SNC-Lavalin Inc.,
Environment & Water

8648 Commerce Court
Burnaby, British Columbia
Canada V5A 4N6

Telephone: 604-515-5151
Fax: 604-515-5150

MEMORANDUM

TO: Zoran Knezevic **DATE:** May 6, 2014

C.C.:

FROM: Bryan McEwen, John Fisera (SNC-Lavalin)

SUBJECT: Emissions Analysis for Port Alberni Transshipment Hub (PATH)

A comparative analysis was done to evaluate the net environmental impacts associated with PATH. In this case the environmental impacts of interest are emissions of criteria air contaminants (CACs) and greenhouse gases (GHGs). Additionally, the net change of truck traffic volumes in Metro Vancouver (MV) is also identified, to elaborate on congestion issues.

Currently, port container traffic in the Canadian LFV is associated with the three large container terminals at Port Metro Vancouver (PMV): Deltaport, Centerm and Vanterm. Container traffic is also associated with the container facilities along the Fraser River (Seaspan, Coast 2000, Annacis Island, Interfor (Fraser Surrey Docks), Westran Intermodal, etc) for container shipments but moreso for container processing ('restuffing'). Fraser Wharves capacity is also planned for the future. The relative locations of these facilities are shown in Figure 1.

PATH, when operational, is expected to displace or adjust the container traffic that would otherwise go through the PMV container terminals and terminals south of the border (Seattle, Tacoma).

The existing inbound container traffic affected by PATH once operational is considered to be:

- Ships of average capacity 6,000 TEU that come in to Deltaport, Centerm and Vanterm (after visiting BC Pilot station)
- Unloading to these facilities, transferred to rail (70%) and truck (30%)
- Rail transport continues out of the valley
- Truck continues to a transloading/shipping facility (Coast 2000, Seaspan, Interfor (Fraser Surrey Docks), Euro Asia Transload, Van Isle Barge, Westran Intermodal) for container restuffing/shipping
- Truck transport continues through the LFV with both local as well as distant (outside the LFV) destinations.

The existing outbound container traffic affected by PATH once operational is expected to be:

- Rail brings in 70% of containers to the Container terminals Deltaport, Centerm and Vanterm (3/7 of containers are full, 4/7 empty on average)
- Trucks bring in 30% of containers to the same terminals

- Trucks take the empty rail containers from the terminals to the transload facilities for restuffing
- Trucks return restuffed containers to the terminals
- Containers are loaded on to vessels of average capacity 6,000 TEU
- Ships continue to Seattle (46%) and Tacoma (54%), after going through both BC and Puget Sound pilot stations

PATH, once operational, is expected to involve the following activities for inbound containers:

- Ships of average capacity 18,000 TEU will come into PATH from Asia (after Pilot boarding)
- Vessel will be unloaded
- Containers will be re-loaded onto 1000 TEU capacity barges
- A 5,000 HP Tug will take each 2-barge convoy to an area around Brotchie Point
- A 2,500 HP tug will take each barge to its destination: movements to the U.S. (Seattle and Tacoma), and movements to the LFV (Fraser Surrey Docks and Fraser Wharves)
- In the LFV, barges will be unloaded, transferred to rail (70%) and truck (30%)
- Rail continues transport continues out of the valley
- Truck continues to a transloading/Shipping facility (Coast 2000, Seaspan, Interfor (Fraser Surrey Docks), Euro Asia Transload, Van Isle Barge, Westran Intermodal) for container restuffing/shipping
- Truck transport continues through the LFV with both local as well as distant (outside the LFV) destinations

