MAJOR COMMERCIAL TRANSPORTATION SYSTEM

mcts

Appendix

Greater Vancouver Gateway Council:

Economic Impact Analysis Of Investment In A Major Commercial Transportation System For The Greater Vancouver Region

Prepared By:

DELCAN

Economic Development RESEARCH GROUP

JULY 2003
SW1040

TABLE OF CONTENTS

Appendix 1

Major & Minor Road Improvements

The following pages of this section present a description of the major and minor road improvements identified in this study[1]. Each of the major and minor improvement descriptions include information on the major features and characteristics for each project in order to provide direction in coding the EMME/2 regional model and/or SYNCHRO capacity analysis software. The information provided also assisted the project team in the development of cost estimates such that these could be used to derive the actual impact of implementing the road improvements.

Each project was described in terms of the following categories:

Title:	A short title identifies the proposed improvement.
Basic Project Description:	A short paragraph including the basic features of the project in terms of the improvement proposed.
Length:	The length of the proposed improvement.
Number of Lanes:	The number of lanes of the improvement - when different cross sections are found at specific locations, the number of lanes refers to the general/predominant number of lanes for the typical sections.
Design Speed:	The predominant design speed of the project.
Analysis Tool:	Refers to the tool used to analyse the effect of the improvement on traffic congestion. The main tools used are the regional EMME/2 model and special SYNCHRO networks developed for this study.
Intersection/Interchanges:	Refers to the intersection/interchanges found along the project's alignment.
Other Unique Features:	Additional characteristics of the project that distinguish it from other improvements as well as other features that may affect its performance and management such as bus lanes, stops, frequent accesses, etc., are included under this category.
Implementation Costs:	Refers to the capital costs associated with the implementation of the proposed improvement.
Information Derived From:	Refers to the documents reviewed to develop the description, features, and cost estimates of the project.
Assumptions:	The general description of the coding assumptions in EMME/2 and/or SYNCHRO as well as other assumptions for cost estimate purposes are included in this category.
Identified Improvements:	Under this category, a description of the improvements at specific locations is included.

[1]In addition to the road improvements, two non-road major investments are included in the project descriptions: the Richmond Airport/Vancouver Rapid Transit and the New Westminster Rail Bridge.

MAJOR ROAD IMPROVEMENTS

Project: HIGHWAY 1 EXPANSION FROM VANCOUVER TO CHILLIWACK*

Basic Project Description:

Upgrade of Trans Canada Highway between Grandview / Willingdon and 200th Street in Langley to add capacity through the provision of at least one general purpose lane in each direction. *It should be noted that previous studies indicated that expansion of the Trans Canada Highway east of Langley may be unnecessary, therefore, the extension to Chilliwack has not been included.

The project can be divided into the following sectors:
- Burrard Peninsula
- Cape Horn Area
- Fraser River West (Cape Horn to 200th Street)

For the section on the Burrard Peninsula, the basic recommendations of the Trans Canada Highway Upgrading Study (Delcan 1993) were used. For the Cape Horn area, the basic recommendations of the Cape Horn Area Network Study (Delcan 2000) were used. At the Port Mann Bridge, the proposed configuration will include the twinning of the Port Mann Bridge to accommodate eight lanes (3+1 / 3+1).

East of the Port Mann bridge, the existing highway will be widened to accommodate one additional lane in each direction. These lanes would be designated as a HOV lane. An add / drop lane (in both directions) will be provided across the Port Mann Bridge between the 152nd Street Interchange and the Cape Horn Interchange. The Port Mann Bridge, as mentioned would therefore possess an eight lane cross section (3+1/3+1). The additional lane / widening would continue only to the 200th Street interchange area - terminate / develop approximately 1000 metres east of the 200th Street interchange.

Existing Roadways Affected:

The following roadways are likely to be affected by the upgrading of Highway 1:
- Highway 1
- Grandview Highway
- Willingdon Avenue
- Kensington Avenue
- Gaglardi Way
- Brunette Avenue
- Lougheed Highway
- Highway 7 (Mary Hill Bypass)
- 152nd Street
- 104th Avenue
- 160th Street
- 176th Street
- 192nd Street
- 200th Street (to be constructed to accommodate at least six lanes)

Length: 35+ kilometres

Number of Lanes:

1st Avenue to Grandview Street - 6 GP
Grandview to 152nd Street - 6 + 2 HOV
152nd Street to 200th Street - 4+ 2 HOV

Transition from 4 GP to 4 GP + 2 HOV just east of 200th Street (assume 1000 metres). Transition from 4+2 HOV via add / drop lanes at the 152nd Street Interchange.

Design Speed:

100 km/h east of 152nd Street
90 km/h west of Port Mann
90 km/h west of Gaglardi

As per base EMME/2 model

Intersections / Interchanges:

Highway 1 is a freeway, therefore all intersecting roads will be connected through interchanges. Interchange upgrades are anticipated at the following locations:

- Grandview/Boundary I/C (with 12-lane core/collector system) - Scheme 2 from TCH 1993
- Willingdon Avenue I/C - Scheme 2 from TCH 1993
- Sprott and Kensington Avenue - Scheme 4 from TCH 1993.
- Stormont Connector***
- Gaglardi Way - from ET 2001
- Brunette Avenue - from ET 2001
- Cape Horn / Highway 7 - I/C Option 3 from Cape Horn Study 2000
- 152nd Street - Option recommended in Cape Horn Study 2000
- 104th/160th Street - ET reviewed, scheme 2 TCH 93
- 176th Street - SFPR 2000
- 192nd Street (superseded by TransLink 2001)
- 200th Street (DB Concept and Translink 2000)
- 216th Street (parclo A - Highway 1 Port Mann Bridge to Hope Study)

Other Unique Features:

- Several railway crossings to be widened (west of Cape Horn / CP Rail, east of Gaglardi / BNSF)
- Several creek and minor river crossings (Brunette River, Vedder Canal, Sumas River)
- Several flyover structures to be reconstructed (Glimour, Sprott, King Edward)

Implementation Costs: $ 1000 M to $ 1200 M

Information Derived From:

- Highway 1 Corridor Planning Study - Port Mann to Hope, 2001
- Cape Horn Area Network Study, 2000
- Lower Mainland Systems Analysis Study, 2002
- Trans Canada Highway Upgrading Study - 1st Avenue to 200th Street, 1993
- Trans Canada Highway Chilliwack Interchange Study, 2001
- Highway 1/11 Interchange Conceptual Planning Project Value Analysis, 2000
- Other information from the Ministry of Transportation

Project: **SOUTH FRASER PERIMETER ROAD**

Basic Project Description:

The project consists of a proposed new and upgraded corridor that generally runs in an east-west direction from Highway 1 / 15 to Highway 99 along the south side of the Fraser River. A further extension to Highway 17 has also been assumed.

The section between Highway 91 and Highway 99 has not been significantly studied. Therefore, information obtained from the Ministry has been augmented to meet the basic assumption for the Highway 17 corridor. As such, an East Ladner bypass has been assumed to replace Highway 17 as the main route to the Highway 99 corridor from Roberts Bank, the ferry terminal, and Tsawwassen.

The SFPR / East Ladner Bypass can be divided into eight sections as follows:
- Highway 17 at Deltaport Way to Highway 99
- Highway 99 to 60th Avenue
- 60th Avenue to Highway 91
- Connection to Highway 91 interchange at the western terminal
- The Delta Section from Alex Fraser Bridge to the Delta / Surrey border
- The South Westminster, Bridgeview, and Port Mann Section from the Delta / Surrey border to 112B Avenue east of Port Mann Bridge
- The Fraser Heights Section from 112B Avenue to 176th Street
- Connection to Highway 1 / 15 at the eastern terminal

The project generally consists of the following:
- Close to eight kilometres of new expressway from Deltaport Way at Highway 17 to the new interchange at Highway 99 / SFPR
- Approximately 30 km length of mainline along the south shore of the Fraser River from Highway 17 / 99 in Delta to Highway 1 / 15 in Surrey
- Improved connections between the SFPR, the Highway 91 interchange, and River Road
- Connection of River Way at a signalized intersection to the connecting road between the SFPR and Hwy 91 interchange
- Connection of the SFPR to Highway 1 and Highway 15
- Connection of the Port Kells Industrial area to the SFPR at 104th Avenue and 176th Street
- A westbound entrance ramp and an eastbound exit ramp from Highway 1 at Harvie Road
- Associated local road system changes and improvements
- Accommodation of cyclists in accordance with MoT cycling policy
- No direct access

Existing Roadways Affected:

- Highway 99
- River Road
- River Way
- Centre Street
- Delwood Drive
- 130th Street
- Highway 17 / Deltaport Way
- Highway 10 (overpass)

Length:

31 km + 8 km

- Highway 17 at Deltaport Way to Highway 99 (8 km)
- Highway 99 to 60th Avenue - 1.0 km (to be confirmed)
- 60th Avenue to Highway 91 - 7.8 km (to be confirmed)
- Connection to Highway 91 - 1.3 km
- Alex Fraser Bridge to Delta / Surrey Border - 3.1 km
- Delta / Surrey border to 112B Avenue - 4.1 km
- 112B Avenue to 176th Street - 12.3 km (to be confirmed)
- Connection to Highway 1 - 1.6 km

Number of Lanes:

4-Lane divided (basic lanes)

Design Speed:

80 km/h west of 139A Street and 90 km/h to the east

Intersections / Interchanges:

Signalized Full Movement

- 60th Avenue (to be confirmed
- Progress Way (to be confirmed)
- 96th Street
- Elevator Road ("T" Intersection)
- Grace Road ("T" intersection)
- Tannery Road
- Old Yale Road
- 114th Avenue
- Bridgeview Drive (130th Street)
- 136th Street

Right-In / Right-Out

- Centre Street
- Delwood Drive
- 88th Street (to be confirmed)

Interchange Reconfiguration

- Highway 99 / 17 (to be removed)
- Reconfigure Deltaport Way / Highway 17 interchange
- Flyover at Highway 10
- New interchange at Highway 99
- Highway 1 / 15 interchange changes to accommodate a new loop on the SW quadrant

- 104th Avenue / 176th Street intersection is replaced by new interchange

Other Unique Features:

- Eastbound on-ramp from River Road in the vicinity of Knudson Place
- BNSF Overhead near Centre Street (twin parallel structures 382 m long)
- Unnamed Creek - 27 m span (Sta 60+00)
- McAdam Creek - 30+33+30 m spans (Sta 61+50)
- Collings Creek - 24+33+24 m spans (Sta 63+50)
- Norum Creek - 24+33+24 m spans (Sta 67+50)
- Gunderson Creek - 27 m span (Sta 69+00)
- Widening of Colleries Creek Bridge
- Reconstruction of Southern Rail Bridge
- 104th Avenue Interchange Bridge

Implementation Costs:

$401 million ($22 million have been already expended by the Province, the City of Surrey, and others) - Section from Highway 1 to Highway 91.

$100-$150 million - Cost for section from Highway 91 to Highway 99/17 to be developed.

Information Derived From:

South Fraser Perimeter Road - Planning and Preliminary Design Study - 2001.
South Fraser Perimeter Road Extension Study - 2002

Model of network between Highway 1 and Highway 99 previously coded.

Outstanding Information:

- Cost estimate for Highway 91 to Highway 99/17 is cursory and needs to be confirmed at a later stage.
- Confirmation of connections to above section to be undertaken.

Project:

NEW FRASER RIVER CROSSING

Basic Project Description:

New river crossing to be located between Maple Ridge / Pitt Meadows and Langley with connections/road improvements to Surrey. The crossing has the following basic design parameters:

- Four-lane corridor wide section with localized additional auxiliary lanes.
- A free flow design speed of 80 km/h at most sections and the river crossing. A design speed of 60 km/h along segments with at-grade intersections.
- Limited access with connections to major arterials only.

Three feasible crossing options are under consideration by TransLink. All of them have similar alignment in the north shore (Maple Meadows alignment). Different alignments are being studied for the southern section and its connections to the arterial network.

The following three options are being studied:

- Option 1 assumes a main bridge to cross the river and connects to Highway 1 through an upgraded 200th Street before continuing westwards to end in the vicinity of 176th Street/96th Avenue intersection.
- Option 2 follows a similar alignment as option 1 but instead of crossing the river through a single structure, it uses Barnston Island providing a hybrid crossing comprised of a tunnel to cross the main river channel and a bridge to cross the southern channel. The main connections to Highway 1 are provided through a new interchange at 192nd Street.
- Option 3 is similar to Option 1 but instead of connecting to Highway 1 through 200th Street, a new interchange is proposed at Highway 1/192nd Street as in Option 2.

For coding purposes, it has been assumed that Option 1 will be implemented. This has been divided into six segments for cost estimating purposes:

- Segment A - 176th Street to 186th Street
- Segment B - 186th Street to 199A Street
- Segment C - 199A Street to 102nd Avenue
- Segment D - The River Crossing
- Segment E - 113B Avenue Interchange
- Segment F - 113B Avenue Interchange to Lougheed Highway

Existing Roadways Affected:

The following roadways are likely to be affected by the construction of this new river crossing

- Maple Meadows Way
- Lougheed Highway
- 113B Avenue
- 201st Street

- 199B Street
- 200th Street
- 192nd Street
- 96th Avenue
- Telegraph Trail
- Lougheed Highway
- 176th Street

Length: Approximately 20 km (exact length depends on final configuration)

Number of Lanes: Bridge - 6 Lanes
Connecter Roadway - four lanes plus auxiliary lanes where required.

Design Speed: 80 km/h along free flow segments; 60 km/h on other new connectors*

Intersections / Interchanges: Intersection improvements are required along Maple Meadows Way, 199B St, 200th St, 201st St , 192nd St, 190th St and 96th Ave.*

New interchanges are proposed at Lougheed Highway/bridge connector, 113B Avenue/Maple Meadows Way, 176th Street/96th Avenue. A southbound flyover is proposed to access 199B Street. New on/off ramps are provided on Highway 1 at 182nd Street and 192nd Street.*

Other Unique Features: Various structures along the main corridor.

Implementation Costs: Between $600 and $660 M depending on the option implementation strategy. The cost for the various segments of Option 1 are as follows:

• Segment A:	$50 million
• Segment B:	$50 million
• Segment C:	$105 million
• Segment D:	$230 million
• Segment E:	$60 million
• Segment F:	$90 million
• Cycling and other components:	$20 million
Capital Cost:	**$605 million**

Information Derived From: New Fraser River Crossing Due Diligence Report, May 2002

*Model network for the project has been previously developed. Therefore all connection roadways have been described in this network.

Project:	**RICHMOND AIRPORT - VANCOUVER RAPID TRANSIT PROJECT**
Basic Project Description:	Provision of an LRT connection between Richmond / Vancouver International Airport and Vancouver Central Business District. Various alignments and technologies have been studied. An exclusive right-of-way system with fully separated alignments from the street level was chosen for assumption purposes. An alignment along Cambie Street was assumed.
Length:	From Waterfront to Granville Avenue/Airport: 15.25/15.13 km Airport Branch (from Bridgeport Road): 3.77 km
Travel Time:	from Waterfront to Granville Avenue/Airport: 22/21 min Airport Branch (from Bridgeport Road): 5 min
Average Speed:	from Waterfront to Granville Avenue/Airport: 43.8 km/h Airport Branch (from Bridgeport Road): 44.0 km/h
Frequency of Service:	from Waterfront to Granville Avenue/Airport: 4/3 minutes Airport Branch (from Bridgeport Road): 8/6 minutes
Combined Frequency on mainline:	2.0 min
Vehicles Required based on assumed frequencies:	55
Peak Direction Capacity per Hour:	7200 passengers 160 passengers per car
Stations:	13 stations: • Waterfront • Robson/Granville • Nelson • Mainland • Broadway • King Edward • 41St Avenue • 49th Avenue • Marine • Bridgeport • Cambie • Alderbridge • Westminster • Granville

Implementation Costs: $1.86 Billion (to be confirmed given recent studies)

Information Derived From:

- Richmond / Airport - Vancouver Rapid Transit Project, April 2001
- Richmond / Airport - Vancouver Rapid Transit Project - Richmond T/2 Segment, August 2002

Model of transit network for this project has already been developed

Project: NORTH FRASER PERIMETER ROAD

Basic Project Description:

Improvement of existing east-west corridor within New Westminster and Coquitlam formed by a series of arterial roads such as Stewardson Way, Front Street, Columbia Street, Brunette Avenue and United Boulevard. The project intends to improve mobility along the corridor through various improvements along United Boulevard in Coquitlam/New Westminster and Columbia / Front Street in New Westminster. A key component of the proposed NFPR is the construction of the United Boulevard Extension consisting of a 4-lane road from west of King Edward Street to Brunette Avenue via a new rail grade separation and a new interchange on Brunette Avenue. The section of United Boulevard from King Edward to the New Westminster boundary is constructed.

A grade separated intersection is to be provided at the north intersection between Front Street and Columbia Street. The interchange at the north bridge head to the Queensborough bridge is to be reconfigured.

Existing Roadways Affected:

- United Boulevard Extension (UBE) from Coquitlam Boundary to Brunette Avenue. The key component of the proposed 4-lane extension of United Boulevard into New Westminster is the construction of a grade-separated structure over the railways, together with an interchange connecting United Boulevard with Brunette Avenue. This piece will connect with the section of the UBE which has been constructed in Coquitlam.
- Second Eastbound Lane at East Columbia. Widening the existing eastbound one-lane section of east Columbia Street / Brunette Avenue from east of Cumberland Street to Keary Street to two lanes such that the East Columbia/Brunette connection will be a continuous 4-lane cross section.
- Possible grade separated tunnel at east Columbia Street / Front Street Intersection to allow westbound left turning traffic to Front street to cross the eastbound traffic lanes unimpeded.
- New interchange at the north end of the Queensborough bridge.

Length:

- United Boulevard Extension: 2.0 km (to be confirmed in model)
- Second Eastbound Lane at East Columbia Street: 0.7 km (to be confirmed in model)

Number of Lanes: 4 basic lanes throughout corridor

Design Speed: 70 km/h (to be confirmed)

Intersections / Interchanges:

- Intersection Improvements, United Boulevard at King Edward Avenue (assumed constructed)

  Improvement of United Boulevard from Nelson Creek east to King Edward Avenue, plus signal improvements, to better accommodate increased traffic volumes at this intersection.

- Queensborough North Bridgehead Reconfiguration

  Reconstruction of the interchange at the bridge head to a new on-ramp configuration, including an improved 2-lane connection from the NFPR to Marine Way (see outstanding information).

- United Boulevard / Brunette Avenue Interchange (see outstanding information)

- Grade separation of Front Street / East Columbia intersection (see outstanding information)

Other Unique Features:

- Front Street / East Columbia Truck Tunnel

  Construction of a tunnel underneath the Front Street / East Columbia Street intersection to transfer westbound truck traffic from East Columbia Street onto Front Street, hence eliminating the existing left turn movement at the intersection.

Implementation Costs:

Short Term	
United Boulevard Extension	$35 million
Second Eastbound Lane on Columbia	5 million
Front Street/East Columbia Street Tunnel	10 million
Total	$50 million
Longer Term	
Queensborough Bridgehead Improvements	$35 million

Information Derived From:

- Review of Major Capital Projects, TransLink, August 2001.
- New Westminster Area Network Study, 2001.

Project:	**NEW WESTMINSTER RAIL BRIDGE / TUNNEL**
Basic Project Description:	Replacement of existing structure with a tunnel crossing of the Fraser River. The existing bridge currently handles 46 trains per day with an estimated capacity of 59 trains per day. The new tunnel will accommodate two tracks. Grade of tunnel approaches has been assumed to be only one percent (1%). However, 1.5% could be considered to reduce tunnel length. Depth of tunnel under the Fraser River has been assumed to be 25 metres (top of rail to water surface). Tunnel is assumed to be located in a similar location to the existing bridge. A spiral bored tunnel is assumed to be located on the New Westminster side. Immersed tube technology has been assumed for the tunnel in the river section. Cut and cover tunnel technology has been assumed in the soft soils on the Surrey side. Significant retaining walls and cut cover tunnelling expected on Surrey side of river. There is a possibility that the new tunnel will be combined with road traffic as a replacement of the Pattullo Bridge.
Length:	> 5.5 kilometres (under development)
Capacity:	> 100 trains per day
Design Speed:	30 to 50 km/h (500 metre radius curve - 3.5 degree of curvature)
Other Unique Features:	Relocation of significant portions of existing track network on Surrey side. Possibility of Wye sections in tunnel on either side of river to connect to existing rail network. Immersed tube technology in river section. Bored spiral tunnel section in New Westminster. Surplus material to be used as fill (into the Fraser River) on the New Westminster side to create an opportunity to reduce the tunnel length by providing some of the track curves beyond the hillside in order to connect to the existing rail network. Potential to reduce costs.
Implementation Costs:	Included as part of the railway investments
Information Derived From:	Developed by Delcan Corporation

Outstanding Information:

Scope under development - configuration of connections to existing rail network; extent of tunnel section / retaining walls on Surrey section. Cost estimate to be prepared.

Actual feasibility of this configuration needs to be confirmed through significant geotechnical and environmental investigations. A future feasibility study is planned to analyse/review this improvement in further detail.

Project:

GEORGE MASSEY TUNNEL AT HIGHWAY 99 - CAPACITY IMPROVEMENTS

Basic Project Description:

Significant upgrade of the existing Massey Tunnel river crossing along Highway 99. Upgrade to include new immersed tube tunnel section, separated approximately 50 metres upstream from existing tunnel. New tunnel section to possess only two lane cross section consisting of two northbound general purpose lanes. Existing tunnel to consist of two southbound general purpose lanes and two HOV lanes (one in each direction).

Reconfiguration of interchange at Steveston Highway to accommodate six through lanes. Current structure pier configuration may accommodate these lanes. Counterflow system to be radically changed to accommodate the four lanes northbound during AM peak periods and four lanes southbound during the PM peak periods.

Reconstruction of interchange at Highway 17 to accommodate six through lanes. This interchange will tie in with upgraded River Road (South Fraser Perimeter Road to the east). New structures required.

The HOV lanes would be reconfigured such that these are located in the median. The HOV lanes will be extended southward to King George Highway. The HOV lanes will be extended northward to the Westminster Highway interchange.

The Westminster Highway interchange will need to be reconstructed to accommodate six through lanes (Note: this is part of Oak Street Bridge Project). Widening of Highway 99 north of the Westminster Highway to the Oak Street bridge will be required to accommodate the six lanes (4 + 2 HOV). (part of Oak Street Bridge Project)

Existing Roadways Affected:

The following roadways are likely to be affected by the construction of this upgraded river crossing: (to be confirmed)

- Highway 99
- Steveston Highway
- Highway 17
- River Road
- Rice Mill Road
- Blundell Road

Length:

Massey Tunnel Section between Highway 17 and Steveston Highway is approximately 3.9 kilometres.
HOV extension south to 8th Avenue is approximately 25 km
HOV extension to Westminster Highway is approximately 3.6 km

Number of Lanes:	Tunnel Section: 2 + 1 HOV (each direction - normal) 3 + 1 HOV NB / 1 + 1 HOV SB (AM peak period) 3 + 1 HOV SB / 1 + 1 HOV NB (PM Peak Period) South of Tunnel: 3+ 1 HOV (each direction) North of Tunnel: 3+1 HOV (each direction)
Design Speed:	90 km/h on Highway 99 except in tunnel section (80 km/h) Unchanged on other intersecting corridors
Intersections / Interchanges:	Highway 17 (to be relocated to SFPR and east Ladner Bypass) Steveston Highway Westminster Highway Blundell Road (new interchange)
Other Unique Features:	New immersed tube tunnel - exact location upstream assumed to be only 50 metres. Will affect Deas Island regional park and most likely the Town and Country Inn. Widening of the highway for the new tunnel will be located upstream.. Overpass structure at Shell Road / CP Rail. Assume that Highway 91 / No. 5 Road unaffected. Rail structure at existing tunnel to be lengthened for new tunnel. Assume that only the Highway 91 interchange can accommodate six lanes. Therefore, assume that 112th Street, and Highway 10 overpass structures need to be reconstructed to accommodate six lanes. The BNSF structure will need to be widened, however, the BC Rail overpass structure can accommodate six lanes on Highway 99. Structures over Serpentine River to be widened to six lanes. The culvert under Highway 99 for 72nd Avenue needs to be lengthened. Existing road sections: HOV lanes extend from Highway 17 south approximately 4.2 kilometres in the northbound direction only. Between Westminster Highway and Steveston Highway, the existing cross section is six lanes (2+1 southbound and 3 northbound). Elsewhere, the highway cross section is 2 / 2. Coordination with east Ladner Bypass and SFPR need to be addressed to avoid duplication of the connections.
Implementation Costs:	$ 500 M to $ 700 M
Information Derived From:	Developed by Delcan. Cost estimate should be considered cursory as it needs to be validated in further detail through future studies.

Project: OAK STREET BRIDGE UPGRADE

Basic Project Description:

HOV lanes are to be added to the Highway 99 corridor. As part of the Massey Tunnel upgrade, HOV lanes have been extended up to Westminster Highway. For this project, the HOV lanes will be extended northward to the Oak Street Bridge. The Oak Street Bridge will be widened to six lanes to accommodate the HOV lane in each direction plus the two general purpose lanes in each direction. The HOV lanes are assumed to remain in the median of Highway 99 across the bridge. At the north end of the bridge, the HOV designation will end, and the lane will be treated as a general purpose lane from the north bridge abutment through the 70th Ave intersection.

The Westminster Highway interchange will need to be reconstructed to accommodate six through lanes. Widening of Highway 99 north of the Westminster Highway to the Oak Street bridge will be required to accommodate the six lanes (4 + 2 HOV).

Existing Roadways Affected:

The following roadways are likely to be affected by the construction of this upgraded river crossing: (to be confirmed)

- Highway 99
- Westminster Highway
- Shell Road
- Cambie Street

Length:

HOV extension to Oak Street at 70th Avenue from Westminister Hwy is approximately 6 km

Number of Lanes:

North of Westminster Highway: 2+1 HOV (each direction)

Design Speed:

90 km/h on Highway 99
Unchanged on other intersecting corridors

Intersections / Interchanges:

Highway 91
Bridgeport - Sea Island Way
Shell Road - No. 4 Road

Other Unique Features:

Implementation Costs:

$100 M

Information Derived From:

Developed by Delcan: Inclusion of Oak Street Bridge through information provided by TransLink. Cost estimate should be considered cursory as it needs to be validated in further detail through future studies.

Project:

HIGHWAY 15 UPGRADING FROM HIGHWAY 1 TO US BORDER

Basic Project Description:

Upgrade of the existing Highway 15 corridor from US Border in Surrey to Highway 1. Upgraded corridor to consist of a homogeneous four lane cross section.

The highway can be divided in three segments:

US Border to Colebrook Road, just south of Highway 10.The section of Highway 15 from the US border at the Pacific Highway border crossing to 32nd Avenue is already four lanes. The project consists of:

- completing the four-lane cross section from the US border to Highway 10.
- intersection upgrades for the section, south of 32nd Avenue.

Highway 10 to 88th Avenue. The project consists of:

- Widening of the existing urban cross-section through Cloverdale and realignment of municipal roads to improve sight distance and safety.
- Realignment of the spur line, immediately south of the Highway 10/15 intersection, to eliminate the at-grade crossing.
- The widening work includes the twinning of the Roger Pierlot CPR rail overpass, 400m south of the intersection of Highway 15 with Highway 10.
- Widening the existing two-lane highway to four-lane and reconstruction of some major intersections, north of Cloverdale, to address current and future traffic demand.

Highway 15 widening (88th Avenue to Barnston Avenue (north end of Trans Canada Highway). The project consists of:

- Widening of the two-lane highway to a four-lane and reconstruction of the some major intersections.
- The Trans Canada Highway interchange upgrades are required for the South Fraser Perimeter Road project and for the Fraser River Crossing but funding has not yet been secured for these upgrades as part of either of these projects.

Existing Roadways Affected:

The following roadways are likely to be affected by the upgrading of this north south corridor:

- 96th Avenue
- 88th Avenue
- Fraser Highway
- 64th Avenue
- 60th Avenue
- 59th Avenue
- 58A Avenue
- Highway 10
- 8th Avenue

Length:	20.1 km US border to Colebrook Road: 10.6 km Colebrook Road to 88th Avenue: 7.4 km 88th Avenue to Barnston / TCH 2.1 km
Number of Lanes:	Four Lanes throughout corridor
Design Speed:	Varies between 50 and 80 km/h (50 km/h through Cloverdale - Highway 10 to 64th Avenue)
Intersections / Interchanges:	25 intersections will be upgraded, one will be relocated and two will be closed. 80th Avenue intersection will be signalized.
Other Unique Features:	Highway 1/15 interchange upgrades
Implementation Costs:	$85 million capital cost, $15 million property cost US border to Colebrook Rd: $18 million capital; $ 4 million property Colebrook Rd. to 88th Ave.: $61 million capital, $11 million property 88th Ave. to TCH: $6 million capital, $0.2 million property
Information Derived From:	• Ministry of Transportation internal report, October 2002. • Highway 10/15 Access Management Study, 2003 • Highway 1 Corridor Planning Study - Port Mann to Hope, 2001

Project: **HIGHWAY 10 UPGRADING FROM HIGHWAY 1 TO HIGHWAY 91**

Basic Project Description:

Upgrade of the existing Highway 10 corridor from Highway 1 in Langley to Highway 91. It has been assumed that the section between Hwy 91 and Hwy 17 is not included as it is unwarranted and unwanted by Delta (Hwy 10 / Ladner Trunk Road closed to truck traffic).

Upgraded corridor to consist of a homogeneous four lane cross section.

Previous option development has been developed internally by the Ministry of Transportation for the segment between Highway 91 and Highway 1. These options have been focussed on access management to the Highway. No intersection improvements are envisioned other than the four lane cross section requirements of Highway 10.

The following is a list of options for the different segments of the sector between Highway 91 and Highway 1:

- Highway 91 to 120th Street. Provision of a climbing lane eastbound.
- 120th Street to King George Highway. Four-lane divided cross section with bus bays. Currently, a three/four lane section between King George Highway and 136th Street.
- King George Highway to 152th Street. Four-lane divided cross section with limited median breaks, widening of King George Highway intersection and extension of the climbing lanes west of 152nd Street. The current cross section between King George Highway and 152nd Street is two lanes, except in the westbound direction where two lanes are provided between 152nd and 148th street. A westbound auxiliary lane exists between 152nd Street and approximately 148th Street also.
- 152th Street to Highway 15. Four-lane divided cross section. Existing cross section is basically two lanes.
- Highway 15 to 192nd Street: Bypass of the Cloverdale Town Centre. Localized widening to accommodate raised median and turn bays at 176th Street as existing cross section is basically four lanes.
- Langley Bypass. Non-traversable median, increase in posted speed to 80 km/h.
- Glover Road to Highway 1. Four-lane cross section. Existing cross section is only two lanes. Significant impacts at Crush Crescent to accommodate additional lanes /widening.

