the north side. In segments with ROW restrictions on both sides, such as the segment between the East Don River and Yonge Street, the fill section will be retained on both sides with walls. **Figures 6-1, 6-2, and 6-3** illustrate the typical cross sections proposed for the various conditions of embankments and cuts along the entire transitway.

6.2 Stations

The following sub-section provides a description of the preferred alternatives for the seven proposed stations. The proposed station configurations were developed during the Planning and Preliminary Design Stage of the study. The final exact configurations of all stations will be determined in the Detailed Design Stage, in consultation with other agencies and other transit providers.

6.2.1 Design Criteria

The station functions that support the service design are described as follows:

- Off-line bus platforms for vehicles transferring passengers to 407 Transitway service will be required at certain station locations;
- Transit vehicle access from the road system to the transitway will be required at all locations;
- Vehicle layover facilities will be provided at certain types of station;
- Intelligent Transportation Systems (ITS) equipment, such as fare collection and passenger information systems to display service status will be accommodated; and,
- Operator washroom facilities may be required at certain station locations.

From the station functions, the subsequent planning framework was used to develop the consideration factors and associated station design principles. These principles, described in **Table 6-2,** were developed with the ultimate goal of improving transit user experience and were applied during concept design.

Table 6-2: Station Consideration Factors and Design Principles

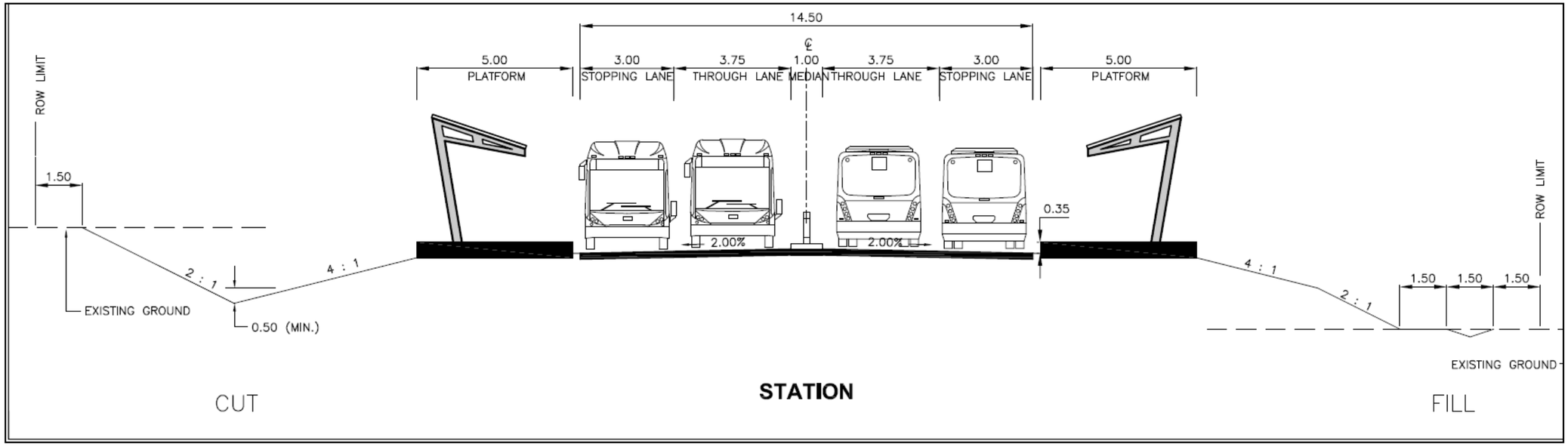
Consideration Factors	Station Design Principle
Passenger	• Clear, direct (single point of transfer) and / or short transfers between transit modes, services and routes by minimizing walking distances and removing physical barriers within transit stations. • Stations and station areas that are universally accessible and that can accommodate the needs of all members of society.
Pedestrian	• Prioritized, safe and direct pedestrian and cycling routes to rapid transit stations from major destinations and regional cycling and pedestrian networks. • Convenient, comfortable, direct and safe pedestrian linkages to and from all transit stations in order to support a walkable station area and promote the use of transit. • A high level of pedestrian priority, safety and amenities within and around the transit facility to enhance customer comfort, safety and information.
Vehicular Facilities	• Clearly marked and protected access for pedestrians and cyclists at station areas to minimize conflicts, particularly at PPUDO's, bus facilities and parking access points. • PPUDO's located to feed the parking circulation system while unloading pedestrians as close to the station or transit plaza. • Parking lots and PPUDO's designed to promote easy navigability with sufficient queuing distances at intersections.
	• Carpooling and alternate fuel vehicles parking in close proximity to the station entrance. • Limit commuter parking expansion by prioritizing feeder transit service to stations. • Well lit parking slots and station areas with unobstructed sightlines. • Off-line bus platforms will be designed to accommodate 40 and 60 foot buses. Number of required bays will be addressed in coordination with the corresponding transit Agencies during detail design.
Station Architecture	• Incorporation of ancillary uses such as coffee shops, newspaper stands or convenience retail in stations and or plazas to expand the function of the intermodal station and provide additional amenity for users. • A high-quality station architecture and public realm that is sensitive to the surrounding built context and projects a clear, identifiable 407 Transitway brand and vision. • Transitway bridges, structures and retaining walls as prominent visual elements with good design potential. • Extensive use of glass in shelters and station areas to enhance the natural surveillance and lighting of these areas.
Station Design	• Weather protected station areas through the use of plant screens, wall canopies and heated station areas for waiting. • Station and plaza orientated to maximize levels of natural lighting. • Legible and permeable transit stations through consistency and clarity in station entrances and interfaces, spaces, layout and visual cues connected by barrier-free movement spaces. • A unified way finding and signage strategy to support the legibility and permeability of the transit station. • Station and the transitway elements to act as landmarks both locally and for passing transit • Extending the design continuity of the transit station areas, including paving patterns, colours and materials to adjacent sidewalks, plazas and pedestrian crossings. • A high level architectural and landscape design for parking facilities to reduce its environmental impact and to improve pedestrian connections and access. • Priority and implementation of proven and innovative sustainable energy, water, landscape and waste management practices in the design of intermodal station, transit facilities and station areas. • High-quality materials in both the station and landscape design that will "stand the test of time" and continue to maintain a positive image of the system. • Mitigating visual presence of parked cars by concealing them appropriately through screening, landscaping, or design treatments.
Community Effect	• Local neighbourhood involvement in the review of final station area designs and in the development of a public art program for station plazas to help promote community place making. • Facilities designed to minimize traffic and noise impacts on adjacent neighbourhoods

Locating Intermodal Stations

Station locations were identified to maximize the flexibility and reduce the need for transfers and were placed at key locations along the transitway to ensure:

- Maximize ridership;
- Serve existing communities and future TOD's;
- Ensure that each transit station has the potential to become an intermodal hub where passengers can connect to other modes of travel; and,
- Intermodal station as catalysts to further intensify growth within UGC's.

