

There is Complexity in Beauty;
Engineering Toronto's New Waterfront Boulevard

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Abstract

Queens Quay is Toronto's main waterfront street. In 2006, Waterfront Toronto hosted a design competition to transform and revitalize the street into a major destination. The winning concept proposed four parallel linear systems, one for each mode, within the same right-of-way. The concept included, from south to north, a grand new pedestrian promenade, an extension of the Martin Goodman Trail, reconstructed transitway, and placement of two-way general traffic north of the tracks. This is a truly complete street and expected to be one of the most vibrant and attractive streets in Toronto.

The corridor is a major transit route with streetcar connections to Union Station via the underground tunnel beneath Bay Street. The new configuration; however, meant more signals and potentially more delay for transit users. The interaction of bikes and pedestrians at intersections led the design team to consider various options in two primary contenders: a shared space concept, and a fully controlled concept with bicycle signals. The final decision was to pursue the bicycle signal concept for positive guidance, safety and compliance with the Highway Traffic Act.

The complex geometry and balancing of competing priorities led to various operational concepts and innovative solutions at every intersections. There are closely spaced intersection pairs which are interconnected for safety and reliability, a special laneway which introduces a tricky left turn trap, and the streetcar loop at Lower Spadina Avenue which may end up being the most complex intersection in the City.

Despite its complexity, the ultimate cross section will include the 4 parallel transportation systems along with a double allay of trees, one on either side of the Martin Goodman Trail, creating a linear park within the right-of-way. The new iconic boulevard will be an address for thousands of existing and future residents, and a must-see destination for the millions of annual visitors to the waterfront of Toronto.

The street opens in the summer of 2015.

Introduction

Queens Quay Boulevard West is the centerpiece of Toronto's Central Waterfront. The corridor was reconfigured to connect the Martin Goodman Trail within the city's waterfront, and leverage much-needed rehabilitation of the streetcar tracks. It is now an iconic boulevard and public space to be enjoyed by Torontonians and visitors alike.

Working closely with West 8 + DTAH and Waterfront Toronto, Arup reconfigured the transportation plan, redesigned the street and prepared an operational concept to address requirements of the community, businesses, and tourism and transit by incorporating extensive landscape features within existing built environment and within strict site boundaries.

During the Environmental Assessment process, the team undertook feasibility studies, conceptual and schematic design and selection of preferred design solutions to address challenging constructability constraint with limited space within the Queens Quay right-of-way. Constructability and feasibility reviews continued during the construction phase in some site specific locations to address unforeseen conditions related to utility conflicts, high water-table levels and conflicting utility relocation schedule constraints.

Part of the stakeholder consultation process included using cutting edge simulations in VISSIM to show anticipated traffic and transit flows and to demonstrate how the planned narrowing of Queens Quay would not negatively affect area traffic. Local officials thus gained a comfort level for a plan that promotes sustainability by reducing vehicle traffic and improving public transit. In order to ensure that emergency vehicles can utilize the LRT right-of-way, Arup designed a rolled curb that accommodates emergency vehicle access.

Since streetcar platform locations require loading of passengers in the middle of the intersection which required the careful placement of traffic signals and pedestrian push-buttons. The unique configuration of the roadway required careful and detailed planning and design to make sure that traffic, transit, cyclists and pedestrians on the promenade could safely use the intersection together.

The design, including the LRT platforms, accommodate boarding access for current LRT vehicles, but can also accommodate future low-floor vehicles.

Because plans called for the boulevard to be tree-lined, a detailed analysis of the major and minor flow systems across the corridor was used to identify opportunities for improvements that would promote tree growth. These included introduction of passive irrigation systems to maintain tree health over the long term. Using the space beneath the multi-use trail to increase available soil volume and therefore growing space, and using innovative technology in the form of silva cells resulted in an optimized growing environment.

Stages of the project

Arup was able to work with Waterfront Toronto throughout the entire project lifecycle. Phases included:

Pre-project

- Design Competition
- Quay to the City Pilot

Studies

- Traffic Feasibility Study
- Environmental Assessment (10%)

Design

- Schematic Design (30%)
- Detailed Design (60%, 90%, 100%, IFC)

Construction

- Engineering Services During Construction
- Commissioning

Design Competition

In 2006, Waterfront Toronto announced the Central Waterfront Innovative Design Competition. Arup joined a team led by Dutch Landscape architecture firm West 8 in partnership with local landscape firm du Toit Allsopp Hillier (now DTAH). The winning master plan concept included a new waters edge promenade, wave decks at each major slip, and a revitalized Queens Quay Boulevard as the spine of the Central Waterfront.

