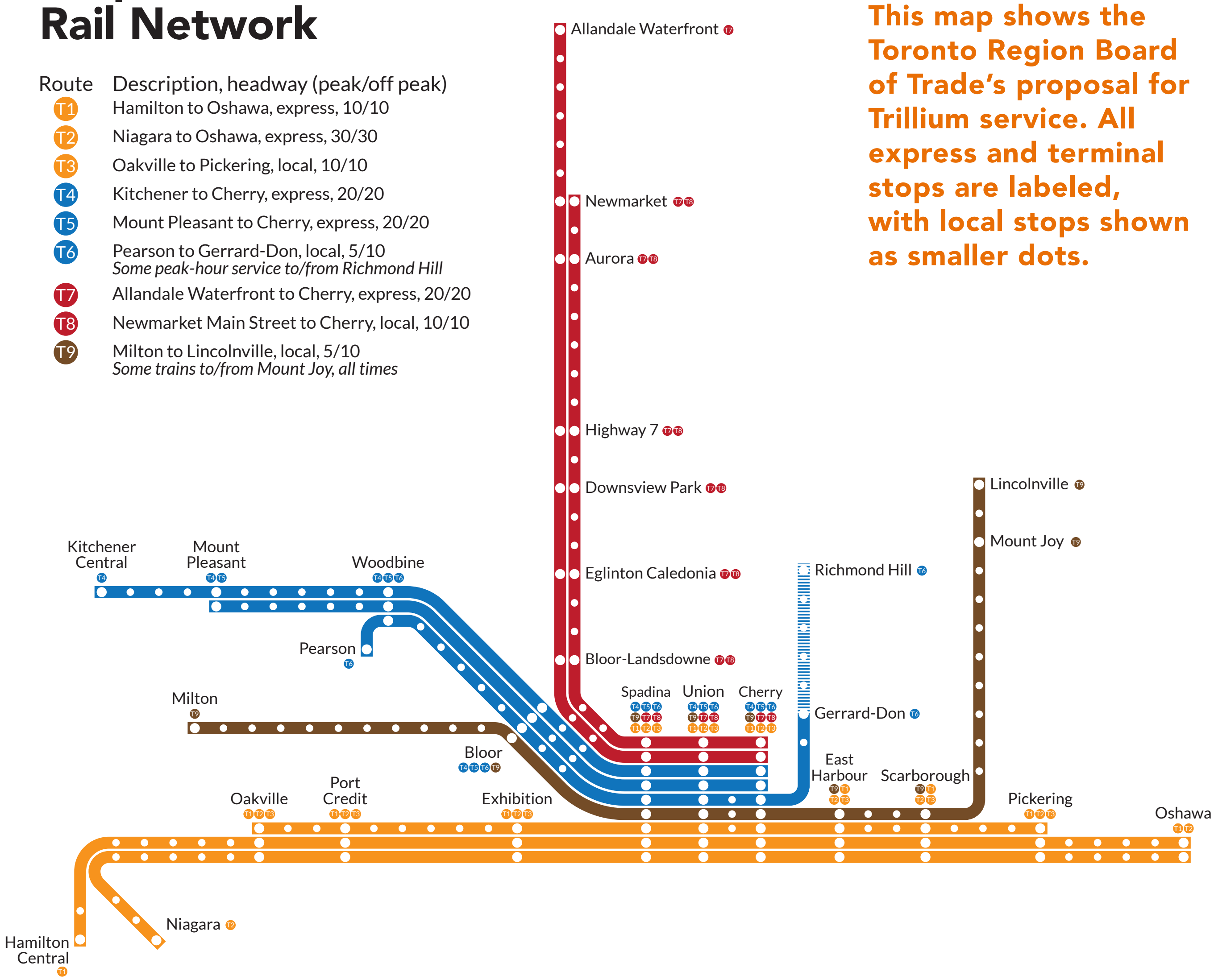
GO Transit is North America's greatest commuter rail success story. Since the Lakeshore Line opened in 1967 as an experiment to relieve congestion on the QEW, GO Transit has expanded into a vast network. Prior to the arrival of COVID-19, it transported tens of thousands of people every morning to their jobs in downtown Toronto and back again every evening. The growth of central Toronto as a global business centre would never have been possible without GO. The highways and subway lines feeding the downtown core have been at capacity for decades—the only added capacity has been on GO Transit.

As the Toronto Region prepares to enter a post-COVID world, a different model is needed for our region's rail network. At a time when many office workers are considering permanently shifting their work partially or fully to their homes, with as much as 25% of downtown commuters on GO anticipated not to return post-pandemic, the network's focus on traditional rush hour commuting may limit its recovery. Employment is changing. It is stronger than ever in many essential worker roles, such as health care and logistics, which tend to have work hours different from the traditional office peaks and work locations outside the downtown core. This means that the GO Transit customer is also changing. They are looking for travel options outside of the traditional commute. Now is the opportunity to make the policy decisions necessary to nudge customers away from their vehicles. Transit must, more than ever, become a truly all-day, anywhere-to-anywhere service, planned and designed around the needs of the customer. In other words, the GO network must become regional rail instead of commuter rail (see chart on page 6).

This report builds on proposals from the Board's previous report in this series *(Erasing the Invisible Line – Integrating the Toronto Region's Transit Networks)* and makes the case for the development of a regional rail network across the Toronto Region. By examining best practices already in use around the world, it explains guiding principles for the successful implementation of regional rail, and outlines a proposed **Trillium Regional Rail Network** for the Toronto Region.

## Proposed Trillium Rail Network

| Route | Description, headway (peak/off peak) |
|---|---|
| T1 | Hamilton to Oshawa, express, 10/10 |
| T2 | Niagara to Oshawa, express, 30/30 |
| T3 | Oakville to Pickering, local, 10/10 |
| T4 | Kitchener to Cherry, express, 20/20 |
| T5 | Mount Pleasant to Cherry, express, 20/20 |
| T6 | Pearson to Gerrard-Don, local, 5/10 *Some peak-hour service to/from Richmond Hill* |
| T7 | Allandale Waterfront to Cherry, express, 20/20 |
| T8 | Newmarket Main Street to Cherry, local, 10/10 |
| T9 | Milton to Lincolnville, local, 5/10 *Some trains to/from Mount Joy, all times* |




**This map shows the Toronto Region Board of Trade's proposal for Trillium service. All express and terminal stops are labeled, with local stops shown as smaller dots.**

| **Commuter Rail** (GO Transit) | **Regional Rail** (Berlin S-Bahn) |
|---|---|
| Focuses on relieving rush hour highway congestion by encouraging downtown-bound commuters to park at suburban rail stations and ride the train into the city. | Serves as a high-speed, high-capacity backbone to the local transit system, much like a subway. Most riders walk or use the bus to reach stations; heavily used for local trips with destinations widely dispersed across the region. |
| Uses nineteenth-century rail corridors shared in many cases with intercity and freight rail services. | Uses nineteenth-century rail corridors connected with more recent segments, shared in many cases with intercity and freight rail services. |
| Schedules heavily weighted to unidirectional rush hour service, with multiple trains per hour at rush hour, and every 30 to 60 minutes (or not at all) outside rush hour. | Consistent, frequent (generally every 15 minutes or better) service all day, every day. |
| Large trains designed for passengers to sit down and ride for long distances. | Trains designed for rapid loading and unloading, with many doors and room for both seated longer-distance riders and standing passengers making short trips. |
| Service operating largely independently of local transit, with some local bus feeder services. | Service closely integrated with local transit, with integrated fares and coordinated schedules designed for multimodal trips. |
| Auto-oriented stations with large park-and-ride lots. | Stations sited near major arterial roads to improve local transit connections, surrounded by high-density development, and closely spaced for pedestrian access in the core. |
| Lines radiating out from the downtown core, with trains emptying at downtown station and then going out of service or turning around at the main downtown station. | Lines running through the downtown core, with multiple downtown stations and trains turning at non-downtown stations. |
| Has premium fares. | Fares are fully integrated with local transit. |

# The Case for Regional Rail

Toronto is one of North America's most dynamic urban regions, with tens of thousands of residents and a wide array of businesses choosing to locate there every year. This growth, while welcome, places an increasing burden on the region's transportation infrastructure, with ever-longer commutes and severe congestion. The issue is twofold. While transit is well used within the City of Toronto, many riders suffer slow trips involving long bus journeys to distant subway transfers, or another bus. In the communities surrounding the City of Toronto, many residents are all but forced to drive to get to and from work and other destinations. Many live far from rapid transit stations, meaning long bus journeys if they want to use transit to go long distances. GO Transit provides excellent service for rush hour commuters to downtown Toronto, but it is far more limited for other trips. Notably, 92% of passengers travel to and from Toronto Pearson International Airport by car, as do a similar percentage of the 300,000 people who work within the airport employment zone (AEZ)—the second-largest concentration of employment in Canada. This is generating one million daily car trips, more than the number of trips made to downtown Toronto.[1] While GO's Kitchener corridor passes through the area, limited service means it is of limited utility for commuters to its tens of thousands of jobs. The resulting widespread car use at Pearson and at countless other regional activity centres helps make transportation a major contributor to noxious air pollution and greenhouse gas emissions in the region—a critical environmental and public health concern.

Mobility is about more than rush hour and a 9-5 commute into Toronto's central business district. Population and employment, both pre-and post-covid, have been trending towards growth in metropolitan areas. From 2019-2020, growth in Kitchener-Cambridge-Waterloo, Brampton, Barrie, Belleville, and Guelph, all outpaced Toronto, with Hamilton not far behind. Despite still showing overall positive population growth, primarily due to international migration, the Toronto CMA continued to see more people moving to other regions of Ontario than moving in—leading to a record loss of people as a result of these population movements. This effect was most pronounced for the City of Toronto, the largest municipality in the Toronto CMA. The City of Toronto's population growth from 2019 to 2020 was +0.8%, compared to +3.4% in neighbouring Brampton and +4.1% in Milton. Over the last year, Toronto has seen over 50,000 people leave the city to the outlying suburbs, and areas absorbing this growth include Oshawa, at 2.1% growth, and the Kitchener-Cambridge-Waterloo area, which saw 2% growth.

The Toronto Region as a whole will continue to see considerable overall growth in the coming years thanks to immigration, but that growth will continue to be disproportionately located in the outer part of the region—necessitating regional transportation solutions.

To add to the trend in growth outside of Toronto, employment trends are also shifting. More than 4 in 10 public transit users (42%) are currently teleworking. Most organizations foresee a future hybrid of remote work and maintaining a physical footprint; many are exploring higher employee to desk ratios, and some are considering decentralizing downtown offices and creating satellite or co-working spaces.

Will the work-from-home trend be sustained for Toronto's downtown core? Almost 70% of jobs downtown can reasonably be performed remotely. That equates to over 400,000 of 584,659 total downtown jobs that can be performed remotely (Strategic Regional Research Alliance, December 2020).

These trends point to a need to ensure that the focus of the transit network be not only on improving access to the city centre, but also on supporting movement to and from the outer ring to ensure that we are supporting the region's overall economic success and recovery.

Meanwhile, employment growth is stronger than ever in many essential worker roles, such as health care and logistics. Deloitte's January 2021 economic forecast indicated that health care and social assistance should see strong growth as the sector continues to battle the ongoing effects of the pandemic while beginning the vaccine rollout and, catching up on an unprecedented delay in non-critical procedures that were postponed during the height of the pandemic.

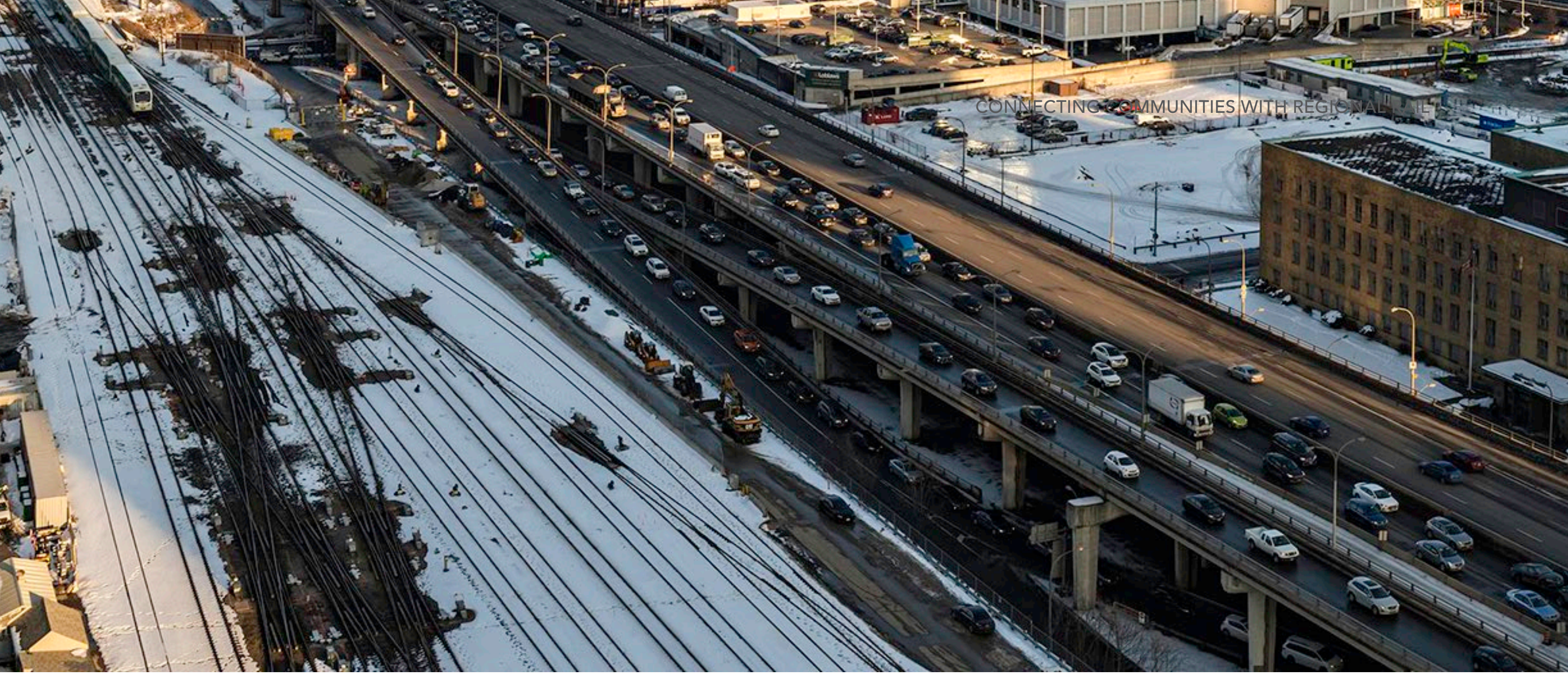
Many of these roles have non-traditional work hours or, in the case of logistics, have work locations focused outside of the downtown core (such as in employment zones near Pearson Airport).

In addition, one of the underlying drivers of productivity growth in the economy continues to be the density (or proximity) of economic activity—even post-COVID. Continued improvements in commuter rail service would continue to support this economic driver of the growth in living standards, especially at a time when productivity growth is at an all-time post-war low, and when the acceleration of the remote-work trend may undermine economic density.

To meet these challenges, the most effective and economical choice is to build a regional rail network. GO Transit is already planning a major expansion program that intends to dramatically increase service by providing two-way, all-day service throughout its network. It has already begun the process of shifting from a rush hour, downtown-focused operation into an anywhere-to-anywhere, anytime approach. Shifting to this more flexible service is a key element of regional rail, and this report builds on that vitally important work to highlight many equally critical global best practices that are essential to include for an effective implementation of regional rail.

### THE COST OF CONGESTION

Congestion has been estimated to cost the region $6 billion every single year in lost productivity. That figure is expected to grow to $15 billion by 2031.[2] Congestion limits the access of workers to jobs, and contributes to the inaccessibility of affordable housing in the region—a growing crisis that particularly affects essential workers.[3] It also disrupts supply chains and prevents workers from reliably making and receiving deliveries, harming the competitiveness of Toronto region businesses. Only transit can add sufficient capacity to meet the



region's growing needs. One regional rail line can move five times as many people as another Gardiner Expressway—if it were even possible to build another expressway. Meaningfully addressing the regional problem of congestion requires a regionally scaled solution.

The movement of goods, which is critical to the region's economy, is being increasingly hampered by severe congestion. The area around the airport is Canada's largest logistics and distribution centre, and it is home to the region's main intermodal rail hubs. However, trucks find it increasingly difficult to get to their destinations because the area's highways are at a crawl for much of the day. Regional rail can get thousands of cars off the Highway 401, freeing up space for the trucks that keep our economy moving and help bring our exports to market.

### REDUCING EMISSIONS

Automobile transportation is responsible for nearly a third of all greenhouse gas emissions in the City of Toronto.[4] Reducing these emissions will be essential if Toronto is to reach its goal of net zero emissions by 2050 or sooner.  Vehicular emissions are also responsible for air pollution that has a serious impact on health—particularly for those with respiratory health vulnerabilities. Air pollution from vehicles is estimated to be responsible for about 280 deaths and 1,090 hospitalizations every year in the City of Toronto alone.[5] PM2.5 particulate emissions, many of which come from vehicles, have even been linked to COVID-19 morbidity. Regional rail will provide a greener alternative for travel than a single occupancy vehicle.

**One regional rail line can move five times as many people as another Gardiner Expressway.**

**Air pollution from vehicles is estimated to be responsible for about**

**280 deaths + 1,090 hospitalizations**

**every year in Toronto.**

## A regional rail system based on global best practice operations could move over 300,000 people per hour into the core—compared with 30,000 per hour on the Yonge subway.

### A REGION-WIDE RAPID TRANSIT NETWORK THAT LEVERAGES OUR INFRASTRUCTURE LEGACY

The Toronto Region is already blessed with a legacy of rail corridors that radiate in all directions from the urban core. Well over a century old, they form the backbone of GO Transit's 450-km network and connect to all points of the region. Building such an expansive network from scratch today would be all but impossible, requiring a half-dozen tunnels across the city. At the Ontario Line's projected cost of about $750 million per kilometre, recreating GO's network would be a $337.5 billion expenditure.

Not every city in the world is endowed with a network of corridors as complete as Toronto's. In many European cities, like Paris and London, enormous megaprojects were needed to link disconnected corridors that fed different downtown rail termini to create a cross-city network. In Toronto, that work is already done. After decades and billions of dollars of investment, Paris will soon have created cross-city corridors totalling eight tracks. On those eight tracks, the RER moves millions of riders per day—more than ten times as many as use the GO network.

The Toronto region, with ten cross-downtown tracks, is already ahead of Paris. Without needing to build a single subway tunnel or elevated line, Toronto's rail network—using global best practice standards of operation—could move as many people as could conceivably be needed in the Toronto Region. A regional rail system based on global best practice operations could move over 300,000 people per hour into the core*—compared with 30,000 per hour on the Yonge subway—all without needing to build expensive tunnels or other major infrastructure. The rail network is the Toronto Region's greatest underused resource—one that needs to be tapped if this will continue to be the fastest-growing urban region in North America.

### PLANNING IMPROVED RAIL IN THE TORONTO REGION

Plans for two-way, all-day service on the GO network were included in The Big Move, a 2008 plan (updated several times) that laid out Metrolinx's long-term plans.[6] Subsequent studies have also built on the concept, such as the Neptis Foundation's 2013 review of Metrolinx's plans.[7] All of them called for taking advantage of the impressive radial rail network in the Toronto region to expand frequent transit service. Metrolinx and Infrastructure Ontario are currently

*Based on a service pattern of 12 trains per hour on Kitchener, Lakeshore, Stouffville, and Milton corridors and 6 trains per hour on other corridors, *using Paris RER MI09 rolling stock of the same length as existing GO trains. At 12 trains per hour, the trains would have a capacity of nearly 47,000 passengers per hour per direction. At the intensity of operations and station design typical of European or Japanese operations, ultimate capacity on the ten-track downtown corridor would increase to as much as one million people, per hour, per direction, compared with GO Transit's pre-COVID total rail ridership of 215,000 per day.

undertaking several procurements to deliver major expansion of GO rail service. Organizations in other North American cities, like 5th Square in Philadelphia and TransitMatters in Boston, have also been advocating for regional rail in their communities.

The City of Toronto's SmartTrack plan builds on these efforts with its aim of fully integrating part of the Stouffville, Lakeshore, and Kitchener corridors into the local TTC transit with frequent, rapid transit service. This means that riders would pay the same fare as the TTC, including free transfers from bus, subway, and streetcars to the new SmartTrack trains. It also means redesigning bus routes where necessary to bring passengers to the stations, as is the case on the subway, and it means additional stations to facilitate those connections and to serve key urban nodes. SmartTrack is an important step toward realizing regional rail, and this report is intended to build on the city's and province's plans, highlighting globally proven practices to aid in their implementation. It calls for implementing and going beyond two-way, all-day GO service to true electrified regional rail.

This report also builds on the Board's call for a fully integrated regional transit system in its recent playbook Shaping Our Future, which examines the need for key investments to support the region's economic recovery.[8] Regional rail also offers the potential to truly knit together the Innovation Corridor into a globally competitive technology region, emulating the efforts currently being made to transform Caltrain in Silicon Valley into a regional rail system.[9]

The Board has strongly supported the work of the Connect the Corridor organization, which has long been advocating for the infrastructure upgrades needed to enable two-way, all-day service on the Kitchener corridor without impeding CN freight traffic.

Regional rail is popular, too. In polling by CTC, 80% of Ontario residents indicated that they supported two-way, all-day GO service in the Kitchener corridor, and a majority said that they would use it.[10]

Toronto was the only city in North America to increase transit ridership between 1946 and 1970, in large part because transit was provided at the same time new developments were built. Regional rail offers the potential to repeat this success. Realizing the promise of regional rail entails expanding the integrated and frequent service model proposed in SmartTrack plans to the entire region. Unlocking the network's capacity could yield massive benefits at reasonable cost.

There is an opportunity for all regional transit partners to come together and agree on a common framework for integrated transit. The environmental and regional economic imperative is strong, and it is time to revisit the work that was started by the City of Toronto and Metrolinx.

