BC MINISTRY OF TRANSPORTATION CONTAINER TRUCKING FORUM

CONTAINER SIMULATION PROJECT

FINAL REPORT

DECEMBER 17, 2007

IBI GROUP

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EXECUTIVE SUMMARY

IBI Group has been engaged by the British Columbia Ministry of Transportation to analyze and model container truck movements in the Lower Mainland. This project has been undertaken as an initiative of the Lower Mainland Container Logistics Stakeholder's Forum, which is led by the BC Ministry of Transportation and jointly funded by the federal and BC governments. The mandate of the Forum is "to develop and implement logistics and tactical solutions and identify strategic long term solutions that improve the reliability, productivity and efficiency of the land side container logistics system involving trucks, inland facilities and port terminals."

The Forum was created as a means of addressing problems in the Lower Mainland container logistics system highlighted by the withdrawal of service by container truck drivers belonging to the Vancouver Container Truck Association (VCTA) in the summer of 2005. In addition to low levels of compensation related to intense competition in the drayage sector, the VCTA identified two major sources of inefficiencies in the container logistics system: long queuing delays at on-dock and off-dock container terminals, and increases in unpaid "third leg" trips caused by the expansion of off-dock storage of empty containers.

This analysis is based on driver surveys undertaken through the efforts of the BC Ministry of Transportation. The data consists of daily trip diaries compiled using three different survey instruments to gather data on container truck movements over a period spanning October through December of 2006.

An extensive analysis of the survey data was carried out. Key findings of this analysis include:

- Drivers are achieving an average of 7 one-way trips per day, but the trucks are loaded with a container for only 5 of these on average.
- Drivers average approximately 9.7 hours on duty per day.
- More than half of drivers' trip time is spent waiting or being processed at terminals.
- Turn times (including queuing delays) are longest at the on-dock container terminals, followed by rail intermodal and off-dock terminals. All terminals have a high level of variation in their turn times.
- Turn times at on-dock container terminals average 52 minutes, and are almost identical among the three large terminals (Vanterm, Deltaport and Centerm). On average, these terminals process 80% of trucks within 80 minutes.
- Turn times at off-dock terminals average 41 minutes, but there are significant differences in performance between them, with the fastest (Metropolitan) exhibiting turn times averaging 20 minutes.
- Travel times between origins and destinations exhibit less variation relative to the average than terminal turn times

A simulation model was designed to estimate the impact of changes to basic system parameters including turn and travel times and trip distribution patterns. While the trip origin/destination patterns are not representative of the system as a whole due to the nature of the sample, the patterns are generally predictable for each type of terminal (on-dock, off-dock, transload, etc.) based on their roles in the container logistics system.

The major flows from on-dock container terminals are destined to transload warehouses, and consist primarily of loaded import containers for unloading.

The major flows from transload warehouses depend on whether they are primarily dedicated to handling import or export cargo. Import warehouses accept loaded inbound containers from the on-dock terminals and generate empties. Export warehouses accept inbound empties and generate loaded containers destined for the on-dock terminals.

The major flows from off-dock container facilities are empty containers destined for export transload warehouses, or to the on-dock terminals for evacuation by vessel.

Key findings from the simulation modeling include the following:

- The simulation model indicates that large improvements in efficiency require substantial changes in turn or travel times. The impact of reducing turn times at all terminals is much greater than simply reducing them at the on-dock or off-dock terminals. The analysis indicates that reducing turn times at all terminals by 25% would reduce drayage costs by approximately $17 million per year based on 2006 traffic levels. A reduction of 50% would result in savings of over $41 million.
- On the assumption of similar turn and travel times, simply extending the terminal hours of operation has little impact on driver trips per hour. It does provide owner/operators with opportunities to improve their income and the productivity of their assets through working longer hours, assuming that all terminals are open and that the availability of on-dock terminal reservations is not a constraint. Extending terminal operations by 2 hours is estimated to reduce annual drayage costs by $13.2 million. Extending terminal operations to 2 shifts would reduce annual costs by $17.9 million, based on the assumptions used in the simulation analysis. Since the completion of this study, extended gate hours have been implemented on a routine basis at Centerm, Vanterm and Deltaport. This is a positive step in providing opportunities for increasing the efficiency of the drayage sector.
- Improvements in efficiency can be realized through elimination of deadhead trips, but substantial changes in trip patterns are required for large benefits. The simulation cases for reducing deadhead trips indicate a system benefit of $6.9 million annually, and a return to on-dock storage would result in benefits of $7.2 million.

Conclusions and Recommendations

Operating practices at the on-dock terminals are the major determinant of container logistics processes in the Lower Mainland. The two major drivers for changes in on-dock operations have been the strategy of the terminal operators of maximizing terminal capacity through the reduction of container dwell time, and industrial unrest in the drayage sector. These two factors are interrelated.

The changes designed to reduce the dwell time of containers at the on-dock terminals include off-dock storage of empty containers, reduced Earliest Receiving Dates (ERD's) for export containers, and imposition of high storage charges to induce shipping lines to evacuate containers from the docks quickly. Changes resulting from industrial unrest in the drayage sector include imposition of mandatory reservation systems at the on-dock terminals.

These changes increased the effective capacity of the port terminals but imposed additional costs on shipping lines, trucking companies and drivers. The introduction of off-dock storage introduced a non-revenue “third leg” to trip patterns which increased trucking costs and reduced productivity. The mandatory reservation systems have increased the complexity of managing drayage operations.

Data on past performance of the drayage sector is limited. Previous estimates relied on anecdotal reports or small samples of drayage trip and financial records. The available information suggests that there has been no significant increase in the efficiency of the drayage sector. The survey data which was collected for this study provides the first substantive quantitative information on drayage performance, and will provide a valuable benchmark for monitoring performance and analyzing the impact of operational and infrastructure improvements in the future.

Recommendation: An Active Commitment by All Participants to Reducing Turn Times

Our analysis shows that total terminal service time, including both service time and queuing time, is the key factor impacting the number of truck turns achieved in a day. The simulation model indicates that relatively large reductions in terminal turn times, throughout the system, are required to generate significant improvements. In order to maximize the benefits of reduced terminal turn times, substantial improvements have to be made across the board – at on-dock terminals, off-dock terminals, rail terminals and transload warehouses. The key requirement to maximizing system benefits is a broadly shared and active commitment to improvement.

Recommendation: Reduce Deadhead Trips by Better Coordination

The simulation model indicates that substantial benefits can be generated if deadhead trips can be reduced through more efficient trip patterns. Unlike terminal turn times, more efficient trip patterns are unlikely to be achieved by any single participant in the logistics system. Solutions require better information flows and enhanced coordination among shipping lines, importers and exporters, and on-dock and off-dock terminals. A Virtual Container Yard is one potential approach to explore for enhancing coordination, and other approaches should be pursued.

In addition, a number of recommendations for further research have been suggested, including detailed data analysis to identify practical methods of improving efficiency, analysis of the impact of on-dock terminal reservation systems, analysis of queuing at on-dock and off-dock container terminals, analysis of institutional options to cope with increases or to reduce drayage costs, and geographic analysis of drayage trip patterns.

INTRODUCTION

IBI Group has been engaged by the British Columbia Ministry of Transportation to analyze and model container truck movements in the Lower Mainland. This project has been undertaken as an initiative of the Lower Mainland Container Logistics Stakeholder's Forum, which is led by the BC Ministry of Transportation and jointly funded by the federal and BC governments. The mandate of the Forum is "to develop and implement logistics and tactical solutions and identify strategic long term solutions that improve the reliability, productivity and efficiency of the land side container logistics system involving trucks, inland facilities and port terminals."

The Forum was created as a means of addressing problems in the Lower Mainland container logistics system highlighted by the withdrawal of service by container truck drivers belonging to the Vancouver Container Truck Association (VCTA) in the summer of 2005. In addition to low rate levels, the VCTA identified two major sources of inefficiencies in the container logistics system which were reducing drivers incomes.

The first related to long queuing delays at the on-dock and off-dock container terminals which resulted in a reduction in the number of trips which drivers could make in a day. The second related to changes in trip patterns associated with increased use of off-dock storage, which often required long "deadhead" trips with an empty chassis to pick up empty containers from off-dock storage terminals. This also limited driver income because they were not paid for trips without a container, and the additional trip miles resulted in increased costs.

The 2005 service withdrawal was settled through establishment of a two year agreement which specified substantially increased rates to be paid to container truck drivers. This agreement expires on August 2, 2007, and there is continuing concern over the impact of on-dock and off-dock terminal operating practices on the efficiency of the trucking industry. This study is designed to assess the current state of efficiency of Lower Mainland container trucking, and to identify high priority options for improvements in system efficiency.

The scope of the work contracted to IBI Group includes the assembly, processing and analysis of survey data provided by BC Ministry of Transportation, development of a visual simulation model to analyze the impact of changes to container logistics system parameters, and recommendations for further study.

This report includes a description of the survey data gathered through the efforts of the BC Ministry of Transportation, and analysis to establish benchmark measurements of existing system efficiency based on terminal turn times, truck trip patterns, and daily driver itineraries.

We wish to recognize the contribution of the Greater Vancouver Transportation Authority (TransLink) for the development and provision of one of essential sources of data for this project. TransLink provided Global Positioning System (GPS) tracking equipment, management of field work and storage of satellite data at no cost to the Ministry of Transportation for this project work. GPS tracking units were placed in trucks with TransLink's assistance to track truck movements throughout the Lower Mainland.

The following TransLink staff assisted the project in directing and advising on key aspects of the fieldwork: Clark Lim P.Eng.; Ken Tseng P.Eng.; and Ryan So.

The original idea for incorporating this data approach into the project was generated by Tom Culham P.Eng. of City University and Clive Rock P.Eng. of TransLink.

1. DESCRIPTION OF DATA

The analysis in this report is based on the following sources of data.

1.1 Survey Data Collected Through the Efforts of the BC Ministry of Transportation

This includes survey data from three separate sources:

- Electronic data generated by Global Positioning System (GPS) tracking devices temporarily installed on a sample of container trucks, and associated driver trip diaries. GPS devices were installed on twenty trucks belonging to two different trucking companies, and trip diaries were recorded, between November 20 and December 18, 2006. The GPS devices were supplied by Translink, and the methodology mirrored that used by Translink to develop a database of average travel times and speeds between major regional centres for their 2003 Greater Vancouver Travel Time Survey.
- The GPS data includes observations on truck identification and location at 5 second intervals throughout the work day. The associated trip diaries include 251 daily trip sheets encompassing 1531 origin-destination trips. The trip diaries included information on dates, trip origins and destinations, chassis and container numbers, queuing delays, time of entry through terminal gates, check boxes for container status (carrying a full container, carrying an empty container, no container (but pulling chassis), and bobtail (no chassis)), and check boxes (optional) indicating additional trip parameters such as coffee breaks, fuelling, maintenance, or other. A sample of the survey form is reproduced in Appendix A.
- Container Driver Trip Survey forms designed by BC Ministry of Transportation. These were issued to drivers who filled them out between November 14 and December 8, 2006. This generated 177 trip sheets encompassing 1218 origin-destination trips.
- Samples of company daily trip sheets used for billing purposes by one trucking company. The sheets in the sample were recorded between October 6 and November 24, 2006. These were provided to BC Ministry of Transportation by the company and include information on dates, trip origin and destinations, trip start and end times, and container numbers. This source generated 167 daily trip sheets encompassing 1117 origin-destination trips.

A summary of the sample data generated from BC Ministry of Transportation's survey initiatives is shown below:

BC Ministry of Transportation Survey Data				
	Source			
Sample Data	GPS sheets	CDTS	Trip Sheets	Grand Total
Number of Daily Trip Sheets	251	177	167	595
Number of Trips	1531	1218	1117	3866
Period	Nov 20- Dec 18	Nov 14 - Dec 8	Oct 6 - Nov 24	

Data generated from the BC Ministry of Transportation surveys was entered into an Access database designed by IBI Group.

Data Sample Limitations

While the data gathered through these surveys provides a useful basis for analyzing the efficiency of container truck movements under current conditions, the sample limitations must be kept in mind when drawing conclusions about the system as a whole:

The origin-destination patterns in the sample data are not representative of the system as a whole. The sample surveys are drawn from only 4 companies out of 125 local drayage companies listed as licensed to serve the port on the Pacific Gateway Portal website at http://www.pacificgatewayportal.com/tlsportal/. As an illustration of the size of the sample relative to total trips, the trucks in the sample generated 175 trips to Centerm in November out of a total of 3929 reported on the Pacific Gateway Portal website, or around 4.5% of the total. With the exception of the on-dock and off-dock container terminals which are essentially common facilities accessed by all container trucking firms, the origins and destinations included in the sample represent only those customers with whom these companies have commercial relationships.

None of the survey trip sheets provide sufficient data to distinguish individual components of terminal turn times i.e. to distinguish between queuing delays and processing times within the terminals. Similarly, they provide insufficient data for analyzing the impact of service stops (for the driver, truck or chassis) on trucking efficiency. The Container Driver Trip Survey Forms do not provide sufficient data to analyze travel and turn times; all analysis of travel and turn times was limited to the GPS and company trip sheets.

The survey trip sheets do not provide sufficient data to distinguish delays caused by terminal operating procedures which occur outside of port property. The most significant potential source of these delays relates to the mandatory reservation systems adopted by the in-dock container terminals. Trucks are not allowed to queue at the terminal gates prior to the reservation grace period, which may result in trucks being forced to wait outside of the port property. These delays would be recorded as increased travel times rather than increase turn times at the terminals.

1.2 External Data Sources – Vancouver Port Authority

In addition to the survey data provided through the BC Ministry of Transportation, data related to truck movements on the South Shore of the Port of Vancouver's Inner Harbour facilities has been obtained from Vancouver Port Authority (VPA). This data includes the following:

Entry and exit data from VPA's Vehicle Access Control System (VACS). This is gathered as trucks enter and exit at the security checkpoints at the truck entrances at Clark Street and Commissioner Street, thereby providing data on the total time spent by the truck within the port boundaries ("turn time") on each individual trip.

Data on truck turn times within VPA's boundary on the South Shore of the Inner Harbour generated by VPA's Radio Frequency Identification Device (RFID) technology pilot project. This project uses radio frequency "tags" attached to a sample of the container truck fleets which are read by "readers" installed at locations along the port roadways to generate truck movement data including truck identification, time of day and location.

Data posted by Vancouver Port Authority on the Pacific Gateway Portal website including turn times within the port, turn times within the terminal (Centerm), dwell times outside the terminal gates, truck arrivals by time of day, and reservation system compliance. This data is generated from VPA's VACS and RFID systems, and Centerm terminal data.

2. DRIVER DAILY ITINERARIES

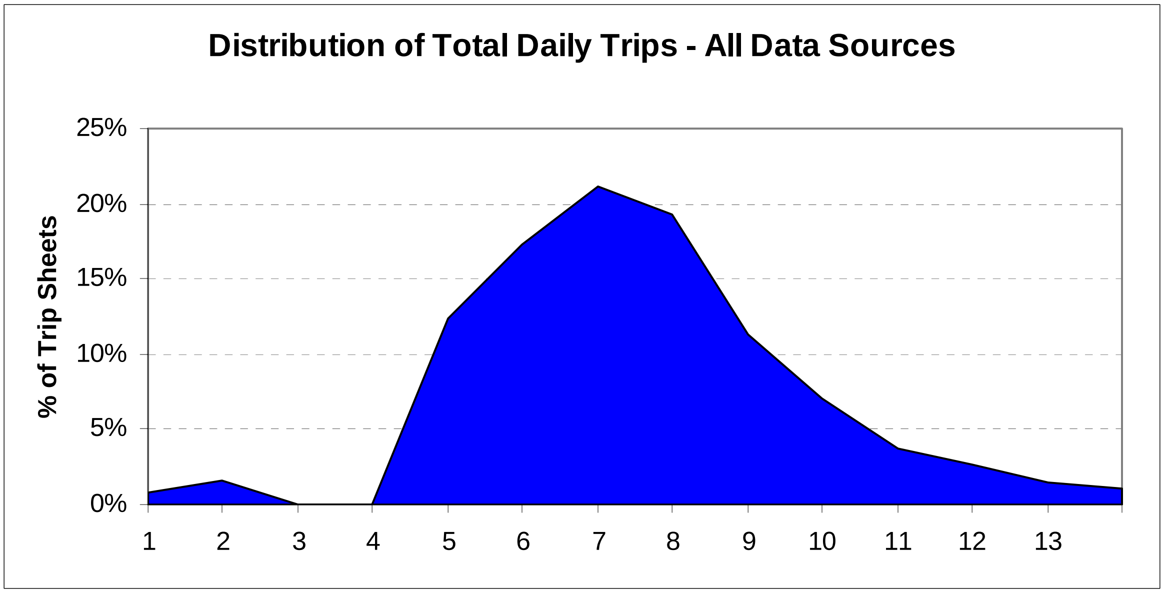
The analysis in this section is based on the 533 daily trip sheets collected in the three surveys generated by the Ministry of Transportation and Translink.

2.1 Average Daily Trips – Loaded and Empty

The average number of trips (one way legs) per day for each sample source is shown below. The distribution between empty and loaded trips does not appear to vary much between the sample sources; the overall average is 7.2 trips per day.

	Trip Sheets	GPS Sheets	CDTS	Grand Total
Average Daily Trips	6.8	7.6	7.0	7.2
Total Trips	1117	1531	1218	3866
Container (Loaded or Empty)	773	1061	834	2668
No Container (Bobtail or Empty Chassis)	335	397	232	964
Container Status Unknown	9	73	152	234

The distribution of the number of trips is shown below:



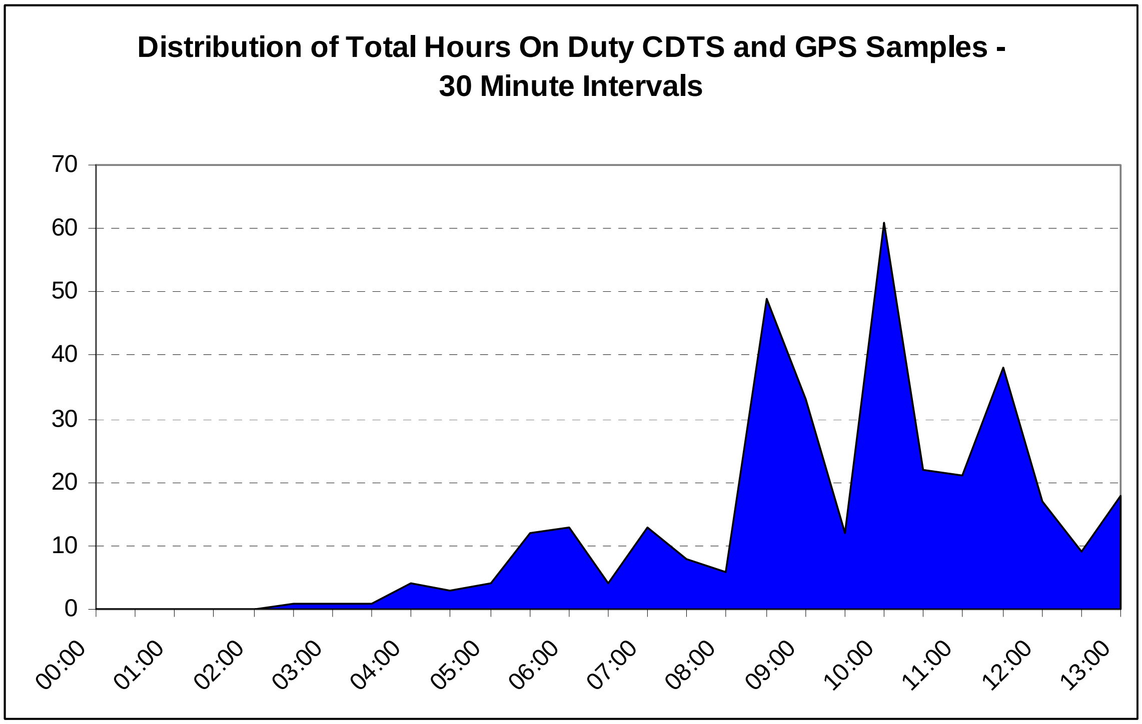
The distribution of trips between loaded trips (i.e. trips in which the truck transports a loaded or empty container) and empty trips (i.e. trips with an empty chassis or "bobtail", with no chassis) is important as an indicator of system efficiency and as an indicator of owner/operator revenue. The increase in empty "third leg" trips due to the expansion of off-dock storage of empty containers was identified by the VCTA as a major factor in the 2005 strike. Of the trips for which the status is known, 73.5% of trips were loaded and 26.5% were bobtail or empty chassis. On this basis, drivers would average 5.3 loaded trips and 1.9 empty trips on an average day.

2.2 Hours On Duty

The average number of hours on duty was similar for drivers completing the Container Driver Trip Survey form and for drivers in the GPS sample. Data was not available from drivers in the Trip Sheets sample.

