PORTS, TRUCKS, AND AUTOMOBILES: CONTAINER TRUCK TRAFFIC IN VANCOUVER

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Abstract

As Vancouver's ports become busier so too does local container truck traffic. Additional trucking exacerbates local road congestion during peak hours, a problem projected to increase in the future. The increased time spent in congestion also creates environmental concern as diesel trucks emit large amounts of pollutants. This study develops and assesses four policy options aimed at reducing container truck traffic in Vancouver during peak hours by using a longitudinal case study of Los Angeles. Data from Los Angeles indicate extending gate hours and charging container trucks fees during peak hours significantly shifted container truck traffic out of peak hours. Generated policy options considered in this study include: (1) continuing with the status quo; (2) initiating short-sea shipping; (3) extending terminal hours with and (4) without peak hour fees. These options are assessed and the study recommends Vancouver's container terminals extend gate hours and with a peak hour fee.

Keywords: ports; container trucks; transportation policy; Vancouver

Subject Terms: Urban Transportation Policy; Trucking; Traffic Congestion; Shipping -- British Columbia; Harbors -- British Columbia -- Vancouver

Dedication

To my father, who I miss every day, and my mother. Thank you for all the support, love, and encouragement.

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This project would not have been possible without the support and guidance of Kennedy Stewart. I would also thank Nancy Olewiler for sparking my interest in this area of study, as well as for her guidance and opinions. I would also like to thank Patrick Smith for the challenging questions at my defence and the suggestions afterwards. Thanks to Louise Yako for the interview.

Thank you Meara, for being there when I needed it the most.

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Glossary

AB	Assembly Bill
LO/LO	Load On/ Load Off
RO/RO	Roll On/ Roll Off
SB	State Bill
TEU	Twenty-Foot Equivalent Unit

1: The Problem of Container Truck Traffic in Vancouver

The backbone of globalization is international trade and the backbone of international trade is shipping. West Coast Ports in North America are experiencing the greatest growth on the continent due to the growing trade with China and other Asian countries. In Canada, Port Metro Vancouver is not only the largest port authority, but also the fastest growing (Western Transportation Advisory Council, 2006). Increased levels of shipping traffic for Port Metro Vancouver add significant demands to landside transportation including trucks and trains. Trains handle long-haul transportation to most destinations outside a 700 km radius of Vancouver with most going to or from Eastern Canada. Short-haul, regional cargo to and from Port Metro Vancouver and the surrounding Lower Mainland region is almost entirely moved by truck.

Between 1996 and 2006, container truck traffic from Port Metro Vancouver grew by 10 percent annually, with over one million Twenty-Foot Equivalent Container Units (TEU) passing through Port of Vancouver gates in 2006 by truck (IBI Group, 2007).[1] Associated regional container movement by truck from Port Metro Vancouver was projected to grow by over seven per cent annually from 2004 to 2020 (Novacorp, 2005). While the economic crisis may somewhat limit this truck traffic growth, the British Columbia government continues with plans to implement the Gateway Strategy, and the Port Metro Vancouver Port Authority continues to plan to expand by building and upgrading facilities, thus indicating their perception of continued growth (Port Metro Vancouver, 2009). Currently the third berth project at Deltaport is scheduled to be completed in Fall 2009, increasing container capacity by 600,000 TEUs. A second three-

[1] Containers generally come in three sizes, 20 feet, 40 feet, or 45 feet. The industry standard is to measure by 20 feet. It was estimated that the average container size in Vancouver was 1.7 TEU (IBI Group, 2007).

berth terminal is also in the planning stage at Roberts Bank in Delta, which will further increase the container capacity in Vancouver (Port Metro Vancouver, 2009).

Vancouver residents generally consider congestion to be one of the most pressing issues facing the region. A 2006 Translink survey shows 82 per cent of respondents consider traffic congestion a serious or very serious problem (Ipsos Reid, 2002). The survey also suggests 27 per cent of respondents consider transportation the most important local issue requiring attention from municipal, provincial, and federal leaders, with traffic congestion topping individual transportations issues. Congestion is problematic for commuters wasting time driving within Metro Vancouver and for shipping companies whose productivity drops when truckers spend more time travelling between destinations. Where trucks generally do not make up the majority of traffic on most roads, trucks disproportionally affect traffic congestion as they are much bigger and heavier than passenger vehicles. When heavy-duty trucks are involved in an accident they create bigger and longer traffic jams than passenger cars. Trucks accelerate and decelerate more slowly, thus slowing the overall flow of traffic (Poole, 2007).

Environmentally, diesel-powered trucks produce much more greenhouse gas and other ultra-fine harmful particles than do smaller, gasoline- powered vehicles. A 2007 Los Angeles-based freeway study found "concentrations of ultrafine particles, black carbon, nitric oxide, and PM-hound polycyclic aromatic hydrocarbons are generated primarily by diesel-powered vehicles" despite the relatively low fraction (approximately 6 per cent) of diesel-powered vehicles on Los Angeles freeways (Fruin, Westerdahl, Sax, Sioutas, and Fine). A 2002 New York-based study also shows that the concentration of elemental carbon and other emissions is directly related to large truck traffic in the immediate surrounding area (Lena, Ochieng, Carter, Holguin-Veras and Kinney). Traffic congestion compounds these negative truck impacts. A 2002 US Environmental Protection Agency study of idling heavy-duty diesel trucks concludes trucks can emit 144 grams NOX, and 8224 grams of CO2 while consuming over 3 litres of diesel in one hour (Lam, 2002). The study also notes diesel emissions have a positive correlation with higher

incident rates of diseases such as asthma and cancer. In Vancouver, Transport Canada suggests most regionally-based container trucks are older, high-mileage highway tractors which produce more emissions than newer trucks (2005).

Further compounding Vancouver truck traffic problems are the hours of travel for container trucks, which are mostly constrained by terminals gate hours. Of the three Port Metro Vancouver container terminals, Deltaport and Vanterm truck gate are only open 7:00 am – 4:00 pm, Monday to Friday. Centerm's truck gate hours are open from 7:00 am – 8:30 pm on Mondays, Tuesdays, and Thursdays, 7:00 am – 4:00 pm on Wednesdays and Fridays. These restricted gate hours ensure most container truck trips occur during the busiest, most congested periods.

This study investigates how to reduce peak hour container truck traffic in Greater Vancouver. The rest of this section explains the increase of container trucks on Vancouver's road networks, detailing recent and predicted growth. The section also introduces current strategies implemented in Greater Vancouver to address the issue. This section concludes by outlining section contents found in the remainder of the study.

1.1 Port Metro Vancouver

Port Metro Vancouver is the largest port authority in Canada. It has three container terminals. Vanterm and Centerm are located in the City of Vancouver's Burrard Inlet, with Deltaport located in the suburban municipality of Delta. In terms of container traffic, Port Metro Vancouver is the 4th largest port on the North American West Coast and with an annual average growth rate of 13.5 percent between 1995-2005, is the fastest growing port in North America (American Association of Port Authorities, 2009).

The port is a major economic driver for the region, generating $4 billion in annual GDP for Canada, and $8.9 billion in total economic output. It is the major North American port closest to Asia, with cargo loads expected to triple over the next 20 years (British Columbia Ministry of

Transport, 2009). Traffic through the west coast also generally increased since the 1988 introduction of post-Panamax ships, ships too large to use the Panama Canal. Port Metro Vancouver Authority is seeking to improve and expand its current facilities and create new terminals to meet this predicted shipping traffic increase. Changes are required on the landward rail and roadway links, as they are currently near their capacity, to ensure cargo moves on after reaching Vancouver's shores (McCalla, 2007).

The 2005 port container truckers' strike illustrates the importance of trucking to Vancouver's ports. During the strike incoming containers destined for regional locations were either stored on dock or diverted to nearby ports such as Seattle or Tacoma. A port spokesperson claimed that the month long strike cost the Canadian economy nearly $400 million dollars (CBC News, 2005). Truck drivers were calling for a 15 percent fuel surcharge to combat the rising fuel prices, and a standard set of wages to prevent drivers from undercutting each other. During the strike, the mostly independent owner- operators complained of earning only $300 - $400 per day, with $350 going towards fuel costs and expenditures (CBC News, 2005).

The strike of 2005 brought regulated pay rates and unionization to container trucking in Vancouver. The Port instituted policies requiring companies to obtained container port access licenses, the terms of which included minimum pay for drivers. Licenses were limited to carriers using company equipment and drivers, with the owner-operators at the time being grandfathered into the new system. By the end of 2007, more than 800 of the 1,000 old owner-operators joined a new chapter of the UAW and worked with trucking companies under collective agreements (Tower, 2007). Truckers threatened striking again in 2009 to protest companies undercutting agreed driver pay rates. The president of the Vancouver Container Truck Association/ Canadian Auto Workers Local 2006, claimed 23 of 40 trucking companies audited were undercutting pay rates to truckers and considered the subsequent penalties "the cost of doing business" (Tower, 2008). The union is currently pleased with the BC government's progress on rate enforcement,

but is still demanding a licence moratorium to limit the number of new truckers (CAW/TCA, 2009).

1.2 Truck Traffic and Truck Traffic Congestion in Metro Vancouver

Trains or trucks are currently responsible for all landside cargo movements to and from the Port. Trains transport most cargo going to and from Eastern Canada or the United States. Improving grade separation in key areas or replacing the New Westminster single-lane swing railroad bridge are among plans and ideas currently being considered for improving Vancouver's rail system (McCalla, 2007).

Trucks transport the 35 percent of port container freight that remains in Greater Vancouver. Currently trucks access the Burrard Inlet Terminals through existing city streets. Connections from Vanterm and Centerm to the TransCanada Highway are located near the Second Narrow Bridge. The TransCanada Highway then leads to the heavily congested Port Mann Bridge for shipments east. Shipments south to Vancouver City, Richmond, Delta, or Surrey move primarily through the Clark-Knight Corridor, a designated truck route with many streetlights and on-street parking (McCalla, 2007). Total daily vehicular traffic along the Clark-Knight corridor increased from 14,000 southbound vehicles to over 24,000, with truck traffic comprising 9 to 13 per cent of total traffic (McCalla, 2007). According to public announcements and its website, the Gateway project spearheaded by the provincial and federal governments stated goal is to reduce congestion in Metro Vancouver, and to improve the movement of goods including truck access to Port Metro Vancouver container terminals.

The most significant aspects of the Gateway program for container truck traffic concern are increasing Highway 1 capacity and constructing new infrastructure. Highway 1 capacity will be increased from McGill Street in Vancouver to 216th Street in Langley. Highway 1 expansion adds one new lane in each direction from McGill to the Port Mann Bridge, and from 200th Street

to 216th Street according to the Gateway program website. A new Port Mann Bridge will replace the existing five-lane bridge (Government of British Columbia News Release, 2009a). Construction on the South Fraser Perimeter Road to help traffic flow from Deltaport began in January 2009(Government of British Columbia News Release, 2009).

While creating further infrastructure will perhaps decrease road congestion in the short term, there is ample evidence suggesting that increasing transportation infrastructure merely stimulates traffic growth, with once-alleviated congestion returning with increased environmental effects (Knoepfel, Grant, and Perl, 1999). As infrastructure merely delays, rather than eliminates, congestion problems, this study examines policies other than increasing road infrastructure to utilize current and future roads more efficiently.