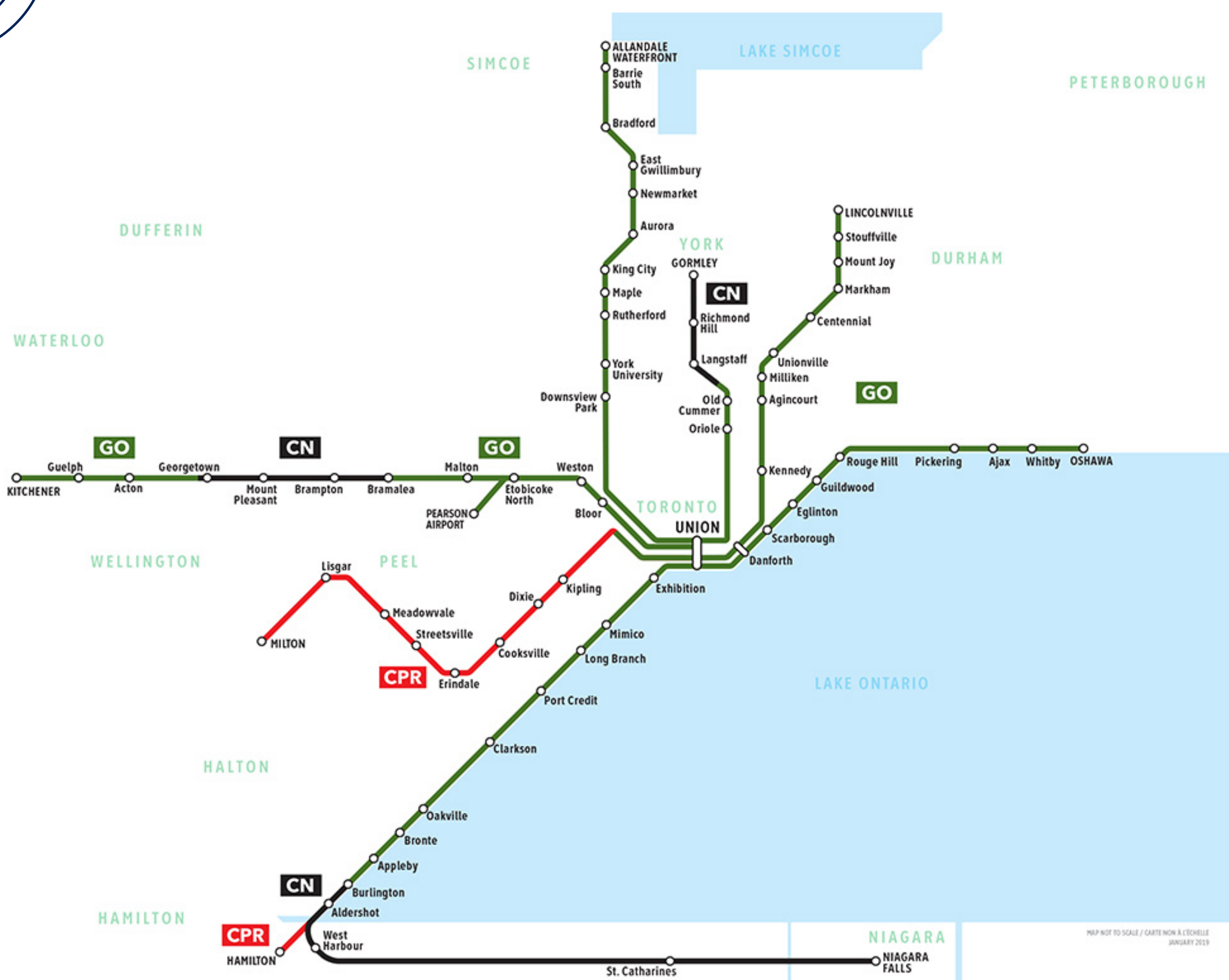
### USING INFRASTRUCTURE MORE EFFICIENTLY

The TTC operates its subways with trains arriving and departing better than every five minutes all day. Yet the Kitchener and Stouffville corridors, which have more potential capacity than any subway—due to longer trains, and in the case of Kitchener, a greater number of tracks—run infrequently, with trains coming once an hour or less outside rush hour. This is not by merit of their surroundings—they pass through areas of similar density to the subway and cross many busy bus and streetcar routes. On a few segments—mainly the Milton corridor, the Kitchener corridor between Bramalea and Georgetown, and the Lakeshore West corridor in the City of Hamilton—GO shares tracks with critically important freight traffic that must also be prioritized. The remaining portions of the network, however—including the Lakeshore corridor between Burlington and Oshawa, the Kitchener corridor from Union to Bramalea, and the entire Stouffville and Barrie corridors — are already owned by Metrolinx and have limited freight traffic. Fundamentally, the limited service on these lines is a choice. These routes have as much potential as any subway, but subway-level demand will only materialize if their service levels and fares are made comparable to local transit.

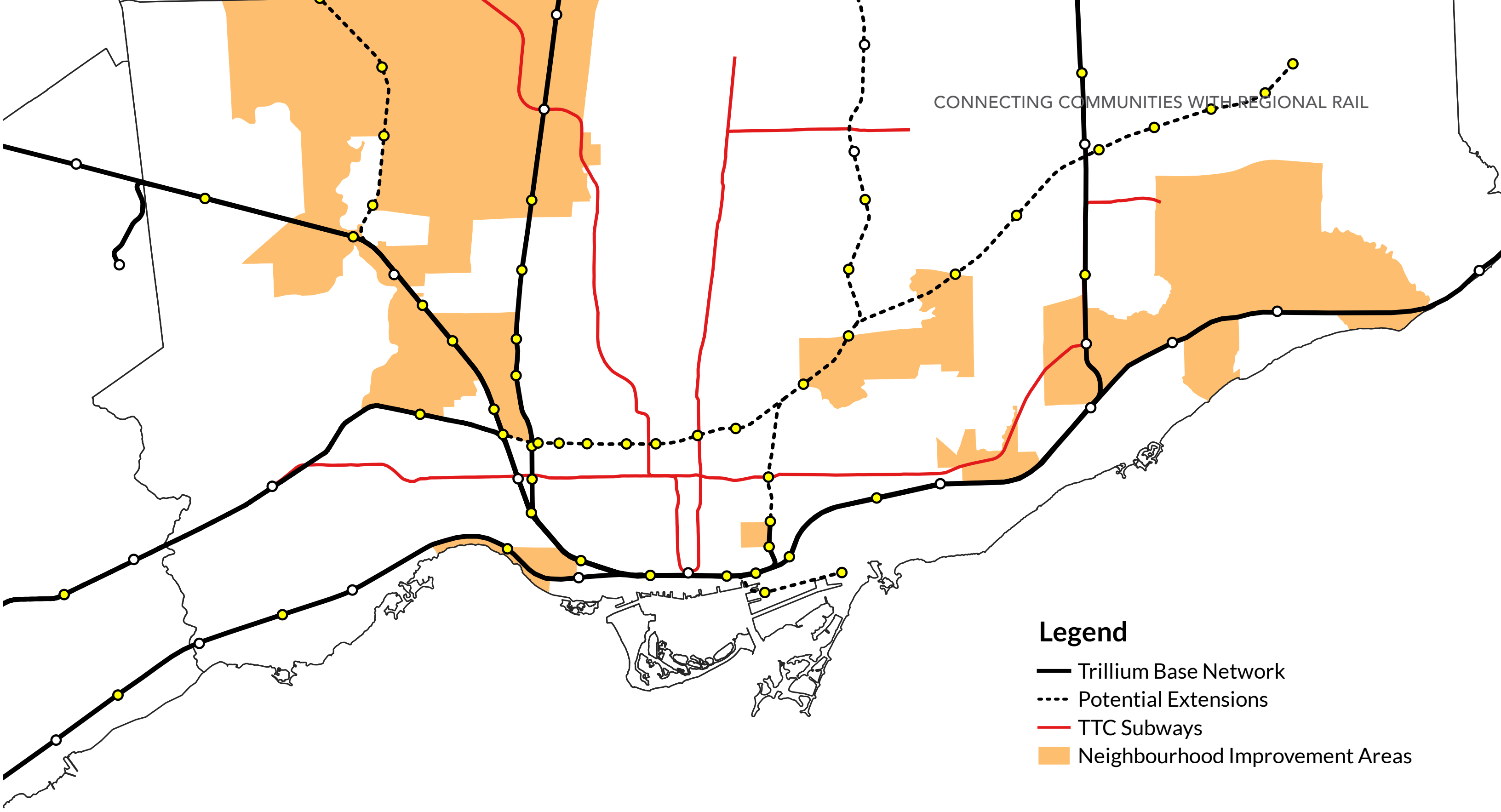
This neglected integration and limited service amounts to an incredibly inefficient use of billions of dollars of infrastructure. Hundreds of train cars and invaluable trackage sit idle for all but a few hours of the day, five days per week, while carrying loads artificially depressed by fare policy. The limited market that this service addresses also reduces potential revenue. Commuter rail, while ostensibly highly efficient by focusing only on the highest-density markets, comes at significant efficiency and broader economic costs when compared to regional rail.

Regional rail can serve as a cost-effective means to extend the reach of rapid transit throughout the Toronto Region. Torontonians have long lamented the comparatively limited extent of their city's subway network compared to many of Toronto's peer cities around the world. Considering the cost of recent subway construction projects, it would never be possible to afford the comprehensive networks found in cities like Paris, London, Madrid, Shenzhen, Seoul, or Beijing, all of which have hundreds of kilometres of routes compared to Toronto's more modest 76 kilometres. With regional rail, however, it would be possible to add hundreds of kilometres to Toronto's rapid transit network—without needing to dig a single tunnel.

**The Lakeshore corridor between Burlington and Oshawa, the Kitchener corridor from Union to Bramalea, and the entire Stouffville and Barrie corridors, are already owned by Metrolinx.**




The current ownership of rail corridors in the region. (Source: Metrolinx)




The regional rail network is especially effective at improving transit to equity-seeking communities, like the City of Toronto's designated Neighbourhood Improvement Areas.

## IMPROVING ACCESS TO OPPORTUNITY FOR EQUITY-SEEKING COMMUNITIES

Many of the areas that would enjoy improved service through regional rail are home to substantial equity-seeking communities. Regional rail could bring high-speed rapid transit to northwest Etobicoke, north Scarborough, east Scarborough, Weston, to name only a few. For example, instead of needing to ride the bus all the way from Malvern to the overcrowded Yonge subway to get downtown, Scarborough residents could take a short bus ride to the Stouffville corridor, which would save them as much as 80 minutes on a round-trip downtown. It isn't just about downtown, either. Frequent bidirectional service makes it possible to use regional rail for non-downtown trips. A resident of Weston could get to work in the large industrial employment centres of Brampton in under 20 minutes. As the Board's recent research on the prohibitive cost of housing for essential workers has demonstrated, a community service worker earning a salary of $50,000 could only afford to rent a 1-bedroom unit in Long Branch, Keelesdale-Eglinton West, or Rexdale-Kipling—all areas that are difficult to access by existing local transit but that would be directly served by regional rail.[11] Currently, the score for transit service and accessibility in high-income areas of the city is almost four times higher than low-income ones.[12] The radically improved access afforded by regional rail would be life-changing for residents of the region who currently struggle to get to their jobs and to other services.

**Frequent bidirectional service makes it possible to use regional rail for non-downtown trips and to choose travel times that are less congested.**

## By knitting together the region's patchwork of local transit systems, regional rail can quickly and cheaply improve their efficiency and increase their ridership.

### CONNECTING BUSINESS DISTRICTS ACROSS THE REGION

While commuter service currently effectively serves commuters to downtown Toronto, the area represents about 16% of the region's nearly 3.5 million jobs. The Board's regional recovery playbook, *Shaping Our Future*, introduced a business districts framework that spatially organizes economic activities in the region into five types of business districts that capture nearly 75% of the jobs in the region, including goods production and distribution districts, as well as regional centres. These districts are defined by similar types of economic activity, workforce profiles, and infrastructure needs. As the region recovers from the pandemic, improving connectivity to its business districts is critical. Regional rail is particularly effective for serving commutes to regional centres, which are home to 208,000 jobs, like Mississauga Centre and the downtowns of Brampton, Hamilton, Oakville, Burlington, Oshawa, Guelph, and Kitchener—all of which are proximate to a regional rail station.[13]

### KNITTING TOGETHER THE REGION'S LOCAL TRANSIT

Regional rail is not just about regional trips. With additional stations, frequent trains, and connections to local transit, it can function as a kind of local subway within cities across the region. By knitting together the region's patchwork of local transit systems, regional rail can quickly and cheaply improve their efficiency and increase their ridership. In Mississauga, for example, the Lakeshore and Milton lines could work like east-west subways, enabling people to get from Cooksville to Meadowvale in a matter of minutes. Regional rail stations could be fed by local bus routes just as the subway is in Toronto. Similarly, regional rail on the Kitchener corridor could allow Brampton transit riders to get from Mount Pleasant to Bramalea station in only 15 minutes, rather than an hour on the bus. In less than 15 minutes, a Hamilton resident could use regional rail to get from Stoney Creek to downtown, or a resident of Mount Joy in Markham could reach Downtown Markham. In Durham and Halton Regions, the Lakeshore corridor is a perfectly located rapid transit route. With frequent service and fare integration, regional rail could dramatically shorten travel times, increase capacity, support major employment development at stations, and improve the efficiency of bus operations by increasing rider turnover.

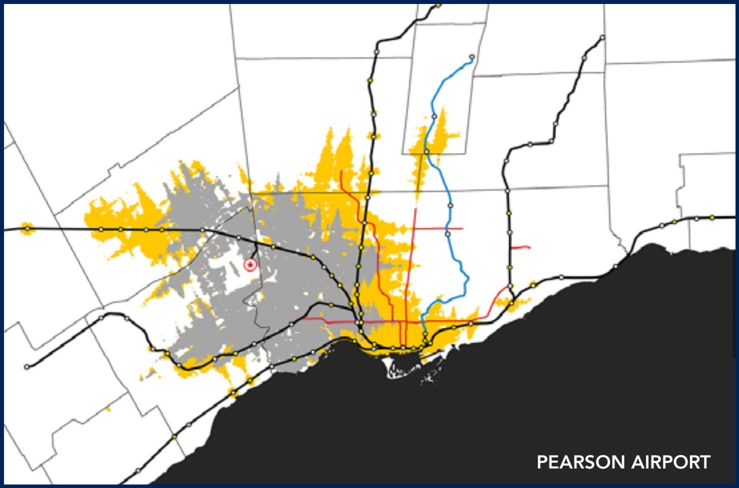
## A vastly greater area can be reached within a reasonable commute time when regional rail service is introduced. This is true as much from Pearson Airport, Downtown Brampton, or Downtown Markham as it is from Union Station.

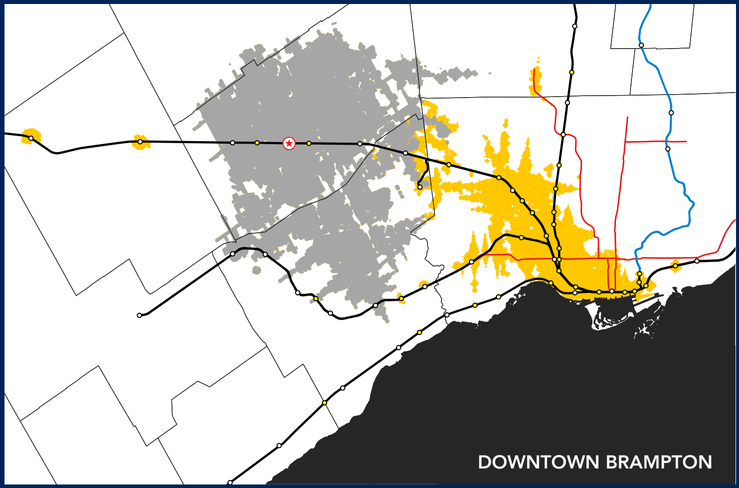
**Areas Within 60 Mins of Origin Point**

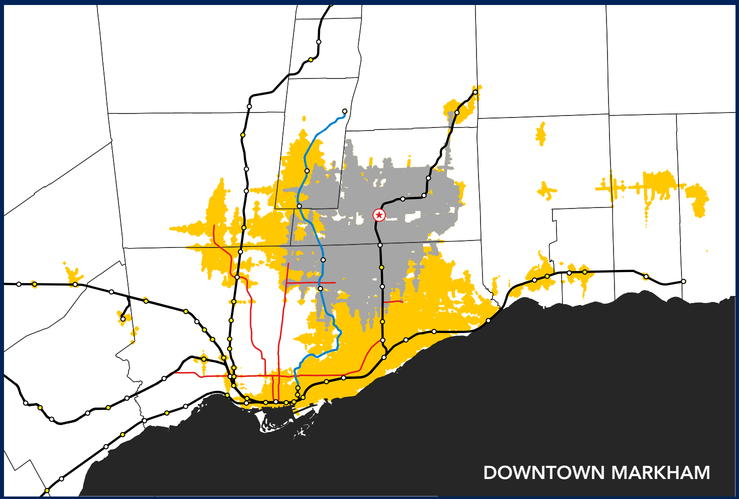
- With Exisiting Local Transit
- With Existing Local Transit + Trillium + GO Bus

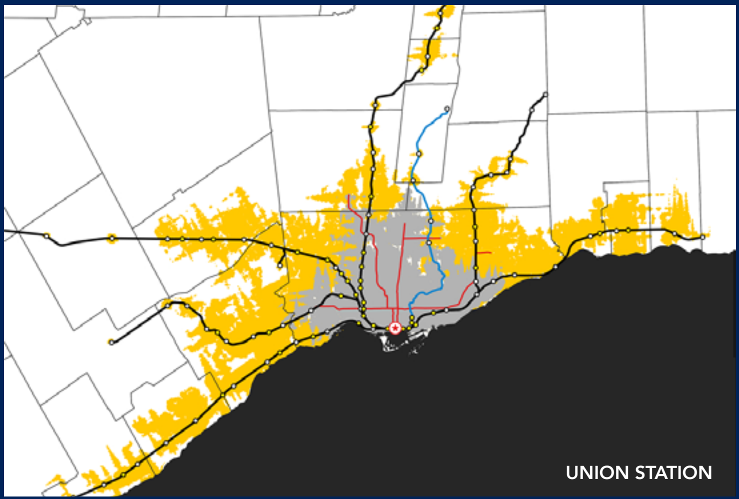
**Legend**

- Origin Point
- Trillium Base Network
- Peak-Only Corridors
- TTC Subways



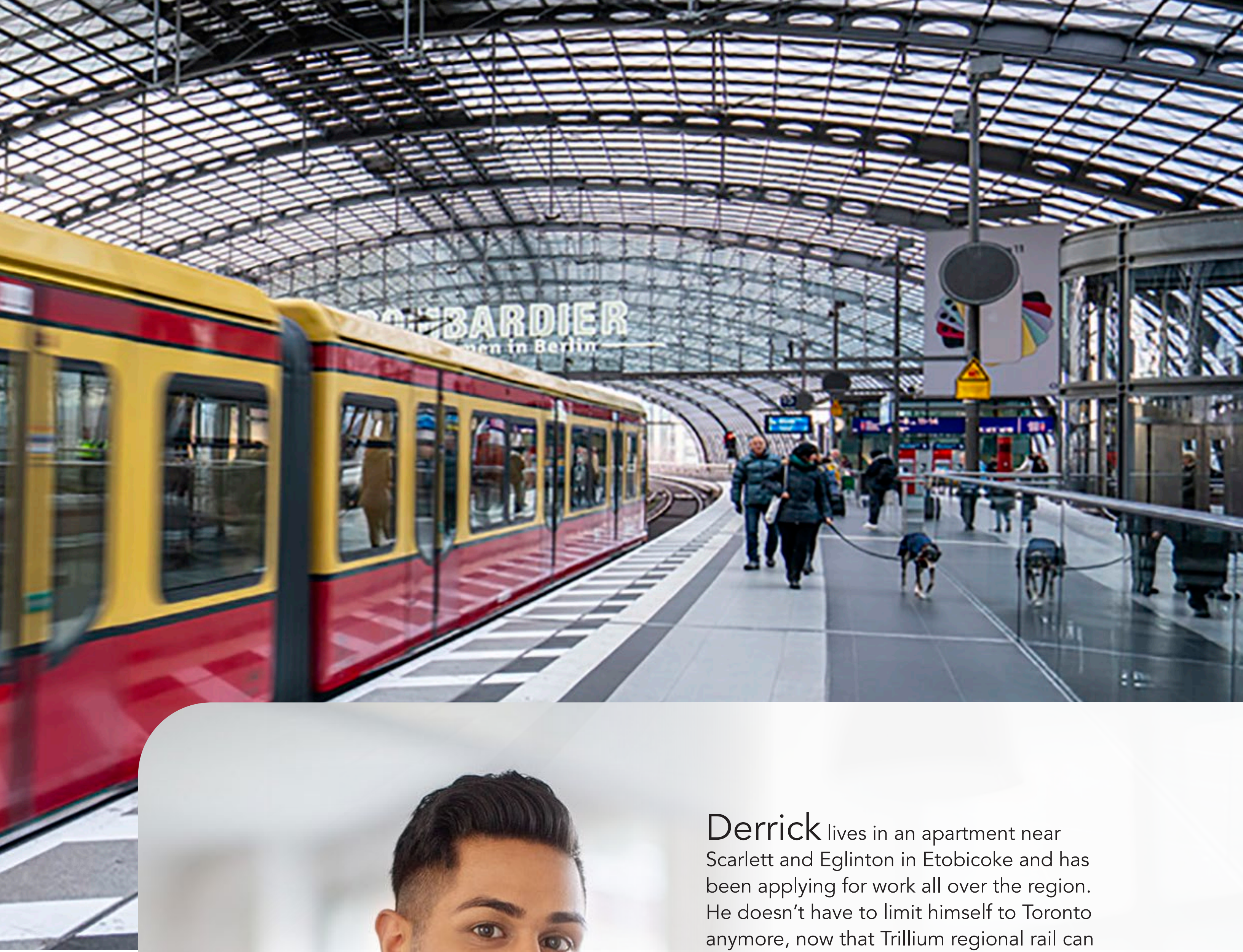



### PROVIDING A FOUNDATION FOR FUTURE GROWTH

Looking to the future, regional rail provides an infrastructure upon which the network can grow even more. Whether it be adapting other rail corridors to create crosstown lines, or building short spurs or diversions into growing regional hubs, the expansiveness and flexibility of regional rail enables small, incremental additions to bring high-quality service to new markets, eliminating the need to build entirely new lines.

