Vaughan Aerial Mobility

Vaughan Transportation Plan

January, 2022 (Final)

Prepared for:
City of Vaughan, Ontario

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Project Information

Project:	Vaughan Transportation Plan
Prepared for:	City of Vaughan, Ontario

Project Representative

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Project Reference:	SCJ # 1881.03

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Introduction

Vaughan Transportation Plan (VTP)

The City of Vaughan has been going through dynamic changes and rapid growth over the past few decades. The City of Vaughan (herein referred to as the "City") is one of Ontario's fastest-growing cities and home to approximately 300,000 residents and employs over 180,000 people. By 2051, it is anticipated that the City will grow to approximately 570,000 residents and 350,000 jobs. In response to this growth, the Vaughan Transportation Plan (VTP) is being developed to update the City's Transportation Master Plan - a blueprint for moving people and goods sustainably for the next 20 years and beyond.

In addition, the City has a number of significant regional attractions that draw visitors and tourists from all over the country. As a result of these and other factors, the City has chosen to pursue an update of their Transportation Plan in order to keep up with the growing community and provide an infrastructure network that can support an efficient and sustainable future through innovative, accessible, and functional solutions.

HDR, the lead consultant for the Vaughan Transportation Plan, retained SCJ Alliance to conduct a study for opportunities and concept assessment of a potential cable-propelled transit (CPT) system as part of the larger transportation network for the City of Vaughan. The consultant team at SCJ Alliance prepared this memorandum for said study.

Memo Structure

This memorandum can be broken down into four primary sections:

1. Context, opportunities, and constraints
2. Potential cable car alignment and recommended technology
3. Capital and operational cost estimates
4. Conclusions and next steps

The memorandum discusses the existing and planned conditions within the project area, identifies the major destinations in the City of Vaughan, and evaluates areas that can benefit from and/or support the infrastructure for a cable-propelled transit system. It also highlights challenges and areas of concern that need to be addressed should this study move forward into concept design.

Based on known information and projected future demand, a primary CPT alignment is identified along with potential station and tower locations. Stations are positioned to achieve the most convenient transit connections as well as easy access to the destination points along the alignment, while minimizing impacts to the surrounding uses. Similarly, tower locations along the alignment are optimized based on existing conditions and anticipated future land uses. Using SCJ Alliance's Dynamic Planning Tool, 3D visuals of the entire system are produced within context using the Google Earth platform to provide better understanding of how the system would fit within the urban fabric of the City.

In the CAPEX & OPEX Estimates section, high-level costs are estimated based on known conditions and current market values in the region. These high-level costs should be re-evaluated after conducting additional planning and concept design work should this project move forward.

Finally, the last section of this memo discusses benefits and concerns that relate to this study, and a business case is presented for this potential project. Recommendations for next steps to further this study into concept design are also listed in the last section of this memorandum.

It is worth noting that this is not a fully-fleshed out technical feasibility study, and that it does not include any engineering or formal costing. The information provided in this memo is based on high-level planning informed by the consultant's experience on similar urban gondola projects and studies.

A technical feasibility study and the associated economic and technical specifications on any cable car alignment can only truly be validated once the necessary surveys, geological studies, and detailed engineering calculations have been conducted on the cable car alignments contained within.

Context

Points of Interest

The City of Vaughan has many features that draw visitors from all over. The City is constantly growing and evolving, and there is a considerable amount of new construction and condominium buildings popping up throughout the City.

Four primary locations stand out as high-profile attractions in the City of Vaughan. They vary between a mixed-use urban district, shopping and entertainment destinations, and a brand new modern medical facility. These are described below.

Vaughan Metropolitan Centre (VMC)

With the growth the City has been seeing, creating a true downtown came to the forefront of the City's vision. Vaughan Metropolitan Centre will realize this vision by becoming the City's new Central Business District (CBD). The area of about 179 hectares is planned to be a modern and vibrant mixed-use urban centre that encompasses all aspects of true urban living. The images below show the existing beginnings of the CBD and planned build-out conditions at Vaughan Metropolitan Centre.

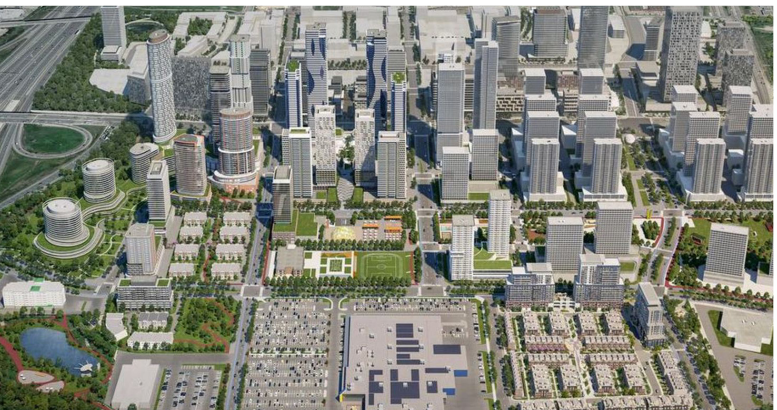
VMC is planned to support approximately 64,000 residents in a concentration of new condominium towers. It will also provide 11,000 jobs in around 1.6 million square feet of new high density office and mixed-use space. The area will have green open space, urban squares, pedestrian-oriented shopping and dining, and will promote walking and cycling over motorized transportation.

In addition to all the new residential and office development, VMC will become a true downtown by being the transit hum for the City of Vaughan. The district is at the intersection of three major transit stations:

- Toronto's Subway Line 1 terminus station, operated by Toronto Transit Commission (TTC) and opened in 2017; this line connects Vaughan with Downtown Toronto and a larger subway system
- Vivastation Highway 7 Rapidway, operated by York Region Transit (YRT) and opened in 2017
- SmartVMC Bus Terminal, operated by York Region Transit (YRT) and opened in 2019

All three stations are connected with a protected underground walkway.

VMC Station & Bus Terminal (Image by Claude Cormier + Associes)



Festival Neighborhood Vision at VMC (Image by MyVMC)

VMC Subway Station (Image by City of Vaughan)

Vaughan Mills (Image by Ivanhoe Cambridge)

Cortellucci Vaughan Hospital (Image by MacKenzie Health)

Canada's Wonderland (Image by Attractions Ontario)

Vaughan Mills

Vaughan Mills is one of the largest enclosed shopping centres in Canada, and the destination with the highest visitor count in the City of Vaughan. The mall attracts over 14.6 million shoppers and tourists annually, the equivalent of the population of all of Ontario. It is busy year-round, and it is home to LEGOLAND Discovery Centre, the only LEGOLAND location in Canada.

Canada's Wonderland

Canada's Wonderland is the first major theme park to be built in Canada, and remains the largest in the country. In 2019, it attracted around 3.9 million visitors.

While the park is primarily a seasonal park that operates from April to the end of October, in 2019 the park added the new WinterFest to its list of annual events. WinterFest extends the park's operations till the end of December. This addition makes the park close to a year-round destination, with its downtime only lasting for three months of the year, between January and March.

The park is also a venue for a variety of special events and food festivals. It is the location of "Celebration Canada", an annual month-long festival celebrating Canada Day.

