York Region Rapid Transit Corporation

Sustainable urban transportation
an award submission

vivaNext - Highway 7 East [H3] BRT Dedicated Lanes

York Region Rapid Transit Corporation [YRRTC] is responsible for the planning, design and construction of the York Region Rapid Transit System and related infrastructure to deliver the transit priorities set out in the Regional Municipality of York Transportation Master Plan. Sustainability is defined as meeting present needs without compromising the ability of future generations to meet the same needs. YRRTC has refined our organizational goals to foster sustainable strategies and approaches to transportation challenges. More specifically, addressing the present and future transit needs from the perspective of the environment, economy, and social equity.

Since the 2005 passage of *Ontario's Places to Grow Act*, Ontario municipalities must plan for sustainable, more intensive land use, adopting provincially mandated growth targets and densities for their communities. York Region has welcomed this planning framework and has developed its official plan, *Centres and Corridors* strategy, which concentrates growth and development in key areas, and strengthens downtowns in the Municipalities of Markham, Newmarket, Richmond Hill and Vaughan. By building more intensively in these areas, there will be less pressure for growth in existing neighbourhoods and a reduction in traffic congestion. The vivaNext project is a vital part of the Region's plan for the next generation of rapid transit being built to support growth and to provide a sustainable future for York Region.

York Region is located in the heart of the Greater Toronto and Hamilton Area [GTHA] in Southern Ontario. It is comprised of nine area municipalities covering 1,756 square kilometres [678 square miles], stretching from the City of Toronto in the south, to Lake Simcoe and the Holland Marsh in the north, and bounded by Peel Region in the west and Durham Region in the east. As the fastest growing region in Ontario, York Region currently has more than one million residents and is expecting to reach 1.5 million by 2031.

Since 2001, York Region has had legal jurisdiction and responsibility for transit services, which prior to 2001, was the responsibility of its local area municipalities. In 2002, the Region procured York Consortium 2002 as its private sector partner to design and develop the bus rapid transit [BRT] component of the York Region Rapid Transit System [YRRTS], as a part of the regional transportation system in York Region.

YRRTS was designed to link the four regional centres in York Region along two main corridors, namely: from Richmond Hill [in the south] up Yonge Street to Newmarket [in the north] and from Vaughan [in the west] along Highway 7 through to Markham [in the east], providing a sustainable, long-term alternative mode of transit and connecting to other transit systems across the GTHA.

York region rapid transit system

YRRTC delivered the first phase of Viva service, which involved the planning, design and implementation of the BRT network running in mixed traffic, the purchase of new buses, and the provision of off-board payment facilities. This phase was launched in 2005, and to date, there has been 38% increase in ridership and over 22.7 million riders.

The second phase, which is currently underway, is known as vivaNext and involves the design and construction of 34.2 kilometres of segregated centre-lane rapidways along much of the current Viva network. The plan is being implemented in stages with contracts being awarded for different segments within the network, namely:

- Highway 7 East in Richmond Hill and Markham [H3],
- Davis Drive in Newmarket [D1],
- Highway 7 West in Vaughan [H2] [two contracts], and
- Yonge Street [Y2.1, Y2.2 and Y3.2] in Richmond Hill and Newmarket.

The vivaNext project is being funded by Metrolinx, an agency of the Province of Ontario, with a mandate for a 25-year plan to implement a common vision for transportation in the GTHA also referred to as *The Big Move*. The project is an example of The Big Move in action and represents $1.4 billion [2009] in provincial transit investment, as a sustainable option for the future reducing the dependency on cars and providing viable alternatives.

The project is to be delivered in its entirety by 2021. This award submission is for the segment that was completed and put into revenue service on August 18, 2013 – Highway 7 East in the Town of Richmond Hill and City of Markham [H3.1].

Highway 7 East [H3.1] project overview

The H3.1 segment of the project included the construction of 6 stations [12 platforms] at key intersections, together with the design and implementation of related infrastructure and facilities. The two platforms at Bayview Station are curbside and include two accessibility buildings with stairs and elevators connecting Highway 7 to Bayview Avenue. The design and construction of this project is based on solid sustainable development best practices for transportation delivery of a bus rapid transit system.

