

WATERFRONT TRANSIT NETWORK – UNION STATION-QUEENS QUAY LINK AND EAST BAYFRONT LRT

The Waterfront Transit Network Program comprises several transit expansion and improvement projects in various stages of the project lifecycle. Two priority segments of the Waterfront Transit Network are the Union Station-Queens Quay Link (and East Bayfront LRT), and the Exhibition Loop - Dufferin Gate Loop Connection (see Attachment 1).

This Attachment reports on the updated options analysis associated with the Union Station-Queens Quay Link as a component of the East Bayfront Transit (LRT) Project.

A focused study area for the Union Station-Queens Quay Link includes the lower Bay Street Corridor between Front Street and Queens Quay, and the Queens Quay Corridor between approximately York and Freeland Street (Figure 1). The surface section of LRT along Queens Quay to the vicinity of Parliament Street, approved through the 2010 East Bayfront Transit EA is already in an advanced phase of design (>30%).

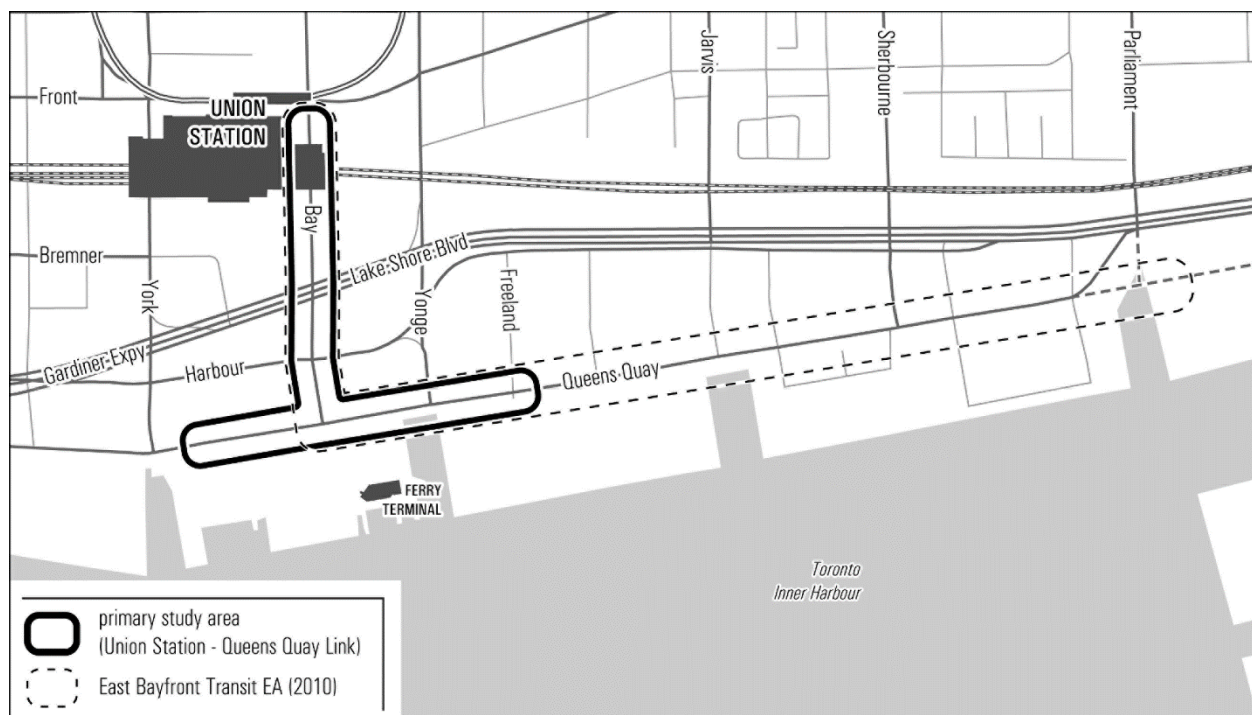


Figure 1. Project Study Area

The Union Station-Queens Quay Link, including the integrated East Bayfront LRT along Queens Quay is currently in the initiation and development phase of the project lifecycle, and is now at a decision-gate seeking authority to move to the next phase – preliminary design and engineering.

Decision History

In November 2015, City Council considered the report *EX9.9 Waterfront Transit Reset*, and directed City staff in consultation with the TTC and Waterfront Toronto to undertake a comprehensive review of waterfront transit initiatives and options.

Link: <http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2015.EX9.9>

In July 2016, City Council considered the report *EX16.17 Waterfront Transit Network Vision* and directed City staff to initiate a second phase of the Waterfront Transit "Reset" for further development and costing of alignment concepts, detailed analysis of transit operations and ridership, identification of priority segments, as well as a Business Case and implementation strategy for delivering a coordinated waterfront transit solution.

Link: <http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2016.EX16.17>

In January 2018, City Council considered the report *EX30.1 Waterfront Transit Network Plan*, and endorsed the overall Waterfront Transit Network Plan, including identification of priority segments. Council directed staff to complete a focused feasibility study of light rail and automated funicular technology options for connecting transit below grade between Union Station and Queens Quay.

Link: <http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2018.EX30.1>

Current Status of Project

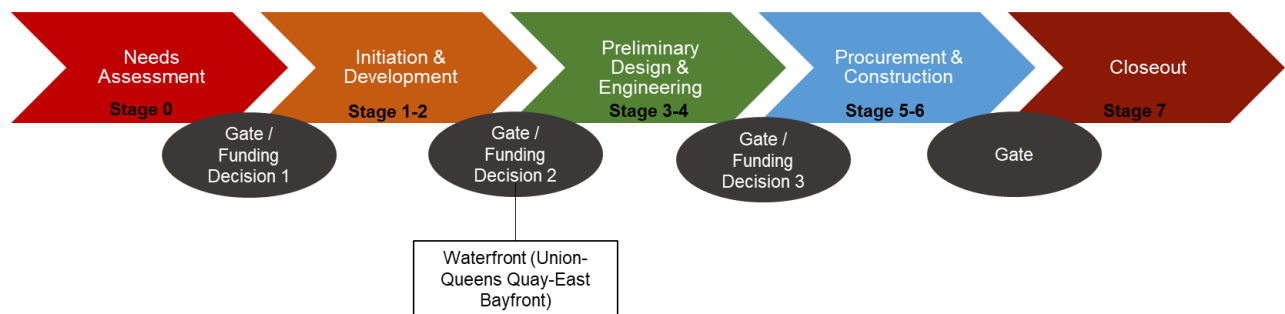


Figure 2. Current Status in the Project Lifecycle

The Union Station-Queens Quay Link is at a minimum of 5-10% design, with updated Class 4 cost estimates (Figure 2). The project is now ready to seek approval of the preferred technology option to proceed to the preliminary design and engineering phase. The previously approved surface section of the East Bayfront LRT along Queens Quay to the vicinity of Parliament Street is already in an advanced (>30%) phase of design. The line will ultimately connect to the Port Lands via an extension of Queens Quay to Cherry Street.

The 2010 East Bayfront Transit EA approved an LRT line from Union Station and along Queens Quay East to an interim loop in the vicinity of Parliament Street.¹ The EA included a streetcar portal along Queens Quay east of Yonge Street to transition the line from below grade under Bay Street to the surface along Queens Quay East. The EA also included a concept to expand the Union Station streetcar loop in order to accommodate the increased demand on the line. This element and the Bay Street section of the EA in particular were the focus for this study.

As directed by Council in EX30.1,² the feasibility study of light rail and automated funicular technology to connect transit below grade between Union Station and Queens Quay has been completed. A consultant team (led by Arup Canada) assisted the City with the study. This project is a partnership between the City, TTC, and Waterfront Toronto, led by the City Planning Division. Metrolinx was also consulted on the project.

The results of this study confirmed two viable options to improve the transit link between Union Station and Queens Quay – a Streetcar (Loop Expansion) Option and a driverless Automated People Mover (APM) Option. Each option was found to be consistent with Provincial 2041 Regional Transportation Plan Goals that will achieve higher transit ridership along the waterfront while providing access to key destinations for both residents and visitors.

Based on the analysis described in this attachment, the recommended preferred option is the Streetcar (Loop Expansion) Option. The key reason is that it expands the TTC's streetcar network capacity at the critical Union Station hub, allowing substantial flexibility for future waterfront streetcar service and operations to serve the significant and unique demands of the waterfront. The Streetcar Option provides a more convenient, moderately faster, and more accessible connection because no additional transfers or changes in vertical access would be required.

The preferred Streetcar (Loop Expansion) Option is generally consistent with the approved 2010 East Bayfront Transit EA Concept, with some key additional modifications to the design of both the Union and Queens Quay/Bay streetcar stations. The purpose of the modifications is to meet current transit station design and building codes, improve service and operational flexibility, and better integrate and connect transit passengers to adjoining land uses, transit services, and Union Station improvement plans.