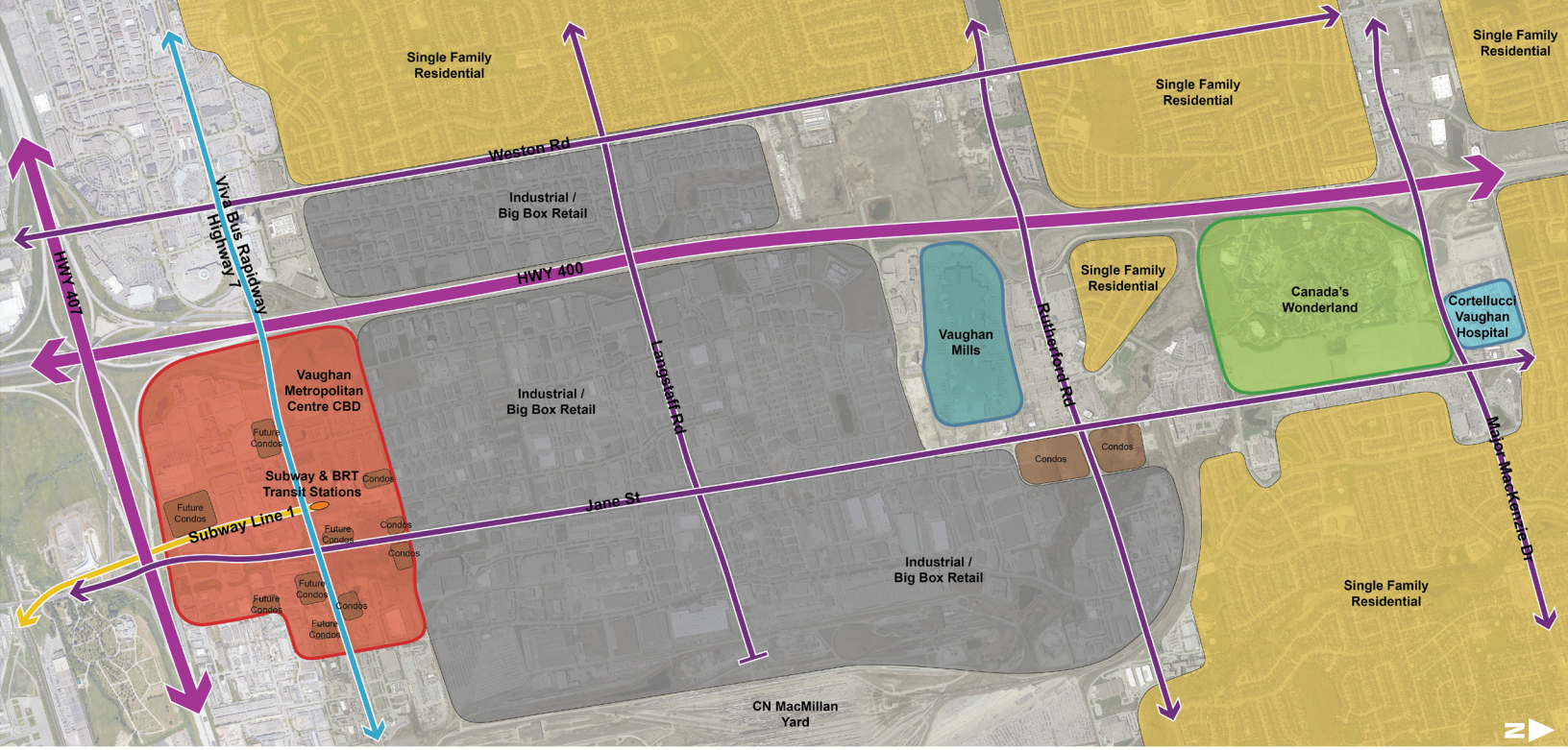
Cortellucci Vaughan Hospital

The new Cortellucci Vaughan Hospital is Ontario's first net new hospital in over 30 years. It is also the first and only hospital in the City of Vaughan. This means that easy access and proper connectivity to the hospital is of high importance for the City and the region.

The hospital opened for full service in June of 2021. It has 1,800 full-time staff in addition to 100 specialist physicians. It provides 350 hospital beds for in-patient service, and has an Emergency department that can handle 75,000 visits annually. The Cortellucci Vaughan Hospital is the first hospital in Canada equipped with fully integrated "smart" medical technology.

Regional Transportation

Downtown Vaughan is the only downtown in the Greater Toronto Area, outside of Toronto, to be serviced by a subway line. The VMC Station is the northernmost station in the Toronto subway system. It provides a 45-minute direct connection between Vaughan Metropolitan Centre and Downtown Toronto. In addition to subway, the City of Vaughan is also served by an east-west rapid bus transit service, which means that it enjoys a unique position of having regional connectivity through multiple modes of public transportation.



Vaughan's Attractions/Destinations with Surrounding Land Uses, Regional Transportation, and Major Roads

The four main destinations in the City of Vaughan: Vaughan Metropolitan Centre, Vaughan Mills, Canada's Wonderland, and Cortellucci Vaughan Hospital are all located between Highway 400 and Jane Street, a major North-South arterial road. While these roads may suggest an easy connection between the four destinations, traffic congestion in the area means that the 6.2-kilometre trip may currently take anywhere between 10-30 minutes by car and more than 35-40 minutes by transit*. In the future, these travel times are expected to be longer due to future growth and added congestion.

Surrounding Land Uses

The graphic above highlights the four destinations listed earlier in addition to showing major roads, regional transit lines, and surrounding uses. The area along Highway 400 and Jane Street has a variety of commercial and mixed uses. Further away from this primary corridor, single family residential becomes the land use with the largest footprint.

VMC is the modern CBD for the City and is planned to become the financial, innovation, and cultural centre of Vaughan. The area will encompass a great mix of uses including high density residential and office towers, urban districts with unique characteristics, pedestrian oriented streets and plazas. VMC is set to embody the true meaning of metropolitan living where people can live, work, and play. A high concentration of condominium towers are already built, under construction, or in planning phases within VMC.

The area between VMC and Vaughan Mills consists primarily of large industrial parks and big box retail. Today, the area has low density development, is very auto-oriented in its planning, and lacks any residential development. Considering the booming development and rapid growth taking place just south of that at VMC, there is high potential in the future for this industrial area to accommodate new development based of future demand.

From VMC to Cortellucci Hospital, including access time, egress time, wait time, and in-vehicle travel time.

Gondola Opportunities

Regional Connectivity

While the City of Vaughan has the unique benefit of direct connectivity between VMC to Downtown Toronto via Toronto Subway Line 1 (Subway network shown below), this subway connection stops short of Vaughan's other main attractions and destinations. Places like Vaughan Mills and Canada's Wonderland draw tens of millions of people every year to the City of Vaughan without a convenient public transit route. Additionally, the new Cortellucci Vaughan Hospital is likely to become a popular destination for patients from the entire region coming into Vaughan for the tip-tier modern medical facility. The hospital is also one of Vaughan's newest and largest employers.

The same applies to the Highway 7 bus rapidway. While the rapid bus line arrives to the heart of VMC and has a convenient transfer connection to Toronto Subway Line 1, this regional transit line lacks an easy and convenient connection to Vaughan's northern destinations like Vaughan Mills, Canada's Wonderland, and Cortellucci Hospital. The BRT station does have a fairly easy transfer to the VMC Bus terminal that can connect to those destinations, however the bus connection may take an entire hour to travel just over 6 kilometres.

Providing a convenient and reliable public transit connection that bridges the gap between the multiple regional transit lines that converge at VMC and the other major destinations in the City can have great added value to overall transit and accessibility. It may also encourage people to use the regional public transit system to get to these destinations. This can potentially alleviate traffic congestion from visitors who would otherwise come into the City of Vaughan with no other option than a private automobile.

