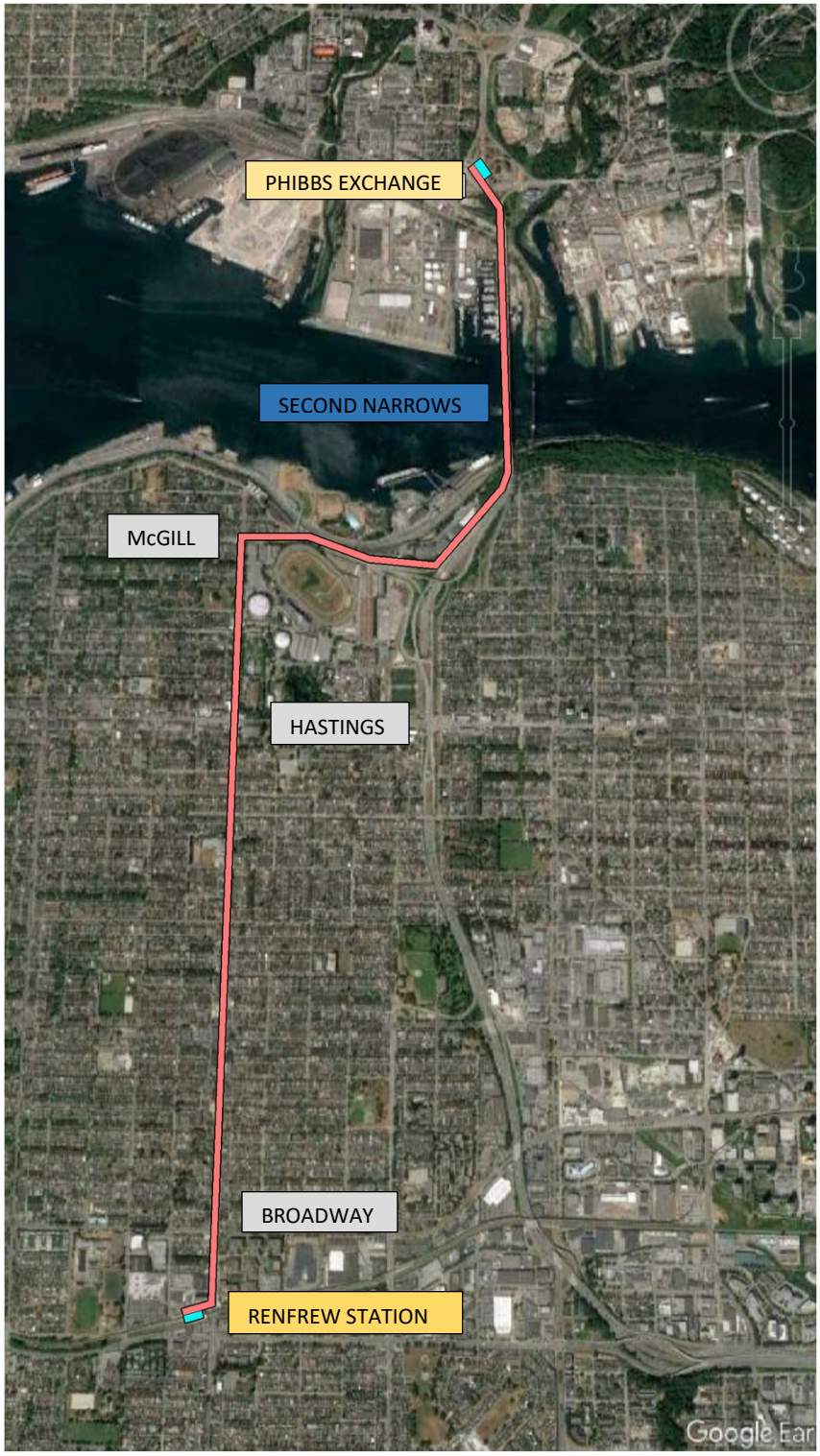
THE PHIBBS EXCHANGE – RENFREW STATION LINE



A RESEARCH REPORT INTO BUS RAPID TRANSIT SYSTEMS AND A PROPOSAL FOR A BRT LINE BETWEEN PHIBBS EXCHANGE IN NORTH VANCOUVER AND THE SKY TRAIN RENFREW STATION ON THE MILLENNIUM LINE