Figure 6-3 Cross-section through Station Platforms



Design Goals for Station Facilities

The entire station layout was designed based on the principles of Crime Prevention through Environmental Design (CPTED). CPTED is a multi-disciplinary approach to deterring criminal behaviour through environmental design. CPTED strategies rely upon the ability to influence offender decisions that precede criminal acts. As of 2004, most implementations of CPTED occur solely within the built environment. Incorporating CPTED techniques should be considered in the design of pedestrian corridors and all transit facilities to optimize natural surveillance.

The pedestrian vertical circulation to the eastbound and westbound platforms located at the 407 Transitway level by means of stairs, escalators and elevators are present to accommodate the requirements of universal accessibility.

The facility's façade and roof structure will use materials which maximize natural light infiltration at the platforms areas. In addition it is envisioned that the following elements/principles will be incorporated at all stations:

- Universal accessibility at the station, station areas and access routes for all people, including those relying on physical and cognitive mobility aids;
- No barriers or commuter congestion when transferring between transit modes;
- Comfortable and clean transit waiting areas;
- A bicycle storage facility located near the main entrance;
- The use of alternative energy sources to power outdoor systems such as emergency phones and parking fare meters;
- The provision of electrical service to hybrid car owners;
- At-grade parking designed with the following: a landscaped street edge, dedicated pedestrian routes, shade and high quality landscaping (bio-retention areas) and with permeable surfaces that also mitigate the heat island effect;
- Transit facilities designed to achieve a minimum of LEED Silver status; and,
- Transit facility canopy will incorporate green roofs and/or solar panels where possible.

6.2.2 Station Layouts

6.2.2.1 Jane Station

Location

The Jane Station is located south west of the intersection of Highway 407 and Jane Street between Highway 400 and Kennedy Road as shown in **Plate 35** and **Plate 36** at the end of **Section 6.** Jane Station is the terminal station at the west end of the central section of the 407 Transitway.

Transportation Function

Jane Station will serve as a regional intermodal station for passengers transferring between the subway, GO Transit, YRT/Viva, and the 407 Transitway. Jane Station connects with the TTC Spadina Subway and serves the Vaughan Metropolitan Centre and the surrounding metropolitan area.

Intermodal Facility - Type & Services

Jane Station ground facilities were designed as part of the TTC Spadina Subway Extension 407 Station project. The facility was developed primarily as an intermodal hub allowing for passenger transfer between the subway, the transitway, the bus service and private auto users. It was designed as a multilevel facility. The subway central platform is located at an elevation of 177 metres, concourse level at 189.1 metres, entrance level at 194.4 metres and surface bus terminal level at 198.5 metres. The grade level varies throughout the station site.

The site layout as detailed by the subway station design provides for car parking, PPUDO, an enclosed bus terminal with platform edge and lay-over bus bays. With the implementation of the 407 Transitway at this site additional parking spaces will be added.

In addition to the subway box, the design of the 407 Subway Station includes surface facilities comprising all facilities outside of the subway box, i.e. at concourse and entrance level, a bus terminal and site development. The concept plans show the connections between the 407 Transitway Station and the proposed 407 Subway Station. The site plan also shows the overall linkages, on and off the transitway, to maintenance and layover facilities, as well as the site circulation system.

The 407 Transitway Station was designed to integrate with the subway station and bus facilities at the east end of both east and westbound platforms due to the configuration of the subway station design which dictates the location of the transitway station on the site. Ticketing booths as well as the fare line (if required) will be located at this eastern access point at both the entrance and concourse levels. **Plate 35** and **Plate 36** at the end of **Section 6** provides a detailed layout of the site plan and passenger circulation movements.

During the Detailed Design Stage, the surface facility at this station will be reviewed with the other transit agencies to confirm requirements and preferences.

Access/Egress to the Facility

The site is accessible from Jane Street for southbound buses through a one-way, right-in roadway just south of the ramp off eastbound Highway 407 and a proposed signalized intersection, located south of the bus only access allowing for all traffic movements into and out of the station facility off of Jane Street.

6.2.2.2 GO Barrie (Concord) Station

Location

GO Barrie (Concord) Station, if constructed, will be located in a parcel of land encompassed by the GO Transit Railway to the west, Highway 7 to the north and Highway 407 to the south, as illustrated in **Plate 37** and **Plate 38** at the end of **Section 6.**

Transportation Function

The GO Barrie (Concord) Station will primarily serve as a regional intermodal station for passengers transferring between the proposed 407 Transitway, GO Rail line as well as bus services run by GO Transit and YRT/Viva. Additional key functions of GO Barrie (Concord) Station, will be to provide park-and-ride and PPUDO facilities for commuters from existing and future residential communities mainly expected from areas west of Bowes Road and northeast of Centre Street; and local walk–in opportunity to residents of the immediate surrounding existing and future developments.

Intermodal Facility - Type & Services

GO Barrie (Concord) Station's surface facilities include: a parking area (including carpool spaces), PPUDO and bus loop for local buses. The at-grade transit plaza accommodates the pedestrian movement, the above noted feeder modes and the inter-modal station. A canopy provides weather protection for part of the transit plaza and the circulation to the GO Transit platform. The at-grade inter-modal station accommodates the basic station services and other station elements; ticketing, offices, storage, and other facilities etc. which are conveniently located near the main entrance of the station. The station facility was designed to accommodate a central entrance type platform serviced from the main entrance/vertical access from the inter-modal station. During the Detailed Design Stage, the surface facility at this station will be reviewed with the other transit agencies to confirm requirements and preferences.

Access/Egress to the Facility

A new signalized intersection on Highway 7 is proposed approximately 250 m east of the existing CPR overpass. The north leg will connect to the proposed Concord development and the south leg will provide access to the park-and-ride facility, the potential GO- Barrie (Concord) Station, PPUDO and the local transit bus loop. Some improvements will also be required on Highway 7 at this intersection. The station access will mainly run parallel with the transitway with a shared bridge structure crossing Don River for approximately 70 m. The details of the station access is shown in **Plate 37.** The construction of this signalized intersection will require coordination with the Concord development and YRT/Viva.