Toronto Subway Map (TTC) and the Potential Connection to Vaughan's Main Attractions/ Destinations

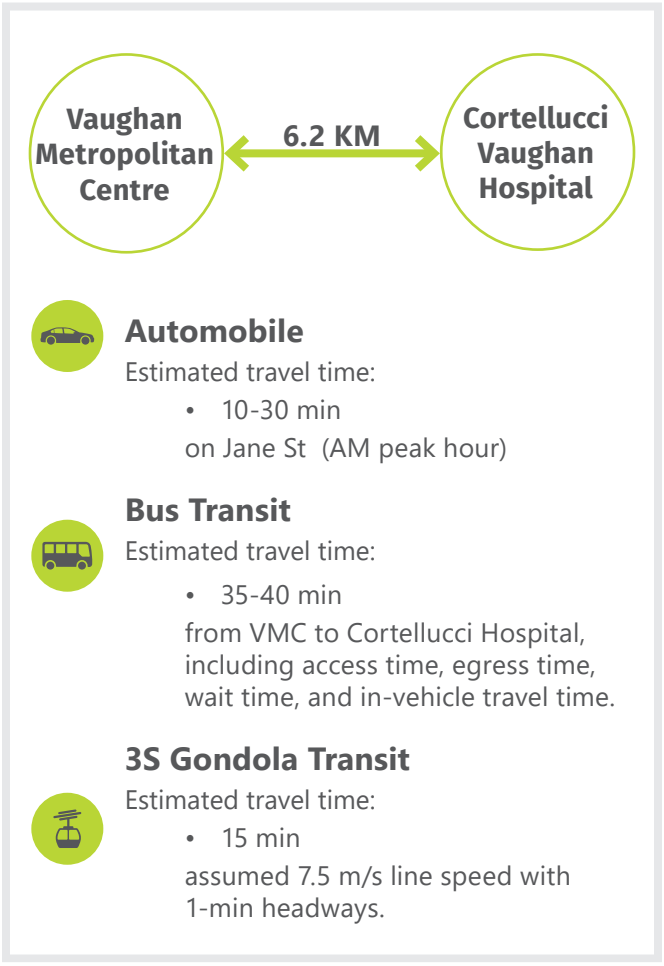
Transit Benefit

Introducing a reliable high-capacity public transit connection between the various transit hubs at Vaughan Metropolitan Centre and the rest of the main destinations in Vaughan can add great value to both local and regional transportation networks. The high reliance on private automobiles to get to these destinations is environmentally and spatially unsustainable, and with the build-out of VMC and the increase of residents and workers in the area, traffic congestion can present a real challenge for future mobility in the City.

While the City currently provides bus connection along Jane Street, buses often have inconvenient headways and typically share traffic lanes with private vehicles, which means they are just as likely to be impacted by surface traffic congestion. An aerial transit connection offers grade-separation and exceptionally short wait times, making it a highly attractive system from a passenger experience perspective.

The adjacent graphic is a comparison of travel times using available modes of connection between VMC and Cortellucci Vaughan Hospital, a distance of about 6.2 kilometres. The automobile and bus travel times are based on existing conditions, assuming morning peak hours on weekdays. Added to that is an option for a 3S gondola transit connection along Jane Street connecting the same destinations.

Travel times on the gondola are faster than both automobile and bus transit in all direction except for private automobile traveling northbound. Even so, unexpected traffic accidents or road detours may delay automobile travel times, making the gondola the more efficient and reliable mode of transit.

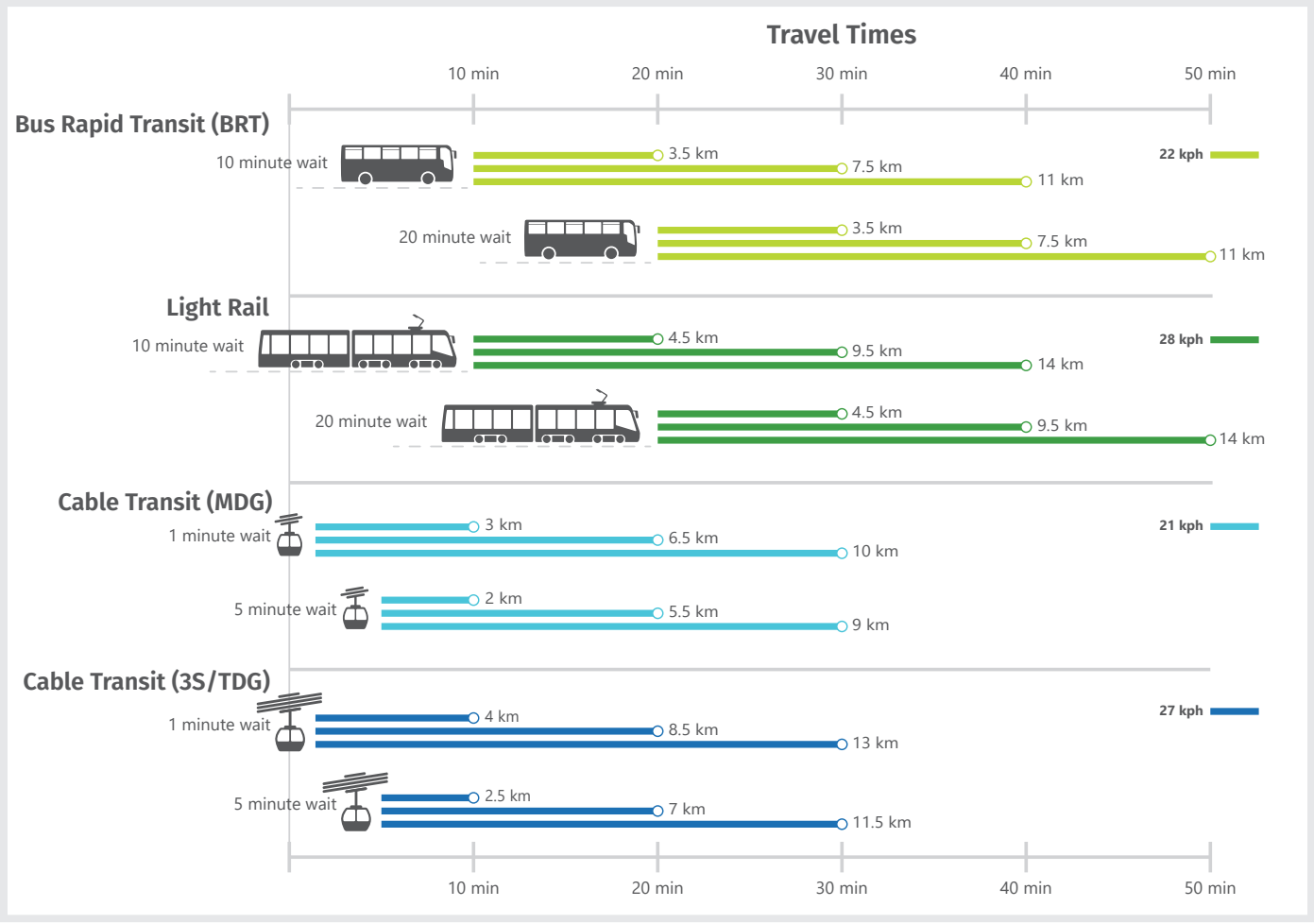


Estimated automobile, bus, and 3S Gondola travel time comparison between Vaughan Metropolitan Centre and Cortellucci Vaughan Hospital

CPT systems also have a travel time advantage over potential but rapid transit as well as light rail systems in urban environments. 3S aerial gondola systems have comparable operating speeds to those of light rail, and monocable gondola system speeds compare closely to bus rapid transit speeds. With that said, when comparing the entire trip time, both types of CPT systems can travel distances that well-exceed BRT and light rail systems within a specific period of time due to the short headways CPT systems offer as opposed to those of BRT and light rail.

The graphic below represents this comparison of travel times and distances between BRT, light rail, monocable detachable gondola (MDG), and tri-cable detachable gondola (3S). It becomes evident from this graphic that CPT systems are more advantageous as fast and reliable transit solutions, especially when considering the total trip time, including both travel and wait times.

It should be noted that 5-minute CPT wait times are during busy periods such as for special events or peak rush hour. For normal operation wait times will be or near zero. As such, CPT will have competitive or superior travel times compared to typical LRT configurations with wait times in excess of 10 minutes.



Comparison between distances traveled within specific time periods by BRT, Light Rail (in urban settings), Monocable Detachable Gondola, and 3S Detachable Gondola

Potential Gondola Alignment

A gondola system alignment that utilizes the wide public right-of-way of Jane Street can provide a convenient connection between the four main attractions/destinations in the City of Vaughan:

- Vaughan Metropolitan Centre (VMC)
- Vaughan Mills
- Canada's Wonderland
- Cortellucci Vaughan Hospital

In addition to connecting these destinations to each other, the connection at VMC also means connecting to the Greater Toronto Area via public transit through subway and rapid bus networks.

The adjacent graphic shows the proposed alignment along Jane Street. It is approximately 6.2 kilometres long with the southern terminus at Vaughan Metropolitan Centre and the northern terminus at Cortellucci Vaughan Hospital. The Vaughan gondola system would have four stations, one at each of the above-listed locations, as well as 15 towers along the alignment. The alignment is proposed to remain entirely within the public right-of-way, eliminating potential property conflicts as well as the need to acquire additional land.