Total Hours on Duty by Data Source

	CDTS	GPS	Trip Sheets	Total
Mean	9:54	9:30	n/a	9:39
Standard Deviation	2:39	2:17	n/a	2:26
Observations	142	238	n/a	380



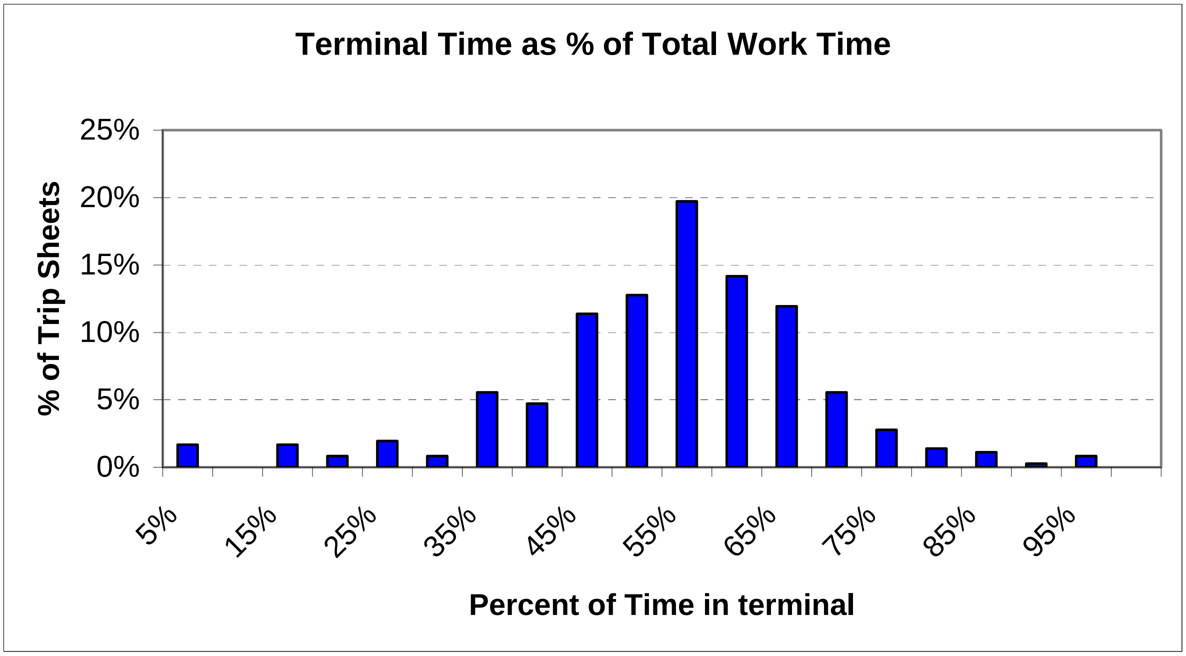
2.3 Distribution of Driver Trip Time – Travel vs. Terminal Turn Time

Drivers' "work" time – the time spent on container trips, including travel and turn times, averages around 7 hours and 35 minutes.The percentage of total time on duty spent traveling, and the time spent at terminal, is an important indicator of the high potential areas for improvements in trucking efficiency. On average, the drivers in the surveys spent 52% of their work time waiting or being processed at terminals.

Percentage Of Work Hours Traveling vs. Time Spent in Terminals

	Travel Time	Terminal Time	Total Time*
Mean (Hours)	3:44	3:55	7:35
% of Total Hours	48%	52%	
Standard Deviation (Hours)	1:24	1:30	2:08
Observations	354	355	361

*Total does not add due to variation in sample size.



2.4 Key Findings

Drivers are achieving an average of 7 one-way trips per day, but the trucks are loaded with a container for only 5 of these on average.

Drivers average approximately 9.7 hours on duty per day. This includes approximately 2 hours of "mobilization" time at the beginning and end of shifts, in addition to the time spent travelling and at terminals during container trips.

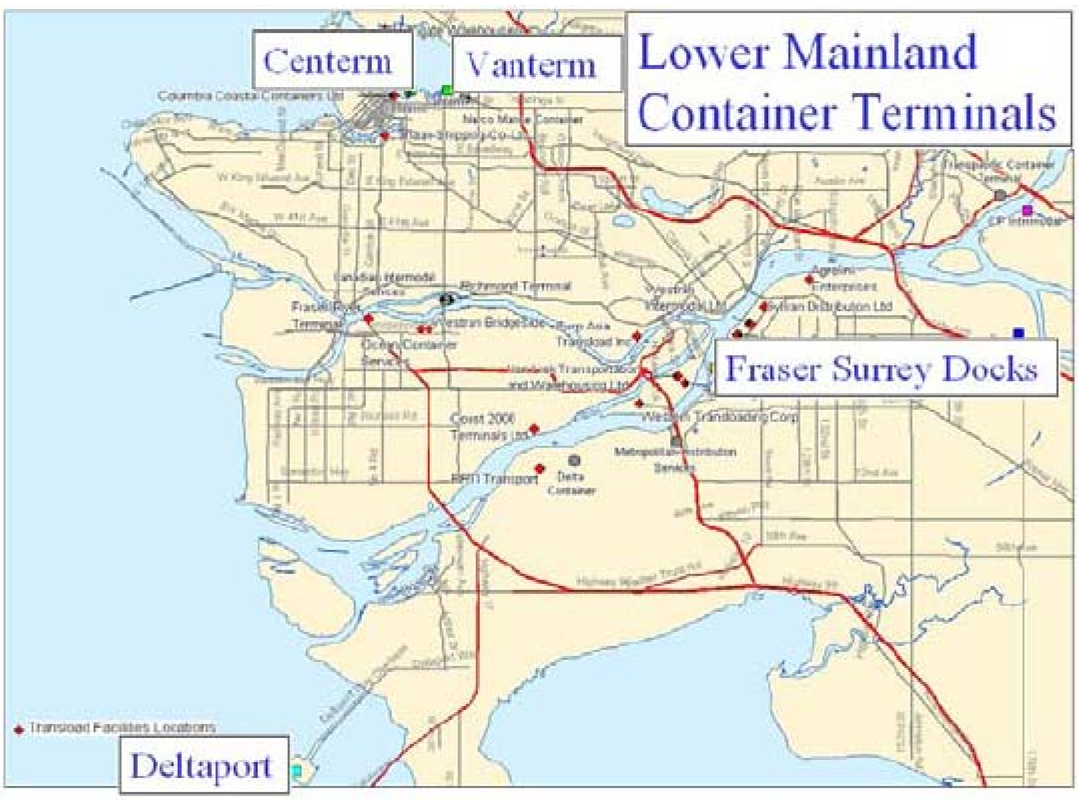
More than half of drivers' work time is spent waiting or being processed at terminals.

3. TERMINAL PERFORMANCE

3.1 Overview of Terminal Roles in Lower Mainland Container Logistics

The terminals which are identified as container trip origins and destinations in this study fall into four broad categories, each with a specific role in the Lower Mainland container logistics system.

3.1.1 On-Dock Container Terminals load and unload containers from ocean-going vessels, marshal them in their container yards, and transfer them to rail cars and trucks which provide the connecting links to inland destinations. There are 4 on-dock container terminals in the Lower Mainland- Centerm, Vanterm, Deltaport, and Fraser Surrey Docks – located as shown below:



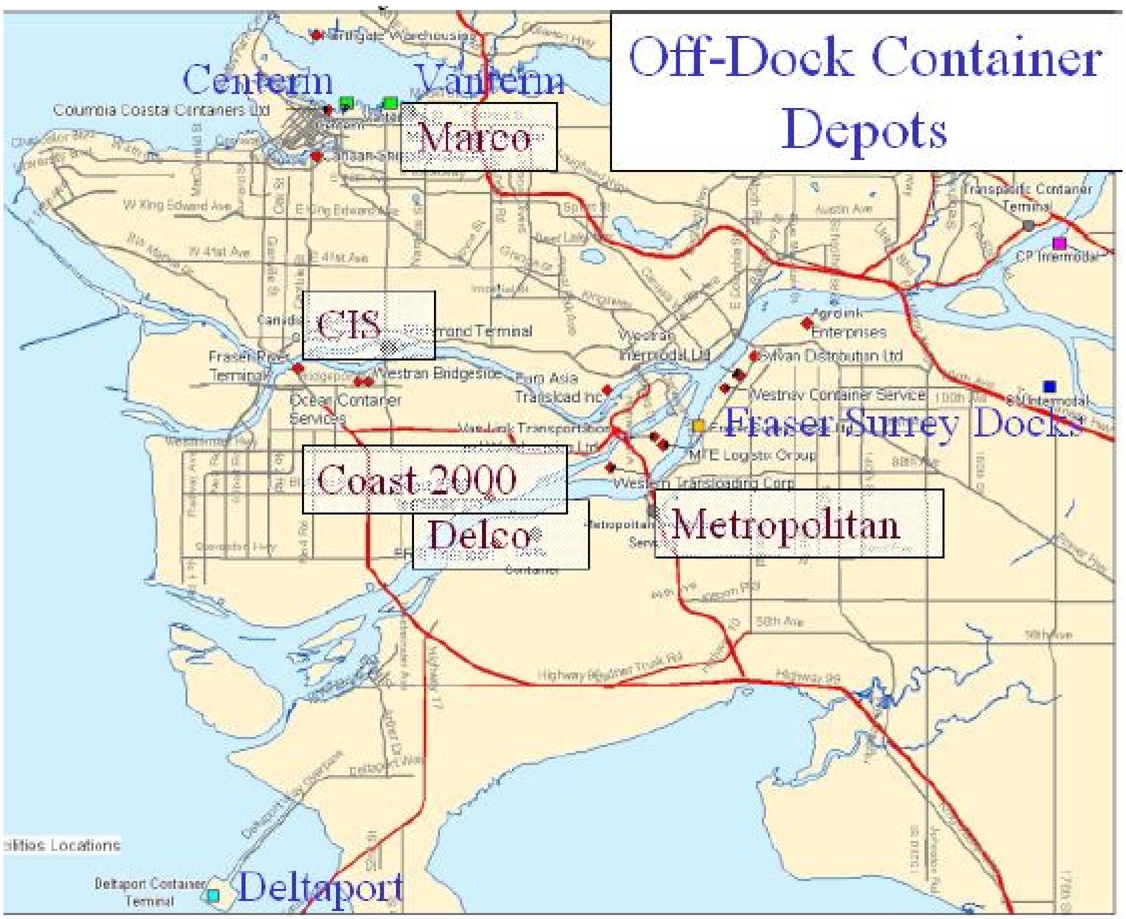
Approximate nominal capacities of the terminals are shown below:

Terminal	Capacity 2006 (TEU's)
Centerm	800,000
Vanterm	600,000
Deltaport	900,000
Fraser Surrey Docks	450,000
Total	2,750,000

Deltaport and Vanterm have been operating at throughput levels exceeding their design capacity throughout 2006.

Approximately 35% of import containers entering the Lower Mainland on-dock terminals are transferred by truck from the on-dock terminals to regional destinations or transload warehouses. The balance is loaded to rail cars for direct transfer to destinations outside of British Columbia.

3.1.2 Off-dock Container Terminals provide storage, maintenance and repair of empty containers. In December 2006 there were 5 major off-dock container terminals in the Lower Mainland - Canadian Intermodal Services, Coast 2000, Delco, Marco, Metropolitan – located as shown below:

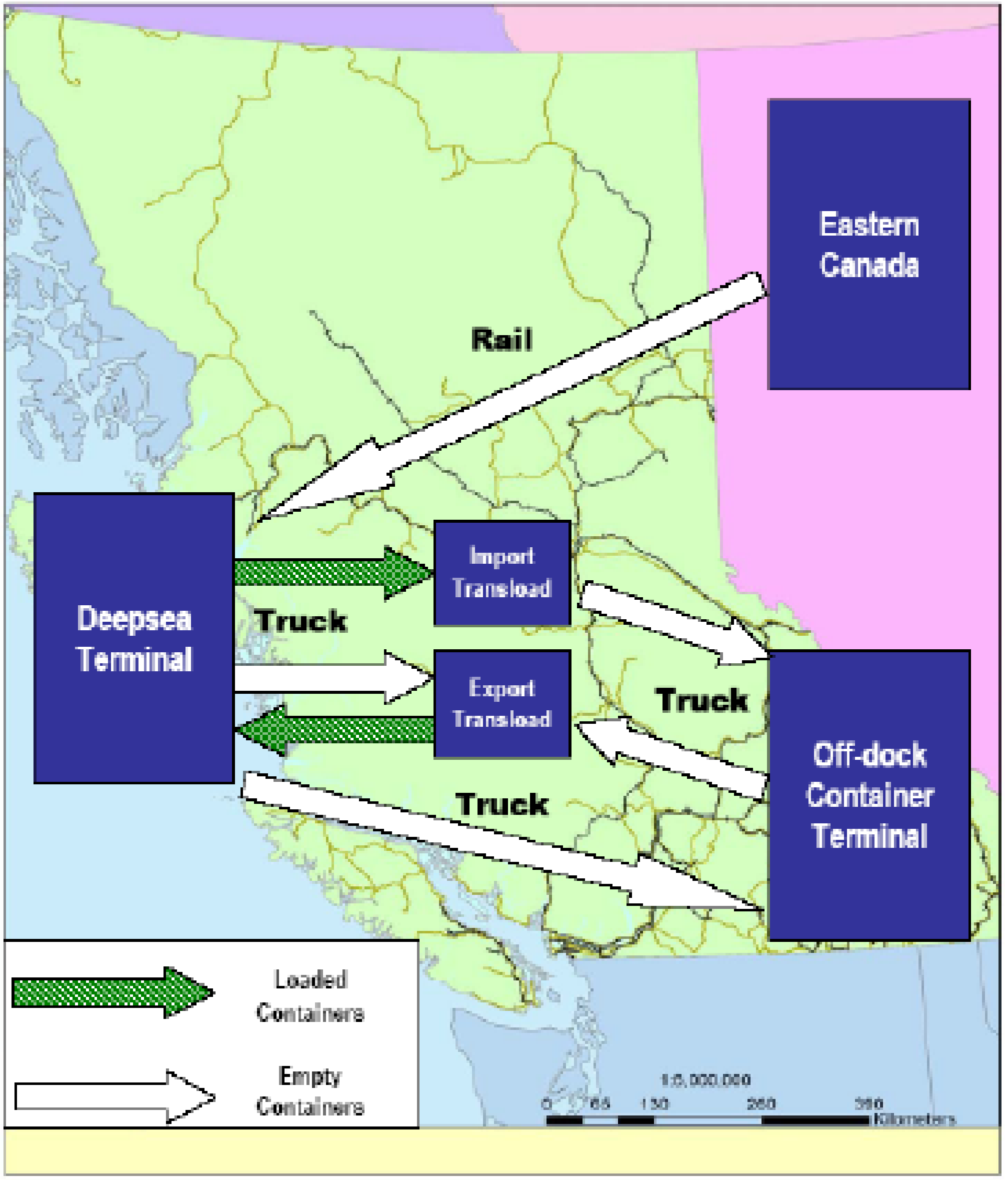


The off-dock container terminals have assumed a larger role in the container logistics system due to increased use of off-dock container facilities for storage of empty containers. In December 2003 the Vancouver Port Authority announced a target of moving 50% of empty containers to off-dock storage to improve the throughput capacity of the on-dock terminals. Spurred by recurring on-dock terminal congestion, the on-dock terminal operators at the Port of Vancouver have tightened their restrictions on the storage of containers, and in the case of the terminals operated by Terminal Systems Inc. (TSI) – Deltaport and Vanterm - imposed substantial penalties for containers which are delivered too far in advance of vessel loading or not picked up promptly after they are unloaded from the vessel.

3.1.3 Rail Intermodal Terminals include CP Rail's Vancouver Intermodal Facility (VIF) in Pitt Meadows and CN's Vancouver Intermodal Terminal in Surrey. Traffic at these facilities is primarily "domestic" cargo in 48 or 53 foot containers, including inbound marine cargo transferred from 20 or 40 foot marine containers to the larger domestic containers to improve the efficiency of inland movement.

3.1.4 Transload Facilities are warehouses or distribution centres where cargo is loaded or unloaded from containers for storage, delivered to end users, or transferred to truck or domestic intermodal containers for further shipment. These tend to specialize in either imports or exports. Import traffic consists primarily of consumer products for final consumption regionally or in the rest of Canada. Export traffic consists primarily of forest products and specialty grains. Empty containers generated by unloading of import cargo may be transferred by truck back to the on-dock terminal for an empty return by vessel to Asia, to an off-dock container terminal for storage in anticipation of being reloaded with exports, or transferred directly to an export transload warehouse for loading. The last alternative is referred to as "triangulation" since it reduces the number of truck trips made by the container from 4 to 3. Typical container circulation patterns under the current system are shown below:

Empty Container Terminal - Current System (Off-Dock Storage)



3.1.5 Yards and Other Facilities are primarily sites for the storage and parking of empty chassis or trucks.

3.2 Overall Terminal Performance

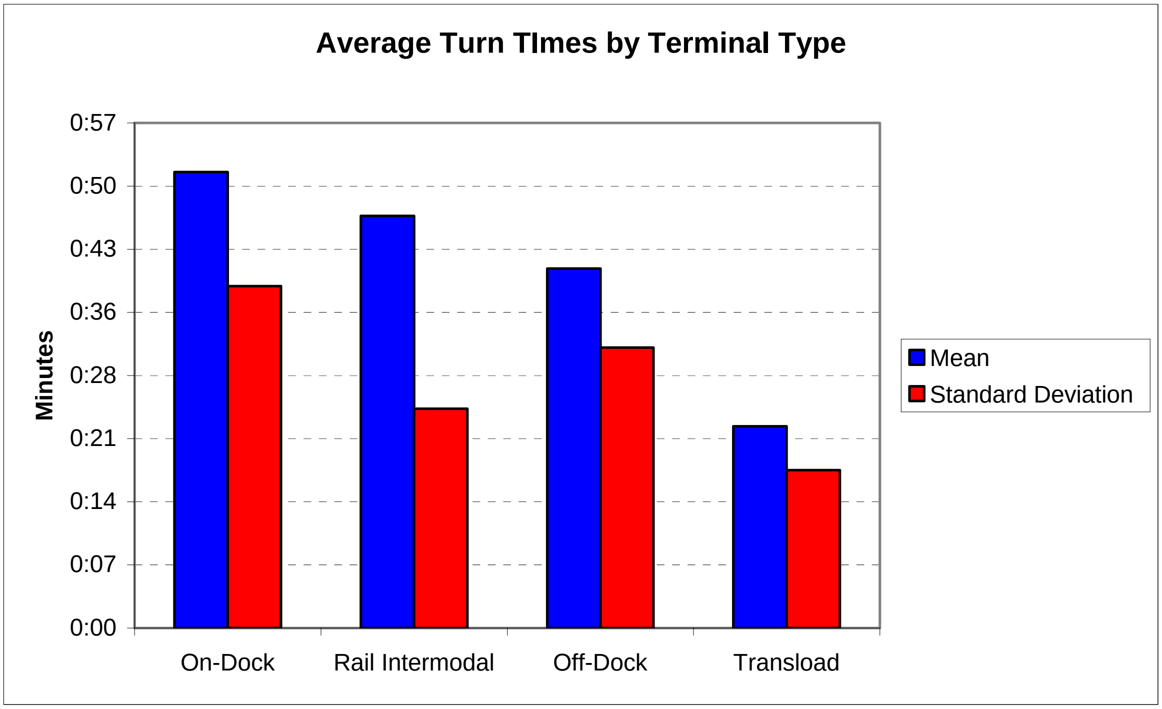
Average travel and turn times are shown below for the different types of terminals are shown below:

Average Turn Times*: Container Handling Facilities

	Dock	Rail Intermodal	Off-Dock	Transload
Total Trips	1113	116	757	1079
Average Turn Time	0:52	0:47	0:41	0:23
Standard Deviation of Turn Time	0:39	0:25	0:32	0:18
Average Total Trip Time	1:23	1:14	1:12	1:04
Standard Deviation of Total Trip Time	0:50	0:48	0:42	0:39

*Turn times include queuing delays.

Only the GPS survey and company trip sheets include data on total travel and turn times (queuing delay plus processing time) for trips to the various terminals, and the averages above are based only on the total of those trips (360 trip sheets encompassing 2648 trips). On average the sample trips to on-dock terminals are slightly longer than those to the intermodal rail terminals, and shorter than trips to off-dock container terminals and transload facilities. Terminal turn times are highest for the on-dock terminals, averaging 52 minutes. Turn times at transload facilities are significantly lower than at the other terminals. Operations at these sites usually consist of dropping and/or picking up a container and chassis, which does not involve lifting the container from the chassis, but in some cases the truck driver incurs a delay waiting while cargo is unloaded from or loaded into a container.