Property Required

The GO Barrie (Concord) Station is located on a combination of publicly owned Crown land and private property. In an effort to preserve the existing woodlot, the parking was extended to the north affecting approximately 1.9 ha of private property. In addition the access road passes through approximately 0.9 ha of privately owned land. **Plate 37** details the extent of the private property effects.

6.2.2.3 Bathurst Station

Location

Bathurst Station is situated on the land located inside the jughandle road connecting Highway 7 and Bathurst Street. This station will serve as an intermediate station providing connectivity for passengers transferring between the proposed 407 Transitway and other transit operations including YRT/Viva.

Transportation Function

Bathurst Station's primary function is to serve as a park and ride facility for the Vaughan and Richmond Hill residential growth areas both north and south of Highway 407. It also provides park and ride capacity for the Yonge Station at the Yonge Street/RHC; however, it is severely limited in available land for this use. In addition to park and ride capacity the station includes a PPUDO facility and a feeder bus loop.

Pedestrian access from YRT/Viva services to the transitway station will be via an at-grade signal-controlled crossing of the ramp at Highway 7. The station was designed to accommodate an end entrance type platform serviced from the main entrance located on the north side of Highway 7 directly adjacent to the Parking, PPUDO and bus facilities. Basic

station services and other station elements like ticketing, offices, storage, other facilities etc. will be located near the main entrance. The pedestrian overpass will be connected to the eastbound and westbound platforms located at the 407 Transitway level by means of vertical circulation designed to accommodate the requirements of universal accessibility.

Intermodal Facility - Type & Services

Bathurst Station's surface facilities are divided into parking areas (including carpooling), a PPUDO and a bus loop for local buses. A pedestrian and bike overpass is planned over Highway 7 to access the 407. **Plate 39** and **Plate 40** at the end of **Section 6** illustrate the preliminary intermodal station concept for Bathurst Station. During the Detailed Design Stage, the surface facility at this station will be reviewed with the other transit agencies to confirm requirements and preferences.

Access/Egress to the Facility

A new signalized intersection is located on the Highway 7 E/W to Bathurst N/S Ramp approximately 240m southeast of Bathurst Street and 220m northwest of Highway 7. The T-intersection will provide access to the park-and-ride facility, PPUDO and the local transit bus loop. The construction of this signalized intersection will require coordination with the YRT/Viva. Some improvements will also be required at intersection with Bathurst Street.

6.2.2.4 Yonge Station

Final configuration of the 407 Transitway Station and its integration within the Richmond Hill-Langstaff Gateway is under development in collaboration with the York Region/TTC Young Subway Extension Study Team.

Location

The proposed transitway station is located immediately north of the Hydro One ROW and Highway 7 on the west side of the CN Rail/GO Richmond Hill Line ROW. **Plate 41** at the end of **Section 6** illustrates the anticipated location and orientation of the transitway's Yonge Station and its relationship to the proposed Yonge Subway Station, the GO Langstaff Rail Station and York Region Bus Terminal, the elements making up the Richmond Hill-Langstaff Gateway.

In the area of the existing RHC Bus Terminal, the proposed 407 Transitway is one level below existing ground. The facility is essentially aligned across the south-west corner of the bus facility. During the Detailed Design Stage, there will need to be coordination with the TTC-York Region Yonge Subway project team, to ensure optimum integration, constructability and cost effectiveness.

Transportation Function

The primary role of the station is to provide a convenient connection for passengers transferring to and from the Yonge Street Subway and GO Richmond Hill Rail Line within the Richmond Hill-Langstaff Gateway. The station orientation must also allow a good interface with York Region's major bus terminal planned for the hub.

Of equal importance is selection of a location and configuration that offers attractive access for walk-in and community-shuttle passengers originating in all parts of the overall Richmond Hill-Langstaff Regional Centre.

The immediate station precinct must also include a transit plaza with PPUDO facilities for passengers accessing all transit systems. Also, bicycle storage must be available in close proximity to the transitway station entrances.

As noted in **Section 5.4.2.3**, the station and immediate runningway configuration must allow transit vehicles providing service to areas east of Yonge Street to terminate at this location and turn back to the east.

Intermodal Facility - Type & Services

Plate 41 at the end of **Section 6** illustrates one possible configuration for the transitway at the Yonge Station is a typical side-platform arrangement with turn back loops for BRT operation at both ends of the station, the north end accommodating layover bays. An alternative layout based on a centre platform arrangement has been considered and found to be compatible with the footprint required for the side platform layout shown. Implicit in the use of a centre platform layout is the requirement for BRT vehicles to cross over at each end of the station from right-hand running to left hand through the platforms since vehicles will have doors on the right-side only. However, acceptance of this crossover manoeuvre will allow a more efficient, cost-effective vertical circulation form the transitway platform to the sub-surface walkway to the subway and bus terminal. A centre platform arrangement can be configured to accommodate LRT operation for which, vehicles will have doors on both sides.

Station entrances at surface level can be provided at both north and south ends of the platform and can be integrated with any covered walkway developed adjacent to the CN ROW to reach the Langstaff lands south of Highway 407. The north entrance can be linked to the existing pedestrian bridge over the CN/GO tracks to provide convenient access to the GO platforms and future development on the lands to the east of the CN ROW. Basic station services and other station elements like ticketing, offices, storage, other facilities etc. will be integrated with the main entrance.

At this station, as at most others, BRT vehicles must be able to reach the surrounding surface road system from the dedicated transitway. This will necessitate a ramp, configured in a manner which allows integration with the regional bus terminal (shaded blue) being proposed by TTC as apart of their Yonge Subway Extension RHC Station project.

Vertically, the transitway platforms are proposed at approximately the level of the subway station mezzanine floor. If access to the subway platforms has to be via the mezzanine floor, this can be achieved by a ramped walkway linking the transitway vertical circulation elements to the subway mezzanine below grade. Although the grade of this ramp is likely less than 5%, barrier-free access will also be possible via elevators to and from the surface at both the transitway and subway station entrances. Platforms in the regional bus terminal can also be linked to the ramped walkway to facilitate feeder bus to transitway transfer.

During the Detailed Design Stage, the surface facility at this station will be reviewed with the other transit agencies to confirm requirements and preferences.

The transitway station roof structure will be designed to incorporate a structure to carry the approach road for the new CN Rail overpass between High Tech Road and Highway 7. Ventilation for the station and approaches will be accommodated on either side of this road and the CN ROW as well as within the proposed public open space west of the station.