Comments / Analysis

1. Project Objectives and Benefits

Toronto's waterfront is a unique and defining characteristic of the City. The area sees millions of annual visitors at its many venues and natural amenities and is increasingly

¹ https://waterfrontoronto.ca/nbe/wcm/connect/waterfront/611b92f5-1201-48ff-ac74-2f3de96dc609/ebf_environmental_study_report_1.pdf?MOD=AJPERES

² <http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2018.EX30.1>

becoming a mixed-use environment with new residences, schools, parks and workplaces. In the coming years, thousands of new residents will call the waterfront home, and many more will travel to and from the area on a daily basis to work and play. Population in the larger waterfront between Long Branch and the Port Lands is projected to increase by approximately 280,000 (83%) between 2011 and 2041, and employment growth for the same period is anticipated to increase by approximately 190,000 new jobs (38%). The East Bayfront in particular is anticipated to accommodate 6,000 residential units and 8,000 jobs, with millions of square feet of employment space. The completion of the waterfront transit network, and the improvements to the Union Station-Queens Quay Link in particular, is critical to support existing residents, businesses, tourism, and future growth.

Beginning in 2015, the Waterfront Transit Reset established a new vision for guiding Toronto's waterfront transit network planning: "*Provide high quality transit that will integrate waterfront communities, jobs, and destinations and link the waterfront to the broader City and regional transportation network.*"

Travel demand forecasting at various stages of the study all confirmed that light rail transit or equivalent capacity technology will support future transit demand along the waterfront between Long Branch and Leslie Street to the 2041 horizon year. The network can be phased according to infrastructure coordination and demand priorities, but the most critical component is the link to Union Station. The improvement of this connection will allow the benefits of the rest of the waterfront network to be fully realized. The existing underground streetcar loop at Union Station and connecting 540 metre long tunnel to Queens Quay opened in 1990. This facility is currently overtaxed with existing demand and inadequate to serve future ridership needs. A single narrow platform is currently used for both alighting and boarding by two separate routes, served by a single track. A streetcar loop expansion concept at Union Station was approved in 2010 as part of the East Bayfront Transit EA, but has remained unfunded.

Currently, approximately 1,000 passengers use the existing streetcar service southbound between Union Station and Queens Quay in the AM Peak Hour and up to 1500 passengers use the system northbound in the AM Peak Hour. Additionally, thousands of walk trips are made along Bay Street and in the PATH network between Union Station and destinations in the Queens Quay and Bay Street area.

During special events at Exhibition Place or in the Central Waterfront, transit demand at the existing Union streetcar loop is even greater, exceeding weekday peak volumes. For example, during the Canadian National Exhibition, hourly volumes approach 2,000 on the 509 Harbourfront streetcar. Queues for streetcar service during these events routinely extend into the Union Station concourse level.

Future AM peak hour transit demand in the corridor is projected to be 4,000 to 8,000 passengers southbound by 2041, with significantly greater numbers of walking trips. Demand projections assume all Council-approved transit projects including the Relief Line South, and fare integration.

As noted, waterfront areas feature a very high concentration of tourism, recreation and special event activities, which increase all day transit ridership. Trips generated by these significant travel activities, and trips made to/from the Billy Bishop City Centre Airport, are not fully captured in the transit demand estimating model, and therefore the actual all-day ridership numbers will likely be higher. This issue would affect the Business Case findings for both technologies, which reflect the all-day transit forecast generated by the ridership model.

2. Detailed Background Investigation and Initial Screening Process

The January 2018 report to Council on the Waterfront Transit Network Plan carried forward two categories of options for further focused assessment:

1. Streetcar loop expansion at Union Station including either 2 or 4 platforms;
2. Funicular (or alternative transit technology) below Bay Street including either a below-grade or above-grade streetcar at Queens Quay and Bay.

The following work was undertaken by the project team to help refine the two categories of options for the Union Station-Queens Quay Link:

- A. Background and Constraints Review – to improve understanding of constraints to constructability;
- B. Confirm technology – to further examine transit technologies which can serve forecast ridership considering the constraints to constructability;
- C. Ridership Review – to update the forecast transit demand for the Bay and Queens Quay corridors; and
- D. Screening – an initial screening of options within the two categories

A) Background and Constraints Review

The project team reviewed transit designs, utilities and other information from a number of previous and ongoing initiatives in the project area.

In summary, the review found the most significant constraints in the vicinity of the existing Union Station streetcar loop area below and adjacent to the Bay Street right-of-way and the Union Station Rail Corridor (USRC). Key constraints in this area include existing high pedestrian volumes/corridors, major hydro and sewer utilities, existing and proposed building foundations including 141 Bay Street and Union Station, as well as the piers supporting the Union Station Rail Corridor. Key constraints at the southern end of the Bay Street corridor and along Queens Quay include the narrow right-of-ways, high multi-modal at-grade activity, and requirements for property access. Finally, based on previous work in the study area, much of the below grade environment consists of contaminated fill.

B) Confirm Technology

The two technology options were confirmed to be either the TTC low floor streetcar (LFLRV) used in the existing streetcar network or customized, driverless Automated People Mover (APM) Transit Vehicles.³ Both options can accommodate forecast transit demand in the ~540 metre lower Bay Street Corridor. The key characteristics of the two technologies are summarized in Figure 3 below.



TTC Low-Floor Streetcar		Automated People Mover (APM) Vehicle	
<i>Length</i>	30m	<i>Length</i>	36m
<i>Capacity (standard load)</i>	130	<i>Capacity (standard load)</i>	200 (mostly standing)
<i>Propulsion</i>	Traction power	<i>Propulsion</i>	Cable-pulled
<i>Boarding/Alighting</i>	Single side	<i>Boarding/Alighting</i>	Both sides
			

Figure 3. Transit Technologies

While the streetcar is a well-known component of the TTC network, APM technology would be a new vehicle type. The Terminal Link Train at Toronto Pearson Airport is a local example of APM technology. This line is approximately 1.5 km in length, and runs on an elevated, mostly outdoor guideway that connects the Airport UP Express station with Terminals 1, 3, and a satellite parking facility. The project team completed further due diligence of APM technology, including review of various APM systems in operation worldwide and a meeting and site visit with Greater Toronto Airport Authority (GTAA) officials to gain a better understanding of APM operations and maintenance requirements and the overall reliability of the technology.

In summary, the due diligence review confirmed that APM are proven transit systems relied upon by many transit agencies, cities and airports worldwide to fulfill short distance transit needs. Due to operational constraints, APM are generally not an appropriate technology to serve longer distance (i.e., >2km) transit needs.

C) Transit Ridership Review

Transportation demand forecasting for the two confirmed technologies was undertaken using the City's Regional Demand Model (GTAModel V4). Forecasting was completed for a 2041 horizon year assuming the funded/committed future transit network and fare integration. The list of funded/committed projects includes the Line 2 East Extension, Eglinton Crosstown LRT, Finch West LRT, Sheppard East LRT, GO Expansion, SmartTrack Stations, and Relief Line South. The Waterfront LRT is assumed as the Council approved section from Park Lawn/Lake Shore Boulevard to Leslie

³ During the previous phase study, the second option was referred to as a "funicular", which is a particular sub-type of APM

Street/Commissioners Street. For the ridership analysis, an assumption was made that the APM would be operated as part of the TTC network, although there is the potential that the APM could be operated as a separate and/or fare-free service.

Forecast peak hour transit volumes in the Bay Street Corridor (AM Southbound) ranged between approximately 4,000 and 8,000, representing more than a quadrupling over the peak hour demand at the existing undersized Union Station Streetcar loop (see Figure 4). The wide range in the forecast is due to transit passengers choosing to walk or take one of the technology options for one-stop trips. The significant forecast increase is attributed mainly to the planned major GO Transit service expansion at the Union Station hub, and substantial ongoing development in the waterfront, and the eastern waterfront in particular. The forecasting also found that approximately 40% of future (AM) peak hour trips are destined from Union Station to the vicinity of Queens and Bay and the remaining 60% of trips are destined to the wider waterfront beyond.