The design proposed to repurpose two of the existing four traffic lanes and turn them over the pedestrians and cyclists as part of a grand new public promenade and completion of the Martin Goodman Trail within Toronto's Central Waterfront. This move fills a critical gap in the larger waterfront trail which circles all of Lake Ontario.

The opportunity came with the need for the Toronto Transit commission (TTC) to replace aging streetcar tracks on Queens Quay which were beginning to crumble. The new design had all traffic to the north, the streetcar tracks in the center and Martin Goodman Trail with a double allay of trees creating a significant linear park where before there was only concrete.

With the TTC as a critical stakeholder, Arup was able to bring its considerable experience in Urban Transit and LRT to help Waterfront Toronto achieve its goals. True story of taking the project from concept and pilot, through planning requirements and design, to contract administration and commissioning. The project also was the beginning of a long standing working relationships between the teams in New York and Toronto.



Quay to the City Pilot

In the summer of 2006 the project began with a pilot project called Quay to the City. The pilot included closing the eastbound lanes of traffic on Queens Quay and building a mockup of the new Martin Goodman Trail. Thousands of potted flowers were used to line the trail, and a huge Arche de Triomph made bicycles was used to mark the entrance to the trail.

During the pilot, Arup undertook extensive traffic counts before, during and after the study to learn what effects the closure would have on traffic patterns on adjacent streets. Eastbound traffic on Lake Shore Boulevard increased as expected in order to accommodate traffic formerly using Queens Quay. At the same time as counting general traffic, changes in bicycle traffic were measured as well and a significant increase in bicycle traffic was observed. In addition to these counts, Waterfront Toronto undertook intercept surveys of visitors to the waterfront along with surveys of businesses and residents. Overall, aside from the apparent traffic challenges, there was a very positive response to the project.

[photo of bicycle arch]



Traffic Feasibility Study

Immediately following the Quay to the City Pilot, we embarked on a Traffic Feasibility Study. The purpose of this study was to provide the City with confidence that, with all of the development planned for the Waterfront, taking away lanes of traffic would not cripple the transportation system.

Approach

Arup teamed with Intellican, a commercial arm of the Intelligent Transportation Centre at the University of Toronto, to model the entire central waterfront in Paramics.



Challenges

While the Paramics model did show increased travel times and congestion within the model, the City of Toronto was confident that the project could proceed.

Outcomes

The traffic feasibility study was halted when there did not appear to be major gridlock resulting from the proposal. Work was suspended and scoping for the EA began.

Environmental Assessment

On September 20th 2007, the official 'Notice of Study Commencement' was begun for the Queens Quay Revitalization Environmental Assessment (EA). In Ontario, all major infrastructure projects are subject to an EA which takes a project from initial planning or concept phase, through to functional design. This process is similar to other environmental impact assessment processes used globally.

Approach

The EA spanned over two years from September 2007 to December 2009. The project was the subject of considerable debate among residents, business, agency stakeholders and politicians alike. There were several technical issues associated reconfiguring the street, not the least of which were the impacts to transit. Because the TTC had an existing service and plans to expand service on the waterfront, they were particularly interested in how their streetcar service would operate in the future.

[Evaluation sheet]

Challenges

Part of the stakeholder consultation process included using cutting edge simulations in VISSIM to show anticipated traffic and transit flows and to demonstrate how the planned narrowing of Queens Quay would not negatively affect area traffic. Local officials and other project stakeholders thus gained a comfort level for a plan that promotes sustainability by reducing vehicle traffic and improving public transit.

[VISSIM Model]

Outcomes

After several spirited debates between Waterfront Toronto, the TTC, the City of Toronto, Stakeholder and politicians, the design competition scheme with side running transit was selected as the preferred for the EA. Now, the challenge was figuring the finer details on how to make it work.

The quality of environmental design is evident in the boulevard's trees which are each given adequate growing space using innovative technology in the form of silva cells and providing significant environmental benefits, on-site stormwater management, improved soil and water quality and reduced erosion.