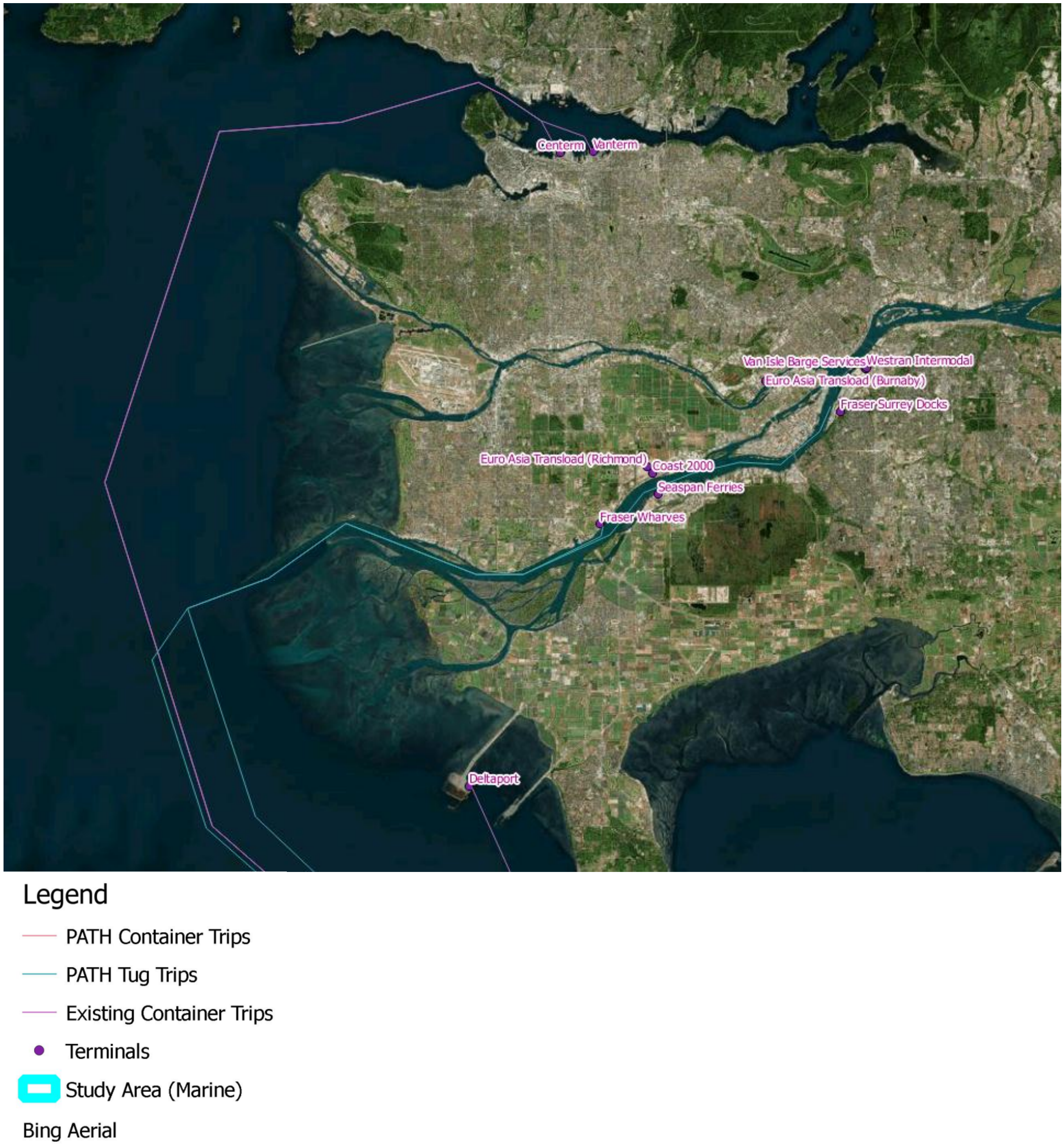

Figure 1: Port Metro Vancouver and Container Facilities

Figure 2: Inbound Container Traffic with PATH and Existing Containership Routes

The existing outbound container traffic for PATH varies to some degree, due to options that are expected. A ***best case scenario*** in terms of limited movements can be identified as follows[BAM1]:

- Rail brings in 30% of containers to transload facilities
- Trucks bring 20% of containers to transload facilities
- Containers are restuffed, as required, some of which are trucked to Fraser River terminals (FSD, FW)
- Trucks bring 50% of containers direct to terminals (FSD, FW)
- Containers are loaded onto barges
- Barge movements back to PATH occur as per the inbound barge movements (including ones from USA)
- Barges are unloaded at PATH
- Containers are re-loaded onto containership, which leaves PATH for Asia (after Pilot disembarking)