OVERVIEW SUMMARY

- Over the past few years there has been increasing traffic congestion along the North Shore particularly at rush hours, with bottle necks at the bridges. For a very low capital cost and extremely minor construction disruption to communities the proposed Bus Rapid Transit (BRT) system will, amongst other things:
    - reduce congestion on the Iron Workers Memorial Bridge by providing an efficient public transportation system as a viable alternative to driving across the bridge;
    - more fully integrate the North Shore into the public transportation system south of the Burrard Inlet; and
    - reduce the attrition of lower paid workers in North Shore businesses by enabling their commute from their residences in the more affordable neighborhoods in which they reside.
- The Bus Rapid Transit (BRT) Line across the Iron Workers Memorial Bridge has been researched, resulting in a structural design for a high capacity line that bypasses the bottle necks on the bridge and connects Phibbs Exchange on the North Shore to Sky Train Renfrew Station on the Millennium Line.
- The Research includes:
    - A survey of BRT networks around the world showing how common such networks are.
    - A choice of Bi-Articulated Buses capable of carrying up to 250 passengers.
    - A proposed structural design for carrying the buses across the bridge separate from traffic lanes, without overloading the bridge.
    - A proposed design for automated guideway lanes from the bridge structure north to Phibbs Exchange and south to McGill Avenue.
    - Examining the use of McGill Avenue and Renfrew Street for Bi-Articulated Buses to travel from the bridge to the Sky Train Renfrew Station on the Millennium Line.
    - A proposed design for large BRT Stations at Phibbs Exchange and Sky Train Renfrew Station and road side Stations at McGill, Hastings and Broadway where the avenues cross Renfrew Street.
- Measuring passenger capacity, the BRT Line from Phibbs Exchange to the Sky Train Renfrew Station will have a maximum capacity of 7,500 people/hour, similar in scale to the Sky Train Network.
- The Projected Budget is $150M - $200M for 2.7 km of bridge structures, 3.3 km of guideway lanes, 4.1 km of road preparation, 8 Stations and 45 buses. It will be, in total, the most economical high capacity transit system being proposed in Metro Vancouver.
- The project will reasonably quick to construct with minimum interference with bridge and bridge approach traffic.

INTRODUCTION


IRON WORKERS MEMORIAL BRIDGE

The North Shore needs a rapid transit connection to Metro Vancouver. Over the past few years there has been an increasing traffic congestion along the North Shore particularly at rush hours with bottle necks at both the Lions Gate Bridge and the Iron Workers Memorial bridge. This is partially due to the population growth of the North Shore with more people buying homes and condos on the North Shore and driving to work and play in Vancouver coupled with many workers on the North Shore having to live elsewhere, where housing is cheaper, and drive over the bridges to work and visit. To deal with the North Shore congestion itself, there is at present, a strong comprehensive effort to get people out of cars and into a convenient transit network, starting with a new B-Line from Phibbs Exchange to Dundarave. However, this does not address the need to get people out of their cars before they try to cross the bridges. While some people are already using bus lines that presently cross the bridges, they are equally tied up in traffic during rush hour. The only facility that provides a consistently convenient transit service is the Sea Bus which is central to a network of buses and rapid transit lines at both docks. What is needed is an additional facility that connects the rapid transit lines south of Burrard Inlet to an upgraded North Shore transit network so that an increasing number of people can conveniently and economically get to and from the North Shore without using a vehicle.

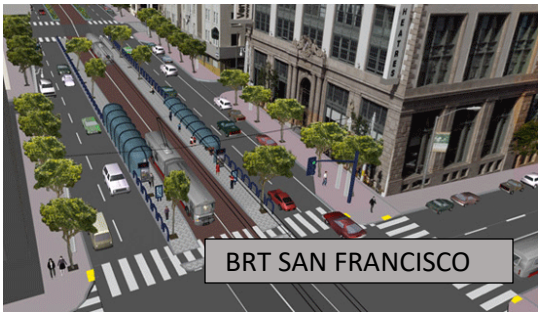
A standalone Bus Rapid Transit (BRT) line attached to the Iron Workers Memorial Bridge is proposed to be that facility. It would consist of a light structure for two extra lanes attached to the sides of the existing bridge structure that would only carry buses and would be designed in a way that wouldn't overload the bridge. It would be constructed in a way that there would be minimal interference with bridge traffic during construction and when completed will be separated from the vehicle lane traffic so it won't be affected by traffic backup. It would be the core concept for a rapid transit line between Phibbs Exchange in North Vancouver and the Sky Train Renfrew Station on the Millennium Line and would have transit capacities similar to a Sky Train but at the fraction of the cost.