Existing Roadways Affected:	The following roadways are likely to be affected by the construction of the upgrade of this east west corridor: (to be confirmed) • Highway 10 • Glover Road • Crush Crescent • 200th Street* • Fraser Highway* • 176th Street • 152nd Street • King George Highway
Length:	Approximately 27 km (Highway 1 to Highway 91)
Number of Lanes:	Four lanes throughout corridor (Basic Lanes)
Design Speed:	Varies between 50 and 80 km/h (50 km/h between Highway 15 and 180th Street)
Intersections / Interchanges:	Several intersections - similar to existing network *To be considered: • 200th Street interchange at Highway 10 (grade separation of some movements) • Fraser Highway interchange at Highway 10 (grade separation of some movements)
Other Unique Features:	50 km/h speed limit in Cloverdale Twining of the Serpentine River Bridge Poor soil conditions between 152nd and Highway 15 - will increase cost of construction Possible grade separation with rail track prior to Glover Road along the Langley Bypass
Implementation Costs:	Between $60 and $80 million between Highway 1-Highway 91 Structure costs at Fraser Highway and 200th Street to be considered along with rail separation
Information Derived From:	• Highway 10/15 Access Management Study (2003-on going) • Highway 10 Access Management Study - MoT • Highway 1 Corridor Planning Study - Port Mann to Hope, 2001 • Highway 10 - King George Highway to Scott Road Preliminary / Detailed Design • Information developed by Delcan

Project:	**PACIFIC BORDER CROSSING - IMPROVED ACCESS FROM HIGHWAY 99**
Basic Project Description:	Upgrade/widening of 8th Avenue connection from Highway 99 to Highway 15. The project also includes the interchange upgrade at Highway 99 and intersection upgrade at Highway 15 and other locations. The improvement can be subdivided into the following three components:

- Highway 99 and 8th Avenue Interchange Reconfiguration
  - Widen overpass by three lanes to a five-lane facility.
  - Add dual SB to EB left turn on King George Highway
  - Lengthen the SB deceleration lane of the SB to EB off loop.
  - Convert the eastern half of the interchange to a diamond configuration with signalized intersections or roundabouts.
  - Lengthen the NB acceleration lane of the NB on-ramp.
- 8th Avenue Improvements
  - Four lane from King George Highway to Highway 15.
  - Provide EB to NB left turn bay at 168th Street.
  - Provide WB-to-SB left turn bay at 172nd Street and preducting for future signalization.
  - Restrict access at 171st Street to right-in right out.
- Highway 15 and 8th Street intersection
  - Add dual NB-to-WB left turn lanes.
  - Add full EB-to-SB right turn signalization.

Existing Roadways Affected:

The following roadways are likely to be affected by the upgrading of 8th Avenue:

- Highway 99
- Highway 15
- 168th Street

Length:	1.7 kilometres
Number of Lanes:	Four lanes on the entire corridor with additional lanes at key intersections.
Design Speed:	70 km/h

Intersections / Interchanges:

- Highway 99 interchange modification - eastern side quadrants to accommodate a diamond configuration.
- Highway 15 intersection will accommodate dual left turn NB to WB lanes. Channelisation of the EB to SB lanes is also expected.
- 168th Street intersection will potentially include a roundabout configuration.
- 162nd Street intersection to be signalized.

Other Unique Features:

The Douglas Neighbourhood is bounded by Highway 99, 8th Avenue, Highway 15 and the border. A previous traffic impact study itemized the following traffic issues for this community:

- Unique traffic patterns caused by border crossing operations including rat-running;
- Safety concerns at 8th Avenue/172nd Street intersection; and,
- Problems at the Highway 99/8th Avenue interchange.

Implementation Costs:

Total estimated costs:	$20 Million*
Highway 99 I/C upgrade:	$12 Million
8th Avenue Upgrading:	$ 7 Million
Highway 15 intersection upgrades:	$ 1 Million

* Order of Magnitude Costs (Class B estimates)

Information Derived From:

- British Columbia Lower Mainland Trade Corridor Border Projects, Business Case Evaluation - Final Report. Request for Strategic Highway Improvement Program. Funded under the TransCanada Border Crossing Transportation initiative. UMA, 2002.
- Preliminary Investigation made by the Ministry of Transportation.

MINOR ROAD IMPROVEMENTS

Project:	**MARINE DRIVE - GRANVILLE ST. TO BOUNDARY ROAD**
Basic Project Description:	Conversion of one of the existing general-purpose (GP) traffic lanes in each direction to High Priority Vehicle (HPV) lanes, in conjunction with traffic signal coordination.
Existing Roadways Affected:	Marine Drive between Granville Street and Boundary Road will be affected as will all signalised intersections on the corridor (see below). It is to be noted that although the corridor has been analysed in isolation, the amendment of traffic signal timings will impact on the surrounding street network especially when the signals are coordinated.
Length:	8.9 km
Number of Lanes:	Generally two GP lanes and one HPV lane in each direction with additional turning lanes at intersections
Design Speed:	50 km/h
Analysis Tools:	EMME/2 for new laning analysis Synchro for signal coordination analysis
Intersections / Interchanges:	Numerous unsignalised intersections as well as the following signalised intersections: • Granville St/70th Avenue • Oak St/70th Avenue • Marine Dr/Oak St • Marine Dr/Heather St • Marine Dr/70th Avenue • Marine Dr/Cambie St • Marine Dr/Manitoba St • Marine Dr/Main St • Marine Dr/Prince Edward St • Marine Dr/Fraser St • Marine Dr/Knight St (west) • Marine Dr/Knight St (east) • Marine Dr/Argyle St • Marine Dr/Victoria St • Marine Dr/Elliot St • Marine Dr/Jellicoe St • Marine Dr/Kerr St • Marine Way/SE Marine Dr • Marine Way/Boundary Rd

Other Unique Features:

There are numerous bus stops and timing points which significantly impact on the roadway capacity. For the HPV lanes to be effective, bus bays will need to be provided to keep the HPV lanes open. On the south side of Marine Drive, parking is permitted at certain times of day. For the purposes of this assignment, it has been assumed that parking will be prohibited. There are also a number of signalized pedestrian crossings on the corridor which have also been excluded from the analysis.

Implementation Costs:

< $100,000

Information Derived From:

GVGC descriptions / Delcan
Traffic volume and signal timing data from the City of Vancouver.

Assumptions:

- One of the three GP lanes in each direction was converted into a HPV lane resulting in two GP lanes and one HPV lane in each direction.
- Signal timing improvements were only evaluated for the 2002 scenario.
- For the evaluation of signal coordination, 70th Avenue was included in the network, as it is used as an alternative route between Granville Street and Marine Drive East.

Identified Improvements:

- Existing signals had cycle lengths of 75 and 90 seconds plus there were a number of uncoordinated signals. Optimized cycle length was 90 seconds resulting in reduced network delay.

Project:	**PORT ROAD (COMMISSIONER STREET AND STEWART STREET) BETWEEN ROGERS STREET AND RENFREW STREET**
Basic Project Description:	To restrict access to Port traffic only
Existing Roadways Affected:	Commissioner Street and Stewart Street will be directly affected, but other parallel routes such as Powell Street, Dundas Street, and Nanaimo Street will be indirectly affected due to non-port traffic diverting off the South Shore Road.
Length:	Commissioner Street - 1.9 km Stewart Street - 1.1 km
Number of Lanes:	Two
Design Speed:	50 km/h
Analysis Tools	None - Not applicable for analysis
Intersections / Interchanges:	On the corridor the following intersections exist: • Clark Street/ Stewart Street./Rogers Street • Stewart Street/Commissioner Street/Victoria Drive • Commissioner Street./ McGill Street
Other Unique Features:	Victoria Drive access to the Port is closed and access restricted zones are to be added
Implementation Costs:	$1.5 Million
Information Derived From:	PBA / Delcan functional design study

Project:	**HASTINGS STREET / POWELL STREET CORRIDORS**
Basic Project Description:	Convert the parking lanes to High Priority Vehicle (HPV) lanes in both directions on: • Hastings Street between Clark Drive and Highway 1 • Powell Street between Clark Drive and Semlin Drive • Dundas Street between Semlin Drive and Nanaimo Street The traffic signals within the network are also to be coordinated.
Existing Roadways Affected:	• Hastings Street between Clark Drive and Boundary Road • Powell Street between Clark Drive and Semlin Drive • Dundas Street between Semlin Drive and Nanaimo Street
Length:	Hasting Street - 3.3km Powell Street - 1.0 km Dundas Street - 0.5 km
Number of Lanes:	Powell Street - two in each direction Hastings Street - three in each direction
Design Speed:	50 km/h
Analysis Tools	EMME/2 for new laning analysis Synchro for signal coordination analysis
Intersections / Interchanges:	There are a number of unsignalised intersections as well as the following signalised intersections: • Clark Dr./Hastings St. • Commercial Dr./Hastings St. • Victoria Dr./Hastings St. • Nanaimo St./Hastings St. • Renfrew St/Hastings St. • Cassiar St/Hastings St. • Clark Dr./Powell St • Commercial Dr./Powell St. • Victoria Dr./Powell St./Dundas St • Dundas St./Nanaimo St.
Other Unique Features:	None
Implementation Costs:	< $100,000

Information Derived From:

GVGC Description/Delcan
Traffic volume and signal timing data from the City of Vancouver

Assumptions:

- Parking is currently prohibited in the peak direction and permitted in the non-peak direction. For analysis purposes it was assumed that parking would be prohibited in both directions.
- The existing HOV lanes on Hastings St. between Renfrew St and Highway 1 and the parking lanes to the west of Renfrew St. were converted to HPV lanes. This resulted in a total of three lanes in each direction (2 GP + 1HPV).
- On Powell St. and Dundas St., two lanes in either direction were modelled (1GP + 1HPV)
- Signal timing improvements were only evaluated for the 2002 scenario.

Identified Improvements:

- Existing signals had cycle lengths of 75 seconds plus one uncoordinated signal at Cassiar/Hastings St. Optimized cycle length was 100 seconds resulting in reduced network delay.

Project:	**GRANVILLE STREET - GRANVILLE BRIDGE TO MARINE DRIVE**
Basic Project Description:	Remove all parking on Granville St. to provide a new HPV lane in each direction and coordinate all traffic signals on the corridor.
Existing Roadways Affected:	Granville Street plus all intersecting roads (see below).
Length:	7.3 km from False Creek to Marine Drive
Number of Lanes:	6 lane cross section - 3 in each direction (includes existing parking lane)
Design Speed:	50km/h
Analysis Tools	EMME/2 for new laning analysis Synchro for signal coordination analysis
Intersections / Interchanges:	In the section to the south of Granville Street Bridge there are numerous unsignalized intersections plus the following signalized intersections on Granville Street: • 7th Avenue • Broadway • 12th Avenue • 16th Avenue • King Edward Avenue • 33rd Avenue • 41st Avenue • 49th Avenue • 57th Avenue • 59th Avenue • 70th Avenue • Marine Drive
Other Unique Features:	The amendment of traffic signal timings will impact on the surrounding street network especially when the signals are coordinated. The traffic signals on Granville Street to the north of False Creek form part of the downtown coordinated traffic signal network. Any signal timing modifications on this portion of Granville Street will have serious impacts on the network. The removal of parking will also likely cause consternation with local property owners and may not be implementable. For the purposes of this assignment, the section of Granville Street north of False Creek has been omitted and only the portion to the south of False Creek has been evaluated. It has therefore been assumed that the improvements (parking removal and signal coordination) will only be tested to the south of Granville Bridge.

Implementation Costs: < $100,000

Information Derived From: GVGC descriptions/Delcan.
Traffic volume and signal timing data from the City of Vancouver.

Assumptions:

- Parking is currently prohibited in the peak direction and permitted in the non-peak direction. For analysis purposes it was assumed that parking would be prohibited in both directions.
- Generally, with the removal of parking, two GP lanes and one HPV lane in each direction were modelled.
- Signal timing improvements were only evaluated for the 2002 scenario.

Identified Improvements:

- Existing signals had cycle lengths of 75 seconds. Optimized cycle length was 80 seconds resulting in reduced network delay.

Project:	**CAMBIE STREET - SEYMOUR STREET TO MARINE DRIVE**
Basic Project Description:	Remove all parking on Cambie Street to provide a new HPV lane in each direction and coordinate all traffic signals on the corridor.
Existing Roadways Affected:	Cambie Street between Seymour Street and Marine Drive. Including all intersecting roads (see below).
Length:	6.0 km between False Creek and Marine Drive
Number of Lanes:	Three lanes each way including the parking lanes.
Design Speed:	50km/h
Analysis Tools	EMME/2 for new laning analysis Synchro for signal coordination analysis
Intersections / Interchanges:	To the south of the Cambie Bridge over False Creek, there are numerous unsignalized intersections as well as the following signalised intersections on Cambie Street: • 7th Ave • Broadway • 10th Ave • 12th Ave • 16th Ave • King Edward Ave • 29th Ave • 33rd Ave • 41st Ave • 43rd Ave • 45th Ave • 49th Ave • 57th Ave • 59th Ave • Marine Drive
Other Unique Features:	The traffic signals on Cambie Street to the north of False Creek form part of the downtown coordinated traffic signal network. Any signal timing modifications on this portion of Cambie Street will have significant impacts on the network. In addition, the removal of parking in this area will be met with consternation by local businesses. For the purposes of this assignment, the section of Cambie Street to the north of False Creek has thus been omitted, and only Cambie Street to the south of False Creek has been evaluated.

Implementation Costs:	< $100,000
Information Derived From:	GVGC descriptions/Delcan Traffic volume and signal timing data from the City of Vancouver
Assumptions:	• Parking is currently prohibited in the peak direction and permitted in the non-peak direction. For analysis purposes it was assumed that parking would be prohibited in both directions. • Generally, with the removal of parking, two GP lanes and one HPV lane in each direction were modelled. • Signal timing improvements were only evaluated for the 2002 scenario.
Identified Improvements:	• Existing signals had cycle lengths of 75 and 80 seconds plus some uncoordinated signals. Optimized cycle length was 90 seconds resulting in reduced network delay.

Project:	**CLARK DRIVE/KNIGHT STREET CORRIDOR BETWEEN POWELL STREET AND KNIGHT STREET BRIDGE (HWY. 91)**
Basic Project Description:	Convert existing parking to High Priority Vehicle (HPV) lanes in both directions and carry out minor intersection improvements such as the introduction of left turn lanes at key locations.
Existing Roadways Affected:	• Clark Drive between Powell Street and 12th Ave; and • Knight Street between 12th Ave and the Knight Street bridge.
Length:	7.9 km
Number of Lanes:	Six-lane cross section - three in each direction
Design Speed:	50 km/h
Analysis Tools	EMME/2 for new HPV laning analysis Synchro for left turn lane analysis
Intersections / Interchanges:	The are numerous unsignalised intersections plus the following signalised intersections: • Powell St • Hastings St • Venables St • 1st Ave • 6th Ave • Broadway • 12th Ave • 15th Ave • Kingsway • King Edward Ave • 33rd Ave • 41st Ave • 49th Ave • 57th Ave
Other Unique Features:	None
Implementation Costs:	$7.90 Million
Information Derived From:	GVGC descriptions / Delcan Traffic volumes and signal timings from the City of Vancouver

Outstanding Information: Scope to be confirmed / determined from initial analysis. Cost estimates to be prepared.

Assumptions:

- All intersections which did not have north and south left trun lanes were investigated for capacity problems. These were at:
  - Hastings Street
  - Venables Street
  - 6th Avenue
  - 15th Avenue
  - 33rd Avenue
  - 49th Avenue
  - 57th Avenue

- Left turn lanes were added at the above locations and the signal timings for those intersections were re-optimized.
- If an intersection displayed a poor level of service (LOS worse than D) which was not attributable to left turn laning, the signal timings were optimized.
- Parking is currently prohibited in the peak direction and permitted in the non-peak direction. For analysis purposes it was assumed that parking would be prohibited in both directions.
- Generally, with the removal of parking, two GP lanes and one HPV lane in each direction were modelled.

Identified Improvements:

- The following signalized intersections included left turn bay improvements in both directions of travel (northbound and southbound):
  - Hastings Street
  - Venables Street
  - 15th Avenue
  - 33rd Avenue
  - 49th Avenue
  - 57th Avenue

- A northbound left turn bay was proposed for 6th Avenue.
- Signal timings were improved at Powel Street, 1st Avenue, Broadway and 57th Avenue.

Project:	**BOUNDARY ROAD - HWY. 1 TO MARINE DRIVE**
Basic Project Description:	Coordinate traffic signal timings along the corridor.
Existing Roadways Affected:	Boundary Road between Highway 1 and Marine Drive. Possibly some of the intersecting cross streets (see below).
Length:	6.2 km
Number of Lanes:	Varies along corridor as indicated below: • between Highway 1 and Henning Drive, three lanes in each direction; • between Henning Drive and Grandview Highway, two lanes southbound, three lanes northbound; • between Grandview Highway and 22nd/Elmwood, three lanes in each direction; • between 22nd/Elmwood Street and 29th Avenue, three lanes southbound, two lanes northbound; • between 29th Avenue and Moscrop Street, two lanes in each direction; • between Moscrop Street and Kingsway, three lanes in each direction; • between Kingsway and Rumble Street, two lanes in each direction; and • between Rumble Street and Marine Drive, two lanes southbound, three lanes northbound.
Design Speed:	50 km/h
Analysis Tools	Synchro
Intersections / Interchanges:	At the Highway 1/Boundary Road interchange, there is an eastbound off-ramp from Highway 1 to Boundary Road southbound, and an on-ramp to Highway 1 westbound from Boundary Road northbound. Both ramps are unsignalised. There are numerous unsignalised intersections, plus signalised intersections on Boundary Road at: • Grandview Highway; • Canada Way; • 22nd Avenue/Elmwood Street; • 29th Avenue; • Moscrop Street; • Vanness Avenue;

- Kingsway;
- 49th Avenue/Imperial Street;
- Arbor Avenue;
- Rumble Street; and
- Marine Way

Other Unique Features:

- Steep gradient estimated at 6% on Boundary Road to the north of Marine Way.
- Inconsistent road cross section in terms of the number of lanes and median island treatments.
- The Highway 1/Boundary Road interchange does not accommodate all movements. Certain movements are thus displaced to/from the 1st Avenue and Grandview Highway/Willingdon interchanges with Highway 1.

Implementation Costs:

< $100,000

Information Derived From:

GVGC descriptions / Delcan
Traffic volume and signal timing data from the City of Vancouver

Assumptions:

- All intersections were coded in Synchro to identify those with operational problems using the 2002 signal timing and volume data.
- Problem intersections were then analysed to determine if new signal timing and/or laning would improve operations to acceptable levels (LOS better than D)

Identified Improvements:

- Grandview Highway - reduced the signal cycle length from 151 to 80 seconds resulting in a LOS improvement from D to C.
- Kingsway - reduced cycle length from 145 to 80 seconds resulting is a LOS improvement from D to C.

Project:	**RUSS BAKER WAY / NO. 2 ROAD BETWEEN ARTHUR LAING BRIDGE AND WESTMINSTER HIGHWAY**
Basic Project Description:	Extend the existing High Occupancy Vehicle (HOV) lane southwards and convert the lane into a High Priority Vehicle (HPV) lane.
Existing Roadways Affected:	Russ Baker Way from Miller Road (approximately 100 metres south) to the No. 2 Road bridge. Northbound direction only Possibly Cessna Drive
Length:	910 m
Number of Lanes:	One additional lane - Northbound lanes 2+1
Design Speed:	50 km/h
Analysis Tools	EMME/2
Intersections / Interchanges:	Major interchange at McConachie Way/Russ Baker Way with ramp merges / diverges, plus the following signalized intersections: • Miller Road • Cessna Drive • Dinsmore Bridge Connection/Gilbert Road • Inglis Drive / South Terminal Access
Other Unique Features:	Widening of Russ Baker Way may affect Cessna Drive as right-of-way is limited in this area.
Implementation Costs:	$1.20 Million
Information Derived From:	Delcan
Assumptions:	• The HPV lane is assumed to only continue to the No.2 Road Bridge and not included the bridge itself (ie. not to continue to Westminster Highway).
Identified Improvements:	HPV lane extension along Russ Baker Way

Project: **WESTMINSTER HIGHWAY BETWEEN NO. 2 ROAD AND HIGHWAY 91**

Basic Project Description: Coordinate the traffic signals along the corridor.

Existing Roadways Affected: Westminster Highway between No. 2 Road and the Highway 91 / Knight Street intersection.

Length: 6.2 km

Number of Lanes: Four basic lanes

Design Speed: 50 km/h

Analysis Tools Synchro

Intersections / Interchanges: On Westminster Highway, there are signalised intersections at the following locations:

- No.2 Road
- Gilbert Road
- No.3 Road
- Cooney Road
- Garden City Road
- No. 4 Road
- Shell Road
- No. 5 Road
- Jacombs Road
- Knight Street
- No.6 Road
- No.7 Road
- No.8 Road
- Nelson Road
- No.9 Road
- Highway 91

The following ramps have been provided at the Highway 99 / Westminster Highway interchange:

- northbound off-ramp from Highway 99 to Westminster Highway;
- southbound on-ramps from Westminster Highway to Highway 99.

Other Unique Features: At the Highway 99 / Westminster Highway interchange ramps to / from the south have only been provided. To travel north on Highway 99 from Westminster Highway, or to proceed southbound from Highway 99 to Westminster Highway requires re-routing.

Implementation Costs:	< $100,000
Information Derived From:	Delcan Volume and signal timing data from the City of Richmond
Assumptions:	• Signal timing improvements were only evaluated for the 2002 scenario.
Identified Improvements:	• The existing signals are a combination of coordinated signals with 100 second cycle length, and three uncoordinated signals. Optimized cycle length was 80 seconds resulting in a reduced network delay.

Project:	**DINSMORE BRIDGE / GILBERT ROAD / ELMBRIDGE WAY / ALDERBRIDGE WAY TO HIGHWAY 91**
Basic Project Description:	This corridor provides a circuitous link between Dinsmore Bridge and the Highway 91/Highway 99 interchange complex. The project is to coordinate the traffic signals between the Dinsmore bridge and the start/end of Highway 91 / Alderbridge Way at Shell Road.
Existing Roadways Affected:	• Gilbert Road between Dinsmore Bridge and Elmbridge Way • Elmbridge Way between Gilbert Road and Alderbridge Way • Alderbridge Way between Elmbridge Way and Shell Road
Length:	5. 0 km
Number of Lanes:	Gilbert Road - Two lanes Elmbridge Way - Two lanes Alderbridge Way - Two lanes (west of No.3 Road) Alderbridge Way - Four lanes (east of No. 3 Road)
Design Speed:	50 km/h
Analysis Tools	Synchro
Intersections / Interchanges:	There are signalized intersections at the following locations: • Gilbert Road/Elmbridge Way • Elmbridge Way/Alderbridge Way • Alderbridge Way/Cedarbridge Way • Alderbridge Way/Minoru Blvd • Alderbridge Way/No.3 Road • Alderbridge Way/Kwantlen Street • Alderbridge Way/Garden City Road • Alderbridge WayNo.4 Road • Alderbridge Way/Shell Road/Hwy 91
Other Unique Features:	None
Implementation Costs:	< $100,000
Information Derived From:	GVGC description/Delcan. Signal timing and volume data from the City of Richmond
Assumptions:	• Signal timing improvements were only evaluated for the 2002 scenario.

Identified Improvements:

- The existing signals are a combination of coordinated signals with 100 second cycle length, and four uncoordinated signals. The optimized cycle length was 90 seconds resulting in a reduced network delay.

Project:	**HIGHWAY 91 / HIGHWAY 91A BETWEEN HIGHWAY 99 AND QUEENSBOROUGH BRIDGE**
Basic Project Description:	Replace the Highway 91A/Howes Street intersection and traffic signal with a diamond interchange.
Existing Roadways Affected:	• Highway 91A/Howes Street
Length:	The length of Highway 91A between the Highway 91/Highway 91A interchange and the northern Queensborough bridge is 3.3km.
Number of Lanes:	Four basic lanes on Highway 91A
Design Speed:	80 km/h
Analysis Tools	EMME/2
Intersections / Interchanges:	On the section of road under consideration there are two interchanges, namely: • Highway 91/Highway 91A; and • Highway 91A/ Marine Way/Stewardson Way. There is only one signalised intersection at Highway 91A/Howes Street which provides access to the Queensborough/ Port Royal areas.
Other Unique Features:	None.
Implementation Costs:	$ 26.10 Million
Information Derived From:	Initial project description provided by TransLink and refined by Delcan based on the Ministry plans.
Outstanding Information:	Cost estimate to be prepared.
Assumptions:	• The at grade intersection at 91A/Howes Streets is to be replaced with a diamond interchange.
Identified Improvements:	Interchange Implementation

Project:	**BRIDGEPORT ROAD BETWEEN MORAY BRIDGE AND KNIGHT STREET**
Basic Project Description:	To improve the reliability of the Moray swing bridge by permanently closing the bridge to serve traffic (new structure).
Existing Roadways Affected:	• Moray Bridge • Sea Island Way • Bridgeport Road
Length:	Total length between the western bridge head and Knight Street is 4.6 km
Number of Lanes:	Existing structure - two lanes New structure - three lanes
Design Speed:	50 km/h
Analysis Tools	None
Intersections / Interchanges:	There is a full movement interchange at Knight Street/Bridgeport Road and major intersections at the following locations: • No 3. Road/Sea Island Way • No 3. Road/Bridgeport Road • Bridgeport Road/Shell Road • Bridgeport Road/No. 5 Road
Other Unique Features:	Existing Bridge is a swing bridge to serve marine traffic. New structure will be constructed at a similar height as the recently constructed parallel structure (part of Sea Island Connector Project). New structure will be a permanent span bridge.
Implementation Costs:	$ 30 million
Information Derived From:	Delcan
Assumptions:	• It is not possible to model the swing bridge operations. It has therefore been assumed that the existing bridge will be replaced with a fixed link bridge.
Identified Improvements:	N/A

Project:

HIGHWAY 17 BETWEEN HIGHWAY 99 AND TSAWWASSEN FERRY TERMINAL

Basic Project Description:

This project is to consider High Priority Vehicle (HPV) Lanes in the northbound direction along Highway 17 between the Ferry Terminal and Highway 99. In addition, traffic signal coordination in the Tsawwassen area (52^{nd} and 56^{th} Streets) is to be considered. As well, a new interchange at the Ladner Trunk Road/Highway 10 intersection is included as part of the project.

The HPV lane approaching the Highway 99 interchange will use a modified queue jumper to Highway 99 northbound (similar to the existing HOV queue jumper). It is assumed that the HPV lanes would not extend past the beginning of the causeway to the ferry terminal.

Since the southern section of the South Fraser Perimeter Road (SFPR - major project 2) runs parallel to Highway 17, it is expected to divert major commercial traffic from Highway 17 to SFPR. Accordingly, this project was not examined.

Existing Roadways Affected:

Highway 17
Highway 99
Highway 10 / Ladner Trunk Road

Length:

13.6 km

Number of Lanes:

Four Basic lanes plus one HPV lane northbound

Design Speed:

80 km/h

Analysis Tools:

None

Intersections / Interchanges:

On Highway 17, there are interchanges at the following locations:
- Highway 99
- Deltaport Way

There are signalized intersections on Highway 17 at:
- Highway 10/Ladner Trunk Road
- 52^{nd} Street
- 56^{th} Street

Other Unique Features:

It is assumed that the HPV lane will continue to be located in the median of Highway 17 and only in the northbound direction. An interchange is most likely necessary at Highway 10 to allow this lane designation / configuration. However, there will be issues with respect to lane designation at the intersections of 52^{nd} and 56^{th} Streets.

Implementation Costs: None

Information Derived From: GVGC descriptions / Delcan

Project:	**DELTAPORT WAY (HIGHWAY 17 TO ROBERTS BANK)**
Basic Project Description:	No improvements are proposed as part of this project. The initiative is to preserve and maintain the corridor in it's current status and not allow it to degenerate through the permission of multiple access points.
Existing Roadways Affected:	Deltaport Way between Highway 17 and Roberts Bank
Length:	9.45 km
Number of Lanes:	N/A
Design Speed:	N/A
Analysis Tools:	None
Intersections / Interchanges:	There are intersections on Deltaport Way at the following locations: • Highway 17 • 57B Street • 53rd Street • 41B Street • 27B Avenue
Other Unique Features:	Since no improvements are proposed, the corridor will not be analysed in detail as part of this assignment.
Implementation Costs:	None
Information Derived From:	GVGC description / Delcan

Project:	**HIGHWAY 91 BETWEEN HIGHWAY 91A AND HIGHWAY 99**
Basic Project Description:	Introduce an interchange and northbound HPV queue jumper lane at the existing "T" junction with 72nd Avenue. An exemption for unladen trucks to bypass the Nordel weigh scale is also proposed, but since this is a policy issue, it has not been considered as an improvement option for analysis purposes.
Existing Roadways Affected:	Highway 91 72nd Avenue
Length:	The total length of the section of Highway 91 between Nordel Way and Highway 99 is 7.0 km
Number of Lanes:	Four general-purpose lanes and one HPV queue jumper lane northbound
Design Speed:	90 km/h
Analysis Tools:	EMME/2
Intersections / Interchanges:	There are interchanges to the north and south of the proposed 72nd Street interchange, namely: • Nordel Way to the north; and • 64th Avenue to the south.
Other Unique Features:	The configuration of the proposed interchange is assumed as a partial diamond. An intersection would be located on the southbound off ramp / westbound to southbound on-ramp.
Implementation Costs:	$9.60 Million
Information Derived From:	GVGC description / Delcan
Assumptions:	• New interchange at 72nd Avenue.
Identified Improvements:	Partial diamond Interchange

Project: **88 AVENUE/NORDEL WAY - HWY.15 TO HWY. 91**

Basic Project Description: Upgrade 88th Avenue from two lanes to four lanes in each direction throughout its length (between Highway 15 and 152nd Street) and coordinate the traffic signals along 88th Avenue and Nordel Way (which has recently being constructed to connect directly to 88th Avenue).