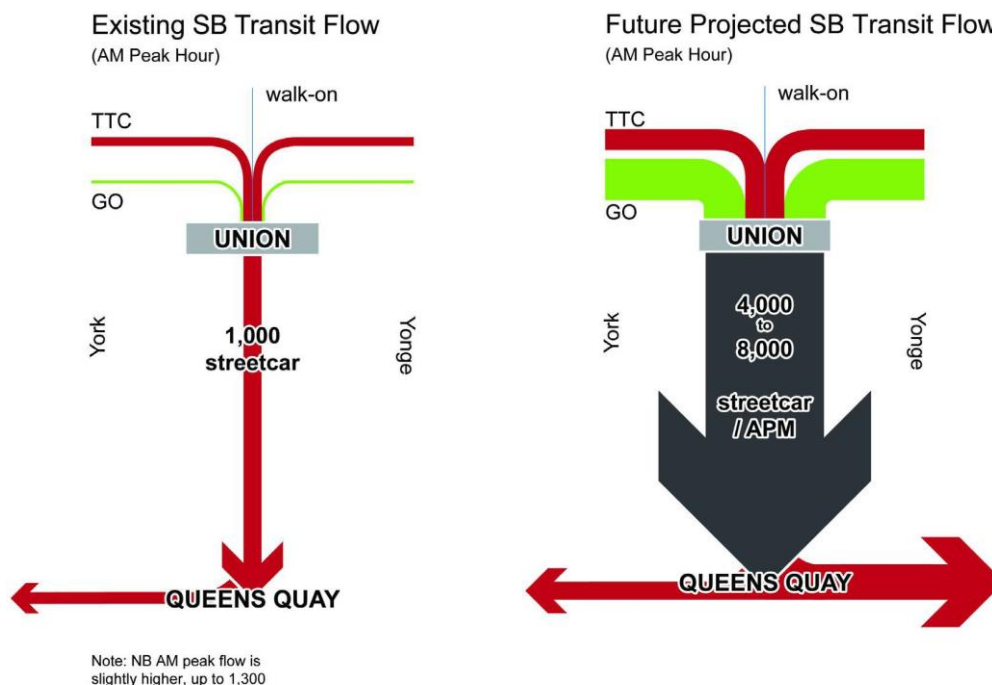


Figure 4. Existing vs. Forecast Transit Demand

The very high concentration of tourism, recreation and special event activities increase all-day transit ridership in the waterfront. Trips generated by these significant travel activities, and trips made to/from the Billy Bishop City Centre Airport, are not fully captured in the transit demand estimating model, and therefore the actual all-day ridership numbers will likely be higher than forecasts for all day ridership. Forecasts for all-day ridership are inputs into the Initial Business Case Assessment.

As noted during previous phases of the Waterfront Transit Reset, walk trips are very significant and growing in the Bay Corridor in particular, and pedestrian infrastructure should continue to be improved regardless of the transit option provided.

D) Link Options Screening

The City's Rapid Transit Evaluation Framework (RTEF) was used to compare the two categories of options for the Union Station-Queens Quay Transit Link.

The screening criteria included: user experience (including travel time, accessibility, connectivity, comfort, and reliability measures), cost (based on previous cost estimates), constructability (including impact to transit, pedestrians, and traffic), urban design and place-making opportunities, and other factors such as capacity and property impacts.

The two categories of options for screening included:

- Option 1: An expanded Union Station Streetcar Loop and Queens Quay/Ferry Docks Station (consistent with but building upon the approved EA concept);
 - 1A: Including four platforms at Union Station
 - 1B: Including two platforms at Union Station
- Option 2: Automated People Mover (APM) system under Bay Street from Union Station to Queens Quay
 - 2A: Including underground streetcar along Queens Quay at Bay Street;
 - 2B: Including surface streetcar along Queens Quay at Bay Street

Ultimately, Option 1B was screened out for the key reason that it cannot support the projected demand forecast for the project.

Option 2B was also screened out for the following reasons:

- The volumes of transit passengers transferring between the APM and a surface streetcar on Queens Quay (approx. 60% of peak hour trips) would create significant potential for conflicts between pedestrians, cyclists, transit, and traffic at the busy intersection;
- There is insufficient space to fit at-grade streetcar platforms without significant impacts to intersection operations and vehicle lanes; and
- Transit passengers making the transfer at Queens Quay and Bay would not have the benefit of a weather protected environment.

Based on the results of the screening, Options 1A and 2A were carried forward for further design refinement. For Option 2A, it was also confirmed that a double track bypass midway between Union Station and Queens Quay would not be required to support the projected demand forecast, with two larger APM trains (one in each tunnel) replacing four smaller APM trains (two in each tunnel).

3. Refining Options for Each Technology

The design of Options 1A and 2A were advanced to a 5-10% level and described in the following section. All stations for each option are designed to current standards (Ontario Building Code, AODA, National Fire Protection Association Standards for Fixed

Guideway Transit and Passenger Rail Systems (NFPA 130) and City of Toronto PATH guidelines).

1A) Streetcar Option

The expansion of the existing streetcar loop terminal at Union Station allows for increased passenger capacity and accommodates future streetcar service both east and west of Bay Street along Queens Quay. The design is essentially the 2010 EA-approved concept with some modification to both infrastructure and TTC service assumptions. The option includes, in summary:

- Four underground streetcar platforms at Union Station, two each on either side of the loop, including bypass tracks for all platforms, allowing separation of passenger flows for different directions of service, or for boarding and alighting;
- Lengthening the existing underground Queens Quay/Ferry Docks Station platform from approximately 35 metres to 60 metres to allow double berthing of streetcars;
- An underground streetcar track connection between Bay Street and Queens Quay East with portal to surface at a location east of Bay Street;
- Underground east-west (through) streetcar track at Queens Quay and Bay Street to allow flexibility for future streetcar service bypass of Union Station;
- Improved transit passenger connectivity to Union Station, Line 1 Subway, GO Transit, local developments, and the pedestrian network at both Union Station and Queens Quay/Ferry Docks Station;
 - Includes a proposed new connection to/from the Jack Layton Ferry Terminal under Queens Quay
 - Includes a proposed new connection to the Bay East Teamway, although this will require further review in conjunction with Metrolinx to determine overall feasibility/location
- Removal of the existing pedestrian level-crossing of the streetcar track underground at Queens Quay/Ferry Docks Station, and replacing it with an under-track accessible pedestrian connection to minimize delays to transit service;
- Replacing Union Station Rail Corridor piers between the teamways and roadway with reduced profile columns or alternative supporting structures to allow for efficient boarding and alighting of streetcars underground;
- Lowering the streetcar track/platforms a minimum of 1.4 m at Union Station in order to accommodate overtrack ventilation;
- Property required at 141 Bay, 1 Front, and Union Station (Metrolinx);
- Protection for a potential Bremner LRT service in the longer term to connect to the expanded Union loop.

Appendix A illustrates the Streetcar Option 1A Design.

2A) Automated People Mover (APM) Option

This option includes repurposing of the existing streetcar tunnel and stations under Bay Street with driverless, cable propelled vehicular transit systems connecting Union

Station to an east-west LRT/streetcar along Queens Quay. The option includes, in summary:

- Separate, individually propelled, automated transit system within each bore of the existing streetcar tunnel under Bay Street;
 - Three platforms at both Union Station and Queens Quay/Ferry Docks Station;
 - A common central platform to facilitate boarding to each vehicle/track and side platforms to facilitate alighting from each vehicle/track;
 - Boarding and alighting of vehicles at each station would occur simultaneously with doors on both sides of the vehicle;
- East-west streetcar track and new station underground at Queens Quay and Bay Street. The new station would include 60 m platforms to allow for streetcar double berthing;
- Underground pedestrian ramps between the east-west streetcar service and the north south APM vehicles to facilitate passenger transfers and reduce delays to streetcar operations;
- APM drive room including horizontal cable-drive wheel below Union terminal;
- APM maintenance room below track level north of the Queens Quay/Ferry Docks station;
- Streetcar portal on Queens Quay East to surface at a location east of Bay Street;
- Improved transit passenger connectivity to Union Station, Line 1 Subway, GO Transit, local developments, and the pedestrian network at both Union Station and Queens Quay/Ferry Docks Station;
 - Includes a proposed new connection to/from the Jack Layton Ferry Terminal under Queens Quay;
- A potential Bremner LRT in the longer term would not be able to connect to the existing Union Station terminal area and an alternative terminal for this route would need to be provided.

Appendix B illustrates the Automated People Mover Option 2A Design.

Eastern Portal Location & Analysis

The previously approved East Bayfront Transit EA provides for a streetcar portal located in the vicinity of Queens Quay and Freeland Street, east of Yonge Street. Due to costs and constraints involved with this design, an alternative portal location west of Yonge Street along Queens Quay may be more appropriate. The alternative portal location west of Yonge Street may provide benefits in terms of cost, public realm, and transportation operations. A new portal location may be accommodated with either technology option and is not a decision relevant factor for the evaluation of options, but further analysis is recommended during the next stage of design.

4. Key Evaluation Criteria and Detailed Assessments

The evaluation framework used for the initial screening process was further refined to include only the key criteria which would indicate notable differentiation between Option 1A (Streetcar Option) and Option 2A (APM Option). The key criteria used in the final

evaluation between the technologies included *Transit User Experience*, *Network Transportation*, *Constructability*, and *Cost*. A summary of the analysis is as follows.