Implementation and construction of the project included the following elements:

- Median removals;
- Drainage works;
- Utility relocations;
- Grading;
- Fencing and barriers;
- Retaining structures;
- Culvert extensions;
- Paving and pavement markings;
- Sidewalk (boulevard) construction;
- Hard and soft landscaping;
- Lighting and traffic signalization;
- Intelligent transportation system elements;
- Twelve [12] vivaNext station platforms and canopies;
- Accessibility towers at Bayview Station due to grade separation;
- Station furniture and way-finding;
- Communications and fare vending equipment, complete with ancillary electrical infrastructure; and
- Temporary works, traffic control, environmental controls and other related activities required for the execution of the work.

Project organization

Funding for the vivaNext H3.1 project is provided by Metrolinx, an agency of the province of Ontario. After handover of each segment, Metrolinx will own the entire transit infrastructure. York Region will own the road infrastructure, and will operate and maintain both the road and the transit infrastructure.

The overall vivaNext H3.1 project is led by YRRTC, acting as Project Manager. McCormick Rankin Corporation [MRC], a member of MMM Group, is the Owner's Engineer or also referred to as YRRTC's Consulting Engineer. Kiewit-Ellisdon, a partnership [KED] was awarded the Design-Build Contract, and completed the work with various construction subcontractors and Design Consortium [IBI Group, Delcan Corporation and Aecom].

Innovation in design and sustainable elements

Stations

The curbside stations are a series of steel half-arch frames and supporting blue glass panels cantilevering over waiting areas and the transit platform. The design is reflective of old train station designs to create an iconic transit shelter and was inspired by transportation architecture from historic and modern European examples. The stations are designed with functional details that define them as placeholders along Highway 7. The size of the canopies was important to make passengers feel comfortable while waiting.

Integral to the design is a heated 27-metre glass enclosure which offers protection from the elements, with automatic doors at each end. Safety and accessibility features include; textured surfaces at platform edges and near-level boarding from the platform to the bus. The two shelters are aligned with each other on the north and south sides of the rapidway, and are able to accommodate two double articulated buses at a time.

A feature of the rapidway and station design is that they could be easily converted to Light Rail Transit [LRT] in the future when ridership warrants it.

Security

Crime Prevention Through Environmental Design [CPTED] is a pro-active crime prevention strategy utilized by planners, architects, police services, security professionals and everyday users of public spaces. The incorporation of the principles of CPTED into the streetscape design provides monitoring capabilities and safety peace of mind for users.

There are four underlying CPTED concepts:

- **Natural Surveillance**
  The placement of physical features and/or activities, and people that maximizes natural visibility or observation.
- **Natural Access Control**
  Deters access to a target and creates a perception of risk to the offender.
- **Territorial Reinforcement**
  Defines clear borders of controlled space from public to semi-private to private, so that users of an area develop a sense of proprietorship over it.
- **Maintenance**
  Allows for the continued use of a space for its intended purpose.

Intelligent Transportation System [ITS] Advancements

ITS is an international transportation-engineering discipline that is concerned with improving the efficiency of travel, whether it involves the travelling public, commercial vehicles, or transit. This new technology is an absolutely critical component of the vivaNext program. Located at each station are a bank of fare collection equipment, including a Ticket Vending Machine [TVM], a Ticket Validator [TV], and two PRESTO machines. PRESTO allows transit customers in the Greater Toronto and Hamilton Area [GTHA] to pay their fare using a convenient, electronic, reloadable smartcard. PRESTO makes it easy to pay your fare while travelling within and between transit systems by the simple tap of a card. The new machines are user friendly, interactive and Accessibility for Ontarians with Disabilities Act [AODA] compliant.

There are several transit priority measures that help Viva vehicles on the new Highway 7 rapidways run smoothly and quickly through congestion. These include on-board components on each vehicle including a GPS system and transmitters. There are also the components at each intersection that help each traffic signal respond to changing traffic requirements including radio and infrared receivers that pick up signals from approaching buses and emergency vehicles, and loop detectors in the roadway that detect cars waiting at the intersection. Lastly, there are variable message signs [VMS] located at each platform that provide next-bus arrival information to customers.

Each component needs to be connected to the overall transit system which keeps track of the schedule for each vehicle, and determines when the traffic signal phasing requires a temporary adjustment to let a delayed bus get back on schedule.