6.2.2.5 Leslie Station

Location

Leslie Station is located on the west side of Leslie Street, south of the Highway 407 Eastbound off-ramp and opposite the St. Robert Catholic High School and north of the Hydro One ROW.

Transportation Function

The main function of Leslie Station is to function as a park and ride facility for the local residential communities. It will also serve as an inter-modal station for passengers transferring between the 407 Transitway and other transit systems operating on Leslie Street, including TTC and YRT/Viva bus services as well as the proposed TTC Leslie LRT. It is anticipated that local shuttle buses will be employed to service the Beaver Creek and Commerce Valley Business Parks.

Intermodal Facility - Type & Services

Leslie Station surface facilities include: parking areas (carpool with a potential for additional at-grade spaces) and a PPUDO area. A bus loop was not included as any bus services running along Leslie Street would remain as an on street service due to the anticipated time penalty for entering and exiting the station facility. The station facilities would provide turn around opportunities for services terminating at or near this location. Vertical access to the street will be provided directly to the street to minimize the passengers' walking distance.

The at-grade transit plaza accommodates the pedestrian movement, the above feeder modes and the inter-modal station. A weather protection canopy covers part of the transit plaza. The at-grade station accommodates the basic station services and other station elements like ticketing, offices, storage, and other facilities etc. which are located near the main entrance of Leslie Station. The station was designed to accommodate an end entrance type platform serviced from the main entrance/vertical access from the station. The at-grade station surface facilities will be connected to the eastbound and westbound platforms located at the 407 Transitway level by means of overhead vertical access such as stairs, escalators and elevators to accommodate the requirements for universal accessibility. The preliminary station concept for Leslie Station is illustrated in **Plates 42** and **Plate 43** at the end of **Section 6.**

During the Detailed Design Stage, the surface facility at this station will be reviewed with the other transit agencies to confirm requirements and preferences. As well, the Detail Design Stage of the station ground facility will ensure that any proposed development is out of the floodplain of the German Mills Creek Tributary 1.

Access/Egress to the Facility

The site access roadway to the proposed Leslie Station site will be aligned with the existing signalized St Robert Catholic High School access to form a four-way signalized intersection. The new roadway will provide access to the PPUDO and the park-and-ride facility.

6.2.2.6 Woodbine/Rodick Station

Location

Woodbine Station is located north of Miller Avenue, east of Woodbine Avenue and is restricted by the presence of the Hydro Corridor to the south and the private property to the north. The station surface facilities are located north of and within the Hydro One ROW where the existing Miller Avenue crosses diagonally.

Transportation Function

Woodbine/Rodick Station will serve largely as a park and ride station with a PPUDO facility but it will also provide local bus connections to TTC and YRT/Viva bus services. In addition it is anticipated that local shuttle buses will be employed to transport passengers to the local Woodbine Avenue/Highway 404 business park.

Intermodal Facility - Type & Services

Woodbine/Rodick Station's surface facilities are comprised of a parking area (including carpool), a PPUDO and a bus loop for local buses. The bus loop is located directly in front of the main entrance of the station building. The at-grade transit plaza accommodates the pedestrian movement, the above feeder modes and the station. A weather protection canopy covers part of the transit plaza. The at-grade station accommodates the basic station services and other station elements like ticketing, offices, storage, and other facilities etc. which are conveniently located near the main entrance of the station. The station plan and elevations are designed to accommodate an end entrance type platform serviced from the main entrance/vertical access from the station building. The preliminary intermodal station concept for Woodbine/Rodick Station is illustrated in **Plate 44** and **Plate 45** at the end of **Section 6.**

During the Detailed Design Stage, the surface facility at this station will be reviewed with the other transit agencies to confirm requirements and preferences

Access/Egress to the Facility

With the consideration of the future Miller Avenue and the planned road network improvements, two signalized intersections are proposed for this Station. The first access road is located 280 m west of Rodick Road for the park-and-ride facility and the PPUDO. The second access is a transit access only which is located 180 m west of the first access road, in order to provide a direct local bus access to the station. The intersection will be aligned with the planned local road to form a four-way signalized intersection.

6.2.2.7 Kennedy Station

Location

Kennedy Station will be located on the east side of the GO Stouffville Line. Due to the preference to pass under the rail line, the station will be depressed one level below the surface road system and existing GO Station parking lot.

Transportation Function

Kennedy Station will serve as an intermodal facility that provides transfer opportunities between the 407 Transitway and the GO Stouffville Line service as well as the bus services operated by GO Transit and YRT/Viva. Kennedy Station will also serve the Markham Regional Centre's business, commercial and residential development surrounding the station. Park-and-ride, PPUDO and bicycle storage facilities will be provided at this station.

Intermodal Facility - Type & Services

The inter-modal station facilities are comprised of a parking area (project being undertaken by Metrolinx), PPUDO and a two level bus loop (project being undertaken by the YRT/Viva program). The YRT/Viva platforms and the 407 Transitway platforms are located below grade while the GO platforms, feeder bus bays and the inter-modal station concourse are located at grade. The at-grade transit plaza accommodates the PPUDO and leaves room for the mobility hub expansion.

The potential intermodal plaza will also incorporate light wells for natural light infiltration to the bus loop areas and transitway platforms located below grade. Vertical circulation elements such as staircases, elevators and/or escalators are provided for convenient circulation between the below-grade bus loop areas and the at grade inter-modal station plaza. **Plate 46, Plate 47** and **Plate 48** at the end of **Section 6** illustrate the preliminary intermodal station concept for the Markham Regional Centre.

A weather-protected, at-grade circulation corridor would connect the future YRT/Viva LRT platforms to the inter-modal station. Vertical access is provided to the YRT/Viva platforms below-grade. The inter-modal station will also be connected to the future parking structure which also would accommodate overhead pedestrian bridges connecting to a future southbound GO Station platform west of the tracks. The at-grade inter-modal station building accommodates the basic station services including elements like ticketing, offices, waiting areas, bicycle storage, maintenance and other facilities etc., conveniently located near the main entrance of Kennedy Station. The station plan and elevations are based on accommodating a major entrance at the west end of the platform serviced from the main concourse entrance/vertical access in the inter-modal station building.

The station configuration has flexibility for integration with the future road network and any future elements of the development of the Markham Centre lands both east and west of the GO Line and on both sides of YMCA Boulevard.

During the Detailed Design Stage, the surface facility at this station will be reviewed with the Town of Markham and the other transit agencies to confirm requirements and preferences.