Transit User Experience Assessment

For the two options, a transit user experience assessment was conducted to assess travel time, convenience, reliability, and station accessibility and safety from a passenger perspective. Overall, both options offered certain travel time and convenience advantages depending on the individual transit trip destinations and origins. For those passengers connecting between Union Station and the east and west waterfront, the Streetcar Option provides a more convenient, moderately faster, and more accessible connection because no additional transfers or changes in vertical access would be required. For those passengers travelling only between Union Station and Queens Quay (such as to access or depart the ferry terminal, hotel, office, and residential buildings), the APM Option provides a moderately faster and more reliable connection.

The majority of trips are longer distance, and the transfer would be particularly inconvenient for those with accessibility needs, families with strollers, and large groups. As a result, the Streetcar Option ultimately was preferred in this component of the evaluation.

Network Transportation Assessment

For the APM Option, forecast ridership is lower on the eastbound and westbound Queens Quay streetcars compared to the Streetcar Option. This is attributed to the inconvenience of forcing a passenger to transfer from APM to the streetcar at Queens Quay and Bay to complete a longer distance trip. The APM Option has higher forecast ridership volumes than the streetcar option between Union Station and Queens Quay because the frequent, reliable and convenient service attracts significant numbers of passengers who would otherwise walk the one-stop distance.

Overall TTC network ridership may be slightly higher with the Streetcar Option, and overall GO network ridership may be slightly higher with the APM Option, but the difference in overall transit network ridership between the options is minimal.

As established during the earlier phases of the Waterfront Transit Reset, the overarching vision is an interconnected and continuous network where possible, and not individual, segmented transit lines. For this key reason the Streetcar Option is preferred in this component of the evaluation because it expands the TTC's streetcar network presence at the critical Union Station hub. It also provides significant flexibility for future waterfront streetcar service, operations, and adaptability to the evolving and unique demands of the waterfront. This includes the potential for a future Bremner LRT service to connect to Union Loop.

Constructability Assessment

For the Streetcar Option, the construction of the expanded Union Station Loop is complex and will require advanced construction techniques and more time to implement due to the extent of works required under the active Union Station Rail Corridor (estimated duration 4-5 years). This work requires replacing rail corridor piers in combination with lowering the streetcar track underground due to clearance requirements for overtrack ventilation to meet fire and life safety requirements. It is important to note that the replacement of rail corridor piers has been undertaken for the adjacent revitalization of Union Station and the appropriate construction methodology is well-understood. The Bay East and West pedestrian teamways under the Rail Corridor, as well as portions of property at 141 Bay Street and 1 Front Street would be impacted during the construction of the streetcar option because the proposed station platforms and passenger circulation areas are located directly beneath them. The next phases of design would determine temporary pedestrian structures and/or diversion routes for the significant pedestrian activities within this area in particular.

For either option, construction of the new/expanded Queens Quay/Ferry Docks Station will likely be a traditional open cut excavation using secant pile walls. Construction in this area would be of a longer duration for the APM Option due to the significantly larger station footprint, including adding new streetcar platforms under Queens Quay, but the overall construction period is shorter with the APM option (estimated duration 3-4 years).

Utility relocations throughout the study area will be significant for either option and a SUE B level utility investigation will be required as an early component of follow-up works.

During the construction period, direct streetcar service to/from Union Station would be suspended during tunnel work. Mitigation for impacts to transit during construction would be evaluated in follow up work, including replacement bus service, phasing options to minimize downtime for streetcar service along Queens Quay, and improvement of pedestrian routes. One lane of traffic will be preserved in either direction on impacted roads during the construction period.

Overall, the APM Option would have both a shorter duration and less complex construction (e.g., teamways could remain open) and is preferred in this component of the evaluation.

Both capital and operating costs were included as key evaluation criteria and are presented in the following section.

5. Costs

Table 1 includes preliminary (Class 4) capital construction cost estimates for each transit option for the Union Station-Queens Quay Link, and includes the cost of completing the East Bayfront LRT to the vicinity of Parliament Street. The capital cost

estimates were prepared by A.W. Hooker quantity surveyors based on the definition for estimate classifications (Class D) outlined in the *Guide to Cost Predictability in Construction* prepared jointly by the Federal Government and an Industry Cost Predictability Taskforce. Class 4 cost estimates are intended for planning purposes only and will be refined as detailed design and project planning advances. Further design work is required to provide an increased level of confidence and greater precision with regard to project elements, feasibility and risks suitable for budget authorization. Per best practice established by the Association for the Advancement of Cost Engineering International (AACE), the project budget and schedule should be established once a Class 3 cost estimate has been achieved.

Table 1. Capital Costs

Option	Capital Costs (2019\$)
1A. Streetcar Expansion below Bay Street integrated with streetcar along Queens Quay East (Streetcar Option)	\$612 M
2A. Automated People Mover below Bay Street and streetcar along Queens Quay East (APM Option)	\$600 M
Note: Class 4 cost estimates include capital construction for each transit option for the Union Station-Queens Quay Link and includes the cost of completing the East Bayfront LRT to the vicinity of Parliament Street, including revitalization/roadway reconstruction along Queens Quay between Bay Street and Parliament Street. Excludes costs associated with procurement, escalation, lifecycle, operations and maintenance.	

The above cost estimates exclude any required property costs and include the EA-approved eastern streetcar portal located on Queens Quay East of Yonge Street. There are potential cost savings with an alternative portal location west of Yonge Street which will be further evaluated during the next phase of design. Escalated costs for the streetcar option are shown in Table 2.

Table 2. Streetcar Option Escalated Costs

Option	Capital Costs (YOE\$)
1A. Streetcar Expansion below Bay Street integrated with streetcar along Queens Quay East (Streetcar Option)	\$745 M
Note: Escalated by 4% per year to midpoint year of project, assuming a 2021-2027 construction period. Based on a Class 4 cost estimate of \$612 M (2019\$) from Table 1. Excludes costs associated with procurement, lifecycle, operating and maintenance.	

A high level review of operations costs was completed by Arup. This review confirmed that operating costs between the two options would be relatively similar for a 30-year lifecycle. The APM Option would likely result in labour cost savings for operation of the link service, but this would likely be offset by increased streetcar operating costs due to the loss of the streetcar operating flexibility provided by the centralized Union Station Loop.

6. Evaluation Summary

Table 3. Summary of Evaluation

Criterion	Streetcar Option	APM Option
User Experience		
<i>Travel time assessment</i>	Medium/longer trips faster	Short trips faster
<i>Service reliability</i>	Union Loop subject to potential on-street delays	Higher headway reliability for Bay Street trips
<i>Comfort/convenience/accessibility</i>	Direct ride to/from Union	Additional transfer to/from Union
Conclusion	Preliminary Preferred	
Transportation		
<i>Local (QQ & Bay) transit riders</i>	Higher along QQ east and west	Higher for Bay Street
<i>Network (GTA) transit riders</i>	Small increase in TTC ridership	Small increase in GO ridership
<i>Streetcar network</i>	Expanded terminal at Union with more flexibility for routing and service	No terminal at Union with less routing flexibility for waterfront network
Conclusion	Preliminary Preferred	
Construction Impacts		
<i>Risk profile</i>	Rail viaduct risks	No rail viaduct risks
<i>Pedestrian teamways</i>	Teamways closed and pedestrians rerouted due to construction	Teamways not closed for construction
<i>Property impacts</i>	141 Bay basement impacts and teamways	No significant impacts
<i>Bay Street lane impacts</i>	South of rail viaduct impacts	No significant impacts
<i>Duration estimation</i>	4-5 years	3-4 years
Conclusion		Preliminary Preferred
Cost		
<i>Capital costs (to vicinity of Parliament St.) - Class 4, \$2019</i>	\$612 million	\$600 million
Conclusion	Comparable; No Preliminary Preferred	
Overall Preliminary Preferred	Streetcar Option	

7. Consultation

Public and stakeholder consultation was undertaken to present and receive feedback on the analysis, key criteria and the preliminary evaluation of alternatives. The consultation program included:

- Stakeholder Advisory Committee (SAC) meetings on January 22, 2019 and February 28, 2019
- A public meeting on March 4, 2019 at the Harbourfront Centre
- Online consultation through updates to the project website (www.toronto.ca/waterfronttransit) and emails to the project mailing list (waterfronttransit@toronto.ca)

Through these methods of consultation, over 100 participants were engaged in person and over 50 detailed comment forms and online responses were received.

The feedback received showed overwhelming public and stakeholder agreement with the identification of the Streetcar Option as a preliminary preferred option. Most participants indicated support for this option because it retains the continuous existing transfer free link to Union Station.

Overall, participants agreed that the evaluation criteria and evaluation were logical and clear. A common concern was uncertainty about the project timeline and funding from Council. Some participants raised concerns about the length and impact of the construction period and that streetcar service to Union Station would not be possible during construction of the Streetcar Option. Others suggested the City should look for ways to allow for an east-west streetcar service along Queens Quay to operate during the construction period.