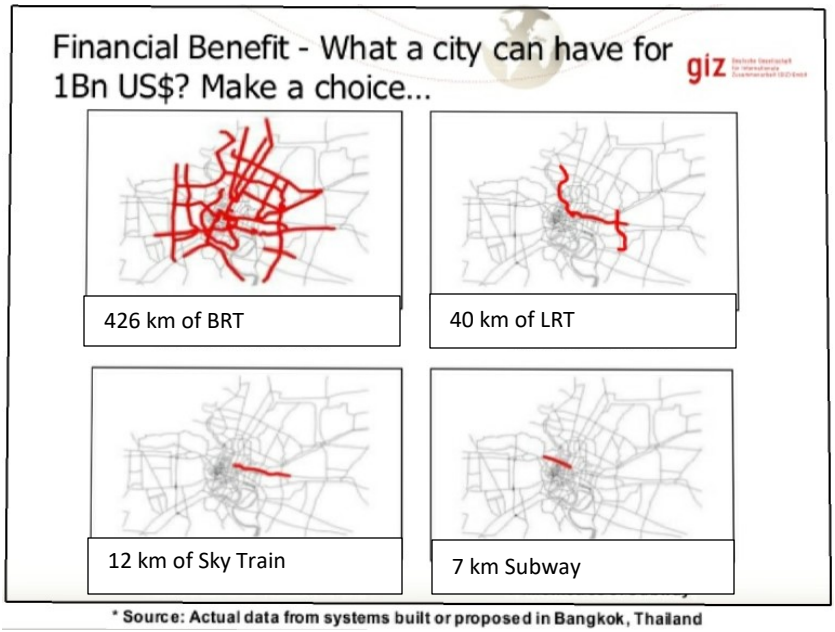
The following sections will show how this can be done.

ABOUT BUS RAPID TRANSIT NETWORKS


BRT NEW YORK

Bus Rapid Transit (BRT) systems are not unique. There are many BRT Networks that are already operating in the Americas, Europe and Asia, with more underway. In the Americas alone, since 1974 more than 200 cities have built, are successfully operating and are expanding their BRT networks. The reason for the increase in BRTs is that the new networks have high capacity, are increasingly competitive with vehicles in convenience and time and are far less costly to build than most rapid transit systems as shown in the graph below from GIZ, a transportation system consultancy based in Germany doing a project in Bangkok, Thailand. According to a Research Report on BRT Technologies carried out at the Center for Transportation Studies, University of Minnesota, "BRT combines the quality of rail transit and the flexibility of buses. It can operate on exclusive transitways, HOV lanes, expressways or ordinary streets". This flexibility is essential when extending a transit network within an urban environment of increasing density where BRT, as a distributed transportation system, will carry more people more conveniently than a broadly spaced rapid transit network. These points confirm that the development of a BRT line between Phibbs Exchange on the North Shore and the Sky Train Renfrew Station on the Millennium Line would be the best solution for a rapid transit line joining the North Shore to the rest of the Metro Vancouver's Rapid Transit Network and at the same time prove the capability, convenience and economy of BRT.


BRT SAN FRANCISCO



* Source: Actual data from systems built or proposed in Bangkok, Thailand


BRT ISTANBUL


BRT BOSTON

THE CORE CONCEPT: A BRT SPANNING THE BRIDGE

The core concept for a BRT across the Iron Workers Memorial Bridge is to attach light weight steel structures, one on each side of the bridge to support 2 new lanes for bus use only. These structures would not be at the same level as the main roadway on the bridge. They would be below the roadway decks with a bus guideway lane on top of each attached structure also below the deck. The lanes would be just wide enough for a bus moving under automated guidance monitored by the driver.

On the north end of the bridge each guideway lane would be extended to a turn around at Phibbs Station. On the south end, each guideway lane would merge into McGill Avenue. Switching to driver control, the buses would travel to Renfrew Street, then south to a turn around at the Sky Train Renfrew Station on the Millennium Line with intermediate stations on Renfrew Street where regular bus lines cross at McGill, Hastings, Broadway and in future when there is an increasing demand for additional stations. The result would be a high capacity BRT line connecting the North Shore to the Sky Train Network.