Table 1: Annual Proportion of Vehicle Traffic on Highway 17 Over 12.5m

Year	Total number of vehicles per week (12.5+ meters).	12.5+ meters vehicles per week counted on weekdays.
2005	9,418	91%
2006	13,399	93%
2007	14,775	93%

Source: BC Department of Transit, Highway Counter P-16-20NS - N

Although Vancouver highway data is limited, to partially estimate volume increases of truck traffic and the days trucks are travelling data from a Highway 17 traffic counter located just north of the access road to Deltaport can be used. The counter tracks all trucks 12.5 metres and longer heading to and from Deltaport and Greater Vancouver. However, due to missing data, the sample includes only four weeks each year between 2005 and 2007 with annual totals left unestimated. Table 1shows the proportion of 12.5 + metre vehicles travelling along Highway 17 during weekdays. This data does not show at what time during the day trucks travelled or even whether they were container trucks. However, the data does provide a basic idea of the distribution of trucks and the number of trucks throughout an average week. For example, if vehicles were evenly distributed throughout the week, only 71.4 percent of vehicles over 12.5

meters would have been counted on weekdays a much smaller proportion than the 93 percent actually counted. Given that container terminal operating hours are between 7:00 am and 4:00 pm, it is reasonable to assume the majority of weekday vehicles would be counted within those hours or just slightly outside of them. The additional trucks that will result from a growing port will all continue to travel during weekday peak hours because of terminal gate hours. The additional trucks will contribute to congestion and further slow traffic.

In addition to these rough road counter estimates, the vast majority of container trucks either originate or are destined for the three deep-sea container terminals in Vancouver: Centerm, Vanterm, and Deltaport. With the expectation of Mondays, Tuesdays and Thursdays at Centerm when gates are open until 8:30 pm, truck gates are only open from 7:00 am to 4:00 pm Monday – Friday. The hours of operation ensure nearly all the container movements to and from the ports are made during peak hours on weekdays, when congestion levels on the road system are the highest.

1.3 Summary

As trade with China increases, so too does Port Metro Vancouver's rapid growth. As a result, there has been an increase of container trucks going to and from the port to transport cargo with estimates predicting five percent annual growth over the next 20 years (IBI Group, 2007). Current truck traffic increases have disproportionally contributed to Vancouver's congestion, environment and health problems, compounded by most container trucks travelling during weekday peak hours. This section also details the working and associated issues with the port container trucking industry.

While rough projections of container truck traffic in Vancouver are possible, much more information is needed to understand what options are available to reduce container truck traffic. This study uses a case study of Los Angeles and the San Pedro Bay ports to shed light on how these authorities have been able to manage increasing container truck traffic since 2002. The next

section provides a background on Los Angeles and its ports as well as methodological details. Section 3 provides case study evidence and analysis, treating each of eight included years as a case by which to understand the recent evolution of container truck traffic management. Section 4 outlines the criteria by which to evaluate possible options for Transport Canada including effectiveness, cost, environmental impact, administrative ease, stakeholder responses and implementation time. Section 5 details the policy options by which Transport Canada might reduce current and future congestion causes by container truck traffic. Section 6 provides policy option analysis, with conclusions offered in Section 7.

2: Study Methodology and Case Background

This study explores strategies to reduce weekday peak hour container truck traffic in Vancouver, with this section providing the study methodology. Due to the lack of Vancouver-based data, the study uses a longitudinal analysis of Los Angeles and the San Pedro Bay ports. Not only are these ports located on the North American West Coast, they also have similar growth patterns. The larger size of Los Angeles and the San Pedro Bay ports make them a strong case from which to draw lessons for Vancouver's future. The case study analyzes traffic data collected from two freeways used extensively by trucks from the Ports of Los Angeles and Long Beach from 2002-2008.

2.1 Case Study Approach and Case Selection

Ideally, a study of Vancouver container truck traffic would use information from Greater Vancouver, such as hourly container truck count data. The data would then be compared to those from other international ports to attempt to determine why some ports have more truck congestion. Unfortunately, Vancouver has very little truck traffic data. Attempts to get hourly truck counts from the Port Metro Vancouver, the City of Vancouver, or the Government of British Columbia were unsuccessful. Security concerns prevented Port Metro Vancouver from releasing any detailed data. The City of Vancouver does keep traffic counts with automatic counters, but the counters cannot differentiate trucks from other traffic.[2] The province of British Columbia maintains counters on provincial highways, and these counters differentiate traffic by length, allowing for a good initial estimate of truck traffic. As shown in the last section, counters

[2] Trucks counts were counted on five days in October and November in 2004 at certain locations. These truck counts were done manually, and only between the hours of 8:00 am and 5:00 pm. The counts did not provide any useful data as it does not count any trucks outside of these hours nor from any other years to make comparisons.

along highway 17 in Delta in Vancouver capture a significant proportion of the trucks going or leaving the Deltaport terminal, but also capture other trucks or vehicles over 12.5 meters long. For instance, along highway 17 the counters also count trucks destined for or coming from the Tsawwassen Ferry terminal. The data from the provincial counters does not break truck traffic into hourly divisions, only daily from 2005, and up to February of 2008. The data does not detail the hours during which trucks travel so it cannot be determined what time of day trucks are travelling.

Given this lack of Vancouver specific information, the next best option is to use a case study methodology to examine container truck traffic at other ports with growth rates similar to Vancouver. Initial cases considered include two Canadian ports, Halifax and Montreal, and several US West Coast ports: Seattle/Tacoma, Portland, Oakland, and the San Pedro Ports of Los Angeles and Long Beach.[3]

Table 1 contains information regarding growth in the considered cases. Halifax, Montreal and Vancouver handle approximately 90 percent of all Canadian containers, with Vancouver replacing Montreal as the busiest Canadian container port in 1999 (American Association of Port Authority, 2009). Halifax and Montreal's primary trade is with European and Mediterranean markets with neither experiencing the same trade growth as Vancouver (Guy and Alix, 2007). The Port of Montreal continues to handle more containers, but growth has not been nearly as great as that of Vancouver, while Halifax suffered a loss of trade from 2002-2007. The ports of Seattle and Tacoma are often viewed as one port due to their close proximity and shared landside transportation infrastructure. Combined, these two ports have been growing at a much slower pace than Vancouver, making them unsuitable as a case study. Portland is also eliminated as a possible Vancouver comparator as it is the only major west coast port experiencing negative

[3] The Port of Los Angeles and the Port of Long Beach are two separate port authorities competing for ships and customers. However, the two ports are often grouped together and considered one entity when discussing landside transportation because they are located next to each other on San Pedro Bay. Trucks accessing either port utilize the same road network. In this study I treat these ports as one entity referred to as the "San Pedro Bay Ports" for ease and consistency.

growth. Oakland's traffic is also growing, but this growth is at a much slower pace and much more sporadic than Vancouver's. In the end, only the San Pedro ports have a growth rate comparable to Vancouver and as such, they are the considered case. The next section provides background to the San Pedro case.

Table 2: Port Container Volumes (000 TEU's) and growth rates

	TEU Volume 1997	**TEU Volume 2002**	**TEU Volume 2007**	**% change 1997-2007**
Vancouver	724	1,458	2,307	219
LA/Long Beach	6,464	10,630	15,672	142
Montreal	870	1,055	1,363	57
Halifax	459	524	490	7
Seattle/Tacoma	2,632	2,910	3,898	48
Oakland	1,531	1,708	2,388	56
Portland	295	256	260	-12

Source: American Association of Port Authority Statistics

The decision to use a single-unit case study also relates to the scope of the study. The purpose of the study is to look for solutions to a problem of a single metropolitan area. A study seeking general solutions to problems faced by all ports cities would require more cases. As this study only seeks solutions for Vancouver's container truck traffic problems, the San Pedro Ports would seem an appropriate case.

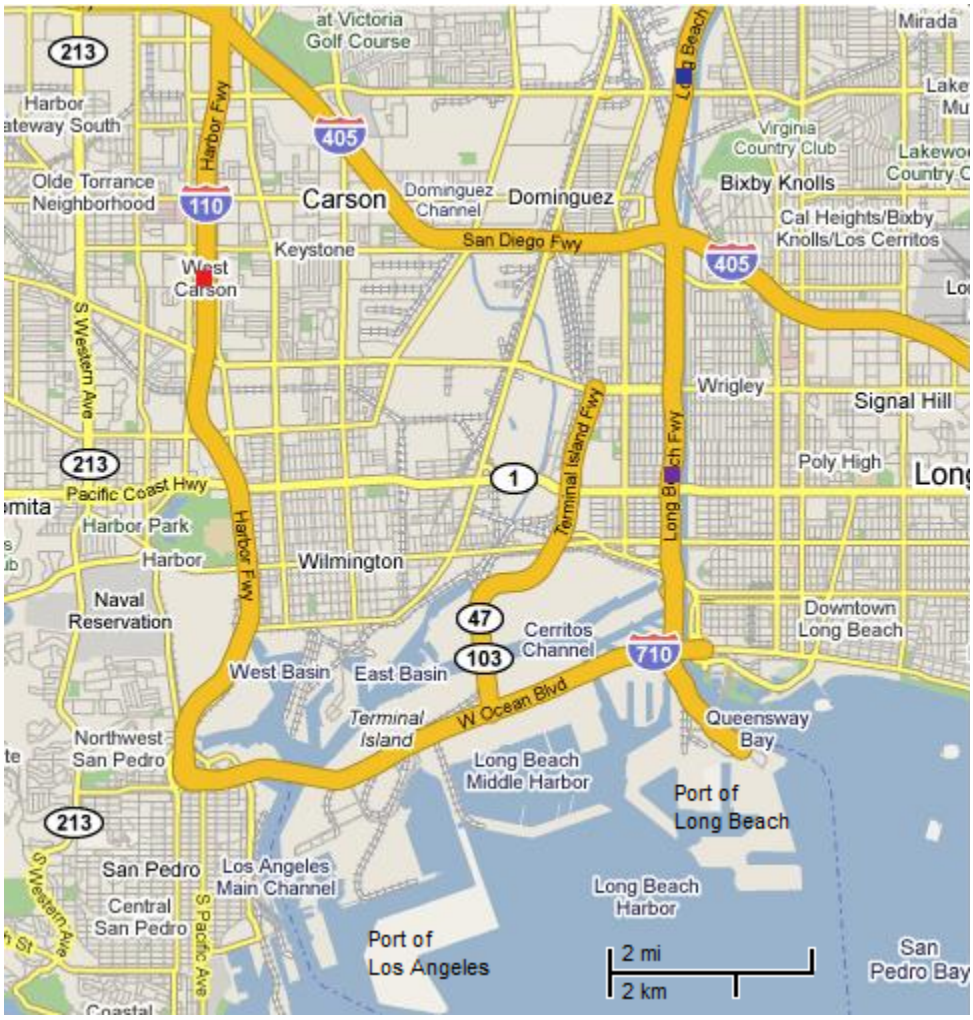
To identify potential independent variables in each case year, an analysis of all factors and polices that could affect the proportion of container truck traffic during weekday peak hours in Los Angeles is conducted in the next section. Relevant literature for each year was reviewed to

identify independent variables. The independent variables are then analyzed against the dependent variable to determine their effectiveness.

2.2 San Pedro Ports

The Port of Los Angeles and the Port of Long Beach are two separate ports operated individually by the two port authorities. However, as shown in Figure 1, the two ports share the same bay and are located directly adjacent to each other. They compete and cooperate with each other, and share many of the same characteristics, prosperity and problems (Bonacich and Wilson, 2008). The two ports are the two largest in the United States, and are experiencing growth for the same reason as Vancouver, that is, increased trade with China and the rest of Asia (Bonacich and Wilson, 2008). The two ports handle many more containers than Vancouver. Combined in 2007 the San Pedro Bay ports had a total throughput of 15,672,000 TEU's compared to Vancouver's throughput of 2,500,000 (American Association of Port Authority, 2009). The growth rate of the San Pedro Bay ports is positive, but it is not as high as Vancouver's.