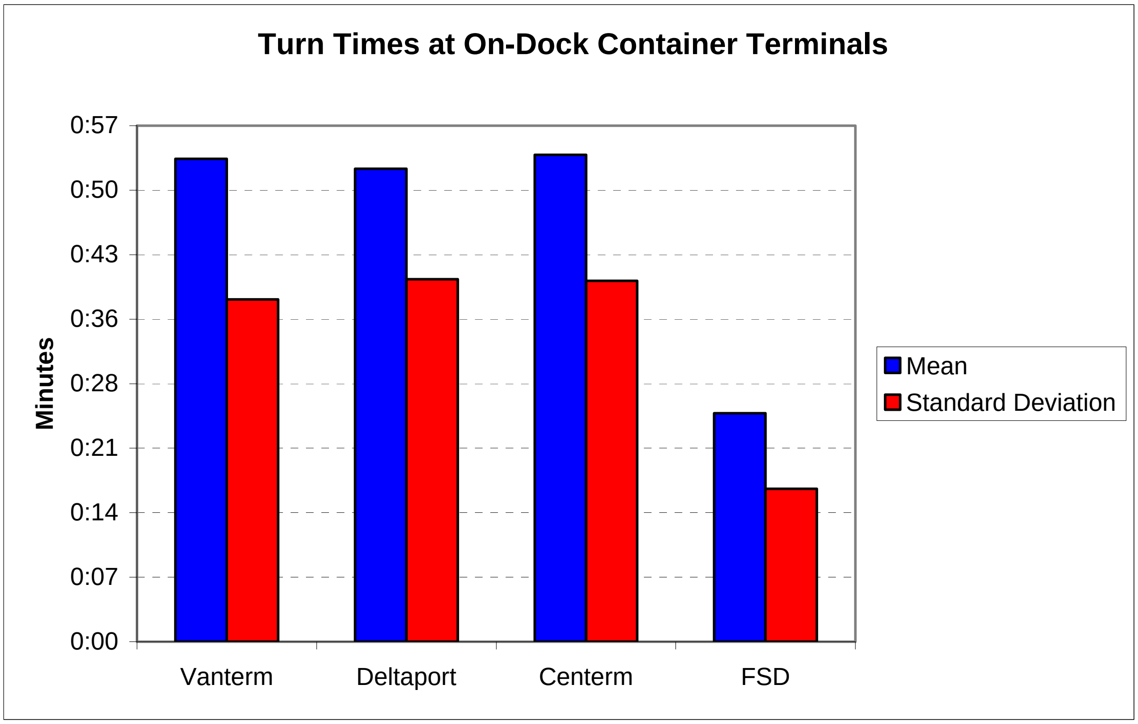
The standard deviations are high relative to the mean for both travel and terminal turn times. This indicates a lack of reliability in the system. The high standard deviation for travel times in total is probably due to the dispersed geographic distribution of origins and destinations.

3.3 Performance of On-Dock Container Terminals

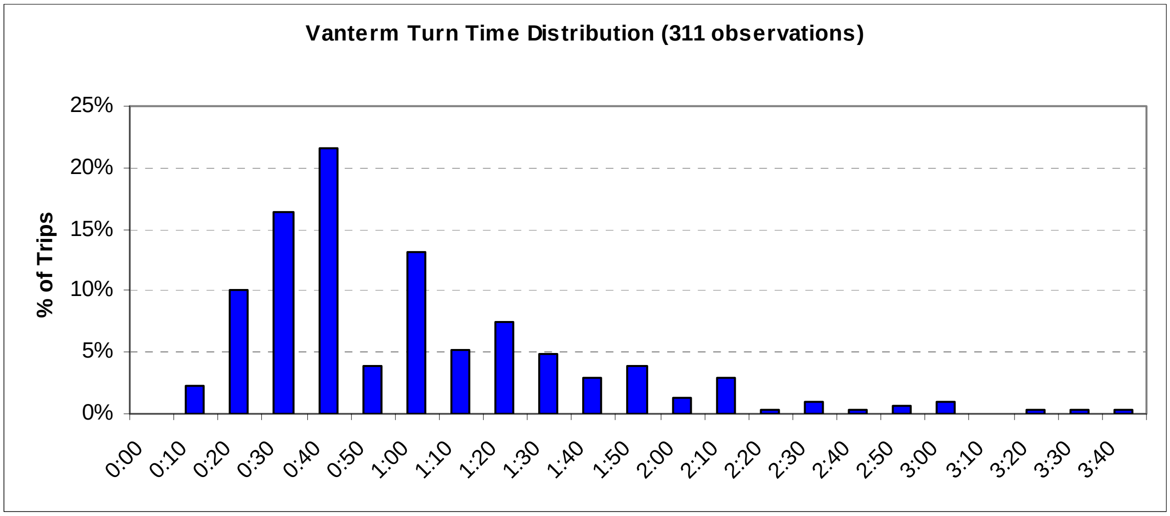
3.3.1 Turn Times

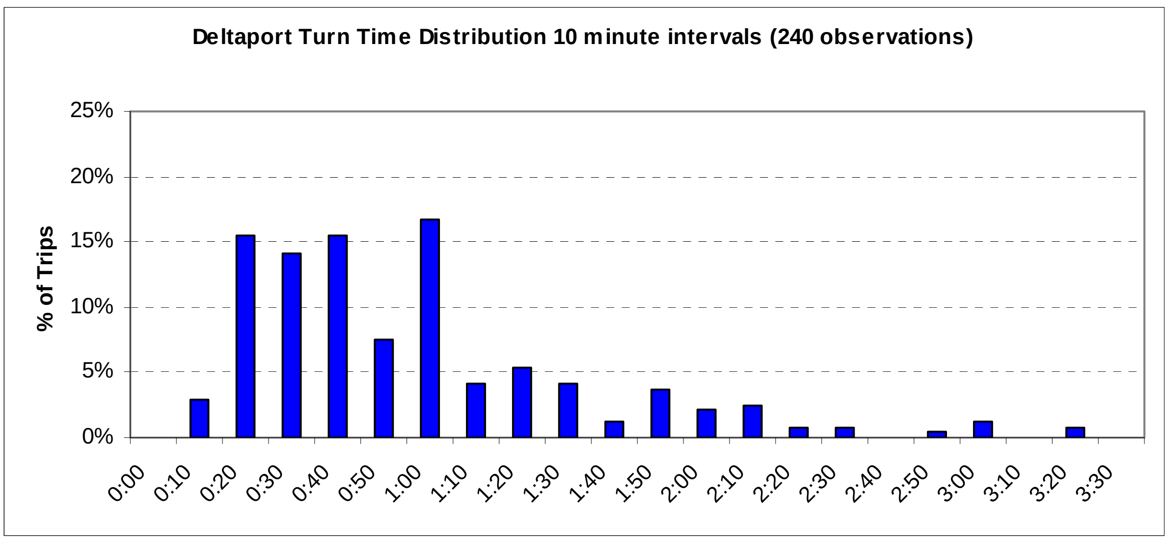
Average turn times at the three larger terminals are almost identical. Turn times at Fraser Surrey Dock are significantly lower, but traffic levels have been low since early in 2006 at this terminal. The standard deviation of turn times is high relative to the average, indicating a high degree of variation.

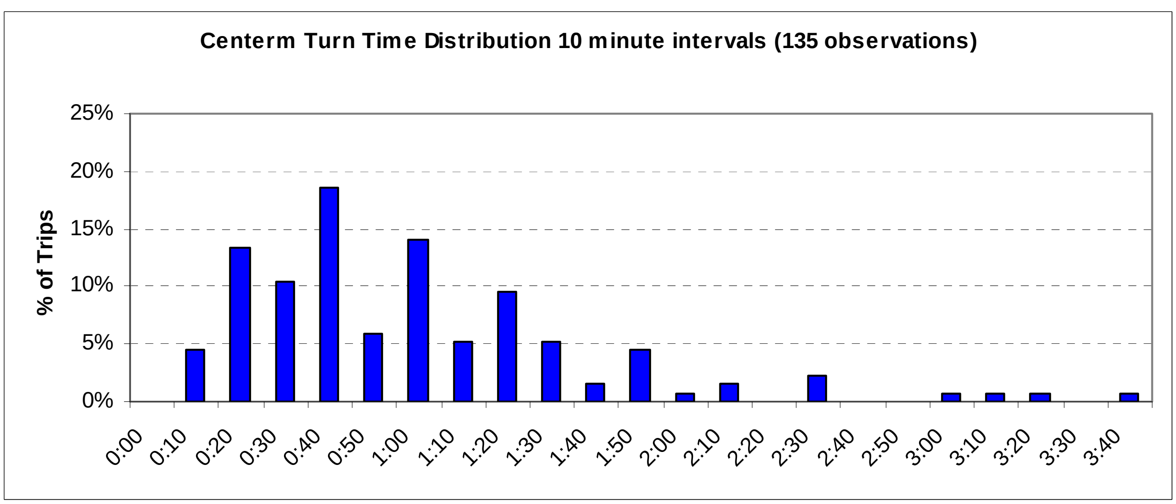
Turn Time Statistics - On-Dock Terminals				
	Vanterm	Deltaport	Centerm	FSD
Mean	0:53	0:52	0:54	0:25
Standard Deviation	0:38	0:40	0:40	0:17
Observations	311	240	135	22



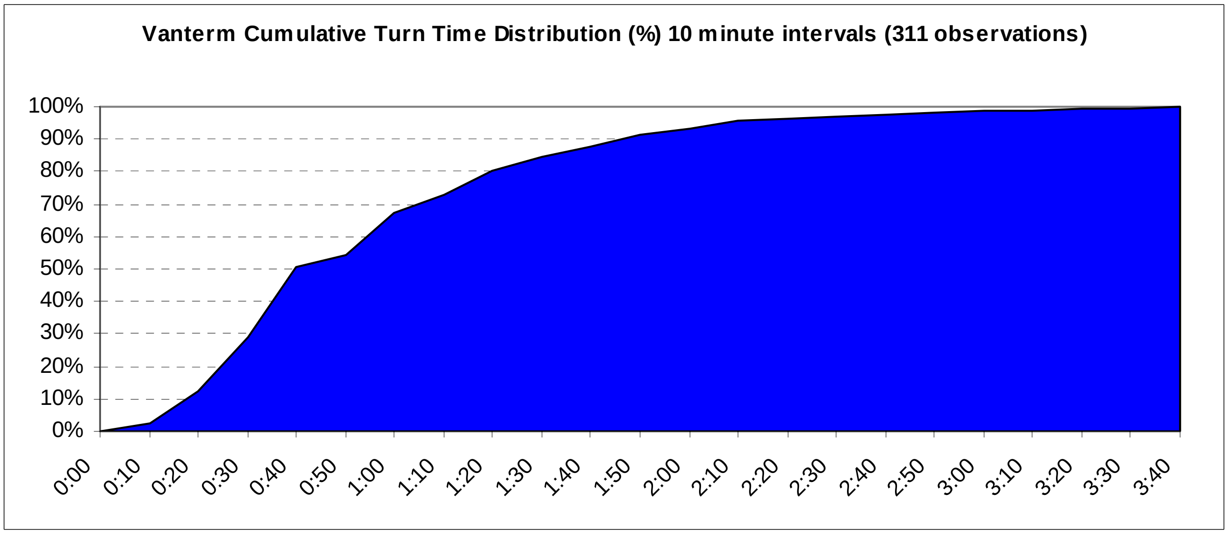
A more detailed breakdown of on-dock terminal turn times is shown below.

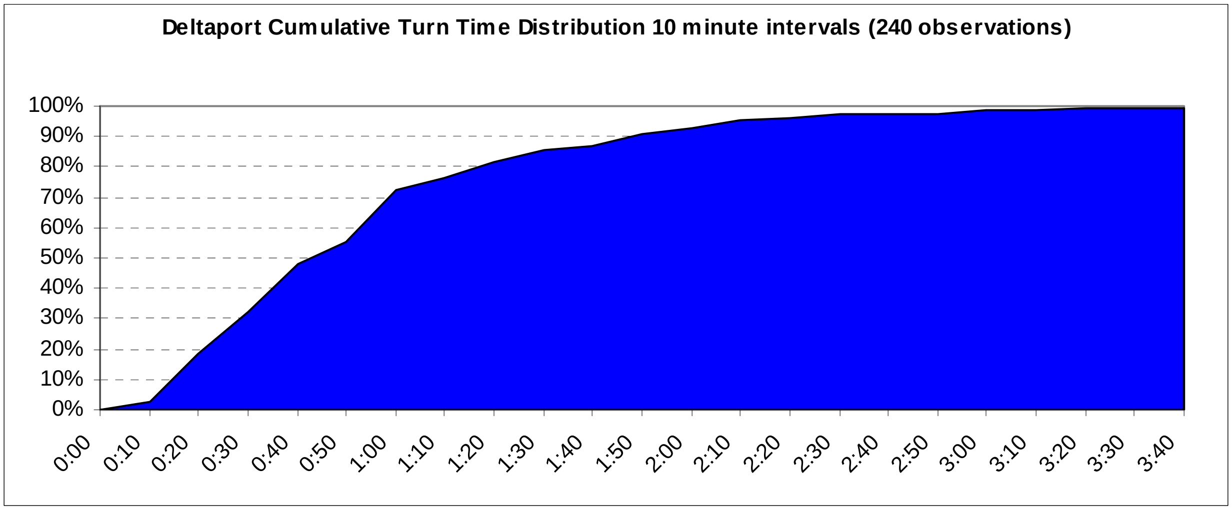


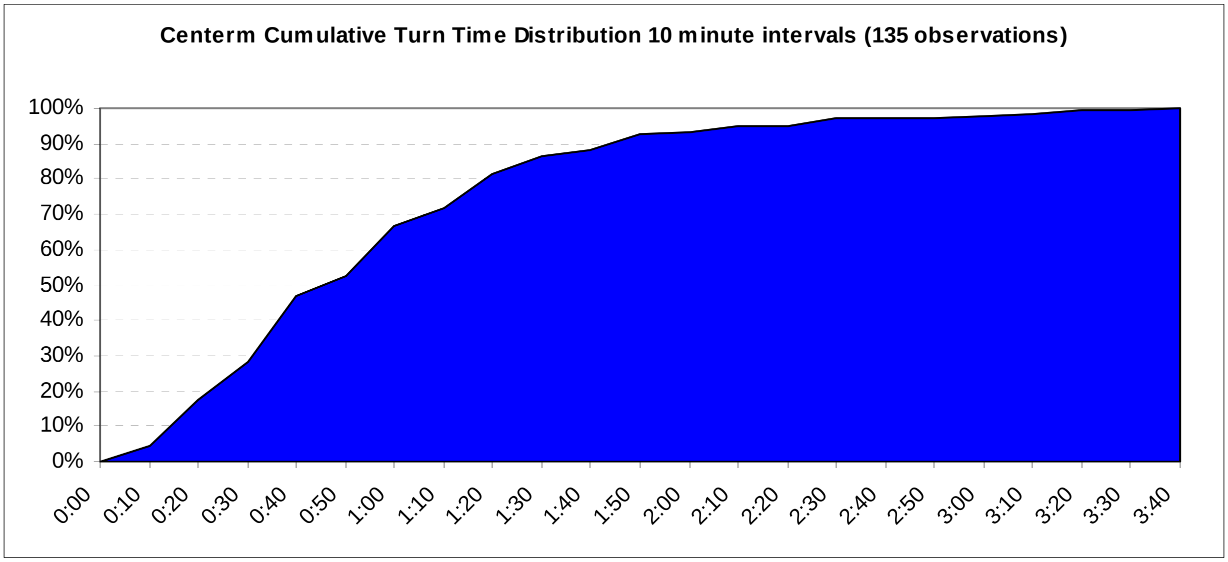




All terminals exhibit similar distributions. Cumulative distributions are shown below:







The cumulative distributions are almost identical; for all three terminals, around 80% of trucks are processed within 80 minutes of arrival time. A more detailed breakdown is shown below:

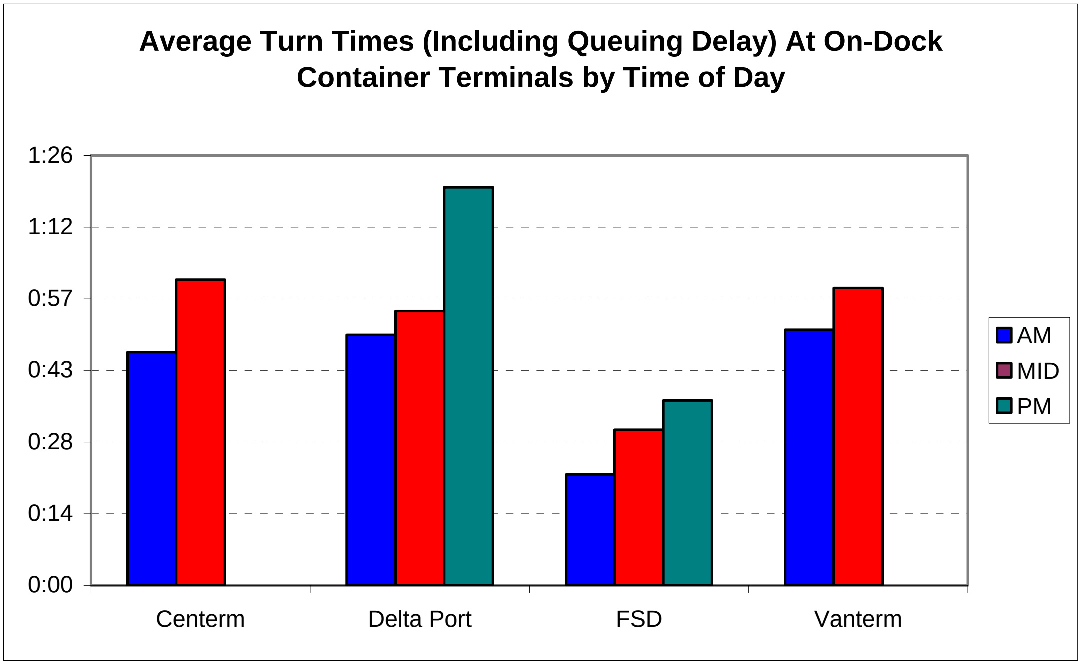
On-Dock Container Terminals Distribution of Turn Times

Vanterm	0-30 Minutes	30-60 Minutes	60-90 Minutes	90-120 Minutes	Over 120 Minutes
Trips	38	130	80	36	26
% of Total	12%	42%	26%	12%	8%
Cumulative %	12%	54%	80%	92%	100%
Deltaport	0-30 Minutes	30-60 Minutes	60-90 Minutes	90-120 Minutes	Over 120 Minutes
Trips	44	89	63	22	22
% of Total	18%	37%	26%	9%	9%
Cumulative %	18%	55%	82%	91%	100%
Centerm	0-30 Minutes	30-60 Minutes	60-90 Minutes	90-120 Minutes	Over 120 Minutes
Trips	24	47	39	15	10
% of Total	18%	35%	29%	11%	7%
Cumulative %	18%	53%	81%	93%	100%

For purposes of analysis, the trips were divided into three categories based on trip start times: AM (trip start prior to 9 a.m.), Midday (trip start between 9 a.m. and 3 p.m.), and PM (trip start after 3 p.m.). Few observations were recorded for trips starting after 3 p.m. destined for the on-dock terminals. All of the on-dock terminals show increasing turn times as the day wears on; there was only 1 PM trip destined for Centerm and none for Fraser Surrey Docks in the sample.

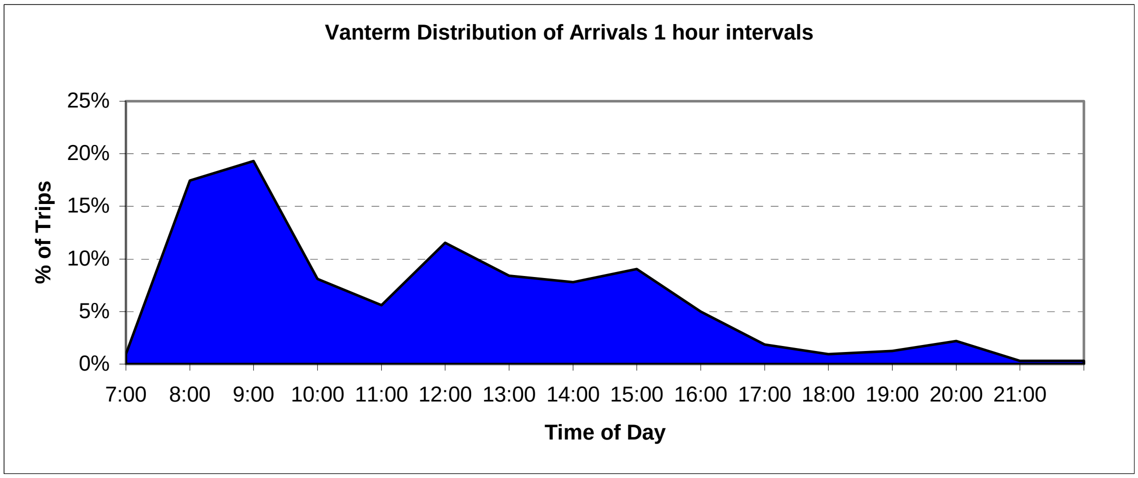
On-Dock Terminals Average Turn Times (Including Queuing Delay) by Time of Day

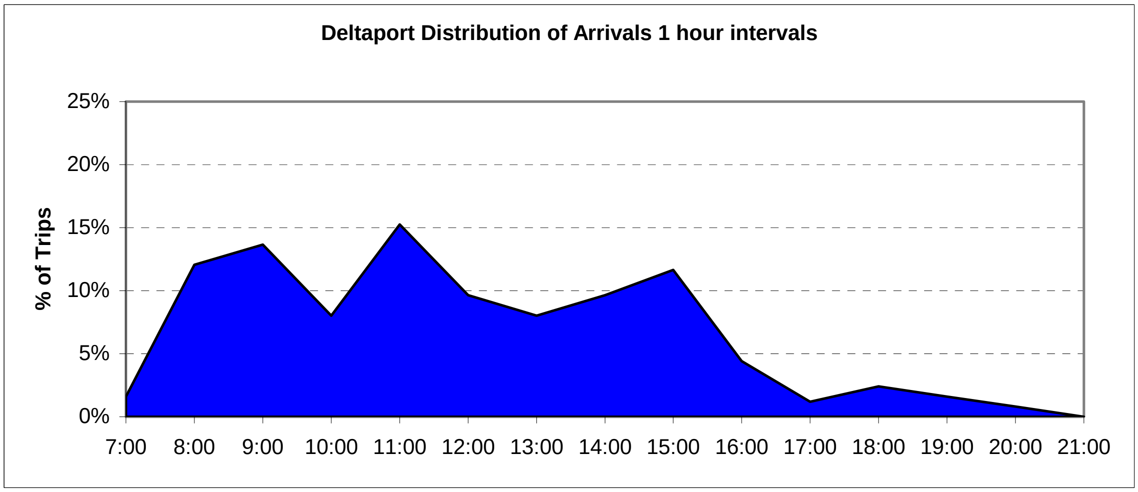
	AM				AM Total
Data	Centerm	Delta Port	FSD	Vanterm	
Average Turn Time	0:46	0:50	0:22	0:51	0:48
Observations	88	187	30	197	502
	MIDDAY				MID Total
	Centerm	Delta Port	FSD	Vanterm	
Average Turn Time	1:01	0:55	0:31	0:59	0:57
Observations	129	192	24	215	560
	PM				PM Total
	Centerm	Delta Port	FSD	Vanterm	
Average Turn Time		1:20		0:37	0:40
Observations	1	22	0	45	68
					Grand Total
Average Turn Time					0:52
Observations					1130