A meeting with the Waterfront BIA and local landowners was held on March 8, 2019. Overall, the feedback from this meeting generally echoed the feedback received from the public, including construction impacts and potential phasing to advance the East Bayfront LRT. Additionally, the BIA/landowners were interested in opportunities to extend the PATH network connections to the waterfront.

The project was presented to the Waterfront Design Review Panel for information on March 20, 2019. Overall, the feedback from this meeting also echoed the feedback received from the public, indicating general support for the streetcar option and the need to prioritize the project. One suggestion from the panel, to be considered for subsequent design refinements, was to apply a refined architectural touch such as "radii" to the station walls to help create a "sense of place" within the stations.

8. Summary of Initial Business Case Assessment (IBCA) Findings for the Waterfront Transit Network

An initial business case assessment (IBCA) for the implementation of the entire waterfront transit network was undertaken by Arup, the lead study consultant, using

methodology consistent with Metrolinx business case guidance and modified for City of Toronto purposes. The IBCA included a comparative assessment of the Union Queens Quay Link Streetcar Option 1A and APM Option 2A including the extension of LRT to the East Bayfront for both options.

The following is a high level summary of initial business case findings. The full findings of the IBCA for waterfront transit can be found on the project website at www.toronto.ca/waterfronttransit.

Strategic case

Both the APM Option and the Streetcar Option meet the 2041 Regional Transportation Plan (RTP) goals and accommodate and facilitate greatly increased transit ridership in the waterfront. The significant increase in weekday commuter (peak hour) demand is only one part of the findings. There is significant additional demand outside of typical commuter peaks (e.g., all-day and weekends) associated with the Jack Layton Ferry Terminal, Harbourfront Centre, Billy Bishop Toronto City Airport, and other general activities, events and recreational uses in the waterfront.

Based on the analysis of specific criteria identified for the comparative evaluation, the Streetcar Option is preferred over the APM Option for the Union Queens Quay Link. The key strategic benefits of the Streetcar Option are for the key reasons of one less transfer in the network and increased routing flexibility for the network.

Financial case

The financial case includes capital costs, 60 year operating and maintenance (O&M) costs and incremental revenue. Costs are based on previous Class 5 cost estimates for the waterfront transit streetcar network from Park Lawn to Leslie, plus the updated Class 4 cost for the Union Station-Queens Quay Transit Link Options. Approximate total net costs for the waterfront transit network including either APM or Streetcar Option for the Union Queens Quay Link are in the order of \$2.05 billion.

Economic case

The resulting expanded benefit-cost ratio (BCR) for the waterfront transit network including either an APM Option or Streetcar Option for the Union Station-Queens Quay Link is in the range of 0.41-0.55. Because of the unique network location, new transit technology and all-day ridership considerations that are not well captured in the forecasting model, there could be variations on the BCR; hence a range is presented. Also, the IBCA did not include an analysis of land value uplift and agglomeration economies, which, if considered in a more detailed analysis, would provide for a higher BCR range.

Deliverability and operations case

The Streetcar Option has a higher risk profile associated with a longer construction period. There are long term operational efficiencies for TTC in servicing the wider waterfront network.

The APM Option has a lower risk profile associated with a shorter construction period. The APM has a higher operational risk profile due to the fact this is a new vehicle and system type in the network which would require specific training and procedures. Introduction of the APM would also require a terminal station be constructed for a potential future Bremner streetcar.

Overall, further expansion of the waterfront transit network will continue to increase pressure on the existing streetcar loop at Union Station. Given this, the Union-Queens Quay Link should be prioritized in advance of, or concurrent with, delivery of other waterfront network expansion projects.

9. Recommended Option and Next Steps

In conclusion, the analysis described in this report reinforces the need to implement a waterfront streetcar/LRT network that will serve growth in the eastern waterfront in particular. Based on both the results of the technical evaluation (in particular the benefits to streetcar service network planning and operations), as well as input from the public and stakeholders, the Streetcar Option is recommended as the preferred option for the Union Station-Queens Quay Transit Link. The recommended Preferred Streetcar Option for the Union Station-Queens Quay Transit Link was well received by the public and stakeholders, who expressed the importance of ensuring this project moves to the next phases of design and construction as soon as possible.

In view of these findings, staff recommend that City Council approve the Streetcar Option as identified in this report, and authorize advancing the preliminary design and engineering of the project in order to develop a Class 3 cost estimate and Level 3 schedule, which would include the previously approved section of the Queens Quay LRT to Parliament Street. Any requirements for EA Addendum, if appropriate, would be undertaken as part of the next phase of design.

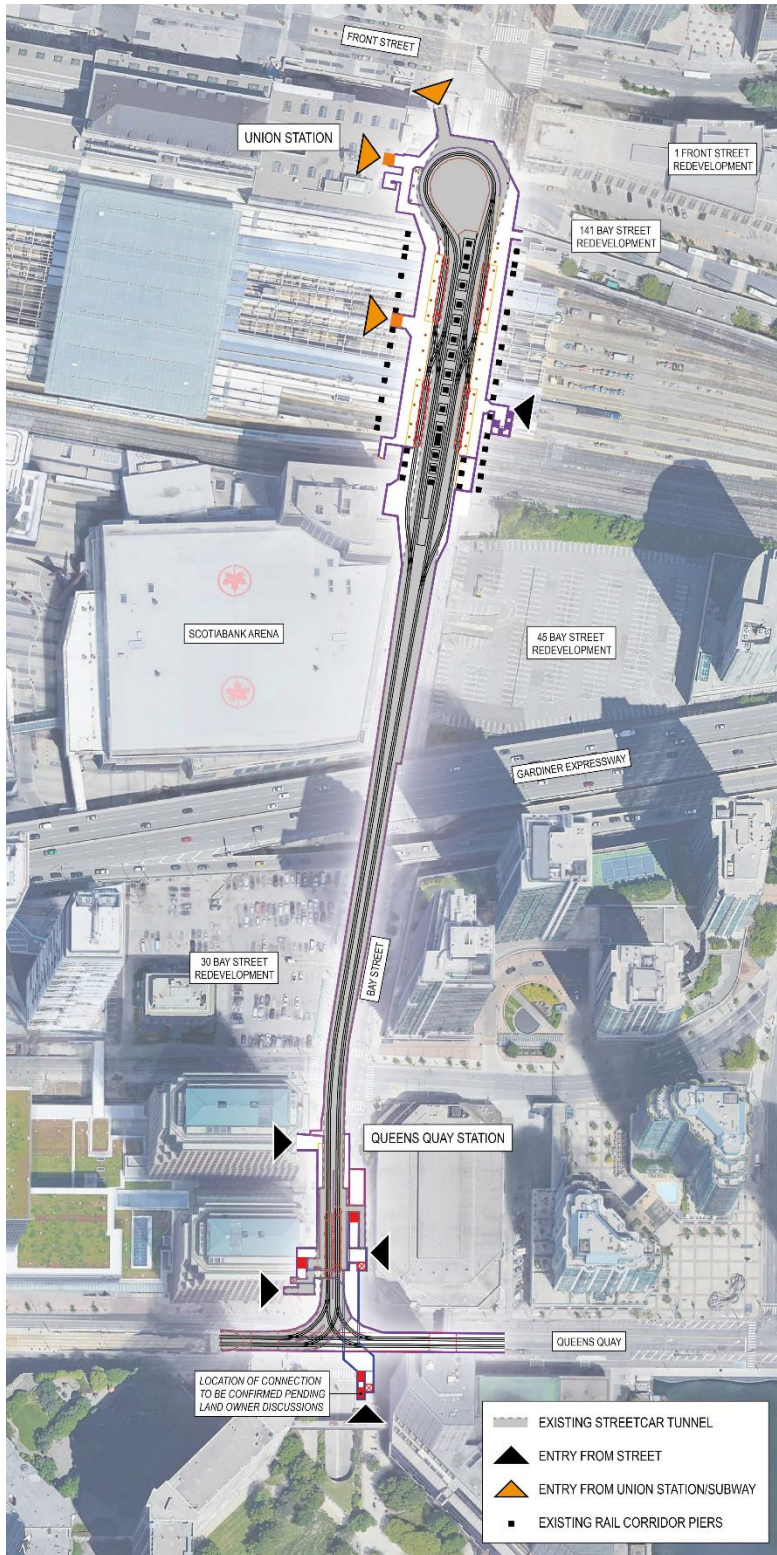
In addition to the key task of advancing the overall project design, the next stage of the project would include considering and advancing, if warranted, a potential cost-saving alternative eastern portal west of Yonge Street, and an alternative streetcar turning loop location at the east end of the project. In addition, the City will continue to work with landowners in the lower Bay Street and Queens Quay corridors to identify further opportunities for improvements to the PATH/pedestrian network.

