

***Analysis of Railway Fulfillment of
Shipper Demand and Transit Times***

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Rail Freight Service Review

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Executive Summary

Purpose of the Project

The Government of Canada is conducting a review of rail freight service in response to concerns raised by stakeholders in the rail freight logistics system regarding the service performance of Canada's railways and as part of a broader initiative which included changes to the shipper protection provisions of the Canada Transportation Act. The general objectives of the review are to examine the performance of the rail freight logistics system in Canada and to identify problems and issues with respect to railway service including those stemming from the operations and activities of stakeholders other than the railways – such as shippers, receivers and logistics partners.

This report is part of the quantitative and analytical stage of the Rail Freight Service Review. It has been prepared in response to the requirements of the Request for Proposals (RFP) covering the "Analysis of Order Fulfillment and Transit Times". As part of the broader review, the objective of this report is to assess the extent to which the railways meet shipper demand for service. There are two main components to this report: firstly an assessment of railways' fulfillment of shipper demand and secondly an assessment of railways' transit time performance.

The choice of these factors for assessment in the quantitative analysis phase of the review - demand fulfillment and transit time consistency - was reinforced by the findings of the customer satisfaction survey conducted by NRG Research for the Rail Freight Service Review.¹ This survey identified car supply (which is a key component of demand fulfillment) and transit consistency as very important factors influencing shippers' satisfaction with railway service.

Furthermore, this report and the service review process in general recognize that the performance of the rail freight logistics system in Canada is not solely a railway responsibility but a joint effort of all key stakeholders in the system. As part of the service review process QGI prepared a report on operating practices in Canada's rail freight logistics system.² In that report QGI, using the Supply Chain model of logistics, demonstrated that Canada's rail freight logistics system is a joint responsibility of all supply chain partners. This system requires effective collaboration in the planning and operations activities of supply chain participants including railways, shippers, receivers, shipping lines and their intermodal and bulk shipping partners.

¹ The two most important service factors were 'on-time delivery of cars at origin' and 'on-time delivery of cars at destination'. *Survey of Shippers. Prepared for the Rail Freight Service Review* NRG Research Group November 30, 2009.

² *Analysis of Operating Practices* QGI Consulting October 2009 Report prepared for the Rail Freight Service Review.

General Approach

For the transit time performance analysis this study reviews railway, shipper and receiver performance in the loading, movement and unloading of rail cars across a number of dimensions of shipper and railway network characteristics including:

- Railway Canadian National (CN) and Canadian Pacific (CP)
- Commodity Broken out by customary classifications such as: Grain Products, Fertilizers, Forest Products, Fuels and Chemicals, Intermodal, Automotive and others.
- Size of Shipper
- Size of Order or Flow Size Represented by the number of cars shipped in a particular shipper/commodity/origin/destination combination.
- Point or Province of Origin and Destination including major border crossings
- Main Line vs. Branch Line Origins
- Short Line vs. CN/CP Origins
- Access to Alternative Transportation
- Length of Haul (LOH)
- Time

The order fulfillment analysis, including both annual forecast demand and weekly car supply processes, are generally based on the same framework of railway and shipper characteristics but due to data limitations do not include as detailed an assessment of performance across all railway and shipper characteristics. Furthermore, as is described in report Section 2.2 - Railway Car Supply Performance, the analysis of railway performance with respect to the supply of empty cars in response to customer car orders is limited to those Merchandise and Grain customers who submit their orders through the railways' electronic car ordering systems.

The analysis in this report is based on data provided by CN and CP for the period from October 1, 2006 to September 30, 2008.

Order Fulfillment Analysis

The order fulfillment analysis examines two distinct aspects of railway performance in meeting shipper demand. First, the analysis of forecast versus actual volumes shipped evaluates the relative success of the railways in meeting shipper demand based on the railways' medium term demand forecasts that are developed as part of their annual planning processes. Secondly the car supply performance analysis examines railway performance in meeting short term (weekly) shipper demand by comparing the actual number of empty cars spotted on a weekly basis against shipper railcar orders and the railways' planned level of empty car supply. This analysis also evaluates the performance of shippers by assessing the degree of volatility in shipper demand – i.e. the frequency and magnitude of changes to shipper car orders.

Annual railway budgets are developed for both revenues and operating costs that are based on the railways' forecast of demand. Railway budgets are constructed using multiple inputs including shipper demand estimates, historical shipment patterns, commodity specific market intelligence and macroeconomic assumptions. The volume forecasts that underlie these budgets are used to determine the necessary investment and maintenance plans for railway assets such as freight cars, locomotives and train crews as well as train service design. In developing their asset and service plans the railways rely on both shipper information and historical traffic patterns to account for seasonal fluctuations in volumes.

In finalizing their planned resource requirements to respond to shipper demand railways will also consider the revenue yield opportunities and capabilities across their traffic base and the level of operating income that may be achieved. As such, railway budgets are not simply a direct reflection of underlying customer demand but rather the level of demand the railways plan to fulfill throughout the year in the pursuit of their broader financial objectives. Therefore the accuracy of railway forecasts should be viewed in the context of how such forecasts are constructed and the many factors that can impact traffic volumes and traffic patterns through the course of a year.³

The railways measure their performance against plan as part of their ongoing quarterly and monthly planning processes. These shorter term planning processes are designed to identify emerging changes in absolute demand or the timing of demand that can result from the actions or performance of shippers or other system stakeholders, broader market issues, railway performance or systems disruptions beyond the control of all stakeholders (e.g. weather). The railways look to develop appropriate short term operational and service strategies in response to demand changes that create potential capacity constraints in the railway network. These strategies can include short term leasing of railcars and or locomotives and changes to train design in specific corridors. The measurement of empty car supply performance in this report provides insight into two issues: the level of demand volatility from

³ For a more detailed explanation of railway budgeting and forecasting processes see, *Railway Demand Forecasting and Service Planning Processes* QGI Consulting March 2010. Report prepared for the Rail Freight Service Review.

shippers and the performance of the railways in meeting both stated shipper demand and the railways' own car supply plans.

Forecast vs. Actual Volumes

Methodology and Scope of Analysis

Prior to the commencement of the railway service review, Transport Canada reached an understanding with the railways that this study would be based on a data sampling approach. QGI worked with both railways and Transport Canada on a sampling methodology to ensure that the study could examine railway service at a sufficient level of detail to provide analysis with reasonable statistical validity. QGI's sampling methodology was based on stratified random sampling.⁴ QGI's sample was drawn from traffic data for traffic shipped during calendar year 2007. Both CN and CP encountered difficulties in providing budget data at the shipper-origin-commodity (sample key) level of detail that was requested in QGI's sample due to the budgeting and forecasting practices in place at both railways. Due to this limitation each railway submitted data at varying levels of detail as compared to the sample keys for which data was requested. The analysis for order fulfillment uses simple ratios such as (carloads shipped/budgeted carloads) and variance measures such as (cars budgeted – cars shipped) that provide the necessary performance metrics.

Key Findings

- At an aggregate level for the two year study period, the railways' forecasting processes were accurate in estimating traffic volumes within 10% based on the performance of both CN and CP. For individual years within the study period, variance to plan for the two railways individually ranged between +1% and -8%. For the entire 24 month service review period⁵ CN and CP had similar performance with respect to the volume of cars shipped vs. railway forecast with actual shipments for both railways falling short of plan although more so for CN (-6%) than for CP (-2.6%).
- During the study period performance to plan was consistent across the major lines of business for both railways with all business lines performing below forecast levels with the exception of CP's Intermodal segment that was 4.5% better than forecast in Year 1.
- The combined shortfall to plan experienced by CN and CP during the study period represented, for the sample of traffic analyzed, a total of 332,000 carloads with CN accounting for 74% of the shortfall.
- There was a higher degree of variance to plan at the individual commodity subgroup level with annual forecast accuracy varying by as much as 40% reflecting both positive and negative variances to plan.
- There is also significant variance to plan on a monthly basis at the individual commodity subgroup level averaging 36% for the two railways over the course of the study period.
- Variance to plan at the individual shipper origin/commodity flow level varies widely with maximum annual percentage variance ranging from -100% to more than +100% of forecast. For the sample of forecasts analyzed, approximately 42% of the sample keys (46% of carloads) had a variance to forecast of +/- 10% and 70% of sample keys (84% of carloads) had variability of +/- 30%.

⁴For more details refer to *Technical Report: Sampling Methodology* QGI Consulting March 2009. Report prepared for the Rail Freight Service Review.

⁵Excluding the month of February 2007 which was removed due to the CN strike.

Empty Car Supply

The objective of the empty car supply analysis is to determine the degree to which railways meet shipper requirements in the supply of empty rail cars. This car supply analysis is a review of the daily and weekly empty car order and supply process that takes place between shippers and railways. In addition to this short-term process, shippers and railways share information through longer term budgeting and forecasting processes that operate over annual and monthly time frames.⁶

The railways' car ordering processes are designed to encourage shippers to provide the railways with advanced views of shipper demand by allowing shippers to enter their orders a number of weeks in advance. These processes allow for weekly service planning by imposing a cut-off date for order entry typically during the week prior to the week for which cars have been ordered.⁷ In assessing the railways' performance in meeting customer demand for empty rail cars, it is important to remember that a railway's failure to supply cars may or may not imply lost sales or lost economic productivity for the shipper. The degree to which an empty car order represents true demand depends in part on whether or not there are economic consequences to the shipper associated with the car order transaction.

As both CN and CP impose financial penalties on shippers for empty railway owned cars ordered and not used and as demurrage charges accrue on empty railway supplied cars - neither railway operates in an environment where car orders can be considered as "unconstrained demand." However, interpretation of the meaning of car order demand remains problematic – particularly in situations and at times where shippers believe that total demand for empty rail cars is likely to exceed available supply.

In reviewing railway performance in supplying shippers' demand for empty rail cars it is important to keep in mind the practical restrictions that face railways in their response to changes in shipper demand. Railway car supply is provided by fleets that are relatively fixed on a month to month basis as opportunities for railways to increase their fleet supply through short term leasing or the use of foreign railway fleets are in most markets quite limited and may carry unacceptable costs to the railway. When railway operations or demand changes cause congestion in the rail network it can significantly affect the short term availability of cars for loading at origin.

For all of the reasons above, caution must be used when interpreting the car order fulfillment statistics that are presented in this report. In order to more fully understand the issues and concerns related to how the railways are fulfilling empty car demand QGI recommends that the data presented herein be used in conjunction with other information sources on this topic. These sources include the results of the railway customer satisfaction study

⁶ These longer term processes for predicting and planning for rail freight customer demand are examined in a different report that QGI has prepared as part of the Rail Freight Service Review. *Railway Demand Forecasting and Service Planning Processes* QGI Consulting March 2010.

⁷ Railway cut-off dates will vary by railway and are different for Merchandise and Grain shippers. The specific cut-off dates for CN and CP's Merchandise and Grain car order programs are discussed in greater detail in Section 2.2 of this report.

undertaken for the Rail Freight Service Review by NRG Research⁸ and QGI’s reports on railway car order and supply processes and on railway demand forecasting and service planning⁹. In addition, readers may wish to consider the information provided in any submissions that may be made to the Service Review by shippers, railways, and others.

Methodology and Scope of Analysis

Not all types of railway shippers or business segments are included in this analysis. The car supply analysis has only been conducted for situations *where the railway controls car supply to the shipper* and excludes intermodal traffic. In addition, situations where cars are supplied without the use of railway electronic car order processes have been excluded.¹⁰

The data requested from the railways was therefore limited to the Merchandise (including Fertilizer) and Grain products shippers of both railways. The products shipped by these customers include forest products, mine and mineral products, construction materials, agricultural and grain products. The following table provides a breakdown of the proportion of both railways’ non-Intermodal business that is shipped using each of the car types that were included in this analysis.

Car types covered by ordered/supplied analysis¹¹

Car Type	Percentage Railway Non-Intermodal Business Shipped by car type
Boxes	14%
Covered Hoppers	28%
Flat Cars	10%
Gondolas	9%
Open Hoppers	< 1%
Total	61%

The original terms of reference for this project did not include provision for the supply by the railways to QGI of any data on empty rail car orders, or empty supply information. QGI, with the support of Transport Canada, entered into discussions with CN and CP to discuss the terms under which the railways would be able to provide empty rail car demand and supply data to QGI and the railways agreed that this data

would be provided to QGI but summarized at the weekly level. As a result, this analysis is provided at the weekly

⁸ *Survey of Shippers. Prepared for the Rail Freight Service Review.* NRG Research Group. November 30, 2009.

⁹ *Railway Car Order and Car Supply Processes and Railway Demand Forecasting and Service Planning Processes* QGI Consulting March 2010. Reports prepared for the Rail Freight Service Review.

¹⁰ The analysis was limited to situations where railways supply cars as there is no car order process that can be subjected to measurement in situations where shippers supply cars – such as in the petroleum and chemical industries. In addition, when cars are supplied through the provision of specially assigned fleets (customer pools) of cars, there is no record of shipper car demand that can be assessed against the cars actually supplied. Intermodal traffic was excluded as the railways do not have reliable electronic data on equipment demand for railway supplied intermodal equipment.

¹¹ This table estimates the proportion of the total non-Intermodal rail business that is included in the car order and supply analysis based on the sample reference year 2007. The percentages for each car type in this table take into account all of the exclusions from the analysis described in the text with the exception of the traffic that was excluded due to the use of customer assigned pools. For CN, this is a nominal proportion of its traffic. For CP, customer assigned pools are more commonly used. Based on a review of CP data QGI estimates this proportion at approximately 8% of CP’s non-Intermodal business.

level. However, since the issue of daily car supply performance was of great interest to stakeholders, QGI also requested the railways provide data on daily car order performance for a very limited number of shippers and locations. This report contains a brief analysis of daily car supply performance for this small sample of shippers.

QGI validated the railway supplied car order and supply data with a select number of grain and merchandise customers for both railways. These shippers were asked to validate data for a total of 19 origins. While shippers identified some minor anomalies in the timing of order and supply data from week to week all were in agreement that the railway supplied data was representative of their experience and consistent with their own records.

For this railway car supply analysis, simple ratios such as (cars ordered/cars supplied) and variance measures such as (cars ordered – cars supplied) were developed to provide the necessary performance metrics. These metrics are used to assess the railways' car supply performance against both shipper demand (orders) and where appropriate the planned or allocated supply the railways communicate to their customers.¹² In addition to railway performance in the supply of empty rail cars, shipper performance with respect to rail car order activities is reviewed in this report.

Key Findings

Grain Car Order/Supply Analysis

Car Demand

The empty car order processes for grain cars are quite similar between CN and CP. Between 25% and 30% of grain car orders¹³ on both railways are subject to cancellation by customers after the cut-off date for orders and prior to the cars being supplied by the railways. While the number of overall cars affected is much smaller than the number of orders affected, it is still very significant ranging from 11-12% of CP's and 15-17% of CN's total grain cars ordered by shippers. While there was no statistical relationship between overall car order levels and car order cancellation rates, the period of declining overall demand during grain year 2007-2008 did coincide with a period of great volatility in grain order cancellations from week to week, especially during the last half of the grain year when volumes were in decline. Shippers may reduce some or all cars ordered for a particular location prior to railway placement for a variety of reasons including: the cancellation of previously unfilled orders, agreement between a railway and a shipper to shift orders from one location to another to facilitate operations planning for either party, or changes in grain collection or final market outlooks.

¹² Measures of performance for planned or allocated supply are not provided for CP's Merchandise business as CP's existing car order process does not provide for electronic communication to their customers regarding the level of empty car supply the railway plans to supply in response to the orders submitted.

¹³ A grain car order is defined as an order by a shipper for the placement of one or more empty covered hopper cars at a specific location for a specific week.

Car Supply

At an aggregate level, the two railways' performance in fulfilling shipper demand for empty grain cars was almost the same with CN fulfilling 98% and CP fulfilling 97% of total orders for the service review period from October 1, 2006 through September 30, 2008. On a week to week basis, however, there was significant variability in performance with each railway providing grain shippers with at least 90% of the cars that they had ordered at a specific location only half the time. Furthermore, as with the transit time performance assessment, both railways' weekly car supply performance deteriorated significantly during the winter of 2007/2008.

Merchandise Car Order/Supply Analysis

While the empty car order processes for grain cars are quite similar between CN and CP, the processes for Merchandise cars are quite different. CN offers shippers a Guaranteed Car Order (GCO) program which includes performance penalties for both shipper and railway. CP's car order process does not include a commitment to supply, and there are no financial penalties to CP for failure to meet merchandise car orders placed through its Internet based Delta car order program.¹⁴

CN's car supply process includes a review of orders and the entry by CN into its car order system of CN's allocation (guarantee) of its projected available empty fleet for each car order. In addition, CN's information systems track changes to car orders that took place between the cut off date for car order and the actual date for which cars were ordered and, as a result, were able to provide QGI with the related information. CP's data only included its final car order numbers as CP's systems do not track changes in the orders between cut-off and actual car order dates and therefore no such information could be provided to QGI.

Because of these significant differences between the two car order programs and the data provided by CN and CP, the analyses of the two programs cannot be directly compared. Consequently the results of the analysis are presented separately for each railway and the analysis of CP car supply processes cannot include an assessment of the volatility of CP's customer car orders.

Car Demand – CN Merchandise

The CN empty car demand analysis showed that 36% of the CN car orders were subject to changes after the cut-off date. The absolute value of the percentage change to car orders for all Merchandise car types was 11% of the cars

¹⁴ CP does charge for cars that have been ordered by shippers through its Delta car order program that are not used by shippers and must be pulled empty from a shipper's siding. In addition, for both railways, demurrage charges on empty cars begin to accrue to the shipper after the expiry of the railways' free time provisions for loading empty cars. For a more thorough discussion of the details of CN and CP's car order processes see QGI's report on this topic – [*Railway Car Order and Car Supply Processes*](#) QGI Consulting March 2010.

ordered for the entire service review period.¹⁵ This change resulted in a 5% net increase in cars ordered (increases minus decreases) after the cut-off date and before the order delivery date. The analysis of car order changes by CN customers suggests that the short term prediction of final demand for empty rail cars is a very dynamic process.¹⁶ Given the demonstrated variation in demand prediction, railway car distribution staff will face challenges in their ability to satisfy customer car orders while maintaining their focus on asset utilization. Changes in car demand from day to day and week to week will be affected by such factors as railway performance in meeting previous demand requirements, final demand changes by the customers' customers, changes in customer operations and upstream logistics and supply processes/performance.

Car Supply - Merchandise

On an annual basis, CN has an average annual fulfillment rate of 86% for Merchandise customer car orders and an average annual fulfillment rate of 95% for the car guarantees made under its GCO program. When considered across size of car order, network/shortline/competitive status and province of origin, there is very little variation in the overall car order fulfillment rate for CN customers.¹⁷

However, as with grain car orders, CN's weekly performance with respect to car supply is much lower with an estimated 68% of Merchandise customers receiving at least 90% of their car orders on a weekly basis. CN's average weekly performance against its car order guarantees under the GCO program is estimated at 81% (at a fulfillment rate of 90% of cars ordered).

On an annual basis, CP performance against car orders for all Merchandise car types averaged 73% for all customers in the CP sample and the median performance was 79%. When assessed against various network and shipper characteristics, the sample data suggest that CP customers located at competitive origins receive somewhat better car supply than customers without access to direct rail competition.¹⁸ On a weekly basis, an estimated 50% of CP Merchandise customers received at least 90% of the cars that they had ordered for a given week.

Daily Car Supply Performance

While annual fulfillment rates for both grain and merchandise customers that were included in the daily performance analysis were comparable at better than 90%, on a daily fulfillment basis the merchandise customers received significantly better performance than the grain customers. This was true for both CN and CP. Performance for both railways in serving the selected grain customers improved somewhat on a daily basis when performance was examined from the perspective of cars available for loading by the requested day including cars spotted early, as

¹⁵ The absolute value of a number is that number expressed only as a positive value. Thus the absolute value of -15 is 15. The use of absolute values permits the analysis of the range of variation of car orders so that decreases in car orders do not "cancel out" increases in car orders.

¹⁶ Appendix 2 includes a more detailed analysis of changes to CN car orders after cut-off, across a number of shipper and network characteristics.

¹⁷ The results of this analysis are in Appendix 5 – CN Overall Car Supply Performance.

¹⁸ This analysis is available in Appendix 2 - CP Overall Car Supply Performance.

opposed to cars spotted for loading on the requested date.¹⁹ On this basis, CP's performance was significantly better than CN's, as CP provided its customers with an average of 83% of planned cars - compared to CN who provided an average of 43% of planned cars.

It is important to note that this performance assessment was limited to nine customers and may not be representative of daily performance in general. It is also important to understand that with the exception of CN merchandise customers, who receive guarantees of daily car supply, the railways do not commit to supply either the planned or ordered cars on a specific day notwithstanding the importance shippers place on this level of performance. The railways' ability to achieve precision in daily car spotting performance can be impacted by a range of factors. These include volatility in week to week demand for cars and shipper order accuracy – especially when car fleets are under allocation. From a supply perspective the smooth flow of empty cars to meet demand is dependent on the railways maintaining fluidity in their networks and other shippers and receivers loading and unloading cars in shared fleets efficiently to maintain a smooth flow of cars in the system. In addition, the performance of connecting carriers in moving empty equipment back without delay to the originating railway can seriously impact the available supply of rail cars.

¹⁹ This was done to reflect the common railway practice of pre-spotting empty cars in advance of the order date.

Transit Time Analysis

Importance of Transit Time Performance

A key element of railway service is the consistency of the transit time provided to customers. Consistent service may also be termed reliable service. Consistent transit time allows supply chain partners to plan for the movement of the shipments through their supply chains. Unreliable service, as characterized by highly variable transit times, requires shippers and receivers to invest in higher average levels of inventory, storage capacity and product handling capacity than would be needed if transit times were more consistent. Highly variable service also impairs the production planning and marketing activities of railway customers and ultimately affects the competitiveness of Canadian industry.

In addition to the consistency of transit time, the average transit time, which is determined by the speed of rail traffic, is also of importance to shippers. In general, when average transit times are longer, the range of variation of transit times will also be wider than for traffic with higher speed and therefore shorter average transit time.

Therefore, in this report both the average transit time and the range of variation of transit times are examined and compared for a number of railway, shipper and railway network characteristics.

Methodology

Data Sampling, Screening, and Structure

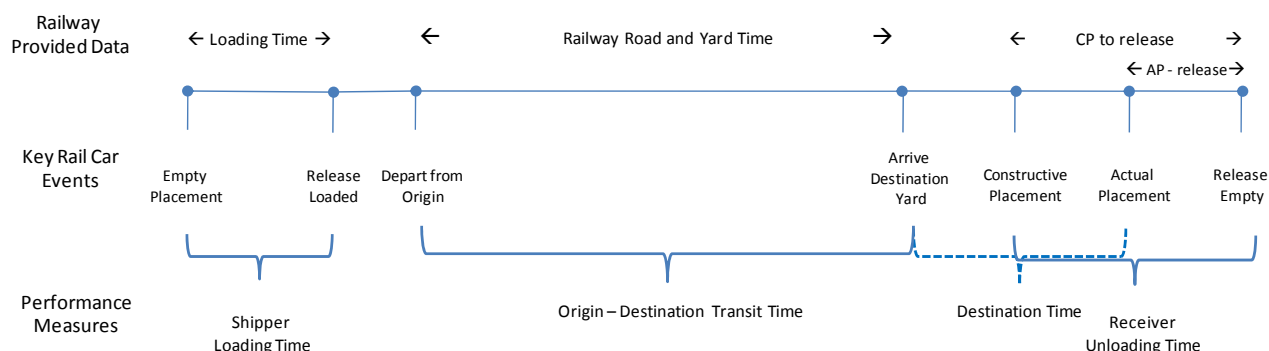
The sample transit time data provided by the railways was requested using sampling methodology developed by QGI and referenced earlier in the report. This data was reviewed to ensure that it was representative of the overall railway traffic base and was then screened to confirm railway methodology for calculation of time intervals and to remove extreme or unreasonable values due to railway reporting or data errors. In addition, the data was reviewed to identify any periods of special disruption. As a result of this review, all traffic on CN and CP that moved during the CN labour disruption of early 2007 was removed from the analysis.²⁰

The railways provided QGI with transit time data for individual rail car trips identified in the sample. Each data record contained time intervals calculated by the railways for key trip segments at origin, en route, and at destination. These specific time intervals were selected to allow for the assessment of not only railway performance but also the performance of shippers and receivers for loading and unloading activities respectively.

²⁰ The period for which data was excluded was Feb. 4 through March 3, 2007 (service review weeks 19-22 of service review year 1). Traffic moving during this five week period of winter weather would be expected to have slightly higher average transit times than would be experienced at other times of the year. While CP's average velocity and consistency of transit time were only slightly higher than their annual averages for all traffic during this period, CP's traffic moving during the CN strike was excluded from analysis to ensure that both railways were treated equally in the study.

The following graphic summarizes the transit time performance data provided by the railways and the elements of rail car trips that are examined in this report. The graphic demonstrates that both shippers and consignees have critical roles in the overall logistics chain as they control the time spent in loading and unloading of rail cars.

Railway car events and key performance measures²¹



Two key elements of all rail car trips are the primary focus of assessment in this report – origin to destination transit time, and time at destination.²² For origin to destination transit time both the average duration and variability of railway performance will be examined. For time at destination, there is a mix of accountability for performance between railways and receivers. In some situations cars can be immediately placed at receiver sidings upon arrival. However, many receivers require railways to stage rail traffic in railway yards at destination locations until customers request that cars be placed on their sidings. Due to the complexity of this issue, time at destination is examined in a separate section of this report.²³

Measurement Framework

While most readers will be familiar with the calculation of averages, measuring transit time consistency requires the use of somewhat complex measures of the variation of performance - such as standard deviation of transit time, and

²¹ In the graphic illustrated above, the term “Constructive Placement” (CP) refers to situations where rail cars are held on railway property at customers’ convenience awaiting the customers’ instructions on actual physical placement at their facilities.

²² Due to data constraints the analysis of intermodal transit time performance examined origin to destination transit time and time at origin intermodal terminal.

²³ For the movement between origin and destination, the railways provided QGI with the total time that each car spent on trains, and the time the car spent in rail yards prior to its arrival at destination. The relative time that an individual car spends moving on trains versus the time spent idle in rail yards depends on a number of factors including; the frequency of scheduled and available train connections between yards, the level of congestion in yards at a specific time, and the availability of train capacity between specific locations. Thus, while the railways provided QGI with both total train time and total yard time for each car, the analysis of transit time does not differentiate between time on trains and time in yards at intermediate locations between origin and destination. In the absence of much more detailed information providing the actual location of delays in specific yards at specific times it was determined that segmenting the analysis into yard time and train time would not provide any useful insight into the performance of the rail logistics system.

the coefficient of variation of transit time.²⁴ The population standard deviation²⁵ (Std Dev) is an absolute measure of the dispersion of the values in a population. The standard deviation can also be thought of as the “typical” variation of a random observation from the mean value of the population. It is useful for comparison purposes between populations only when the populations have very similar means.²⁶ In this report, the key statistic used to measure the consistency of transit time is the *coefficient of variation of transit time (CV)*. The CV simply expresses the standard deviation as a percentage of the mean of a population. For example, if an origin/destination pair had an average transit time of 150 hours with a standard deviation of 20 hours, the CV would be $(20/150 * 100) = 13.3$. A lower CV is better.

The transit time for an individual car trip is determined by the length of haul and the speed of movement of the car between origin and destination. This speed is a function of the time that a car spends in rail yards and the time spent on trains and the speed of movement of those trains. *Speed is a critical element of transit time analysis as the range of transit times achieved by a railway will be determined by both the average speed of the traffic and the level of transit time consistency for a particular origin – destination pair.*

Transit Time Ranges

For each of the characteristics of railway networks and railway shippers for which service is assessed in this report, typical ranges of transit time performance have been calculated. These performance ranges are used to illustrate directly the actual service levels that are experienced by typical railway shippers. Thus, for each shipper or railway characteristic, a typical range of transit times that represent an estimated 75% of the shipments in that grouping is calculated and displayed in both tables and graphs. It is important to note that these illustrations of railway performance are meant to represent the service that will be experienced by “typical” customers. The individual samples of shippers that were analysed for this report are made up of very different customers whose actual service levels are higher and lower than the averages and who have varying lengths of haul. However, by creating ranges of performance for typical customers the report clearly demonstrates the range of performance that is actually experienced – without readers having to reference the underlying statistical measures in order to understand performance.²⁷

²⁴ The calculation of all means, medians standard deviations and coefficients of variation in this analysis is made for each sample key, for each service review year. Service review year 1 is from October 1, 2006 to September 30, 2007. Service review year 2 is from October 1, 2007 to September 30, 2008.

²⁵ Population standard deviation is customarily abbreviated by the Greek letter σ . In the report the abbreviation Std Dev for the benefit of non-statistics oriented readers will be used.

²⁶ The standard deviation is the square root of the average of the squared differences between the individual observations in a population and the mean of that population.

²⁷ For a more detailed explanation of the methodology used to create the transit time ranges, see the section on “Analytical Methods” in the main body of the transit time analysis in this report.

Key Findings

Many railway customers receive rail service with highly variable transit times. Some level of variability of transit time is expected by railway customers and good performance in both absolute transit time and transit consistency requires investment in railway capacity and operations. The average transit time and the degree of variation of this time (reliability or consistency) are matters that shippers can negotiate with their railway partners. In addition, there are no regulatory or industry standard benchmarks against which railway performance can be compared. Therefore, this report does not seek to define an absolute level of reliability that railways should be expected to achieve. This report does clearly illustrate the levels of reliability that were being provided to shippers during the study review period.

- In general, depending on the traffic characteristics being assessed there were considerable differences in transit time for movements with similar lengths of haul. However, for a number of variables where one might expect there to be differences in performance based on the service or shipper characteristics, there was remarkably little differentiation in service performance. Examples where major systemic differences in performance were **not** found were²⁸
 - Shipper size
 - Flow size
 - Access to rail competition
 - Core versus non-core railway origins
 - Shortline versus CN and CP origins
- For both railways, significant deterioration of service is noted during winter months. However, CP was more likely to have more variable transit times outside of the winter period than CN. Railway Intermodal terminal times from in-gate to depart were much worse in winter months and these disruptions to Intermodal terminal throughput during the winter lasted longer for CN than for CP
- At final destination, the time taken for placement of cars at receivers' sidings varies widely based on the type of traffic with bulk traffic generally being placed within 10 hours and merchandise traffic averaging over 40 hours. There were significant differences between CN and CP with respect to the use of "constructive placement" at destination (26% vs. 3% respectively). This much greater use of constructive placement can create the potential for conflict with shippers as this reporting can trigger the beginning of allowable free time for demurrage calculations on railway supplied cars
- The day of week of arrival has a significant effect on the time taken for final placement with traffic arriving on Friday and Saturday taking 23% longer to be placed than traffic arriving on all other days of the week
- Of cars released in a block by shippers, 42% of CN's and 38% of CP's do not arrive at destination in a single block. The average maximum delay between the first cars in a split block to arrive at destination and the last car is 46 hours for CN and 82 hours for CP²⁹
- Like transit times, shipper and receiver loading and unloading times are subject to wide levels of variability. The commodity groups with the shortest and most consistent loading and unloading times were grain and

²⁸ There were some exceptions to this general statement about the lack of differentiation of service levels across these characteristics and where these exceptions are significant they are identified in the body of the report.

²⁹ In most cases, there is no commitment made by railways that cars released in a block will be delivered as a block at final destination. Railways may choose to consolidate or break-up car blocks based upon the need to either increase or reduce train length to deal with operating restrictions either between origin and destination or at intermediate points in the trip of the car blocks. In addition, car blocks may be broken up and delivered in smaller groups if customers at destination cannot receive and unload the cars in the original car block size.

coal amongst bulk products. In the merchandise group, finished vehicles had the most consistent unloading times. The groups with the longest times and most variable performance are metal products and ores and concentrates at origin and destination, and potash and other forest products³⁰ at destination unloading points.

Railway Performance by Commodity Group

In the report, performance is analyzed across a number of characteristics of the railway and shipper population for both CN and CP. Care must be exercised when drawing conclusions from any of the cross-tabulations of performance but particularly when comparing railways’ performance to each other. While the railways compete directly with each other for many railway customers’ business, the mix of traffic that is handled by each railway is somewhat different. In addition, there are differences in the geographic reach and in the terrain characteristics of the railways’ networks. These customer and network differences can affect railway performance and make direct comparisons between railways difficult. For example, the following table shows the breakdown of carloads handled by each railway by commodity grouping.³¹

Business Unit	Carloads (000s)		Percent Carloads	
	CP	CN	CP	CN
Grain & Fertilizers	573	579	21%	13%
Coal	281	375	11 %	8%
Forest Products	92	511	3 %	11%
Industrial Products	341	1,572	13 %	34%
Intermodal	1,216	1,377	46 %	30%
Automotive	141	201	5 %	4%
Total	2,645	4,615		

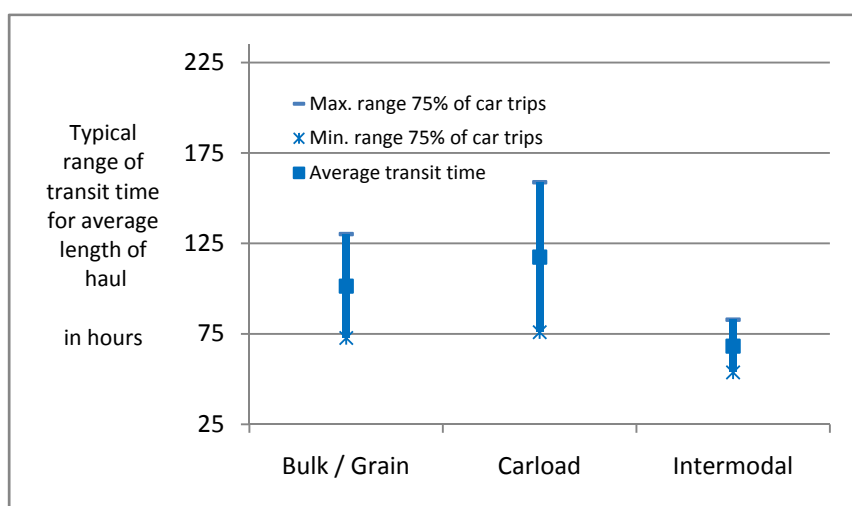
While the Grain, Intermodal and Automotive business volume (carloads) for both railways are very similar, there are large differences in the volume of Industrial and Forest Products - with these two groupings accounting for most of the difference in overall volume between CN and CP. This large base of mixed carload traffic provides CN with advantages in maintaining the frequency of train movement of carload traffic in certain corridors.

³⁰ The other forest products group in the sample data is primarily made up of pulpwood chips and wood pellets with a smaller volume of logs, poles and ties.

³¹ Data derived from *Description of Canada’s Rail Based Freight Logistics System: Prepared for: Rail Freight Service Review*. QGI Consulting 2009
 Note that in this table, the precise mix of traffic in commodity classification may differ for each railway. For example, CP dry fertilizer traffic is classified within the Grain and Fertilizers group however for CN this traffic is grouped with Industrial Products. In addition, this data includes all traffic handled by both railways including their US originated traffic.

Canadian National

	Bulk / Grain	Carload	Intermodal
Average LOH - miles	1030	1078	1635
Typical Transit Time - hours	101	117	68
Average CV of transit time	24.6	30.7	18.5
Typical range of transit times - hours	57	83	29
Maximum in range – hours	130	159	83
Minimum in range - hours	73	76	54
Percentage of traffic ³²	17%	39%	44%



At a summary level, as is shown in the table and chart adjacent, CN transit time consistency varies widely between the Intermodal, bulk/grain and carload groups.³³ As might be expected, average transit time is lower and the range of transit times is narrower for Intermodal than for either of the other two commodity groupings. This is a function of the higher average speed of Intermodal traffic and due to the difference in the measurement of transit time for Intermodal versus other traffic. Intermodal traffic is measured from the time it departs from a railway intermodal terminal, rather than from a customer’s facility. Therefore, the

time taken for a customer to move a container from their facility and through a railway origin terminal is not included in Intermodal data while the corresponding time for a railway to move a shipper’s car from the shipper’s siding and through their originating terminal is included.³⁴ As average speed through terminals is expected to be lower than average speed when trains are moving on mainlines, this gives some immediate measurement advantages to Intermodal traffic.

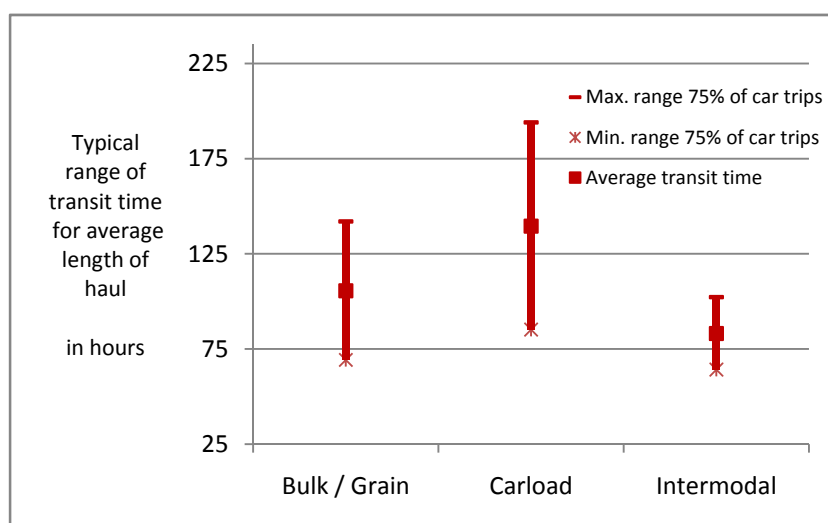
³² These percentage calculations indicate the proportion of carload and/or intermodal traffic that moved in calendar year 2007 for each railway. Calendar year 2007 was the reference year used for the selection of the sample traffic that was provided by the railways for this study.

³³ Carload traffic included all merchandise, automotive and fertilizer traffic.

³⁴ For non-Intermodal traffic, transit time for customers originating on shortlines is calculated from the time the car is received in interchange by CN or CP, from the shortline railway.

Canadian Pacific

	Bulk / Grain	Carload	Intermodal
Average LOH - miles	877	754	1739
Typical Transit Time - hours	106	140	83
Average CV of transit time	29.9	33.9	19.9
Typical range of transit times - hours	73	109	38
Maximum in range – hours	142	194	102
Minimum in range - hours	69	85	64
Percentage of traffic	27%	21%	52%



At a summary level, as is shown by the table and graph adjacent, CP shows a similar pattern to CN of variation in transit time performance, across the Intermodal, carload and bulk/grain commodity groups.³⁵ However, the range of variation in transit times for CP’s bulk/grain and carload shippers are wider than for similar CN shippers.

In particular, CP’s carload shippers experience wide variations in transit time - as is illustrated in the table and graph opposite. For a typical CP carload shipper with a 754 mile length of haul, transit times will customarily vary between 85 and 194 hours or from 3.5 to 8 days. Note that this calculation only covers an estimated 75% of the car trips and 25% of trips will lie outside of

this estimated range of transit times for a typical CP carload customer.

³⁵ As with the CN analysis, carload traffic included all merchandise, automotive and fertilizer traffic.

1. General Approach

Prior to the commencement of this study, Transport Canada had reached an understanding with Canada's two major railways, CN and CP, on the provision of data to support this study to whichever independent consultant Transport Canada selected for the project. QGI Consulting met with both CN and CP to review the data needs for the study and executed confidentiality agreements with each railway to ensure that no shipper specific confidential information that was to be provided to QGI by the railways would be released to any outside party. In addition, these agreements provide the opportunity for each railway to review QGI's reports prior to their release for the sole purpose of ensuring that such information was neither included in nor could be derived from any of the written reports released to any third party.

The terms of reference for the project required that service performance be assessed based on the following factors:

- Railway CN and CP
- Commodity Broken out by customary classifications such as: Grain Products, Fertilizers, Forest Products, Fuels and Chemicals, Intermodal, Automotive and others.
- Size of Shipper
- Size of Order or Flow Size Represented by the number of cars shipped in a particular shipper/commodity/origin/destination combination.
- Point or Province of Origin and Destination including major border crossings
- Main Line vs. Branch Line Origins
- Short Line vs. CN/CP Origins
- Access to Alternative Transportation
- Length of Haul
- Time

The understanding between Transport Canada and the railways contemplated that this study would be based on a data sampling approach. QGI worked with both railways and Transport Canada on a sampling methodology to ensure that the study could examine railway service at a sufficient level of detail to provide analysis across each of the dimensions referenced above with reasonable statistical validity. QGI's sampling methodology was based on stratified

random sampling. The detailed technical report on the sampling methodology used for this project is available publicly through Transport Canada’s and QGI’s websites.³⁶

The railways provided QGI with annual summary data at the Railway/Shipper/Origin/Destination/Commodity (sample key representing individual traffic flows³⁷) level for the purpose of sample selection for the transit time analysis. For the order fulfillment and car supply analyses, the railways were requested to summarize data at the Shipper/Origin/Commodity/Rail Car type level. A sample that was made up of approximately 10% of all traffic flows was selected. The railways were requested to provide detailed data at the car trip level for all of the individual car shipments in the sample during the period from October 1, 2006 to September 30, 2008 (The Study Review Period). The sample requested for the order fulfillment and car supply analysis was based upon the transit time analysis sample and also reviewed to ensure that it was statistically valid.

A challenge to the creation of a statistically valid and analytically practical sample arose due to the extraordinary concentration of railway traffic amongst a small number of very large customers. As can be seen by the following table, the top 3% - 4% of CN and CP’s customers originate approximately 80% of Canadian rail traffic.

Figure 1 Shippers by size and by overall traffic volume

Shipper Size number of shipments per year	Number Shippers		Percentage traffic on railway	
	CN	CP	CN	CP
Large > 5000	101 (4%)	74 (3%)	82%	76%
Medium 1001 - 5000	155 (6%)	127 (5%)	12%	14%
Small 301- 1000	195 (8%)	204 (8%)	4%	6%
Very Small < 301	2107 (82%)	2132 (84%)	2%	4%

Because of the high number of very small shippers it was determined that this group of shippers would be treated separately to ensure that they were not oversampled.

The sampling process completed by QGI yielded summary data sets consisting of 1,489 flows for CN and 1,397 flows for CP for a total of 541,025 car trips for 585 individual shippers³⁸ combined for the two railways. This represented 12.3 % of CN’s and 12 % of CP’s Canadian originated freight traffic for calendar year 2007.³⁹ Although calendar year

³⁶ *Technical Report: Sampling Methodology* QGI Consulting March 2009 Report prepared for the Rail Freight Service Review.

³⁷ Each unique Railway/Shipper/Origin/Destination/Commodity combination was randomly assigned a unique identifier for use in management of the data. This unique identifier is called a sample key and represents one of the individual traffic flows in this study.

³⁸ This represents the number of unique shippers contained in the sample some of whom use the services of both CN and CP. Calculated separately for the two railways the sample included a total of 728 shippers.

³⁹ Calendar year 2007 was selected as the reference year for sampling as it provided a full year of data for each railway.

2007 was selected as the reference year for sampling purposes the time frame for the service review analysis consists of a 24 month period from October 1, 2006 to September 30, 2008.

2. Order Fulfillment Analysis

2.1 Forecast vs. Actual Shipment Volumes

The purpose of this analysis of railway forecast vs. actual volumes shipped is to evaluate the relative success of the railways in meeting shipper demand based on the railways' medium term forecasting processes. Railway budgets are constructed each year using multiple inputs including shipper demand estimates, historical shipment patterns, commodity specific market intelligence and macroeconomic assumptions. The volume assumptions that underlie these budgets are used to determine the necessary investment and maintenance plans for railway assets such as freight cars, locomotives and train crews as well as train service design.

In finalizing their planned resource requirements to respond to shipper demand railways will also consider the revenue yield opportunities and capabilities across their traffic base and the level of operating income that may be achieved. As such, railway budgets are not simply a direct reflection of underlying customer demand but rather the level of demand the railways plan to fulfill throughout the year in the pursuit of their broader financial objectives. Therefore the accuracy of railway forecasts should be viewed in the context of how such forecasts are constructed and the many factors that can impact traffic volumes and traffic patterns through the course of a year.

2.1.1 Performance Measurement Framework

This analysis uses simple ratios such as (actual carloads/budgeted carloads) and variance measures such as (cars budgeted – cars shipped) to assess performance.

Unlike the transit time and car supply analyses discussed later in this report where aspects of both railway and shipper performance were included in the assessment of system performance this analysis does not assess shipper performance directly. While railway revenue budgets will in part reflect information provided by shippers, there are numerous other inputs to these processes. The analysis examines the relationship between the volumes budgeted (forecast) by the railways and the volume of traffic that was shipped. While railways will revise forecasts for volumes and revenues throughout the course of a calendar year – generally on a monthly basis – this analysis is based on the original budget or plan that was established by the railways during the course of their annual budget development processes. Revised outlooks created by the railways throughout the year in response to actual demand are not considered here.

2.1.2 Data Structure and Data Validation

The railways provided data for monthly budgeted carloads and actual carloads shipped for the period October 1, 2006 to September 30, 2008 based on sample keys provided by QGI.⁴⁰ CN provided the data to QGI summarized monthly with budget and actual shipment data consolidated in a single file. CP provided the data to QGI in a more disaggregated manner with individual data files provided for Intermodal, bulk, grain and merchandise.⁴¹

Both CN and CP encountered difficulties in providing budget data at the level of detail defined in QGI's sample keys. The inability to provide data at the requested level of detail is the result of budgeting and forecasting practices at both railways. CN and CP do not, in many cases, budget monthly carload volumes at an individual shipper-origin-commodity level – this is particularly true for smaller shippers. Some examples of where this level of forecasting is not done and the reasons why include:

Intermodal (Import-Export) – for medium to long term planning purposes the railways do not differentiate between individual container terminals at a given port but rather forecast traffic to and from the port. From the railways' perspective the specific terminal at a given port is not required to plan train and intermodal car capacity or estimate freight revenues which are the two most important outcomes of annual budgeting activities.