And a ***normal case scenario*** for outbound containers can also be defined:

- Rail brings in 30% of containers to terminal facilities (FSD, FW), which are then trucked to transload facilities
- Trucks bring 20% of containers to transload facilities
- Containers are restuffed, as required, some of which are trucked to terminals (FSD, FW) and some loaded directly to barge
- Trucks bring 50% of containers direct to terminals (FSD, FW)
- Containers are loaded onto barges
- Barge movements back to PATH occur as per the inbound barge movements (including ones from USA)
- Barges are unloaded at PATH
- Containers are re-loaded onto containership, which leaves PATH for Asia

As can be seen in Figure 1 and Figure 2, PATH is expected to reduce containership movements in and near the ports and additionally reduce truck movements in the LFV due to the marine transport of containers closer to the processing facilities (e.g., short-sea shipping). Several operations scenarios are assessed in this document, adhering to realistic equipment profiles based on the PATH Pre-Feasibility Study document completed by Hatch Mott MacDonald in 2014 (PATH planning document) as well as previous assessments associated with container terminals. Activity rate assumptions for the landside equipment are provided in Table 1.

Table 1: Landside Equipment Profiles

Equipment	Handling Rate	Engine/motor size	Fuel source	Load factor	Reference
PATH					
Ship to shore crane	63 TEU/hr	377 kW	Electric	0.5	PATH Planning Document
Feeder berth cranes (barge)	53 TEU/hr	300 kW	Electric	0.5	PATH Planning Document
Gantry cranes or top picks	35 TEU/hr	150 kW	Electric	0.5	PATH Planning Document
Automated Guided Vehicles	15 TEU/hr	140 kW	Electric	0.5	PATH Planning Document
PMV Container Terminals (DP, Vanterm, Centerm)					
Ship to shore crane	53 TEU/hr	549 kW	1 electric, 3 diesel	0.5	PMV 2010 LEI
Reach stackers	35 TEU/hr	217 kW	Diesel	0.5	PMV 2010 LEI
Top or side picks	35 TEU/hr	194 kW	Diesel	0.5	PMV 2010 LEI
Yard trucks	8 TEU/hr	148 kW	Diesel	0.5	PMV 2010 LEI
Transload Facilities					
Ship (barge) to shore cranes	43 TEU/hr	300 kW	Diesel	0.5	PMV 2010 LEI, PRPA projections
Top/side picks	35 TEU/hr	194 kW	Diesel	0.5	PMV 2010 LEI, PRPA projections
Yard trucks	8 TEU/hr	148 kW	Diesel	0.5	PMV 2010 LEI, PRPA projections
Forklifts	35 TEU/hr	98 kW	Diesel	0.5	PMV 2010 LEI, PRPA projections

Some of the information in Table 1 stems from information available to the PRPA (‘PRPA projections’), notably container handling rates for PMV and transload facilities. The engine/motor size data, while available for the existing PMV facilities (including number of electric versus diesel units) were estimated for PATH based on SNC-Lavalin expectations that electric equipment tends to be approximately 20% smaller (kW) than similar diesel units. The average load factor applied to the CHE pieces is based on SNC-Lavalin experience conducting port level emission studies.

To complete the energy and emission estimates associated with several defined scenarios on the following pages, the Transport Canada Port Emissions Inventory Tool (PEIT) was used. PEIT has equipment emission rates by type, size and model age additionally accounting for different fuel types and fuel regulations by year. Additional assumptions (to those in Table 1) that are significant to the emission estimates include the following:

- 6,000 TEU ships are similar to the existing ships of this type/size that frequent PMV currently, assuming a model build year of 2010
- 18,000 TEU ships are similar to the existing ships of this type/size that are now being commissioned
- The year for comparison is 2018
- The PMV cargo handling equipment (CHE) and truck age distributions are scaled forward to 2018 (e.g., if the average age of an equipment type in 2010 was 2008, the average age in 2018 is considered to be 2016)
- 1.75 TEU per truck for transfer from the terminals to the transload facilities and back
- US landside emissions are not included in the calculations, since the necessary details are not available

As the marine emissions dominate the scenario totals, sample marine emission calculations are provided in attachment 1 for ship and barge movements.