Access/Egress to the Facility

As part of future transit developments in York Region, Viva buses will operate in their own separate right-of-way for part of their routes. A station access road with a median downhill ramp dedicated for Viva transit operation will be provided on the YMCA Boulevard, as illustrated in **Plate 46** and **Plate 47.** The station access road will provide access to the unloading and loading area for non-Viva buses, GO Transit, 407 Transitway and the park-and-ride facility users.

6.2.3 User Accessibility and Connections

Connections to other transit service providers, as well as pedestrian and cyclist circulation are provided and include:

- Connections to TTC, YRT/Viva, GO Bus and GO Rail as well as local shuttle buses to business parks;
- Pedestrian connections and circulation; and,
- Bike circulation and access.

6.3 Structures

Locations of new structures and structures requiring modification and/or rehabilitation along the proposed route were identified. Locations where the transitway traverses high volume roadways (e.g. the 400 series highways) have been identified, as have locations where prefabricated and/or tunnel technology would be a feasible alternative to conventional construction.

The preliminary design of the structures is based on the CHBDC and the requirements of *MTO Structural Manual Rev #55 May 2008*.

Where applicable all background information was collected, feasible structural alternatives for new structures were developed and compared for each site. Factors such as environmental effects, capital cost, life cycle cost, durability, constructability and traffic staging, future maintenance and widening were taken into account in determining the optimum solution for each structure.

The 407 Transitway's vertical profile imitates that of the 407 ETR; because it runs in the same corridor all arterial and rail crossings were already either elevated or depressed in order to cross the 407 ETR. This resulted in an existing grade difference which was used to minimize cut and fill requirements as well as the necessity for retaining walls along the edge of the 407 ETR. There were exceptions to this however, when conflicts occurred with utilities, hydro and existing or proposed physical constraints such as buildings and the preferred horizontal profile and station location. All high volume roads and large crossings were determined to be overpasses due to ease of construction as well as minimized impact to traffic and minimized cost.

6.3.1 Overpasses and Underpasses

A total of 39 new structures have been identified along the transitway route. Bridge and tunnel widths were determined based on roadway lane requirements, minimum sidewalk widths and side clearances as specified in the *407 Transitway Design Standards* and the Geometric *Design Standards for Ontario Highways (1994)*.

Overpass and underpass structures will be constructed at main water courses as well as at all road, rail and interchange crossings. **Section 5** discusses the criteria followed to determine if the crossing would be an overpass or an underpass. **Section 8** describes the conceptual construction staging of the underpasses, necessary to minimize general traffic effects.

In general, the crossings have been divided into five classifications: waterway crossing, arterial and minor road crossings, major highway crossings, and rail crossings.

Waterway crossing: A crossing structure used where the transitway will pass over a waterway (river, creek, tributary). The crossing configuration was determined through an assessment of ecological constraints, and both hydraulic and structural requirements. A hydraulic analysis (refer to **Appendix M**) was undertaken to establish the design flood levels at the crossing, the opening required for the watercourse through the bridge and the required bridge deck clearance. This information was used to identify the preferred structure type and prepare the preliminary design. During the Detail Design Stage the actual bridge spans will be confirmed based on additional field surveying, updated hydraulic modelling, the actual shape of the section under the bridge, a detailed assessment of long-term channel movement (via meander belt analysis), erosion effects, and provision of wildlife and fish passage.

Arterial and other minor road crossings: A grade separation in which the transitway will pass over or under an intersecting road. The 407 Transitway's profile mimicked the profile of the 407 ETR for all crossings given that there were no conflicts with utilities or the existing conditions adjacent to the crossing. As explained in **Section 5**, in most road crossings the transitway is proposed under the intersecting road. This category includes the Highway 407 ramps to and from the crossing arterial roads. **Section 8** describes and illustrates a typical construction staging sequence of a Highway 407-arterial road interchange to minimize operational effects for York Region and 407 ETR.

Major highway crossings: A grade separation in which the transitway will pass over the core lanes of a high speed, high volume road such as a 400 series highway. Due to the high traffic volume and importance of these roads, the construction of the transitway should not cause traffic interruption on the crossing highway; consequently, two options were considered: i) Tunnelling, which was eliminated due to excessive cost; ii) Overpass, which was selected as the preferred option. This situation occurs in the three crossings of the Highway 407 core lanes.

Rail crossing: Grade separations whereby the transitway will grade separate a railway. There are four rail crossings of the transitway: i) the CN Macmillian Yard spur tracks; ii) the GO Barrie Line track; iii) the CN Bala Subdivision track; and, iv) the GO Stouffville track. Similar to the case of road crossings, crossing over/under the track was assessed considering various operational, physical and environmental factors as described in **Section 5**. Rail overpasses are slightly different than arterial road overpasses as additional clearance is required for trains. Rail underpasses have the same requirements as arterial underpasses with respect to clearance required. Construction staging of rail underpasses will be addressed in coordination with the railway owner and operators during the Detail Design Stage.

Using the crossing classifications above, the following table (**Table 6-3**) presents the preferred structural options for each identified crossing:

Table 6-3: Preferred Structural Options for each Identified Crossing

Structure Reference No.	Location	Crossing Classification	Proposed Structure Type
6.1.1	Transitway under Highway 400	N/A	Not included in study. Considered to ensure that transitway design for the central section can be successfully integrated with the eastern and western sections of PBWP.
6.1.2	Transitway over Black Creek Tributary	Waterway Crossing	2-Span slab-on-CPCI Girders with Integral Abutments
6.1.3	Transitway under Jane Street	Arterial underpass	Cast-in-place reinforced concrete box structure constructed by top-down method.
6.1.4	Transitway over Black Creek	Waterway Crossing	3-span CIP voided post-tensioned slab bridge.
6.1.5	Transitway over CN MacMillan Yard*	Rail Crossing	4-span slab-on-steel trapezoidal girders.
6.1.6	Transitway under Keele Street and 407 ETR Ramp S-E	Arterial underpass	Single span reinforced concrete box structure.
6.1.7	Transitway over Highway 407 ETR, east of Keele Street **	400 series overpass	2-span slab-on-steel trapezoidal girders.
6.1.8	Transitway under GO Barrie (Concord) Line *	Rail Crossing	Cut-and-cover reinforced concrete structure box.
6.1.9	Transitway over West Don River Tributary	Waterway Crossing	2-span slab-on-Steel I - Girders Bridge with Integral Abutments
6.1.10	Transitway over West Don River	Waterway Crossing	3-Span slab-on-CPCI Girder Bridge with Integral Abutments
6.1.11	Transitway over Centre Street	Arterial overpass	2-span slab-on-CPCI I-Girders with integral false abutments.
6.1.12	Transitway over Westminster Creek	Waterway Crossing	Single span side-by-side CPCI box beams bridge with semi-integral abutments.
6.1.13	Transitway under Dufferin Street and Highway 407 ETR N-W, and E-N/S Ramps	Arterial underpass	Single span reinforced concrete box structure.
6.1.14	Transitway under 407 ETR Ramp S-W, Bathurst, Ramp E-N/S and Ramp S-W	Arterial underpass	Single span reinforced concrete box structure.
6.1.14A	Transitway over Baker Sugarbush-East Don River Tributary	Waterway Crossing	Reinforced Concrete Rigid Frame Open Footing Culvert
6.1.15	Transitway over East Don River	Waterway Crossing	Single span slab-on-steel I-Girders with integral abutments
6.1.16	Transitway over East Don River	Waterway Crossing	3-span slab-on-CPCI I-Girders with integral abutments.
6.1.17	Transitway over Highway 407 Ramp N-W, Yonge St and Highway 7	Arterial overpass	8-span slab-on-steel trapezoidal girders.
6.1.18	Transitway under Yonge / Highway 7 Link Road	Arterial underpass	Single span reinforced concrete box structure.
6.1.19	Transitway under YRT/Viva Access Road	Arterial underpass	Single span reinforced concrete box structure.
6.1.20	Transitway under CN Rail *	Rail Crossing	Single span reinforced concrete box structure.
6.1.21	Transitway under Highway 7	Arterial underpass	Single span reinforced concrete box structure.
6.1.22	Transitway over Cedar Avenue	Arterial overpass	Single span slab-on-steel I-Girders with integral abutments.
6.1.23	Transitway under Bayview Avenue	Arterial underpass	Single span reinforced concrete box structure.
6.1.24	Transitway over German Mills Creek	Waterway Crossing	Single span slab-on-steel I-Girders with integral abutments.
6.1.25	Transitway over Highway 407 ETR East of Bayview Avenue **	400 series overpass	2-span slab-on-steel trapezoidal girders.
6.1.26	Transitway over German Mills Creek Tributary	Waterway Crossing	3-Span slab-on-CPCI Girders with Integral Abutments.
6.1.27	Transitway under Leslie Street	Arterial underpass	Single span reinforced concrete box structure.
6.1.28	Transitway over Highway 407 ETR Ramp S-W, Ramp E-S, Highway 404 **	400 series overpass	3-span slab-on-steel trapezoidal girders.
6.1.29	Transitway under Highway 404 / 407 Ramp S-W	Arterial underpass	Single span reinforced concrete rigid frame.
6.1.30	Transitway under Highway 404 / 407 Ramp S-E	Arterial underpass	Single span reinforced concrete rigid frame.
6.1.31	Transitway over Burncrest Road	Arterial overpass	Single span slab-on-trapezoidal steel girders with integral RSS false abutments.
6.1.32	Transitway over Woodbine Avenue	Arterial overpass	Single span slab-on-trapezoidal steel girders with integral RSS false abutments.
6.1.33	Transitway under Rodick Road	Arterial underpass	Single span reinforced concrete box structure.
6.1.34	Transitway over Rouge River/Beaver Creek Tributary	Waterway Crossing	3-span slab-on-CPCI girders with integral abutments.
6.1.35	Transitway under Warden Avenue	Arterial underpass	Single span reinforced concrete box structure.
6.1.36	Transitway over Highway 407 ETR East of Warden Avenue A **	400 series overpass	2-span slab-on-steel trapezoidal girders.
6.1.37	Transitway over Tributary 1 of Rouge River	Waterway Crossing	Single span Reinforced Concrete Rigid Frame
6.1.38	Transitway under CN Rail *	Rail Crossing	Single span reinforced concrete box structure.
6.1.39	Transitway under Kennedy Road	Arterial underpass	Single span reinforced concrete box structure.
6.1.40	Transitway over Highway 407 ETR East of Kennedy	N/A	Not included in study. Considered to ensure that transitway design for the central section can be successfully integrated with the eastern and western sections of PBWP.

* Railway Crossing ** High Volume Crossing

6.3.2 Culverts

Within the project limits there will be a total of one structural culvert. Culverts for the transitway will be an open footing rigid frame box structure. The structural culvert is crossing Baker Sugarbush – East Don River Tributary located west of Bathurst Street and between Highway 7 and Highway 407.

6.4 Stormwater Management and Drainage

The proposed 407 Transitway will cross 16 creeks within three major watersheds as illustrated in **Figure 6-4**. From west to east, they are the Humber River, Don River and Rouge River watersheds. A study has been completed that assesses the impact of the transitway and stations on existing watercourses and drainage systems.

The study report, entitled: *Preliminary Design Report for Drainage, Hydrology, Stormwater Management & Floodplain Hydraulics (the "Drainage Report") (August 2010)*, is included in **Appendix M** of the EPR. The study activities included a comprehensive hydrologic analysis to assess impacts on the existing watercourses, mitigation measures, calculation of stormwater storage volumes where needed to provide quantity and/or quality control of runoff generated by the proposed transitway including stations, parking lots and workyards, hydraulic analysis of proposed 407 Transitway structures at the water crossings, and SWM strategy. SWM criteria developed by the TRCA and used in the Drainage Report are described in **Table 6-4.**

Table 6-4: Stormwater Management Criteria

Quantity Control	• Black Creek - Unit Release Rates • Don River - sites greater than 5ha apply unit release rates as defined in "Unit Flow Rates for Stormwater Control Upper Don River Watershed", sites less than 5 ha apply the 2 to 100 post to pre control, • Rouge River - From a watershed management perspective no quantity control is required. However local Municipalities may have requirements, should drainage be directed to municipal infrastructure.
Quality Control	Enhanced protection (Level-1) is required for the Humber River, Don River and Rouge River - Use criteria defined in Table 3.2 of the *Stormwater Management Planning and Design Manual (MOE, 2003)* to determine the minimum permanent pool size for end of pipe facilities
Erosion Control	25mm event or as approved by the Authority
Water balance	Pre-development rate of infiltration should be maintained through one or a combination of on-site measures to the extent possible. Site water balance following new development shall resemble pre-development conditions to the extent possible

The hydrologic analysis was undertaken using Visual OttHYMO modeling software. The storm distributions analyzed for each watershed are 6-hr AES for Humber River and 12-hr SCS storm distribution for the Don River and Rouge River watersheds. The return periods analyzed for each storm event are 2-yr, 5-yr, 10-yr, 25-yr, 50-yr and 100-yr, as well as the Regional Storm. A number of hydrologic reference points were selected at strategic locations downstream of the proposed transitway to use for comparative analysis of pre-development and post-development discharges. The pre-development peak flows were determined using the original model areas provided by TRCA (refer to **Appendix M**).