Grain (CP) – CP does not budget its grain traffic by individual shipper but rather on a more aggregated origin-destination region basis. While historical market share of individual grain companies can be used to project which elevators may originate grain this level of detail is not required for the required outputs at this level of planning.

Intermodal (Domestic) – a significant portion of domestic intermodal business consists of small shippers with irregular shipping patterns and low annual volumes. In 2007, 2,400 or 84% of all CN and CP domestic intermodal shippers shipped less than 100 units. While the railways do budget at the shipper-terminal level for their larger retail and wholesale customers they do not generally develop shipper-origin specific budgets for smaller shippers.

Forest Products – CN, for whom Forest Products represents approximately 11% of volumes and 19% of revenues, does not budget consistently at a shipper-origin-commodity level. For rail car fleet sizing, a key consideration for railway planning in this business segment, forecasts must at a minimum be defined at a level that reflects the demand for different car types and supports the estimation of car cycles and revenues. Often this will be at the origin region to destination region commodity level.

Recognizing the forecasting and planning practices in place at both CN and CP and the resulting impact on data availability, discussions with both railways resulted in agreement on the structure of the data that would be submitted

⁴⁰A sample key is defined as a unique shipper-origin-commodity combination other than for Intermodal which excludes commodity.

⁴¹The analysis excludes the automotive segment for CP as this traffic data was not included in the initial sampling frame provided to QGI.

by CN and CP for those sample keys where the level of detail requested was not available. These differences and the resulting constraints on the analysis are discussed below.

Data Validation

As noted earlier the provision of forecast and actual shipment data was problematic in a number of areas for both railways specifically with respect to their ability to provide data at the origin station level of detail. Whereas CN was able to only provide 6 or 1% of the keys at this level of detail CP was more successful in this regard providing 278 or 61% of sample keys at the shipper-commodity-origin level of detail. Therefore, in order to assess the railways' response rate to the sample request a modified key definition was adopted removing the origin criteria for non-intermodal traffic and examining the resulting reduced number of shipper-commodity combinations in the sample versus the data supplied. For intermodal data the railway data was assessed using this criteria as well as the number of unique shippers in the sample for which data was provided.

The principal gap for non-intermodal traffic was for grain where CP submitted no shipper specific data but rather aggregated the budget and actual shipment data on an origin-destination region basis. This resulted in CP submitting 19 distinct grain keys as compared to the 93 shipper-commodity-origin specific keys contained in the sample. For intermodal traffic the 163 sample keys represented 84 customers and 147 unique shipper-origin combinations. CP provided data for 53 or 63% of shippers and 113 unique shipper-origin combinations. In some instances CP also aggregated import-export traffic by port rather than individual port terminal.

These changes and modifications to the structure of the data resulted in 680 keys being available for analysis prior to screening for data integrity – 436 for CN and 244 for CP. Despite the reduction in the level of detail in the data, the volume of data (measured on the basis of actual shipments) exceeded what was expected to be received based on the sample by 18% with actual data available for analysis consisting of 7.4 million shipments for the 24 month service review period.

Figure 2 Summary of forecast and actual shipment data requested and received

		CN	CP
Percent of sample keys provided at requested level of detail	Non Intermodal	1%	37%
	Intermodal	0%	78%
Percent of shipper-commodity combinations provided	Non Intermodal	91%	46%
	Intermodal	65%	77%

The higher level of aggregation in the data supplied by the railway places some practical limitations on the characteristics of the sample that can be analyzed. The absence of origin station and in most cases even origin province does not allow us to examine performance across geographic and network characteristics such as origin province, core versus non-core network location or Class 1 versus shortline railway origin. Similarly the absence of shipper specific data in some instances prevents examination by shipper size and competitive status. Given these

limitations performance has been assessed across major business lines, industry subgroups, and volume characteristics.

2.1.3 Forecast versus Actual Shipment Analysis

Comparison of forecast and actual volumes was done in two ways. Firstly, in terms of the absolute quantity of cars shipped versus forecast and secondly in terms of the degree of variability that exists between forecast and actual volumes for the study period as a whole and on a monthly basis.⁴² The following table shows for each railway its experience of how actual shipments related to forecast volumes during the service review period.

Figure 3 Railway variances to forecast by service review year

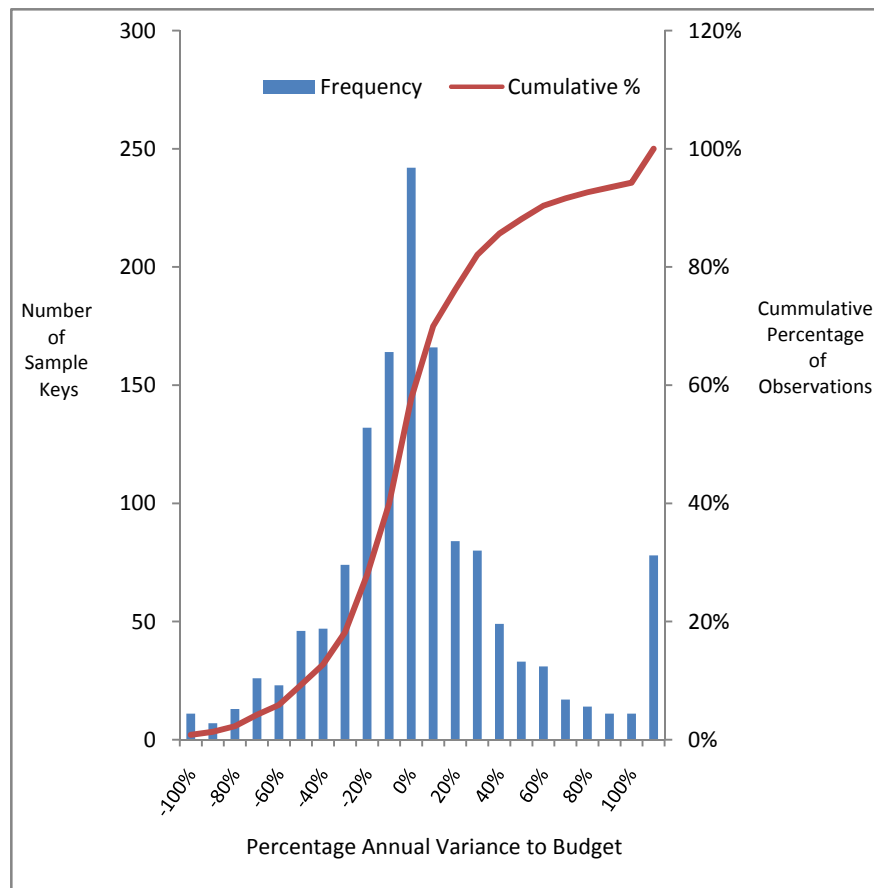
Period	Railway	Budget	Actual	Variance	Percent Variance
ServiceYear1	CN	1,934,325	1,864,216	(70,109)	-3.6%
	CP	1,583,975	1,597,966	13,991	0.9%
Total Year 1		3,518,300	3,462,182	(56,118)	-1.6%
ServiceYear2	CN	2,145,086	1,969,301	(175,785)	-8.2%
	CP	1,808,140	1,707,527	(100,613)	-5.6%
Total Year 2		3,953,226	3,676,828	(276,398)	-7.0%
Service Review Period	CN	4,079,411	3,833,517	(245,894)	-6.0%
	CP	3,392,115	3,305,493	(86,622)	-2.6%
Total		7,471,526	7,139,010	(332,516)	-4.5%

This table shows that for the 24 month service review period⁴³ the railways experienced similar performance in terms of the volume of actual carloads shipped as compared to volumes forecast. For both railways actual shipments fell short of forecast volumes although more so for CN (-6%) than for CP (-2.6%). We can see that the shortfall to budget for the entire service review period is, for both railways, driven by the performance in year 2 (October 2007 – September 2008).

⁴² For this analysis a negative variance means that actual volumes shipped were less than forecast.

⁴³ Excluding the month of February 2007 which was removed due to the CN strike.

Figure 4 Distribution of variances for actual shipments versus forecast volumes



While on a percentage basis the shortfall to forecast volumes appears relatively small - 4.5% for the two railways combined over the two year period - in absolute terms this represents a shortfall of more than 332,000 carloads. CN's shortfall accounts for 74% of the total.

In examining performance in this area it is important to look beyond the aggregate and understand the volatility of variances across time and the range in the magnitude of variances.

The histogram on the left shows the distribution of annual percentage variances to forecast

volumes for 1325 sample keys analyzed over the study period⁴⁴. Of interest is how broadly distributed the variance is - ranging from -100% to more than 100%.⁴⁵ The noticeable tail on the extreme right hand side of the histogram representing variances to budget of greater than 100% is made up of 78 keys or 5.7% of the total sample keys. These keys reflect situations where keys had very low budget values and very high actual shipment values. While these keys only represent 2.1% of total shipments in the sample when examined on a percentage variance basis, the values appear somewhat exaggerated.

The shape of the histogram shows us that the range of variances is approximately normally distributed with 42% of keys having a variance of +/- 10% and 70% of keys having a variance that falls within +/- 30%.

This wide distribution only represents the range of variance on a percentage basis and does not distinguish between large and small volumes of traffic within the keys and therefore a variance of 100% to forecast may represent 100 cars or 10,000 cars. It is important therefore to also understand what this dispersion means for the actual volumes of cars

⁴⁴ Represents the 680 keys for which data was submitted measured for each 12 month period separately excluding 35 sample keys representing 0.4% of shipments where no budget values are present

⁴⁵ Variances to forecast of -100% reflect situations where the railways forecast volume but there were no actual shipments

that are short or surplus to the railways' expectations. Figure 5 provides some perspective on this issue by showing the percentage of actual cars shipped during the period that falls into each variance category.

Figure 5 Distribution of variances for actual shipments versus budgeted volumes

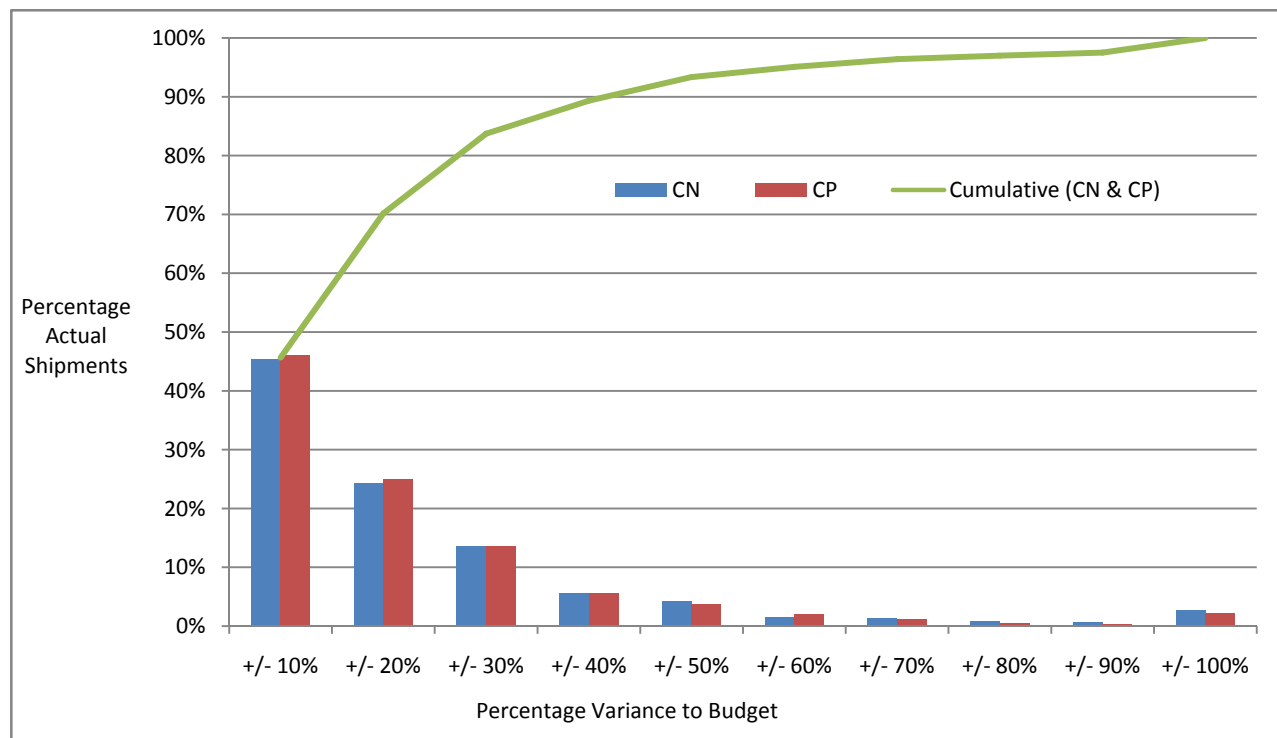


Figure 6 Distribution of actual shipments by variance category

Range of Variance	Percentage of total shipments		Cumulative total (CN & CP)
	CN	CP	
+/- 10%	45.3%	46.1%	46%
+/- 20%	24.2%	24.9%	70%
+/- 30%	13.6%	13.5%	84%
+/- 40%	5.6%	5.6%	89%
+/- 50%	4.3%	3.7%	93%
+/- 60%	1.5%	2.0%	95%
+/- 70%	1.4%	1.2%	96%
+/- 80%	0.8%	0.4%	97%
+/- 90%	0.7%	0.3%	98%
+/- 100%	2.7%	2.2%	100%

What we see is that the larger the percentage variance between forecast and actual shipments the smaller the number of cars that are impacted. As shown in the table adjacent, 84% of actual shipments for CN and CP fall within +/- 30% of the railways' initial budgets whereas only 16% of shipments are represented by variances greater than 30%. It should be noted that the experience of both railways in this regard is nearly identical.

Because railways use medium to long term demand forecasts to determine fleet sizes for freight cars and locomotives and to

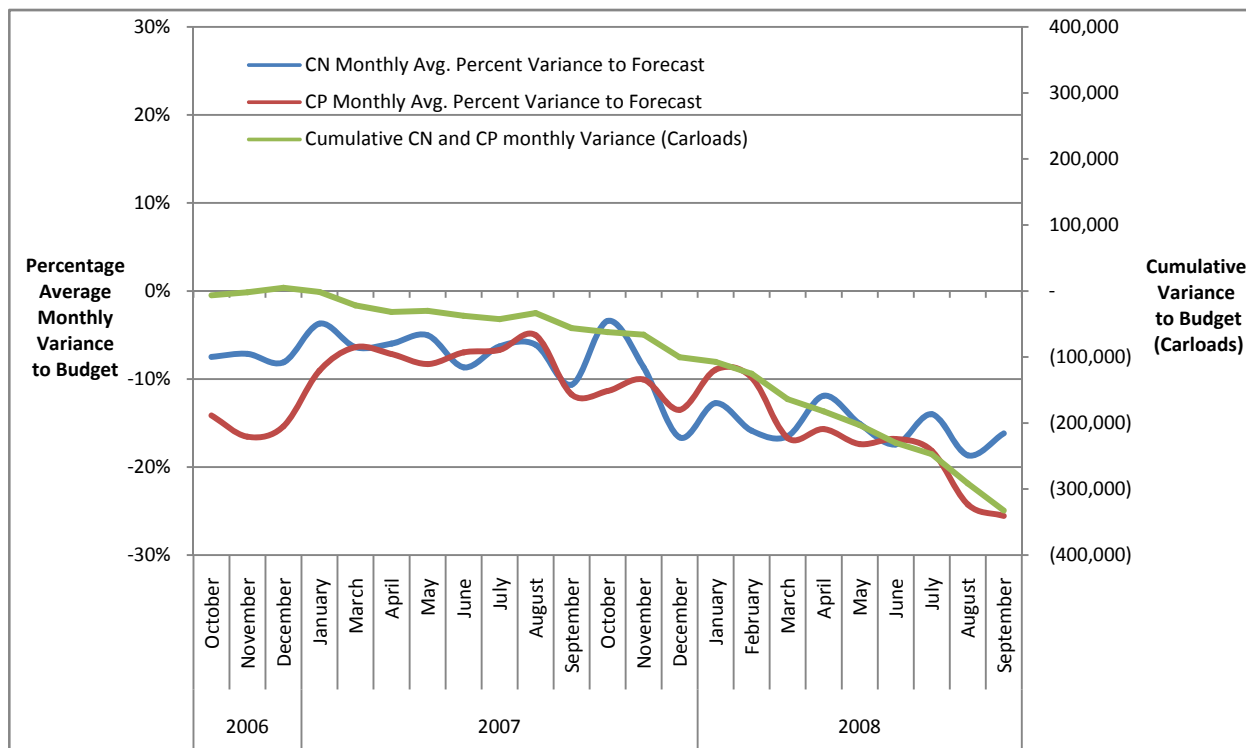
determine requirements for train crews and to plan train services – errors in the prediction of volume on a monthly

basis are also important. Even if a railway is correct about the total volume to be moved, if errors are made in predicting the timing of peak volumes, assets and services may not be adequate to handle the traffic offered. Alternatively, railways may plan for more rail cars, locomotives or crews than are required.

The chart below shows the average percentage variance of actual shipments to forecast volumes for all sample keys by railway on a monthly basis and the net cumulative variance (in carloads) for both railways combined for the service review period. What this chart shows is that, for the sample keys analyzed, actual shipments as a percentage of forecast were on average negative in each month of the service review period. On a cumulative basis however, total railway volumes during the initial 6 months of the review period were at or near budgeted levels. The cumulative performance reflects the impact of sample keys with larger volumes of cars that had slightly better performance.

During this period CN’s monthly average percentage variance for all business combined ranged from -4% to -18% and for CP monthly variance ranged from -5% to -25%. Month to month performance was similar for both railways in that it was consistently below forecast levels with the magnitude of variances increasing in service review year 2 between October 2007 and September 2008.

Figure 7 Monthly and cumulative variance to forecast volumes



2.1.4 Commodity and Volume Characteristics

The nature and degree of impact on railway operations that results from variations in forecast volumes will be influenced by a number of factors including the type, concentration and size of the traffic flow where variance is experienced as well as the timeframes around such variability. For instance a short term reduction in volumes from a large bulk shipper moving trainload lots to a single destination may have limited impact on the railway's network operations. Conversely widespread variation in planned volumes across many shippers and commodities may affect the frequency and capacity of mixed carload trains affecting many railway customers. Depending on the size and duration of reduced or increased traffic levels the railway may choose to change service in some corridors in order to optimize network productivity thus affecting other shippers whose volumes and shipment frequency have not changed.

Major Commodity Group

The table below displays the variance to forecast experienced by the railways across their major business segments. As we can see performance is similar for both railways during this period with all major lines of business for both carriers having negative variances to forecast with the exception of CP's Intermodal traffic in Year 1 that showed a positive variance to budget.

Figure 8 Railway forecast and actual carloads shipped by service review year

Year	Major Group	CN				CP			
		Budget	Actual	Variance	Percent Variance	Budget	Actual	Variance	Percent Variance
1	Bulk / Grain	304,726	272,473	(32,253)	-10.6%	460,064	457,201	(2,863)	-0.6%
	Carload	715,235	696,132	(19,103)	-2.7%	195,021	169,904	(25,117)	-12.9%
	Intermodal	914,364	895,611	(18,753)	-2.1%	928,890	970,861	41,971	4.5%
Total		1,934,325	1,864,216	(70,109)	-3.6%	1,583,975	1,597,966	13,991	0.9%
2	Bulk / Grain	314,280	275,212	(39,068)	-12.4%	498,697	460,718	(37,979)	-7.6%
	Carload	732,094	687,822	(44,272)	-6.0%	212,692	171,312	(41,380)	-19.5%
	Intermodal	1,098,712	1,006,267	(92,445)	-8.4%	1,096,751	1,075,497	(21,254)	-1.9%
Total		2,145,086	1,969,301	(175,785)	-8.2%	1,808,140	1,707,527	(100,613)	-5.6%
Total		4,079,411	3,833,517	(245,894)	-6.0%	3,392,115	3,305,493	(86,622)	-2.6%

Looking at the range of variance by major commodity group as shown in the table below, we can see that with the exception of the merchandise and fertilizer segments all business lines have more than 85% of traffic within +/- 30% of

forecasted volumes and for the railways as a whole nearly 84% of volumes fell within this range. The performance of merchandise and fertilizer traffic is consistent with the composition of these business segments that are characterized by a higher percentage of individual car and small block shipments as compared to the automotive, bulk and grain segments. These smaller volume car block shippers typically present greater challenges to the railways in forecasting traffic levels accurately.

Figure 9 Percent of actual shipments by variance range (CN and CP)

	Automotive	Bulk	Fertilizers	Grain	Intermodal	Merchandise	Total
Variance within 30% of forecast	97.7%	90.4%	66.1%	86.4%	85.7%	73.6%	83.7%
Variance greater than 30% of forecast	2.3%	9.6%	33.9%	13.6%	14.3%	26.4%	16.3%

Industry Subgroup

We have examined the variance between actual shipments and forecast volumes for the entire service review period at the commodity subgroup level on both a net and absolute basis and ranked them from largest to smallest as shown in the tables below. It is interesting to note that for the two railways combined five of the top six commodity subgroups – coal, machinery, lumber, paper products and other forest products – are the same when viewed from either perspective. In other words these five commodity groups incurred both the largest net shortfalls to forecast and exhibited the highest levels of absolute variance to budget. The variance averaged 36% for the two railways over the course of the study period.

Figure 10 Percentage Variance by Commodity Subgroup

Average Absolute Percentage Variance			
Commodity Subgroup	CN	CP	Total
Coal	s/c ⁴⁶	s/c	41.4%
Machinery & Equipment	s/c	s/c	41.3%
Lumber & Panels	27.0%	45.8%	32.5%
Paper Products	29.7%	35.9%	31.2%
Petroleum Products	25.8%	54.5%	30.3%
Other Forest Products	26.9%	s/c	29.3%
Metal Products	25.2%	39.5%	28.8%
Miscellaneous	s/c	27.3%	27.3%
Grain	27.9%	25.4%	27.1%
Fertilizer	22.5%	35.3%	26.6%
Intermodal (D)	25.8%	27.4%	26.5%
Potash	20.7%	28.7%	26.1%
Woodpulp	15.8%	37.2%	25.2%
Intermodal (Impex)	19.3%	26.6%	23.6%
Railway Equip. & Materials	s/c	s/c	23.6%
Chemicals	19.3%	32.5%	23.5%
Sulphur	23.6%	s/c	23.3%
Agricultural & Food Products	21.4%	s/c	21.4%
Plastics	23.3%	10.3%	19.7%
Ores & Concentrates	17.0%	21.6%	18.9%
Building Materials	21.4%	16.3%	18.7%
Pulses & Special Crops	15.9%	s/c	15.9%
Finished Vehicles	13.9%	s/c	13.9%
Coke	s/c	s/c	7.4%

Average Net Percentage Variance			
Commodity Subgroup	CN	CP	Total
Machinery & Equipment	s/c	s/c	-34%
Coal	s/c	s/c	-26%
Lumber & Panels	-18.8%	-39.4%	-25%
Woodpulp	-12.1%	-26.0%	-18%
Other Forest Products	-15.3%	s/c	-18%
Paper Products	-13.5%	-26.4%	-17%
Railway Equip. & Materials	s/c	s/c	-7%
Building Materials	-16.0%	1.4%	-7%
Plastics	-6.3%	-5.6%	-6%
Miscellaneous	s/c	-5.0%	-5%
Chemicals	0.0%	-12.6%	-4%
Agricultural & Food Products	-3.8%	s/c	-4%
Intermodal (D)	-2.7%	-5.0%	-4%
Pulses & Special Crops	-3.3%	s/c	-3%
Fertilizer	-1.4%	-6.8%	-3%
Ores & Concentrates	8.6%	-19.2%	-3%
Metal Products	0.9%	-9.3%	-2%
Coke	s/c	s/c	-1%
Petroleum Products	2.1%	-13.0%	0%
Sulphur	4.8%	s/c	0%
Intermodal (Impex)	-6.0%	6.3%	1%
Finished Vehicles	2.9%	s/c	3%
Potash	-17.4%	13.5%	3%
Grain	3.4%	3.7%	4%

Shipment Volume

Performance to budget was also examined by forecast volume. All sample keys for each year were classified into one of five categories based on the volume of cars budgeted by the railways.

As the table below shows, for both railways there were negative variances to the volumes forecast for the three largest volume groups and positive variances to budget for the two smallest groups. For both railways the smallest volume keys (less than 250 cars annually) showed very large positive variances to budget. This group represents a very small proportion of total cars (1%) and therefore does not significantly affect overall performance.

⁴⁶ In any cross-tabulation where there are less than 5 sample keys available for analysis, the results of analysis are suppressed in order to protect railway/shipper confidentiality. In addition, in small samples such as this the data are less likely to be representative of general performance across a shipper population. In all cases in the text where data is suppressed for this reason, the abbreviation s/c will appear in the appropriate tables.

Figure 11 Distribution of net variances by forecast volume (carloads)

Railway	Period Volume	Budget	Actual	Variance	% Variance
CN	> 5000	2,959,832	2,711,409	(248,423)	-8.4%
	2501 - 5000	571,320	539,476	(31,844)	-5.6%
	1001 - 2500	411,673	397,418	(14,255)	-3.5%
	251 - 1000	132,496	153,356	20,860	15.7%
	< = 250	4,090	31,858	27,768	678.9%
CN Total		4,079,411	3,833,517	(245,894)	-6.0%
CP	> 5000	2,898,349	2,813,677	(84,672)	-2.9%
	2501 - 5000	270,064	241,435	(28,629)	-10.6%
	1001 - 2500	146,259	137,864	(8,395)	-5.7%
	251 - 1000	73,826	84,236	10,410	14.1%
	< = 250	3,617	28,281	24,664	681.9%
CP Total		3,392,115	3,305,493	(86,622)	-2.6%

2.1.5 Key Findings

Based on this analysis we can make some general observations regarding the accuracy of railway forecasting processes and some of the factors that influence performance in this area.

First, at an aggregate level the railways' forecasting processes are accurate in estimating traffic volumes within 10% as we can see based on the performance of both CN and CP during the study period. For individual years within the study period variance to plan for the two railways ranged between +1% and -8%. If considered for the entire two year study period the degree of accuracy improved to 2.6% and 6% for CP and CN respectively. Performance to plan was similar for both carriers with actual shipments falling short of forecast volumes for the 24 month service review period.

Second, there is higher degree of variance to plan when performance is measured at the individual commodity subgroup level. At this level of detail annual forecast accuracy can vary by more than 40% reflecting both positive and negative variances to plan. There is also significant variance to plan on a monthly basis at a commodity subgroup level averaging 36% for the two railways over the course of the study period.

Third, variance to forecast at the shipper-commodity level varies widely with annual percentage variances ranging from -100% to +100% of forecast. For the sample of forecasts analyzed approximately 42% of keys (46% of carloads) had a variance of +/- 10% and 70% of sample keys (84% of carloads) had a variance of +/- 30%.

Lastly the accuracy of railway forecasts as described above should be viewed in the context of how such forecasts are constructed and the many factors that can impact traffic volumes and traffic patterns through the course of a year. Railway forecasts use a combination of input factors including shipper demand estimates, historical shipment patterns, commodity specific market intelligence and macroeconomic assumptions. They are constructed using the best

available data and information available at the time and may not anticipate changes in customer sourcing and production patterns or changes in individual commodity markets. Even the best forecasts will therefore be only an estimate of actual volumes realized.

2.2 Railway Car Supply Performance

The objective of the empty car supply analysis is to determine the degree to which railways meet shipper requirements in the supply of empty rail cars. This car supply analysis is a review of the daily and weekly empty car order and supply process that takes place between shippers and railways. In addition to this short-term process, shippers and railways share information through longer term budgeting and forecasting processes that operate over annual and monthly time frames.

2.2.1 Performance Measurement Framework

For this railway car supply analysis simple ratios such as (cars ordered/cars supplied) and variance measures such as (cars ordered – cars supplied) were developed to provide the necessary performance metrics. In addition to railway performance in the supply of empty rail cars, shipper performance with respect to rail car order activities will be reviewed in this report.

As the processes for rail car ordering are significantly different at CN and CP for shippers of grain and merchandise products – the analysis has been segregated for these two groups of commodities.

In assessing the railways' performance in meeting customer demand for empty rail cars, it is important to consider what is implied by the various order fulfillment measures that are presented in the following analysis. For example, if a customer orders an empty car and the railway fails to supply that car does that imply lost sales or lost economic productivity for the shipper? The answer is uncertain but it depends in part on the degree to which one can be confident that an empty car order represents true demand for transportation services. If shippers have no practical options to shipping by rail, and their car orders represent true demand then an unfilled car order is a lost economic opportunity. However, in some cases empty car orders may represent only a shipper's forecast for demand and not their ultimate underlying actual demand. This may be the case where there are no economic consequences to the shipper associated with the car order transaction.

Both CN and CP impose penalties on shippers for empty railway owned cars ordered and not used. In the case of both railways, demurrage charges will accrue for the time that empty cars remain in shippers' possession beyond the free loading time allocated by the railway. In addition, both railways impose charges for switching empty cars that have been ordered but are surplus to shippers' requirements and are pulled empty from a shipper's siding. In addition, in the case of CN's Guaranteed Car Order program, there are financial penalties if car orders are cancelled after the weekly cut-off date for car orders.

Thus, neither railway operates in an environment where car orders can be considered as "unconstrained demand" as car orders that have been entered by shippers and confirmed as of the cut-off dates have financial consequences associated with them.

However, interpretation of the meaning of car order demand remains problematic – particularly in situations and at times where shippers believe that total demand for empty rail cars is likely to exceed available supply. In these situations, shippers may have an incentive to request more cars than are needed in order to secure as many cars as possible from a rationed fleet. This type of car order which does not reflect true demand but is rather a device used by shippers to secure as much of a rationed fleet as possible – so called “phantom” orders – has become less prevalent in recent years as railways have increased the financial consequences associated with over-ordering. In particular, the imposition of demurrage costs on empty rail cars and car order cancellation fees have introduced useful and appropriate discipline into the car order and supply process. However, even with these on-going adjustments to railway car order processes, the degree to which car orders reflect true demand is impossible to determine from the data made available to QGI for the purposes of this report.

In reviewing railway performance in supplying shippers’ demand for empty rail cars it is important to keep in mind the practical restrictions that face railways in their response to changes in shipper demand. Railway car supply is provided by fleets that are relatively fixed on a month to month basis as opportunities for railways to increase their fleet supply through short term leasing or the use of foreign railway fleets are in most markets quite limited and may carry unacceptable costs to the railway. When railway operations or demand changes cause congestion in the rail network it can significantly affect current and future car supply. Understanding and anticipating how rail network behaviour will influence future car supply requires fleet distribution managers to carefully monitor the performance of shippers, connecting railways and receivers on their own and connecting networks to predict how future car supply may be affected and to put in place distribution strategies that reflect these considerations.

When railway car fleets become surplus to needs, most railway distribution managers will remove some of the fleet from active use and move it to locations that do not affect the efficient flow of traffic through terminals. If surplus cars are allowed to build up in terminals they decrease the available productive capacity of those terminals by taking up clear track space that can be used for train arrivals and departures and especially for traffic classification. However, the decision on moving fleet out of active use and into storage is difficult as it entails some cost to move the empty cars and will result in additional costs when the cars are again needed by shippers.

For all of the reasons above, caution must be used when interpreting the car order fulfillment statistics that are presented in this report. In order to more fully understand the issues and concerns related to how the railways are fulfilling empty car demand QGI recommends that the data presented herein be used in conjunction with other information sources on this topic. These sources include the results of the railway customer satisfaction study undertaken for the Rail Freight Service Review by NRG Research⁴⁷ and QGI’s reports on railway car order and supply

⁴⁷ Survey of Shippers Prepared for the Rail Freight Service Review. NRG Research Group. November 30, 2009.

processes and on railway demand forecasting and service planning⁴⁸. In addition, readers may wish to consider the information provided in any submissions that may be made to the Service Review by shippers and railways.

2.2.2 Scope of Analysis

As noted earlier this analysis is a review of the daily and weekly empty car order and supply process that takes place between shippers and railways. The longer term budgeting and forecasting processes that see shippers and railways share information over annual and monthly time frames for predicting and planning for rail freight customer demand are examined in a different report that QGI has prepared as part of the Rail Freight Service Review.⁴⁹ Therefore, this report will focus on the day to day and week to week transactional processes whereby shippers order empty rail cars from railways for placement on specific days or weeks at specific loading points.

Not all types of railway shippers or business segments are included in this analysis. The car supply analysis has only been conducted for situations *where the railway controls car supply to the shipper* and excludes intermodal traffic. In addition, situations where cars are supplied without the use of railway electronic car order processes have been excluded. This has been done as it is impossible for QGI to verify demand levels (and in some cases supply levels) where demand is not recorded in the railways' car order systems. As a result, the following situations have therefore been excluded from the analysis:

Intermodal - is excluded because, in the case of import/export traffic, container supply is provided by shipping lines rather than railways and for domestic intermodal the railways' information systems do not include a sufficiently detailed and consolidated equipment order and supply database to allow for meaningful analysis.

Tank cars – used for petroleum and chemical traffic are supplied exclusively by shippers.

Multi-level auto carriers – supply of these cars, used for shipments of finished vehicles, is controlled on an industry-wide basis in North America by the Reload Group of the TTX Company⁵⁰ and the railways neither take car orders directly from automotive customers nor do they control the supply of railcars.

Bulk commodities - for most bulk commodities, rail car supply is managed on a monthly forecast basis at the trainload level and the systems for capturing and tracking demand are unique to the business segments on each railway.

⁴⁸ *Railway Car Order and Car Supply Processes* and *Railway Demand Forecasting and Service Planning Processes* QGI Consulting March 2010 Reports prepared for the Rail Freight Service Review.

⁴⁹ *Railway Demand Forecasting and Service Planning Processes* QGI Consulting March 2010.

⁵⁰ The TTX Reload Group manages the flow of most of the North American autorack cars. Reload operations use optimization modeling to assist in distributing an industry-wide fleet of 59,000 multi-level autorack cars to 131 automotive loading points serving 17 auto manufacturers.

Customer assigned pools – some customers in the automotive and merchandise business segments on both railways use specialized equipment where fleets are sized and placed in exclusive pools for the use of these individual customers and there is no on-going car order process that is subject to measurement.

The data requested from the railways was therefore limited to the Merchandise (including Fertilizer) and Grain products shippers of both railways. The products shipped by these customers include; forest products, mine and mineral products, construction materials, agricultural and grain products. The following table provides a breakdown of the proportion of both railways' non-Intermodal business that is shipped using each of the car types that were included in this analysis.

Figure 12 Car types covered by ordered/supplied analysis⁵¹

Car Type	Percentage Railway Non-Intermodal Business Shipped by car type
Boxes	14%
Covered Hoppers	28%
Flat Cars	10%
Gondolas	9%
Open Hoppers	< 1%
Total	61%

[2.2.4 Data Structure and Data Validation](#)

[Daily versus Weekly Car Order/Supply Data](#)

The original terms of reference for this project did not include provision for the supply by the railways to QGI of any data on empty rail car orders, or empty supply information. However, QGI in discussion with Transport Canada determined that this important element of rail service should be included in the Review of Rail Freight Service. QGI entered into discussions with CN and CP to discuss the terms under which the railways would be able to provide empty rail car demand and supply data to QGI.

⁵¹ This table estimates the proportion of the total non-Intermodal rail business that is included in the car order and supply analysis based on the sample reference year 2007. The percentages for each car type in this table take into account all of the exclusions from the analysis described in the text with the exception of the traffic that was excluded due to the use of customer assigned pools. For CN, this is a nominal proportion of their traffic. For CP, customer assigned pools are more commonly used. Based on a review of CP data QGI estimates this proportion at approximately 8% of CP's non-Intermodal business.

While ideally it would have been desirable for QGI to have access to detailed daily car order and supply data, both railways were concerned that the complexity of the data would lead to serious problems in interpretation of available daily car supply that may compromise the consultant's ability to provide an objective and fair view of railway performance. As a result, QGI, Transport Canada and the railways agreed that empty car order and supply data would be provided to QGI but summarized at the weekly level. As a result, this analysis is provided at the weekly level.

However, as both Transport Canada and QGI recognized that the issue of daily car supply performance was of great interest to stakeholders, QGI also requested the railways provide data on daily car order performance for a very limited number of shippers and locations – with a view to providing insight into this area as well.

Data Validation Process

For each of the sample keys⁵² the railways provided data for customer orders, empty rail car supply, and loaded cars released (shipped) for the period October 1, 2006 to September 30, 2008. CN provided the data to QGI summarized weekly with orders, supply, and releases consolidated within the same files. CP provided the data to QGI at a much more granular level. With the exception of grain order data, which was provided at the weekly level, all other order, supply and loaded release data was provided to QGI at an individual car level. This detailed data was summarized weekly for each sample key by QGI. Therefore, QGI was able to conduct demand and supply analysis on a week basis for both railways.

Total data submitted by the railways prior to screening by QGI included 1,350,024 net car orders for the 24 month service review period. As was done for the transit time analysis data related to the CN strike period – specifically the period from February 4 to March 3, 2007 – was excluded from the analysis for both CN and CP. This resulted in the removal of 55,008 orders or 4.1% of the data.

The data was then reviewed to remove data that reflected inaccurate reporting, or extreme and unusual values that were not representative of normal performance and may provide misleading results. A detailed discussion of the data screening and data integrity processes is included as Appendix 1.

⁵² A sample key is defined as a unique shipper, origin station, equipment type combination.

Figure 13 Percent of car order records removed through screening

Screening Criteria	Major Group	Railway	Box Car	Cov. Hopper	Flat Car	Gondola	Total
CN Strike Period	Grain	CN	-	3.8%	-	-	3.8%
		CP	-	3.7%	-	-	3.7%
	Merchandise	CN	4.4%	2.5%	4.7%	3.9%	4.3%
		CP	3.8%	3.5%	4.8%	4.3%	4.1%
Data Quality	Merchandise	CN	1.1%	29.7%	0.0%	0.0%	1.5%
		CP	18.3%	1.8%	30.7%	13.5%	16.8%

Whereas the percentage of data records removed to account for the CN strike period was similar for both railways a significantly higher percentage of CP Merchandise records were removed for data quality issues. QGI assessed the quality of the data by applying three screening criteria to the Merchandise data at an individual sample key level. First, keys where no order data was present were removed. Second, QGI assessed the data by examining the ratio of empty placements (supply) to net orders. All keys with a ratio greater than 1.20 – i.e. where empty cars supplied exceeded customer orders by more than 20% – were removed from the data. Situations such as this indicate that rail cars are either being placed for loading outside of the normal car order process – e.g. assigned pools and private cars – or orders are not being recorded accurately. Lastly the data was examined using a ratio of loaded releases to empty placements again with an established threshold of 1.20. All keys where this ratio exceeded the threshold were also removed from the data. Where loaded shipments by customers exceed the supply of empty cars suggests that empty placement events are not being reported correctly.

QGI validated the railway supplied car order and supply data with a select number of grain and merchandise customers for both railways. In selecting customers to validate the data QGI sought to include shippers for each major car type for both grain and merchandise and both large and small shippers. Three grain shippers each of whom use both CN and CP including both hopper car and box cars were selected to validate data from a total of 12 different origins. Three merchandise shippers using flat, gondola and box cars were selected including one CN shipper, one CP shipper and one shipper that used both railways. These shippers were asked to validate data for a total of 7 origins. In each case the shippers were provided with weekly summaries of the order, supply and loaded release data and asked to validate the railway data against their own records. QGI representatives then met individually with each shipper to discuss their findings.⁵³ While shippers identified some minor anomalies in the timing of order and supply data from

⁵³ Four of the shipper meetings took place in person and two were done via telephone. One of the shippers that agreed to participate determined after reviewing their internal records that their information was not robust enough to support the review of the railway data.

week to week all were in agreement that the railway supplied data was representative of their experience and consistent with their own records.

2.2.5 Grain Car Supply Analysis

Grain Car Demand

Shipper demand

CN and CP grain shippers generally order empty rail cars through each railway's Internet systems. At CN the cut-off for orders is Tuesday preceding the week for which the cars are ordered. For CP there are various cut-offs depending on the specific grain service product through which cars have been ordered.⁵⁴ CN accepts orders up to 16 weeks in advance. At CP, customers can reserve grain car capacity through CP's advance ordering systems up to one year in advance⁵⁵. However, they must apply such reserved capacity to specific origin-destination combinations weekly by the deadlines applicable to each service product.

Railway confirmation of car orders

For both railways grain car orders are confirmed, including any reduction in the expected supply, by the railway, by Friday morning for the following week's orders. Unlike merchandise shippers, however, grain car shippers order cars for placement during a one week period rather than for a specific order date and time. Each railway has a process for notifying shippers of the day(s) of the week that service is expected for the following week. However, the data provided to QGI for this analysis was aggregated at the weekly level so a comprehensive analysis of railway performance by day of the week was not possible for grain car supply. As noted earlier in the report, in order to provide some insight into issues related to day of the week performance, data was requested from the railways for a select number of locations to allow a case study examination of daily supply performance. This case study is included in Section 2.2.6 Daily Car Supply Performance - of the report.

For the purposes of this study, a "car order" for grain cars is defined as an order by a shipper for the placement of one or more empty covered hopper cars at a specific location for a specific week. As indicated in the previous sentence, an individual car order may represent a request for a single car or many cars. Shippers may reduce some or all cars ordered for a particular location for a variety of reasons prior to the cars being placed by the railway. These can include the cancellation of old orders that the railways were not able to fill in a timely way, an agreement between a railway and a shipper to shift orders from one location to another to facilitate operations planning for either party, or changes in grain collection or final market outlooks. For example, orders can be cancelled or deferred if a grain

⁵⁴ The latest cut-off for CP shippers to designate specific origins and or destinations against confirmed orders occurs on the Friday, nine days prior to the grain week for which the cars have been ordered.

⁵⁵ A comprehensive description of CN and CP car ordering programs and processes can be found in QGI's report: Railway Car Order and Car Supply Processes, March 2010.

company has a sale cancellation or deferral due to a delayed vessel arrival at port. In other cases, grain companies may choose to source grains at elevators at other locations than originally planned, or even at locations on a different railway.

In some cases, fees will be assessed by railways for changes to orders. For example, if changes to origins or destinations are made after the railway has confirmed acceptance of an order both CN and CP will assess order change fees. However, if railways have not placed cars within a specified period after the requested want date – no fees are assessed.⁵⁶

Figure 14 Percent of grain car orders and total grain car demand reduced by shippers

Grain Crop Year ⁵⁷	CN		CP	
	Percentage orders affected	Percentage car demand reduced	Percentage orders affected	Percentage car demand reduced
2006-2007	30%	16%	30%	11%
2007-2008	28%	15%	30%	12%
2008-2009	25%	17%	28%	11%

As can be seen from Figure 14, a significant percentage of grain car orders on both railways are subject to reduction⁵⁸ by

customers prior to the cars being supplied by the railways. While the table also shows that the absolute number of cars affected is much smaller than the number of orders affected, it is still very significant ranging from 11-12% of CP’s and 15-17% of CN’s total grain cars ordered by shippers.

When reviewed in terms of which types of customers are responsible for the most order cancellations it is apparent from the data in Figure 15 below that shippers with smaller volumes cancel a higher proportion of their orders. However, these cancellations still account for only a small proportion of the overall car orders cancelled in the sample data.

⁵⁶ CN grain car order changes may be made without charge if the cars have not been placed after 14 and before 28 days after the want date. For CP grain car orders, charges apply for cancellation of orders under most of their advance products programs which allow shippers to guarantee rail car capacity in specified corridors under specific conditions. For their general week to week grain car order program – ReadyMax – orders can be cancelled without penalty if received up to five days prior to the grain shipping week. If cars are not placed within 7 days of the grain shipping week, CP grain car orders may be cancelled without penalty.

⁵⁷ In the analysis of car supply performance for grain, time series data is presented by annual Grain Crop Year. In Canada the grain crop year runs from August 1 to July 31. This annual time frame matches the seasonal crop production and harvest calendar and is used by all Canadian grain industry stakeholders for business planning purposes.

⁵⁸ The percentage of orders changed by shippers includes any order for which a reduction was either entered into railway systems by shippers or, in the case of CP, where changes are made in CP car order systems at the request of shippers. An order was identified as changed if it was reduced by one or more cars prior to the cars being supplied by the railway.

Figure 15 Grain car order cancellations by order size

	Annual Order Size			
	> 1000	101-1000	51-100	<50
Cars Ordered	457,112	89,853	444	856
Cars Cancelled	59,735	13,269	131	406
Percent Cancelled	13.1%	14.8%	29.5%	47.4%

Across most of the other dimensions of analysis including: province of origin, core vs. non-core network origins, and shortline vs. Class I origins there were no noteworthy differences in the order

cancellation rate amongst the groups of shippers.⁵⁹ However, as shown in the following table, shippers at origins which have competitive access to another railway were more likely than shippers at non-competitive points to cancel their car orders.