Regional rail is an essential investment in Toronto's future. Fast, frequent, zero-emissions trains running entirely on existing corridors have the potential to radically transform the reach and experience of transit in the region, speeding existing trips and making possible countless trips that were previously impossible. Integrated with local transit and running at high frequencies, regional rail could become the backbone of a truly unified regional transit network.



Derrick lives in an apartment near Scarlett and Eglinton in Etobicoke and has been applying for work all over the region. He doesn't have to limit himself to Toronto anymore, now that Trillium regional rail can quickly and affordably take him anywhere he needs to go. He just got offered a job at a distribution centre in Brampton. In the past, that would have meant an hour-and-a-half trip on four local buses—and a double fare. With Trillium, he takes the Eglinton Crosstown West LRT for two minutes to Mount Dennis Station, rides the Trillium train for less than 20 minutes to Bramalea Station, and then takes a quick trip on the bus to his new job.

Less than 45 minutes in all—and thanks to fare integration, he can do it all on a single fare.

*The vignette characters illustrate the struggles of commuters, and are formed based on real life examples

# Implementing a Regional Rail Network

**Each aspect of the system fundamentally affects every other aspect, so nothing can be designed in isolation**

Key to planning a successful and cost-effective regional rail network is the treatment of the network as an integrated whole. Each aspect of the system fundamentally affects every other aspect, so nothing can be designed in isolation. The performance characteristics (particularly braking and acceleration) and capacity of trains (rolling stock) determines how much track capacity will be required, how much electrical infrastructure will be needed, the weights for which infrastructure like bridges and overpasses must be designed, and how stations should be designed. Conversely, station design determines the choice of rolling stock—if the main station has small platforms and narrow access points, smaller but more frequent trains are likely a better approach than large trains. These are only a small number of ways that different aspects of the infrastructure affect each other, necessitating integrated planning.

## START WITH A TIMETABLE

For these reasons, best-practice major global regional rail infrastructure projects start with designing the timetable that will be expected to operate when the project is completed—before a single shovel of dirt is turned. This is not simply a service plan indicating basic service patterns and frequencies. It is a detailed timetable—European regional rail planners know a decade in advance which trains will be departing at 7:15, 7:18, 7:21, et cetera. Such a plan includes precise performance characteristics of the trains to be operated, as well as projected crowding (which governs station dwell times). Designing infrastructure without a detailed projected timetable that incorporates a full and integrated understanding of all aspects of the planned operation is a recipe for overbuilding—potentially wasting billions of dollars on unnecessary infrastructure.

There are many examples of infrastructure that have needed to be rebuilt when they were not designed as part of a comprehensive operations plan, including in the Toronto Region. This is particularly important in the context of regional rail, which requires complex integration with other network users, like freight rail, VIA Rail, and connecting transit agencies. West Harbour GO Station in Hamilton, for example, was built on the south side of the corridor, even though that meant that GO trains therefore need to cross the path of CN freight trains running to Niagara. Platforms on the north side would have made that unnecessary. Downsview Park station has been designed to accommodate a third express track bypassing the platforms, even though service plans indicate that it will be served by both express and local trains. At Bronte station, a station access building and ramp were recently built directly in the path of a fourth track, which would be necessary for frequent express and local service. Most importantly, Union Station was recently rebuilt without changing the original layout from the 1920s. Its layout included every second platform being very narrow since it was designed for loading and unloading sacks of mail from long distance trains. These platforms are now being used by thousands of passengers on GO Trains. The original layout was retained rather than rebuilding on a new layout optimized for frequent, high-capacity regional service. These kinds of unnecessary expenditures can be avoided when a comprehensive infrastructure plan, guided by a detailed operations plan, is created before infrastructure is built.

Corazon lives in Scarborough and works just west of the Financial District near Front and Spadina. Before Trillium, she took the bus to the RT to the Bloor-Danforth subway to the Yonge subway before walking from the subway to her office. It was a one hour and twenty minute trip, and every day she struggled to squeeze onto the Yonge subway transferring at Yonge-Bloor station—a situation that made her consider buying a car after the pandemic. GO trains were never an option because of the double fare with TTC and the lack of schedule options. Now, she can ride Trillium for the same fare as TTC, get downtown in half the time, and she doesn't have to worry about the overcrowded subway anymore.

Even better, she can get off at the brand new Spadina stop, so she doesn't have to worry about the crowds at Union (and she always gets a seat on the way home!).

## ORGANIZATION BEFORE TECHNOLOGY BEFORE CONCRETE

The German-speaking world has propounded the planning and engineering doctrine of "organization before technology before concrete." The highest priority is to resolve issues of organization, which includes factors like fare and service integration between agencies. Then, technology, such as better signalling systems and rolling stock, should be improved. The last priority is the building of new infrastructure, like additional tracks and grade separations on corridors. This prioritization provides the most economically efficient means of improving service and capacity on a network.

So, the first task when planning a major infrastructure project is to develop a clear understanding of how the project will be integrated into the broader transit network and how it can be operated more efficiently by adjusting operating practices. The second step is to invest in technology where appropriate—using advanced signalling systems and higher-performance rolling stock to squeeze more capacity out of existing infrastructure. Then, only when necessary, new physical infrastructure should be built.

This approach requires a willingness to make important decisions about service and technology upfront, rather than delaying them to future phases. The need for specific infrastructure investments and their knock-on effects on service can therefore be carefully evaluated and their need assessed. For example, large expenditure on grade separating road-rail crossings may not be needed at minor roads, as they may offer minimal benefit for the overall network. On the other hand, retaining obsolete rolling stock may require far more expensive or duplicate infrastructure, more than negating any cost savings from delaying the purchasing of replacements.

Developing a comprehensive timetable for a system as large and complex as Trillium may be challenging. That is why it may make sense to build one corridor at a time, enabling challenges to be uncovered and lowering overall project risk.

**Develop overall service plan**
**1**

**Develop a timetable incorporating rolling stock characteristics, station constraints, corridor constraints**
**2**

**Develop an infrastructure plan**
**3**

**Begin detailed design and construction**
**4**

Wanda just got a job at the newly reopened GM plant in Oshawa, and she has bought a condo in the new development on the old parking lots at Pickering station—they're not needed anymore now that most riders get to the train on the fare-integrated bus. Before, that trip on local transit took an hour and ten minutes. With Trillium, she can get to Oshawa Station in under 20 minutes, and then it's just a short bus ride to the plant. Many of her coworkers choose to take Trillium to work too, taking hundreds of cars off the 401 every day.

Trillium eases congestion on the 401 and reduces vehicle emissions.

## GUIDING PRINCIPLES

Drawing from international best practices, it is possible to demonstrate five guiding principles that form part of successful implementations of regional rail. Based on these principles, it is possible to design a network and operations plan for the Toronto Region.

### 1 Two-way, All-day Service

The majority of trips in any region—even work trips—do not involve the downtown core and do not take place at rush hour. A service plan that provides service all day, every day is essential if a regional rail system is to become a core part of the regional transit network.

### 2 High Frequency (turn up and go)

Research by Transport for London indicates that riders on routes with a frequency of 12 minutes or less will not need to consult a schedule and can instead simply "turn up and go." This level of service has been demonstrated to drive major increases in ridership. Frequency is even more important when making connections because wait times can multiply when a trip involves several connecting segments, and a missed connection could result in an unacceptable delay.

### 3 Seamless Integration with Local Transit

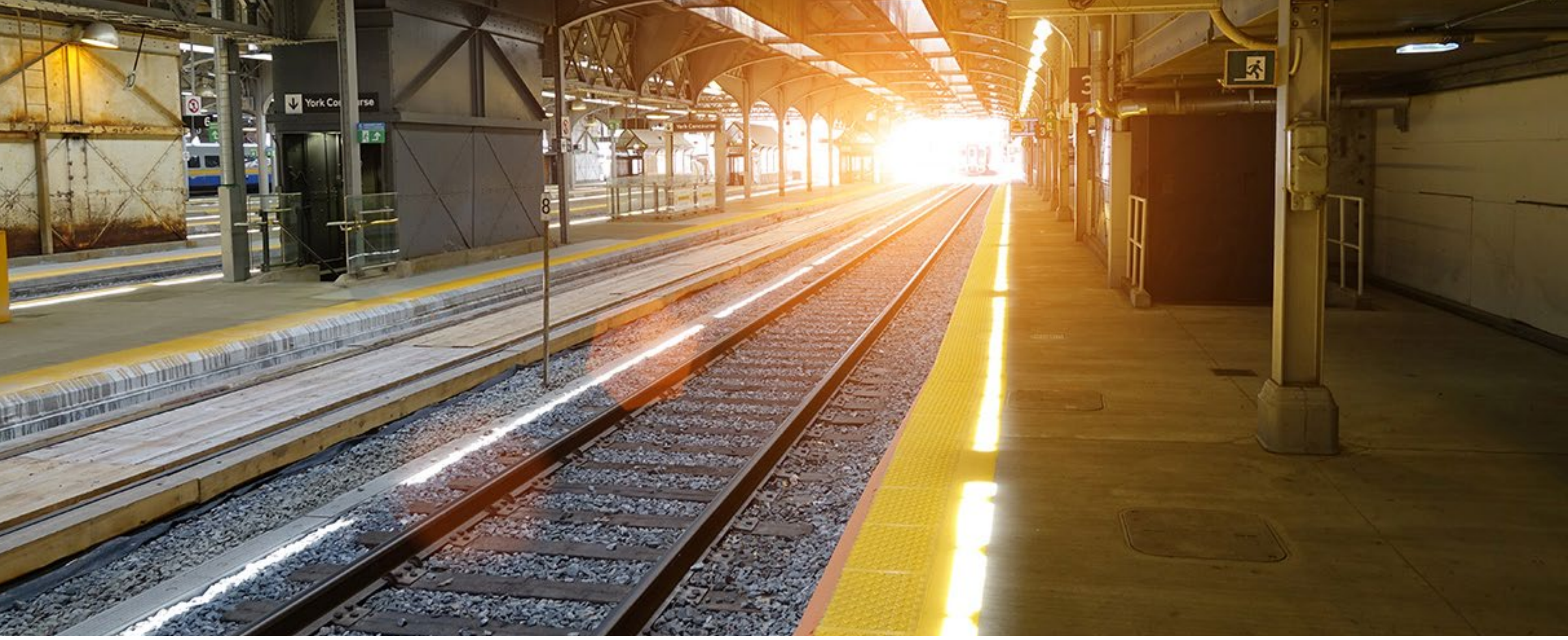
On a busy commuter rail service like GO Transit, park-and-ride lots fill up early in the morning. That makes them effectively useless for mid-day travellers. For two-way, all-day service, there needs to be another way to access the station. Transit-oriented development can play a role—and provides a major opportunity for recovery of regional rail investment—but as the TTC subway demonstrates, the most effective way to deliver large numbers of riders is by seamlessly integrating rail with local bus and streetcar services. That means fully integrated fares—a transfer is an inconvenience, so you should not have to pay more for it. It also means having bus routes designed to connect with stations, additional rail stations to connect with busy surface corridors, and schedules with timed transfers where necessary. The objective is to create the equivalent of a subway backbone for the whole region, serving local trips as much as long-haul. By being a backbone of a broader transit network, regional rail does not just serve residents of neighbourhoods adjacent to stations—it serves everyone in the region.

### 4 Focus on Equity

Planning should intend to prioritize improved access to employment opportunities and services for equity-seeking communities. This means reducing travel times, locating additional stations where they would serve communities like the City of Toronto's Neighbourhood Improvement Areas, and ensuring that fares are not prohibitively expensive. Transit must function as an integrated network, particularly for those who rely on it for all their trips—so it is imperative that no transit mode be deemed "premium."

### 5 Integration with Regional Planning

With its region-wide extent and high level of service, regional rail should become a centrepiece of regional planning. In Copenhagen, for example, all substantial office developments must be located within walking distance of a rail station.[13] This would not be possible today in Toronto, given the limited size of the existing rapid transit network, but it could be possible with regional rail. Greenfield suburban developments could be designed around rail stations, creating "15-minute communities"[14] oriented to walking and cycling, rather than following the traditional auto-oriented pattern centred on concession road blocks. Regional rail is the most feasible path to a truly transit-oriented region.



# Applying Best Practices

## The Trillium Regional Rail Network

Using the guiding principles outlined in this report, and based on global best practices, we propose the development of a Trillium Regional Rail Network to serve the Toronto Region. Trillium is comprised of a base network of four lines and nine services, serving the Lakeshore, Stouffville, Kitchener, and Barrie corridors with all-day electrified service. If an agreement with Canadian Pacific is possible, the Milton corridor would also be included. Nearly all stations in this base network will see service every 10 minutes or better all day, with a mix of express and local trains rapidly linking them to the rest of the region. Through close integration with local transit, Trillium will radically increase transit accessibility in the Toronto Region, bringing people closer together.

To support this vision for high-quality regional rail, we believe it necessary to make a number of strategic investments in the network:

- Writing a final system timetable for the Trillium network, which can serve as a guidebook for investments in infrastructure necessary to achieve it.
- Electrifying all line segments in the All-Day Trillium Base Network to support high-capacity, high-speed operations across the entire system.
- Reimagining Union Station with fewer tracks and fewer, but wider, platforms to facilitate circulation, and minimize train dwell times.
- Replacing the current GO Transit diesel bilevel fleet with modern electric trains capable of higher speeds and faster acceleration.
- Making targeted investments in track, signal, and yard infrastructure to support higher capacity, higher reliability operations with fewer conflicts between trains.
- Adding infill stations to facilitate Trillium's integration with local transit, and to support transit-oriented development.
- A targeted study to understand what will draw Toronto area customers to regional rail, and to enable broader planning for how to incorporate regional rail into the broader economic structure.

Together, these investments will pave the way for the implementation of a transformative, yet affordable, expansion of transit service across the Toronto Region.

## THE TRILLIUM REGIONAL RAIL PLAN

1. **Service Plan**
   Trillium will offer service on its corridors at least every 10 minutes, all day, every day, so riders can be certain that they will be able to show up at the station and catch a train whenever they need to. On the busiest corridors, particularly through densely populated areas closer to the core, service could be as much as every five minutes, ensuring adequate capacity that mirrors the subway level of service. For longer distance trips, such as to Barrie, Hamilton/Niagara, and Kitchener, express service will be provided to ensure time-competitive journeys. Thanks to electrification, modern multiple-unit trains, and increased reliability, travel times on the local services will be considerably faster than today. On express services travel times will be geared to meet or beat driving times. Corridors on either side of the region will be paired so that trains can run through, enabling cross-region journeys while eliminating the need for trains to occupy scarce space at Union as they turn around. They will be given simple numerical route names, like the subway, to improve simplicity and accessibility for riders. The service plan is designed to be customer-focused, and designed to seamlessly integrate with other modes, including local transit and new mobility technologies. It will serve key urban centres across the region, as well as offer direct frequent service to Pearson International Airport.

2. **Rolling Stock**
   Trillium will use proven, off-the-shelf electric multiple-unit trains currently operated by regional rail services in Europe or Asia. There is a wide variety of train suppliers who produce suitable trains, including Alstom/Bombardier and Siemens, who already produce trains for the Canadian market. The trains will be designed to provide adequate seating for long-distance travellers but will be optimized for frequent turnover like the subway. This means that they will have at least three sets of doors on each side of a car, and they will be designed to maximize internal circulation, potentially through single-level design where possible. They will be similar in length to existing GO trains, but even if they have lower capacity per train, they will more than make up for that with considerably increased frequency. Stations will have platforms that are level with train doors to enable easy and wheelchair-accessible loading and unloading. All corridors are to be electrified wherever possible, while ensuring full compatibility with freight service. Trains operating on relatively short non-electrified segments could use rapidly advancing battery technology.

3. **Fare Policy**
   Trillium will be fully integrated with local transit, enabling riders to use it as a part of their seamless journey including buses, subways, and LRT. This is outlined in the previous Toronto Region Board of Trade report on fare and service integration, *Erasing the Invisible Line*. A rider can begin their journey on a Brampton Transit bus, ride to the nearest Trillium station, catch a train to Eglinton, and ride the Eglinton Crosstown LRT to their final destination at Yonge and Eglinton, paying a fare based on the distance they are travelling rather than one based on the number of agencies they used. Residents within the City of Toronto can use the Trillium service for the same fare that they pay for the TTC.

4. **Union Station**
   Union Station will be converted from a traditional intercity station to an urban regional rail station, with fewer but much wider, safer, and more comfortable platforms designed to enable riders to wait for their trains on the platform. Dwell times will be further reduced, increasing capacity, by providing wide staircases that enable the rapid clearing of a platform after a train arrives. Union Station will take advantage of the new access points available through the construction of the York and Bay concourses. Each train route will arrive at the same platform every time, so riders know exactly where they need to go. The service pattern will be designed to eliminate capacity-killing conflicts between corridors.

# Trillium in Depth

## Technical Details

There are many successful operators of regional rail around the world, and over decades they have developed proven technologies and techniques from which the Toronto Region can draw , recognizing the complexity of adapting approaches to local circumstances and the important work that is already underway in this area.

### BRANDING: WHY TRILLIUM?

The GO Expansion project, despite its unmatched potential to transform travel within the Toronto Region, has long fallen under the radar in comparison with more conventional subway and light rail projects. In part, this is because the GO Transit brand is already very familiar to, and well-regarded by, region residents as a commuter railway. The radical change to a regional rail operation is simply not captured by a term like GO Expansion. York Region Transit was able to highlight the fundamental change presented by its introduction of bus rapid transit through the distinct branding of its BRT lines as "Viva." This pattern has followed in Brampton with Züm, and in Durham Region with Pulse. A Trillium Regional Rail Network should have a distinct brand to instantly convey to riders that this is an entirely different level of service from traditional GO Transit. Consequentially, a distinct brand could also highlight the importance and value of the investment. The Trillium brand must go beyond traditional branding. As part of the first steps, the brand has to identify how it will attract and retain customers. What is its value proposition? What are the key partnerships or services necessary to attract riders?

Lines should receive standardized names, such as T1, T2, et cetera, much like the Toronto subway. These standardized names make it easier for riders to understand the services, while improving accessibility. Separate branding, such as the existing GO Transit branding, could be used for longer-distance regional service to destinations like Kitchener, Niagara, and Barrie, to underscore their higher speed, lower frequency, and increased comfort.

## SERVICE DESIGN

**High-Frequency All-day Arrivals and Departures**

People who have a choice rarely use transit systems where they need to check a timetable. Research has shown that the frequency at which riders can simply turn-up-and-go is about 12 minutes.[15] 10-minute frequency provides the opportunity for a "clockface schedule," where trains depart at the same time every hour. Australian scholar Paul Mees has referred to a "network effect" to explain that when all routes are sufficiently frequent, it becomes possible to conveniently make transfers between routes. This has a compounding positive effect on the utility of a transit system. Instead of only being able to reliably reach destinations on the line that happens to run past the rider's origin, a network that facilitates connections enables the rider to go from anywhere to anywhere in the region.

Regional rail frequencies in international peer cities vary widely, often due to infrastructure constraints. Munich's S-Bahn corridors have frequencies of up to every 20 minutes, but that is because all trains must pass through an extremely congested two-track tunnel across the city centre. Munich is currently planning an expensive project to add a second tunnel so that they can improve service frequency and capacity. In Paris, the core sections of the RER network operate at frequencies of up to every two minutes, but on their outer ends, they divide into many branches with lower frequency. In Berlin, S-Bahn routes generally operate every 10 to 20 minutes. London's Crossrail will operate trains every three minutes on its core double-track segment (2.5 minutes during the peak), with outer branch frequencies ranging from every six minutes in the east, 10 minutes to Heathrow Airport, and 15 minutes to Maidenhead in the West. In general, the heavily branched routes in many international regional rail implementations tend to be constrained by the capacity of their double-track central segments. With a ten-track central corridor, the Toronto Region has no such constraints. Capacity increases by multiples with frequency. A corridor with a train every five minutes has three times the capacity of a corridor with a train every 15 minutes. Maximizing the frequency of trains on a line through operating practices and signalling is the most efficient way to increase capacity.