Jane Street has a right of way width up to 45 metres, roadway pavement width that averages about 24 metres, and a continuous median/turn lane that is about 4 metres in width. The current width of the median is likely sufficient to contain the structural columns at gondola stations as well as tower footprints touching the ground. Utilizing these existing conditions means that introducing a new public transit system to the right-of-way of Jane Street can be achieved without any significant impacts to vehicular, pedestrian, or cyclist movement taking place on the surface. Further research and design is required to confirm these high-level assumptions.

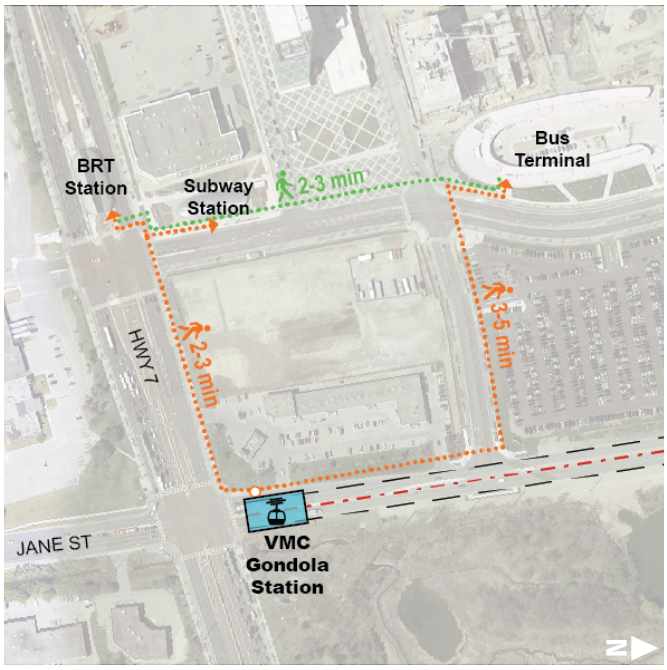
The following pages present a high-level description of the four stations and the opportunities found at each station location.

Vaughan Metropolitan Centre (VMC) Station

The VMC Gondola Station is a terminal station at the southern end of the line. It can be located at the heart of VMC within a walking distance to subway, bus rapidway, and bus terminal. Because the gondola alignment needs to travel in a straight line, it would take approximately 2-3 minutes to connect from the VMC gondola station on foot to the existing Subway Line 1 station as well as the Highway 7 rapid bus station. It would take a similar distance to connect from the gondola station to the VMC bus terminal as it is to connect from the subway station to the bus terminal. The pedestrian connection can be on the sidewalk or through a protected enclosed walkway.

Considering the future development within VMC, the elevated gondola station over Jane Street can provide a pedestrian connection between the east and west sides of Jane Street that offers grade separation from vehicular traffic as well as weather protection. This can potentially help reduce conflict between pedestrians and automobiles on the surface level and enhance overall pedestrian safety in the area.

The station footprint would be around 25x50 metres and would be located above the Jane Street roadway. Structural supports may be located within the centre lane or straddling the roadway. The images to the right and below show a visual representation for the gondola station with supports within the centre lane.



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DYNAMIC PLANNING TOOL

View showing VMC Gondola Station and the proximity to the subway and bus rapidway stations; Stations in these views are merely indicative and conceptual

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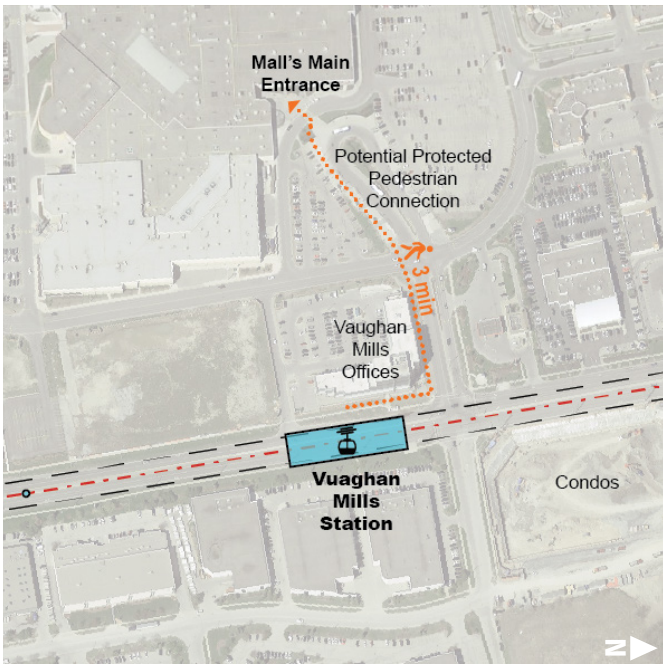
Google Earth

Vaughan Mills Station

The Vaughan Mills gondola station is an intermediate station with an approximate 3-minute walk to the mall's main entrance. It is located just south of the Jane Street and Riverock Gate intersection to avoid potential adjacency and view conflicts with the new condominium development at the northeast quadrant of that intersection.

The pedestrian connection between the gondola station and the mall can be accommodated within an elevated walkway from the station boarding platform to the mall. The walkway can be enclosed for weather protection, and can potentially include some retail and dining components, making it an extension of the mall.

The station footprint would be around 25x100 metres and would be located above the Jane Street roadway. Structural supports may be located within the centre lane or straddling the roadway.



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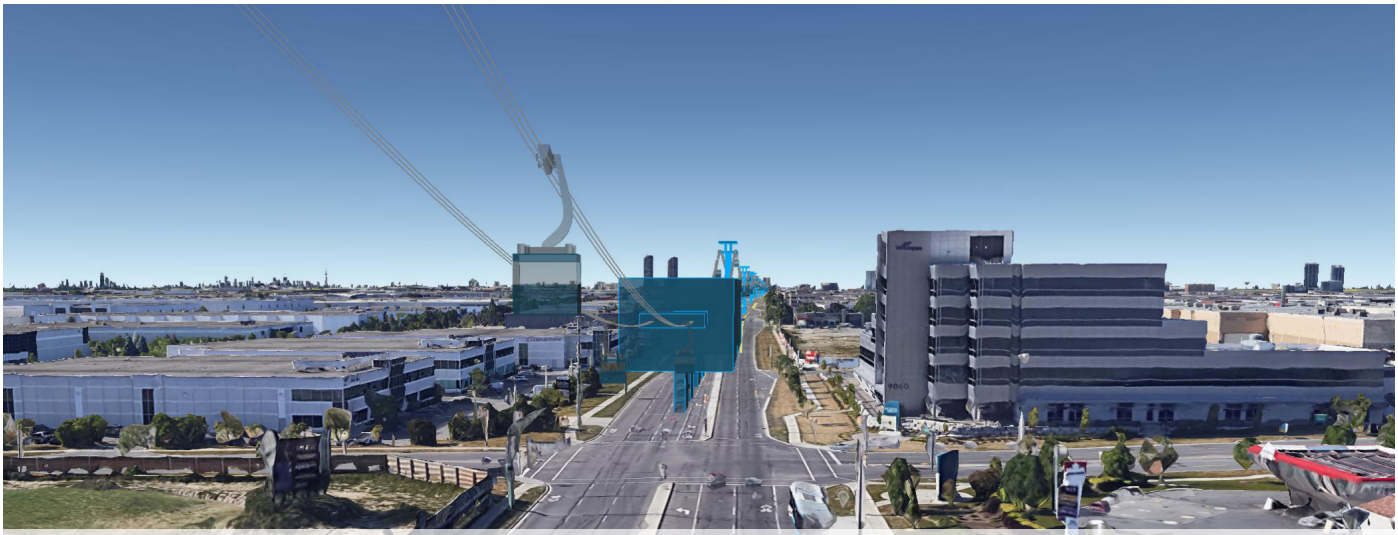

View showing Vaughan Mills Station and Vaughan Mills' office building; Stations in these views are merely indicative and conceptual

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Google Earth

Canada's Wonderland Station

Canada's Wonderland gondola station is an intermediate station with an approximate 3-minute walk to the park's main entrance. At this location, the walking distance from the station to the park's entrance is shorter than the walk from approximately 65% of available parking spaces at the park.