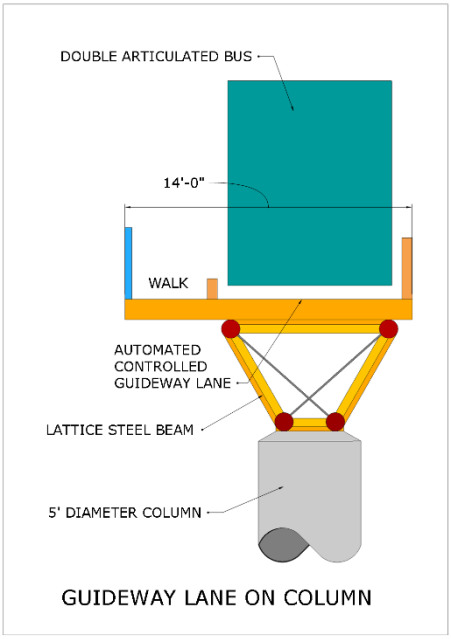
BI- ARTICULATED BUS ON AUTOMATED GUIDEWAY LANE STRUCTURE OVER IRON WORKERS MEMORIAL

Why the use of McGill Avenue and Renfrew Street? The reason for these roads is that this BRT line is primarily a link. Phibbs Exchange is already in place at the north end of the bridge and would be reconstructed to be a Hub connecting the BRT to the bus network already or proposed on the North Shore. There is not a similar hub close on the south end of the bridge. The closest connection to the Metro Vancouver Rapid Transit Network would be the Sky Train Renfrew Station on the Millennium Line which is about 30 short blocks south of McGill Avenue. In addition, the existing approach roads at the south end of the bridge are already arranged in such away that the bus lane guideways coming off the bridge will transfer easily onto McGill Avenue. The guideways will remain separated from the existing roadways between the bridge and the Cassiar Connector tunnel until they connect to McGill Avenue thus avoiding the traffic and potential congestion on Highway 1. The regular traffic on McGill Avenue and along Renfrew Street is not dense, and the road width includes 4 lanes plus parking lanes which could be converted to HOV lanes to the Sky Train Renfrew Station during rush hours.

In more detail, the proposed North Shore - Renfrew BRT Line consists of 5 SEGMENTS which are shown in the following diagrams as colored lines, approximately the width of a bus lane.