Figure 16 Grain car order cancellations by competitive access at origin

	Competitive access at origin	
	No	Yes
Cars Ordered	483,540	64,725
Cars Cancelled	62,633	10,908
Percent Cancelled	13%	17%

Car order cancellations and car order cancellation rates were compared statistically to overall car order levels using regression analysis and no statistically significant

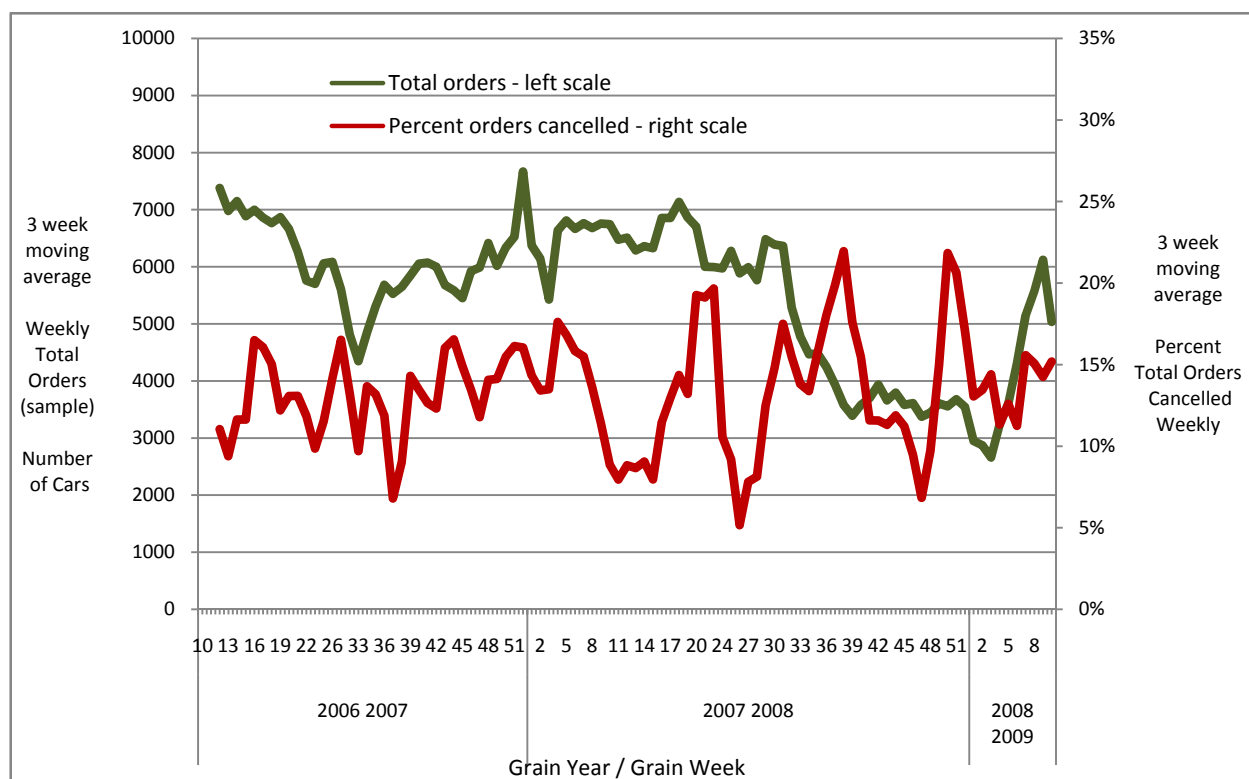
relationship was identified.⁶⁰ However, as shown in the following graph, the period of declining overall demand during grain year 2007-2008 did coincide with a period of great volatility in grain order cancellations from week to week, especially during the last half of the grain year when volumes were in decline.

In general, the analysis of car order cancellation rates for grain suggests that volatility of car orders is relatively high, affecting 25% of CN's and 28% of CP's car orders. Some car order cancellations are undoubtedly the result of railways' inability to supply car orders in the original order week. However, regardless of the reasons for car order cancellations, this relatively high level of order volatility will impact railway empty fleet distribution managers' ability to ensure that empty grain car orders are filled according to shippers' requirements.

⁵⁹ Tables with the results of this analysis are included in Appendix 2.

⁶⁰ The variation in car order cancellations was also compared statistically to the weekly order fulfillment rate described below. No statistically significant relationship exists between these two performance variables.

Figure 17 Grain car order cancellations and total orders – time series graph



Grain Car Supply Performance

Supply performance for railway delivery of empty grain cars was assessed in two ways. First, in terms of the absolute quantity of cars provided compared to shipper car orders annually and second, in terms of the railways’ provision of cars during the week for which they were ordered.

In addition to car order and supply data, the railways provided QGI with weekly information on the number of car orders that they had included in their supply planning for each customer on a weekly basis. This permitted the calculation of performance with respect to the railways’ weekly supply planning. It is important to note that in any given week, railways may plan to supply more cars than have been ordered for that week if there is a carryover of demand from previous weeks that was not supplied (shortfalls). For grain car orders, unlike merchandise car orders at both railways, car supply that is not provided in the week for which it is ordered is still considered as outstanding unless it is cancelled by the customers.

On a weekly basis, CN and CP review orders submitted by grain shippers and confirm to shippers the car demand that is accepted at each location. They must then develop and communicate their operating plans which identify the specific days that each railway is scheduled to deliver rail cars to each shipper facility. CN’s Planned Service report is available via the Internet on Thursday and is sent out via fax on Friday morning preceding the grain service week that

begins on the following Sunday. CP currently advises grain shippers with its Final Service Plan on the Wednesday preceding the next grain service week.

Figure 18 Railway plan and net order performance by grain crop year

		CN	CP
2006-2007	Plan % of Net Orders	108%	100%
	Plan Fulfillment	88%	99%
	Net Order Fulfillment	96%	98%
2007-2008	Plan % of Net Orders	104%	95%
	Plan Fulfillment	97%	100%
	Net Order Fulfillment	101%	95%
2008-2009	Plan % of Net Orders	88%	97%
	Plan Fulfillment	109%	101%
	Net Order Fulfillment	95%	97%
Total Service Review	Plan % of Net Orders	104%	97%
	Plan Fulfillment	94%	99%
	Net Order Fulfillment	98%	97%

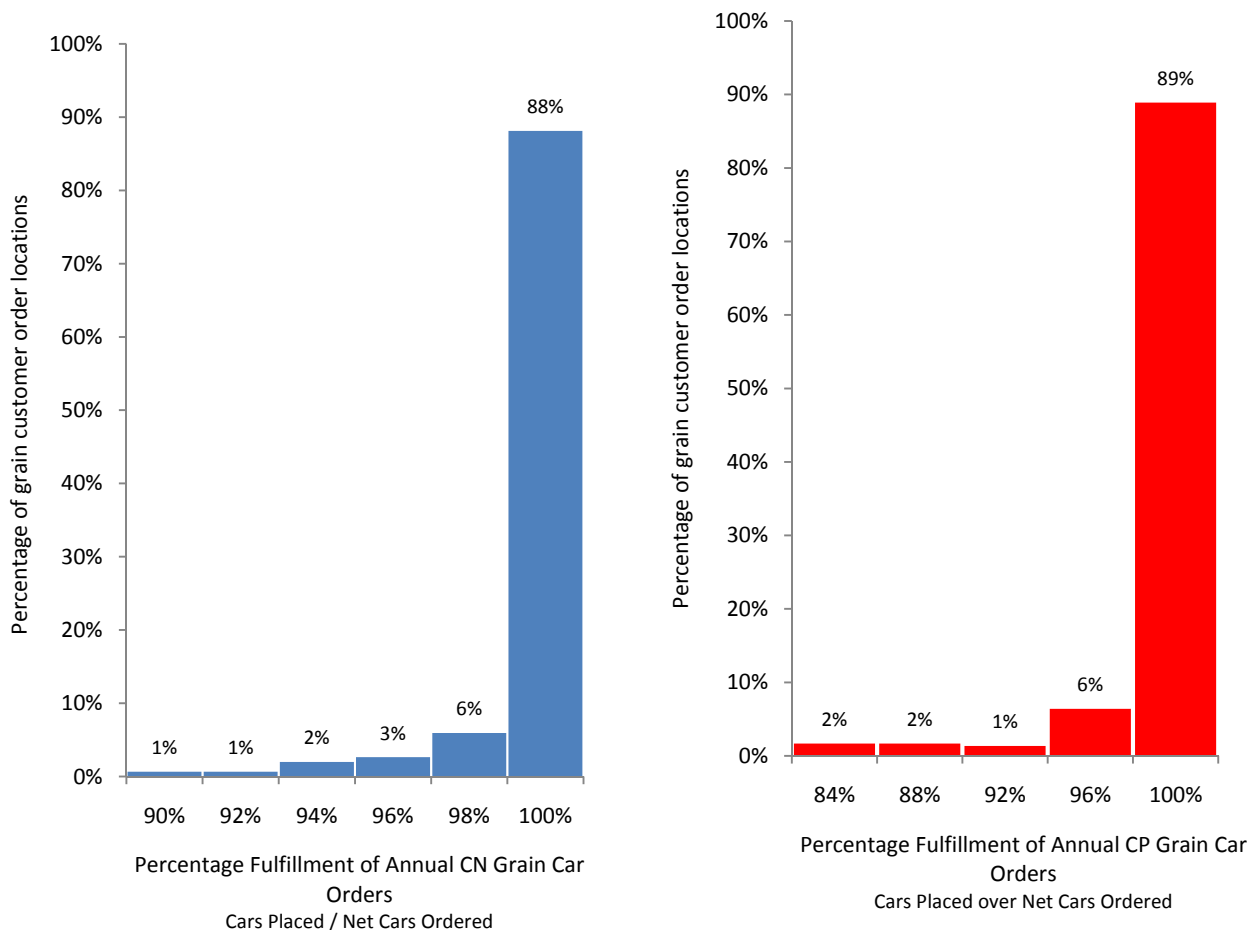
In the following analysis, railway performance is assessed both against shippers' net orders (cars ordered for a given week less customer cancellations) and against the service plans developed by the railways and communicated to customers on a weekly basis (Plan Fulfillment). In addition, the percentage of net cars ordered that are represented in the weekly railway service plans is also evaluated (Plan % of Net Orders). This last metric shows the degree to which railways

expect on an annual basis to fulfill customer demand as represented by net cars ordered.

This table shows that for the entire service review period, the railways had virtually the same performance in spotting empty grain cars to fulfill shipper demand and that CP had better performance than CN at delivery of empty grain cars to their planned performance. This table consolidates demand for rail cars across all car orders for all customers at all locations. For greater clarity, in the table above, Net Order Fulfillment refers to the aggregate supply of rail cars for all shippers against the aggregate demand for rail cars.

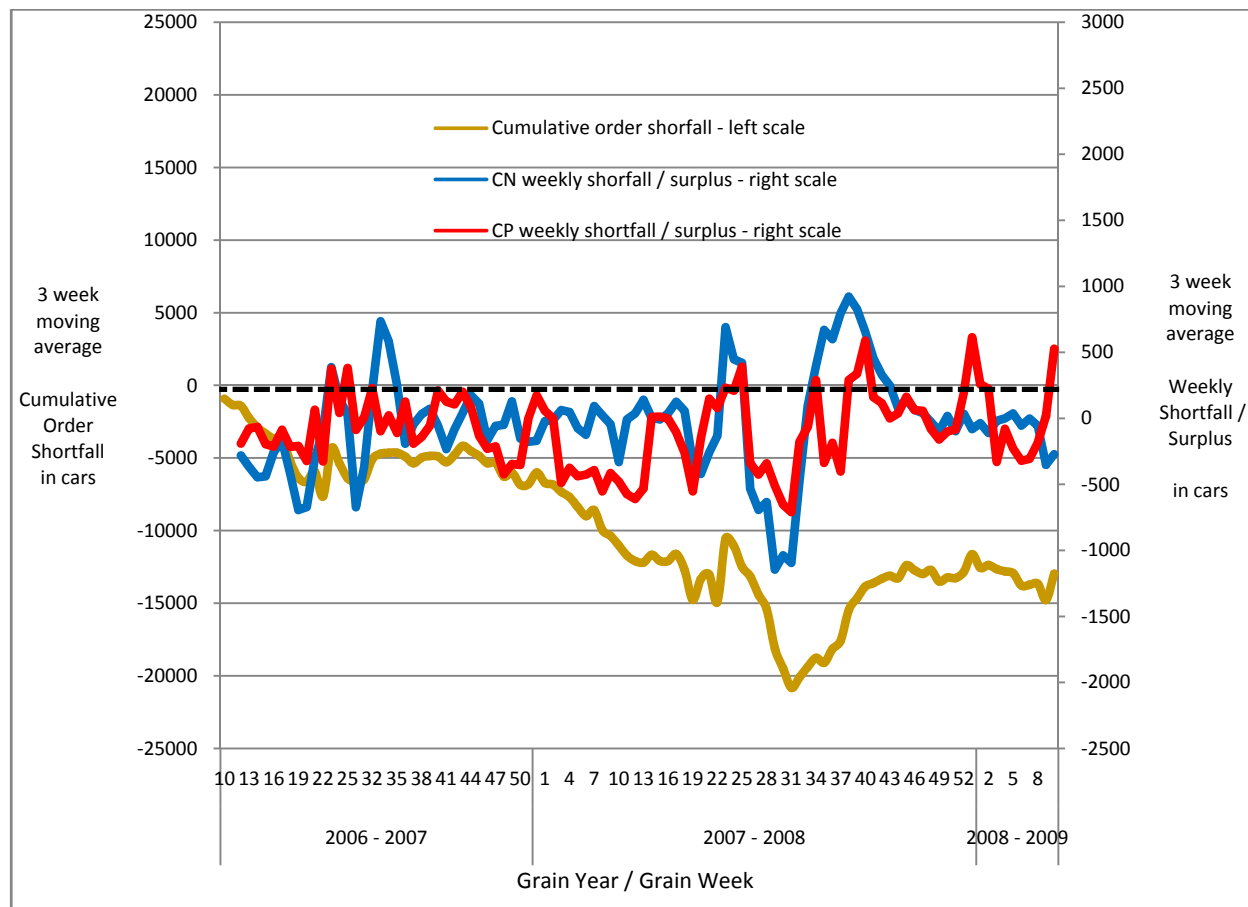
In addition to reviewing the fulfillment of demand at an aggregate level, the following graphs display the relative annual fulfillment rates at individual customer shipping locations. These graphs show that not only is most aggregate grain car demand filled on an annual basis, but most grain customers at an individual shipper/origin location level receive a very high percentage of their net cars ordered on an annual basis. As illustrated in the frequency distribution graphs below 88% of CN and 89% of CP shipper order locations received 100% of their annual net cars ordered.

Figure 19 Frequency distributions of annual demand fulfillment rates – grain car orders



However, the following graph shows that while most empty grain car demand was eventually filled by the railways, on a week to week basis there was significant variability in performance. The graph also shows that, as with transit time data, railway service performance deteriorated significantly in the winter period during crop year 2007-2008 (Service Review Year 2). As noted earlier, if demand from a previous week is not fulfilled, it is still considered as outstanding unless it is cancelled by the customer. Thus in the graph attached, a given week's surplus may reflect a previous week or weeks' shortfall. The cumulative shortfall graph shows that over the entire service review period there was a shortfall amounting to approximately 3% of total net orders.

Figure 20 Weekly grain car spotting performance to net weekly orders – time series⁶¹



The following table shows weekly railway grain car supply performance in terms of the percentage of the time that a shipper received a specific proportion of their net car orders.

Figure 21 Weekly railway grain car supply performance

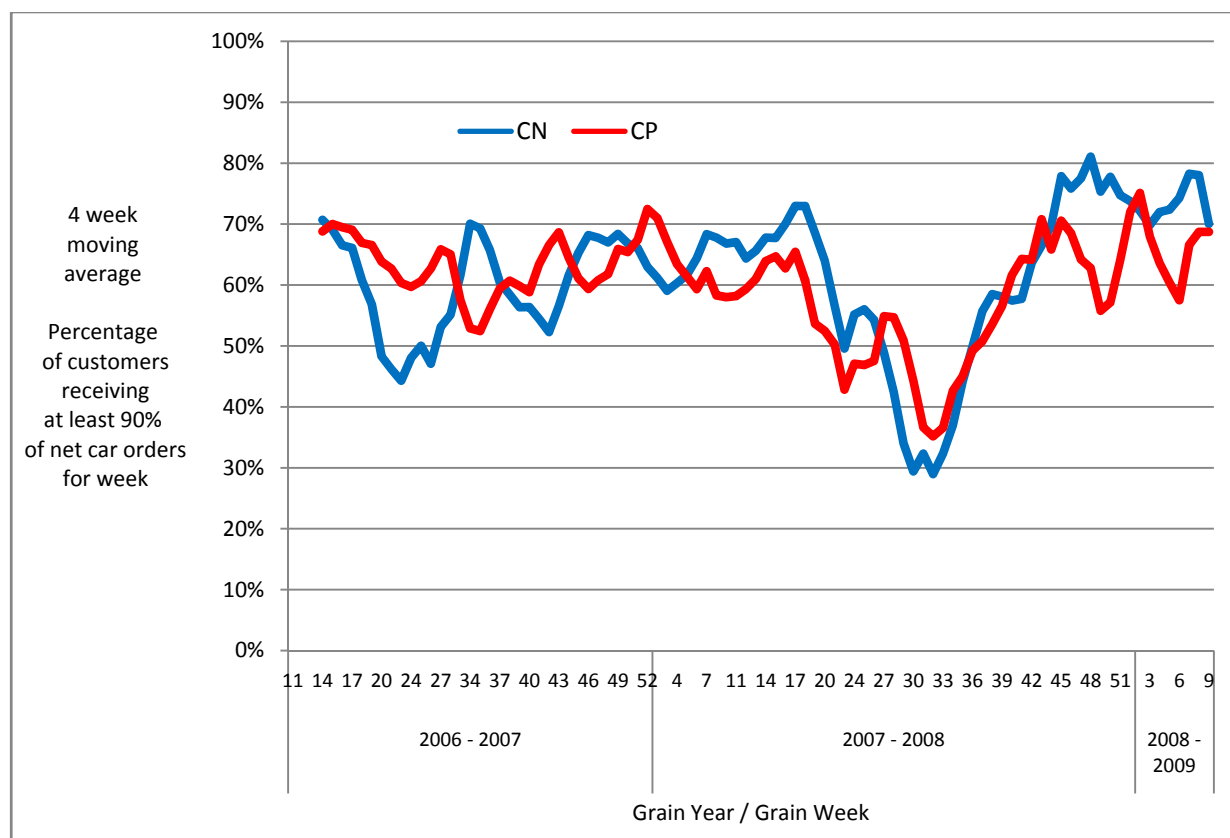
	Net Order Fulfillment 100%	Net Order Fulfillment 90%	Net Order Fulfillment 75%
CN	50%	57%	61%
CP	49%	51%	53%
Industry Total	49%	54%	57%

The table shows that each railway provides grain shippers with all of the cars they have ordered only half the time. In the case of CN, customers received at least 75 percent of the cars

they ordered 61 per cent of the time, while in the case of CP, customers received 75 per cent of their order 53 per cent of the time. Furthermore, as shown by the following graph, these average performance levels mask week to week changes in performance that are very significant.

⁶¹ In this graph, supply shortfall and surplus is only calculated against orders for a given week. Thus if supply is provided in a subsequent week for an order in a given week, it will show as surplus against the week it is actually provided.

Figure 22 Weekly grain car order fulfillment - 90% performance standard - time series

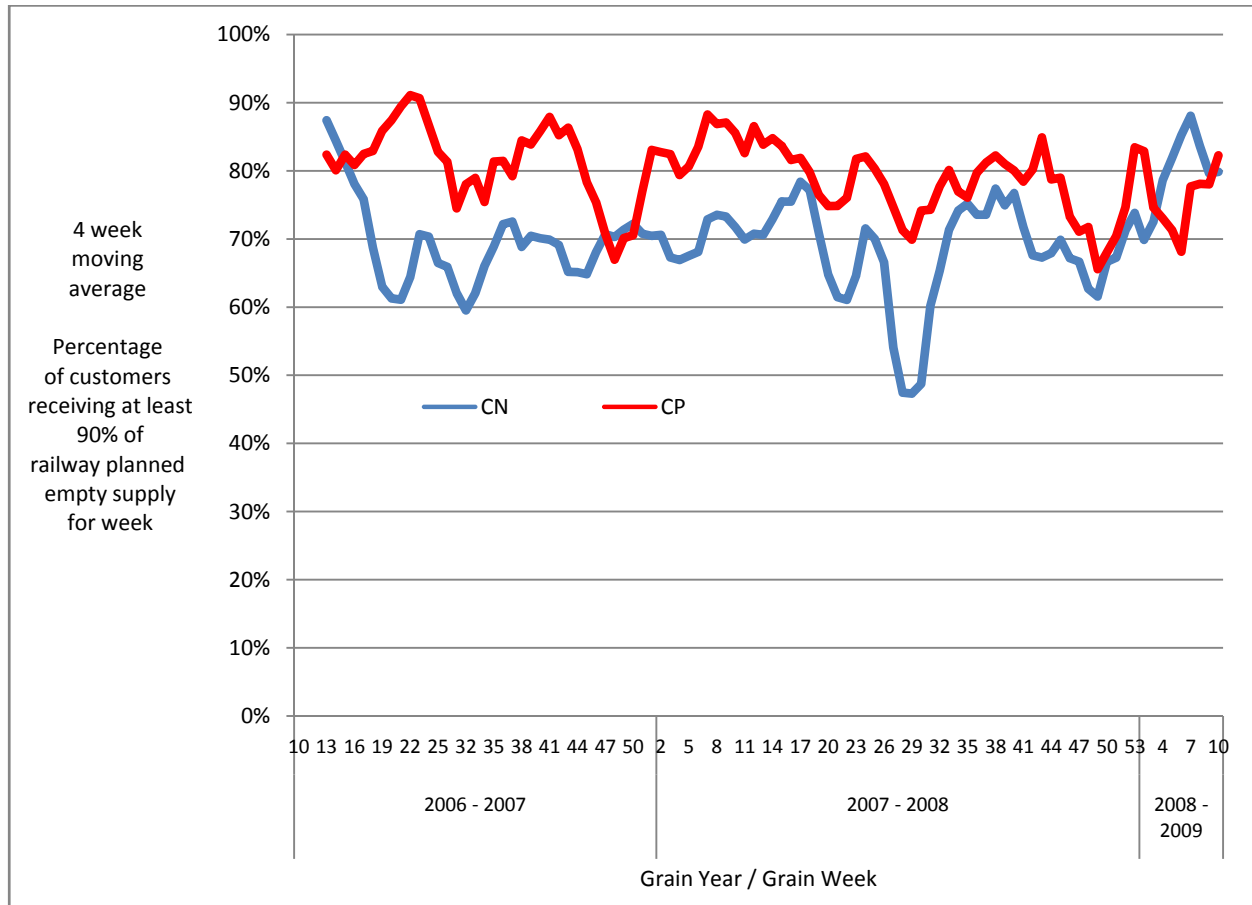


The data above show that while railways ultimately supply the vast majority of grain cars ordered by grain shippers, their weekly performance levels in supplying the number of cars requested by shippers (net car orders) for a given week are highly variable.⁶²

On a weekly basis, following the cut-off for car orders, the railways plan their future empty supply distribution and communicate this plan to their customers. The graph below shows the railways’ performance in supplying empty grain cars in conformance with these railway plans as opposed to the customers’ net orders at cut-off. Railway performance as illustrated in this graph is significantly higher when measured in relation to their weekly planning process. As this process is communicated to customers for use in their own logistics planning this improved level of performance is a positive factor for the overall grain handling and transportation system.

⁶² While this analysis measures railway performance in spotting cars against the number of cars ordered by the grain shipper for a given week, railways do not commit to the provision of cars in the week for which they are ordered. CN and CP commit to supplying grain cars by the Tuesday following the grain week for which cars are ordered.

Figure 23 Weekly railway grain plan fulfillment - 90% performance standard - time series



Appendix 2 includes a number of tables that show shipper order cancellation and railway empty grain car supply performance across a number of shipper and network characteristics. These tables show that annual car order fulfillment rates for both railways do not vary significantly regardless of the size of a customer’s weekly order. Neither were differences in annual performance noted based on competitive access nor province of origin. However, for the weekly fulfillment performance, the tables show that CP customer locations with the smallest weekly orders (average of <10 cars per week) only received at least 90% of the cars they ordered 32% of the time while customers with larger orders received at least 90% of their cars over 50% of the time.

2.2.5 Merchandise Car Supply Analysis

While the empty car order processes for grain cars are quite similar between CN and CP, the processes for Merchandise cars are quite different. CN offers shippers a Guaranteed Car Order (GCO) program which includes performance penalties for both shipper and railway for failures when shippers do not use ordered equipment or when CN does not supply equipment that is committed to or “guaranteed” before its specified weekly cut-off times. While CN commits to the provision of a specified number and type of empty cars on or before specified days, CP’s car order process does not include a commitment to supply, and there are no financial penalties to CP for failure to meet merchandise car orders placed through its Internet based Delta car order program.⁶³

The data provided by the two railways to support this car supply analysis by QGI also differed in several respects. CN’s car supply process includes a review of orders and the entry by CN into its car order system of CN’s allocation of its projected available empty fleet for each car order. This allocation of cars establishes the number of cars that are “guaranteed” under the CN program. In addition, CN’s information systems track changes to car orders that took place between the cut off date for car order and the actual date for which cars were ordered and, as a result, were able to provide QGI with the related information. CP’s data only included its final car order numbers as CP’s systems do not track changes in the orders between cut-off and actual car order dates and therefore no such information could be provided to QGI.

Because of these significant differences between the two car order programs and the data provided by CN and CP, the analyses of the two programs cannot be directly compared and consequently the results of the analysis will be presented separately for each railway.

Empty car orders for Merchandise traffic at both railways are entered into the railways’ Internet based car order systems. These car orders indicate the number of cars by car type that shippers request be placed at their specific loading locations by day of the week. However, as noted earlier, the data provided by the railways to QGI was summarized at the weekly level. Therefore, in this analysis, **a car order is defined as the total weekly demand by a customer at a single location for a specific car type.** In the CN and CP data, the provision of a substitute car type that is defined in the car order as an acceptable substitute is counted as supply for that car order.

⁶³ CP does charge for cars that have been ordered by shippers through its Delta car order program that are not used by shippers and must be pulled empty from a shipper’s siding. In addition, for both railways, demurrage charges on empty cars begin to accrue to the shipper after the expiry of the railways’ free time provisions for loading empty cars. For a more thorough discussion of the details of CN and CP’s car order processes see QGI’s report on this topic – Railway Car Order and Car Supply Processes QGI Consulting March 2010.

CN Car Supply Analysis

Merchandise Car Demand

Figure 24 Prevalence and magnitude of changes to CN car orders after cut-off by car type

Car Type	Percentage of Car Orders Changed (Shipper/Origin/Car Type)	Percentage of changes in total cars ordered <u>absolute value</u>	Percentage of changes in total cars ordered <u>net value</u>
Box Car	38%	11%	5%
Covered Hopper	70%	42%	42%
Flat Car	33%	10%	4%
Gondola	31%	10%	4%
CN Merchandise Total	36%	11%	5%

While CN, like CP, establishes a cut-off for the receipt of car orders for future dates, it does accept changes to these orders after the cut-off date. These changes may or may not be guaranteed under the CN GCO program. CN car distribution managers review such changes and determine the feasibility of adding any additional

demand to the number of cars that will be “guaranteed.” However, the car demand levels in place before cut-off are a key indicator of projected demand and as such an analysis of changes made to demand after the cut-off dates can provide insight into the level of reliability of customer car orders for empty equipment. Unlike grain car orders, which cannot be increased after the cut-off date, CN Merchandise car orders can either be increased or decreased. In analysing changes to car orders, it is useful to measure not only the net effect of change to customers’ car orders on overall demand but also the absolute value of such changes. For example, if three customers increase their orders by 15 cars each and one customer decreases their order by 45 cars the net effect on overall demand is 0. However, the absolute value of such changes is 90 cars.

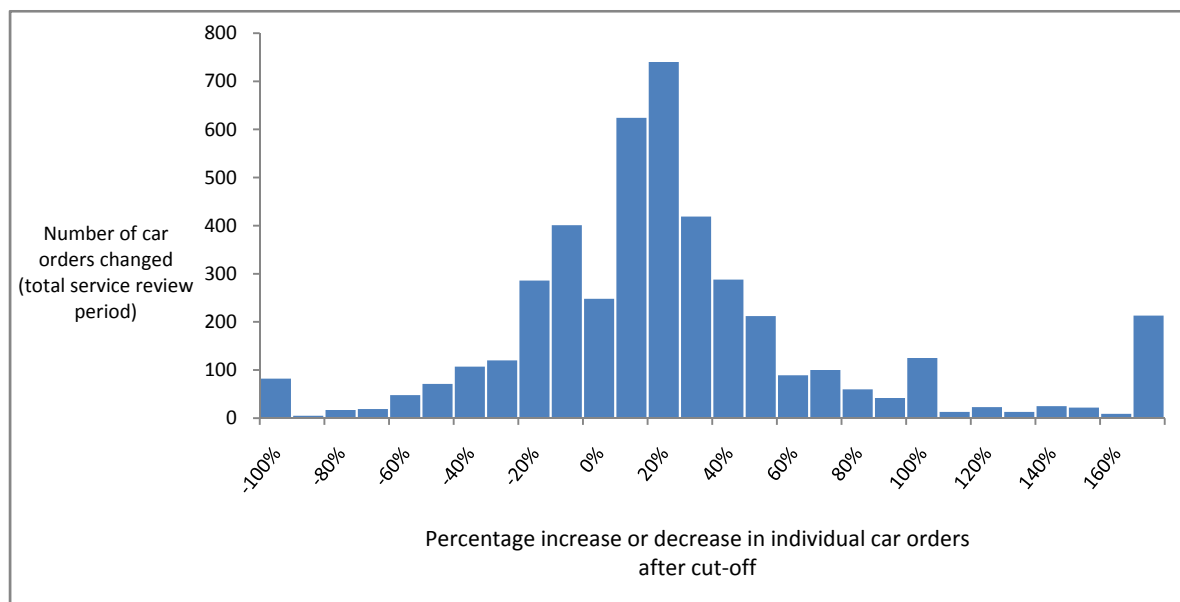
As the increases and decreases to car orders may not be in the same locations or for identical rail car types, the off-setting impact on demand may not be relevant to the railway from a car distribution perspective as the supply available in one area may not in a short time period be available to satisfy a shortage in another area.

Figure 24 above shows that 36% of the CN sample car orders were subject to changes after the cut-off date. The prevalence of changes in orders for covered hoppers ordered through the Guaranteed Car Order program was particularly high at 70%. Figure 24 also shows the absolute value of increases and decreases by car type and the net effect of such changes on overall demand.⁶⁴

⁶⁴ The absolute value of a number is that number expressed only as a positive value. Thus the absolute value of -15 is 15. The use of absolute values permits the analysis of the range of variation of car orders so that decreases in car orders do not “cancel out” increases in car orders.

The data in this table reveal that while the net effect of changes after cut-off was a 5% increase in car orders for the entire service review period, the absolute value of increases and decreases in car orders was 11%. The following histogram illustrates the distribution of changes to car orders, for the 36% of orders where changes were made after cut-off.

Figure 25 Frequency distribution of percentage changes to CN car orders after cut-off

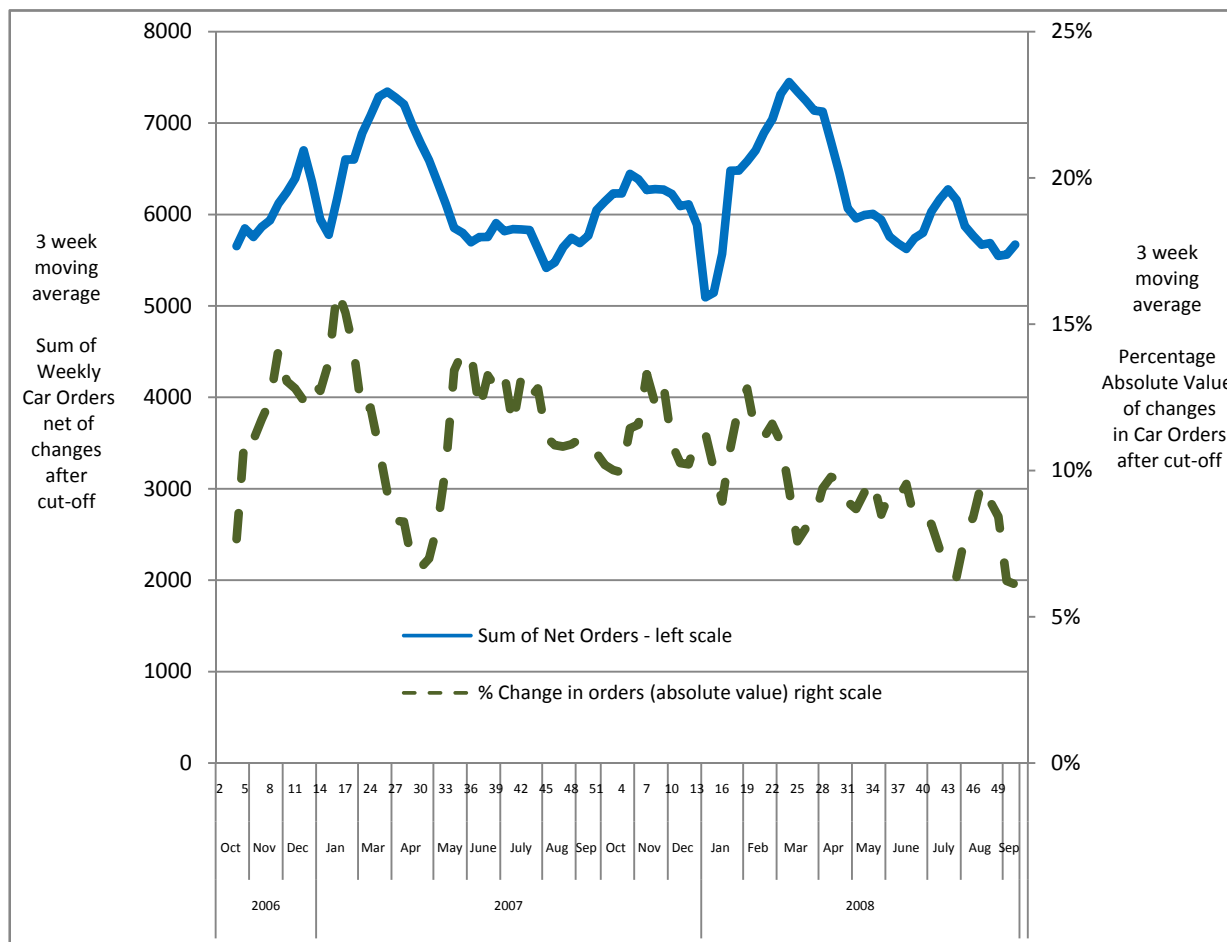


The chart above shows that car order changes range from increases of over 160% of original orders to decreases of up to 100% of cars ordered with more car orders being increased than decreased.

When examined over time, there does not appear to be any relationship between overall levels of car order demand and the magnitude of order changes.⁶⁵ This relationship is illustrated by the chart in Figure 26, below. This chart does however show a decreasing trend in car order changes over the service review period. This suggests that the car order process for CN customers may have become more disciplined and predictable over the course of the time period examined.

⁶⁵ This relationship was examined using regression analysis.

Figure 26 CN car orders and car order changes over time



The analysis of car order changes by CN customers suggests that the prediction of final demand for empty rail cars is a very dynamic process.⁶⁶ It is reasonable to believe that the changes to car order demand in the days and weeks prior to cut-off are at least as dynamic as the changes to demand after cut-off. Given this wide variation in demand prediction, railway car distribution staff will be challenged in their ability to satisfy customer car orders while maintaining their focus on asset utilization. It is important to note that swings in car demand are not necessarily a result of poor demand forecasting by railway customers. Changes in car demand from day to day and week to week will be affected by such factors as: railway performance in meeting previous demand requirements, final demand changes by the customers’ customers, changes in customer operations and upstream logistics and supply processes.

CN Merchandise Car Supply Performance

As noted earlier, CN’s car supply process includes a review by CN of all car orders received before cut-off and the communication of the allocation of available empty cars to customer car orders. This allocation of predicted empty

⁶⁶ Appendix 2 includes a more detailed analysis of changes to CN car orders after cut-off, across a number of shipper and network characteristics.

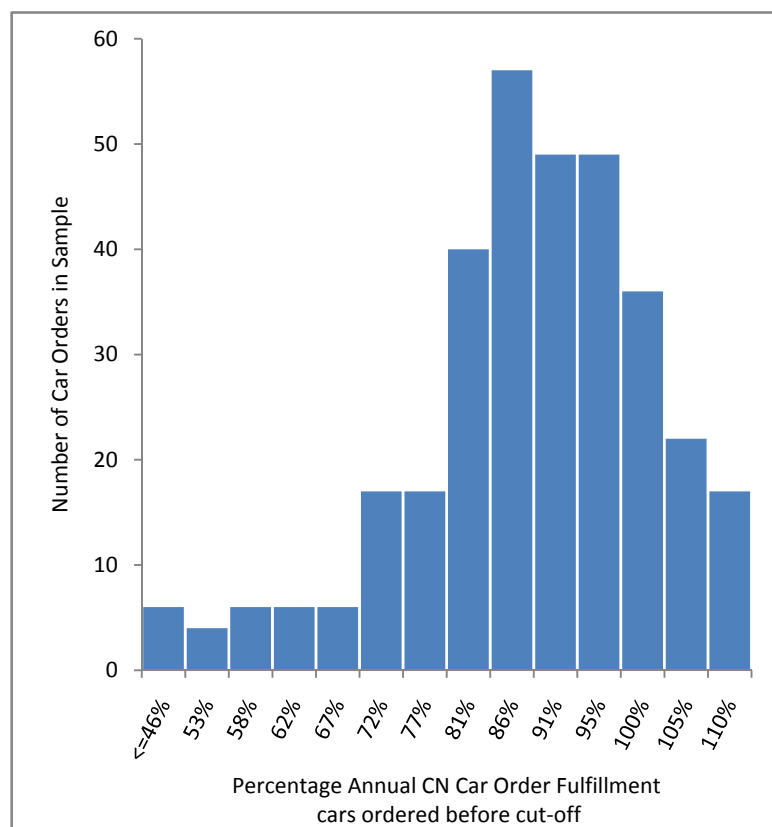
car availability becomes the fleet which is “guaranteed” to customers in the CN GCO program. As shown in the table below, CN is able to supply a high percentage of the cars allocated to customers, when performance is assessed over the long term.

Figure 27 CN average annual car supply performance versus orders and allocation (guarantee)⁶⁷

Car Type	Orders	Allocation
Box Car	84%	92%
Covered Hopper	82%	88%
Flat Car	90%	94%
Gondola	79%	98%
CN Merchandise Total	86%	95%

When considered across size of car order, network/shortline/competitive status and province of origin, there is very little variation in the overall car order fulfillment rate for CN customers.⁶⁸

Figure 28 Distribution of annual car order fulfillment rates - CN Merchandise



Furthermore, the distribution of car order fulfillment displayed in Figure 28 shows that the variation of performance around the mean of 86% is approximately normal, with the median performance (at 87%) being only slightly greater than the mean (average) performance. The customers in the sample where CN had the lowest car order performance were Merchandise shippers in Manitoba and Saskatchewan (See Appendix 2).

As with grain car orders, car supply performance was also examined in terms of the performance of the railways in meeting a customer’s empty car demand on a weekly basis. Unlike with grain car orders where

⁶⁷ This table displays the average fulfillment of customer car orders versus the demand at time of cut-off and versus the allocation (guarantee) levels for each car order communicated by CN to customers. This calculation is the average of the annual fulfillment rates for all customer car orders for both years of the service review period.

⁶⁸ The results of this analysis are in Appendix 2 – CN Overall Car Supply Performance.

demand that is unfilled in a particular week carries over to the following weeks – merchandise car demand at CN and CP is specific to the day and week for which orders are placed. If demand is unfilled in a given week, customers are required to enter this unfilled demand in their future car orders.

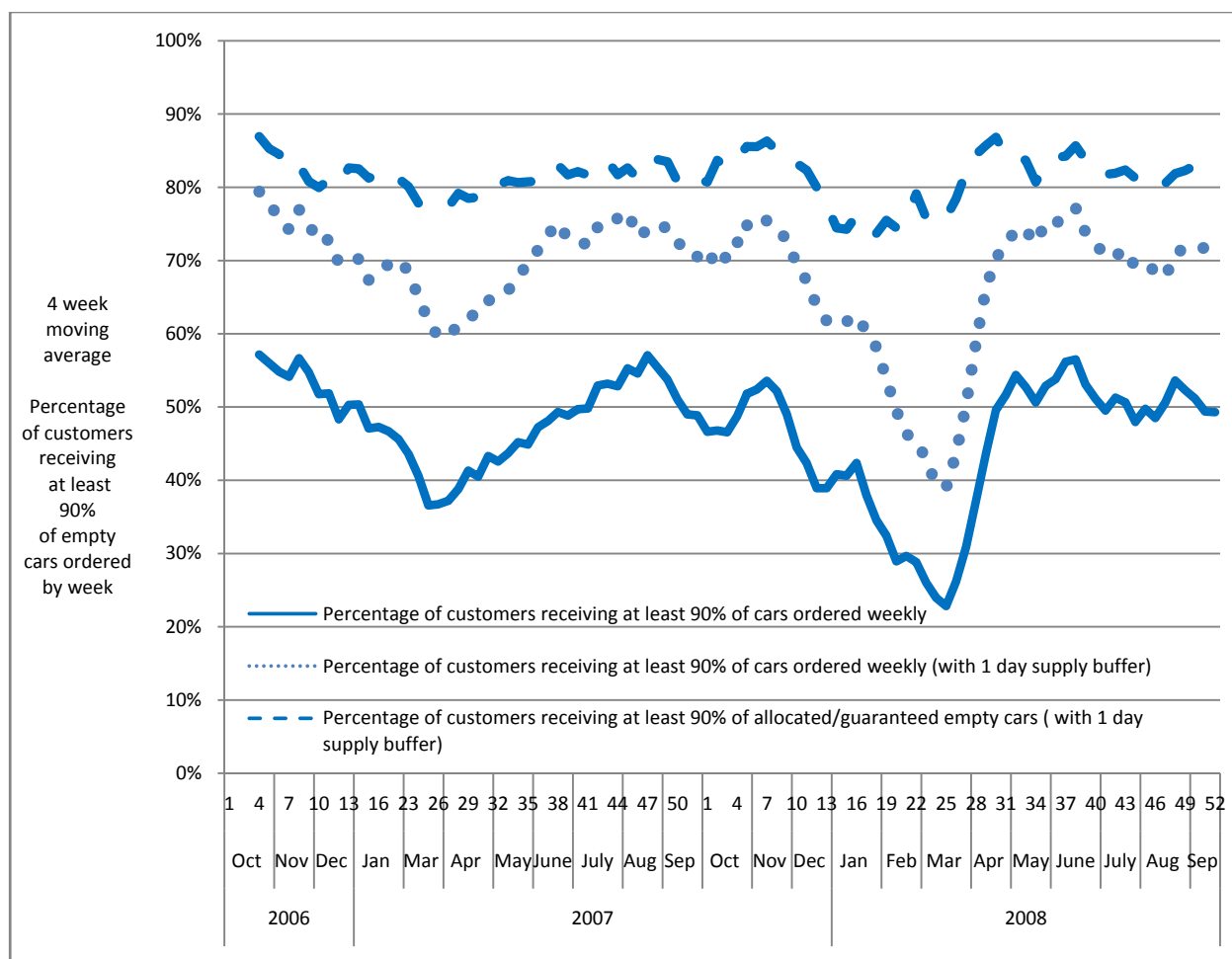
The data provided to QGI by the railways did not include the number of empty cars (if any) that were spotted in advance at each of the customer locations in the study, prior to the first week in the study review period. As a result, QGI was limited to assessing the cars placed, versus the cars ordered at each location on the assumption that there were no cars on spot at any of the customer facilities at the beginning of the study period. While this may have been true for some of the locations normal practice for railways will be to pre-spot some empty equipment at some customer locations prior to the day of demand. This practice takes place for a number of reasons including allowing railways to provide empty cars to customers using scheduled train services on the days that cars are available on the railway, rather than waiting until the day that shippers have ordered the cars. For example, a railway may have weekend train service that can spot empty cars at a shipper's facility even if that shipper operates only on a Monday – Friday basis. In other cases, empty rail cars may be available for spotting in advance due to the natural ebb and flow of receipts of empty equipment from unloading points and foreign railway interchanges. The railway may provide excess cars to shippers who have regular and predictable demand and shipping patterns to ensure that uneven empty equipment flows back to shippers do not cause shortages of equipment at demand points.

However, as no data was available from the railways providing exact details of the empty equipment inventory that was available at each of the shipper locations in the study at the beginning of the study period, some estimates needed to be provided of the average “float” of empty equipment that may be available at shipper locations on an on-going basis. Therefore, for the weekly performance analysis of car supply it was assumed that the equivalent of 20% of the weekly demand was available at each location in addition to the cars that the railways reported as having been placed empty for a given week.⁶⁹ This 20% of weekly demand is equivalent to one day of car supply for a customer that loads empty rail cars 5 days per week.

As can be seen from the chart below in Figure 29, CN's weekly car supply performance over time is far better when compared to its allocation process (guarantee) than to the original customer car orders before cut-off.

⁶⁹ For the analysis of CN car supply performance this 20% factor was equal to 20% of the customer allocation for the current week. For the CP analysis the factor was equal to 20% of customer car orders for the week.

Figure 29 CN weekly car order performance – time series



As noted above, this chart displays the percentage of customers receiving at least 90% of their orders, and their allocation (guarantee) cars from CN each week under their GCO program. The two upper lines on the graph show the effect on the performance data of including the assumption that each customer location has available during the week 1 additional day of car supply (20% of weekly supply) that was pre-spotted by the railway the week previously. Of interest in the graph is the fact that notwithstanding that there is periodically a wide gap between customer orders and CN’s car allocation to customers, CN’s performance versus car allocation is less variable over time than its supply performance against car orders. This suggests that CN has a significant degree of success in communicating to customers over the short term any limitations in its weekly car supply capability.

Figure 30 Average percentage of CN customers receiving 90% of weekly car orders/allocation - by car type

	Box Car	Covered Hopper	Flat Car	Gondola	Merchandise Total
Order Fulfillment 90%	42%	43%	52%	43%	46%
Order Fulfillment 90% 1 day buffer	66%	50%	73%	61%	68%
Allocation Fulfillment 90% 1 day buffer	78%	82%	83%	83%	81%

The table above shows that CN performance against original orders on a weekly basis is an estimated 68% against car orders at the time of cut-off and 81% versus CN’s allocation –including an assumed 1 day car supply buffer which was added to the empty supply provided in the sample data.