The station is located adjacent to the existing drop off area at the park's parking lot. An adjacent landscape buffer zone between Jane Street and the parking lot can be converted into an arrival plaza and queuing space, taking into consideration that there is typically peak arrival and departure hours at the park.

The station footprint would be around 25x100 metres and would be located above the Jane Street roadway. Structural supports may be located within the centre lane or straddling the roadway.

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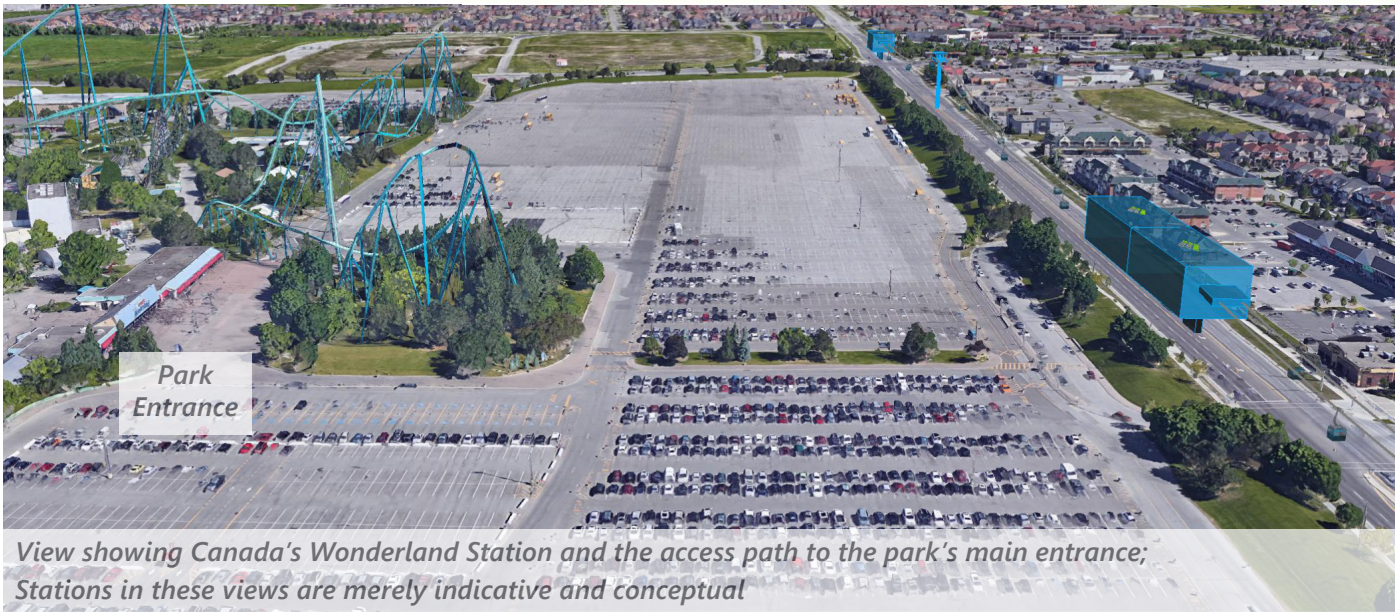
DYNAMIC PLANNING TOOL



View showing Canada's Wonderland Station and the access path to the park's main entrance; Stations in these views are merely indicative and conceptual

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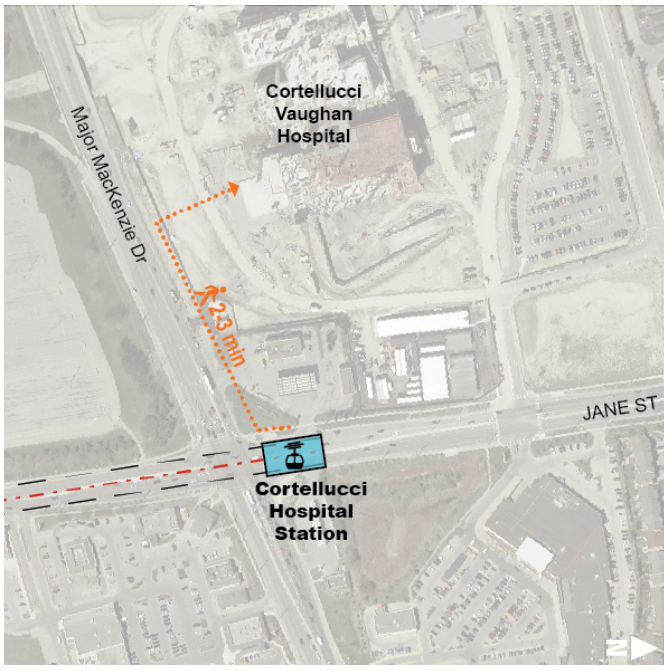
Google Earth

Cortellucci Vaughan Hospital Station

The Cortellucci Vaughan Hospital gondola station is a terminal station located at the northern end of the gondola alignment. It is within a 3-minute walking distance to the hospital's entrance. It is located just north of the intersection of Jane Street and Major MacKenzie Drive.

The pedestrian connection between the station and the hospital can be accommodated directly on the sidewalk or through a protected enclosed walkway. Special consideration should be paid to ADA and other accessibility needs for people using the gondola system to get to the hospital.

The station footprint would be around 25x50 metres and would be located above the Jane Street roadway. Structural supports may be located within the centre lane or straddling the roadway.



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DYNAMIC PLANNING TOOL

View showing the Cortellucci Vaughan Hospital Station with Downtown Toronto in the background; Stations in these views are merely indicative and conceptual

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Google Earth

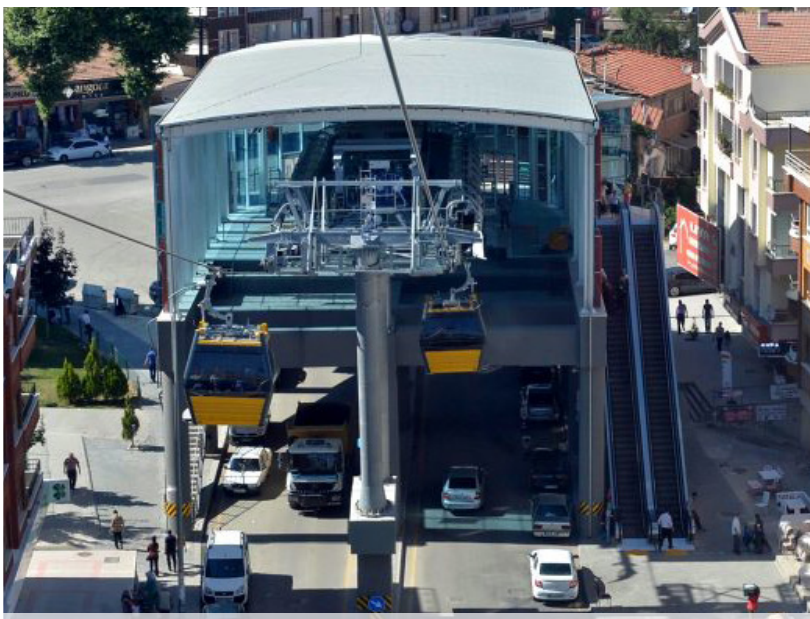
EXAMPLES OF GONDOLA STATIONS BUILT OVER THE STREET

Mi Teleferico, La Paz, Bolivia

Mi Teleferico, La Paz, Bolivia

Mi Teleferico, La Paz, Bolivia

Yenimahalle Teleferik, Ankara, Turkey



Yenimahalle Teleferik, Ankara, Turkey

Alignment Variations

At this conceptual planning stage, the proposed gondola alignment has some areas with considerable flexibility. While the desired station locations are clearly defined, they still offer flexibility in height and exact positioning of the station footprint along the alignment. Tower locations also offer great technical flexibility, as they can potentially be located anywhere along the centreline of the alignment. Towers can therefore be located at areas that offer the best tower-placement opportunity within the existing context.

