SSR Group

Jane Street Rapid Transit Corridor

Final Report

April 9th, 2020
CIV498 TUT0106

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Executive Summary

SSR Group has prepared the final deliverable for transit improvement on Jane Street between Bloor Street West and Steeles Avenue West in the City of Toronto.

Currently, the two existing bus routes (express and local services) running through Jane Street have high ridership and relatively unreliable service. High level of inequities, high density residential or mixed-use zoning, high auto volumes and potential connections to other transit services bring the need to improve existing transit service on Jane Street. Goals and objectives were considered to improve the study area and relevant guidelines and official plans were studied.

The team proposed five alternatives for transit improvement: do nothing, BRT, Surface LRT, Mixed Surface/Underground LRT, and Light Metro. For each alternative, an example of a successful project from other cities was studied. Two successful examples of transit hubs are also discussed. The project will be designed as a transit hub to enhance integration into the existing transit system in Toronto.

Detailed analysis of each alternative was conducted with respect to each objective. This includes transportation analysis (travel time, connectivity, reliability, congestion reduction and multi-modality) and quality of life analysis (sustainability, safety, accessibility and economic development).

Mixed Surface/Underground LRT was selected as the preferred alternative. The constructability of the project is analyzed and four major aspects of construction challenges are identified: underground construction, utility relocation, property impacts and traffic disruption. A detailed cost analysis shows that the capital cost of the project will be $2.19 billion.

Preliminary design for surface alignment, surface intersection plan, tunnel cross section, and transit hub design at Dundas Street and Jane Street are presented. The design will be finalized based on comments from the client and stakeholders and will move forwarded to procurement and implementation.

1 Introduction

SSR Group has prepared the following report as the interim submission for the Jane Street Rapid Transit project. This report presents a detailed analysis to evaluate 5 proposed alternatives and complete design of the preferred alternative for the Jane Street corridor.

2 Project Goals and Vision

The aim of the Project is to improve transit service along Jane Street. To fulfill this purpose, SSR Group has developed goals and objectives for alternative assessment, project design, and evaluation, as illustrated in Figure 1. The goal of this project is twofold: to improve the efficiency of the existing transit system and to improve the quality of life and user experience. SSR Group has developed these goals and objectives based on a review of governing plans for development in GTHA, as summarized in Table 1.

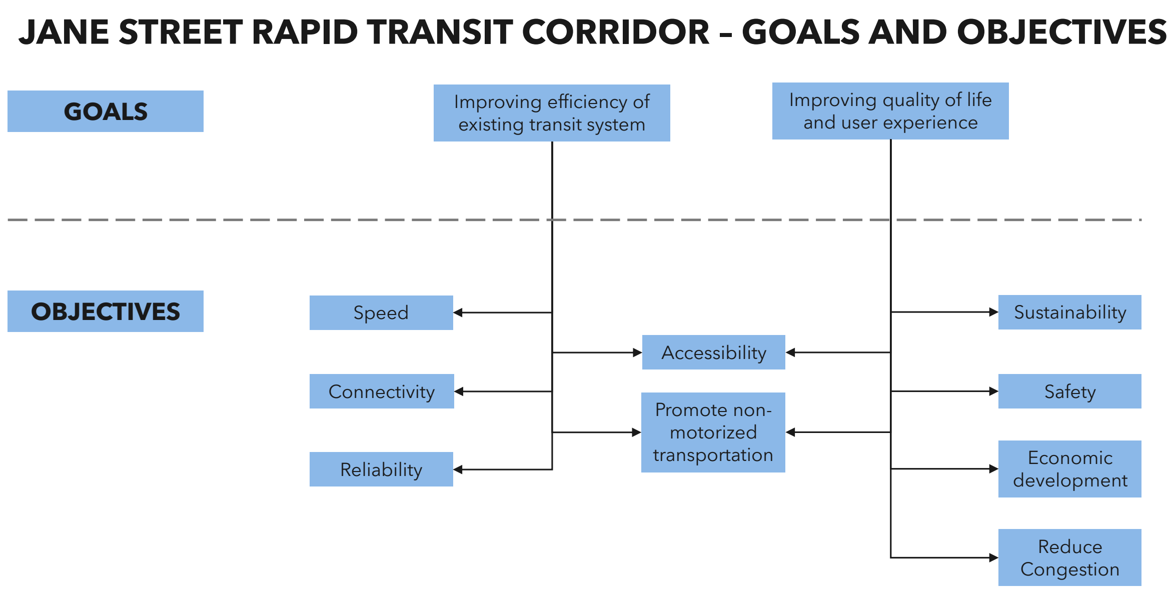


Figure 1: Project Goals and Objectives

2.1 Goal #1: Improve Efficiency of Existing Transit System

This goal is aimed at moving people more efficiently not only within the study area but also in the existing transportation network in the City of Toronto and other adjacent municipalities. The objectives for this goal include improved mode choice, reliability, speed, connectivity, and accessibility

2.2 Goal # 2: Improve Quality of Life and User Experience

This goal is concerned with the general well-being of people travelling near and on Jane Street. The objectives for this goal include: safety, economic development, mode choice, sustainability, reduced congestion and accessibility.

Table 1: Review of Governing Plans

Plan	Key Points
Places to Grow	Consider transit as the first priority for infrastructure planning to reduce automobile usage Focus on areas with high residential and employment densities
Metrolinx Regional Transit Plan	Improve sustainability and connectivity of transportation network Optimize the existing transportation system Integrate the transportation system with land use
Toronto Congestion Management Plan	Optimizing the existing network to reduce congestion Improve safety, efficiency, and reliability Increase multimodal considerations
Toronto Official Plan	Promote diversity and opportunity for all citizens Improve transit accessibility and land use integration Develop multimodal "Avenues" with mixed-use zoning

Transit City	Improve connectivity of transit network with higher order transit such as LRT lines
"Feeling Congested?"	Integrate transportation network with land use such as mobility hubs
City of Toronto Complete Streets Guidelines	Design streets for transit users, pedestrians and cyclists Improve user experience of intersections and streets
TTC 5-Year Service Plan and 10-Year Outlook	Move transit users safely, reliably, and swiftly Improve key routes, including Jane Street

Jane Street was identified to be the future rapid transit route in the Metrolinx Regional Transit Plan, the Transit City and the TTC 5-Year Service Plan and 10-Year Outlook.

All the aforementioned plans emphasized increasing ridership of public transit, reducing modal share of automobile trips and promoting multi-modal transportation such as walking and cycling. Goal #1 of this Project focuses on moving people more efficiently by transit. The corresponding objectives include promoting non-motorized transportation, improving reliability, speed and connectivity of the transit system.

The plans also aims to improve the quality of life and user experience, with a great emphasis on safety, sustainability and accessibility as specified under Goal #2. Integrating future development with transit in areas that are current focus of planned growth to provide transportation-supportive land use is also an essential part of most official plans as mentioned above, and is consistent with the economic development objective under Goal #2.

Based on the team's goals and objectives, the following criteria will be used to evaluate the performance of each alternative.

Table 2: Evaluation criteria and rationale.

Criteria	Rationale
Minimize Lifecycle Cost	With constrained funding, it is important to ensure an undue burden is not placed

	onto GTHA residents, so as not to harm current or future transit operations.
Provide Reliable Transit	Transit users should consistently expect a similar transit experience and LOS, no matter the time of day or area.
Increase Transit Mobility	Transit users should be able to travel from one area to another in an efficient manner.
Allow Residents to Easily Access Transit	There should not be barriers to access transit using their mode of choice, and transit should be in close proximity to residents.
Improve Regional Connectivity With Other Transit Modes	Users should be able to connect with other regional transit options to make efficient regional trips.
Reduce Congestion	Residents should avoid spend excessive time in traffic congestion.
Promote Mode Choice	The design should attempt to make as many modes of transportation viable and friendly to motorists, cyclists, transit users and pedestrians.
Promote Economic Revitalization	Transit improvements should facilitate investment into the area, such as through TODs, and allow residents to access a better economic standing.
Be Environmental Sustainable	Improvements should not cause damage to the localized or global environment, and seek to improve the environment for a better quality of life.
Be a Safe Mode of Transportation	It is important for a solution to prioritize transportation safety among all users of the corridor.

3 Project Scope

The purpose of this project is to evaluate alternatives and complete the preliminary design of one preferred alternative for the planned rapid transit on Jane Street between Bloor Street West and Steeles Avenue West. The study area is located in the City of Toronto. The new rapid transit will cross Highway 401 and the Black Creek, and will connect to Jane Station on TTC Subway Line 2. The following road segments are also included in the study area to provide potential connections to existing transit lines:

- Road segment on Steeles Avenue 0.9 km east of Jane Street connecting to the Pioneer Village Station on TTC Subway Line 1
- Road segment on Lawrence Avenue West 1.3 km west of Jane Street connecting to Weston GO/UP Station.

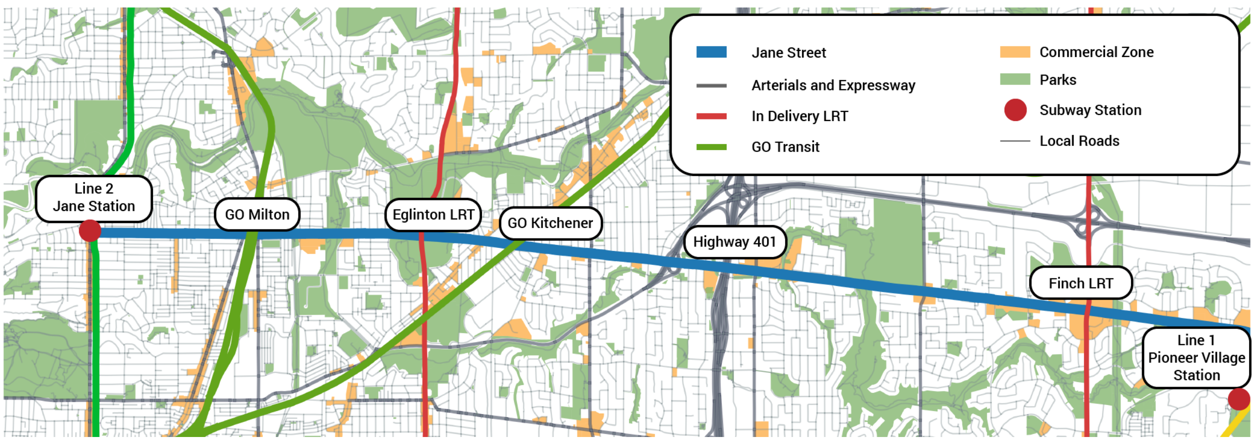


Figure 2: Scope of the corridor under analysis, including current and in-delivery rapid transit.

4 Background

4.1 Existing Transportation Network and Conditions

4.1.1 Existing Transit Service on Jane Street

The 35 Jane and 935 Jane busses operate local and express service the entirety of Jane Street within the City of Toronto, respectively. They operate in a mixed traffic, at a combined headway of 10 minutes or shorter. 35 Jane operates at an average operating speed of 18km/h during the peak period, while 935 Jane express service operates at a slightly higher 22km/h (TTC, 2019a). Among all TTC surface transit routes, 35 Jane has the 11th highest daily ridership (TTC, 2016).

Bus routes on Jane Street have often exceeded the TTC's crowding standard of an average of 51 passengers per vehicle (TTC, 2018), which does not take into consideration situations where the vehicle has reached the absolute crush capacity, and merely averages all vehicles. This is the case with 35 Jane and 935 Jane operating at a combined frequency of 36 vehicles during morning peak hour, already at the maximum achievable frequency in the mixed traffic right of way (City of Toronto, 2018; Kittelson & Associates et al., 2013).

4.1.2 Improving Connectivity of Transit Network

Multiple transit routes connect to Jane Street. The following are key high frequency routes that connect to Jane Street.

- Current
    - 52 Lawrence West
    - 89 Weston
    - 84 Sheppard West
    - 96 Wilson
    - Line 1 Yonge University Spadina
    - Line 2 Bloor-Danforth
    - GO Milton
    - GO Kitchener
- In delivery or under planning
    - 512 St Clair
    - Line 5 Eglinton
    - Line 6 Finch

The TTC recognizes the large amounts of transfers occurring on Jane Street between these surface routes, and is prioritizing improving customer experience at these intersections (Toronto Transit Commission, 2019). Multiple YRT buses and GO Transit buses also terminate either at Pioneer Village or at Highway 407, so improvements along the Jane corridor can improve customer experience for inter-municipality trips.

While there are north-south rapid transit east of Line 1, between Line 1 and the proposed Hurontario LRT, there are no north-south rapid transit options for commuters, so improvements to the Jane Street corridor can fulfil that gap, leading to more direct commutes for commuters wishing to avoid Line 1, and offering a method of relief for those who want to avoid the crowding along Line 1. In addition, offering more connections using Mobility Hubs, is a stated goal of Metrolinx's 2041 Regional

Transportation Plan (Metrolinx, 2018), which advocates regional connectivity, and frequent rapid transit covering the entire region.

4.1.3 Automobile Volume

Jane Street is classified as a major arterial by the City of Toronto for the entire length (City of Toronto, 2000), and has an 8 hour automobile volume ranging from 10,000 vehicles to a peak of around 27,000 vehicles. Noticeable spikes in traffic volume are observed near 3 intersections. At the intersections near St. Clair Avenue and Dundas Street West, Jane Street provides a north-south crossing of CPR's Galt subdivision. Similarly, Jane Street provides a north-south crossing of Metrolinx's Weston subdivision. These two crossings can be attributed to the spikes in volumes near the crossings. Additionally, relatively high traffic volumes are observed near the interchange at Highway 400/Black Creek Drive. The corridor traffic volume is illustrated in Figure 3.

While the street has 2 lanes of auto traffic in each direction for the entirety of the corridor, Jane Street has a varying ROW width:

- 20m from Bloor to St. Clair
- 27m from St. Clair to Highway 400, with the exception of the Eglinton intersection
- 36m north of Highway 400

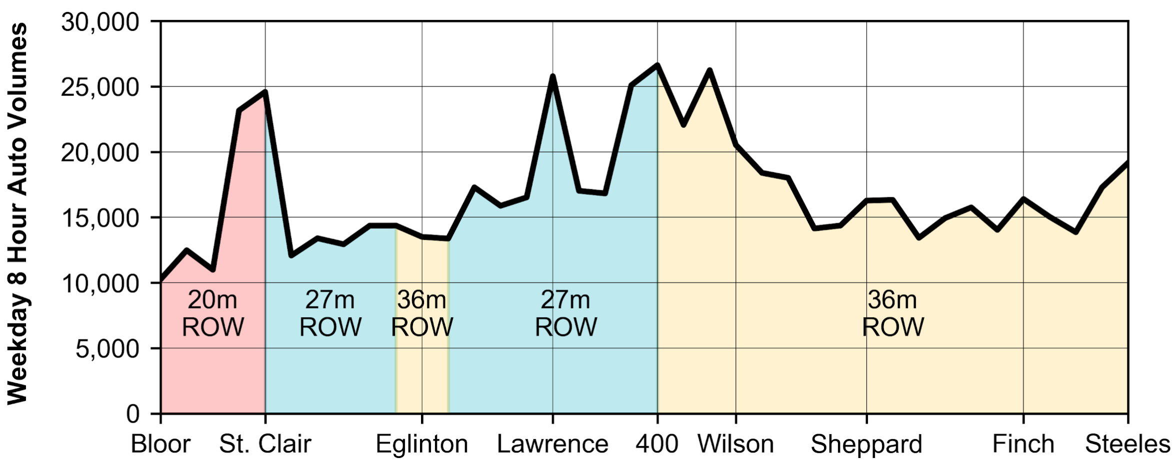


Figure 3: 8 hour weekday volume, and ROW widths along Jane Street (City of Toronto, 2015b, 2018)

4.1.4 Cycling Infrastructure

A goal of both Metrolinx, and the City of Toronto is to improve the feasibility of using sustainable modes, specifically cycling. The Jane corridor lies near the Etobicoke creek trail, black creek trail, and existing cycling infrastructure along Annette Street, and the 10 year cycling plan would add cycling infrastructure on the West Toronto Rail Path, the Finch Hydro Corridor, Lawrence Avenue West, Eglinton Avenue West and on Jane Street itself. Cycling and walking can help mitigate the last mile problem of accessing transit stops (Johnson, 2017) that transit normally face, so it's important that improvements on Jane would allow for the accommodation of bikes and cycling infrastructure to improve mobility options and increase accessibility to transit, compared to the lacking infrastructure currently on Jane Street.

The 10 year cycling plan would also build dedicated bike lanes on Jane Street, north of Wilson Ave W, so it's important any improvements would integrate this within the design.

4.2 Economic Development

Along with a high ridership, Jane Street is also home to the most marginalized neighbourhoods in the City of Toronto. Except for the section south of Dundas Street West, the entire corridor runs through neighbourhood improvement areas (City of Toronto, 2019a), as illustrated in Figure 4. These neighbourhoods have been defined by the City of Toronto as the neighbourhoods where the greatest level of inequities exist, have the lowest incomes, the highest population of recent immigrants, the highest populations of visible minorities, the lowest access to city services, and the lowest health outcomes among the entire City of Toronto.

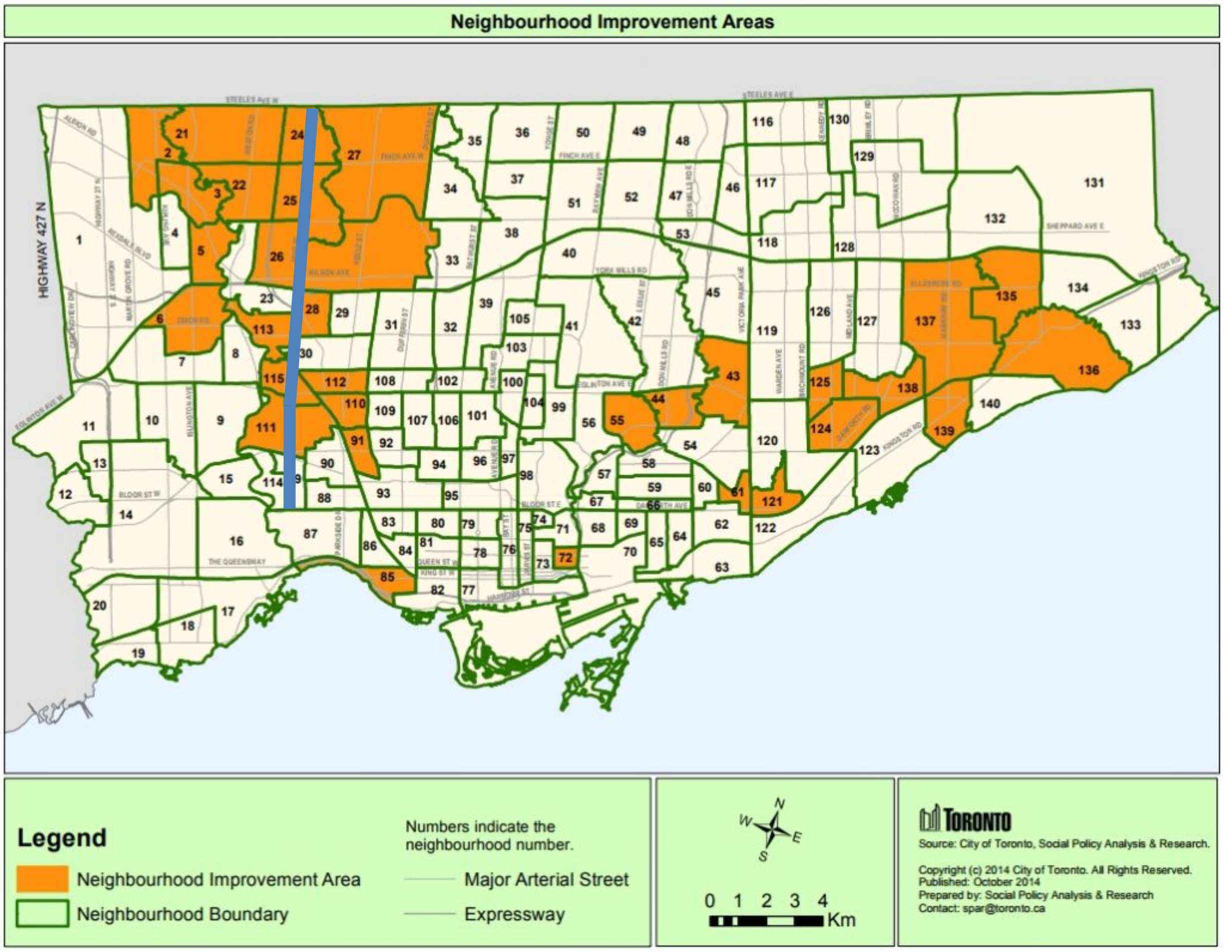


Figure 4: Neighbourhood improvement areas in Toronto, Jane Street is highlighted in blue (City of Toronto, 2014a).

Toronto's existing rapid transit network is concentrated in areas that are already affluent (Hulchanski et al., 2011), and may have deepened the equity divide within the city. Moreover, sufficient transit and reduced commuting time can dramatically improve the quality of life of residents (Olsson et al., 2013). In the TTC's most recent 5 year service plan (Toronto Transit Commission, 2019), the agency committed to addressing the social inequity in the neighbourhood improvement areas, and addressing vertical equity, meaning governmental bodies should overinvest in transit in inequitable areas (Litman, 1999), would greatly improve the lives of those who have been historically marginalized the most. With existing transit service at a poor LOS, and a capped ability to improve it using conventional buses, improvements must be made along the Jane Street corridor.

Additionally, areas along Jane are home to major employment centers. Malls at Jane Street/Finch Avenue West and Jane Street/Sheppard Avenue West are key destinations for those living in the area, and improved transit will improve the accessibility of those destinations. Much of the corridor is also zoned by the City as mixed use or high density residential, whereas similar north-south streets in Etobicoke-York, such as Keele or Islington, have residential zoning for most of the corridor (City of Toronto, 2015b). This type of zoning is seen on other rapid transit corridors, such as Eglinton Avenue West or Yonge Street, and is very conducive for high transit ridership, and potential TOD (Polyzoides, 2011).

The junction near St. Clair Avenue West and Dundas Street West, and areas near Downsview and Keele Street, are major employment hubs identified by the City of Toronto (City of Toronto, 2019b), and are relative proximity to Jane Street. The study area would also intersect York University, a major education center home to 55,000 students. Connecting these areas to the core of the city in a faster and more reliable mode will not only benefit transit users needing to access those destinations, it will also greatly advance economic development, leading to more jobs and prosperity for those living in the area

4.3 Environmental Considerations

Public transit has the potential to heavily reduce GHG, because the occupancy factor is high. With the ability to carry around 50 - 1100 passengers per vehicle, depending on the mode, passengers can spread will have a lower unit GHG emission than a single occupancy or double occupancy vehicle that commuters normally use. The USDOT reports that diesel buses can lead to a 33% reduction in carbon emissions per passenger mile, and a 60%-80% (Federal Transit Administration, 2010)reduction for rail transit, depending on operating characteristics. This wholly depends on users switching modes from using private automobiles to transit, so it is important that improvements will be significant enough to entice riders to switch, and increase the market share of transit.

However, for common air pollutants such as CO, NOx, Particulates, and VOC, the benefit is less clear. Because diesel buses rely on diesel fuel, and produce higher break wear, on a per capita basis, they generate higher NOx and VOC emissions than a private car. This is dependent on the method of propulsion as electric rail transit or electric buses have a reduction of 50 - 66% (Kennedy, 2002) in their CO, NOx and VOC emissions depending on the pollutant. CNG buses can also reduce these air pollutants, but not at the same extent as electrically propelled transit (Hesterberg et al., 2008), and would generally increase GHG emissions.

In terms of other environmental impacts, the Toronto and Region Conservation Authority reports that Jane Street will intersect the Black Creek floodplain at two points (TRCA, 2019). Traditional transit improvement measures would normally exacerbate the impacts of flooding because of impermeable surfaces on the right of way, so sufficient design should account for the potential of a 100 year flood. In addition, changes to transit infrastructure along vulnerable areas of the Jane corridor should be resilient enough to withstand potential flooding of Black Creek.

5 Literature Review

SSR Group has conducted literature review of successful examples of rapid transit projects in the world, as summarized below.

5.1 BRT

Viva is an active BRT system operated by York Region Transit in York Region, just north of Toronto (York Region Transit, 2019). It is planned to serve the key corridors in the region with frequent services. The services were launched in 2005 with buses running in mixed traffic with only priorities at intersections. To reduce delay caused by traffic congestion, rapidways (fully-dedicated or partial right-of-way) were being designed and built by segments with the first segment opened in 2015 on Highway 7. These rapidways are usually located in center medians on the roads with some exceptions at curbsides or on dedicated new roads. Since rapidways were open, decreases in travel time and increases in ridership have been observed. Up to January 2020, the system has 6 routes, a total 27.3 km of rapidway and multiple transit hubs.

Figure 5: Viva BRT (York Region Transit, 2019)

5.2 Surface LRT

Portland Metropolitan Area Express (MAX) is one of the most successful LRT systems in the United States. It began operating in 1986 and it currently consists of five lines serving 97 stations (TriMet, 2019). The MAX light rail connects Portland city centre with surrounding municipalities and the Portland International Airport. The five MAX rail lines run on surface streets in downtown Portland and Hillsboro. Elsewhere, they mainly run within their exclusive right-of-way in street medians, alongside highways, etc. The MAX rail lines have prompted more than $20 billion development within walkable distance of MAX stations which are compact, mixed-use and pedestrian-friendly, reducing the residents' reliance on automobiles.

Figure 6: Portland MAX LRT (TriMet, 2019)

5.3 Hybrid LRT

Link Light Rail is a LRT system in Seattle that opened in 2009. It provides a north south alternative to Interstate 5 in Seattle, and runs for approximately 30km. Its ridership has risen quickly, and is now at 80,000 trips per weekday, with ridership continuously increasing, and vehicular congestion successfully reduced in downtown Seattle (Trickey, 2019). This can be attributed to it's fast and relatively high capacity system, with only 10km exposed to at grade intersections, and the rest underground, elevated, or in a freeway median.

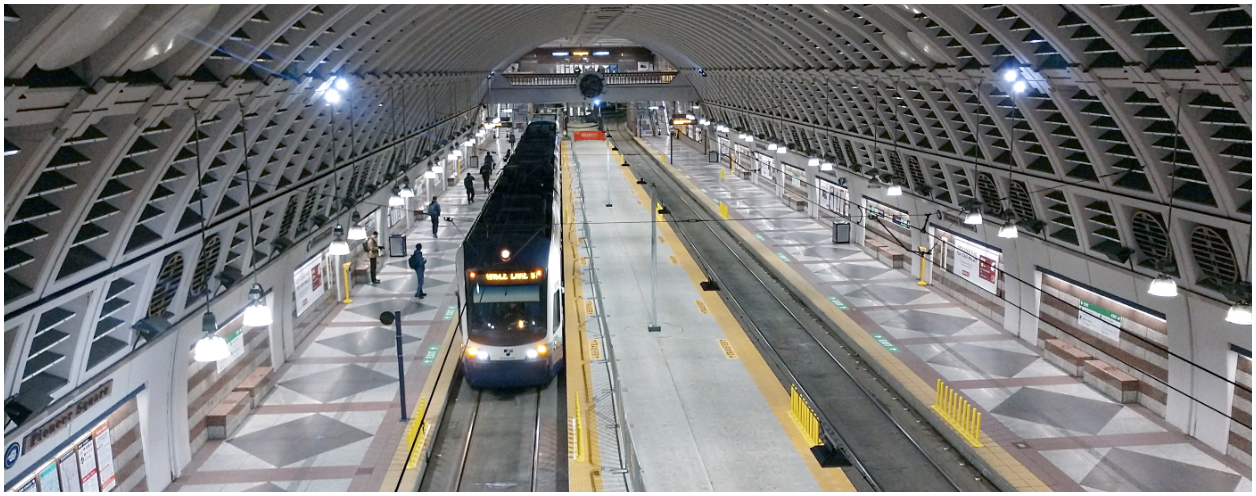


Figure 7: Link Light Rail (Minnick, 2020)

5.4 Light Metro/Medium Capacity Transit

Canada Line is a rapid transit system within the SkyTrain transit system in Vancouver, operating since 2009 ahead of the 2010 Winter Olympics (InTransit BC, 2019). It provides reliable service from Waterfront Station in Downtown Vancouver to Richmond Brighouse and YVR Airport in Richmond. The transit units operate on an elevated guideway in Richmond and underground in Vancouver. Since its launch, the medium capacity metro system has attracted much higher demand than expected, with a ridership of 147,000 average weekday boardings. At a construction cost of only $108 million per kilometer, 3 times lower than the TYSSE cost per kilometer, it is a successful example of an efficient rapid transit line delivered at a comparatively low cost to other major North American cities (English, 2012) by using shorter platforms, cut and cover construction and smaller mezzanines (Chan, 2019).

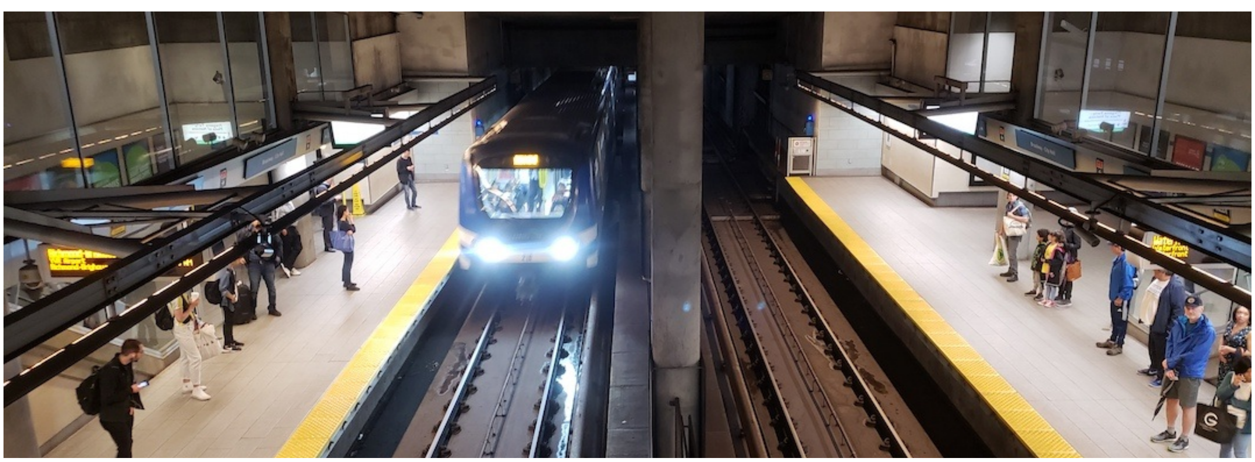


Figure 7: Canada Line at Broadway Station (Chan, 2019)

5.5 Mobility Transit Hubs

Kennedy Station is a transit hub operated and maintained by the TTC, and is a terminal station for two of its subway lines, Line 2 Bloor-Danforth and Line 3 Scarborough (Metrolinx, 2018). From the sheltered bus bay, it provides a direct connection to 13 TTC bus routes. The station also allows passengers to transfer between TTC services and GO Transit services, specifically the Stouffville line. In addition, it features PUDOand parking spaces for vehicular access to the station. The station will also be the terminal station for the Eglinton Crosstown LRT which is proposed to be open in 2021.