CP Car Supply Analysis

As noted earlier, CP does not have an electronic formal process for communicating through its Merchandise products car order systems its expected weekly supply of empty rail cars that will be available to fulfill customer orders and it does not have a system whereby car supply levels will be in any way “guaranteed” to customers, as CN does for its Merchandise fleets. In addition, CP does not track and did not make available to QGI data on changes to car orders over time. Therefore, the analysis of CP car supply processes cannot include an assessment of the volatility of CP’s customer car orders. In addition, as was noted earlier, the CP sample of valid car order data is much smaller than the CN sample. For all of the reasons above, caution should be exercised in the comparison of the CN to CP car supply performance data.

Figure 31 CP annual car supply performance versus orders

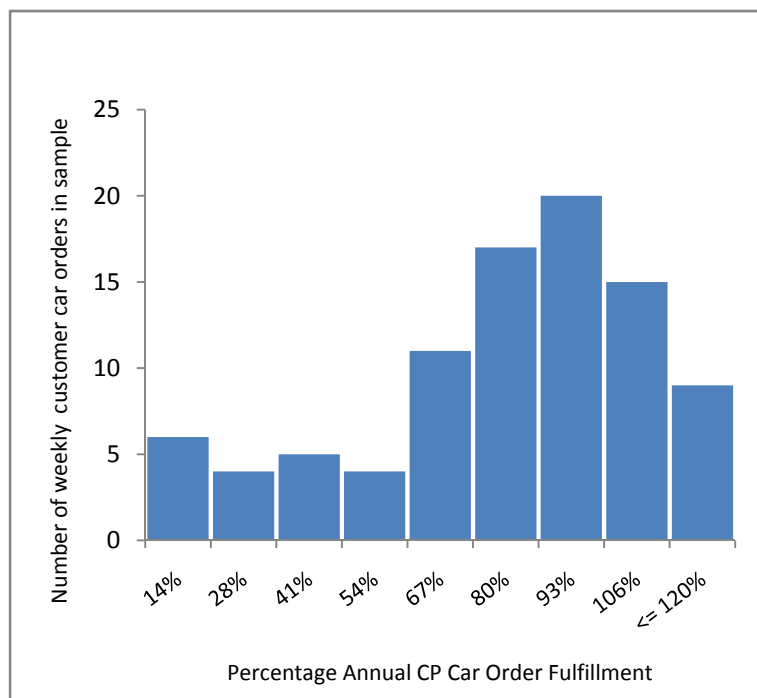
Box Car	67%
Covered Hopper	69%
Flat Car	78%
Gondola	81%
CP Merchandise Total	73%

CP performance against car orders for all car types averaged 73% for all customers in the CP sample. When assessed against various network and shipper characteristics, the sample data suggest that the CP customers located at competitive origins receive somewhat better car supply than customers without access to direct rail competition.⁷⁰ CP’s customers

with the largest weekly car orders received the highest annual order fulfillment rate (80%); however, customers with small orders of less than 10 cars per week also had a relatively high order fulfillment rate (76%).

⁷⁰ This analysis is available in Appendix 2 - CP Overall Car Supply Performance.

Figure 32 Distribution of annual car order fulfillment rates - CP Merchandise



The distribution of annual car order fulfillment rates is shown in the chart opposite. The mode of performance (most frequent observation) is approximately 93% and the median performance of the sample was 79%. Average performance, as noted in the table above, was 73%.

As noted above in the section on CN Car Supply performance the data provided to QGI by the railways did not include the number of empty cars (if any) that were spotted in advance at each of the customer locations in the study prior to the first week in the study review period. As with the CN performance data, in order to take account of cars that may have

been spotted in advance of the service review period, it was assumed that the equivalent of 20% of the weekly demand was available at each location in addition to the cars that the railways reported as having been placed empty for a given week. This 20% of weekly demand is equivalent to one day of car supply for a customer that loads empty rail cars 5 days per week. As can be seen from the chart below, on a weekly basis, the average level of performance is quite low when assessed using the data provided by CP and applying the assumptions made by QGI in determining a reasonable buffer stock of cars available.

Figure 33 CP weekly car order performance – time series

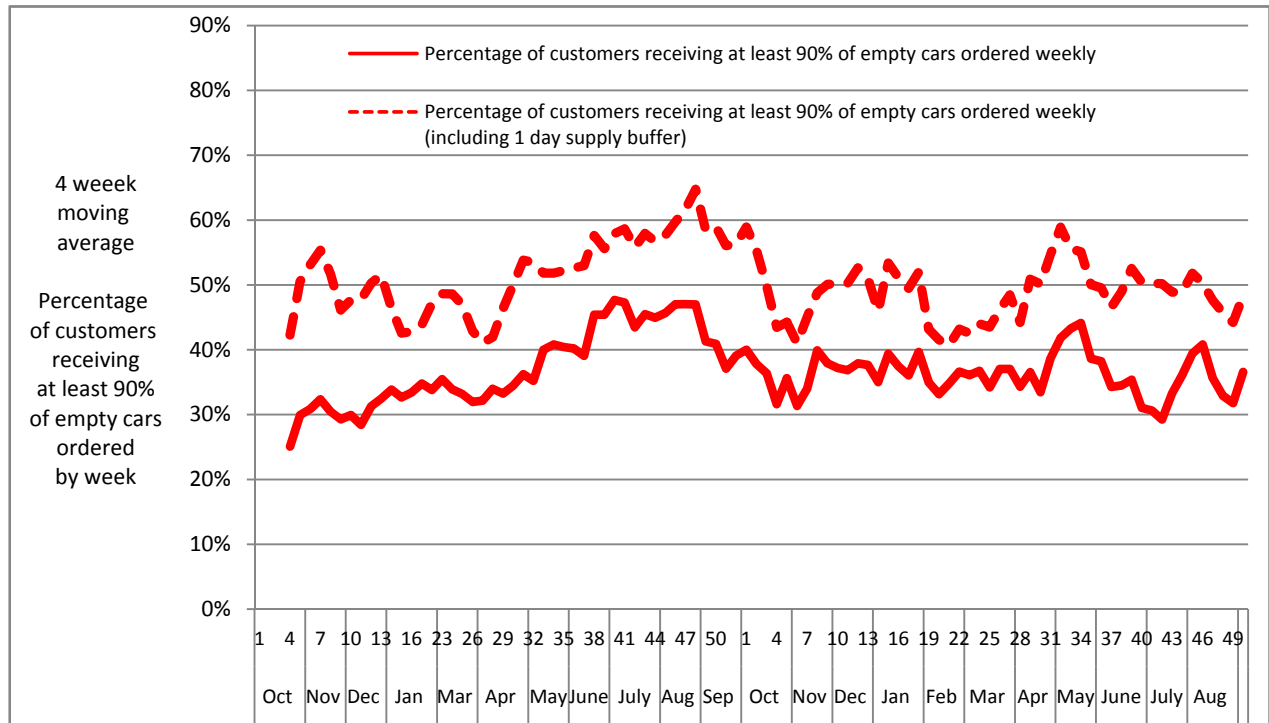


Figure 34 Average percentage of CP customers receiving 90% of weekly car orders/allocation - by car type

	Box Car	Covered Hopper	Flat Car	Gondola	Merchandise Total
Order Fulfillment 90%	40%	30%	36%	37%	37%
Order Fulfillment 90% 1 day buffer	51%	39%	52%	54%	50%

While overall *annual* car order fulfillment rates at CP are in the 72-81% range with a median of 79%, based on the data provided by CP and applying the assumptions regarding pre-spotting of empties that have been made by QGI, an average of only 50% of customers receive at least 90% of their car orders on a weekly basis.

2.2.6 Daily Car Supply Performance

Planning for the daily supply of empty rail equipment is an important element of shippers' supply chain planning. The principal analysis of car order supply performance in this report has been done using weekly data provided by the railways. However, the issue of daily car supply performance was identified as an important issue by shippers during consultations for Project 2 that examined the operating practices of system stakeholders. Shippers also raised this issue during meetings to validate the railways' weekly order and supply data. In response to this issue QGI solicited daily car order and empty supply data from the railways for a small number of grain and merchandise shippers to be used in case study analysis of daily car supply performance.⁷¹ The analysis for grain shippers examines daily performance for four shipper locations, two served by each of CN and CP whereas the merchandise analysis looks at three CN shippers and two CP shippers.

QGI's analysis of daily car supply relies on railway supplied data to establish the actual number of empty cars that are available on a given day at a given location to support shipper loading. The precise times when empty rail cars are made available to shippers and when they have been loaded and can no longer be counted as empty "supply", however, cannot always be precisely determined through examination of railway reported car event data. Therefore, this analysis is only meant to illustrate the issues associated with problems in the provision of empty car supply to customers on a daily basis. It cannot be expected to provide any definitive conclusions with respect to this issue but it is hoped that this analysis and discussion will support the on-going debate between shippers and railways with respect to this important issue.

Grain

Rail car orders are placed by grain shippers for delivery by the railways within a specific grain service week. Orders are not placed for a specific day within the shipping week. As part of the railways' grain planning processes CN and CP review orders submitted by shippers, confirm to shippers those orders that are accepted and develop operating plans to deliver the rail cars during the course of the planned grain service week. Once railway operating plans have been established, CN and CP communicate their respective planned service to shippers.⁷² These service plans identify the specific days that CN and CP plan to deliver rail cars to each shipper facility. CN's Planned Service report is available via the Internet on Thursday and is sent out via fax on Friday morning preceding the grain service week that begins on the following Sunday. CP currently advises grain shippers with its Final Service Plan on the Wednesday preceding the next grain service week. This allows customers to then plan their grain loading operations which may include the

⁷¹ Additional data was not requested from CP as its original data submission for cars planned and empty supply for all grain shippers was provided on a daily basis.

⁷² CN's weekly report is known as the "Planned Service Report" and CP's term for this publication is the "Final Service Plan".

scheduling of labour and inspection personnel and in the case of grain elevators the suspension of grain deliveries from producers for those days.

For this daily service analysis, QGI has analyzed railway performance on the basis of railway plan fulfillment as opposed to customer order fulfillment. Plan data reflects the published service plans communicated to railway customers in advance of the grain service week. The table below summarizes performance for these four shippers for plan fulfillment for the period from October 1, 2006 to September 27, 2008 consisting of 101 grain service weeks.⁷³

Figure 35 Daily grain car plan fulfillment performance

	CN		CP	
	Shipper 1	Shipper 2	Shipper 1	Shipper 2
Plan Fulfillment (Service Review Period)				
# of cars planned	6,730	4,271	7,095	5,112
# of planned cars supplied	6,423	3,896	7,095	5,109
% of total planned cars supplied	95%	91%	100%	99%
% planned cars supplied on planned service day	32%	14%	19%	22%
% planned cars available by planned day including early spots ⁷⁴	49%	37%	87%	79%
Daily Plan Fulfillment				
100% Performance standard Daily Plan Fulfillment	21%	12%	18%	17%
90% Performance standard Daily Plan Fulfillment	28%	12%	18%	19%
75% Performance standard Daily Plan Fulfillment	31%	12%	18%	19%

As can be seen in the table above, while both CN and CP fulfilled more than 90% of their planned empty car supply to these shippers during the study period, the performance of both railways degrades significantly when performance to plan on a daily basis is calculated. The four shippers included in this analysis received 90% of planned car supply on the planned day only 12-28% of the time over the course of the study period.

Recognizing that railway operations and railway-customer planning processes for the supply of empty rail cars are somewhat dynamic some care must be exercised when viewing these performance statistics. While the performance data reflects actual performance to published plans there are instances where published plans can be changed by mutual agreement of the railways and their customers during the course of a grain week. Such changes may be requested by shippers to accommodate day to day operations at their loading facilities or agreed to by shippers if they are more operationally efficient for the railways and do not negatively impact customer operations. Such changes are usually agreed to at the local operating level and would not necessarily result in the modification of plan data contained in the railways' information systems. Such changes to car spotting plans may result in the railway supplying

⁷³ As noted earlier grain service weeks 28-31 inclusive for crop year 2006-2007 have been removed from the analysis as they fall into the CN strike period in February-March 2007. Grain week 10 for crop year 2008-2009 has also been excluded as only a portion of the week falls in the defined service review period and empty car supply data for this week was not complete for all shippers.

⁷⁴ Cars spotted early (in advance of the planned day) for this analysis reflect actual car spotting records as provided by the railways.

empty cars in advance of the planned day (e.g. weekend spotting). As shown in the table above, if plan fulfillment performance is examined from the perspective of the available supply by the planned day, performance somewhat improves. CN's performance improves to 37-49% whereas CP's performance improves to 79-87% fulfillment for the selected shippers. This data should not be interpreted to mean that all early spotting activities are by agreement of shippers or that the early supply of cars may not be disruptive to grain facility operations. It is rather QGI's intent in providing this measure to recognize that because these agreed changes in railway plans do exist but are not reflected in the data that actual performance levels likely lie between these two extremes.

Merchandise

As was noted earlier, CN and CP differ with respect to their commitments to their merchandise customers for the supply of rail cars. This difference notwithstanding, QGI's methodology assesses the performance of both carriers in meeting customer demand on a daily basis. The performance measure selected for this analysis examines whether or not there were sufficient empty cars available at a customer location to meet car orders for a given day. The number of available empty cars is defined as the number of cars at a customer location at the beginning of each day (starting inventory) plus any cars supplied by the railway on that day. The starting inventory for a day is assumed to be the net difference between empty cars available for loading and cars released for the prior day. The number of days in the period where available cars was equal to or greater than the car orders for the day was calculated. Performance is expressed as the percent of time (number of days for which customers have placed orders) where the available cars met or exceeded 100 / 90 / 75% of customer demand.

Calculating daily availability of cars is complex as it requires very precise information regarding the railway service provided to a customer at a specific location and the operating practices of the customer. The precision in the calculation of available cars on a given day will be influenced by several factors including the time of day a shipper releases loaded cars to the railway and the time of day the railway physically places the cars at the customer location. Without the benefit of customer specific knowledge, QGI's methodology assumes that cars placed on a day are available to the customer for loading that day and that cars released by a shipper are released at the end of the day.

CN

The analysis of daily car performance has been done for three CN customers – one boxcar and one flat car customer in Western Canada and a boxcar customer in Eastern Canada. The analysis includes the period from October 1, 2006 to September 30, 2008 excluding the four week CN strike period in February-March 2007.⁷⁵

The table below summarizes performance for these three shippers.

⁷⁵ Due to data integrity concerns the measurement period for one customer also excluded the period June 1, 2008 – September 30, 2008.

Figure 36 Daily CN merchandise car supply performance

	Shipper 1	Shipper 2	Shipper 3
Order Frequency (Service Review Period)			
Number of days customer ordered cars	446	702	578
Number of days shipper location serviced by RR	433	693	437
Number of cars ordered	8,105	22,054	3,563
Number of cars supplied	7,449	18,210	3,324
Percent of total ordered cars supplied	90%	90%	93%
Daily Order Availability			
Percent of time 100% of ordered cars available on requested day	78%	96%	96%
Percent of time 90% or more of ordered cars available on requested day	81%	98%	96%
Percent of time 75% or more of ordered cars available on requested day	86%	99%	96%

As can be seen in the table above CN supplied cars for 90-93% of all orders submitted by these customers over the course of the measurement period. When examined on a daily basis performance varied somewhat with availability of 100% of ordered cars ranging from 78–96% of the time. As would be expected when the performance threshold was reduced to 90% and 75% of cars ordered performance generally improved.

CP

QGI's ability to examine the performance of CP on this basis was more limited due to data constraints. As was noted earlier in the discussion on the integrity of rail car order and supply data, CP encountered difficulties in providing the requested data including, in some instances, the inability to accurately match orders, supply and releases for individual sample keys. As a result QGI, in applying its quality criteria, eliminated approximately 17% of the data supplied from the analysis. Further challenges were encountered when examining the data at a daily level. As a result, the daily performance analysis for CP is limited to two customers: a flat car customer and a hopper car customer. Additionally the analysis is limited to the period from October 1, 2007 to September 30, 2008. The table below summarizes performance for these two shippers.

Figure 37 Daily CP merchandise car supply performance

	Shipper 1	Shipper 2
Order Frequency (Service Review Period)		
Number of days customer ordered cars	223	178
Number of days shipper location serviced by RR	180	210
Number of cars ordered	739	2,573
Number of cars supplied	552	2,251
Percent of total ordered cars supplied	75%	87%
Daily Order Availability		
Percent of time 100% of ordered cars available on requested day	81%	93%
Percent of time 90% or more of ordered cars available on requested day	81%	93%
Percent of time 75% or more of ordered cars available on requested day	83%	93%

Fulfillment of total customer demand (orders) for the measurement period ranges from 75–87% for the two customers examined although daily performance measured on the basis of empty car availability is somewhat higher.

In summary, for the specific cases examined we can see that daily performance for the merchandise customers for both railways was significantly better than the performance experienced by grain customers. For grain customers precision in daily planned performance ranged from 14-32% and there is no appreciable improvement in performance when the performance standard is lowered from 100% to 75% fulfillment of plan. This level of precision appears to be consistent with the railways' weekly supply commitment.

For the selected merchandise shippers performance for both railways was similar ranging from 78-96% despite the differences in their respective car order processes and the nature of the commitments they make to their customers.

2.2.7 Key Findings

Grain Car Order Analysis

Car Demand

Between 25% and 30% of grain car orders on both railways are subject to adjustment by customers after the cut-off date for orders and prior to the cars being supplied by the railways. While the absolute number of cars affected is much smaller than the number of orders affected, it is still very significant ranging from 11-12% of CP's and 15-17% of CN's total grain cars ordered by shippers. While there was no statistical relationship between overall car order levels and car order cancellation rates, the period of declining overall demand during grain year 2007-2008 did coincide with a period of great volatility in grain order cancellations from week to week, especially during the last half of the grain year when volumes were in decline.

Car Supply

At an aggregate level, the two railways' performance in fulfilling shipper demand for empty grain cars was almost the same with CN fulfilling 98% and CP fulfilling 97% of total orders for the service review period from October 1, 2006 through September 30, 2008. On a week to week basis, however, there was significant variability in performance with each railway providing grain shippers with at least 90% of the cars that they had ordered at a specific location only half the time. Furthermore, as with the transit time performance assessment, both railways' weekly car supply performance deteriorated significantly during the winter of 2007/2008.

Merchandise Car Analysis

Car Demand

Data from CN's Guaranteed Car Order (GCO) process included information on changes to orders between the car order cut-off dates and the time of actual placement. This permitted an analysis of changes that are made to car orders and some discussion of the impact that this can have on car supply processes.

This CN empty car demand analysis showed that 36% of the CN car orders were subject to changes after the cut-off date. The absolute value of the percentage change to car orders for all Merchandise car types was 11% of the cars ordered for the entire service review period. This change resulted in a 5% net increase in orders after the cut-off date and before the order date. The analysis of car order changes by CN customers suggests that the prediction of final demand for empty rail cars is a very dynamic process.⁷⁶ Given the demonstrated variation in demand prediction, railway car distribution staff will face challenges in their ability to satisfy customer car orders while maintaining their focus on asset utilization. Changes in car demand from day to day and week to week will be affected by such factors

⁷⁶ Appendix 2 includes a more detailed analysis of changes to CN car orders after cut-off, across a number of shipper and network characteristics.

as: railway performance in meeting previous demand requirements, final demand changes by the customers' customers, changes in customer operations and upstream logistics and supply processes

Car Supply

On an annual basis, CN has an average annual fulfillment rate of 86% for Merchandise customer car orders and an average annual fulfillment rate of 95% for the car guarantees made under its GCO program. When considered across size of car order, network/shortline/competitive status and province of origin, there is very little variation in the overall car order fulfillment rate for CN customers.⁷⁷

However, as with grain car orders, CN's weekly performance with respect to car supply is much lower with an estimated 68% of Merchandise customers receiving at least 90% of their car orders on a weekly basis. CN's average weekly performance against its car order guarantees under the GCO program is estimated at 81% (at a fulfillment rate of 90% of cars ordered).

CP does not have an electronic process for communicating to customers through its Merchandise products car order system (DELTA) its expected weekly supply of empty rail cars. Furthermore, CP does not track and did not make available to QGI detailed data on changes to car orders over time. Therefore, the analysis of CP's car supply processes does not include an assessment of the volatility of orders. As CP does not have a guaranteed car order program and as its data sample is much smaller than CN's for Merchandise customers, caution should be exercised in any comparison of the CN to CP car supply performance analysis.

CP performance against car orders for all car types averaged 73% for all customers in the CP sample and the median performance was 79%. When assessed against various network and shipper characteristics, the sample data suggest that CP customers located at competitive origins receive somewhat better car supply than customers without access to direct rail competition.⁷⁸ On a weekly basis, an estimated 50% of CP Merchandise customers received at least 90% of the cars that they had ordered for a given week.

Daily Car Supply Performance

While annual fulfillment rates for both grain and merchandise customers that were included in the daily performance analysis were comparable at better than 90%, on a daily fulfillment basis the merchandise customers received significantly better performance than the grain customers. This was true for both CN and CP. Performance for both railways in serving the selected grain customers improved somewhat on a daily basis when performance was examined from the perspective of cars available for loading by the planned day including cars spotted early, as opposed to cars spotted for loading on the planned date. On this basis CP's performance was significantly better as

⁷⁷ The results of this analysis are in Appendix 2 – CN Overall Car Supply Performance.

⁷⁸ This analysis is available in Appendix 2 - CP Overall Car Supply Performance.

they provided their customers with an average of 83% of planned cars - compared to CN who provided an average of 43% of planned cars.

It is important to note that this performance assessment was limited to nine customers and may not be representative of daily performance in general. It is also important to understand that with the exception of CN merchandise customers, who receive guarantees of daily car supply, the railways do not commit to supply either the planned or ordered cars on a specific day notwithstanding the importance shippers place on this level of performance. The railways' ability to achieve precision in daily car spotting performance can be impacted by a range of factors. These include; volatility in week to week demand for cars, and shipper order accuracy – especially when car fleets are under allocation. From a supply perspective the smooth flow of empty cars to meet demand is dependent on the railways maintaining fluidity in their networks and other shippers and receivers loading and unloading cars in shared fleets efficiently to maintain a smooth flow of cars in the system. In addition, the performance of connecting carriers in moving empty equipment back without delay to the originating railway can seriously impact the available supply of rail cars.

3. Transit Time Performance

A key element of railway service is the consistency of the transit time provided to customers. Consistent service may also be termed reliable service. Consistent transit time allows supply chain partners to plan for the movement of the shipments through their supply chains. Unreliable service, as characterized by highly variable transit times, requires shippers and receivers to invest in higher average levels of inventory, storage capacity and product handling capacity than would be needed if transit times were more consistent. Highly variable service also impairs the production planning and marketing activities of railway customers and ultimately affects the competitiveness of Canadian industry.

In addition to the consistency of transit time, the average transit time, which is determined by the speed of rail traffic, is also of importance to shippers. In general, when average transit times are longer, the range of variation of transit times will also be wider than for traffic with higher speed and therefore shorter average transit time.

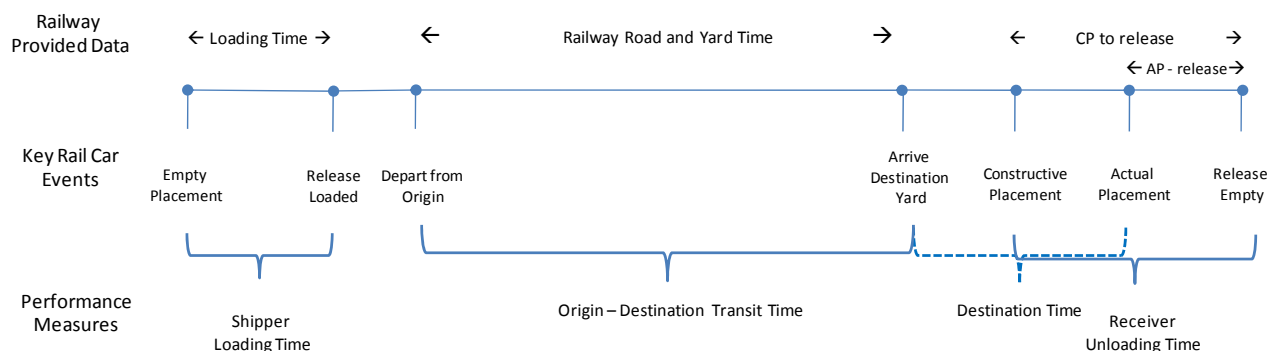
3.1 Approach and Methodology

3.1.1 Elements of Transit Time Performance

The railways provided QGI with transit time data for individual rail car trips identified in the sample. Each data record contained time intervals calculated by the railways for key trip segments at origin, en route, and at destination. These specific time intervals were selected to allow for the assessment of not only railway performance but also the performance of shippers and receivers for loading and unloading activities respectively.

The following graphic summarizes the transit time performance data provided by the railways and the elements of rail car trips that are examined in this report. The graphic demonstrates that both shippers and consignees have critical roles in the overall logistics chain as they control the time spent in loading and unloading of rail cars. As a result, these activities are subject to special analysis in the report.

Figure 38 Railway car events and key performance measures⁷⁹



Two aspects of railway transit time performance are subject to assessment – origin to destination transit time, and time at destination.⁸⁰ For the movement between origin and destination, the railways provided QGI with the total time that each car spent on trains, and the time the car spent in rail yards prior to its arrival at destination. The relative time that an individual car spends moving on trains versus the time spent idle in rail yards depends on a number of factors including; the frequency of scheduled and available train connections between yards, the level of congestion in yards at a specific time, and the availability of train capacity between specific locations. Thus, while the railways provided QGI with both total train time and total yard time for each car, the analysis of transit time does not differentiate between time on trains and time in yards at intermediate locations between origin and destination. In the absence of much more detailed information providing the actual location of delays in specific yards at specific times it was determined that segmenting the analysis into yard time and train time would not provide any useful insight into the performance of the rail logistics system.

For time at destination, there is a mix of accountability for performance between railways and consignees. In situations where cars can be immediately placed at receiver sidings upon arrival, all time between arrival at destination and placement of cars on receiver sidings will be the responsibility of railways. However, many railway receivers require railways to stage rail traffic in railway yards at destination locations until the customers specifically request that cars be placed on their sidings. In these cases, the time at destination will be a mix of railway controlled and customer controlled time. Due to the complexity of this issue, time at destination is examined in a separate section of this report.

⁷⁹ In the graphic illustrated above, the term “Constructive Placement” (CP) refers to situations where rail cars are held on railway property at customers’ convenience awaiting the customers’ instructions on actual physical placement at their facilities.

⁸⁰ Due to data constraints the analysis of intermodal transit time performance examined origin to destination transit time and time at origin intermodal terminal. The railway data provided did not allow QGI to examine the time from arrival at destination railway Intermodal terminals to terminal departure enroute to receivers. Railway provided data also did not include accurate and comprehensive information on the time between when containers were released by customers or picked up by roadway carrier at shipper origins to the time that they were delivered to railway Intermodal terminals. Neither did QGI receive data on the time taken for containers to be delivered from railway Intermodal terminals to receivers.

Although QGI's analysis of railway performance is limited to Canadian originated traffic it includes traffic moving over the networks of both CN and CP that in some instances will originate and or terminate at stations served by other railways. This may include traffic that originates or terminates on the lines of a Canadian short line railway as well as interline forwarded traffic that moves over the networks of CN and CP for interchange to connecting carriers in Canada and the United States. Because CN and CP's involvement in a trip can vary depending on the origin or destination of a car not all time intervals are necessarily applicable for measurement of their performance for all trips. The type of rail car trip determines in some instances how specific time intervals are defined and which time intervals are relevant and appropriate for examination. For example, no railway destination terminal or receiver unloading time is available for analysis for trips where CN and CP do not terminate the traffic. When CN or CP interchange rail cars to other railways, whether short lines or other Class I railways, for movement to final destination the rail car events beyond their own networks are not necessarily available from connecting roads for reporting in CN and CP's information systems.

To allow for the proper grouping of individual records for analysis QGI developed rules to classify each rail car trip into one of six trip types. These rules are based on the classification of railway stations, whether at origin or destination, according to which carrier serves the station. In some instances, where stations were jointly served by both CN and a short line operator, the rules for trip type classification were extended to specific customers at specific rail stations. Using these rules each car trip record was assigned a trip type designation. Figure 39 below provides a definition of the car trip types developed for this analysis.

Figure 39 Trip type definitions for transit time analysis

Trip Type	Definition
Local	Trip that both originates and terminates at stations served by a single carrier (CP or CN)
Interline forwarded	Trip that originates at a station served by CP or CN that is delivered in interchange to a connecting carrier that is not a Canadian short line railway
Short line local	Trip that originates on a Canadian short line railway and terminates at a station served by either CN or CP
Short line interline	Trip that originates on a Canadian short line railway that is interchanged to CN or CP and moved by CN or CP for interchange to a connecting carrier that is not a Canadian short line railway
Short line destination	Trip that originates at a station served by CN or CP and terminates at a station served by a Canadian short line railway
Short line bridge	Trip that originates on a Canadian short line railway that is interchanged to CN or CP and moved by CN or CP to a destination that is served by a different Canadian short line railway

The time intervals provided by CN and CP have been structured to allow for analysis of the performance of shippers, railways, and receivers for those trip segments where each stakeholder is in control of the rail car. For example, at origin the shipper will have control of a rail car from the time the railway places the empty car at the shipper’s facility for loading until the shipper notifies the railway the car is loaded and ready to be picked up. Once released by the shipper the railway assumes control of the rail car at the originating station until the car is placed at the receiver’s facility for unloading or constructively placed by the railway at the destination terminal. Once the car is placed at the receiver’s facility the receiver remains in control of the car until such time as the railway is notified the car is empty and available to be picked up.

The type of trip and the data available determine which time intervals are appropriate for measurement. The availability of meaningful time interval data in some instances is affected by the reporting practices of CN and CP as well as their interchange partners. For example, not all short lines have implemented the required information systems to allow for the reporting of individual car events and the sharing of car event data with their railway partners. In many instances short line railways in Canada do not electronically report the car events associated with the movement of a rail car from the time it is received in interchange from CN or CP until it is returned to the interchange. In such cases the specific time associated with loading or unloading at the customer facility while on the short line cannot be identified and therefore cannot be measured.

Figure 40 below provides definitions for the basic time intervals included in the transit time data. A more detailed definition and association of specific intervals by trip type is provided in Appendix 3.

Figure 40 Railway supplied transit time intervals

Trip Segment	Time Interval	Definition
Origin	Empty placement to loaded release	<ul style="list-style-type: none"> For trips originating at CN or CP served stations the time from the placement of the empty car at the shipper’s location to the release of the loaded car by the shipper back to the railway
	Offline loading time	<ul style="list-style-type: none"> For short line originated trips the time from CN / CP delivery of the empty car to the short line at the interchange to receipt in interchange by CN / CP of the loaded car from the short line
	Loaded release to depart on train	<ul style="list-style-type: none"> For trips originating at CN or CP served stations the time from the release of the loaded car by the shipper to the railway to the departure of the car on the first train For short line originated trips the time from the receipt of the loaded car in interchange by CN / CP to the departure of the car from the interchange
On-line	Railway on-line road time	<ul style="list-style-type: none"> The elapsed time from a loaded rail car’s departure on the first train at origin to arrival at the destination station excluding intermediate yard time

		<ul style="list-style-type: none"> For trips interchanged to connecting carriers at destination including trips destined to Canadian short lines and other carriers the elapsed time from a loaded rail car's departure on the first train at origin to delivery at the interchange
	Railway on-line yard time	<ul style="list-style-type: none"> The sum of elapsed times for all intermediate yards between the origin and destination stations as measured by arrival at intermediate station to departure from intermediate station
Destination	Arrive destination yard to constructive placement	<ul style="list-style-type: none"> The elapsed time from arrival at the destination station to the placement of the rail car in constructive placement status by the railway
	Constructive placement to actual placement	<ul style="list-style-type: none"> The elapsed time from the placement of car in constructive placement status to the actual placement of the loaded car at the receiver location for unloading
	Arrive destination yard to actual placement	<ul style="list-style-type: none"> The elapsed time from arrival at the destination station to the actual placement of the loaded car at the receiver location for unloading
	Actual placement to release empty	<ul style="list-style-type: none"> The elapsed time from the actual placement of a loaded car at the receiver location for unloading to the release of empty car by receiver back to the railway
	Offline unloading time	<ul style="list-style-type: none"> The elapsed time from the delivery of a loaded car to a Canadian short line railway by CN / CP at the interchange to the receipt of the empty car at the interchange by CN / CP

3.1.2 Performance Measurement Framework

A key element of railway service is the time taken by railways to move shipments from origin to the destination. This transit time has two key elements. Firstly, the typical, average or planned time those railways take to move the traffic. Secondly, but no less important is the range of variability of transit time – or the consistency of the transit time provided. Consistent service is often viewed and termed by shippers as 'reliable service'. Consistent transit time allows supply chain partners to plan for the movement of the shipments through their supply chains. The degree of variation of transit time performance for an individual shipper's traffic is therefore a measure of the reliability of railway service. As noted earlier, unreliable service, as characterized by highly variable transit times, requires shippers and receivers to invest in higher average levels of inventory, storage capacity and product handling capacity than would be needed if transit times were more consistent and also impairs the production planning and marketing activities of railway customers.

Some level of variability of transit time is expected by railway customers and certainly both absolute transit time and transit consistency require investment in railway capacity and operations. The expected average transit time and the degree of variation of this time (reliability or consistency) are matters that shippers can negotiate with their railway

partners. Therefore, this report does not seek to define an absolute level of reliability that railways should be expected to achieve. This report will provide a clear illustration of the levels of reliability that were being provided to shippers during the study review period. During the course of the analysis, QGI had occasion to contact the railways to seek explanations for instances of significant variation in performance and to ask the railways to provide insight into the conditions surrounding such instances. Where these are relevant, such explanations are included in this report. However, this report relies primarily on the statistical analysis itself to provide insight into the conditions and time periods that led to major variations in performance. ***While both railways showed evidence of variation in performance across time, shipper and network characteristics, it was not the purpose of this analysis to engage in a detailed review of any particular perceived service problem but to provide a thorough and transparent analysis of the current state of freight railway service in Canada.***

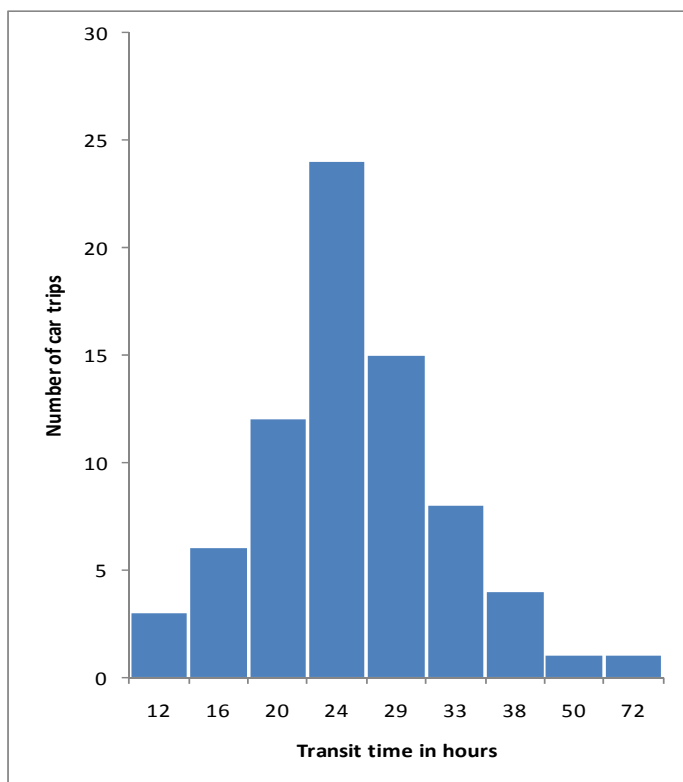
The report will also provide insight into the impact of shipper and receiver activities of loading and unloading railcars on the performance of the rail logistics system as a whole.

Analytical Methods

The key variables that will be used to describe railway performance are average or typical transit time for shippers and shipments of varying types, and transit time consistency.

Transit Time Consistency

Figure 41 Average versus Median measures of central tendency



Number of car trips	Transit time In hours	Average transit time (Arithmetic Mean)	Median transit time
3	12	25.96 hours	24 hours
6	16		
12	20		
24	24		
15	29		
8	33		
4	38		
1	50		
1	72		

Measuring transit time consistency is made more effective through the use of somewhat complex measures of variation of performance. Measurements of variation in performance usually are made with reference to the difference between an individual observation and the average of all similar observations – for example the height of a particular person, versus the average height of all

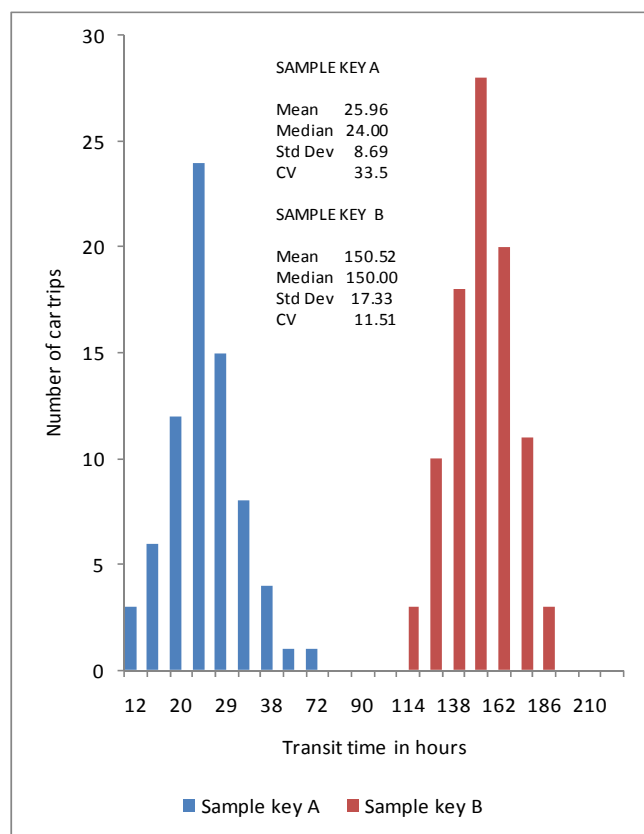
people living in a particular place. In addition, the combined variation of all observations as compared to the average performance can also be described statistically. The key measures of performance of transit consistency that will be used in this report are: average transit time, median transit time, standard deviation of transit time, and the coefficient of variation of transit time.⁸¹

In the example shown in Figure 41 above and its accompanying table of a theoretical movement of traffic between a single origin and a single destination, the average (arithmetic mean) transit time is 25.96 hours. However, the median transit time is somewhat less at 24 hours. The median of any distribution of observations is the value for which half of

⁸¹ The calculation of all means, medians, standard deviations and coefficients of variation in this analysis is made for each sample key, for each service review year. Service review year 1 is from October 1 2006 to September 30 2007. Service review year 2 is from October 1, 2007 to September 30, 2008.

the observations are larger and half the observations are smaller. In a distribution like the one that is illustrated by the frequency distribution chart (histogram) above, the population of car trips has more observations to the right of the middle of the distribution. In cases like this, the mean (average) value will be greater than the median value. Both mean and median values will be used in our analysis. To measure the dispersion of the population around the mean, the standard deviation and the coefficient of variation of the population are calculated.

In the example below, an additional population of car trips is added to the histogram. For both populations, the mean and median values are displayed, as well as the standard deviations and the coefficients of variation. The population



standard deviation⁸² (Std Dev) is an absolute measure of the dispersion of the values in a population. It is useful for comparison purposes between populations only when the populations have very similar means. The standard deviation is the square root of the average of the squared differences between the individual observations in a population and the mean of that population. The standard deviation can also be thought of as the “typical” variation of a random observation from the mean value of the population. The formula for the calculation of a standard deviation σ is:

Population Standard Deviation

$$\sigma = \sqrt{\frac{\sum(x-\mu)^2}{N}}$$

Where x = an observed value
 μ = the population mean
 N = the number of elements of the population

For our analysis, we will use the measure of coefficient of variation which simply expresses the standard deviation as a percentage of the mean of a population.

$$\begin{aligned} \text{Coefficient of Variation} &= (\text{Standard Deviation} \div \text{Population Mean}) * 100 \\ &= \left(\frac{\sigma}{\mu}\right) * 100 \end{aligned}$$

⁸² Population standard deviation is customarily abbreviated by the Greek letter σ . In our report we will use the abbreviation Std Dev for the benefit of non-statistics oriented readers.

The coefficient of variation (CV) allows the direct comparison of the dispersion of values (in our case transit times) between populations where the average performance is very different. For example, in the histogram above the first sample key had a mean of 25.96 and a standard deviation of 8.69 resulting in a coefficient of variation of 33.5%. In other words, the standard deviation was 33.5% of the mean value. In the second flow, while the standard deviation is much higher at 17.33, when expressed as a percentage of the mean (coefficient of variation) it is only 11.51%. The lower CV indicates that Sample Key B has lower average variation and therefore shows a greater consistency of transit time, as is also indicated by the histogram having more of the trips clustered towards the centre of the distribution. In our analysis, a smaller relative dispersion of performance values around the average transit time for a flow will reflect better performance for that flow relative to flows with larger dispersions of performance. Thus, the lower the CV for a sample key, the better the transit time consistency.

Our analysis will use both tabular and graphical presentation of data to display railway transit time performance and it will also provide a set of representative transit time histograms in Appendix 4 so that readers can see directly the variation in performance that is experienced by railway customers.

z score

In addition to the population performance characteristics described above, we will use a statistical approach that will allow for the measurement of each rail car that was moved in each of the sample keys analysed for this report. It is referred to as a “z score” statistic and it measures the performance of an individual car relative to the average performance for all other cars in a sample key. The performance score is expressed in terms of the number of standard deviations that an individual car’s transit time was from the mean transit time. For example, in a sample key where the average transit time is 50 hours and the standard deviation for all cars in the key is 12.5 hours - a car that has a transit time of 62.5 hours will have a z score of 1.0 as its performance was exactly 1 standard deviation higher than the mean. A z score can also have a negative value, for example if in the example above a car had a transit time of 37.5 hours it would have a z score of -1.0.

The z score is useful in the analysis of transit time because it allows the examination of individual cars relative to average performance and also allows us to look at the performance of all of a railway’s traffic over time to identify situations where performance is generally above or below average performance. The formula for calculation of a z score is:

$$z = ((\text{observed value} - \text{population mean}) \div \text{standard deviation}) = \frac{x - \mu}{\sigma}$$

Speed

For the purposes of assessing railway performance, the measure of transit time is calculated from the time a car departs from its origin station until the time it arrives at its destination station. This includes all time spent on trains

and in rail yards between origin and destination. It does not include the time taken by the railway to place the car at the receiver's siding after arrival at destination. As noted earlier, performance at destination is assessed separately in a later section of the report.⁸³ The transit time for an individual car trip is determined by the length of haul and the speed of movement of the car between origin and destination. This overall speed is a function of the time that a car spends in rail yards and the time spent on trains and the speed of movement of those trains. *Speed is a critical element of transit time analysis as the range of transit times achieved by a railway will be determined by both the average speed of the traffic and the level of transit time consistency for a particular origin – destination pair.*

In this report, the measure of speed for each sample key is calculated for each car trip by dividing the length of a trip in miles⁸⁴ by the transit time in hours. This provides the average speed in miles per hour (MPH) of the car during the trip. For a single traffic flow (sample key) the average speed for the sample key was calculated for each year in the study review period by taking the total miles travelled by all cars divided by the sum of transit time for all cars for each key. These average speeds were then used to calculate the transit time ranges that are illustrated in this report, as described below.

Transit Time Ranges

For each of the characteristics of railway networks and railway shippers for which service is assessed in this report, typical ranges of transit time performance have been calculated. These performance ranges are used to illustrate directly the actual service levels that are experienced by typical railway shippers. Thus, for each shipper or railway characteristic, a typical range of transit times that represent an estimated 75% of the shipments in that grouping is calculated and displayed in both tables and graphs. It is important to note that these illustrations of railway performance are meant to represent the service that will be experienced by "typical" customers. The individual samples of shippers that were analysed for this report are made up of very different customers whose actual service levels are higher and lower than the averages and who have varying lengths of haul. However, by creating ranges of performance for typical customers the report clearly demonstrates the range of performance that is actually experienced – without readers having to reference the underlying statistical measures in order to understand performance.

The calculations of the ranges of transit time for 75% of car trips use the following logic:

- Statistical theory dictates that in a normal distribution (the commonly referenced bell shaped curve) 75% of values will be found within 1.15 standard deviations of the mean of a population
- For each characteristic, the typical transit time is calculated using the average length of haul and average speed for that characteristic from the data provided using the following methodology:

⁸³ Time at destination is assessed separately from transit time as the time taken for delivery of a car from the destination station to a receiver's siding may include times that are under the control of railways, and time that is under the control of receivers.

⁸⁴ Miles (as opposed to kilometers) are the common unit of distance measurement for Canadian railways. All distance measurements provided to QGI by CN and CP were in miles and this report therefore uses miles rather than kilometers.

- As we have calculated the variability of performance by calculating the coefficient of variation of transit time we can infer the standard deviation, and range of transit times for this average or “typical” service level.
- For example – if the actual average length of haul for a group of customers and actual average speed are 750 miles and 10 mph respectively – the typical transit time will be $750/10 = 75$ hours.
 - If CV = 25 then standard deviation for the typical flow = $.25 * 75 = 18.75$
 - The range of transit times that will cover 75% of the traffic is therefore

$$75 \pm (1.15 * 18.75) = 56.25 - 93.75 \text{ hours}$$

3.1.3 Detailed Data Validation

Time Interval Integrity

QGI developed programming logic to assess the quality of all time intervals submitted by the railways as well as additional time intervals and metrics – e.g. transit speed – calculated by QGI using the railway supplied data. In addition to identifying what percentage of the data was usable for the analysis it also provided a way to identify the specific records for each time interval to be included in the calculation of the statistical values used for the performance analysis. The data was screened to identify whether or not a time interval should be present for a given trip type and then checked to ensure the interval value was valid.⁸⁵ As noted earlier because of the different types of rail movements not all time intervals are relevant or appropriate for all trip types. These tests were applied to all car trips for which data was provided. For Intermodal traffic eight separate intervals were tested while for carload traffic thirteen intervals were tested.⁸⁶ In total QGI tested the quality of approximately 9.5 million time interval values.