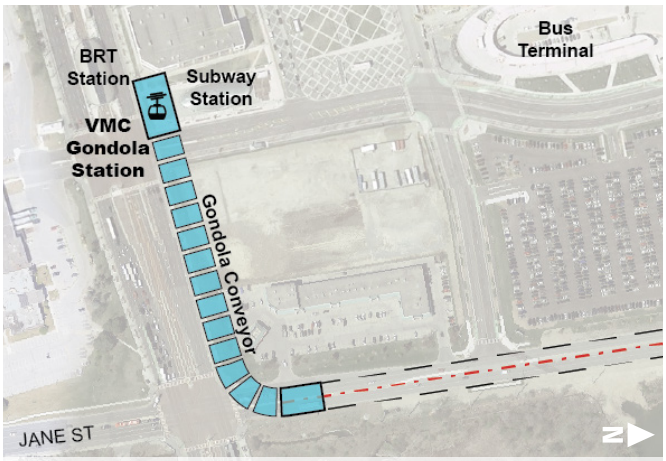
Below are a few examples of alternatives to some areas/components of the alignment.

Extended Conveyor Systems at VMC Station and Cortellucci Vaughan Hospital Station

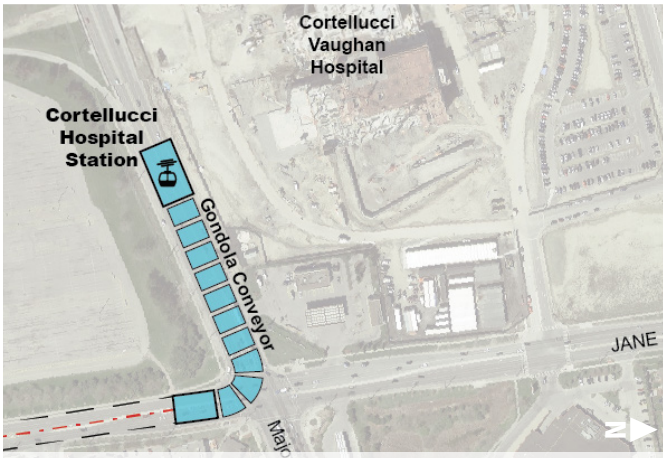
While the gondola alignment needs to be traveling in a straight line, station positioning at certain locations can potentially deviate from the system alignment by extending the station's conveyor system. The conveyor carries the cabins along fixed rails to the desired location where passengers can get on and off.

At both terminus locations of the alignment, VMC and Cortellucci Vaughan Hospital, this option may be proposed in order to locate the gondola station closer to the point of interest. For VMC, this means the closest position possible for easy transfers between the gondola system and the subway and bus rapidway stations. At Cortellucci Vaughan Hospital, this would be as close as possible to the hospital's entrance. Further planning would be required to understand how those conveyor systems would fit within the existing context.

Alternatively, high-quality enclosed and elevated pedestrian walkways can provide a climate-controlled and grade-separated connection from the gondola station to the final destination/connection point. These walkways have the potential for integrating art, advertising, retail, food and beverage components, and others. They can also contain moving walkways for a faster and more comfortable trip on foot.

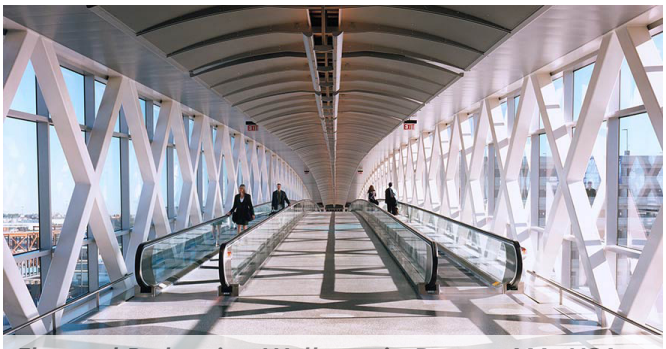


Station Alternative at VMC



Station Alternative at Cortellucci Hospital

Elevated Pedestrian Walkway in Calgary, Alberta



Elevated Pedestrian Walkway in Boston, MA, USA

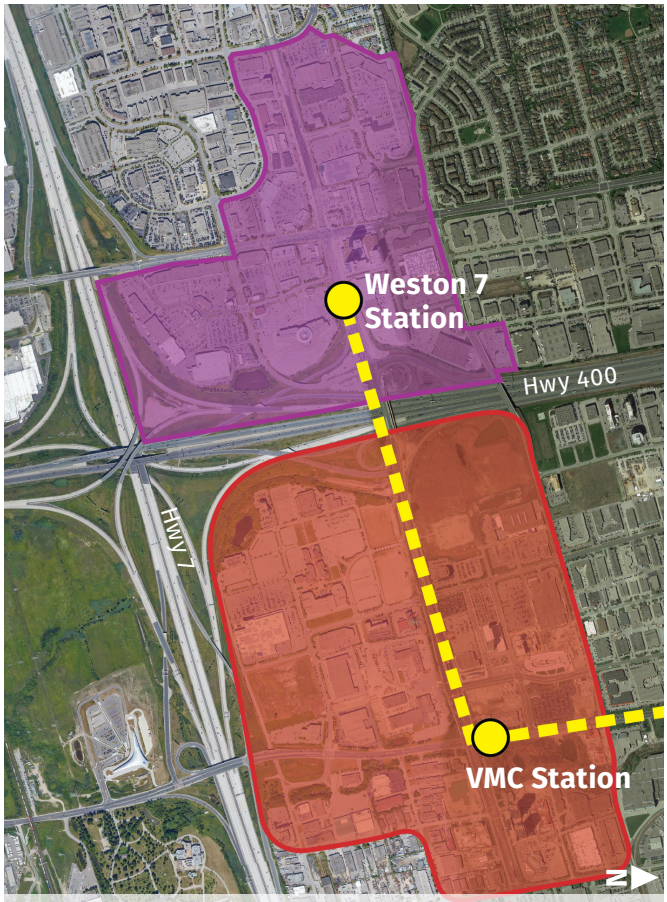
Elevated Pedestrian Walkway in Illinois, USA

Alignment Extension to Weston 7

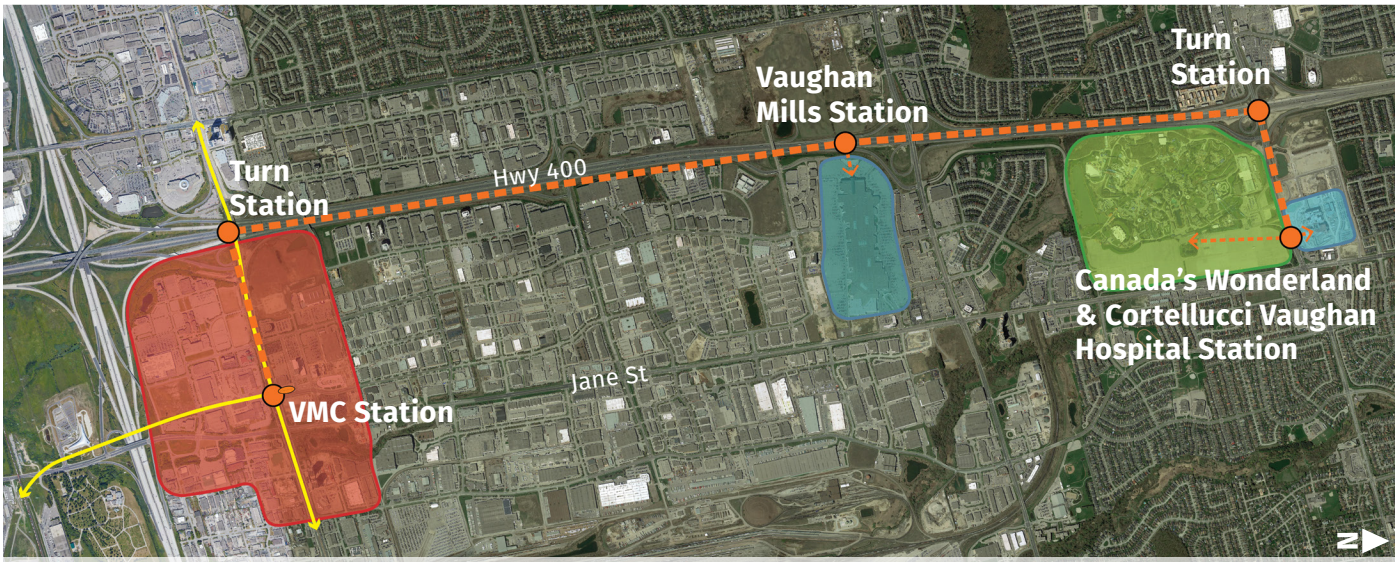
The City of Vaughan has identified the area around the intersection of Highway 7 and Weston Road as one of the primary growth centres for the City. Weston 7 is planned to become a distinct urban place with a variety of commercial, cultural and entertainment destinations as well as housing. While the area is planned to be served by the Highway 7 bus rapidway, extending the gondola alignment to Weston 7 provides a direct, single-mode connection from this new urban hub to the main attractions and destinations in the City of Vaughan. Additional planning would be needed to identify the best station location at Weston 7 and an optimized connection alignment for reduced impacts or required easements.