In the post-development condition, the increase in paved areas from the proposed transitway and stations was taken into account in the analysis (refer to **Chapter 4 of Appendix M**). The post-development SWM strategy includes the design of several enhanced swales for quality treatment of runoff generated by the transitway for drainage areas less than 5 hectares. Where transitway drainage contributes to an existing SWM pond either directly or via a grass swale with or without quantity storage, quality treatment will continue to be provided by the existing SWM pond. Where the runoff does not contribute to a SWM pond, water quality treatment will be provided by the enhanced grass swales. The enhanced grass swales will be part of a treatment train approach comprised of: sheet flow off the roadway surface; flow through grassed filter strips (roadway embankment); and enhanced grass swales. Enhanced grass swales have been shown to reduce total suspended solids (TSS) by 76% and grass filter strips provide a reduction of 20% to 80% *(Low Impact Development Stormwater Management Manual, Toronto and Region Conservation and Credit Valley Conservation, Draft 2009).* While the report does not provide documentation on a combination of grass filter strip and enhanced grass swale, it is expected that the combination should provide a total reduction of at least 80% which would meet the Enhanced (Level 1) water quality target.

In addition, several SWM ponds were designed for drainage areas greater than 5 hectares (details included in **Chapter 5 of Appendix M**). All ponds were designed for quantity and quality control providing Level 1 protection at the outlet. The MOE document *Stormwater Management Planning and Design Manual (MOE, 2003)* provides guidance for the design of Stormwater Management Facilities (SWMF) which are illustrated in Table 3.2 of the Manual and has been used to establish volumetric requirements for the level of protection required. The sizes of these facilities are summarized in **Table 6-5** (refer to **Appendix M**).

Table 6-5: Summary of Stormwater Management Ponds Within the Study Limits

Stormwater Management Facility (SWMF)	Location	Total pond volume required (m^3)	Quality and Quantity Control
1	Jane Station	8,620	yes
2	Jane Station	4,950	yes
3	Jane Station	3,400	yes
4	GO Barrie (Concord) Station	6,090	yes
5	Bathurst Station	4,380	yes
6	Leslie Station	3,880	yes
7	Woodbine Station	3,750	yes

As illustrated in **Table 6-5**, SWMFs have not been developed for the underground stations (Yonge Station and Kennedy Station). During the Detailed Design Stage, any required SWMF for these underground stations will be developed following best management practices.

At the transitway stations, a combination of SWM ponds and on-site controls (parking lot and roof storage) is proposed. These best management practices should be considered during the Detailed Design Stage as part of a Low-Impact Development strategy for each station. The location of proposed enhanced swales and ponds is indicated in **Figure 6-4** (refer to **Appendix M**).

The hydraulic analysis was undertaken using HEC-RAS modeling software. All water crossings were modeled as bridges. The structures were designed to convey the regional storm without overtopping the roadway, as well as conveying the 100-year storm with adequate clearance to the bridge soffit with minimal or no increase in upstream water levels. In the few instances where there may be minimal increase in upstream water levels, the flow is either contained in the channel or within MTO property. No impacts are expected for upstream properties. The preliminary design information for the water crossings is shown in **Table 6-6.** The floodplain mapping and results of the hydraulic analysis are included in **Appendix M**.

The following elements of the proposed drainage and SWM plan will need to be assessed further during the Detailed Design Stage (refer to **Appendix M**):

1. The redesign and reconstruction of three 407 ETR ponds that are in the way of the proposed 407 Transitway alignment;
2. The adequacy of four 407 ETR ponds identified in the study to serve as outlets for transitway drainage areas will need to be confirmed;
3. The HEC-RAS model developed for Tributary 1 of Black Creek should be updated to take into account the proposed work for the Toronto-York Spadina Subway Extension project. In addition, the study entitled *Black Creek Stormwater Optimization Master Plan Class Environmental Assessment* undertaken by the City of Vaughan is in process of being finalized and has not been specifically addressed in our work. The intent and targets of this study should be considered during the preparation of the detailed design;
4. The grading plans for the stations are not available. Given their close proximity to watercourses, grading plans are required to confirm the constructability of the ponds, to avoid encroachment into the floodplains, and to ensure that the ponds are set high enough to avoid back-water effects from the watercourses into the ponds;
5. At the West Don River, several crossings are proposed in an area that is currently considered to be in the floodplain. To minimize encroachment of the 407 Transitway into the floodplain, the construction of vertical walls or elevated structures should be considered;
6. A re-alignment of the creek to the west of Leslie Station may be required to minimize the risk of flooding of the station if changes to the transitway alignment are not possible. The proposed pond for Leslie Station (SWMF-6) is located in the hydro corridor. A creek re-alignment would also make space for the pond;
7. The culvert under Highway 7 west of Bathurst Street appears to be significantly over-sized based on flow calculations. The final crossing will be assessed during detailed design;
8. The bridge layouts for the Tributaries 1-2 of the East Don River should be reviewed further to minimize large amounts of embankment fill. A cut and fill analysis should be performed for this crossing during re-design of the existing pond; and;
9. NASHYD command will be used to represent predevelopment conditions for the transitway ROW and STANDHYD will be used to represent post development conditions.

6.5 Utility Relocation

Over 80% of the alignment lies on a vacant strips located between Highway 407, Highway 7, the Utility Corridor and the Hydro Corridor; consequently potential requirement of utility and municipal service relocation only occurs at the grade separation crossings with York Region's arterial roads and some local municipal roads, or on short segments where the alignment somehow affects the Utility Corridor.

Section 4 of this EPR includes the list of all utilities and municipal services located within the 407 Transitway footprint, while **Section 7** includes the effects and proposed mitigation measures to the cases considered significant due to size and importance of the facility or degree of relocation difficulty and/or complexity during the construction stage. All these cases will need to be addressed in detail during the Detailed Design Stage of the transitway.

Hydro One has a list of general requirements for facilities to be built near their transmission lines to ensure the compliance of safety regulations and maintenance access to their structures. These requirements have been considered during the evaluation of alternatives and will be addressed during the Detailed Design Stage.