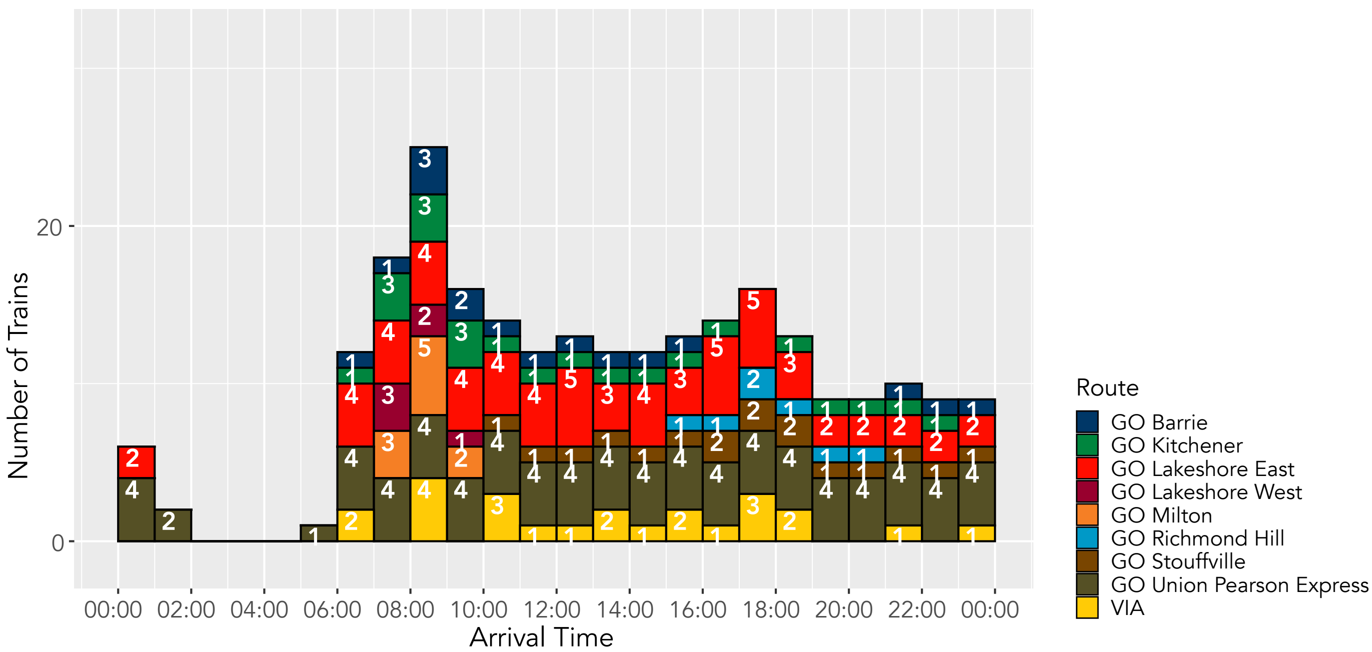
**EXPLAINER:**
**CLOCKFACE SCHEDULE**

A clockface schedule is a schedule in which trains arrive at the same times every hour throughout the day. So, if trains at Station X arrive at 5:15, 5:35, and 5:55 AM, there will be trains at 6:15, 6:35, 6:55 AM, and so on. Some hours may have more trains than others, but these, too, can follow a clockface pattern—you might have arrivals at 7:05, 7:25, and 7:45 AM to supplement the :15, :35 and :55 arrivals for the morning rush.

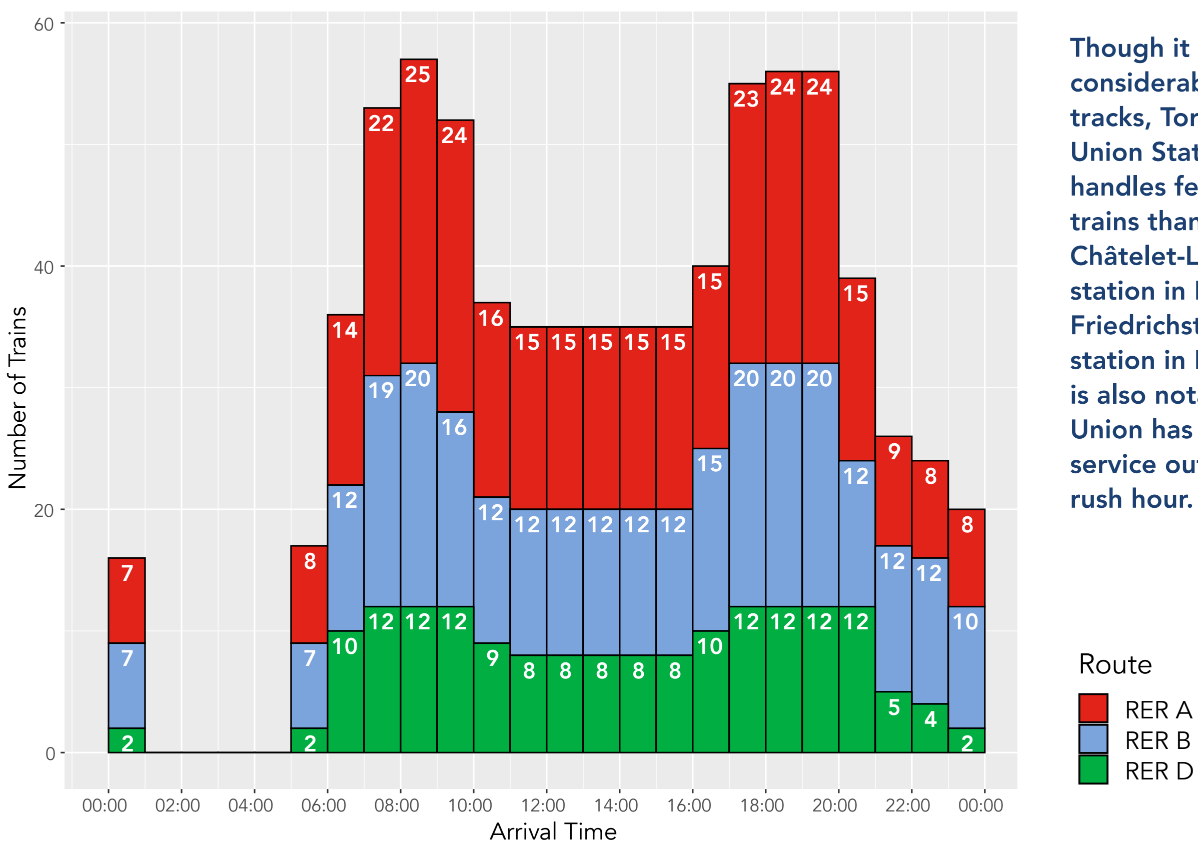
Clockface schedules have two key benefits:

1. By simplifying and regularizing schedules, they make transit more user-friendly—no more memorizing complex timetables.
2. Designing services to follow the same pattern all day reduces infrastructure needs. If your trains meet at the same points and terminate in the same patterns all day, you can be more targeted in your investments.

### Eastbound Trains Toronto Union Station (14 tracks) by Hour

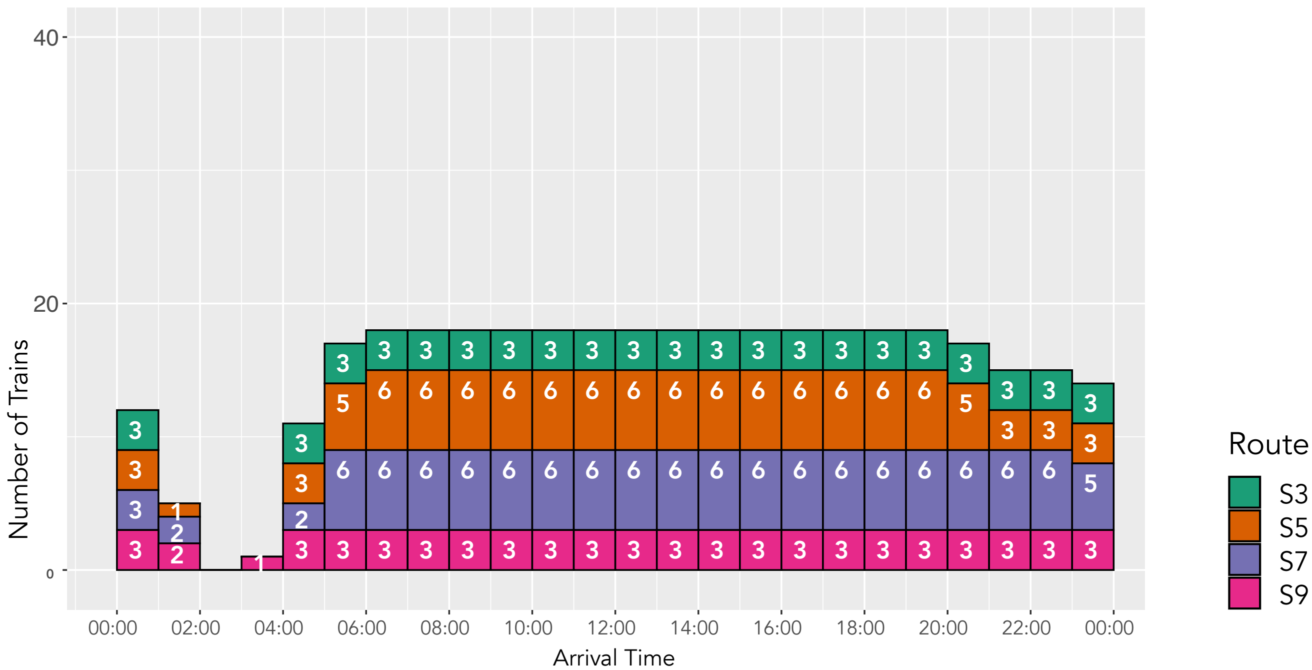



### Northbound Trains Arriving at Paris Châtelet-Les Halles Station (7 tracks) by Hour




**Though it has considerably more tracks, Toronto Union Station handles fewer trains than either Châtelet-Les Halles station in Paris or Friedrichstrasse station in Berlin. It is also notable that Union has far less service outside rush hour.**

### Westbound Train Arriving at Berlin Friedrichstrasse Station (4 Tracks) by Hour




These high and regular frequencies mean Trillium will act as a large expansion of Toronto's subway network. Unlike the TTC's subways, however, Trillium's high frequency trains will stretch far beyond city limits, essentially creating a subway network for Halton, Peel, York, and Durham regions, as well as Hamilton.

Adding capacity at the midday, evenings, and weekends is a comparative bargain. Virtually all the infrastructure and equipment needed to operate it is already purchased to operate peak services. It is simply a matter of using it rather than letting it sit idle. The marginal cost is simply the additional hours for the operating crew, along with electric power for the trains. Adding off-peak service is also a valuable way to attract riders to existing services, since they will have more flexibility for their return journey, which can help decongest rush-hour trains.

*In the initial Trillium plan, the Richmond Hill corridor would remain peak-only beyond the turnaround point in the Don Valley, because its speeds are limited by challenging curvature in the valley and there are conflicts with freight traffic on its northern end.

The Trillium plan proposes the following frequencies on the base network:

**T1** (Hamilton to Oshawa express):
every 10 minutes

**T2** (Niagara to Oshawa express):
every 30 minutes

**T3** (Oakville to Pickering local):
every 10 minutes

**T4** (Kitchener to Cherry express):
every 20 minutes

**T5** (Mount Pleasant to Cherry express):
every 20 minutes

**T6** (Pearson to Gerrard-Don local):
every 10 minutes; peak service every 5 minutes. Some peak-hour trips to/from Richmond Hill*

**T7** (Barrie Allandale to Cherry express):
every 20 minutes

**T8** (Newmarket to Cherry local):
every 10 minutes

**T9** (Milton to Lincolnville local):
every 10 minutes; peak service every 5 minutes.

**Adding capacity at the midday, evenings, and weekends is a comparative bargain. Virtually all the infrastructure and equipment needed to operate it is already purchased to operate peak services.**

### Through-Running

Traditional commuter rail services, like GO Transit, generally have corridors that start on the outer edge of the region and end at the main downtown station. This approach works adequately for a smaller system, but it significantly limits capacity. It takes time for a train to turn around, due to the need for operators to switch ends, and to perform safety measures like brake checks. Time spent sitting at the platform eats up scarce capacity at a busy station like Union. It is therefore far more efficient to "through run"—in other words, to pair up corridors coming from either side of the region, so that trains run through downtown and then be turned at the outer edge of the region where station capacity is comparatively abundant. Through-running also brings significant benefits to riders, making single-seat journeys possible across the region. It can also enable a more even distribution of riders across several stations in the city centre. For example, riders coming from the eastern GTA could ride past the crowded platforms at Union Station to another station down the line, like Spadina, if their destination were on the west side of downtown.

Through-running also increases the efficiency of rail operation. A conventional commuter service starts with empty trains at the outer end and gradually fills up until the train reaches the downtown terminal, at which point it fully empties, often continuing out of service to a storage yard. A through-running service can have passengers boarding and alighting throughout the train's route, helping to decongest the central station.

Because of its service, efficiency, and capacity benefits, through-running is an almost universal approach among world-leading regional rail systems, like those of Paris, Munich, Berlin, Tokyo, and London.

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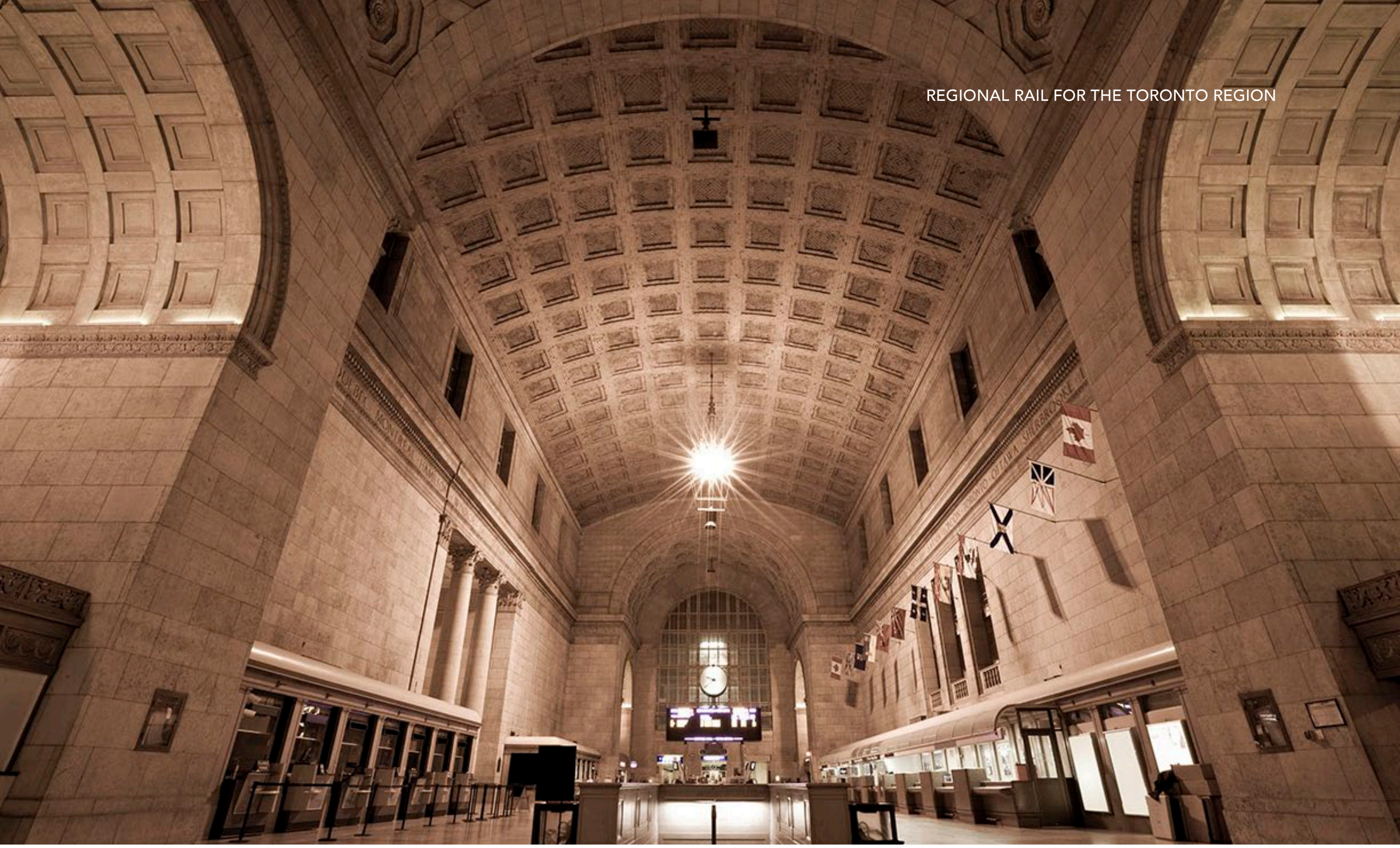
The Trillium plan proposes the following ultimate corridor pairings:

| WEST | | EAST |
|---|---|---|
| Barrie | ↔ | No Eastern Pair (terminating downtown) |
| Kitchener | ↔ | Richmond Hill (peak only) |
| Milton | ↔ | Stouffville |
| Lakeshore West | ↔ | Lakeshore East |



**Express and Local Service**

Express service is a key advantage of regional rail over other types of rail rapid transit. While it is generally not necessary on short urban routes, where modern trains accelerate fast enough to provide reasonable travel times, it is very useful for longer-distance regional trips. In Germany, for example, there are separately branded RegioExpress services, which operate with more comfortable seating and limited stops out to about 100 km from the city centre—a model that makes considerable sense in the Toronto context for destinations like Barrie, Kitchener, and Niagara. Some operations, like the Paris RER, use a variety of service patterns that skip certain stations to provide a slightly faster ride and to balance loadings. In Japan, highly precise schedule adherence makes it possible to run numerous express and local service patterns even on a single pair of tracks. In most cities, however, services predominantly make all stops. There are three key reasons for this practice: express service generally requires expensive additional track infrastructure to allow trains to pass each other; it can result in unacceptably infrequent service at local-only stations; and it is made less necessary by rapidly accelerating electric multiple-unit trains that can generally still provide time-competitive service while making all stops, given reasonable stop spacing.

Nevertheless, express service is necessary for longer corridors, and it could be operated by trains that are fitted with seating better suited to longer trips.

The Trillium plan proposes express service on three corridors, all of which serve key regional hubs and longer distance travelers, along with providing local service. These are:

- The Lakeshore corridor, making limited stops between Oakville and Pickering
- The Kitchener corridor, making limited stops between Highway 27 and Bloor
- The Barrie corridor, making limited stops between Newmarket and Lansdowne-Bloor

Electrified regional rail and high-clearance freight rail can coexist, as seen in this example from Philadelphia.

## ROLLING STOCK

### Electrification

There is good reason why every rapid transit system in the world is operated using electric power. Electrification brings enormous advantages to urban passenger rail operation. First and foremost, it eliminates point emissions of pollutants, which can significantly affect residents of neighbourhoods adjacent to diesel-powered railway lines. In a province like Ontario where the electricity supply is nearly carbon-free, electrifying trains can have major positive effects on overall greenhouse gas emissions. On a diesel train, momentum energy is dissipated as heat when the train brakes. An electric train can run its motors backward and feed that energy back into the grid—a key function on urban transit routes with frequent stops. The business case for electrification is further enhanced by major advances in battery technology over the past decade. High-capacity batteries mean that it is possible to operate some sections of the line without overhead wires, such as on relatively lightly used sections, in yards, or in areas where they would unacceptably affect freight traffic.

The benefits are not just environmental—there are enormous practical benefits to electrifying busy railway lines. We have all become familiar with the performance advantages of electric cars—sedans that can leap from 0-60 faster than a Ferrari. The performance difference is just as real with trains as it is with cars. Electric trains require no time to ramp up to full power, and they have an effectively unlimited source of power from the provincial grid. They are also much lighter, as they don't haul their power plant with them everywhere they go. When trains are making very frequent stops on an urban rail line, acceleration is far more important than top speed. With faster acceleration, additional stops can be introduced—to place stations closer to residents and serve new and existing developments—while still reducing travel times. A GO Transit train of bilevel cars has a power-to-weight ratio of only 4.1, compared with 22.4 for a typical German regional rail electric multiple unit EMU. Even if two locomotives were used on each train, it would still have a ratio of only 6.9--less than a third of that of a German EMU. This lack of power means very slow acceleration, which in turn means reduced line capacity, especially if such trains were to be operated on the same tracks as high-performance EMUs. Like getting stuck behind an overloaded truck when the light turns green, it takes a long time to get up to speed, causing a traffic jam behind. Faster trains also reduce costs, since they allow for the same number of services to be operated with fewer trains.

**A GO Transit train of bilevel cars has a power to weight ratio of only 4.1, compared with 22.4 for a typical German regional rail EMU. This lack of power means very slow acceleration, which in turn means reduced line capacity, especially if such trains were to be operated on the same tracks as high-performance EMUs.**

Electrification must be designed in a way that is compatible with equally important freight rail operations throughout the region, particularly on key freight corridors. Rail operations in the New York and Philadelphia areas have shown that passenger services using overhead catenary systems can be fully compatible with frequent freight services—even with high clearance double-stack trains. Any implementation of electrification on major freight corridors must also ensure zero interference with freight railway signalling systems. If possible, separate tracks should be dedicated to freight and regional rail service, ensuring that passenger upgrades do not in any way impede goods movement. If neither separation nor mixed-traffic electrification is possible, the procurement of battery or dual-mode (electric and diesel-electric) multiple unit trains should be investigated.

Building from these principles, the Trillium plan proposes electrification of the following corridors:

- The Lakeshore corridor, from Hamilton to Oshawa
- The Kitchener corridor, from Kitchener to Union Station (ensuring that electrification can be made compatible with CN freight services between Georgetown and Bramalea)
- The Milton Corridor, from Milton to Union Station (if it can be implemented in a way that does not conflict with CP freight operations)
- The Barrie corridor, from Barrie to Union Station
- The Stouffville corridor, from Lincolnville to Scarborough

Because of low proposed service levels and freight interactions, electrification is not proposed on the upper Richmond Hill corridor, or on the Niagara branch of the Lakeshore corridor.

**Modern Multiple-Unit Trains**

Electrification is not the only important element for improving acceleration performance. Just as all subway trains around the world are electric, they are also all multiple units. This means that rather than having a locomotive pushing and pulling unpowered cars, as GO does today, they have electric motors in each car, so the whole length of the train is powered, just like a subway train. This is important because track adhesion is often the limiting factor for acceleration from a stop, rather than power. Trains are so efficient because there is very little friction between a steel wheel and steel rail. When starting from a stop, however, this lack of friction can be a problem—just like bald tires on a car. No matter how big the engine may be, or how much you stomp on the gas, the car will not move if the wheels are slipping. A multiple-unit spreads that power across the length of the train—instead of a handful of powered axles, there can be dozens. For a regional train starting from a stop every couple of minutes, the time savings from being able to quickly accelerate add up and shorten trips for passengers. This is the reason locomotive-hauled trains are virtually unheard of in frequent urban rail operations in major cities like Paris, Berlin, Sydney, Tokyo, and London. Purchasing modern trains off-the-shelf can provide substantial savings, and since they are generally designed for interoperability, it would mean that Trillium is not locked into a single vendor.

Modern trains are also much lighter than the traditional North American trains currently used by GO Transit. Over the past decades, automobiles have become lighter, and therefore more fuel-efficient, owing to new technologies that nevertheless make them considerably safer in crashes. While these kinds of technologies have been implemented on European and Asian trains, North American trains—thanks in part to dated regulations—continue to be built like a 1950s Studebaker, with heavy weight as the primary means of crash protection. Lighter trains reduce infrastructure wear and the cost of infrastructure construction, in addition to being more energy-efficient and high-performing.