The connection is provided through a fibre optics communications network that links all of the intersections and every vivastation to York Region Transit's [YRT] operations and YR traffic operations. This system is fully automated, with approaching vehicles alerting intersections that they are arriving, and each intersection sharing that information with the central traffic control system, which in turn compares that information with the transit schedule.

Each platform and the accessibility towers are well equipped with electronic security devices, overseen 24/7 by YRT staff at transit headquarters. Stations are monitored constantly by three CCTV [Closed Circuit Television] cameras. In addition to providing coverage of the platform at all times, transit staff can maneuver the cameras manually as needed.

To add to passenger's sense of security, a clearly marked Emergency Call Button [ECB] is located inside the stations glass enclosure, and its speaker provides immediate two-way contact between the caller and YRT operators. The audio of the call is recorded and time-stamped, as is the video that is automatically captured by the closest camera when the button is pushed.

Another ITS element is the stations Public Address [PA] system. To make sure the new PA system is always audible, we started with an acoustic analysis study using special "Enhanced Acoustic Simulator for Engineers" [EASE] software. This study analyzed the two elements most critical to sound: Sound Pressure Level [SPL] and Speech Transmission Index [STI]. The SPL, measured in decibels [dB], is concerned with sound magnitude and takes into account ambient noise levels – it is the relative "loudness" of a sound. STI predicts how the equipment being used and the surrounding environment will affect the quality of the sound, and therefore how intelligible it is to hear. This allows the PA system to automatically adjust to ambient surrounding sound levels to ensure that it does not disturb area residents during the non-peak rush hours.

Red Asphalt

The Transportation Association of Canada [TAC] has designated red as the colour to designate Bus Rapid Transit lanes. Extensive research and analysis was conducted for a number of alternatives to achieve a red colour, including various surface treatments. However, based on a life-cycle analysis, it was determined that adding red pigment to achieve red asphalt was the most cost effective.

The design, production, and placement of the red asphalt introduced new challenges that provided the design team with an opportunity to be part of a project to construct a mix that is durable, aesthetically appealing and clearly defines' the rapidway from mix traffic lanes.

To achieve the final "look" of the mix design, red aggregates were used with polymer modified black asphalt cement, and the addition of an engineered red pigment. The challenge was balancing the right amount of pigment to achieve the color without compromising the quality of the mix and achieving a significant contrast between the red asphalt and regular asphalt.

The other physical properties of the mix have been met and the mix has excellent resistance to rutting based on the Asphalt Pavement Analyzer. Now implemented, the results in the field are achieving the desired contrast.

Construction innovations and sustainable features

In 2011 a model station was built on a short section of the vivaNext network in the City of Markham at Enterprise Boulevard. Lessons learned were applied to H3.1 as a means to maximize the cost savings and minimize constructability challenges. The major lessons learned include:

- Constructability modifications to improve design and reduce construction time. The station canopy steel column supports were directly connected to the foundation thereby reducing the required length of the anchor bolts and increasing the tolerances. The canopy concrete columns were changed to steel post and gypsum reinforced concrete cladding which provided more accurate setting to steel tolerances. A continuous concrete subsurface toe wall was installed between the traffic roadway and a pedestrian boulevard which separated the two work zones and provided construction flexibility.
- The Warden station was designed with automatic door openers, there were communication issues experienced with the door sensors to the door openers. In many occasions the door sensor would miscommunicate the bus movement adjacent to the station and would open the door. This issue was mitigated in the H3.1 design. Manual push buttons are used for door openers; this solution not only mitigated the malfunction but was more cost effective.
- Due to ongoing steel rusting issues on the Warden station, the steel used on the H3.1 project is higher grade and galvanized. Such consideration and protection will avoid costly maintenance.
- The number of glass panel sizes used on the H3.1 station canopies was minimized compared to the Warden station while at the same time presenting a consistent architectural look. As a result, the station canopy construction costs were reduced and maintenance requirements minimized.
- Providing ambient temperature inside the station canopy enclosure during the winter time was an issue at the Warden station. To mitigate this issue, the H3.1 stations are equipped with radiant heaters for the enclosed area and louver covers were designed and installed to protect cold air infiltration during winter time.