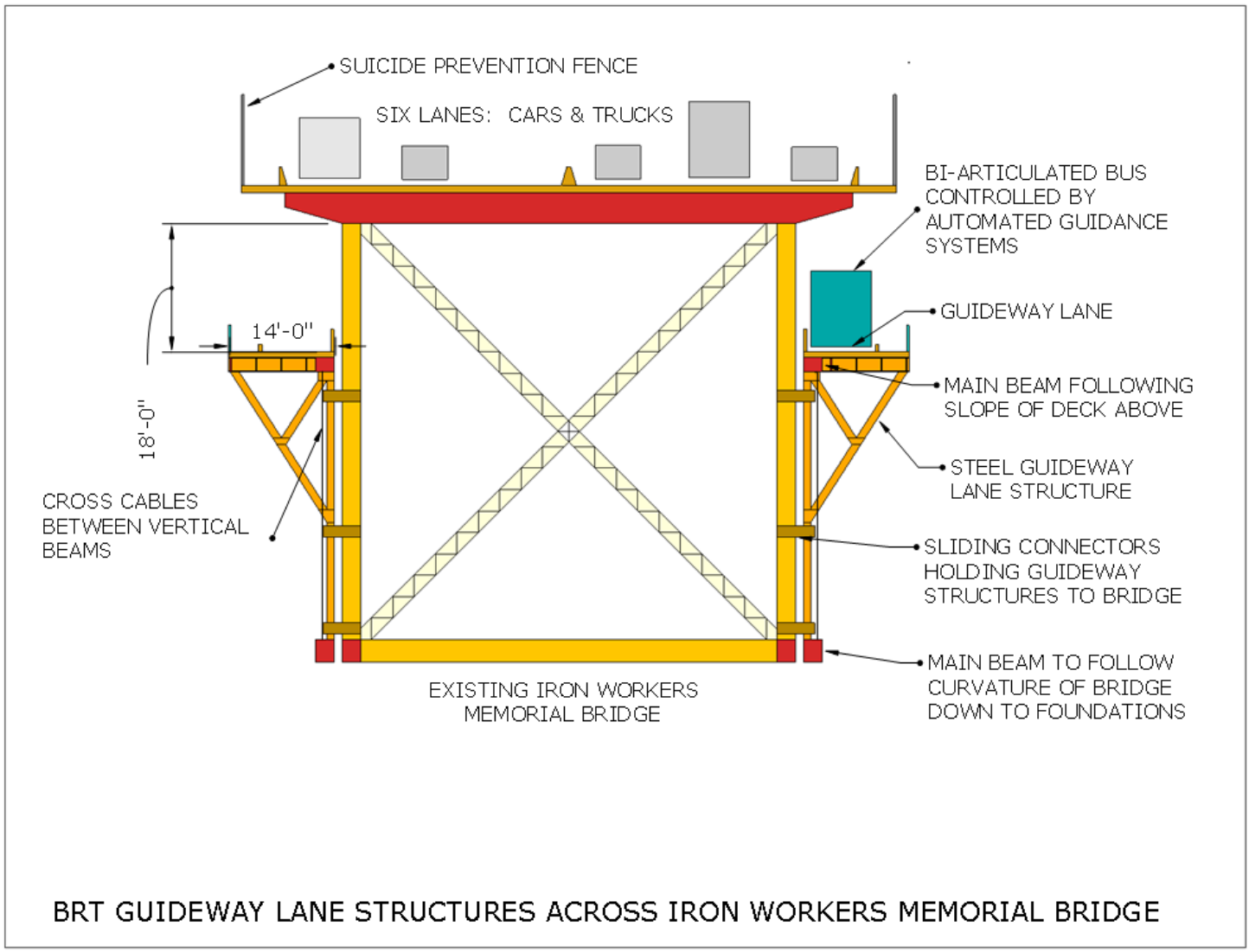
THE BRT NORTH AUTOMATED GUIDEWAY LANES

The FIRST SEGMENT starts at Phibbs Exchange Station which will be a hub for north shore bus routes east and west of Phibbs Exchange Station. The buses leaving the station to go south would head up an automated guideway lane ramp on columns over Main Street. They would then follow beside the existing curved vehicle ramp until leveling off to meet a new guideway lane structure on the west side of and below the main bridge deck. There would be a similar guideway lane on the east side of the bridge leading to a similar curved guideway lane on columns that would go over the Dollarton Highway before dropping down to road level and under the main approach to the Iron Workers Memorial Bridge to Phibbs Exchange.



STEEL AUTOMATED GUIDEWAY STRUCTURE ON THE BRIDGE

The SECOND SEGMENT is the bridge itself with new light weight unobtrusive bracket shaped steel structures on each side of the existing Iron Workers Memorial Bridge structure to carry the buses. The structures would support a narrow guideway bus lane on each side of but below the existing bridge deck. The structures could be installed using the existing bridge structure as scaffolding but should not seriously interfere with the existing main deck above. When finished they could be wholly supported by the existing bridge if engineering calculations prove that the bridge is strong enough for the loads. If not, the complete structure could be based on the guideway bus structure being light beams connected together in a pattern matching the pattern of beams on the sides of the bridge but with sliding connections to the bridge beams so that the weight of the guideway bus structure is carried directly down to the bridge foundations. In this way the guideway bus structure weight would not be carried by the existing bridge structure.