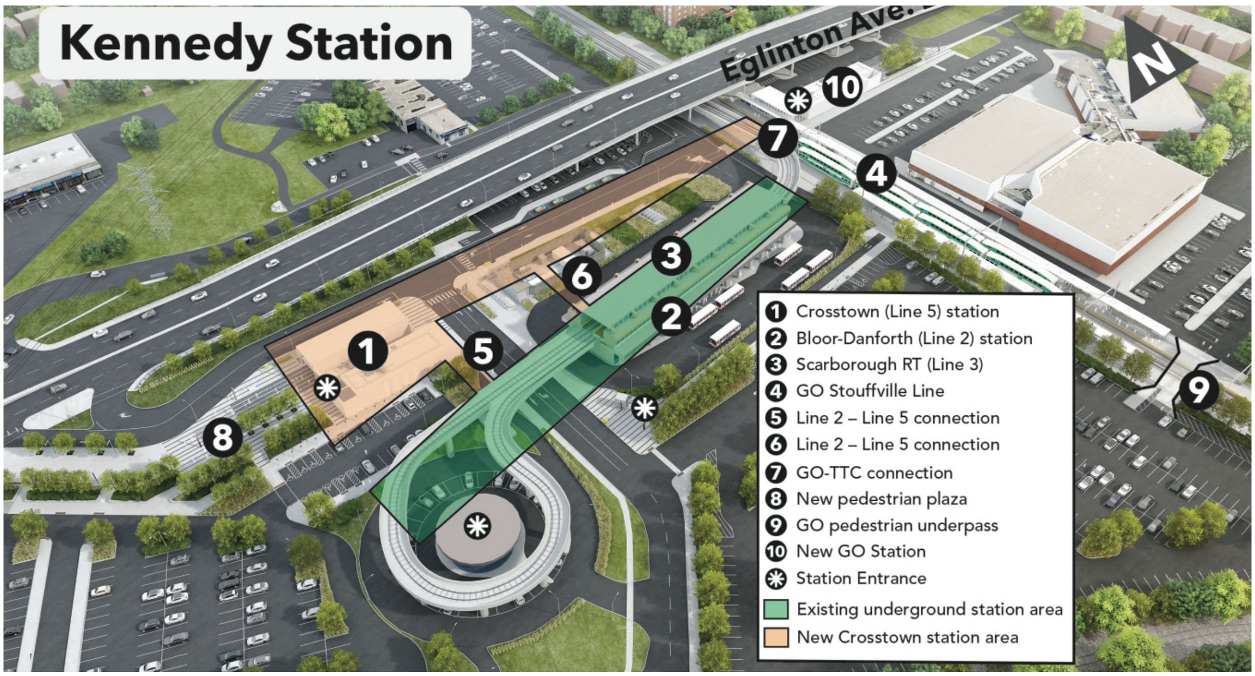


Figure 8: Kennedy Station Rendering (D'Urbano, 2019)

Denver Union Station is a multi modal station that offers connection to their commuter rail, Amtrak long distance rail, light rail, and a downtown bus circulator in a transit mall. In addition to these rapid transit options, there is also a 24-bus-bay complex for transit agencies, and private bus companies (Aono, 2019). The station has been praised for its integration to the surrounding land, and the large amounts of public spaces and public realm improvements it adds to the area. Wayfinding is very clear, and is often integrated with public art and the surrounding public realm. After the completion of the 2016 renovations, the station has led to multiple new TODs, which have a value over $1 billion (Jaffe, 2014).

6 Alternatives Designs

Five alternative solutions have been considered for the Jane Street between Bloor Street West and Steeles Avenue West:

- Alternative 1 Do Nothing
  - Alternative 1 would maintain the existing local/express bus services on Jane Street, with transit-oriented improvements such as queue jump lanes and additional TSP signals along the corridor.
- Alternative 2 Surface BRT
  - Alternative 2 would provide BRT services on surface roads with 28 stops along the route. A dedicated transit ROW would be provided at the centre of the road.
- Alternative 3 Surface LRT
  - Alternative 3 would operate LRVs on surface roads with 28 stops along the line. A dedicated transit ROW would be provided at the centre of the road. Some of the existing overpasses and underpasses along Jane Street may not be suitable for LRVs.
- Alternative 4 Hybrid LRT
  - Alternative 4 would run LRVs partly at-grade and through underground tunnels, with a total of 23 stations. The station spacing is larger along the underground segment than the surface segment. The underground segment extends between Bloor Street West and Wilson Avenue, to accommodate insufficient ROW widths along Jane Street, and to avoid reconstructing overpasses or underpasses along Jane Street.
- Alternative 5 Underground Light Metro
  - Alternative 5 would operate underground rail transit through tunnels, with vehicle technology and capacity similar to the Skytrain system in Vancouver. 16 stations would be provided along the line.

The locations of stations/stops are as illustrated in Figure 9. The number and locations of stations/stops are determined on the basis of major intersections, transfer points, and land-uses around the area. For all alternatives, appropriate MSFs need to be allocated. The underground operations of transit vehicles in Alternative 4 and 5 would potentially require additional accessibility-oriented facilities such as elevators.

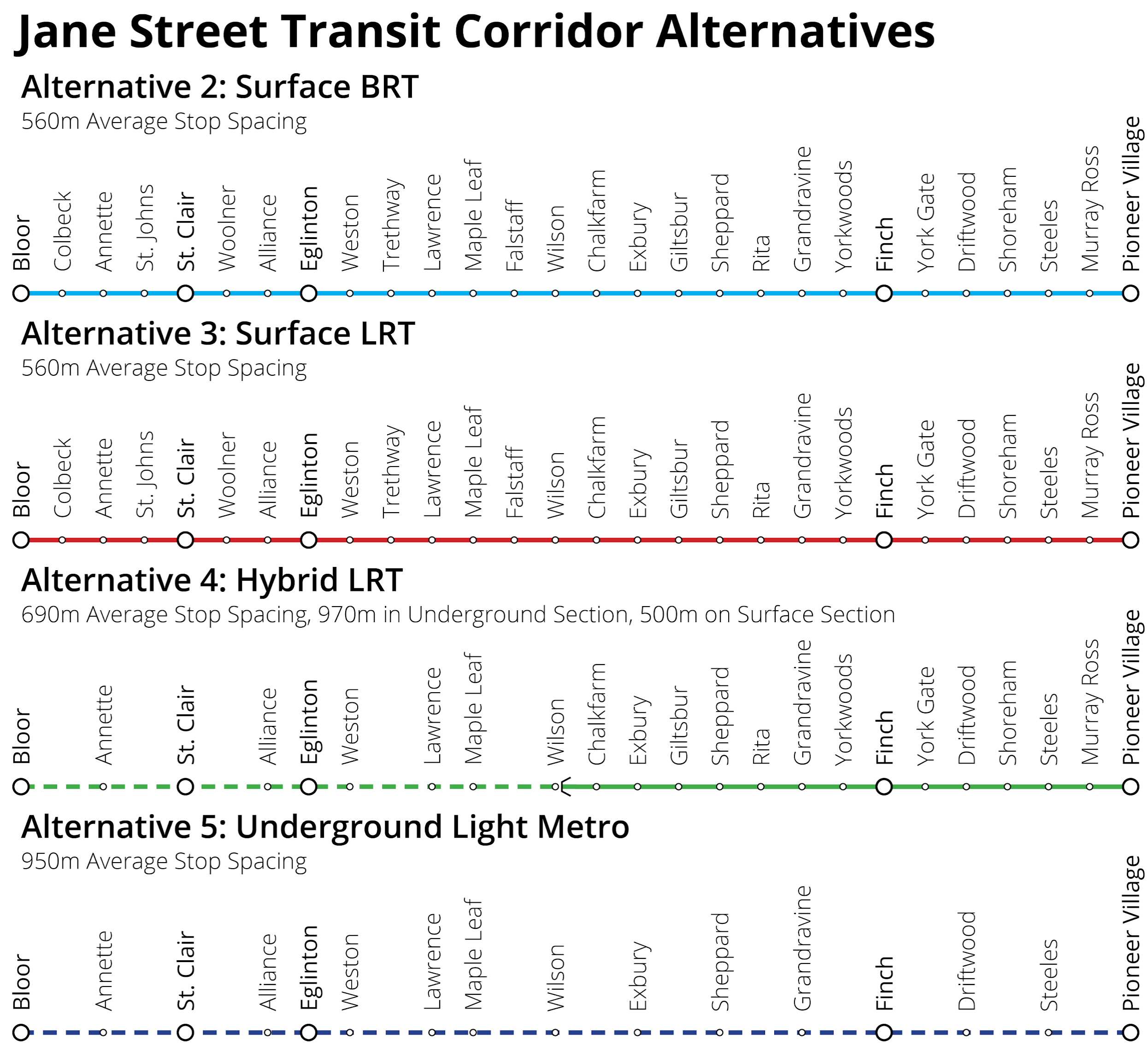


Figure 9: Conceptual alternatives developed for Jane Street. Bolded stations indicate current or in-delivery rapid transit lines connecting to that station.

Currently, most road segments within the study area have 2 through traffic lanes and 1 dedicated left-turn lane in each direction, except for the segment from Chalkfarm Dr/Heathrow Dr to Highway 400 Interchange which have 2 northbound and 3 southbound through lanes. For Alternative 2 - 4, a dedicated transit ROW is to be provided for each direction. For segments with insufficient ROW width for this configuration, two options are proposed:

- Option 1: Acquire adjacent properties and widen ROW width such that two vehicular lanes and one transit lane can be provided for both directions.

Property acquisition process will have a significant impact on project cost and schedule.

- Option 2: Reduce vehicular ROW from 2 lanes to 1 lane. This option may induce a negative impact on vehicular operations along the corridor.

7 Methodology

Figure 10 illustrates the project methodology. A Gantt chart of the work SSR Group will complete, along with a preliminary Gantt chart for the entire project, can be found on Appendix A and B respectively.

7.1 Analysis of Functional Designs

To evaluate the performance of each of the alternative designs, the Evaluation Criteria are classified into the different analysis:

- Feasibility Related MOEs
  - Cost
  - Constructability
- Transportation Mobility Related MOEs
  - Speed of the transit line
  - Connectivity with regional transit
  - Reduction of Congestion along Jane Street
  - Increasing the viability of transit and active modes of transportation
- Quality of Life Related MOEs
  - Sustainability
  - Safety of transit users
  - Ability to generate economic development
  - Accessibility

SSR Group will discuss the data needs, steps required and the tools used for the analysis for each MOE analysis.

JANE STREET RAPID TRANSIT CORRIDOR PROJECT METHODOLOGY

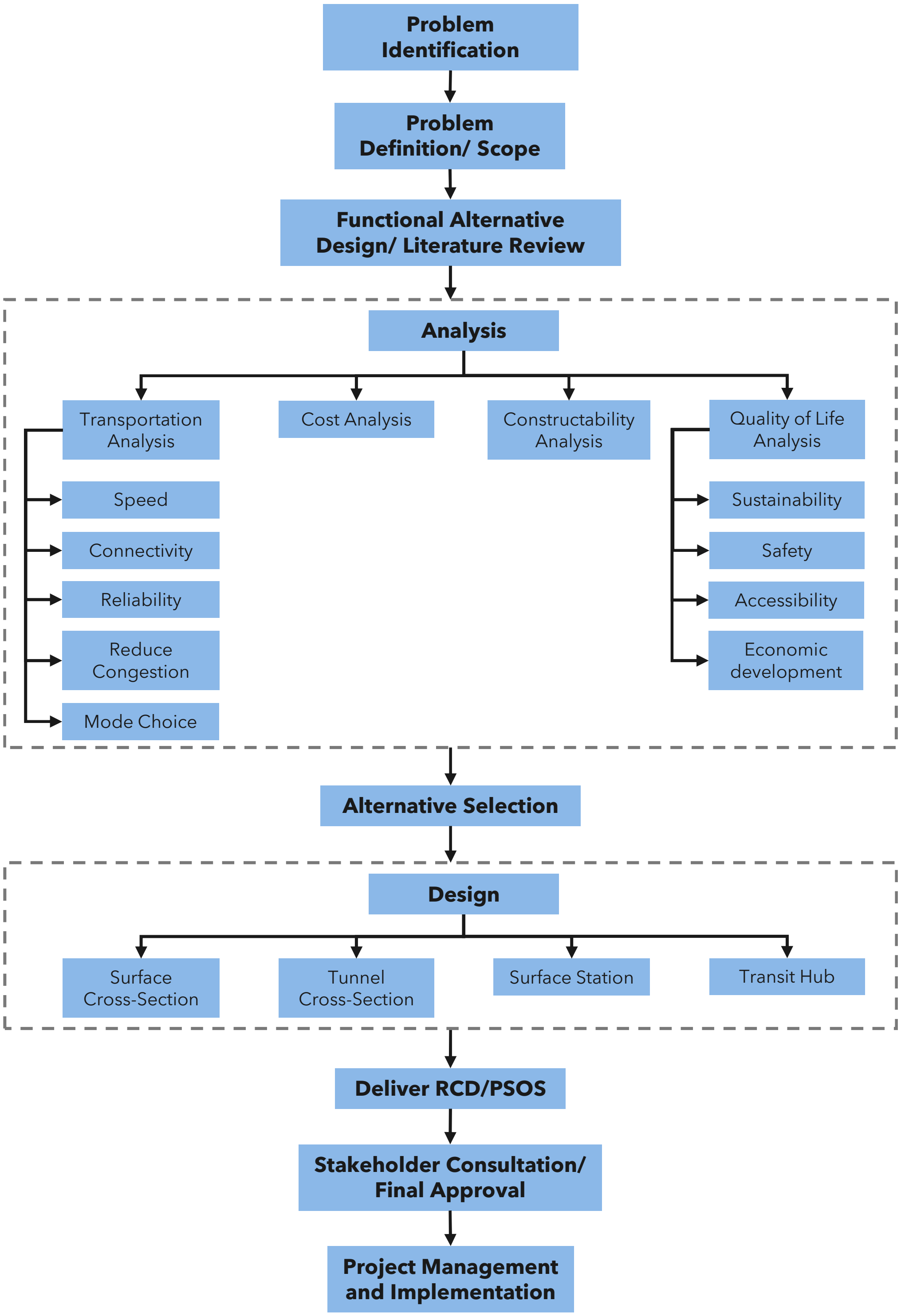


Figure 10: Project Methodology Flow Chart

7.1.1 Transportation Analysis

Transportation analysis consists of assessing the travel demand and performance of the transportation network. A qualitative analysis was done using research and SSR Group's own expertise to determine the best option.

These results correspond to the following project's MOE:

- Speed of the transit line
- Increasing the viability of transit and active modes of transportation
- Reduction of Congestion along Jane Street

The optimal functional design increases transit ridership and minimizes trip lengths, with reduced number of automobiles in the network.

7.1.2 Connectivity Analysis

Connectivity in the transportation context is defined as how well a destination is connected. It is normally based on the traveling distance, options of travel, and facilitating other modes of transportation. Ways to analyze the connectivity of using different technology for a transit line includes studying and comparing the followings:

- Access/transfer time, existences of barriers/gates and differences in elevation
- Availability of pedestrian/cyclist/parking facilities based on countings at a station or on a vehicle
- Frequency or headway of the line

The best alternative would be the one which:

- Has the lowest access/transfer time, least number of barriers/gates and minimal difference in elevation
- Provides the largest number of pedestrian/cyclist/parking facilities
- Allows highest frequency

7.1.3 Reliability Analysis

Reliability in transportation reflects the quality of travel and variability of travel time. A reliable transit line would provide customers a consistent range of travel times that is predictable and desirable. To analyze the reliability of using each technology for the transit line, the SSR Group will research and compare the on-time performance of the existing transit lines around the world using each technology. The best alternatives would be the one which has the highest on-time performance.

7.1.4 Cost Analysis

The cost for each alternative design is to be estimated, taking into account both capital cost, and operation and maintenance cost. The capital cost typically includes design and construction of appropriate infrastructure and purchasing of transit vehicles. The operation and maintenance cost typically consists of transitway and vehicle maintenance and wages for transit operators.

The ideal functional design will have the lowest total cost, although a design will be financially acceptable if within a set budget. The inflation will be accounted for appropriately.

7.1.5 Constructability Analysis

Constructability analysis aims to minimize the complexity of construction. The common technique of constructability analysis is to review the construction process from start to finish and identify any potential challenges or obstacles.

The following steps will be taken.

- Site visits and documentation of site conditions.
- Identifying potential construction challenges, with an emphasis on:
    - Proposed overpasses and underpasses
    - Widening of existing bridges or culverts
    - Major grade changes
    - Potential underground tunnelling
- Developing land acquisition plans.
- Reviewing conflicts with existing overhead and underground utilities.
- Coordination with stakeholders and land owners.
- Developing construction staging plans, with an emphasis on:
    - Traffic management
    - Detours and road closures
- Material availability and transportation

7.1.6 Economic Development Analysis

The new rapid transit line should support growth and future development of the Jane Street corridor. The following steps will be taken to identify opportunities to integrate the rapid transit line with future development.

The following steps will be taken:
- Identifying existing and future development along Jane Street
- Developing strategies for future land use planning and growth management

7.1.7 Accessibility Analysis

Accessibility in the transportation context is generally defined as the ability for individuals to easily access the transit station (Foth et al., 2013). One common way to access transit accessibility is to find the catchment area of a station (Bok & Kwon, 2016), or the population within a 5 minute walk of the transit station. A 5 minute walk is generally equal to a 500m radius around the station, and is the standard used for this type of analysis.

The following data sources is required for the analysis:
- Canadian 2016 Census Data
  - Population at the CDA level
- Toronto Open Data
  - Toronto Centreline Network
  - GTFS Data (for the base case)

The following steps and softwares will be used:
1. All data will be loaded into a PostgreSQL database.
2. Using PostGIS, a GIS extension for SQL databases, a 500m radius will be drawn around each station.
3. PostgreSQL queries will calculate the population located within each station, and will deliver the total population able to access each functional design under a 5 minute walk.
4. In addition to the numeric results, the analysis will be exported to QGIS to be exported as maps.

The best performing design will be the one that has the most residents living within 500m of any station along the line.

7.1.8 Safety of Transit Users Analysis

A significant safety concern for transit users is crossing the street and/or transit ROW to access the station. The ideal experience for transit users would involve making as few crossings of the road or transit ROW as possible to board the vehicle.

The following data sources is required for the analysis:

- Toronto Open Data
  - Toronto Traffic Signals Spatial Layer

The analysis will be a qualitative measure of the following 3 aspects:

- The number of crossings required to access the station
- The number of midblock crossings required
- The vehicular volumes of the roads that must be crossed
- The number of entrances at each station

The best performing functional design would seek to minimize the potential conflicts between transit users and other modes, by either increasing the number of entrances, reducing the required number of crossings, or use crossings at less busy roadways.

7.1.9 Sustainability Analysis

The environmental assessment considers various valued environmental components (VECs) including physical environment, aquatic environment, and terrestrial environment. For this project, VECs such as atmospheric pollution, noise, and vibration will be considered. The team will conduct a literature review and a site visit to determine the results.

The best performing functional design minimizes the impact of atmospheric emission, noise, and vibration.

7.2 Alternative Selection

The alternative selection will be based on aforementioned analysis methodologies. In case where methodologies yield different selection alternatives, the analysis criteria will be ranked in the order of importance.

7.3 Design Components

After the selection of the preferred alternative design, SSR Group will develop the following design components. For each component, the team will discuss the data needs, steps required and the tools used to complete the design.

7.3.1 Typical Surface Cross Section

For any surface sections of the transit line, a typical cross-section will be delivered. The cross section will illustrate all elements of the ROW, including any sidewalk, median, curbs, cycling infrastructure, public realm space, transit ROW, and vehicular lanes, along with the required slopes and widths for each section.

The primary purpose of this is to illustrate the required space allocation required for each mode of transportation.

The following data will be required for the completion of the design:

- Toronto Official Plan ROW Widths

The above data is required to determine the ROW width at each point along Jane Street.

7.3.2 Tunnel Cross Section

For any underground sections of the rapid transit line, a typical underground cross-section will be produced. The cross section will contain essential design elements including the tunnel excavation, supporting structure, dimensions of the track, vehicle offset from the tunnel, grading, etc.

The following steps will be done for satisfactory completion of the design:

1. SSR Group will review appropriate design manuals for requirements.
2. AutoCAD will be used to produce the design drawing.

7.3.3 Typical Surface Station Plan

To complement the typical surface cross-section, a plan view of a typical surface level station will be completed. This will display all ROW elements described in the typical surface cross-section, along with the platform for a typical station.

This is done to show how well does the station integrate with the surrounding intersection and block, and can visualize potential vehicular, cyclist and pedestrian flows through the intersection and/or accessing the transit station.

The following data will be required to complete the design:
- Toronto Open Data
    - Toronto Sidewalk and Road Topographic Layer

The above data is necessary to show a CAD view of any intersection along Jane Street.The following steps will be done for satisfactory completion of the design:
1. SSR Group will review appropriate design manuals for space allocation requirements at intersections, specifically focusing on platform design and intersection design.
2. Both spatial layers will be imported to AutoCAD to provide a baseline to modify the intersection.
3. AutoCAD will be used to draw all elements of the plan.

7.3.4 Transit Hub Design

A conceptual design of the Jane and Milton Corridor transit hub will deliver the design briefs, 3D renderings, and design drawings of all the components of the transit hub. These include Jane Rapid Transit ROW and station platforms, GO station tracks and platforms, bus bays on both St Clair Ave and Dundas St, streetcar terminal, station building/amenities, community connections and station access for pedestrian and bikes, bicycle storage, and PUDO areas.

The primary purpose of the design is to provide connections between different modes of transportation and access plan for the hub.

The following data will be required for the completion of the design:
- Toronto Open Data
    - Toronto Centreline Network
    - Toronto Sidewalk and Road Topographic Layer
    - Toronto 3D Massing Layer
    - Toronto Property Boundaries

The above data is necessary to identify the landscape and topography of the area around the proposed transit hub.

The following steps will be done for satisfactory completion of the design:

1. SSR Group will review appropriate design manuals for hub/station requirements
2. Based on the design manuals, SSR Group will determine the space required for the hub and develop plans for property acquisition, AutoCAD will be used to take an inventory of the affected properties
3. All data will be imported into SketchUp to model the current site condition
4. Each components of the hub design will be developed according to the design manuals and 3D modelled in SketchUp based on the space allocated
5. Layouts of certain design components will be exported from SketchUp and further edited into convert into design drawings using AutoCAD
6. The revised transit network after adding the transit hub will be produced using GIS

7.4 Reference Conceptual Design (RCD) and Project Specific Output Specifications (PSOS)

The SSR Group will deliver the RCD which includes design brief and design drawings of all the design components of this project. The RCD will document the design intent and requirements for the Jane Street Rapid Transit Corridor Project as part of the design process.

The SSR Group will also deliver the PSOS at the same time of the RCD submission. The PSOS defines what the Owner wants by setting out the minimum compliance requirements. It provides the basis of the detailed design to be developed by the RFP Proponents during RFP periods.

7.5 Stakeholder Consultation

The SSR Group will identify potential conflict of interests with stakeholders that may be impacted by the project and develop strategies to engage the stakeholders at the early stage of the project. Interested parties and residents will be consulted and kept informed throughout all phases of the project. Various public open houses and consultation meetings will be held to provide up-to-date information to the public and enhance public engagement.

7.6 Project Management and Implementation

The SSR Group will develop an implementation plan. Detailed project schedule will be produced using Microsoft Project, and cost estimates will be provided using Excel spreadsheet. The SSR Group will also develop project management plans and schedule regular meetings with the owner and other stakeholders in order to meet the schedule and budget. Microsoft Powerpoint and Project will be used to produce flow charts and gantt charts and to manage the timeline and resources for this project.

Once the contract is awarded, the SSR Group (as the owner's engineer) will provide technical advisory services (review of detailed design with PSOS) and contract administration services (monitoring of contractors' performance) to the client during the detailed design and construction phase until substantial completion of the project.

8 Review of Design Manuals and Guidelines

8.1 City of Toronto Official Plan

8.1.1 Purpose of the Document

Toronto's Official Plan (City of Toronto, 2015) is the plan that guides planning in the city. The plan focuses on guiding the development and distribution of services in Toronto. Within the project, the plan will guide how the project will best integrate the land use and transportation needs together, with a particular emphasis on TOD.

8.1.2 Applicable Criteria

Section 2.2.3 Avenues: Re-urbanizing Arterial Corridors

- Avenues should have transit supportive measures such as minimum development densities, parking maximums and minimums and a restriction on auto-oriented retailing and services
- Development on Avenues shall be suitable to the character of the neighbourhood and be supported by appropriate infrastructure
- Development on major avenues shall:
  - Promote the use of transit
  - Contribute to a wide range of housing option
  - Contribute to an attractive and safe pedestrian environment that supports businesses

    - Provide universal access
    - Be environmentally sustainable through the reduction of stormwater, waste, water use, the urban heat island effect, and create green spaces

Section 2.4 Bringing the City Together: A Progressive Agenda of Transportation Change

- The city should promote active transportation by integrating it all streets, neighbourhoods, transit facilities and mobility hubs
- New development should reduce auto dependency
- Subway and underground LRT should be integrated into multi-storey developments
- Adequate off-street bicycle parking shall be provided
- In areas served by frequent transit, development should:
    - Meet density requirements
    - Meet parking requirements
    - Redevelop surface commuter parking lots
    - Reduce surface parking
    - If parking is allocated, it should discourage long term commuter parking in favour of short-term parking
- Sidewalk inclusion should be prioritized
- Transportation terminals should include facilities for multi-modal connections such as buses, taxis, and other public transit modes
- Transportation facilities should be fully accessible
- Grade separated crossings of highways and long-distance rail lines should be provided where possible

Section 3.1.4 Public Art

- The city should devote 1% of the budget to public art in all municipal projects

Section 4 Land Use

Jane Street contains a mixture of neighbourhoods, mixed-use, parks and open space, and apartment neighbourhoods zoning fronting the street.

Section 4.1 Neighbourhood Areas

- Small scale retail or offices should cater to the local context and prevent residents from making automobile trips
- Development should respect the character of the neighbourhood
- Intensification of these areas is not encouraged

Section 4.2 Apartment Neighbourhood Areas

- Create safe and comfortable public realm spaces
- Entrances should front the street, with limited, if any, surface parking

Section 4.3 Parks and Open Space Areas

- Public transit projects should have minimal adverse impacts on parks, and ideally avoid impacting parks whenever possible
- During development, parks should protect the existing natural space, or expand it whenever possible

Section 4.5 Mixed Use Areas

- Mixed use zones should contain a balance of commercial, residential, institutional, and open space areas that reduce auto dependency
- Building should be massed to appropriately fit in the neighbourhood context, allow sunlight to pass through, and create adequate wind conditions
- Provide an attractive pedestrian environment that takes advantage of transit
- Intensification is possible after a secondary plan is approved

8.2 City of Toronto Complete Street Guidelines

8.2.1 Purpose of the Document

Toronto's Complete Street Guidelines (City of Toronto, 2013) are a local application of NACTO's Urban Street Design Guide. Toronto's adoption of complete streets principles means that the city envisions its streets are for all users and aims to ensure along with the traditional transportation function a street provides, it also enables community placemaking, and economic development, as stated in Chapter 1 of the guideline.

8.2.2 Applicable Criteria

Section 2.3.7 Mixed-Use Connector Street

Jane Street is designated as a mixed-use connector street, which are streets that provide routes to connect people and goods in several neighbourhoods.

- Separated bicycle facilities are recommended
- Transit priority measures are recommended
- Provide a safe and inviting street for pedestrians and cyclists, and ensuring safety is a priority
    - Intersections should have clear and well-marked crossing features

- A wide planting zone shall be provided for a continuous tree canopy and stormwater management
- Enhanced transit amenities (such as street furniture) shall be provided
- Buildings should be setback from the street

Section 4.3 Importance of the Pedestrian Clearway Zone
- A 2.1m sidewalk clearway should be implemented.
- A direct path shall be provided to aid people with low vision or mobility issues

Section 4.4 Accessibility and Universal Design
- Sidewalks should be flat, minimize gaps, and have TWSI at curbs

Section 4.5 Pedestrian Crossings
- Traffic lights shall be provided at intersections or mid-block intersections to provide pedestrians an opportunity to cross

Section 5.2 Context Sensitive Cycling Facilities
- A minimum bike lane of 1.5m wide is desired for cycling facilities, with a suggested standard of 1.8m

Section 5.3 Key Cycling Elements
- Dedicated cycling facilities are desired on streets with high vehicle volumes or speed
    - Examples include a painted buffer, bollards, planters, parked cars, or a raised lane

Section 7.3 Key Green Street Elements
- Stops should be clear of clutter for optimal boarding and alighting

Section 8.3 Design for Safety of Vulnerable Users
- Shortened crossing distances is preferred to reduce the exposure of vulnerable users to the roadway
- Separation of modes is ideal

Section 8.4 Design Using a Target Speed for the Street Context
- Street design is more effective in achieving the desired target speed than speed limits, and design elements should ensure the posted speed limit is the exact same as the design speed limit
    - Rightsizing lane widths

  - Trees and vertical elements to create visual friction
  - Placement of pedestrian and cyclist facilities to encourage the presence of pedestrians and cyclists

Section 8.5 Design to Support Placemaking and Street Context
- Focus should be on the complete public realm experience from "building to building"
- Streets shall take into account the land use, and first floor building contexts
- Streets should attempt to create public and cultural space that respect the local character through furniture, lighting, and art

Section 9.4 Context-Sensitive Intersection Design (Mixed-Use Connectors)
- Due to high pedestrian volumes, the following aspects should be considered
  - LPI
  - Smaller turning radii
  - Crossing islands
  - Adequate waiting space at street corners

Section 9.5 Intersection Elements and Geometric Design
- Visible pavement markings are required to illustrate intersection elements
- Clear sightlines are required to ensure visibility of all users

8.3 Metrolinx LRT Design Criteria Manual

8.3.1 Purpose of the Document

The DCM (Metrolinx, 2016) published by Metrolinx provides guidelines and principles to design safe, reliable and accessible rapid transit lines. The DCM focuses on LRT operations, design of and construction of infrastructure to support LRT services, as well as maintenance of facilities. It sets minimum design requirements and evaluation criteria and provides other relevant information such as cost estimates, impacts of construction and operations.

8.3.2 Applicable Criteria

A5.3.2 Maximum Operating Speed & B1.3.3 Design Speed
Tangent track maximum operating speeds for LRV
- 80 km/h on exclusive ROW;
- 70 km/h on semi-exclusive and non-exclusive ROW;

- LRV speeds are not to exceed posted speed limits.
- 30 km/h on connecting track
- 10 km/h for yard design speed

B1 Alignment, Clearances, Rights-of-Way

B1.3 Horizontal Alignment

As specified in this section, horizontal alignment should be developed, and any calculated values should be rounded up to the nearest full metre wherever practical.

B1.3.4 Horizontal Tangent Lengths

Table 3: Horizontal Tangent Lengths

Case	Length (m)
Absolute minimum tangent length beyond platforms	10
Main line absolute minimum tangent length between curves	14
Acceptable yard tangent between reverse curves	9~15
Acceptable yard tangent lengths between same direction curves	<6 and >16
Absolute minimum yard tangent length between any curves	3

B1.6 Structure Clearance

Table 4: Structure Clearance

Case	Dimension (mm)
Top of safety walkways above top of adjacent rails	290
Track centre line to edge of passenger platform dimension	1400
Between LRV Dynamic Envelope and any physical element or obstruction	50
Between tangent track centre lines	3720
Line structures minimum vertical clearance	4650
Station structures minimum vertical clearance at motor vehicle lanes and bus loops	4650
Station structures minimum vertical clearance at pedestrian ways	3000

B3 Civil Work

This section provides basic criteria for Metrolinx LRT projects based on passenger safety and comfort, acceptable engineering requirements and LRV stability and performance.