In addition to the data screening that was described earlier, all railway transit time data was reviewed with the intention of removing data that reflected inaccurate reporting, or extreme and unusual values that were not representative of normal variation in performance and may provide misleading results. After examination of the data it was determined that all trips where average line speed exceeded 50 MPH should be removed. This resulted in the removal of 2319 or 0.3% of the total car trips. In addition, to exclude extreme outliers from the analysis, trips with transit time z scores greater than ± 3.0 were also removed from the analysis. This resulted in the removal of 12,242 trips or a further 1.4% of the cars.

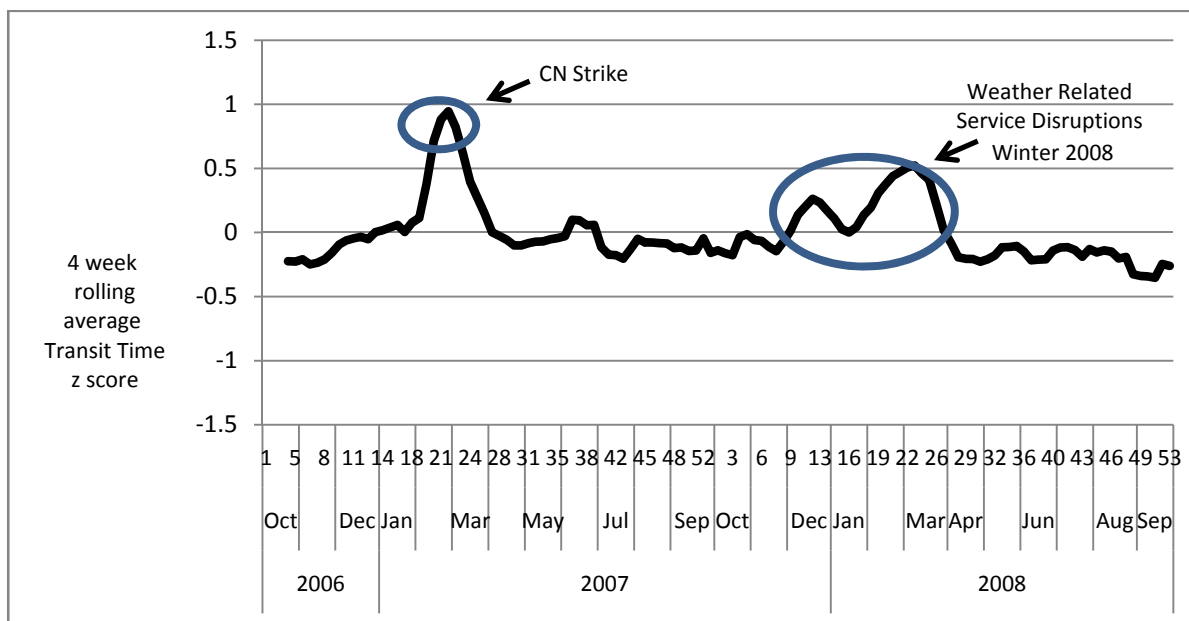
In addition to removing extreme or unusual values, the data was examined to determine if there were special periods during the study review period when exceptional events or disruptions may have occurred. In order to do this, the weekly average of all transit time z scores was calculated for each railway for the entire review period. By averaging

⁸⁵ At this stage of screening, an interval value was considered valid if it was a non-negative number. Negative values in an interval indicated an error in railway reporting of a car event.

⁸⁶ The structure of the data for carload and intermodal trips was different. Fewer time intervals were available for intermodal trips resulting from both the characteristics of the business and availability of data.

all transit time z scores in each week, this permitted the identification of periods when a high proportion of traffic was experiencing particularly poor performance (as reflected by a high average z score).

Figure 42 Average Transit Time z scores: CN traffic



In the case of CN traffic it was noted that significant disruptions were experienced during the CN strike in early 2007 and then again during the period from December 2007 to March 2008, as shown in Figure 42 above. The CN strike in 2007 clearly caused severe disruption to rail service on CN as illustrated by the very high average transit time z scores. As the analysis would not benefit in any way from having traffic moving during this period included in the analysis of transit time performance, all data on traffic originating during the strike period were excluded from this study⁸⁷

QGI provided information to CN that summarized their performance by sample key during identified service disruption periods. CN was asked to investigate their performance during periods of service disruption in 2007 from November 25 – December 22; and then again in early 2008 between February 3 – March 8. CN’s investigation determined that disruption to traffic flows during both periods resulted from adverse weather conditions which caused generalized slowdowns in transit performance and also resulted in mainline disruptions due to slides. These disruptions included:

⁸⁷ The period for which data was excluded was Feb. 4 through March 3 2007 (service review weeks 19-22 of service review year 1). Traffic moving during this five week period of winter weather would be expected to have slightly higher average transit times than would be experienced at other times of the year. While CP’s average velocity and consistency of transit time were only slightly higher than their annual averages for all traffic during this period, CP’s traffic moving during the CN strike was excluded from analysis to ensure that both railways were treated equally in the study.

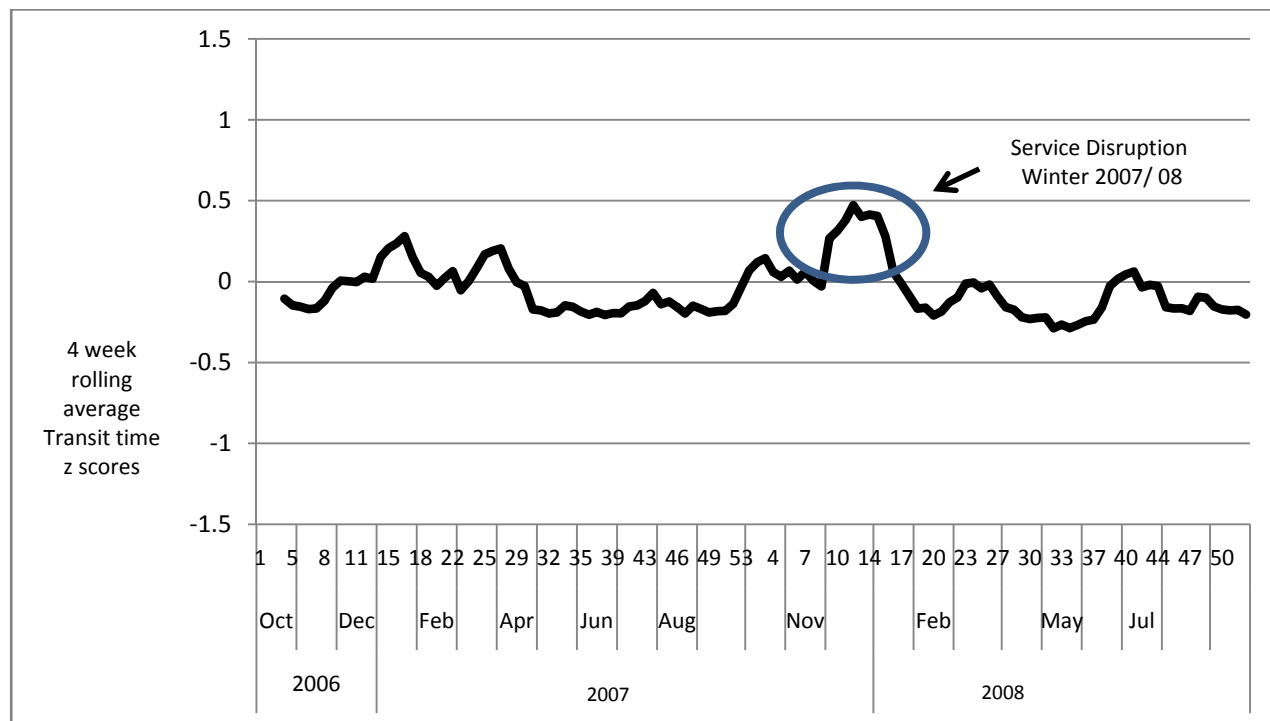
- December 3, 2007 Six snow slides blocked mainlines in BC west of Kamloops and blocked the Squamish subdivision south of Lillooet, BC.
- December 4, 2007 Rock slide on mainline west of Kamloops blocked traffic for additional 5 hours after snow slides had been cleared.
- December 19, 2007 Rock slide on CP's Cascade subdivision in British Columbia over which CN and CP traffic moves as part of a CN-CP coproduction agreement.
- January 2008 Extreme cold weather conditions across the Prairies resulted in CN reducing service and implementing train length restrictions. These restrictions were in place from the third week of January until the first week of February 2008.

CN's review of service during this period also included an assessment of temperature and precipitation events during these weeks. Their review showed that centres in BC, AB, MB, ON and NS all experienced severe winter weather during this period and these conditions were in many cases more severe than would be experienced in an average winter period in Canada.⁸⁸

However, while these conditions were severe, they were not unique or outside the range of reasonable probability for Canada. In addition, as these conditions would be expected to affect both railways more or less equally, the data for performance during this period was included in this study. While CP's traffic experienced longer than normal transit times in December 2007 as seen in Figure 43 below, the CP customers in the sample study did not experience the type of disruption to service that CN customers experienced in February and March of 2008.

⁸⁸ CN's response to QGI included detailed weather data compiled from Environment Canada sources. In addition, CN provided copies and summaries of their customer service bulletins that were provided to CN customers during these disruption periods.

Figure 43 Average Transit Time z scores: CP traffic



The graph above shows the average performance of traffic on the CP system as measured by average transit time z score for all sample traffic moving over the twenty four month review period. CP Rail was provided with data that summarized their performance by sample key and asked if they could explain the apparent disruption to service evident in December 2007. CP’s response did not deal directly with operating exceptions experienced in December of 2007; however they provided data that reinforced the assertions made by CN that the winter of 2007/2008 was particularly severe. They listed four major line outages on their transcontinental mainlines between January and March of 2008 that lasted from 30 to 75 hours. In addition, the CN data provided evidence of weather events in December of that year that would reasonably be expected to account for the disruption to service observed in the CP data.

Data Integrity Summary

After screening data for logical values, extreme values and unusual or one-time events (CN strike), some 96% of the records provided by CN, and 79% by CP were available for use in this analysis. The following table provides a detailed breakdown by business unit of the data that was available for analysis of transit time performance.

Figure 44 Percent of railway data records valid for transit time analysis (car trips)⁸⁹

<u>CN</u>	<u>Automotive</u>	<u>Bulk</u>	<u>Fertilizers</u>	<u>Grain</u>	<u>Intermodal</u>	<u>Merchandise</u>	<u>Total</u>
% Data Provided	88%	99%	92%	94%	64%	82%	77%
% Records Available for Analysis	95%	96%	95%	96%	96%	95%	96%
<u>CP</u>	<u>Automotive</u>	<u>Bulk</u>	<u>Fertilizers</u>	<u>Grain</u>	<u>Intermodal</u>	<u>Merchandise</u>	<u>Total</u>
% Data Provided	109%	98%	104%	98%	91%	102%	96%
% Records Available for Analysis	87%	92%	91%	91%	62%	82%	79%

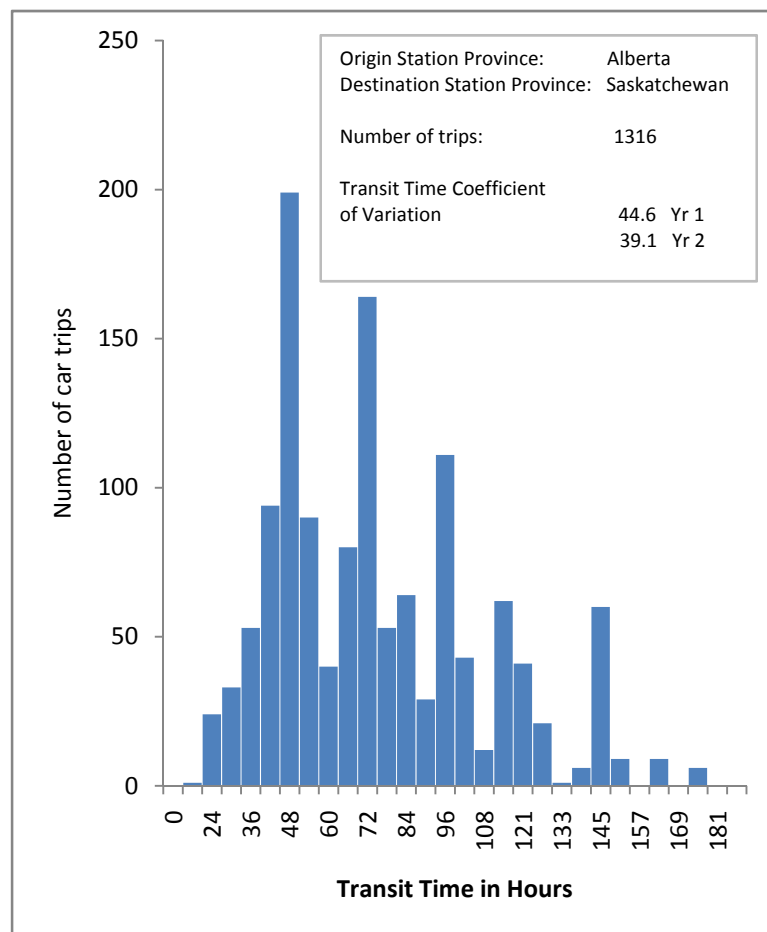
As noted earlier, the details of the data acquisition and screening process are described in more detail in Appendix 1.

⁸⁹ Percentage of data provided by railways calculated based on reference year 2007. Quality of individual time intervals based on full 24 month service review period.

3.2 Railway Transit Time Performance

3.2.1 Planned versus Unplanned Variation in Transit Time

Figure 45 Sample histogram data



Based on the project team’s experience in railway planning and operations, a special review was conducted of the impact on overall performance of the day of the week on which a rail car was shipped.

Various summary statistics and cross-tabulations of the data were reviewed to identify major trends or characteristics of transit time performance. In addition, histograms of representative flows chosen from each of the major commodity groupings for each railway were reviewed. Upon inspection of the data, it was apparent that some flows displayed distributions of transit time that had non-continuous or multi-modal (multiple peaks or concentrations of values) characteristics. The histogram in Figure 45 represents data from an actual CN flow of rail traffic between Alberta and Saskatchewan

over the study period. The multiple peaks separated on the histogram suggest that there may be a variety of levels of transit time performance that were provided by the carrier and the team speculated that one reason for the data to display this very distinctive type of pattern may be that the carrier offered different service levels by day of the week.

In order to determine how prevalent it was that service might vary by day of the week QGI used the transit calculator on CN’s web site⁹⁰ to request transit standards by shipping day of the week for 12 origin/destination/commodity combinations that corresponded to 12 of the sample keys provided to QGI by CN. CN’s web-based system provided transit standards for 8 of the 12 keys. Transit standards for these 8 randomly selected flows varied widely by day of the week. The minimum transit standard across these eight flows was 64 hours and the maximum was 268 hours and the length of haul varied from less than 100 to over 1500 miles. The maximum range of planned transit hours across

⁹⁰ CN’s Transit Calculator allows users to enter an origin, destination and product to be shipped by intermodal or carload services. The system then returns the expected transit time by day of the week, including information about cut-off times and expected delivery times at destination.

the different days of the week for an individual flow was 96 hours and the minimum was 0 hours with the average for the eight flows being 48 hours.

It is important in the transit time analysis to differentiate where possible planned variation in transit time from unplanned variation in transit time. When railways have different service design plans and therefore different transit standards for different days of the week – this is planned variation. Planned variation may be accommodated by shippers and receivers and incorporated in their own logistics planning. It is the degree of performance variation around a given transit standard – in other words unplanned variation – that has the potential to create difficulty for both railways and their customers.

In order to determine the degree to which service performance varied primarily due to the day of the week on which it was shipped, 40 sample keys were selected from the data for further analysis using a statistical technique known as “analysis of variance” (ANOVA). This technique provides an analysis of the degree to which differences in performance amongst groups within a population are due to the variation within the sub-groups as compared to the variation across the total population. In our case, the purpose of this analysis was to determine what proportion of variation in transit time performance is due to variation in performance across all days of the week as opposed to variation in performance for cars shipped on individual days of the week.⁹¹ The number of keys selected for analysis in each group was approximately proportional to the number of keys in the sample data being used for transit time analysis. The keys selected had the following general characteristics.

Figure 46 Sample keys selected for Analysis of Variance – day of the week analysis

Major Commodity Group	CN	CP	Total
Automotive	1	1	2
Bulk	1	1	2
Fertilizers	2	1	3
Grain	4	2	6
Intermodal	4	4	8
Merchandise	12	6	18
Total	24	15	39

Of the keys selected, one key had data for traffic shipped on a single day of the week so it was excluded from analysis. The summary of the analysis of the remaining keys is displayed in the following table.

⁹¹ The ANOVA calculations were done using Microsoft Excel’s one way ANOVA formula.

Figure 47 Results of ANOVA tests for day of the week variability

Number of keys	Percentage Variation in Transit Time due to Shipping Day of the Week	Percentage Variation In Transit Time due to Other Factors
17	1% – 5%	95% - 99%
10	6% - 10%	90% - 94%
11	11% - 30%	70% - 89%

This analysis suggested that variation due to the day of the week on which a car is shipped can be significant but that the impact of the shipping day of the week varies widely across the sample keys.

As the day of the week on which traffic is shipped can affect overall variance in performance due in part to the railways having different service plans for traffic by day of the week, it was decided that the key measure of transit time consistency – coefficient of variation of transit time - should be adjusted to reflect this possibility.

If railway service planning has day of the week differences, then ideally the performance variation around each of these daily service standards should be subject to measurement. This could be done by calculating mean performance on a daily basis for each flow and calculating the standard deviation and coefficient of variation on a daily basis. However, dividing each flow up into as many as 7 daily flows would reduce the average flow size and increase the number of very small flows in the sample. As will be noted in the next section of the report, measuring variation in performance for very small populations is problematic as there may not be sufficient observations to provide statistically meaningful calculations of means, and measures of variation such as standard deviation and coefficient of variance.

Therefore, for the larger flows of greater than 500 cars in a service review year, the measure of transit time variability – coefficient of variation – was adjusted to reflect day of the week performance. This was done by recalculating the statistics of mean, standard deviation and coefficient of variation for each sample key by day of the week, for each year in the study review period. A weighted average of the coefficients of variation for each key across all days of the week was calculated. This weighted average of the coefficients of variation for a sample key across all days of the week is used as the primary measure of transit time consistency for flows of 500 cars or more per year.⁹² For smaller flows of less than 500 cars per year, the coefficient of variation was not weighted across the days of the week as this would have created many very small flows and would have led to misleading results when evaluating the performance of these flows.

⁹² The formula for calculating the weighted average CV of transit time used the percentage of cars or intermodal containers shipped on each day of the week for each sample key in each year, to determine the weighted average. In the rest of the report, when reference is made to coefficient of variation of transit time, the weighted average number for each flow is the statistic that is used in the calculation for flows over 500 cars.

3.3 Performance by Railway, Shipper and Network Characteristics

The following sections of the report provide a summary of the analysis of transit time performance across all the required characteristics of the railway and shipper population as outlined in the RFP for the project. For the analysis of each cross tabulation in the report, tables are included in Appendix 5 which display the count of sample keys that were found. Where less than 5 sample keys were present in a cross tabulation, the data is not shown in the report in order to protect railway shipper confidentiality. In addition, samples of less than five sample keys may not be generalizable to the overall population and would be suppressed for this reason as well, even if issues of shipper confidentiality were not of concern. In all cases where data is suppressed for these reasons, the data is however included in the calculation of column and row totals as appropriate. Appendix 5 also contains more detailed performance data across the major commodity groups for each railway for each of the shipper and network characteristics discussed below.

Caution must be used when drawing conclusions from the results of the cross-tabulations of performance. When looking at performance for a given characteristic of traffic – for example Major Commodity Group by Flow Size – it is not appropriate to conclude that the characteristic itself is the cause of variations in performance. Other differences in the population or sample can result in differences in performance besides the characteristic being analysed. The mix of traffic in a particular cross tabulation of the sample can strongly influence the reported performance. Only in cases where the cross tabulations are sufficiently large and the nature of the traffic in the groups being compared for a given characteristic are similar is it appropriate to infer that performance may be related to the presence or absence of a given factor. Even when aggregated to a high level, the most that can be inferred with certainty from the data is that performance differs across certain characteristics – not that the differences in performance are caused by the characteristics.

Average transit time and the range of variance of transit time were assessed for all sample keys and across a number of characteristics of the railway and shipper populations as required by the terms of reference for this project. The following sections of the report discuss transit time consistency across each of these characteristics and identify where there are material differences across these characteristics. Flows with less than 30 cars in a service review year are not included in the calculation of performance of coefficient of variation of transit time. This was done to ensure that these calculations were not unduly affected by flows which did not have sufficient traffic to calculate meaningful performance statistics for the flow. For example, if a flow of 30 cars was made up of three blocks of 10 cars each that moved together, there would only be three effective transit time observations.

This report provides analysis of each railway's performance in a number of areas. However, care must be exercised when making any comparisons between the railways' performance. While the railways compete directly with each other for many railway customers' business, the mix of traffic that is handled by each railway is somewhat different.

In addition, there are differences in the geographic reach and in the terrain characteristics of the railways' networks. These customer and network differences can affect railway performance and make direct comparisons between railways difficult. For example, the following table shows the breakdown of carloads handled by each railway by commodity grouping.⁹³

Business Unit	2008 Carloads (000s)		Percent Carloads	
	CP	CN	CP	CN
Grain & Fertilizers	573	579	21%	13%
Coal	281	375	11 %	8%
Forest Products	92	511	3 %	11%
Industrial Products	341	1,572	13 %	34%
Intermodal	1,216	1,377	46 %	30%
Automotive	141	201	5 %	4%
Total	2,645	4,615		

While the Grain, Intermodal and Automotive business volume for both railways is very similar, there are large differences in the volume of Industrial and Forest Products with these two groupings accounting for most of the difference in overall volume between CN and CP. This large base of mixed carload traffic provides CN with advantages in maintaining the frequency of train movement of carload traffic in certain corridors and this

increased frequency of trainload volume availability can affect CP's ability to maintain the same levels of service as CN for mixed carload freight as CN may have sufficient volumes for more frequent train services in certain corridors than CP.

⁹³ Data derived from *Description of Canada's Rail Based Freight Logistics System*: Prepared for: Rail Freight Service Review. QGI Consulting. 2009
 Note that in this table, the precise mix of traffic in commodity classification may differ for each railway. For example, CP dry fertilizer traffic is classified within the Grain and Fertilizers group however for CN this traffic is grouped with Industrial Products. In addition, this data includes all traffic handled by both railways including their US originated traffic.

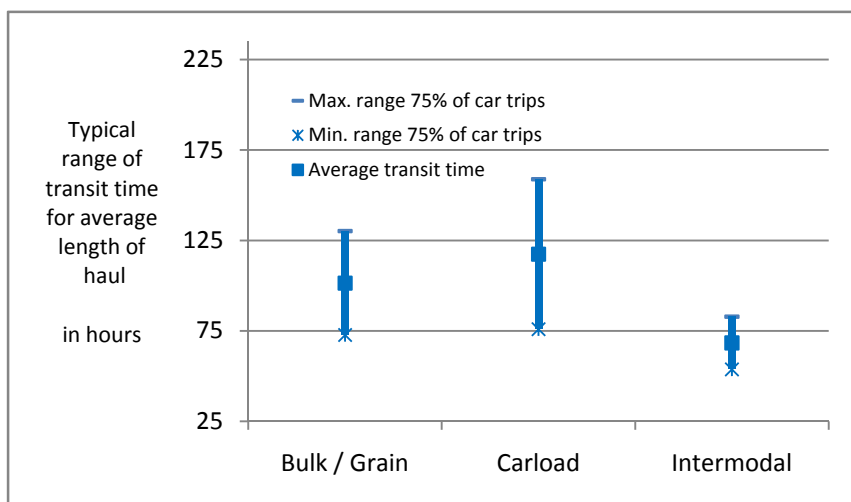
3.3.1 Canadian National Transit Time Performance

Performance by Shipper Characteristics

Performance by Commodity Group

Figure 48 CN Performance by Commodity Group

	Bulk / Grain	Carload	Intermodal
Average LOH - miles	1030	1078	1635
Typical Transit Time - hours	101	117	68
Average CV of transit time	24.6	30.7	18.5
Typical range of transit times - hours	57	83	29
Maximum in range – hours	130	159	83
Minimum in range - hours	73	76	54
Percentage of traffic ⁹⁴	17%	39%	44%



At a summary level, as is shown by in Figure 48, transit time consistency varies widely between the Intermodal, bulk/grain and carload groups.⁹⁵ As might be expected, as seen in the graph adjacent, average transit time is lower and the range of transit times is narrower for Intermodal than for either of the other two commodity groupings. This is a function of the higher average speed of Intermodal traffic and due to the difference in the measurement of transit time for Intermodal versus other traffic. Intermodal traffic is measured from the time it departs from a railway intermodal terminal, rather than from

a customer’s facility. Therefore, the time taken for a customer to move a container from their facility and through a railway origin terminal is not included in Intermodal data while the corresponding time for a railway to move a shipper’s car from the shipper’s siding and through their originating terminal is included.⁹⁶ As average speed through railway terminals is expected to be lower than average speed when trains are moving on mainlines, this gives some immediate measurement advantages to Intermodal traffic.

⁹⁴ These percentage calculations indicate the proportion of carload and/or intermodal traffic that moved in calendar year 2007 for each railway. Calendar year 2007 was the reference year used for the selection of the sample traffic that was provided by the railways for this study.

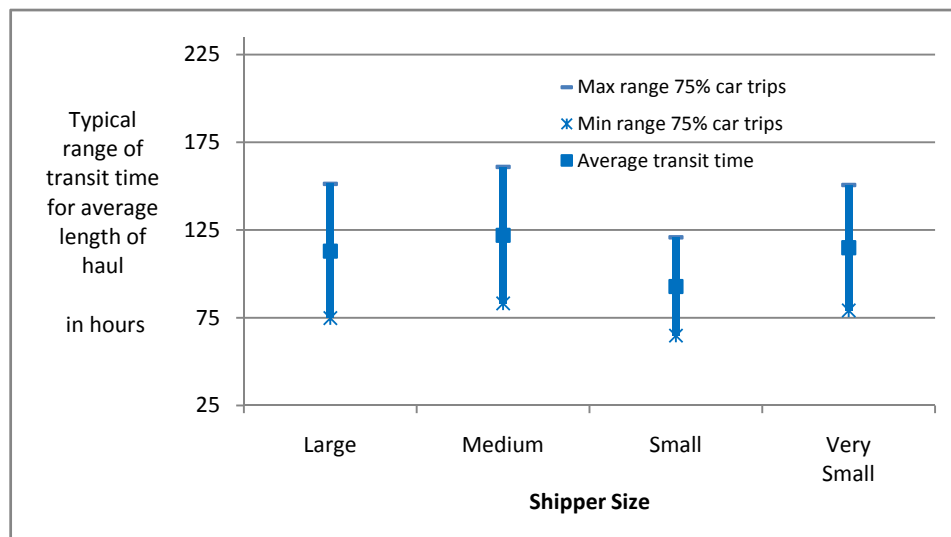
⁹⁵ Carload traffic included all merchandise, automotive and fertilizer traffic.

⁹⁶ For non-Intermodal traffic, transit time for customers originating on shortlines is calculated from the time the car is received in interchange by CN or CP, from the shortline railway.

Performance by Shipper Size

Figure 49 CN Non-Intermodal Performance by Shipper Size Traffic⁹⁷

	Large	Medium	Small	Very Small	All
Average LOH - miles	1064	1066	1091	924	1063
Typical Transit Time - hours	113	122	93	115	112
Average CV of transit time	29.4	27.7	26.2	27.1	28.8
Typical range of transit times - hours	77	78	56	72	74
Maximum in range – hours	151	161	121	151	149
Minimum in range - hours	75	83	65	79	75
Percentage of traffic	78%	15%	5%	2%	100%



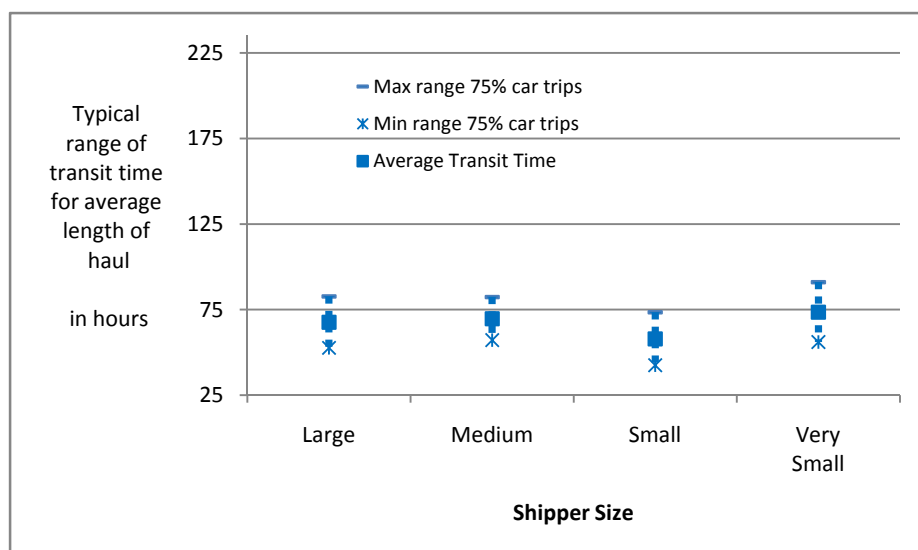
For CN non-Intermodal traffic there is no clear pattern of differentiation of performance by shipper size. This is consistent with CN’s stated intention of planning their services to provide the best average performance for all shippers regardless of shipper or shipment characteristics. While the transit time range for “small” shippers is somewhat lower than for the other three groups, this is likely due to specific characteristics of the mix of customers in this sample group rather than

representing any trend relating to size of customer.

⁹⁷ Shipper size was defined according to the number of cars and intermodal units that a shipper moved on each railway in Calendar year 2007. Large - > 5000; Medium 1001 – 5000; Small 301 – 1000; Very Small < 301.

Figure 50 CN Intermodal Performance by Shipper Size⁹⁸

	Large	Medium	Small	Very Small	All
Average LOH - miles	1566	1827	1313	1673	1635
Typical Transit Time - hours	68	70	58	73	68
Average CV of transit time	19.3	15.7	23.2	20.7	18.5
Typical range of transit times - hours	30	25	31	35	29
Maximum in range – hours	83	82	73	91	83
Minimum in range - hours	53	57	42	56	54
Percentage of traffic	87%	9%	2%	2%	100%



The same pattern, whereby there is little differentiation in service levels by customer size, is observed in the graph showing the average range of transit times by size of CN Intermodal shippers. In addition, the absolute range of typical transit times is much narrower for Intermodal customers than for non-Intermodal customers. This more consistent performance and lower average transit times are achieved for lengths of haul for Intermodal traffic that are on average 54% longer than non-Intermodal hauls. As noted earlier, a portion of the shorter average transit times of

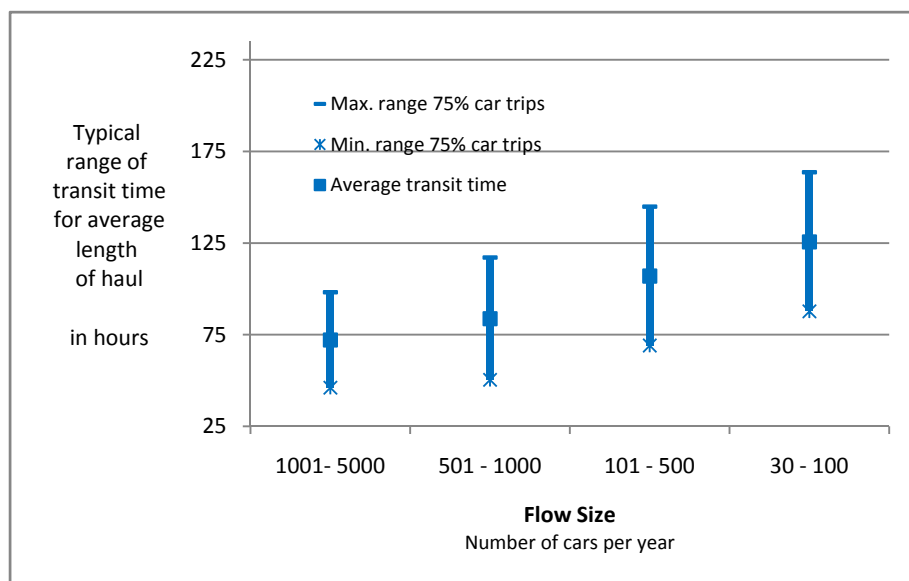
Intermodal traffic is caused by the differences in measurement of Intermodal and non-Intermodal transit times.

⁹⁸ Shipper size was defined according to the number of cars and intermodal units that a shipper moved on each railway in Calendar year 2007. Large - > 5000; Medium 1001 – 5000; Small 301 – 1000; Very Small < 301.

Performance by Flow Size

Figure 51 CN Non-Intermodal Performance by Flow Size – cars per year⁹⁹

	> 5000	1001-5000	501 - 1000	101 - 500	30 - 100
Average LOH - miles	s/c ¹⁰⁰	772	749	1002	1188
Typical Transit Time - hours	s/c	72	84	107	126
Average CV of transit time	s/c	31.3	34.6	30.8	26.2
Typical range of transit times - hours	s/c	52	67	76	76
Maximum in range – hours	s/c	98	117	145	164
Minimum in range - hours	s/c	46	50	69	88
Percentage of traffic	17%	24%	14%	28%	11%



For Non-Intermodal traffic, when looked at from the perspective of flow size, CN shows remarkably little differentiation in service levels. The higher average transit times and slightly higher ranges in transit time performance are due to the fact that the average length of haul for the small flow sizes is considerably higher than for the larger flow sizes.

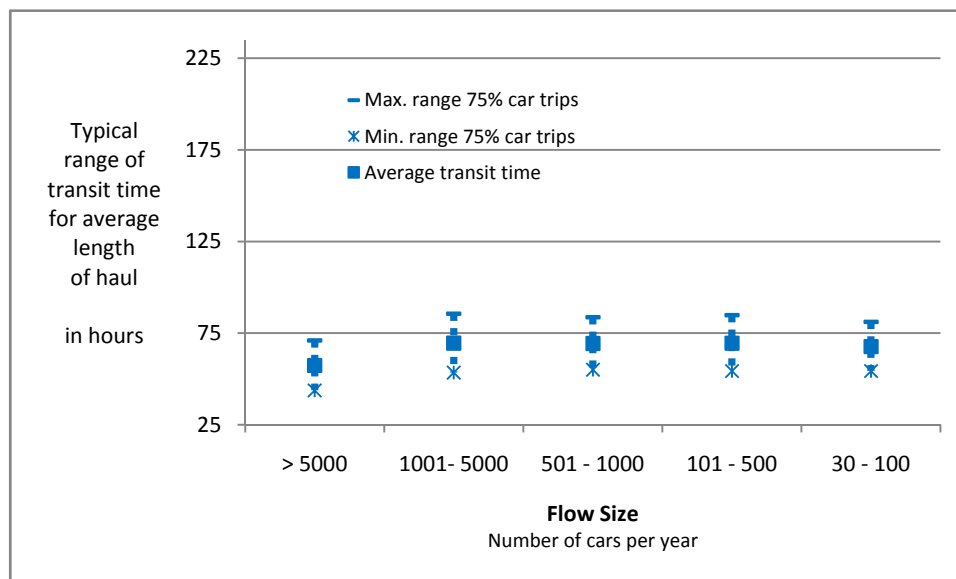
⁹⁹ There were too few sample keys (less than 5) in the largest flow size grouping to allow for analysis of performance for this group.

¹⁰⁰ As noted earlier in the text, in any cross-tabulation where there are less than 5 sample keys available for analysis, the results of analysis are suppressed in order to protect railway/shipper confidentiality. In addition, in small samples such as this the data are less likely to be representative of general performance across a shipper population. In all cases in the text where data is suppressed for this reason, the abbreviation s/c will appear in the appropriate tables.

For CN Intermodal traffic as illustrated in Figure 52, service performance showed little differentiation by flow size.

Figure 52 CN Intermodal Performance by Flow Size – containers per year

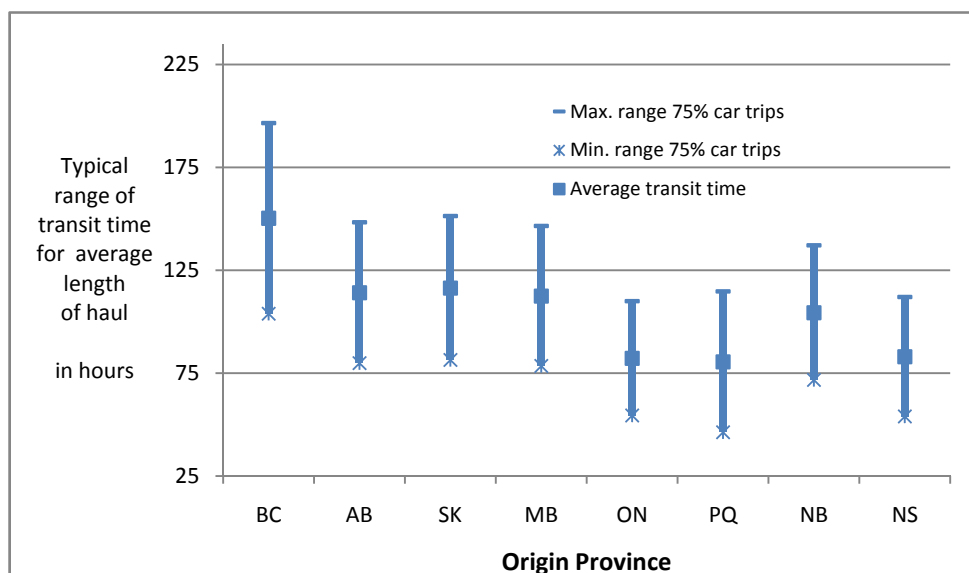
	> 5000	1001-5000	501 - 1000	101 - 500	30 - 100
Average LOH - miles	1288	1676	1611	1707	1613
Typical Transit Time - hours	57	70	69	70	68
Average CV of transit time	20.6	20.1	17.9	19.0	17.1
Typical range of transit times - hours	27	32	29	30	27
Maximum in range – hours	71	86	84	85	81
Minimum in range - hours	44	53	55	54	54
Percentage of traffic	32%	38%	10%	13%	4%



Performance by Shipper Origin

Figure 53 CN Non- Intermodal Performance by Shipper Origin Province

	BC	AB	SK	MB	ON	PQ	NB	NS
Average LOH - miles	1727	1168	1174	1036	707	569	888	828
Typical Transit Time - hours	150	114	116	112	82	81	104	83
Average CV of transit time	26.8	26.1	26.1	26.3	29.3	37.0	27.2	30.4
Typical range of transit times - hours	93	68	70	68	55	68	65	58
Maximum in range - hours	197	148	151	147	110	115	137	112
Minimum in range - hours	104	80	81	78	55	46	72	54
Percentage of traffic	19%	24%	13%	4%	19%	16%	3%	4%



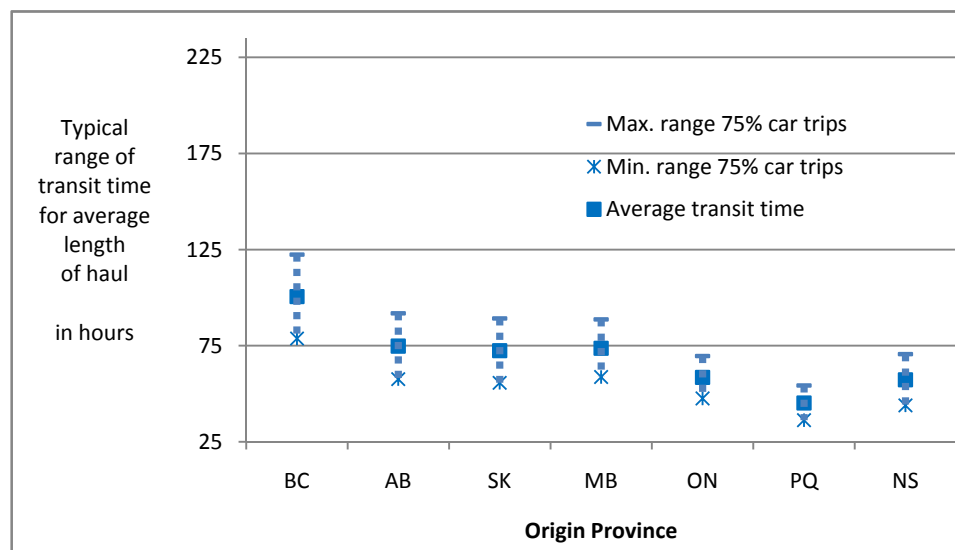
As with the shipper characteristics examined thus far, CN shows little differentiation of service by this characteristic as well - origin province. One notable exception is traffic originating in the province of Quebec where the coefficient of variation of transit time and the absolute range of transit times are relatively high for the shortest average length of haul of any of the provinces.

This is primarily due to the presence in the sample of a small number of very short haul

movements of plastics in the Montreal area. These short haul movements have low mean transit times which can create misleading results with respect to the calculation of coefficient of variation of transit time. When flows have low average transit times in the range of 2-10 hours but are subject to delays of 1-2 days in transit – the calculation of coefficient of variation of transit time will be very high. This is the case with this traffic. When these 6 plastics flows are excluded from the calculation, the CV of transit time for CN’s Quebec originated traffic drops from 37.0 to 24.1.

Figure 54 CN Intermodal Performance by Shipper Origin Province

	BC	AB	SK	MB	ON	PQ	NB	NS
Average LOH - miles	2005	1553	1629	1687	1704	1253	733	1377
Typical Transit Time - hours	101	75	72	74	59	45	s/c	57
Average CV of transit time	18.9	19.9	20.1	17.7	16.4	17.4	s/c	20.2
Typical range of transit times - hours	44	34	33	30	22	18	s/c	27
Maximum in range - hours	122	92	89	89	70	54	s/c	71
Minimum in range - hours	79	58	56	59	48	36	s/c	44
Percentage of traffic	29%	11%	2%	3%	29%	17%	2%	7%

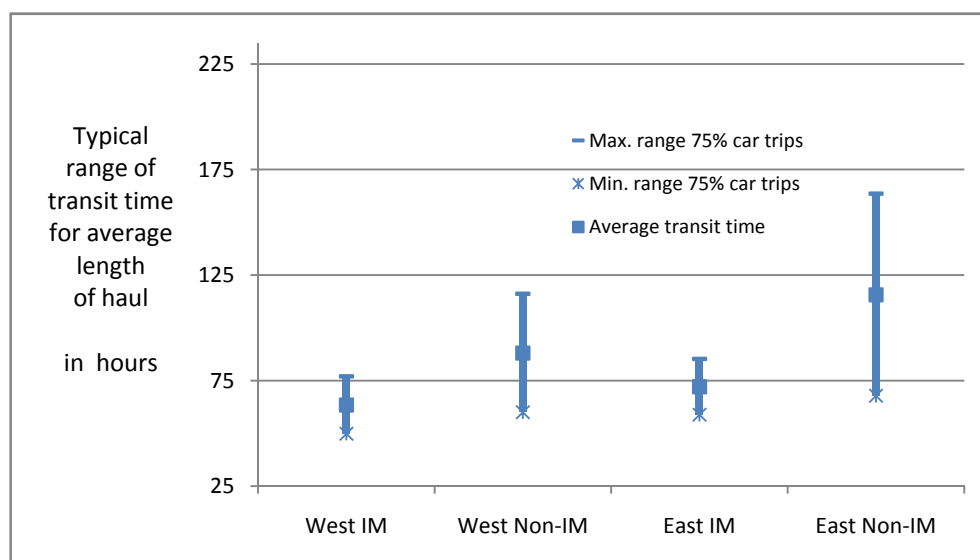


The table and chart in Figure 54 illustrate that CN transit time consistency for Intermodal is best from the high volume terminals in the Toronto and Montreal area. There was not sufficient data in the sample to allow for publication of performance data on Intermodal traffic originating in New Brunswick.

Performance by Destination

Figure 55 CN Performance to Canadian Destination Regions

	West IM	West Non-IM	East IM	East Non-IM
Average LOH - miles	1529	916	1830	1099
Typical Transit Time - hours	63	88	72	116
Average CV of transit time	18.6	27.7	15.9	36.0
Typical range of transit times - hours	27	56	26	96
Maximum in range - hours	77	116	85	164
Minimum in range - hours	50	60	59	68
Percentage of traffic	41%	40%	49%	25%



For the analysis by destination, traffic was grouped into destination regions in Canada and the US.¹⁰¹ This was done to provide large enough samples to support the analysis.