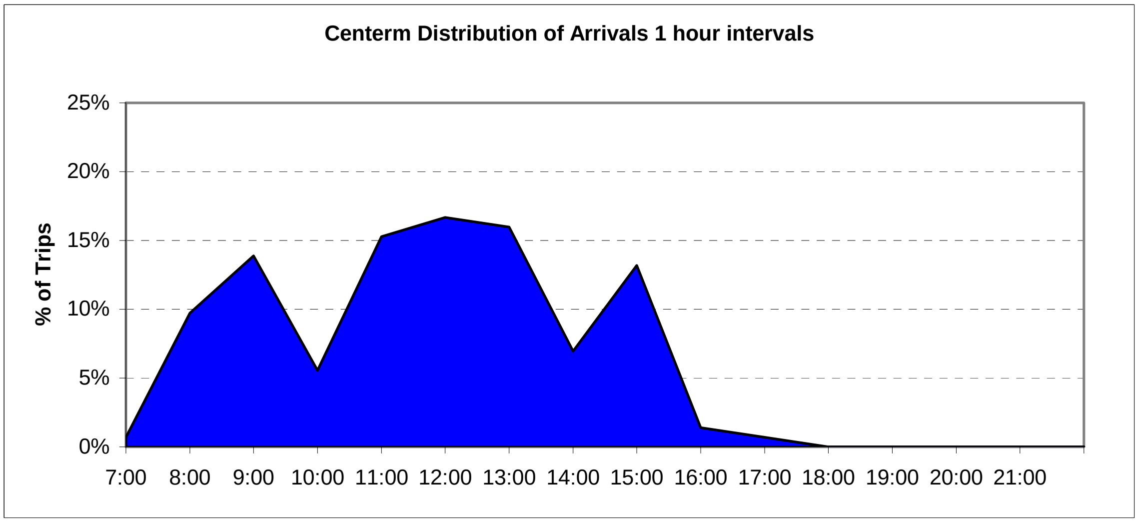


3.3.2 Arrival Rates

Arrival rates by time of day for Vanterm, Deltaport and Centerm are shown below:


Vanterm Distribution of Arrivals 1 hour intervals
% of Trips
25%
20%
15%
10%
5%
0%
7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00
Time of Day

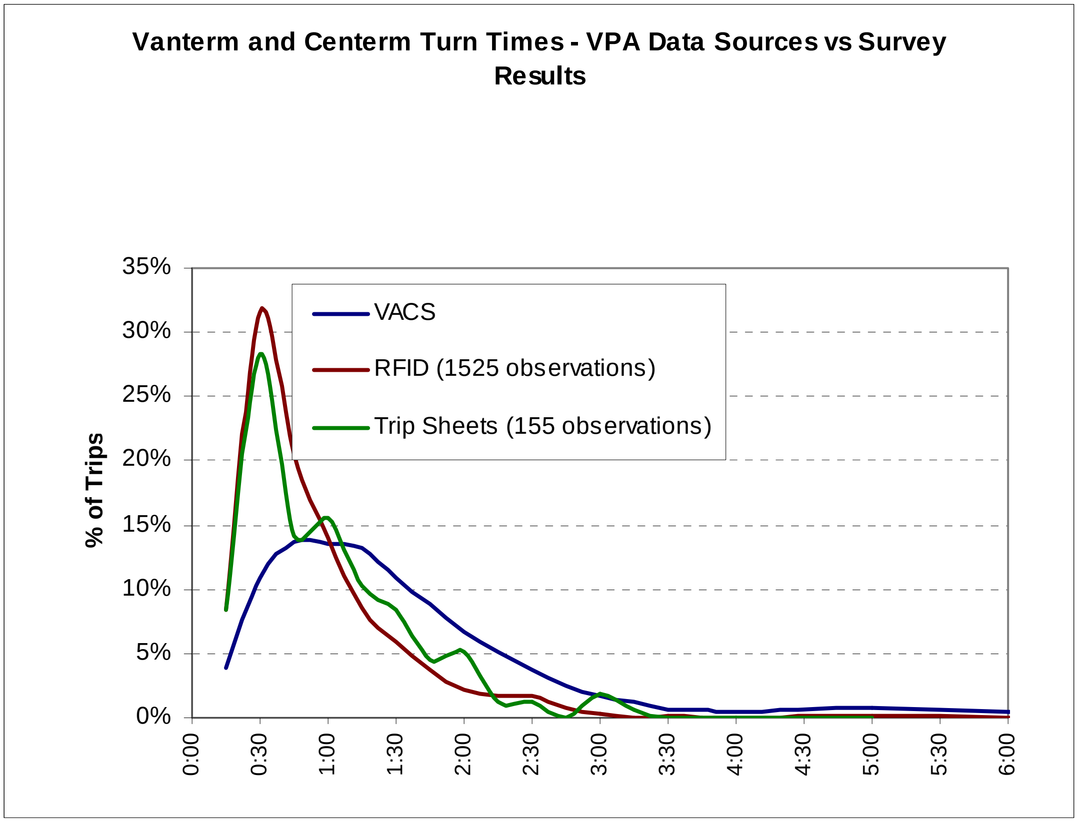

Deltaport Distribution of Arrivals 1 hour intervals
% of Trips
25%
20%
15%
10%
5%
0%
7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00


Centerm Distribution of Arrivals 1 hour intervals
% of Trips
25%
20%
15%
10%
5%
0%
7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00

There is a significant difference between the arrival patterns for the terminals operated by TSI Terminals (Vanterm and Deltaport) and Centerm, in that Centerm's arrival rate has a prolonged peak throughout the midday period, and the others do not. This is probably due to the specific parameters and enforcement policies of the mandatory reservation systems used by the terminals. At least theoretically the mandatory reservation systems control the arrival rate of trucks at the terminal, smoothing the flow to maximize terminal efficiency.

3.3.3 Comparison of Survey Results with Vancouver Port Authority Data

In order to verify the results of the surveys, a comparison was done with data collected by Vancouver Port Authority from their Vehicle Access Control System (VACS)and Radio Frequency Identification Device (RFID) data. The results are illustrated below. The survey data closely resembles the RFID data. The turn times from the VACS data are slightly longer, which is consistent with expectations since the turn times include additional travel time between the access gates and the container terminals.



3.4 Off-Dock Container Terminals Performance

3.4.1 Turn Times

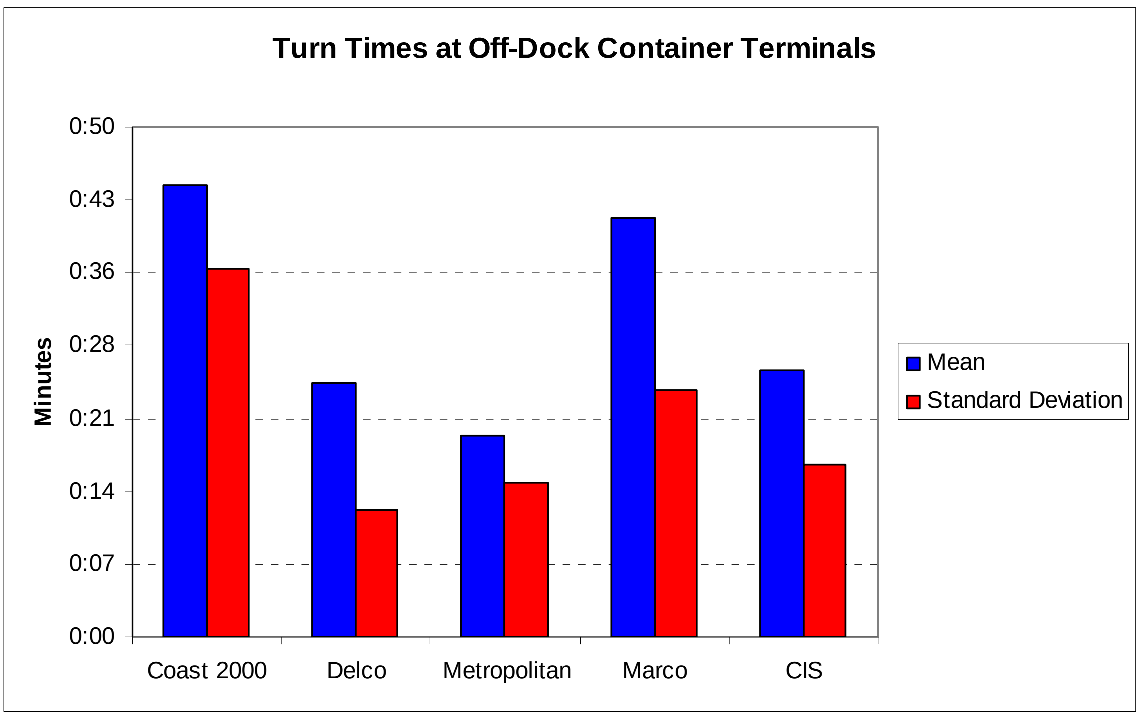
Average turn times for the major off-dock container terminals are shown below:

Average Turn Times – Off-Dock Container Terminals

Average and Standard Deviation of Turn Times* – Off-Dock Container Terminals					
	CIS	Coast 2000	Delco	Marco	Metropolitan
Total Trips	20	449	167	251	50
Average Turn Time	0:26	0:44	0:24	0:40	0:20
Standard Deviation of Turn Time	0:17	0:36	0:13	0:24	0:15

*Includes Queuing Delays

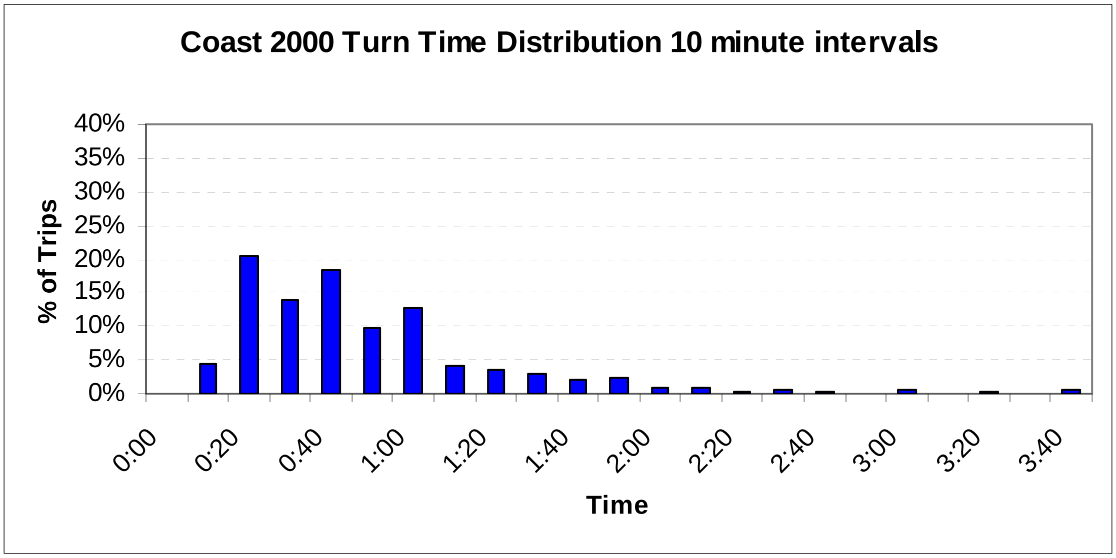
The turn times vary significantly among these facilities, as shown below:



The turn times at the off-dock terminals are significantly less than those at the on-dock terminals. Coast 2000, which has the highest average turn time among the off-dock terminals, still has a turn time which is only 85% of the average for the on-dock terminals. Metropolitan, which has the lowest average turn time among the off-dock terminals, has an average turn time that is only 38% of the average turn time at the on-dock terminals.

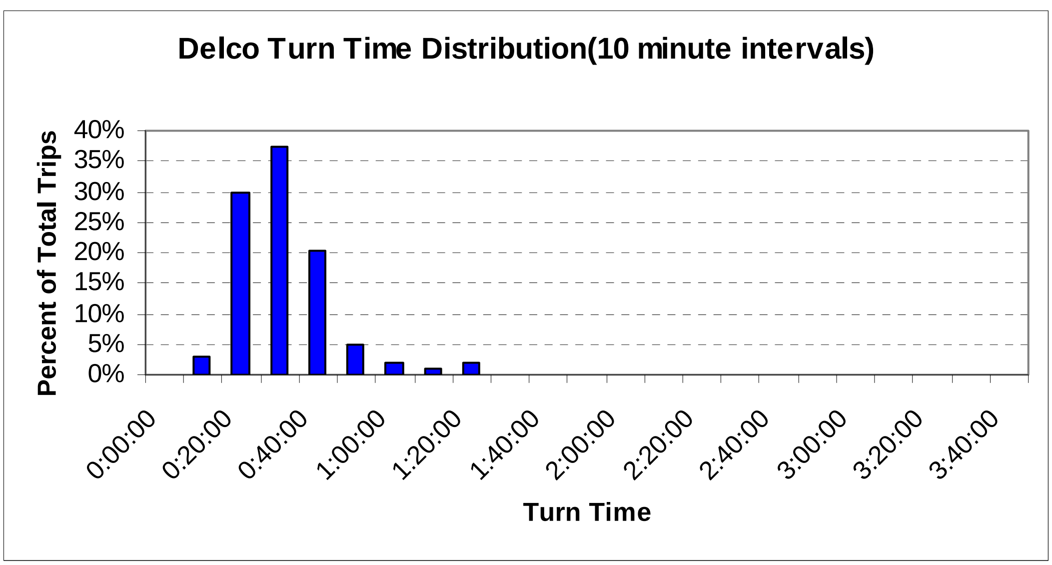
3.4.1.1 Coast 2000

The distribution of turn times by time of day at Coast 2000 is shown in the following graph



3.4.1.2 Delco

For comparison purposes, the turn time performance at Delco is highlighted below. According to our sample data, the average turn time at Delco is 24 minutes, less than half the average at the on-dock terminals and 55% of the average turn time at Coast 2000. Analysis of the cumulative distribution of turn times indicates that Delco processes 80% of trucks within around 35 minutes of arrival.



3.5 Key Findings

Turn times (including queuing delays) are longest at the on-dock container terminals, followed by rail intermodal and off-dock terminals. All terminals have a high level of variation in their turn times.

Turn times at on-dock container terminals average 52 minutes, and are almost identical among the three large terminals (Vanterm, Deltaport and Centerm). On average, these terminals process 80% of trucks within 80 minutes.

Turn times at off-dock terminals average 41 minutes, but there are significant differences in performance between them, with the fastest (Metropolitan) exhibiting turn times averaging 20 minutes.

4. TRIP PATTERNS AND TRAVEL TIMES

4.1 Origin-Destination Trip Patterns

Data on the terminal type at destination for trips from major origin locations or zones is summarized below.

Origin-Destination Trips by Destination Terminal Type

Origin Zone	Dock	Off-Dock	Transload	Rail Intermodal	Yard	Other	Exclude	Grand Total
Coast 2000	257	16	148		6	1	3	431
Vanterm	15	65	223	5	5	17	2	332
Delta Port	5	99	118	2	10	7	4	245
TCTL-CFF	59	170	4	18	7	2		260
MarcoPlus	174	10	47	5	3			239
NorthVan	189	6	18		6	1		220
Centerm	16	38	85	5	6	10	1	161
HBC-SV	33	71	8			1	4	117
Annacis	24	29	30	22	4			109
CP	2	12	49		4	1		68
Tilbury	12	14	26	3	9		2	66
BurnabyNewWest	30	7	14	2				53
FSD	12	6	25	2	1			46
Metropolitan	11	8	24	4		2		49
Coquitlam	5	7	10	8		2		32
Fraser Valley	2	22	5					29
Surrey	5	1	13	4	2			25
North Richmond	11	12	5					28
Border	22		4					26
Delta	14	2	5	1	2			24
CN	7	2	11	1	2	1		24
Exclude	9	2	10					21
Richmond		7	7					14
Vancouver	6	2	1	2				11
Grand Total	920	608	890	84	67	45	16	2630

As noted in section 1.1, the origin and destination data is not representative of system flow, but the data is consistent with the overall logic of container and cargo flows:

The major flows from on-dock container terminals are destined to transload warehouses, and consist primarily of loaded import containers for unloading.

The major flows from transload warehouses depend on whether they are primarily dedicated to handling import or export cargo. For example, the North Vancouver zone is dominated by export transload warehouses, and the flows consist of loaded containers destined for the on-dock container vessels for loading onto vessels. The TCTL-CFF zone, which includes the import transload facilities of TransPacific Container Terminals Limited and Consolidated Fastfrate, has flows of empty containers destined primarily to off-dock container terminals for storage.

The major flows from off-dock container facilities such as Metropolitan are empty containers destined for transload warehouses, or to the on-dock terminals for evacuation by vessel. Coast 2000 is an anomaly in that is both an off-dock container terminal and a major export transload warehouse, and its traffic includes a high proportion of loaded export containers destined for the on-dock terminals.

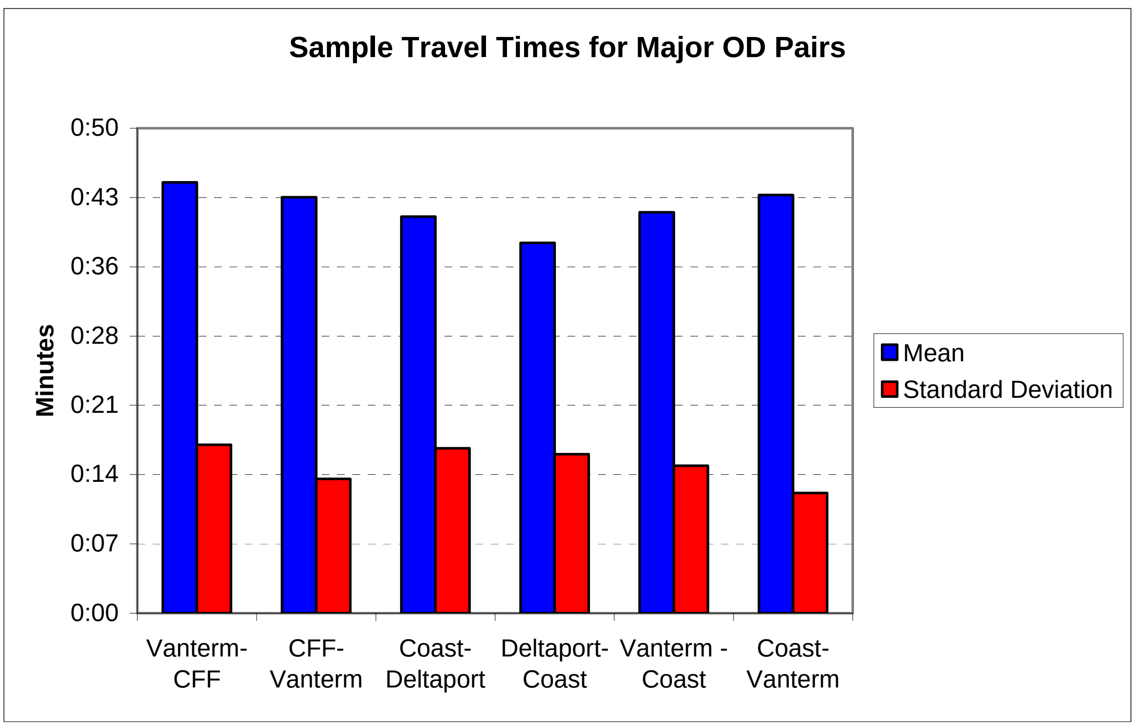
The survey results include data on container status for each trip – loaded container, empty container, empty chassis or bobtail – and analysis of this data confirms these conclusions.

4.2 Travel Times

Some sample travel time data for major origin-destination pairs in the sample are shown below.