B3.4 Roads and Paving

This section specifies minimum limits of road construction to accommodate LRT system and facilities.

Table 5 Minimum Traffic Lane Widths

Type	Minimum	Preferred
Through traffic lanes	3.3 m	3.5 m
Left turn lanes	3.0 m	3.3 m

Table 6: Street Grades

Case	Grade (%)
Longitudinal grade	0.4
Slope around street curbs and gutters	0.5
Maximum change in longitudinal slope per 15 m straight horizontal distance without vertical curve transition	1.0
Street cross slopes	1.0 ~ 4.0
Preferred street cross slopes	2.0 ~ 3.0

Table 7: Sidewalk Slopes

Case	Grade (%)
Sidewalk cross slope	2.0 ~ 3.0

B4 Structures

B4.15.4 Construction Methods

This section provides information on three basic underground structure construction methods: bottom-up, top-down and combined top-down/bottom-up, which will be useful in construction staging and constructability analysis.

B5 Stations, Stops, Facilities

B5.2.5 Intermodal Access & B5.2.6 PPUDO Areas

These two sections provide guidelines to accommodate bicycle access and parking, taxi stands, parking, bus facilities and PPUDO areas to support multiple modes of travelling.

B5.3 Station and Stop Architecture

This section provides design principles for at-grade and underground stop, including:

- Providing stop platform access via ramped walkways not to exceed 5% slope.
- Providing side platform Stops with 3 m minimum wide platforms.
- Providing centre platform Stops with 5 m minimum wide platforms.

- At-grade stop platforms cross slope: not to exceed 2% with 1% minimum toward platform edge.
- At-grade Stop platforms longitudinal slope: 2% maximum, with exceptions only upon MX LRT review and acceptance.
- Provide platform edges with a tactile warning strip 610 mm wide extending full length of platform.

B5.4 Station Elements

This section provides design principles for station entrances/exits, concourses, platforms, escalator and other important elements.

Station platforms longitudinal slopes should satisfy the following:

- Desirable: 0.3%;
- Acceptable Minimum: 0.0% level with special measures to ensure sufficient drainage;
- Acceptable Maximum: 1.0%;
- ABSOLUTE Maximum: 1.5% for individual Stations with grades greater than 1.0% subject to MX LRT review and acceptance.

B6 Maintenance and Storage Facilities

This section specifies detailed design requirements for maintenance and storage facilities of an LRT system.

8.4 NACTO Transit Street Design Guide

8.4.1 Purpose of the Document

Transit Street Design Guide (National Association of City Transportation Officials, 2016) published by NACTO provides high-level design recommendations for transit-oriented street design. It includes primary design principles, service contexts for different types of transit services, and design recommendations and guidelines for transit streets, stations and stops, station and stop elements, transit lanes and transitways, and intersections.

Transit streets focus on configurations of road elements for transit-oriented streets, taking into consideration of interactions between transit vehicles, pedestrians, cyclists, and automobiles. For an inter-regional corridor extending out from the city centre like Jane Street, the guide recommends implementing a median rapid transit corridor as illustrated in Figure 11 due to its ridership demands. This section will discuss the requirements of the median surface transit corridor.

When NACTO standards and Metrolinx standards conflict, the project will generally follow Metrolinx standards, unless there are other limitations.

Figure 11: Median Rapid Transit Corridor

8.4.2 Applicable Criteria

Table 8: Transit Related Requirements

Section of the Guide	Description	Standard
2 Transit Streets	Speed of auto traffic	Maximum 40km/h to 50km/h
	Crossing distance to transit stop in the median	Maximum 7.3m
3 Station and Stops	TWSI width	0.61m
	Gap between vehicle and platform	Maximum 5cm
	Platform height	25-36cm for level boarding on low floor vehicles. High floor vehicles are not recommended
	Clear walking space on platform	Minimum 1.22m

	Right side boarding platform width	Minimum 2.44m
	Left side boarding, unidirectional, platform width	Minimum 2.74m
	Left side boarding, bidirectional, platform width	Minimum 3.66-6.10m, ridership dependent
5 Transit Lanes and Transitways	Vehicle lane width	3.05-3.35m
	Transit vehicle cruising design speed	40km/h
	Transit vehicle lane width	3.35m-3.96m
	Physical separation between auto and transit ROW	Minimum 0.30m
	Typical LRV height (rail to pantograph)	5.79m
	Typical LRV height (rail to roof)	3.51m
	Typical LRV width (mirror to mirror)	3.57m
	Typical LRV width (door to door)	2.90m

2 Transit Streets

- A fully separated ROW should be provided
- Median stations should be designed for pedestrian access and safety
- Median stations should have provisions for shelter
- Left turns for auto traffic should either be prohibited or have a dedicated signal phase
- Adjacent blocks should be rezoned to mixed use development

- Driveways fronting the street should be prohibited

3 Station & Stops

- LRV platforms should be from rear door to front door
- LRV ramps do not need to be deployed for level platforms

4 Stop Elements

- Shelters or station walls should be enclosed with a transparent material, such as glass for passenger safety
- Shelters should adapt to the local climate context, such as heating for cold weather locations
- Adequate trash bins should be provided
- Advertisements should not block sightlines to the transit vehicle
- Open designs are recommended for accessibility, and supports should not block pedestrian path
- Off board fare collection is recommended
- Real time information and displays is recommended
- Roofs should be sloped to account for potential precipitation, and may overhang the vehicle ROW to prevent precipitation at the door area
- Seating should be provided, and should be at least 13.11m long, 0.51m to 0.61m wide, and 0.43m to 0.48m tall
- Adequate wayfinding information, catering to both vision and hearing impaired, should be provided at all stops
- Green infrastructure at station areas, such as tree canopies or planters, should be provided for passenger comfort, traffic calming, and stormwater treatment

5 Transit Lanes and Transitways

- Centre transitways are recommended for frequent transit to avoid congestion and curbside conflicts with cyclists, right turning vehicles, illegally parked cars, or deliveries
- Physical separation should be treated with reflective material for nighttime operations
- Medians should be used for green infrastructure whenever possible
- Markings should be provided to indicate the transit ROW
- Transit signals should be used instead of general traffic signals
- Red colour pavement, or other control measures, should be used for the transit ROW
- Concrete should be used to construct the ROW
    - Green transitways, such as grass, are also recommended to reduce noise, and stormwater runoff. Green transitways should not be used at intersections or crossings for pedestrian and vehicle accessibility. There

should be adequate measures to prevent root penetration to the concrete base

7 Transit System Strategies

- Routes should avoid unnecessary turns to avoid delay
- TSP should be used for frequent transit
- Branching should be avoided

8.5 Metrolinx GO DRM

8.5.1 Purpose of the Document

The DRM (Metrolinx, 2020) provides the requirements and technical details for infrastructure designs of GO Stations, Terminals, and Facilities. It is used as a reference tool for Metrolinx staff and design consultants.

8.5.2 Applicable Criteria

5.1.1 Site Components and Typical Schematic Layout

- A continuous unobstructed external and internal the travel path to/from/between the barrier free parking or drop off area, to the rail mini platform / bus platform is required to enable personal barrier free mobility.
- A redundant secondary barrier-free means of access/egress from the rail platform to the station building or pick-up area should be provided.
- An accessible elevated "mini-platform" is required for barrier-free access to the designated accessible rail car.
- A Designated Waiting Area (DWA) should be located on the mini platform to provide assistance and sense of safety to a passenger.

5.2 Rail Platform and Platform Access

The use of side platforms is preferred. Platforms should be located to minimize travel distances to adjacent transit modes and barrier-free paths. Mini-Platform shall be designed in the configuration shown in Appendix F; the locomotive end is the east end of Union Station.

5.2.1 Rail platforms shall follow the following criteria:

Table 9: Rail Platform Clearances

Criteria	Specification
Horizontal from track center line	2.55 m
Vertical above top of rail	6.7 m
Lateral clearance from mini-platform to track center line	1.98 m
Lateral clearance from major and elevated platform structures to track center line	3.35 m
Tunnel clearance to top of tunnel roof membrane	0.8 m

Table 10: Rail Platform Criteria

Design Criteria	Specification
Track centres, centre line to centre line	3.96 m
Width of island platform	7.4 m (min.)
Width of side platform	3.6 m (min. clear width) 4.9 m (min. including shelter)
Length of platform	315 m
Center line of mini-platform to locomotive end of main platform	122.5 m
Centre line to centre line of tracks serving island platform	10.67 m
Clearance from edge of platform to platform structures (shelters/stair enclosures, etc.)	2.44 m
Height of mini-platform above top of rail	0.56 m (max.)
SLOPES	
Island platform cross	2% (max.)
Side platform	Drain away from the track
Longitudinal • Tracks, elevator floor, stair enclosure and shelter buildings shall be raised transitionally to prevent water entry	1% (max.)

Table 11: Rail Platform Clearances

Criteria	Specification
Horizontal from track center line	2.55 m
Vertical above top of rail	6.7 m
Lateral clearance from mini-platform to track center line	1.98 m
Lateral clearance from major and elevated platform structures to track center line	3.35 m
Tunnel clearance to top of tunnel roof membrane	0.8 m

5.2.2 Platform Canopies shall follow the following criteria:

- Canopies shall be provided on all rail platforms with integrated shelters and accesses such as elevator and stair enclosures and related amenities
- The canopy shall be continuous and provide coverage of at least 85% of platform length
- Vertical clearance of canopy (from top of platform to underside of lowest point) shall be 3350mm. Vertical clearance of all obstructions (including digital screens and signs) suspended from the underside of canopy shall be 2440 mm for operations of equipment
- Min. 400mm high concrete pier shall be provided at each support column.

5.2.3 Rail Platform Access–Tunnels/Ramps/Stairs

Pedestrian Tunnel shall follow the following criteria:

Table 12: Pedestrian Tunnel Criteria

Criteria	Specifications
Height	2.7 m (min.) Overhead signs shall not obscure the field view of CCTV
Width	3.66 m (min.)
Slope	0.30% (min.) for drainage
Drainage	40 mm deep by 80 mm wide side gutters

Digital Signs	Located at tunnel entrances
Wall and Floor	Porcelain wall system and smooth finish floor

Ramps shall be used as an alternative to stair as a direct access. Exterior ramps shall be heated or covered to prevent slippery conditions.

Rail Platform Stair shall follow the following criteria:

Table 13: Rail Platform Stair Criteria

Criteria	Specifications
Walls	• Fully glazed, clear, and fully-tempered • Designed for local wind loads, and high-speed train turbulence
Handrails	• Stair centre handrails shall terminate at landings to permit crossover • Have stainless steel or rust resistant finish
Floor	Concrete floor, broom finished, sealed
Wall Base	• Concrete wall base, to be sandblasted finish, and sealed, no paint • Base shall be 600 mm high (min.) above the rail platform
Enclosure	• Fully glazed enclosures with stainless steel framing system • Frameless with silicone butt-joint glazing, with top and bottom stainless-steel glazing channels • Contained within the building envelope • All exposed structural steel framing, including all anchors and fasteners, shall be non-corrosive • Provide appropriate protective coatings or cover plates as required

5.2.4.1 Elevators

Elevators shall be Machine-Room-Less (MRL) Elevator type with Barrier-free, “flow through” configuration.

5.3 Bus Loops

- Separate the accesses for bus from other vehicular, bicycle and pedestrian accesses
- Have decorative fencing to control pedestrian traffic and limit pedestrian access through the bus loop
- Access and egress must allow necessary clearances to accommodate buses
- GO vehicles should govern the design for GO Facilities. MCI model shall govern bus length and width, and the double deck coach shall govern the height clearance
- Platforms shall use hard, level materials
- Concrete Curbs along the entire length of the bus loop shall be painted yellow
- Straight or sawtooth platform design shall comply with Metrolinx Standard Drawings Bus Bay Requirements (Appendix F)
- The vertical clearance shall be 5.3 m minimum between driveway pavement and underside of overhead structures in any bus travel area
- Canopy and roof assemblies shall be set back 2.0 m minimum from the face of the bus platform curbs
- The supporting structure of a canopy or roof assemblies shall have a horizontal clearance of 3.0 m minimum from the from the face of the bus platform curbs
- The platform curb shall be 150 mm above the driveway pavement

5.3.1 Bus Loop Configuration Traffic Flow

There are four typical configurations:

- A: Linear Configuration–Linear Traffic Flow
- B: Island Configuration–Clockwise Traffic Flow
- C: Teardrop Configuration–Counter-Clockwise Traffic Flow
- D: Bi-Directional Configuration–Clockwise and Clockwise Traffic Flow

Configuration A is preferred by Metrolinx. However, configurations shall be studied and applied incrementally (from A to D) based on the bus and passenger volumes, space available, accessibility reasons and anticipated safety concerns.

5.3.2 Bus Radii

This Bus Radii Turning Template in Appendix F shall be used for bus bay entrances, bus loops and entrance roads.

5.4 Passenger Pick-Up and Drop-Off

PPUDO facility shall be designed to:

- Be free flowing and give easy access to station entrance and exit

- Orient vehicle circulation in the same direction to eliminate vehicle crossover
- Face the station building or entrances to the platform
- Use linear or parallel layout, sized based on modal split, providing a space of 3000 mm wide by 6000 mm long for each vehicle. Where possible, provide more lanes of shorter length to allow for easier vehicles access and exit
- Be visible from enclosed passenger waiting areas (station building)
- Accommodate the physical requirements of customers in a mobility aid device
- Have pedestrian movement parallel with the flow of traffic to minimize the conflict between pedestrian and cars
- Include a 3000 mm wide hatched area for lift equipped vehicles. Ensure a barrier-free drop-off zone complete with curb cuts and dedicated loading/unloading area to be located on the right to discharge passengers at the curb or walkway
- Allow physical separation through a 2500 mm, raised curb or landscaped buffer between vehicles and pedestrians
- Provide Taxi Lane(s)

5.5 Pedestrian Connections

Walkways shall be:

- Dedicated and continuous throughout the station and connections to surrounding areas
- Separated from vehicular traffic, whenever possible
- 1600 mm wide (min.)
- Raised and constructed of hard and sustainable level materials that are slip resistant

DS-07 Bike Infrastructure Design Standard (Appendix F)

Bikeway

- Pedestrian access across the bikeway should be channelized as much as possible
- A lateral clearance of 0.5 m shall be provided on each side of the bikeway
- Width of the Bike Path is recommended to be 1.8-2.5 m for one way and 3.0-3.6 m for two-way

Bike Parking

- Bike parking shall be located no more than 50 metres from station accesses and no more than 10 metres from the terminus of bikeway with a curb-free and barrier-free access
- Bike parking shall not hinder pedestrian flow to or from the train

- Bike Parking shall be accommodated with bike racks using the configuration following the minimum spacing requirements in the figure

9 Analysis of Alternatives

9.1 Transit Travel Time

Total one-way passenger travel time between two terminals are estimated to compare BRT, LRT and Light Metro systems.

The following are the corridor Characteristics of Jane Street from Bloor Street to Steeles Avenue.

- Total length = 15.5 km from Steeles Avenue to Pioneer Village Subway Station.
- Length = 8.3 km from Steeles Avenue to Wilson Avenue.

The following assumptions are made to estimate the total travel time between terminals:

- Passenger walking speed = 3.6 km/hr (1.0 m/s from City of Toronto standard)
- Ignore additional passenger access, egress and transfer time for Option 5: Light Metro underground structure as it will be impacted significantly by station layout.
- Perfect TSP implementation exists

Table 14: Typical Characteristics of Rapid Transit Systems

System	BRT	Surface LRT	Mixed LRT	Light Metro
Maximum Speed (km/hr)	50	60	69.3	80
Acceleration and Deceleration (m/s^2)	1.5	1.5	1.5	1.5
Number of Proposed Stations	28	28	23	16
Average Station Spacing (km)	0.57	0.57	0.70	1.03
Average Running Time between Stations (s)	51	46	49	61

Total Running Time (s)	1366	1230	1088	920
Average Access / Egress Time (min)	2.39	2.39	2.94	4.31
Dwell Time per Station (s)	30	30	30	30
Total Dwell Time, One-Way (s)	780	780	630	420
Total Travel Time between Two Terminals (min)	40.6	38.3	34.5	30.9

Note:

- Total travel time = total running time + access and egress time + total dwell time
- Assume underground LRT operates at a speed similar to subway or light metro. Mixed LRT operating speed = weighted average of surface LRT and light metro based on proportion of underground section length.

Existing on-board scheduled travel time from Bloor to Steeles of Route 35 on Jane Street is 49 min during the weekday peak periods. From the above estimate it is clear that Light Metro would have the shortest travel time.

Table 15: Performance of each option in relation to transit travel time

Option 1 Do Nothing	Option 2 Surface BRT	Option 3 Surface LRT	Option 4 Mixed LRT	Option 5 Light Metro
Worst				Best

9.2 Connectivity with Other Transit

Connectivity is largely dependent on access and transfer time of passengers which is related to physical characteristics such as barriers, gates, walking distance, differences in elevation, etc.

Option 1 operates existing bus service along Jane Street and any complexity in addition to Option 1 may impede the service connectivity.

Option 2 and Option 3 operates on exclusive ROW that may be on the side lanes or on the middle lanes with passenger boarding islands. In the case of operating on side lanes, passengers boarding pattern is similar to existing conditions. However, in the case of middle lanes, passengers will expect higher average access and transfer times while waiting for signals.

Option 4 and 5 includes underground stations that require longer talking distance and difference in elevation and are more complex to access. However, Option 5 will be more complex than Option 4 as it operates underground for the entire corridor

Table 16: Performance of each option in relation to connectivity

Option 1 Do Nothing	Option 2 Surface BRT	Option 3 Surface LRT	Option 4 Mixed LRT	Option 5 Light Metro
Best				Worst

9.3 Reliability of Transit

On-time performance (OTP) is used to measure the service reliability of each alternative. It is the percentage of vehicles that depart or arrive at stations within a certain interval of scheduled time. Existing transit lines and their performance will be evaluated. The OTP measure depends largely on the standards set by different agencies and local operating conditions. Therefore, variations among different cities are expected

Option 1: Do Nothing

This option maintains existing standard bus service on Jane Street which is experiencing bunching and unreliable headways.

Option 2: BRT

Viva is an express BRT service operated by YRT in York Region with exclusive at-grade ROW crossing regular traffic at road intersections. From 2015 to 2018, the OTP of Viva remains above 90% (York Region Transit, 2019). Since the BRT system on Jane Street will be operating on exclusive ROW, it is expected that Option 2 will experience lower congestion level and achieve higher OTP than Option 1.

Option 3: LRT

Portland MAX is a surface LRT service operated by Tri-Met in Portland, Oregon, US which runs mainly on exclusive at-grade ROW. The OTP of Portland MAX remains above 80% most of the time in 2019 (Tri-Met, 2019).

Option 4: Hybrid Surface/Underground LRT

The Edmonton LRT consists of two lines with 7 underground stations and 12 surface stations in total. From 2012 to 2015, the on-time performance declined from 74% to 69%. The City of Edmonton believed that the decline in performance is due to increased number of passengers with mobility devices, construction activities and increased traffic congestion.

The Calgary CTrain is lines operated mostly on exclusive ROW, except the downtown portion which is shared ROW. The system consists of 6% underground and 7 % elevated segment. It achieved 85% to 90% OTP in 2016 (McKendrick, 2005).

Option 5: Light Metro

Light Metro will operate 100% underground integrated with existing TTC subway lines at Jane Subway Station. From the TTC daily performance report, the OTP for four subway lines are continuously 95% or higher, which indicates that Light Metro can be highly reliable.

Table 17: Performance of each option in relation to reliability

Option 1 Do Nothing	Option 2 Surface BRT	Option 3 Surface LRT	Option 4 Mixed LRT	Option 5 Light Metro
Worst				Best

The on-time performance varies among different transit agencies in North America. In general, Light Metro is expected to have the highest reliability as there is no at-grade crossing with regular traffic. Options with systems operating on surface are expected to have some delays due to at-grade crossings at intersections, even on exclusive right-of-way.

9.4 Multi-Modality of the Corridor

Infrastructure and facilities are required to support multi-modal travelling such as walking, cycling or ride-share.

Availability of Pedestrian/Cyclist/Parking Facilities at Stations or Onboard
Option 1 has no additional infrastructure to support multi-modal transportation.

Table 18. Facilities to be provided for each option

Facility	Option 2 Surface BRT	Option 3 Surface LRT	Option 4 Mixed LRT	Option 5 Light Metro
Sidewalk Improvements	x	x	x	
Cycle lane on road pavement	x	x	x	
Bicycle racks onboard	x	x	x	x
Bicycle racks at stations			Partial	x
Parking			Partial	x
PUDO Area			Partial	x

Table 19: Performance of each option in relation to multi-modality

Option 1 Do Nothing	Option 2 Surface BRT	Option 3 Surface LRT	Option 4 Mixed LRT	Option 5 Light Metro
Worst			Best	

9.5 Congestion Reduction

Since Jane Street is a major arterial which provides access to expressways and other major arterials, it is important that the traffic operation along Jane Street is maintained at an acceptable level. Due to the lack of resources and the situation with COVID-19, we were unable to conduct quantitative means of travel demand forecasting and operational analysis using GTAModel V4.0. This proposed methodology was intended to accurately predict travel demand characteristics such as traffic volumes and modal shares and to assess traffic operation performance metrics such as volume-to-capacity ratio.

Instead, a qualitative analysis based on a number of assumptions was conducted. The first criteria assessed the high-level road capacity. It was based on the number of vehicular lanes provided in each direction. The second criteria assessed the intersection capacity, taking into account the impact of changes in intersection geometry, changes in signal timing, and changes in a number of pedestrian crossings. This was completed by qualitatively assessing the expected intersection capacity The third criteria qualitatively assessed the automobile travel demand.

This method of analysis assumed that the maximum capacity is largely governed by a number of lanes provided. This method of analysis was also based on an assumption that the automobile demand along Jane Street will be comparable to the existing conditions, considering the increased overall travel demand counteracted by the modal shift from automobile to transit.

Table 20: Qualitative Road Congestion Assessment

Option 1 Do Nothing	Option 2 Surface BRT	Option 3 Surface LRT	Option 4 Mixed LRT	Option 5 Light Metro
Worst				Best

9.6 Cost

Operating cost for rapid transit systems varies due to widely different conditions such as labour costs and operating constraints. Only capital costs are considered for analysis.

Table 21. Capital Costs for Existing Rapid Transit Systems (Cervero, 2013; McKendrick, 2005; Chan 2019)

Project	Total Length (km)	Capital Cost (Million)	Capital Cost per km in Million 2000 USD
		BRT (Exclusive ROW)	
Bogota TransMilenio	41.2	US$975.4	22.2
Los Angeles Orange Line	22.5	US$323.0	13.4
		Surface LRT	
Portland MAX	52.6	US$1245	26.6
Salt Lake	24.1	US$397.5	15.4
Minneapolis	18.7	US$612.5	30.7
Calgary CTrain	29.3	CA$543	15.2
Edmonton LRT	12.2	CA$543	25.9
		Light Metro	
Vancouver	19	CA$2050	93

Table 22: Capital Costs of Rapid Transit from Case Studies (2000 US$/km)

Option 1 Do Nothing	Option 2 Surface BRT	Option 3 Surface LRT	Option 4 Mixed LRT	Option 5 Light Metro
0	8.4	21.5	66.3	104.5

Overall, BRT systems are much cheaper than other options while light metro systems are much more expensive. The cost for LRT is largely dependent on the proportion of underground or grade-separated segments.

Table 23: Performance of each option in relation to cost

Option 1 Do Nothing	Option 2 Surface BRT	Option 3 Surface LRT	Option 4 Mixed LRT	Option 5 Light Metro
Best				Worst

9.7 Constructability and Feasibility

Constructability and feasibility must be evaluated to identify any obstacles and minimize the complexity of implementation. For Option 3, 4 and 5 which include surface segments, the Jane Street corridor will be widened to six lanes: two automobile through lanes and one transit lane in each direction while keeping turning lanes at intersections.

Table 24: Major Infrastructure Improvements

Option	Major Infrastructure Improvements
Option 1: Do Nothing	No change in infrastructure.
Option 2: Surface BRT	● Widening to six lanes. ● Cycle tracks and bicycle racks ● Widening of bridge or culvert structures where Jane Street overpasses other roads/highways/railway tracks.
Option 3: Surface LRT	● Widening to six lanes. ● Cycle tracks and bicycle racks ● Widening of bridge structures or culvert where Jane Street overpasses other roads/highways/railway tracks. ● LRT tracks and overhead wires
Option 4: Mixed LRT	● Cycle tracks and bicycle racks ● LRT tracks and overhead wires ● Underground excavation.

Option 5: Light Metro	• Underground tunneling. • Bicycle racks, parking garage and PUDO areas. • Passenger access to underground stations.

Table 25: Corridor Alignment

Option	Major Corridor Alignment Change
Option 1: Do Nothing	No change in alignment.
Option 2: Surface BRT	Minor profile or grade change.
Option 3: Surface LRT	Minor profile change. Major grade change as the LRT clearance may be higher than existing overpass clearance at some locations such as the Highway 401 interchange.
Option 4: Mixed LRT	Major profile change for underground segments. Minor grade change.
Option 5: Light Metro	Major profile change for underground segments. No change in alignment on existing surface road pavement.

Table 26: Utility Relocation

Option	Utility Relocation
Option 1: Do Nothing	No utility relocation.
Option 2: Surface BRT	Moderate utility relocation.
Option 3: Surface LRT	Moderate utility relocation.
Option 4: Mixed LRT	Major utility relocation.
Option 5: Light Metro	Major underground utility relocation due to excavation.

Option 2, 3 and 4 may require the relocation of both overhead and underground utilities, as keeping utilities away from the road pavement is preferable.

Table 27: Property Impact

Option	Property Impact
Option 1: Do Nothing	• No impact on property.
Option 2: Surface BRT	• Major impacts on property along the corridor. • Construction easement is needed for temporary grading and drainage. • Land acquisition needed for transit hubs and transitway.
Option 3: Surface LRT	• Major impacts on property along the corridor. • Construction easement is needed for temporary grading and drainage. • Land acquisition needed for transit hubs and transitway
Option 4: Mixed LRT	• Moderate impacts on property along the corridor. • Construction easement is needed for temporary grading and drainage. • Land acquisition needed for transit hubs.
Option 5: Light Metro	• Moderate impacts on property along the corridor. • Construction easement is required for underground excavation. • Land acquisition needed for transit hubs.

Table 28: Traffic Disruption

Option	Level of Traffic Disruption during Construction
Option 1: Do Nothing	No traffic disruption.
Option 2: Surface BRT	Moderate traffic disruption due to the following tasks: • Widening the road to six lanes • Constructing boarding islands for exclusive transit ROW at middle lanes

	● Reconfiguring pavement markings
Option 3: Surface LRT	Moderate traffic disruption due to the following tasks: ● Widening the road to six lanes ● Installing LRT tracks and overhead wires ● Constructing boarding islands for exclusive transit ROW at middle lanes ● Reconfiguring pavement markings
Option 4: Mixed LRT	Moderate traffic disruption due to the following tasks: ● Widen the road to six lanes ● Excavation for underground segments ● Installing LRT tracks and overhead wires ● Constructing boarding islands for exclusive transit ROW at middle lanes ● Reconfiguring pavement markings ● Launching TBMs for excavation
Option 5: Light Metro	Minor traffic disruption due to the following task ● Launching TBMs for excavation ● Excavation for underground segments

Table 29: Performance of each option in relation to constructability

Option 1 Do Nothing	Option 2 Surface BRT	Option 3 Surface LRT	Option 4 Mixed LRT	Option 5 Light Metro
Best				Worst

9.8 Transit Accessibility

Table 30: Performance of each option in relation to transit accessibility

Option 1 Do Nothing	Option 2 Surface BRT	Option 3 Surface LRT	Option 4 Mixed LRT	Option 5 Light Metro
Best				Worst

Catchment population, the population within a 5 minute walk (500m) of the stop was evaluated for all options as a proxy for how many people can easily reach transit. Table 31 displays the results.

Table 31: Catchment population measures for all alternatives.

Measure	Option 1 Do Nothing	Option 2 Surface BRT	Option 3 Surface LRT	Option 4 Mixed LRT	Option 5 Light Metro
Total Catchment Population	131,300	119,800	119,800	101,900	83,300
Jane-Finch Station Catchment Population	7,000	8,900	8,900	8,900	9,400

In all alternatives, the station at Jane and Finch will have the highest catchment population. Option 1 would be the most accessible to residents since the 55 stops along the 35 Jane would ensure that all parts of the corridor has access to the bus.

With identical stop configurations, Options 2 and 3 perform similarly, and will ensure improved transit performance while only resulting in a small loss in the catchment population compared to option 1.

Option 4 has 20,000 fewer people living in the catchment area, and therefore worse accessibility than Options 1 to 3. However the catchment population at the Jane-Finch station is relatively similar to Option 2 and 3, and shows that this option can provide equivalent accessibility to Options 2 and 3 at the densest area of the corridor. This is because Option 4 shares the same stop configuration as Options 2 and 3 north of Wilson Ave W.

Option 5 would have the lowest catchment population than the other options, and would result in nearly 50,000 having worse access to transit than their existing bus route. This is the result of the option having the lowest number of stations, a necessary tradeoff due to the cost of the option.

9.9 Sustainability

Table 32: Performance of each option in relation to safety

Option 1 Do Nothing	Option 2 Surface BRT	Option 3 Surface LRT	Option 4 Mixed LRT	Option 5 Light Metro
Worst			Best	

For sustainability, 4 factors were evaluated: GHG emission reduction, NOx, SOx, and particulate pollution, noise pollution, and the potential for green infrastructure.

Option 4 will have excellent sustainability potential:

- The line will attract a moderate ridership, and avoid severely reducing road capacity, leading to a reduction in vehicular volume while maintaining or improving travel times, and lower GHGs.
- The LRV will produce zero NOx and SOx pollution, and produce minimal particulate pollution.
- The surface section can support a green transitway in addition to green beautification using street trees, which can reduce excessive runoff and lower the local temperature.
- For the surface portion, a moderate level of noise will be emitted.

Option 2 will have a high sustainability potential:

- The line will attract high ridership, and will maintain existing road capacity, which can improve travel time and lower GHGs.
- The LRV will produce zero NOx and SOx pollution, and any particulate pollution caused by rail wear or braking is shielded from the surface by the tunnel.
- The status quo of green infrastructure will be provided.
- The underground deep-bore alignment will result in the lowest amount of noise among the 5 options.

Option 3 will provide a moderate sustainability potential:

- While some riders might switch to using transit, congestion south of Wilson Ave W due to a loss in road capacity can result marginal decreases in GHG.
- The LRV will produce zero NOx and SOx pollution, and produce minimal particulate pollution.
- The alignment can support a green transitway which can mitigate any removal of green infrastructure south of Wilson Ave W.
- A moderate level of noise will be emitted.

Option 2 will provide a low sustainability potential:

- While some riders might switch to using transit, congestion south of Wilson Ave W. due to a loss in road capacity can result marginal decreases in GHG.
- Significant NOx, SOx, and particulate pollution will be emitted if a diesel bus is chosen. Some reductions can occur due to the improved speed of the transit vehicle by being in an exclusive ROW.
- Green infrastructure such as street trees may be removed, because of the increased ROW requirements
- A high level of noise will be emitted.