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Appendix A – Preferred Streetcar Option



Note: All drawings are preliminary and are not necessarily representative of final design.

Figure A1. Concept Map, Preferred Streetcar Option for Union Station-Queens Quay Link



Figure A2. Union Station Streetcar Station looking South-Southeast along West platform. Artist's depiction subject to change and future design refinement.



Figure A3. Queens Quay/Ferry Docks Streetcar Station looking South along East platform. Artist's depiction subject to change and future design refinement.

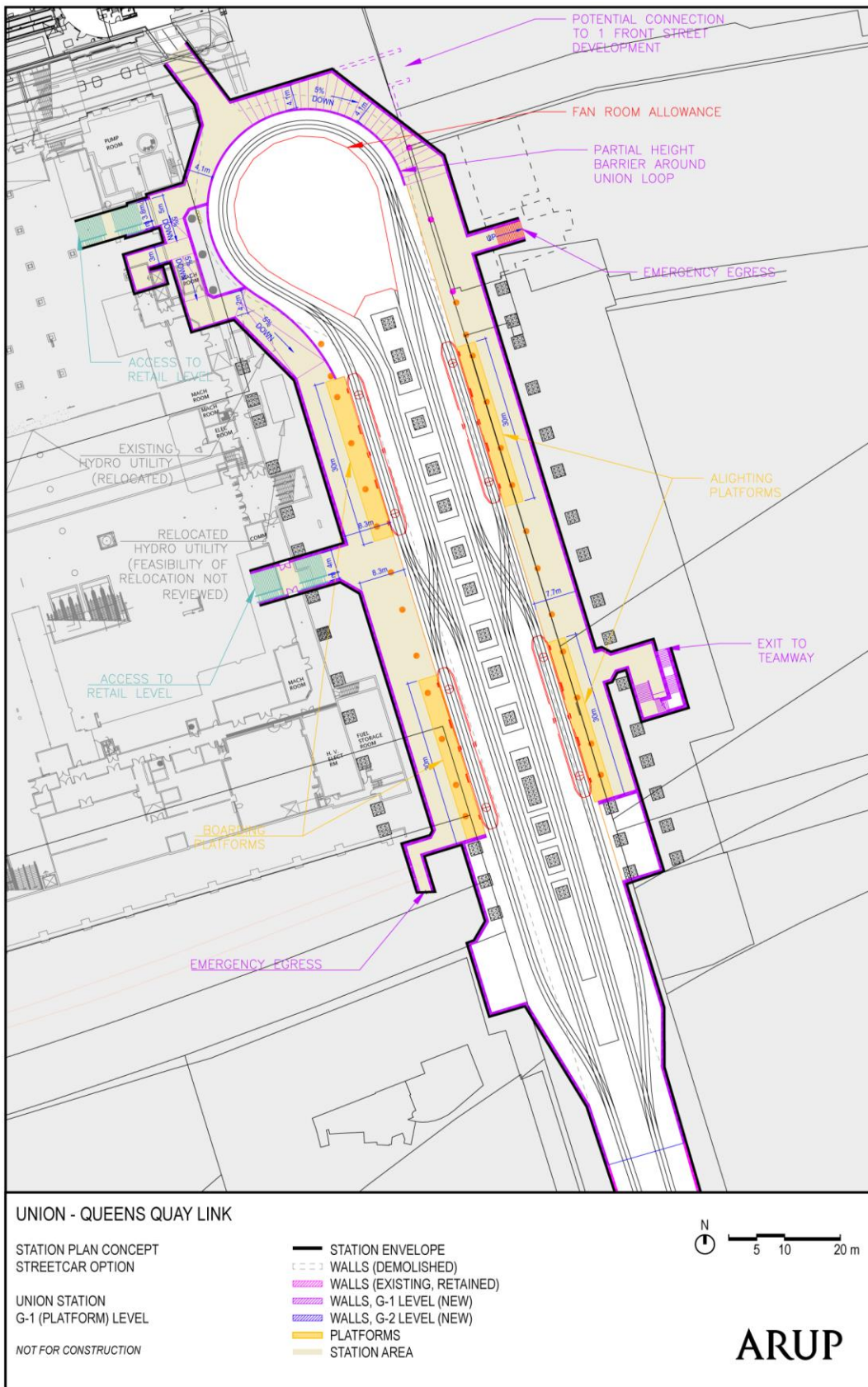