Figure 1: Map of Los Angeles and San Pedro Bay



Source: Google Maps

The two ports are located in San Pedro Bay in Southern California. The surrounding region is densely populated, and both the ports are located at the edge of a large urban centre that make up the six counties of Los Angeles, Orange, Riverside, San Bernardino, Imperial, and Ventura, with a combined population of nearly 17 million. All freight received by the San Pedro Bay ports moves through a dense urban area. Both rail and roads used for the transportation of cargo are shared with the public for passenger transit and other uses. The I-110 and the I-710 are the main truck routes for the two ports. Both of the interstate highways suffer from congestion.

Additional trucks or trains have the potential to increase congestion because the stressed state of the transportation networks.

California has a very large population and economy. If compared with nations, it ranks fifth behind the United Kingdom and ahead of France. The large population and economy creates a high demand for goods, and much of the cargo received through the San Pedro Bay ports stays in the region. Due to the large amount of containerised freight shipped through the San Pedro Bay ports, the shipping network required to disperse the containers is incredibly complex and no attempts have been made to track the network (Bonacich and Wilson, 2008).

The San Pedro Bay ports are highly advantaged compared to other West Coast ports due to their location in a highly populated urban area of southern California. There is a wide range of figures estimating the amount of goods received by the port that remain in the region (Bonacich and Wilson, 2008). Unlike Vancouver where most containers are either loaded on trains at the port and taken to Eastern Canada or put on trucks for regional destinations, the Los Angeles situation is extremely complex. On-dock railways transport some containers out of the region once they arrive at the ports. Trucks transport other containers to railheads near the ports or downtown to transport them further east. Trucks also take some containers to local warehouses to distribute container to the local region by truck, or east by rail. Some freight is also taken into the Inland Empire, around Ontario, California, where it ships back into the basin, or into the broader Western United States by rail or by truck (Bonacich and Wilson, 2008).

Due to the complexity and size of the transportation network, the amount of containerized freight remaining in the Southern California region is undetermined. No detailed survey data is available on shippers or warehouses receiving imports from the ports. Rough estimates suggest approximately a 50-50 split for freight remaining in the area compared to freight outside the region. Bonacich and Wilson use John E. Wall's estimates of 65 percent of received freight is immediately shipped east by rail from either on-dock railway or railheads near the docks or downtown with 35 percent drayed locally by truck. Of that 35 percent, 30 percent goes to the

South Bay, and 70 to the Inland Basin. Wall also believes only 20 percent of the cargo remains in the basin region (Bonacich and Wilson, 2008). Bonacich and Wilson argued in 2008 that the estimate of twenty per cent of the goods received by the San Pedro Bay ports remaining in the region was believable; though they acknowledge that some estimates place the figure as high as 50 percent. The southern California region with its population of more than 16 million can absorb many more of the products shipped than Seattle's population of 4 million.

In 2002, Hasbro, a toy company, consolidated its distributional activities in Ontario, California, 50 miles away from the San Pedro Bay Ports. In doing so, it closed distributional activities in Seattle. Seattle offered advantages, such as much shorter truck hauls from its ports to inland warehouses, and overall cheaper shipping rates. Hasbro still chose to consolidate in Southern California because it was cheaper in the end. Southern California was its biggest consumer market on the West Coast and not as much of Hasbro's products needed shipped out of the region (Mongelluzzo, 2002).

The shipping of cargo on public roads near the ports in Los Angeles is a major public policy issue. The increased truck traffic exacerbates the congestion problem generated by a growing population because heavy-duty trucks add disproportionably to congestion (Giuliano O'Brien, Dell'aquila, and Hayden, 2005). The Southern California Association of Governments estimates goods shipments on some major highways near the ports reduced average highway speed by over 65 percent (Giuliano et al., 2005).

While the San Pedro ports have container traffic many times that found in Vancouver, they have experienced recent rapid growth and are suffering from heavy traffic congestion (Giuliano and O'Brien, 2008). The San Pedro Bay ports are very similar to Vancouver in that both are the biggest ports for their respective countries and both serve as important nodes((Bonacich and Wilson, 2008; IBI Group, 2007). Shippers generally find it much cheaper to have ships stop at ports as infrequently as possible, so the ships often stop at large ports that can disperse the cargo (Bonacich and Wilson, 2008). The ports act as a hub and the spokes of

intermodal transport connect the final locations. A difference between Vancouver and the San Pedro Bay ports is their respective trucking industries. Because of the 2005 strike, the truck drivers in Vancouver are relatively powerful, organized and able to assert some strength upon the ports and its policies. By law, truckers in Los Angeles are forbidden from organizing and are mainly individual owner-operators (Giuliano and O'Brien, 2008).[4] This means that such policies implemented in Vancouver would likely require to have cooperation from truckers, whereas in Los Angeles needs less cooperation.

Table 2 compares the proportion of all traffic to trucks on Vancouver's Highway 17 and the two measured freeways in Los Angeles.[5] The I-710 counters record that approximately10 percent of overall traffic counted are trucks and has the highest proportions of the highways being studied. Vancouver's Highway 17 in Delta shows that truck traffic is making up an increasing amount of traffic each year increasing from 3.5 percent in 2005 to 5.5 percent in 2007. The proportion of truck traffic compared to all traffic in 2007 in Delta was not as great as at any time on the I-710, but greater than at any time on the I-I10 which has trucks making up about 3 percent of total traffic. Section 3 data examines the percentage of trucks in Los Angeles moving in weekday peak hours in a year from 2002-2008.

[4] For the purpose of this study, I use name of Los Angeles to refer to the urbanized area around the San Pedro Ports which is located in Los Angeles county.

[5] The methodology for the collected data is outlined in appendix A. The sample dates used in Los Angeles are listed in appendix B. The sample dates used for the highway 17 data is listed in appendix C.

Table 3: Proportion of Trucks to Total Traffic

	Los Angeles			Vancouver
	I-110	**I-710 Del Amo**	**I-710 Rte 1**	**Highway 17**
2002	2.35	9.15	-	-
2003	2.90	9.40	-	-
2004	2.98	10.28	-	-
2005	3.10	-	9.75	3.49
2006	2.59	-	11.23	4.89
2007	3.06	-	6.81[6]	5.48
2008	2.69	-	11.14	-

Source: CalTran Traffic Counts and BC Provincial Highway Traffic Counts

2.3 Summary

Due to similarity with Vancouver, this study offers a longitudinal case study analysis of San Pedro Bay ports and seeks to explain variation in weekday peak hour truck traffic to and from San Pedro Bay ports between 2000 and 2007 by examining corresponding policy changes and other external factors. Gerring describes a case study as "an intensive study of a single unit for the purpose of understanding a larger class of (similar) units (2004). To study the problem of too many port container trucks on Greater Vancouver roads during peak weekday hours, a longitudinal case study with Los Angeles chosen as the studied unit. The study examines each year from 2002-2008 as a case and seeks to find what affected the variation of the proportion of total container truck traffic.

Both Vancouver and San Pedro face similar problems. The San Pedro Bay ports and Vancouver are the largest ports of their respective nations. They are also the largest American and Canadian metropolitan areas on the west coast. Both have terminals in these urban centres, and landside transportation networks to and from both must compete with other traffic from the urban

[6] The total truck number is similar to the other counts from the counter, but the total vehicle is higher, leading to the lower proportion.

region. Both ports are growing, mainly due to increased trade with Asia. The lessons Vancouver can learn from Los Angeles are significant. Due to the larger size of the San Pedro Bay ports, and the much denser and larger urban region surrounding it, the challenges of regional containerized freight movement are greater. The challenges confronting Vancouver are not unique. Los Angeles has faced and continues to face, similar but even greater difficulties, yet the ports and regional container movement there continue to move efficiently and effectively.

Choosing only a single unit case study allows intensive focus on variables affecting the dependent variable. Choosing more than one unit to create a sample of units would mean less intensive study would be applied to each. As argued above, other ports would also not be as representative of Vancouver and its policy problems. Los Angeles, by being larger and facing nearly identical congestion and growth problems, offers a unique and not easily replicated view into the future for Vancouver. The next section examines the San Pedro Bay ports and the surrounding urban region to determine factors influencing variation in weekday peak hour container truck traffic flows.

3: Analysis

This section gives a brief San Pedro Bay port background including accounts of recent port growth and its effect on container truck traffic. The traffic count data from Caltrans is analyzed and aggregated to provide the annual proportion of truck traffic during peak hours. This analysis reveals a significant proportion of truck traffic was shifted out of weekday peak hours in 2005. Each year between 2002 and 2008 is examined for any policy changes, political events, or other occurrences possibly affecting change in the proportion of container truck traffic operating during peak weekday hours. This examination reveals two major port-related trucking policies: the 2003 Assembly Bill (AB) 2650 and the 2005 PierPASS program. Two other major events are also identified, the 2002 port strike and 2004 port congestion crisis. Section 4 provides data analysis from three San Pedro Bay traffic counters to explain changing container truck traffic flows.

3.1 Dependent Variables: Peak Hour Traffic

Truck traffic counts were conducted on the I-110 (Harbour Freeway) and the I-710 (Long Beach Freeway) in Los Angeles from 2002-2008 by Caltrans.[7] Because of missing data, four sample weeks from each year had to be used instead of total annual count.[8] The traffic counters originally counted all vehicles, but were broken down into fifteen classifications. Using these classifications it was possible to count only trucks with trailers, which would include all container trucks, but also include some other non-container truck traffic. The data from the three counters

[7] Detailed information on data collection is available in appendix A.
[8] The dates used for the sample weeks are listed in appendix B.

shows a reduction in the proportion of trucks counted during peak hours in 2005 which corresponds with the implementation of the PierPASS program.[9]

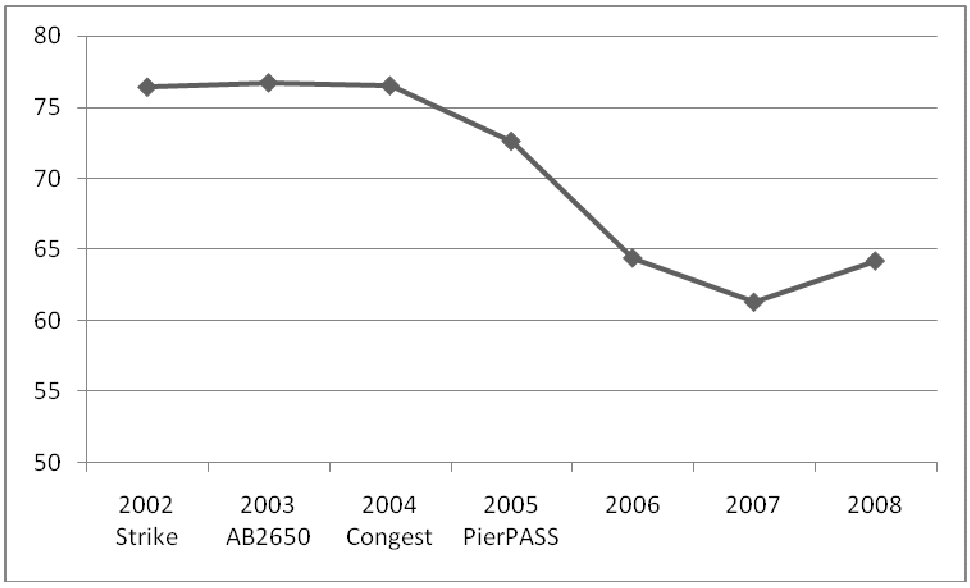
Table 4: Annual Truck Traffic Proportion During Peak Hours in Los Angeles,

Year	Total Trucks	Peak Trucks	Percentage in Peak
2002	601433	459594	76.4
2003	598355	458947	76.7
2004	690099	527772	76.5
2005	588746	427484	72.6
2006	631434	406386	64.4
2007	581415	356216	61.3
2008	618019	396683	64.2

Tabel 4 shows the total number of trucks driving over counters during the four sample weeks each year, the total number of trucks counted in peak hours during the sampled weeks and the percentage of trucks in peak hours – calculated by dividing the peak trucks by the number of total trucks for each year. Figure 2 shows these data in graphical form to better indicate trend. Here we can see the proportion of truck traffic was level at 76 percent from 2002-2004 and dropped to under 73 percent in the 2005 before levelling off again near 64 percent for the remainder of the years counted. The data from all the counters it indicate that the shift of truck traffic proportion out of peak hours was on both I-110 and I-710 and was not exclusive to either highway.