Scenario Assessments

Several meaningful scenarios are defined for analysis, leveraging the expected container logistics identified at the start of this document. In each case, all movements associated with PATH are compared to all movements associated with the 'business as usual' (BAU) case at the PMV facilities. Energy and emissions estimates are provided by source group, showing the percent reduction associated with PATH. In each case, several key air contaminants (nitrogen oxides, sulphur oxides, $PM_{2.5}$ and CO_2e) are included. The comparisons are shown to the 'PATH Boundary' (the entire study area shown in Figure 2) as well as the 'MV Landside Boundary', which includes the PMV facilities and areas within Metro Vancouver (meaning only marine berthing emissions are included with the CHE and trucking, see Figure 1).

In all cases, rail emissions are not included. While some scenarios may have additional rail advantage for PATH it is expected that rail movements would be similar in general. Additionally, some of the rail movements are difficult to properly assess, as trains of varying length may move from the container terminals to switching yards for assembly to larger trains (Centerm and Vanterm[BAM2]).

All estimates are in tonnes, with the exception of energy (GJ) and relate to the movement of 18,000 TEUs (e.g., one containership to PATH, three smaller containerships to PMV).

1) 18,000 TEU ships to PATH with subsequent barge movements to Fraser Wharves, compared with 3 X 6,000 TEU ships to the PMV container terminals (DP, Centerm, Vanterm). Coast 2000 is the transload facility.

Table 1 – Scenario 1 (to the PATH Boundary)

Case	Source Group	NO_x	SO_x	$PM_{2.5}$	CO_2e	Energy (GJ)
Business as usual (BAU)	CHE	1.0	0.0	0.0	371.5	4,862.1
	Marine	57.4	1.6	1.0	2,342.7	31,285.0
	Trucking	1.7	0.0	0.1	458.8	6,607.1
	TOTAL	**60.0**	**1.6**	**1.1**	**3,173.1**	**42,754.1**
PATH	CHE	0.5	0.0	0.0	226.3	5,227.8
	Marine	17.2	0.2	0.3	978.8	13,707.5
	Trucking	0.5	0.0	0.0	134.6	1,937.7
	TOTAL	**18.2**	**0.2**	**0.4**	**1,339.6**	**20,873.0**
Percent reduction	CHE	46%	44%	54%	39%	-8%
	Marine	70%	87%	65%	58%	56%
	Trucking	70%	71%	69%	71%	71%
	TOTAL	**70%**	**87%**	**65%**	**58%**	**51%**

Table 2 – Scenario 1 (to the MV Landside Boundary)

Case	Source Group	NO_x	SO_x	$PM_{2.5}$	CO_2e	Energy (GJ)
Business as usual (BAU)	CHE	1.0	0.0	0.0	371.5	4,862.1
	Marine	4.2	0.2	0.1	359.3	4,891.2
	Trucking	1.7	0.0	0.1	458.8	6,607.1
	TOTAL	**6.8**	**0.2**	**0.2**	**1,189.7**	**16,360.3**
PATH	CHE	0.5	0.0	0.0	209.8	2,702.9
	Marine	-	-	-	-	-
	Trucking	0.5	0.0	0.0	134.6	1,937.7
	TOTAL	**1.0**	**0.0**	**0.0**	**344.4**	**4,640.7**
Percent reduction	CHE	46%	44%	54%	44%	44%
	Marine	100%	100%	100%	100%	100%
	Trucking	70%	71%	69%	71%	71%
	TOTAL	**85%**	**99%**	**82%**	**71%**	**72%**

2) 18,000 TEU ships to PATH with subsequent barge movements to Fraser Surrey Docks, compared with 3 X 6,000 TEU ships to the PMV container terminals (DP, Centerm, Vanterm). Westran Intermodal (Fraser Surrey Dock Intermodal) is the transload facility.