Alternative Alignment Along Highway 400

If Jane Street becomes infeasible for the gondola system, the transit benefit can potentially still be provided to serve all major destinations listed in this memo by moving the centreline over Highway 400. This variation will require additional stations in order to make the needed bends in the alignment to follow the public ROW. A more detailed study of this option can provide additional information on tower locations, other connection opportunities, and potential required aerial rights from private properties.



Alignment Extension to Weston 7



Potential Alternative Alignment Utilizing Highway 400 Public Right of Way

Technology Choice

Cable Propelled Transit in Urban Applications

Cable-propelled transit (CPT) technology continues to improve and evolve. Over the past few decades, CPT use for transportation within urban environments has been growing exponentially. While there is a variety of types of aerial CPT systems, three are the most commonly used: aerial tramway, monocable detachable gondola, and tri-cable detachable gondola. The table at the bottom of this page lists a number of examples of urban CPT systems around the world utilizing one of the mentioned technology options.

Aerial Tramway

Aerial tramway systems are the fastest operating CPT technology. They are highly reliable systems and can operate in most weather conditions. Trams are fixed-grip systems and can have cabins that can carry more than 200 people. While cabin capacity is large, the aerial tramway system's capacity per hour is restricted by the distance the cabin needs to travel between the two stations, as tramway systems are typically limited to two cabins only. The cabins can be operated together or independently. Tramways are best suited for areas connecting two points with a relatively short travel distance.

Monocable Detachable Gondola (MDG)

Monocable detachable gondola systems utilize a single cable which provides both propulsion and support. Cabins continuously circulate the system and are equipped with a detachable grip that allows them to detach from the propulsion cable upon entering a station then reattach when exiting. Typical MDG cabins can carry 4-15 passengers each. MDG systems are flexible and relatively inexpensive to build and operate, which makes them the most commonly used aerial gondola system. MDG systems can be designed to carry a maximum capacity of 3,600 people per hour per direction (pphpd).

Tri-Cable Detachable Gondola (TDG/3S)

Tri-cable (3S) detachable gondola systems utilize three cables, two track cables that are fixed and one haul cable that provides additional support as well as propulsion. The three-cable support allows the system to have much larger cabins that can carry 35-40 people per cabin, as well as significant wind stability. Similar to the MDG, 3S gondola cabins continuously circulate the system and are equipped with a detachable grip that allows them to detach from the propulsion cable upon entering a station then reattach when exiting. 3S gondola system capacity can go up to 5,000 pphpd which is comparable to the operating capacity of many light rail systems in urban environments.

AERIAL TRAMWAY TECHNICAL CHARACTERISTICS	
Number of Cables	3
Max Cabin Capacity	200+
Grip	Fixed
Max Wind Speed	75+ kph
Max Speed	~46 kph
Max Span Length	~3000 m
Headway Time Range	Length Dependent
Max Capacity	Length Dependent
Relative Cost	Med-High

MONOCABLE DETACHABLE GONDOLA TECHNICAL CHARACTERISTICS	
Number of Cables	1
Max Cabin Capacity	15
Grip	Detachable
Max Wind Speed	~40 kph
Max Speed	~22 kph
Max Span Length	~300 m
Headway Time Range	9 to 23 seconds
Max Capacity	3600 (pphpd)
Relative Cost	Low

pphpd - Persons per hour per direction

3S/TRI-CABLE DETACHABLE GONDOLA TECHNICAL CHARACTERISTICS	
Number of Cables	3
Max Cabin Capacity	40
Grip	Detachable
Max Wind Speed	75+ kph
Max Speed	~27 kph
Max Span Length	~3000 m
Headway Time Range	15 to 20 seconds
Max Capacity	5000 (pphpd)
Relative Cost	High

pphpd - Persons per hour per direction

Examples of Urban CPT Applications

The use of CPT for transit in urban applications has seen a rapid growth over the past decade. Cities all over the world are realizing the substantial transit benefits these systems can over with the greatly reduced cost and impact. Below are a few examples of the three types of CPT systems mentioned earlier.

System	Portland, Oregon, USA	Roosevelt Island, New York, USA	La Paz, Bolivia	London, England	Mexico City, Mexico (Mexicable)	Mexico City, Mexico (CableBus)	Koblenz, Germany
Year Opened	2007	1976 (Upgraded 2010)	2018	2012	2016 (New line added in 2021)	2021	2010
Technology	Reversible Tramway	Reversible Tramway	Monocable Detachable Gondola	Monocable Detachable Gondola	Monocable Detachable Gondola	Monocable Detachable Gondola	Tri-cable Detachable Gondola (3S)
Capacity (Persons per hour, per direction)	980	1,500	3,000	2,500	3,000	3,000	3,800
Distance	1.0 kilometre	0.9 kilometres	2.9 kilometres	1.1 kilometres	4.8 kilometres	9.2 kilometres	0.9 kilometres
Annual Ridership Estimates	2.6 million (2016)	2.4 million (2012)	101 million (Gondola network, 2019)	1.4 million (2018)	5.5 million (mid-2016 to mid-2017)	Not available	Not available
Time	4 minutes	3 minutes	13 minutes	5 minutes	19 minutes	33 minutes	4 minutes
Cabin Size	79 people	110 people	10 people	10 people	10 people	10 people	35 people

Recommendation: 3S Detachable Gondola

Considering the types of destinations identified in this memo, as well as the initial and final capacity for the system to support, the SCJ Alliance team recommends using the tri-cable (3S) detachable gondola system as the transit technology of choice. This recommendation is based on multiple factors described below.

Ridership demand

3S gondola systems offer a great range of capacity that can go up to 5,500 pphpd. While the demand in Vaughan might not be of this level, providing a system with higher capacity can mean easily accommodating changing demands without overcrowding the system.

Because it is a detachable gondola system, there is high flexibility in controlling capacity as needed. Considering the dynamic changes taking place within the City of Vaughan, especially anticipating the population and visitor increase with the build out of Vaughan Metropolitan Centre, providing such flexibility for accommodating opening demand and later adjusting for final demand becomes a great advantage. Additionally, the added cost for increasing the system's capacity is marginal, especially when properly planned for.

Wind

The City of Vaughan does not have particularly windy conditions. However, based on information collected from Thornhill and Woodbridge, March tends to be the windiest month of the year, with occasional gusts that exceed 40 kilometres per hour. A 3S gondola system can support rides with high wind stability for wind speeds up to 100 kilometres per hour. This means that the system can potentially be able to operate year-round without weather-related obstructions to the service, while also providing a stable and comfortable ride for passengers.