Existing Roadways Affected:

- 88 Avenue
- Nordel Way

It is to be noted that although the corridor has been analysed in isolation, the amendment of traffic signal timings will impact on the surrounding street network especially when the signals are coordinated.

Length: 16 km

Number of Lanes: Four basic lanes

Design Speed: 88th Avenue - 60 km/h
Nordel Way - 70 km/h - 80 km/h

Analysis Tools: EMME/2 for the new laning
Synchro for the signal coordination

Intersections / Interchanges: At the Highway 91 / Nordel Way interchange ramps have been provided which enable merge manoeuvres to take place. Along the corridor there are numerous unsignalised intersections plus the following signalised intersections:

- 84th Ave
- 112th Street
- 116th Street
- 120th Street (Scott Road)
- 124th Street
- 128th Street
- 132th Street
- King George Hwy
- Bear Creek Park
- 140th Street
- 144th Street
- 148th Street
- 152nd Street
- Fraser Hwy
- 156th Street
- 160th Street
- 168th Street
- 176th Street (Hwy 15)

Other Unique Features:	None
Implementation Costs:	$26.00 Million
Information Derived From:	GVGC description / Delcan Traffic volume and signal timing data from Delta, Surrey and Ministry.
Assumptions:	• Signal coordination will only be beneficial when more than two lanes in each direction have been provided. Coordination was therefore only evaluated using Synchro for the four lane section to the west of 156 Street. • The additional lanes were added to the east of 156 Street and modelled in EMME/2.
Identified Improvements:	Widening of the 152nd Street - Highway 15 segment Signal coordination along corridor

Project:	**NORTH BLUFF ROAD AND 16TH AVENUE CORRIDOR BETWEEN HIGHWAY 15 AND 200TH STREET**
Basic Project Description:	Implement localised improvements to improve roadway capacity on 16th Avenue between Highway 15 and 200th Street.
Existing Roadways Affected:	16th Avenue Some of the intersections identified below.
Length:	4.8 km
Number of Lanes:	Two lanes
Design Speed:	60 km/h
Analysis Tools:	Synchro
Intersections / Interchanges:	There are signalized intersections at the following locations: • Hwy. 15/16th Ave • 16th Avenue at 184th Street
Other Unique Features:	Four way stop at 16th Avenue / 200th Street due to be replaced with a signal in 2003.
Implementation Costs:	Nil
Information Derived From:	GVGC description/Delcan Traffic volume and signal timing data from the City of Surrey and Ministry
Assumptions:	• 16th Ave/200 St. intersection is evaluated under the 200 Street project.
Identified Improvements:	Since the traffic operation at the intersections of the corridor presented Level of Service C or better, no improvements were justified for implementation.

Project:	**HIGHWAY 99A - COLEBROOK ROAD - 152ND STREET CORRIDOR BETWEEN HIGHWAY 99 AND 56TH AVENUE**
Basic Project Description:	Upgrade Colebrook Road between Highway 99A and 152nd Street and provide new signal at Colebrook Road and 152nd Street.
Existing Roadways Affected:	Colebrook Road 152nd Street
Length:	1.2 km
Number of Lanes:	1 lane each way
Design Speed:	50 km/h
Analysis Tools:	Synchro
Intersections / Interchanges:	Colebrook Road / 152nd Street
Other Unique Features:	Route is used as a detour to avoid grades on Highway 99A / Highway 10 route.
Implementation Costs:	$1.75 Million
Information Derived From:	City of Surrey
Assumptions:	No traffic volumes were available. Volumes were estimated based on 152nd Street / 16th Avenue counts.
Identified Improvements:	• Introduce signal at 152nd Street / Colebrook Road. • Upgrade Colebrook Road to formal paved single lane each direction.

Project:	**200TH STREET - 16TH AVENUE TO 92 AVENUE**
Basic Project Description:	Implement localized improvements along 200th Street between 16th Avenue and 92nd Avenue.
Existing Roadways Affected:	200th Street Some of the intersecting cross streets
Length:	15.5 km
Number of Lanes:	96th Avenue to 36th Avenue - Four basic lanes 36th Avenue to 16th Avenue - Two basic lane Between Logan Avenue and Willowbrook Drive - three NB lanes
Design Speed:	50 km/h between Highway 1 and Highway 10 60 km/h between Highway 10 and 16th Avenue (to be verified)
Analysis Tools:	Synchro (localized improvements)
Intersections / Interchanges:	There is an interchange at 200th Street/Highway 1 - signals associated with this interchange have been indicated by an asterisk (*)

Signals are provided at the following intersections on 200th Street:

- 96th Avenue
- 201 Street
- 92A Avenue
- 91A Avenue
- 88th Avenue*
- Ramp Terminus (new I/C)*
- 88th Avenue*
- 86th Avenue*
- 80th Avenue
- 72nd Avenue
- 65th Avenue
- 64th Avenue
- Willowbrook Avenue
- Highway 10
- Logan Avenue
- Fraser Highway
- 56th Avenue
- Michaud Avenue
- 53rd Avenue
- Grade Road
- 48th Avenue
- 44th Avenue

- 42nd Avenue
- 41A Avenue
- 40th Avenue
- 38A Avenue
- 36th Avenue

New signals are planned for installation in 2003 at 16th and 32nd Avenue.

Other Unique Features:

The 200th Street/Highway interchange is currently being reconstructed as a single point diamond interchange. There are currently Four Way Stop controls at 16th and 24th Avenues.

Implementation Costs:

$ 320,000

Information Derived From:

GVGC description / Delcan.
CTS/LCP Signal Timing Design report

Assumptions:

- The intersections to the north of 80 Avenue will all be affected by the new Hwy. 1/200 Street interchange under construction and were thus not assessed.
- Based on information contained in the CTS/LCP report, intersection operations are acceptable (LOS better than C) at all intersections between 36th and 80th Avenues (excluding Hwy 10) in the AM peak. These intersections were not therefore assessed.
- The only remaining signalised intersection is Hwy 10 and this was assessed for possible upgrading.
- The 16th and 32nd Ave intersections were assessed with and without the proposed signals. It was assumed that left turn lanes would be provided prior to signal installation.

Identified Improvements:

- The Hwy. 10/200 St. intersection operates with LOS of C in the 2002 AM peak. No improvement required.
- New signals at 16th and 32nd Ave intersections due for construction in 2003.

Project:	**HIGHWAY 13 BETWEEN HIGHWAY 1 AND THE ALDERGROVE BORDER CROSSING**
Basic Project Description:	Optimize signal timings at various locations to provide improved travel times along Highway 13 corridor.
Existing Roadways Affected:	Highway 13 Some of the intersection cross streets
Length:	11.2 km
Number of Lanes:	Two lanes between Highway 1 and 16th Avenue Three lanes (1 SB, 2 NB) between 16th Avenue and 8th Avenue Two lanes between 8th Avenue and US Border Two southbound lanes through Fraser Highway intersection.
Design Speed:	80 km/h
Analysis Tools:	Synchro (for localized improvements)
Intersections / Interchanges:	There is an interchange at Highway 1/Highway 13, with signalised intersections at: • Ramp Terminal • Fraser Highway • 16th Avenue
Other Unique Features:	Two northbound lane section between 8th Avenue and just prior to 16th Avenue.
Implementation Costs:	$150,000
Information Derived From:	GVGC description / Delcan / Ministry
Assumptions:	On Hwy. 13 there are only two traffic signals, namely at Fraser Highway and at 16 Avenue. These intersections were therefore assessed to identify operational problems.
Identified Improvements:	Optimised signal timings at Fraser Highway.

Project:	**BARNET HIGHWAY BETWEEN ST JOHNS STREET AND LOUGHEED HIGHWAY**
Basic Project Description:	To implement localized improvements to improve roadway capacity along the section of Barnet Highway between St.Johns Street / Ioco Road and Pinetree Way.
Existing Roadways Affected:	Barnet Highway between the St Johns Street/Ioco Road intersection (railway overpass widening) and the Barnet Highway / Lougheed Highway (Pinetree Way) intersection. Some intersecting cross streets (see below) will also be affected.
Length:	1.9 km
Number of Lanes:	Four basic lanes
Design Speed:	60 km/h
Analysis Tools:	Synchro
Intersections / Interchanges:	The following signalised intersections are present on the corridor: • St Johns Street/Ioco Road/Barnet Highway • Barnet Highway/Falcon Drive • Barnet Highway/Landsdowne Drive • Barnet Highway/Johnson Street/Mariner Way • Barnet Highway/Lougheed Highway/Pinetree Way
Other Unique Features:	The intersection at Pinetree Way is significantly over capacity. The City of Coquitlam has identified the need for an interchange at this location in the long term. Similarly, the intersection at Ioco Road is significantly over capacity - major improvements are required. The City of Port Moody has examined the Murray Clarke Connector as a possible solution to divert traffic from St. Johns. However, the analysis has indicate that the benefits do not exceed the cost of construction.
Implementation Costs:	$ 6.45 Million
Information Derived From:	GVGC description / Delcan

Project:	**LOUGHEED HIGHWAY BETWEEN HANEY BYPASS AND MISSION**
Basic Project Description:	Provide a consistent four lane cross section between Haney Bypass and Mission
Existing Roadways Affected:	Lougheed Highway
Length:	12.1 km
Number of Lanes:	Four and two-lane sections
Design Speed:	80 km/h
Analysis Tools:	EMME/2
Intersections / Interchanges:	There are several intersections affected by the upgrade of Lougheed Highway: • River Road • 280th Street • 285th Street • 287th Street • Donatelli Street • Silverdale Street • McLean Street • Chester Street • Nelson Street • Oliver Street • Wren Street
Other Unique Features:	None
Implementation Costs:	$29.05 Million
Information Derived From:	Delcan
Assumptions:	A consistent two-lane cross section with localised left turn bays was assumed from River Road to Mission by-pass.

Identified Improvements:

- Four-lane expansion between River Road and Mission Bypass.
- Upgrade of the following intersections:
  - River Road
  - 280th Street
  - 285th Street
  - 287th Street
  - Donatelli Street
  - Silverdale Street
  - McLean Street
  - Chester Street
  - Nelson Street
  - Oliver Street
  - Wren Street

Project:	**CANADA WAY BETWEEN BOUNDARY ROAD AND 10TH AVENUE**
Basic Project Description:	Implement localized improvements along Canada Way between Boundary Road and 10th Avenue.
Existing Roadways Affected:	Canada Way Some of the intersecting cross streets (see below)
Length:	8.6 km
Number of Lanes:	2 lanes each direction
Design Speed:	50 km/h
Analysis Tools:	Synchro
Intersections / Interchanges:	Canada Way provides indirect access to Highway 1 at the following locations: • Kensington Avenue • Willingdon Avenue There are numerous unsignalised intersections as well as the following signalized intersections on Canada Way: • Boundary Road • Smith Ave • Gilmore Way Diversion • Willingdon Ave • Beta Ave • Wayburne Dr • Royal Oak Ave • Hardwick St • Douglas Rd • Spruce St • Deer Lake Pl / Norland Ave • Sperling Ave • Burris St • Imperial St • Edmonds St • 10th Ave
Other Unique Features:	At most of the unsignalised intersections, left turn lanes have not been provided with the result that turning vehicles delay through traffic on Canada Way. At some locations, no left turn or right in/right out only restrictions have been imposed to address this. To solve these issues will be the focus of the initial analysis.

Implementation Costs:	$4.75 Million
Information Derived From:	Traffic volume and signal data from City of Burnaby GVGC description / Delcan
Identified Improvements:	• Add northbound through lane at Kensington Street intersection. • Add northbound through lane at Edmonds Street Intersection • Add southbound left lane at Willingdon Avenue intersection

Project:	**MARINE WAY BETWEEN BOUNDARY ROAD AND QUEENSBOROUGH BRIDGE**
Basic Project Description:	Provision of a new High Priority Vehicle (HPV) lane in each direction on Marine Way between the Queensborough bridge and Boundary Road (to connect to section between Granville Street and Boundary Road). It has been assumed that the HPV lanes will be added to the existing four lane cross section. The HPV lanes will be located in the shoulder lane.
Existing Roadways Affected:	Marine Way Some intersecting cross streets (see below)
Length:	5.9 km
Number of Lanes:	Four general purpose lanes Two HPV lanes
Design Speed:	60 km/h
Analysis Tools:	EMME/2
Intersections / Interchanges:	There is an interchange at the Queensborough Bridge (Hwy. 91A). On Marine Way, there are signalised intersections at the following locations: • Boundary Road • Greenall Avenue • Riverway Drive • Byrne Road • Marshland Avenue
Other Unique Features:	HPV lane assumed to be located in shoulder lane HPV lane assumed to be added to existing four lane cross section
Implementation Costs:	$25.50 Million
Information Derived From:	GVGC description / Delcan

Appendix 2

Cost Estimates of Improvements

The following are summaries of the 'order of magnitude' cost estimates for some of the improvement elements associated with the Major Commercial Transportation System. In general, costs were obtained either from previous engineering reports provided by GVGC, MoT, and other stakeholders. Where previous information was not available, costs were derived using MoT's E. Wolski spreadsheet costing methodology.

For those cost estimates provided by third parties, a list of the previous engineering reports studied during the projects/investments review is included.

For the E. Wolski spreadsheet methodology, the following cost categories were summarized:

- Project Management;
- Engineering;
- Land Acquisition;
- Grade Construction;
- Roadside, Utility & Other Construction;
- Structural Construction;
- Paving Construction;
- Operational Construction;
- Tender Contingency & Management Reserve.

Major Improvement 1

HIGHWAY 1 EXPANSION FROM VANCOUVER TO CHILLIWACK

Description:

Upgrade of Trans Canada Highway between Grandview / Willingdon and 200th Street in Langley to add capacity through the provision of at least one general purpose lane in each direction. It should be noted that previous studies indicated that expansion of the Trans Canada Highway east of Langley may be unnecessary; therefore, the extension to Chilliwack has not been included.

Cost Summary:

Component	Cost $M
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**$1,000 M to $1,200 M**

Notes:

Based on:

- Highway 1 Corridor Planning Study / Port Mann to Hope, 2001.
- Cape Horn Area Network Study, 2000.
- Lower Mainland Systems Analysis Study, 2002.
- Trans Canada Highway Upgrading Study - 1st Avenue to 200th Street, 1993.
- Trans Canada Highway Chilliwack Interchange Study, 2001.
- Highway 1/11 Interchange Conceptual Planning Project Value Analysis, 2000.
- Other information from the Ministry of Transportation.

Major Improvement 2

SOUTH FRASER PERIMETER ROAD

Description:

The project consists of a proposed new and upgraded corridor that generally runs in an east-west direction from Highway 1 / 15 to Highway 99 along the south side of the Fraser River. A further extension to Highway 17 has also been assumed.

Cost Summary:

Component	Cost $M
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total - Highway 1 to Highway 91	**$401 M**
Total - Highway 91 to Highway 99/17	**$100 M – 150 M**

Notes:

Based on:

- South Fraser Perimeter Road - Planning and Preliminary Design Study, August, 2001.
- South Fraser Perimeter Road Extension, 2002.
- Model of network between Highway 1 and Highway 99 previously coded.

Major Improvement 3

NEW FRASER RIVER CROSSING

Description:

New river crossing to be located between Maple Ridge / Pitt Meadows and Langley with connections/road improvements to Surrey. The crossing has the following basic design parameters:

- Four-lane corridor wide section with localized additional auxiliary lanes.
- A free flow design speed of 80 km/h at most sections and the river crossing. A design speed of 60 km/h along segments with at-grade intersections.
- Limited access with connections to major arterials only.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**$605 M**

Notes:

Based on:

- New Fraser Crossing Due Diligence Report, May 2002.

Major Improvement 4

RICHMOND AIRPORT –VANCOUVER RAPID TRANSIT PROJECT

Description:

Provision of an LRT connection between Richmond / Vancouver International airport and Vancouver Central Business District. Various alignments and technologies have been studied. An exclusive right-of-way system with fully separated alignments from the street level was chosen for assumption purposes. An alignment along Cambie Street was assumed.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**$1,860 M**

Notes:

Based on:

- Richmond / Airport - Vancouver Rapid Transit Project, April 2001.
- Richmond / Airport - Vancouver Rapid Transit Project - Richmond T/2 Segment, August 2002.

Major Improvement 5

NORTH FRASER PERIMETER ROAD

Description:

Improvement of existing east-west corridor within New Westminster and Coquitlam formed by a series of arterial roads such as Stewardson Way, Front Street, Columbia Street, Brunette Avenue and United Boulevard. The project intends to improve mobility along the corridor through various improvements along United Boulevard in Coquitlam/New Westminster and Columbia / Front Street in New Westminster. A key component of the proposed NFPR is the construction of the United Boulevard Extension consisting of a 4-lane road from west of King Edward Street to Brunette Avenue via a new rail grade separation and a new interchange on Brunette Avenue. The section of United Boulevard from King Edward to the New Westminster boundary is constructed.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**$85 M**

Notes:

Based on:
- Review of Major Capital Projects, TransLink, August 2001.
- New Westminster Area Network Study, 2001.

Major Improvement 6

NEW WESTMINSTER RAIL BRIDGE / TUNNEL

Description:

Replacement of existing structure with a tunnel crossing of the Fraser River. The existing bridge currently handles 46 trains per day with an estimated capacity of 59 trains per day.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	Included as part of the railway investments

Major Improvement 7

GEORGE MASSEY TUNNEL AT HIGHWAY 99 – CAPACITY IMPROVEMENTS

Description:

Significant upgrade of the existing Massey Tunnel river crossing along Highway 99. Upgrade to include new immersed tube tunnel section, separated approximately 50 metres upstream from existing tunnel. New tunnel section to possess only two lane cross section consisting of two northbound general purpose lanes. Existing tunnel to consist of two southbound general purpose lanes and two HOV lanes (one in each direction).

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**$500 M to $700 M**

Notes:

Developed by Delcan Corporation. Cost estimate should be considered cursory as it needs to be validated in further detail through future studies.

Major Improvement 8

OAK STREET BRIDGE UPGRADE

Description:

HOV lanes are to be added to the Highway 99 corridor. As part of the Massey Tunnel upgrade, HOV lanes have been extended up to Westminster Highway. For this project, the HOV lanes will be extended northward to the Oak Street Bridge. The Oak Street Bridge will be widened to six lanes to accommodate the HOV lane in each direction plus the two general purpose lanes in each direction. The HOV lanes are assumed to remain in the median of Highway 99 across the bridge. At the north end of the bridge, the HOV designation will end, and the lane will be treated as a general purpose lane from the north bridge abutment through the 70th Ave intersection.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**$100 M**

Notes:

Developed by Delcan Corporation. Inclusion of Oak Street Bridge through information provided by TransLink. Cost estimate should be considered cursory as it needs to be validated in further detail through future studies.

Major Improvement 9

HIGHWAY 15 UPGRADING FROM HIGHWAY 1 TO US BORDER

Description:

Upgrade of the existing Highway 15 corridor from US Border in Surrey to Highway 1. Upgraded corridor to consist of a homogeneous four lane cross section.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total – Capital Cost	**$85 M**

Notes:

Based on:

- Ministry of Transportation internal report, October 2002.
- Highway 10/15 Access Management Study, 2003.
- Highway 1 Corridor Planning Study - Port Mann to Hope, 2001.

Major Improvement 10

HIGHWAY 10 UPGRADING FROM HIGHWAY 1 TO HIGHWAY 91

Description:

Upgrade of the existing Highway 10 corridor from Highway 1 in Langley to Highway 91. It has been assumed that the section between Hwy 91 and Hwy 17 is not included as it is unwarranted and unwanted by Delta (Hwy 10 / Ladner Trunk Road closed to truck traffic).

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total - Highway 1-Highway 91 Structure costs at Fraser Highway and 200th Street to be considered along with rail separation	**$60 - $80 M**

Notes:

Based on:

- Highway 10/15 Access Management Study , 2003 - ongoing.
- Highway 10 Access Management Study – MoT.
- Highway 1 Corridor Planning Study - Port Mann to Hope, 2001.
- Highway 10 - King George Highway to Scott Road Preliminary / Detailed Design.
- Information developed by Delcan Corporation.

Major Improvement 11

PACIFIC BORDER CROSSING – IMPROVED ACCESS FROM HIGHWAY 99

Description:

Upgrade / widening of 8th Avenue connection from Highway 99 to Highway 15. The project also includes the interchange upgrade at Highway 99 and intersection upgrade at Highway 15 and other locations.

Cost Summary:

Component	Cost $M
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**$20 M**

Notes:

Based on:

- British Columbia Lower Mainland Trade Corridor Border Projects, Business Case Evaluation - Final Report. Request for Strategic Highway Improvement Program. Funded under the TransCanada Border Crossing Transportation initiative, April 2002.
- Preliminary Investigation made by the Ministry of Transportation.

Minor Improvement 1

MARINE DRIVE – GRANVILLE STREET TO BOUNDARY ROAD

Description:

Conversion of one of the existing general-purpose (GP) traffic lanes in each direction to High Priority Vehicle (HPV) lanes, in conjunction with traffic signal coordination.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**< $0.1 M**

Notes:

Based on:
- GVGC descriptions / Delcan.
- Traffic volume and signal timing data from the City of Vancouver.

Minor Improvement 2

PORT ROAD (COMMISSIONER STREET AND STEWART STREET) BETWEEN ROGERS STREET AND RENFREW STREET

Description:

To restrict access to Port traffic only.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**$1.5 M**

Notes:

Based on:
- PBA / Delcan functional design study.

Minor Improvement 3

HASTINGS STREET / POWELL STREET CORRIDORS

Description:

Convert the parking lanes to High Priority Vehicle (HPV) lanes in both directions on:
- Hastings Street between Clark Drive and Highway 1;
- Powell Street between Clark Drive and Semlin Drive;
- Dundas Street between Semlin Drive and Nanaimo Street.

The improvement also included traffic signal coordination.

Cost Summary:

Component	Cost $M
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**< $0.1 M**

Notes:

Based on:
- GVGC Description / Delcan Corporation.
- Traffic volume and signal timing data from the City of Vancouver.

Minor Improvement 4

GRANVILLE STREET – GRANVILLE BRIDGE TO MARINE DRIVE

Description:

Remove all parking on Granville St. to provide a new HPV lane in each direction and coordinate all traffic signals on the corridor.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**< $0.1 M**

Notes:

Based on:

- GVGC descriptions / Delcan Corporation.
- Traffic volume and signal timing data from the City of Vancouver.

Minor Improvement 5

CAMBIE STREET – SEYMOUR STREET TO MARINE DRIVE

Description:

Remove all parking on Cambie Street to provide a new HPV lane in each direction and coordinate all traffic signals on the corridor.

Cost Summary:

Component	Cost $M
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**< $0.1 M**

Notes:

Based on:
- GVGC descriptions / Delcan Corporation.
- Traffic volume and signal timing data from the City of Vancouver.

Minor Improvement 6

CLARK DRIVE / KNIGHT STREET CORRIDOR BETWEEN POWELL STREET AND KNIGHT STREET BRIDGE (HIGHWAY 91)

Description:

Convert existing parking to High Priority Vehicle (HPV) lanes in both directions and carry out minor intersection improvements such as the introduction of left turn lanes at key locations.

The following signalized intersections included left turn bay improvements in both directions of travel (northbound and southbound):

- Hastings Street
- Venables Street
- 15th Avenue
- 33rd Avenue
- 49th Avenue
- 57th Avenue

A northbound left turn bay was proposed for 6th Avenue. Signal timings were improved at Powel Street, 1st Avenue, Broadway and 57th Avenue.

Cost Summary:

Component	Cost $M
Project Management	0.398
Engineering	0.228
Land Acquisition	3.900
Grade Construction	0.534
Roadside, Utility & Other Construction	0.020
Structural Construction	-
Paving Construction	0.168
Operational Construction	0.841
Tender Contingency & Management Reserve	1.628
Sub Total	7.717
Resident Engineering	0.172
Total	**$7.889 M**

Notes:

Based on E. Wolski costing methodology.

Minor Improvement 7

BOUNDARY ROAD – HIGHWAY 1 TO MARINE DRIVE

Description:

Coordinate traffic signal timings along the corridor.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**< $0.1 M**

Notes:

Based on:

- GVGC descriptions / Delcan Corporation.
- Traffic volume and signal timing data from the City of Vancouver.

Minor Improvement 8

RUSS BAKER WAY / NO. 2 ROAD BETWEEN ARTHUR LAING BRIDGE AND WESTMINSTER HIGHWAY

Description:

Extend the existing High Occupancy Vehicle (HOV) lane southwards and convert the lane into a High Priority Vehicle (HPV) lane.

Cost Summary:

Component	**Cost $M**
Project Management	0.062
Engineering	0.133
Land Acquisition	0.014
Grade Construction	0.447
Roadside, Utility & Other Construction	0.031
Structural Construction	-
Paving Construction	0.085
Operational Construction	0.132
Tender Contingency & Management Reserve	0.217
Sub Total	1.121
Resident Engineering	0.076
Total	**$1.197 M**

Notes:

Based on E. Wolski costing methodology.

Minor Improvement 9

WESTMINSTER HIGHWAY BETWEEN NO. 2 ROAD AND HIGHWAY 91

Description:

Coordinate the traffic signals along the corridor.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**< $0.1 M**

Notes:

Based on:
- GVGC Description / Delcan Corporation.
- Volume and signal timing data from the City of Richmond.

Minor Improvement 10

DINSMORE BRIDGE / GILBERT ROAD / ELMBRIDGE WAY / ALDERBRIDGE WAY TO HIGHWAY 91

Description:

The project is to coordinate the traffic signals between the Dinsmore Bridge and the start/end of Highway 91 / Alderbridge Way at Shell Road.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**< $0.1 M**

Notes:

Based on:
- GVGC Description / Delcan Corporation.
- Signal timing and volume data from the City of Richmond.

Minor Improvement 11

HIGHWAY 91 / 91A BETWEEN HIGHWAY 99 AND QUEENSBOROUGH BRIDGE

Description:

Replace the Highway 91A/Howes Street intersection and traffic signal with a diamond interchange.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**$26.1 M**

Notes:

Based on:
- Initial project description provided by TransLink and refined by Delcan based on the Ministry plans.

Minor Improvement 12

BRIDGEPORT ROAD BETWEEN MORAY BRIDGE AND KNIGHT STREET

Description:

To improve the reliability of the Moray swing bridge by permanently closing the bridge to serve traffic (new structure).

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**$30 M**

Notes:

Based on:
- Delcan Corporation.

Minor Improvement 13

HIGHWAY 17 BETWEEN HIGHWAY 99 AND TSAWWASSEN FERRY TERMINAL

Description:

This project is to consider High Priority Vehicle (HPV) Lanes in the northbound direction along Highway 17 between the Ferry Terminal and Highway 99. In addition, traffic signal coordination in the Tsawwassen area (52nd and 56th Streets) is to be considered. As well, a new interchange at the Ladner Trunk Road/Highway 10 intersection is included as part of the project.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**N/A**

Notes:

Since the southern section of the South Fraser Perimeter Road (SFPR - major project 2) runs parallel to Highway 17, it is expected to divert major commercial traffic from Highway 17 to SFPR. Accordingly, this project was not examined.

Minor Improvement 14

DELTAPORT WAY (HIGHWAY 17 TO ROBERTS BANK)

Description:

No improvements are proposed as part of this project. The initiative is to preserve and maintain the corridor in its current status and not allow it to degenerate through the permission of multiple access points.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**N/A**

Notes:

Based on:
- GVGC Description / Delcan Corporation.

Minor Improvement 15

HIGHWAY 91 BETWEEN HIGHWAY 91A AND HIGHWAY 99

Description:

Introduce an interchange and northbound HPV queue jumper lane at the existing "T" junction with 72nd Avenue. An exemption for unladen trucks to bypass the Nordel weigh scale is also proposed, but since this is a policy issue, it has not been considered as an improvement option for analysis purposes.

Partial diamond interchange.

Cost Summary:

Component	Cost $M
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**$9.6 M**

Notes:

Based on:

- GVGC Description / Delcan Corporation.

Minor Improvement 16

88TH AVENUE / NORDEL WAY – HIGHWAY 15 TO HIGHWAY 91

Description:

Upgrade 88th Avenue from two lanes to four lanes in each direction throughout its length (between Highway 15 and 152nd Street) and coordinate the traffic signals along 88th Avenue and Nordel Way (which has recently been constructed to connect directly to 88th Avenue).

Cost Summary:

Component	Cost $M
Project Management	1.368
Engineering	1.442
Land Acquisition	9.851
Grade Construction	5.327
Roadside, Utility & Other Construction	0.354
Structural Construction	-
Paving Construction	1.433
Operational Construction	0.863
Tender Contingency & Management Reserve	4.480
Sub Total	25.118
Resident Engineering	0.874
Total	**$25.992 M**

Notes:

Based on E. Wolski costing methodology.

Minor Improvement 17

NORTH BLUFF ROAD AND 16TH AVENUE CORRIDOR BETWEEN HIGHWAY 15 AND 200TH STREET

Description:

Implement localised improvements to improve roadway capacity on 16th Avenue between Highway 15 and 200th Street.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**N/A**

Notes:

Since the traffic operation at the intersections of the corridor presented Level of Service C or better, no improvements were justified for implementation.

Minor Improvement 18

HIGHWAY 99A – COLEBROOK ROAD – 152ND STREET CORRIDOR BETWEEN HIGHWAY 99 AND 56TH AVENUE

Description:

Upgrade Colebrook Road to formal paved single lane in each direction between Highway 99A and 152nd Street and provide new signal at Colebrook Road and 152nd Street.

Cost Summary:

Component	**Cost $M**
Project Management	0.092
Engineering	0.170
Land Acquisition	-
Grade Construction	0.712
Roadside, Utility & Other Construction	0.036
Structural Construction	-
Paving Construction	0.212
Operational Construction	0.108
Tender Contingency & Management Reserve	0.290
Sub Total	1.620
Resident Engineering	0.118
Total	**$1.738 M**

Notes:

Based on E. Wolski costing methodology.

Minor Improvement 19

200TH STREET – 16TH AVENUE TO 92ND AVENUE

Description:

Implement localized improvements along 200th Street between 16th Avenue and 92nd Avenue. New signals at 16th and 32nd Ave intersections due for construction in 2003.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**$0.32 M**

Notes:

Based on:
- GVGC Description / Delcan.
- CTS/LCP Signal Timing Design report.

Minor Improvement 20

HIGHWAY 13 BETWEEN HIGHWAY 1 AND THE ALDERGROVE BORDER CROSSING

Description:

Optimize signal timings at various locations to provide improved travel times along Highway 13 corridor.