Table 3 – Scenario 2 (to the PATH Boundary)

Case	Source Group	NO_x	SO_x	$PM_{2.5}$	CO_2e	Energy (GJ)
Business as usual (BAU)	CHE	1.0	0.0	0.0	371.5	4,862.1
	Marine	57.4	1.6	1.0	2,342.7	31,285.0
	Trucking	1.8	0.0	0.1	502.6	7,237.4
	TOTAL	**60.2**	**1.6**	**1.1**	**3,216.9**	**43,384.4**
PATH	CHE	0.5	0.0	0.0	226.3	5,227.8
	Marine	17.5	0.2	0.3	993.0	13,910.8
	Trucking	0.3	0.0	0.0	83.5	1,202.3
	TOTAL	**18.3**	**0.2**	**0.4**	**1,302.8**	**20,340.9**
Percent reduction	CHE	46%	44%	54%	39%	-8%
	Marine	70%	87%	65%	58%	56%
	Trucking	70%	71%	69%	71%	71%

	TOTAL	**70%**	**87%**	**66%**	**59%**	**53%**

Table 4 – Scenario 2 (to the MV Landside Boundary)

Case	Source Group	NO_x	SO_x	$PM_{2.5}$	CO_2e	Energy (GJ)
Business as usual (BAU)	CHE	1.0	0.0	0.0	371.5	4,862.1
	Marine	4.2	0.2	0.1	359.3	4,891.2
	Trucking	1.8	0.0	0.1	502.6	7,237.4
	TOTAL	**7.0**	**0.2**	**0.2**	**1,233.4**	**16,990.6**
PATH	CHE	0.5	0.0	0.0	209.8	2,702.9
	Marine	-	-	-	-	-
	Trucking	0.3	0.0	0.0	83.5	1,202.3
	TOTAL	**0.8**	**0.0**	**0.0**	**293.3**	**3,905.2**
Percent reduction	CHE	46%	44%	54%	44%	44%
	Marine	100%	100%	100%	100%	100%
	Trucking	82%	83%	81%	83%	83%
	TOTAL	**88%**	**99%**	**87%**	**76%**	**77%**

3) 18,000 TEU ships to PATH with subsequent barge movements to Fraser Surrey Docks, compared with 3 X 6,000 TEU ships to the PMV container terminals (DP, Centerm, Vanterm). All PATH containers go straight to Rail mode of transport (PMV container terminal flow as normal). Westran Intermodal (Fraser Surrey Dock Intermodal) is the transload facility.

Table 5 – Scenario 3 (to the PATH Boundary)

Case	Source Group	NO_x	SO_x	$PM_{2.5}$	CO_2e	Energy (GJ)
Business as usual (BAU)	CHE	1.0	0.0	0.0	371.5	4,862.1
	Marine	57.4	1.6	1.0	2,342.7	31,285.0
	Trucking	1.8	0.0	0.1	502.6	7,237.4
	TOTAL	**60.2**	**1.6**	**1.1**	**3,216.9**	**43,384.4**
PATH	CHE	0.1	0.0	0.0	73.4	3,258.6
	Marine	17.5	0.2	0.3	993.0	13,910.8
	Trucking	0.0	0.0	0.0	0.0	0.0
	TOTAL	**17.6**	**0.2**	**0.3**	**1,066.5**	**17,169.4**
Percent reduction	CHE	46%	44%	54%	39%	-8%
	Marine	70%	87%	65%	58%	56%
	Trucking	70%	71%	69%	71%	71%
	TOTAL	**71%**	**87%**	**69%**	**67%**	**60%**

Table 6 – Scenario 3 (to the MV Landside Boundary)

Case	Source Group	NO_x	SO_x	$PM_{2.5}$	CO_2e	Energy (GJ)
Business as usual (BAU)	CHE	1.0	0.0	0.0	371.5	4,862.1
	Marine	4.2	0.2	0.1	359.3	4,891.2
	Trucking	1.8	0.0	0.1	502.6	7,237.4
	TOTAL	**7.0**	**0.2**	**0.2**	**1,233.4**	**16,990.6**
PATH	CHE	.1	0.0	0.0	57.0	733.7
	Marine	-	-	-	-	-
	Trucking	0.0	0.0	0.0	0.0	0.0
	TOTAL	**0.1**	**0.0**	**0.0**	**57.0**	**733.7**
Percent reduction	CHE	86%	85%	95%	85%	85%
	Marine	100%	100%	100%	100%	100%
	Trucking	100%	100%	100%	100%	100%
	TOTAL	**98%**	**100%**	**100%**	**95%**	**96%**