Travel Time Distributions - Sample Origin/Destination Pairs

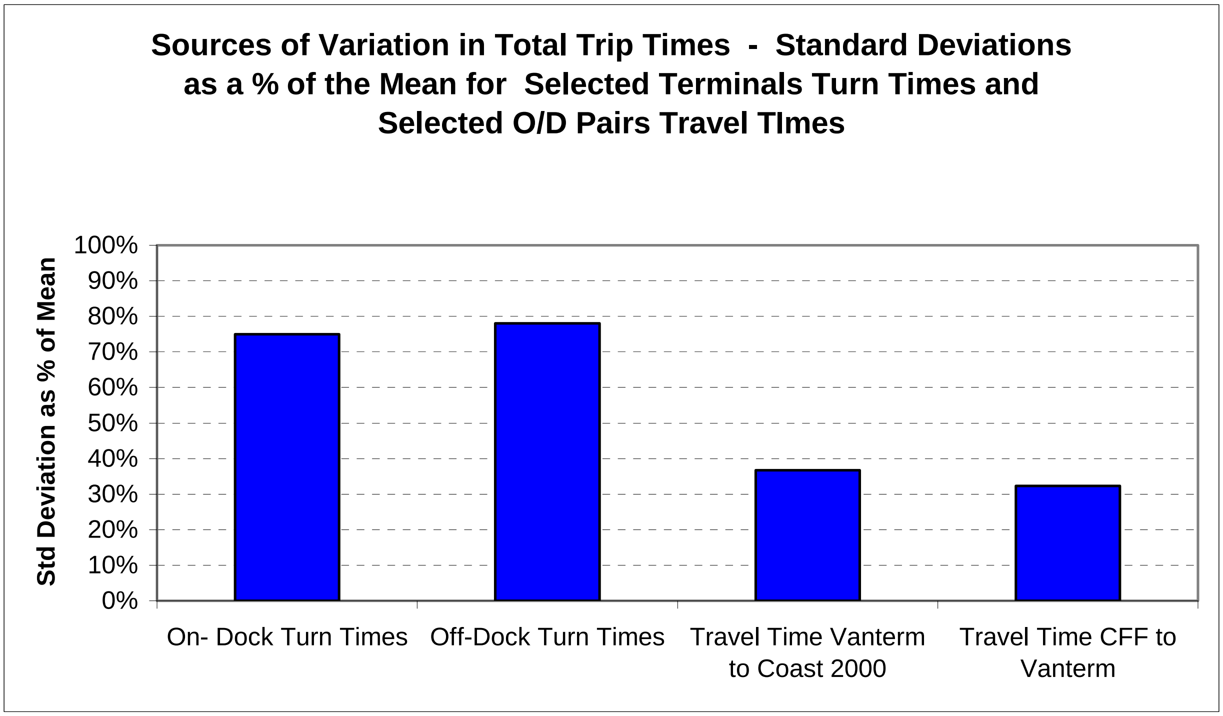
	Vanterm-CFF	CFF-Vanterm	Coast-Deltaport	Deltaport-Coast	Vanterm - Coast	Coast-Vanterm
Mean	0:44	0:43	0:41	0:38	0:41	0:43
Standard Deviation	0:17	0:13	0:17	0:16	0:15	0:12
Trips	125	34	108	72	18	81



In general the sample standard deviation is lower relative to the mean than was found for the terminal turn times, indicating a greater level of reliability.

4.3 Variation in Turn Times Relative to Travel Times

A comparison of standard deviations relative to the mean for turn times for selected terminals and travel times for sample origin/destination pairs is shown below. The higher value for terminal turn times indicates that performance is less predictable.



4.4 Key Findings

While the trip origin/destination patterns are not representative of the system as a whole due to the nature of the sample, the patterns are generally predictable for each type of terminal (on-dock, off-dock, transload, etc.) based on their roles in the container logistics system. The major flows from on-dock container terminals are destined to transload warehouses, and consist primarily of loaded import containers for unloading.

The major flows from transload warehouses depend on whether they are primarily dedicated to handling import or export cargo. For example, the North Vancouver zone is dominated by export transload warehouses, and the flows consist of loaded containers destined for the on-dock container vessels. loading onto vessels. Import transloads generate flows of empty containers destined primarily to off-dock container terminals for storage.

The major flows from off-dock container facilities are empty containers destined for export transload warehouses, or to the on-dock terminals for evacuation by vessel.

Travel times between origins and destinations exhibit less variation relative to the average than terminal turn times.

5. SIMULATION RESULTS

A simulation mode was developed to estimate the impact of changes in operating parameters to productivity in the drayage sector. Details of the model are included as Appendix A.

5.1 Changes in Terminal Turn Times

The analysis of time spent by drivers at terminals ("turn time") highlighted the importance of terminal turn times on performance. According to the survey results, 52% of drivers' time is spent at terminals, and 48% traveling. Since terminal turn times can be more directly managed, they were a major focus of the simulation analysis.

The turn time data indicated a high degree of variability for all types of terminals, so separate simulation cases to analyze the impact of changes in the average and the variability of turn times were included.

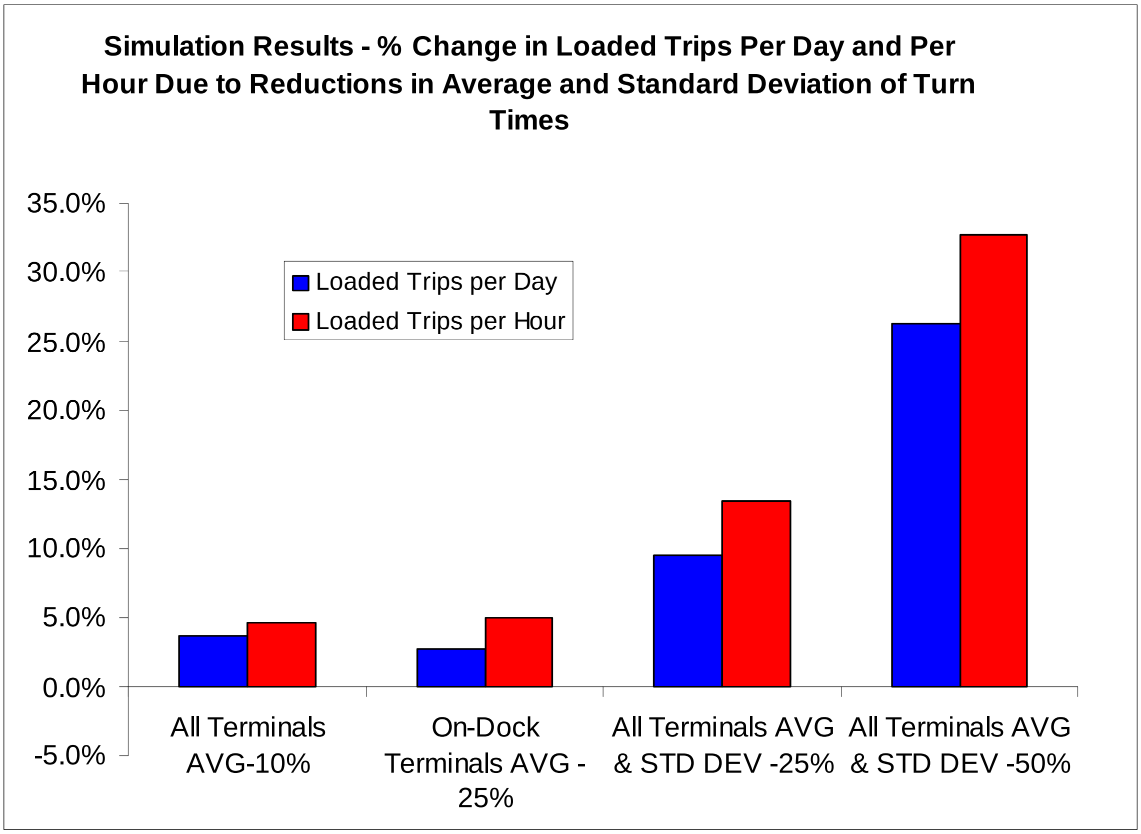
A summary of the results of the turn time simulations is shown in the graph below. Several other cases were analyzed, including changes in the standard deviation alone, which did not result in significant changes to the number of loaded trips.

The most striking result from this analysis is the relative insensitivity of loaded trips to small changes in turn times. A reduction of 10% in average turn times at all terminals resulted in an increase of less than 5% in loaded trips. This is not surprising given the average duration per trip of approximately 90 minutes; a reduction of 10% in turn times would not add up to enough time for an additional trip.

Given the broad distribution of trip patterns among the terminal types, it is also not surprising that turn time reductions at the on-dock terminals alone are not sufficient to substantially increase the number of loaded trips. A reduction of 25% in average turn times at the on-dock terminals would on average reduce turn times by 13 minutes, and even if the driver made several trips to on-dock terminals in the course of his day the total time savings would not approach the time required for a full trip.

The simulation results show that in order to generate substantial changes in loaded trips, a large reduction in turn times throughout the system is required. If turn times at all terminals were reduced by 25%, average loaded trips per day would increase by 9.5%. However, it may be more appropriate to consider loaded trips per hour on duty as the measure of efficiency, to adjust for changes in the driver's work day. By this measure, the improvement is greater, with loaded trips per hour increasing by 13.5%. A reduction of 50% in the average and standard deviation of turn times would have dramatic results, increasing loaded trips per day by 26.2% and loaded trips per hour by 32.7%.

These results indicate that substantial improvements in drayage efficiency would require concerted effort at all terminals to reduce turn times – not just at the on-dock terminals.



5.2 Extended Hours and Night Operations

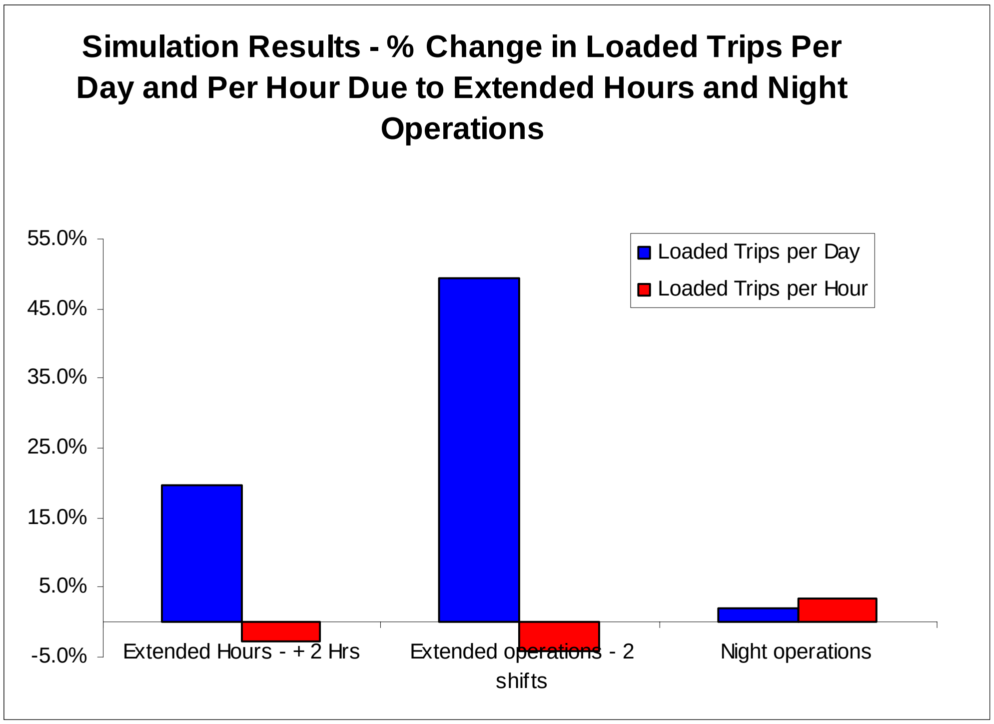
Three simulations were conducted with changes in hours of operation. They include extending terminal operations by two hours; extending terminal operations by a full shift (8 hours); and nighttime operations.

The Base Case model uses terminal operating hours as a cutoff for driver duty time. This approach is carried through to analysis of extending terminal operations by two hours and by a second shift. Consequently the driver's duty time increases as a consequence of the extended hours, to around 11.7 hours in the 2 hour extension.

This scenario assumes that all terminals are open during the extended hours, and that the availability of reservations at the on-dock terminals is not a constraint. This is not currently the case.

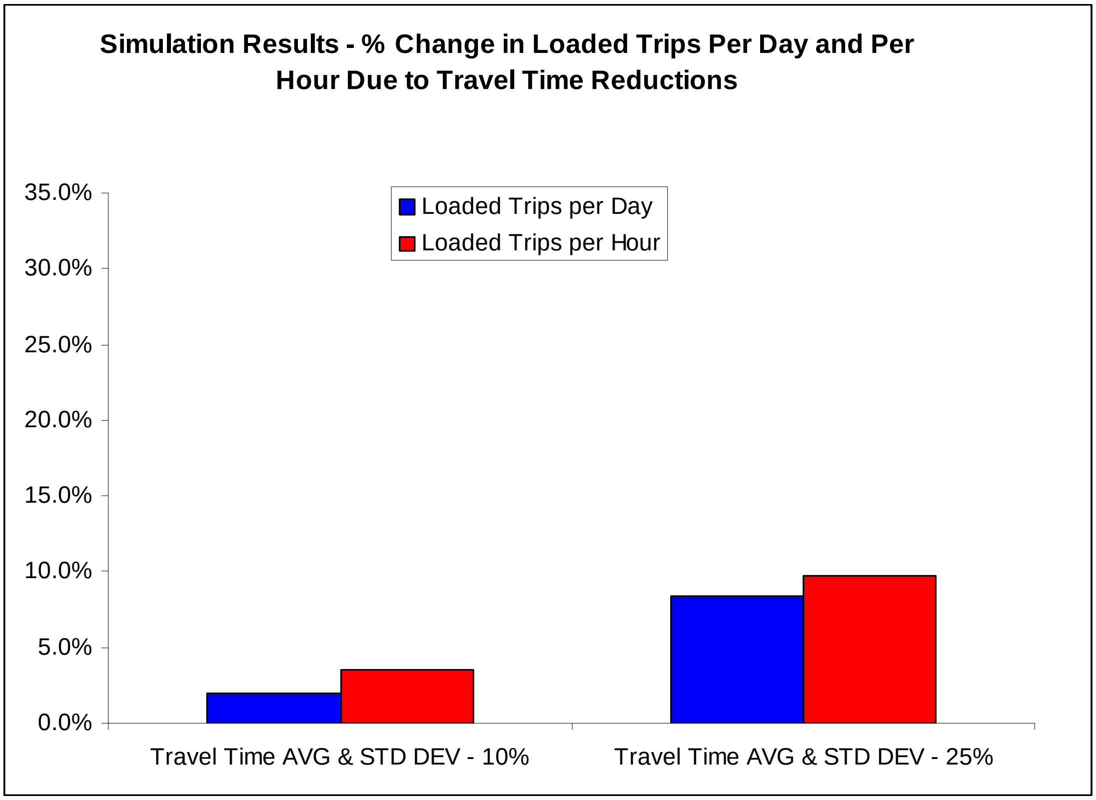
Extended hours of operation resulted in more trips, but the increase was accompanied by a (slightly) more than proportionate increase in duty hours. The simulation assumed that drivers “work” hours (time spent on container trips either for travel or at terminals) totaled an average of 13 hours. With the addition of 2 hours of mobilization time, this would require two drivers since the total on duty time would exceed the 13 hour maximum under Hours of Service Regulations.

For purposes of the simulation, it was assumed that nighttime operations would reduce the average and standard deviation of travel times by 10% from the Base Case scenario. The reduction in travel time for night operations resulted in a 2.0% increase in loaded trips per day, and a 3.6% increase in loaded trips per hour.



5.3 Travel Time

A simulation to test the impact of reductions in travel time was conducted, assuming a reduction of 25% in the average and standard deviation of travel times. For purposes of illustration, the result is compared to the case in section 3 (nighttime operations) which assumed a 10% reduction.



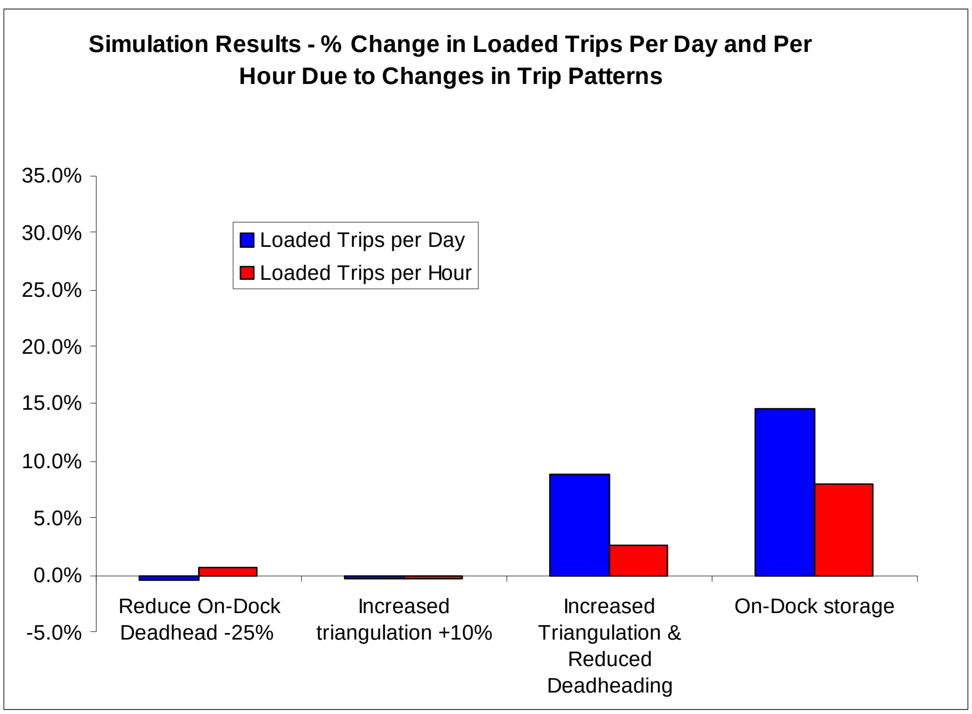
The results are similar to those for reductions in turn times. This seems logical since the distribution of overall duty time is almost symmetrical i.e. roughly half the driver's time is spent traveling, and half at terminals. Implementation of reductions in travel times will probably require the involvement local, regional and provincial agencies which oversee the road network, and thus will be more difficult to address than improvements such as turn times which can be addressed by individual terminal operators.

5.4 Trip Patterns

A number of simulations were conducted to analyze the impact of driver trip patterns. Deadheading (i.e. a trip with no load) is a serious concern from both the driver and the overall system efficiency perspective. From the driver's perspective, the deadhead trip increases costs but does not provide any revenue. From a system perspective, deadheading increases regional truck trips with no economic benefit, increasing traffic congestion and air emissions.

Deadhead trips are a byproduct of off-dock storage of empty containers. When containers are stored at the on-dock terminals, drivers have more opportunities for loaded round trips.

The results of the simulation analysis are shown below. The simulation results show little impact due to simply improving the number of two-way transactions (i.e. so trucks carry a container both in and out) at the on-dock terminals ("Reducing on-dock deadhead"), or for a modest increase in the number of empty containers transferred directly from import transloads to export transloads for stuffing. A more substantial increase in triangulation results in an increase in average loaded trips per day but a decline in average loaded trips per hour. Substantially increased triangulation (50% of import empties currently destined for off-dock terminals transferred to export transloads) in concert with a reduction in one-way trips at the on-dock terminals shows an increase of 8.9% in average loaded trips per day, and increases average trips per hour by 2.5%.

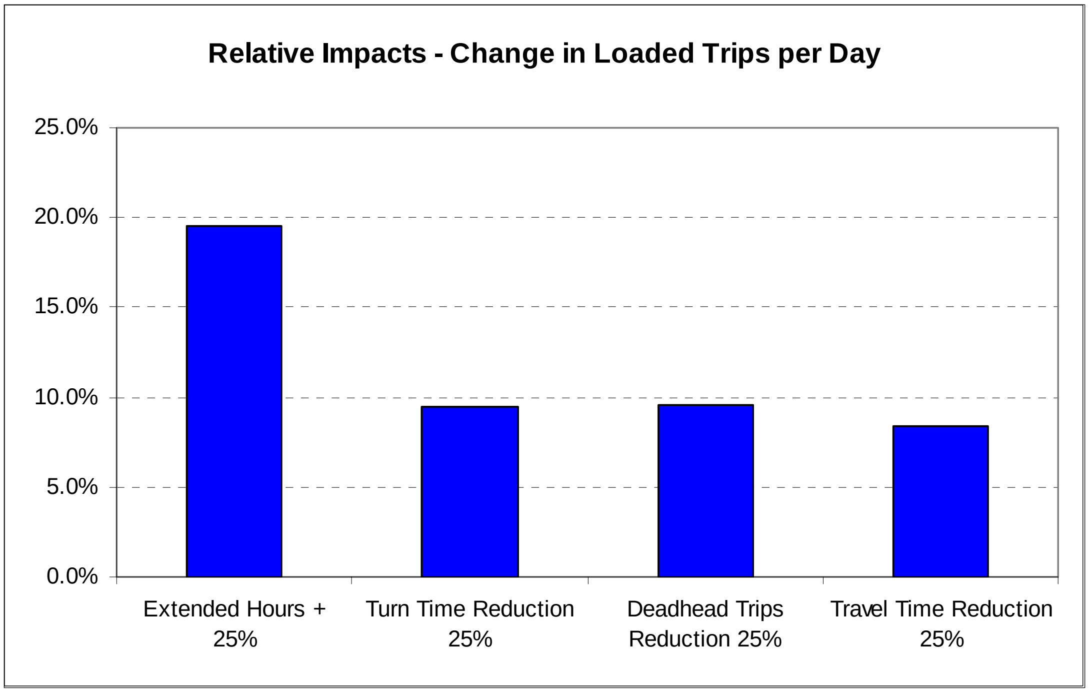


The largest improvement is shown through a reduction in the number of empty containers routed to off-dock terminals in favour of the on-dock terminals, combined with an increase in the number of two-way loaded trips at the on-dock terminals resulting from the availability of empty containers, results in an increase in loaded trips per day of

15% and an increase in loaded trips per hour of 8.3%. This case is shown less as an indication of a potential strategy for improving drayage efficiency than as an indication of the impact of off-dock storage has already had on the system.