[9] Peak hours were categorized from 6:00 am to 6:00 pm. This is because the PierPASS fee was applicable from 3:00 am to 6:00 pm. The Caltrans data indicated that there was very little traffic from 3:00am to 6:00 am; and as such those hours were not categorized as peak hours.

Figure 2: Proportion of Truck Traffic during Peak Hours on I-110 and I-710



3.2 Independent Variable Identification

Independent variables are also shown in Figure 2; each is described below in more details. Major events and policies include: the port strike in 2002, the implementation of Assembly Bill 2650 in 2003, the congestion crisis in 2004, and the implementation of the PierPASS program in 2005. From 2002-2008, many policy proposals were considered and discussed, but not many were enacted. This became particularly true after 2005 when Governor Schwarzenegger vetoed several bills relating to container truck traffic. Each variable is examined below according to its corresponding year. When the identified independent variables are compared with the data analysis conducted in the previous subsection, it is clear that the only change in the dependent variable occurred in 2005, when the PierPASS program was implemented.

3.2.1 2002

Californian political Alan Lowenthal has been involved in many of the policy developments regarding the ports in California, including the San Pedro Bay ports. In 2002, when

he was a State Assemblyman, Lownethal introduced legislation that aimed to reduce diesel emissions, truck congestion on highways near ports and truck idling at the ports. Terminals had the options of extending gate hours from a typical 45 hours per week to 70 hours per week or of implementing an appointment system that schedules appointments for specific cargo drop offs and pick ups as a means of complying with the legislation. If these changes were not made, a fine of $250 was levied against the terminal for every truck idling in a queue for longer than thirty minutes outside the terminal games. This legislation, known as Assembly Bill (AB) 2650, was passed in August but did not go into effect until July 1, 2003 (Guiliano and O'Brien, 2008).

Also in 2002, the Alameda Corridor opened. The Alameda Corridor is a $2.4 billion dollar (US) twenty-mile freight rail corridor that connects the San Pedro Bay ports with intermodal facilities in Los Angeles and the national rail network. It was expected that the project would greatly decrease rail times, and would divert some truck traffic to rail. The reduction in truck traffic did not happen (Giuliano et al., 2005).

At this time, under consideration were plans for expansion of the I-710. The favoured plan by politicians called for a ten-lane highway, six lanes for general traffic with four truck lanes. The plan called for the destruction of many residences and businesses, and as a result there was negative public reaction that was well publicized. The unwanted negative publicity caused city and county politicians to quickly withdraw their support for the plan (Guiliano and O'Brien, 2008).

There was a labour dispute from September 27 to October 8, 2002, which shut down the San Pedro Bay ports. The dispute was between the International Longshoremen and Warehouse Union (ILWU) who represented dock workers and marine clerks, and the Pacific Maritime Association (PMA) which represented the ports. A month of conflicts preceding the strike reduced productivity. The dispute caused a large build-up of cargo on the docks, which led to congestion on the docks. Trucks faced much greater than norm queue times, and it took months to recover from the strike (Giuliano et al., 2005). The strike is identified as an independent variable

because of its effects, which were wide spread and had severe implications for the container trucking industry.

3.2.2 2003

AB 2650 went into effect on July 1. The legislation imposed a fine of $250 on marine terminal operators for each truck idling more than 30 minutes outside the gates while waiting to enter the terminal gate at the ports. As mentioned above, the San Pedro Bay port terminals could avoid fines by extending their gate hours to 70 hours from a typical 45 hours or by implementing an appointment system. An appointment system has the potential to increase the efficiency of port operations. Port operators will know in advance what containers are being dropped off or picked up and so can manage truck flows and container moves (Giuliano et al., 2005). Appointment systems could reduce the congestion on the port docks.

The San Pedro Bay ports have fourteen terminals among them. Five terminals already used extended hours before the implementation of AB 2650 and had to make no changes. Eight terminals implemented an appointment system. One terminal simply chose to comply with the 30-minute idling regulation (Giuliano et al., 2005). No terminal chose to comply with the legislation by implementing extended gate hours.

To comply with AB 2650, terminal operators chose the option that would have the least impact on their terminals (Giuliano and O'Brien, 2008). Those terminals that already had extended hours did not need to change anything to comply with the regulation. Two of those terminals had recently changed locations to state-of-the-art facilities, and had ample room to put most of their containers on chassis . The storage of containers of chassis means that truckers attach directly to the chassis and eliminate the cost of labour for container moves. Less labour greatly reduces the cost of extended gate hours (Giuliano et al., 2005).

Two terminals chose to incorporate an appointment system with a 70-hour week. In one instance, the terminal only used extended gates on a limited basis and chose to implement

appointments as that was cheaper than modifying their extended hours to be full time as required by the legislation. In the other instance, the company chose to implement an appointment system to improve operations (Giuliano et al., 2005).

Three terminals were in the process of implementing appointment systems before AB 2650 was passed, and continued with these systems. These three were smaller terminals which lacked the space to have wheeled operations, making extended hours much more costly than for their larger counterparts. In the last five terminals, it appears that appointments were chosen as they were a cheaper alternative to extended hours (Giuliano et al., 2005).

A study conducted on AB 2650 found that some terminal operators did not find appointment systems useful. These operators tended to believe that terminals must be flexible. The study found that it was because of the great variety of products, number of ships being served at any one time, customer requirements and dock space available (Giuliano et al., 2005). It was also believed that new technologies such as GPS tracking, and using the internet to provide data for truckers on container availability would have more potential. The terminals that had previously developed or were in the process of developing an appointment system perceived it as an invaluable tool for dock management that allows truck traffic to be spread more evenly across the day and allows space to be rationed (Giuliano et al., 2005). Its goals and new regulations identify AB 2650 as an independent variable.

3.2.3 2004

State Senator Alan Lowenthal, who also sponsored AB 2650 as an Assemblyman, introduced AB 2041 in February, 2004, in an attempt to force terminals to use extended gate hours and to try to shift twenty percent of container moves outside of peak hours. AB 2041 also created the Port Congestion Management District, a regional governing body. The bill also created a charge for cargo moved at the San Pedro Bay ports between the hours of 8:00 am and 5:00 pm on weekdays, with the revenue going to congestion projects. Terminal operators were

greatly opposed to the bill, as any revenue from fees would be controlled by a public body, and not the terminals themselves (Giuliano and O'Brien, 2008a). The previous implementation of AB 2650 showed that the state government was serious about implementing change to the ports, and it seemed certain that AB 2041 would pass.

AB 2041 legislation was amended in April and in May of 2004. The changes clarified who would be on the regional governing body, the Port Congestion Management District, and it included longshore labour, elected officials, truckers, and community members, none of which terminal operators wanted involved in their operations. The amendments also included further undesired requirements for terminal operators, as they were to supply detailed data and information to the District Board (Giuliano and O'Brien, 2008a).

To ensure that AB 2041 was not passed, the terminal operators sought and were granted permission from the federal government to try to create rules, procedures, and changes to encourage off-peak hour services. Terminal operators were also granted the right to collect and use funds collected for off-hour operations, and were allowed to create their own rules and enforcements. On August 23, the terminal operators announced the created of a non-profit operation known as PierPASS Inc to create a program for extended gate hours. With this announcement, Senator Lowenthal agreed to withdraw AB 2041 (Giuliano and O'Brien, 2008a).

With the creation of PierPASS Inc and the withdrawal of AB 2041, terminal operators were able to structure an extended gate program based on their needs and interests. Unlike the provision of AB 2041, the terminal operators were able to set the fees, and control and allocate the revenue as they saw best. The terminal operators were also able to limit the information and data they provided, as well as exclude the longshore labour, trucking industry, community members and elected officials from the decision making process (Giuliano and O'Brien, 2008a).

The original plan from PierPASS was to charge a $20 per TEU for movement between the hours of 8:00 am and 5:00 pm on weekdays, and to gradually implement extended hours. This was to begin in November, 2004, and all extended hours were to be implanted within three years.

A start date of November proved impossible, as consultants and vendors were not brought into the project until the fall, and there was concern that there was not enough labour for the additional shifts (Giuliano and O'Brien, 2008a).

The start date was pushed from November, to February, and then to June 1. During that time, the fee per TEU increased from $20 to $40, and the decision was made to open all the gates at once for extended hours, instead of doing it gradually over three years(Giuliano and O'Brien, 2008a).

The year 2004 was not only notable for the creation of PierPASS but for a congestion crisis. In the peak season from the end of September to mid-November, the two Southern Californian ports experienced massive congestion due in part to the landside transportation system being severely overwhelmed. Ships were forced to wait outside the ports before they could enter and drop off and pick up their loads of cargo. At the peak of the congestion on October 11, 2004, ninety-four vessels were lined up outside the ports. There were several reasons for the massive congestion. There was a 10.4 percent increase in port traffic over 2003, and there were not enough dock workers to unload the ships fast enough. Railroads did not have the equipment or infrastructure to handle the additional cargo. There was also a shortage of trucks, aggravated because many truckers were not willing to put up with delays in getting their cargo (Bonacich and Wilson, 2008). Because of the disruption to the container trucking industry, the strike is identified as an independent variable.

3.2.4 2005

The PierPASS program missed its scheduled date to begin in June, and instead began on July 23 of 2005 with the addition of five off-peak shifts on container terminals. Night shifts were added from Monday to Thursday, as was a Saturday shift. Despite the opening of the extended hours on July 23, fees for moving cargo during peak hours were not collected until July 29. The fee of $40 per TEU was added to containers picked up or dropped off during regular daytime

hours but there were some exemptions. Empty returns, chassis returns, domestic freight, freight being transhipped to other ports, and freight subject to the Alameda Rail Corridor fee were all exempt (Giuliano and O'Brien, 2008a). The $40 fee acted as a congestion fee on most container movements by truck for the regional transportation system. Trucks were then able to operate during the extended hours when regional traffic was less and so avoid the fee. Shifting some of the transportation of freight to the extended night and Saturdays hours helped reduce congestion during the regular daytime hours, when congestion was usually the worst. The goal for PierPASS was to shift 15-20 percent of cargo movement to the off-hours (same as AB 2041), but the program was more successful than anticipated (BST Associates, 2008). About 30-35 percent of cargo movement was done during the off-peak hours. This figure represents about 10,000 trucks a day (PierPASS website). Because the implicit goal of the program was to shift container truck traffic out of peak hours, the PierPASS program is categorized as an independent variable.