4) 18,000 TEU ships to PATH with subsequent barge movements to Fraser Surrey Docks, compared with 3 X 6,000 TEU ships to the PMV container terminals (DP, Centerm, Vanterm). On the export stream, 50% (75%) of containers come straight to Fraser Surrey Docks for loading to barge.

Table 7 – Scenario 4a (50%) (to the PATH Boundary)

Case	Source Group	NO_x	SO_x	$PM_{2.5}$	CO_2e	Energy (GJ)
Business as usual (BAU)	CHE	1.0	0.0	0.0	371.5	4,862.1
	Marine	57.4	1.6	1.0	2,342.7	31,285.0
	Trucking	1.8	0.0	0.1	502.6	7,237.4
	TOTAL	**60.2**	**1.6**	**1.1**	**3,216.9**	**43,384.4**
PATH	CHE	0.6	0.0	0.0	249.3	5,523.8
	Marine	17.5	0.2	0.3	993.0	13,910.8
	Trucking	0.5	0.0	0.0	135.7	1,953.8
	TOTAL	**18.6**	**0.2**	**0.4**	**1,378.0**	**21,388.3**
Percent reduction	CHE	46%	44%	54%	39%	-8%
	Marine	70%	87%	65%	58%	56%
	Trucking	70%	71%	69%	71%	71%
	TOTAL	**69%**	**87%**	**65%**	**57%**	**51%**

Table 8 – Scenario 4a (50%) (to the MV Landside Boundary)

Case	Source Group	NO_x	SO_x	$PM_{2.5}$	CO_2e	Energy (GJ)
Business as usual (BAU)	CHE	1.0	0.0	0.0	371.5	4,862.1
	Marine	4.2	0.2	0.1	359.3	4,891.2
	Trucking	1.8	0.0	0.1	502.6	7,237.4
	TOTAL	**7.0**	**0.2**	**0.2**	**1,233.4**	**16,990.6**
PATH	CHE	0.6	0.0	0.0	232.8	2,998.9
	Marine	-	-	-	-	-
	Trucking	0.5	0.0	0.0	135.7	1,953.8
	TOTAL	**1.1**	**0.0**	**0.0**	**368.5**	**4,952.7**
Percent reduction	CHE	41%	38%	54%	37%	38%
	Marine	100%	100%	100%	100%	100%
	Trucking	71%	73%	69%	73%	73%
	TOTAL	**84%**	**99%**	**81%**	**70%**	**71%**

Table 9 – Scenario 4b (75%) (to the PATH Boundary)

Case	Source Group	NO_x	SO_x	$PM_{2.5}$	CO_2e	Energy (GJ)
Business as usual (BAU)	CHE	1.0	0.0	0.0	371.5	4,862.1
	Marine	57.4	1.6	1.0	2,342.7	31,285.0
	Trucking	1.8	0.0	0.1	502.6	7,237.4
	TOTAL	**60.2**	**1.6**	**1.1**	**3,216.9**	**43,384.4**
PATH	CHE	0.5	0.0	0.0	208.4	4,997.4
	Marine	17.5	0.2	0.3	993.0	13,910.8
	Trucking	0.2	0.0	0.0	47.7	687.0
	TOTAL	**18.1**	**0.2**	**0.4**	**1,249.2**	**19,595.2**
Percent reduction	CHE	46%	44%	54%	39%	-8%
	Marine	70%	87%	65%	58%	56%
	Trucking	70%	71%	69%	71%	71%
	TOTAL	**70%**	**87%**	**67%**	**61%**	**55%**

Table 10 – Scenario 4b (75%) (to the MV Landside Boundary)