Fast-accelerating electric trains also reduce costs for transit agencies because slow acceleration limits capacity on a line, reducing the utilization of expensive infrastructure. They can also be split and joined easily, so that trains can be shortened off-peak to match demand, and the unneeded trains can receive maintenance, reducing total fleet requirements.

Increasingly, regulators in both Canada and the United States have relaxed and granted waivers to these regulations, recognizing that advanced signalling and modern safety systems greatly reduce the risk of collisions. Caltrain, for example, is acquiring off-the-shelf European EMUs for their regional rail upgrade. It is far cheaper to buy better-performing trains (which also last longer and require less maintenance than diesel trains) than to build new tracks. These problems are compounded when dealing with mixed fleets. Just as a busy highway develops a traffic jam when one vehicle is moving much more slowly than others, trains with different performance standards end up bunching and therefore reducing capacity on the line. To maximize the value of infrastructure, it is best to exclusively operate trains with very similar performance characteristics on a given line. This not only means converting as much of the system as is possible to electrified multiple-unit operation, but also investing in battery, diesel or bi-modal multiple unit trains (similar to those used today on Union Pearson Express trains) for corridors which will not immediately be electrified. Continuing to use legacy locomotive-hauled equipment on these diesel segments may save money in fleet procurement, but will likely end up costing much more than that in infrastructure, as locomotive-hauled sets' slow acceleration reduces line capacity and requires grades that are less steep.

GO Transit's capital budget for its expansion project is in excess of $12.2 billion. The cost of replacing the entire GO fleet with equivalent capacity in EMUs, based on a recent German order, is about $4.2 billion—well within the project budget while reducing the cost of other project elements and greatly improving performance. Some of the bilevel fleet will soon need to be replaced in any case, while other cars could be sold or repurposed for longer-distance services. The benefits from a uniform, high-performance fleet built to a single standard for platform height and other characteristics far outweigh the benefits of stretching a few extra years out of GO Transit's legacy fleet. The long and phased implementation period that will be needed for regional rail to be extended across the region will give many more years of service to the bilevel fleet.

**Faster Loading and Unloading**

As we will see, the primary constraint on GO Transit's capacity is Union Station, where it takes a long time for passengers to board and disembark from full trains. While part of the issue lies in the design of the station itself, another key problem is the train cars. A comparison with the subway is instructive: even at the crowded Bloor-Yonge station, it takes a matter of seconds for a train to load and unload. At Union Station, a GO Train can take several minutes to do the same thing. That means that the track is occupied, and the following train must wait. Clearly, if it took minutes to load and unload at Bloor-Yonge, the subway would quickly grind to a halt. What's the difference? A single Toronto subway car is 23 metres long, compared to 26 metres for a GO bilevel car. However, it has four doors on each side, compared to only two on the GO bilevel. Furthermore, the GO car has two levels, making for an extremely high ratio of passengers to doors and adding an additional choke point at each car's narrow interior stairs. Other cities, such as Sydney and Paris, also use double-decker trains in their regional rail networks. However, GO trains have fewer and narrower doors than the trains in these other systems.

Level boarding is also critical to fast loading and unloading at stations. When passengers have to take a step down from a train, they slow down. This is an especially serious issue for families with small children, the elderly, and people with disabilities. It limits access for wheelchair users, who would require assistance from train staff.

High platforms (assuming sufficient platform width) also allow trains to safely enter stations at full speed, significantly reducing journey times and increasing line capacity. Many European railways are generally standardizing on a platform height of 55 cm, which allows for level boarding with all modern train models. Though such low floors come at some disadvantages,

Extra-wide doors on Sydney's new Waratah trains allow for quick loading and unloading, which increases capacity.

it enables trains to still serve stations with low platforms where passengers would simply step up. GO Transit's existing bilevels have a 63.5 cm floor height. That is non-standard, but it would not be a problem for modern European EMUs to be built to that floor height, enabling level boarding for both existing bilevels and new EMUs at the same platforms.

A decision on platform height based on rolling stock design needs to be taken at the outset so that it is possible to develop a comprehensive strategy for raising platforms. Some systems have sought to take a phased approach to raising platforms—like Philadelphia's SEPTA Regional Rail or the San Francisco Bay Area's Caltrain. Many European systems are standardizing on a platform height of 55 cm, which is low enough to still allow riders to step up from existing low platforms. It may also be possible to standardize on the existing bilevel platform height, allowing both bilevels and new EMUs to have level boarding from the same platform. The UP Express project demonstrates the feasibility of building high platforms on a corridor that is in active use. There are numerous examples of successful network-wide platform height adjustments, such as the Brussels RER project.

Counterintuitively, using cars with less capacity can increase overall line capacity if it means passengers can board and alight more quickly, and therefore trains won't need to dwell so long at stations. A GO bilevel car has about 80% more capacity than a Toronto Rocket subway car, which is significant. But if a subway-style train can run every 2.5 minutes while the GO train can only run every ten minutes because of long station dwells, the subway realizes a 300% increase in train throughput. Even taking into account the smaller number of people who can fit on a subway car, that's still more than twice as much overall line capacity. A typical European single-level EMU, like the new Class 490 trains of the Hamburg S-Bahn, would have

**The primary constraint on GO Transit's capacity is Union Station, where it takes a long time for passengers to board and disembark from full trains. While part of the issue lies in the design of the station itself, another key problem is the train cars.**

Paris regional train interiors offer attractive design to entice riders.

**Counterintuitively, using cars with less capacity can increase overall line capacity if it means passengers can board and alight more quickly, and therefore trains won't need to dwell so long at stations.**

a little more than half as many seats as a GO train of the same length (though the difference including standing riders is smaller). That means that doubling frequency would exceed existing capacity—something that is easily achievable with the far higher performance, and faster loading and unloading, of single-level EMUs.

### Global Best Practice in Rolling Stock

Placing these elements of fleet strategy together in a way that supports modernized operations in the Toronto Region points us towards a fleet vision centred around a uniform group of high-performance electric multiple units. Around the world, this is the norm, with operators selecting from the many examples of the technology, including Alstom's Coradia, Bombardier's Talent 3, Siemens' Mireo, and Stadler's Flirt, to supply their urban fleets.

In defining the exact nature of Toronto's future electric multiple unit fleet, there are a number of key questions to consider surrounding train size and width, and fleet uniformity. Given the dramatic increase in capacity possible with more frequent operation, Toronto could probably operate well with single-level trains, which benefit from eliminating the choke points at stairs and thus spend less time sitting at stations. Many of the busiest regional railways in the world, like Tokyo's, use single-level cars for this reason. If bilevel trains are preferred due to their larger seating capacity, which is valuable on longer routes where riders don't want to stand, there are numerous high-performance bilevel multiple unit trains available on the global market. Examples include the MI09 used on the busiest lines of Paris' RER or the new Waratah EMUs of Sydney Rail.

Another way to squeeze out more seating capacity without the added complexity and longer station dwell times of bilevel trains would be to consider acquiring wider trains. Since GO Transit does not have existing high platforms to

These MI09 trains, made by Alstom and Bombardier, are used on the busiest Paris RER corridors.

constrain train width, it may be possible to use the wider train standard of the Nordic countries. This would have the additional advantage of reducing the potential for conflict with wide freight trains operating on the corridors.

Finally, a consistent theme among top global regional rail operators is that they operate uniform electric multiple unit fleets, and they do not use any locomotive-hauled trains on main urban routes. The existing locomotive-hauled bilevel trains operated by GO Transit have such radically different performance characteristics from modern regional rail trains (both in terms of acceleration and station dwell times), that their retention would force serious sacrifices in capacity and the need for otherwise unnecessary infrastructure investment. Infrastructure must always be designed for the poorest-performing train that will use it. In 1989, Munich's S-Bahn tested for a month a 4-car bi-level train powered by two electric locomotives; this very high-powered (11.2MW) train still could not match the timetable of a less powered (7MW) single-level EMU because of much longer station dwell times. That means that operating even a small number of trips on a corridor with less optimized rolling stock would require large and disruptive investments in additional infrastructure. The legacy GO Transit fleet may find a second life on longer-distance inter-regional services to which they are better suited, perhaps refitted with seats designed for long-haul travel.

The Trillium plan proposes the acquisition of a fleet of high-performance electric multiple units with uniform performance characteristics to maximize corridor capacity, reliability, and speed. While single level trains are likely to offer sufficient capacity on all corridors for the foreseeable future, given the high frequency of operations, modern two-level multiple units could be used on the longest distance services to maximize seating capacity. The legacy GO bilevel car and locomotive fleet should be gradually phased out as corridors are converted to regional rail operations. Stations should be upgraded to high platforms that enable level boarding using a phased approach, with one half of the platform raised while the other half remains in service, with the remainder raised once new equipment is introduced.

**When creating a service plan, it can be possible to eliminate many crossing routes without needing to build expensive overpasses simply by pairing matching corridors on either side of the central segment.**

## INFRASTRUCTURE

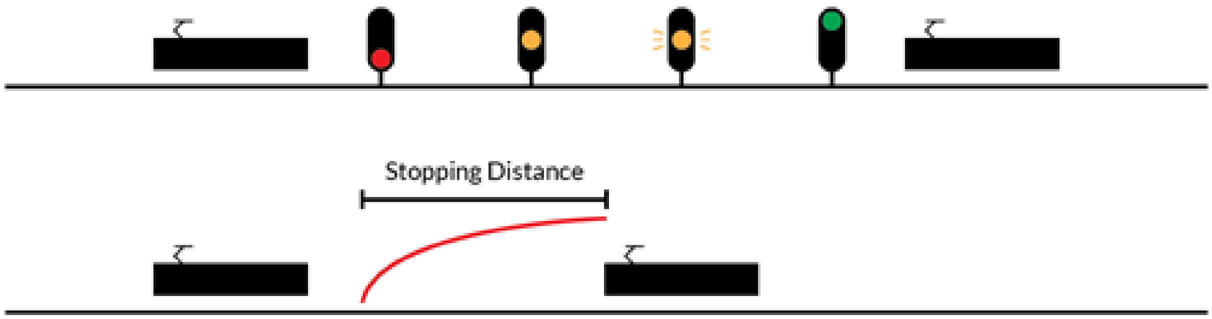
### Eliminate Conflicts

When designing a service and infrastructure plan, it is essential to eliminate instances where corridors cross one another. Much like on a road, these at-grade intersections dramatically reduce capacity, as vehicles can only move in one direction at a time—consider the difference in vehicle speed and volume between a cloverleaf interchange and a traffic light. For a railway, crossings are even more restrictive than for a road since trains are much longer and require larger safety margins. Any schedule delays can ripple throughout the system. This is why GO Transit has invested in a number of overpasses and underpasses to eliminate these conflicts between GO corridors and important freight rail routes in the region.

When creating a service plan, it can be possible to eliminate many crossing routes without needing to build expensive overpasses simply by pairing matching corridors on either side of the central segment. For example, Lakeshore East and Lakeshore West both are the southernmost corridors in the network. So, as long as they run on a dedicated set of tracks on the south side of Union Station, Lakeshore trains would not need to conflict with any other service. Likewise, pairing the Kitchener or Barrie lines with the Richmond Hill line could enable such a corridor to operate conflict-free on the north side of the central corridor. In cases where it is necessary to cross other lines to meet service planning goals, a flyover or flyunder should be built to prevent potential conflicts. Additional flyovers could be added to increase routing flexibility, if desired, but designing routes to avoid such conflicts where possible minimizes the need for building that expensive infrastructure.

The Trillium plan proposes to pair corridors on the eastern and western sides of the downtown core in a way that eliminates nearly all conflicting movements of trains while minimizing the need for new grade separation infrastructure. Routes will also be designed to pass through the Union Station area without passing through sharply angled switches that force trains to slow to a crawl. The existing flyunder to the west of Union Station is poorly located for such operations, and in any case would need to be removed to accommodate a Spadina Station. It will be replaced by a smaller, single-track flyunder located to enable eastbound Milton corridor trains to reach the southern part of the Union Station rail corridor so that they can join with Lakeshore trains east of Union. This modest infrastructure is all that is needed to enable conflict-free movements through the station area, if the track layout (illustrated on page 41) is rationalized to avoid conflicts.

**Comparison of traditional (above) and moving-block signalling systems (below)**




**EXPLAINER: ETCS**

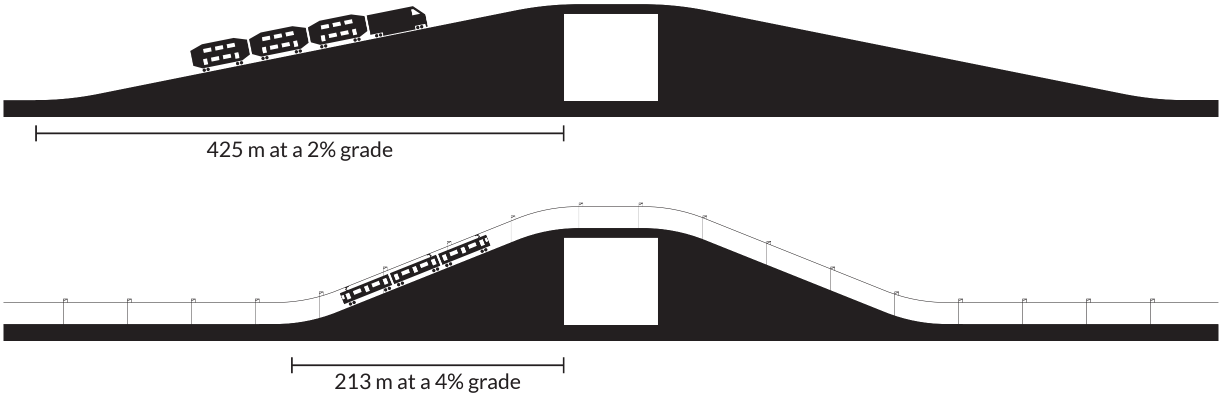
Conventional railroad signaling divides tracks into fixed blocks separated by signals to keep trains apart. ETCS dynamically calculates train spacing based on each train's braking performance and displays this information directly to the driver. This allows higher speed and higher throughput operation while reducing the likelihood of collisions—critical to the success of a regional rail plan.

### Implement Modern Interoperable Signalling

A key goal for signalling a regional rail system is to take advantage of international standards, so that the agency does not get locked into a single vendor for a bespoke system. There are many different signaling technologies that have been used by major regional rail operators worldwide. The European Train Control System (ETCS) is the de facto global railway signalling standard deployed in Europe, Asia, Australia, South America and Mexico. The ETCS standard was designed to achieve rigorous safety, performance and interoperability criteria; with years and billions of dollars having already been spent to advance technology and meet these goals, it is ideal for a Trillium Regional Rail Network. The key advantage of adopting ETCS is that it is, unlike many other signaling technologies, a fully interoperable standard. That means that an operator is not dependent on a single technology vendor. All major signaling vendors produce equipment that meets its interoperability standards for onboard and trackside equipment. ETCS is capable of delivering very high capacity—up to 30 trains per hour on a single track. It precisely determines where a train is located and the speed at which it is traveling, in order to calculate the minimum safety margin in real time. Traditional signalling systems are based on dividing the line into fixed blocks, only allowing trains into unoccupied blocks. Since the precise location of trains is not known, large safety margins are required. ETCS precisely determines where a train is located and the speed at which it is traveling, in order to calculate the minimum safety margin in real time. ETCS also enables Automatic Train Operation (ATO) to deliver consistent performance and energy savings in congested areas like the Union Station Rail Corridor. Drivers would still be required to monitor systems and operate on non-automated segments. ETCS can be installed alongside conventional signalling, providing safety and performance benefits to passenger trains without requiring freight operators to retrofit hundreds of locomotives to travel on short sections of the Trillium network.

## Up to 30 trains per hour on a single track, with ETCS

The Trillium plan proposes the use of ETCS or a similar proven, interoperable standard with multiple vendors for maximum future flexibility. Conventional signalling can be used on shared segments with freight services. It can use either moving blocks or short fixed blocks. It must be capable of achieving high throughput levels while maintaining safety.




The steeper climbs that are possible with modern trains allow the length of overpasses to be cut in half, reducing expense and community disruption.

**Infrastructure Design Based on Rolling Stock**
There are different types of trains with widely varying performance characteristics. These characteristics determine infrastructure requirements. For example, a freight train cannot climb steep grades, and it requires stout bridges and overpasses to handle high axle weights. Metrolinx's current design standards generally limit grades to 2% (two feet of elevation change per hundred feet of horizontal distance), significantly less than the 3, 4 or 5% grades used in rapid transit operation. These standards have the impact of doubling (or more) the length of flyovers, increasing community impact and project costs.

By contrast, a modern electric multiple unit train designed for regional rail operation is much lighter and can climb much steeper grades, like a subway train. Infrastructure designed for such trains can be much cheaper and less disruptive to build. Existing GO Trains have performance levels that lie between those of modern regional rail trains and freight trains. If these are operated even for occasional services, considerably heavier infrastructure must be built to support them.

Most Toronto Region rail corridors have at least occasional freight rail services. This means that, for a proposed Trillium Regional Rail Network, most infrastructure must be designed to accommodate freight rail, which is also an essential part of the region's transportation system. Furthermore, North American freight trains are far heavier and longer than their European and Asian equivalents. On busy freight routes, like Milton corridor and the Kitchener corridor between Bramalea and Georgetown, separate freight and passenger tracks are essential. These have already been built between Pickering and Oshawa on the Lakeshore East corridor. On routes with limited freight service, it should be possible, for example, to enable freight trains to avoid using steep grade separations through short bypass tracks. Canadian Pacific follows this approach in the Weston area of Toronto. Lighter rolling stock could also provide some flexibility on rules regarding construction on sites adjacent to rail corridors. Wide setbacks and tall crash walls are essential when heavy freight trains, potentially carrying dangerous goods, pass by. They are, however, entirely unnecessary when a line is being exclusively used by lightweight passenger trains. Such a change would go a long way to facilitating transit-oriented development.

The Trillium plan proposes that infrastructure be designed to the precise needs of high-performance electric multiple units wherever possible, reducing the expense that would be needed to design for lower-performing equipment. Bypass tracks will be used for freight trains to avoid using steep grade separations and other infrastructure.

This flyover in Germany illustrates how much smaller grade separations can be with modern trains. (Image: Deutsche Bahn)

**Yards Located on the Outskirts**

Peak-period-focused, unidirectional commuter rail operations use much of their equipment only for a few hours per day. Not only is this a massive underutilization of equipment and infrastructure, but it also requires trains to be stored somewhere near the city centre. This results in having to occupy some of the most expensive real estate in the country to store trains that could otherwise be out on the network providing service.

A Trillium Regional Rail Network provides a balanced service plan with through-running, meaning that trains would run through the city centre to the other side of the region. Thus, if some trains need to be stored off-peak, it can be done on far less expensive real estate. Meanwhile, large city-centre storage yards can be redeveloped with additional stations to improve system access, or with transit-oriented development. Triple-track arrangements are very rare outside North America because they create unbalanced operations that require trains to be stored in the city centre. Instead, double- or quad-track corridors enable balanced operation that maximizes use of infrastructure and equipment.

**Road/Rail Grade Separation**

Building overpasses or underpasses to separate road and rail traffic is important at very busy intersections, but its high cost is not necessary everywhere. At more minor intersections, the cost and disruption of overpasses or of closing streets is a major contributor to project budget and community opposition. Transport Canada has traditionally used a standard based on the number of road vehicles multiplied by the number of trains using a level crossing each day. This approach, however, does not take into account the very different ways a train can occupy a crossing. A long freight train operating at low speed can have the crossing gates down for five minutes or more. A short passenger train operating at comparatively high speed will only occupy a crossing for a few seconds. Even with the safety margin required before and after

The Trillium plan proposes to through-run all trains where possible, with turnarounds located at the outer ends of lines. Since there are more corridors on the western side of the region than on the eastern, it will be necessary to turn at least some trains. Trillium proposes this be done at a new station located at Cherry Street on the existing Don Yard site, which would also serve developments in the West Don Lands, East Bayfront, and Port Lands. Some trains could also be turned at the proposed GO Transit facility in the Don Valley north of the Bloor Viaduct, enabling additional stations along the Don River at Queen and Gerrard Streets. The latter would provide direct rapid transit service to Regent Park.

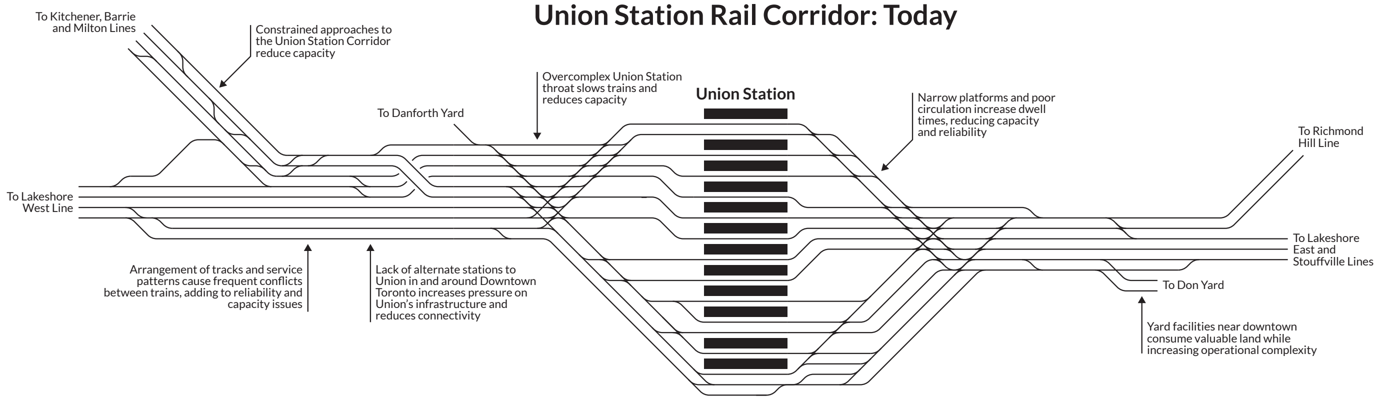

In Europe and Asia, it is common to have level crossings even on busy urban rail lines to reduce cost, avoid construction disruption, and prevent visual impact from elevated structures (image source: Google Earth).

a train passes, the road will still be obstructed for less time than at a normal red traffic light. The shorter braking distances of a modern EMU train can significantly shorten the time gates must be closed.