5.5 Summary of Productivity Impacts: Loaded Trips per Day

The results of the simulation analysis show the impact of operational changes on drivers' loaded trips per day. The comparison is based on a 25% change in the relevant operational parameters: an increase of 25% in trip hours, a reduction of 25% in turn and travel times, and a reduction of 25% in the number of deadhead trips per day through more efficient trip patterns: The results are illustrated below:



The results suggest that the largest increase in loaded trips per day can be achieved through extending the hours of trucking operations. Reducing turn times at all terminals and reducing deadhead trips have roughly the same impact. The impact of reducing travel times is slightly lower.

5.6 Key Findings

The simulation model indicates that facilitating the extension of duty hours for truck operations has the largest impact on daily loaded trips. It provides owner/operators with opportunities to improve their income and the productivity of their assets through working longer hours. However, the simulation results assume that all other terminals are also open, and that the availability of reservations at the on-dock terminals is not a constraint.

The model also indicates that large improvements in efficiency require substantial changes in terminal turn times. A 25% reduction in turn times at all terminals is required to generate an increase of around 10% in loaded trips. The impact of reducing turn times at all terminals is much greater than simply reducing them at the on-dock or off-dock terminals.

Improvements in efficiency can be realized through elimination of deadhead trips, but substantial changes in trip patterns are required for large benefits. Efficiency can be achieved through increased triangulation of empty containers, and increased numbers of two-way loaded trips at the on-dock terminals.

The model indicates that a 25% reduction in travel times would increase loaded trips per day by 7%.

6. DRAYAGE COSTS AND SYSTEM BENEFITS

6.1 Context and Scope

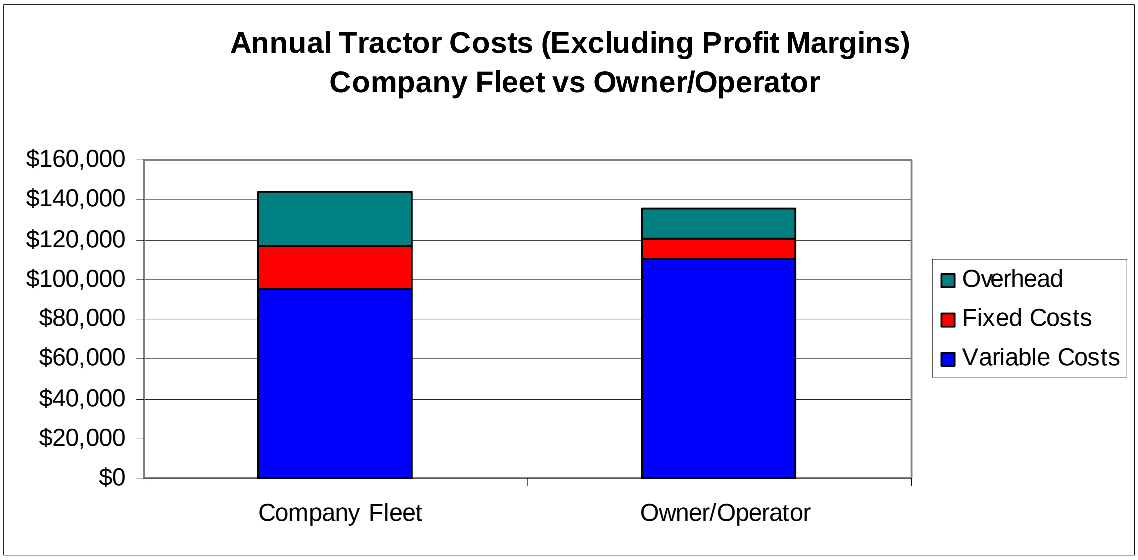
Estimates of efficiency benefits in the drayage sector which could be achieved through a variety of operational improvements were developed in the previous sections. This section contains the results of additional analysis undertaken in order to develop estimates of the value of these benefits based on high-level estimates of average drayage costs.

The purpose of this exercise was to generate order of magnitude estimates of overall system benefits for the purpose of guiding the Forum in focusing further efforts on areas with significant potential benefits. The drayage cost estimates have been developed from publicly available sources of data, adjusted where appropriate to conform to specific aspects of industry operations and to current input prices (particularly fuel prices). As such we believe these estimates fall within a range of plus or minus 20% of actual and are acceptable for the purposes of this study. The estimation methodology and detailed results are shown in Appendix B. In preparing these estimates, IBI Group had access to insufficient actual cost data from trucking firms or owner/operators for it to be used without revealing confidential data. To the extent that our cost estimates differ from actual costs, the estimates of benefits may need to be adjusted. However, we are confident that this work was of sufficient accuracy to rank opportunities for further work and action.

6.2 Drayage Costs

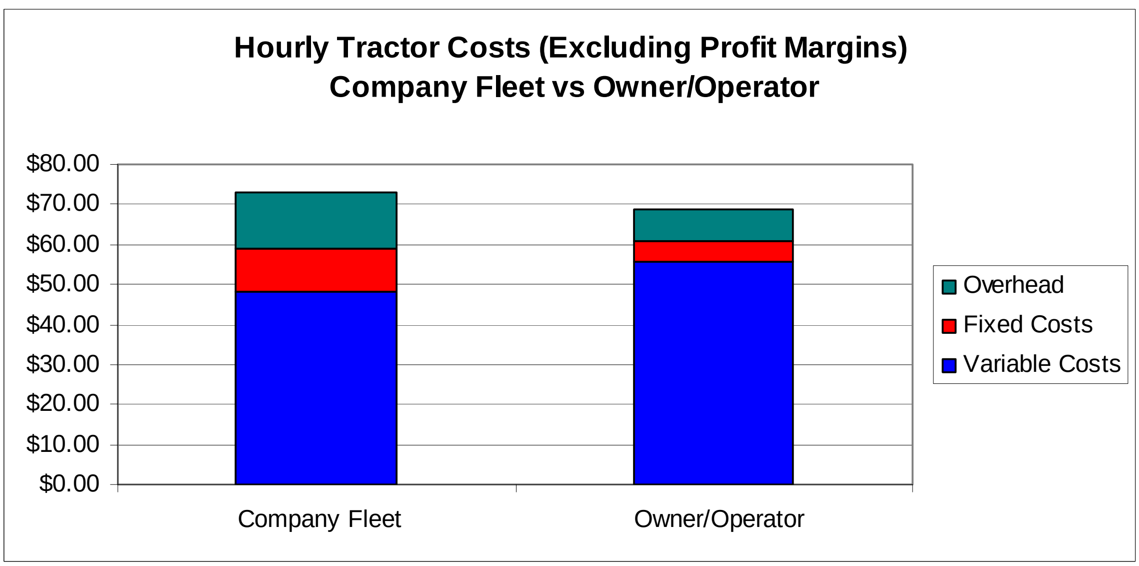
Analysis of drayage costs is challenging due to the differences in operating models – company trucks vs owner/operators – and due to industry reluctance to disclose actual costs. There are two sources of public information on trucking costs which are accessible for this analysis: the periodic update of trucking costs commissioned by Transport Canada from BulkPlus Logistics, and the cost estimates released by the Vancouver Container Truck Association at the time of the dispute in the summer of 2005. Data from these sources was analyzed in the Final Report of the Lower Mainland Ports Trucking Task Force in the fall of 2005. The analysis presented here draws on that analysis, updated where possible through adjustment to 2007 input price levels.

Estimated annual costs (net of profit margins) for operating a tractor used in drayage operations are depicted below. For purposes of comparison, these estimates assume that the owner/operator pays himself an hourly wage equivalent to current hourly wage levels; any additional income is considered a contribution to his profit margin. The estimates show that (under the assumption of equal labour costs) the annual cost for an owner/operator is around 6% lower than that of a company truck, due to the use of older tractors by owner/operators. Owner/operator capital costs are significantly below those of company fleet operations, but maintenance costs are higher.



This cost difference enables the owner/operator to generate a larger profit margin at similar revenue levels. For the case detailed above, a revenue level which returns a profit margin of 5% on operation of a company-owned tractor would provide an 11.5% margin for an owner/operator.

A similar comparison of hourly costs is show below. The estimated cost per hour for company fleet tractors is $72.83; for owner/operators, $68.74.



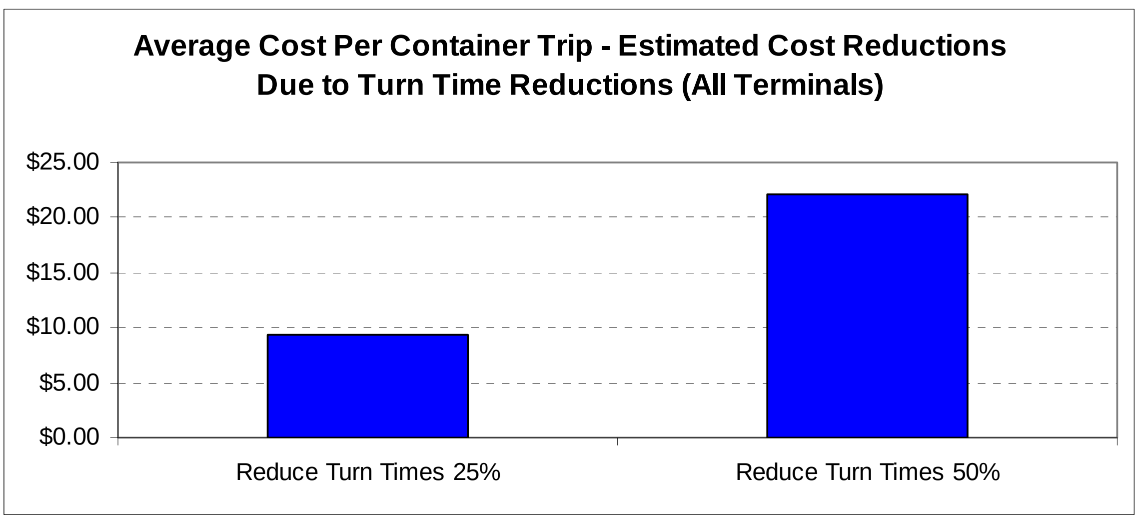
6.3 Impact of Efficiency Improvements on Cost per Trip

The drayage costs estimated above have been used to generate estimates of potential cost reductions per container trip based on the results of the simulation model. It is assumed that cost reductions apply to all categories of costs because efficiency improvements would enable the same amount of work to be done with a smaller fleet, thus affecting both fixed and variable costs per trip. The (higher) costs of the company fleet operation have been used as the benchmark, under the assumption that this cost (including a 5% profit margin) would be the minimum required to induce firms to participate in the market. Costs for each scenario are based on turn times, travel times, and the number of loaded trips; fuel costs are adjusted to account for total kilometers driven for each scenario.

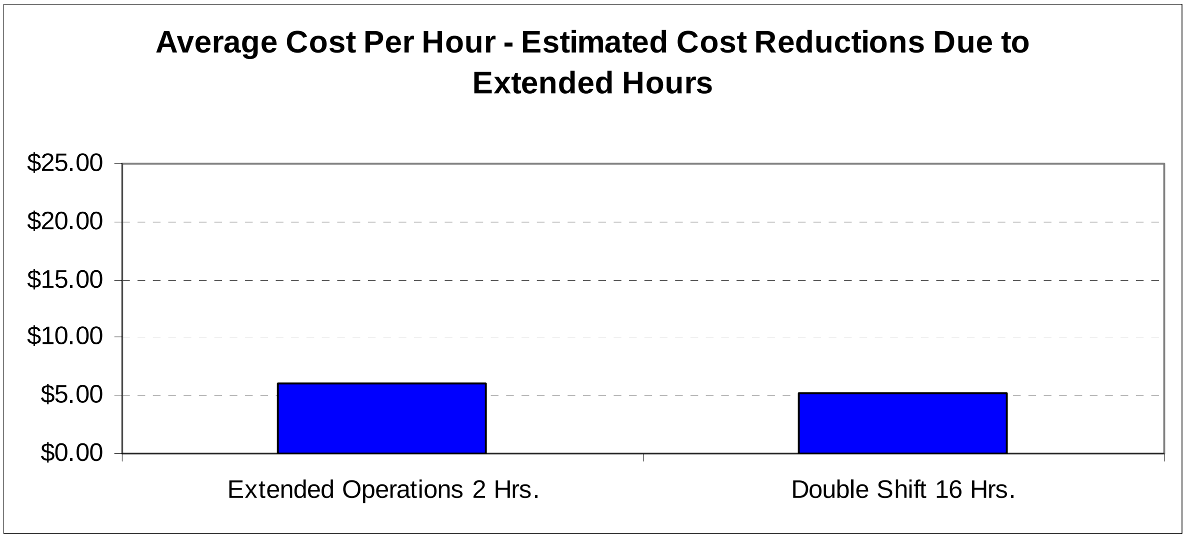
The simulation model base case generates an average cost per loaded trip of $114.28 based on these costs. The cost reduction obtainable from operational improvements based on the model results are highlighted below.

6.3.1 Reduction in Terminal Turn Times

The impact of reductions in terminal turn times on cost per container trip is illustrated below:



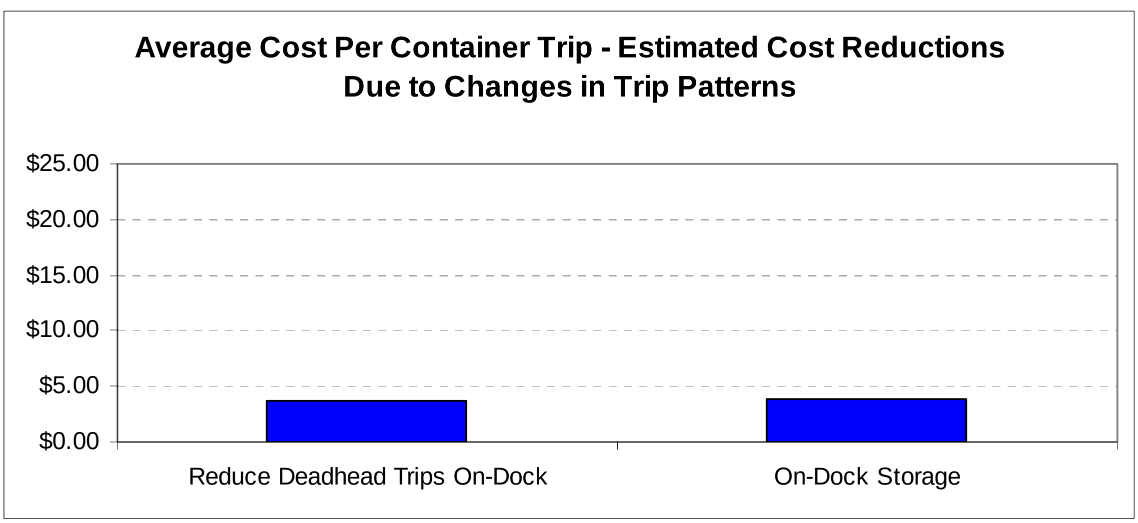
6.3.2 Extended Hours of Operation
Extending the hour of operation has a significant impact on costs, by allowing the fixed costs and overhead to be spread across more trips.



The double shift scenario assumed an average working time of 13 hours. The survey data indicates that drivers work an additional 2 hours on average at the beginning and end of the work time period analyzed in the simulations; this would imply that to be in compliance with the maximum 13 hour on duty time under Hours of Service regulations, there would have to be two drivers for this scenario. The reduction in trip costs is less for the double shift scenario due to the mobilization costs (2 hours) for the additional driver. The potential use of two drivers is more applicable to company fleet operations than to owner/operators.

6.3.3 Changes in Trip Patterns

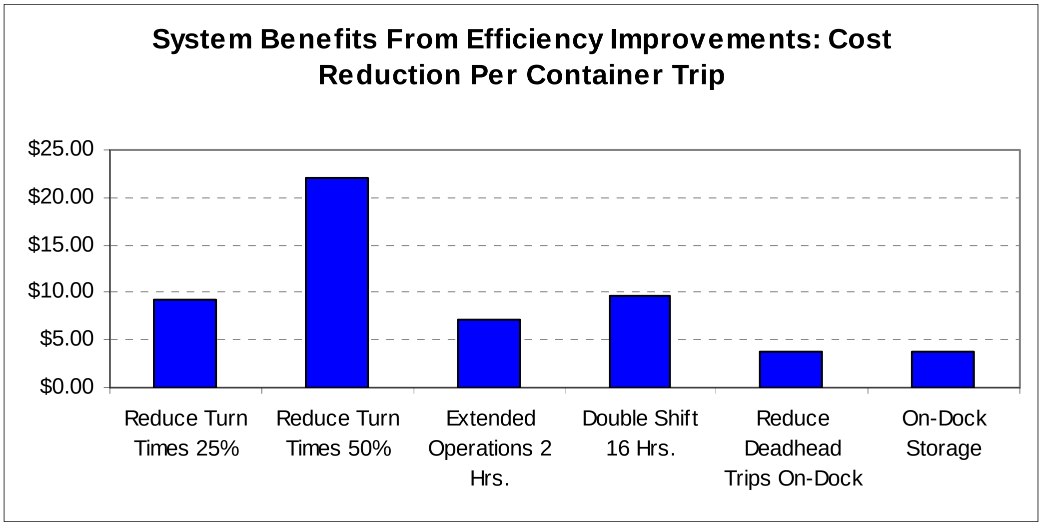
The results of simulation scenarios dealing with changes in trip patterns are highlighted below:



The first case assumes a reduction in the number of empty trips leaving the on-dock terminals (reducing the number of deadhead trips leaving the on-dock terminals from around 40% to 10%). The second assumes a change in trip patterns consistent with a return to on-dock storage – primarily the diversion of empty container trips from import transloads to the on-dock terminals rather than to off-dock storage.

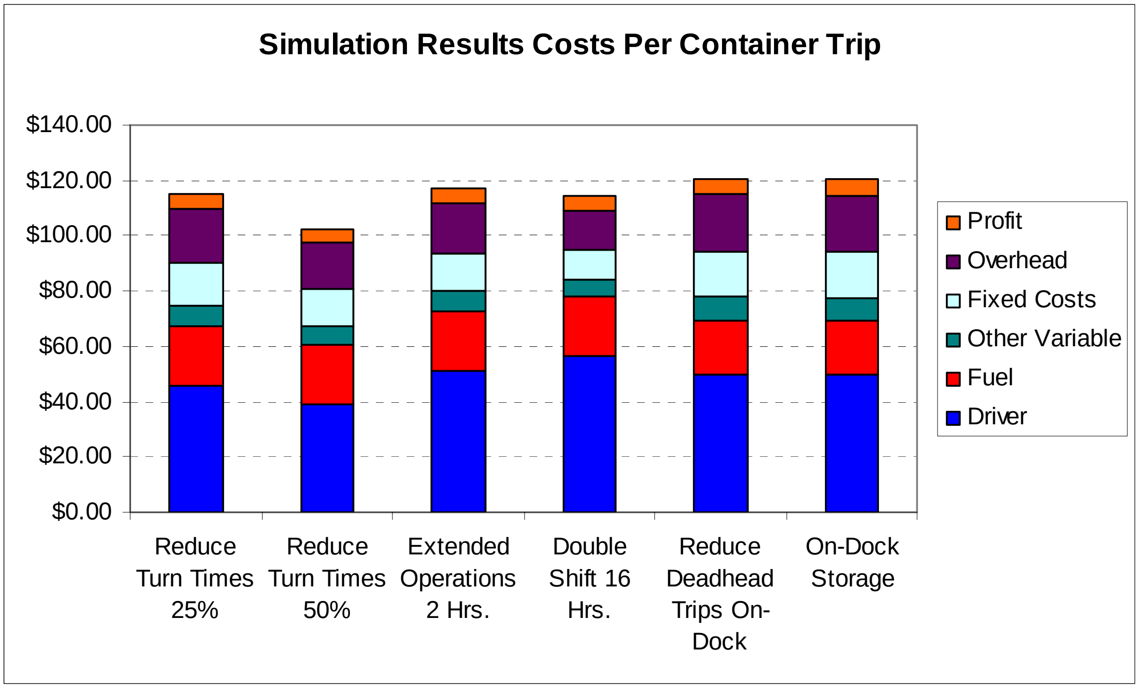
6.3.4 Cost Per Trip Summary

A summary of the reductions in cost per container trip from the efficiency improvements is shown below.



6.4 Composition of Cost Savings

The impact of the scenarios described above is highlighted in the graph below, which shows the components of total trip cost for each. The major cost savings from reductions in turn times is due to reduced labour costs; the reduction in trip costs due to extended hours of operation results largely from reduced fixed costs and overhead; and the major impact of changes in trip patterns is a reduction in fuel costs.



6.5 System Traffic Estimate

The survey data accounts for only a small portion of overall container movements by truck within the Lower Mainland. In order to estimate the total number of container movements in the Lower Mainland, total truck movement data from the Vancouver Port Authority has been expanded based on the trip origin/destination patterns from the sample.

Total container movements by truck at the VPA terminals (Centerm, Deltaport and Vanterm) are shown below:

Container Movements by Truck at Port of Vancouver Terminals 2006		
	TEU's	**Containers**
Import Laden	356,323	209,601
Export Laden	465,182	273,637
Export Empty	108,906	64,062
Import Empty	163,063	95,919
Total	1,093,473	643,219
Total inbound	574,088	337,699
Total outbound	519,385	305,521
Source: Vancouver Port Authority		

Assuming a conversion rate from TEU's to containers of 1.7 based on the historic distribution of container sizes in the Lower Mainland, these figures indicate a total of 643,219 container movements (loaded and empty) by truck in 2006.