Cost Summary:

Component	**Cost $M**
Project Management	N/A
Engineering	N/A
Land Acquisition	N/A
Grade Construction	N/A
Roadside, Utility & Other Construction	N/A
Structural Construction	N/A
Paving Construction	N/A
Operational Construction	N/A
Tender Contingency & Management Reserve	N/A
Sub Total	
Resident Engineering	N/A
Total	**$0.15 M**

Notes:

Based on:
- GVGC Description / Delcan Corporation / Ministry.

Minor Improvement 21

BARNET HIGHWAY BETWEEN ST. JOHNS STREET AND LOUGHEED HIGHWAY

Description:

To implement localized improvements to improve roadway capacity along the section of Barnet Highway between St. Johns Street / Ioco Road and Pinetree Way.

Cost Summary:

Component	Cost $M
Project Management	0.221
Engineering	0.337
Land Acquisition	1.879
Grade Construction	0.660
Roadside, Utility & Other Construction	0.037
Structural Construction	1.680
Paving Construction	0.086
Operational Construction	0.103
Tender Contingency & Management Reserve	1.155
Sub Total	6.158
Resident Engineering	0.270
Total	**$6.428 M**

Notes:

Based on E. Wolski costing methodology.

Minor Improvement 22

LOUGHEED HIGHWAY BETWEEN HANEY BYPASS AND MISSION

Description:

Provide a consistent four lane cross section between River Road and Mission Bypass.

Upgrade of the following intersections:

- River Road
- 280th Street
- 285th Street
- 287th Street
- Donatelli Street
- Silverdale Street
- McLean Street
- Chester Street
- Nelson Street
- Oliver Street
- Wren Street

Cost Summary:

Component	**Cost $M**
Project Management	1.528
Engineering	1.868
Land Acquisition	8.222
Grade Construction	6.521
Roadside, Utility & Other Construction	0.714
Structural Construction	0.864
Paving Construction	1.724
Operational Construction	1.376
Tender Contingency & Management Reserve	4.995
Sub Total	27.812
Resident Engineering	1.213
Total	**$29.025 M**

Notes:

Based on E. Wolski costing methodology.

Minor Improvement 23

CANADA WAY BETWEEN BOUNDARY ROAD AND 10TH AVENUE

Description:

Implement localized improvements along Canada Way between Boundary Road and 10th Avenue which include the addition of:

- a northbound through lane at Kensington Street intersection;
- a northbound through lane at Edmonds Street Intersection; and
- a southbound left lane at Willingdon Avenue intersection.

Cost Summary:

Component	Cost $M
Project Management	0.058
Engineering	0.116
Land Acquisition	3.420
Grade Construction	0.457
Roadside, Utility & Other Construction	0.027
Structural Construction	-
Paving Construction	0.061
Operational Construction	0.102
Tender Contingency & Management Reserve	0.451
Sub Total	4.692
Resident Engineering	0.074
Total	**$4.766 M**

Notes:

Based on E. Wolski costing methodology.

Minor Improvement 24

MARINE WAY BETWEEN BOUNDARY ROAD AND QUEENSBOROUGH BRIDGE

Description:

Provision of a new High Priority Vehicle (HPV) lane in each direction on Marine Way between the Queensborough Bridge and Boundary Road (to connect to section between Granville Street and Boundary Road). It has been assumed that the HPV lanes will be added to the existing four lane cross section. The HPV lanes will be located in the shoulder lane.

Cost Summary:

Component	Cost $M
Project Management	1.343
Engineering	1.226
Land Acquisition	8.636
Grade Construction	4.272
Roadside, Utility & Other Construction	0.176
Structural Construction	1.500
Paving Construction	1.406
Operational Construction	1.582
Tender Contingency & Management Reserve	4.404
Sub Total	24.545
Resident Engineering	0.969
Total	**$25.514 M**

Notes:

Based on E. Wolski costing methodology.

Appendix 3

Ranking of Major, Minor & Railway Improvements

The implementation priority of the various improvements is determined using a semi-quantitative cost effectiveness methodology. Understandably, although the improvements are classified into categories, the nature of the improvements varies significantly. Thus, quantitative criteria combined with qualitative engineering judgement are required in ranking the improvements. The following sections summarize the methodology used in each category.

Major Improvements

Four quantitative criteria reflecting the cost effectiveness of the major improvements are used in assessing the implementation priority: change in usage (in both volume and percentage), change in volume-to-capacity ratio, and cost. In essence, higher priority is assigned to improvements with positive and significant change in usage, percent difference in usage, and volume-to-capacity ratio, as well as low cost. Volumes obtained from EMME/2 modelling representing the projected scenario in year 2021 are used in the assessment. Before ranking, each improvement is summarized based on the highest estimated change in usage in each direction of flow. In addition, in cases where a high-occupancy-vehicle (HOV) lane or high priority vehicle (HPV) lane is suggested, the comparison of usage and volume-to-capacity ratio are conducted using the combined volume of the general-purpose and HOV / HPV lanes. The results are shown in ***Table 3.1***.

Although the ranking results should reasonably reflect the implementation priority of each improvement, readers should be reminded of the assumption that when the EMME/2 modelling was conducted for the projected scenario in year 2021, either all or none of the suggested improvements would be implemented. As such, it is impossible to identify the isolated usage changes generated by individual improvements.

Finally, it should be noted that two improvements are excluded from the ranking in this category, namely the Rapid Transit – Richmond / Airport / Vancouver project and the New Westminster Rail Bridge. The former is not a direct road improvement project, and the latter is an improvement to the railway system therefore it is ranked in the railway category.

Minor Improvements

The methodology and the associated assumptions used in assessing the implementation priority of the minor improvements are similar to those of the major improvements. In addition to the four criteria described previously, the change in 2002 delay (in hours and in percentage) is used. Higher priority is given to improvements with greater positive change in delay. Similar to the major improvements, in cases where a high-priority-vehicle (HPV) lane is suggested, the comparison of usage and volume-to-capacity ratio are conducted using the combined volume of the general-purpose and HPV lanes. ***Table 3.2*** presents the results.

Again, it should be noted that four improvements are excluded from the ranking as specific information on these improvements was not calculated due to the nature of the proposed improvements (i.e. reliability was a main issue which is difficult to quantify). These improvements are: Highway 17 from Ferry Terminal to Highway 99, Sea Island Connector, Deltaport Way, and 16 Avenue.

Railway Improvements

The railway improvements are classified into three groups according to the suggested types of improvements, namely major, grade separation, and other. Similar to the major and minor road improvements, the cost effectiveness of the railway improvements is assessed. Different categories of benefits are considered, including operations, capacity, safety, passenger service, and retention of market. Although only safety benefits and implementation costs are quantified in monetary terms and are thus shown in the ranking results in ***Table 3.3***, consideration is given to other categories of benefits through engineering judgement.

Major Commercial Transportation System Economic Analysis Study
TABLE 3.1 RANKING - MAJOR IMPROVEMENTS

Ranking	Project #	MAJOR IMPROVEMENTS	Suggested Improvement(s)	EB/NB							WB/SB							Costs (B $)
				Volume				V/C			Volume				V/C			
				Base Case 2021	MCTS 2021	D Volume	% Diff	Base Case 2021	MCTS 2021	D V/C	Base Case 2021	MCTS 2021	D Volume	% Diff	Base Case 2021	MCTS 2021	D V/C	
1	3	**200th Street Bridge**	New Fraser River crossing	N/A	1750	N/A	N/A	N/A	0.55	N/A	N/A	3175	N/A	N/A	N/A	1.33	N/A	0.605
2	2	**South Fraser Perimeter Road**	New connection bet Hwy 1 at 176 St and Hwy 91 at River Rd	275	1975	1700	618%	0.17	0.62	0.45	1325	2025	700	53%	0.83	1.01	0.18	0.401 +
3	1	**Highway 1**	Additional capacity: twinning of Port Mann Bridge, extension of HOV lanes, upgrades to various interchanges	2325	3075	750	32%	0.72	0.64	-0.08	4700	6325	1625	35%	1.34	1.02	-0.32	1.0 - 1.2
4	10	**Highway 10**	Increase capacity from two to four lanes	750	1250	500	67%	0.93	0.79	-0.14	1175	2075	900	77%	1.18	1.04	-0.14	0.08
5	9	**Highway 15**	Increase capacity from two to four lanes	825	1725	900	109%	0.51	0.54	0.03	775	1200	425	55%	0.48	0.76	0.28	0.085
6	5	**North Fraser Perimeter Road**		25	150	125	500%	0.01	0.1	0.09	925	1150	225	24%	0.29	0.36	0.07	0.085
7	11	**8th Avenue**	Widening of 8th Ave along with interchange improvements			0							0					0.023
8	7	**Massey Tunnel / Oak Street Project**	Two new lanes under river, extension of HOV lanes fr KGH to Westminster Hwy	6025	7375	1350	22%	1.25	1.15	-0.1	800	1400	600	75%	0.25	0.22	-0.03	0.50 - 0.70
9	8	**Oak Street Bridge (Highway 99)**	Widening of the bridge by adding 1 HOV lane in each direction	2125	3150	1025	48%	1.18	0.93	-0.25	2400	2700	300	13%	0.75	0.56	-0.19	0.1
N/A	4	**Rapid Transit - Richmond / Airport / Vancouver**	New rapid transit line from Richmond and Vancouver International Airport to downtown Vancouver															
Ranked with other rail improvements	6	**New Westminster Rail Bridge**	Road tunnel to parallel proposed rail tunnel under portions of New Westminster and Fraser River															

Major Commercial Transportation System Economic Analysis Study
TABLE 3.2 RANKING - MINOR IMPROVEMENTS

Ranking	Project #	MINOR IMPROVEMENTS	Suggested Improvement(s)	improvement in 2002 delay (hrs)	% improvement in 2002 delay	EB/NB								WB/SB								Costs (M $)
						Volume					V/C			Volume					V/C			
						Base Case 2021	MCTS 2021	HPV only 2021	D Volume	% Diff	Base Case 2021	MCTS 2021	D V/C	Base Case 2021	MCTS 2021	HPV only 2021	D Volume	% Diff	Base Case 2021	MCTS 2021	D V/C	
Under Way	2	**Port Road - Heatley Street to McGill Street**	Restrict South Shore roadway to Port traffic only																			N/A
Under Way	11	**Highway 91/91A - Highway 99 to Queensborough Bridge**	Replace intersection at Ewen Street / Boyd Avenue with grade separation																			26.1
Under Way	15	**Highway 91 - Highway 99 to Alex Fraser Bridge**	Replace at grade intersection at 72nd Avenue with grade separation																			9.6
1	3	**Powell/Hastings**	Signal coordination, convert parking to HPV lane in both directions	94	23%	1150	1400	275	250	22%	0.72	0.58	-0.14	1450	1900	450	450	31%	1.21	1.06	-0.15	0.1
2	16	**88th Avenue**	Signal coordination, increase capacity with consistent four lane cross section	73	24%	75	450	N/A	375	500%	0.19	0.27	0.08	500	825	N/A	325	65%	1.27	1.03	-0.24	26
3	6	**Clarke Drive / Knight Street**	Provision of left turn lanes at key intersections; convert parking to HPV lanes in both directions	58	11%	800	950	175	150	19%	0.67	0.52	-0.15	525	550	175	25	5%	0.22	0.23	0.01	7.9
4	24	**Marine Way - Boundary to Queensborough**	Signal Coordination, implement high priority vehicle (HPV) lane in both directions through the construction of two additional lanes			1400	1525	200	125	9%	0.7	0.5	-0.2	1275	1825	275	550	43%	0.8	0.76	-0.04	25.5
5	1	**Marine Drive**	Signal coordination, convert existing lane to HPV lane in both directions	194	35%	1125	1150	175	25	2%	0.47	0.48	0.01				0					0.1
6	22	**Lougheed Highway - Laity St to Mission Bypass**	Widen highway fr 2 to 4 lanes; spot treatments: improve intersection capacity at problem intersections						0					1025	1425	N/A	400	39%	0.64	0.44	-0.2	29
7	4	**Granville Street**	Signal coordination, convert parking to GP lanes in both directions	58	14%	1625	1650	300	25	2%	0.34	0.21	-0.13	1575	1775	225	200	13%	0.49	0.27	-0.22	0.1
8	5	**Cambie Street**	Signal coordination, convert parking to HPV lane in both directions	148	24%				0								0					0.1
9	23	**Canada Way - Boundary to 10th**	Spot treatments; improve intersection capacity at problem intersections	80	43%																	4.8
10	10	**Alderbridge Way - Dinsmore Bridge to Highway 91**	Signal coordination	48	32%																	0.1
11	9	**Westminster Highway - No.2 Rd Bridge to Highway 91**	Signal coordination	49	17%																	0.1
12	7	**Boundary Rd - Highway 1 to Marine Dr**	Intersection Improvements	34	13%																	0.1
13	18	**Colebrook Rd to 152 St**	Improve unsignalized intersection - install traffic signal	22	88%																	1.75
14	21	**Barnet Highway - Ioco Rd to Pinetree Way**	Spot treatments; improve intersection capacity at problem intersections	36	18%																	6.5

Major Commercial Transportation System Economic Analysis Study

TABLE 3.2 RANKING - MINOR IMPROVEMENTS

Ranking	Project #	MINOR IMPROVEMENTS	Suggested Improvement(s)	improvement in 2002 delay (hrs)	% improvement in 2002 delay	EB/NB								WB/SB								Costs (M $)
						Volume					V/C			Volume					V/C			
						Base Case 2021	MCTS 2021	HPV only 2021	D Volume	% Diff	Base Case 2021	MCTS 2021	D V/C	Base Case 2021	MCTS 2021	HPV only 2021	D Volume	% Diff	Base Case 2021	MCTS 2021	D V/C	
15	19	**200th Street - 16 to 92**	Spot treatments; improve intersection capacity at problem intersections	2 (16 Ave) &1 (32 Ave)	67% (16 Ave) & 100% (32 Ave)																	0.3
16	20	**Highway 13 - Highway 1 to US Border**	Spot treatments; improve intersection capacity at Fraser Highway and at 16th Avenue	1	8%																	0.15
17	8	**Russ Baker Way**	Extend existing HOV lane and convert to HPV			1900	2000	200 (300 without improvement)	100	5%	0.63	0.67	0.04				0					1.2
N/A	13	**Highway 17 - Ferry Terminal to Highway 99**	Signal coordination between intersections at 56th Avenue and 52nd Avenue in Tsawwassen Area																			N/A
No specific information available	12	**Sea Island Connector**	Improvements to the existing swing bridge to improve reliability																			30
No specific information available	14	**Deltaport Way - Roberts Bank to Highway 17**	Preserve corridor with access management																			N/A
No specific information available	17	**16 Avenue - 200 Street to Highway 15**	No improvements required																			N/A

Major Commercial Transportation System Economic Analysis Study
TABLE 3.3 RANKING - RAILWAY IMPROVEMENTS

Major New Improvements

Ranking	Project	Costs ($ M)	Comments	Safety Benefits ($K)
1	New Westminster Bridge & BN New Yard to Spruce Street	750 - 1000, plus 1	Capacity issues projected along with current operational issues. Significant investment required.	N/A
2	Colebrook - North/South	2	Capacity issues projected. These issues currently restrict additional passenger train operations.	N/A
3	Colebrook - East/West, or Boundary Bay	3	Capacity issues projected. These issues currently restrict additional passenger train operations.	N/A
4	Pitt River Span Rail Bridge	250	Significant investment with limited economical benefits if replaced with similar configuration.	N/A

Grade Separation Improvements

Ranking	Project	Costs ($ M)	Comments	Safety Benefits ($K)
1	King Edward Street	15 - 20	Construction of grade separation at this location not only provides increase safety benefits, but will also improve rail operations and vehicle operations. Furthermore, improvements at this location have benefits with respect to the upgrading of the Cape Horn Interchange (Highway 1, Highway 7).	3.5
2	Harris Road	10 - 15	Primarily safety benefits and improved vehicle operations in Pitt Meadows.	20
3	Westwood Street	10 - 15	Primarily safety benefits and improved vehicle operations.	13-17
4	Roberts Bank	15 - 20	Limited safety benefits for vehicle movements. Benefits for rail operations.	Nil
5	Front Street	25 - 30	Improved safety benefits.	2-9
6	Pemberton Avenue	10 - 15	Limited safety benefits.	4
7	Yale Road	25 - 35		TBD

Other Improvements

Ranking	Project	Costs ($ M)	Comments	Safety Benefits ($K)
1	Mud Bay Area	15	Wye reduces travel time / distance between Roberts Bank and other areas of Greater Vancouver.	N/A
2	BNSF Burrard Inlet Line at Powell Street	20 - 25	Improved rail operations.	N/A
3	BNSF Line - CN Junction	2	Improved rail operations.	N/A
4	Queensborough Bridge	10		N/A
5	Victoria Drive - Rail Crossing Upgrade	N/A	To be closed as part of Vancouver Port Authority's increased security measures.	N/A

Appendix 4

Development of Travel Benefits

1. Introduction

The Major Commercial Transportation System (MCTS) comprises proposed major and minor improvements to the road, rapid transit and rail network.[1] Together, they are expected to increase benefits to and reduce the costs of moving people and goods in Greater Vancouver.

The travel benefits that are associated with the MCTS infrastructure are important to establishing the economic merit of these improvements. Travel benefits are expressed in two key ways: savings in trip time for travellers (to which a monetary value can be assigned) and savings in trip distance (which is expressed in terms of vehicle operating costs). The travel benefits were derived from forecasts of conditions with and without the MCTS improvements in place, separately for light and heavy truck trips, using TransLink's EMME/2 travel demand forecasting model as well as traffic operations software.

This technical appendix explains the derivation of the travel time and distance forecasts. It addresses the impacts of the MCTS road and rapid transit improvements: as noted below, the benefits of the rail improvements are measured in different ways, and are discussed elsewhere.

To develop the travel benefits, the Consultant:

- Procured and reviewed the TransLink EMME/2 model.
- Reviewed the key model inputs that influence truck traffic demand, and made adjustments as appropriate.
- Defined and modelled the major and minor MCTS improvements in EMME/2 (and other software, as explained below).
- Generated forecasts for 2021, with and without the MCTS improvements in place.
- Tabulated differences in travel time and distance, with and without the MCTS improvements in place.

As noted, the TransLink EMME/2 travel demand forecasting model was the basis of the travel benefit analysis. However, two exceptions should be noted: the main benefit of many of the minor MCTS improvements is operational and localized; therefore, they were analyzed with Synchro (a model of traffic operations) rather than EMME/2 (for which such details are too fine).

EMME/2 does not simulate rail freight. Moreover, the benefits of the rail improvements are measured in terms of impacts to operations and safety. Therefore, the major MCTS rail improvements were analyzed separately.

[1] It should be noted that the "MCTS" does not have any regulatory or administrative status with local, regional or provincial governments.

2. The TransLink EMME/2 Travel Demand Model

2.1 Overview

The EMME/2 model forecasts travel across Greater Vancouver. The model simulates auto (private vehicle) trips, public transit trips (by all transit modes), light trucks and heavy trucks. In other words, it simulates road-based transportation (autos, buses and trucks) as well as rail transit (WestCoast Express and SkyTrain) and the Seabus. Moreover, the model differentiates auto trips into single-occupant vehicle (SOV) trips and those with two or more occupants (high-occupancy vehicle [HOV] trips).

Air, marine and non-transit rail traffic is not simulated in the model. However, freight carried by these others modes – that is, loaded or unloaded at the marine ports, the airport and the intermodal rail terminals –was taken into account, in terms of the truck trips that were generated.

EMME/2 is widely used in Canada and around the world to simulate urban travel. In Greater Vancouver, the model simulates travel during the AM commuter peak hour (i.e., the time of peak *overall* loading onto the transportation network; although it is recognized that the peak *truck* loadings occur mid- to late-morning). Different versions of the Greater Vancouver model exist, with the version developed by the Vancouver Port Authority (VPA) in 2002 for the AM peak hour considered to be the most recent.

Accordingly, TransLink directed that the VPA model should be used for this study. TransLink also has a PM peak hour model. The AM and PM models generally are similar in structure, with a notable exception being the number of zones.[2] However, an exact PM counterpart to the VPA AM model does not exist, so the analysis used only the latter.

2.2 The VPA Model

The VPA version was developed in order "to better address Port requirements," and TransLink subsequently updated and consolidated its networks.[3] Compared with previous versions of the TransLink model, the VPA model:

- A refined depiction of the zones and road network in the vicinity of the marine ports in Greater Vancouver. Twenty-two new zones were added to the model, therefore increasing the total number of zones to 726.

---

2 "Zones" are analogous to Census Tracts. They represent neighbourhoods or areas of common land uses (e.g., the Airport is a unique zone; as is UBC, major shopping centres, etc.). The model can test the impacts of proposed developments in particular zones. The different versions of the model comprise between 705 and 880 zones (reflecting in large part the development of detailed sub-area models for some individual municipalities). *The difference in the number of zones means that different networks, trip tables (matrices), etc., must be converted to an alternate zone system before they can be used with the latter.*

3 This discussion is based upon a review of the VPA EMME/2 data bank (version of 18 November 2002) and two VPA documents that were provided to the Consultant:

- *Vancouver Port Authority EMME/2 Model Documentation*, prepared by UMA Engineering Ltd. for the VPA, August 2002.
- *Notes* regarding the development of the 2002 base networks for the Gateway Council, letter from Ward Consulting Group to TransLink, 13 November 2002.

- An improved method to forecast truck movements to and from the marine ports, as a function of container traffic. This was based in large part upon a truck origin-destination survey, conducted in 2001 at the major container ports.
- Updated road and transit networks, to reflect 2002 conditions (notably, the September 2002 opening of the Millennium SkyTrain line, associated changes to the feeder bus network and the addition or upgrade of other lines [e.g., the 97B Line]).
- Simplification of the HOV demand model, in which HOV is defined as having two or more occupants (rather than the previous separation into HOV 2 and HOV 3+ categories). The existing park-and-ride model was retained.

2.3 Method of Forecasting Auto and Transit (Passenger) Travel

Future travel demand varies mainly according to two types of changes: changes in Greater Vancouver's transportation network (such as those envisioned by the MCTS improvements); and/or in its expected demographic and economic development (land use scenario). Thus, the model can be used to identify requirements and priorities for road or transit infrastructure according to future land use; or to test the impacts of possible new road or transit investments (such as the MCTS improvements).

The Greater Vancouver Regional District's land use scenario for its *Livable Region Strategy* for the year 2021 was used for this analysis. This is the *Growth Management Scenario* (GMS), which promotes the location of future jobs in suburban town centres – i.e., nearer to where people live, as well as higher density, mixed-used development (especially at suburban town centres). The resultant balance in how a community develops would reduce the need to travel to the urban core and promote alternatives to SOV trips, while containing urban sprawl and maximizing the use of available capacity in the off-peak direction. A second scenario, the Decentralized Regional Scenario (DRS), was tested under a sensitivity analysis. It reflects the impacts of current trends, which tend towards increased low-density sprawl. It should be noted that the DRS does not have status.

For this study, it was agreed that the 2021 land use scenario would be applied to the base 2002 (i.e., existing) network, with and without the MCTS improvements.

Like most other models around the world, TransLink's models forecast demand and supply in four steps:

- Trip generation, which calculates the number of trips starting and ending in each zone as a function of that zone's population, employment, student enrollment, and other demographic and socio-economic factors. Trips are generated by purpose: home-to-work, home-to-school, etc.

- Trip distribution, which links trip starts and trip ends by purpose between zone pairs according to network characteristics (i.e., the 'cost' of traveling between zones, which is a function of travel time between the zones, out-of-pocket cost, etc.) and the relative attraction of that zone's demographic and socio-economic characteristics.

- Modal split, which allocates the resultant trips by mode: SOV auto trip, HOV auto trip and public transit.

- Trip assignment, which allocates the resultant trip table (matrices) by mode to the respective networks. The TransLink model adds light trucks and heavy trucks to the assignment process (more on this below). The results are expressed in terms of vehicle trips on each segment (link) of the road network (categorized by auto, light truck and heavy truck, with traffic on HOV lanes distinguished) and person trips on each segment of each route of the transit system (bus, SkyTrain, WestCoast Express and Seabus).

The first three steps (trip generation, distribution and modal split) define the demand for travel. The fourth step (trip assignment) relates this demand to the supply of transportation. Demand is calculated for the two-hour AM peak period (i.e., the peak period has a fixed two-hour duration), then factored to represent the AM peak hour before it is assigned to the network (that is, spreading of traffic within or beyond the peak hour is not modelled explicitly).

The demand for light and heavy trucks is forecast separately and in different ways, although the AM peak hour trip tables for SOV autos, HOV autos, light trucks and heavy trucks are assigned together.

3. Derivation of Truck Trip Forecasts

3.1 Method

Trip tables for light and heavy commercial vehicles were derived from the 1999 *Lower Mainland Freight Study*, which collected special data for the purpose. Trip tables were developed for a 'typical' 24 hour weekday period, which reflect (among other points) the fact that peak activity for trucks occurs around mid-morning. However, as noted the dominant overall loadings on the transportation system occur during the commuter peaks, and so an AM peak hour trip table was extracted for use in the TransLink model.

Forecasts of the demand for light and heavy commercial traffic are developed as a function of forecasts of employment (and also taking into account specific 'special truck generators' such as the Airport, the demands for which are based on other factors). As noted, the process used to develop forecasts of the movement of goods is different from that used to develop forecasts of the movement of people. The resultant light and heavy commercial vehicle trip tables have been incorporated into the TransLink models.

There are three categories of truck trips: internal (trips starting and ending within Greater Vancouver), external (trips starting or ending outside Greater Vancouver, including cross-border trips) and special generators (special high-activity truck zones; namely, the ports, the airport and the intermodal rail terminals.). Light and heavy truck trips are simulated separately. Trips are calculated for 24 hour volumes, then factored to represent AM peak hour values. With the exception of the updated VPA ports forecasts, the light and heavy truck models were based upon data derived from the *1999 Lower Mainland Truck Freight Survey.*

The three categories are simulated as follows[4]:

- Internal trips. These are estimated according to the four-step paradigm; namely, trips are generated as a function of employment by industry type, then distributed according to a gravity model formulation. In other words, internal truck trips are a direct function of projected employment (in this case, for 2021) and of the assumed transportation network (in this case, for 2002 with and without the MCTS). Different rates are used for light and heavy trucks.

- External trips. These trips are factored from base year (1999) light and heavy trucks. The factor is estimated as the ratio of forecast (2021) versus base (1999) employment (that is, different types of employment). In addition, the factor is further increased by a rate of 2% per year, compounded. In other words, external truck trips retain the base year distribution, independent of any assumed changes in the transportation network.

- Special generators. These trips are simulated in two ways: The VPA model generates and distributes truck trips for Deltaport, Centerm and Vanterm as a function of projected container traffic (which it estimates separately). Truck traffic at the remaining special generators – Seaspan, Fraser Surrey Docks, the CN and CP intermodal terminals and Vancouver International Airport – is based upon base year (1999) truck trips, factored by a rate of 4% per year, compounded. In other words, truck traffic at the three major ports is estimated as a function of future conditions, whereas traffic at the other special generators is factored from base year conditions. Heavy trucks are simulated for all special generators, although light trucks are simulated only for the airport.

Factors to expand results beyond the AM peak hour must be developed in order to yield daily and, ultimately, annual figures.

3.2 Review of Factors Influencing Truck Trips

Before using the VPA model, the Consultant was asked to verify the factors that influence the demand for truck trips, as follows:

- Peak hour factors. These are important in expanding the AM peak hour model outputs to daily values (and, from daily values, to annual values for input to the economic analysis). The Consultant reviewed the 1999 *Vehicle Volumes and Classification Survey* traffic counts across the entire region (peak direction), and found that – on average – AM peak hour volumes of light trucks represented 7.6% of the total daily traffic and heavy trucks represented 6.4%. The latter differs from, but is reasonably close to, the documented factor of 8.4%. It was agreed that the factors derived from the classification counts would be used for this analysis.

[4] The descriptions are derived from the *1999 Lower Mainland Truck Freight Survey* documentation and from the 'macros' (EMME/2 operating instructions) upon which the VPA model was based.

- Internal truck trip generation rates. The Consultant was directed to review the truck trip rates used in the VPA model. The Consultant compared the documented truck trip rates with those presented in *Truck Trip Generation Data*, NCHRP Synthesis 298 (Transportation Research Board, Washington, DC), a 2001 compilation of truck trip generation rates from across North America. ***Table 1*** compares the two sources (although it should be noted that the NCHRP report also cites Vancouver data, and is based upon limited samples).

  The table indicates that the cited NCHRP trip generation rates generally are 10 times higher than those used in the VPA model. However, the NCHRP rates often reflect the predominant land use at specific sites, whereas the VPA model is using several independent variables to generate truck trips for each zone. Accordingly, when the individual VPA rates are summed up, the light truck rate of 0.7856 trips per job and the heavy truck rate of 0.4912 trips per job are of the same magnitude as the NCHRP rates. As a result, it was agreed to retain the existing VPA rates for this study.

Table 1. Comparison of NCHRP and VPA Truck Trip Rates

Industry Group	NCHRP Average Rates	NCHRP number of samples	VPA Model Average Rates
Manufacturing and Wholesale	0.3678	5	0.09325
Retail	0.283	3	0.08675
Retail	0.917	15	0.08675
Education Health & Social	0.437	4	0.012
Services, Schools and Government	2.966	3	0.012

- Growth rate for internal truck trips. As noted, employment growth rates are used as the basis for forecasting internal light and heavy truck trips. However, a more representative indicator may be projected growth in GDP, because it reflects gains in productivity. Sources for long-term GDP projections are limited. However, a reasonable indicator is that provided by the *TD Economics* April 2002 forecast; namely, a 2.7% annual national growth rate over the long term. (By comparison, British Columbia's 2003 GDP growth rate was estimated to be 2.7%, and that of Canada estimated to be 2.9%.) The long-term GDP growth rate is greater than that of the projected increase in employment of 2.0%, which is incorporated into the model. The use of the GDP as the basis for forecasting would increase the forecasts by about 15%. It was agreed to use GDP rather than employment as the basis for the internal truck trip forecasts.

- Growth rates for special generators. The VPA model incorporated the Vancouver Port Authority's forecasts of container traffic at the Deltaport, Centerm and Vanterm in its revised model. Forecasts at the remaining ports (Seaspan and Fraser Surrey Docks) assumed a growth rate of 4% per year: available information from the VPA suggests that these are reasonable. The 4% growth rate also was assumed for the rail terminals and for Vancouver International Airport: forecasts for rail traffic are not available, so no comparison can be made. However, the Vancouver International Airport projects an annual increase of 3.5% in inbound and outbound cargo to 2022, which is less than the cited 4%. The use of the lower growth rate would result in a 10% reduction in airport-generated truck trips; however, the absolute difference in overall truck trips is small. Accordingly, it was agreed to retain the existing forecasts for the special generators.