Figure A4. Union Station Streetcar Station Design, track level

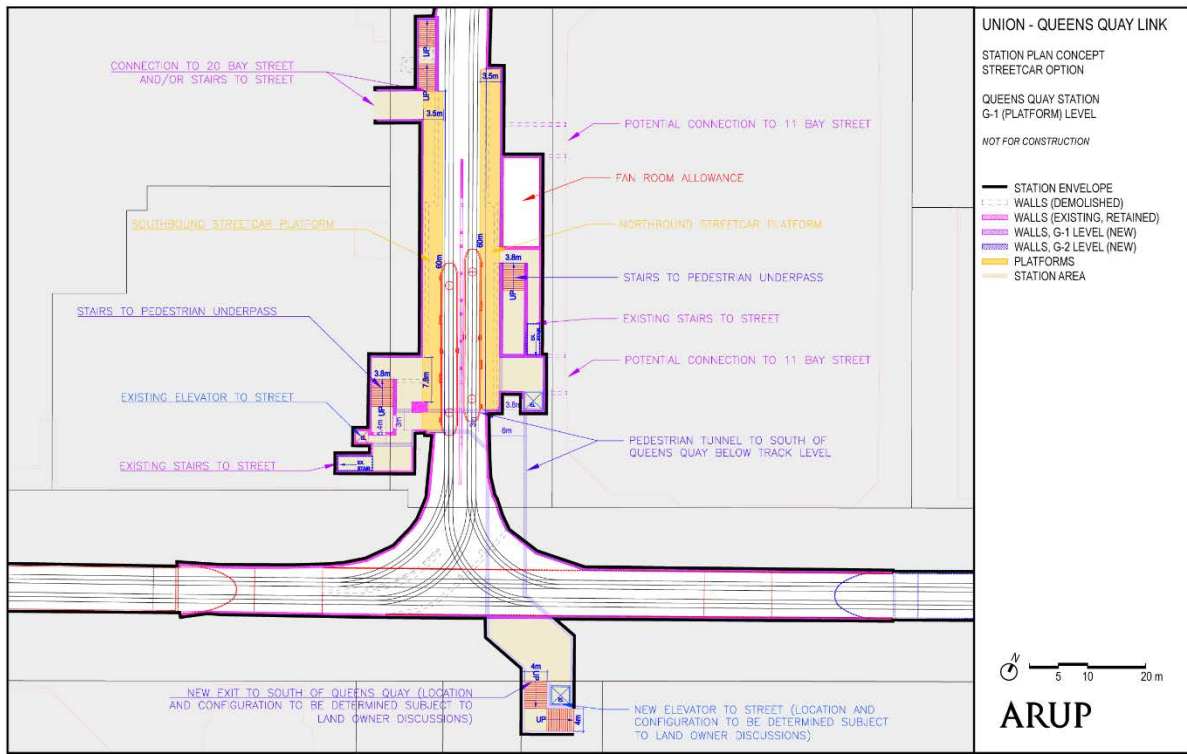


Figure A5. Queens Quay/Ferry Docks Streetcar Station Design, track level

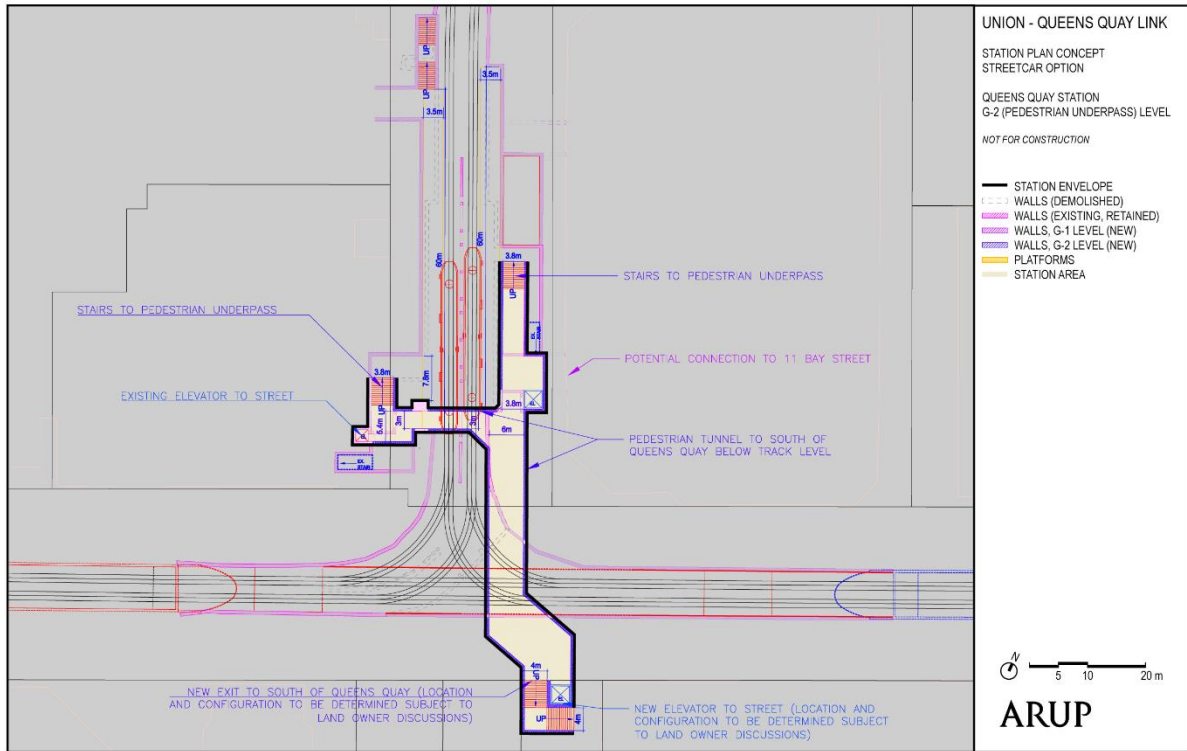


Figure A6. Queens Quay/Ferry Docks Streetcar Station Design, below track level

Appendix B – APM Option

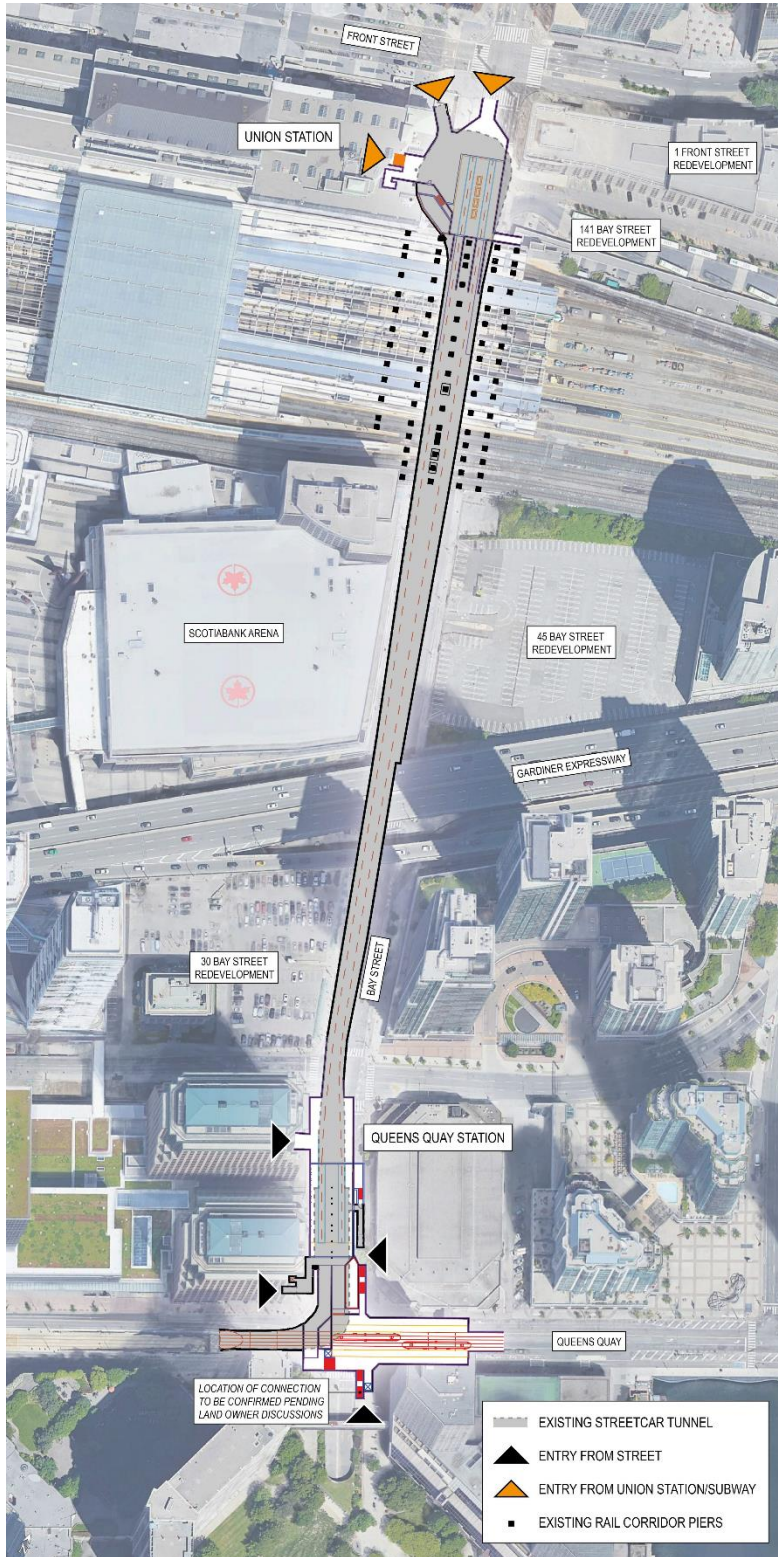


Figure B7. Concept Map, APM Option for Union Station-Queens Quay Link



Figure B8. Union Station APM Station looking South-West from Northeast portion of circulation area. Artist's depiction.



Figure B9. Queens Quay/Ferry Docks APM Station rendering looking South from East platform. Artist's depiction.