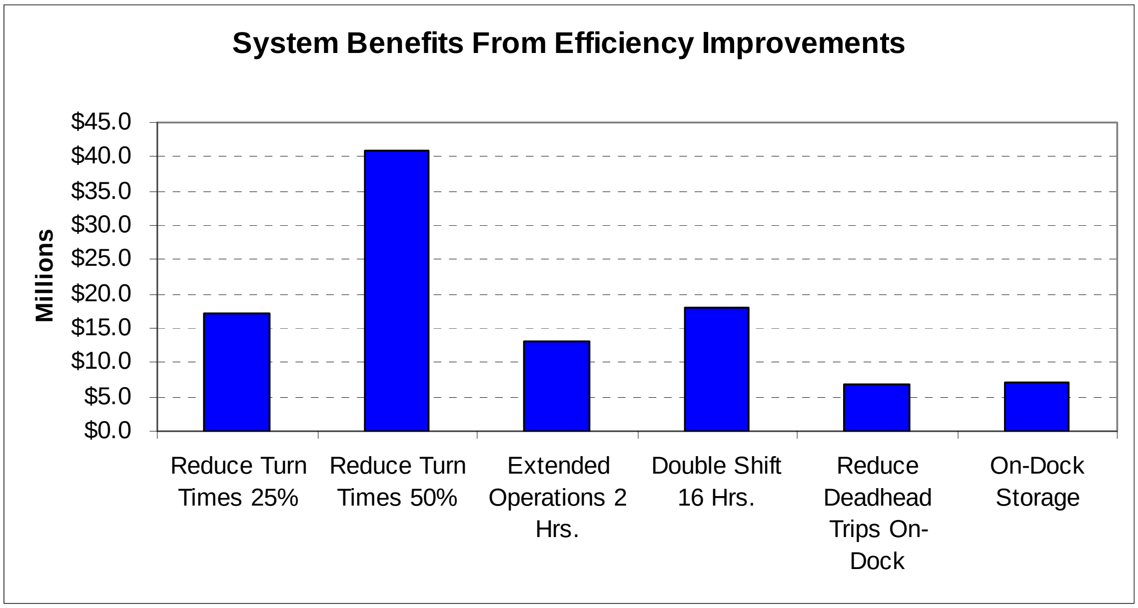
The percentage of truck movements (inbound and outbound) accounted for by the VPA terminals in our sample is shown below:

Estimated Total System Container Movements by Truck			
	Inbound	**Outbound**	**Total**
Sample Data (Trips)			
On-Dock Terminals	706	655	1361
Total	2231	1738	3969
On-Dock Terminals Share of Traffic	32%	38%	
On-Dock Total Movements	337,699	305,421	643,120
Estimated System Total Movements	1,067,148	810,415	1,877,563

On the basis of this calculation, total Lower Mainland container movements (loaded and empty) by truck amounted to around 1.9 million in 2006. Using the average cost per container from the drayage cost estimates, the cost of these movements is approximately $231 million per year.

6.6 Priorities for Action Based On System Cost Savings Improvements

The comparative estimated system benefits related to reduced drayage costs for the simulation cases are illustrated below. A reduction of turn times at all terminals is estimated to reduce drayage costs by around $17 million per year based on 2006 traffic levels. A reduction of 50% would result in savings of over $41 million. The extended hours examples show significant benefits as well, largely due to the impact on average fixed costs as volumes increase.



6.7 Key Findings

The estimated annual cost (net of profit margins) for operating a tractor in drayage fleet operations is $143,838.

Under the assumption of equal labour costs, the annual cost for an owner/operator is around 6% lower than that of a company truck, due to the use of older equipment. Owner/operator capital costs are significantly below those of company fleet operations, but maintenance costs are higher.

The major cost savings from reductions in turn times is due to reduced labour costs; the reduction in trip costs due to extended hours of operation results largely from reduced fixed costs and overhead; and the major impact of changes in trip patterns is a reduction in fuel costs.

The analysis indicates that reducing turn times at all terminals would reduce drayage costs by around $17 million per year based on 2006 traffic levels. A reduction of 50% would result in savings of over $41 million.

Extending terminal operations by 2 hours is estimated to reduce annual drayage costs by $13.2 million. Extending terminal operations to 2 shifts would reduce annual costs by $17.9 million, based on the assumptions used in the simulation analysis.

The simulation cases for reducing deadhead trips indicate a system benefit of $6.9 million, and a return to on-dock storage would result in benefits of $7.2 million.

The results indicate that the top priority for reducing drayage costs is a reduction in turn times at terminals.

7. SYNTHESIS OF FINDINGS

7.1 Evolution of Container Logistics and Review of Previous Studies

Operating practices at the on-dock terminals are the major determinant of container logistics processes in the Lower Mainland. The two major drivers for changes in on-dock operations have been the strategy of the terminal operators of maximizing terminal capacity through the reduction of container dwell time, and industrial unrest in the drayage sector. These two factors are interrelated.

The changes designed to reduce the dwell time of containers at the on-dock terminals include off-dock storage of empty containers, reduced Earliest Receiving Dates (ERD's) for export containers, and imposition of high storage charges to induce shipping lines to evacuate empty containers from the docks quickly. Changes resulting from industrial unrest in the drayage sector include implementation of mandatory reservation systems at the on-dock terminals.

The current structure of port drayage can be traced to a series of events and decisions starting in 1999. In 1999 an estimated 450 owner/operators withdrew service from July 22 to August 23. The major issues in 1999 were low rates of compensation, and excessive delays at the on-dock terminals. The dispute was ended following the implementation of a licensing scheme by Vancouver Port Authority which attempted to force trucking companies to move to hourly compensation of drivers. The attempt to force a move to hourly rates failed. VPA abandoned attempts to enforce the compensation provisions of the MOA within a few months.

Reservation systems for the on-dock terminals were embraced as the solution to delays at the terminals. A telephone-based reservation system was hurriedly put into place following the 1999 dispute, and Vancouver Port Authority commissioned the Terminal Access Study to recommend solutions to terminal congestion, specifically by "levelling out the arrival pattern of trucks throughout the day at the Port's three container terminals".[1] Recommendations of the study included investigation of long term solutions to reducing empty container movements at the terminals, ongoing monitoring of system performance (i.e. gate delays), development of a web-based reservation system with mandatory reservations for import pickups, and several improvements to terminal gate operations.

A web-based reservation system was implemented in 2001. In May 2002 the Empty Container Dynamics Study (ECDS) was prepared for Vancouver Port Authority by Sandwell Engineering. The purpose of the study was to "provide conclusions on practical opportunities to optimize VPA's container terminal assets through the effective management of empty container flow and storage"[2].

The ECDS identified three strategies for increasing effective terminal capacity through the reduction of dwell time of containers. They included:

(1) Off-dock storage of empty containers

[1] Terminal Access Study Prepared by Reid Crowther for Vancouver Port Authority April 2000, p1-2.
[2] Empty Container Dynamics Study Prepared by Sandwell Engineering and Novacorp Consulting for Vancouver Port Authority May 2002, p. 1-2.

(2) Diversion of empty containers repositioned by rail to off-dock locations

(3) Diversion of empty containers repositioned by truck to off-dock locations.

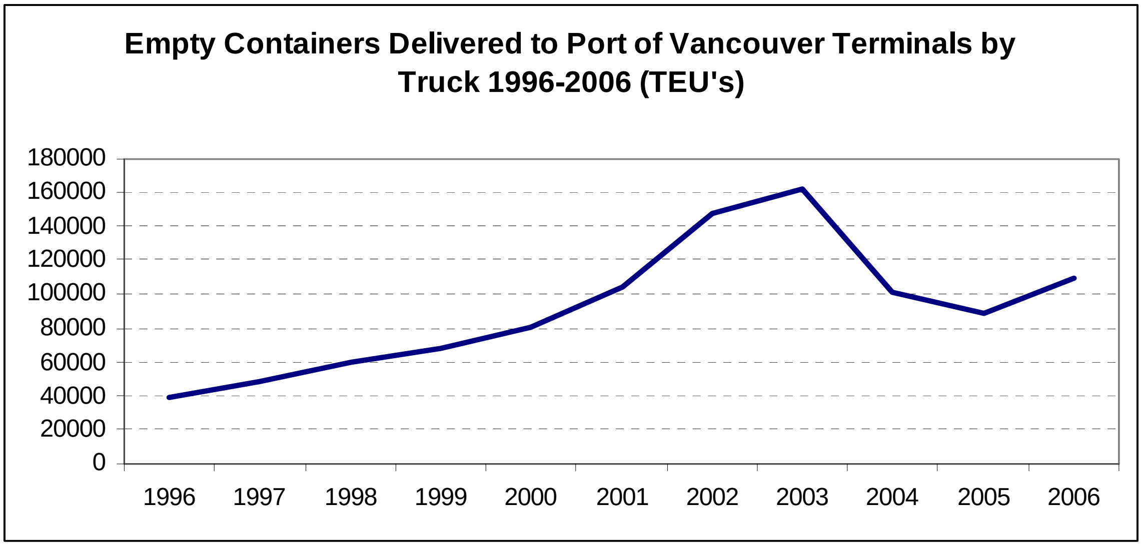
The consultants estimated the following potential capacity enhancements from these strategies:

Estimated Capacity Enhancements through Dwell Time Reductions: Empty Container Dynamics Study 2002

Table 5.4.4 Summary of Dwell Time Reductions

	Net Savings		
	Ground Slots	**Area (m^2)**	**Throughput (TEU/yr.)**
Current Traffic Levels - 2001			
Dwell Time Reduction (12.5 to 5 days)	1,710	34,400	300,000
Rail Re-positioning (5 to 0 days)	350	7,000	70,000
Truck Re-positioning (5 to 0 days)	285	5,700	60,000
Sub Total	2,345	47,100	430,000
Future Traffic Levels – 2020			
Dwell Time Reduction	4,230	84,400	800,000
Rail Re-positioning	1,540	31,000	275,000
Truck Re-positioning	1,255	25,300	250,000
Sub Total	7,025	140,700	1,325,000

VPA had already taken action to reduce the dwell time of containers on the docks following the 1999 dispute by encouraging the terminal operators to reduce Earliest Receiving Dates (ERD's) for export shipments from 10 working days to 5. In December 2003, VPA announced a target of 50% for reduction in the number of empty containers stored at the container terminals. The terminal operators adopted this strategy, and have dramatically reduced the volume of empty containers received by truck, as indicated below. The number of empty containers returned to the on-dock terminals by truck fell by 46% from 2003 to 2005.



The move to off-dock storage made fundamental changes to drayage operations and imposed additional costs on shipping lines, trucking companies and drivers. Trip patterns and compensation were based on round trips to and from the container terminals. Importers pay a single rate for delivery of a loaded container and return of the empty to the docks. Exporters pay a single rate for delivery of an empty and return of a loaded container to the dock. Owner/operators have traditionally been paid on the basis of a 70/30 revenue-sharing split with trucking companies; i.e. they received 70% of the round trip rate. Since they were picking up or dropping empties at the docks, they were paid for each leg of the round trip.

The introduction of off-dock storage introduced a non-revenue “third leg” to trip patterns. Instead of a balanced haul to and from the docks, owner/operators are required to travel unloaded (i.e. without a container) to an off-dock facility to pick up an empty container. This can add significantly to trip mileage, and delays at off-dock facilities reduce the number of trips they can make in a day.

In the summer of 2005, port operations were disrupted by another withdrawal of service by drayage drivers. The issues in this dispute included those from the 1999 dispute (low rates and terminal delays), but the impact of the increase in off-dock storage of containers was also cited as a serious concern by the owner/operators.

Following the 2005 dispute, the federal and provincial governments appointed a three-person task force “to make enquiries into the factors that led to the dispute, and to provide recommendations aimed at avoiding a recurrence while also increasing the efficiency of port operations.” [3] The Task Force cited evidence that the existing reservation system had not resolved problems related to excessive queuing delays at the on-dock terminals, and the reduced ERD’s and US Customs Freight Remaining on Board (FROB) reporting requirements led to peaking of traffic at the terminal gates. Recommendations of the Task Force included ongoing monitoring of queuing delays at terminals, extended truck gate hours to reduce congestion, and examination of the

[3] Final Report of the Task Force on the Transportation and Industrial Relations Issues Related to the Movement of Containers at BC Lower Mainland Ports Trucking Task Force, Oct. 26, 2005 p. 1.

potential benefits of a mandatory reservation system (including implementation if it was found to be beneficial).

Prior to the 2005 dispute, Centerm had developed the SCORE system which alleviated some of the problems facing exporters in obtaining reservations for their shipments. Centerm instituted mandatory use of its reservation system in August 2005. Deltaport and Vanterm made their reservation systems mandatory in the spring of 2006. The terminal operators have mandated a minimum level of compliance with their reservation systems as a condition of access, and the Vancouver Port Authority requires compliance with reservations systems as a licensing requirement for trucks serving the Port.

In theory, the reservation systems are supposed to increase the productivity of the terminals by reducing variability in the arrival rates for trucks, and increase the productivity of trucking operations by reducing turnaround time for picking up and dropping off containers. The net effect on the trucking industry depends on their ability to accommodate the additional complexity of operations. Benefits from the reduction of turn times at the terminal may be offset by problems in scheduling operations in other areas. "... tight time windows may not be met by trucking companies unless they increase the number of vehicles and personnel … Also, time windows may take away some of the scheduling flexibility … having a negative effect on customer service."[4]

7.2 Drayage Efficiency: Previous Research vs. Current Survey Data

This project is the first major attempt to benchmark the efficiency of the Lower Mainland drayage sector. However, several of the studies cited above contained estimates of system performance based on stakeholder discussions or small data samples.

7.2.1 Terminal Access Study

The Terminal Access Study assessed several performance measures following the 1999 strike. A table showing comparing these figures to the data from the surveys analyzed in sections 2 through 4 of this report is shown below:

Drayage Performance Measures 2000 vs. 2006		
	Terminal Access Study 2000	Container Truck Simulation Project Data 2006
Hours on Duty	10 Hours	9 Hours 39 min.
Total Daily Trips	6	7.2
On-Dock Queuing Delay	35-40 minutes	
On-Dock Terminal Turn Time	20-25 minutes	
On-Dock Total Turn Time	55-65 minutes	52 minutes
Average Travel Time	30 minutes	32 minutes
Average Trip Time	90 minutes	84 minutes

[4] Cooperative Optimum Time Window Generation for Cargo Delivery/Pick up with Application to Container Terminals METRANS Project 03-18 Petros Ioannou, Anastasios Chassiakos, Hossein Jula, Gil Valencia April 2005 (University of Southern California Los Angeles and California State University, Long Beach) p. 14.

The Terminal Access Study found that drivers were on duty an average of 10 hours. The average number of total daily trips (including deadhead trips) was estimated at 6, compared with 7.2 for the current sample. Turn times at the on-dock terminals are marginally lower for the current sample. Travel time comparisons are probably not significant, due to uncertainty regarding the actual origins and destinations, and changes in trip patterns (particularly with the increase in Deltaport's share of traffic relative to the Inner Harbour since the Terminal Access Study was completed.

There is no information on the methodology or coverage of the data gathering undertaken in the Terminal Access Study, nor any further detail on the findings.

7.2.2 Ports Trucking Task Force

The Ports Trucking Task Force contained analysis of a small sample of trip sheets (3 drivers) from 2003 through spring 2005. According to that analysis, the number of loaded trips per day achieved by these drivers declined from 6.4 in January 2003 to 5.6 in January 2005, a decline of 13.1%. The average of 5.3 loaded trips per day from the current sample is 5.4% below the 2005 average found in the Task Force report. In 2005, queuing delays at the on-dock terminals were reaching crisis levels, particularly at Centerm where construction activity related to the terminal expansion was affecting operations. The average hours on duty recorded in the Task Force research is consistent with the estimates from the Terminal Access Study, averaging around 10 hours per day, similar to the 9.7 hours indicated in the current survey.

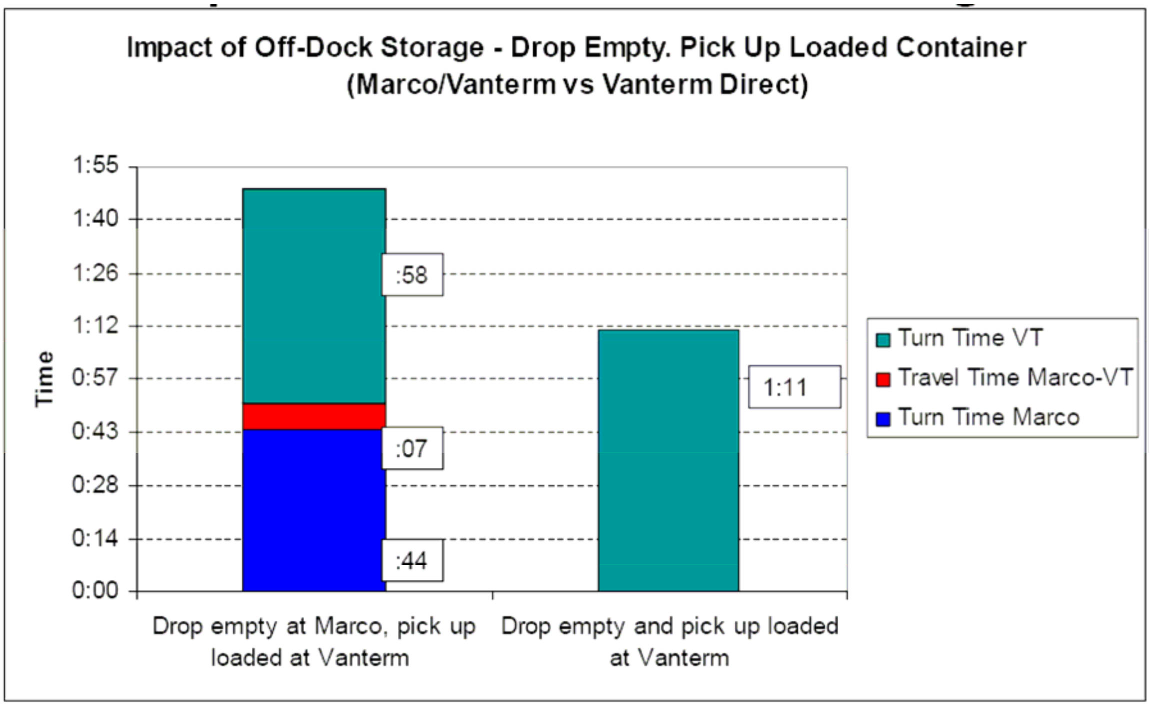
7.3 Conclusions

The data surveys and analysis presented in sections 1 through 4 provide a useful snapshot for benchmarking the performance of the drayage system in the Lower Mainland experienced in 2006. Comparisons with the limited data available from earlier periods, the impact of changes in on-dock terminal policies and procedures can be evaluated.

7.3.1 Off-Dock storage of empty containers

Results from previous research and our simulation analysis suggest that this has had a significant impact on drayage efficiency, through the impact of additional turn times at off-dock terminals to normal trip patterns, and an increase in the number of deadhead trips.

The impact of additional turn times is highlighted by the illustration below. It shows a comparison on the total time required to drop an empty and pick up a loaded container at Vanterm, compared to a similar trip where the empty has to be dropped at Marco before the load can be picked up at Vanterm. The total time for the trip with inclusion of the off-dock terminal is 99 minutes, almost 40 percent more than the time for a move direct to Vanterm in spite of the proximity of the two terminals.



The impact on the number of deadhead trips attributable to off-dock storage can be analyzed by examining the results of the simulation of a return to on-dock storage. Reducing the number of empty containers routed to off-dock terminals in favour of the on-dock terminals, combined with an increase in the number of two-way loaded trips at the on-dock terminals resulting from the availability of empty containers, results in an increase in loaded trips per day of 15% and an increase in loaded trips per hour of 8.3%. This is consistent with the findings of the Ports Trucking Task Force which estimated a reduction in average trips per day of 13.1% from 2003 through 2005, when the move to off-dock storage resulted in a 46% decline in the number of empty containers returned to the on-dock terminals by truck.

The capacity benefits of reduced dwell time at the terminals which were forecast by the Empty Container Dynamics Study appear to have been partially realized. Deltaport and Vanterm have been most aggressive in imposing restrictions and penalties on containers stored on the docks, and both have been operating at a level considerably beyond their rated capacity since early 2006.

7.3.2 Reservation Systems

There is no evidence that the imposition of mandatory reservations has reduced overall turn times. From our sample, the current average for the on-dock terminals ranges from 52 minutes at Deltaport to 54 minutes at Centerm (including queuing delay and turn time within the terminal). This is not much different than the level reported in the Terminal Access Study in 2002, which estimated a range between 55 and 65 minutes. The turn times remain very unreliable, with a standard deviation which is over 70% of the mean.

On the other hand, there is some anecdotal evidence that the mandatory reservation system has imposed additional costs on drayage operators, which is consistent with the predictions of the theory. Large drayage firms are hiring more drivers and obtaining more chassis to meet their service commitments. They report difficulties in obtaining sufficient reservations to fulfill their commitments, particularly for export shipments. Significant queuing delays are still being reported periodically at on-dock terminals, and the reservation system and limitations on service on night shifts are resulting in more empty miles and lower driver compensation. We are unable to estimate the magnitude of these impacts from the current survey data, which recorded only turn times at the port terminals. However it appears likely that the productivity of drayage operations is being adversely affected by delays related to the reservation system which occur away from the on-dock terminals, since drivers are forbidden to line up at the terminals more than 30 minutes in advance of their reservation time.