3.2.5 2006

On April 24, 2006 the fee for moving a TEU in peak hours was increased from $40 per TEU to $50 per TEU. The terminal operators claimed that the increased fee was necessary due to higher than anticipated costs in running extended gates (Giuliano and O'Brien, 2008a). Because fees were hard to collect after containers were dropped off, in August a new policy was introduced requiring all fees to be paid in advance.

Since the success of PierPASS and the model of fees implemented on containers proved successful, several bills have been created in California to try to further improve the system. SB 760 was introduced by Lowenthal but failed in 2006. The bill called for a $30 per TEU fee from the San Pedro Bay ports on all containers regardless of time of day with the fee going to mitigate pollution, security, and rail projects (Giuliano and O'Brien, 2008a).

Lowenthal did not give up after the failure of SB 760 as he revived it with some amendments as State Bill (SB) 927 in August. Legislators approved SB 927 in September, but

Governor Arnold Schwarzenegger vetoed the bill later in the month as he claimed that there was no plan to use the fees collected, and that it unfairly targeted containers and not other forms of shipping as well as only applied to the San Pedro Bay ports (Schwarzenegger, 2006).

3.2.6 2007

Senator Lowenthal again tried to revive a bill to implement a $30 fee on containers from the ports in the form of SB 974. Fifty percent of the fees collected were to develop infrastructure to reduce congestion, and the other fifty percent was to mitigate air quality impacts from the port. The bill called on the ports to be responsible for collecting the fee. The bill went through several amendments in 2007 (Giuliano and O'Brien, 2008a).

3.2.7 2008

SB 974 was still being discussed and amended by the California State Legislature in 2008. It passed the assembly in July, and the Senate in August. Despite the claims of Senator Lowenthal and Governor Schwarzenegger to try to work together, the Governor vetoed the bill on September 30. In his veto message, Governor Schwarzenegger noted that he was publicly supportive of the concepts of the bill but that there was "no mechanism for the coordination and integration of infrastructure programs." He also claimed that the fee would place more hardship on businesses during the economic downturn that began in 2008 (Schwarzenegger, 2008).

3.3 Summary

This section analyzes the Los Angeles case study. Caltrans data indicates a substantial shift of the proportion of truck traffic out of peak hours in 2005. In the years previous to 2005, approximately 76 percent of all truck traffic was travelling during peak hours, but by 2006 the proportion dropped to approximately 64 percent. The section also conducted an analysis of each year from 2002-2008, to determine independent variable. Four factors stood out as possible

variables that could affect the proportion of port container truck traffic during peak weekday hours. Two policies were created and implemented, AB 2650 in 2003 and PierPASS in 2005, to try to reduce the amount of port container trucks on the roadways during peak hours. The strike of 2002 and the congestion crisis of 2004 reduced the number of truck trips for a few weeks. There was not much in terms of crisis or policy developments after 2004. The election of Republican Governor Schwarzenegger in late 2003 and his reluctance to sign into law new bills regarding port traffic which were often sponsored by Democrat State Senator Lowenthal, in part explain the lack of policy developments.

The shift of truck traffic out of peak hours in 2005 corresponds with the implementation of the PierPASS program at the San Pedro Bay ports. There is no evidence suggesting that any other of the identified variables affected the proportion of truck traffic counted during peak hours on I-710 or I-110. Determining that the PierPASS program was successful, I analyze it against other policy options being considered in Vancouver to reduce the effects of container truck traffic during peak hours.

4: Criteria and Measures

This section introduces the criteria used to analyze the policy options presented in section 5, including: effectiveness, cost, administrative ease, stakeholder response, and implementation time. Each criterion is operationalized using a ranking of one to four with four being the best and one being the worst with the exception of the first criterion, effectiveness. Effectiveness scores are doubled in value to better reflect the importance of the criterion. Section 5 describes each policy option. The policy options are then ranked by each criterion in section 6.

4.1 Effectiveness

Table 5: Measurement of Reduction of Proportion of Port Container Truck Traffic during peak hours

Score	Measurement
2	No reduction.
4	0-15% reduction.
6	15-30% reduction.
8	Over 30% reduction.

The effectiveness criterion measures the proportion of container trucks moving during peak hours on weekdays. Weekdays between the hours of 6:00 am and 6:00 pm are classified as peak hours for the purpose of this study. Because of the importance of this criterion, it is the primary goal of the policy alternatives and is weighted to be double the value of other criteria. The greater proportion of container truck traffic shifted out of peak hours the more efficient. If no container trucks are shifted out of peak hours a score of two will be applied. If there is a reduction

in the proportion of trucks between zero and 15 percent a score of four will be applied. A reduction between 15 and 30 percent will receive a score of six, and any reduction over 30 percent results in a score of eight. No policy option discussed will remove all trucks from public highways during peak hours, which is why a reduction of 30 percent or more of all trucks from the road results in the highest ranking.

4.2 Cost

Table 6: Measurement of Costs

Score	Measurement
1	Over $100 million.
2	$50 - $100 million.
3	0-$50 million
4	No Cost.

The cost criterion is measured as the amount the federal government will pay to implement the policy option. If applicable, this measures both the capital cost to build the needed infrastructure and the incremental operational costs to move a single container when compared to the status quo. Because there are incremental costs for container movement for some options, a formula is used to determine the present value. Currently the Treasury Board of Canada recommends using an eight percent social discount rate for infrastructure projects in cost-benefit analysis. I use the same discount rate over the course of 20 years to determine the present value of incremental costs for individual container movements based on an average cost and the annual quantity of containers expected to be transported. The present value of the movement of containers is added to the infrastructure costs to give a final cost estimate. For the final score, a rating of four is given to any zero cost program, with the rating decreasing one step with every

$50 million spent. A rating of three is awarded to any option that costs $50 million or less, a rating of two between $50 and $100 million, and a rating of one for any option costing more than $100 million.

4.3 Administrative Ease

Table 7: Measurement of Administrative Ease

Score	Measurement
1	Four organizations involved.
2	Three organizations involved.
3	Two organizations involved.
4	One organization involved.

This criterion assesses the administrative ease of a proposed policy option. It identifies the possible difficulties in implanting a policy option, particularly the number of governments and organizations required to implement an option. Ports are under the jurisdiction of the federal government but operations take place in conjunction with other levels of government and other organizations, and the administrative process can be complicated. The provincial government is responsible for highways, and municipal governments for other roads. Administrative ease will measure how difficult it will be to implement an option based on the number of organizations required to be involved. The lower the number of other governments or organization required, the better the ranking. The top ranking of four applies if only one organization or government has to be involved. A score of one applies if four organizations have to be involved in the implementation.

4.4 Stakeholder Response

Table 8: Measurement of Stakeholder Response

Score	Measurement
1	Three or more negative responses.
2	Two negative responses.
3	One negative response.
4	No negative responses.

This criterion determines the response stakeholders will have towards the measured policy option, based in part from stakeholder interviews. Stakeholders include the general public, truckers, as represented by an interview with Louise Yako of the BC Truckers Association, Port Terminal Operators, and the municipal governments of Greater Vancouver. Nancy Olewiler, a professor of economics at Simon Fraser University with expertise on transportation policy, advised on the possible responses of the public and municipal governments. Municipal governments are responsible for the costs of roads and road repair and are typically against increased truck traffic. If no one would object to the plan, a score of four is awarded. If it is determined that four of the key stakeholders as noted above would object, a score of one is applied.

4.5 Implementation Time

Table 9: Measurement of Time Implementation

Score	Measurement
1	Three years or more.
2	Two to three years.
3	One to two years.
4	Under one year.

This criterion is a simple measure of how long it would take to implement the policy option. The estimated times will be based on the case study of Los Angeles, as well as literature. The time measured will be how long it will take the policy option to be implemented and to be fully operational, including time for planning and construction. Time is measured in one-year intervals. A score of four means the policy option could be implemented in under one year. A score of one means over three years.

4.6 Summary

In this section, the criteria and measures to analyze the policy options described in section 5 are outlined. Five criteria are described: effectiveness, cost, administrative ease, stakeholder response, and implementation time. Each is scored out of four based on the measures described. In section 6, the policy options will be analyzed using these criteria and form a recommendation that will be presented in section 7.

5: Policy Options

This section examines three policy alternatives to reduce the proportion of container trucks travel during peak hours as well as the status quo including: extended gate hours, extended hours with a peak hour fee, and short-sea shipping. The options are generated from information gathered in relevant literature and from the case study of Los Angeles.[10]

5.1 Status Quo

The status quo is a policy option in this study. Under this option, no policy will be implemented to lower the proportion of container truck traffic out of peak hours and current policies and practices will continue. The majority of container trucks will continue to travel during peak hours. The number of container trucks travelling is predicted to continue its high rate of growth.

5.2 Extended Terminal Hours

Extended terminal hours are often proposed and investigated as a solution to ease congestion and speed up trucking turn over and travel times in Vancouver (IBI Group, 2007). Ports around the world use extended gate hours to handle large amounts of traffic, and some of the busiest ports have terminals that are open 24/7. Extended terminal hours would allow trucks to pick up or drop off containers at ports later or earlier in the day, outside regular shifts. Extending hours so more trucks use the roads at non-peak hours could help them avoid the time

[10] Exclusive truck lanes is occasionally mentioned as a possible solution. Vancouver does not have the truck traffic to make this an effective option as part of a larger transportation strategy. The United States Department of Transportation recommends that a minimum requirement for exclusive truck lanes is for the road to have an average annual daily traffic count of 100,000 with 25 percent or more of overall traffic being trucks (Battelle, 2006). It is a requirement that any of Vancouver's roads are close to meeting. Much more infrastructure would be needed at a high cost.

sinks of congestion. Taking trucks off the road would also help alleviate some of the congestion faced by trucks that continue to use regular daytime hours and anyone else using the roads and reduce the average amount of pollution created per trip.

Vancouver had introduced a system of extended terminal hours in January, 2006. The objective was to gradually increase the extended hours. The first extended hours at the three port container terminals were until midnight on Thursday and a day shift on Saturdays. The program was unsuccessful and extended hour use was 20 percent lower than original estimates four months into the project (White, 2006). Drivers were reported to be unhappy with working outside normal working hours. The gradual implementation was not successful, as at first there was only two options to use the extended gate service, making scheduling difficult. It was also noted that the extended hours did not allow trucks to be used for a full second shift, making it difficult to make use of the truck over the entire time it was open (Yako, 2009). Since the global slowdown of trade in 2008, the extended gate hours have been cut. Another proposed extended gate hour system that is not phased in could be considered once the current recession ends and could be forced upon the terminals through legislation.

A first attempt at forcing extended gate hours occurred in Los Angeles and Long Beach in 2003 with AB 2650. One of the purposes of the bill was to try to divert some of the truck traffic to off-hours. This goal was not successful as it left a loophole to give terminals the choice of extended hours, implementing an appointment system, or reducing truck idling time, and most terminals chose to use an appointment system.

Some lessons were learned through the difficulties encountered under Vancouver's first attempt to implement extended gate hours. Gate hours should be extended further to 1:00 am to allow for a full second shift. They should not be phased in, to allow full time drivers to work exclusively at night, and not have to switch from days, to nights. For this study, I will use these adjustments to the extended hour option to measure and analyze the policy option.