Case	Source Group	NO_x	SO_x	$PM_{2.5}$	CO_2e	Energy (GJ)
Business as usual (BAU)	CHE	1.0	0.0	0.0	371.5	4,862.1
	Marine	4.2	0.2	0.1	359.3	4,891.2
	Onroad	1.8	0.0	0.1	502.6	7,237.4
	TOTAL	**7.0**	**0.2**	**0.2**	**1,233.4**	**16,990.6**
PATH	CHE	0.5	0.0	0.0	192.0	2,472.5
	Marine	-	-	-	-	-
	Onroad	0.2	0.0	0.0	47.7	687.0
	TOTAL	**0.7**	**0.0**	**0.0**	**239.7**	**3,159.5**
Percent reduction	CHE	52%	49%	67%	48%	49%
	Marine	100%	100%	100%	100%	100%
	Onroad	90%	91%	89%	91%	91%
	TOTAL	**91%**	**99%**	**92%**	**81%**	**81%**

CONCLUSION

PATH is shown to have considerable energy consumption and emissions benefit in all of the scenarios assessed. Within the larger study boundary, this advantage primarily relates to the marine movements. Within the urban landside boundary of Metro Vancouver, a sizeable benefit is associated with the (reduced) trucking trips moving containers to and from the marine terminals and intermodal facilities.

The Scenario 1 per-TEU differences to the study boundary are shown graphically for CO_2e and GJ in Figures 1 and 2 below, additionally showing the contributions by source group. These results are similar to the other scenarios evaluated.

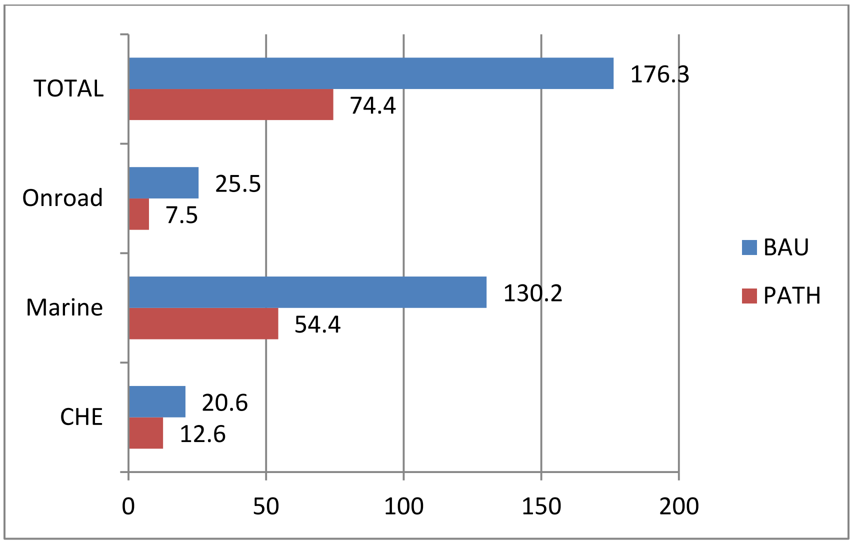

Figure 1 – kg of CO_2e per TEU (to the PATH Boundary)

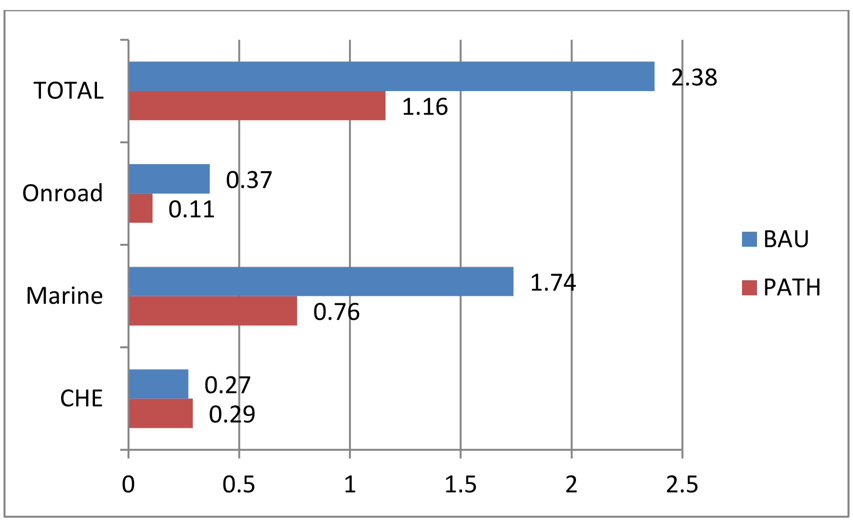

Figure 2 – GJ of Energy per TEU (to the PATH Boundary)