4. Travel Impacts of the Road and Rapid Transit Investments

4.1 Forecasts

Using the regional EMME/2 transportation planning model and a traffic operational model, the Consultant estimated the travel time and distance impacts of the major and minor road and rapid transit improvements.

The Major New Investments (road and rapid transit) were coded into the EMME/2 model; specifically, into a copy of the 2002 base network. The EMME/2 model was then used to estimate AM peak hour travel for a recent (base year), namely, 1999; and for a horizon year (2021).[5] Three scenarios were developed:

- 1999 demand with the base 2002 network (i.e., representing the existing situation).
- 2021 demand with the base 2002 network (without the MCTS improvements).
- 2021 demand with the base 2002 network plus the MCTS improvements.

In this way, two types of comparisons could be made:

- Impacts of growth in demand; that is, comparing conditions in 2021 with those of 1999, using the same (base) 2002 network.
- Impacts of changes to the transportation network; that is, comparing the 2021 demand with and without the MCTS improvements in place.

The former comparison recognizes that travel will grow as a function of demographic and economic growth (as represented by the *Growth Management Scenario* for land use); and the latter comparison demonstrates how this growth in travel is impacted by the proposed improvements. Truck trips are expected to grow as function both of the population (that is, to serve the population's needs), but also as the freight moving through the ports, airport, rail terminals, border crossings and internal gateways (i.e., to the rest of BC and Canada) grows. Finally, for the purposes of the economic analysis, it was assumed that *all* improvements would be implemented at the same time; and that these would be implemented in the short-term.[6]

[5] The use of 1999 as the reference year reflects the most recent year for which population, employment *and* travel data were all available. Similarly, 2021 is the horizon year for TransLink's plans and policies.

[6] In other words, the purpose of this exercise was to compare the situation *with* and *without* – and not *among* - the improvements in place.

The economic analysis requires that travel time and distance be measured as vehicle-hours travelled (VHT) and vehicle-kilometres travelled (VKT), respectively. VHT and VKT represent the number of vehicle-trips * time per trip and the number of vehicle-trips * distance per trip, respectively, summed by vehicle type (SOV, HOV, light truck and heavy truck) over the entire region. These were calculated from the model for the AM peak hour. They then were expanded to represent daily (24 hour) values and then annual values.[7]

Table 2 summarizes the results of the AM peak hour forecasts, which are presented below.

Table 2. Summary of Forecasts (1999 and 2021, AM peak hour)

Demand / Network	Population	Employment	SOV	HOV	Transit	Light Trucks	Heavy Trucks	Total Person-Trips	Total Vehicle-Trips*
1999 / base 2002	2,188,835	1,058,895	232,074	75,292	60,453	9,629	5,222	382,671	284,571
2021 / base 2002	3,098,322	1,594,086	325,591	95,452	81,804	14,619	8,534	526,000	396,470
2021 / 2002 + MCTS	3,099,322	1,594,086	325,803	97,253	82,413	14,619	8,534	528,623	397,583

* Calculated as the sum of SOV, light trucks and heavy trucks, plus HOV / 2 (to approximate the number of persons per vehicle). Transit person-trips are not included (the on-road capacity taken up by buses is taken into account during the assignment of autos and trucks).

- Greater Vancouver's population is expected to grow by 42% between 1999 and 2021 (from 2.2 million to 3.1 million people), and jobs by 45% (from 1.1 million to 1.6 million jobs).

- Between 1999 and 2021, AM peak hour traffic on a 'typical' weekday (all vehicles) is expected to grow by 39%, from 320,000 vehicle-trips in 1999 to 445,000 vehicle-trips. In 1999, trucks represented 4.6% of all traffic on the roads during the AM peak hour; by 2021, this will have increased slightly to 5.2%.

Traffic in the morning peak hour will not grow as fast as the population (or jobs). However:

- Truck traffic is expected grow by 56% (from 14,900 truck trips in 1999 to 23,200 truck trips in 2021), with heavy truck traffic growing by 63% (5,200 truck trips in 1999 to 8,500 truck trips in 2021). Despite their relatively small numbers, trucks will have proportionately a slightly greater impact on capacity (because they are slower and occupy more road space than autos).

[7] The light and heavy truck peak hour factors discussed in Section 3.2 were used for this expansion (as well as factors derived for auto vehicles). More important, the same factors were used to expand both VKT and VHT: the assumption being that congestion (travel time) over the rest of the day would vary according to activity on the roads (measured by distance). Although this is a simplification, it is reasonable in light of the lack of region-wide data regarding how travel time changes by hour of day.

- Single-occupant vehicle (SOV) trips will continue to dominate, comprising 73% throughout the planning period. High-occupancy vehicle (HOV) trips will comprise 21% of all trips, HOV trips will grow by 27%, but SOV trips will grow even faster, at 40%.

- Transit trips will grow at 35%, meaning that its expected growth will be at a slightly lower pace than the growth in population and auto traffic, all of which will be much lower than the growth in jobs. Overall, this translates into a very slight decline in the transit share of AM peak hour passenger trips, to 16.3% (from today's 16.4%: essentially stable). The SOV share will continue to dominate, at 82% of all peak hour passenger trips.[8]

All of these factors lead to <u>increased congestion</u> in the future:

- VKT will increase by 32%, from 3.7 million vehicle-kilometres travelled during the AM peak hour in 1999, to 4.9 million vehicle-kilometres travelled in 2021. VHT will increase faster, at 54%, from 95,000 vehicle-hours travelled in 1999 to 146,000 vehicle-hours travelled in 2021.

- As a result, it is projected that each driver will spend, on average, 10% more time travelling due to slower speeds and longer delays. (This is projected to occur even though the land use projection calls for the average trip length to be 5% shorter than today, as the mix of jobs, homes, schools and shopping activities becomes denser over time and people are able to access more opportunities closer to where they live).

All this would occur in the absence of the proposed (or any other major) MCTS projects. The MCTS projects can be expected to impact travel in Greater Vancouver in several ways:

- <u>Divert some drivers to transit or to ridesharing</u>; that is, through improvements to the transit system and HOV networks respectively. As ***Table 2*** indicates, transit trips would grow slightly (1% over the situation without the MCTS projects, for an overall growth of 36% over 1999), as would HOV trips (2% over the base situation, and 29% overall). However, SOV trips would still dominate, with the transit share essentially unchanged. (It should be noted, however, that these figures reflect region-wide conditions: the RAV rapid transit line, for example, can be expected to generate significant increases to transit ridership in and around that corridor.)

- <u>Reduce the time spent in congestion</u>, by increasing capacity and throughput with new roads, additional lanes, intersection improvements and improved signal coordination. With the proposed improvements, there will still be some peak period traffic congestion but each driver will spend, on average, 6-10% less time travelling. This is a benefit in traveller saving time and in time-related operating costs for vehicles, though the vehicle impact is offset by average trip distance that is 1-3% longer than it is today. In other words, although congestion will still be high, each driver's trip, on average, will be more 'efficient' than it would be without the proposed projects in place. (The

[8] These figures include only motorized travel, by auto, transit or bus. Walking and cycling trips are not included. Although important, their impact generally is localized.

projected small increase in trip lengths is due to the fact that the increased capacity afforded by the proposed projects allows drivers to have more ways to get around congested bottlenecks.)

- Improve accessibility within Greater Vancouver, by increasing connectivity and eliminating circuitry. Projects such as the Fraser River Crossing would eliminate roundabout travel and, over the long term, would encourage people to change their jobs or workplace to take advantage of the new connections.

4.2 Impacts on VKT and VHT

Table 3 summarizes the VKT and VHT for 1999 and for 2021, with and without the MCTS. Because the benefits must be assessed in annual increments, the AM peak hour VKT and VHT were first expanded to daily totals, by applying the factors discussed in Section 3.2 (inverse of the ratio of observed 1999 AM peak hour traffic to 24-hour volumes, separately for light trucks, heavy trucks and all other vehicles),[9] then to annual totals: The daily expansion used the peak-hour factors identified in Section 3.2 (as well as similar factors for autos). The daily values were multiplied by 312 to yield annual totals.[10]

Table 3. Differences in VKT and VHT with and without MCTS Improvements (2021)

Vehicle type	2021 daily VKT - no MCTS	2021 daily VKT - with MCTS	% Change	Daily difference	Annual difference
24 hour VKT SOV	52,471,764	52,567,164	0.18%	95,399	29,764,639
24 hour VKT HOV	12,893,564	12,922,391	0.22%	28,827	8,993,906
24 hour VKT Light Trucks	2,050,751	2,062,433	0.57%	11,682	3,644,883
24 hour VKT Heavy Trucks	3,168,929	3,189,840	0.66%	20,911	6,524,106
Total 24 hour VKT	70,585,009	70,741,828	0.22%	156,819	48,927,534

Vehicle type	2021 daily VHT - no MCTS	2021 daily VHT - with MCTS	% Change	Daily difference	Annual difference
24 hour VHT SOV	1,429,498	1,331,522	-6.85%	-97,976	-30,568,620
24 hour VHT HOV	332,119	310,603	-6.48%	-21,516	-6,712,970
24 hour VHT Light Trucks	47,874	43,552	-9.03%	-4,323	-1,348,700
24 hour VHT Heavy Trucks	60,906	54,234	-10.95%	-6,672	-2,081,658
Total 24 hour VHT	1,870,398	1,739,911	-6.98%	-130,487	-40,711,949

9 Travel time on a particular section of road varies by volume – hence, a simple but reasonable approximation (in light of the lack of available information) is to apply the peaking factors to the AM peak hour VHT to derive daily VHT. Similarly, on the assumption that average trip length does not vary by time of day (a [necessary but reasonable] simplification, given the absence of information), VKT would be proportional to the volume of traffic – hence, the application of the peaking factors to the AM peak hour VKT to derive daily VKT.

10 That is, taking 100% of the daily VHT and VKT values for each of the five weekdays in a week, and 50% of the daily values for each of Saturday and Sunday (i.e., taking six of seven days in a week).

Table 3 indicates the following:

- There is a benefit of 7% overall in reduced travel time (VHT), although travel distance increases slightly, by 0.2% (VKT). In other words, congestion would decrease with the MCTS improvements in place.

- The travel time benefit is proportionately greatest for light and heavy trucks, which experience reductions of 9% and 11%, respectively, in VHT. This is due to proportionately greater distances travelled by trucks, compared with auto traffic (0.6% and 0.7% increases in VKT, for light and heavy trucks, respectively), although the increases are still small.

4.3 Discussion

The following should be noted in reviewing these results:

- The impacts of the minor MCTS improvements are expressed in terms of travel time savings. However, their small scale and localized impact means that they would not impact trip distances noticeably. Therefore, there was a VHT impact, but not a VKT impact for the minor improvements.

  VHT for the minor improvements was calculated as follows: first, the time saved by each improvement was estimated using Synchro, a traffic operational software. Next, the resultant times were matched to the individual link volumes in EMME/2 (for which VHT already had been calculated from the EMME/2 results), and subtracted from the EMME/2-based VHT.

- VHT and VKT can be calculated in two ways: link-based and matrix-based. Both can be used in the calculation of economic benefit. Using VHT as an example, the link-based tabulation sums the product of the vehicles on each link (in each direction) and the time required to travel on the link (i.e., the travel times at equilibrium), over all applicable links. The matrix-based tabulation sums the product of the vehicle-trips between each origin-destination pair and the equilibrium travel time between each pair. (The calculation of VKT uses the link length and the equilibrated distance between each origin-destination pair, respectively.) The Consultant used the link-based method for the calculation of economic benefit. This method is considered to be more precise, because it is specific to individual links. It also allowed the inclusion of the impacts of the minor MCTS improvements (which, because they are link-specific, cannot be used in the matrix-based method).

- In theory, both the VHT and VKT should decrease when new infrastructure (i.e., additional capacity) is provided: that is, on average trips between two given points should be faster and more direct. However, as the model outputs indicate, VHT decreases but VKT increases slightly with the MCTS in place. Although this is a plausible finding, it is not intuitive. The reason for this may relate to the way EMME/2's trip assignment ("equilibrium assignment") works: the algorithm iterates until the average travel time between each origin-destination pair on *all* possible paths is the same (in other words, the point at which a driver cannot improve his travel time by switching routes). The rationale is that drivers typically measure the possible routing alternatives in terms of time, rather than distance (at least, for an urban trip). This means, for example, that two drivers travelling between a particular origin and destination may each take 30 minutes for the trip; but one may be assigned to a highly congested route that is 5 kilometres long while the route of the other may be less congested but is 6 kilometres long.

Second, even with the improvements in place, the road system still remains congested. This is evidenced by the above-noted changes in *average* trip times and trip distances: drivers are 'forced' to take increasingly indirect (longer) routes in order to maintain the 'same' travel time (noting the 6-10% reduction in average travel time but a 1-3% increase in average trip distance when the MCTS improvements are in place, compared to the situation without the MCTS improvements). Also, the rate of growth in the base 2021 VHT (54% over 1999) is faster than those of VKT (32%), population (42%) and jobs (45%). Moreover, the model does not take into account the possibility that – under these levels of congestion – the duration of the peak period might expand over time: in turn, this means that the 'slice' of the peak period that is now represented by the peak hour could change as well. As a result, the anticipated levels of congestion suggest that it was not likely that more trips would be induced to travel during the peak hour: therefore, no induced traffic was assumed.

4.4 Sensitivity Analysis

At the request of the study's Steering Committee, the Consultant conducted a sensitivity analysis using an alternative land use scenario (Decentralized Regional Scenario (DRS)). This scenario does not have status; hence, the results are for comparative purposes only. The DRS forecasts approximately the same total population and employment for 2021 as the GMS. However, the distribution of these people and jobs follows more closely current trends; that is, residential growth in the suburbs and jobs in the urban core and at town centres.

The resultant VKT and VHT are summarized in ***Table 4***. The findings are essentially identical to those of the base GMS. However, they are slightly exaggerated (slightly higher differences in VKT and in VHT [although the signs are the same]; greatest proportional differences occur for light trucks and heavy trucks).

Table 4. Differences in VKT and VHT – DRS Land Use (2021)

Vehicle type	2021 daily VKT - no MCTS	2021 daily VKT - with MCTS	% Change	Daily difference	Annual difference
24 hour VKT SOV	52,687,216	52,773,042	0.16%	85,826	26,777,710
24 hour VKT HOV	12,992,758	13,016,392	0.18%	23,634	7,373,806
24 hour VKT Light Trucks	2,246,793	2,257,519	0.48%	10,726	3,346,620
24 hour VKT Heavy Trucks	3,309,067	3,329,708	0.62%	20,641	6,440,012
Total 24 hour VKT	71,235,834	71,376,661	0.20%	140,827	43,938,149

Vehicle type	2021 daily VHT - no MCTS	2021 daily VHT - with MCTS	% Change	Daily difference	Annual difference
24 hour VHT SOV	1,450,453	1,342,947	-7.41%	-107,506	-33,541,767
24 hour VHT HOV	337,506	313,162	-7.21%	-24,345	-7,595,501
24 hour VHT Light Trucks	53,037	47,548	-10.35%	-5,489	-1,712,607
24 hour VHT Heavy Trucks	64,793	57,181	-11.75%	-7,612	-2,374,939
Total 24 hour VHT	1,905,789	1,760,837	-7.61%	-144,951	-45,224,814

Appendix 5

Profile of Gateway Transport & Port Facility Activity

Table of Contents

1. PROFILE OF GATEWAY TRANSPORT AND PORT FACILITY ACTIVITY

We estimated the direct economic impact of Greater Vancouver Gateway facilities and services spanning the four transportation modes - marine, air, truck, and rail. We present our estimates for 2000-2002 for comparison with earlier estimates for 1996 prepared by the Greater Vancouver Gateway Council (GVGC). For the 2000 marine and air transport impacts, we relied on estimates prepared by Intervistas Consulting, Inc. We estimated 2001 and 2002 direct impacts based on changes in cargo shipment and passenger volume since 2000.

It is important to note that the 2000 airport and marine port estimates of economic impacts were prepared on a facility basis and include not only employment classified as transportation, but other related industries found at the facilities, such as facility administration, co-located services (such as restaurants, hotels, personal services), and other businesses linked to the facility, such as manufacturing. Also included in their estimates are impacts of other transportation activity observed to support the facilities, such as rail and trucking employment located at the marine ports (or linked to maritime shipments in other provinces) and trucking employment in support of the airport. As such, it becomes difficult to compare the estimates of Gateway employment presented in our study (Report Table 4-1) to British Columbia provincial statistics on transportation sector employment, as published by BC Statistics (summarized in Report Table 4-2 and provided in further detail below, in ***Appendix Table 5-1***). The reason is that BC Statistics uses an industry definition of employment and not one that includes other industries' employment located within a facility.

Appendix Table 5-1
BC Transportation Employment by Industry, 1997-2001

	1997	1998	1999	2000	2001	2002
TRANSPORTATION SECTOR	**103.2**	**102.9**	**113.6**	**111.2**	**102.5**	**105.1**
Air	16.2	17.0	19.9	18.9	15.1	13.9
Rail	7.4	9.7	8.5	6.1	6.4	6.5
Water	7.6	7.0	6.5	5.3	6.7	6.5
Truck	27.8	27.0	28.0	30.9	26.0	28.2
Transit & Ground Pass. Transport.	12.6	13.6	13.3	12.0	14.9	16.3
Pipeline	*	*	*	*	*	*
Scenic & Sightseeing	13.5	10.7	18.5	19.9	18.0	19.3
Postal Service	7.8	9.2	7.1	8.8	7.7	7.4
Couriers	9.6	8.3	11.0	8.8	7.7	6.7

* Less than 1.5

Source: BC Statistics

We present estimates for the direct, indirect, and induced economic impacts of each transportation mode/facility, measured for employment, gross domestic product (GDP) and output. The definition of these impacts is described below:

(1) **Direct Activity:** Direct effects for any given industry are measures of economic activity, i.e., jobs, GDP, output, for that industry alone. For use with economic activity multipliers, such as those prepared by BC Statistics through its provincial input-output model, it is important to keep the industry definitions of direct activity conformable with those of the input-output model. We will return to this issue later in the Appendix.

(2) **Indirect Activity:** Indirect activity occurs in those sectors which supply or purchase outputs of whatever industry we are observing as direct. For example, indirect activity associated with rail transport includes inputs to rail transport, such as diesel fuel, track maintenance services, insurance, banking services, etc, as well as inputs to each of those sectors. The re-spending of revenues by a direct industry rapidly connects it to virtually all other industries, but with each set (or round) of transactions, the amounts get smaller and smaller. The sum total of these indirect effects can be estimated with an input-output model, and are expressed as a multiplier for output. These indirect output multipliers can be expressed in terms of employment and GDP measures as well.

(3) **Induced Activity:** In addition to inter-industry indirect effects, persons employed in the various industries earn wages and salaries which can be linked to the level of output. Thus, if wages constitute 20% of all input costs, 20% of the value of that industry's direct output can be translated to wage and salary income. If workers take that income and use it for personal consumption expenditures over the full range of consumption goods, it can form the basis of another series of transactions that generate induced activity. The sum of this activity, too, can be estimated and expressed as a multiplier for output, employment, and GDP.

The multipliers reflect the ratio of indirect and induced impacts to direct impacts. They are shown below in ***Appendix Table 5-2***.

Appendix Table 5-2
Economic Multipliers for British Columbia Transportation Sectors

Mode	Output		GDP/Output			Employment (PY/$mil.)		
	Total Indirect	Induced	Direct	Total Indirect	Induced	Direct	Total Indirect	Induced
Air	0.64	0.17	0.39	0.27	0.10	6.33	5.17	1.57
Marine	0.71	0.20	0.39	0.27	0.11	6.07	4.64	1.86
Truck	0.54	0.17	0.47	0.23	0.09	8.88	4.07	1.51
All Transport	0.63	0.18	0.45	0.26	0.10	7.45	4.82	1.65

Source: BC Statistics. 2002. Special tabulation for Economic Development Research Group.

For each mode, i.e., marine, truck, rail, and air, we obtained the latest published data concerning annual and year-to-date activity levels to support our estimates. The new facility-based estimates, shown as a combined total in ***Appendix Table 5-3***[1], indicates that gateway transportation has a significantly greater role than shown in the 1996 estimates (GVGC, 1996). Some of the increase reflects changes in measurement methods and assumptions rather than a real shift in the importance of the sector, and therefore, the new results are probably not comparable to the old for all modes.[2]

Appendix Table 5-3
GVGC Direct Economic Impacts of Transportation Activity

	1996	**1996**	**2002**
TOTAL	*Jobs & Yr 1996 $*	*Jobs and Yr 2002$*	
Total Direct Jobs	28,108	28,108	75,190
Wages ($, mil.)	1,196	1,278	3,632
GDP ($, mil.)	2,048	2,189	4,606
Output ($, mil.)	3,949	4,220	10,409

Sources: GVGC. 1996. "Economic Impact Overview" and update by Economic Development Research Group based on statistics provided by Vancouver International Airport, Port of Vancouver, North Fraser Port and BC Stats (See also Table51-6).

As shown in ***Appendix Table 5-4***, direct GVGC transportation employment in 2001 accounted for over 75,000 jobs and over $10 billion of output (in constant 2000 dollars). These jobs and output are more than double the figures presented in the 1996 estimates by the GVGC[3]. Rather than represent a vast increase in the economic importance of transportation in the greater Vancouver region, however, we believe the difference is attributable to differences in the estimated direct impacts rather than a result of the multipliers used. In fact, ignoring the starting values and looking at the ratio of total impact to direct impact indicates that the latest BC Statistics multipliers for BC have declined somewhat from those used in the 1996 estimates. This decline indicates that a higher percentage of indirect and/or induced transactions are leaving the BC economy. Without access to the details of original and current BC models, however, it is impossible to provide a precise explanation for the overall decline in multiplier values.

[1] Excluding urban public transportation.

[2] These estimates are controlled to eliminate double counting across transport modes. They do include impacts located outside of British Columbia due to linkages of activity to various ports located within the GVGC region.

[3] GVGC. 1996. "Economic Impact Overview"

Appendix Table 5-4
Total Economic Impacts of Gateway Transportation Activity on BC, 2002

Category of Impact	Jobs	GDP ($million)	Output ($million)
Direct (Gateway Facilities & Services)	75,190	$4,606	$10,409
Indirect (Suppliers)	47,141	$2,741	$6,438
Induced (Income Re-spending)	17,216	$1,080	$1,938
Grand Total	**139,546**	**$8,427**	**$18,784**

Source: Calculations by Economic Development Research Group. Direct effects are based on data shown in Appendix Table 4-2. Indirect and induced effects are calculated using economic multipliers for British Columbia, derived from provincial input-output tables (provided by BC Stats).

Impacts by Mode and Facility-Type

Appendix Table 5-5 shows mode-specific details on facility-based estimates of the direct economic impacts. As previously noted, we believe that earlier 1996 figures appear to have been based on a narrower definition of jobs at Greater Vancouver Gateway facilities. The year 2000-2002 figures for marine and airport do reflect recent studies of employment at Vancouver International Airport and the Port of Vancouver. However, all values shown here have been revised downward to eliminate double counting of trucking and rail employment at those facilities (since they are also counted in the trucking and rail industries), and they also exclude some non-related business activities. The downward trend from 2000 to 2002 reflects the current economic downturn, which has reduced air and sea passenger and cargo activities.

Appendix Table 5-5
GVGC Direct Economic Impacts of Transportation Activity, By Mode

	1996	1996	2000	2001	2002
	(Jobs and$1996)	*(Jobs and $2000)*			
Total Direct Jobs	28,108	28,108	80,219	77,712	75,190
Wages ($, mil.)	1,195	1,277	3,822	3,624	3,532
GDP ($, mil.)	2,047	2,187	4,721	4,660	4,606
Output ($, mil.)	2,854	3,050	10,719	10,472	10,409
MARITIME					
Total Direct Jobs	9,044	9,044	38,769	35,687	33,527
Wages ($, mil.)	433	463	2,233	1,922	1,846
GDP ($, mil.)	851	909	2,094	1,917	1,942
Output ($, mil.)	1,865	1,993	5,858	5,341	5,399
AIR					
Total Direct Jobs	14,931	14,931	24,732	23,945	23,385
Wages ($, mil.)	597	638	989	958	935
GDP ($, mil.)	970	1,037	1,626	1,576	1,484
Output ($, mil.)	494	528	2,623	2,543	2,394

	1996	1996	2000	2001	2002
TRUCK					
Total Direct Jobs	1,414	1,414	16,718	14,060	14,214
Wages ($, mil.)	48	51	600	505	510
GDP ($, mil.)	80	85	1,001	841	851
Output ($, mil.)	179	191	2,238	1,883	1,903
RAIL					
Total Direct Jobs	2,719	2,719	3,832	4,020	4,064
Wages ($, mil.)	117	125	228	239	241
GDP ($, mil.)	146	156	310	326	329
Output ($, mil.)	316	338	672	705	713

Sources: GVGC. 1996. "Economic Impact Overview" and update by Economic Development Research Group based on statistics provided by the Vancouver International Airport, Port of Vancouver, North Fraser Port and BC Stats (See also Table 5-6); see text for further definition.

Additional Measurement Notes

Maritime Impacts. For the three major ports in the Greater Vancouver region (Port of Vancouver, Fraser River Port and North Fraser Port), we derived direct impact estimates from earlier studies commissioned for those specific sites. We updated them as appropriate to represent year 2000-2001 conditions based on observed changes over time in cargo and passenger volumes. The total shown in ***Appendix Table 5-6*** is over 54,600 jobs at these sites. We then subdivide this figure as: 6,100 jobs in the marine shipping industry, 27,400 jobs in industries related to port operations, and 11,000 jobs associated with on-site manufacturing at the ports. For consistency with other modes of transportation, we adopt an estimate of Gateway marine employment (33,500) that excludes the manufacturing activities that are not directly related to port operations.

Appendix Table 5-6
Employment by Maritime Port and Industry, 2000

PORT	EMPLOYMENT
TOTAL MARITIME	**54,614**
1. North Fraser	**13,612**
Maritime Cargo	8,039
Noncargo (e.g. mfg, trucking, etc.)	5,573
Sawmill & Planning Mills	*1,360*
Plywood, panelboard, wholesale wood prd	*816*
Iron,Steel, etc.	*298*
Fish Processing & Prods.	*178*
Admin. Support	*1,021*
Ready-mix, aggregates	*179*
Trucking	*529*
Restaurant, accomod., retail	*657*
Other	*535*

PORT	EMPLOYMENT
2. Port of Vancouver	**27,484**
Maritime Cargo	19,720
Rail Transportation	*7,690*
Truck Transportation	*2,631*
Other Transport Services	*1,250*
Cruise	4,510
Construction	1,326
Ship Repair	726
Nonmaritime	1,202
3. Fraser River Port Authority	**13,518**
Maritime Cargo	11,917
Rail Transportation	*197*
Truck Transportation	*696*
Other (Construction, repair, nonmaritime)	1,601

Sources:1. North Fraser Port Authority. 1989. (Updated based on activity level changes, 2003).
2. Intervistas Consulting, Inc. 2001. "Port Vancouver Economic Impact Study"
3. Intervistas Consulting, Inc. 2002. "Fraser Port Economic Impact Study"

The 2000-2002 direct maritime job estimates are significantly greater than the 1996 estimate of 9,000, reflecting a definitional difference rather than an industry upsurge in activity.[4] The direct employment estimates prepared for the recent port impact studies are based on broad definitions of direct employment with data obtained by extensive survey of port and related businesses. It is defined to include shipping company and cruise-line employees who work at the port, as well as those in ship repair, port construction, and port-located businesses. This latter group serves both port employees and tourists, and includes eating and drinking places, marinas, fishing, and fish processing businesses. The total direct employment, as currently defined, includes not only employees at work in BC, but also those in transportation and other services related to cargo shipments destined for the port. Thus, nearly 6,000 direct jobs in maritime cargo are identified as being in Alberta, Saskatchewan, and Manitoba. As some of these jobs are in non-maritime transportation and some are in other industries, we face difficulties when comparing these direct job estimates with relevant industry-level employment data, as the former are multi-industry in nature.

Air Transport Impacts. These figures are drawn from an economic impact study prepared for the Vancouver International Airport and appear to be comparable in methods and assumptions to the two studies found for maritime ports.[5] We note that the differences between the 1996 and 2000-2002 estimates are less severe for air transport than they were for maritime transport, but they remain due to definitional differences in the coverage of trucking employment and non-related businesses.

[4] Using industry-level data, employment in water transportation fell from 7,000 in 1996 to 6.1 in 2000. See Table 1.

[5] Intervistas Consulting, Inc. 2001. "The 2000 Economic Impact of the Vancouver International Airport"

Truck Transport Impacts. Unlike air and maritime transportation, our estimates for truck and rail are industry-based definitions of direct employment, in which a share is assigned to be attributable to Greater Vancouver Gateways. We have attempted to identify the Greater Vancouver Gateway portion of observed BC employment based on freight movement and industry employment data. To derive gateway trucking employment, we have used estimated truck shipment volumes (tonnage) linked to port activity and US-BC border traffic to estimate the share of jobs and income attributable to the gateway function. Our estimates have been adjusted upward to reflect an increment for own-account trucking that is left unmeasured in standard economic accounts, amounting to 30% of for-hire trucking activity measured by value of output. See "Estimating Transportation Dependent Impacts" below.

The estimate for total direct truck transport employment at Greater Vancouver Gateways is slightly more than half of total BC trucking industry employment. While we are unsure of the method used to estimate the 1996 value, we note that total BC employment in the trucking industry stood at 27,000 in 1996, and believe that gateway-related trucking (estimated in 1996 to be 1,400) would certainly have to have been more than 5% of that figure. Estimates for value of output and wages are taken from the latest truck transport data compiled by Statistics Canada for for-hire trucking.[6] Of the 14,000 jobs linked to Gateway activity in year 2002, 4,000 of these are identified as being within the air and seaport themselves, with the balance made up of trucking associated with Gateway import/export activity. (Note: Statistics Canada's estimates for own-account trucking are incomplete and unavailable for examination.)