5.3 Extended Hours with Peak Hour Fee

The PierPASS program was introduced by the Marine Terminal Operators at the San Pedro Bay ports in July, 2005, and is run by the industry. The creation of the PierPASS program was only in response to political pressure. The Los Angeles program was created as an alternative to legislated extended hours with fees that would be run by public organizations. Before the Marine Terminal Operators agreed to create the PierPASS program, the California state legislature was about to pass a bill that would have created a similar program under government control. In Vancouver, the cooperation of the Marine Terminal Operators cannot be taken for granted, and for the purpose of the study I will assume that the federal government will have to legislate such a change.

The program in Los Angeles extended the gate hours of the terminals allowing trucks to pick up or drop off containers at extended night hours (6:00 pm – 3:00 am) and on day shift on Saturdays. This policy option differs from an expanded gate operation because it offers incentives to use off-peak hours. In Los Angeles, those that continued to pick up or drop off containers during regular daytime hours, (3:00am – 6:00pm) were charged a fee of $40 per TEU picked up or dropped off. The program has resulted in approximately 30-35 percent of cargo movements occurring during off-peak shifts. Before the program was implemented about 10 percent of port traffic moved during off-peak hours (BST Associates, 2008). The fees are intended to act as an incentive to mitigate container truck traffic out of peak hours. There are many possibilities for the revenues collected. In Los Angeles, the fees collected for daytime use could go to help pay for the incremental costs of operating terminals during the extended hours minus overhead costs for operating the program (BST Associates, 2008).

For Vancouver, the hours would likely have to be different. For the purpose of this study, like the previous option, the gate hours should be extended a full shift until 1:00 am, and a full shift from 7:00 am to 4:00 pm on Saturdays. This would allow all extended hours to be utilized

by a full shift, and allow two separate drivers to use the same truck for a full shift on the same day.

5.4 Short-sea Shipping

Short-sea shipping is an option that is under consideration by the federal and provincial governments. Short-sea shipping would utilize the waterways of the Fraser River to transport containers to and from several designated sites. Previous studies have indicated that potential sites for short-sea shipping include Tilbury, Coast 2000, Fraser Surrey Docks, Parsons Channel/Port Kells, and Pitt Meadows (IBI Group, 2007). These sites were selected for physical characteristics and site suitability, accessibility reasons such as water depth, operational issues, and development factors. Of these Tilbury, Coast 2000 and Fraser Surrey Docks have existing infrastructure that would reduce capital costs. Pitt Meadows does not have the infrastructure but has available industrial land suitable for use. Parsons Channel/Port Kells was selected to contrast the other chosen sites as it has limited land and infrastructure and is further up river (IBI Group, 2007). Two operational options are often brought up for consideration for short-sea shipping in Vancouver. The first is Load On/Load Off (LO/LO). A LO/LO short-sea shipping operation has containers loaded and stacked on barges by a quay crane or a reach stacker. Once at the destination, the containers are moved off the barged to ground storage. From there the containers are placed on trucks that take the containers to their destination.

Roll On/Roll Off (RO/RO) is the second option for short-sea shipping. RO/RO is used in BC with the BC Ferry system as containers are driven on and off with truck and chassis. Drop trailers would probably be used in this option. Tractors would drive onto the barge and pick up and drop off containers but not be transported. The container would remain on a chassis. This option does not have the carrying efficiency of a barge that could stack containers upon each other and the costs for the barging portion of the trip would be much higher. Infrastructure needs would be considerably less then a LO/LO operation as there would be no need for loading

equipment on the short-sea shipping docks. A RO/RO option would also reduce turnaround times compared to a LO/LO option. However, due to the five meter tidal range at the container terminals which can cause seven to nine meter differentials between dock apron and barge deck, the RO/RO option is impossible and ruled out in this study.

A short-sea shipping operation would likely be a public-private partnership. Novacorp's study claims that there is private sector interest in short-sea shipping within Metro Vancouver (2005). The expertise of the private industry would likely be required as the shipping industry is operated by private companies.

5.5 Summary

This section details four policy options to reduce the proportion of container truck traffic during peak hours in Vancouver. Implementing a policy of extended gate hours would allow container trucks to travel in off-hours, and implementing extended gate hours with a peak fee would offer a financial incentive for container trucks to travel during non-peak hours. Creating a short-sea shipping network would remove truck container traffic on the road by utilizing Vancouver's waterways. In the next section, the policy options are analyzed using the criteria and measures described in section 5.

6: Assessment of Policy Options

In this section, the policy options outlined in section 5 are analyzed against the criteria as described in section 5. Each policy option is ranked on a scale of one to four for each criterion with four being the most desirable score. From the score a total ranking out of 24 is applied, which is used to recommend policy options in section 7.

6.1 Evaluation Summary

Table 10: Evaluation Matrix

	Status Quo	Extended Hours	Peak Fee	Short-sea Shipping
Effectiveness (/8)	2	4	8	4
Cost (/4)	4	4	4	2
Admin. Ease (/4)	4	3	3	1
Stakeholder (/4)	2	2	2	2
Time (/4)	4	4	4	2
Total (/24)	**16**	**17**	**21**	**11**

6.2 Evaluation of Status Quo

The status quo will not shift any container truck traffic outside of peak hours. No regulation will be imposed and current policies and practices will remain in place. Trucks will continue do the vast majority of container movement in the region during peak hours. The status quo receives a score of two for effectiveness. The status quo will not increase or lower costs as there is no policy to reduce the proportion of container truck traffic. Because there are no changes required under the status quo option, it receives the highest score, four, for cost, implementation time, and administrative ease.

The status quo is the approach favoured by the truckers. The truckers are against most forms of regulation and believe that any problems relating to congestion travel time are best addressed by infrastructure upgrades. Louise Yako of the Vancouver Trucking Association does note that container trucks are not popular with the general public. It is fair to estimate that the public would not be satisfied with the status quo, nor would be local municipal governments, due to the increasing container truck traffic. Based on the experience of Los Angeles, the terminal operators would be in favour of this option as they are against regulation of any kind. The score for stakeholder response is two, due to the opposition from municipal governments and the public.The final score for the status quo is sixteen. Despite not being effective, the status quo is an option that has no costs and would be the easiest to accomplish. Due to its lack of effectiveness and the growth rate of container truck traffic, public opposition to the status quo would likely increase over time.

6.3 Evaluation of Extended Hours

With extended hours, trucks would have the option of using off-hours. The only incentive for truckers would be to avoid traffic while the late hours generally act as a disincentive to working during the extended hours. Recent attempts to extend hours in Vancouver have failed, as there were low numbers of truckers using the extended hours. Extended hours were believed to be a potential way to appease drivers by allowing them to haul containers faster by avoiding congested periods. They were originally implemented after the strike of 2005. Due to the low use, the extended hours were reduced from being available four times a week to two, and are no longer available at two terminals, and three times a week at one and only until 8:30 pm instead of the original midnight. While it was low, there was some use of the extended hours indicating it reduced truck traffic a minimal amount. However, it is unlikely the reduction was as high as 15 percent, therefore this option earns a score of four for effectiveness.

With no fee for peak hour usage, there would be no incremental cost for container movement directly. However with no fee there is no revenue. This would increase terminal expenditures because of the additional labour costs. These costs would likely be passed on through extra fees for cargo going through the terminals. The costs for extra labour for PierPASS were annually $160 million (US) for the San Pedro Bay ports. Since the San Pedro Bay ports are about five times as large as Vancouver, it can be estimated that the costs would be approximately $32 million a year. The cost is not necessarily placed upon the government and could be borne by the terminal operators. This means that extended gate hours earns a score of four for cost.

The only organization that would be required to implement extended gate hours would be the port container terminals themselves. Extended hours were unsuccessful in the, so they are unlikely to be implemented by the terminals unilaterally. The change would likely need to be imposed by policy from the federal government. The policy option of extended hours earns a score of three for administrative ease.

The only cost from the extended hours would be to the terminals so they would oppose any regulation forcing them to extend gate hours. Truckers would have more freedom to choose when to ship goods. Louise Yako of the Vancouver Trucking Association indicated that this was her preference after the status quo, but that she still had some reservations. Some municipal governments are not likely to favour such a regulation as there would be noise complaints about container trucks running at night which will negatively affect residents near truck routes as there would be complaints from residents near truck routes about the noise of trucks running at night. The problem could be partially addressed by closing certain roads at night, but the trucks would have to go somewhere, likely disturbing some people no matter where. Except for the disturbed residents, the program is likely to be favoured as it reduces the environmental impact of trucks and confronts the issue of increased container truck traffic. The policy option of extended hours earns a score of two for stakeholder response.

The implementation time would be quick. No new infrastructure is needed, only additional labour to work the increased hours at the terminal gates. The implementation time is low as it could be operational within months. Extended gate hours receives a score of four for implementation time.

The extended option earns a final score of seventeen, a slightly higher score than the status quo option. It is more effective than the status quo and would be more popular among the public but would be more difficult to implement due to the opposition of the port terminal operators.

6.4 Evaluation of Extended Hours with Peak Fee

Since the implementation of the PierPASS program in 2005 at the San Pedro Bay ports, approximately one third of container movements to or from the ports have occurred in the off-peak hours (BST Associates, 2008). Trucks that use off-peak hours avoid the peak fee. By removing trucks from peak hour travel times, there is a reduction in travel times during peak hours.

The fee for containers picked up or dropped off during regular hours would act as an incentive to use the off-peak hours. Vancouver's previous attempt to extend terminal hours was not successful in part because of the lack of incentives for the truckers to use the extended hour shifts. More trucks will use the extended hours with the financial incentive than without, so the improvements in peak hour truck proportion will be greater with the peak fee than with extended gate hours alone. From the analysis done in section 3, over 30 percent of trucks used the extended hours but this counted all trucks. The PierPASS program reports that currently, over 40 percent of non-exempt trucks use the extended hours (BST Associates, 2008). Peak fee receives a score of eight for the effectiveness criterion.

Operating terminal gates cost more during off-hours due to the need to pay overtime or shift differential to employees working at night or on weekends. The fees collected from the

regular hour use are used to offset these costs at the San Pedro Bay ports and if done in Vancouver could be used to keep cost near zero for terminal operators.

The fee would add incremental costs to transporting containers within Vancouver. If the fee is similar to the PierPASS Program, it could add $40 to $60 to the movement of containers. This added cost would only be borne by shippers moving during peak hours, not to the federal government. Peak fee earns a score of four for cost.

Using the San Pedro Bay Ports as indicators, the PierPASS program could be operated by the terminals themselves. However, it did take a lot of political pressure through the threats of legislation to get terminals to implement the system. Vancouver terminals cannot realistically be expected to start a program like this on their own. Policy would be required from the Federal Government who has jurisdiction of ports. The federal government would need to involve the terminal operators as well. Peak fee earns a score of three for administrative ease.

Container terminals would likely have to be forced to use such a system, much as they were in LA, so terminal operators would be against adding costs to truckers in the form of a fee for daytime use. Truckers would also be against the fee as the costs would be imposed upon them. Louise Yako noted also noted that considering the human element, the truckers would not be in favour of this option as they would not want to work the undesirable hours of nights and weekends. Nancy Olewiler indicated that this is her preferred option of those presented. Public opinion would vary as some would be in favour of non-infrastructural solutions. However, opposition from those who reside near truck routes should be expected which would mean some municipal governments would be against the program. Trucks would still be using municipal government roads and creating noise during the evening hours but would be creating greater efficiency during peak hours. TransLink is currently seeking taxes on containers (Nagel, 2009). There is the possibility of some revenue collected from the peak fee be used as a tax. Because of the perceived opposition from truckers and port terminal operators, the peak fee program earns a score of two for stakeholder response.