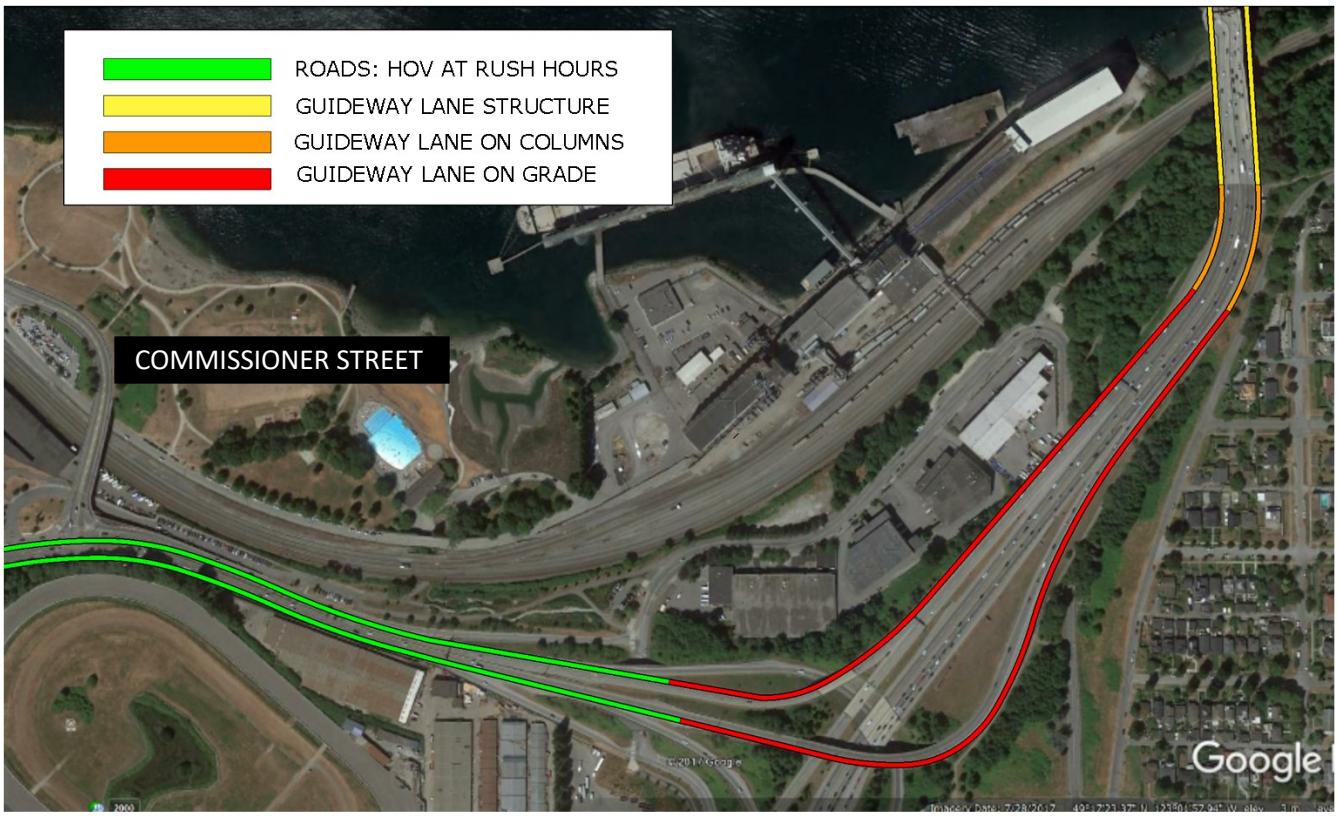


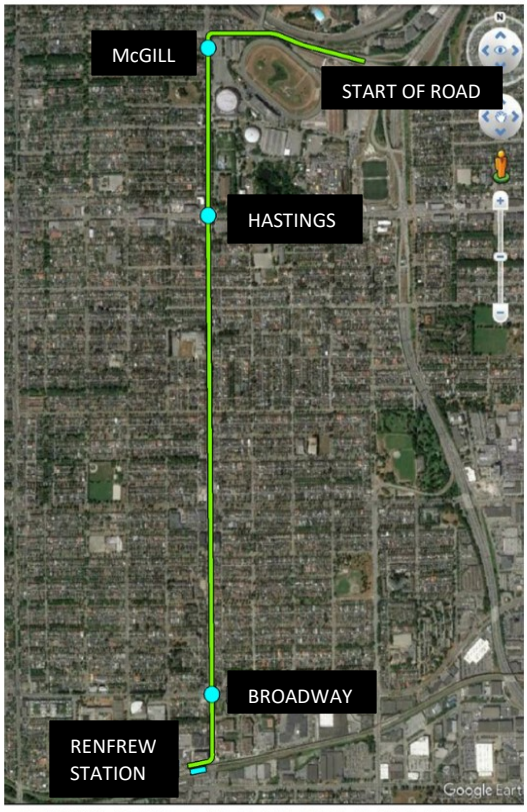
BRT GUIDEWAY LANE STRUCTURES ACROSS IRON WORKERS MEMORIAL BRIDGE

Given the overall lightness of the BRT structure fitting within an available height of no less than 60’- 0” from deck to the underside of the of the bridge structure and that the only live load being 1 or 2 buses on the structure at any one time, a structure independent of the existing bridge is highly possible.

THE BRT SOUTH AUTOMATED GUIDEWAY LANES

SOUTH END OF IRON WORKERS MEMORIAL BRIDGE TO COMMISSIONER STREET JUNCTION





RENFREW STREET FROM McGILL TO RENFREW STATION

The THIRD SEGMENT begins at the south end of the automated guideway lane structure on the Iron Workers Memorial Bridge. The buses would then be on grade but in constructed separate guideway lanes until they merge into the existing vehicle lanes from the bridge turning to and from McGill Avenue.

The FOURTH SEGMENT would consist of the buses running on the existing multi lane roads on McGill Avenue to Renfrew Street then along the existing 4 lane (plus parking) road on Renfrew Street, stopping at stations at the corner of McGill and Renfrew, Hastings, and Broadway, to Hebb Avenue and looping around at the Renfrew Station on the Millennium Line. The buses would

be under standard traffic control from the merging into McGill Avenue to Renfrew Street, and along Renfrew Street to Hebb Avenue and the Millennium Line.