Rail Transport Impacts. We estimate that gateway-related rail transport employment was approximately 4,000, about ½ of the total for the rail transport industry in BC. Our estimates are based on the proportion of tonnage travelling to and from the three marine ports, as well as the volume moving across the Canada-US border in and out of BC. Estimates for value of output and wages (per tonne) are taken from the latest rail transport data for 2000 compiled by Statistics Canada.[7] These estimates do not include direct jobs in the other three provinces related to multimodal rail-marine shipments passing through the gateway ports.

Estimating Transportation Dependent Impacts

One of the key shortcomings of most economic accounting schemes is the failure to capture in-house transportation service activity. Whereas transportation for-hire is treated as a separate activity in the economy, self-generated services (e.g., firms using their own vehicle fleets and drivers) remain undistinguished from a firm's primary outputs when it comes to estimating value added, capital investment, and input costs. For certain sectors of the economy, in-house transportation services can represent a significant proportion of total transport services used in

[6] Statistics Canada. 2002. "Trucking in Canada 2000." Statistics Canada. Ottawa, Ontario.

[7] Statistics Canada. 2002. "Rail in Canada 2000." Statistics Canada. Ottawa, Ontario.

production. We show the percentage of self-generated transportation services for different U.S. industries in ***Appendix Table 5-7***.

Since no published data on in-house production of transportation services have yet been identified for Canada, we assume that the Canadian proportions are similar to those of the U.S. (as contained in its transportation satellite accounts), which is reasonable as long as industries in the two countries employ roughly similar technologies. From these accounts, we see that nearly 33.95% of all transportation services (by value) are generated in-house, and have incremented the existing level of for-hire trucking for the gateway region by this amount.

Appendix Table 5-7
Percentage of Industry Transportation Requirements Produced In-House

INDUSTRY	%	INDUSTRY	%
Communications, except radio and TV	96.0	Miscellaneous electrical machinery, supplies	14.0
Radio and TV broadcasting	79.5	Other printing and publishing	13.7
Computer and data processing services	77.3	Household appliances	13.6
Advertising	70.4	Cleaning and toilet preparations	13.4
Water and sanitary services	67.7	Aircraft and parts	13.0
Insurance	66.8	Other agricultural products	12.8
Legal, engineering, accounting, related services	65.0	Plastics and synthetic materials	12.5
Real estate and royalties	63.9	Furniture and fixtures	12.2
Wholesale trade	63.2	Miscellaneous fabricated textile products	12.2
Own-account transportation	60.0	Heating, plumbing, and fabricated structural	11.8
Retail trade	59.5	Farm, construction, and mining machinery	11.7
Personal and repair services (except auto)	57.9	Apparel	10.6
Amusements	56.2	Railroads and passenger ground trans.	10.3
Finance	55.0	Footwear, leather, and leather products	10.0
Other business and professional services, etc	54.5	Other transportation equipment	10.0
Health services	54.0	Misc. textile goods and floor covering	9.1
Educational and social services, and membership	53.2	Screw machine products and stampings	9.0
Pipelines, freight forwarders, and related services	43.4	Nonmetallic minerals mining	8.9
Automotive repair and services	40.5	Glass and glass products	8.8
Scientific and controlling instruments	34.7	Metallic ores mining	8.8
Audio, video, and communication equipment	34.3	Engines and turbines	8.6
Computer and office equipment	33.8	Truck and bus bodies, trailers, motor vehicles	7.4
Hotels and lodging places	33.2	Rubber and miscellaneous plastics products	6.7
Drugs	28.6	Air transportation	6.5
Newspapers and periodicals	28.3	Broad and narrow fabrics, yarn and thread	6.4
Electronic components and accessories	28.2	Metal containers	6.0
Ophthalmic and photographic equipment	27.8	Livestock and livestock products	5.6
Special industry machinery and equipment	23.8	Paints and allied products	5.4
General industrial machinery and equipment	23.7	Industrial and other chemicals	5.4
Eating and drinking places	21.4	Federal Government enterprises	5.1
Crude petroleum and natural gas	21.0	Food and kindred products	4.8
Electrical industrial equipment and apparatus	21.0	Motor freight transportation and warehousing	4.8
State and local government enterprises	20.5	Lumber and wood products	4.8
Metalworking machinery and equipment	20.5	Paper and allied products, except containers	4.7
Ordnance and accessories	20.1	Paperboard containers and boxes	4.7
Maintenance and repair construction	17.0	Electric services (utilities)	4.7
Miscellaneous machinery, except electrical	17.0	Gas production and distribution (utilities)	4.2

INDUSTRY	%	INDUSTRY	%
New construction	16.5	Primary nonferrous metals manufacturing	4.1
Tobacco products	16.2	Motor vehicles (passenger cars and trucks)	3.8
Miscellaneous manufacturing	16.2	Stone and clay products	3.7
Service industry machinery	15.8	Primary iron and steel manufacturing	3.5
Electric lighting and wiring equipment	15.4	Petroleum refining and related products	3.1
Materials handling machinery and equipment	15.3	Forestry and fishery products	3.0
Other fabricated metal products	14.8	Agricultural fertilizers and chemicals	2.7
Agricultural, forestry, and fishery services	14.3	Coal mining	2.6

Source: US Bureau of Transportation Statistics. 1996 U.S. Transportation Satellite Accounts.

2. ESTIMATING ECONOMIC IMPACTS OF TRANSPORATION ACTIVITY

The total economic impacts of transportation for BC and other Western Canadian provinces are based on provincial input-output multipliers, shown in ***Appendix Table 5-8***. The resulting calculations are shown in ***Appendix Table 5-9*** and ***5-10***. It is a fairly straightforward exercise to interpret the figures. For indirect output effects, the "total indirect" multiplier is multiplied by direct output to yield the indirect effect. For example, maritime transport has a total indirect multiplier of 0.71. For each $1.00 of direct output, $0.71 is needed from all other industries to meet the initial and subsequent needs for the maritime transport and all linked industries. For each $1.00 of direct output, maritime transport generates a total $0.20 of output derived from consumption spending. It becomes readily apparent that maritime transport has the highest output effect compared to other modes, but not the highest direct or indirect employment or GDP effects because of its relatively higher wages. The higher wage, however, does yield higher induced employment effects, as shown by the 1.86 person-years of employment attributable to induced spending effects initiated in that sector.

For purposes here, we had to apply the general "All Transport" multipliers to the rail direct effects, since these cannot be separately disclosed in the BC Input-Output Multipliers for reasons of corporate confidentiality. We also note that the induced effects estimated here are the so-called "safety-net" effects, which assume that induced effects of income displace income received from unemployment compensation programs. This reduces the induced effects significantly from what would result if we treated all induced effects as occurring in a full employment economy. In this sense, our estimates are conservative ones.

Limitations on the Use of Estimated Impacts

One of the key assumptions in using input-output based multipliers is that the industry definitions used to develop the model carry-over to those used for impact analysis. This is not the case for the direct impact estimates we found in several economic impact studies prepared for several of the port authorities that participate in the GVGC. In all cases, direct impacts were estimated based not on a standard industry definition, but on a functional basis of classifying firms as being a port or port-related enterprise. Thus, cargo and cruise line employees are combined with freight forwarders, ship repair businesses, ship outfitters, port construction firms, port restaurants, and other businesses linked to the port, regardless of physical location. In this way, rail employees servicing trains bound for Vancouver's ports are also said to be direct port-related employment regardless of where they physically work. In contrast, when using the BC Statistics model, all but the direct cargo and cruise line employment would be treated as indirect, not direct. The definitional difference is not trivial, as evidenced by the difference in the direct effects we show for 2000 and later which use the broad definition, and the 1996 values, which most likely use a strict industry-based definition. For impacts estimated to evaluate transportation infrastructure improvements, it will be necessary to limit our direct impacts to those that are specific to industries and not common function.

For the impact forecasts, some of the economic activity occurs in provinces other than BC. For estimating these economic impacts, we used a special tabulation of direct and indirect multipliers for all four provinces, prepared by Statistics Canada. To complete these estimates for induced impacts, we drew on the induced multipliers given in the Intervistas reports. The provincial multipliers for indirect impacts are shown on the pages which follow as ***Appendix Table 5-8***. Impacts of Gateway Transportation on all four provinces are shown in ***Appendix Tables 5-9*** and ***5-10***.

Appendix Table 5-8. Provincial Input-Output Multipliers

Air Transportation			
		Employment	
	Direct	Total	Multiplier
Manitoba	5.87	10.04	1.71
Saskatchewan	4.28	7.54	1.76
Alberta	4.84	10.20	2.11
British Columbia	5.53	10.55	1.91
		GDP	
	Direct	Total	Multiplier
Manitoba	367264.41	565292.06	1.54
Saskatchewan	357020.78	507500.16	1.42
Alberta	356844.12	674604.87	1.89
British Columbia	360256.47	614908.89	1.71
		Income	
	Direct	Total	Multiplier
Manitoba	271723.08	402159.10	1.48
Saskatchewan	186726.70	281316.22	1.51
Alberta	238887.58	421225.40	1.76
British Columbia	282817.42	455527.22	1.61
		Output	
	Direct	Total	Multiplier
Manitoba	1000000.00	1415013.70	1.42
Saskatchewan	1000000.00	1350489.60	1.35
Alberta	1000000.00	1715693.50	1.72
British Columbia	1000000.00	1554967.70	1.55
Rail Transportation			
		Employment	
	Direct	Total	Multiplier
Manitoba	8.63	12.40	1.44
Saskatchewan	7.16	10.71	1.50
Alberta	4.41	8.32	1.89
British Columbia	4.26	9.41	2.21
		GDP	
	Direct	Total	Multiplier
Manitoba	524089.34	714782.21	1.36
Saskatchewan	507932.88	722240.05	1.42
Alberta	503413.69	782828.14	1.56
British Columbia	513207.82	784980.95	1.53
		Income	
	Direct	Total	Multiplier
Manitoba	353641.79	489638.19	1.38
Saskatchewan	231103.92	369412.76	1.60
Alberta	345116.78	511865.20	1.48
British Columbia	227442.07	429472.84	1.89
		Output	
	Direct	Total	Multiplier
Manitoba	1000000.00	1364366.60	1.36
Saskatchewan	1000000.00	1452778.60	1.45
Alberta	1000000.00	1620007.70	1.62
British Columbia	1000000.00	1538792.60	1.54

Source: Unpublished tabulation, Statistics Canada, 2003

Appendix Table 5-9
Total Economic Impacts of Gateway Transportation on BC, 2002

Category of Impact	Jobs	GDP ($million)	Output ($million)
MARITIME			
Direct (Gateway Facilities &	33,527	$1,942	$5,399
Indirect (Suppliers)	23,117	$1,471	$3,834
Induced (Income Re-spending)	9,267	$599	$1,079
Total	65,911	$4,012	$10,313
AIR			
Direct (Gateway Facilities &	23,385	$1,484	$2,394
Indirect (Suppliers)	12,842	$647	$1,532
Induced (Income Re-spending)	3,900	$239	$407
Total	40,127	$2,370	$4,333
TRUCK			
Direct (Gateway Facilities &	14,214	$851	$1,903
Indirect (Suppliers)	7,746	$439	$1,027
Induced (Income Re-spending)	2,874	$171	$324
Total	24,833	$1,462	$3,252
RAIL			
Direct (Gateway Facilities &	4,064	$329	$713
Indirect (Suppliers)	3,435	$184	$44
Induced (Income Re-spending)	1,176	$71	$128
Total	8,675	$583	$886
TOTAL: ALL MODES			
Direct (Gateway Facilities &	75,190	$4,606	$10,409
Indirect (Suppliers)	47,141	$2,741	$6,438
Induced (Income Re-spending)	17,216	$1,080	$1,938
Grand Total	**139,546**	**$8,427**	**$18,784**

Source: Calculations by Economic Development Research Group. Direct effects are based on data shown earlier in Table 4-1. Indirect and induced effects are calculated using economic multipliers for British Columbia, derived from provincial input-output tables (provided by BC Stats).

Appendix Table 5-10
Total Economic Impacts of Gateway Transportation on BC, 2002

Category of Impact	Jobs	GRDP	Output
		$millions	$millions
ALBERTA			
TRUCK			
Direct	1,511	90	65
Indirect and Induced	743	56	31
Total	2,254	146	97
RAIL			
Direct	356	41	28
Indirect and Induced	316	23	13
Total	672	63	41
TOTAL: TRUCK AND RAIL			
Direct	1,868	131	93
Indirect and Induced	1,059	78	45
Grand Total	**2,927**	**209**	**138**
MANITOBA			
TRUCK			
Direct	770	36	27
Indirect and Induced	295	15	10
Total	1,065	50	37
RAIL			
Direct	278	17	11
Indirect and Induced	121	6	4
Total	399	23	16
TOTAL: TRUCK AND RAIL			
Direct	1,048	53	38
Indirect and Induced	416	21	14
Grand Total	**1,464**	**73**	**52**
SASKACHEWAN			
TRUCK			
Direct	1,210	46	34
Indirect and Induced	411	19	12
Total	1,621	65	46
RAIL			
Direct	299	21	10
Indirect and Induced	148	9	6
Total	447	30	15
TOTAL: TRUCK AND RAIL			
Direct	1,509	67	43
Indirect and Induced	559	28	18
Grand Total	**2,067**	**95**	**61**

3. ECONOMIC TRENDS AND PROJECTIONS

Economic Analysis and Forecast

Transportation improvements have the effect of altering short-run travel time, travel cost, and trip-making behavior. In the long-run, such improvements have the additional effect of changing the nature of the region's cost competitiveness and economic growth. Such impacts are measured as changes in employment, income, output, and gross product in the constituent provinces of the Greater Vancouver Gateway. We use the change in trip frequency developed from the EMME2 model (discussed in ***Appendix 4***) as the basis for estimating direct changes in economic output in the GVGC region. These are then used in conjunction with provincial economic multipliers to estimate the overall (indirect and induced) impacts on the regional economy.

This section is divided into five parts: In the first section, we describe our approach to the analysis and forecasting procedures. In the second section, the data and models used to develop the forecasts of impacts are described. In the third section, we present illustrative results using our current baseline forecast for marine cargo volume growth to estimate economic impacts on the region. In the fourth section, we illustrate our baseline forecast methodology for maritime cargo using the Port of Vancouver baseline forecast. Finally, in the last section, we summarize issues affecting the measurements of total freight flows in British Columbia.

Baseline Forecast by Mode

For each mode, a baseline forecast of volume is required against which to measure the effect of proposed improvements. We describe each below:

Maritime

The maritime forecast was developed exclusively for cargo. Commodity-specific annual growth forecasts for imports and exports were assembled separately for key commodities, such as coal, fertilizers, forest products, etc. and applied to the 2001 historical values to obtain a time series of annual tonnages imported or exported at each port. For a full description of each of the commodity growth rate forecasts, see "Port of Vancouver Baseline Forecast Description and Methodology" below.

Air Transport

The air transport baseline forecast was developed for three air cargo markets separately. The markets are: (1) Vancouver to/from rest of Canada, (2) Vancouver to/from US, and (3) Vancouver to/from all other international destinations/origins. For the Canadian and US air passenger markets, we assumed a low rate of the growth (0.5%) between 2002 and 2005, reflecting the disruptions to these markets caused by recent events involving SARS, wars, and terrorist threats real or imaginary. Beyond 2005, volume in these markets revert to the long-run

(2002-2022) forecast rates adopted by the Vancouver Airport Authority (YVR). For non-US international markets, no growth is assumed to occur for 2002-2005, for the same reasons by which a low rate was assumed for the other markets, followed by the YVR rate for 2002-2022 for the 2006-2021 period.

For air cargo, we developed a baseline forecast based on the commodity-specific forecast growth which we then allocated to the three markets according to historical proportions.

Truck Transport

The baseline truck transportation forecast was drawn from the BC Freight Study's commodity-specific forecast annual growth rates and applying these to three market segments: (1) Intraprovincial BC shipments, (2) Interprovincial shipments to/from BC, and (3) International shipments to/from BC and to/from the US.

Rail Transport

The rail transportation forecasts were developed in two phases. Our forecast of total rail tonnage was developed using the maritime commodity shipment growth developed for the Port of Vancouver for the significant proportion of inbound and outbound cargo that moves both by sea and rail. Total commodity shipments were forecast through 2021. In the second phase, we disaggregated these to obtain market specific forecasts using historical data from the BC Freight Study to apportion 1998 shipments by commodity and three separate markets. The markets were the same as those for truck transport.

Changes in Trip Volume and Transport Costs

The impact of each proposed project is measured either as a change in trip volume or as a change in transport costs. For trucking and rail, the EMME2 model, discussed in ***Appendix 4***, is the source of estimated changes in trip volume. These changes in trip volume are converted to changes in the movement of commodities/passengers measured in terms of tonnage or passengers. For maritime and airport cost changes, costs are incurred as a consequence of congestion costs and/or loss of market share among competitive ports serving many of the same markets. These are measured as reductions in output from what otherwise would have occurred.

In the absence of infrastructure improvements, certain shippers may face transport cost changes linked to congestion or reliability that influences whether they ship through GVGC ports. In general, this will apply to shipments that require multiple modes to reach the destination, specifically truck and rail to/from the maritime ports or border crossing points, and not shipments originating or terminating in and around Vancouver. Where costs rise at one location relative to others, competitive pressures may encourage shipments through other ports or points of entry. Our economic model forecasts the impact of these cost changes through the following process:

(1) For transport of goods over the highway network within BC, the VKT (vehicle-kilometres of travel) and VHT (vehicle-hours of travel) increases are translated directly in additional costs of doing business. Businesses pass those costs on to their customers in the form of higher prices, and the input-output model traces the downstream impacts on other industries. (see section titled Base Economic Data for estimates of VKT and VHT. In the case of congestion, the delay shows up primarily in VHT, which is valued at approximately CN $23 - $50/hour depending on the type of truck and commodity.)

(2) For transport of goods over the rail network within BC, constraints on capacity growth effectively lead to higher rail transport prices that keep demand from exceeding the existing capacity limit. This too translates directly in additional costs of doing business. Businesses also pass these costs on to their customers in the form of higher prices, and the input-output model traces downstream impacts on other industries. (See section titled Initial Results.)

(3) For products coming in and going out of BC via marine transport, there is often a choice of ports and so these additional ground (highway and rail) transport costs are seen as affecting the total cost of using Vancouver Gateway ports. We apply an economic model that translates these relative cost changes into shifts in Vancouver's market capture rate of Pacific trade (compared to competing ports located elsewhere). (See section titled Port of Vancouver Baseline Forecast Description and Methodology.)

(4) For products coming in and going out of BC via air transport, it is assumed that the choice of airport is based primarily on convenience for local delivery rather than ground transport costs. However, the absence of infrastructure improvements is assumed to prevent the airport from achieving capture of additional growth markets that were projected for the future assuming the existence of additional infrastructure to improve movements to/from downtown and outlying areas. (See section titled Port of Vancouver Baseline Forecast Description and Methodology.)

Translation of Cost Changes into Economic Output

Once we have established the volume of transport changes that occur as a result of improvements, we need to transform trip volume and cost changes into economic output measures. In the case of trip volume, this involves estimating the average output value per trip for trucking and rail trips, while for maritime and airport, foregone output becomes the output measure used to estimate subsequent impacts. Output value per trip can be derived from historical shipment and trip data, while foregone output is based on the "no-build" forecast of output and the percentage of output subject to some cost or market share constraint.

Base Economic Data

Three sets of data are used in developing the economic impact estimates of transportation improvements, as summarized in ***Appendix Table 5-11***. The first set provides historical measures of cargo/passenger volumes by mode (and point of entry into the GVGC region if truck or rail) and commodity type. The commodity type becomes most important for maritime cargo, where the transportation costs per unit shipped vary widely according to cargo type (i.e., bulk, break bulk, or container.) These data are also the basis for mode specific forecasts of shipment volumes when combined with a second set of data, national/regional forecasts in production, imports, and exports by commodity type. These are derived from a number of public sources, including Canadian and US government agencies. The third set are the economic multipliers used to transform direct changes in transport output to direct, indirect, and induced changes in output, employment, income, and GDP. These have been obtained from BC Stats for BC, and Statistics Canada for Alberta, Saskatchewan, and Manitoba.

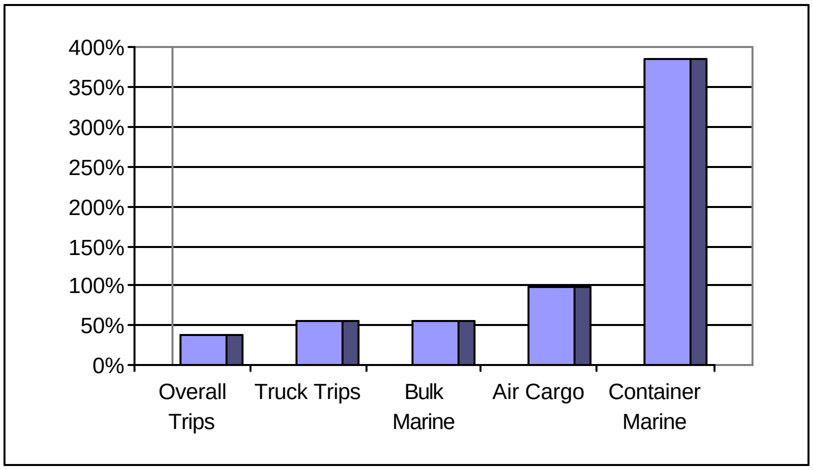
Appendix Table 5-11
Datasets Used for GVGC Economic Impact Estimation

I. Historical Transportation Volume and Composition	Source
Air Cargo, Air Passengers	Vancouver International Airport
Maritime Cargo	Port of Vancouver Authority, Fraser River Port Authority, North Fraser Port Authority
Rail Cargo, Rail Passengers	Statistics Canada: "Rail in Canada, 2000:", BC Freight Study
Trucking	Statistics Canada: "Trucking in Canada, 2000", BC Freight Study, Border Traffic Study
II. Mode/Commodity Forecast	Source
Agricultural Commodities	Agriculture Canada, Sparks Companies, US Department of Agriculture
Nonagricultural Commodities	Industry Canada/Statistics Canada, US Energy Information Agency
Container Traffic	American Association of Port Authorities
Modal split on imports-exports from US	US International Trade Commission
Other import-export trends	Industry Canada/Statistics Canada
III. Economic Multipliers	Source
British Columbia	BC Stats
Other GVGC Provinces	Statistics Canada, Intervistas Studies

Basis for Marine Forecasts

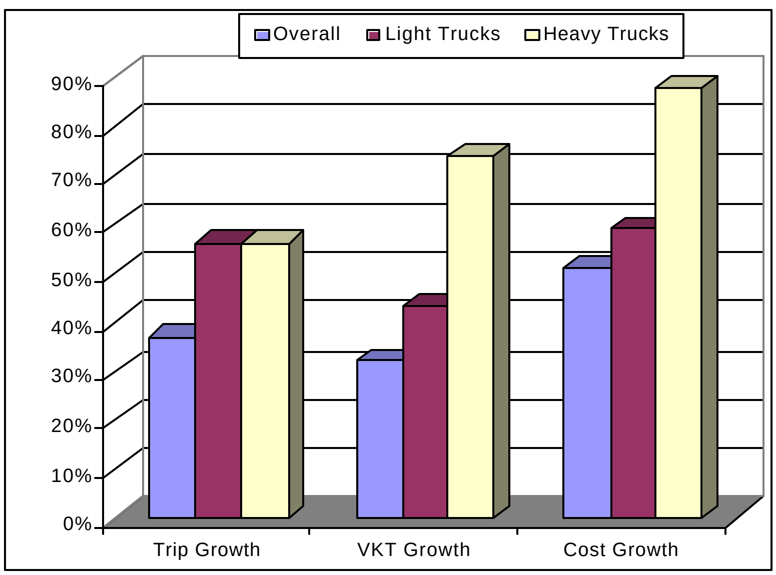
The main report showed trends and impacts for all modes and all ports comprising the Greater Vancouver Gateway. It was built upon a foundation of more detailed forecasts that the study team developed for key air, marine, truck and rail services (see ***Appendix Figures 5-1*** and ***5-2***. These forecasts were derived using trend data from the above-cited sources, as well as economic growth and Pacific trade forecasts provided by private firms.

Appendix Figure 5-1
Growth in Marine Container Transport and Air Cargo will Outstrip General Traffic Growth (forecast period 2001-2021)



Source: truck trips were forecast using EMME2 traffic forecasting model; air and marine cargo were forecast using methodology discussed in text.

Appendix Figure 5-2
Ground Transport Costs will Rise with Increasing Travel Times, which will Outstrip the Increases in Total Trips and Distance Traveled (forecast period 2001-2021)



Source: EMME2 traffic forecasting model

Appendix Table 5-12a
Forecast of Maritime Cargo Shipments by Commodity Type

Commodity	Shipments (tonnes)			Percent (total annual shipments)	
	2001	2021	Ann. Gr. Rate	2001	2021
Food and Kindred Products	6,858,657	8,320,254	1.010	5.4	4.7
Grains, cereals	11,721,872	13,248,333	1.006	9.3	7.5
Coal	29,706,632	30,432,016	1.001	23.5	17.3
Nonmet. And metalic min. ore	4,353,711	13,695,130	1.059	3.4	7.8
Sand, gravel, gyp., limest., aggreg.	5,857,217	5,511,495	0.997	4.6	3.1
Sulphur	5,140,749	6,547,105	1.012	4.1	3.7
Fertilizers	7,048,003	9,829,866	1.017	5.6	5.6
Portland Cement	917,216	4,303,620	1.080	0.7	2.4
Chemicals	6,592,247	9,194,222	1.017	5.2	5.2
Petroleum	3,395,875	4,934,070	1.019	2.7	2.8
Salt	405,840	404,793	1.000	0.3	0.2
Metal Prods. (ferr. & nonferr.)	1,804,699	9,128,112	1.084	1.4	5.2
Forest Products & Paper	34,419,360	43,204,527	1.011	27.2	24.5
Machinery	3,334,745	11,947,360	1.066	2.6	6.8
Vehicles & Parts.	372,218	519,133	1.017	0.3	0.3
Mixed, Misc., Otherwise NEC	4,512,435	5,039,107	1.006	3.6	2.9
TOTAL	**126,441,478**	**176,259,144**	**1.017**	**100.0**	**100.0**

Source: Maritime cargo data reported by Vancouver Port Authority, Fraser River Port Authority and North Fraser Port Authority, supplemented by Freight Transportation in British Columbia, and adjusted to represent common 2001 year levels. Forecasts for 2021 were calculated by Economic Development Research Group, based on a combination of port and provincial economic trends and forecasts, with further adjustment for future exchange rate uncertainty.

Appendix Table 5-12b
Forecast of Rail Cargo Shipments by Commodity Type

COMMODITY	Shipments (tonnes)			Percent (total annual shipments)	
	2001	2021	Ann. Gr. Rate	2001	2021
Food and Kindred Products	5,440,737	7,333,922	1.015	3.2	2.5
Grains, cereals	32,572,355	54,790,377	1.026	19.1	18.9
Coal	49,924,464	83,870,479	1.026	29.3	28.9
Nonmet. and metalic min. ore	1,258,265	2,122,828	1.026	0.7	0.7
Sand, gravel, gyp., limest., aggreg.	3,013,547	3,150,918	1.002	1.8	1.1
Sulphur	10,335,582	17,383,934	1.026	6.1	6.0
Fertilizers	7,980,793	13,423,199	1.026	4.7	4.6
Portland Cement	471,909	2,460,377	1.086	0.3	0.8
Chemicals	2,233,736	3,816,822	1.027	1.3	1.3
Petroleum	7,282	11,757	1.024	0.0	0.0
Salt	208,805	231,420	1.005	0.1	0.1
Metal Prods. (ferr. & nonferr.)	102,484	575,986	1.090	0.1	0.2

COMMODITY	Shipments (tonnes)			Percent (total annual shipments)	
	2001	2021	Ann. Gr. Rate	2001	2021
Forest Products & Paper	31,252,724	54,000,260	1.028	18.3	18.6
Machinery	1,715,732	6,830,299	1.072	1.0	2.4
Vehicles & Parts.	1,482,987	1,719,095	1.007	0.9	0.6
Mixed, Misc., Otherwise NEC	22,648,040	38,565,091	1.027	13.3	13.3
TOTAL	**170,649,441**	**290,286,764**	**1.027**	**100.0**	**100.0**

Source: Rail cargo flows were derived from data on shipments for major commodity groups reported in the study Freight Transportation in British Columbia, plus data for additional commodities reported in the British Columbia Trade Corridor Flow Study and supplementary data for additional rail shipments reported by the Port of Vancouver. All values were adjusted to represent common 2001 year levels. Forecasts for 2021 were calculated by Economic Development Research Group, based on a combination of port and provincial economic trends and forecasts, with further adjustment for future exchange rate uncertainty.

Appendix Table 5-12c
Forecast of Truck Cargo Shipments by Commodity Type

COMMODITY	Shipments (tonnes)			Percent (total annual shipments)	
	2001	2021	Ann. Gr. Rate	2001	2021
Food and Kindred Products	13,108,120	15,704,583	1.009	21.4	21.0
Grains, cereals	292,098	140,852	0.964	0.5	0.2
Coal	11,913	3,662	0.943	0.0	0.0
Nonmet. and metalic min. ore	6,386,785	8,889,191	1.017	10.4	11.9
Sand, gravel, gyp., limest., aggreg.	1,560,791	2,248,176	1.018	2.5	3.0
Sulphur	0	0	0.000	0.0	0.0
Fertilizers	51,783	58,067	1.006	0.1	0.1
Portland Cement	0	0	0.000	0.0	0.0
Chemicals	994,712	1,075,195	1.004	1.6	1.4
Petroleum	4,283,756	6,517,243	1.021	7.0	8.7
Salt	33,590	63,334	1.032	0.1	0.1
Metal Prods. (ferr. & nonferr.)	867,194	946,235	1.004	1.4	1.3
Forest Products & Paper	21,228,153	22,462,062	1.003	34.7	30.0
Machinery	1,942,679	2,120,503	1.004	3.2	2.8
Vehicles & Parts.	1,445,576	2,012,759	1.017	2.4	2.7
Mixed, Misc., Otherwise NEC	9,045,354	12,589,414	1.017	14.8	16.8
TOTAL	**61,254,505**	**74,831,276**	**1.010**	**100.0**	**100.0**

Source: Truck cargo flows were derived from data on shipments for major commodity groups reported in the study Freight Transportation in British Columbia, plus data for additional commodities reported in the British Columbia Trade Corridor Flow Study. All values were adjusted to represent common 2001 year levels. Forecasts for 2021 were calculated by Economic Development Research Group, based on a combination of port and provincial economic trends and forecasts, with further adjustment for future exchange rate uncertainty.