Small amounts of infrastructure would be needed to collect fees and keep track of when containers enter and leave gates. Once it was decided to implement PierPASS at the terminals at the San Pedro Bay ports, implementation was done in slightly under a year. Using Los Angeles as the indicator, peak fee earns a score of four for implementation time.

The extended gate hours with a peak fee is the most effective option analyzed in the study as it could shift over thirty percent of container trucks out of peak hour traffic. Despite its effectiveness, this option would face opposition from the trucking industry and the container terminals, and would take slightly longer to implement than the extended hours operation alone. It earn the highest total score of the evaluated options with a score of twenty-one.

6.5 Evaluation of Short-Sea Shipping

Two major studies have been conducted on the potential use of short-sea shipping in the Lower Mainland. These two studies are the source of most of the measurement data for short-sea shipping. In 2005, Novacorp published the "Greater Vancouver Short-Sea Container Shipping Study: A Pre-feasibility Report." This report was funded by the Vancouver Port Authority, the Fraser River Port Authority, Transport Canada, and the Fraser River Estuary management Plan. In 2007, the IBI Group came out with their report for Transport Canada, "Opportunities for Short-sea shipping of Containers in British Columbia's Lower Mainland: Review and Critical Analysis." The figures and estimates for effectiveness and cost are derived primarily from these two reports.

Short-sea shipping has the potential to take some trucks off the road by shipping containers via rivers closer to their end destination. The potential to remove trucks from the road is high, but based on the estimates from reports and considering the potential sites and barge access, Novacorp in their 2005 study estimated that the target market for short-sea shipping is approximately 20,000 containers per year, or about 32,000 TEU. Currently this represents about three to five percent a year, and as containers increase the proportion will continue to decrease.

The proportion of container trucks under this option is not zero but is under ten percent, and receives a score of four for effectiveness.

Both Novacorp and IBI conducted extensive research on the costs of short-sea shipping in the Lower Mainland in the studies noted above. The costs of short-sea shipping will depend on a few factors such as the size of the barge and the frequency of trips. I will only examine the most economically viable of these options.

The IBI study is more recent than the Novacorp study, and in general has much higher cost estimates. IBI claims that Novacorp did not consider that specialized barges would be needed and would cost much more than the average barges currently used in the Lower Mainland, which is what Novacorp based its estimates on. IBI also argues that Novacorp made some unrealistic assumptions about labour. For instance, Novacorp based its labour costs on the assumption that the river terminals could be operated by private non-union labour, a decision the more recent study does not agree with. The arguments from IBI are compelling and convincing and I have used their estimates.

To estimate the cost of the barge using a short-sea shipping operation, I used estimates that had multiple trips occurring during a week, with barges loaded with 320 TEUs. Under those circumstances, estimated barging costs for a round trip from any of the three deep-sea container ports to Coast 2000 or Tilbury would cost $25,000. A round trip to Fraser Surrey docks would cost $27,000, and a round trip to Pitt Meadows or Port Kells would cost $31,000. If put in one-way trip per TEU, the barging cost it would be $39.06 to Coast 2000 or Tilbury, $42.19 to Fraser Surrey Docks, and $48.43 to Pitt Meadows or Port Kells.

The handling of the containers, the actual loading and unloading of the containers onto barges adds to the cost of short-sea shipping. ISI determines that the cost for a trip including all costs per TEU from the inner harbour to Coast 2000 or Tilbury would be $144.21, or to Pitt Meadows or Port Kells $153.58. These costs assume that full loads are taken in both directions, but as noted above, imports would likely have less demand. The costs stated do not include the

cost of trucking containers to or from short-sea shipping terminal. As of 2006, there was a minimum charge of $143 per container for a one-way truck trip to or from ports, but there are no rates set for short-sea shipping terminals that do not yet exist. Currently to get a TEU to Richmond where Coast 2000 is from the inner harbour, it would cost $98.13 by truck. With short-sea shipping and the minimum rate of trucking added ($89.37 per TEU) it would cost $233.58 or about 138 percent more.

The costs do not include any infrastructure costs. FSD and the current deep-sea terminals would need very little in terms of infrastructure, while Tilbury, and Coast 2000 already have some of the necessary infrastructure, so costs would be about 50 percent compared to a "Greenfield" site such as Pitt Meadows and Port Kells. Novacorp estimated that infrastructure costs for the five proposed sites including land and development would cost about $38.25 million.

Short-sea shipping proves to make transporting containers in the Vancouver region much more expensive. The implementation of a short-sea shipping service would not work in the free market alone. The federal governments would need to subsidize the cost to make it a viable option over the status quo. Negotiations with the truck industry might be able to lower the minimum fee for transporting containers.

All the estimates were made under the assumption that the same number of containers would arrive and leave the port terminals, but this is unlikely. Short-sea shipping will increase the amount of time needed per trip for containers. Short-sea shipping, while it will shorten the amount of driving a container has to do, will add time since it has to wait to be unloaded and loaded onto a short-sea shipping barge, only to have to wait for a truck to take it the remaining distance to its destination. The time sensitivity difference between the imported containers and exported containers is high. Imported containers on average contain cargo that is valued at $29,000 per TEU while the average exported container usually only has cargo worth approximately $6,000 per TEU (IBI Group, 2007). The more expensive goods are generally more time sensitive, so it would be more difficult for short-sea shipping to compete with trucks in this

regard. The prices are different because the imports are predominantly finished consumer products such as electronics, automobiles, and furniture, while the exports are raw resources such as lumber and wood pulp. The difference in time sensitivity suggests that there will be less demand for the slower short-sea shipping for imported containers than exported containers even if short-sea shipping was economically viable.

For short-sea shipping to be an economically viable choice for shippers, the cost to use it would need to be subsidized. If the estimate of 32,000 TEU units moved annually is used, and if it would cost $135 at best incremental to trucking for an LO/LO option, it would cost $4.3 million annually not counting infrastructure. Using the discount rate of 8 percent over twenty years, the present value for twenty years of shipping would be $42.4 million. Infrastructure is estimated to be $38.25 million for a total cost of $80 million earning a score of two for short-sea shipping in cost criterion.

The federal government could operate a short-sea shipping program, though it is a project that is likely to be a private-public partnership since it involves the shipping of goods in a competitive market with trucking (Novacorp, 2005). The government would have to work with Port Metro Vancouver to be able to operate in conjunction with the container terminals there, and to get space for the short-sea shipping terminals. Municipal governments would also need to be involved where the river terminals are planned to be built for issues such as land development, taxation, fees and regulatory issues (IBI, 2007). Since at least four organizations would have to work together, the Federal Government, municipal governments, the private company and Port Metro Vancouver, short-sea shipping earns a score of one for administrative ease.

The public acceptance of this option would not be high due to the costs. It removes a number of container trucks from the road but at a very high price to the taxpayer. Olewiler did not

see any benefit at this time for a short-sea shipping operation.[11] Yako of the BC Trucking Association was not in favour of this option as she believed that it would not adequately address the problem of container truck traffic because trucks would still be needed to take the containers to their final destination. The Novacorp study indicated that the port terminal operators would have to use valuable port space for barges adding a further factor of complexity to a increasingly complex operation. From this analysis, I determine that the terminal operators would likely not favour the policy option. The municipal governments would likely favour this approach if the federal government were funding it and were able to receive proper taxation for the land usage. Short-sea shipping earns a score of two for stakeholder response.

For short-sea shipping to become operational, infrastructure would need to built at the terminals, and a barge would also be needed. As mentioned above, some river terminals such as Coast 2000 have existing infrastructure that could be used, but other sites such as Pitt Meadows and Port Kells have no infrastructure in place. There is no official estimate on the length of time to build the infrastructure needed, but considering the amount needed, a time length over two years does not seen unreasonable, though is a rough estimate, earning short-sea shipping a score of two for this criterion in this study.

Short-sea shipping earns the lowest combined score of any policy option analyzed with a final score of eleven. It is not as efficient as the peak fee option, but about the same as the extended gate hour option. It is much more expensive than the other policy options considered. Short-sea shipping would also require more cooperation between governments and organizations than any other option analyzed.

[11] Olewiler did note for future consideration that there may be a time when short-sea shipping might become necessary and recommended that industrial land near waterways be preserved. Vancouver's waterfront property has become increasingly valuable with former industrial lands being rezoned into residential area. Redevelopment of industrial lands to residential could prove to be short-sighted.

6.6 Summary

In this section, the policy options identified in section 6 were analyzed against the criteria and measurements described in section 5. From the analysis done, it was determined that the option of extended gate hours with a peak fee option was ranked the highest, with a score of twenty-one out of twenty-four. It has the highest effectiveness rating, scoring the maximum of eight. It loses points because of, stakeholder response and administrative ease. Extended gate hours were the second best option with seventeen points. Extended gate hours have a low effectiveness score, have no costs, are easy administratively, and are able to have a quick implantation. Because of its ineffectiveness, the status quo scores sixteen due but receives maximum scores in the cost, and administrative ease, and implementation time criteria. Short-sea shipping scores an eleven for fourth place.

7: Recommendations

There are several ways to help alleviate container truck traffic during peak hours on Vancouver's roads. It will be impossible to try to limit the overall number of container trucks, as trade through our ports will continue to grow. It is likely that new infrastructure will be required in the future, but it is important that all infrastructure, whether existing or planned, is used efficiently.

I recommend that extended terminal hours with an associated peak fee be introduced at the Port Metro Vancouver container terminals. This will reduce the number of trucks on highways during peak hours by encouraging the use of off-peak hours. To accomplish this, the federal government will have to introduce legislation. The San Pedro Bay port terminal operators argued that industry is better able to create a program that will meet both its needs and government's objectives, than government regulation alone. However, industry only did so after regulation was passing though the California State Congress. When the terminal operators at the San Pedro Bay ports were forced to create and operate an extended gate hours program in the summer of 2004, it was operational with all its benefits a year later. If the industry in Vancouver is willing to create a program, it should be allowed to do so. The experience of Los Angeles indicates that the federal government must be able and willing to implement the policy without terminal approval or cooperation, if necessary. The extended hours with a peak fee is something that can have a large impact on Vancouver's container truck traffic, can be implemented quickly, fairly easily, and with no cost.