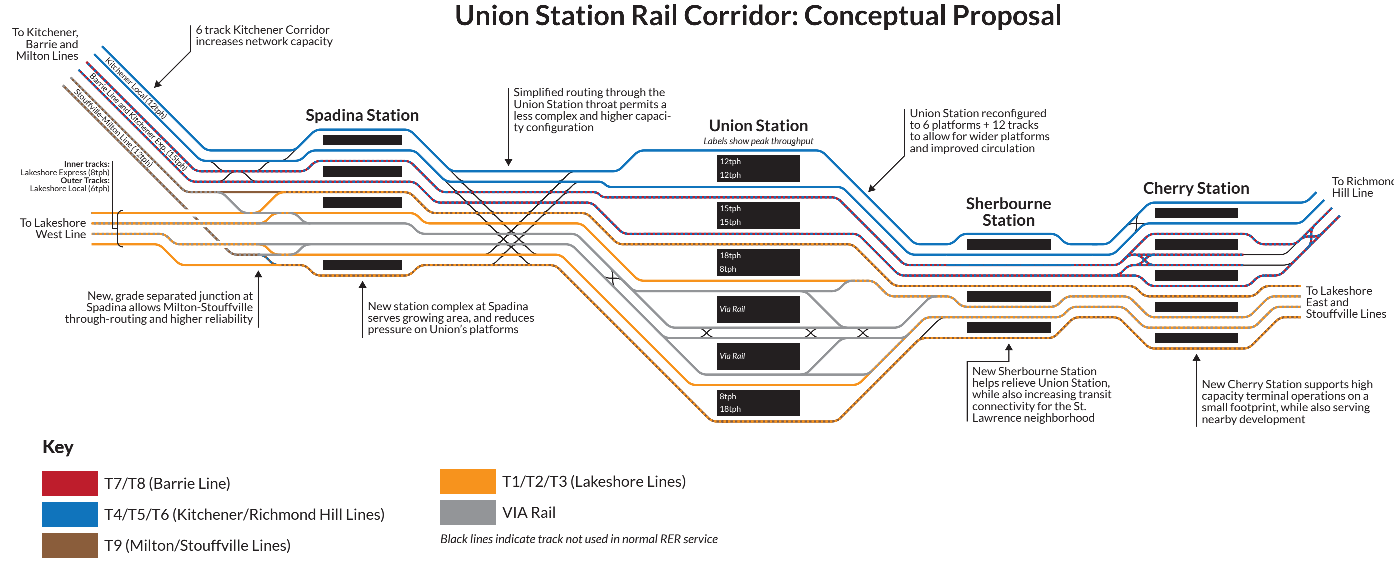
European and Asian regional railways, even on some very busy rail corridors, do not grade separate all crossings. Instead, they adopt a more selective approach, separating the busiest roads where there is the greatest possibility of conflict while elsewhere using high-quality gates that fully block a road and prevent drivers from attempting to race the train. Given that road-rail grade separations can cost tens of millions of dollars, separating every crossing on a corridor can add up to a very large expenditure. At major arterial roads, grade separation is usually essential. For minor neighbourhood streets, however, it may not be necessary to spend tens of millions of dollars to avoid minor inconvenience for a small number of drivers. Avoiding unnecessary grade separations also significantly reduces the neighbourhood impact of regional rail operations, potentially preventing the need for unsightly concrete viaducts and disruptive construction. One of the large advantages of regional rail over metro systems or other rapid transit technologies is that expensive grade separations do not have to be undertaken all at once. Instead, they can be added one at a time as deemed necessary or as communities request them.

The Trillium plan proposes a phased approach to the elimination of level crossings. Underpasses should be built immediately at the busiest arterial roads. However, given the short time that regional rail trains will occupy a level crossing, it is not necessary to eliminate them at less busy roads. This will significantly reduce the need for disruptive and expensive construction or for permanent road closures.

## Union Station Rail Corridor: Today




## Union Station Rail Corridor: Conceptual Proposal




# Union Station

Union Station and its adjacent rail corridor is the keystone of the regional rail network. Toronto is incredibly fortunate to already have a very wide corridor with immense potential capacity. It is constrained, however, by station platforms and track layout that were designed a century ago for the operating patterns of that time. They need substantial change if the promise of regional rail is to be achieved. Fortunately, there is sufficient land area to do it without needing expensive underground stations, like in many European and Asian cities.

The following sections detail these constraints and the international best practices that could resolve them.

> The Trillium plan proposes the conceptual layout for the Union Station corridor shown in the figure above. While this proposal's finer details are flexible, we believe this platform assignment, station location, and line pairing scheme would maximize this key corridor's capacity without incurring excessive costs to build more complex infrastructure like underground platforms.

## TRACK LAYOUT

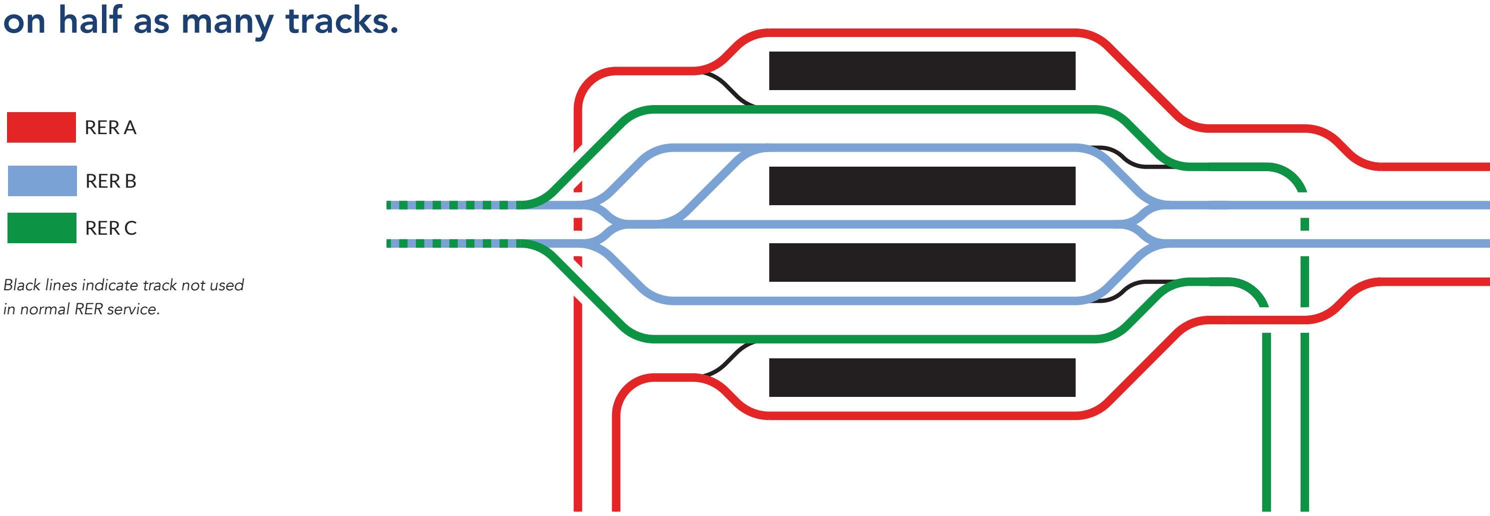
A traditional rail station focuses on flexibility, allowing any train to use any platform. This flexibility, however, comes at a cost. Trains crossing one another create conflicts that limit capacity. A complicated web of switches forces trains to slow to a crawl, further reducing capacity since capacity is maximized by operating trains at steady and consistent speeds. It is also confusing for passengers, since they don't know which platform their train will be using before it arrives.

Modern regional rail networks, whether in Tokyo, Paris, or Berlin, almost always use dedicated tracks designed to optimize quick and efficient travel for each individual route. It is important that a Trillium Regional Rail Network do so as well. Most modern rail stations are far simpler than Toronto's Union Station, and that helps them to move many more passengers. We propose rebuilding Union Station based on these international best practices—reducing the number of tracks, widening platforms, and reducing the complexity of service patterns and the terminal interlockings. Simpler track layouts mean that trains will no longer need to slow to a crawl as they move through the Union Station area. We propose an arrangement that provides every corridor with its own dedicated platforms at Union, with a reduction to 12 tracks enabling much wider platforms. Each track would serve no more than 18 trains per hour--considerably less than at many regional rail stations in Europe and Asia. VIA Rail would receive four dedicated platform tracks; given the very long platforms at Union, it would be possible to handle multiple VIA trains at a time per track. Additional core area stations would be included to spread out the load from Union and to eliminate the need to turn any trains at Union.

These changes pose some challenges, and it is unfortunate that they were not implemented at the same time as the broader reconstruction of the station. Still, they are absolutely essential if the goals of regional rail are to be achieved. It should be possible to relocate tracks where needed. Most of the existing tracks are situated directly above support columns. If it is necessary to move the tracks, it should be possible to support them with a beam running between the two adjacent columns. If shifting the location of tracks should prove to be entirely impossible, it would still be feasible to simply remove some tracks and build expanded platforms overtop.

Regional rail plans should also maximize the use of advanced switch geometries. European turnout design allows switches of the same footprint to handle trains moving at significantly higher speeds, reducing travel time for riders and increasing capacity.[16]

**The Châtelet-Les Halles RER complex in Paris moves more than twice as many trains per hour as Toronto Union on half as many tracks.**




*Black lines indicate track not used in normal RER service.*


Berlin Hauptbahnhof (above) was built with wide platforms that leave ample room for passengers to wait and that can accommodate access points broad enough for two escalators and a wide staircase. Toronto Union Station platforms (next page) are barely wide enough for a few people to pass, have very narrow stairs for access, and can become dangerously overcrowded.

## PLATFORMS

The key capacity constraint on the GO network is the amount of time trains are required to sit at Union Station to load and unload. It is an order of magnitude longer than, for example, how long subway trains sit even at busy Bloor-Yonge station. In part, the problem is the limitations of the existing bilevel trains. But once passengers get off the train, they face an equally important problem on the platform. Union Station's platforms were designed a century ago for a very different kind of rail service—predominantly long-distance trains. It even has platforms that were designed to handle mail. Today, their narrow width is such a severe choke point that it is a safety hazard. Passengers must then crowd single file onto narrow stairs down to the concourse. In Berlin and Paris, for example, platforms are at least three times as wide as at Union Station. Instead of narrow stairs, they have enough room for a broad staircase flanked by a pair of escalators. This means that passengers can quickly clear the platform when they get off the train. It also means that there would be enough room for passengers to wait on the platform, as they do on the subway, rather than waiting downstairs in the concourse until the train arrives.

Counterintuitively, the best solution for Union Station would be to reduce the number of its platforms in order to make them wider. Platforms that are wide enough that riders aren't forced to wait downstairs until their train arrives, and that a full arriving train doesn't cause to become dangerously overcrowded, will dramatically increase capacity by shortening the amount of time trains need to sit at the station. It will also make possible much wider stair access points, enabling platforms to be emptied much more quickly after a train arrives and to provide the convenience and comfort of escalators for passengers.

Rebuilding the platforms to a modern arrangement would likely require the removal of the train shed. While the structure has historical significance, part of it has already been removed for the addition of a high glass structure, and the need to improve the city's most important transit hub means that it may need to be removed. An excellent solution could be to dismantle and move the structure to a different location, potentially on the waterfront, where it could be effectively repurposed as a market, exhibition hall, or similar use.


Photo: Rodney Gaviola

## Local Stations

### ECONOMICAL DESIGN

A Trillium Regional Rail Network could incorporate stations with relatively simple design, since they would be located on the surface, and would not require expensive and disruptive underground digging. A station built over an arterial road can simply consist of a platform with canopy, with stairs and elevator down to the street. Ideally, a station should have a full-length canopy, given the frequently inclement weather in the Toronto Region. On the other hand, if trains are frequent, there is no need for large station buildings or waiting areas. Main station access could ideally be located at different points along the platform at different stations along a line, in order to encourage distribution of passengers along the length of a train. This could be further aided by coloured light strips above the platform indicating crowding levels in each car of an approaching train, as is being planned at New York's Long Island Rail Road.

While some new GO Transit station projects are very impressive facilities, their high cost is not always necessary—especially for stations that are anticipated to have relatively modest ridership. The five proposed City of Toronto stations on the GO network are planned to have an average cost of $239 million each, excluding additional amenities like pedestrian improvements requested by the City, while the new Bloomington GO station cost $82 million. In Montreal, a recently completed commuter rail station cost $14.2 million,[17] while in Italy, typical regional rail stations cost between $3.8 and $9.2 million. A group of seventeen new regional rail stations in Germany averaged $3.61 million apiece.[18]

**The five proposed City of Toronto stations on the GO network are planned to have an average cost of $239 million each. In Montreal, a recently completed commuter rail station cost $14.2 million, while a group of seventeen new regional rail stations in Germany averaged $3.61 million apiece.**

## ADDITIONAL STATIONS

The slow acceleration of GO Transit's current trains makes it impractical to have frequent stations in urban areas like a true rapid transit service. More modern trains will make additional trains feasible, enhancing access to jobs and enabling new development. They will also decongest the choke point at Union Station. Regional rail operations in Europe, Asia, and Australia generally have far more frequent stops than GO Transit in the urban core. At the very least, a station should always be built where lines intersect with busy surface transit routes or near significant concentrations of development. Given the far better performance of modern trains, which would mean that even with the addition of new stations, travel times would still be shorter than they are today. More consistent service patterns would also improve reliability, which would in turn make for faster trips through the reduction of allowance for delays in the timetable.

The Trillium plan proposes a number of infill stations, which go beyond existing GO RER and Smart Track plans in fostering integration with local transit and opportunities for transit-oriented growth. Notably, stations will be added along the rail corridor across the downtown core to better distribute loads, such as at Spadina, Sherbourne, and Cherry. Trains can use Metrolinx's planned Don Valley layover facility to turn around, instead of lay over, enabling the addition of stops along the Don Valley at Queen and Gerrard, improving service to Riverdale and Regent Park. A more urban concept of station location would enhance the value of the system, particularly within the urban core. These station proposals are detailed in the appendix of this document.

## TRANSIT-ORIENTED DEVELOPMENT

While most riders on a Trillium Regional Rail Network will likely reach their stations by connecting bus routes, as on the suburban stretches of the TTC subway, transit-oriented development will still be an excellent means of augmenting ridership at a station while raising revenue.

While all development around the network's stations will be desirable, employment will be of particular benefit to ridership. Firstly, it is a way to generate bidirectional traffic on lines, improving infrastructure utilization. Secondly, office employment has higher density than residential, as office buildings contain more people per square foot, and their occupants are more likely to be making commuter journeys. GO Transit currently has acres of parking around most of its stations. By shifting access to the station primarily to surface transit through integrated fares and increased frequency, as well as improving pedestrian and cycling access, it will be possible to monetize much of that land through high density development. Local transit feeding regional rail trains can facilitate "missing middle" development throughout the region.

**Regional rail operations in Europe, Asia, and Australia generally have far more frequent stops than GO Transit in the urban core. The Trillium plan proposes a number of infill stations, which go beyond existing GO RER and Smart Track plans in fostering integration with local transit and opportunities for transit-oriented growth.**

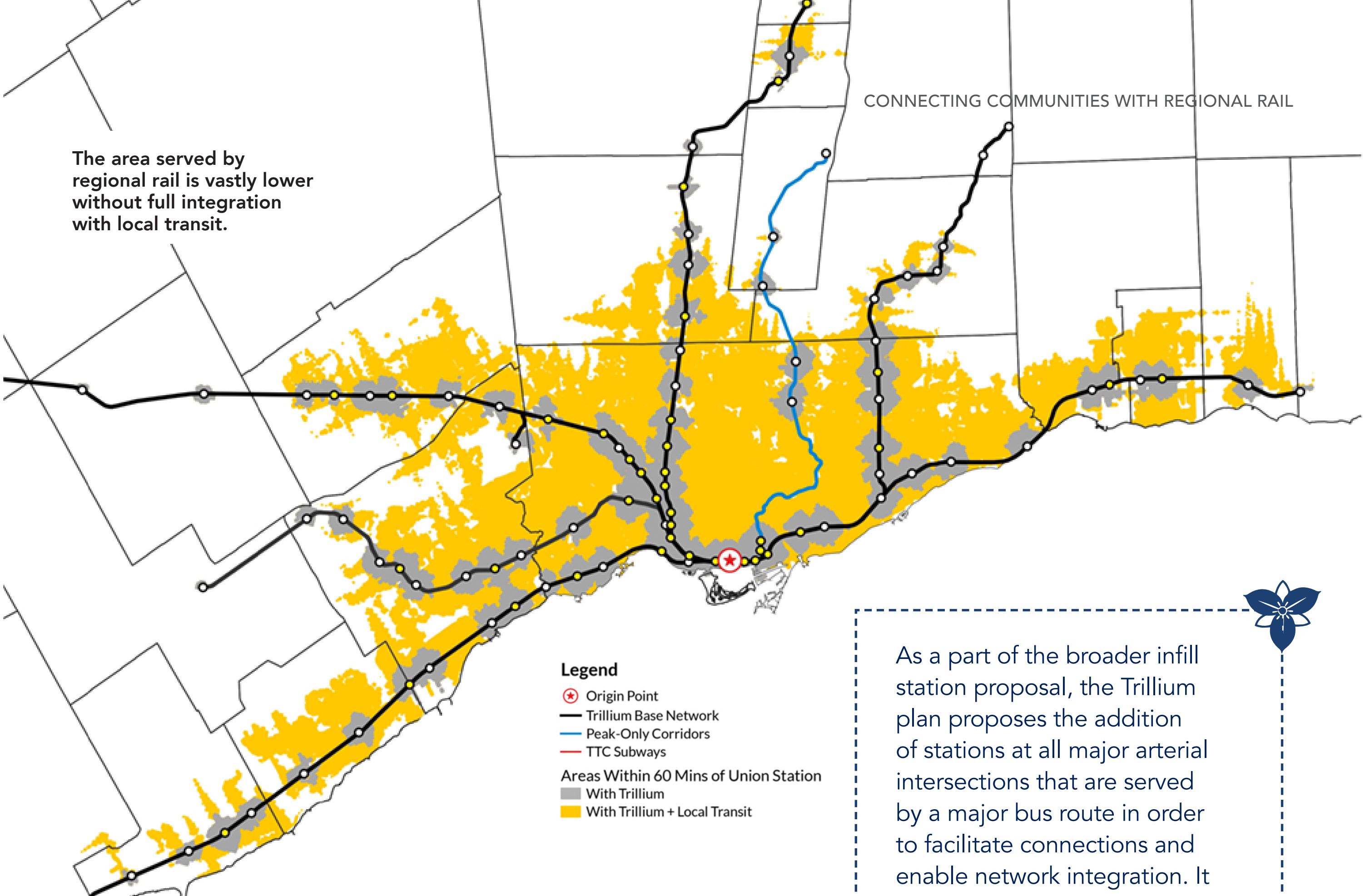
The Trillium plan proposes the redevelopment of GO station parking lots wherever possible into dense, transit-oriented communities. The revenues from these developments can be partly used to defray the cost of the project. Additional stations should be located along lines in areas that are well-suited for intensification.


The simple design of GO Transit's Bloor Station is ideal for allowing passengers to get directly to the street from the platform, making connections to surface transit easier. Photo: Wylie Poon

## CASE STUDY

### Ottawa's O-Train

The record-low figure for construction costs is Ottawa's Trillium Line, which cost only $21 million in 2001 for an 8km line with five stations. It used an existing, lightly used freight rail corridor to connect two segments of Ottawa's Transitway bus rapid transit system with Carleton University. Implemented as a pilot project, it used off-the-shelf Bombardier Talent diesel multiple-unit trains that were part of a larger order in Germany. It was built as a single-track route, with a single passing track at the midpoint of the line. This was sufficient for an all-day service every 15 minutes in both directions. Its stations were extraordinarily spartan, but adequate for their purpose. The platforms were simply asphalt with a bus shelter, and tickets were sold from a repurposed parking vending machine. Even a surface light rail route in Toronto costs tens of millions of dollars per kilometre. The O-Train model has extraordinary potential, even though its capacity is likely inadequate for major corridors in Toronto. At $21 million for such a substantial project, it would be feasible to quickly and affordably add rail rapid transit service on secondary routes and in many smaller cities with well-located and lightly used rail corridors.




## NETWORK INTEGRATION

### Route Integration

To be able to serve as the backbone of the regional transit network, it is essential that regional rail be fully integrated with local transit. Bus routes must be designed, and regional rail stations situated, to facilitate intermodal transfers. For example, instead of locating stations behind acres of parking lots, additional stations could be designed with direct pedestrian access to and from the sidewalks of major arterial roads, minimizing the need for buses to divert from their route or for passengers to walk long distances to make transfers. More frequent, urban-style stop spacing— potentially with stations spaced as close together as subway stations when the circumstances justify it—is possible with faster-accelerating modern electric multiple-unit trains. This will also minimize the need for buses to divert from their most direct routes. Stations should also be designed to integrate seamlessly with other mobility modes, such as through the inclusion of bike storage, scooters, and facilities for ride-hailing pickup and drop-off. Integration with local transit will allow people to take a short bus trip to the station and then the train for the rest of the journey, rather than needing to use a slow local bus for the entirety of long journeys. Trains can provide real-time information about connecting routes at upcoming stations.

As a part of the broader infill station proposal, the Trillium plan proposes the addition of stations at all major arterial intersections that are served by a major bus route in order to facilitate connections and enable network integration. It also proposes the adoption of urban stop spacing within the Toronto downtown core, with the addition of stations at Spadina, Sherbourne, East Harbour (with connection to the Ontario Line), and a station for some trains along with a turnaround facility at Cherry Street to serve the Port Lands. This stop spacing will help to re-orient downtown development on an east-west axis, unlocking underserved development lands along the waterfront—particularly for new employment. The new stations will also serve the essential role of relieving congestion at Union Station by spreading traffic to the region's core over multiple stations. Passengers connecting between corridors could be encouraged to do so at these stations rather than at Union, further reducing pressure on the system's busiest station.