Several cross sections were considered to find the optimum configuration and placement of various utilities and tree soil structures in the constrained right-of-way. To maintain healthy trees, several details were considered including irrigation and using space beneath the multi-use trail to increase available soil volume.

Arup also coordinated the permits and approvals associated with the Ministry of the Environment, City of Toronto, TTC and utilities.

To ensure the continued operations of the LRT system throughout winter, and potential heavy snowfalls, the design team carefully considered both the longitudinal profile and transverse section to ensure adequate positive drainage was provided to prevent flooding during thaws (when road and tracks are salted throughout the winter, and in the spring).

Inherent in the project is a mode shift on the street away from cars toward pedestrians, cyclists and transit users. By updating the transit signal priority and bike signals, the newly redesigned street makes alternative modes of transportation more comfortable, reducing the number of cars. Additionally, in the simulations, improved traffic flows resulted in less delay and therefore reduced vehicle emissions.

Schematic Design

Approach

The schematic design involved

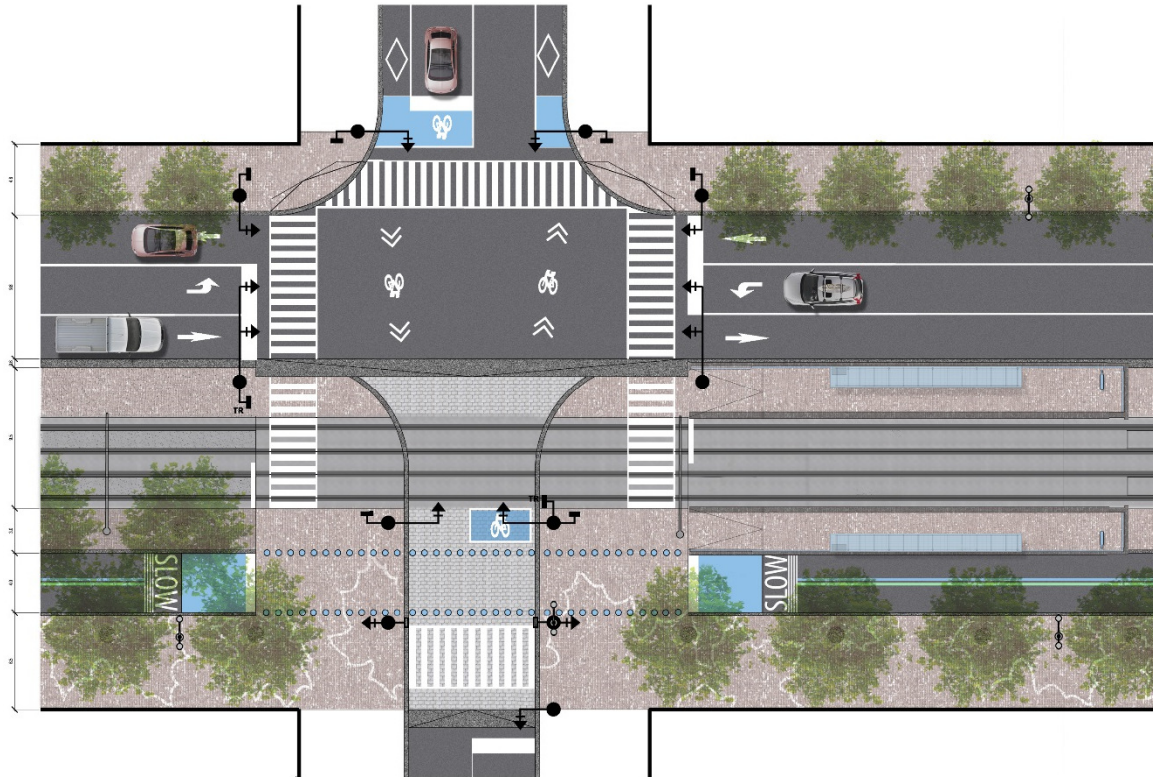
- Vertical and horizontal alignment
- Major million dollar issues
- Drawing packages for
 - Removals
 - Roadway
 - Track
 - Composite utilities
 - LRT hardware, conduits, loops
 - Signals (TSL)
- Comprehensive truck routing and turning path study for large vehicles and emergency vehicles in particular. Significant attention was paid to the height of the TTC ROW which

Challenges

The revitalization of Queens Quay Boulevard provided a multitude of complex challenges that needed to be addressed by Waterfront Toronto and the design team. The 3.5km stretch of road that was redeveloped sits at the heart of downtown Toronto and is used as a key thoroughfare for east-west traffic along the city's waterfront.