Option 1 will have the lowest sustainability potential

- Existing levels of GHGs will be produced due to congestion along the corridor.
- Significant NOx, SOx, and particulate pollution will be emitted if a diesel bus is chosen.
- The status quo of green infrastructure will be maintained.
- A high level of noise will be emitted.

9.10 Safety

Table 33: Performance of each option in relation to safety

Option 1 Do Nothing	Option 2 Surface BRT	Option 3 Surface LRT	Option 4 Mixed LRT	Option 5 Light Metro
	Worst			Best

Option 5 would be the safest option. Each underground station will have entrances on both sides of Jane Street, so transit users can minimize the number of crossings they will have to make across the arterial. In addition, the underground platform will reduce their exposure to street traffic, which reduces their potential to be involved in automobile collisions.

Option 1 is the next best option because the number of stops, and short access time will prevent transit users from travelling excessively to their stop. However, waiting at street level can create the potential for automobile accidents while they are waiting for the bus. In addition, the bus is not in an exclusive ROW, and can be involved in collisions with other users of the road.

Option 4 has an underground alignment from Bloor Street W to Wilson Ave W, but has a surface alignment in an exclusive ROW north of Wilson Ave W. In the surface alignment, transit users will need to cross the road to get to the median, which is more dangerous than Option 1's stop configuration of having transit stops along the curb lane. This can be mitigated by having two signals or PXO per surface station.

Option 2 and 3 shares the same problems as the surface section of Option 4, but since those two options are on a surface ROW for the entire corridor, the problems would increase in magnitude. In addition, the median transitway for both options might confuse drivers and create the potential for T-Bone collisions, where a left turning vehicle may get hit by the transit vehicle. This can partially, but not completely, negate the effect of the transitway.

9.11 Economic Development Potential

Table 34: Performance of each option in relation to economic development

Option 1 Do Nothing	Option 2 Surface BRT	Option 3 Surface LRT	Option 4 Mixed LRT	Option 5 Light Metro
Worst			Best	

The rise of land value was used as a proxy for economic development potential, and TOD potential. This is justified since increased land values will attract more investment and development into the area.

2 factors were evaluated for economic development potential:

- Number of stations
  - This is directly related to the area of land that can be redeveloped.
- Transit technology

- While the research does not offer a perfect consensus, mainly due to the difficulty at comparing different municipalities, some research suggests that a heavy rail mode, such as metro or commuter rail, increases land values more than LRT, and LRT has a bigger effect than BRT (Zhang, 2009).

Option 4 and 5 are the best performing options for economic development potential:

- Both options have significant underground portions, which will increase transit speed and capacity
- While Option 4 has a surface portion, it also has more stations that open more areas up for redevelopment, especially the high density area of Jane Street north of Finch Ave W.

Option 2 and 3 will both perform moderately:

- Both options offer lower transit speed and reliability, which lowers the economic development potential.
- The additional stops can mitigate the loss of potential due to the surface LRT and BRT mode
- Option 3 will perform slightly better than option 2

Option 5 will only retain the status quo of economic development:
The literature notes that any form of rapid transit will most likely create more economic development potential and increases in land value over local bus service, no matter how much more accessible the local bus service is (Ingvardson & Nielsen, 2018).

10 Design Selection

After conducting the analysis, SSR group determined that a mixed LRT, with underground and surface segments, performed the best among the 11 measures of effectiveness. Table x lists the relative aggregated rank of the 5 alternatives.

Table 35: Relative aggregated performance of the alternatives among all evaluation criteria

Option 1 Do Nothing	Option 2 Surface BRT	Option 3 Surface LRT	Option 4 Mixed LRT	Option 5 Light Metro
3	5	4	1	2

11 Design

11.1 Corridor Alignment Details

For the Jane Street LRT, the project will have both an underground segment, and a surface segment. The underground segment will start from Jane Station on Line 2 and be underneath Jane Street, and will detour slightly to the east in order to intersect Line 5 and GO Transit's Kitchener Line at Mount Dennis Station. It will then veer to the west to follow Jane Street until the tunnel portal slightly north of Jane-Wilson Station.

For the surface segment, the LRT line will be in the median of Jane Street in an exclusive ROW. The ROW will follow Jane Street until Steeles Ave W, where it will make a turn to the east along Steeles Ave W, also in an exclusive ROW. The LRT will then terminate at Pioneer Village Station, where it intersects with Line 1, and connecting YRT and GO Transit services.

Throughout the corridor, existing auto capacity will be maintained. This will mean that Jane Street will have 2 lanes of auto traffic in each direction throughout the corridor, as it is currently.

Stops for the underground portion were chosen with the following criteria, in order or priority:

- Connecting rapid transit or commuter rail lines
- Connecting TTC bus and streetcar lines
- Maintaining appropriate stop spacing for the respective underground or surface segment
- Roads classified as:
    - Arterial Roads
    - Minor Arterials and Collectors

Key physical characteristics of the LRT are shown below.

Table 36: Key Physical Characteristics of the Line

Length	15.25km
Number of Stops	23

	10 Underground Stops 13 Surface Stops
Stop Spacing	690m
Underground Length	8.25km
Surface Length	7.00km
Underground Stop Spacing	970m
Surface Stop Spacing	500m
MSF Location	West of the Jane Street and Falstaff Ave intersection
Anticipated Rolling Stock	Bombardier Flexity Freedom, Alstom Citadis Spirit, Siemens S70, Kinki Sharyo LF LRV
LRVs Required	60 to 80 Depending on Manufacturer
Power Source	Overhead Catenary
Platform Length	100m
Track Gauge	1,435mm (Standard Gauge)
Maximum Longitudinal Slope	2%
End to End Travel Time	35 minutes

A map illustrating the alignment can be found in figure 12.

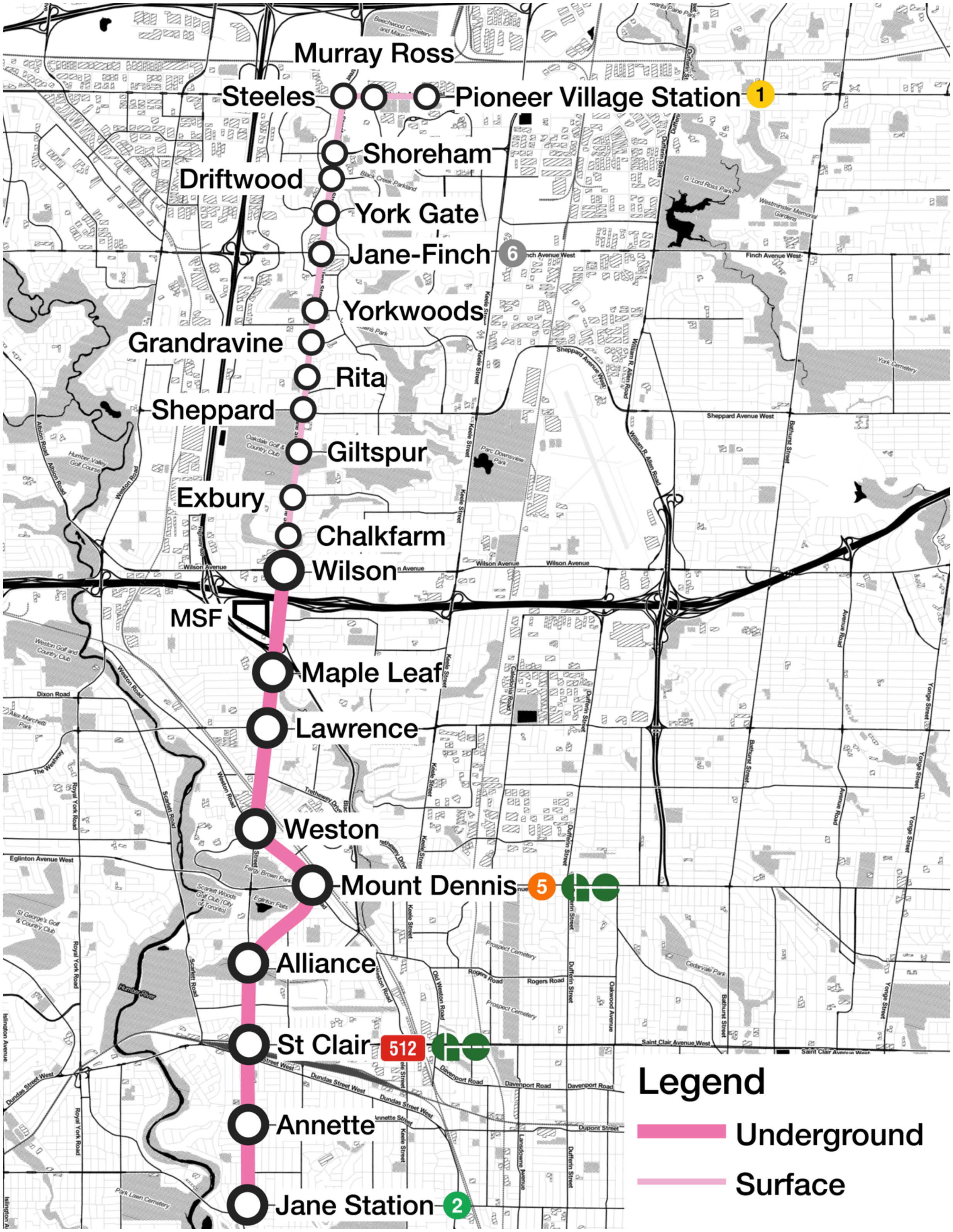


Figure 12: Alignment of the Jane LRT, including key regional transit connections

11.2 Land Use Integration

As discussed in the background, the corridor already provides much of the key land use characteristics that is a prerequisite for effective rapid transit. The LRT can seamlessly fit into the corridor without rezoning large swaths of land that can cause community upheaval.

Some land use changes will be needed to ensure the project is a successful city building project. Much of the residential zoning fronting Jane Street will need to be rezoned to a mixed use zone. This is especially prevalent near Annette and Alliance stations, where single family detached homes front the corridor.

In accordance with the official plan, the existing density and height limits will need to be reexamined. Generally, increased density is desired since the corridor is able to support more residents and commercial spaces.

TOD opportunities are available at all stations with the change in zoning regulations discussed above. In addition, new TODs can take advantage of station infrastructure by offering a direct connection to the station, or integrate the station into the building envelope through either overbuilding, or a more direct integration. Private sector involvement can occur to ensure a seamless integration between new development and transit infrastructure can occur.

With new development, planning measures must be taken to ensure that the gentrification the transit line will inevitably bring will not push existing residents out of their homes. While this is not directly within the scope of SSR Group's work, the team recognizes the importance that residents of Toronto's neighbourhood improvement areas provide to the city. The team recommends the city look into further protection measures, such as inclusionary zoning, stringent localized rent control measures, and additional Toronto Community Housing units to ensure this project is beneficial to all residents and income classes of Toronto.

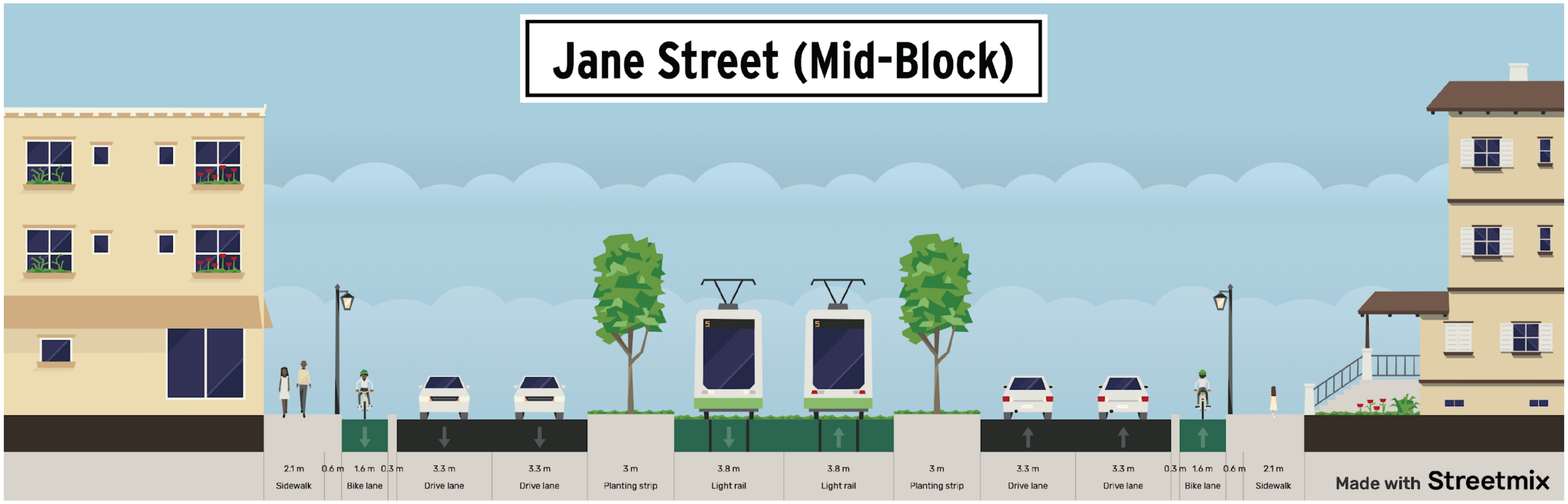
11.3 Surface Corridor Design

Figure 13 shows the cross section of Jane Street for the surface portion of the LRT, along with all dimensions for the street elements. Both a mid-block section and a surface station are included in the figure.

A 7.6m wide transitway will be built in the median of Jane Street, with catenary poles to be built in the centre of the transitway. Sufficient ROW on this portion of Jane Street will allow for 3.3m lane widths to be maintained on the street. In addition, public realm improvements will be made to ensure all users of the street are accommodated. This will include the following:

- Widening of the sidewalk to a 2.7m, with a clear walkway of 2.1m. Additional benches and bike racks will be placed on the sidewalk.
- In accordance with Toronto's 10 year cycling plan, fully separated bike lanes will be built from Wilson Ave W to Steeles Ave W. The separation will consist of a concrete curb.
    - To allow for left turn lanes at major intersections, the separation will be temporarily removed to ensure a 3m left turn lane.
- Local artists will be commissioned to dedicate public art at all stations, intersections, and transformer buildings to beautify the street. As per city bylaw, 1% of the budget will be directed to public art.

The surface section will feature active TSP, to minimize delays at signals, and ensure as fast travel times as possible. Signals will preempt existing phases with a transit priority green extension or red truncation whenever a nearby LRV is detected. Left turns will be restricted at a number of intersections; however, all stations will allow for left turns with a dedicated left turn lane.



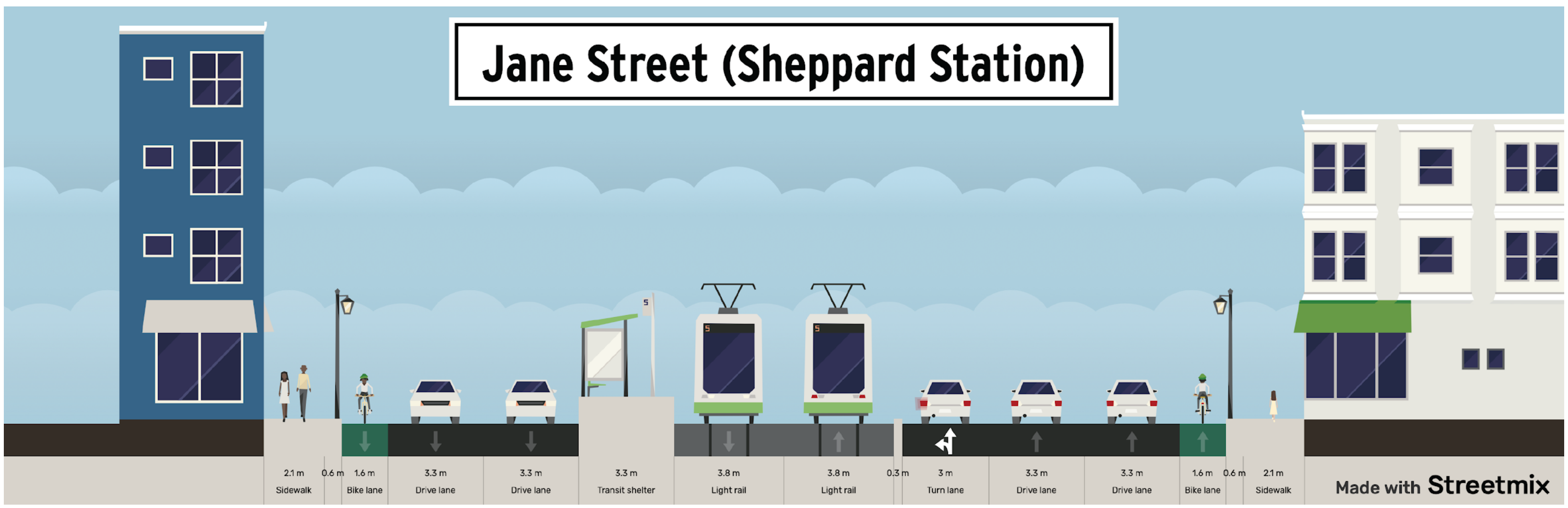


Figure 13: Cross section of the surface portion of the LRT, at a mid-block location, and at Sheppard station

Various forms of green infrastructure will be provided. While the transitway will be paved at intersections and at stations along the surface portion, a green transitway will be built. Grass will be planted in the median of the transitway, surrounding the concrete ties, instead of paving the transitway with concrete. At midblock segments where there are no platforms, trees will be planted on either side of the transitway. The decision to put catenary poles in the centre of the transitway was made in part to allow for sufficient clearances to the tree canopy. Planter boxes will be incorporated into the planting strip to allow for adequate tree growth.

Figure 14: Example of a green transitway in Portland (left) and a tree lined streetcar route in New Orleans (National Associations of City Transportation Officials, 2016; Demyan, 2009))

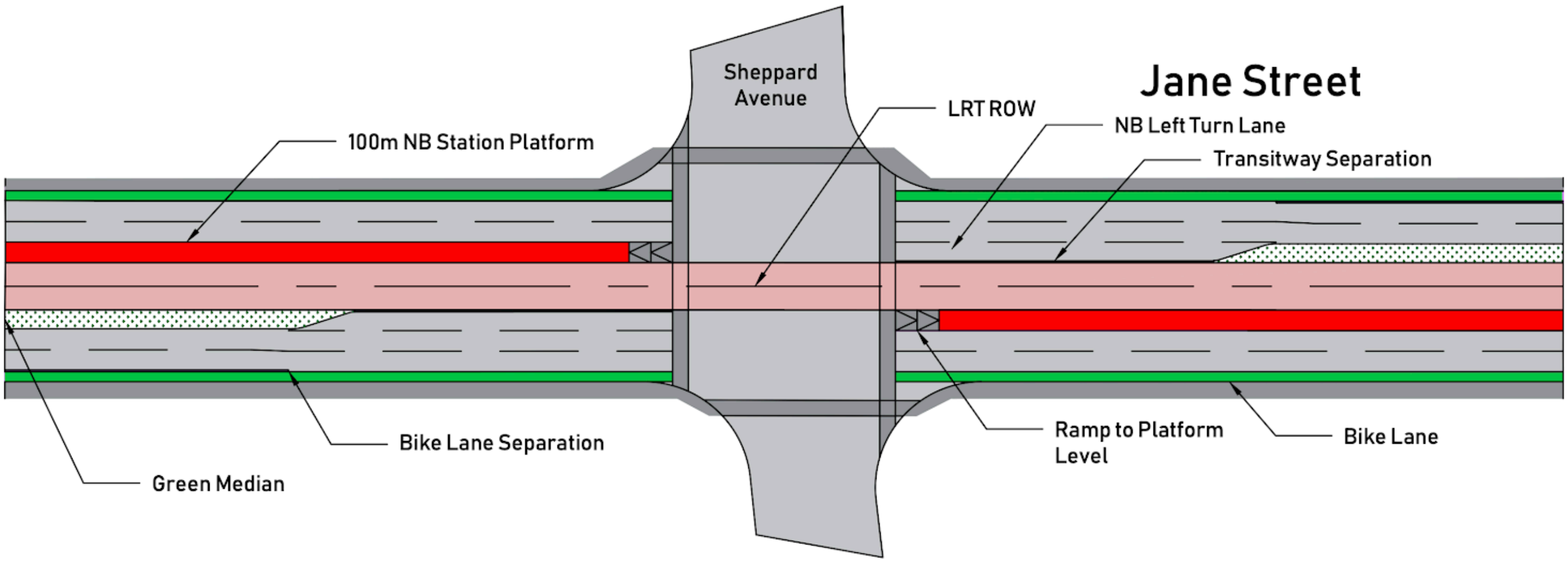
Green infrastructure will reduce local temperatures by reducing the urban heat island effect, and prevent the spread of noise and pollution from both the auto traffic and LRT. The green transitway in particular will reduce runoff from stormwater and will lessen the strain on Toronto's stormwater system. Both the measures will also increase the aesthetic appeal of the street, and liven up the public realm.

11.4 Surface Intersection Plan

A reference design of an intersection was completed for the Jane and Sheppard intersection, seen in Figure 15. The design was made by using existing CAD drawings of the intersection. This design will be used for all other surface stations along Jane Street, with the following exceptions.

- Pioneer Village Station, which will feature an underground LRT station
- Steeles Station, which features island platforms instead of side platforms. The 90 degree turn at Steeles and Jane adds complications to keeping the split platform style of the rest of the corridor. The 45m wide ROW on Steeles Avenue will provide sufficient room to keep this configuration.

Figure 15: Plan of the Jane and Sheppard Intersection



Platforms will be split across the intersection, with far side platforms being used to conserve ROW space. Dedicated left turn lanes will be provided at all stops. In addition, U-turns will be allowed from the left turn lanes to ensure access is kept to all directions of traffic, given that there will be physical separation between the two directions of traffic and the centre transitway. Bike lanes will not be separated at the intersections, since extra space will be needed for the platform.

The station will feature the following elements:

- Heated and enclosed waiting spaces
- Heated platform to reduce maintenance cost during winter conditions, and for safer conditions
- Ticket vending machines to support proof of payment operation
- Glass canopy and wall covering the entirety of the platform
- Entrance and exits on both sides of the platform
    - If one end of the platform is not abutting an intersections, a PXO or a signal will be installed to allow for access to the station
- Adequate lighting and visibility to the street for sufficient safety, along with multiple emergency alarms to alert local first responders
- Interactive infotainment systems to display next vehicle arrival times, service announcements, wayfinding, and advertisements

These stations will generally be different than those currently in southern Ontario, and will be reminiscent of those in Portland and Seattle, along with best practices from all North American LRT systems. The stations found in these systems feature more passenger amenities than Toronto's surface rail station, and will greatly enhance the passenger experience and perception of transit.

Phoenix

Calgary

Charlotte

Figure 16: Examples of LRT Station Architecture in Phoenix, Calgary and Charlotte to be Emulated for the Jane LRT (GEC Architecture, 2012; Kubes Steel, 2016; Kuhner, 2008)

As part of the Toronto Official Plan, 1% of all public infrastructure expenditures must be spent on public art. SSR Group proposes this be focused on developing unique station architecture for all 23 stops. These stations will be developed by local architects and designed in a way that integrates seamlessly into the surrounding environment. In some cases, the stations will reflect the local character of the neighbourhood which will ensure the LRT line is the focal point of the neighbourhood. Some examples are listed below:

- Jane-Finch Station: The history of immigration and diversity in the communities around the area
- St Clair: The meatpacking district near St. Clair and Keele, and the influence of railway work on the Junction community

Grade separated crossings of the road to the platforms may be incorporated into the station based on the safety concerns of residents. The outcome will be known after a case by case review during the stakeholder consultation process. Developers can also initiate a grade separated crossing through a partnership with the municipal government, similar to crossings seen in the Skytrain system in Vancouver.

11.5 Tunnel Cross Section

According to GO Design Criteria Manual, the minimum recommended clearance of the tunnel is 6.7 m. The two-bored tunnel has an offset of 1.0 diameter. To avoid vibration noise, the tunnels are located around 3 to 4 times of tunnel diameter (20.1 metres to 26.8 metres). The depth of cover varies depending on the topography and soil conditions on site.

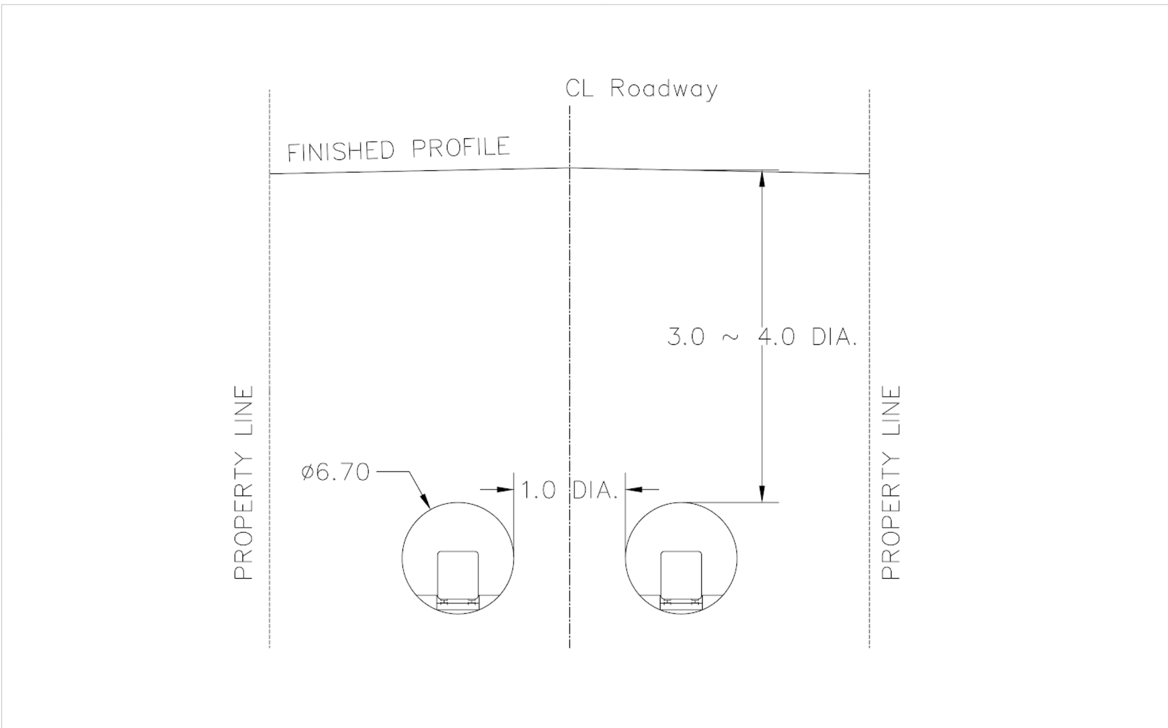


Figure 17: Typical Tunnel Cross Section (Two Bored) - Dimension in Metres

11.6 Jane-St. Clair Transit Hub Design

Jane-St. Clair Transit Hub is proposed to be located at the intersection of the GO Milton Rail Corridor (CPR's Galt Subdivision) and Jane Street, between Dundas Street and St. Clair Avenue West. Project scope for the hub shall include; Jane LRT station, GO station tracks and platforms, TTC bus loop, TTC streetcar loop, PPUDO, station amenities and access points, pedestrian tunnels and bicycle storage.

11.6.1 Context and Site Plan

Currently, the properties at the transit hub project site is owned by the following owners:

- North of the rail corridor and south of St. Clair Avenue West, 2595 and 2615 St. Clair Avenue West is owned by Old Mill Cadillac Chevrolet Buick GMC Ltd., which is an auto dealer.
- South of the rail corridor and at the north-east corner of Jane Street and Dundas Street West, 3528-3534 Dundas Street West is owned by Canada Iron And Metal which is a company that recycles scrap metal, used cars, and electronic waste.
- CPR owns the rail corridor including the rail bridge above Jane Street. The properties south of the rail corridor and at the north-west corner of Jane Street and Dundas Street West are also owned entirely by CPR and are currently unused.
- The ROW of Jane Street below the rail grade separation is owned by the City of Toronto.

The Jane-St. ClairTransit Hub will take the entire or partial properties listed above. The site plan of the hub is shown in Figure X with the following areas starting from the north end:

- TTC streetcar loop and the north station access are located at the south-west corner of St. Clair Avenue West and Jane Street and will encroach part of 2615 St. Clair Avenue West.
- The LRT Underground Station is located between St. Clair Avenue West and Dundas Street West, below Jane Street City's ROW.
- GO station is located on the rail corridor servicing the south and north track of the mainline on CPR's property.
- South-west station access, TTC bus loop, bike storage and station plaza and main building are located at the north-west corner of Jane Street and Dundas Street West south of the rail corridor on CPR's property.

- East station access (secondary station building) and PPUDO are located at the north-east corner of Jane Street and Dundas Street West and will encroach the entire 3528-3534 Dundas Street West.