Over a full year at the Phase I capacity of 200,000 TEU, PATH is expected to avoid release the release of emissions in the region by:

- 470 tonnes of NO_x
- 16 tonnes of SO_x
- 8 tonnes of $PM_{2.5}$
- 22,000 tonnes of CO_2e

Focusing on the Metro Vancouver landside boundary alone, the following amounts are estimated to be avoided:

- 70 tonnes of NO_x
- 2 tonnes of SO_x
- 2 tonnes of $PM_{2.5}$
- 11,000 tonnes of CO_2e

These estimates assume that the four scenarios encompass the PATH activities in approximately equal proportion. At the Phase II capacity of 500,000 TEU the potential emissions avoided would be 2.5 times these amounts.

In addition to the avoided emissions, an estimated 674,000 kms of trucking movements in Metro Vancouver would also be avoided with Phase I (1.7 million kms with Phase II).

Attachment I – Sample Marine Engine Emission Calculations

Marine engine emissions are calculated using the following equation:

Engines: $E = P \times LF \times T \times EF_{energy}$ (1)

Where E = Emissions

P = Power Rating of Engine (Maximum Continuous Rating)

LF = Load Factor (fraction of rated power for an engine)

T = Time in mode

EF_{energy} = Emission Factors in g/kWh

Table 11 shows the marine engine activity and associated NO_X emissions for selected marine vessels in Scenario 1 (encompassing the full PATH Boundary).

Table 11 – Scenario 1 Marine Activity and NO_X emissions

Marine activity	**Engine**	**Size** (kW)	**Mode**	**Time** (hrs)	**Load factor**	**Emission factor** (g/kWh)	**Emissions** (kg)
1 x 6000 TEU OGV inbound and outbound to Centerm	Aux	11,098	Berth Underway	33.1 10.8	0.15 0.15	11.30 11.30	623 204
	Main	63,459	Underway	10.8	0.80	16.21	8,910
						TOTAL	**9,737**
1 X 18,000 TEU OGV inbound and outbound to PATH	Aux	14,280	Berth Underway	95.5 2.6	0.15 0.15	8.98 8.98	1,838 51
	Main	82,025	Underway	2.6	0.80	14.40	2,485
						TOTAL	**4,373**
1 X 2000 TEU barge tugs outbound and inbound to PATH	Aux	n/a	Berth	10.0	0.00	0.00	0
	Main	3,728	Underway	20.1	0.80	12.07	725
						TOTAL	**725**
1 X 1000 TEU barge tugs inbound and outbound to Fraser Wharves	Aux	n/a	Berth	10.0	0.00	0.00	0
	Main	1,863	Underway	18.5	0.80	11.97	330
						TOTAL	**330**

The time fields in Table 11 above were determined from the expected cruise speeds of the vessels:

- 6,000 TEU vessel: 25 knots
- 18,000 TEU vessel: 20 knots

- 2,000 TEU barge trains: 10 knots
- 1,000 TEU barge: 8 knots

In general these speeds are reasonable although the 6,000 TEU vessels would drop to a lower speed within PMV's inner harbour, which would mean travelling for a longer period of time at a lower engine load. This uncertainty in the calculation method is not considered significant enough to change the outcomes presented here (the inner harbour distances are relatively small).

The sample calculations shown in Table 11 do not include all of the movements and emission sources involved in the scenario analyses (for example, ship boilers are not included in the sample calculations here) but do provide a good representation of the relative difference (benefit) of the PATH marine emissions compared to the BAU marine emissions. Three 6,000 TEU ship movements release over twice the emissions of one 18,000 TEU ship movement and associated barge movements.