CN’s performance for destinations in Western Canada was close to their system-wide average as shown in Figures 49 and 50 illustrating performance by shipper size. However, CN’s performance on non-Intermodal traffic

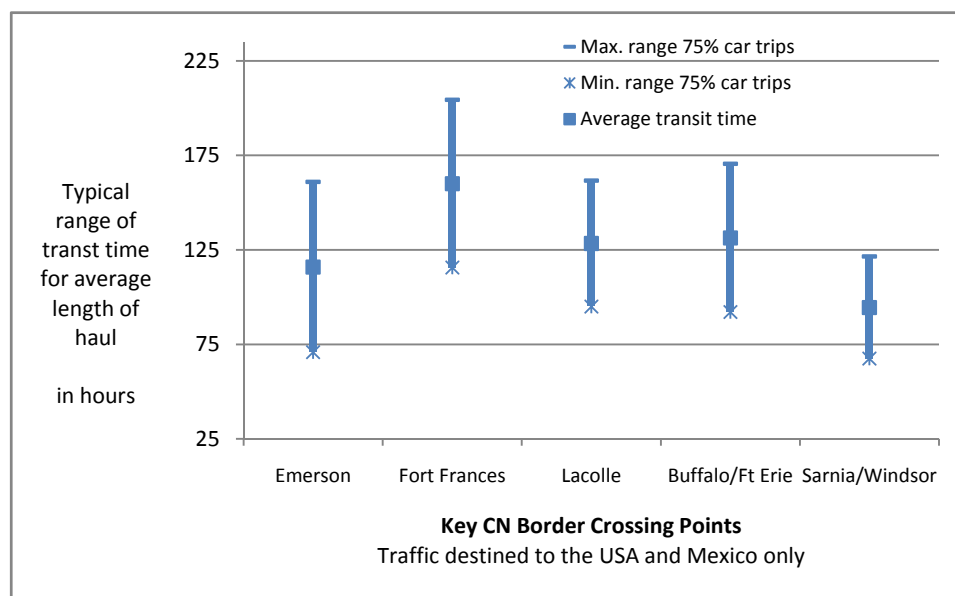
destined to Eastern Canada was much worse than their system average and their Intermodal performance was better. It is important to repeat that these changes may be associated with differences in the traffic mix between the two sample groups rather than any underlying differences in the railway’s operational performance across the regions.

¹⁰¹ Western Canada included the provinces from Manitoba West and Eastern Canada included traffic to Ontario, Quebec, New Brunswick and Nova Scotia. The United States was divided into five destination regions: Northeast, Southeast, Midwest, Southwest, West. Appendix 1 includes a series of charts and tables that provide a break-down of the railways’ performance by destination region in the United States.

For non-Intermodal traffic destined to the USA and Mexico, performance was assessed for all traffic via the railways' principal border crossing points. The CN analysis for their border crossings is summarized in Figure 56 below. The data shows that performance across most of the border crossings is very similar. However, traffic moving south from Canada via Emerson, Manitoba had wider relative variations in transit time than traffic moving via the other crossings relative to the average length of haul of the traffic.

Figure 56 CN Non-Intermodal Performance by Border Crossing Point¹⁰²

	Emerson	Fort Frances	Lacolle	Buffalo/ Ft Erie	Sarnia/ Windsor
Average LOH - miles	865	1563	906	1131	803
Typical Transit Time - hours	116	160	128	131	95
Average CV of transit time	33.8	24.1	22.6	25.9	24.8
Typical range of transit times - hours	90	89	67	78	54
Maximum in range – hours	161	204	162	171	122
Minimum in range - hours	71	116	95	92	68

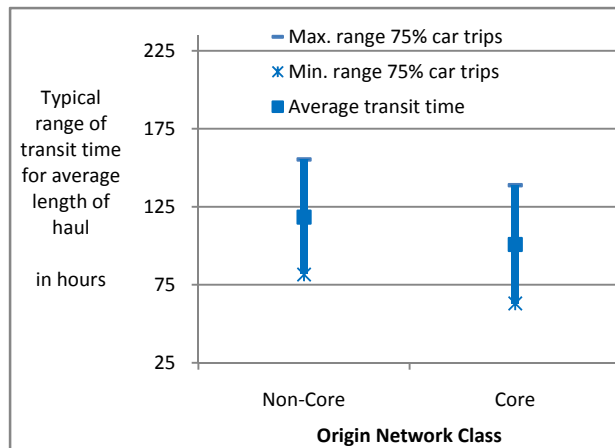


¹⁰² There was insufficient sample data available to assess CN performance via crossing points in the Vancouver area.

Performance by Network Characteristics

Figure 57 CN Non-Intermodal Performance from Core and Non-Core Origins¹⁰³

	Non-Core	Core
Average LOH - miles	1048	1095
Typical Transit Time - hours	118	101
Average CV of transit time	27.0	32.7
Typical range of transit times - hours	74	76
Maximum in range – hours	155	139
Minimum in range – hours	82	63
Percentage of traffic	32%	68%



Railway networks are often characterized as having both core and non-core components. Core components are the tracks with high levels of usage, or in railway terms, a high density of traffic. QGI reviewed with both CN and CP their trackage networks and identified those subdivisions that each railway considered as part of their core networks. All originating stations in the data provided to QGI by the railways were then coded in terms of being on the core, or the non-core network. Figure 57 above shows that at a high level when all non-Intermodal traffic is considered together, there is no advantage to a shipper to be on the CN core network, in terms of transit time consistency and CN’s service was actually more consistent for traffic originating at non-core stations. However, these summary data somewhat mask differences which do exist in performance at the Major Commodity Group level. For both Automotive traffic and for Grain traffic, transit consistency was better for traffic originating at stations on the core network. The advantage for Automotive traffic was substantial while it was nominal for grain shippers.¹⁰⁴

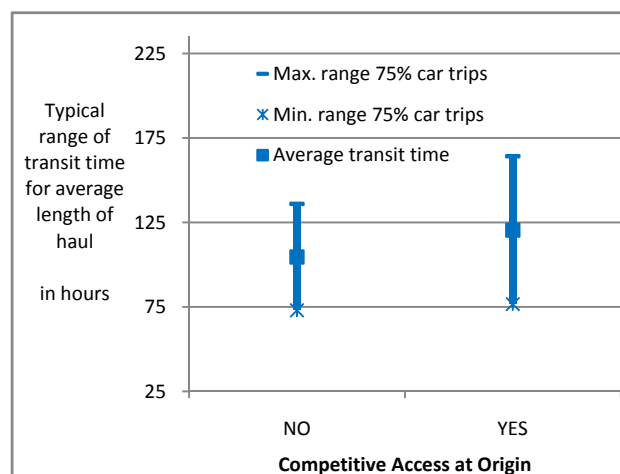
In order to assess the impact of direct rail competition on transit time performance, QGI obtained information from the railways on the competitive status of all of the rail origins in the study data. All rail origins were classified in terms of their status with respect to both direct switching and interswitching access to other rail carriers. In addition, locations where more than one carrier provided direct rail service to a customer were identified as well as all locations that are subject to the former BC Rail access provisions of the Consent Agreement between CN and the Competition Bureau.

¹⁰³ All Intermodal terminals were considered to be part of the core network and therefore Intermodal traffic was not subject to this part of the analysis.

¹⁰⁴ See detailed performance data in Appendix 5.

Figure 58 CN Performance from Competitive and Non-Competitive Origins

	Non Competitive	Competitive
Average LOH - miles	992	1139
Typical Transit Time - hours	104	120
Average CV of transit time	26.2	31.6
Typical range of transit times - hours	63	87
Maximum in range - hours	136	164
Minimum in range - hours	73	77
Percentage of traffic	51%	49%

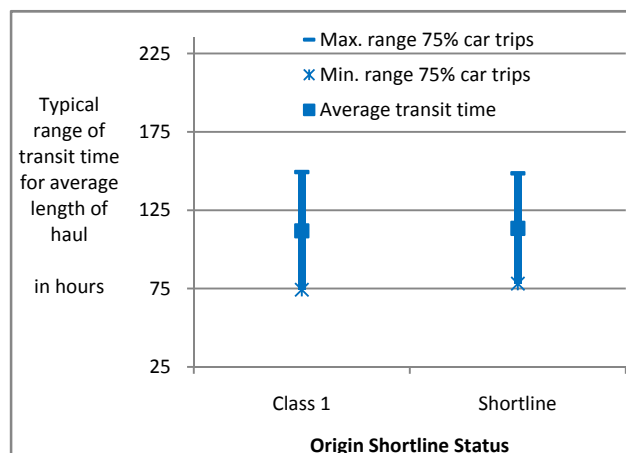


As can be seen from Figure 58, when considered as a group, while it might be expected that shippers with competitive access would have better service, there is no advantage in terms of transit consistency for CN customers with access to direct rail competition, as compared to those at non-competitive origins. In fact, shippers from non-competitive origins have somewhat better transit time consistency. However, this aggregate view masks some important differences across commodities and regions that deserve a more thorough discussion. When reviewed by origin province and Major Commodity Group, there were a number of locations on CN where the following traffic was found to have better transit time consistency at competitive than at non-competitive origins. These locations and commodities are displayed in the table below.

Railway	Origin Province	Major Commodity	Transit Time Consistency Non-Competitive Locations (CV)	Transit Time Consistency Competitive Locations (CV)	Advantage Competitive Locations (Difference in CV)
CN	Alberta	Grain	24.3	22.5	1.8
	Saskatchewan	Grain	25.4	22.6	2.8
	British Columbia	Merchandise (Lumber and Panels)	30.1	26.1	4.0
	Saskatchewan	Merchandise (Forest Products, Chemicals and Petroleum Products)	30.2	28.3	1.9

Figure 59 CN Performance from Shortline Origins

	Class 1	Shortline
Average LOH - miles	1040	1184
Typical Transit Time - hours	112	113
Average CV or transit time	29.2	26.9
Typical range of transit times - hours	75	70
Maximum in range – hours	149	149
Minimum in range - hours	74	78
Percentage of sample car trips	90%	10%



At an aggregated level, CN traffic from shortline origins receives a slightly better consistency of service compared to traffic originating on CN (including cars received in inter-switch service from other lines at origin). This is reflected in their nearly identical average transit times for a shortline LOH that is 13% longer and a lower CV of transit time. When examined at a finer level of detail as is shown in Appendix 5, it is seen that Merchandise and Automotive traffic on both railways has better levels of consistency from shortline origins whereas grain traffic has lower levels of transit consistency when originating on shortline railways. It is important to note that shortline traffic is measured from the time that it is received in interchange by CN or CP and not from the time that it departs a customer’s siding. In some cases, this can give a measurement advantage in terms of transit time to the shortline traffic as the activities associated with industrial switching and wayfreight movements are not included in some of the shortline traffic but are included in CN or CP originated traffic.

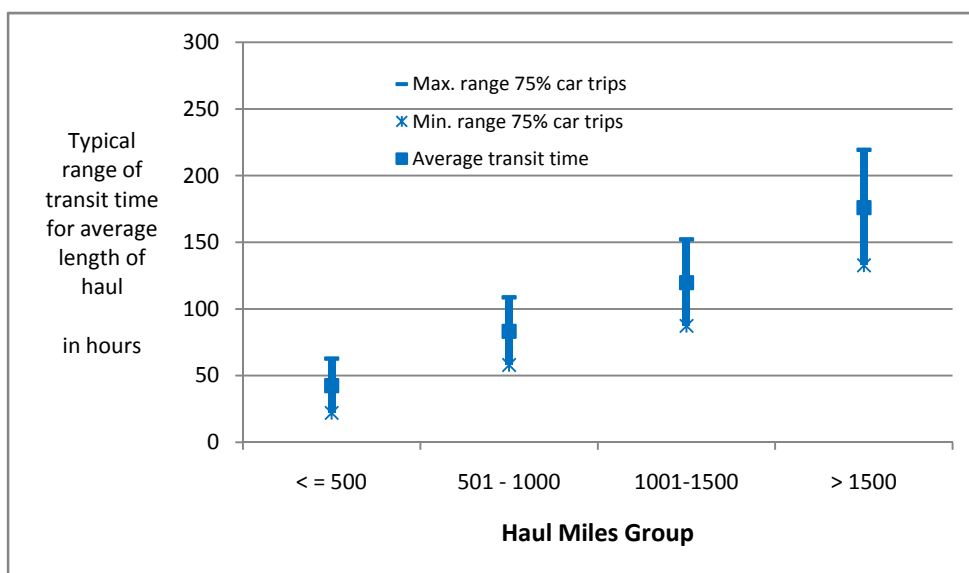
At a more detailed level of analysis, the only commodity group and region where transit consistency for traffic from shortline origins was materially different than from CN and CP origins, and where the characteristics of the traffic in the sample were very similar, was for grain traffic originating on shortlines in Saskatchewan. For both CN and CP origins, grain traffic originating on shortlines has significantly poorer levels of transit consistency than traffic originating on CN and CP.¹⁰⁵

Railway	Origin Province	Major Commodity	Transit Time Consistency Non-Shortline Origins Average CV transit time	Transit Time Consistency Shortline Origins Average CV transit time	Advantage Non-Shortline Origins CV difference
CN and CP	Saskatchewan	Grain	26.0	41.9	15.9

¹⁰⁵ This analysis has been combined for the two railways to maintain shipper confidentiality and to ensure that the sample in cross-tabulation was large enough to support the analysis.

Figure 60 CN Non-Intermodal Transit Consistency by Length of Haul

	<= 500	501 - 1000	1001- 1500	> 1500	All
Average LOH - miles	275	764	1219	2197	1063
Typical Transit Time - hours	42	83	120	176	112
Average CV of transit time	41.7	26.5	23.5	21.4	28.8
Typical range of transit times - hours	41	51	65	87	74
Maximum of range - hours	63	109	152	219	149
Minimum of range - hours	22	58	87	133	75
Percentage of traffic	33%	37%	16%	15%	100%



The length of haul for a car trip is the total distance measured in miles between a car’s origin and the point at which a car is either delivered to a customer or interchanged to a connecting railway. For Intermodal traffic it is the distance between the origin and destination railway Intermodal or port terminals. For CN non-Intermodal traffic, (as seen in Figure 60), transit consistency as measured by the average coefficient of variation of transit time is much better for CN long

haul traffic than for short haul traffic. Part of this is explained by the fact that the measure of coefficient of variation is very sensitive to variations in performance when mean values are very small as they are for short haul switching moves. In addition, as railway traffic is generally planned on a daily basis, delays of 24 hours on a very short haul move will have a proportionately bigger impact than would be experienced by traffic with a much longer average transit time. For non-Intermodal traffic when trips of less than 100 miles are removed from the smallest haul miles group, CN’s average CV drops from 41.7 to a value of 32.5.

Figure 61 CN Intermodal Performance by Length of Haul

	<= 500	501 - 1000	1001- 1500	> 1500	All
Average LOH - miles	368	826	1137	2233	1635
Typical Transit Time - hours	13	39	43	92	68
Average CV of transit time	18.2	21.3	18.2	17.4	18.5
Typical range of transit times - hours	6	19	18	37	29
Maximum of range – hours	16	49	52	111	83
Minimum of range - hours	10	30	34	74	54
Percentage of traffic	9%	21%	11%	59%	100%

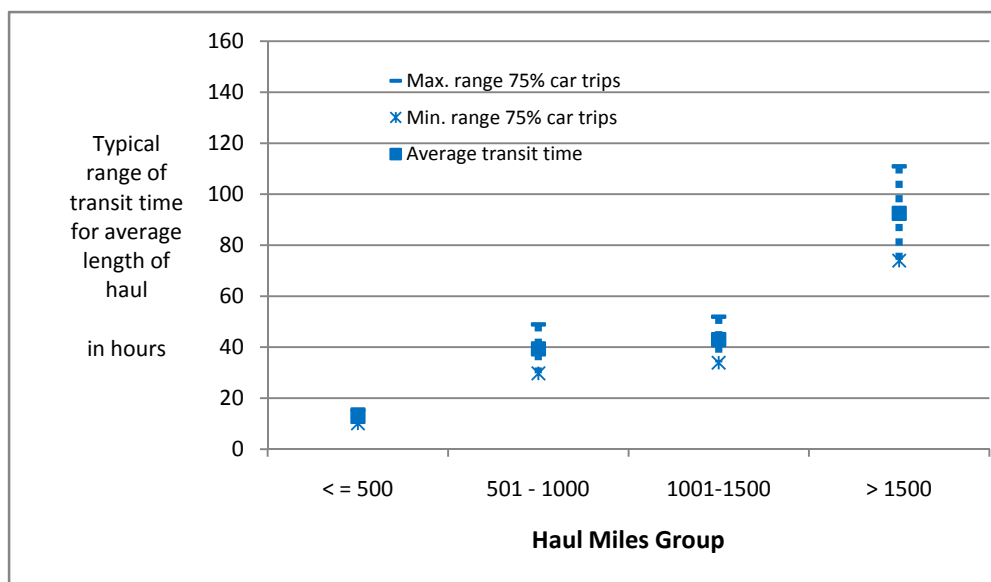


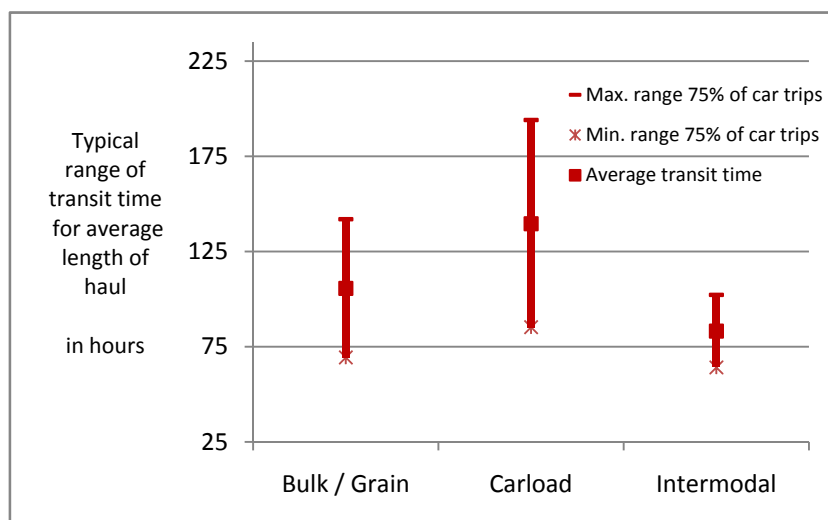
Figure 61 summarizes CN performance across all lengths of haul for Intermodal traffic. While there is some variation in consistency across the haul miles groups, there is no consistent pattern that relates performance to haul miles. Rather, the coefficient of variation of transit time is fairly consistent across the groupings and the overall range of transit times varies proportionately with the length of haul, as would be expected.

3.3.2 Canadian Pacific Transit Time Performance

Performance by Shipper Characteristics

Figure 62 CP Performance by Commodity Group

	Bulk / Grain	Carload	Intermodal
Average LOH - miles	877	754	1739
Typical Transit Time - hours	106	140	83
Average CV of transit time	29.9	33.9	19.9
Typical range of transit times - hours	73	109	38
Maximum in range – hours	142	194	102
Minimum in range - hours	69	85	64
Percentage of traffic	27%	21%	52%



At a summary level, as is shown by the graphs in Figure 62, CP transit time performance varies widely across the Intermodal, carload and bulk/grain commodity groups.¹⁰⁶ CP's performance is much better for Intermodal than for the other two groups. This higher service level is driven partly by the measurement differences alluded to earlier.

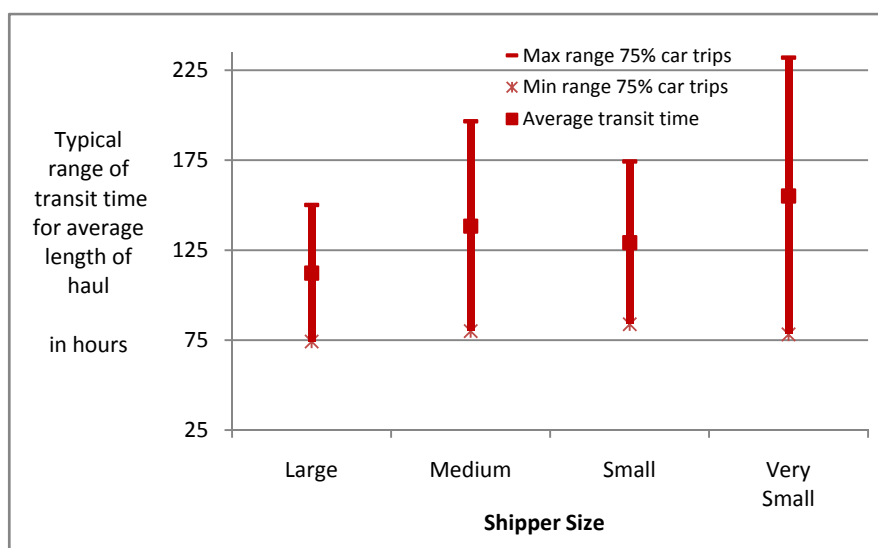
In particular, CP's carload shippers experience wide variations in transit time - as is illustrated in the table and graph opposite. For a typical CP carload shipper with a 754 mile length of haul, transit times will customarily vary between 85 and 194 hours or from 3.5 to 8 days. Note that this calculation only covers an estimated 75% of the car

trips and 25% of trips will lie outside of this estimated range of transit times for a typical CP carload customer.

¹⁰⁶ As with the CN analysis, Carload traffic included all merchandise, automotive and fertilizer traffic.

Figure 63 CP Non-Intermodal Performance by Shipper Size¹⁰⁷

	Large	Medium	Small	Very Small	All
Average LOH	859	698	877	506	812
Typical Transit Time	112	138	129	155	121
Average CV of transit time	29.4	36.6	30.4	43.1	31.7
Typical range of transit times in hours	76	117	90	154	88
Maximum	150	197	174	232	165
Minimum	74	80	84	78	77
Percentage of traffic	71%	18%	8%	3%	100%



When viewed from the perspective of shipper size, CP has better transit consistency for their largest non-Intermodal customers with CP's very small customers receiving much more highly variable service.

While the shorter length of haul of the very small shippers in the sample data may have impacted the calculation of the CV for this group¹⁰⁸, the much higher absolute range of typical transit times of this group versus the other shipper size groupings shows that very small shippers at CP must cope with higher variation in service levels than larger CP shippers.

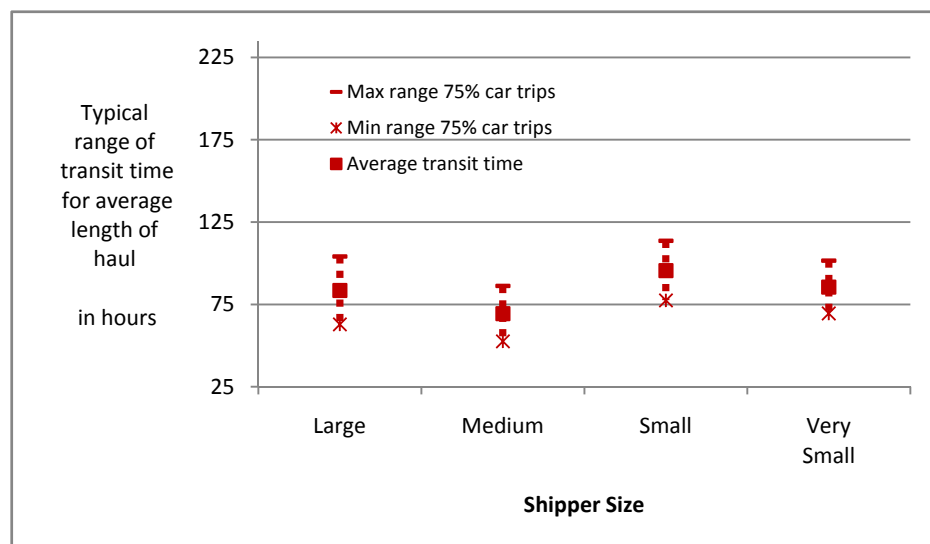
¹⁰⁷ Shipper size was defined according to the number of cars and intermodal units that a shipper moved on each railway in Calendar year 2007. Large - > 5000; Medium 1001 – 5000; Small 301 – 1000; Very Small < 301.

¹⁰⁸ As noted earlier in the section on CN performance by haul miles group, the measure of coefficient of variation is very sensitive to variations in performance when mean values are very small as they are for short haul switching moves. In addition, as railway traffic is generally planned on a daily basis, delays of 24 hours on a very short haul move will have a proportionately bigger impact than would be experienced by traffic with a much longer average transit time.

Figure 64 CP Intermodal Performance by Shipper Size

	Large	Medium	Small	Very Small	All
Average LOH	1584	1602	2169	2007	1739
Typical Transit Time	84	69	96	86	83
Average CV of transit time	21.4	21.0	16.4	16.3	19.9
Typical range of transit times in hours	41	34	36	32	38
Maximum in range – hours	104	86	114	102	102
Minimum in range - hours	63	53	78	70	64
Percentage of traffic	82%	9%	5%	4%	100%

CP's smallest Intermodal shippers by contrast with CP's smallest Non-Intermodal shippers, have the best service of any of the shipper size groups.



This is indicated by their low average coefficient of variation of transit time and relatively low average transit time at 86 hours, on an average haul of 2007 miles.

Overall, CP's Intermodal customers have much more consistent service than CP Non-Intermodal customers despite having an average length of haul that is double

that of Non-Intermodal customers.

Figure 65 CP Non-Intermodal Performance by Flow Size – number of cars per year

	> 5000	1001-5000	501 - 1000	101 - 500	30 - 100
Average LOH	s/c	1078	605	740	873
Typical Transit Time	s/c	110	88	108	134
Average CV of transit time	s/c	33.1	29.7	34.4	29.8
Typical range of transit times in hours	s/c	84	60	85	92
Maximum in range – hours	s/c	152	118	150	180
Minimum in range - hours	s/c	68	58	65	88
Percentage of traffic	25%	17%	11%	26%	12%

Note that no comment on performance could be made for CP's biggest non-Intermodal flows (>5000) due to the small sample size in this cross-tabulation (less than 5 sample keys).

However, there was no clear pattern of variation in levels of service performance across the other flow size ranges for CP non-Intermodal customers.

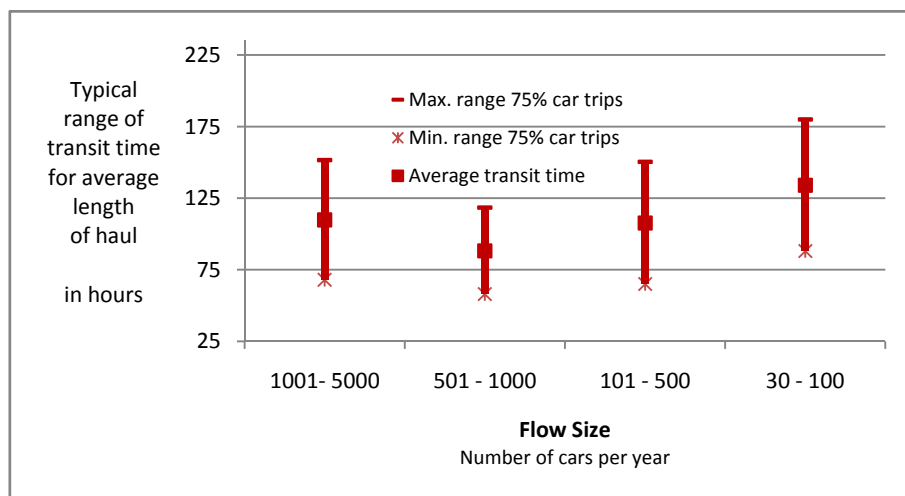


Figure 66 CP Intermodal Performance by flow size – number of containers per year

	> 5000	1001-5000	501 - 1000	101 - 500	30 - 100
Average LOH	1971	1263	1574	1676	1829
Typical Transit Time	104	47	76	82	89
Average CV of transit time	21.8	14.5	21.3	20.8	19.9
Typical range of transit times in hours	52	16	37	39	41
Maximum in range - hours	130	55	94	102	109
Minimum in range - hours	78	39	57	63	68
Percentage of traffic	35%	29%	10%	15%	7%

Once again, as with Non-Intermodal customers, there is no clear pattern of service differentiation by flow size for CP Intermodal customers. Shippers of the second largest flow sizes had the best service performance with the least variation in transit times and the lowest average transit times. While this group also had the lowest average length of haul - the typical transit time relative to this length of haul was also the best of all flow sizes.

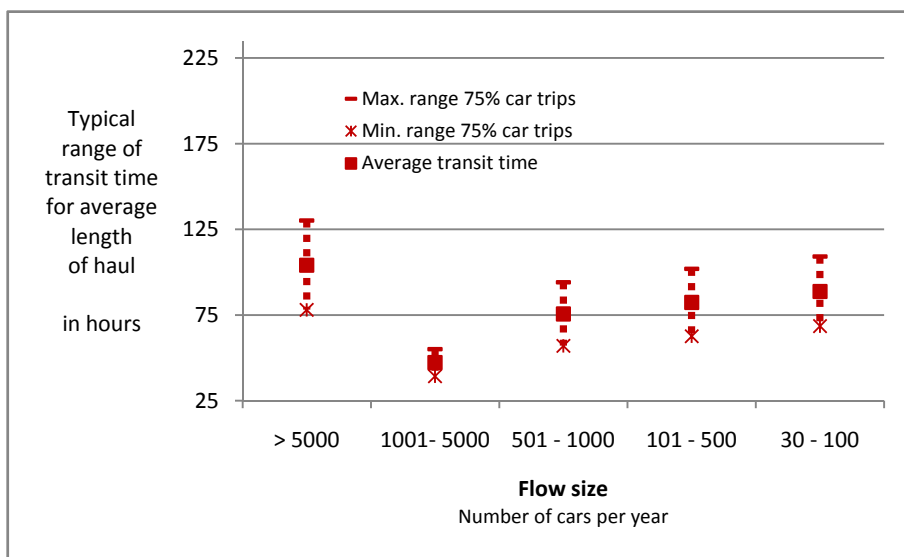
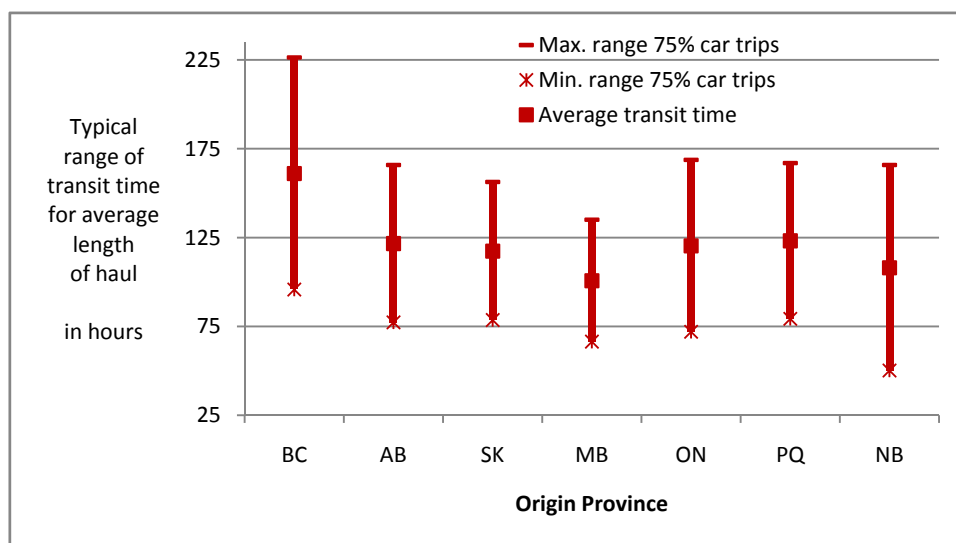


Figure 67 CP Non-Intermodal Performance by Origin Province

	BC	AB	SK	MB	ON	PQ	NB
Average LOH - miles	906	817	884	841	724	647	312
Typical Transit Time - hours	161	122	117	101	120	123	108
Average CV of transit time	35.2	31.6	28.8	29.6	34.9	30.9	46.5
Typical range of transit times - hours	131	88	78	69	97	88	116
Maximum in range – hours	226	166	156	135	169	167	166
Minimum in range - hours	96	77	79	66	72	79	50
Percentage of traffic	28%	22%	19%	6%	21%	4%	<1%



CP’s non-Intermodal traffic originating in Manitoba and Saskatchewan has the best transit time consistency. Of the provinces with large traffic bases, BC and Ontario originated traffic had the widest variations in performance. As can be seen from the more detailed data available in Appendix 5, the wide variation in performance of traffic originating in these two provinces is due primarily to the performance of CP’s BC and Ontario originated Merchandise traffic.

Figure 68 CP Intermodal Performance by Origin Province

	BC	AB	SK	MB	ON	PQ
Average LOH - miles	1941	1371	1528	1289	1803	1725
Typical Transit Time - hours	134	71	120	67	70	78
Average CV of transit time	23.4	23.5	25.8	25.3	15.9	19.4
Typical range of transit times - hours	72	39	71	39	26	35
Maximum in range - hours	170	91	156	86	83	95
Minimum in range - hours	98	52	84	47	57	60
Percentage of sample car trips	31%	8%	3%	3%	27%	28%

Like CN, CP has their best Intermodal performance for traffic originating at their large volume intermodal terminals in Ontario and Quebec (Toronto and Montreal).

CP's traffic from all four western provinces has significantly

greater variability of performance than traffic originating in Ontario and Quebec.

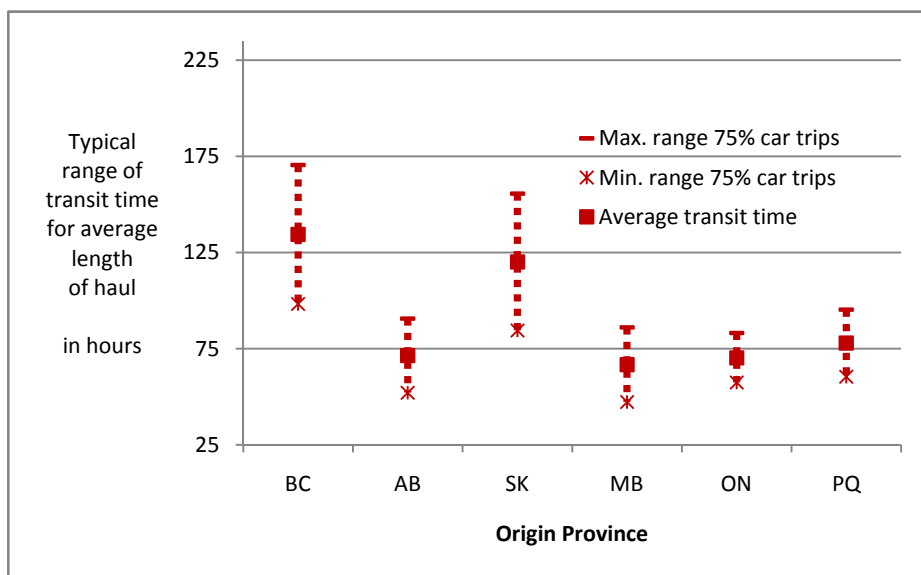
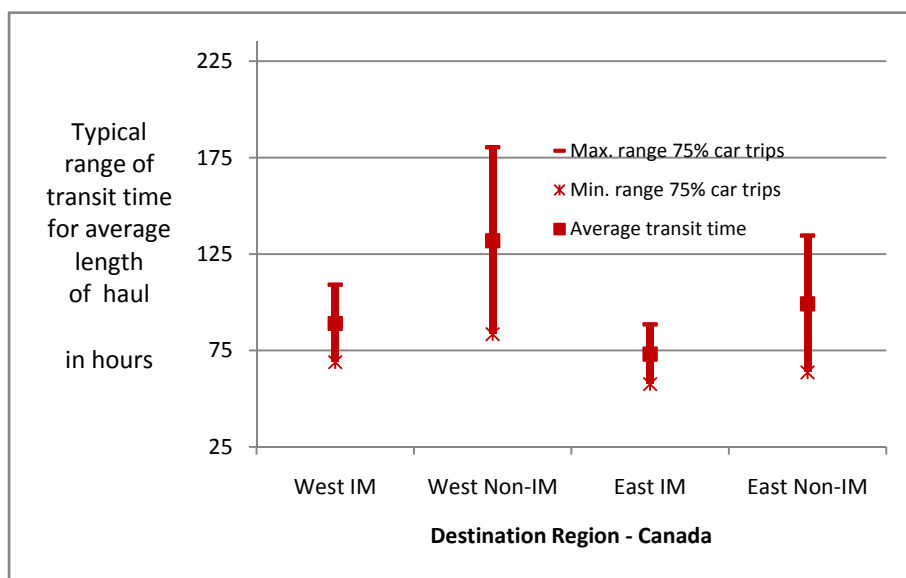


Figure 69 CP Transit Performance to Canadian Destination Regions

	West IM	West Non-IM	East IM	East Non-IM
Average LOH	1817	818	1674	922
Typical Transit Time	89	132	73	99
Average CV of transit time	19.6	31.9	18.4	31.1
Typical range of transit times in hours	40	97	31	71
Maximum in range – hours	109	180	89	135
Minimum in range - hours	69	84	58	64
Percentage of traffic	39%	43%	45%	21%



CP’s Intermodal traffic showed no significant difference in transit time consistency for traffic destined to Eastern vs. Western Canada.

However, analysis revealed that CP’s average transit time for non-Intermodal traffic destined to destinations east of Manitoba was significantly lower than Non-Intermodal traffic destined to Western Canada. CP’s better than average transit times on this traffic was in part due to the inclusion of significant volumes of grain traffic from Western Canada to Thunder Bay, Ontario in this sample group. CP’s average speed on this traffic

was well above their system averages for all other non-Intermodal traffic, and was much higher than their average speed on grain traffic overall.

Figure 70 CP Non-Intermodal Performance by Border Crossing

	Coutts	Emerson	Kingsgate	North Portal	Vancouver	Lacolle	Buffalo/ Ft Erie	Sarnia/ Windsor
Average LOH - miles	404	738	569	1113	899	938	279	532
Typical Transit Time - hours	114	110	120	166	175	139	105	77
Average CV or transit time	29.4	28.8	30.9	28.8	39.1	32.6	41.0	34.9
Typical range of transit times - hours	77	73	85	110	157	104	99	61
Maximum in range – hours	152	147	162	221	253	191	154	107
Minimum in range - hours	75	74	77	111	96	87	55	46

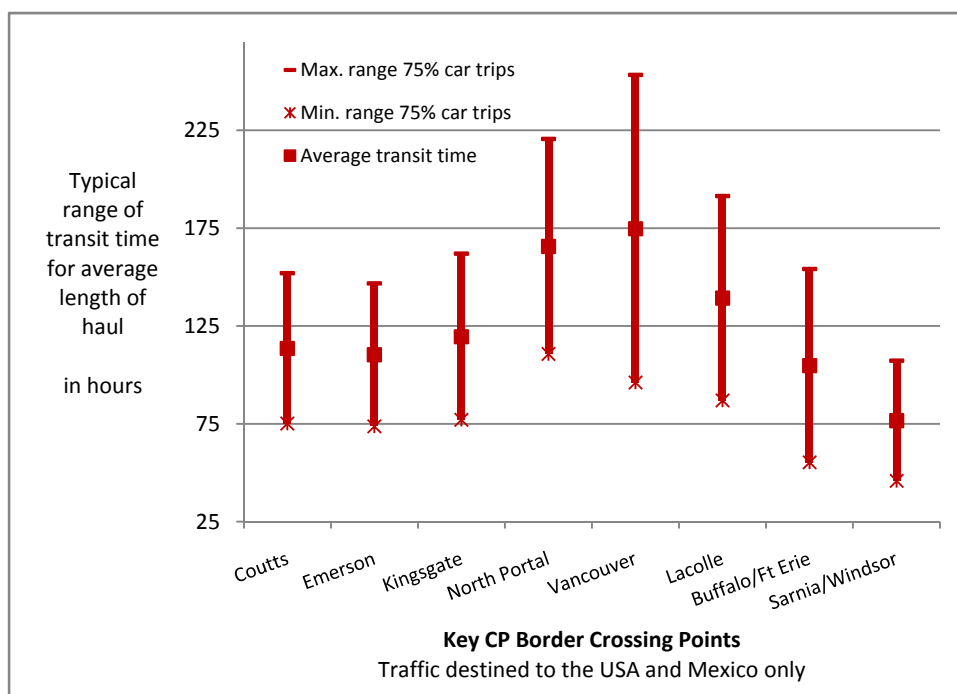


Figure 70 summarizes CP performance on Non-Intermodal traffic destined to the United States and Mexico, by border crossing point.

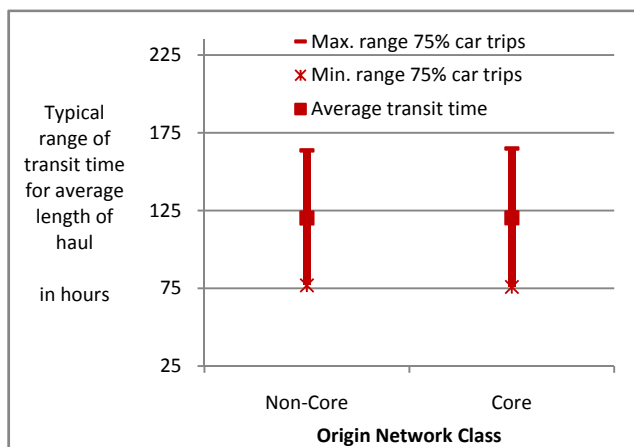
When viewed in terms of average length of haul and average CV of transit time, CP service is similar across all crossing locations except Buffalo/Ft. Erie and Vancouver – where service is worse than average.

Appendix 5 includes a chart that provides a break-down of the railways’ performance by destination region in the United States.

Performance by Network Characteristics

Figure 71 CP Non-Intermodal Transit Performance from Core and Non-Core Origins

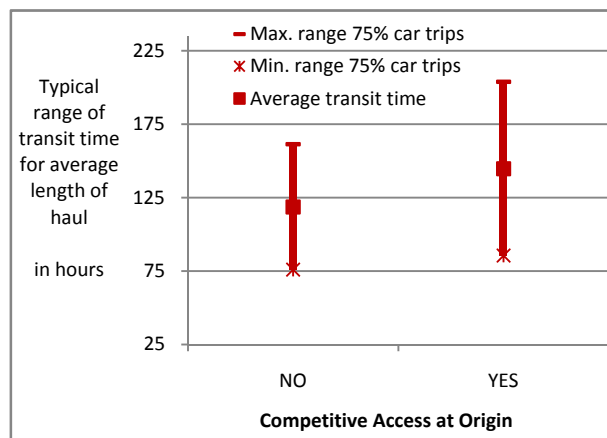
	Non-Core	Core
Average LOH - miles	858	749
Typical Transit Time - hours	120	120
Average CV of transit time	31.3	32.1
Typical range of transit times - hours	87	89
Maximum in range - hours	164	165
Minimum in range - hours	77	76
Percentage of traffic	27%	73%



As noted earlier in the analysis of CN performance, railway networks are often characterized as having both core and non-core components. QGI reviewed with both CN and CP their trackage networks and identified those subdivisions that each railway considered as part of their core networks. The analysis of all non-Intermodal traffic revealed, as depicted in Figure 71, that there is no apparent difference in transit time performance for a shipper located on CP’s core network versus those located on the non-core network.

Figure 72 CP Transit Performance from Competitive and Non-Competitive Origins

	Non-Competitive	Competitive
Average LOH - miles	812	807
Typical Transit Time - hours	119	145
Average CV or transit time	31.3	35.6
Typical range of transit times - hours	85	118
Maximum in range - hours	161	204
Minimum in range - hours	76	86
Percentage of traffic	87%	13%

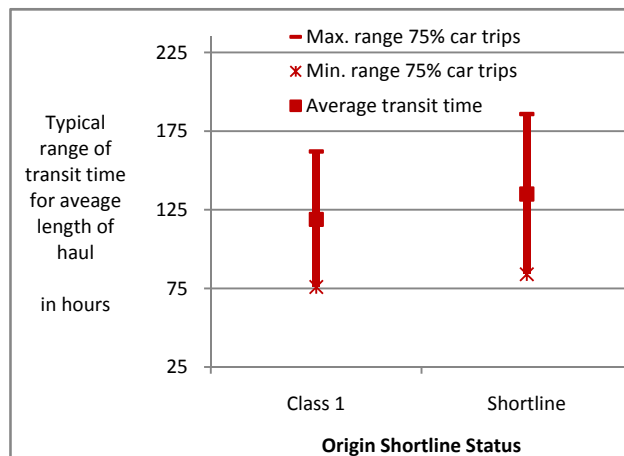


In addition, the transit time data was assessed to determine whether or not shippers who have access to competitive rail services at origin have a service advantage over shippers who do not have competitive access. Competitive access was defined as a shipper either having access to direct rail competition through Interswitching or through joint

service by more than one railway at their origin locations. As can be seen in Figure 72, while it might be expected that shippers with competitive access may enjoy better service, CP shippers at locations that provide access to competitive rail services do not have an advantage at an aggregate level in terms of transit consistency. In fact shippers at locations without competitive access have a relatively shorter and more consistent transit time.

Figure 73 CP Performance from Shortline Origins

	Class 1	Shortline
Average LOH - miles	818	765
Typical Transit Time - hours	119	135
Average CV of transit time	31.5	32.8
Typical range of transit times - hours	86	102
Maximum in range - hours	162	186
Minimum in range - hours	76	84
Percentage of sample car trips	94%	6%



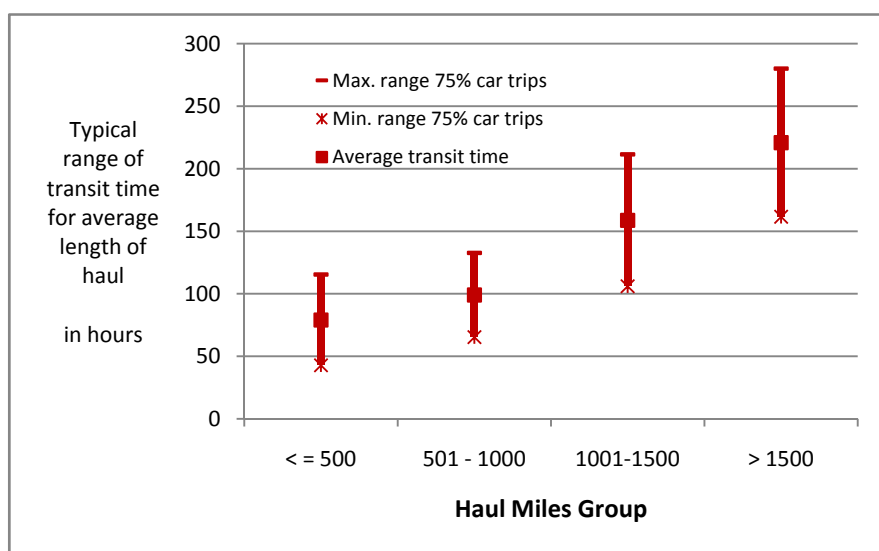
At an aggregated level, CP traffic from origins located on shortlines receives similar service to traffic originating on CP (including cars received in inter-switch service from other lines at origin). When examined at a finer level of detail as is shown in Appendix 5, it is seen that Merchandise and Automotive traffic on both railways has better levels of consistency from shortline origins whereas grain traffic has lower levels of transit consistency when originating on shortlines. It is important to note that shortline traffic is measured from the time that it is received in interchange by CN or CP and not from the time that it departs a customer’s siding.