Elevated passenger experience

Vaughan Mills and Canada's Wonderland are popular destinations for families with small children. 3S gondola cabins are spacious and can comfortably accommodate families with strollers and other needs such as leaving the mall or theme park with large purchases and shopping bags.

Similarly, Canada's wonderland is likely to attract visitors in large groups of people, and the larger cabins of a 3S gondola system makes it a more accommodating and fun ride to take together with your friends. Additionally, because the park likely has peak arrival and departure hours, a higher-capacity system can easily accommodate crowds moving together at the same time without overloading the system.

Considering that the last destination served by the gondola system in the only hospital in the City of Vaughan, providing a system with uncompromised ADA accommodation becomes very essential. Not only does the system offer accessible level-boarding, but the larger cabins can easily accommodate wheelchairs entering and exiting without having to stop the system. Some cabins can also be specially retrofitted to allow for even higher levels of wheelchair accommodation than the standard cabins.

Typical 3S gondola terminus station footprints are approximately 24 metres wide and 45 metres long, and intermediate stations are double the length. Typical 3S monopole towers have bases of around 3-4 metres in diametre. These dimensions may vary based on design.

Ritten Cable Car, Bolzano, Italy; 3S Gondola System

Koblenz Cable Car, Germany; 3S Gondola System

CAPEX & OPEX Estimates

CAPEX & OPEX

SCJ Alliance developed program level costs for the proposed gondola system described in this memo. Baseline assumptions assume that the gondola system will be a 3S/tri-cable detachable gondola system with 4 stations and 15 towers, a capacity of about 2,000 persons per hour per direction (pphpd), and that it would be procured competitively.

There is substantial uncertainty in developing program level costs at this stage including the conceptual nature of the design and forward-looking nature of cost predictions. Nevertheless, approximate cost expectations can be and were developed to provide guidance on policy or go/no-go decisions and potential alternative considerations. These costs consider market conditions, SCJ's assumption of basic transit-style stations, and pricing models of other similar urban aerial transit systems that the team at SCJ is actively engaged in across North America. These costs provide a reasonable expectation of magnitude but should not be used as a basis for future procurement without more thorough detailed design and environmental review.

Operation and Maintenance (O&M) Costs represent what would be expected in the ropeway/cable car industry. They may not accurately reflect the wages, salaries, and benefits that would be expected from a public transit agency in the Southern Ontario context.

Conceptual Capital Costs

Item	Conceptual Capital Costs (CAD)
Ropeway System Elements • Ropeway System • Cabins • Towers (installed)	$81,000,000 - $90,000,000
Stations • Buildings • Vertical Circulation and Access	$44,000,000 - $49,000,000
Soft Costs • Preliminary Design, Studies, Surveys • Permitting • Final Design (station, tower, civil) • Construction + Insurance (during) • Program Management • Cable Car Consultant	$26,000,000 - $29,000,000
Contingency (15%)	$23,000,000 - $25,500,000
Total Conceptual Capital Costs	**$174,000,000 - $193,500,000**

Conceptual Annual Operations & Maintenance Costs

Item	Conceptual Operations & Maintenance Costs (CAD)
Fixed Labor Costs	$1,000,000
Variable Labor Costs	$3,500,000
Other	$4,500,000
Contingency (15%)	$1,500,000
Total Conceptual Annual Operations & Maintenance Costs	**$10,500,000**

Conclusion and Next Steps

Conclusion

The City of Vaughan has been undergoing dynamic shifts in its urban structure especially in the CBD area at Vaughan Metropolitan Centre. Beyond local changes in the City, Vaughan draws visitors from all over the region to various destinations such as Vaughan Mills and Canada's Wonderland. With the City's Transportation Master Plan Update, SCJ Alliance was retained to provide a feasibility study for integrating cable-propelled transit with the transportation network to serve areas not currently served by high capacity transit.

The SCJ Alliance team prepared this memo which concludes that a 3S/Tri-cable detachable gondola system is a favorable solution for this transit connection, as it can accommodate the current and future ridership demand with considerably reduced impact in the area compared to other, more-conventional modes of transportation.

The conceptual gondola system is comprised of two terminal stations, two intermediate stations, and fifteen towers along the 6.2 kilometre-long system. The system would connect the City's transit hub at Vaughan Metropolitan Centre with other major destinations like Vaughan Mills, Canada's Wonderland, and the new Cortellucci Vaughan Hospital. Potential future development and major employers moving into this area would benefit from an efficient transit mode that connects all these major points of interest along the Jane Street corridor. This memo concludes that introducing such a system to the City is not only feasible, but can also provide local and regional transit benefits to the area.

Benefits

- Provides an efficient, accessible and reliable transit connection between important points of interest within the City, as well as connecting those to the larger Toronto subway network
- Provides a transit system with very short wait times compared to other modes of transit
- Provides benefit to a larger zone than the immediate project area by connecting to multiple regional transit lines
- Minimizes the physical footprint along the corridor compared to other modes of transit
- Accommodates current ridership demand with a potential for increasing capacity if desired, with marginal added cost
- Provides future-proofing to prevent the over-saturation of use on the surface level on roads especially considering build-out of VMC
- Capital costs are considerably lower than other mass transit systems
- May be built in a relatively short time period

Areas of Concern

- May be politically-challenging due to the lack of institutional knowledge about the technology and its transit applications
- Views from/to surrounding development need to be addressed, especially at condominium towers
- Construction within the public right of way will required
- Project delivery method is typically a DBOM (Design, Build, Operate, Maintain) model which may not mesh with standard practices at the City of Vaughan.

Suggested Next Steps

- Meet with the City of Vaughan and other parties involved in the Vaughan Transportation Master Plan Update to review the findings of this analysis. Identify strategies to move forward
- Conduct workshops with stakeholders to educate them on urban gondola technology and the growing use of the technology as mass public transit around the world
- Prepare conceptual gondola station layouts for all station locations to better understand and evaluate physical impacts and requirements
- Prepare conceptual layouts for tower bases and where they touch the ground to evaluate physical impacts and constraints
- Conduct a Transit Project Assessment Process (TPAP) in order to fully validate the project. The TRAP study expands upon the work conducted thus far and should include preliminary engineering, station design, ridership analysis, high-level budgets and the creation of a financial model that integrates the various revenue streams the project is likely to realize within the given context.

Timeline

Below is an overall program-level timeline to provide a conceptual road-map for taking this project from initial study to implementation.

- 1-2 years for Detailed Planning
- 2 years for Preliminary Design and Studies
- 1.5 years for Final Design and Fabrication
- 9-18 months for Construction (depending on station design complexity)

In addition to the soft costs described in the CAPEX and OPEX section of this memo, an additional CA$300,000-450,000 would be required prior to preliminary design to define the project.

Vaughan Gondola: Business Case Benefits

In conclusions, the City of Vaughan's conceptual gondola system is a 6.2-kilometre public transit connection utilizing 3S gondola technology. The system would have four stations located at Vaughan Metropolitan Centre (VMC), Vaughan Mills, Canada's Wonderland, and Cortellucci Vaughan Hospital. This system can present various benefits in the four cases shown below, following Metrolinx' Business Case framework.

Strategic Case

Reliable transit connection along a corridor with significant potential for future growth

High-capacity transit system connecting the City's primary points of interest

Short wait times in stations which result in easy integration with other modes as well as an elevated passenger experience

Easy and walkable transfer/connection to regional subway and bus rapidway transit

Trip time is faster than bus service and comparable to private vehicle

Financial Case

$174 Million-$193.5 Million in capital costs for the construction of this investment; considerably lower than other conventional high-capacity transit solutions

$10.5 Million in annual operational costs; considerably lower than other conventional high-capacity transit solutions

Economic Case

Mass-transportation benefits with no point-source emissions

Alleviate traffic congestion and enhance livability in the City

Provide jobs at multiple levels

Connect residential and commercial uses along Jane Street to major CBD areas like VMC and Downtown Toronto

Deliverability and Operations Case

Can be realized in a short period of time: construction of the entire gondola system may be completed in less than 2 years

May eliminate/reduce bus service along Jane Street and replace that with a faster, more reliable system

Possibility for fare-integration with destinations

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