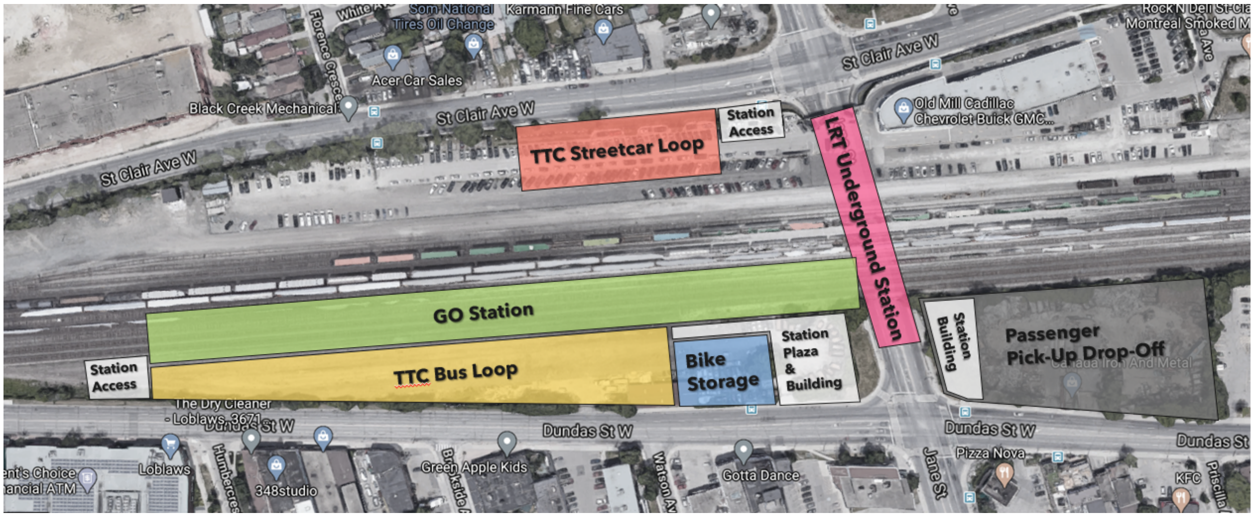


Figure 18: Site Plan of Jane-St. Clair Transit Hub

The hub has four different levels (Figure 19):

- GO station platforms are at the track level (highest level)
- TTC Streetcar Loop, GO station concourse, TTC bus loop, PPUDO, pedestrain tunnel connecting north and south side, bike storage and all four station access points are at the ground level (at-grade level)
- LRT station concourse and two tunnels connecting station access points to the LRT station are at underground level 1
- LRT station platform and tracks is at underground level 2 (lowest level)

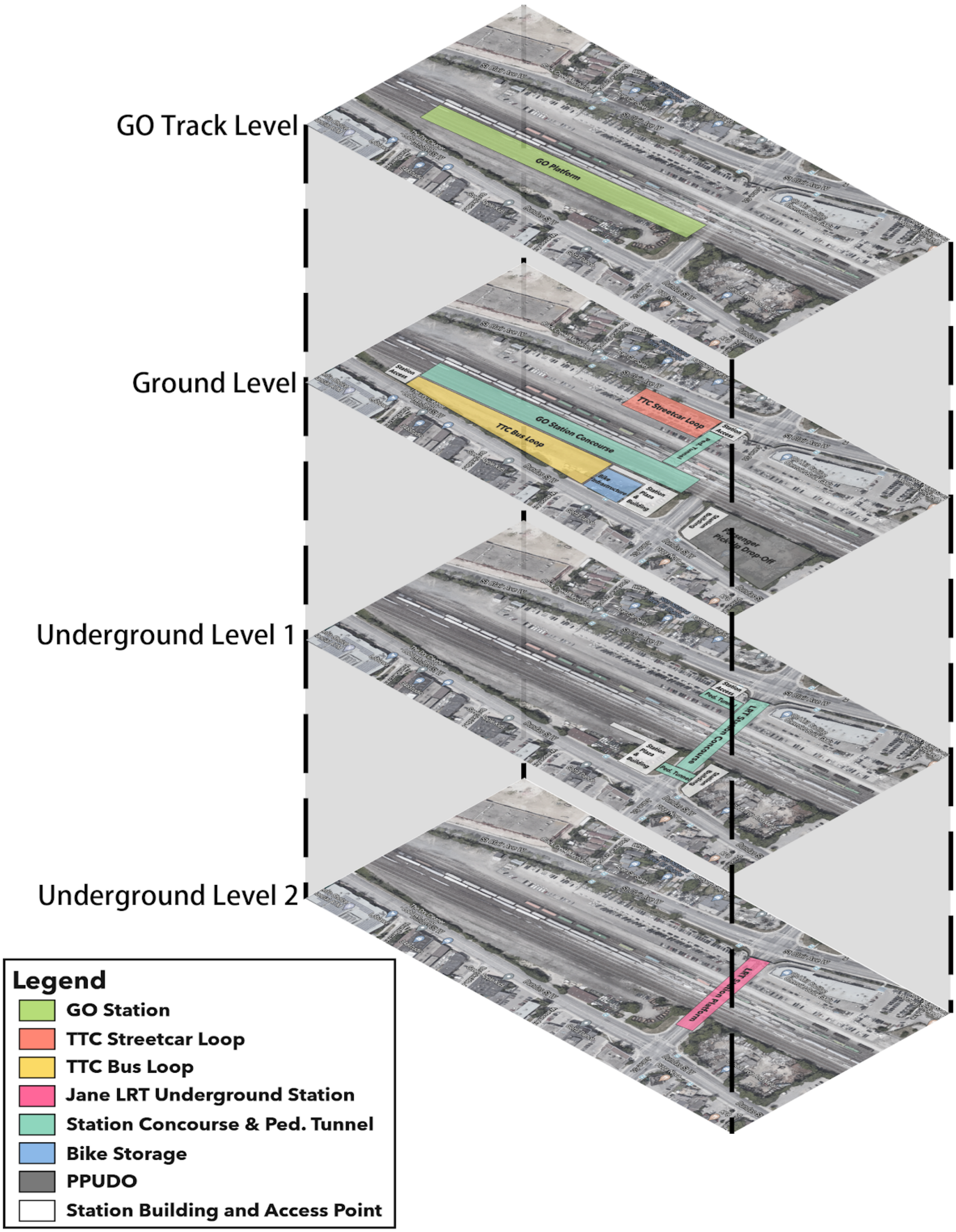


Figure 19: Levels of Jane-St. Clair Transit Hub

11.6.2 Station Access Plan

The Jane-St. Clair Transit Hub will have four station access points including two station buildings. These access points are connected to the LRT, GO, TTC buses and streetcar and PPUDO by three pedestrian tunnels and GO and LRT station concourses (Figure 20). Passengers using any transit services can access the transit hub from any station access points from the communities around or transfer within the hub.

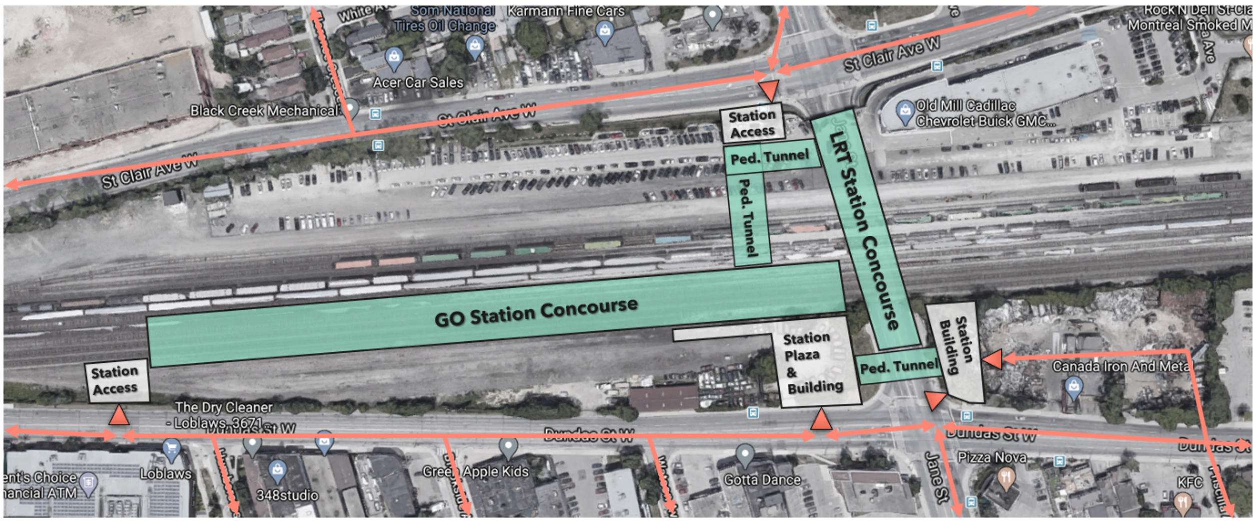


Figure 20: Access Plan of Jane-St. Clair Transit Hub

11.6.3 Transit Hub Design Components

This section describes the design details of all transit hub components.

11.6.3.1 Main Station Building

The main station building is the primary access point for the transit hub. It provides spaces for the following elements:

- Passenger waiting area
- Public washrooms
- Self-service hub
- Ambassador office
- Janitorial and garbage room
- Boiler, generator, electrical and comms rooms

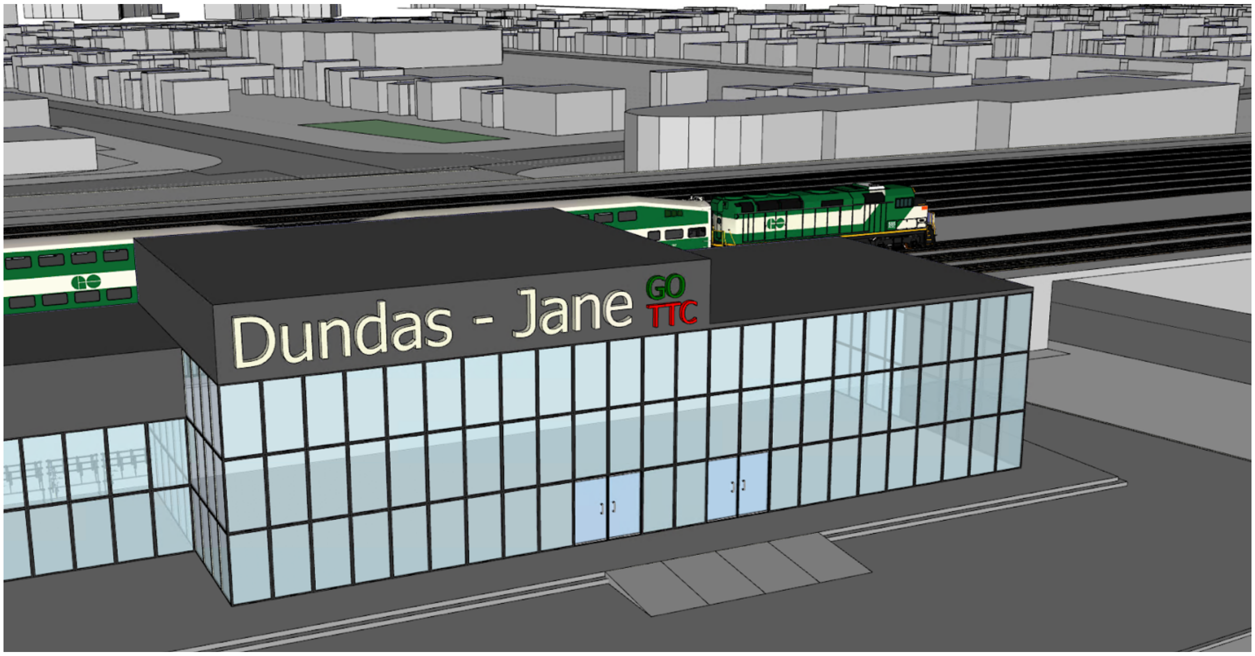


Figure 21: Main Station Building

11.6.3.2 Bike Storage

The bike storage at Jane-St. Clair Transit Hub provides 60 indoor spaces for bicycle parking. The building is 9.6 m x 19.2 m by area to allow 0.9 m of spacing between adjacent racks, 15 m of spacing between opposite racks and 2.4 m of bicycle length for 30 racks as specified by Metrolinx's Bike Infrastructure Design Standard.

Figure 21: Bicycle Storage

11.6.3.3 GO Track, Platform and Platform Access

The GO station at Jane-St. Clair Transit Hub has two side platforms servicing the north and south track of Galt Subdivision mainline (Figure 22). The details are as the following (Figure 23):

- 4.9 m of platform wide
- 127 mm of platform height above top of rail accommodating passive protection for level boarding
- 315 m of platform length accommodating 12-car train
- 2.44 m horizontal clearance from track centerline to platform edge
- Canopies and waiting shelters with 3.35 m vertical clearance
- Snowmelt Systems beneath the platform surface
- Mini-platform servicing 5th coach from east end at height of 559 mm above top of rail

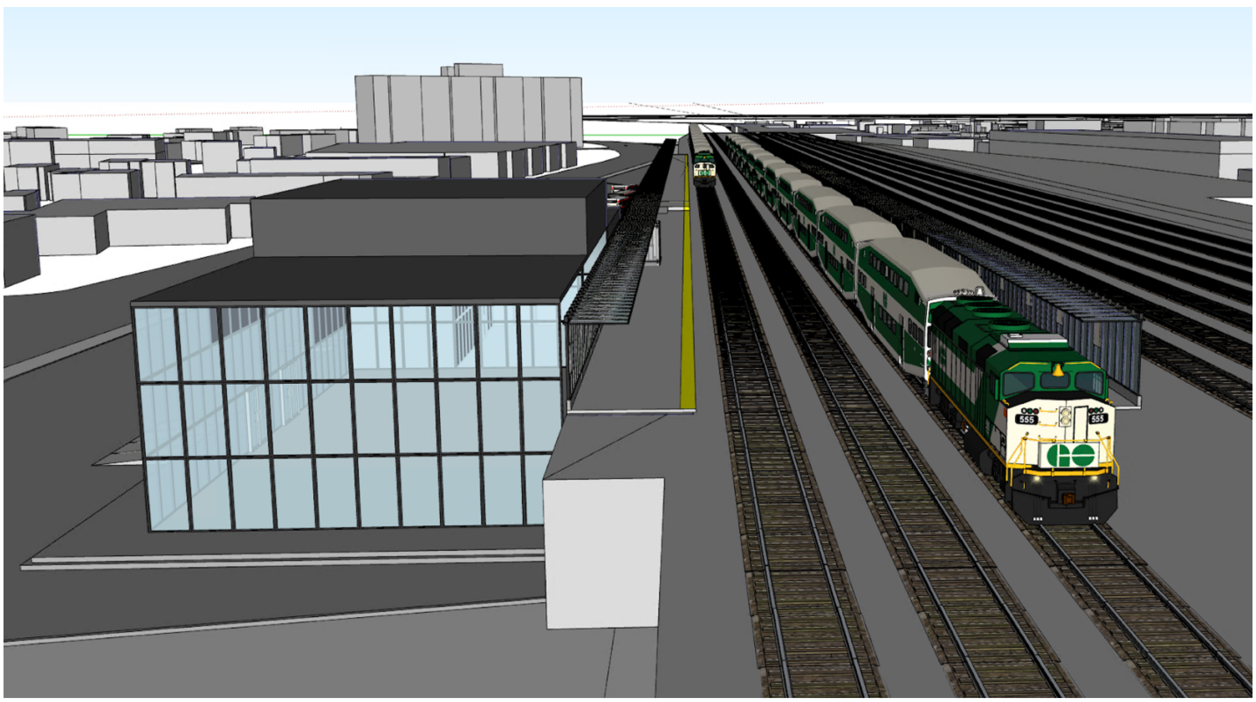


Figure 21: Overview of GO Tracks and Platforms

Figure 22: Detail of GO Tracks and Platforms

Each GO platform has four sets of staircases and three sets of elevators (Figure 23).

The staircases have fully glazed enclosures, concrete floor and stainless steel handrails. The platform end of the staircases are raised by 0.4 m above the platform elevation for accommodating passive protection for future level boarding using a 10:1 slope.

The elevators are using flow-through configuration to allow better accessibility. Redundancy is provided in the situation of which one or two elevators are out-of-service. Same as the staircases, the height of the elevator floor is also raised by 0.4 m above the platform elevation for accommodating passive protection for future level boarding using a 10:1 slope.

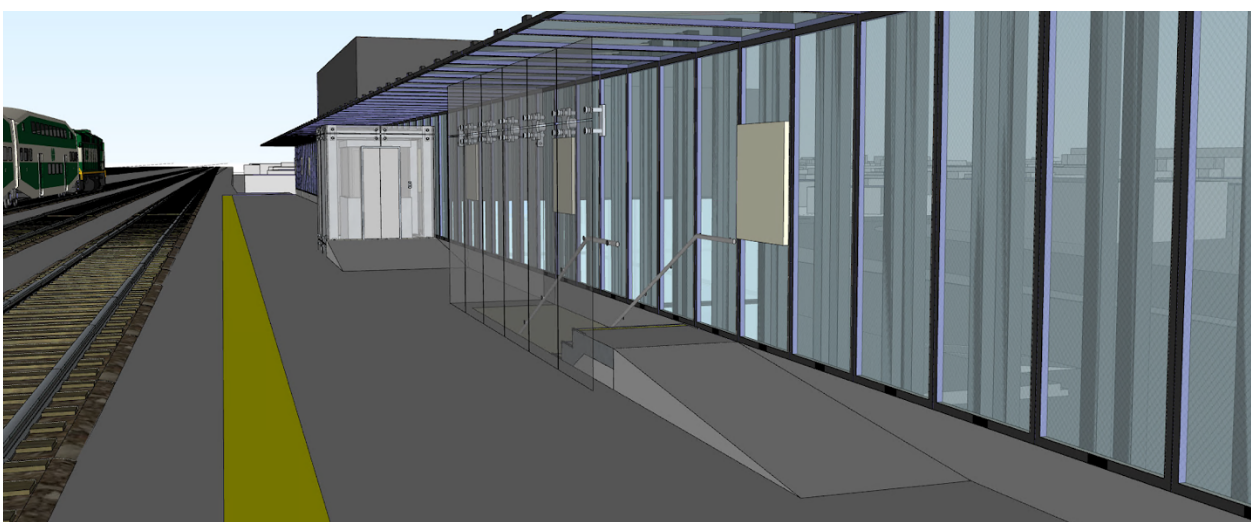


Figure 23: GO Station Platform Access

11.6.3.4 TTC Bus Loop

The bus loop uses the linear configuration with linear traffic flow. Saw tooth platforms are being used with the dimensions shown in Figure 24 as required by Metrolinx's DRM.

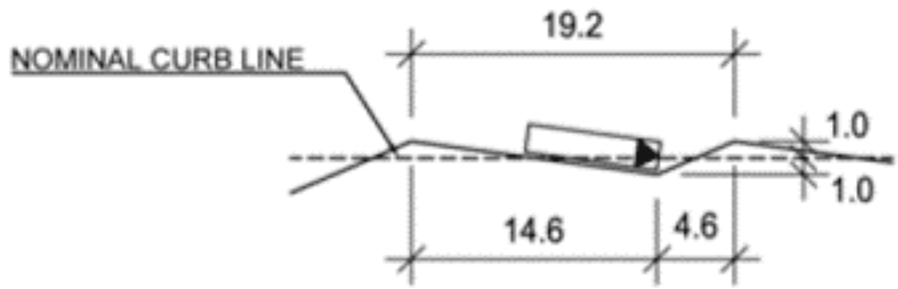


Figure 24: Required Dimensions of Saw Tooth Platform (Metrolinx 2020)

The bus loop has eight bus-bays, including one that can accommodate an articulated bus. The platform concrete curb is 150 mm above the driveway pavement. The radius of all inner curbs at curves are 10 m to allow buses to turn.

Figure 25: TTC Bus Loop

11.6.3.5 TTC Streetcar Loop

The streetcar platform is 60 m long to accommodate 2 LFLRVs. It has a width of 1.5 m and height of 150 mm above top of rail.

The streetcar track has a 1,495 mm track gauge using GGR-118 Standard 115 RE running rails. All horizontal curves have 13.72 m of radius as the minimum required by the TTC for turning of streetcar vehicles.

Figure 26: TTC Streetcar Loop

11.6.3.6 PPUDO and Secondary Station Building

PPUDO is provided at Jane-St. Clair Transit Hub, next to the secondary station building on the east side of Jane Street. Each PPUDO spot is 6 m x 3 m in space, all the spaces are facing the secondary station building. A 3 m wide hatching area is reserved in front of the building for paratransit services, a dedicated taxi and ride-sharing lane is also provided on the north side of the PPUDO. Raised curb and landscaped buffers are 2.5 m wide between vehicles and pedestrians for safety purposes.

Figure 27: PPUDO and Secondary Station Building

11.6.3.7 Jane LRT Underground Station

The LRT station has two levels: the concourse level above the platform level. The platform is 100 m, the same as any surface LRT station. The width of the LRT platform will depend on the spacing of bored tunnels in the vicinity of this station. There are four sets of staircases and/or escalators and three sets of elevators in the station for design redundancy.

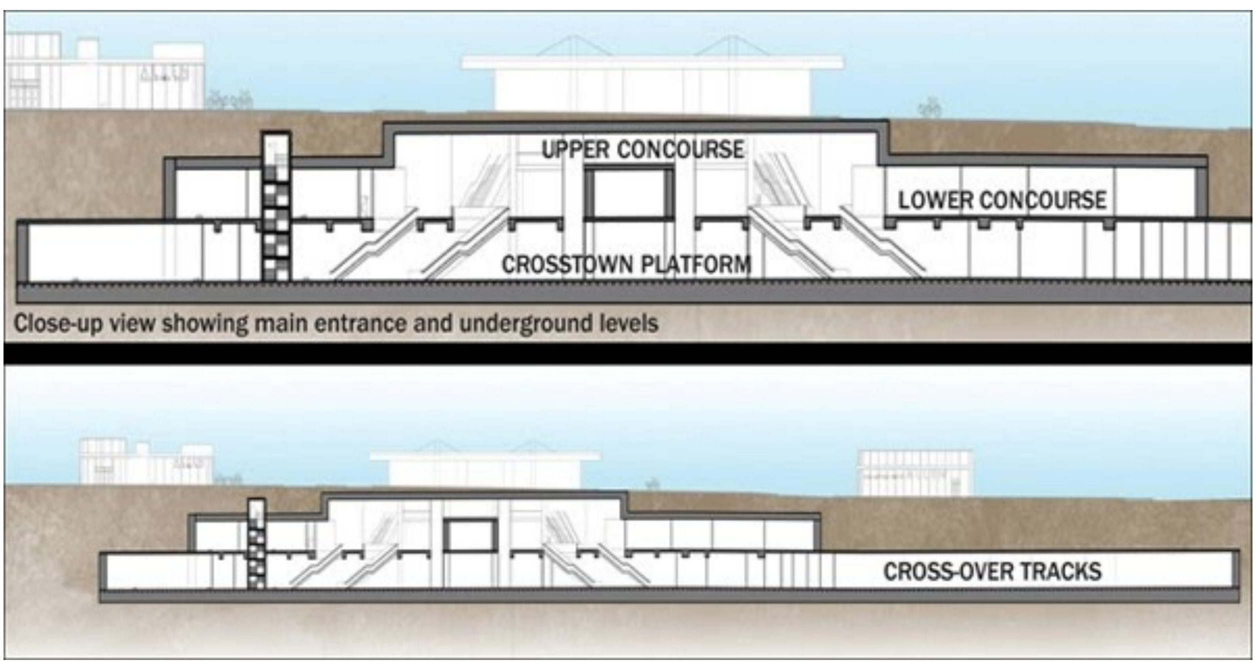


Figure 28: Underground LRT Station Example from Eglinton Crosstown LRT (Metrolinx 2010)

11.6.3.8 Pedestrian Tunnels

As described in Section X.2, Jane-St. Clair Transit Hub has three pedestrian tunnels connecting the station access points to the station concourses (Figure 29).

Each tunnel is:
- 0.8 m vertical clearance to top of tunnel roof membrane,
- 2.7 m tall,
- 3.66 m wide,
- Equipped with digital signs and CCTV,
- Connected by stairs, ramps and elevators

Figure 29: Pedestrian Tunnels

11.6.4 CPR/GO Track Alignment Design

In order to gain space and fit in the GO north platform, two existing storage tracks to the north of the mainlines have to be removed and shifted to the north end of the rail corridor (Figure X). These two new tracks are still located on CPR's property.

The details of the track design are as the following as required by CPR:

- 3.96 m track spacing
- 1,435 mm track gauge (standard gauge)
- 115 lb rail
- 7" x 8" x 8.5' treated hardwood timber cross tie in 22″ spacing
- AREMA Specification Grade 4 ballast
- Connecting to existing tracks on both ends using four #11 – 115 lb turnouts (two right-handed and two left-handed)

Figure 30: Current Track Alignment

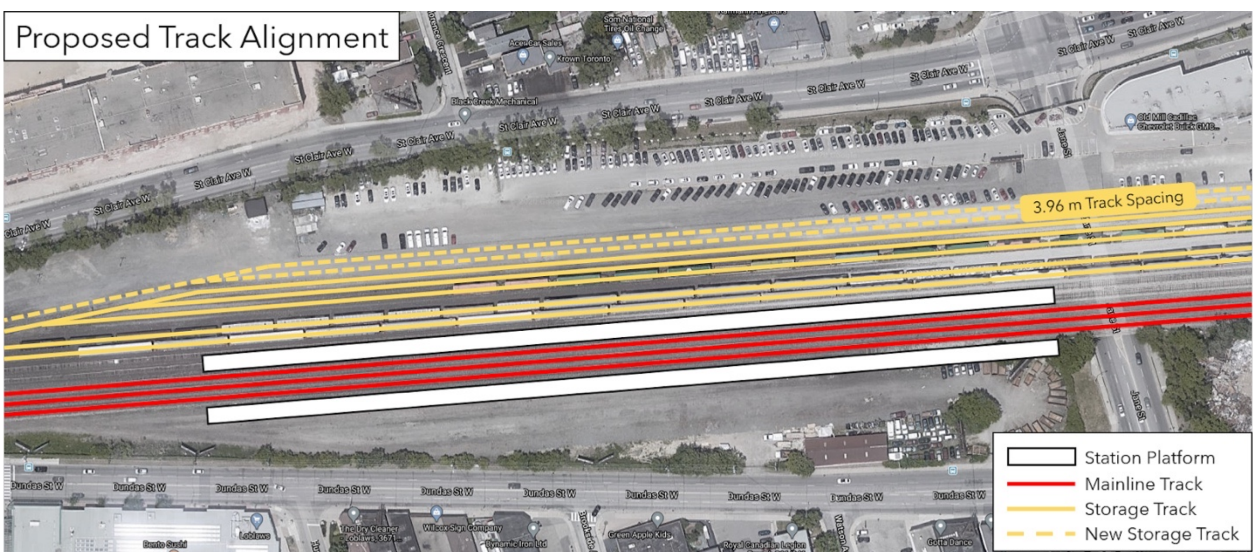


Figure 31: Proposed Track Alignments

11.6.5 Jane-St. Clair Transit Hub TOD Opportunities

In order to correspond with Metrolinx's Transit Oriented Development strategy (TOD), the transit hub footprint is minimized to allow higher density and mixed-use land development in or in the vicinity of the hub in the future. The current design allows TOD overbuild opportunities at the main station building, PPUDO and TTC streetcar loop. Spaces are also provided for commercial opportunities (ie. retails) in the main station building.

11.7 South Jane Street Feeder Transit Redesign

To maximize the connections with the existing TTC network, and to address the last mile problem of commuters accessing their communities, the bus network around Jane Street will need to be redesigned to maximize the potential of the LRT line. The process will generally follow the process used for Line 5 Eglinton (Figure 32).

The network south of Eglinton Ave W will be redesigned, while north of Eglinton will generally retain the existing network. Much of the area north of Eglinton has already been redesigned for the Line 1 TYSSE, Line 5 Eglinton (Figure 32), and Line 6 Finch West, which will reduce the need for a redesign. Additionally, the surface section with shorter stop spacing will eliminate the need for a redesign.

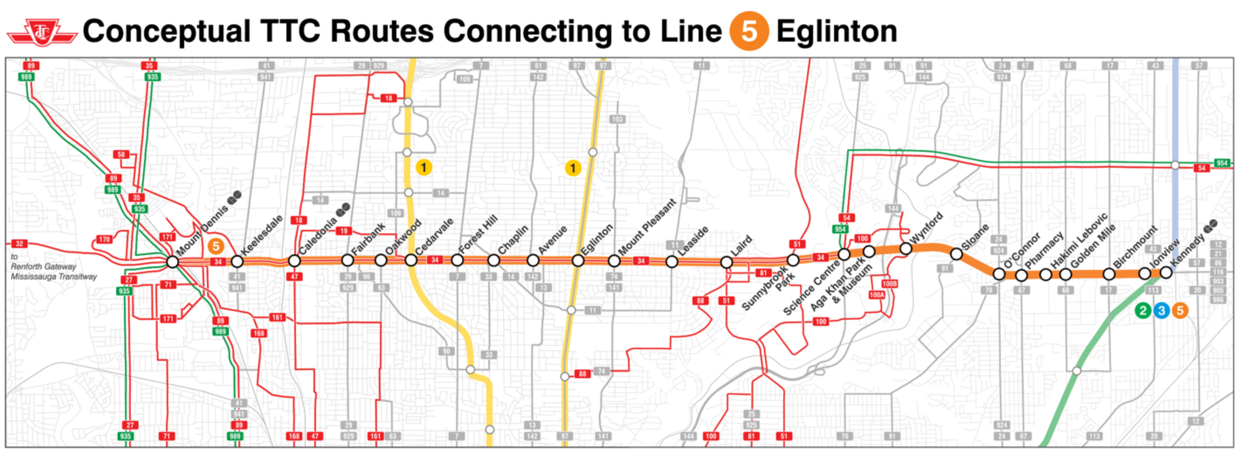


Figure 32: Bus Network Redesign for Line 5 Eglinton (TTC 2019)

Service on the 35 Jane will be retained, while the 935 Jane Express will be eliminated. Since the average stop spacing for the underground section is 970m, bus service on Jane Street is still warranted to serve the community in between the underground stations. However, the revised 35 route will only serve between Wilson and Bloor, the underground section of the LRT line. Additionally, headways will be reduced to 15 minutes, which is in line the 97 Yonge and the future 34 Eglinton; routes whose primary purpose is to serve in between underground stations.