At a more detailed level of analysis, the only commodity group and region where transit consistency for traffic from shortline origins was materially different than from CN and CP origins, and where the characteristics of the traffic in the sample were very similar, was for grain traffic originating on shortlines in Saskatchewan. For both CN and CP origins, grain traffic originating on shortlines has significantly poorer levels of transit consistency than traffic originating on CN and CP.

Railway	Origin Province	Major Commodity	Transit Time Consistency Non-Shortline Origins Average CV transit time	Transit Time Consistency Shortline Origins Average CV transit time	Advantage Non-Shortline Origins CV difference
CN and CP	Saskatchewan	Grain	26.0	41.9	15.9

Figure 74 CP Non-Intermodal Performance by Length of Haul

	<= 500	501 - 1000	1001- 1500	> 1500
Average LOH	306	744	1208	2000
Typical Transit Time	79	99	159	221
Average CV of transit time	39.8	29.5	28.9	23.3
Typical range of transit times in hours	73	67	105	118
Maximum in range - hours	115	133	212	280
Minimum in range - hours	43	65	106	162
Percentage of traffic	34%	52%	9%	5%

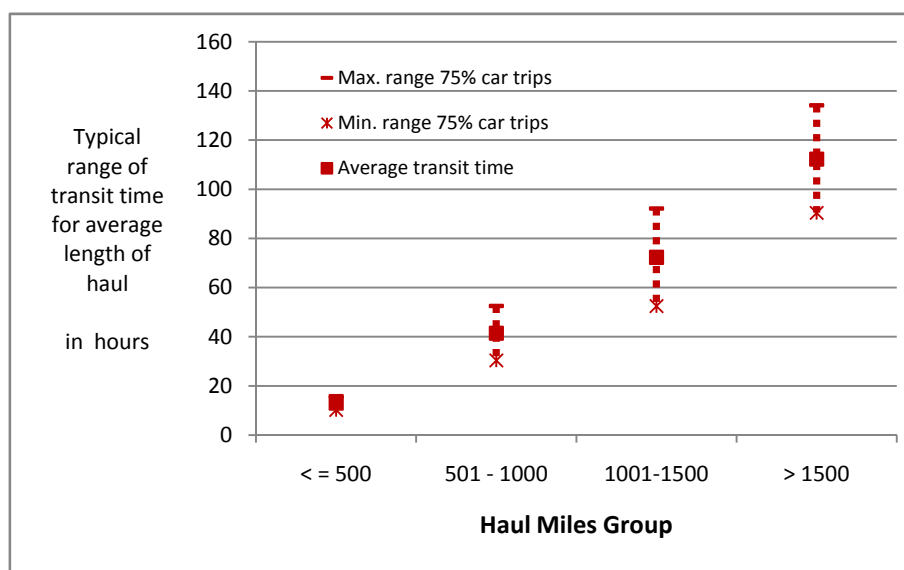


The length of haul for a car trip is the total distance measured in miles between a car’s origin and the point at which a car is either delivered to a customer or interchanged to a connecting railway. For Intermodal traffic it is the distance between the origin and destination railway Intermodal or port terminals. As can be seen in Figure 74, transit consistency as measured by the average coefficient of variation of transit time is much higher (worse) for CP short haul non-Intermodal traffic than for long haul traffic. As noted earlier, part of this is explained by the fact that the measure of coefficient of variation is very sensitive to

variations in performance when mean values are very small as they are for short haul switching moves. In addition, as railway traffic is generally planned on a daily basis, delays of 24 hours on a very short haul move will have a proportionately bigger impact than would be experienced by traffic with a much longer average transit time. For CP non-Intermodal traffic when trips of less than 100 miles are removed from the smallest haul miles group, the CV of transit time drops from 39.8 to 35.2.

Figure 75 CP Intermodal Performance by length of haul

	<= 500	501 - 1000	1001- 1500	> 1500
Average LOH	351	717	1264	2352
Typical Transit Time	13	41	72	112
Average CV of transit time	18.9	23.2	23.9	16.9
Typical range of transit times in hours	6	22	40	44
Maximum in range – hours	16	53	92	134
Minimum in range - hours	10	30	52	90
Percentage of car trips	16%	17%	8%	59%



For CP Intermodal traffic there is less variation in transit consistency across length of haul than is seen for their Non-Intermodal traffic. While the CV of average transit time is best for the shortest and the longest hauls, the typical transit time for an average length of haul varies more or less proportionately with the length of haul and the service levels are therefore fairly consistent regardless of length of haul.

3.4 Performance of Traffic to and from Major Terminals

This section of the report will provide an overview of railway service to and from the major bulk and Intermodal terminals in Canada. Performance will be assessed to and from the three largest railway served ports in Canada: Vancouver, Montreal and Halifax. Note that this is not an analysis of service at the terminal locations alone, but takes into account performance of all of the traffic on each railway’s network destined to or originating from the terminal.

For all three ports the performance of the railways’ Intermodal services will be evaluated for the combined originating and terminating traffic in the area of the port. For the Port of Vancouver service performance on selected bulk and merchandise traffic terminating at the Port will be reviewed in detail and a summary analysis is provided for bulk and breakbulk commodities that moved through the Port of Montreal.¹⁰⁹

3.4.1 Vancouver Intermodal

Figure 76 Transit time consistency Vancouver Intermodal

Vancouver Intermodal Traffic	Transit Time Consistency
Canadian National Railway	19.9
Canadian Pacific Railway	21.3

The table adjacent shows that CN’s overall transit consistency was slightly better than CP’s for Intermodal traffic through Vancouver. Both railways’ performance on Vancouver traffic was below their average

performance for Intermodal across their entire networks. CN and CP’s average speed on Vancouver Intermodal traffic was also below their average network speeds for Intermodal by approximately the same margin of 3 mph for each railway.

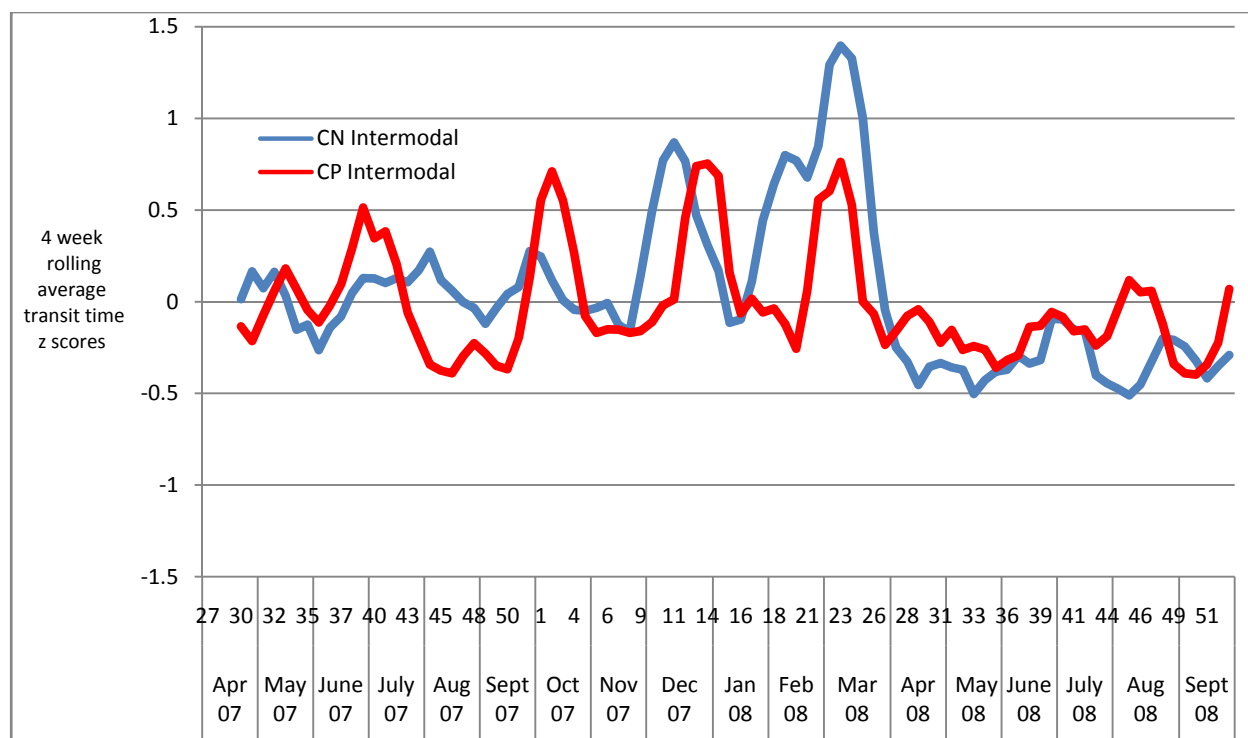
The graph below shows the performance of CN and CP Intermodal traffic originating and terminating at stations in the Vancouver area from April 2007 until September 2008.¹¹⁰ Care must be taken when interpreting this graph. The graph displays a four week rolling average of transit time z scores for all Intermodal traffic originating and terminating at stations in the Vancouver area for each week of the service review period. The graph therefore shows the degree to which transit time for Intermodal traffic at Vancouver departed from average transit time for each railway with the deviations from normal performance expressed in units of standard deviation. A value above 0 shows that transit times were in general higher than average for the week in question.

¹⁰⁹ Intermodal services at Vancouver, Montreal and Halifax are assessed on an originated and terminated basis as all three ports handle loaded containers in both import and export movement. Bulk and breakbulk commodities are almost exclusively handled on an export basis so only terminated traffic at Vancouver will be included in the review. While substantial bulk and breakbulk traffic is exported through the Port of Montreal, the sample data provided by railways was not sufficient to provide a statistically valuable analysis when viewed in time series.

¹¹⁰ Traffic for the period from October 2006 to March 2007 was not included in the detailed time series analysis of performance for Intermodal services to the ports as there were several weeks for which CN Intermodal data were not available at a sufficient level of detail to provide a meaningful analysis. In addition, in this study, the CN strike period in early 2007 has been omitted from analysis as noted earlier. For these two reasons, the detailed time series analysis of performance in this section will be restricted to the April 07 to September 08 period. Summary data was available at a sufficient level of detail to provide summary statistics for the entire period and therefore the measures of transit time consistency and speed will include the available data for the entire study period, but excluding the 2007 CN strike period.

As the deviation of each car trip from average transit time is expressed in units of standard deviation, the magnitude of a z score depends on the variation of transit times for a particular flow. As a result, if one railway has generally higher average standard deviations (less consistent transit times) then for a given variation in transit time, it will show a smaller deviation in performance when measured in units of standard deviation than a railway with more consistent transit times. **For this reason, the performance of CN and CP cannot be compared to each other directly on the graph as their underlying levels of transit consistency are not the same.** As CN has generally more consistent transit time, it will show proportionately greater deviation from 0 on the graph, for any absolute change in transit time, than will CP. However, the graph is useful for identifying periods of disruption from normal service levels and for comparing the frequency and timing of such disruptions for each railway.

Figure 77 CN and CP Intermodal Transit Time z scores – Vancouver



CN traffic shows a relatively narrow fluctuation around 0 except for two periods in December 2007 and January – March 2008. The weather related disruptions in Western Canada during these periods have already been reviewed earlier in the report.

CP traffic displays evidence of disruption during these same two periods though CP’s deviation from their customary service levels is less than CN’s during these periods. However, CP service was also disrupted in June and September of 2007. Detailed examination of the data showed that during these two periods, both import and domestic

Intermodal services on CP had much longer than average transit times between Vancouver and points in Central Canada. The graph suggests that both railways had periods of very significant disruption to service to and from the Vancouver area. CN’s disruptions however appear to be related primarily to weather related events while CP had periods of highly variable service throughout the year.

For both railways, the level of variability of transit time decreases significantly in the period from April – September 2008 and average transit times were lower (faster average speeds) than was the case in the same period in service review year 1. This suggests that the effects of whatever shocks to the logistics system that caused the higher volatility in earlier periods had dissipated somewhat by the end of the service review period.

3.4.2 Vancouver Non-Intermodal traffic ¹¹¹

Figure 78 Transit Time Consistency: Vancouver selected commodities

Vancouver Non-Intermodal	Transit time Consistency Average Coefficient of Variation of Transit Time	
	CN	CP
Bulk & Grain	18.3	27.1
Merchandise	32.2	35.7

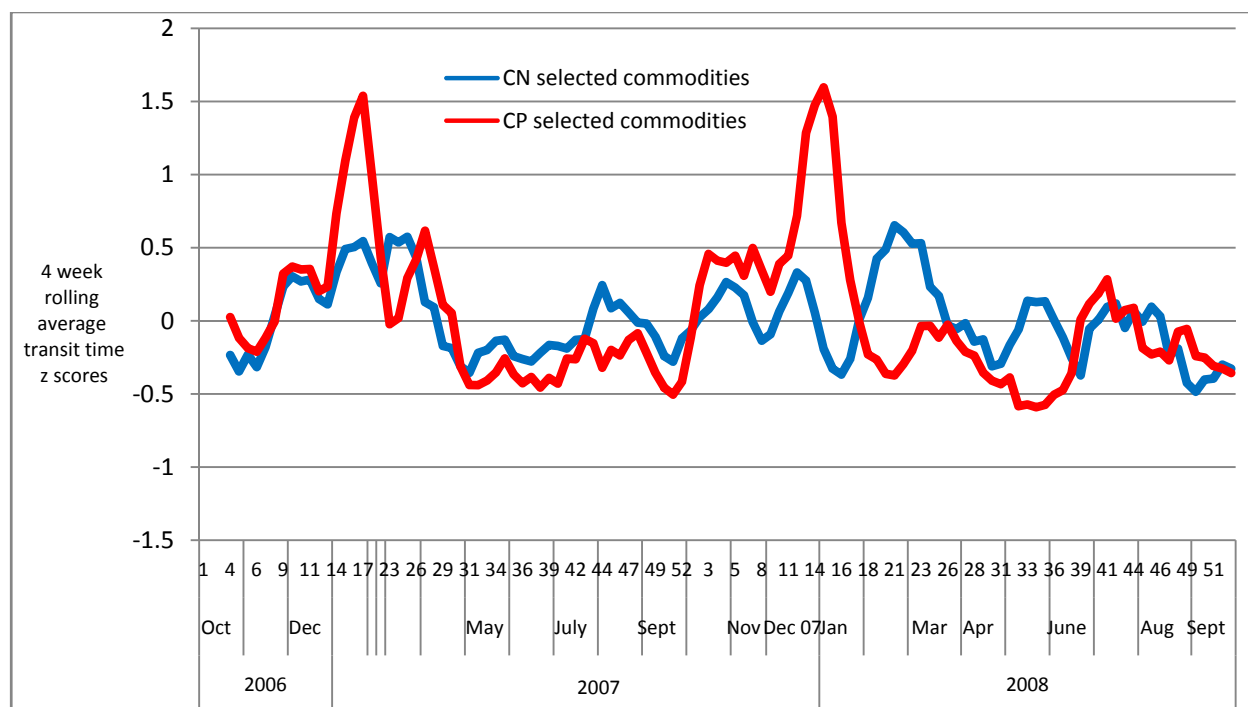
While performance for Intermodal service at Vancouver was assessed for traffic originating and terminating at terminals in the region, traffic for other commodities was done on a terminated basis only, as little rail traffic other than Intermodal originates from

the Vancouver area.

As is shown in the summary table, CN has significantly more consistent transit times on the selected bulk/grain commodities traffic to Vancouver and they have a smaller but still significant advantage on Merchandise traffic.

¹¹¹ The commodities included in the non-Intermodal analysis of service to Vancouver include data for all shipments of: Grain and Grain Products, Chemical and Petroleum Products, Coal, Forest Products, and Sulphur – destined to stations in the Vancouver area. Data for the CN strike period in 2007 have been excluded.

Figure 79 CN and CP Select Commodities: Transit Time z scores – Vancouver



For non-Intermodal traffic destined to Vancouver over the study review period, both railways show seasonal variations in transit time performance during the winter months. CP bulk traffic destined to Vancouver export terminals was delayed significantly in late December 06 and early January 07. In addition, CP bulk, grain and merchandise traffic had much longer than average transit times from mid December 2007 to early January 2008.

3.4.3 Montreal

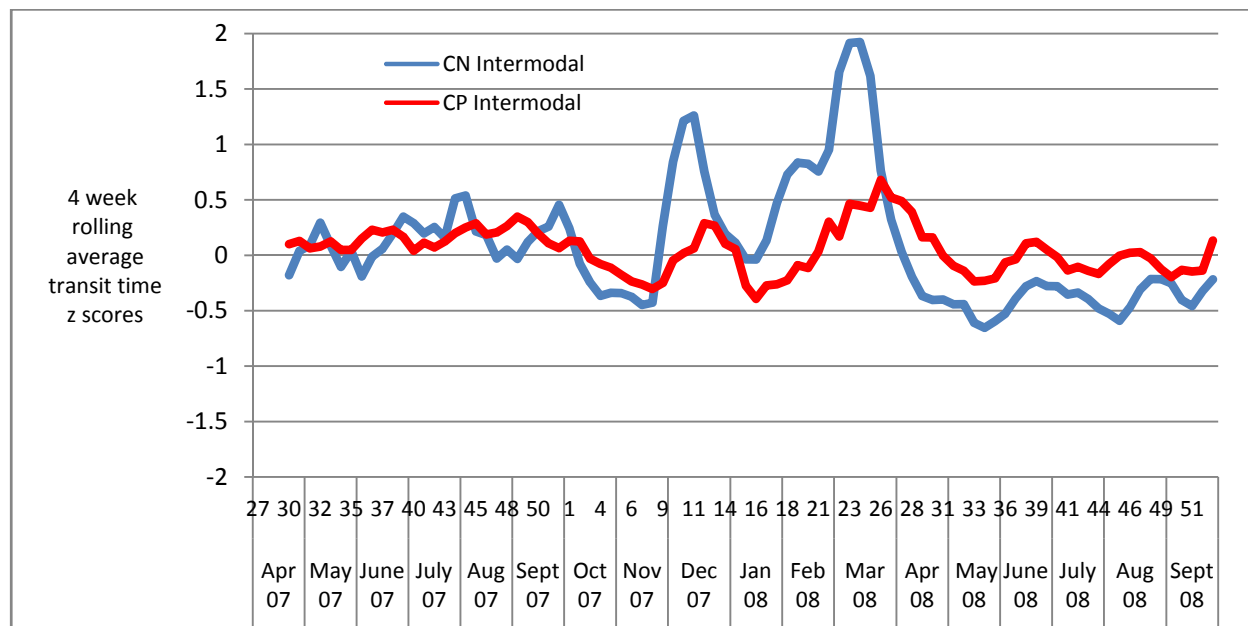
Figure 80 Transit time consistency - Montreal Intermodal

Montreal Intermodal Traffic	Transit Time Consistency
Canadian National Railway	16.2
Canadian Pacific Railway	19.0

The table adjacent shows the relative transit time consistency of CN and CP traffic that originated and terminated at their Montreal area Intermodal terminals

over the course of the service review period. It is important to remember that CN has better underlying transit consistency when viewing the graph below. While CN’s variation in service over time when viewed in terms of average transit time z score is wider than CP’s, their actual levels of service variability are lower.

Figure 81 CN and CP Intermodal Transit Time z scores – Montreal



For Montreal Intermodal traffic, CN’s periods of major disruption are concentrated around the two previously identified periods of weather related disruption in late 2007 and early 2008. CP’s traffic data shows less evidence of special disruption during these two periods.

Figure 82 Transit time consistency - Montreal selected commodities¹¹²

Montreal Selected Commodities	Transit Time Consistency
Canadian National Railway	26.0
Canadian Pacific Railway	29.0

For non-Intermodal traffic, CN and CP’s performance data are shown in the table to the left. These data have not been broken out by commodity group as the individual samples are too small to provide statistically valid analysis. However, it is important to note that the data in the sample for CP non-Intermodal traffic terminating in the Montreal region is made up entirely of grain products and the CN traffic is a mix of grain products and merchandise traffic.

¹¹² The commodities included in the non-Intermodal analysis of service to Montreal include data for all shipments of: Grain and Grain Products, Chemical and Petroleum Products, Metal Products, and Forest Products – destined to stations in the Montreal area. Data for the CN strike period in 2007 have been excluded.

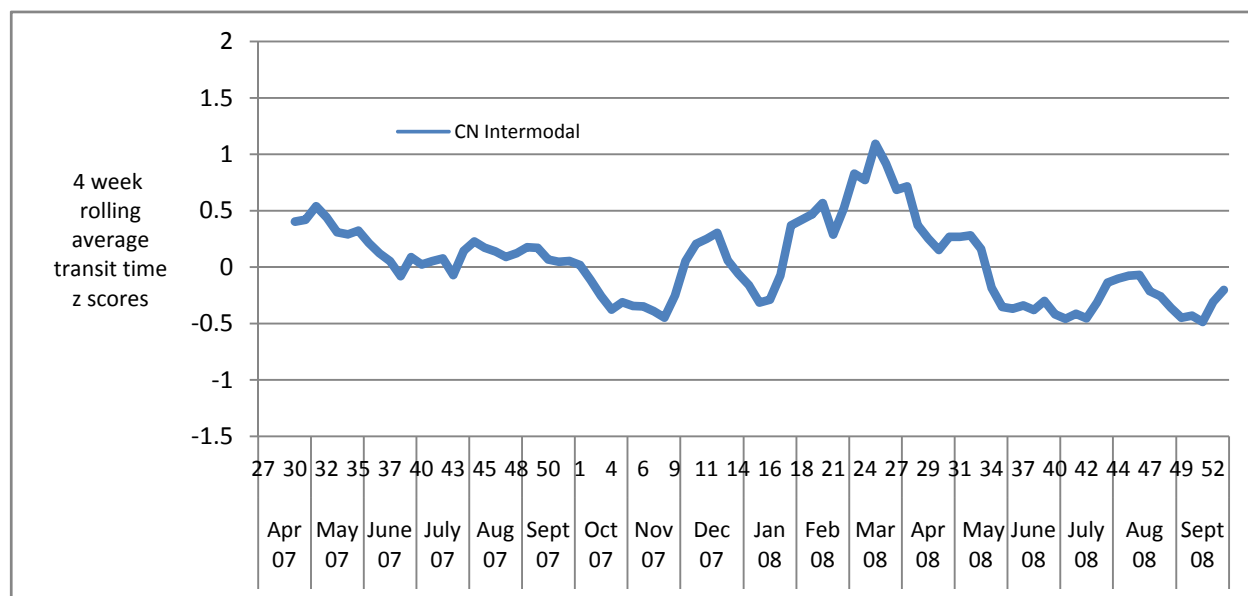
3.4.4 Halifax

Figure 83 Transit time consistency - Halifax Intermodal

Halifax Intermodal	Transit Time Consistency
Canadian National Railway	18.6

CN’s performance for Intermodal traffic originating and terminating at Halifax is approximately equal to their overall system performance on Intermodal. The time series graph below shows that as with Montreal and Vancouver, CN’s major period of disruption to service was in March of 2008 when weather related delays affected service across CN’s network.

Figure 84 CN Intermodal Transit Time z scores – Halifax



3.5 Intermodal Terminal Performance

3.5.1 Detailed Data Validation – Intermodal Terminal Time

The Intermodal terminal time analysis examines the performance of traffic through railway owned intermodal terminals. After reviewing the data in detail, it was determined that the railways had very significant differences in reporting processes at destination intermodal terminals. While CN reports the de-ramp event (removal of container from rail car) directly, CP reports this event using one of four types of event code. They are:

- a. **Awaiting Clearance** - container has arrived at the destination terminal but is not able to be released out the gate as it requires a customs clearance.
- b. **Awaiting Pick-up** - container has arrived at the destination terminal and is able to be released out the gate.
- c. **Offline** - container has arrived at destination and has been provided to another railroad or port for handling.
- d. **Ready Consignee Delivery** - container has arrived at destination and is available to be delivered once an appointment has been agreed to with the customer.

These differences in the data provided were such that a comparison of the two railways would provide misleading information. For this reason, our analysis will be limited to an assessment of railway Intermodal performance through origin terminals only.

At origin the performance assessment is based on the elapsed time from the delivery of the container to the intermodal terminal (in-gate) to train departure. However not all categories of Intermodal traffic could be analyzed due to reporting limitations. The performance of domestic Intermodal traffic that moves between inland railway Intermodal terminals is reported into railway information systems by railway staff and can be assessed without limitation. Import and export traffic, that originates and terminates at port terminals respectively, is only assessed at the inland terminal location. At the port terminal the reporting of container events including loading and unloading of containers to rail cars (ramp and de-ramp events) are reported based on information from port personnel and not controlled by railway personnel. In addition the quality of the available data supplied by CN and CP for events at port terminals was not suitable for analysis that would permit comparison of performance across the railways – 96% of CN import traffic was missing origin in-gate time and 94% of CP export traffic was missing destination train arrival time.

Unlike the carload data provided by the railways that consisted of pre-calculated intervals for individual trip segments the Intermodal data provided by the railways consisted of container trip events, where available, that QGI used to calculate the time intervals used for analysis. The specific events used by QGI for the intermodal origin terminal analysis are shown in Figure 85.

Figure 85 Railway Intermodal Event Types

Container Event	Definition
Origin in-gate	Date and time container delivered to railway intermodal terminal
Origin train departure	Date and time of train departure from origin intermodal terminal

Railway supplied data consisted of 376,512 container trips for Intermodal traffic for the 24 month service review period. As was noted earlier the origin terminal analysis excluded import traffic. Removal of these traffic types yielded a total of 226,836 “origin” trips prior to data quality screening and validation.

The initial screening and validation criteria were similar to that used for other time intervals previously discussed. The data was first trimmed to remove records in the CN strike period as well as any missing event date and time values. This resulted in the removal of 32,671 or 14.4% of eligible origin trips. Secondly the data was reviewed to remove data that reflected inaccurate reporting, or extreme and unusual values that were not representative of normal variation in performance and may provide misleading results. After examination of the data it was determined that all Intermodal terminal times that exceeded a threshold of 168 hours should be removed. This resulted in the removal of an additional 3,315 records or 1.5% of the eligible origin trips.

Figure 86 Percent of records supplied by railways available for intermodal terminal analysis

		Domestic	Import	Export
CN	Origin	66%	See note ¹¹³	58%
CP	Origin	95%	“	55%

3.5.2 Origin Terminal Performance – Intermodal

CN and CP show little difference between them with respect to Intermodal terminal performance at origin. The table below shows that for both railways, origin terminal time is the lowest at their high volume locations in BC, Quebec and Ontario and highest at their lower volume terminals in the Prairie Provinces.

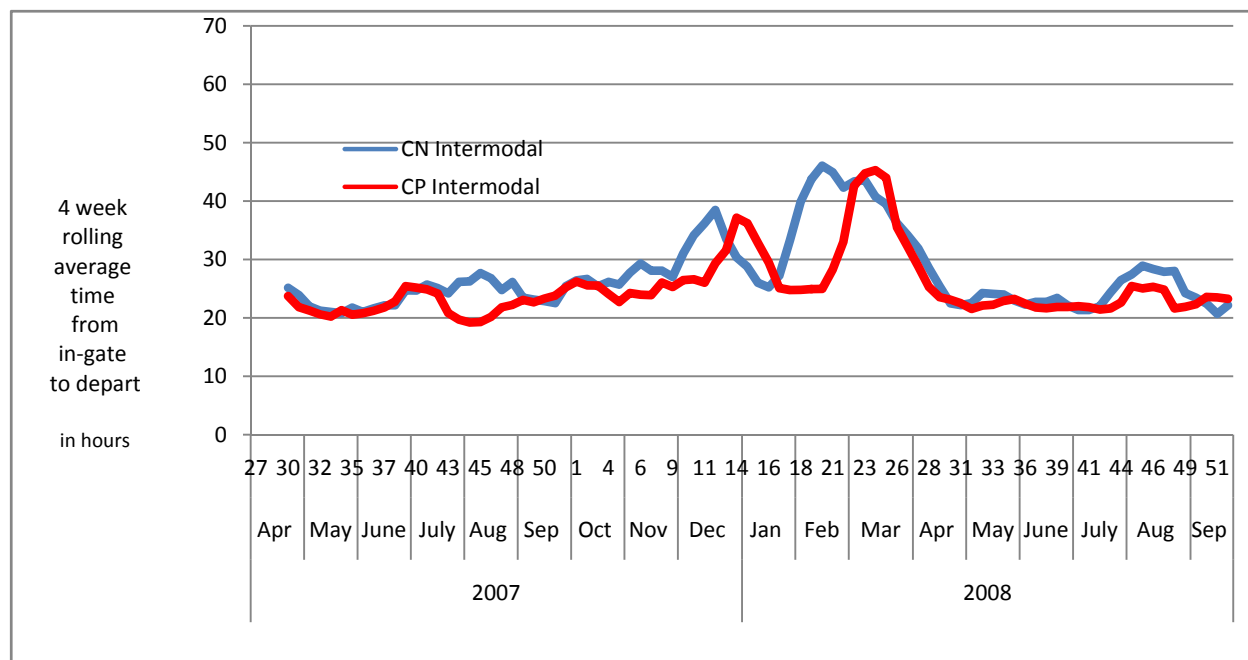
¹¹³ As noted above in the text, at port terminals the reporting of container events including loading and unloading of containers to rail cars (ramp and de-ramp events) are reported based on information from port personnel and not controlled by railway personnel. The quality of the available data supplied by CN and CP was not sufficient to permit the measurement of terminal times for import traffic. 96% of CN import traffic was missing origin in-gate time and 94% of CP export traffic was missing destination train arrival time.

Figure 87 Average time in hours from In-Gate to Departure¹¹⁴

Origin Province	CP - hours	CN - hours
BC	23.8	19.0
AB	31.7	35.5
SK	45.8	65.9
MB	35.8	45.1
ON	20.6	13.8
PQ	22.3	23.8
NS	NA	13.3
Railway Average	24.4	25.9

Underlying these averages is significant variation on both a day to day and seasonal basis. The graph below shows the average origin terminal time for each railway over time.¹¹⁵ Significant increases in average terminal time are apparent for both railways in the winter of 2007-08; however this seasonal increase lasted somewhat longer for CN than for CP.

Figure 88 Intermodal origin terminal time – time series



The railways also have very similar overall performance with respect to the distribution of the average time taken between the in-gate and train departure events as illustrated in the following table. The table shows that within 8 hours 16% of CP traffic and 22% of CN traffic departs on a train. After 24 hours the corresponding numbers are 64% for CP and 61% for CN.

¹¹⁴ This analysis includes all eligible intermodal traffic as described in the data validation section above, for railway terminals in the following locations: Greater Vancouver, Edmonton, Calgary, Regina, Saskatoon, Winnipeg, Greater Toronto, Montreal, and Halifax.

¹¹⁵ As noted in the section on performance by Major Terminal, data for the period from October 2006 to March 2007 were not available at a sufficient level of detail to provide a meaningful time series analysis. Summary statistics by origin province include the available data for the entire study period excluding the 2007 CN strike period.

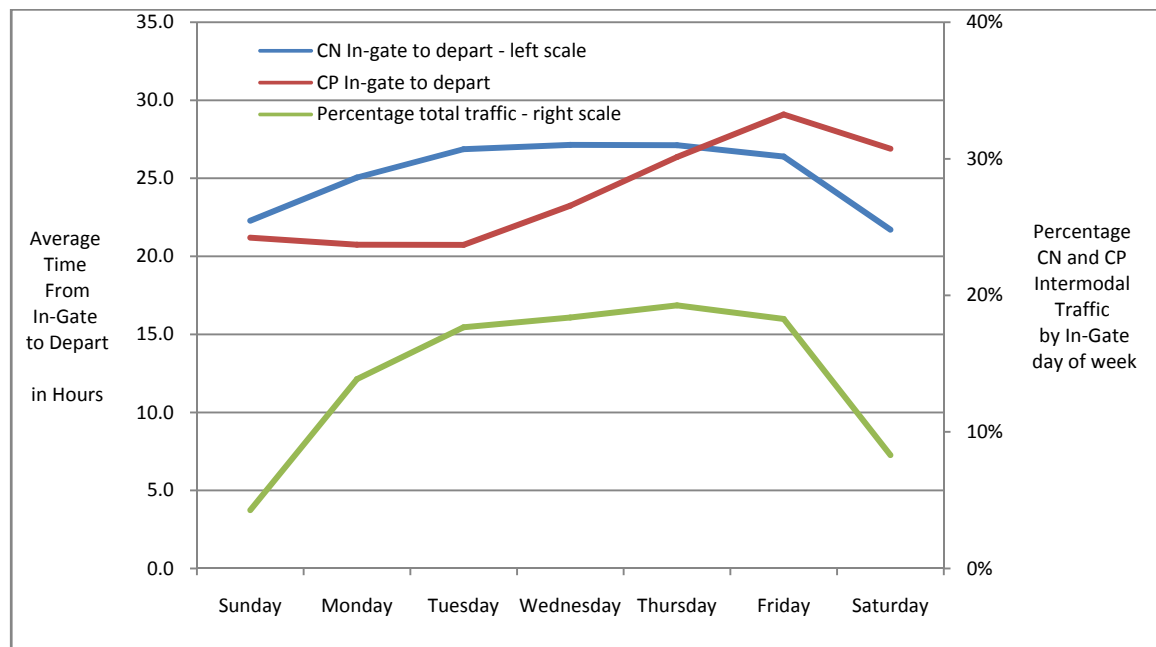
Figure 89 Distribution of Intermodal Origin Terminal Time

Origin Province	0 - 4 hours	> 4 - 8 hours	> 8 - 16 hours	>16 - 24 hours	>24 - 48 hours	> 48 - 72 hours	> 72 hours
AB	0%	1%	17%	24%	44%	9%	5%
BC	2%	11%	30%	19%	27%	6%	4%
MB	0%	1%	6%	17%	59%	12%	5%
ON	5%	18%	34%	16%	20%	4%	3%
PQ	3%	12%	40%	23%	13%	3%	6%
SK	0%	1%	8%	14%	43%	17%	17%
Total CP	3%	13%	30%	18%	25%	6%	5%

Origin Province	0 - 4 hours	> 4 - 8 hours	> 8 - 16 hours	>16 - 24 hours	>24 - 48 hours	> 48 - 72 hours	> 72 hours
AB	1%	6%	16%	21%	35%	10%	12%
BC	2%	23%	37%	9%	21%	5%	2%
MB	0%	2%	7%	14%	43%	18%	15%
NS	5%	37%	38%	2%	15%	2%	1%
ON	16%	29%	26%	12%	14%	2%	1%
PQ	1%	13%	41%	19%	14%	7%	5%
SK	0%	0%	4%	8%	32%	21%	35%
Total CN	6%	16%	23%	16%	25%	7%	7%

In addition, the intermodal origin terminal performance data was assessed to determine whether or not the day of the week that containers were delivered to terminals, affected their terminal dwell time. As can be seen from the following graph, there is a difference between the railways in average origin terminal time by day of the week. CP, while having a 1.5 hour lower average terminal dwell time than CN Sunday - Thursday, shows an increase in the origin terminal time for containers delivered on Fridays and Saturdays.

Figure 90 Intermodal Origin Terminal Time by day of week



3.6 Transit Performance for Car Blocks

The shipment of rail cars in multi car blocks is a common characteristic of railway transportation. For the purposes of this analysis, a car block is defined as a group of more than one car of a single commodity released loaded on the same day by a shipper at a single origin and destined to the same destination. Although generally associated with bulk commodities such as coal, sulphur, potash and grain, shippers in all non-Intermodal commodity groups ship some proportion of their traffic in multi car blocks. Car blocks range in size from 2 to more than 120 cars depending on the commodity. Commodities such as coal, sulphur, potash, and grain often move in unit train lots of more than 100 cars.

In most cases, there is no commitment made by railways that cars released in a block will be delivered as a block at destination. Shippers may have contractual commitments in this regard however, these are quite rare. Even in cases where preferential freight rates are established on the basis of a shipper releasing cars in a block as is common in the grain industry, these rate commitments do not necessarily include a commitment by the railway to deliver the cars in a block. However, when car blocks are split without the expectation on the part of the shipper that this will be done, it can create difficulties in logistics planning as rail customers may not correctly predict the arrival time at destination of split blocks of traffic. As shown in the table below, blocks of 10 cars or more represent approximately 34% of CN’s carload traffic and 24% of CP’s traffic. Car blocks are most common in grain movements for both railways.

Figure 91 Percent of Cars Moving in Blocks of 10 or more cars¹¹⁶

Railway	Automotive	Bulk	Fertilizers	Grain	Merchandise	Total
CN	32%	36%	44%	78%	21%	34%
CP	19%	8%	20%	86%	29%	24%

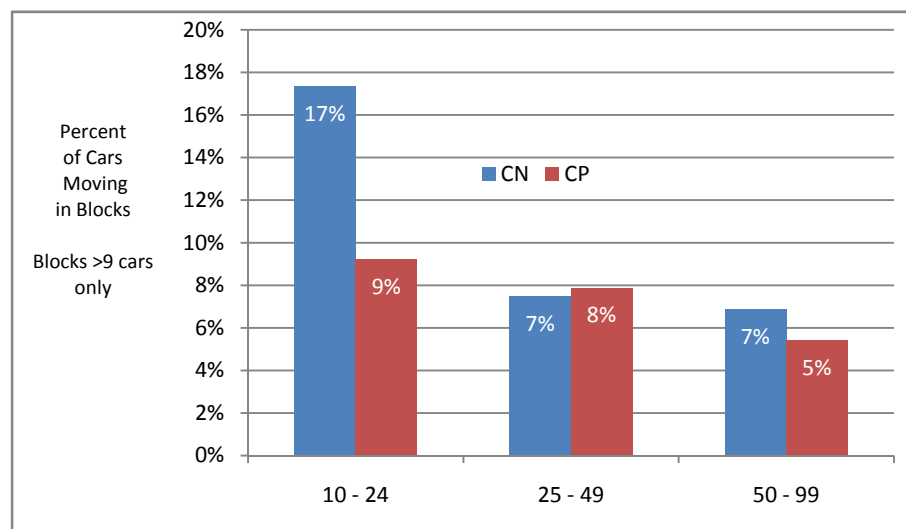
Our analysis of car block transit performance examines the frequency with which car blocks of 10 or more cars shipped at origin are split apart en route and arrive at destination as multiple blocks. Car blocks were identified in the sample data using the first event date information for each car trip provided by the railways. Car blocks were grouped into five categories as follows:

Figure 92 Car Block Categories

Car Block Category	Number of Cars
0	2 – 9
1	10 – 24
2	25 – 49
3	50 – 99
4	>99

Blocks were determined to have been split in transit when one or more cars in a block had a transit time greater than 8 hours longer than (as calculated from departure at origin to arrival at destination station) the minimum transit time for cars in the same block. Blocks arriving at destination were similarly grouped together using the same 8 hour rule.

Figure 93 Percent distribution of sample car trips by block size¹¹⁷



Blocks of 10-24 cars are most common in the Automotive, Fertilizer and Merchandise segments whereas grain is the dominant commodity in the 25-49 and 50-99 car block categories for both railways. Approximately 62% of CP grain traffic and 48% of CN grain traffic move in these block sizes. A more detailed description of

¹¹⁶ The analysis of car block performance excludes coal movements as this traffic moves almost exclusively in unit train lots of 100 cars or more and based on the statistical sample data reveals almost no occurrences of trains being split in transit. The proportion of traffic moving in multi car blocks changes for both railways when coal traffic is included with block movements accounting for 48% and 78% of CN and CP traffic respectively. The CP sample data also reflects a disproportionately heavy weighting of coal traffic.

¹¹⁷ Data for blocks of more than 100 cars are not shown in the discussion of individual car block groups as there were too few observations once coal was removed from the analysis although these are included in summary totals by major group and railway.

multi car block movements by Major Commodity group can be found in Appendix 5.

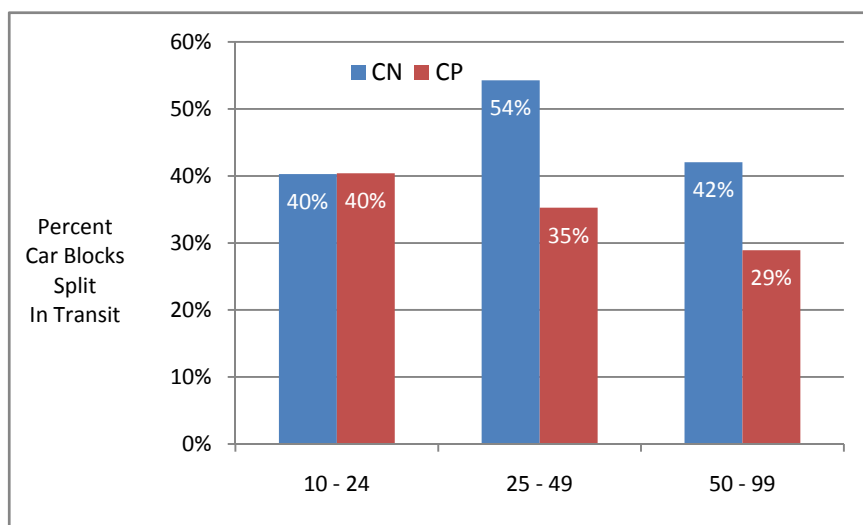
As shown in the table below the frequency of block splitting is comparable for CN and CP both in total and across all Major Commodity groups with the exception of bulk traffic where CN had a noticeably higher incidence of splitting blocks particularly within the 25-49 car block group.

Figure 94 Percent of Car Blocks Split in Transit by Major Commodity Group

Railway	Automotive	Bulk	Fertilizers	Grain	Merchandise	Total
CN	37%	39%	24%	39%	47%	42%
CP	34%	29%	19%	38%	43%	38%

Closer examination of the data reveals that CN’s traffic in this cross tabulation consisted primarily (75%) of potash traffic destined to US locations whereas CP’s traffic while also containing some US destined potash consisted mostly (78%) of sulphur traffic destined to Vancouver. The high incidence of block splitting in this instance reflects the characteristics of the traffic in that sulphur moves to bulk terminal facilities in Vancouver with the destination infrastructure able to handle large car blocks whereas much of US destined potash while originating in blocks is split at destination as receivers often do not have the ability to unload large blocks.

Figure 95 Percent of Car Blocks Split in Transit by Block Size



While CN has a slightly higher incidence of splitting car blocks in transit as compared to CP the performance of the two railways is the same for 10-24 car blocks and CN splits a substantially higher percentage of 25-49 and 50-99 blocks. As noted earlier the 25-49 and 50-99 car blocks for both railways consist largely of grain traffic.

The chart below depicts the frequency of block splitting across time for CN and CP. The relative level of activity rose for each railway during the winter months however, block splitting was more common throughout much of 2008 than it was earlier in the study period.