Sustainable infrastructure

Bike Lanes

As part of the overall *York Region Pedestrian and Cycling Master Plan*, bike lanes are included on the H3.1 corridor. These lanes were designed at 1.4 metres wide, with an additional 0.5 metre buffer zone between the bike and traffic lanes. To give maximum visibility for the bike lanes, they were painted a high-contrast green in the areas around intersections, with specific bike lane markings to clearly identify them in the mid-block. Bike boxes allow cyclists to avoid crossing three lanes of busy traffic to reach the left-turn lanes, and provide a safe waiting area. A key highlight of the Pedestrian and Cycling Master Plan is the construction of the lake-to-lake cycling and Walking trail that will go from Lake Simcoe to Lake Ontario. Through York Region and Smart Commute efforts, biking is being championed as a healthy, more environmentally friendly way to get around, and the vivaNext corridors are facilitating this.

Accessibility Structures

Two accessibility structures were built to provide direct pedestrian access between the 7.0m grade differential of Highway 7 to the local transit on Bayview Avenue, in the Town of Richmond Hill. The towers consist of an elevator shaft, a stairway and service rooms. The elevator is an electric traction unit with glazed doors and a glass rear wall. The stairs are clad with ceramic tile and set into a glass and concrete enclosure. The upper level of the tower is linked to the sidewalk by a steel and glass pedestrian bridge on each side of the road. These bridges run from the face of the tower building to an opening in the balustrade of the Bayview Avenue Bridge. The guards on either side of the pedestrian bridge are predominantly glass for transparency, with stainless steel and aluminum detailing. The pedestrian bridge is heated in the winter to prevent snow and ice accumulation, thus providing safe passageways for users.

The towers are set partially into the hillsides on either side of Highway 7 and as a result, have concrete retaining walls on the back sides. These retaining walls extend from the building rear to the east. On the south side, this forms a significant feature in the landscape allowing the Highway Express Toll Route [407] exit ramp to remain undisturbed and provides architectural details to the streetscape.

Tree Grates and Planters

Tree grates were used near intersections to enhance pedestrian permeability by minimizing obstacles in the pedestrian zone. The 2m x 2m Oblio tree grate will expand to accommodate for tree growth using removable 'grow rings' from 200mm to 500mm. Below-grade tree staking was used to reduce at-grade visual clutter.

Further away from intersections, concrete planters, placed at 8m intervals within intersection limits and 10m at midblock zones, contain a maximum of two trees each. Planters enhance streetscape greening by adding low shrubs, perennials and ornamental grasses. The tree palette has been selected from the Region of York's recommended list and includes a combination of native and non-native species which have been proven to survive in comparably harsh streetscape conditions and are salt and drought tolerant. Existing trees were preserved as conditions permitted, and transplanted to other community spaces as feasible. Sustainability includes green spaces that survive in the urban environment and this project has taken great care to investigate and implement the best options.

Urbanization

Reduced intersection and driveway curb radii was utilized to slow vehicular traffic and reduce pedestrian crossing distances, supporting the commitment to pedestrian priority and creating a more urban public realm. Based on the right-of-way widths of intersecting tertiary and secondary roads and driveways, the size of turning radii is 6m and up, as per civil drawings.

Other urbanization features included reduced traffic lane widths, wider sidewalks, narrower driveway widths, bicycle lanes & buffers, reduced posted speed limit, zero setbacks and boulevard landscaping:

- Reduced traffic lane width provides a more compact urban environment and slows traffic.
- Wider sidewalks encourage more pedestrian activity.
- Narrow driveway widths to minimize sidewalk impact and maximize planter area.
- Bicycle lanes & buffers encourage bicycle usage and provide a safe area for bicyclists.
- Reduced posted speed limit on Highway 7 from 80 km/hr to 60 km/hr that is proportionate with the roadway environment.
- Zero setbacks encourages higher density, buildings tighter to the edge of the right-of-way and walkability.
- Boulevard landscaping provides a buffer between the street and sidewalk.

Soil Cell Technology

To allow long term tree survival and the ability to grow to its maximum potential, the H3.1 project used CUPOLEX® soil cell technology to achieve 16m3 of soil volume for each tree, as per York Region's requirements. This technology is a patented concrete forming system made from 100% recycled plastic. Concrete is poured over the modular dome forms to create floating or structural slabs with an under slab void that results in minimal concrete contact with the soil, while providing a capillary barrier against moisture – it uses less concrete and rebar than a standard slab with equivalent load bearing capacity.