11.7.1 Transit Network

In order to improve connectivity of transit services, the transit network around Jane-St. Clair Transit Hub is redesigned as the following (Figure 32):

- 935 will be replaced by Jane LRT
- Service on the 35 will be reduced and taken over by the Jane LRT
- 335 Overnight route will remain and have improved service. The Jane LRT will not run during overnight periods
- Jane-St. Clair station will be added to the GO Milton Line
- 512 will be extended to Jane-St. Clair from Gunns Loop
- 30 will be extended to Jane-St. Clair from Runnymede Loop and will be interlined with the 55
- 40B, 55 and 79B will be terminated at Jane-St. Clair Transit Hub
- The west terminal of 26 will be relocated to Jane-St. Clair from Jane Subway Station
- 71B will be added to service the Jane-St. Clair Transit Hub
- Westbound 40A will enter the Jane-St. Clair Hub, eastbound will remain on south side of Dundas Street West
- 79A will be removed
- 189 will be removed, while the service section on Keele Street will be taken over by a short turn branch of the 89, 89B
- 77 will have its terminal relocated to Jane Subway Station from Runnymede Station, will also being extended to Humber Loop to connect to the 501 Streetcar

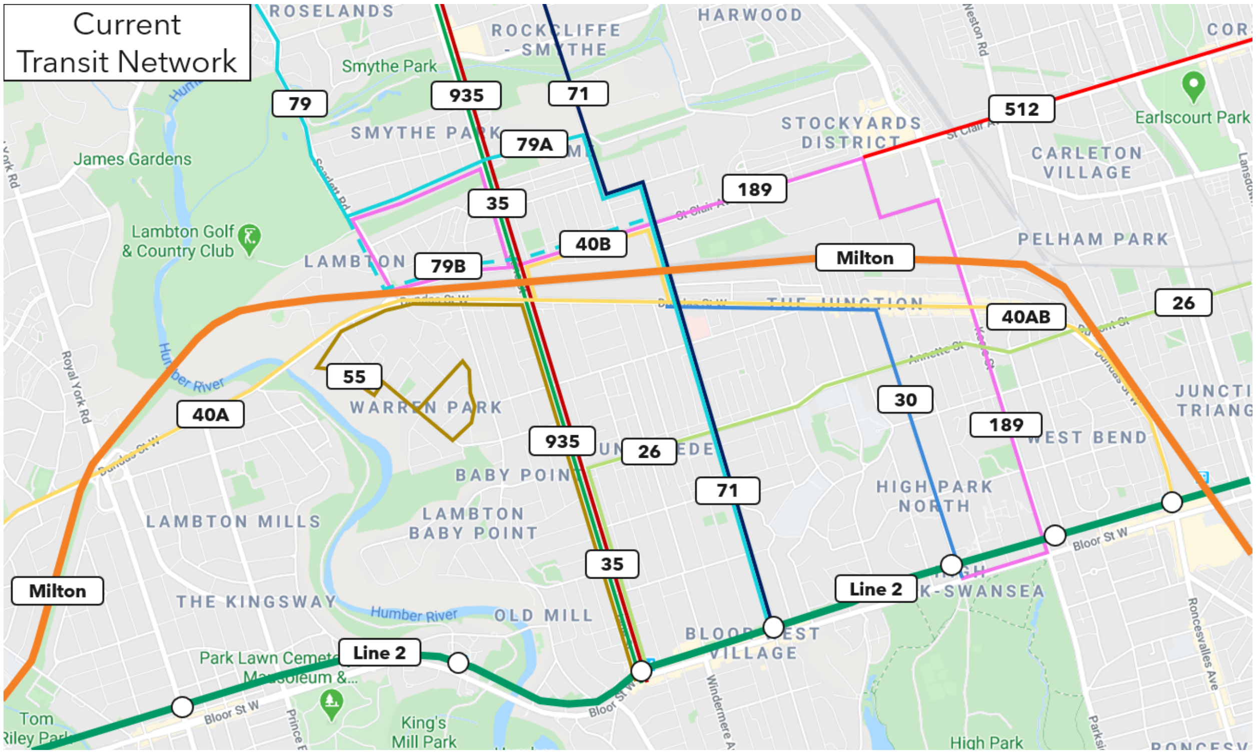


Figure 33. Current Transit Network around Dundas Street West and Jane Station

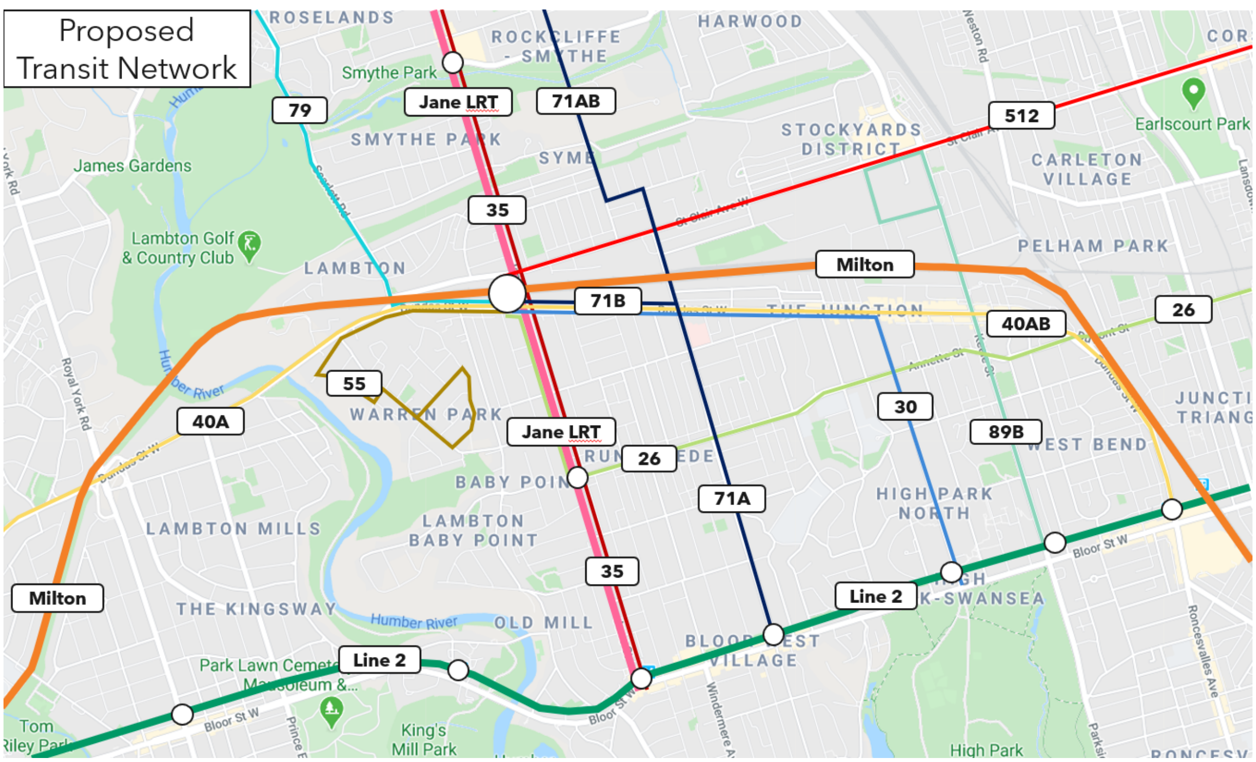


Figure 34. Future Transit Network around Dundas-Jane Transit Hub

11.7.2 Transit Operation

Upon project approval, SSR Group will provide technical advisory services to the client with regards to the redesign of the surface transit network introduced as a result of this project. This includes re-routing of the existing bus services and determination of stop locations. SSR Group will provide with the predicted transit demand in the project proximity to assist the TTC in transit planning. These changes are to reflect route/network changes introduced to better serve the area near the Transit Hub. The future headway and number of transit units are determined based on the expected future demand and professional judgement

Table 37: Expected Changes in Transit Operations for the afternoon peak period (TTC 2019)

Route	Existing[1]		Future[1]		Note
	Headway	Vehicles Required	Headway	Vehicles Required	
26 Dupont	18	5	18	5	Terminal relocated
30 High Park	20	1	15	1	Route extended
35 Jane	5	26	15	9	Reduced operation
40A Junction-Dundas West	18	4.5	18	4.5	Stop relocated
40B Junction-Dundas West	18	2.5	18	2.5	Terminated at Hub
55 Warren Park	15	2	15	1	Terminated at Hub
71A Runnymede	9	7	9	7	Existing 71
71B Runnymede	-	-	12	10	New branch

77 Swansea	9	4	8	5	Route Extended
79A Scarlett Rd	17	5	-	-	Removed
79B Scarlett Rd	17	5	8	8	Terminated at Hub
89B Weston	-	-	20	1	New branch
189 Stock Yards	20	3	-	-	Removed
512 St Clair	5	18	4	27	Route extended
935 Jane Express	10	11	-	-	Replaced by LRT
Line 8 Jane LRT	-	-	3	70	Proposed LRT

12 Detailed Cost Breakdown

Table 37 lists out each components required for construction, and a predicted cost estimated. All cost is in $2020 CAD.

Table 38: Predicted Cost

Component	Unit	Unit Price ($)	Quantity	Total
Utility Relocations	LS	$8,029,000	1	$8,029,000
Removals				
Full depth asphalt removal	m^2	$5	112880	$564,400
Curb and gutter removal	m	$10	31000	$310,000
Catch basin and manhole removal	km	$24,675	15.5	$382,463

Road Work				
Asphalt Base (SP 19)	tonne	$84	12957	$1,088,418
Asphalt Top (SP 12.5)	tonne	$125	12957	$1,619,670
Granular A	tonne	$46	158333	$7,283,295
Granular B	tonne	$36	463063	$16,670,250
Install Curb and Gutter	m	$70	52700	$3,689,000
Concrete Median	m^2	$85	940	$79,900
Sidewalk	m^2	$75	34860	$2,614,500
Install catch basin and manhole	km	$364,800	15.5	$5,654,400
Permanent pavement markings	m	$5	57567	$287,835
Install road subdrains	m	$27	16600	$448,200
Streetlights	each	$7,500	312	$2,340,000
Underground Construction	LS	$513,360,000	1	$513,360,000
Stations				
Street Level Stops	each	$4,000,000	14	$56,000,000
Underground stations	each	$90,000,000	8	$720,000,000
Transit Hub	LS	$6,000,000	1	$6,000,000

Construction Easement	m^2	$45	83000	$3,735,000
Other				
Signals (Permanent)	each	$300,000	37	$11,100,000
Signals (Temporary)	each	$125,000	37	$4,625,000
Landscaping (3% road work)	LS	$1,253,264	1	$1,253,264
Total Construction Cost				$1,367,134,595
Construction Contingency (20%)				$273,426,919
Traffic control (10%)				$136,713,460
Engineering (30%)				$410,140,379
Light Rail Vehicles	LS	$279,360,000	1	$279,360,000
Total Cost				**$2,187,415,352**

13 Constructability

Constructability and feasibility must be evaluated to identify any obstacles and minimize the complexity of implementation.

13.1 Underground Construction

Major grade change and shift of profile is expected when transitioning from surface to underground. Excavation by TBM can generate excessive mass of earth that cannot be recycled by the project. Contaminated soil and excess soil will be managed and transported as recommended by the Government of Ontario.

Groundwater levels under Jane Street are likely to be above the base of proposed tunnel alignment for the entire corridor. Controlling methods such as pumping, well points or deep well dewatering systems are expected. For the safety of workers and passengers, the tunnel requires temporary support and retaining wall structures.

It is likely that the underground segment encounters historical or cultural sites. Documentation and consultation will be conducted in compliance with the requirements of the City of Toronto Heritage Preservation Services to evaluate and minimize the impact on any heritage properties caused by the LRT construction.

13.2 Utility Relocation

There is a large number of underground and overhead utilities running through the Jane Street corridor. As utilities are not supposed to run directly under the road pavement, many of the utilities will be located closer to the property limit line within the Jane Street ROW. The team will communicate and coordinate with utility companies that will be affected to avoid future conflicts.

13.3 Property Impact

The preferred alternative will widen the Jane Street corridor to six lanes: two automobiles through lanes and one transit lane in each direction while keeping turning lanes at intersections, for the surface segments. The proposed surface lane configuration requires a ROW of 36 m.

The existing ROW is 36 m from Highway 400 to Steeles Avenue, which is sufficient for the surface lane configuration. However, from Bloor Street to Highway 400, ROW is reduced. To avoid land acquisition, the team proposes underground stations from Bloor Street to Wilson Avenue.

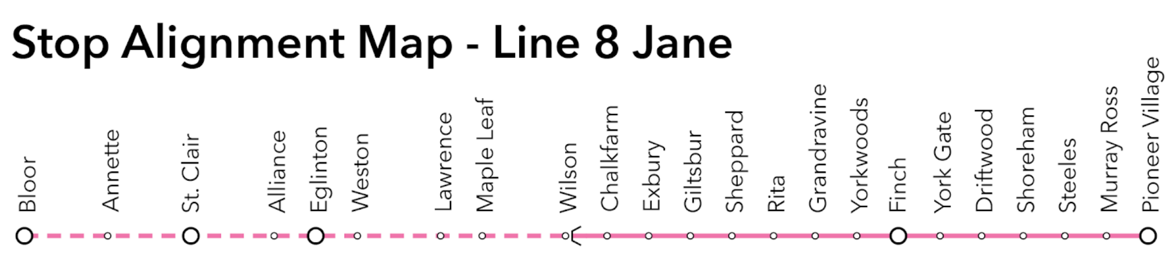


Figure 36: Conceptual stop alignment

The proposed design will have minor property impact along the corridor. However, land acquisition is needed for transit hubs and construction easement is needed for temporary grading and drainage.

13.4 Traffic Disruption

Jane Street is an important north-south corridor through the City of Toronto. The following required construction work, especially at surface from Wilson Avenue to Steeles Avenue, cannot avoid traffic disruption and delays:

- Widen the road to six lanes
- Installing LRT tracks and overhead wires
- Constructing boarding islands for exclusive transit ROW at middle lanes
- Reconfiguring pavement markings
- Launching TBMs for excavation
- Excavation for underground segments

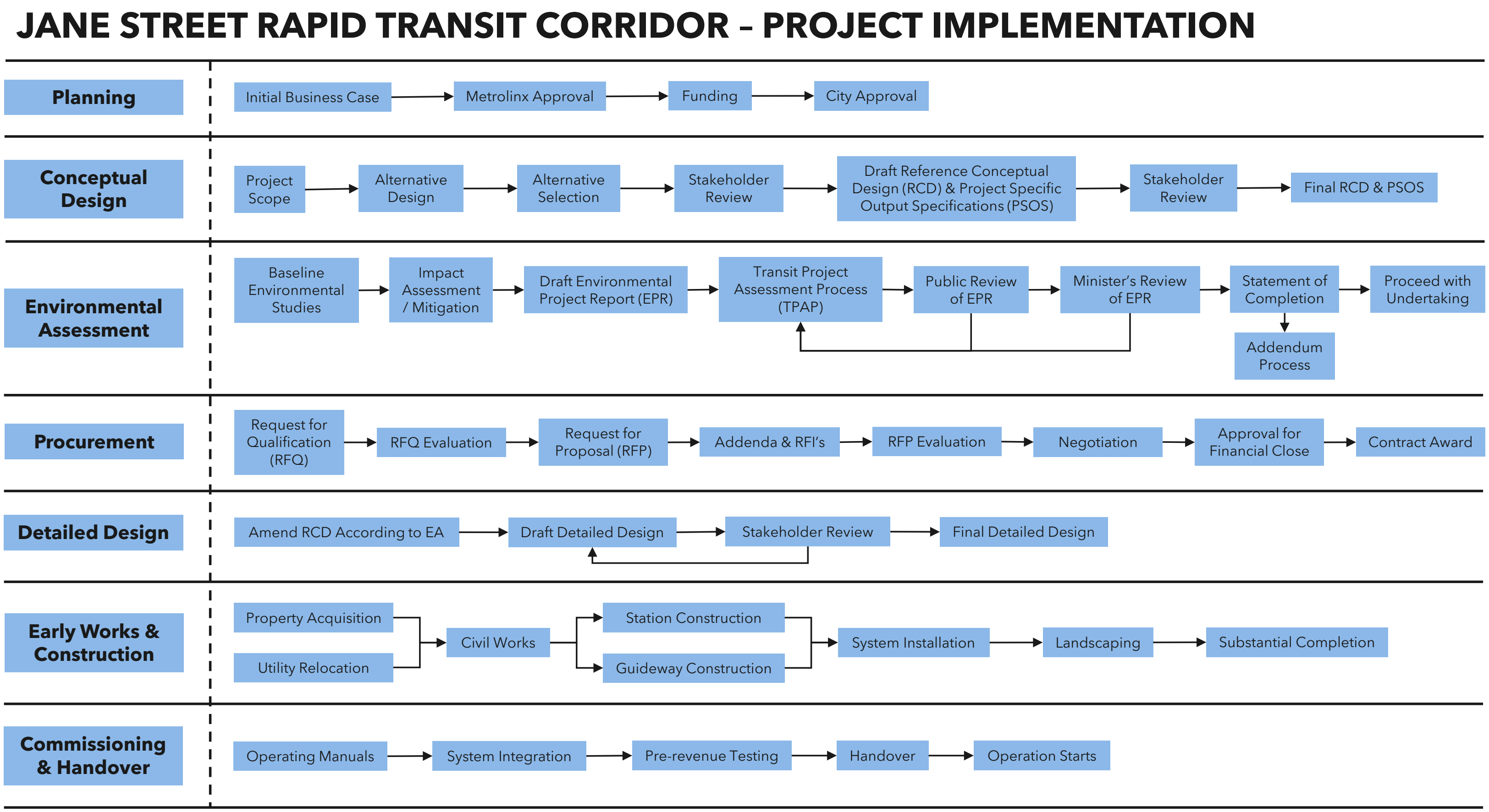
Disruption to traffic will be temporary and construction staging will focus on maintaining vehicular and pedestrian movement whenever possible during construction.

South of Wilson Avenue, the underground portion of LRT will run under the Highway 400 and Highway 401 interchanges, as well as the CN National Railway. Disruption to highway traffic and train operation is minimized by using TBM for underground tunneling.

14 Implementation

The Jane Street corridor is a major arterial road owned by the City of Toronto. The project will involve major changes to existing infrastructure and significant environmental impacts. Therefore, the project will follow the Municipal Class Environmental Assessment (EA) 'Schedule C' procedures for planning and documentation.

Figure 37: Stages and Processes Related to Implementation



The team has completed the conceptual design phase, and the major proceeding steps are Environmental Assessment (EA), Procurement, Detailed Design, Early Works & Construction and Commissioning & Handover.

14.1 Environmental Assessment

The following assessment will be delivered:

- Baseline Environmental Studies
- Impact Assessment and Mitigation
- Environmental Project Report (EPR)
- Transit Project Assessment Process (TPAP)

The environmental assessment will be submitted to MECP for review and will be open for public review.

14.2 Public and Stakeholder Consultation

The SSR Group will identify potential conflict of interests with stakeholders that may be impacted by the project and develop strategies to engage the stakeholders at the early stage of the project. Interested parties and residents will be consulted and kept informed throughout all phases of the project.

Public consultation is a key part of the Class EA process and SSR Group is planning to engage the public through a series of public meetings and open houses. The following key milestones are planned for public consultation.

- Notice of Study Commencement: public notice to be published on newspapers and to be shared on major social media. The notice will also be directly mailed to affected property owners and stakeholders.
- Open Houses: one or two open houses to be scheduled. The SSR Group will attend at the drop-in style open houses to answer questions and address concerns from the public.
- Public and property owner meetings: individual (residential or commercial) land owners who may be significantly impacted by the project will be invited for individual meetings with the project team.
- Notice of Completion: public notice to be published in a similar manner with the Notice of Study Commencement

Stakeholders will be contacted to request information or comments about the project. Communication will be in the form of emails, phone calls and meetings. The following stakeholders are identified:

- Federal departments
- Provincial ministries such as MTO and MECP
- Municipalities
- Utility company representatives
- Indigenous groups

14.3 Procurement

The team recommends an Alternative Financing and Procurement (AFP) method for the project. It is expected that a Design-Build-Finance-Maintain (DBFM) contract will be established for the client to ensure successful project delivery and long-term maintenance. Overall, AFP will be a good procurement method to prevent cost overruns and delays.

14.4 Detailed Design

Once the EA is filed and approved by the MECP and the public is satisfied with the proposed improvement, the preliminary design will be evaluated by stakeholders and agencies. Amendments will be made continuously to reflect the comments received from major stakeholders and the design will be submitted to the client for finalization.

14.5 Early Works and Construction

Property acquisition and utility relocation will commence at the early stages of the project by the client before a construction contract is awarded. Once the contract is awarded, the SSR Group (as the owner's engineer) will provide technical advisory services (review of detailed design with PSOS) and contract administration services (monitoring of contractors' performance) to the client during the detailed design and construction phase until substantial completion of the project. Construction will start with civil work, followed by station and guideway construction, system installation and landscaping.

14.6 Commissioning and Handover

Before operation starts, the team will follow operating manuals, perform system integration, pre-revenue testing and then handover to the operating agency.

15 Conclusion

Transit service improvement on Jane Street is needed due to the growing demand and existing service reliability problems. SSR Group has conducted qualitative analysis, provided detailed justification of alternative selection and completed the preliminary design of the Jane Street Rapid Transit project.

16 Recommendation

To make the project as successful as possible, the team recommends that planning for the following key projects be started simultaneously, while this project is under delivery.

- Redesign bus routes to maximize connections to the LRT
- 512 St. Clair streetcar extension to Jane
    - Necessary to feed into the St Clair Transit Hub
- Go Transit Expansion
    - Missing Link Project and the purchasing of CP Galt Subdivision in Toronto will allow CP to remove freight trains, and allow the full expansion of the Milton Line to frequent all day service
- Rezone the areas to maximize the potential of the line

With these projects, the LRT project will become a key part of the transportation future of the GTA.

SSR Group

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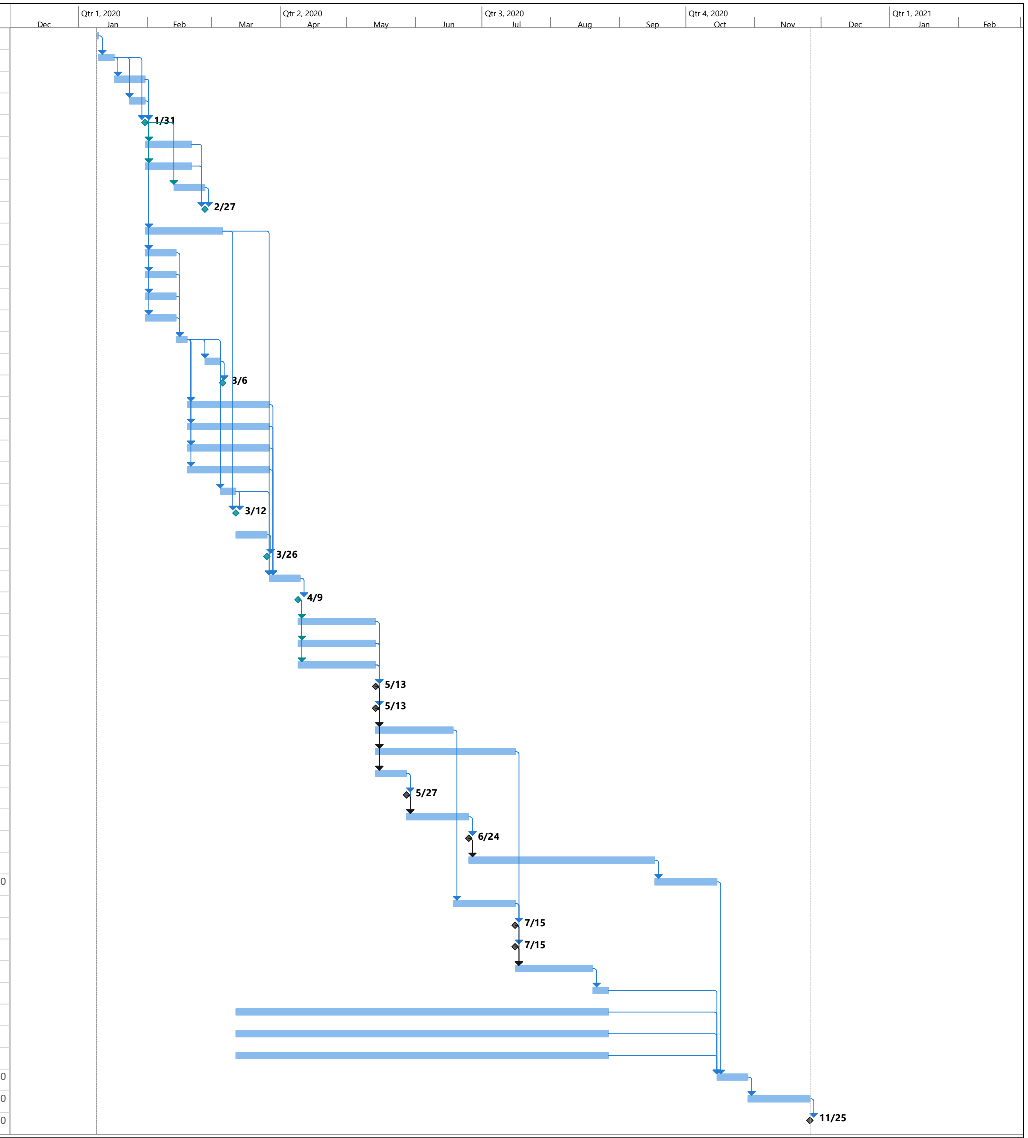
Appendix A – Project Gantt Chart (Excl. Implementation)

ID	Task Name	Duration	Start	Finish
1	Problem Identification	1 day	Thu 1/9/20	Thu 1/9/20
2	Problem Definition/Scope	5 days	Fri 1/10/20	Thu 1/16/20
3	Functional Alternative Design	10 days	Fri 1/17/20	Thu 1/30/20
4	Preparation of Project Proposal Report	5 days	Fri 1/24/20	Thu 1/30/20
5	**[Report] Project Proposal**	0 days	Fri 1/31/20	Fri 1/31/20
6	Project Methodology	15 days	Fri 1/31/20	Thu 2/20/20
7	Review of Design Manuals	15 days	Fri 1/31/20	Thu 2/20/20
8	Preparation of Project Methodology and Review of Design Manuals Report	10 days	Thu 2/13/20	Wed 2/26/20
9	**[Report] Project Methodology and Review of Design Manuals**	0 days	Thu 2/27/20	Thu 2/27/20
10	Transportation Modelling	25 days	Fri 1/31/20	Thu 3/5/20
11	Transportation Analysis	10 days	Fri 1/31/20	Thu 2/13/20
12	Cost Estimation (Class D) and Analysis	10 days	Fri 1/31/20	Thu 2/13/20
13	Constructability Analysis	10 days	Fri 1/31/20	Thu 2/13/20
14	Environmental Assessment	10 days	Fri 1/31/20	Thu 2/13/20
15	Quality of Life Analysis	3 days	Fri 2/14/20	Tue 2/18/20
16	Preparation for Interim Oral Presentation	5 days	Thu 2/27/20	Wed 3/4/20
17	**[Presentation] Interim Oral Presentation**	0 days	Fri 3/6/20	Fri 3/6/20
18	Design of Transit Hub	27 days	Wed 2/19/20	Thu 3/26/20
19	Design of Surface Station	27 days	Wed 2/19/20	Thu 3/26/20
20	Design of Transit Corridor (Surface)	27 days	Wed 2/19/20	Thu 3/26/20
21	Design of Transit Corridor (Underground)	27 days	Wed 2/19/20	Thu 3/26/20
22	Preparation of Preliminary Analysis Report	5 days	Thu 3/5/20	Wed 3/11/20
23	**[Report] Preliminary Analysis Report**	0 days	Thu 3/12/20	Thu 3/12/20
24	Preparation for Final Oral and Poster Presentation	10 days	Thu 3/12/20	Wed 3/25/20
25	**[Presentation] Final Oral and Poster Presentation**	0 days	Thu 3/26/20	Thu 3/26/20
26	Preparation of Final Report (Draft RCD)	10 days	Fri 3/27/20	Thu 4/9/20
27	**[Deliverable] Final Report (Draft RCD)**	0 days	Thu 4/9/20	Thu 4/9/20
28	Stakeholder Consulation for Draft RCD	25 days	Thu 4/9/20	Wed 5/13/20
29	Prepare Cost Estimation (Class D)	25 days	Thu 4/9/20	Wed 5/13/20
30	Prepare Draft PSOS	25 days	Thu 4/9/20	Wed 5/13/20
31	Submit Cost Estimation (Class D)	0 days	Wed 5/13/20	Wed 5/13/20
32	Submit Draft PSOS	0 days	Wed 5/13/20	Wed 5/13/20
33	Stakeholder Consultation for Draft PSOS	25 days	Thu 5/14/20	Wed 6/17/20
34	Prepare Final RCD	45 days	Thu 5/14/20	Wed 7/15/20
35	Prepare Scope Description for RFQ	10 days	Thu 5/14/20	Wed 5/27/20
36	Scope Description Finalized for RFQ Release	0 days	Wed 5/27/20	Wed 5/27/20
37	Metrolinx and Infraustructure Ontatio Approval Period for RFQ	20 days	Thu 5/28/20	Wed 6/24/20
38	Metrolinx Releases RFQ	0 days	Wed 6/24/20	Wed 6/24/20
39	RFQ Period	60 days	Thu 6/25/20	Wed 9/16/20
40	RFQ Evaluation	20 days	Thu 9/17/20	Wed 10/14/20
41	Prepare Final PSOS	20 days	Thu 6/18/20	Wed 7/15/20
42	Submit Final RCD	0 days	Wed 7/15/20	Wed 7/15/20
43	Submit Final PSOS	0 days	Wed 7/15/20	Wed 7/15/20
44	Stakeholder Consultation for Final RCD and PSOS (QA/QC)	25 days	Thu 7/16/20	Wed 8/19/20
45	Addressing QA/QC Comments	5 days	Thu 8/20/20	Wed 8/26/20
46	Subsurface Utility Engineering	120 days	Thu 3/12/20	Wed 8/26/20
47	Geotechnical Investigation	120 days	Thu 3/12/20	Wed 8/26/20
48	Topography Survey	120 days	Thu 3/12/20	Wed 8/26/20
49	Finalize for RFP Release	10 days	Thu 10/15/20	Wed 10/28/20
50	Metrolinx and Infraustructure Ontatio Approval Period for RFP	20 days	Thu 10/29/20	Wed 11/25/20
51	Metrolinx release RFP	0 days	Wed 11/25/20	Wed 11/25/20



Project: CIV498H1 Project Sche
Date: Tue 4/7/20

Task | Summary | Inactive Milestone | Duration-only | Start-only | External Milestone | Manual Progress
Split | Project Summary | Inactive Summary | Manual Summary Rollup | Finish-only | Deadline
Milestone | Inactive Task | Manual Task | Manual Summary | External Tasks | Progress

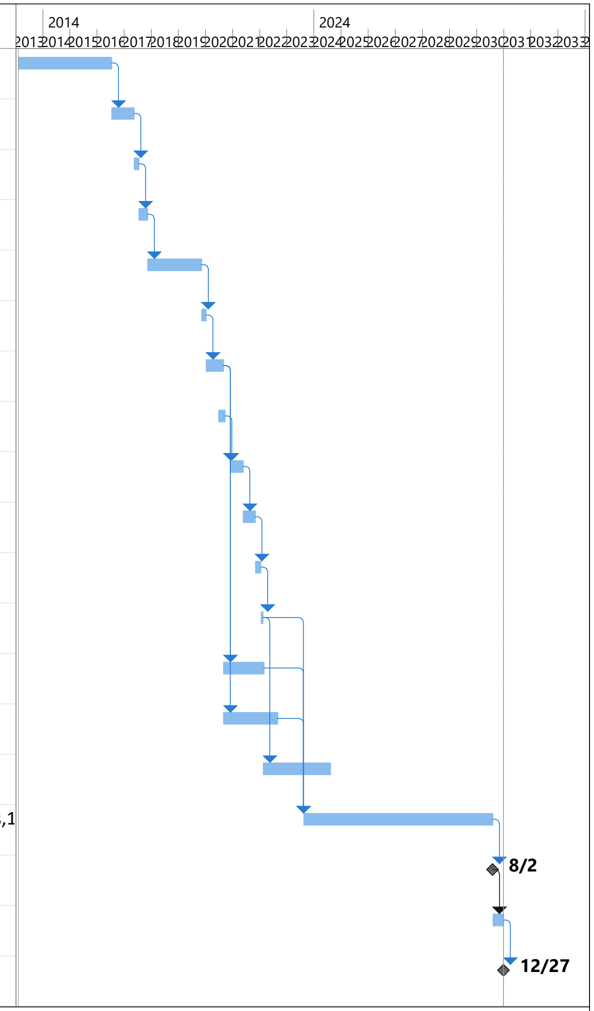
Jane Street Rapid Transit Corridor: Final Report

A

SSR Group

Appendix B - Project Gantt Chart

ID	Task Name	Duration	Start	Finish	Predecessors
1	Planning	899 days	Mon 2/4/13	Thu 7/14/16	
2	Initial Business Case	215 days	Fri 7/15/16	Thu 5/11/17	1
3	Business Case Approval	45 days	Fri 5/12/17	Thu 7/13/17	2
4	Functional Design	85 days	Fri 7/14/17	Thu 11/9/17	3
5	Environmental Assessment	520 days	Fri 11/10/17	Thu 11/7/19	4
6	Finalize Scope	44 days	Fri 11/8/19	Wed 1/8/20	5
7	100% RCD and PSOS	166 days	Thu 1/9/20	Thu 8/27/20	6
8	RFQ Period	60 days	Thu 6/25/20	Wed 9/16/20	
9	RFP Period	125 days	Wed 11/25/20	Tue 5/18/21	8FS+49 days,7
10	RFP Technical, Financial Review and Negotiations	118 days	Wed 5/19/21	Fri 10/29/21	9
11	Metrolinx Approval for Contract Award	55 days	Mon 11/1/21	Fri 1/14/22	10
12	Finalize and Award Contract	20 days	Mon 1/17/22	Fri 2/11/22	11
13	Property Acquisition	390 days	Fri 8/28/20	Thu 2/24/22	7
14	Early Works - Utility Relocation	520 days	Fri 8/28/20	Thu 8/25/22	7
15	Detailed Design	650 days	Mon 2/14/22	Fri 8/9/24	12
16	Construction	1820 days	Mon 8/14/23	Fri 8/2/30	12FS+390 days,1
17	Substantial Completion	0 days	Fri 8/2/30	Fri 8/2/30	16
18	Comissioning and Handover	105 days	Mon 8/5/30	Fri 12/27/30	17
19	Commencing Operation	0 days	Fri 12/27/30	Fri 12/27/30	18



Project: Jane Street Rapid Trans
Date: Tue 4/7/20

Task	Inactive Task	Manual Summary Rollup	External Milestone
Split	Inactive Milestone	Manual Summary	Deadline
Milestone	Inactive Summary	Start-only	Progress
Summary	Manual Task	Finish-only	Manual Progress
Project Summary	Duration-only	External Tasks	

SSR Group

Appendix C – Attribution Table

Tasks	Member			
	Shun Higuchi	Junbo Liang	Rick Liu	Tianqing Wang
Cover Page			x	
Executive Summary				x
Goals and Objectives	x	x	x	x
Project Scope	x			x
Project Background			x	
Developing Alternatives	x	x	x	x
Literature Review	x	x	x	x
Project Methodology	x	x	x	x
Review of Design Manuals	x	x	x	x
Transportation Analysis	x			x
Cost Analysis				x
Constructability Analysis				x
Quality of Life Analysis			x	
Alternative Selection			x	
Corridor Alignment Design			x	
Surface Cross-section Design			x	
Surface Intersection/Station Design			x	
Underground Cross-section Design				x
Transit Hub Design		x		
Transit Services Design	x	x		
Cost Estimate				x

Constructability				x
Implementation		x		x
Conclusion				x
Recommendations		x	x	x
3D Renders		x		
Figures		x	x	
Geospatial Analysis			x	
Project Schedule	x	x		
Presentation Slides	x	x	x	x
Presentation Poster			x	
Formatting			x	
References			x	

Appendix D – Terms and Glossary

Acronym	Term
APS	Audible Pedestrian Signal
AODA	Accessibility for Ontarians with Disabilities Act
BRT	Bus Rapid Transit
CAD	Computer Aided Design
CDA	Census Dissemination Area
CO	Canadian Monoxide
CPR	Canadian Pacific Railway
DCM	Design Criteria Manual
GHG	Greenhouse Gas
GIS	Geographic Information System
GO	Government of Ontario Transit
GTFS	General Transit Feed Specification
GTHA	Greater Toronto and Hamilton Area

HOV	High-Occupancy Vehicle
ITS	Intelligent Transportation System
LOS	Level of Service
LPI	Leading Pedestrian Interval
LRT	Light Rail Transit
LRV	Light Rail Vehicle
LS	Lump Sum
MOE	Measure of Effectiveness
MSF	Maintenance and Storage Facility
MTO	Ministry of Transportation Ontario
MX	Metrolinx
NACTO	National Association of City Transportation Official
NOx	Nitrogen Oxides
OPSD	Ontario Provincial Standard Drawing
OTM	Ontario Traffic Manual

PPUDO	Passenger Pick-up and Drop-off
PUDO	Pick-up and Drop-off Facility
PXO	Pedestrian Crossover
ROW	Right-of-Way
RTP	Regional Transit Plan
TOD	Transit Oriented Development
TTC	Toronto Transit Commission
TWSI	Tactile Warning Strip Indicator
TYSSE	Toronto-York Spadina Subway Extension
USDOT	United States Department of Transportation
VOC	Volatile Organic Compound

Appendix E - Descriptions of Software

GTAModel V4.0 / EMME / XTMF

GTAModel V4.0 is a regional travel demand model developed by Travel Modelling Group at the University of Toronto. It is used to forecast future travel demands and patterns within the GTHA. The model is implemented using EMME, a macroscopic transportation modelling software package by INRO, and XTMF, an in-house model builder.