Critically, additional downtown stations are needed both to relieve pressure on Union Station and to serve additional downtown development. For example, at the typical stop spacing of the Berlin S-Bahn, there would be four or five stations between the Exhibition and the Don River. With a station between Spadina and Bathurst, as well as possible stations at Jarvis/Sherbourne and, for some services, Cherry, the system will much better distribute riders around the downtown core, reduce pressure on Union, and provide rapid transit to developing areas of the waterfront and other downtown neighbourhoods. Stations at East Harbour and Exhibition integrated with the Ontario Line will enable an east-west grid of rapid transit across the downtown core. Those headed to the southern end of downtown could switch from the Ontario Line to regional rail at East Harbour. Those on regional rail bound for the northern areas of downtown could switch to the Ontario Line at Exhibition or East Harbour, shortening journeys and diverting passengers away from Union.

**Fare Policy**

Regional rail must also share the same fare structure as local transit services. This is an approach followed by nearly all successful regional rail systems. Paris' RER and S-Bahns in German cities all share the same fare structure as Metro/U-Bahn trains, as well as most bus routes. London's Crossrail will use the same fare structure as the Tube. An integrated fare structure with local transit, and potentially with other regional operators, will enable the shift toward mobility as a service. GO Transit already follows the global best practice by using the proof-of-payment model for fare collection, which should be maintained in any regional rail system. Gates could be installed at Union Station, if desired, while other stations remain open-access. Anyone who fails to pay a fare at their station would be caught if their destination is Union, and it would allow riders to transfer between Trillium and the subway without needing to pass through a fare gate—assuming a fully integrated fare system. Fare readers at all stations should also be placed on the normal walking path to the platform, on a line that is impossible to miss (like on the subway), rather than being positioned unobtrusively on the side. An integrated fare policy can include a variety of social fares, such as for people with low incomes. In Germany, for example, operators enable holders of a monthly pass to travel with their families at no additional charge on weekends.

The Trillium plan proposes the full integration of regional rail into the local transit fare system, as discussed in the previous report, *Erasing the Invisible Line*. Fare collection would continue to use GO Transit's proof-of-payment system. Fares would match local transit fares, with longer distance trips subject to zone-based increase according to distance travelled. If desired, the longest distance trains, to destinations like Kitchener, Barrie, and Niagara, could offer reserved seating for a supplementary fare.

**Infrastructure**

The new infrastructure needed for regional rail is remarkably small—no subway tunnels, no expensive underground stations, no unsightly elevated viaducts. All that is needed are some road-rail and rail-rail grade separations, additional tracks in select places, and a radically simplified route structure that minimizes conflicts. By combining routes on the east and west of the region into single corridors and turning trains outside the downtown core, it is possible to maximize capacity through Union Station. The infrastructure would be designed for future expansion and the addition of regional rail service on other corridors.

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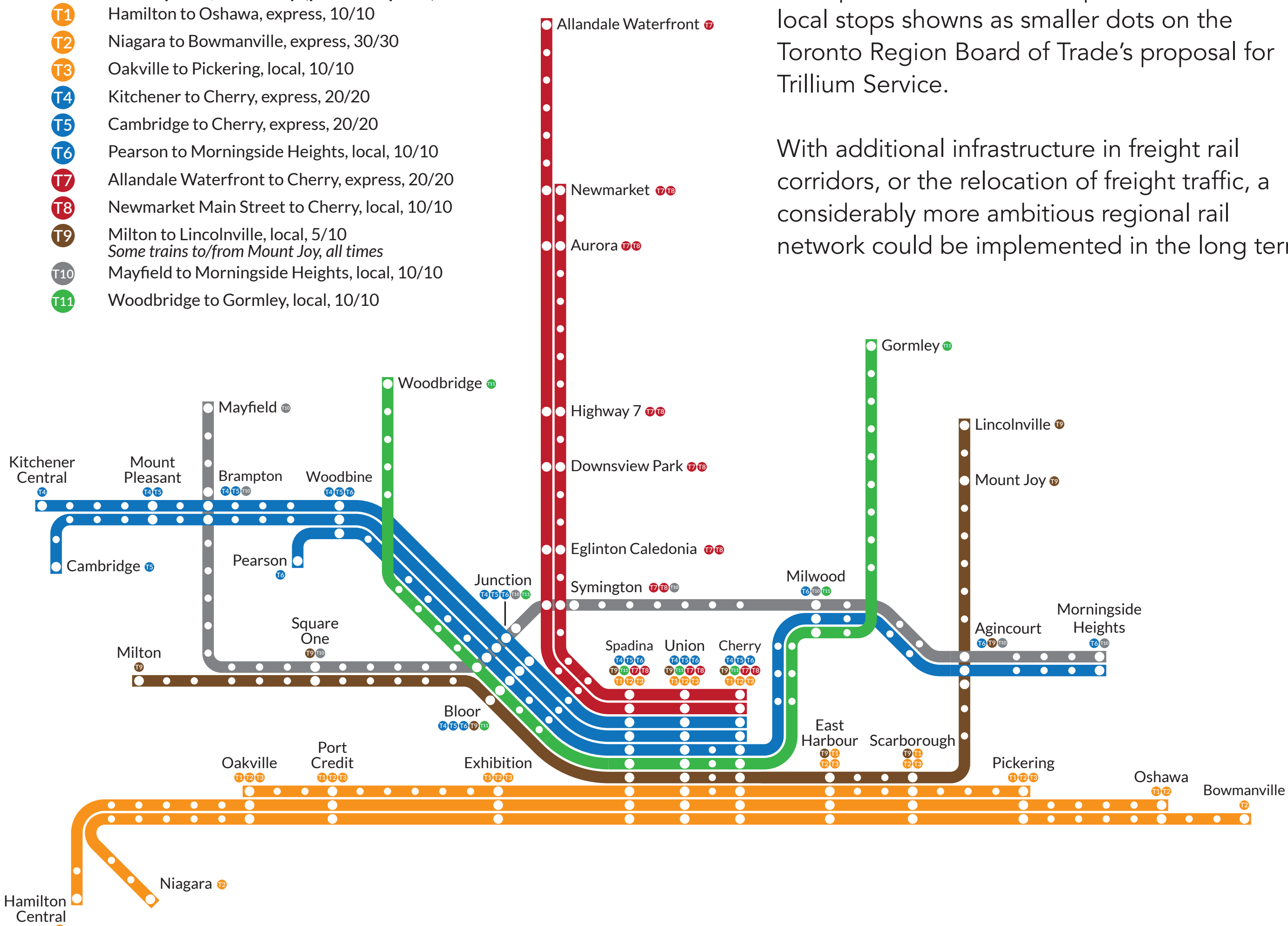
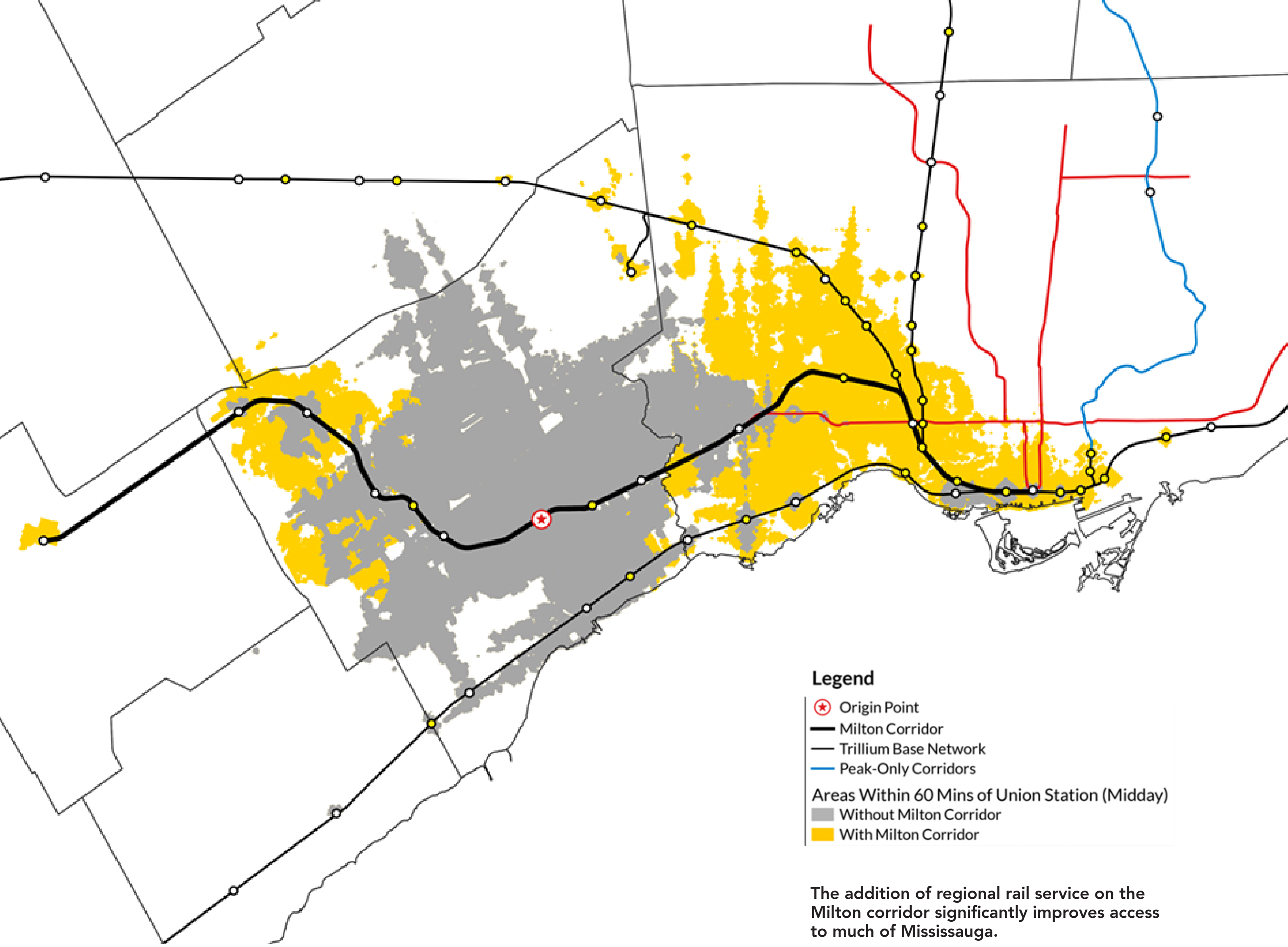
# Trillium Future Service

| Route | Description, headway (peak/off peak) |
|---|---|
| T1 | Hamilton to Oshawa, express, 10/10 |
| T2 | Niagara to Bowmanville, express, 30/30 |
| T3 | Oakville to Pickering, local, 10/10 |
| T4 | Kitchener to Cherry, express, 20/20 |
| T5 | Cambridge to Cherry, express, 20/20 |
| T6 | Pearson to Morningside Heights, local, 10/10 |
| T7 | Allandale Waterfront to Cherry, express, 20/20 |
| T8 | Newmarket Main Street to Cherry, local, 10/10 |
| T9 | Milton to Lincolnville, local, 5/10 *Some trains to/from Mount Joy, all times* |
| T10 | Mayfield to Morningside Heights, local, 10/10 |
| T11 | Woodbridge to Gormley, local, 10/10 |

All express and terminal stops are labeled, with local stops showns as smaller dots on the Toronto Region Board of Trade's proposal for Trillium Service.

With additional infrastructure in freight rail corridors, or the relocation of freight traffic, a considerably more ambitious regional rail network could be implemented in the long term.






**The addition of regional rail service on the Milton corridor significantly improves access to much of Mississauga.**

### The Value of the Milton Corridor

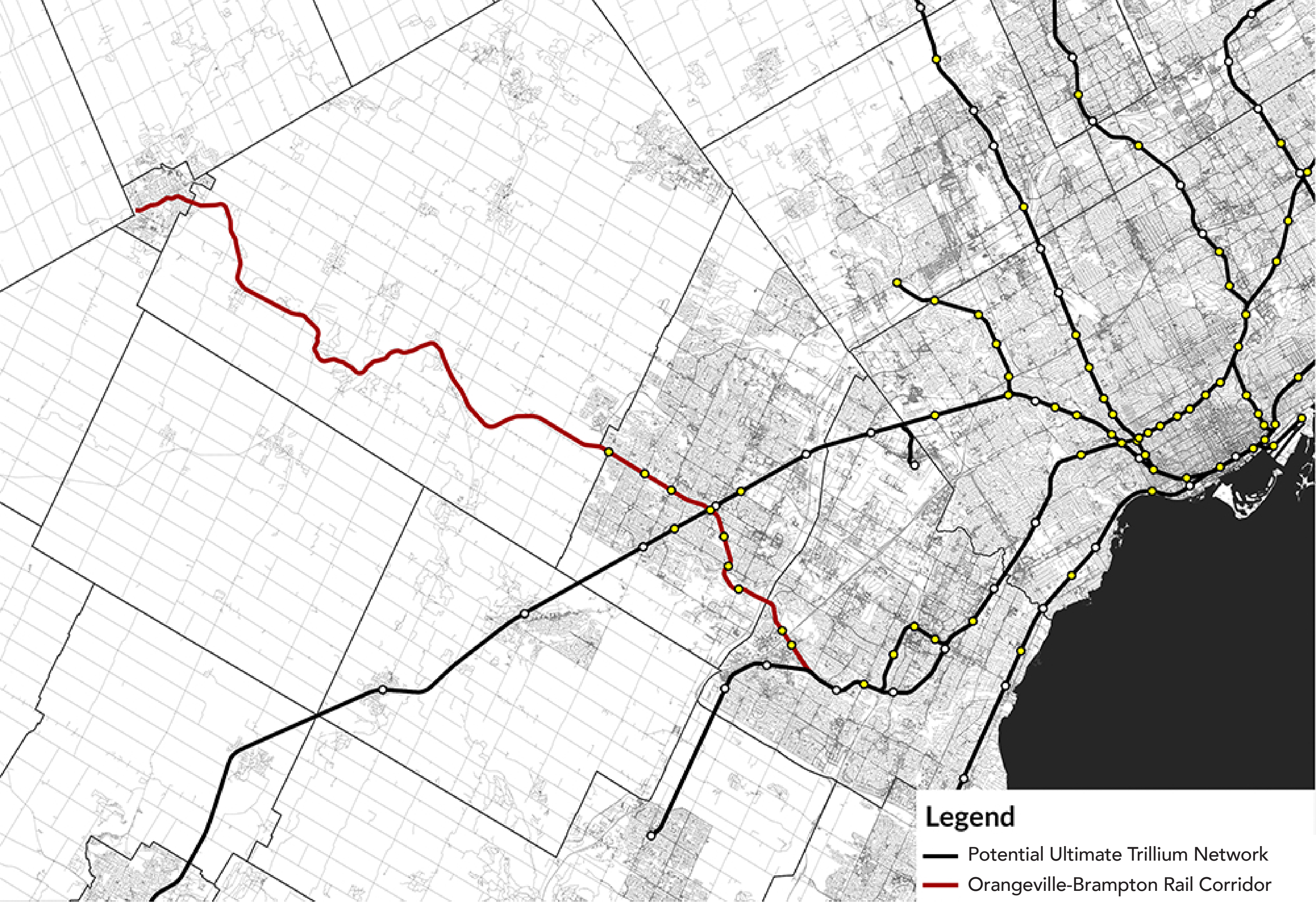
The Milton Corridor has arguably more regional rail potential than any other single corridor in the GO network. It provides a fast service from downtown Toronto to Etobicoke, Mississauga, and Milton. It would also serve as a convenient east-west "subway" for the second-largest municipality in the GTA, creating an 'X'-shaped rapid transit network when combined with the Transitway. The corridor, however, is currently used as Canadian Pacific's main freight route through the region. Given its importance to the region's economy as a goods movement conduit, this role must be accommodated and any plan for regional rail developed through collaboration between government and CP. It may be possible to add additional tracks in the corridor for passenger service, or to shift freight service elsewhere. Since building the Milton corridor from scratch, if it did not exist, would cost $37.5 billion at current rapid transit construction costs, finding ways to make use of the existing corridor would be enormously valuable. The Trillium plan proposes regional rail service on this key corridor, with compensation to CP and additional infrastructure to ensure no loss of freight capacity.

# Conclusion and Future Possibilities

This is just the beginning of the many possibilities for regional rail in the Toronto Region. There are several additional corridors that could be used for regional rail in order to create a truly comprehensive rapid transit network. For example, CP's current freight route across the region links Milton, central Mississauga, central Etobicoke, Midtown Toronto, the Don Mills/Eglinton area, Agincourt, Malvern, and even to the future development area in Seaton. It could provide an express route across the region that would make many east-west trips faster, relieve the Bloor-Danforth subway, and take pressure off the Union Station corridor. It would also improve the value of the Richmond Hill corridor by enabling a more direct routing and potential Ontario Line connection. Certainly, CP's needs must be carefully taken into account in any such measure—movement of goods in the region is just as important as the movement of passengers. Such a 78km corridor would cost $58.5 billion to replicate as a subway at typical construction costs, so it would not be unreasonable to provide CP with needed compensation for them to accept the change to their operations and free up or add additional capacity on the corridor.

Other lines that could be used effectively for regional rail in the longer term would be CP's corridor through northern Etobicoke to Woodbridge and Bolton, CP's corridor from Oshawa to Bowmanville, and the north-south rail corridor, owned by the Town of Orangeville, through Peel Region extending from Streetsville through the Meadowvale business park and downtown Brampton to north Brampton. The latter would serve one of the fastest-growing areas of the region and provide a rapid transit supplement to the GTA West highway. In all cases, it would be essential to ensure that sufficient capacity, or alternative routes, were available

**CP's current freight route across the region links Milton, central Mississauga, central Etobicoke, Midtown Toronto, the Don Mills/Eglinton area, Agincourt, Malvern, and even to the future development area in Seaton. It could provide an express route across the region that would make many east-west trips faster, relieve the Bloor-Danforth subway, and take pressure off the Union Station corridor.**




**The Orangeville-Brampton Railway corridor could be used as a north-south regional rail corridor connecting Brampton with the Meadowvale business park and central Mississauga.**

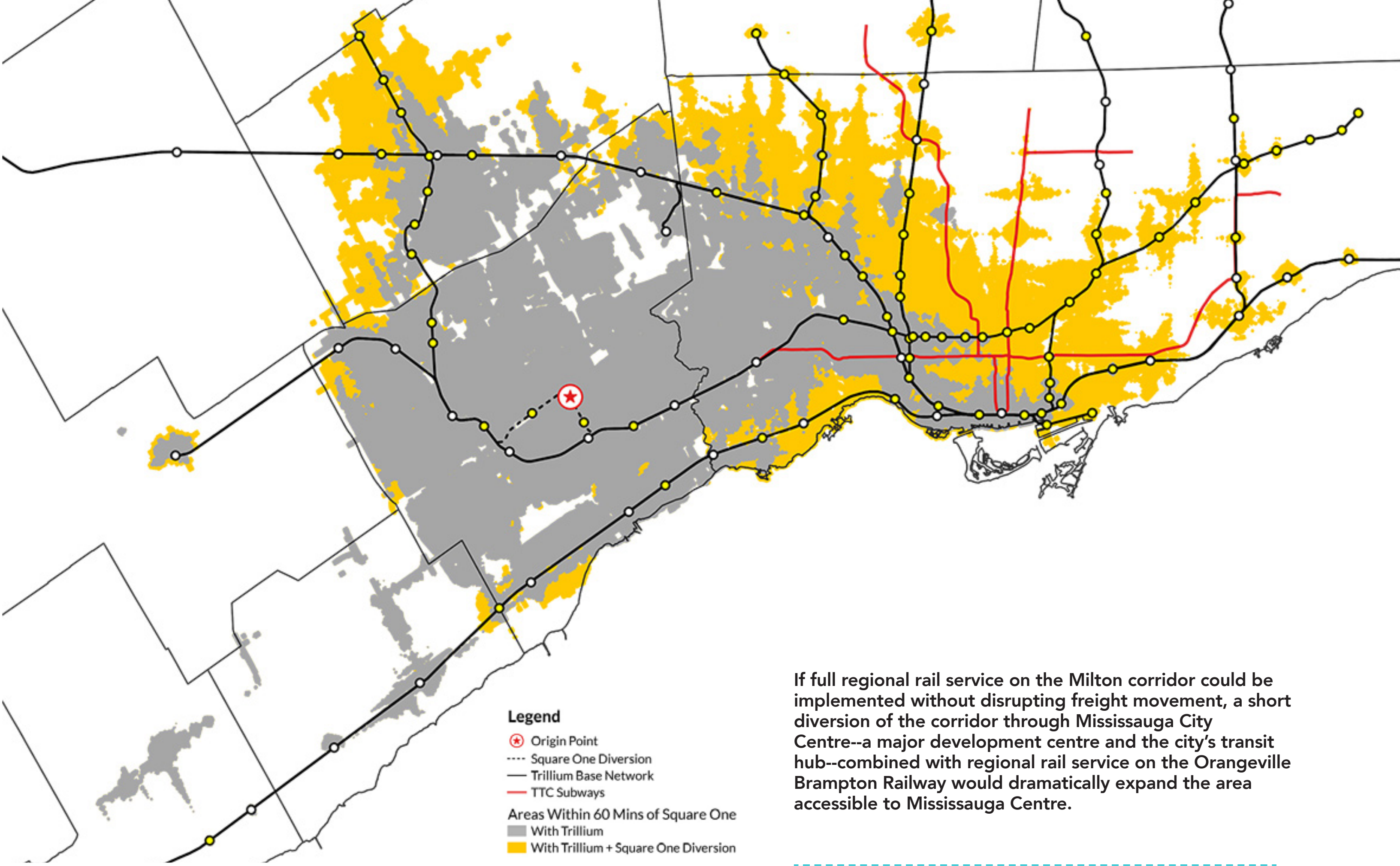
for freight service.