It is lined by a large number of commercial, residential, and industrial users, and includes elements that are under the jurisdiction of the City of Toronto, the TTC, and utility companies. In addition, soil conditions are challenging due to infill and a high water table.

- intersections
- Right-of-way
- Emergency Vehicle Access and Routing



Solutions

- Reduce tree planting width
- Reduce MGT width
- Mountable curb for fire

Detailed Design Development

Following development and approval of the schematic design, the design went on to detailed design development. The detailed design development followed the City of Toronto design process which included progressing the schematic design, completed previously, through to 60%, 90% (tender set), 100% (permit set) and issue for construction or IFC

Challenges

A key challenge was utility relocations because everything had to be out of the TTC ROW, and now within the narrow new pavement width. The existing right-of-way was developed in an ad-hoc fashion, with each utility company laying infrastructure in any available space (water, sanitary and storm mains, power ducts, telecommunications cables, and gas mains.) The design team developed complicated staging plans to allow utilities to be consolidated within a single trench, and, where possible, to be stacked. Given this congestion, permits and approvals for utilities was a major challenge. The solution included extensive stakeholder consultation and negotiation.

Traffic management during construction was a considerable effort (undertaken by BA Group). Given the constrained corridor there was little room within which to work. There are several existing businesses, condominiums and emergency response units which needed access maintained. All this while maintaining reasonable pedestrian access during summer months. The solution included staggered eastbound and then westbound traffic reinstated in stages as various sections were rebuilt.

The profile of the street is extremely flat with grades of 0.5% in some areas. This presented a unique challenge for surface drainage. The solution was to re-grade the street to extent possible while not unnecessarily close access to property.

Additional challenges included:

- Upgrading TTC infrastructure such splicing changes
- Traffic signals

Overall there were various commitments made during EA to stakeholders and property owners that needed to be satisfied during detailed design.

Conclusions

The newly transformed Queens Quay has the potential to substantially contribute to the economic and social quality of life for the citizens of Toronto. The central waterfront area is now a destination for locals and visitors alike, providing a variety of experiences and amenities.

Traffic flow was improved in many respects. Transit and traffic now move together through intersections improving efficiency, whereas before they moved separately. Dedicated parking lay-bys were provided for the many businesses on the north side of the street.

With the city to the north, having traffic north of the tracks improves flow for turning movements. People can experience the waterfront in a variety of ways - by foot along the granite walkway, by bike, by transit and still by car to the various major parking facilities for which access had to be maintained.

Businesses and condominiums on the north side of the street now front onto widened sidewalks with granite sidewalks and a row of mature trees, and provide opportunities for shopping, dining, and a large array of recreational activities. It provides the kind of atmosphere conducive to economic vitality, ground floor retail activity and urban vibrancy.

With the high number of tourists who visit the waterfront for events at Harbourfront Centre, cruises and other recreation, the revitalization also included a comprehensive bus management strategy for large groups arriving via coach and bus. Queens Quay West has become an iconic street that is as beautiful as it is functional.

“This has been an intensive nine-year project and Arup has been a creative partner in creating this new street typology.” ~ John Campbell (Former) Waterfront Toronto President and CEO

The key objective of the Queen’s Quay West revitalization project was to transform the city’s main waterfront thoroughfare into a modern, complete street and public promenade. Waterfront Toronto recognized the need to have Queens Quay act as the ‘spine’ of the central waterfront. The revitalized street now has an iconic design fit for Toronto’s main waterfront street.

The project re-organized the layout of the entire street, separating cyclists and pedestrians from cars and thereby also improving safety.

With outstanding results, the team managed to create an destination that integrates the overall waterfront park and trail system – offering both active and passive users diverse experiences and memories.

The project offers an outdoor space for public gathering that can host compelling activities, community events, entertainment, and cultural activities to draw a range of audiences throughout the different seasons. It also provides a public ‘backyard’ for all Ontarians – one that enhances the natural setting – and one that provides year-round and barrier-free access to outdoor public space.

After three years of construction, Queens Quay West opened to the public in June 2015, on schedule and in time for both the Pan Am Games and the Redpath Waterfront Festival.