Microsoft Excel

Excel is a spreadsheet tool developed by Microsoft that features calculation, graphs, charts and pivot tables. This software will be used for calculations that require large quantities of data and multiple entries of information such as cost estimates.

Microsoft Project

Project is a project management tool developed by Microsoft to develop project schedule, assign resources and tasks, track project progress and manage the budgets. This software will be used to develop timeline and analyze workloads for this project.

AutoCAD

AutoCAD is a computer-aided design (CAD) tools developed by Autodesk. It was used to develop the tunnel cross-section and surface intersection plan. It was also be used for quantity estimates where applicable.

SketchUp

SketchUp is a 3D design/modelling program developed by Trimble. In addition to modeling also allows producing layouts of the model. This program will be used to create 3D models for the stations and hub and output layouts and plans for further editing using GIS and CAD.

QGIS

QGIS is an open-source geographical information system widely used in municipalities in North America. It can produce maps, export information to be used in AutoCAD, and conduct geographic analysis using a series of plugins. Additional connections using PostGIS, can enable QGIS to communicate and work off of PostgreSQL databases.

Python

Python is an open source computer language. Through modules, python will be used in the project to conduct geospatial analysis, compute data, and create graphs or figures in a repeatable and automated fashion.

Appendix F - Data Sources

Toronto Centreline Network

The Toronto Centreline Network is a GIS layer released by Toronto Open Data that represents each boundary, road, trail, and rail line by its centerline.

Toronto Topographic Sidewalk and Road Area

The Toronto Topographic Sidewalk and Road Area layer are GIS layers released by Toronto Open Data that represents the road and sidewalks as a series of polygons. In combination with the property boundaries layer, it can show city ROW.

Toronto 3D Massing Layer

The Toronto 3D Massing Layer are Sketchup and AutoCAD files released by Toronto Open Data that represents buildings according to their massing, and height.

Toronto Property Boundaries

The Toronto Property Boundary layer is a GIS layer released by Toronto Open Data that represents the property line of all property in the city.

Census Population Data (CDA Level)

The data, released after the 2016 Census, lists the number of people living in each CDA, along with the area and population density. The data also contains demographic information of those living in the CDA. The data is available either in a GIS file or comma separated format.

GTFS Data

GTFS Data is a series of files released by the TTC, conforming to the GTFS standards, that show the stops, times, and geometry of all TTC routes.

Appendix G – Supplementary Design Manual Figures

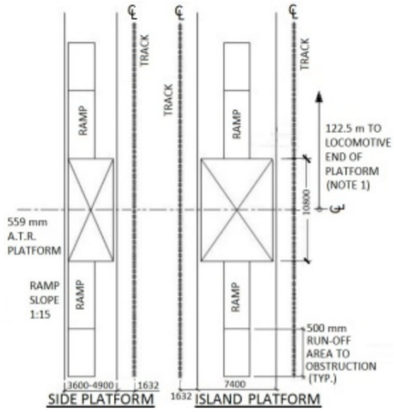


Figure 15: Typical Mini Platform Configuration

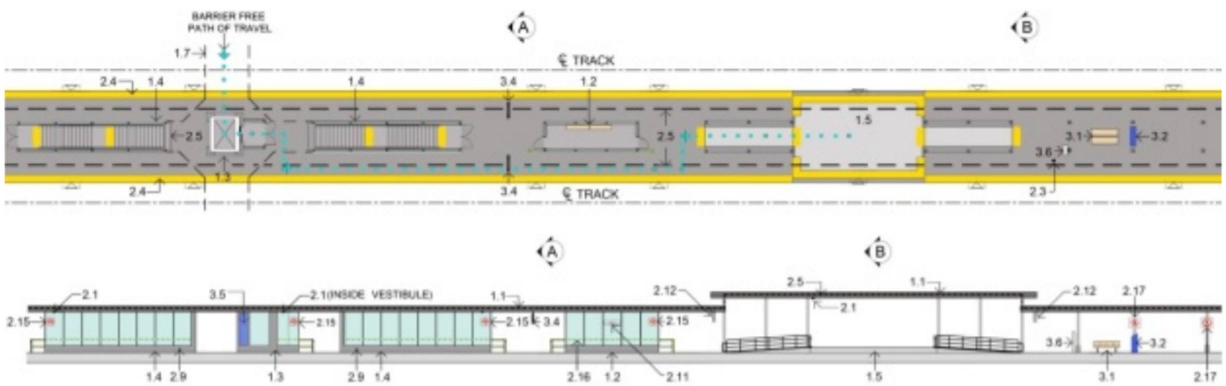


Figure 16: Rail Platform Plan (top) and Elevation (bottom)

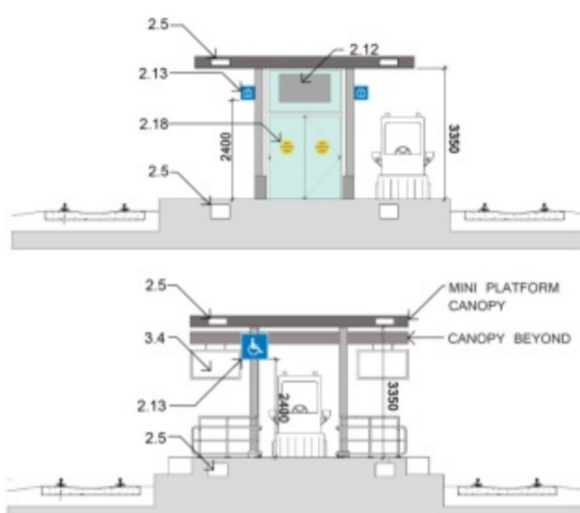


Figure 17: Rail Platform Section A (top) and Section B (bottom)

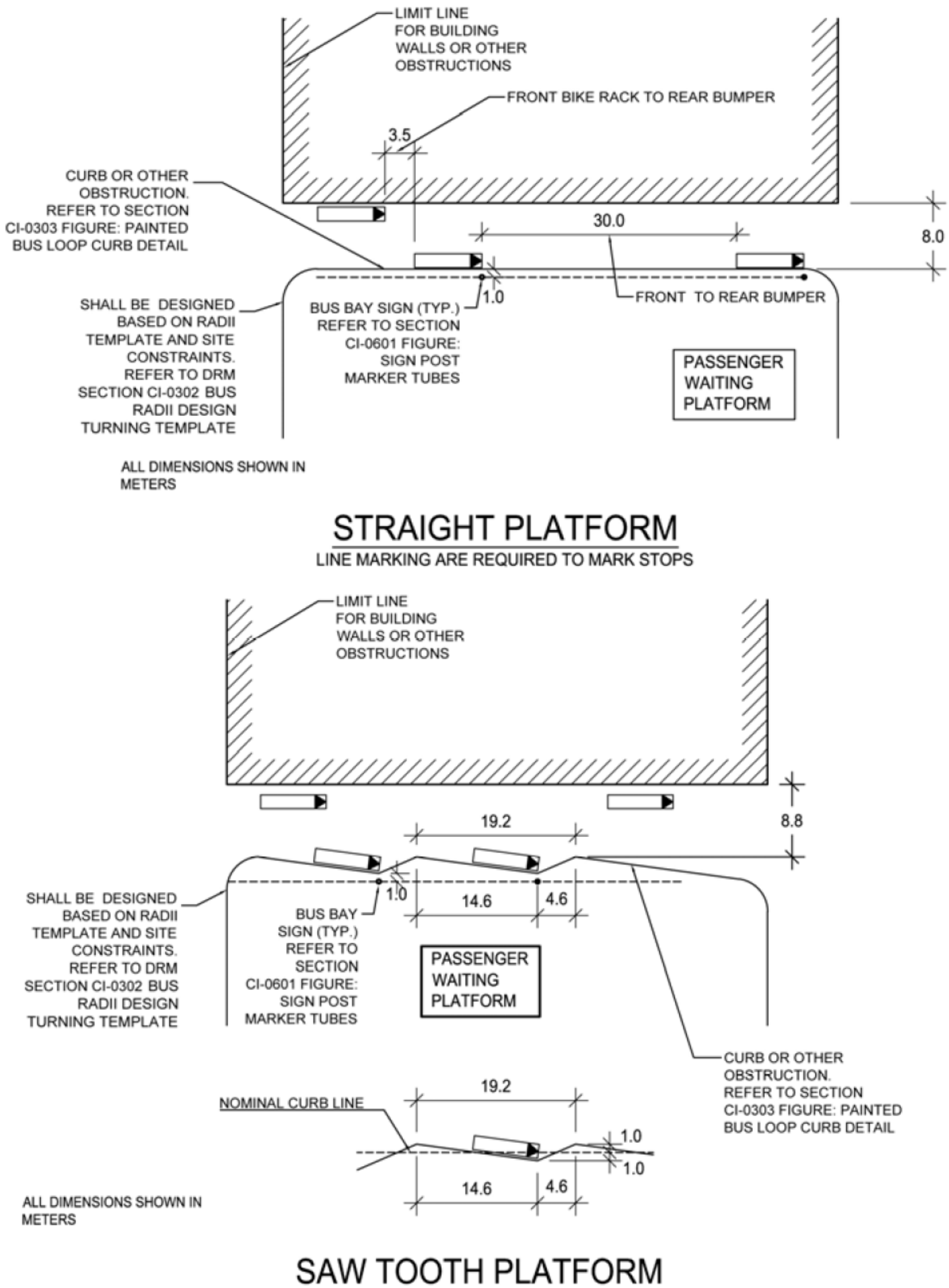


Figure 18: Straight bus platform (top) and saw tooth platform (bottom)

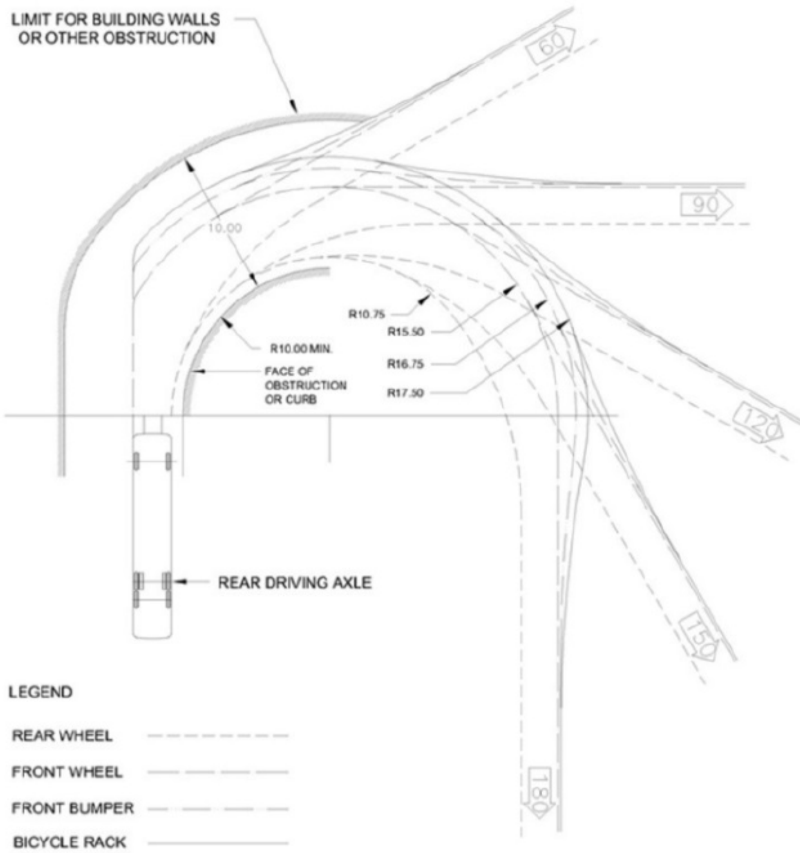


Figure 19: Bus Radii Turning Template

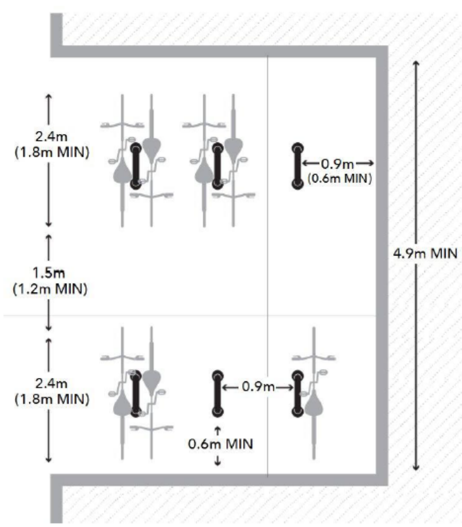


Figure 20: Spacing requirements for bike rack

Appendix H – Final Presentation

Jane Street
Rapid Transit Corridor
Final Presentation

Shun Higuchi, Junbo Liang, Rick Liu, Tianqing Wang

CIV498
MARCH 26, 2020

WHO WE ARE

Shun Higuchi

Transportation Analyst

Junbo Liang

Track and Station Designer

Rick Liu

Transportation Planner

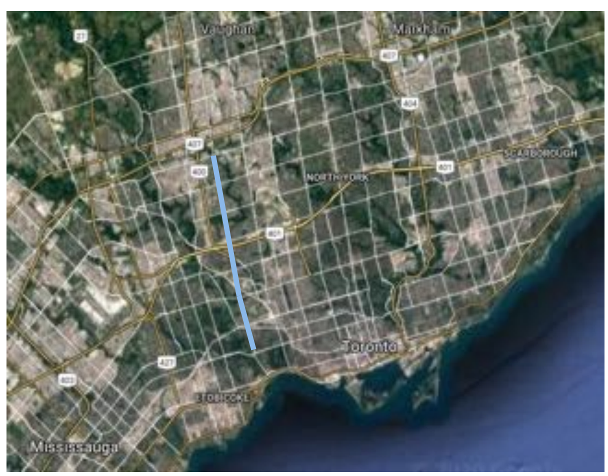
Tianqing Wang

Project Coordinator

Project Background

ABOUT

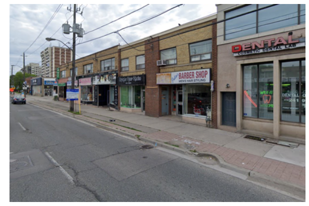
- Jane Street
  - Extends north-south
- This Project
  - Jane Street between Bloor St and Steeles Avenue West
  - Rapid Transit Corridor



LAND USE

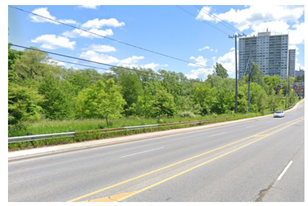
Institutional (York U)

High Density



Mixed Use

Residential

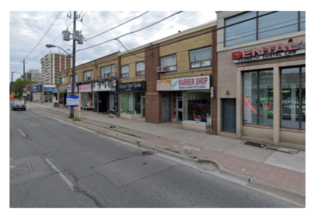


Parkland

LAND USE

Institutional (York U)

High Density



Mixed Use

Key Land Use Types for Successful Transit

TRANSPORTATION NETWORK

- Road Network

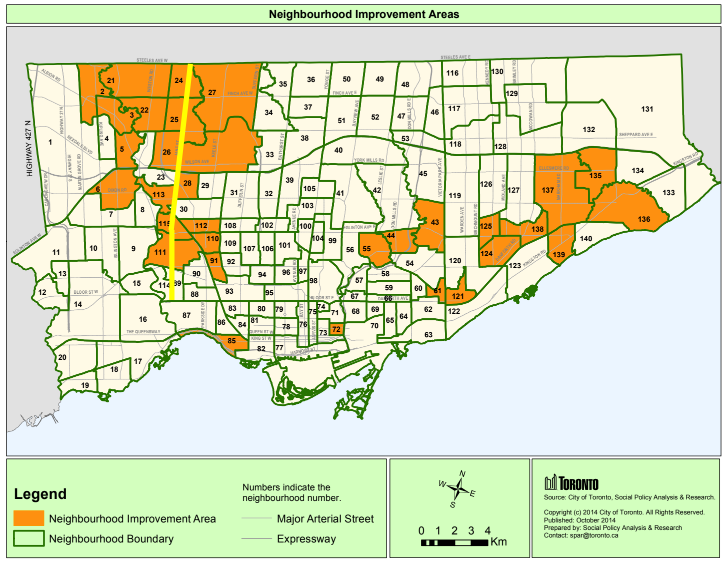
- Cycling Network

TRANSIT

- 35 Jane
  - Local service
  - 11th highest daily ridership in 2016
  - Less than 5 min of headway, 24 Buses per hour
- 935 Jane Express
  - Express service (Formerly 195 Jane Rocket)
  - 7.5 min of headway, 12 buses per hour
- Reached capacity and unreliable service
- Connections
  - TTC bus services on major and minor arterial roads
  - TTC Subway Line 1 and 2 at each end and future Finch LRT

EQUITY

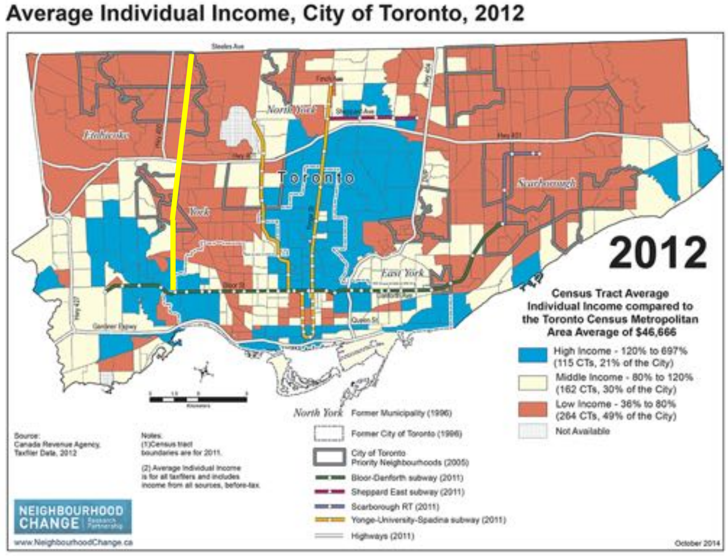
- Many Neighbourhood Improvement Areas Surround Jane Street



EQUITY

- Many Neighbourhood Improvement Areas Surround Jane Street
- Opportunity to Serve Underserved Low Income Residents
  - Boost Quality of Life and Economic Opportunity
  - Deliver Vertical Equity

Average Individual Income, City of Toronto, 2012



PREVIOUS JANE STREET PLANS

- Transit City (2007)
  - 17 km long Jane LRT
    - With potential northern extension into York Region
  - 512 St. Clair Streetcar Extension
- Keesmaat (2016)
  - Jane LRT was recommended to be built between 2022 and 2031
- Metrolinx 2041 RTP (2018)
  - Future rapid transit planned for Jane Street in 2041
- TTC 5-Year Service Plan and 10-Year Outlook (2019)
  - Jane bus service was identified as a key route
  - Jane was identified to be an enhanced priority corridor

Project Vision and Methodology

REVIEW OF PLANS

Plans

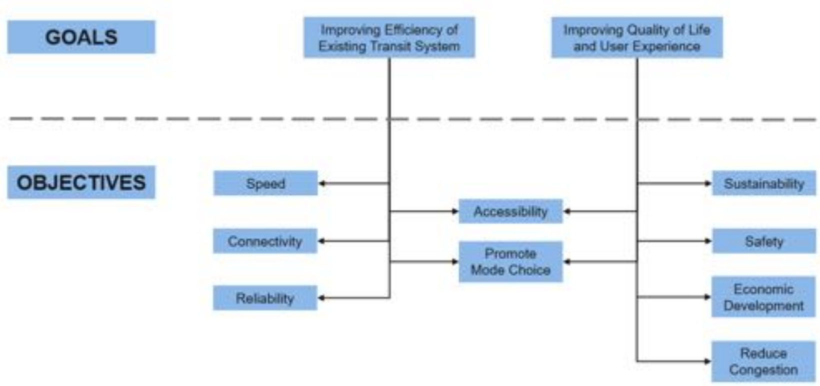
- Places to Grow
- Metrolinx Regional Transit Plan
- Toronto Congestion Management Plan
- Toronto Official Plan
- Transit City
- "Feeling Congested?"
- City of Toronto Complete Streets Guidelines
- TTC 5-Year Service Plan and 10-Year Outlook

Key Points

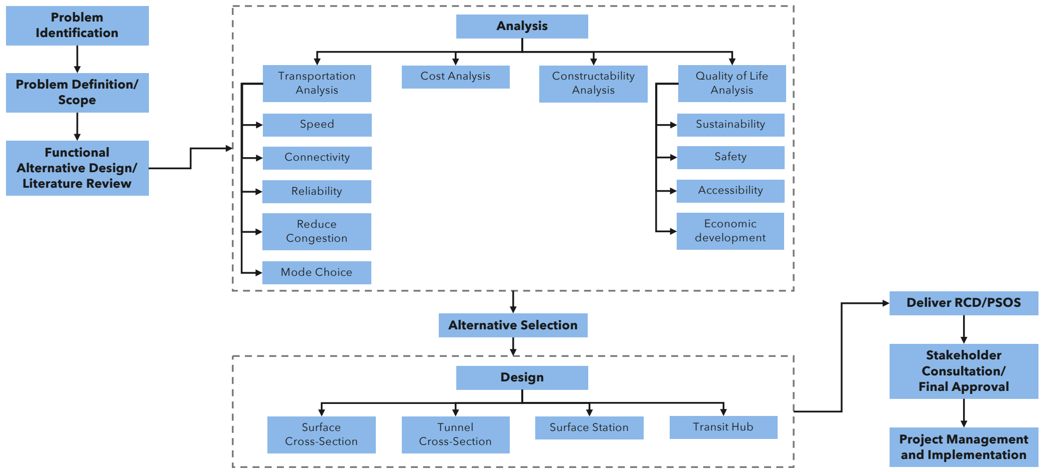
- Focus on safety, efficiency, and reliability of transportation system
- Improve transit accessibility and land use integration
- Promote diversity and opportunity for all citizens
- Develop multimodal "Avenues" with mixed-use zoning
- Jane Street is one of the key transit corridors/routes

PROJECT VISION AND GOAL

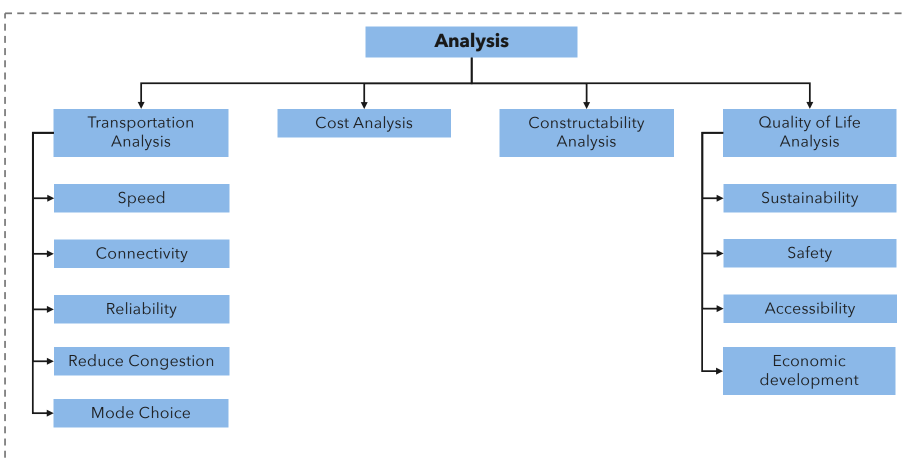
Goal #1: Improve Efficiency of Existing Transit System
Goal # 2: Improve Quality of Life and User Experience



OVERALL METHODOLOGY



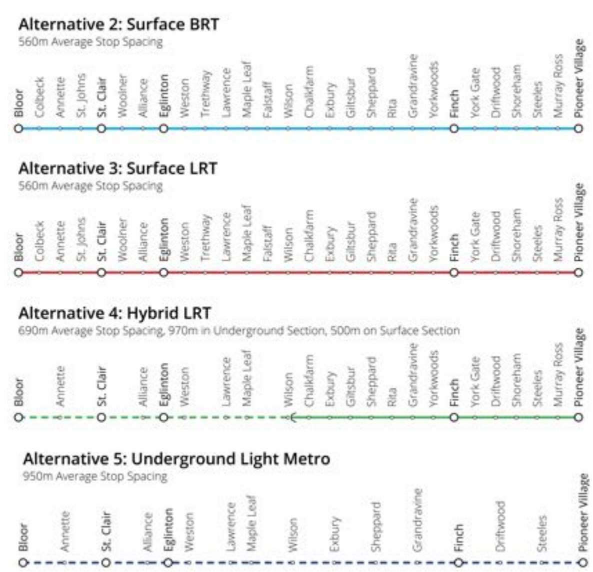
EVALUATING THE OBJECTIVES



Alternative Selection

INTRODUCING THE ALTERNATIVES

- 5 Alternative Solutions
  - 1: Do Nothing
  - 2: Surface BRT
  - 3: Surface LRT
  - 4: Hybrid LRT
  - 5: Light Metro



EXAMPLES OF EACH ALTERNATIVE

BRT (VIVA)

Hybrid LRT (Seattle Link Light Rail)

Surface LRT (Portland MAX LRT)

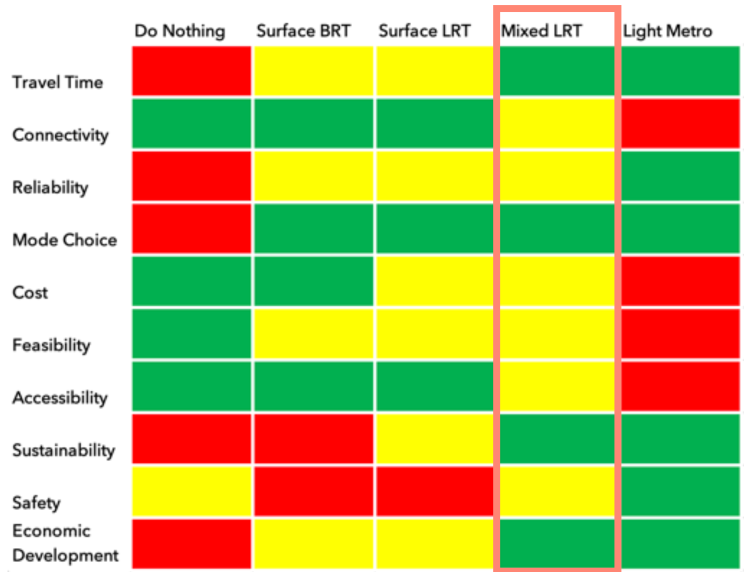
Light Metro (Vancouver Skytrain)

EVALUATING THE OPTIONS

Options	Benefits	Concerns
Do Nothing	Lowest Cost	Capacity Constrained Longest Travel Time Lowest Reliability
Surface BRT	Good Transportation Accessibility Low Capital Cost	Noise and Pollution Capacity Concerns
Surface LRT	Better Passenger Comfort Avoids Tunneling	Land Acquisition Required South of Wilson Reconstruction of Overpasses/Underpasses
Mixed LRT	Good Travel Times and Reliability No ROW Constraints	Large Stop Spacing South of Wilson
Light Metro	Stations Integrates to Neighbourhood Best Transit LOS	Tunneling Cost and Risk Too Much Capacity

RESULT

- **Mixed LRT** is the Selected Design
- Accomplishes Most of the Benefits of Light Metro
- Avoids ROW Constraints
- Does Not Have Major Concerns for Any MOE



Design

REVIEW OF DESIGN MANUALS

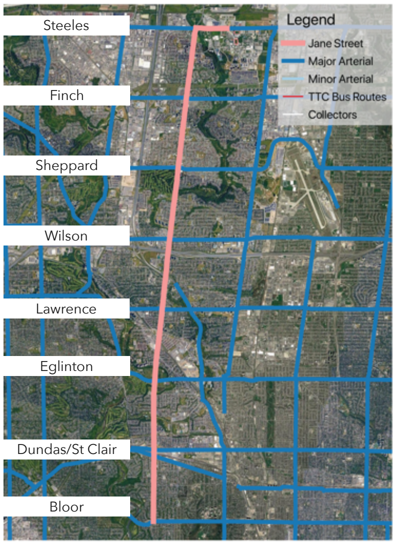
- City of Toronto Official Plan
- Transit Street Design Guide – NACTO
- City of Toronto Complete Street Guidelines
- The Metrolinx LRT Design Criteria Manual (DCM)
- GO Design Requirements Manual (DRM)