Once a rail line operates more frequently than a basic commuter service, it becomes cost-effective to consider building short diversions and spurs from the line to serve major destinations or new developments. For example, the Kitchener corridor passes very near to Pearson Airport. If it were to be diverted to directly serve the airport terminal and link with the Eglinton Crosstown and other local transit infrastructure, it could become a true "Union Station West." This could become the primary transit hub of the Airport Employment Zone—the second-largest concentration of employment in Canada—from which other local transit services could radiate to serve the entire district. It could furthermore serve as a key centre for development, and even be linked by VIA Rail's proposed High-Frequency Rail project with Ottawa and Montreal.

POTENTIAL OPPORTUNITY

### Orangeville Brampton Railway

The Orangeville-Brampton Railway is a rail corridor that links Orangeville with Brampton and the Milton Corridor in Mississauga. Today a freight-only route owned by the Town of Orangeville, the line is currently at risk of abandonment due to traffic losses. It is critical that this corridor be preserved, however: an extension of the regional rail network over the line could significantly increase connectivity within the 905 region, supporting transit-oriented growth and speeding travel. In the shorter term, it could be developed as part of an O-Train-style service connecting Mississauga and Brampton. In the longer term, it could function as a useful branch of a potential Trillium service on the Milton corridor.




**If full regional rail service on the Milton corridor could be implemented without disrupting freight movement, a short diversion of the corridor through Mississauga City Centre--a major development centre and the city's transit hub--combined with regional rail service on the Orangeville Brampton Railway would dramatically expand the area accessible to Mississauga Centre.**

If the Milton Line were to operate a full regional rail service, a short tunnel through the Mississauga City Centre would serve the major developments underway in the area, the city's main bus hub, and a connection to the Mississauga Transitway. It would efficiently link them with homes and employment areas across Mississauga, Milton, and Toronto--not to mention enabling trips from Square One to Union Station in 28 minutes. Much of the diversion could be economically built on the surface in the transit corridor reserved alongside Highway 403, rejoining the Milton corridor near the current Erindale station. Another diversion has been proposed as an alternative to the Scarborough subway extension, which would have the advantage of providing an express trip to downtown and a direct link north to Markham from Scarborough Centre. Yet another option would use regional rail to unlock development in the Port Lands by providing rapid transportation throughout the region. As there are more rail corridors serving a higher population on the western half of the GTA, at least some trains will have to turn around in the city centre. Instead, those services could be extended on a short underground route to the Port Lands, providing much faster and higher-capacity access to this key development area than the planned streetcar, while being relatively cheap to build through the undeveloped land.

POTENTIAL OPPORTUNITY

## Port Lands

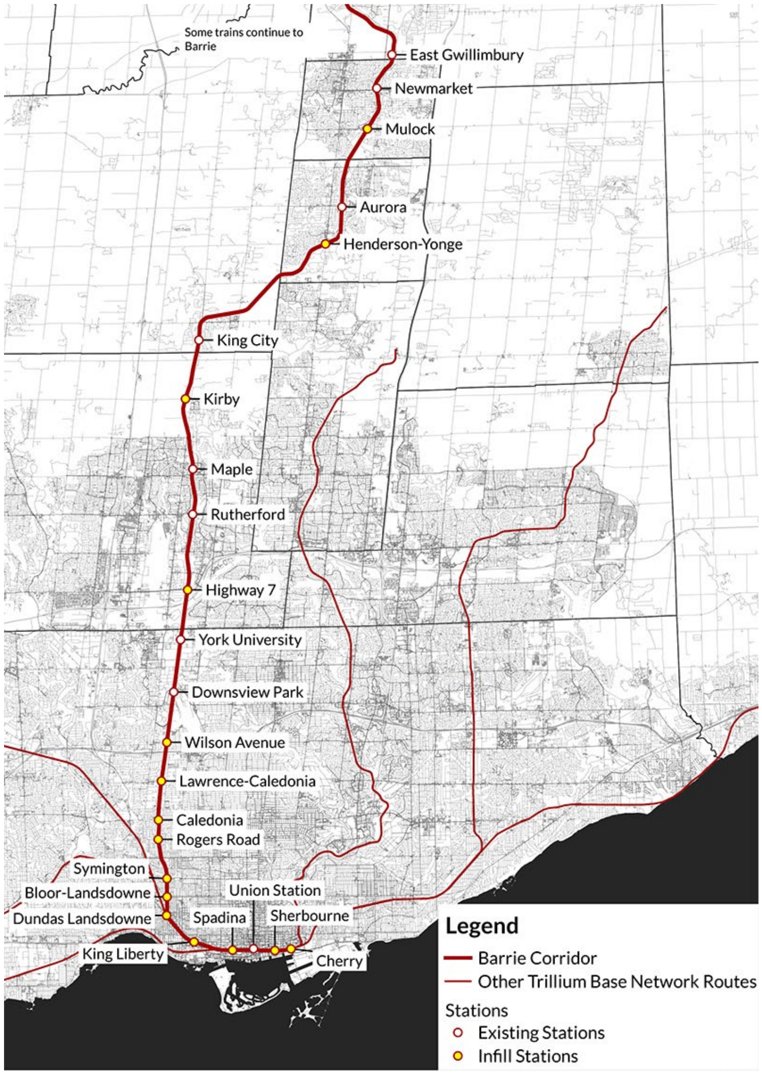
The development currently underway in the Port Lands will add tens of thousands of riders to Toronto's transit network in the coming years. Current plans hold that these riders be handled primarily via extensions of the TTC streetcar network into the new neighborhood, with services feeding an expanded terminal at Union Station. While streetcar service will be essential for local circulation in the Port Lands, a short extension of the regional rail network may be able to deliver more capacity and better regional connectivity to the burgeoning neighborhood. Digging a cut-and-cover tunnel from the Union Station Rail Corridor into the Port Lands would allow trains slated to terminate at Cherry Street in the Trillium plan to instead terminate in the Port Lands. This would increase equipment use in the network, while providing high-speed, high-capacity transit to the new neighborhood.

**Building infrastructure though a built-up community is far more expensive and disruptive than building through a farm field. If major new developments, such as Seaton in North Pickering and Queensville north of Newmarket, were directly served by regional rail branches from the outset, they would be much more likely to develop into the fifteen-minute, transit-oriented communities that we aspire to build.**

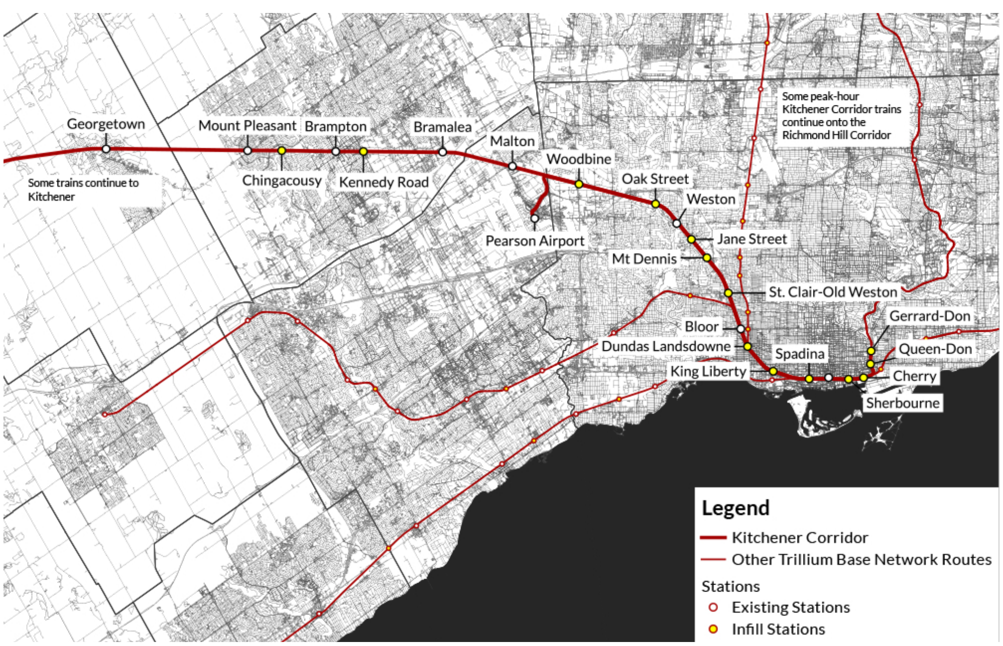
The Toronto Region, as the fastest-growing region in North America, continues to expand its urban area outward. While roads and highways are invariably completed before the first new house is occupied, transit is all-too-often only added later. Building infrastructure though a built-up community is far more expensive and disruptive than building through a farm field. If major new developments, such as Seaton in North Pickering and Queensville north of Newmarket, were directly served by regional rail branches from the outset, they would be much more likely to develop into the fifteen-minute, transit-oriented communities that we aspire to build.

The effective implementation of regional rail can set the Toronto Region on a new path. It would mean more access to jobs and services for residents, and to talent for employers. It would mean reduced congestion on our existing infrastructure. It would mean a lowered carbon footprint and better air quality. And it would help establish more complete, close-knit communities. Best of all, it can be accomplished for a fraction of the cost of building a cross-regional network of corridors from scratch. Building real regional rail must be the transportation task of this generation.

# Appendix: Proposed Station Locations

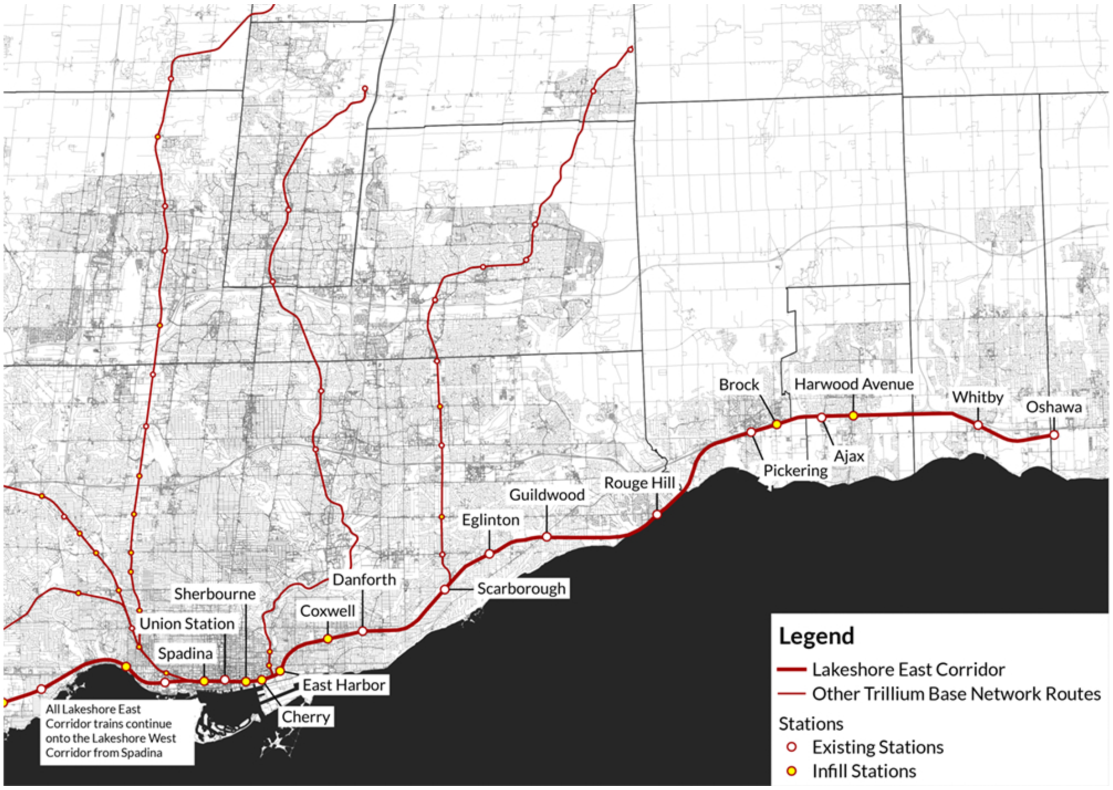



Barrie

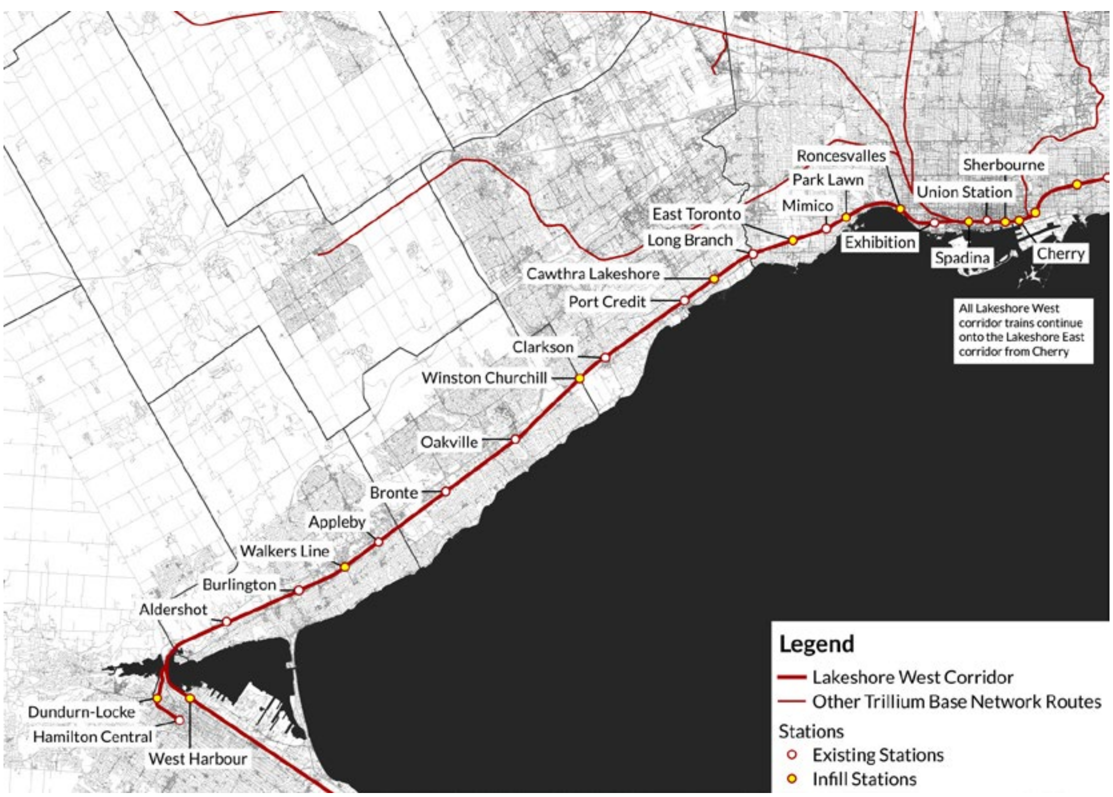



Kitchener

## Appendix

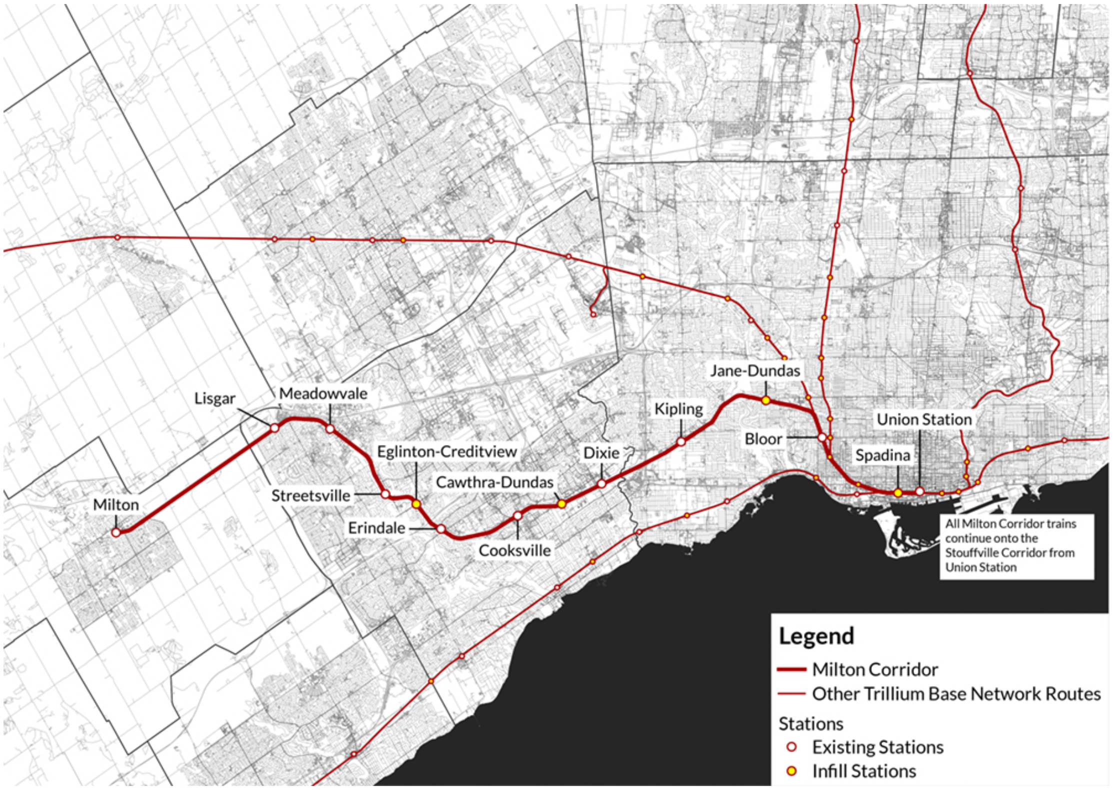



Lakeshore East

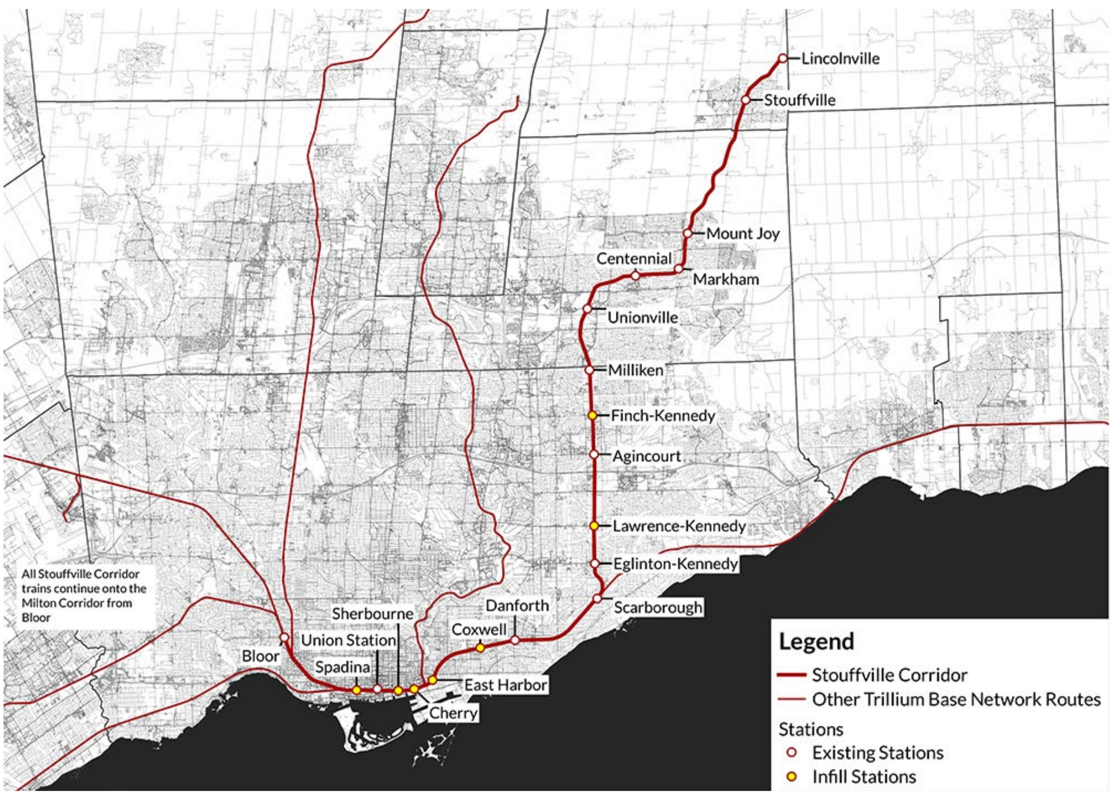



Lakeshore West

## Appendix




Milton




Stoufville

# Map Credits

**CORRIDOR MAP (PAGE 12)**

http://www.metrolinx.com/en/projectsandprograms/corridorownership/corridor_ownership.aspx

**NEIGHBOURHOOD IMPROVEMENT AREAS MAP (PAGE 13) — DATA CREDITS**

NIA boundaries
https://open.toronto.ca/dataset/neighbourhood-improvement-areas/

Municipal boundaries
https://geohub.lio.gov.on.ca/datasets/municipal-boundary-lower-and-single-tier

Transit route shapes
Transit agency GTFS feeds

**ISOCHRONE MAPS (PAGES 15, 47 AND 50)**

Municipal boundaries
https://geohub.lio.gov.on.ca/datasets/municipal-boundary-lower-and-single-tier

Transit route shapes and schedule data
Transit agency GTFS feeds (for 4/2019)

Street network data
OpenStreetMap contributors

Isochrone generation
https://www.opentripplanner.org/ (see here for citation guide)

**TRAINS PER HOUR CHARTS (PAGES 26-27)**

Schedule data
Transit agency GTFS feeds (for 10/2019)

**OBRY MAP AND APPENDIX MAPS (PAGES 52 AND 55-57)**

Municipal boundaries
https://geohub.lio.gov.on.ca/datasets/municipal-boundary-lower-and-single-tier

Transit route shapes
Transit agency GTFS feeds

Street network shapes
OpenStreetMap contributors

OBRY corridor shape
https://open.canada.ca/data/en/dataset/ac26807e-a1e8-49fa-87bf-451175a859b8

## Endnotes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