A possible FIFTH SEGMENT would be extending the line from Hebb Avenue along Renfrew Street to the Boyd Diversion then along Nootka to 29th Avenue and the 29th Station on the Expo Line.

BI-ARTICULATED BUSES FOR BRT LINES


VOLVO

The North Shore - Renfrew BRT Line would have a passenger capacity similar in scale to the Sky Train by using large capacity buses. Bus Rapid Transit Networks elsewhere include bi-articulated buses, some of which can carry as much as 300 passengers each. While there is a number of manufacturers of these large buses, the largest world manufacturer of bi-articulated buses is Volvo, which has delivered more than 4000 bi-articulated buses to BRT Networks. The bus that would be appropriate for the new line is the Volvo B340M which is bi-articulated, 27 m (88.5 ft.) long and can carry as many as 250 passengers.

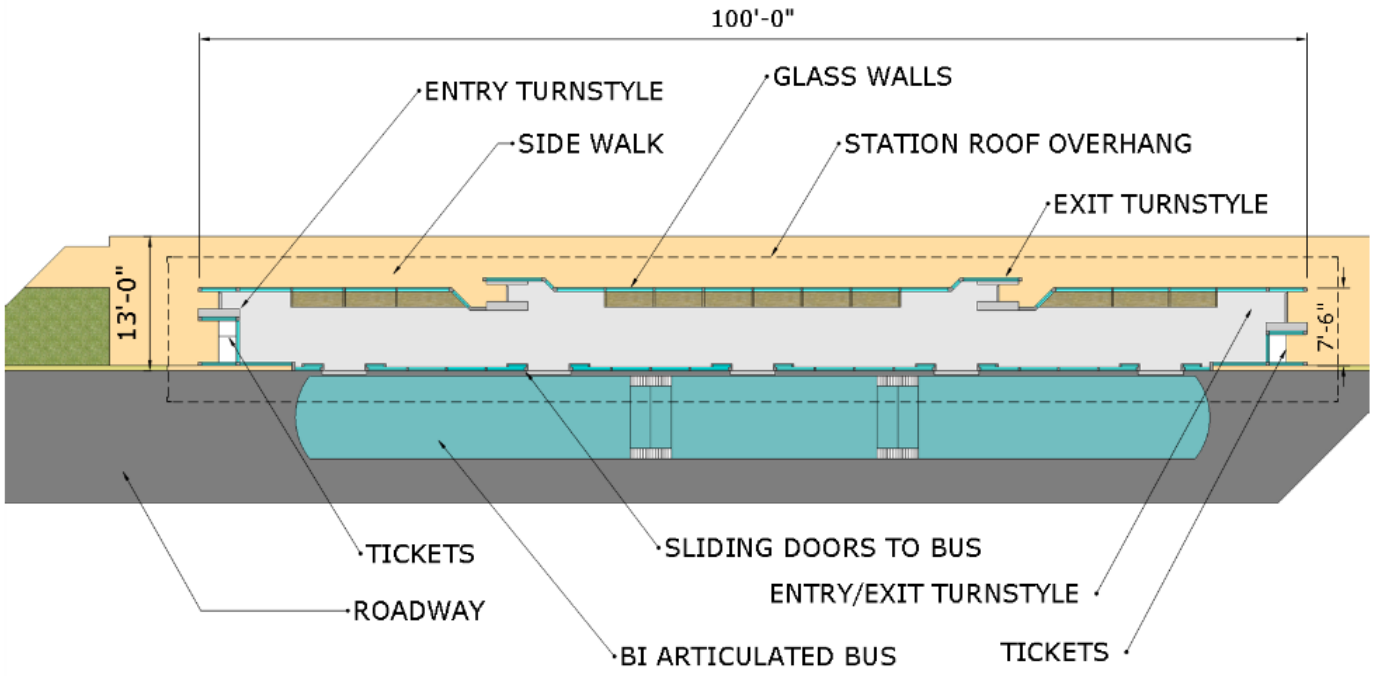

VOLVO

THE BRT STATIONS


CURITIBA, BRAZIL

The BRT Stations would not be the same as the existing shelters for ordinary buses. They would be designed to speed up the loading and unloading of the bus. The Station would be a roof clad, glass enclosed narrow building with entries and exits containing turnstiles for Compass Cards so there would not be any payments on the bus. Also, there would be doors in the wall adjacent to the bus lane to match the bus doors (5 per bus) which would open after the bus stops and opens its doors. Thus, the BRT Stations would be similar to Sky Train stations but, except for the stations at Phibbs and Renfrew, at a much smaller scale to fit into the side of the street. However, they would be large enough to hold up to 100 persons waiting to aboard the bus while those leaving pass on to the exit turnstiles.