STATION LOCATIONS

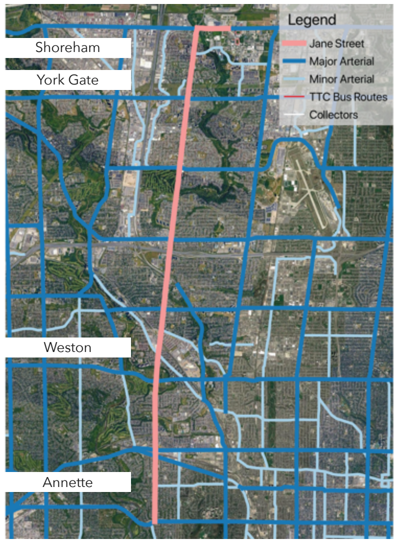
1. Maintain proper station spacing for the context
   - ~500m Surface LRT, ~1000m Underground LRT
2. Signalized Intersections
   - Ensure safe entry and exit to stations
3. Stations at Major Arterials
4. Maximize regional rapid transit connections
   - Finch, Eglinton, GO, Subway, YRT, UP
5. Maximize local TTC connections
6. Minor Arterials, Collectors

STATION LOCATIONS

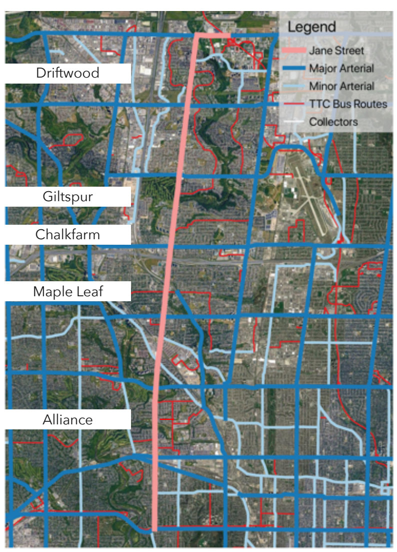
MAJOR ARTERIALS



MINOR ARTERIALS

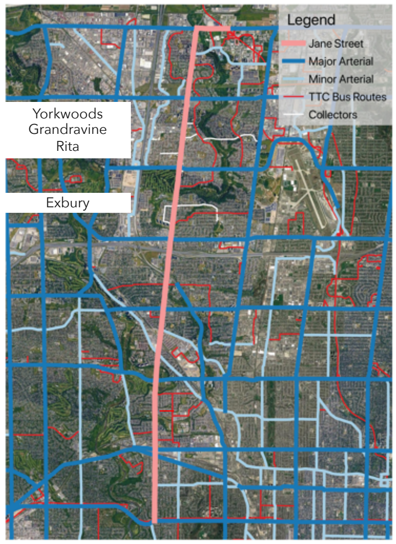


TTC BUS ROUTES

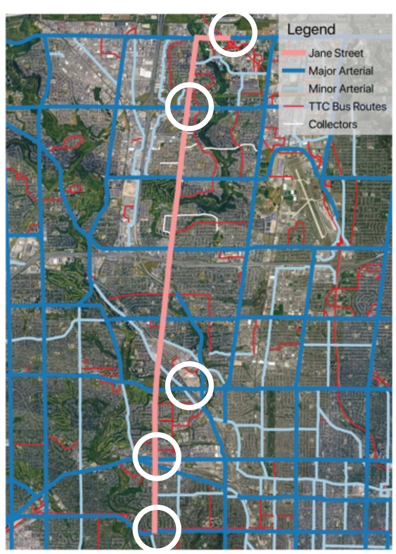


COLLECTORS

(NORTH OF WILSON)



REGIONAL TRANSIT

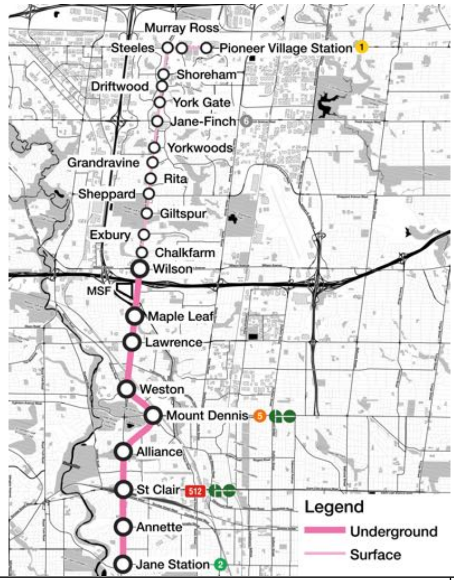


CORRIDOR DETAILS

- 15.25 km Line, 8.25km Underground
- 23 Stops, 500m to 1000m Stop Spacing
- 100m Platforms for 2-3 Car Operation
- 35 Minute Travel Time End to End

- Intermodal Stations at Jane, St Clair, Mount Dennis, Jane-Finch, Pioneer Village
- Dedicated MSF for LRVs

- Maintains 2 Automobile Lanes in Each Direction

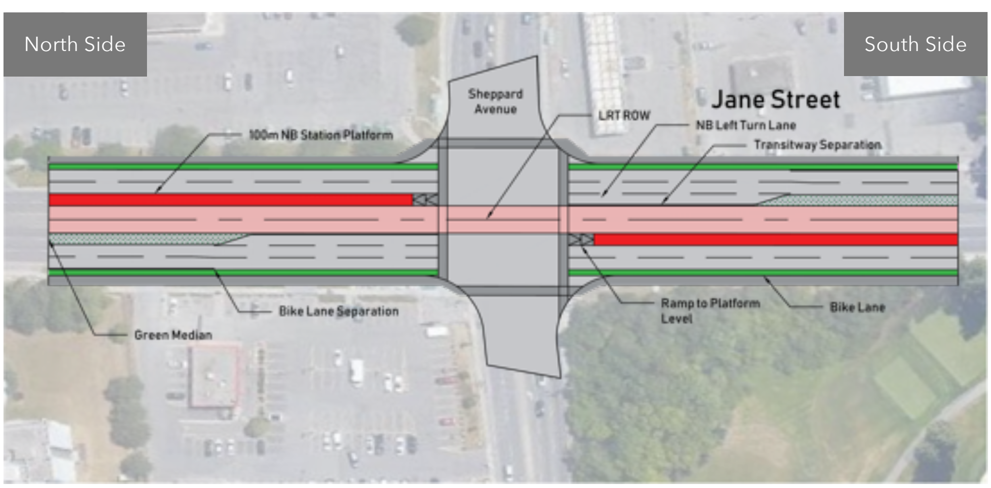


SURFACE CROSS SECTION

- Maintain 3.3m Traffic Lanes
  - Dedicated Left Turn Lane
- Improvements to Pedestrians and Cyclists
  - Wider Sidewalk
  - Separated Bike Lane
- Green Transitway and Green Infrastructure
- Fits Within 36m ROW

JANE – SHEPPARD INTERSECTION PLAN

JANE – SHEPPARD INTERSECTION PLAN



GREEN INFRASTRUCTURE

Portland

Green Tracks

New Orleans

Tree Canopy

Eglinton

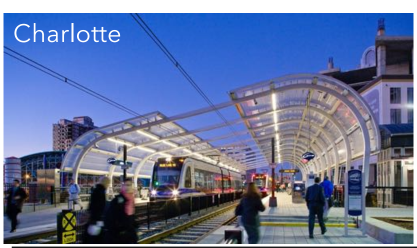
Green Tracks

Boston

Tree Canopy
Green Tracks

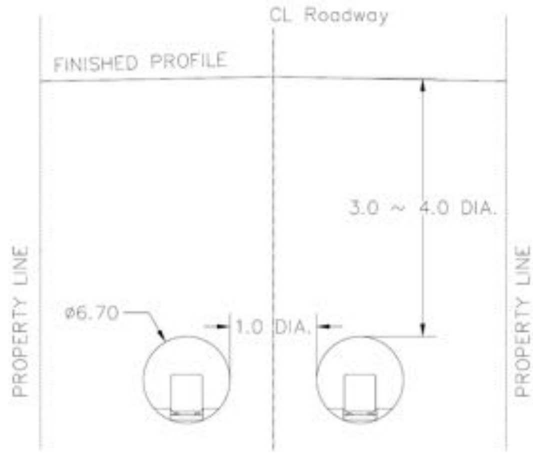
SURFACE STATION DESIGN

- Better than current Ontario LRT/streetcar stops
- Sufficient, safe, and accessible shelter
- Offboard fare vending
- Infotainment, next vehicle arrival, interactive navigation
- Aesthetically pleasing public art/architecture

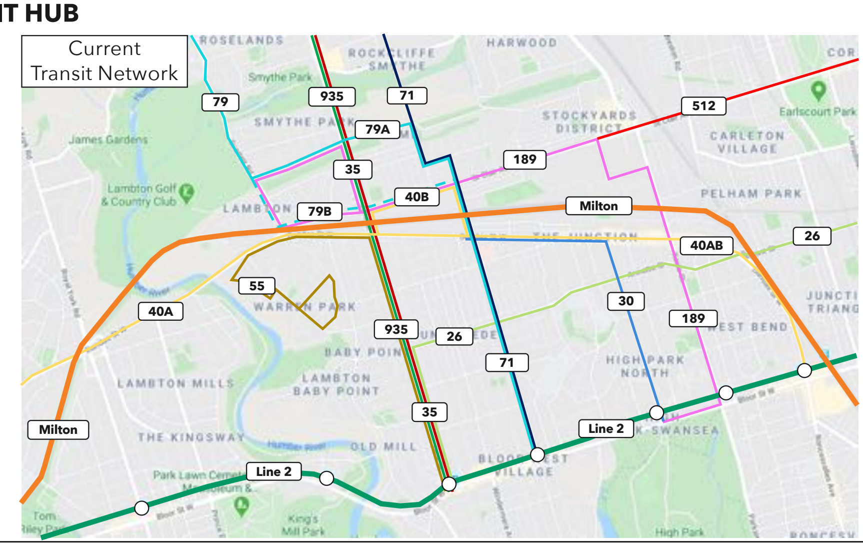


TUNNEL CROSS SECTION

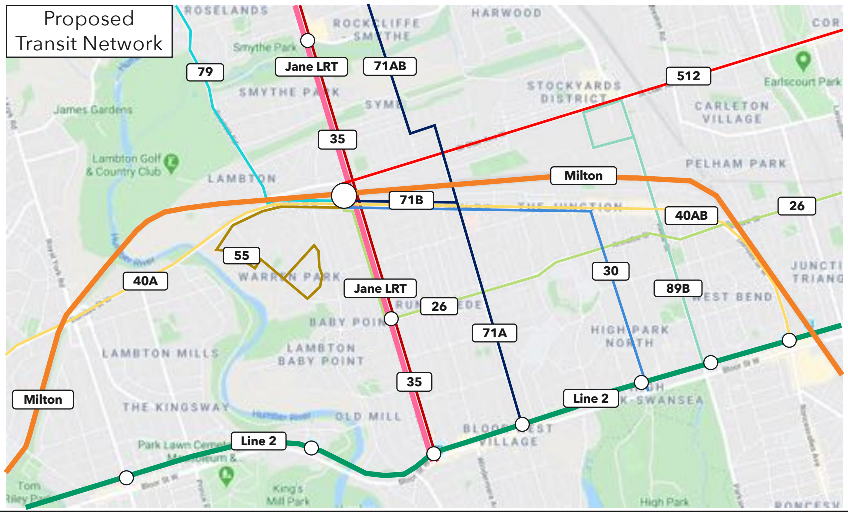
- Two-bored tunnel cross section
- Tunnel Diameter = 6.7 metres
- Depth of cover = 3.0 ~ 4.0 diameter to mitigate vibration noise



TRANSIT HUB

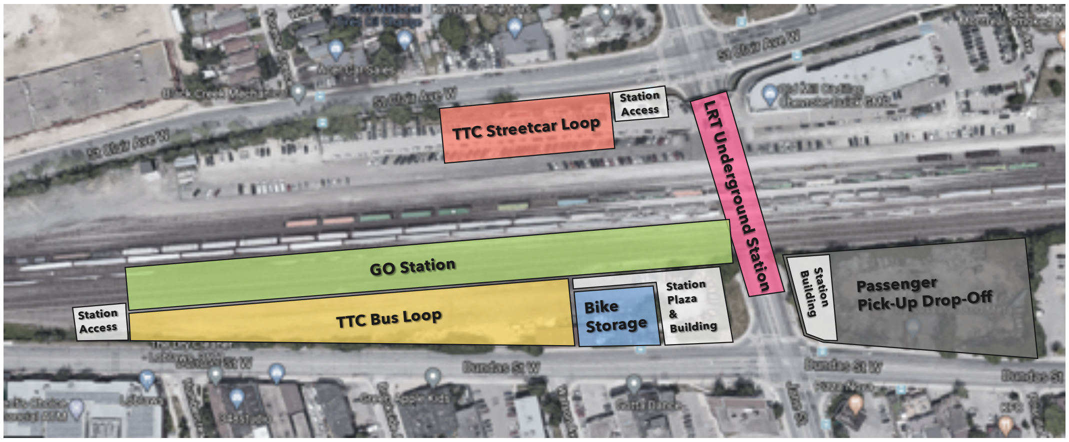


TRANSIT HUB – TRANSIT NETWORK RE-DESIGN



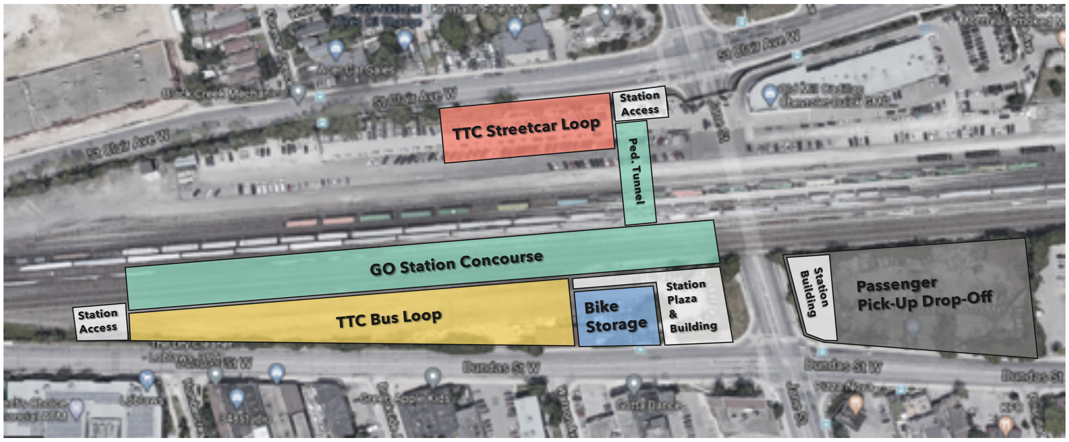
TRANSIT HUB – PROJECT SITE

TRANSIT HUB – SITE PLAN

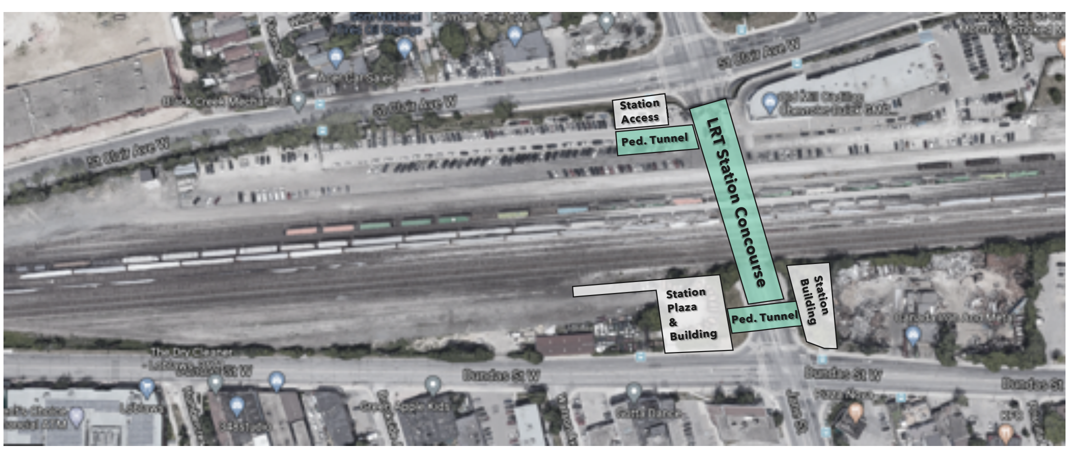


TRANSIT HUB – SITE PLAN, GO TRACK LEVEL

TRANSIT HUB – SITE PLAN, SURFACE LEVEL

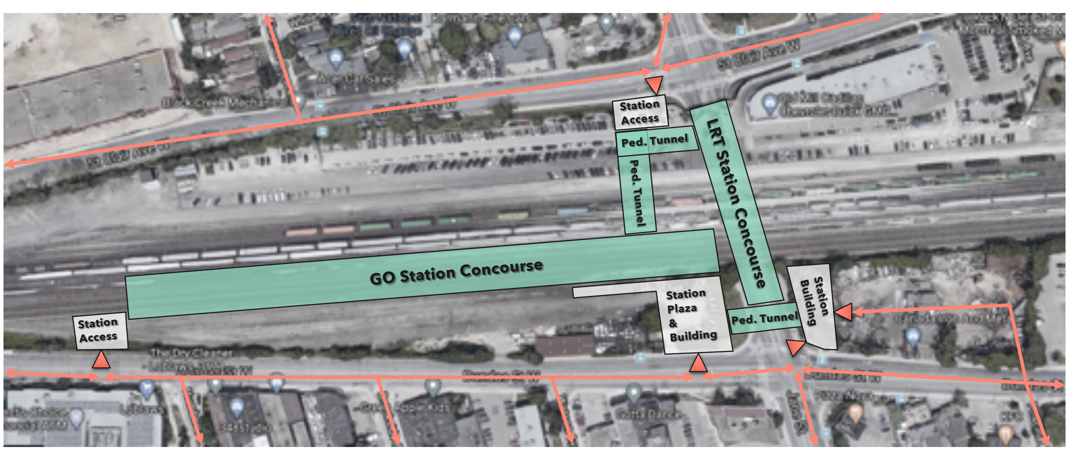


TRANSIT HUB – SITE PLAN, UNDERGROUND LEVEL 1



TRANSIT HUB – SITE PLAN, UNDERGROUND LEVEL 2

TRANSIT HUB – ACCESS PLAN



TRANSIT HUB – MAIN STATION BUILDING & BIKE STORAGE

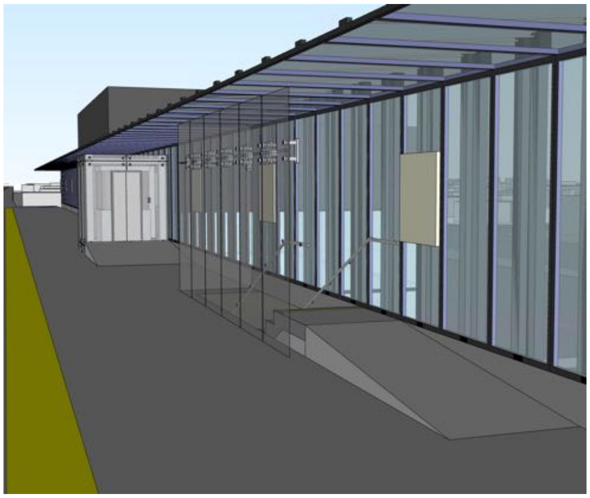
- Station Building
  - Passenger waiting area
  - Public washrooms
  - Self-service hub
  - Ambassador office
  - Janitorial and garbage room
  - Boiler, generator, electrical and comms rooms
- Bike Storage
  - 60 Indoor secured spaces

TRANSIT HUB – GO TRACK & PLATFORM

- 2 side platforms servicing north and south track of the mainline
  - 4.9 m wide
  - 127 mm ATR accommodating passive protection for level boarding
  - 315 m long
  - 2.44 m horizontal clearance from CL
  - Canopies and waiting shelters with 3.35 m vertical clearance
  - Snowmelt Systems
  - Mini-platform servicing 5th coach from east end at 559 mm ATR

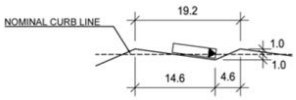
TRANSIT HUB – GO PLATFORM ACCESS

- 4 sets of stairs per platform
  - Fully glazed enclosures
  - Concrete floor
  - Stainless steel handrails
  - Accommodating passive protection for level boarding
- 3 sets of elevator per platform
  - Flow through configuration
  - Redundant access
  - Accommodating passive protection for level boarding



TRANSIT HUB – TTC BUS LOOP

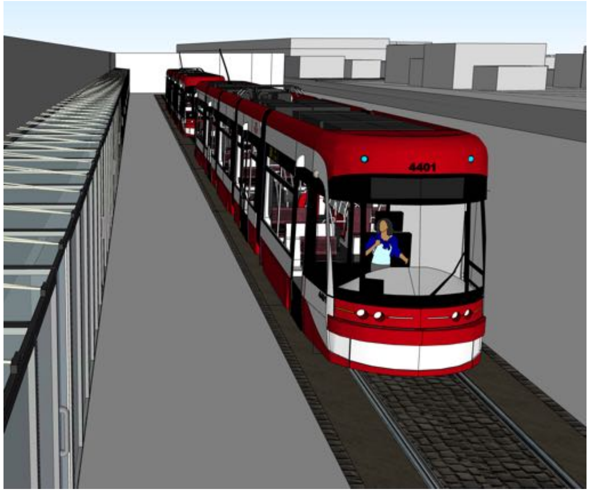
- Linear configuration – linear traffic flow
- Saw tooth platform



- 8 bus-bays (including 1 for articulated bus)
- Concrete platform curb 150 mm above driveway pavement
- 10 m radius for inner curb

TRANSIT HUB – TTC STREETCAR LOOP

- Track
  - 1.495 m track gauge
  - GGR 118, 115 RE running rail
  - 13.72 m horizontal curve radius
- Platform
  - 60 m long
    - Space for 2 LFLRV
  - 1.5 m wide
  - 150 mm ATR



TRANSIT HUB – PUDO & SECONDARY ACCESS

- 6 m x 3 m per space
- Facing the station building
- 3 m wide hatched area for paratransit
- Taxi and ride-sharing lane
- 2.5 m raised curb and landscaped buffer between vehicles and pedestrians

TRANSIT HUB – JANE LRT STATION

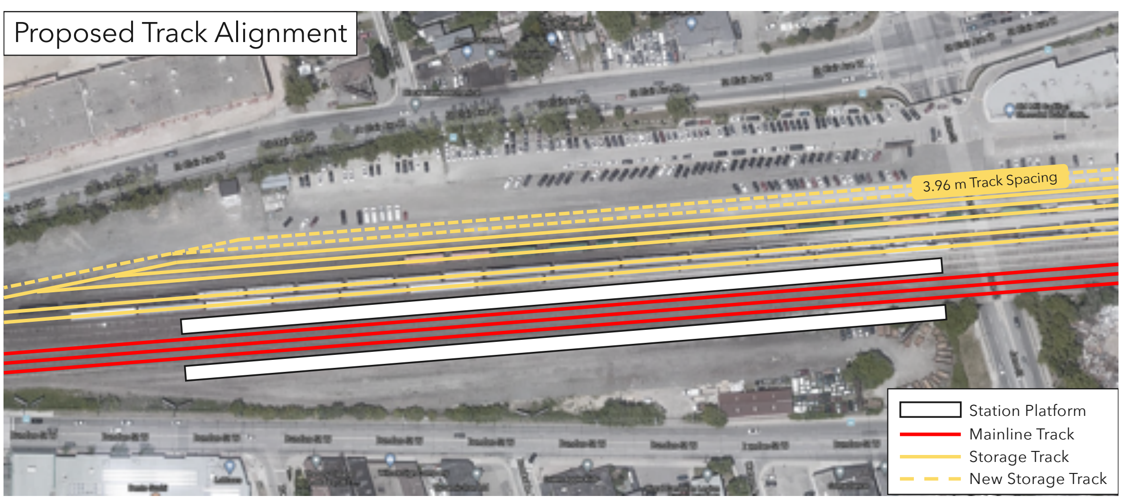
- 2 levels
  - Concourse level
  - Platform level
- Center platform
  - 100 m long

TRANSIT HUB – PEDESTRIAN TUNNELS

- 0.8 m vertical clearance to top of tunnel roof membrane
- 2.7 m tall
- 3.66 m wide
- Equipped with digital signs and CCTV
- Connected by stairs, ramps and elevators

TRANSIT HUB - CP/GO TRACK DESIGN

TRANSIT HUB - CP/GO TRACK DESIGN

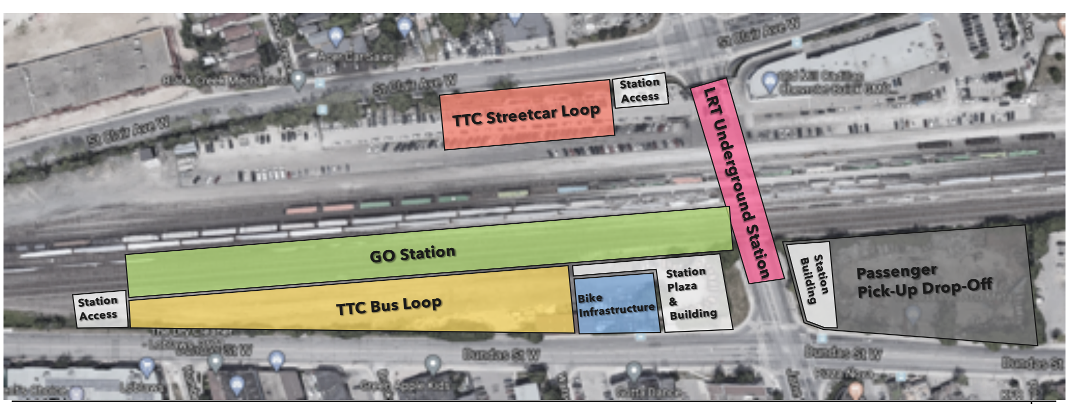


TRANSIT HUB - CP/GO TRACK DESIGN

- Removing 2 existing storage tracks on the south side
- Adding 2 existing storage tracks on the north side
  - 3.96 m track spacing
  - 1,435 mm track gauge (standard gauge)
  - 115 lb rail
  - 7" x 8" x 8.5' treated hardwood timber cross tie in 22'' spacing
  - AREMA Specification Grade 4 ballast
  - #11 – 115 lb turnouts x 4 (2 x RH and 2 x LH)

TRANSIT HUB – FUTURE ACTION

- TOD overbuild opportunities at main station building, PUDO and streetcar loop
- Commercial opportunities in main station building (ie. retails)



Implementation

COST

Project Cost

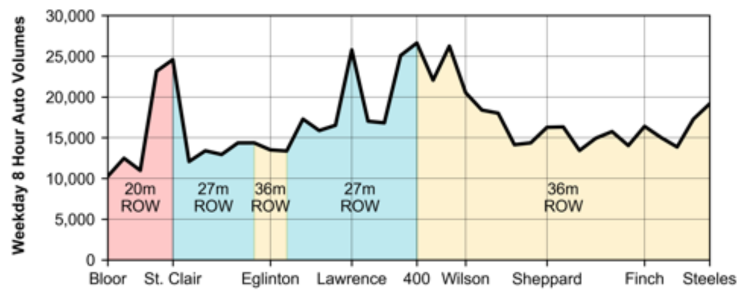
Component	Total
Utility Relocations	$ 8,029,000
Removals	$ 1,256,863
Road Work	$ 611,135,469
Underground Construction	$ 513,360,000
Stations	$ 776,000,000
Transit Hub	$ 6,000,000
Construction Easement	$ 3,735,000
Other (Signals, Landscaping, etc.)	$ 16,978,264
Total Construction Cost	**$ 1,367,134,595**
Construction Contingency (20%)	$ 273,426,919
Traffic control (10%)	$ 136,713,460
Engineering (30% of Construction Cost)	$ 410,140,379
Purchase of Light Rail Vehicles	$ 279,360,000
Total Cost	**$ 2,187,415,352**

Ongoing LRT Projects in GTA

Project	Length	Capital Cost
Eglinton Crosstown	33 km (10 km underground)	$5.3 Billion
Finch LRT	11 km (Surface)	$1.0 Billion
Jane LRT	15 km (8 km underground)	$2.2 Billion

CONSTRUCTABILITY

- Underground construction
  - Major grade change when transitioning from surface to underground
  - Tunneling and dewatering system
- Utility relocation
- Property impacts
- Traffic disruption during construction



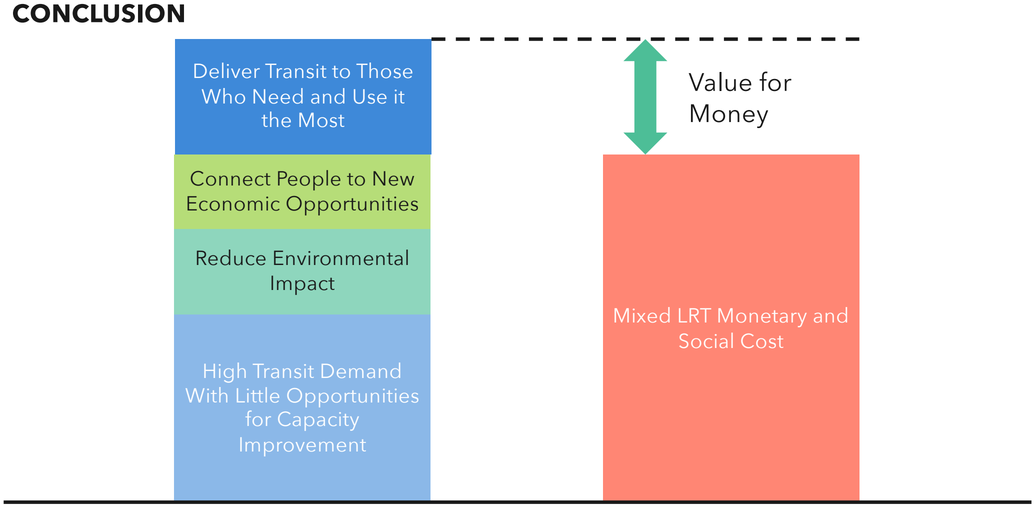
CONSULTATION AND FINALIZATION

- Public consultation
  - Public notices
  - Open houses
- Stakeholder / Agency consultation
- Environmental Assessment (EA) review
  - EA will be filed and submitted to MECP (Previously MOE) for approval

PROJECT SCHEDULE

• Planning	2013-2016
• Initial Business Case	2016-2017
• Functional Design	2017
• Environmental Assessment	2017-2019
• Finalize Scope	2019
• RCD and PSOS	Jan-Aug 2020
• RFQ Period	Jun-Sep 2020
• RFP Period	Nov 2020-May 2021
• Contract Award	Feb 2022
• Property Acquisition	Aug 2020-Feb 2022
• Early Works	Aug 2020-Aug 2022
• Detailed Design	Feb 2022-Aug 2024
• Construction	Aug 2023-Aug 2030
• Substantial Completion	Dec 2030

CONCLUSION



RECOMMENDATIONS

- For TTC:
  - Reconfigure Bus Routes for LRT
  - 512 Extension Procurement
- For Metrolinx:
  - GO Transit Expansion
    - Electrification
    - Level boarding
    - Fare integration
    - Missing Link Project with CN Rail and CP Rail
    - Higher Frequencies on Milton Line
- For City of Toronto:
  - Rezone area for TOD potential

SSR Group