7.3.3 Extended Operations

On the assumption of similar turn and travel times, simply extending the terminal hours of operation has little impact on driver trips per hour. Loaded trips increase, but at a slightly lower rate than duty hours. Extended hours do provide the industry with opportunities to improve their income and the productivity of their assets through working longer hours, assuming that all terminals are open and that the availability of on-dock terminal reservations is not a constraint. Since the completion of this study, extended gate hours have been implemented on a routine basis at Centerm, Vanterm and Deltaport. This is a positive step in providing opportunities for increasing the efficiency of the drayage sector.

7.4 Key Findings

Mandatory reservation systems, off-dock empty storage, and other steps to limit container dwell time at the on-dock terminals have had a major impact on the Lower Mainland container logistics system.

These steps have been successful in increasing the capacity of the on-dock container terminals, but have had negative impacts on the drayage sector.

Data on past performance of the drayage sector is limited, but the available information suggests that there has been no significant increase in the efficiency of the drayage sector.

8. RECOMMENDATIONS

8.1 System Efficiency

8.1.1 Recommendation: A Commitment by All Participants to Reducing Turn Times

Our analysis shows that total terminal service time, including both service time and queing time, is the key factor impacting the number of truck turns achieved in a day. The simulation model indicates that relatively large reductions in terminal turn times, throughout the system, are required to generate significant improvements. In order to maximize the benefits of reduced terminal turn times, substantial improvements have to be made across the board – at on-dock terminals, off-dock terminals, rail terminals and transload warehouses. This does not necessarily require broad cooperation among stakeholders, because it can be undertaken on an individual basis by each terminal operator. However, a cooperative effort may identify opportunities for greater coordination of business processes which can help to avoid delays. The key requirement to maximizing the system benefits is a broadly shared and active commitment to improvement.

8.1.2 Recommendation: Reduce Deadhead Trips by Better Coordination

The terminal operators adopted the recommendations of the Terminal Access Study conducted in 2002 which showed substantial improvements in terminal capacity through container dwell time reductions. This resulted in increased use of off-dock storage for empty containers. The simulation model predicts substantial improvements in efficiency for a return to on-dock storage for empty containers. Given the current capacity constraints facing the on-dock terminals, and the rapid growth in demand, this is probably not feasible. It can be concluded however, that additional terminal capacity was achieved at the expense of reduced efficiencies in the truck drayage system. Given this, terminal operators should be encouraged to do as much as they possibly can to return efficiencies to the trucking system through improving the service they offer to the trucking sector. Reducing total terminal service time is one means of achieving this as noted above. The model indicates that substantial benefits can be generated if deadhead trips can be reduced. The terminal operators could also cooperate to reduce deadhead trips as outlined below.

Unlike terminal turn times, more efficient trip patterns are unlikely to be achieved by any single participant in the logistics system. Elimination of deadhead trips can be achieved through increased triangulation of empty containers, and through developing business processes to ensure that trucks can make balanced trips – i.e. loaded in and out – from terminals. These solutions require better information flows and enhanced coordination among shipping lines, importers and exporters, and on-dock and off-dock terminals. A Virtual Container Yard is one potential approach to explore for enhancing coordination. Other approaches may be identified through discussions among stakeholders.

8.2 Further Research

To date this project has made a valuable contribution to the common understanding of the Lower Mainland drayage system. The data collection efforts undertaken by the BC Ministry of Transportation represent the first major effort to collect baseline data on system performance, and will provide a performance benchmark for measuring the impact of efforts to improve efficiency. The simulation model has provided valuable insights into the dynamics of the drayage system, helping to analyze the impact of previous decisions and to suggest priorities for maximizing efficiency.

To build on this progress, there are a number of extensions and enhancements to the current project which could be undertaken to further our understanding and guide efforts for system improvement.

8.2.1 Perform Detailed Analysis to Identify Practical Methods of Improving Efficiency

The data collected for this project can be analyzed in further detail to identify specific requirements for performance improvements. This work has already begun, through the Truck Turn Times Working Group of the Container Trucking Forum. The initial focus will be identifying individual trips exhibiting excessive turn times at Centerm. Scope of this work will include extraction of individual trip data for trips with turn times greater than 60 minutes from GPS and Trip Sheets surveys, mapping of individual GPS trip records at the terminals, and analysis of VACS and RFID data for the South Shore terminals. This information will be compared with terminal operator data to identify causes and analyze changes in business processes to eliminate excessive turn times. This is one example of how the data and analysis completed to date can be leveraged to achieve substantive improvements in efficiency.

8.2.2 Analyze the Impact of Reservation Systems

The mandatory reservation systems at the on-dock terminals regulate existing container trucking operations in the Lower Mainland. The current model is unable to estimate the impact of the current on-dock terminal reservation systems on efficiency. There are two reasons for this:

The data collected through the surveys does not provide sufficient detail to identify delays related to the reservation system. Delays due to the reservation systems – for example, trucks waiting outside of the terminal area until they can use their reservation – were not recorded.

The methodology for the simulation model analyzes efficiency at the level of individual truck trips. The dispatch function – allocation of trips among the trucks in the fleet to maximize productivity – influences important variables such as trip patterns, and may be as important in ensuring efficiency as the performance of individual terminals.

Logically there are several aspects of current operations which have a substantial effect of the ability of trucking firms to optimize their dispatch efficiency. An obvious example is the high level of variability in turn times at terminals, which make it difficult to predict truck availability at any particular time. At the individual truck level the simulation model predicts little benefit from reduction in the variability of turn times. However, more reliable turn times may improve dispatch efficiency by facilitating advance planning of itineraries.

This research would require gathering data and analysis of individual trucking firm reservation and dispatch performance.

8.2.3 Analyze Queuing at On-dock and Off-dock Terminals

Turn times at the on-dock and off-dock container terminals show a significant degree of variability. This variability makes it more difficult for trucking firms to optimize the efficiency of their dispatch process. Terminal operators identify variation in truck arrivals as the major reason for inconsistency in terminal performance. This relationship could be empirically analyzed using data assembled for this study, and practical solutions identified through incorporation of queuing analysis into the simulation model.

8.2.4 Analyze Institutional Options to Address Drayage Cost Issues

The Ports Trucking Task Force identified the inability of the drayage industry to exercise pricing discipline as a case of market failure. The hyper-competitive environment has made it impossible for owner/operators and drayage firms to pass on increased costs to their customers. In the past, this has resulted in disruptions to port operations due to work stoppages when owner/operators find their costs rising or revenue falling, or both. In the absence of a viable market process for allocating these additional costs, how can they be accommodated? For example, should the cost of deadhead trips be redistributed by incorporating payment for deadhead trips in the drivers' compensation system? These are key questions for the future of Lower Mainland port competitiveness, and should be examined.

8.2.5 Undertake Geographic Analysis of Trip Patterns

In the existing model trips are characterized only by their travel times. Geocoding of the terminals would permit the assignment of trips across the road network and facilitate more detailed analysis of travel time impacts on system efficiency. It would also enable the use of the results of the Translink project to analyze truck travel times through en-route analysis of the GPS data from the truck survey. This would have a broader application in identifying key road infrastructure bottlenecks and priorities for improvements, which while outside the purview of the Container Trucking Forum would be valuable in setting priorities for allocation of regional, provincial and federal capital investments relating to the Asia-Pacific Gateway Initiative.

Appendix A: Truck Simulation Model

The Lower Mainland Container Truck Simulation Model

The Lower Mainland Container Truck Simulation model has been developed to estimate the impact of changes in the variables affecting the efficiency of drayage trips. To accomplish this, the model is designed to represent the existing logistics system, including the functional roles of the various terminals and the pattern of existing performance parameters, within the limitations of the data which is available.

The fundamental performance parameters affecting daily trips are travel time and turn time. Turn times are a major focus of the simulation analysis because they account for more than 50% of drivers on-duty time, and can be more directly managed within the port logistics system.

The model incorporates 12 distinct nodes representing origins and destinations for container trips in the Lower Mainland. The on-dock and major off-dock terminals are included as individual nodes because they are essential elements in the “common” user system (i.e. used by all parties) and account for the largest proportion of truck turn times. The model nodes include:

- The four on-dock container terminals – Centerm, Deltaport, Fraser Surrey Docks, and Vanterm.
- Four major off-dock container terminals – Coast 2000, Delco, Marco and Metropolitan.
- Transload warehouses classified as either export or import.
- The rail intermodal terminals as a single node.
- A generic yard as a start and end point for daily itineraries.

This allows analysis of system impacts using a relatively compact 12x12 origin/destination matrix.

A probability distribution of turn times for each individual terminal was generated based on the results from the data surveys. A gamma distribution was used in the modeling because it was found to accurately represent the existing distributions. For the aggregated nodes (import and export transload warehouses and rail intermodal terminals) the average turn time distribution was used.

Travel times are assumed to be normally distributed with a mean and standard deviation estimated from the survey data for specific origin-destination pairs. For aggregate categories (transload warehouses, rail intermodal terminals) the aggregate mean and standard deviation is used.

Trip patterns are based on probability distributions for destinations for each node, based on their load status (i.e. loaded container, empty container, or no container (deadhead).

The load status distributions are based on the share of each trip type recorded for each node in the survey data.

Thus the simulation results are driven by the following parameters:

- Load status for next trip from each origin
- OD matrix by load status for each origin
- Travel time distribution for each OD pair
- Turn time distribution for each destination

A diagram indicating the basic structure of the model is included in the Appendix.

The model was calibrated by comparing the output of the Base Case to the data collected and described in sections 1 through 4. The correspondence between the data inputs and the Base Case outputs gives an indication of how well the model represents the current logistics system (or at least that portion captured in the survey data). This correspondence is detailed below:

Input Data vs. Base Case Output		
Parameters	**Survey Data**	**Base Case Output**
% Container Trips	73%	72%
% Deadhead	27%	28%
Total Trips	7.2	7.1
Loaded Trips	5.3	5.1
Hours on Duty	7:52	8:44
% Turn Time	52%	53%
% Travel Time	48.0%	48%
Loads/Hour	0.7	0.6

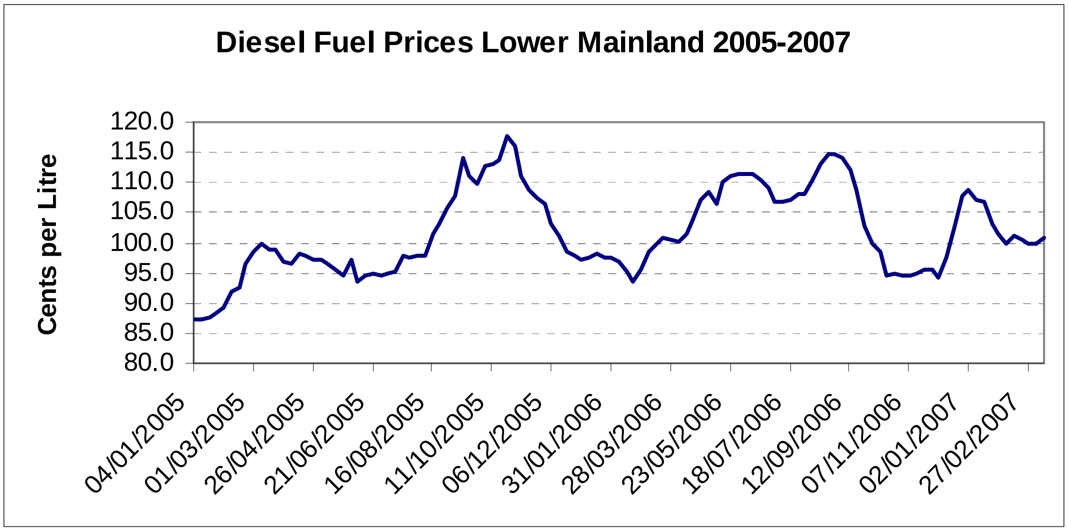
In general the model accurately represents the input data, with the exception of total hours on duty which is higher in the model output (8 hours 44 minute vs. 7 hours 52 minutes). This may be due to deficiencies in the survey data – many trip sheets did not record the first or last trips of the day (i.e. from the location where the truck is parked to the first stop in the morning, or from the last stop in the afternoon to the location where the truck is parked). The model always simulates the first and last trips and this may be the source of the discrepancy in time on duty.

Appendix B: Drayage Cost Estimates

Company Fleet Operations

Operating Costs of Trucks in Canada 2005 (OCTC 2005) provides annual and per kilometer costs for a variety of truck configurations and operating scenarios. It does not specifically analyze drayage operations. For trucks larger than 2 axle straight trucks the scenarios are based on highway line haul operations, with fewer origin/destination trips and longer trip lengths than the drayage sector. For purposes of comparison, the scenario using a 5 axle semitrailer with a Gross Vehicle Weight of 39,500 kg operating a total of 80,000 km per year has been chosen as the most appropriate.

Fuel is one of the largest components of cost in the trucking industry. The evolution of fuel prices in BC from 2005 to 2007 is shown below:



The current price of fuel (as of March 13, 2007) is 100.9 cents per litre.

The cost estimates in OTCT 2005 are based on a number of key assumptions, some of which are not appropriate for estimating costs in the drayage sector due to differing observations. The key assumptions for the OCTC benchmark case include:

- Annual mileage of 80,000 km per year.
- Daily operation based on a single origin-destination trip with a round trip distance of 320 km and a daily traveling time of 5.7 hours.
- Terminalling productivity level of 3 hours unloading for a payload of 27,270 kgs (dry freight) and an average payload of 19,155 kg, which implies a single daily “turn time” of 2.1 hours.
- 250 days of operation per year.
- An hourly wage (B.C.) of $19.25, and line haul labour costs based on distance at a rate of 27.38 cents per kilometer.

- An additional "wage burden" of 27% (holidays, benefits, etc.) for an average hourly labour cost of $24.45 per hour.
- A tractor purchase cost of $121,910, depreciated 79% over 5 years (i.e. with a 21% residual value).
- Administration and interest on working capital costs based on an average industry level for fleets amounting to 12.5% of revenue and taking account of normal interest charges.
- Interest costs for financing equipment based on a rate of 5.25%, loan payback period equivalent to equipment life, and an assumed 75% of equipment purchase costs financed (25% down payment required).
- Insurance rates at a level of 3.2% of revenue based on historic levels in the trucking industry.
- A profit margin of 5% of revenue.
- Fuel costs have been adjusted to account for the increase from the 2005 average level of 95.8 cents per litre to the current level of 100.9 cents per litre.

In order to estimate of the per-tractor cost of drayage operations carried out by a company using company-owned tractors and hourly labour, appropriate modifications were made to the OCTC assumptions to make them conform more closely to the specifics of local transportation of containers. In particular, the following adjustments were required:

- Drayage operations consist of multiple origin/destination trips within a single day. Terminalling productivity is significantly worse than for the OCTC benchmark, with 52% of duty hours spent at terminals according to the survey data. On this basis, an average workday of 7.8 hours consists of 4.1 hours in load/unload time and 3.7 hours traveling, compared to the OCTC estimate of 2.1 hours load/unload time and 5.7 hours traveling.
- The survey data indicates that in addition to time spent "working" (i.e. the time related to container trips which was analyzed using the simulation model), they typically work an additional 2 hours per day at the beginning and end of their shifts. This has been reflected in the drayage cost estimates as a "mobilization cost" equal to 2 hours at the prevailing wage rate. This adds an additional $9625 per year to the annual operating cost estimates.
- All compensation for company drivers in drayage operations is assumed to be based on the hourly rate.
- The OCTC estimates implicitly assume an average travel speed of 56 km/hr; drayage operations entirely within the urban environment are likely to have a lower average speed. An average speed of 50 km/hr is assumed for drayage operations.
- Within the limitations of the 7.8 hour average duty time and reduced terminal productivity, this implies that average annual distance traveled would be significantly less (47,400 km for the base case compared to 80,000 km for the OCTC benchmark).
- Fuel cost estimates for the drayage case are based on an assumption of a consumption rate of .5 litres per km, and the current fuel price of 100.9 cents per litre.

Owner/Operator Costs

Additional assumptions are required to generate estimates of the cost of owner/operator operations. The major difference is the lower level of capital costs due to the use of older tractors, with a corresponding increase in maintenance costs. The estimates shown in the following table are based on cost estimates prepared by the Vancouver Container Truck Association in the summer of 2005, adjusted to take into account current fuel prices. It is assumed that the owner/operator pays himself an hourly wage equivalent to current hourly wage levels; any additional income is considered an additional contribution to his profit margin. The estimates show that (under the assumption of equal labour costs) the annual cost for an owner/operator is around 6% lower than that of a company truck, due to lower capital costs and overhead.

Estimated Trucking Costs				
		OCTC 2005 (est.)	OCTC 2005 (adj.)	VCTA 2005 (adj.)
Configuration:	**5 Axle Semi Unit (Van)**			
Commodity:		**Dry Freight**	**Drayage Company Fleet**	**Drayage Owner/Operator**
	Annual Distance (km):	**80000**	**47400**	**47400**
	Average Payload (kg)	**19,155**		
A. Vehicle Utilization		**Est. 2005 OCTC**	**Drayage**	**Drayage**
	% Travel Time	73%	48%	48%
	% Turn Time	27%	52%	52%
	Trip Running Time	5.7	3.8	3.8
	Load/Unload Time	2.1	4.1	4.1
	Hours/Day	7.8	7.9	7.9
	Days/Year	250	250	250
	Annual Running Hours	1425	948	948
	Total Annual Hours	1952	1975	1975
	Avg. Speed (km/hr)	56	50	50
B. Driver Costs		**Est. 2005 OCTC**	**Drayage Company Fleet**	**Drayage Owner/Operator**
	Load-Unload Time Costs	$10,140	$19,770	$19,770
	Distance Wage	$21,995	$18,249	$18,249
	Total Wages	$32,135	$38,019	$38,019
	Hourly Wage	$19.25	$19.25	$19.25
	Labour Mobilization Costs		$9,625	$9,625
	Wage Burden	$8,676	$12,864	$12,864
	Total Labour Costs	$40,812	$60,508	$60,508
	Hourly labour costs	$24.45	$24.45	$24.45
C. Operating Costs		**Est. 2005 OCTC**	**Drayage Company Fleet**	**Drayage Owner/Operator**
	Tractor Variable Costs			
	Driver	$40,812	$60,508	$60,508
	Fuel	$24,658	$23,913	$23,913
	Repairs	$7,557	$7,557	$18,955
	Cleaning	$199	$199	$1,440
	Transport	$895	$895	$2,660
	Tires	$2,138	$2,138	$2,500
	Total Tractor Variable	$76,259	$95,210	$109,976
	Tractor Fixed Costs			
	Depreciation	$19,262	$19,262	$8,000
	Licences	$2,229	$2,229	$2,229
	Total Tractor Fixed	$21,491	$21,491	$10,229
	Tractor Total	$97,750	$116,701	$120,205
D. Overhead Costs		**Est. 2005 OCTC**	**Drayage Company Fleet**	**Drayage Owner/Operator**
	Insurance Costs	$4,625	$4,625	$7,771
	Administration and Interest	$19,273	$19,273	$6,745
	Interest Financing Equipme	$3,238	$3,238	$1,048
	Overhead Costs	$27,137	$27,137	$15,565
E. Total Costs		**Est. 2005 OCTC**	**Drayage Company Fleet**	**Drayage Owner/Operator**
	Total Costs excl. profits	$124,887	$143,838	$135,770
	5% Profit margin	$6,244	$7,192	$6,788
	Total Costs incl. profits	$131,131	$151,030	$142,558
	Costs/day (250 days/year)	$524.52	$604.12	$570.23
Drayage Fuel Cons = .5 litres per km		Fuel Price = $1.009 per litre		

Appendix C: Data Survey Forms

Date: ____________________

Port Pass: ____________________

Driver Name: ____________________

Tractor #: ____________________ GPS Logger ID: ____________

Book In Time: ____________ Book Out Time: ____________

Chassis # at Start of Day: ____________

Move	Origin	Time Out	Chassis #	Container #	Destination	Time In Line-up	**Time In Gate**	Comments	**Full**	**MT**	**No Container**	**No Chasis**	**Coffee/Lunch**	**Fuel/Repair**	**No Work/Res.**	**Other**
		Black Start Button				Red End Button	**Black Event**		**Check One**				**Optional**			
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																

Driver Signature: ____________ Date: ____________ **Contact Information:** ____________

Port Location		**Off Dock CY Location**
VT	Vanterm	Marco
CT	Centerm	Delco
DP	Delta Port	Coast 2000
		Metro
		CIS

For Office Use Only

Reviewed by: ____________________

Date: ____________________

Start Time	Location	Container Number	Time In	Time Out	Total Time	Destination	Time In	Time Out	Total Time	Full	MT	No Containers	No Chassis	Total Time

Please complete this survey for two weeks starting in early November.
Please keep a record of each trip you make for each day. The Start time is when you physically left for the start of the leg and the Finish time is the time you actually completed this leg.
Waiting time should be recorded for the Start of the leg, the end of the leg or both if necessary.
The Start and Finish time should be a total of waiting time and travelling time to complete this leg.
Please check ✓ box if the container is Full or MT
If the trip is not carrying a container, please note "No Container" in the Container # box.
Please return these sheets to your Dispatch at the end of the week.