6.6 Emergency Response Services (ERS) Considerations

Along the transitway, access to and egress from the route will be available for buses and emergency response vehicles at specific locations. Such locations will occur at each transitway station by way of a circulation road as well as a restricted access point from specific arterial roads that surround the transitway. The connecting arterial roads that will be chosen are compatible with the transitway because they have comparable grade, available land, sufficient space to provide adequate turning radius for buses to access all directions/perform all movements, and an existing intersection. However, emergency response vehicles and access points will not be allowed through private property or residential neighbourhoods regardless of the compatibility of the arterial road.

In order to increase the safety factor of the transitway, the route will have several access and egress points in between stations, where physically possible. The purpose of these points is two-fold: buses will have the opportunity to enter or exit the transitway as required; and emergency response vehicles such as fire trucks, emergency medical response vehicles (ambulances), and police cars will have access to the transitway when necessary as quickly and efficiently as possible. Potential access points for Emergency Response Services (ERS) vehicles and buses in between stations include:

- Rivermede Road (east of Centre Street);
- Langstaff Road (east of Dufferin Street);
- Thornhill Woods Drive (west of Bathurst Street);
- Hunters Point Drive (east of Bathurst Street);
- Silver Linden Drive (west of Bayview Avenue);
- To proposed Miller Avenue (west of Woodbine Avenue); and,
- Proposed Miller Avenue Extension (west of Warden Avenue).

6.7 Illumination

Along the runningway, illumination is being proposed only at the platforms and approaches to them. At surface or above grade sections, the transitway will be affected by light spillage from the HML of Highway 407 which basically runs parallel to the future transitway. Illumination is not being proposed at the proposed underpasses since they are less than 60 metres long.

Illumination will be required at all components of the station exterior facilities including vehicular and pedestrian access and circulation roads and paths, bus facilities, commuter and PPUDO parking facilities and station platforms; as

well as interior elements such as public areas within station building, ticket/passenger information areas, pedestrian walkways and tunnels, escalators and stairwells, operations/maintenance electrical and mechanical rooms. The design criteria for exterior illumination, as well as hardware, should be in accordance with Metrolinx standards as listed in **Table 6-7**.

Table 6-7: GO Transit Standards

Location	Poles	Luminaires	Illumination Level (lux)
Transitway Platforms	6.0m Steel poles	250W HPS	50
Bus Loops, Access Roads & Platforms	12m Steel poles	250W HPS	20
Underpasses and Tunnels		H.O Fluorescent Luminaires with TS lamps 1219mm long	150

Illumination of parking lots should be in accordance with MTO standards as outlined in the following **Table 6-8**:

Table 6-8: MTO Standards for Parking Lots

Location	Poles & Luminaires	Illumination Level	Uniformity	Lighting Control
Parking lots where more than 35 vehicles park on a regular basis and there is a transit stop within or adjacent to the parking lot.	9.0m Steel poles with 250 W HPS or 25m High Mast with 400 W HPS	Full Enhanced 25 lux	Avg/Min – 3:1 Max/Min – 6:1	adaptive lighting controls to enhance energy conservation by reducing lighting levels to 10 lux between. 11 PM and 4 AM

High mast poles should not be used at parking lots located beneath hydro tower transmission lines unless required clearances by Hydro One can be achieved.

Interior illumination will also follow GO Transit guidelines and standards and will be coordinated with the station architectural design.

6.8 ITS

The incorporation of ITS is the application of technology to address the operational needs of transportation agencies. ITS in transit and has become synonymous to the passenger with safety, cost effectiveness and operational efficiency in higher order transit systems such as that envisioned for the 407 Transitway. Pre-planning ensures that the maximum benefits can be appreciated by the widest number of users. The 407 Transitway ITS is expected to include management of transit fare collection; common electronic payment; interactive traveller information; parking management and information; transit signal priority; real-time operations monitoring and passenger security.

6.9 Landscaping

The landscape design for this new transit facility is to focus on mitigating the impacts of the corridor and station sites on the local, natural and cultural environments, as well as to blend the facility into the cultural environment. The proposed landscape treatments for the project are designed in two components, one for the transit corridor and the other for the station sites.

The general intent of the corridor landscape treatment is to provide an aesthetically pleasing environment area along the transit corridor. The corridor provides an excellent opportunity to increase tree canopy cover and enhance the local vegetation diversity. This is to be accomplished using a variety of low maintenance, native, and salt tolerant trees, shrubs and grasses.

The landscape treatments are designed to accomplish a number of functions including; slope stabilization, stream crossing restoration, providing naturalization planting sites, creating visual/wind buffers, and generally improving the general aesthetics of the corridor.

The outdoor area in the vicinity of the stations and associated parking facilities are designed to create a coordinated image for the station sites. The landscape treatments will provide the public with a safe, well defined pedestrian environment, outdoor amenity areas, and an aesthetically pleasing environment. This is to be accomplished using a variety of landscape techniques including, a variety of plantings, upgraded pedestrian paving and a coordinated 'palette' of outdoor furnishings.

Landscape related 'Green' initiatives associated with pedestrian area paving, surface water retention, green roofs, and outdoor lighting are to be implemented in appropriate areas. The landscaping around the station sites and parking facilities is designed to complement the surrounding land uses and present the station sites as a visual asset to the local area.

6.10 Operations and Maintenance Facility

In accordance with the functional requirement to develop the transitway for initial operation as a component of a BRT system but not precluding future conversion of the facility to LRT, conceptual layouts of Operations and Maintenance (O&M) Facilities for both technologies have been developed. Both layouts, shown in **Figure 5-26 (a)** and **(b)**, are considered part of the 407 Transitway Central Section project and their effects have been assessed under this TPA.

The MOE requires that the O&M Facilities for the transitway be designed with the objective of incorporating "green building" design principles and obtaining certification under the Canada Green Building Council's LEED Canada-NC 1.0 Green Building Rating System. The design of O&M facilities will conform to best practices for the control of environmental effects. These include:

- **Capture of hazardous materials.** Tanks will be constructed and used to avoid spillage or seepage at all times. Processes for fuelling and other transfers of oil products or other chemicals will be specified to reduce the risk of accidental release into the environment;
- **Runoff.** Gray water will be allowed for use in the bus washer system. Reclaiming and reuse of this water will be encouraged;
- **Plumbing and drainage.** Systems will conform to local by-laws and codes, as well as provide reliability and service appropriate to functional needs;
- **Ventilation.** All facilities will be heated and ventilated in accordance with applicable building code requirements. Zone heating and cooling will be employed to optimize energy usage and conservation;

Figure 6-5: Conceptual Layout of BRT Operations and Maintenance (O&M) Facility