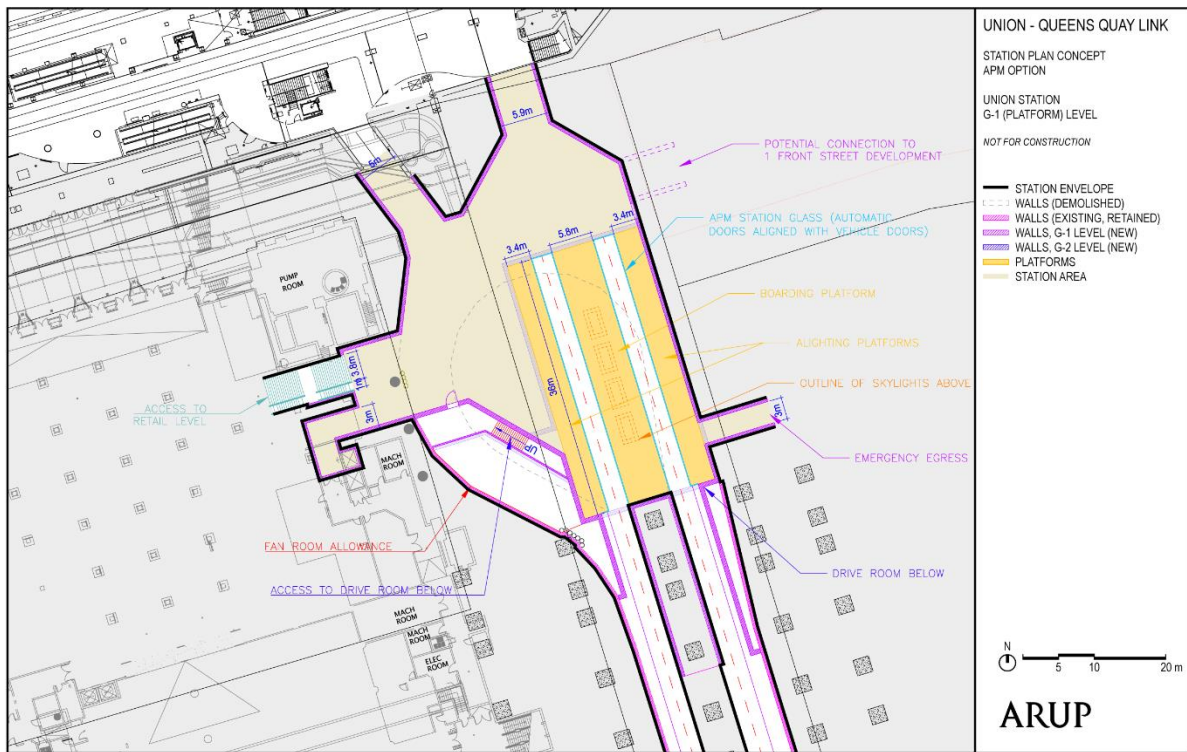


Figure B10. Union Station APM Station Design, track level

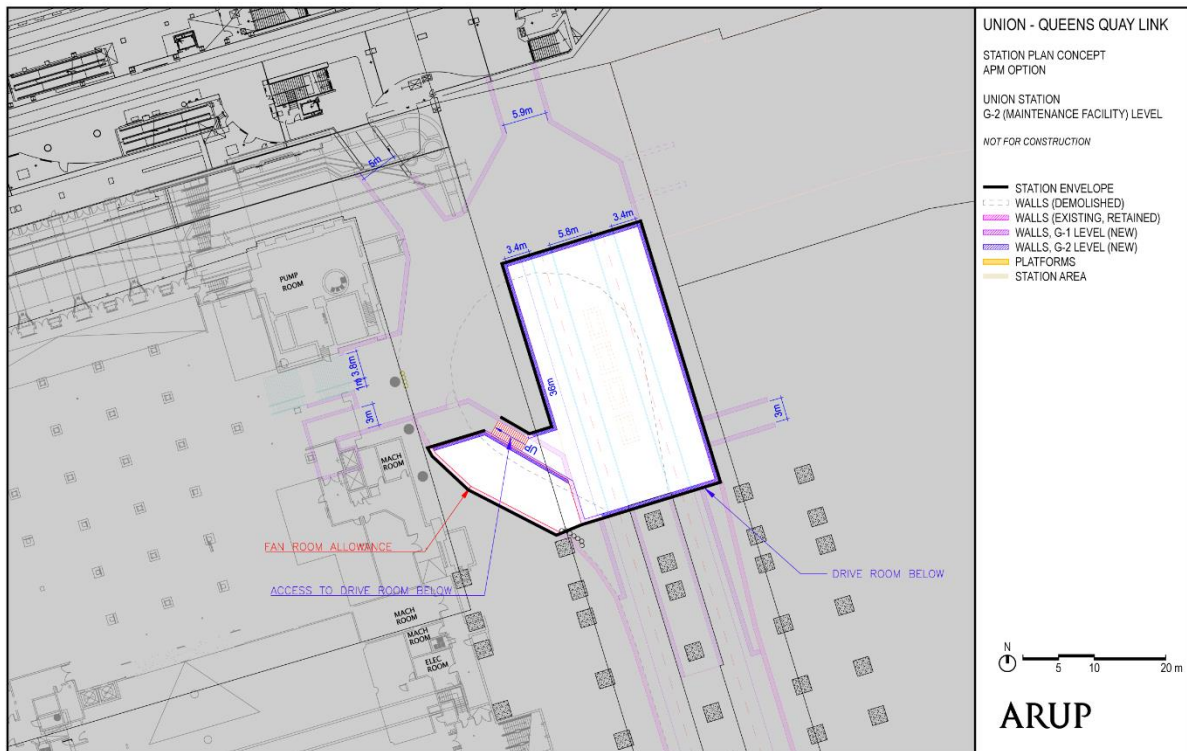


Figure B11. Union Station APM Station Design, below track level

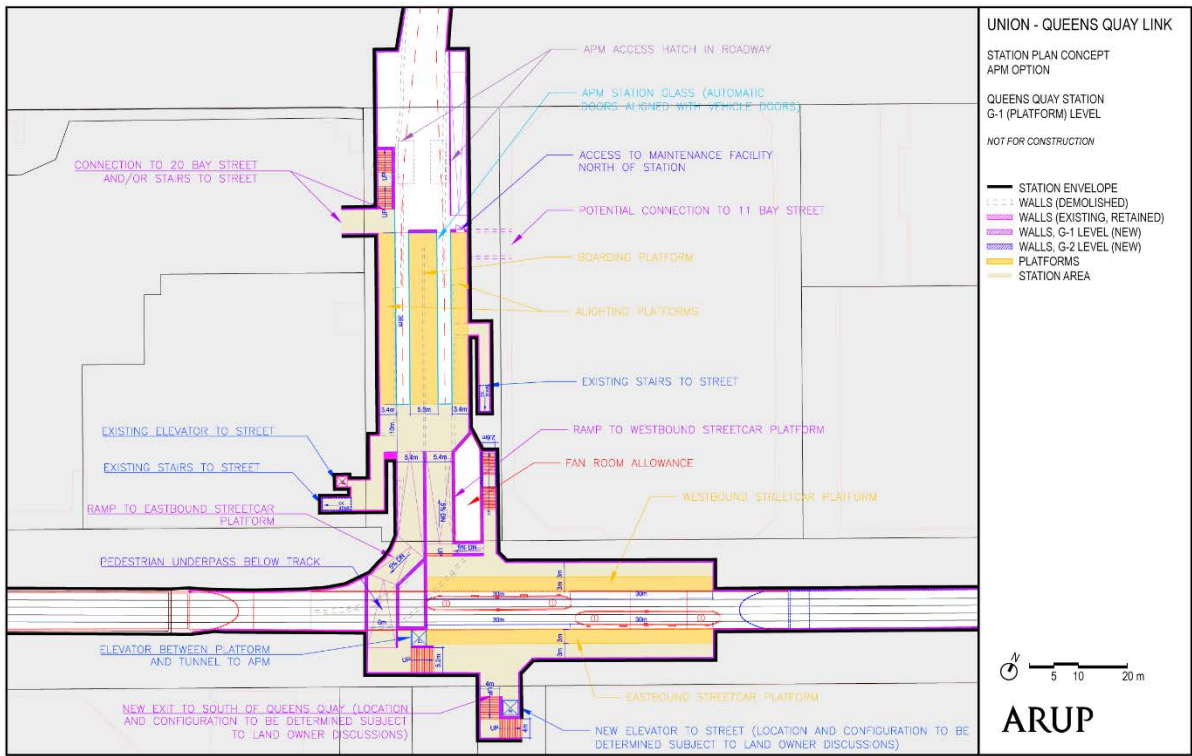


Figure B12. Queens Quay/Ferry Docks APM and Streetcar Station Design, track level

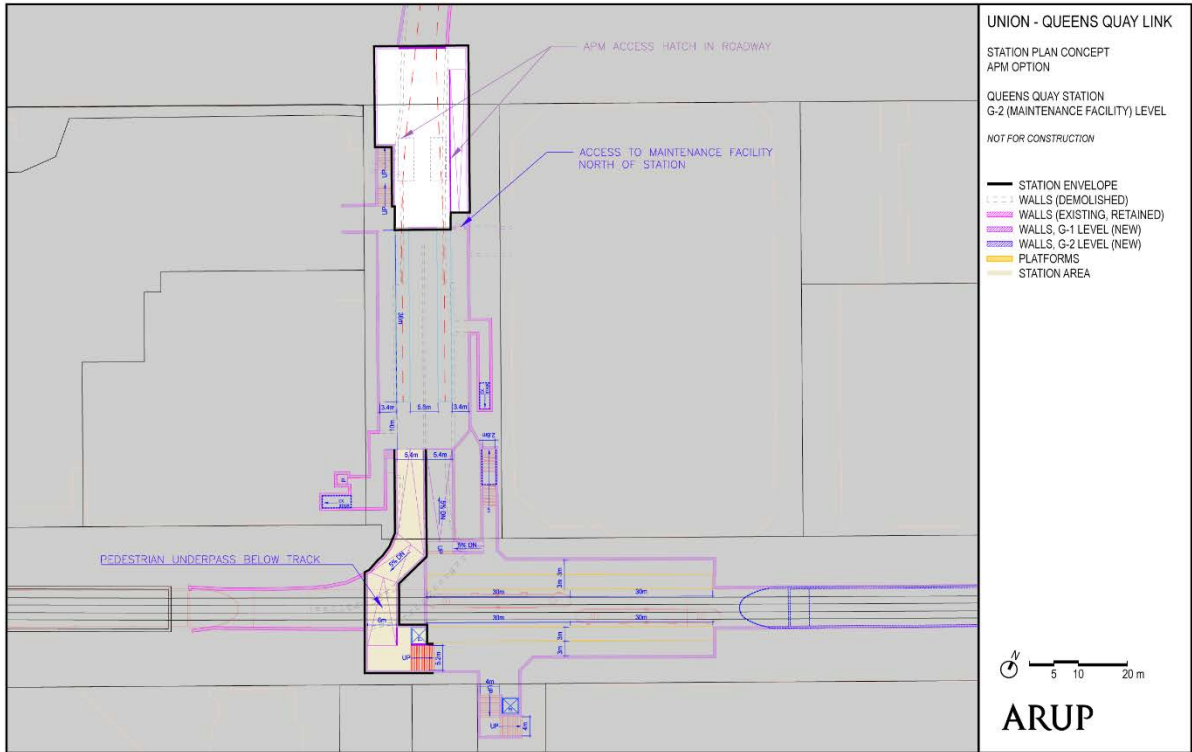


Figure B13. Queens Quay/Ferry Docks APM and Streetcar Station Design, below track level