Appendix Table 5-12d
Forecast of Air Cargo Shipments by Commodity Type

COMMODITY	Shipments (tonnes)			Percent (total annual shipments)	
	2001	2021	Ann. Gr. Rate	2001	2021
Food and Kindred Products	23,656	44,417	1.032	10.3	10.3
Machinery	41,810	78,505	1.032	18.3	18.3
Mixed, Misc., Otherwise NEC	163,206	306,445	1.032	71.4	71.4
TOTAL	**228,672**	**429,368**	**1.032**	**100.0**	**100.0**

Source: Air cargo data were reported by Vancouver International Airport Authority, supplemented by Freight Transportation in British Columbia,, and adjusted to represent common 2001 year levels. Forecasts for 2021 were calculated by Economic Development Research Group, based on a combination of airport and provincial economic trends and forecasts, with further adjustment for future exchange rate uncertainty.

Marine and Airport Baseline Trends and Forecast Methodology

While the analysis and report examined trends and impacts for all modes and all ports comprising the Greater Vancouver Gateway, special attention was given to marine cargo forecasts since marine transport accounts for the largest share of total international freight flow within BC. The effects of infrastructure investment on demand for shipping services at Port of Vancouver were estimated by comparing a baseline (or control) forecast of demand for these services to a forecast of demand given improvements in ground access around the port and thus, lower overall costs associated with using the port.

The *baseline forecast* is developed by growing existing shipping demand based on expected changes in transportation and economic conditions (especially evolving trade patterns with the Asian economies and a long-term trend towards strengthening of the Canadian dollar relative to the US dollar), changes in the forecasts of port activity, and secular trends in modal choice . Specifically, in the absence of true other forecast data, growth in export levels for each product currently shipped at the port is estimated based on recent BC and Canadian export trends, including evolving trade patterns with the Asian economies. However, for grain and coal, which together account for 50% of port export cargo, actual forecasts are available from government sources. For grain and other agricultural products, future exports were estimated based on a combination of Canadian exports of agricultural products through 2007 developed by Agri-Canada and published in Medium Term Policy Baselines: International and Domestic Markets (September 2001). Fossil fuel trade was based on those export projections developed by Natural Resources Canada.

Forecasts of trade by sector were then adjusted to reflect recent trends in vessel usage in international trade. Two trends were captured. The first were sector-specific changes in usage of vessel services relative to other transportation modes (e.g., air) in transporting export products. This captures changing industry preferences for water versus other modes, as driven by factors like changing value-weight ratios of products and greater use of air to meet just-in-time requirements. Because of the importance of Asian trade to the Gateway Ports, data was gathered for trends in vessel usage for Pacific Coast exports to Asia, as well as for Pacific Coast exports to other parts of the world. These trends were used to estimate demand for port cargo services associated with expected changes in exports from BC and Canada.

To estimate baseline demand for port container services, a second adjustment was made. Improvements in performance and cost of container services, as well as changing characteristics of traded products, resulted in a secular increase in demand for container services in North America. (See ***Appendix Table 5-13*** for historical data on North American container shipments.) This trend is expected to continue and was captured by adjusting vessel demand forecasts to reflect increasing demand at the port for container services. Together with the cargo demand estimates described in the previous paragraph, these forecasts will constitute a baseline forecast for freight services at the port. A similar process was used for analyzing airport cargo trends; see ***Appendix Table 5-14*** for historical data on Vancouver air cargo levels.

Because of the massive complexity of estimating changes in demand by sector and end market (e.g., coal exports to Mexico, wheat exports to China), a framework for categorizing effects of infrastructure improvements on individual sectors was constructed. In this framework, two types of sectors were identified based on their existing use of vessel and air modes for transporting exports and characteristics of the sector's products, especially their value added-to-weight ratios. The first group (Group 1) of sectors includes those, like computer and electronics, which rely almost exclusively on air (rather than water) for overseas shipments. For these sectors, the number of products transported by water is extremely limited and unlikely to be affected by the relative price of shipping. In addition, maritime freight in these sectors is likely to be tied almost exclusively to activity among local (i.e., BC) firms. The different characteristics of the three groups require different approaches for forecasting the effects of infrastructure improvement on demand. Shipments of these products also tend to be driven by export growth of local (here, BC), rather than national (i.e., Canadian) export trends. Thus, forecasts of port demand for these products will be driven by expected growth in exports from BC. For other product groups, maritime freight shipments are more common and are driven in large part, by activities from outside BC (e.g., grain shipments from the western Canadian provinces). For these products, Canadian import and export trends provide the best indicator of likely future trends.

With the exception of those sectors discussed above (i.e., agricultural and fuel products), export and import growth rates were based on trade patterns from the past decade. These trends were based on 1992-2002 trade data gathered and reported by Statistics Canada, then extrapolated to the 2021 period based on historical trends, existing port forecasts, and expectations about the rate of future growth, given the unique conditions that characterized the 1992-2002 period, especially the low value of the Canadian dollar relative to the US dollar.

Appendix Table 5-13 North American Container Traffic, 1980-2001 (in TEUs)

U. S./ CANADA CONTAINER TRAFFIC IN TEUs	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980
PACIFIC COAST																						
CANADA																						
Fraser	50,565	66,842	31,921	24,911	18,778	13,343	24,624	27,934	25,460	8,210	15,990	60,675	28,608	31,586	13,044							
Vancouver	1,146,577	1,163,178	1,070,171	840,098	724,154	616,692	496,365	493,843	434,004	441,055	383,563	322,569	305,688	305,738	280,777	222,781	178,175	151,551	136,178	89,296	98,342	124,644
TOTAL CANADA	1,197,142	1,230,020	1,102,092	865,009	742,932	630,035	520,989	521,777	459,464	449,265	399,553	383,244	334,296	337,324	293,821	222,781	178,175	151,551	136,178	89,296	98,342	124,644
UNITED STATES																						
Anchorage	360,615	432,296	367,810	358,480	341,509	337,770	345,865	333,138	275,758	262,722	133,539	136,279	256,078	137,087	81,829	142,710	173,848	184,331	184,331	169,549	169,307	143,853
Apra	140,140	132,688	145,191	163,855	156,047	156,229	145,278	144,154	147,126	146,917	138,618	288,230	104,495	111,205	117,098	84,556	83,223	49,807	40,527			
Everett	9,538	10,177	10,663	11,352	9,944	5,376	1,146	875														
Grays Harbor		322																				
Hilo	55,759	37,945	32,216	37,835	33,712	31,348	53,959	33,671	34,492	35,565	29,571	32,093	29,882	26,890	26,600	n/	a					
Honolulu	803,319	461,102	411,156	479,948	477,776	453,044	805,036	435,658	442,748	438,952	407,996	399,117	375,876	329,710	311,533	456,236	435,921	427,921	108,705	251,733	253,653	
Hueneme	17,221	16,652	17,536	14,972	N/ A	N/ A	N/ A	N/ A	N/ A	N/A	N/ A	N/ A										
Kahului	103,629	59,417	59,059	60,295	56,201	50,845	90,380	48,935	43,282	48,506	46,968	38,915	38,952	34,796	29,742	n/	a					
Kaunakakai	1,552	1,535	972	1,688	1,407	1,662	3,021	1,461	1,394	1,304	1,195	660	600	585	411	n/	a					
Kawaihae	42,016	23,233	19,894	19,099	17,455	17,336	31,617	12,862	10,547	13,007	12,983	11,684	10,461	9,801	5,961	n/	a					
Long Beach	4,462,959	4,600,787	4,408,480	4,097,689	3,504,603	3,067,334	2,843,502	2,573,827	2,079,491	1,829,457	1,767,824	1,598,078	1,575,117	1,539,803	1,460,188	1,394,453	1,141,466	1,444,295	714,410	824,900		
Longview		2,415	3,147	2,687	3,096	2,740	4,360	2,694	2,314	2,331	2,410	2,243	3,039	3,787	3,901	3,702	4,416	5,985				
Los Angeles	5,183,511	4,879,429	3,828,851	3,378,217	2,959,715	2,682,802	2,555,344	2,518,618	2,318,918	2,289,223	2,038,537	2,116,980	2,056,980	1,652,070	1,579,657	1,324,547	1,103,722	910,983	576,278	478,325	488,850	632,784
Nawiliwili	37,203	24,015	21,576	22,100	21,159	21,196	45,508	24,361	29,706	18,768	19,494	18,043	14,395	15,400	11,106	n/	a					
Oakland	1,643,577	1,776,922	1,663,756	1,575,406	1,531,188	1,498,202	1,549,886	1,491,000	1,305,134	1,234,150	1,139,748	817,480	1,069,250	1,020,600	953,861	900,017	855,642	915,871				
Olympia		-	-	-	9,147	-	-	-	-	-	-	-										
Portland(OR)	278,918	290,556	293,262	259,308	294,930	302,171	329,748	317,961	239,439	217,422	175,900	162,933	186,027	164,596	139,824	105,097	111,422	120,796	99,453	73,565	99,808	93,015
Richmond(CA)		-	-	-	9,858	14,005	4,563	2,437	179	109	-	-	-	-	-	-	-	6,217	20,265	24,779	11,200	
San Diego	-	-	-	7,132	7,186	7,745	7,831	6,467	6,385	7,808	6,415	6,395	7,867	7,363	6,952	5,688	2,673	3,194	4,003	2,185		
San Francisco	34,618	50,147	39,547	18,297	17,973	5,553	33,156	66,486	89,579	151,845	223,676	140,364	107,874	122,285	115,970	97,404	107,212	79,012	65,380	72,301		
Seattle	1,315,109	1,488,020	1,490,048	1,543,726	1,475,613	1,473,561	1,479,076	1,414,000	1,151,405	1,151,261	1,154,854	1,171,091	1,041,000	1,024,035	1,026,000	850,616	627,164	775,670	743,903	639,607	781,563	
Tacoma	1,320,274	1,376,379	1,271,011	1,156,495	1,158,151	1,073,471	1,092,087	1,027,928	1,074,558	1,054,449	1,020,707	937,691	924,974	781,816	696,800	666,155	504,807	150,300	132,088	27,943		
Vancouver(WA)	413	1,307	845	360	-	674	2,324	1,141	100	881	1,033	402	857	805	1,017	1,611						
TOTAL U. S.	15,810,370	15,665,344	14,085,019	13,208,941	12,086,670	11,202,390	11,422,037	10,458,857	9,253,596	8,903,896	8,321,316	7,879,309	7,803,269	6,982,686	6,568,238	5,947,642	5,154,460	5,107,798	1,875,508	1,684,346	1,688,448	2,729,768
TOTAL PACIFIC	17,007,512	16,895,364	15,187,111	14,073,950	12,829,602	11,832,425	11,943,026	10,980,634	9,713,060	9,353,161	8,720,869	8,262,553	8,137,565	7,320,010	6,862,059	6,170,423	5,332,635	5,259,349	2,011,686	1,773,642	1,786,790	2,854,412
	93%	93%	93%	94%	94%	95%	96%	95%	95%	95%	95%	95%	96%	95%	96%	96%	97%	97%	93%	95%	94%	96%
ATLANTIC COAST																						
CANADA																						
Halifax	541,640	548,404	462,766	425,435	459,176	392,273	382,575	311,097	300,933	302,377	357,276	447,250	456,331	412,166	331,766	270,762	263,059	261,448	182,620	151,435	188,738	201,414
Montreal	989,427	1,014,148	993,486	932,701	870,368	852,530	726,435	728,799	598,120	537,256	575,554	568,103										
Saint John	47,558	48,274	48,417	42,720	42,898	37,202	30,867	28,424	28,366	15,757	14,462	15,684	19,126	17,019	25,395	60,176	76,930	90,927	88,868	80,903		
St. John's	94,897	90,489	88,049	88,812	85,665	83,983	78,676	80,803	77,318	73,864	78,391	89,539	89,383	73,648	63,556	47,538	50,670	45,791	48,476			
TOTAL CANADA	1,673,522	1,701,315	1,592,718	1,489,668	1,458,107	1,365,988	1,218,553	1,149,123	1,004,737	929,254	1,025,683	1,120,576	564,840	502,833	420,717	378,476	390,659	398,166	319,964	232,338	188,738	201,414
UNITED STATES																						
Baltimore	493,135	508,320	498,108	486,861	476,012	474,816	534,556	530,643	487,772	468,938	465,491	474,301	540,771	584,666	565,900	616,200	706,479	774,200	526,000	480,000	494,000	524,000
Boston	132,650	138,904	154,175	147,156	143,948	127,087	159,844	169,595	152,240	141,950	124,859	141,849	140,039	129,709	136,825	143,534	139,544	126,776	105,470	87,573	94,832	
Brunswick(GA)	580	5,958	582	4	-	90	25	59														
Canaveral	915	917	787	644	-	-	-	-	-	-	-	-										
Charleston	1,528,034	1,632,747	1,482,995	1,277,514	1,217,544	1,078,590	1,023,903	897,480	802,821	805,287	817,388	801,105	795,385	717,477	581,760	480,819	431,040	520,149	320,000	250,177	195,027	238,582
Chester (Units)					32,000	39,000	37,400	32,738	32,246	17,550	24,683	42,275	42,367	38,904	10,376							
Fernandina	26,068	28,709	33,322	29,365	28,754	32,414	30,865	20,000	25,000	18,000	20,000	45,000	35,818	47,748	n/	a						
Hampton Roads	1,303,797	1,347,364	1,306,537	1,251,891	1,232,725	1,141,357	1,077,846	894,066	786,023	846,256	855,219	788,760	685,295	611,677	481,150	436,022	299,532	313,760	222,967	214,517	253,613	390,709
Jacksonville (a)	698,903	708,028	771,882	753,823	675,196	613,448	529,547	480,616	460,238	463,516	453,655	154,491	128,090	136,002	121,789	78,375	80,621	106,476	137,727	198,705	70,674	
Miami	955,671	868,178	777,821	813,761	761,183	656,798	656,175	629,259	572,170	332,660	408,034	373,851	337,961	273,077	223,696	219,524	229,614	189,314	277,246	236,272	231,444	145,814
New York/ New Jersey	3,316,275	3,050,006	2,828,878	2,466,013	2,456,886	2,269,500	2,262,792	2,033,879	1,972,692	2,014,052	1,865,471	1,898,436	1,988,318	2,095,530	2,089,421	2,340,000	2,367,000	2,235,000	2,065,000	1,909,000	1,860,000	1,947,000
Palm Beach	197,541	214,890	192,784	189,804	174,080	174,870	162,045	163,248	158,762	136,317	127,536	118,568	121,137	119,164	120,647	138,219	121,023	95,826	70,904	63,500	62,667	
Philadelphia	178,834	198,680	216,991	233,728	112,588	95,086	107,094	108,832	117,057	113,293	66,745	65,309	80,674	129,181	93,629	91,086	104,522	142,695	119,195	130,308	133,542	124,339
Ponce	59,184	34,592	65,750	52,253	20,195	27,441	40,944	52,473	36,615	30,236	35,328	50,359	36,255	38,309	29,229							
Port Everglades	621,421	676,760	715,585	704,390	719,685	701,281	632,789	395,752	226,674	209,605	192,479	256,327	243,387	228,462	206,458	110,364	88,502	77,215	71,957	50,495	48,240	
Portland(ME)	2,459	5,115	4,601	2,372	2,171	4,177	4,000	4,200	3,300	4,000	2,500	N/	A									
Portsmouth (NH)		-	-	-	-	-	-	-	-	-	281	2,248	2,266	2,047	1,308	1,200	800					
Richmond(VA)					39,376	43,599	41,950	43,994	52,145	52,873	42,934	42,489	41,213	40,642	37,206	36,372	26,001	22,160	25,585	20,948	20,073	26,100
San Juan	2,057,733	2,333,788	2,084,711	1,990,275	1,833,018	1,640,624	1,539,000	1,533,592	1,559,421	783,000	827,251	711,474	674,751	573,976	590,811	486,383	470,202	461,616	457,714	460,732	835,000	776,756
Savannah	1,077,478	948,699	793,165	730,611	734,724	650,253	626,151	562,266	536,303	517,277	479,348	419,079	376,295	365,850	362,350	501,445	368,733	355,078	216,088	163,352	163,906	200,806
Wilmington(DE)	211,784	192,091	199,168	199,240	166,912	162,884	156,940	157,416	172,998	162,946	114,664	91,623	78,284	54,276	40,000	30,162	18,790	35,908				
Wilmington(NC)	107,374	105,110	133,926	112,940	105,786	103,579	104,038	98,667	110,425	106,786	83,651	92,720	99,031	82,474	95,438	111,552	66,816	94,422	60,802	54,407	42,600	
TOTAL U. S.	13,009,212	13,042,455	12,303,718	11,486,639	10,945,552	10,046,168	9,728,863	8,807,236	8,254,029	7,212,311	7,001,789	6,564,147	6,432,125	6,250,689	5,776,372	5,805,833	5,513,291	5,554,535	4,651,070	4,299,038	4,485,545	4,348,006
TOTAL ATLANTIC	14,682,734	14,743,770	13,896,436	12,976,307	12,403,659	11,412,156	10,947,416	9,956,359	9,258,766	8,141,565	8,027,472	7,684,723	6,996,965	6,753,522	6,197,089	6,184,309	5,903,950	5,952,701	4,971,034	4,531,376	4,674,283	4,549,420

U. S. GULF COAST																						
Beaumont		1,409	1,387	1,038	806	971	N/A	N/ A	593	N/ A	N/ A	N/ A										
Corpus Christi		-	-	-	-	-	-	921	5,124	N/ A	N/ A	N/ A										
Freeport	70,000	71,464	63,396	54,694	45,135	48,158	30,516	34,062	30,525	29,708	24,010	29,947	27,898	37,236	36,742	38,786	19,408	17,424				
Galveston	83,796	82,943	68,874	13,391	14,376	9,609	40,423	83,212	97,818	120,138	93,634	51,167	66,928	57,550	57,237	42,593	19,918	49,678	74,839	81,425	42,543	
Gulfport	129,020	141,464	125,874	144,961	154,694	153,470	108,096	93,255	89,862	73,659	77,021	55,929	50,347	49,166	n/	a	n/	a				
Houston	1,071,601	1,074,102	1,001,170	968,169	935,600	794,481	705,367	579,868	541,497	490,106	533,887	502,035	492,158	530,593	484,585	402,972	362,728	372,280	303,488	256,126	335,701	300,395
Lake Charles	14,000	11,000	19,120	622	34,583	33,549	48,293	9,668	31,627	N/ A	34,436	N/ A										
Manatee	5,680	10,088	13,368	16,257	16,532	16,088	16,730	13,780	10,722	8,107	3,361	3,635	4,500	4,506	6,630	2,261	n/	a				
Mobile (b)	21,059	18,735	16,993	24,171	25,753	32,306	30,181	23,499	11,653	8,717	11,264	18,401	15,452	12,380	9,987	14,249	26,342	30,291	31,042	29,309	12,490	
New Orleans (c)	247,106	278,932	268,630	244,624	263,851	261,007	198,424	378,334	366,518	403,840	152,442	157,037	145,396	200,018	312,847	424,116	380,000	358,817	255,880	276,000	190,862	279,544
Saint Bernard	3,249	3,236	2,976	3,177	N/ A	4,341	3,800	N/ A	N/ A	N/ A	N/ A	N/ A										
Tampa	6,212	6,781	6,905	8,013	2,673	4,616	6,020	6,844	8,000	7,382	6,230	4,248	4,459	3,651	3,147	3,341	3,715	2,700	4,794			
TOTAL GULF	1,651,723	1,700,154	1,588,693	1,479,117	1,494,003	1,358,596	1,187,850	1,223,443	1,193,939	1,141,657	936,285	822,399	807,138	895,100	911,175	928,318	812,111	831,190	670,043	642,860	581,596	579,939
WA STATE	2,635,796	2,865,706	2,761,904	2,700,581	2,633,764	2,547,706	2,573,487	2,443,069	2,226,063	2,206,591	2,176,594	2,109,184	1,966,831	1,806,656	1,723,817	1,518,382	1,131,971	925,970	875,991	667,550	781,563	0
TOTAL CANADA	2,870,664	2,931,335	2,694,810	2,354,677	2,201,039	1,996,023	1,739,542	1,670,900	1,464,201	1,378,519	1,425,236	1,503,820	899,136	840,157	714,538	601,257	568,834	549,717	456,142	321,634	287,080	326,058
TOTAL US	30,471,305	30,407,953	27,977,430	26,174,697	24,526,225	22,607,154	22,338,750	20,489,536	18,701,564	17,257,864	16,259,390	15,265,855	15,042,532	14,128,475	13,255,785	12,681,793	11,479,862	11,493,523	7,196,621	6,626,244	6,755,589	7,657,713
GRAND TOTAL	33,341,969	33,339,288	30,672,240	28,529,374	26,727,264	24,603,177	24,078,292	22,160,436	20,165,765	18,636,383	17,684,626	16,769,675	15,941,668	14,968,632	13,970,323	13,283,050	12,048,696	12,043,240	7,652,763	6,947,878	7,042,669	7,983,771

Source: American Association of Port Authorities (http://www.aapa-ports.org)

Appendix Table 5-14. Vancouver International Airport: Cargo Volume (Tonnes) 1992 - 2002

		January	February	March	April	May	June	July	August	September	October	November	December	TOTAL
1992	Integrator	538	542	598	581	568	576	522	455	535	626	508	549	**6,599**
	Other Carriers	9,160	9,740	10,919	10,528	11,427	13,090	12,801	11,746	11,766	12,742	11,960	11,926	**137,806**
	Total	9,698	10,283	11,517	11,110	11,995	13,666	13,322	12,201	12,302	13,368	12,468	12,475	**144,404**
1993	Integrator	549	555	697	621	598	600	614	629	618	624	513	550	**7,168**
	Other Carriers	9,505	9,967	12,124	10,828	11,780	12,319	13,703	12,646	12,240	12,856	13,055	13,277	**144,300**
	Total	10,054	10,522	12,821	11,449	12,378	12,919	14,317	13,275	12,858	13,480	13,568	13,827	**151,467**
1994	Integrator	610	747	918	1,668	1,733	1,906	1,627	1,708	1,998	1,883	2,030	2,234	**19,063**
	Other Carriers	11,259	11,023	13,154	11,982	12,582	14,574	15,400	13,798	14,580	15,424	14,444	15,088	**163,309**
	Total	11,870	11,770	14,072	13,650	14,315	16,481	17,027	15,506	16,578	17,308	16,474	17,321	**182,372**
1995	Integrator	1,810	1,870	2,153	1,942	1,919	1,992	1,937	1,944	2,214	1,955	2,407	2,530	**24,674**
	Other Carriers	14,173	13,504	14,942	15,894	15,651	18,115	18,619	16,198	15,543	15,797	15,234	16,128	**189,798**
	Total	15,983	15,373	17,095	17,836	17,571	20,106	20,557	18,142	17,757	17,752	17,641	18,658	**214,472**
1996	Integrator	2,435	2,672	3,135	2,685	2,721	3,125	3,321	3,461	3,486	4,056	3,954	3,749	**38,800**
	Other Carriers	14,030	14,794	16,872	17,296	17,556	19,445	19,821	18,770	18,222	19,122	18,079	16,395	**210,402**
	Total	16,465	17,466	20,007	19,982	20,277	22,569	23,142	22,231	21,708	23,178	22,033	20,144	**249,201**
1997	Integrator	3,790	3,712	3,772	4,187	4,034	3,758	3,403	3,729	3,832	4,319	4,342	4,328	**47,206**
	Other Carriers	14,756	14,441	17,823	16,889	17,540	20,158	21,331	19,201	19,556	18,351	16,755	16,766	**213,566**
	Total	18,546	18,153	21,595	21,076	21,574	23,916	24,734	22,930	23,388	22,670	21,097	21,094	**260,773**
1998	Integrator	4,172	4,038	4,723	4,429	4,348	4,709	4,087	4,185	4,991	4,911	4,485	5,305	**54,384**
	Other Carriers	13,615	14,408	15,664	15,132	15,483	18,073	19,729	17,274	15,727	17,341	16,447	16,020	**194,913**
	Total	17,788	18,445	20,387	19,560	19,831	22,783	23,816	21,459	20,718	22,252	20,932	21,326	**249,297**
1999	Integrator	4,401	4,063	4,365	4,659	4,824	5,007	4,403	4,529	5,045	4,907	4,943	5,047	**56,193**
	Other Carriers	13,188	13,136	15,621	16,067	16,817	18,312	21,321	18,410	20,614	20,803	18,989	19,657	**212,936**
	Total	17,590	17,199	19,986	20,727	21,641	23,318	25,723	22,939	25,659	25,710	23,933	24,705	**269,129**
2000	Integrator	4,128	4,469	4,808	4,045	4,717	4,546	3,973	4,368	4,370	4,497	4,635	4,369	**52,927**
	Other Carriers	15,789	15,853	17,503	16,250	15,573	17,558	20,163	16,534	15,491	16,289	15,995	15,845	**198,845**
	Total	19,918	20,323	22,311	20,295	20,290	22,105	24,136	20,903	19,861	20,786	20,630	20,214	**251,771**
2001	Integrator	4,751	4,535	5,176	4,320	4,754	4,623	3,774	4,393	3,734	4,476	4,622	4,356	**53,514**
	Other Carriers	12,268	12,090	14,519	13,520	14,261	16,158	18,528	16,881	12,667	14,862	14,972	14,434	**175,160**
	Total	17,019	16,625	19,695	17,840	19,015	20,781	22,302	21,274	16,401	19,338	19,594	18,790	**228,674**
2002	Integrator	3,948	3,684	3,817	3,979	4,259	4,095	4,236	4,620					**32,638**
	Other Carriers	12,971	12,595	15,224	13,932	15,727	16,219	19,048	16,570					**122,286**
	Total	16,919	16,279	19,041	17,911	19,986	20,314	23,284	21,190	0	0	0	0	**154,924**

Source: Vancouver Airport Authority.

Characterizing Total Freight Flows in BC

The volume and mix of goods moving into, out-of and within British Columbia is summarized in Section 3 of the main report. In that report, our characterization of the overall level of cargo movement in BC (over 200 million tonnes annually) and the mix breakdown by commodity and by origin-destination class was based on multiple sources for completeness. This included data from Vancouver's three major marine ports, Vancouver International Airport and two studies of Transport Canada (*Freight Transportation in British Columbia*, supplemented by the *British Columbia Trade Corridor Freight Flow Study)*, and was further updated by Economic Development Research Group based on adjustments for growth and change in the economy since those reports were completed. The table which follows shows some of the differing measures of total freight movement in BC by mode, and their coverage of commodity types and origin-destination classes.

In interpreting these values it is important to note the following issues and factors affecting them:

- Coverage of Freight Flows. Existing sources of data are fragmented and often incomplete, since different freight modes and origin-destination flows are tracked separately. The document, *Freight Transportation in British Columbia: Technical Supplement* provides a picture of major freight flows into and out of BC, but it does not fully account for some other classes of freight movement. The Freight Transportation Study and its Technical Appendix does measure truck movements for the major commodities, but it reports no truck shipments for some other commodities that are indeed reported elsewhere by the *BC Trade Corridor Freight Flow Study*. Also, the level of rail freight movements currently reported by the marine ports is larger than that reported in the Freight Transportation Study. Finally, it is not clear whether or not short distance truck movements -- container drayage, urban goods delivery and courier/mail deliveries are fully covered in that report although they are indeed factors affecting transportation needs in the Greater Vancouver Region.

  None of these findings should be interpreted as criticism of the BC Freight Transportation Study since no single study can solve the problem of piecing together inconsistent data from multiple sources. In fact, these same challenges are faced in measuring freight movements elsewhere in Canada and indeed elsewhere in North America and the world. The problem is due to a variety of government agencies using a variety of data collection methods for tracking different modes of travel (truck, rail, marine and air) and different classes of freight origin-destination movements (international imports and exports, inter-province and intra-province flows).

- Overlap Among Modes. All of the current measurements of commodity movements by mode are subject to overlap, since nearly all freight moving into and out of the marine ports and airport also involve inbound or outbound ground delivery via truck or rail. Some rail freight is also transferred to/from trucks within BC. Unfortunately, current data sources measure truck and rail cargo movements separately from airport and marine port cargo activity, and there is no linkage between these sources. As a result, cargo moving by multiple modes is often measured at least twice – once for each mode.

This situation makes it difficult to calculate an accurate breakdown of freight movements by all modal combinations. It also raises a question of how we are to measure the total magnitude of freight flows: (a) If our goal is to determine the actual *volume of freight ever moving in BC*, then the total must be adjusted downward for inter-modal overlaps and also adjusted upward for any non-measured classes of freight movement. (b) If, on the other hand, our goal is to characterize the *magnitude of use* occurring at BC's major ground transportation facilities, then it may be fully appropriate to look at all freight activity using rail facilities and road facilities without adjustment for the fact that some freight flows may be generating use of multiple modes.

- <u>Origin-Destination Categories.</u> There is also inaccuracy in the characterization of totally internal freight movements vs. import and export freight movements. For instance, some cargo coming into BC ports subsequently travels via rail or truck from those ports to destinations elsewhere in BC. These rail or truck shipments can be reported as "BC-to-BC" movements" even though the cargo actually originated overseas. This is an example of over-estimating the amount of freight movement that is wholly within BC. On the other hand, there is also some under-estimating of freight movements within BC since some classes of short-distance, urban freight truck shipments are not covered by the reports on provincial freight flows.

  This situation again raises a question of how we are to measure the total magnitude of freight flows: (a) If our goal is to determine the actual volume of freight moving within BC, then the BC-to-BC total must be adjusted downward for inter-modal overlaps and also adjusted upward for any non-measured classes of freight movement. (b) If, on the other hand, our goal is to characterize the magnitude of freight moving to and from BC, then the internal freight flows (pass-through that has neither origin nor destination within BC) are deducted from the sum of freight passing across BC's borders -- through marine ports and airports, across its international land border and across other provincial borders. (c) If, on the other hand, our goal is to characterize the magnitude of transportation facility use occurring in the Greater Vancouver Region, then it may be fully appropriate to sum the rail and truck freight activity with adjustment for multi-modal activity, though there still is a need to adjust for under-counted short-distance truck activity.

For our purposes in describing the use and importance of ground transportation facilities in BC, we focus on the total of rail and truck movements to, from and within BC. Using data in the following table, that definition yields estimates of roughly 170-173 million tonnes of freight moving via rail (as a fairly complete measure) and roughly 61-62 million tonnes of freight moving via truck (which has two offsetting error factors – it may overcount the total by including truck movements that are transfers, but it undercounts the total by excluding urban goods delivery and courier/mail truck movements). This yields a total of over 200 million tonnes of freight movement per year.