TAICHUNG, TAIWAN



BUS RAPID TRANSIT STATION

BRT OPERATIONS

The BRT buses would be operated by drivers in 2 modes; either driver operated when the bus is sharing road space with general traffic along conventional roads (McGill Avenue and Renfrew Street) or passively run (gas/brake pedals only) by the driver when using a combination of laser, magnetic and kerb automation guidance systems while moving along the separate guideway lanes. This allows the guideway bus lanes on the bridge and its approaches to be narrower than a standard 12'-0" road lane because of the use of automated systems guiding the bus and facilitating safety while moving at speed along the laneways. Also, the bus's approach to the stations would be automated (as is already done elsewhere) so that the bus aligns with the stations properly when stopping.

Once a bus is on McGill Avenue and Renfrew Street it will move with the traffic and stop at the lights. However, during rush hours, parking would be suspended along the outside lanes to allow the bus to pass slow vehicle traffic and lineups at intersections.

BRT SYSTEM PASSENGER CAPACITY

The North Shore – Renfrew BRT Line will have the capacity to handle the demand of people arriving on buses at the Phibbs Station Hub and arriving at the Sky Train Renfrew Station from both directions on the Millennium Line.

Considering the Phibbs Station Hub, TransLink is proposing an Express Bus Line (B-Line) across the North Shore which will connect to the Phibbs Station Hub, along with a number of regular bus lines. It is possible that the demand on the North Shore B-Line will be similar to the demand on Broadway where according to a report on the proposed Broadway Subway, the B-99 bus line already can, with single articulated buses passing a stop every 2.7 minutes, move up to 2,600 passengers/hour during rush hour and no street parking. Add to this the 4 regular bus lines (209, 210, 211 and 214 which at present pass over the bridge) and, assuming that each passes by every 15 minutes without traffic congestion, could move up to 960 passengers/hour at rush hour. The total would be in the range of 3,600 passengers/hour wishing to cross the bridge.

Considering the Sky Train Renfrew Station on the Millennium Line, the Line at present can during rush hour, move at least 5000 passengers/hour/direction, very similar to the Canada Line. Assuming that 30% of the passengers from each direction get off to go to the North Shore, (Some might also be getting off to go to Hastings Park) the total would be about 3,000 passengers/hour, close to the number of passengers going south.

The North Shore – Renfrew BRT Line could handle this demand. The BRT buses with a 250-person capacity, passing a Station once every 4 minutes (on average) at rush hour will move 3,730 passengers/hour. Actually, the Line will have much more capacity. First, the Stations will have Compass entry turnstiles which allows the BRT stops to be much shorter than at regular bus stops. Second, there will also be a sufficient number of 250 passenger capacity bi-articulation buses which, when organized to pass by a Station once every 2.7 minutes, (same as the Broadway B-99 Line at 2.7 minutes) at rush hour will move up to 5,560 people/hour/direction for a total daily ridership in the range of 154,000 people. This is in the scale of the Sky Train Network. If people can be encouraged to use it there would be a significant reduction of vehicle congestion on the Iron Workers Memorial Bridge.

APPROXIMATE SCOPE OF WORK AND PROJECTED BUDGET

Constructing the North Shore – Renfrew BRT Line will involve the following major items:

- PLANNING, DESIGN, ENGINEERING and AUTOMATION TECHNOLOGY
- STEEL GUIDEWAY STRUCTURES on the Iron Workers Memorial Bridge: 2,700 m
- AUTOMATED GUIDEWAY LANES ON COLUMNS: 1,170 m
- AUTOMATED GUIDEWAY LANES ON GRADE: 2,100 m
- SIGNAL AND HOV ROAD PREPARATION ON McGILL & RENFREW: 4.1 km
- DESTINATION STATIONS: 2
- LINE STATIONS: 6
- BI ARTICULATED BUSES: 45
- BUS GARAGE STORAGE AND MAINTENANCE

PROJECTED BUDGET: $150M -$200M

THIS REPORT HAS BEEN RESEARCHED and PREPARED BY BRUCE WATT using sources and websites from the Internet. Email address: t.bruce.watt@gmail.com