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Appendices

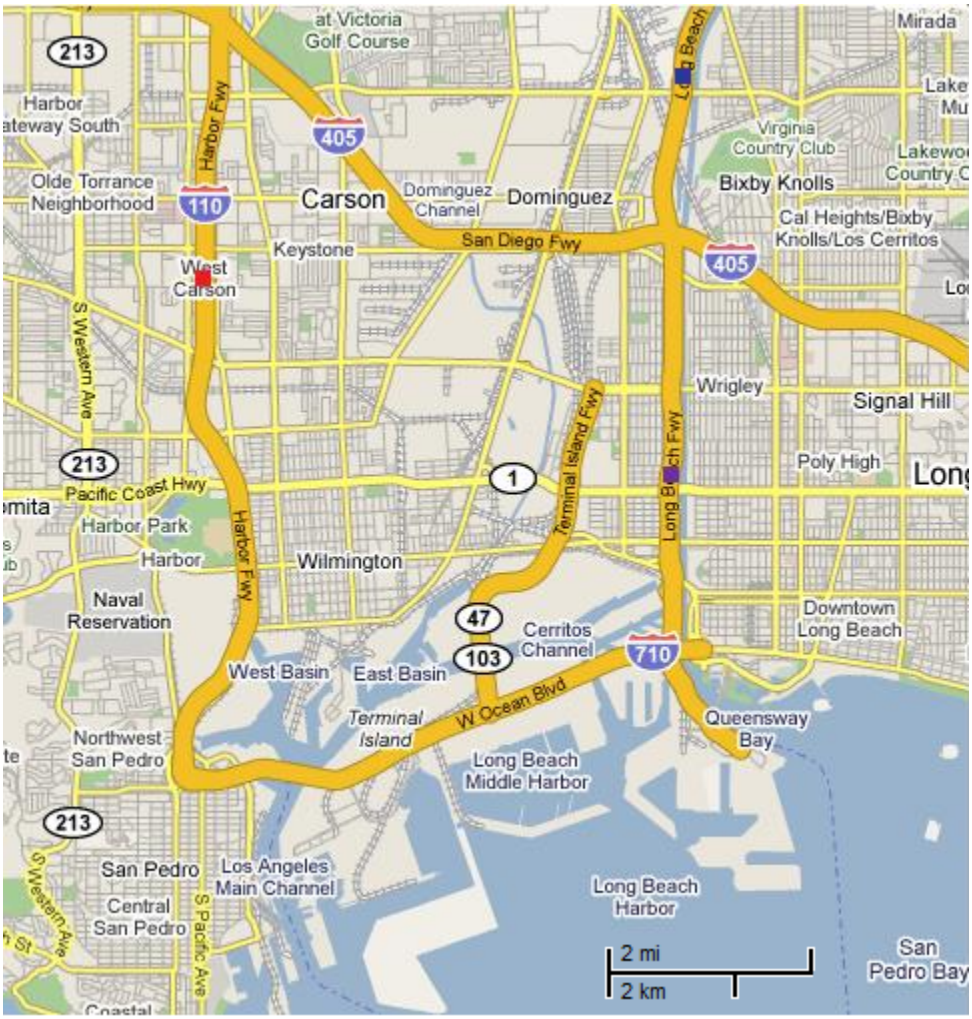
Appendix A - Caltrans Data

The data for the dependent variable is from traffic counters operated by the California Department of Transportation (Caltrans). I used data from three of the counters, one on the I-110, and two on the I-710. The I-110 counter is approximately 8 miles away from the ports and is at the 228th Street Crossing. The first I-710 counter is north of the junction with Route 1 and is approximately 9 miles from the ports. The second I-710 counter is north of Del Amo Boulevard and is approximately 13 miles from the ports. Two counters were needed to be used on the I-710 since both counters had a significant amount of data missing for certain periods. I used the Route 1 counter over the Del Amo Boulevard counter when possible since it is closer. The counters are marked on the map below:

Red Marker = I-110 at 228th Traffic Counter

Purple Marker = I-710 North of Highway 1 Traffic Counter

Blue Marker= I-710 North of Del Amo Boulavard Counter



Source: Google Maps

Methodology

The CalTrans data counted the following fifteen classes of vehicles:

- Class 1 -Motorcycles
- Class 2 -Passenger Cars
- Class 3 - Other Two-Axle, Four-Tire, Single-Unit Vehicles.
- Class 4 -Buses.
- Class 5 -Two-Axle, Six-Tire, Single-Unit Trucks.
- Class 6 -Three-Axle, Single-Unit Trucks.

- Class 7 -Four-or-More Axle, Single-Unit Trucks.
- Class 8 -Four-or-Less Axle, Single-Trailer Trucks.
- Class 9 -Five-Axle, Single-Semi Trailer Trucks.
- Class 10 -Six-or-More Axle, Single-Trailer Trucks.
- Class 11 -Five-or-Less Axle, Multi-Trailer Trucks.
- Class 12 -Six-Axle, Multi-Trailer Trucks.
- Class 13 -Seven-or-More Axle, Multi-Trailer Trucks.
- Class 14 -5 axle , 3 axle tractor pulling a full 2 axle trailer
- Class 15 –Unclassified

Trucks that carry containers are always trailer trucks. The data for trucks are the counts from classes 8 -14 added together, the same technique that was used in the "PierPASS Review" by BST Associates in 2008. The CalTrans data also counted traffic in each direction. This study does not analyze the direction of the traffic, only the total amounts and therefore the two directions were added together.

In all three of the data sets from the separate counters there was significant data missing. Gaps could be as small as a single hour in one direction, to as much as a few years. Caltrans assured me that they gave me all the data they had, and that any gaps are from the data not being recorded, or from their own quality control. The inconsistency of the data meant that simply adding up all the numbers for a year for every traffic counter was impossible, and that even adding the available data would be imprecise. To work around the issue, four week long samples were taken from every year. To try to spread the sample evenly over the year, and to avoid collecting samples that included any federal or state holidays, the best attempt was made to try to collect the four weeks which included the following four dates:

- February 28

- May 23
- August 25
- December 1

The attempts to gather data from every week that included those dates from every year, was not possible. When it was not possible to get the full week that included the above dates, I tried to get a full week as close to those dates as I could, without picking a week that included a holiday. For the complete list of weeks I could not match to the above dates, see the first appendix. For bigger gaps, ranging from years to months, I did not try to work around and did not include the year in my data. The counter years I did that I did not use were:

- I-710 and Rte 1 (2002-2004)
- I-710 and Del Amo Boulevard (2005-2008)

The missing data from both counters on the I-710 was significant, but used together, I was able to get a good idea of the truck traffic count on the freeway from 2002-2008.

For the available years the total number of trucks were counted in the four sample weeks. The total number of trucks counted in peak hours, 6:00am – 5:59pm were also counted. To get the dependent variable the number of trucks in peak hours was divided by the number of total trucks.

Appendix B - Dates Used For California Data Analysis

The following charts show which dates I used in calculating the yearly peak truck distribution. The first column shows the ideal dates I would have used for that year. The idea dates include the days: February 28, May 23, August 25, December 1. The second column shows the dates I actually used. Every week has the first day a Sunday, to maintain consistency. The third column is a reason the date used is not the ideal date and is only used if applicable.

I-110

2001 – Did not use this year for the count because of lack of data. No data before October 12.

2002

Ideal Date	**Actual Date Used**	**Reason**
February 24- March 2	Feb 24- March 2	
May 19-25	May 19-25	
August 25-31	September 8-14	All of August was missing significant amounts. Could not use first week of September due to Labour Day holiday.
December 1-7	December 1-7	

2003

Ideal Date	Actual Date Used	Reason
February 23-March 1	February 23-March 1	
May 18-24	May 18-24	
August 24-30	August 24-30	
November 30-December 6	December 7-13	There was no data in October – November.

2004

Ideal Date	Actual Date Used	Reason
February 22-28	February 22-28	
May 23-29	May 23-29	
August 22-28	August 15-21	There were a few hours missing in ideal dates.
November 28-December 4	December 5-11	There were a few hours missing in ideal dates.

2005

Ideal Date	Actual Date Used	Reason
February 27-March 5	February 27-March 5	
May 22-28	May 22-28	
August 21-27	August 21-27	
November 27-December 3	November 27-December 3	

2006

Ideal Date	Actual Date Used	Reason
February 26-March 4	February 26-March 4	
May 21-27	May 21-27	
August 20-26	August 20-26	
November 26 – December 2	November 26 – December 2	

2007

Ideal Date	Actual Date Used	Reason
February 25 – March 3	February 25 – March 3	
May 20-26	May 20-26	
August 19-25	August 19-25	
November 25 – December 1	November 25 – December 1	

2008

Ideal Date	Actual Date Used	Reason
February 24-March 1	February 24-March 1	
May 18-24	May 18-24	
August 24-30	August 24-30	
Nov 30 - Dec 6	Nov 30 - Dec 6	

I-710 (Route 1)

2001- 2004 No data at all from April 24, 2001 – August 4, 2004. Could not sample these years for this counter due to lack of data.

2005

Ideal Date	Actual Date Used	Reason
February 27-March 5	February 27-March 5	
May 22-28	May 22-28	
August 21-27	August 21-27	
November 27-December 3	November 27-December 3	

2006

Ideal Date	Actual Date Used	Reason
February 26-March 4	February 26-March 4	
May 21-27	May 21-27	
August 20-26	August 20-26	
November 26 – December 2	November 26 – December 2	

2007

Ideal Date	Actual Date Used	Reason
February 25 – March 3	February 4-10	Missing data from Feb 13-June 1
May 20-26	June 3 -9	Missing data from Feb 13-June 1
August 19-25	August 19-25	
November 25 – December 1	November 25 – December 1	

2008

Ideal Date	Actual Date Used	Reason
February 24-March 1	February 24-March 1	
May 18-24	May 11-17	May 18 missing some hours. Can not use May 25th week due to holiday.
August 24-30	August 24-30	
Nov 30 - Dec 6	Nov 30 - Dec 6	

I-710 (Del Amo Boulavard)

2001

Ideal Date	Actual Date Used	Reason
February 25- March 3	March 4 -10	No data from February 17 – March 3
May 20-26	April 15-21	Only one direction was counted from April 21 – July 12
August 19-25	August 12-18	No data from August 19 – September 8
November 25 - December 1	December 2 - 8	No data from November 18 – December 1

2002

Ideal Date	Actual Date Used	Reason
February 24- March 2	March 10 - 16	Many gaps in data from February 1 – March 10
May 19-25	May 12 – 18	No data from May 19 – June 1
August 25-31	September 8 -14	No data from August 18 – September 7
December 1-7	December 1-7	

2003

Ideal Date	Actual Date Used	Reason
February 23-March 1	February 23-March 1	
May 18-24	May 11 - 17	Missing data from May 22 - 31
August 24-30	August 17-23	Missing data from August 26-31
November 30-December 6	November 2 – 8	Missing data from November 20 to the end of the year. Week of Nov 11 is holiday.

2004

Ideal Date	Actual Date Used	Reason
February 22-28	March 7 – 13	No data from February 24-29
May 23-29	May 9 -15	No data from May 21-31, and June 10 -30
August 22-28	August 22-28	
November 28-December 4	November 28-December 4	

2005 – Only measured one direction from September 14 to December 31. Did not use the year for this counter since no week in fourth quarter could be sampled.

2006- Only one direction was measured from Jan 1 - May 1. Did not use the year for this counter since no week in first quarter could be sampled.

2007- No data from Feb 13 – June 1 among others. Lack of data made the year for this counter unusable.

2008 – Only one direction was measured all year. Could not get any data for north bound traffic.

Appendix C - Dates Used For Highway 17 Proportions

The only complete data available for Highway 17 in BC was from the years 2005-2007. The other years had very limited or no data and annual rates were not able to be used.

2005

Ideal Date	Actual Date Used	Reason
February 27-March 5	February 27-March 5	
May 15-21	May 15-21	
August 21-27	August 21-27	
November 27-December 3	November 27-December 3	

2006

Ideal Date	Actual Date Used	Reason
February 26-March 4	February 26-March 4	
May 14-20	June 5-11	Missing Data all May and up to June 4.
August 20-26	August 20-26	
November 26 – December 2	December 4 -10	No data Oct 9 to Dec 3.

2007

Ideal Date	Actual Date Used	Reason
February 25 – March 3	February 25 – March 3	
May 13-19	May 13-19	
August 19-25	August 19-25	
November 25 – December 1	November 25 – December 1	

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