Appendix Table 5-15
Calculation of Total 1998 Freight Flows In BC

Mode	Millions of Tonnes	Source
Maritime (1)	99	p.13, "Freight Transportation in British Columbia," 1998 est.
Maritime (2)	126	Actual reported for Port of Vancouver, North Fraser Port Authority and Fraser River Port Authority, 2001 est
Air (1)	0.19	p, 68, "Freight Transportation in British Columbia," 1998 est.
Trucking (1)	28	p. 59, "Freight Transportation in British Columbia," 1998 est.
Trucking (2)	44	pp.6-9 and 6-10 of "Freight Transportation in British Columbia: Technical Supplement, " sum of commodity group shipments.
Trucking (3)	61	"British Columbia Trade Corridor Flow Study" Screenlines 1.0, 16.1, 979.1 for BC-US and BC-AB show shipments for additional commodities that are not included in the above-referenced Freight Transportation Technical Supplement data. Adjusting for undercoverage at the provincial level for missing commodities raises total from 44 to 61.
Rail (1)		
Rail (1A) Total BC receipts (incoming)	84	p.35, "Freight Transportation in British Columbia," 1998 est.
Rail (1B) Total BC shipments (outgoing)	51	p.35, "Freight Transportation in British Columbia," 1998 est.
Rail (1C) within BC receipts/shipments	36	p.35, "Freight Transportation in British Columbia," 1998 est.
Total Rail (1) all BC shipments	135	p.35, "Freight Transportation in British Columbia," 1998 est. -- "84 million tonnes of receipts and 51 million tonnes of shipments"
Total Net Rail (1) excl. within BC	99	p.35, "Freight Transportation in British Columbia," 1998 est. -- deduct "36 million tonnes that remain within the province"
Rail (2)		
Rail (2A) Within BC	98	From "Freight Transportation in British Columbia: Technical Supplement", p.7.31
Rail (2B) Between BC and Alberta/Rest of Canada	52	From "British Columbia Trade Corridor Flow Study" Shipments for Screenlines 1.0. 16.1, 97.1
Rail (2C) Between BC and US	11	From "Freight Transportation in British Columbia: Technical Supplement", p. 7.32
Rail (2D) Additional port shipments	12	Additional rail commodity shipments found in Maritime/Rail data from Port of Vancouver, which are above values counted above.
Total Rail (2) All BC shipments	173	

4. ECONOMIC MODELLING OF FUTURE SCENARIOS

Introduction

This chapter provides a description as to how the economic impacts of the transportation infrastructure improvements were estimated for 2000-2021. There are three parts to this process: First, we prepared baseline projections for economic activity for the Greater Vancouver Gateway region. Second, we used transportation simulation models to derive a set of changes in transportation output for rail and truck trips. Finally, we applied a set of economic multipliers to estimate the indirect and induced effects of not making infrastructure improvements, along with a series of adjustment and correction factors that reflect long-run adjustments in the economy. We describe the important features of these steps below.

.

Baseline Economic Projections

The economic projections for 2002-2021 are based on direct impact estimates for maritime, truck, rail, and air transport that were either updated from older published values, as in the case of maritime and air transport, or estimated from data found in the BC Freight study, the Trade Corridor study, or publications from Statistics Canada concerning rail and trucking activity in Canada. In all cases, we attempted to construct our estimates based on tonnage of cargo or number of passengers handled so as to permit direct economic impaction based on physical quantities of output.

Updating Earlier Studies

For two of the maritime ports and the airport, there had been prior economic impact studies of the individual ports, estimating employment, income output, and Gross Domestic Product (GDP.) Direct impacts were used in conjunction with Statistics Canada's input-output multipliers to estimate indirect and induced effects, as well. Using disaggregate (by commodity) cargo handling data, such as that published by the Port of Vancouver, we updated the figures from those studies (1989, 2000, and 2001) to 2002 levels, based on output per ton for the different cargo types. Apparent growth rates derived from the tonnage-handled figures were then applied to other activity measures (employment, income, and GDP) to yield a comprehensive set of data describing the current economic impact of these ports.

The earlier studies for maritime and airport direct employment included sizeable direct employment for non-transportation activities that are nonetheless related to port operations (such as freight warehouses), as well as other transportation employment for other modes (such as rail or trucking at the marine ports and trucking at the airport). To correct for double counting such employment, we deleted the trucking and rail employment from the airport and marine port figures. We also deleted non-related manufacturing and offices located at marine ports.

Development of Direct Impact Measures for Trucking and Rail

No studies have been conducted of the economic impact of trucking or rail that specifically focused on cargo movements to and from the Greater Vancouver Gateway. We calculated these values from provincial data from Statistics Canada, the BC Freight study and Corridor studies of freight movement, and data from the Port of Vancouver on inbound and outbound marine shipments with rail linkages. Using output per ton estimated for movement of different cargoes, we developed economic impact estimates using the BC input-output multipliers to transform direct output to employment, income, and GDP, as well as indirect and induced effects.

Projecting 2002-2021 Economic Impacts

Using commodity-specific tonnage-handled and commodity-specific annual tonnage handling growth rates derived from numerous sources, annual projections of tonnage-handled were prepared. Some of those values are shown in the main report. These are straight-line growth projections for each mode, with the commodity definitions aggregated to a common classification scheme. The possibility exists that certain ambiguous definitions of detailed categories could lead to misclassification of some aggregate figures and hence some mis-application of growth rates from other categories. As we did not have access to the most detailed data collected for all modes, such problems are unavoidable.

Direct Economic Impacts of Proposed infrastructure Improvements

Based on transportation analysis models, we developed a set of direct economic impact estimates for the proposed infrastructure improvements. These estimates represent the changes in business costs and output associated with the increased transport costs that are projected to occur in the absence of significant infrastructure investment (or avoided if the infrastructure investments are made). Two separate calculation sequences were done, one for trucking and one for rail.

Direct Economic Impact of Road and Transit Infrastructure Investments

1. **Traffic Modelling.** Road and transit demand, supply and system performance was assessed by Delcan using the EMME2 simulation model. The model calculated peak period levels of vehicle-hours of travel (VHT) and vehicle-kilometres of travel (VKT) within the Greater Vancouver region for the year 2021. Separate forecasts were made for two scenarios – one in which the MCTS improvements are made and another in which they are not made. The forecasts differentiated cars, light trucks and heavy trucks, and they also split car trip impacts into business (commercial) travel and non-business travel. Adjustments were also made for time of day factors, specifically the off-peak timing of many truck trips.

2. **Value of Time.** The changes in VHT and VKT for the year 2021 were translated into constant 2002 dollars based on a series of factors:

- Commercial truck traffic – value of time delay for truck vehicle operation and driver time at $36/hour for light trucks and $45 /hour for heavy trucks. Added logistics, scheduling and productivity impacts for shippers and receivers increase the total value of time delay for full trucks to $77/hour for light trucks and $95/hour for heavy trucks. (Scheduling and warehousing costs can be particularly important for cargo associated with port and airport dependent commodities. Scheduling costs are also important for local delivery of goods and services in major urban areas. Both of these conditions apply here). Changes in vehicle-km of truck travel are calculated at $2.15/km.

- Car (non-work) –personal value of time of $7.90/hr. for single occupant cars and $15.80/hr. for multiple occupant vehicles, which reflects both vehicle operating cost savings and the personal time value of money. (Changes in vehicle-km of car travel are further calculated at $0.49/km.)

- Car (work trip) – value of time of $18.90/hour for single occupant cars and $37.80/hour for multiple occupant vehicles, which reflects both vehicle operating cost savings and the value of time savings for "on-the-clock" business travel. (Changes in vehicle-km of car travel are further calculated at $0.49/km.)

3. **Interpretation of Social Cost and Business Cost**. The values of time and distance reflect a combination of actual money costs for businesses and households, and personal willingness-to-pay for some personal travel time savings. These values were classified as either sources of business cost, sources of personal household cost or just social valuations (personal values of time):

   - Commercial trucks – The added cost from time delay for truck vehicle operation and driver time, as well as added logistics, scheduling and productivity impacts all represent costs for business operation.

   - Car (non-work) –The operating cost difference affects disposable household income. However, we assume that the value of time savings for personal travel is a "social benefit" that affects the quality of life and personal productivity, but does not affect the flow of dollars in the economy.

   - Car (work trip) – Both vehicle operating cost savings and the value of time savings for "on-the-clock" business travel represents a real dollar cost savings to businesses. We assume that businesses also end up absorbing half of this value of time for commuting trips, based on prior studies showing that employers end up paying higher labour-related costs as a consequence of longer worker delays and higher worker travel times.

4. **Calculation of Direct Business Impact of Road and Transit Investment.** Application of the value of time delay and vehicle distance changes led to calculations that by the year 2021, the failure to invest in the MCTS would add a direct social cost of $806 million/year. This includes $414 million/year of business operating expenses and household expenses, plus $392 million/year of personal (non-business) time savings. Note that we can view these same numbers as either the added cost of not investing in the MCTS or the added benefit of investing in the MCTS.

5. **Allocation of Direct Business Impact of Road and Transit Investment.** The $414 million/year of direct business cost savings associated with implementing the MCTS was allocated to businesses in various provinces, based on their share of the total value of truck shipments to/from Gateway facilities (British Columbia: 72%, Alberta: 17%, Saskatchewan: 5%, Manitoba: 6%.) The business costs were further allocated to industries based on the mix of commodities shipped to/from Gateway facilities by truck, and (b) a measure of the relative intensity of reliance on trucking for each industry, expressed as total trucking-related expenses per dollar of output. The latter is known as Transportation Satellite Accounts, which reflect spending on both "for-hire" and "in-house" transportation services. (These values are discussed elsewhere in this appendix.)

<u>Direct Economic Impacts of Rail System Investments</u>

1. **Rail Operations and Safety Analysis.** An analysis of rail operations by Delcan identified MCTS rail benefits (by the year 2021) totaling $1.8 million/year of rail operating efficiencies and $68,500/year of safety benefits from rail crossing improvements. These cost savings (totaling $1.87 million/year in year 2000 dollars) are in addition to the impact of addressing rail capacity constraints, which are discussed next.

2. **Rail-to-Port Capacity.** An analysis of capacity and demand at key rail bridges and yards by Delcan identified two rail system "bottlenecks" that would potentially limit future growth of train volumes – one passing through the New Westminster Bridge (route to downtown ports) and the other at the Colebrook East-West facility (route to Roberts Bank). Together these facilities are currently operating at an average level of 69 trains/day, which is well within their estimated combined operating capacity of 82 trains/day. However, current projections for future growth of rail traffic to/from the marine ports indicates that demand will grow to be full usage of all capacity at these bottlenecks by the year 2015, and an effective demand exceeding the capacity at these facilities after that point in time. By the year 2021, it is projected that demand will exceed capacity by the equivalent of 11 trains/day to or from the marine ports (equivalent to as many as 1,100 rail cars per day).

3. **Value of Capacity Shortfall.** Without future investment in MCTS rail projects, the portion of year 2021 projected demand that is unmet due to insufficient rail capacity represents 9% of projected total rail-to-port commodity flows. This is estimated to have

an economic value of roughly $1.9 billion/year (based on average value/ton of cargo moving to maritime ports, and 52% share of port shipments coming in by rail). Of this economic value, it is estimated that 94% is non-rail business output (value of shipped commodities), 2% is railroad industry output and 4% is other rail transport related business output (based on a combination of Canadian and US input-output tables with the US satellite accounts). In addition, without future investment in MCTS rail projects, there would not be the ability to add three daily Amtrak trains to Vancouver by the year 2021 as proposed – representing another $16 million/year of visitor spending money flowing into BC.

4. **Direct Economic Cost of Capacity Shortfall.** Most of the projected capacity shortfall can actually be avoided by rerouting rail traffic to other routes or shifting to other transportation modes. Of course, any shift to "second best" alternatives would be expected to have some corresponding increase in shipping costs, and that would likely lead to some subsequent loss of market share due to diminished cost-competitiveness for products shipped through international gateways. The nature of this impacts in future years will depend critically on a series of factors not currently knowable -- including market supply/demand balance, cost competition, currency exchange rates and global economic conditions.

   For purposes of this study, we assume that the impact on cost competitiveness will depend on the type of cargo. Container shipments going between Asia and the rest of Canada and US can go via alternative west coast ports. This would raise slightly costs for shippers, but it would also lead to a loss of port and railroad activity in Greater Vancouver. The greatest impact on cost competitiveness is likely to fall on producers of bulk commodities, which are particularly cost-sensitive industries and do not have mobility to relocate. Bulk commodities account for 45% of rail shipments, so the affected portion of port shipments has a value of roughly $850 million. We further assume that: (a) producers located in BC but outside of the Greater Vancouver region can ship products out of the province via alternative means, though at a higher cost leading to a 15% loss of market share and hence output, (b) bulk commodity producers located elsewhere in Western Canada can ship products to Asia via alternative means, with a less dramatic cost impact leading to a 10% loss of output, c) and (c) US visitors can access Vancouver and the rest of BC by existing car, bus, plane or rail options, with small impact on tourism spending. These may be considered to be relatively conservative assumptions, as more severe impacts are certainly possible.

5. **Calculation of Direct Business Impact of Rail Investment.** Applying the estimated economic response (step 4) to the value of affected shipments (step 3) yields a rough estimate that the likely impact of rail capacity improvements is in the range of approximately $95 million/year (constant year 2000 dollars) of cost savings. Adding the rail operations efficiency impact of nearly $2 million/year leads to a total direct cost savings impact of $97 million/year associated with rail system improvements.

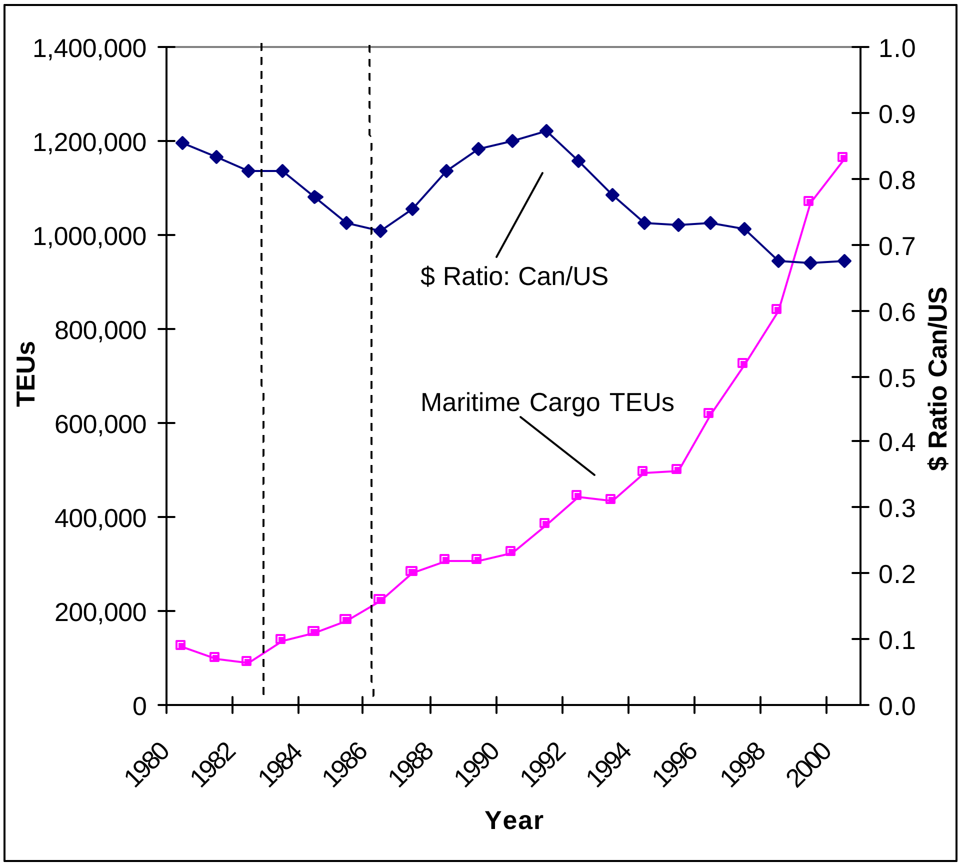
6. **Allocation of Direct Business Impact of Rail Investment.** The rail operations efficiency impact is allocated to railroads. The rail capacity impact is allocated among commodities (following the current rail and port commodity profiles), and then impacts are allocated to provinces. The allocations assume that impacts on coal and forest products occur primarily to BC, minerals and ores are split largely between BC and Alberta, and grains are split largely between Saskatchewan and Manitoba.

Sensitivity of Cargo Shipments to Shipping Cost Changes

Deficient infrastructure capacity can generate congestion which affects road and rail transportation time and costs. The normal response among transporters is to adjust shipping charges to compensate for additional time and distance traveled. Some of these additional charges can be passed on to shippers in the form of higher rates. The degree to which these can be passed on depends on the price sensitivity (elasticity) of demand for shipping by particular modes. These elasticities are, in part, determined by the characteristics of each mode and whether alternate modes are present. In the context of marine-rail shipments through GVGC ports, one such substitute is to ship via nearby US ports. How sensitive are GVGC cargo volumes to shipping costs?

To examine the impact of congestion on shipping charges, we would need to have a time series of shipping rates for different commodities and modes and test for statistical relationships between the cost of shipping and the volume shipped. Unfortunately, these data are unavailable. As a substitute for this in the context of marine and marine/rail shipments, we examined the time series of monthly total cargo shipments through the Port of Vancouver and the Canadian dollar-US dollar exchange rate for the 1980-2001 period. ***Appendix Figure 5-3*** shows that, as the Canadian dollar-US dollar has fallen, shipment volumes through the Port of Vancouver have increased. Obviously, changes in the exchange rate of Canadian dollar versus non-US currencies affect the volume of trade, and perhaps more significantly than the relative shipping cost differentials that might exist between Canadian and US ports. Even so, we note that during 1983-1986, the Canadian dollar declined in value relative to the US dollar, but rose against the Japanese yen. During these intervals, we saw increases in shipment volumes through the Port of Vancouver when we would otherwise expect a decline. This leads us to conclude that a congestion-induced rise in shipping costs would indeed cause a loss of volume through the Vancouver Gateway (the inverse of the exchange rate condition identified in ***Appendix Figure 5-3***).

Appendix Figure 5-3
Canadian-US Dollar Exchange Rate and Port of Vancouver Cargo Tonnage



Source: Cargo container levels as shown in Appendix Table 5-13.

Total Economic Impacts of Proposed infrastructure Improvements

The total economic impacts associated with road and rail infrastructure investments reflects the business response to direct costs and additional indirect and induced economic impacts. Additional steps were carried out to estimate total gross and net impacts on the economy.

1. **Direct Impact on Industry Competitiveness and Economic Growth.** The added costs of doing business for various industries directly affect their relative cost-competitiveness and subsequently their growth within BC and elsewhere in western Canada. Each industry can have a mix of three possible outcomes: (a) lose sales or reduce growth due to a less competitive cost structure; (b) close or move away from the province, (c) remain in place but shift shipments to alternative routes and gateway facilities outside of Greater Vancouver. We recognize "a" as a partial loss of business roughly commensurate with

the magnitude of the cost impact, "b" as a more dramatic impact likely to exceed the magnitude of the cost impact, and "c" as a less dramatic impact that is likely to lead to a smaller level of business loss for the shipper, but a full loss of the corresponding shipping activity for the Gateway-related workers and businesses. The outcomes depend on the cost-sensitivity of the industry's products, extent of fixed locations and dependence on a single mode for shipment.

High Direct Impact Estimate -- In this case, we have an estimate that the total direct business cost impact is $511 million/year, which reflects the $414 million/year of direct road and transit impact and $97 million/year of direct rail impact. The up-side estimate of direct economic impact would thus be to assume that industry absorbs all economic costs of congestion as either a loss of profit or a proportional loss of production, so that the GDP loss from failing to invest in the MCTS (or economic benefit of investing in the MCTS) is equal to the direct cost impact of $511 million/year. This represents the up-side estimate of direct economic impact.

Alternative Direct Impact Estimate -- As alternative estimate would be based on an assumption that there is a relationship between cost changes and business growth/ decline, which we derive based on analysis of historical exchange rate trends (as previously discussed) and regional simulation forecasting models (the REMI model in the US). For this study, our analysis indicates that each 10% sustained increase in business cost leads export industries to lose 4.5% to 8% of their GDP. A conservative alternative estimate would thus be to assume that economic contraction is $230 million/year of GDP, representing 45% of the direct cost impact. (This estimate implicitly assumes that the remaining portion of the $511 of direct cost impact absorbed by business that does not contract or otherwise goes away.)

2. **Indirect and Induced Impacts.** Changes in the growth/decline of directly-affected industries also affect the growth/decline of additional industries throughout the economy. This includes "indirect" impacts on firms that sell goods and services to those directly-affected industries. It also includes "induced" impacts on other industries, as the change in workers and wages (at the directly- and indirectly-affected businesses) affects consumer spending. These additional impacts are traced through provincial input-output economic accounting tables, and are sometimes referred to as "multiplier effects." (The provincial input-output multipliers are shown elsewhere in this appendix.)

   The application of provincial input-output multipliers yields a finding that a *direct* impact on business growth/decline (GDP) of $230 - $511 million/year (from step #1), leads to a *total* GDP impact on the economies of BC and the western provinces of $475 - $1055 million/year. These figures can be viewed as the total economic loss associated with failure to implement the MCTS or the total economic gain associated with implementing the MCTS, not counting the possibility that some affected workers and resources might eventually find alternative employment.

3. **Long-term Workforce Adjustment.** A remaining issue is thus how workers who lose their jobs due to business contractions will respond. In theory, they could adjust by: (a) moving away, (b) remaining unemployed, and (c) finding work in other industries (possibly at lesser wages) that subsequently expand in the area. The net effect is still a loss of aggregate personal income and total Gross Regional Product, but that loss is reduced to the extent that some workers remain and find alternative work (category "c").

   It is not possible to definitively estimate the nature of this impact without further analysis of labor market alternatives, relative wage rates and household mobility throughout western Canada. However, we can bracket the high and low ends of the possible range of impacts. At the low end, economic theory would indicate that the minimum impact on the provincial GDP would occur if all labor and capital resources in the affected provinces can be redirected to other activities, and even then there would be a productivity loss equal to the direct transportation cost impact on businesses in the affected provinces. However, this low end assumption assumes that workers are completely free to shift occupations and work locations as needed to meet demand. The presence of chronically higher unemployment in some communities and regions of Canada is proof that some people are not fully mobile to move to wherever there are jobs. So, at the upper end, it is reasonable to assume an intermediate response of workers to job and income loss.

4. **Net Long-term economic impact – Alternative scenarios.** The total "gross economic impact" is the sum of direct, indirect and induced economic impacts as calculated in step 2. Accounting for the possibility of long-run workforce adjustments, we can also calculate a "net economic impact." The net economic impact can be bracketed through a series of scenarios that reflect different assumptions about business contraction and workforce adjustment. We define the range of impact scenarios as follows:

   (a) High Impact with Multiplier assumes that (a) direct economic contraction will reflect the full cost impact of congestion as per the "High Direct Impact Estimate" in step 1, and (b) it will lead to additional "multiplier effects" on job and income loss that will not be eliminated by redirecting workers and equipment to alternative productive activities. That yields a total economic impact of $1055 million of GDP as per step 2.

   (b) Alternative Impact with Multiplier assumes that (a) direct economic contraction will reflect the full cost impact of congestion as per the "Alternative Direct Impact Estimate" in step 1, and (b) it will lead to additional "multiplier effects" on job and income loss that will not be eliminated by redirecting workers and equipment to alternative productive activities. That yields a total economic contraction impact of $475 million of GDP as per step 2. In addition, there is an additional $281 of cost imposed on business that does not contract but rather absorbs the higher cost of delays. So the total economic impact (including both economic contraction effects and absorbed costs) is $756 million of GDP.

(c) Impact without Multiplier assumes that (a) direct economic contraction will reflect the full cost impact of congestion as per the "Alternative Direct Impact Estimate" as per step 1, but (b) the additional "multiplier effects" on job and income loss will eventually disappear as workers and equipment are redirected to alternative productive activities. That yields a total economic impact of $511 million of GDP. It can be viewed in either of two ways – as $511 million of economic contraction as per the "High Direct Impact Estimate" or as $230 million of economic contraction as per the "Alternative Direct Impact Estimate" plus $281 of cost imposed on business that does not contract but rather absorbs the higher cost of delays as a reduction in net business income or profit. GDP can be measured in terms of net labor and corporate income change, so either way we have a total GDP impact of $511 million.

(d) Low Total Impact Scenario: No Multiplier and Road Impacts Only. This scenario is the same as (c) above but counts only road system delay impacts and not additional costs associated with rail system capacity limitations. That yields a total economic impact of $414 million.

5. **Uncertainty Factors.** The 2001-2021 growth in BC cargo shipments that underlies impact analysis in this study appears to be substantial. As shown in report Table 5-1, they range from 19% for truck to 88% for air cargo. However, those projections for trucks and air are conservative compared to U.S. Dept. of Transportation projections of growth over nearly the same period (1998-2020). In addition, US-Canadian dollar exchange rates (which are currently at favorable levels, by historical standards) remain a key uncertainty factor that can also increase the severity of economic impacts from any increases in transportation costs.

Comparison of Public Benefits and Costs

Public Costs. It is estimated that the cost of completing the MCTS infrastructure improvements is in the range of $6.2 billion to $6.9 billion, expressed in year 2002 dollars. That cost would be incurred over a period of time, most likely spread out over two decades. To represent the timing of public costs, it is first necessary to establish a schedule for construction and completion of the identified projects. It is also necessary to establish a scenario for incurring public costs, including assumptions about public bond costs, funding plans, and the timing of toll revenues. The net present value of that public cost stream can be calculated by assuming an appropriate discount rate (such as 5%/year) for valuing future year benefits.

Benefits to Society. The economic impacts addressed in this report represent the full impact of transportation cost and capacity changes on the economy. These estimates of the full economic contraction impact ($475 – $1055 million/year of GDP, as shown in Report Table 7-3) reflect the economic contraction consequences of traveler and shipper cost impacts.

In addition, some scenarios discussed here assume additional impacts on costs absorbed by businesses that do not contract. Adding that absorbed cost impact to the business contraction impact yields an overall estimate of $756 - $1055 million/year of GDP consequences).

Beyond these economic consequences for the economy, there are additional impacts on personal travel time delays that do not directly affect the economy though they do have a social value. These personal time delay impacts have a social value of $382 million/year as shown in Report table 7-1, and they must be added to provide a complete measure of benefit to society . Adding these figures, we calculate the full benefit for year 2021 to be $1.159 - $1.447 billion/year. Using just the value of non-rail transportation user benefits, we would get a year 2021 benefit of $806 million/year. These values, representing year 2021 impacts as measured in year 2002 dollars, are reflected in Report Table 7-4.

All of the incremental benefits of MCTS improvements (compared to the no-build scenario) are phased in over time. If all MCTS infrastructure improvements are completed immediately, then the benefits can be phased in starting now -- with $0 in 2002, rising to the above-referenced values in year 2021 and growing further in later years. However, if the projects are completed over a period of one or two decades (which is likely), then the benefits can only be phased in as the corresponding elements of the MCTS plan are completed. Once a timing sequence is established for construction and completion of various MCTS elements, then it will be possible to calculate a net present value of the benefit stream.

Benefit-Cost Analysis. Costs and benefits occur at different points in time. In addition, construction costs are represented as a one-time total, while benefits are represented as a recurring annual amount. To compare them on a consistent basis, it is necessary to represent both the future costs and the future benefits in terms of their net present value in today's dollars. This analysis can also incorporate additional relevant factors, such as opportunity costs of raising capital, expenses of ongoing operation and maintenance, toll revenues and residual benefits at the end of the observation time period. There are also likely to be substantial additional jobs and income also generated by project construction activity (discussed next), which is a very relevant interest for the public although it is usually not counted in benefit-cost calculations (since similar benefits can also come from spending on alternative uses of the money). At this point in time, there are many unresolved issues about timing and funding that could affect a benefit-cost analysis. However, it appears clear that recurring benefits in the range of $806 million/year to $1.447 billion/year will present a potential benefit that compares reasonably well to a one-time cost of roughly $6.2 to $6.9 billion.

Findings on Construction Impacts

The proposed set of investments in on highway, rail and bridge/tunnel projects is estimated to involve a total cost in the range of $6.2 billion to $6.9 billion (expressed in constant year 2002 dollars). Most all of this cost will go to highway facility construction, with a smaller amount going to pay for transit facilities, engineering services and administration. This spending will pay directly for construction workers, engineers and managers. It will also pay for construction materials, which indirectly creates additional jobs associated with the production and supply of those materials. In addition, the increase in worker income (resulting from direct and indirect labor) will further increase consumer spending and lead to even more jobs at businesses providing goods and services to consumers.

These impacts are very real, but they are accounted for separately from the benefit-cost analysis since they are a non-recurring (one-time) result of the construction spending rather than a continuing benefit of having the additional roads, rail and bridge/tunnel facilities in place.

Calculation of Direct Construction Impact

Highway Construction

$1B (constant 1993 $US) => 7900 jobs (person-years), source: US Federal Highway Administration, *Highway Infrastructure Investment and Job Creation*, 1994.
Converting to Canadian dollars and updating to 2003 dollars, this translates to be
$1B (constant 2003 $CAN) => 4730 jobs (person-years)

Transit Construction

$1B (constant 1998 $US) => 4500 jobs (person-years), source: American Public Transit Association, *Public Transit and the Nation's Economy*, 1999
Converting to Canadian dollars and updating to 2003 dollars, this translates to be
$1B (constant 2003 $CAN) => 2870 jobs (person-years)

Overall

Assuming a mix of roughly 92% highway/bridge/tunnel and 8% transit spending, yields a finding that the proposed $6.2B – $6.9B of MCTS spending would support 28,400 – 31,600 direct jobs (person-years) of labor, spread out over a twenty-year period.

Calculation of Total Construction Impact

If this is an infusion of additional spending does not displace other economic activity, then it could also support suppliers (indirect impacts) and generate further income re-spending of the additional wages (induced impacts). The BC Input-Output model indicates that the incremental impact of the spending program would lead to a larger total impact on jobs, by a multiplier factor of approximately 1.9. This would create an additional 23,200 indirect and induced jobs in addition to the 27,300 direct jobs. The sum of the two is a total impact of approximately 50.500 job-years of employment (spread out over the 20 year construction period).