CUPOLEX® enhances tree health, reduces aggregate use and can support the weight of service vehicles in the event they are required to access the boulevard limits for maintenance purposes. A manual Root Rain System will supply water and nutrients to the soil within the soil cells. This area will be monitored to weigh the costs of implementation and survivability success.

Root Rain Urban System

- Comprises a perforated plastic ring pipe and a grid inlet.
- Inlet at tree grate surface
- Provides access point for air and nutrients
- The grid allows water and air through but prevents ingress of litter and debris.
- Extremely vandal resistant.
- The vertical piece of pipe can be cut to length to ensure that the inlet is flush or slightly [25 mm] proud of the final tree pit surround.

Growth that works and is sustainable for generations to come

VivaNext will help transform our traffic thoroughfares from busy highways and congested streets into dynamic urban corridors that are welcoming to pedestrians, cyclists and motorists. These corridors will connect to York Region's urban Centres that offer more places to live, work, shop and play, a sustainable advantage.

York region's early commitment to creating and implementing a long-term growth management strategy means we have the right land use policies in place, and are ensuring that growth is managed and supported with effective public transit. Communities that are developed around great transit are more likely to include compact, pedestrian-friendly neighbourhoods. Mixed-use developments make it easier for people to get around without a car, and because more compact developments make it easier to situate transit near more people, it is more likely that people will be willing to walk to transit.

One of the objectives of the vivaNext project, supported by land use policies that encourage Transit-Oriented Development, is to create complete communities within walking distances of transit. With housing, employment, retail, dining, services and recreation all located within a walkable distance, more people will be able to live more of their lives without needing to get in their car. When they do want to move around, people will have travel options to match their purpose and destination. With every full bus taking the equivalent of 70 cars off the road, more people taking rapid transit means less traffic congestion on the roads for everyone.

Operational performance

In order to assess the operational performance of the rapidway, summary notes on field observations were provided by Viva staff, bus operators, traffic operations staff, and the paid duty police officers, along with travel time data collected for vehicles and transit.

Through this feedback, operational adjustments were identified to improve the remaining vivaNext implementation. Signal timing changes were made by York Region staff, and then supplemental reviews were undertaken. The introduction of the rapidway decreased the Viva bus travel time during the morning peak hours by up to 38% in comparison to 2011, and up to 45% when compared to 2012. The Viva bus travel time values were provided by the INIT CAD/AVL systems. This result meets the overall target of up to 40% during peak periods.

These travel time savings are projected for each segment of the vivaNext network as it is completed. This will continue to lead to ridership growth and the promotion of transit as a more sustainable form of transportation.

Conclusion

The sustainable transformation of this urban corridor will support growth, and reduce congestion to help make York Region an even more inviting place to live, work, shop and play. These benefits extend well beyond York Region. For example, the rapidways will also play an important role in a seamless transit system across the GTHA, help reduce traffic congestion, increase productivity and provide sustainable alternatives to car use, which help reduce environmental impacts.

As outlined in this submission, vivaNext is part of the sustainable growth plan within York Region and features transit that has segregated lanes with their own traffic signals, taking buses out of all-purpose congested traffic lanes. Research by Environics, noted that 79% of York Region residents support a more connected transit network and transportation remains the number one issue for residents*. The vivaNext project is key to addressing these priorities.

* Research conducted by Environics, November 2013

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YORK REGION RAPID TRANSIT CORPORATION

Aerial view of completed Highway 7 rapidway [H3.1]

york region rapid transit system

Davis Drive [D1]
Yonge Street to Highway 404

Yonge Street [Y2.1, Y2.2 and Y3.2]
Highway 7 to 19th Avenue / Gamble Road
Mulock Drive to Davis Drive

Highway 7 West [H2]
Pine Valley to Yonge Street

Toronto-York Spadina
Subway Extension

Highway 7 East [H3]
Yonge Street to Warden Avenue

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A Metrolinx vivaNext Project

highway 7 east rapidway [H3.1]

The H3.1 segment of the vivaNext project included innovative construction and design techniques that provide a rapid transit system to support growth and a sustainable future for York Region.

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A Metrolinx vivaNext Project