Figure 96 Percent of car blocks split in transit over time

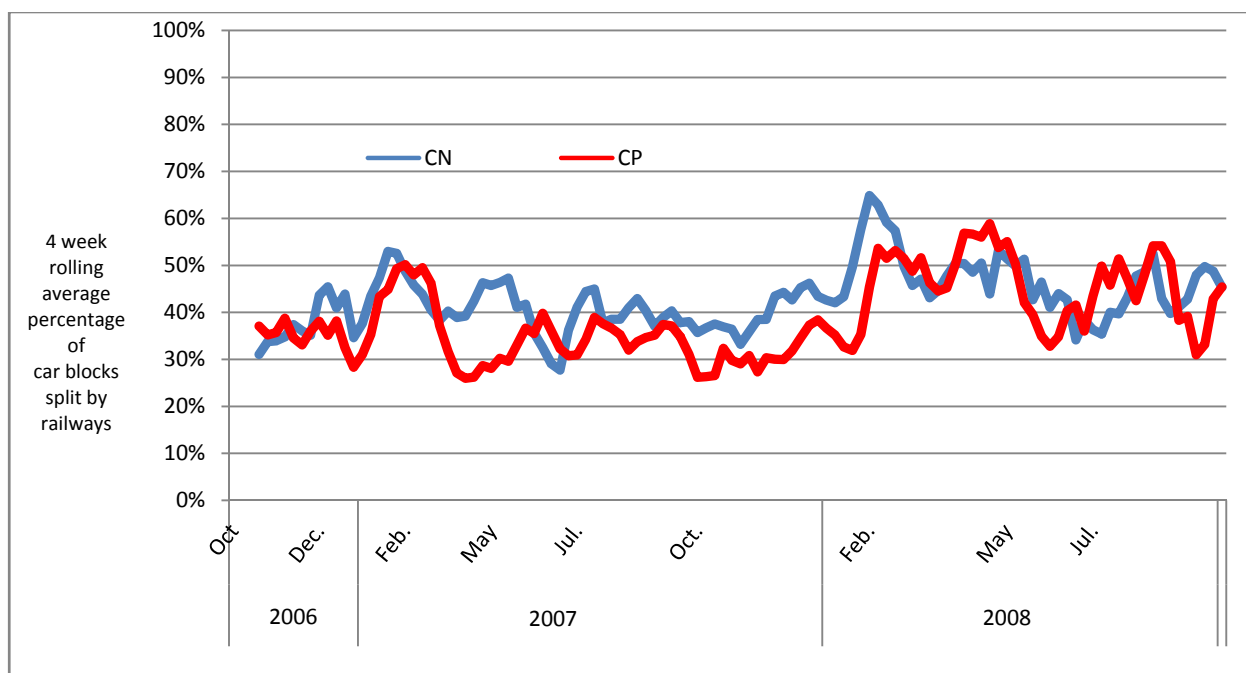
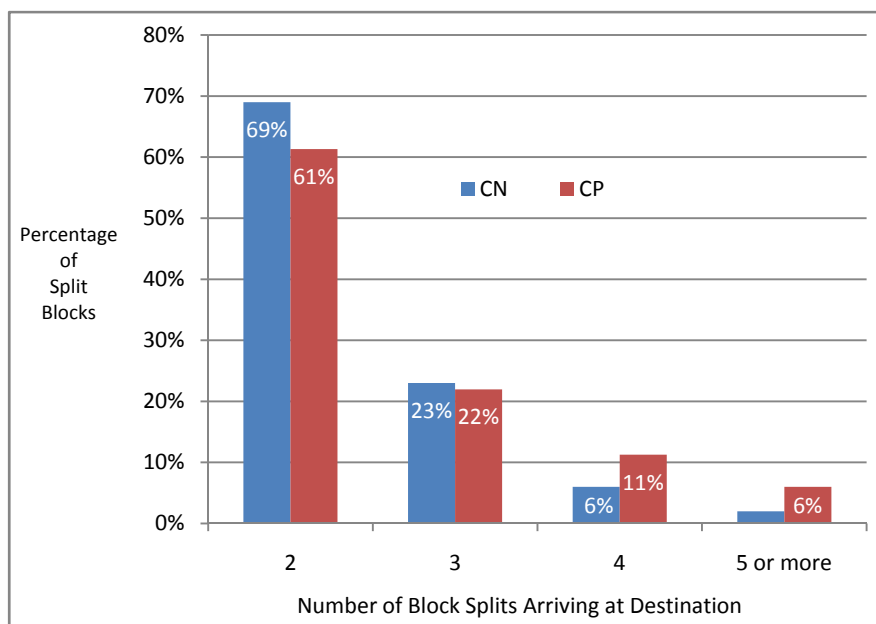


Figure 97 Percentage of Split Blocks by Number of Blocks at Destination



Blocks of cars departing their origin location together can be split into as few as 2 and as many as 10 blocks prior to arriving at destination. As shown in the chart on the left, for both CN and CP, when blocks are split en route they are most often split into two blocks. However, more than 30% of the time a car block that is split en route results in 3 or more blocks arriving at destination.

Fifty-six percent of all cars in car

blocks that are split by railways arrive at destination in the first block (59% on CN and 52% on CP). The average delay incurred by the last block to arrive can range from as little as 8 hours to more than 100 hours. With the exception of

the Potash and Sulphur traffic shown in the Bulk category below, the average delay to CP traffic is significantly higher than to CN traffic when blocks are split.

Figure 98 Average Maximum Delays for Blocks Split in Transit (Hours)

Railway	Automotive	Bulk	Fertilizers	Grain	Merchandise	Total
Canadian National Railway	25.5	71.3	54.8	55.0	38.7	46.2
Canadian Pacific Railway	54.0	57.8	111.9	106.2	73.0	82.3
	33.8	66.4	69.6	76.3	49.6	58.8

3.7 Delivery to Shippers at Final Destination

The transit time analyses in the preceding sections do not include the time taken for railways to deliver rail cars to customers once trains arrive at their final destination. As noted earlier in the report, for time at destination, there is a mix of accountability for performance between railways and consignees. Due to the complexities of apportioning responsibility for time at destination between railways and receivers, the time taken for cars to be delivered at final destination is evaluated separately from the origin to destination transit time analysis.

For bulk unit train traffic this time can be minimal involving only the reporting of the event of delivery, immediately after the train arrives at the destination terminal. In such cases, the final delivery time will be reported within minutes of the arrival time at destination. However, most traffic – including some unit train traffic – must be staged for final delivery to receivers. In the case of bulk terminals, this may be done because of limitations in the receivers' ability to immediately accept trains on their site or it may be done because the delivery of trains to bulk terminals must be coordinated with the use of railway assets and infrastructure for the movement of other products through the same destination terminals. For traffic moving in less than unit train volumes, the activities associated with arrival at a destination terminal will differ depending on the nature of the train service performing the delivery. Where customers are located close to large destination terminals such as Vancouver, Edmonton, Calgary, Winnipeg, Toronto or Montreal – traffic will normally arrive on mixed trains and these trains will need to be broken up in the railways' classification yards so that traffic can be arranged for delivery to customers. Some railway customers have the facilities to accept all traffic offered as it arrives and some customers require the railways to hold their traffic in railway yards. For customers who require railways to hold traffic until it is ordered for delivery, the railways will customarily place the cars in a "constructively placed" status in their information systems. This denotes that the cars are being held at customer rather than railway convenience, and will normally also trigger the beginning of the demurrage process.

As was noted in QGI's report on railway operating practices,¹¹⁸ railway and shipper processes for coordinating their joint operations at both origin and destination can have significant impact on the overall efficiency of the rail freight logistics system. This section of the report provides some insight therefore into the effectiveness of the coordination of railway and receiver processes for managing the movement of rail cars to final placement at destination.

3.7.1 Data Validation

Like the loading and unloading analyses the examination of railway time at destination is limited to trips that terminate at stations served by CN and CP.

Three separate time intervals were validated for inclusion in the analysis. For cars constructively placed at destination prior to final placement two intervals were required – time from arrival to constructive placement and from constructive placement to final placement. For these cars the data was examined to ensure that both intervals were present and valid to allow for the calculation of total time at destination. For cars not constructively placed the time interval from arrival at destination to actual placement at receiver location was validated. These intervals were then used to calculate a time interval for “total destination railway time”. For constructively placed cars this was the total of the two time intervals noted above and for all other traffic it was the time interval from arrival to placement.

Railway supplied data consisted of 502,489 car trips for non-Intermodal traffic for the 24 month service review period. As the analysis is limited to trips terminated by CN and CP all interline forwarded and shortline terminated trips are removed from consideration. This eliminated 172,303 trips or 34.2% of the base records yielding a total of 330,186 records prior to screening.

The screening and validation criteria for the three time intervals noted above was similar to those used for other time intervals previously discussed. The data was first trimmed to remove records in the CN strike period and any blank, missing or negative time intervals. Second the data was reviewed to remove data that reflected inaccurate reporting, or extreme and unusual values that were not representative of normal variation in performance and may provide misleading results. After examination of the data it was determined that all total destination railway times that exceeded a threshold of 168 hours should be removed.

This resulted in the removal of 46,039 or 13.9% of the trips terminated by CN and CP.

Figure 99 Percent of records supplied by railways available for destination railroad time analysis

<u>Railway</u>	<u>Automotive</u>	<u>Bulk</u>	<u>Fertilizers</u>	<u>Grain</u>	<u>Merchandise</u>	<u>Total</u>
CN	95%	96%	96%	96%	94%	95%
CP	75%	75%	42%	62%	68%	72%

¹¹⁸ *Analysis of Operating Practices* QGI Consulting October 2009 Report prepared for the Rail Freight Service Review.

3.7.2 Analysis of Railway Performance – Time to Placement at Final Destination

In the table below, the distribution of delivery times is shown for all traffic that was not constructively placed on arrival at a destination location. In addition, the proportion of traffic that was constructively placed is shown as a percentage of the total. It is clear that the two railways have very different processes for the use of the constructive placement status with far more CN traffic in the non-Intermodal sample being constructively placed than CP traffic (26% versus 3%).

Figure 100 Distribution of Rail Delivery Times at Destination

Major Group		< 1 hour	1- 8 hours	> 8 - 16 hours	>16 - 24 hours	>24 - 48 hours	> 48 hours	Constructively	Total
								Placed at Destination	
CN	Automotive	4%	2%	3%	4%	2%	2%	84%	100%
	Bulk	77%	11%	2%	1%	1%	1%	6%	100%
	Fertilizers	77%	11%	0%	3%	3%	2%	4%	100%
	Grain	55%	12%	3%	3%	3%	2%	22%	100%
	Merchandise	20%	11%	5%	5%	8%	11%	41%	100%
Total CN		47%	11%	3%	3%	4%	5%	26%	
CP	Automotive	61%	10%	7%	7%	9%	7%	0%	100%
	Bulk	97%	2%	0%	0%	0%	0%	0%	100%
	Fertilizers	87%	1%	1%	0%	1%	4%	6%	100%
	Grain	10%	25%	14%	9%	14%	22%	6%	100%
	Merchandise	59%	9%	3%	3%	4%	5%	18%	100%
Total CP		80%	6%	3%	2%	3%	4%	3%	
Total CN CP		65%	8%	3%	2%	3%	4%	13%	100%

In assessing the time taken to place traffic after arrival at destination QGI decided to separate traffic that is generally spotted immediately upon arrival from traffic that must be staged. Therefore, all traffic on either railway where the spotting activity took place routinely within one hour of arrival at destination was excluded from the analysis. When traffic that was placed within one hour of arrival is excluded from the analysis, the railways have very similar service levels at the aggregate level, by major commodity group, as can be seen in the table below.

Figure 101 Average Time from Arrival to Placement – excluding traffic placed within 1 hour of arrival

Average Total Time from Arrival to Placement (in Hours)

Major Group	CN	CP	Total
Automotive	31	27	30
Bulk	10	10	10
Fertilizers	27	s/c	35
Grain	27	35	32
Merchandise	40	47	41

It is important to note that the mix of traffic and destination terminal configurations will affect the normal time required for a railway to position traffic for delivery to customers. **Therefore, while the differences between the railways are shown for illustrative purposes, a higher or lower number for one railway or**

the other should not be interpreted as reflecting either better or worse performance. Appendix 5 includes a table with the average unloading times by railway broken out at a more detailed commodity level.

For traffic that is constructively placed at destination, there is a wide distribution of delivery times, as is shown by the following table.

Figure 102 Distribution of Rail Delivery Times at Destination – constructively placed traffic

Major Group	< 1 hour	1 - 8 hours	> 8 - 16 hours	>16 - 24 hours	>24 - 48 hours	> 48 hours	Total
CN Automotive	6%	15%	15%	18%	25%	20%	100%
Bulk	15%	71%	4%	0%	9%	2%	100%
Grain	0%	19%	22%	11%	23%	25%	100%
Merchandise	3%	15%	7%	9%	27%	39%	100%
	4%	20%	10%	10%	25%	31%	100%
CP Grain	0%	0%	2%	9%	20%	69%	100%
Merchandise	0%	1%	0%	6%	27%	66%	100%
	0%	0%	1%	7%	25%	67%	100%
Total CN CP	3%	18%	9%	10%	25%	36%	100%

When traffic that is and is not constructively placed is considered together, CN placed 58% of the traffic in the sample data within 8 hours of arrival and CP placed 86%. Fertilizer traffic for both railways and bulk and automotive traffic for CP are not included in the above analysis of constructively placed traffic as very little of this traffic is constructively placed, as indicated in the earlier tables. For the traffic that was delayed over 48 hours after constructive placement, the following table summarizes the average time between arrival and placement and shows the percentage of the total traffic in the commodity group in the sample.

Figure 103 Constructively Placed Traffic Delayed over 48 hours at Destination

		Average Time to Placement in Hours	Percentage Total Traffic in Sample Commodity Group
CN	Finished Vehicles	81	17%
	Grain	82	3%
	Lumber & Panels	80	12%
	Metal Products	86	10%
	Ores & Concentrates	73	28%
	Other Forest Products	91	12%
	Petroleum Products	76	10%
	Woodpulp	80	34%
Total CN		82	
CP	Grain	95	3%
	Ores & Concentrates	102	61%
	Paper Products	87	31%
	Petroleum Products	108	11%
	Woodpulp	76	32%
Total CP		96	

It is likely that most of the time for the traffic delayed over 48 hours at destination can be attributed to customers' inability to accept for unloading all of the traffic arriving at destination. However, some of this time is a joint responsibility of the customer and the railways as inconsistency in transit times can create traffic bunching at destination which will contribute to congestion at destination terminals. Shippers, receivers and railways have a joint responsibility to manage the rail logistics system to anticipate and to take action to alleviate periods of congestion at destination locations.

When viewed from a geographic perspective the following locations on CN and CP are responsible for the majority of the total rail car delays for traffic awaiting placement at final destination.

Figure 104 Locations of major delays to traffic at destination

CN	NORTH VANCOUVER	BC
	LULU ISLAND YARD	BC
	ST LAURENT	PQ
	THUNDER BAY	ON
	SHAWINIGAN	PQ
CP	THUND BAY EL	ON
	THUNDER BAY	ON
	VANCOUVER EL	BC
	CALGARY	AB
	TRAIL	BC

For CN, the commodity groups responsible for the majority of the car delays at these destinations were in the forest products group, building materials and grain products. These five locations represented 52% of all CN rail car delays at destination in the sample data.¹¹⁹

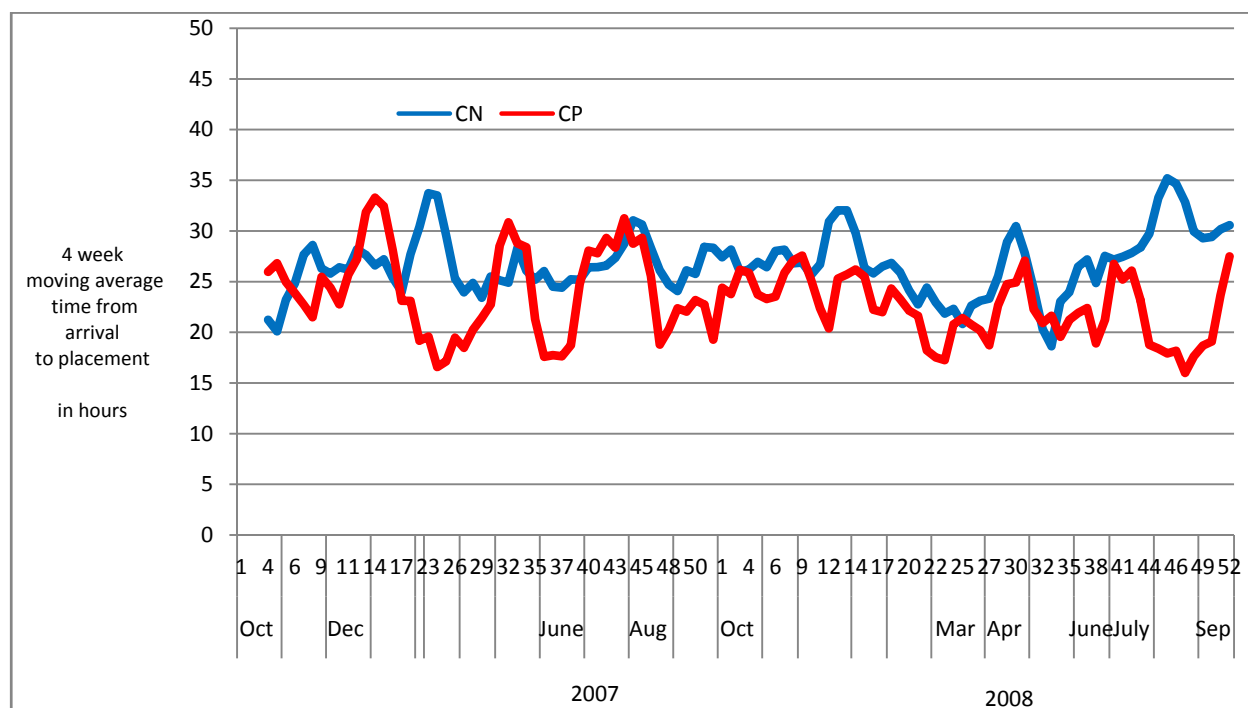
For CP, these five locations were responsible for 63% of all rail car delays at destination in the sample data. The commodity responsible for most of the delays was grain, with smaller impacts

¹¹⁹ Total rail car delays at a location was calculated by taking the average time from arrival to placement in hours and multiplying by the number of cars destined to a location in the sample data.

from ores and concentrates and petroleum products¹²⁰.

While it might be expected that seasonal weather delays would be a major contributor to delays in spotting of rail cars at receivers after arrival at destination, the following chart suggests that this is not the case.

Figure 105 Average Time to Placement at Destination - by week



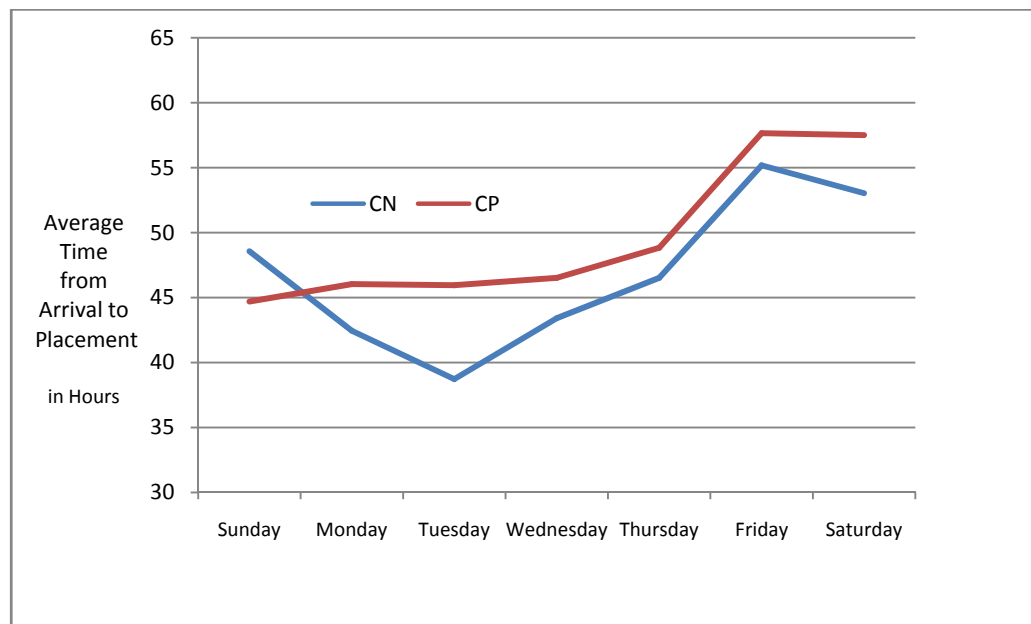
In the above chart, variation in final placement times is noted throughout the year suggesting that the average placement times are affected more by the seasonal mix of traffic and ongoing operating issues than by weather factors.

3.7.3 Delays attributable to Day of the Week Arrival

One of the reasons for delays in the placement of cars at destination is a lack of 7 day per week operations at either receiver facilities or at railway facilities. The following chart suggests that this effect is considerable. When the time between arrival and placement is assessed by day of the week, it is clear that traffic arriving at destination on Saturdays and Sundays takes longer to be placed. It is highly likely that the majority of these delays are due to the railways needing to stage traffic on their own lines awaiting the opening of receiver facilities that do not accept railcars on weekends.

¹²⁰ The destinations stations identified in this table reflect the waybill destinations contained in the railway supplied data.

Figure 106 Average Time from Arrival to Placement – by arrival day of the week¹²¹



As illustrated by this chart above, the impact of the day of week of arrival has a significant effect on the time taken for rail traffic to be placed at receivers’ sidings. Overall, traffic that arrives at destination rail yards on Friday and Saturday takes 23% longer to be placed at destination than traffic arriving on all other days of the week.

¹²¹ This chart displays average times to placement for all traffic on both railways excluding traffic that is placed within 1 hour of arrival at destination, and excluding all coal, sulphur and fertilizer traffic. These commodity groups were excluded as their high volumes and very low average times to placement would skew this analysis and provide misleading results.

3.8 Analysis of Rail Car Loading and Unloading Time

As a component of the total rail car cycle between origin and destination, the time that railway shippers take to load and unload rail cars can be very significant. At an aggregate level for all lengths of haul, loading and unloading time ranged from as low as 10% to over 100% of railway transit time depending on the traffic, equipment and commodity groups.

This section of the report examines loading and unloading time performance for cases where the railways are the predominant suppliers of rail cars to shippers. In many rail transportation markets, shippers provide and control the distribution of their own rail cars for shipping their products. In the petroleum and chemical markets particularly shippers provide their own rail cars in virtually all cases. However, in certain agricultural and food products and fertilizer sub-segments, shipper provided cars are also extremely common. In addition, in Canada, dry sulphur is moved exclusively in shipper provided rail cars. In cases such as these, when shippers are holding private rail cars on their own sidings, it is difficult to distinguish between the time that cars are in the loading or unloading cycle, and the time that cars may be stored on shipper property, at the shippers' convenience.

For this report, loading and unloading time is examined for railway shippers of the following commodities:¹²²

- Grain
- Pulses and Special Crops
- Lumber and Panels
- Paper Products
- Woodpulp
- Machinery
- Metal Products
- Ores and Concentrates
- Other Forest Products
- Potash
- Coal
- Finished vehicles

These commodities accounted for approximately 76% of all non-Intermodal rail traffic in the sample data.

Of interest in this analysis is how loading and unloading time differs across the commodity groups and whether or not there is a relationship between changes in loading/unloading times and railway transit time performance. As noted above, loading time was only assessed for trips originating on CN and CP and unloading time was only assessed for

¹²² In addition to the exclusions listed above, coal shipments were excluded from our loading time analysis as the reported interval times between the empty placement of coal cars and their release loaded often did not accurately reflect the time that the cars spent in the loading process. Loading time for finished vehicles was also excluded from this analysis as multilevel auto carriers are often moved in a load to load cycle, unloading one type of automobile and then re-loading a different type at auto terminals. This is a highly efficient use of rail cars however, it complicated analysis of loading times in the data provided by the railways and prevented the accurate estimation of loading times in this commodity segment. Both coal and finished vehicles were included in the unloading time analysis.

trips terminating on CN and CP. Loading time and unloading time on shortline railways could not be evaluated as the data provided by CN and CP for time spent on shortline railways did not include a breakdown of the time spent in linehaul versus loading or unloading time.

3.8.1 Detailed Data Validation – Loading and Unloading Times

As was done for the transit time analysis QGI screened the data to assess the quality of the time intervals provided by the railways for loading times at origin and for unloading times at destination. These two intervals are to be used for measuring shipper loading performance and receiver unloading performance respectively. Performance analysis in this area excludes all Intermodal traffic. Total data submitted by the railways prior to screening by QGI included 502,489 car trips for non-Intermodal traffic for the 24 month service review period.

As was noted earlier each car trip record was classified into one of six trip types. However for the analysis of loading and unloading performance these six trip types can be grouped into two categories – trips originating and terminating at CN or CP served stations and trips originating and terminating at shortline stations.

The limitations on the data resulting from shortline reporting capabilities and processes do not permit direct comparison of loading and unloading performance between shortline served and CN / CP served shippers. While the loading and unloading times for CN and CP originated and terminated trips reflect shipper and receiver time specifically for shortline originated and terminated trips, they reflect the total time the car is on the shortline, only a portion of which is directly shipper or receiver time.

The initial screening criterion for these time intervals was the same as that used for the transit time analysis – i.e. the data was screened to ensure the time interval value was not a blank or negative value. Secondly the data was reviewed to remove data that reflected inaccurate reporting, or extreme and unusual values that were not representative of normal variation in performance and may provide misleading results. After examination of the data it was determined that all loading times that exceeded reasonable thresholds for both trip types should be removed. For CN and CP originated / terminated trips a threshold of 168 hours was used for both loading and unloading, and for shortline trips a threshold of 720 hours was used. This resulted in the removal of 88,432 or 17.6% of the total car trips. In addition, to exclude extreme outliers from the analysis, records with loading time z scores of +/- 3.0 were also removed from the analysis. This resulted in the reduction of 6,759 trips or a further 1.3% of the cars.

Figure 107 Percent of records supplied by railways available for loading time analysis

<u>Railway</u>	<u>Trip Category</u>	<u>Automotive</u>	<u>Bulk</u>	<u>Fertilizers</u>	<u>Grain</u>	<u>Merchandise</u>	<u>Total</u>
CN	CN Originated	77%	92%	73%	89%	72%	80%
CP	CP Originated	72%	87%	61%	81%	50%	78%

Unloading performance will only be examined for trips that are terminated at stations served by CN and CP. Interline forwarded trips and trips terminating on shortlines are excluded. If we remove these trips from the base the total number of trips submitted by the railways is 340,567 or approximately 68% of the total car trips.

Figure 108 Percent of records supplied by railways available for unloading time analysis

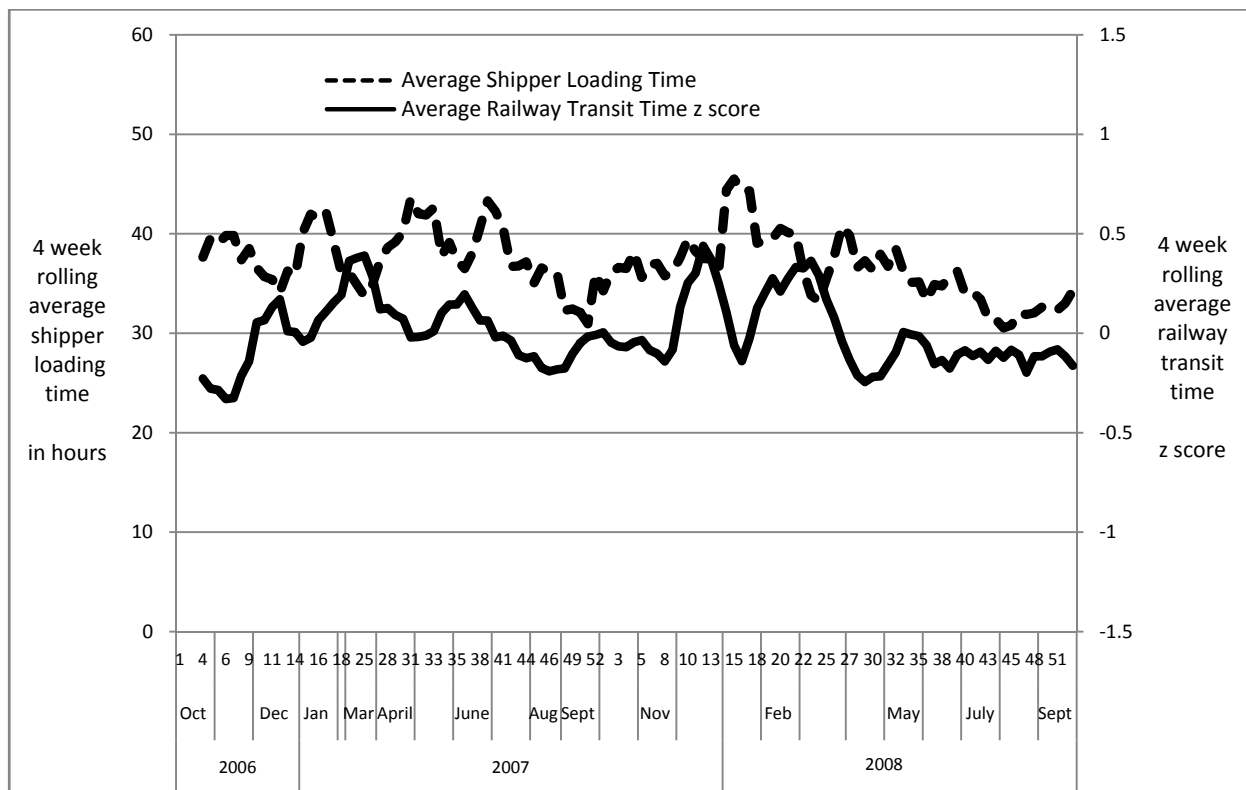
<u>Railway</u>	<u>Trip Category</u>	<u>Automotive</u>	<u>Bulk</u>	<u>Fertilizers</u>	<u>Grain</u>	<u>Merchandise</u>	<u>Total</u>
CN	CN Originated	96%	94%	87%	94%	87%	91%
	Shortline Originated	86%	100%	0%	88%	66%	75%
		95%	94%	87%	92%	82%	88%
CP	CP Originated	57%	73%	36%	17%	64%	62%
	Shortline Originated	0%	0%	0%	0%	17%	13%
		50%	73%	36%	17%	57%	61%

3.8.2 Railcar Loading Time

The chart below shows the relationship between railway transit time performance and loading time performance for shippers of the products listed above. Railway performance is assessed using the average transit time z score per week. As described earlier in the report, this provides a view of the degree to which railway service in a given week deviated from the mean performance for traffic that had a trip start date during that week. While some variation in this measure is to be expected as a result of normal performance variation and changes in the mix of traffic in the sample from week to week, it provides a reasonable way to identify major departures from normal service variation.

The actual loading times for individual rail car shipments were used to assess loading time. This was an alternative to using a more complex variable such as the z scores of loading time for individual rail cars. As loading time is in a more narrow range of absolute values than transit time the average absolute values of loading time provide a useful measure of loading time performance on a system basis. The following graph shows the comparison between transit time z scores and average loading time.

Figure 109 Transit Time Consistency and Average Rail Car Loading Time



In addition to comparing the data series using the above graph, the data was subjected to statistical analysis to determine whether or not there was a statistical relationship between transit time variability and loading time. When loading time and loading time z score and transit time z score values were compared using regression analysis no meaningful relationship between the two values was apparent. This suggests that railway transit time performance does not drive the variability noted in rail car loading time and that shipper specific issues in their own supply chain management activities are the reason for the variability observed.

Appendix 5 contains more detailed loading and unloading performance information for each of the commodity subgroups in this analysis. The following table provides a summary of the average loading performance and the range of performance estimates for each of the sub-groups. The values in this table are reflected in the chart below which provides a visual presentation of the relative consistency of performance of rail car loading by shippers in each of the commodity groups.

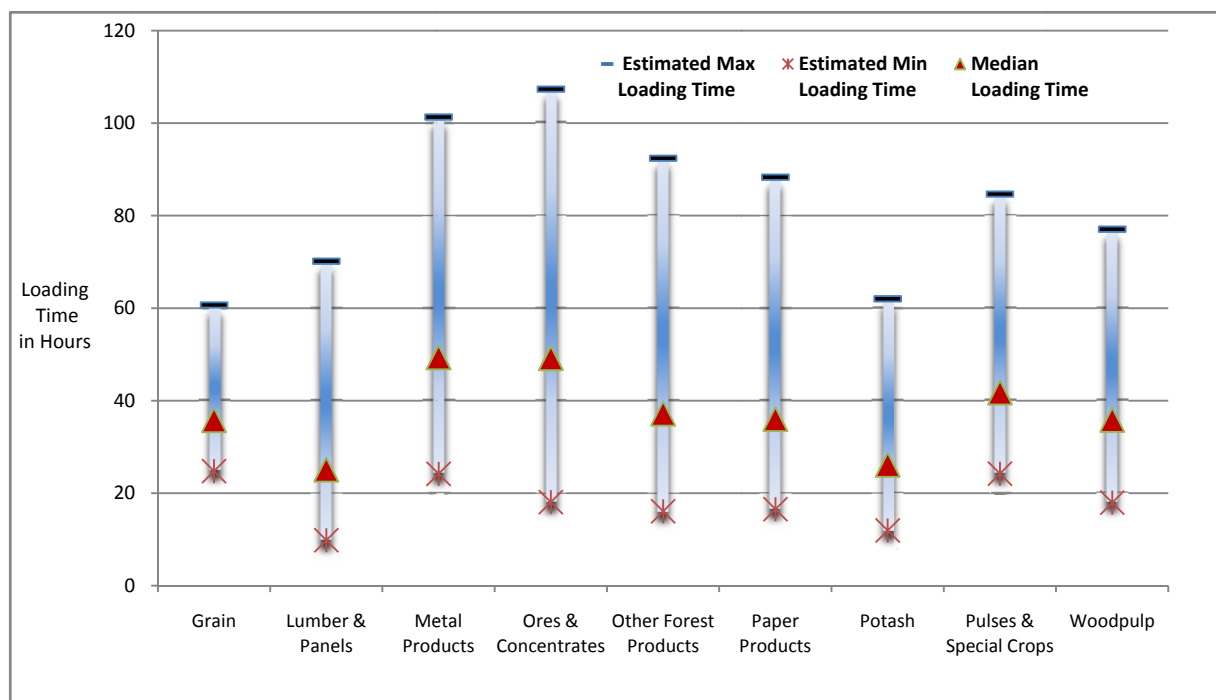
Figure 110 Estimated Minimum, Maximum and Median Loading Times by Commodity¹²³

Commodity Sub-Group	(Hours) Estimated Max Loading Time	(Hours) Estimated Min Loading Time	(Hours) Median Loading Time
Grain	61	25	36
Lumber & Panels	70	10	25
Metal Products	101	24	49
Ores & Concentrates	107	18	49
Paper Products	88	17	36
Potash	62	12	26
Pulses & Special Crops	85	24	42
Woodpulp	77	18	36

The chart below shows that while the lowest median loading times are found in the Lumber and Panels group and the Potash group, Grain shippers have the least variability in loading times. Lower levels of variability suggest greater predictability and reliability of the underlying business processes. Low variability will normally result in a

lower overall logistics cost as it allows supply chain partners to plan their operations more effectively. In general, the lower the variability in all segments of the car cycle, the fewer the number of railcars needed to support a given volume.

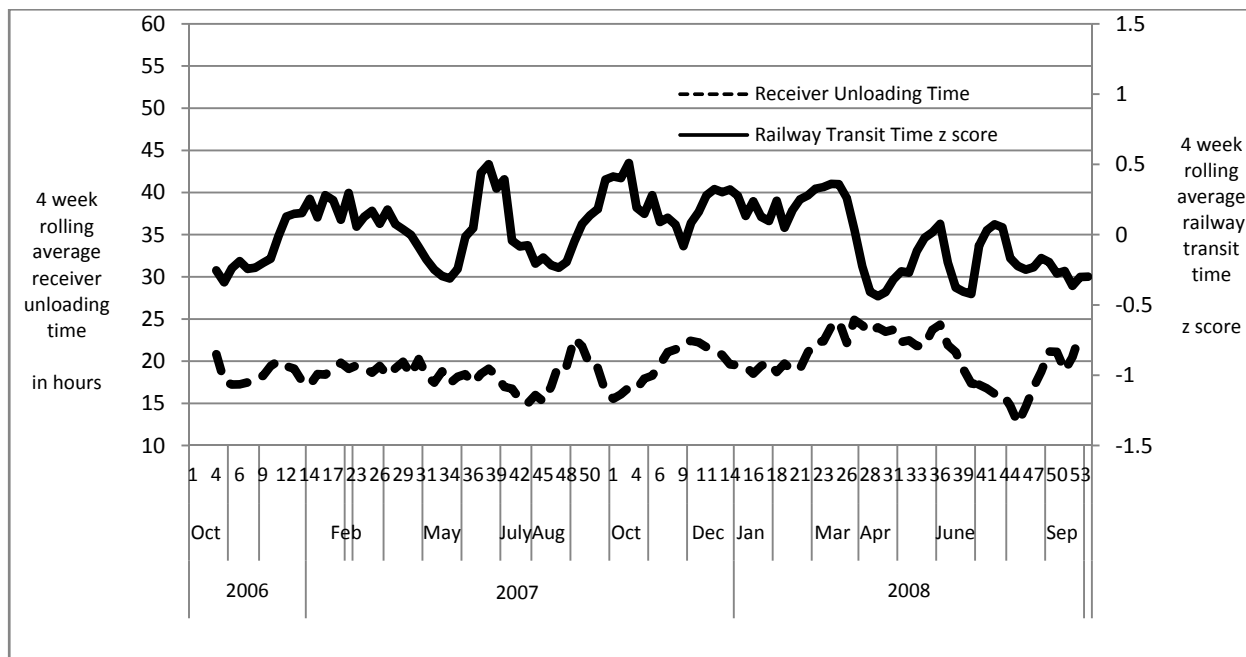
Figure 111 Relative Loading Consistency by Commodity Group



¹²³ Median loading times are calculated directly from the railway data. Estimated maximum loading times are equal to the average loading time for the group multiplied by 1.64 times the actual standard deviation of loading time for the group. In a normal distribution, this would capture 90 percent of the observations above the mean value. The minimum loading time is calculated by subtracting the actual standard deviation of loading time from the mean loading time. 1.0 standard deviation below the mean would normally capture 68 percent of observations below the mean. As most of these distributions were observed to be skewed “to the right” of the mean, this distribution would be conservatively expected to represent the actual distribution of loading times.

3.8.3 Railcar Unloading Time

Figure 112 Transit Time Consistency and Average Rail Car Unloading Time



The chart above shows the relationship between average unloading time and the average transit time z scores for the traffic for which unloading time was evaluated. This graph includes both coal and finished vehicles traffic which was not included in the loading time evaluation, for the reasons noted earlier in the report. The inclusion of coal and finished vehicles traffic lowers the average unloading time considerably as these two commodity groups have particularly low average unloading times. As with the loading time analysis the relationship between unloading times and transit time variability (z scores) was subjected to regression analysis. As seems to be suggested by the chart, no meaningful statistical relationship between transit time volatility and average unloading time was found in the regression analysis suggesting that variability in unloading time (like loading time) is driven by railway customer specific supply chain performance issues.

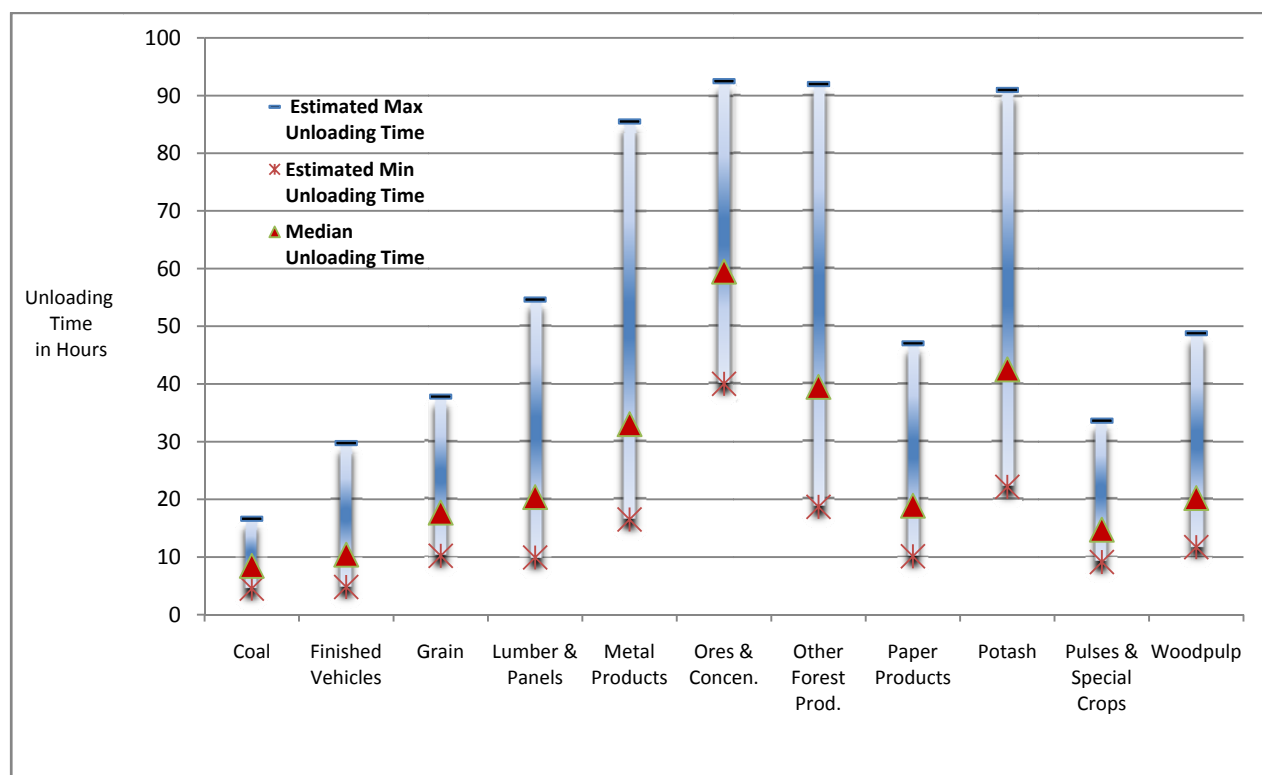
Figure 113 Estimated Minimum, Maximum and Median Unloading Times by Commodity

Commodity Sub-Group	Estimated Max Unloading Time	Estimated Min Unloading Time	Median Unloading Time
Coal	17	5	8
Finished Vehicles	30	5	10
Grain	38	10	18
Lumber & Panels	55	10	20
Metal Products	86	17	33
Ores & Concentrates	93	40	59
Other Forest Prod.	92	19	39
Paper Products	47	10	19
Potash	91	22	43
Pulses & Special Crops	34	9	15
Woodpulp	49	12	20

The values in this table are reflected in the chart displaying the normal range of unloading times, which is displayed below. As with loading times, while a number of groups have low median unloading times, the normal range of variability of unloading times is very wide in a number of groups: particularly, Metal Products, Ores and

Concentrates, Other Forest Products and Potash.

Figure 114 Relative Unloading Consistency by Commodity Group



3.9 Key Findings

The following brief section provides the highlights of the analysis of transit time performance for the key railway customer and network characteristics. It is important to reinforce that caution must be used when drawing conclusions from the results of the cross-tabulations of performance. When looking at performance for a given characteristic of traffic it is not appropriate to conclude that the characteristic itself is the cause of variations in performance. Other differences in the population or sample, such as the mix of traffic in a particular cross tabulation, can result in differences in performance besides the characteristic being analysed. Only in cases where the cross tabulations are sufficiently large and the nature of the traffic in the groups being compared for a given characteristic are similar is it appropriate to infer that performance may be related to the presence or absence of a given factor.

Many railway customers receive rail service with highly variable transit times. Some level of variability of transit time is expected by railway customers and both absolute transit time and transit consistency require investment in railway capacity and operations.

- In general, depending on the traffic characteristics being assessed there were considerable differences in transit time for movements with similar lengths of haul. However, for variables where one might expect there to be differences in performance based on the service or shipper characteristics, there was remarkably little differentiation in service performance. Examples where major systemic differences in performance were not found were¹²⁴
 - Shipper size
 - Flow size,
 - Access to rail competition
 - Core versus non-core railway origins
 - Shortline versus CN and CP origins
- *For both railways, significant deterioration of service is noted during winter months.* However, CP was more likely to have more variable transit times outside of the winter period than CN. Railway Intermodal terminal times from in-gate to depart were much worse in winter months and these disruptions to Intermodal terminal throughput during the winter lasted longer for CN than for CP
- *At final destination, the time taken for placement of cars at receivers' sidings varies widely based on the type of traffic with bulk traffic generally being placed within 10 hours and merchandise traffic averaging over 40 hours.* There were significant differences between CN and CP with respect to the use of "constructive placement" at destination (26% vs. 3% respectively). This much greater use of constructive placement can create the potential for conflict with shippers as this reporting can trigger the beginning of allowable free time for demurrage calculations on railway supplied cars
- *The day of week of arrival has a significant effect on the time taken for final placement* with traffic arriving on Friday and Saturday taking 23% longer to be placed than traffic arriving on all other days of the week

¹²⁴ There were some exceptions to this general statement about the lack of differentiation of service levels across these characteristics and where these exceptions are significant they are identified in the body of the report.

- Of cars released in a block by shippers, 42% of CN's and 38% of CP's do not arrive at destination in a single block. The average maximum delay between the first cars in a split block to arrive at destination and the last car is 46 hours for CN and 82 hours for CP¹²⁵
- Like transit times, shipper and receiver loading and unloading times are subject to wide levels of variability. The commodity groups with the shortest and most consistent loading and unloading times were grain and coal amongst bulk products. In the merchandise group, finished vehicles had the most consistent unloading times. The groups with the longest times and most variable performance are metal products and ores and concentrates at origin and destination, and potash and other forest products¹²⁶ at destination unloading points.

¹²⁵ In most cases, there is no commitment made by railways that cars released in a block will be delivered as a block at final destination. Railways may choose to consolidate or break-up car blocks based upon the need to either increase or reduce train length to deal with operating restrictions either between origin and destination or at intermediate points in the trip of the car blocks. In addition, car blocks may be broken up and delivered in smaller groups if customers at destination cannot receive and unload the cars in the original car block size.

¹²⁶ The other forest products group in the sample data is primarily made up of pulpwood chips and wood pellets with a smaller volume of logs, poles and ties.

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Appendix 1 Data Screening and Validation

Forecast versus Actual Shipment Data

Data Acquisition

The sampling process¹²⁷ completed by QGI yielded summary data sets consisting of 683 sample keys for CN and 455 keys for CP consisting of a total of 3.0 million shipments for 332 individual shippers¹²⁸ combined for the two railways. This represented 67% of CN's and 60% of CP's Canadian originated freight traffic for calendar year 2007.¹²⁹

The samples were submitted to CN and CP on March 13, 2009 with a request for budgeted and actual shipment volumes (carloads) by month to be provided for all sample keys for the period October 1, 2006 to September 30, 2008. From the time QGI submitted detailed data requests to the railways it took CN 201 days and CP 168 days to complete submissions of data to QGI.¹³⁰

As was done with the transit time and car supply data the order fulfillment data submitted by the railways was examined to assess its quality and completeness. Validation of received data against the sample requested was done to: confirm that the count of records received was consistent with the sample; that all expected data (budgeted and actual shipment volumes) were present and where omissions were identified to investigate the reasons for the missing data.

Data integrity

CN

The 683 sample keys submitted to CN consisted of 520 non-intermodal and 163 intermodal keys. The 520 non-intermodal keys represented 313 unique shipper-commodity combinations. CN submitted data for 285 or 91% of these. CN provided the balance of non-intermodal shipper data without commodity specific information. For intermodal traffic the 163 sample keys represented 73 customers and 158 unique shipper-origin combinations. CN provided data for all 73 shippers but for only 102 unique shipper-origin combinations. The reduced number of shipper-origin combinations submitted reflects the fact that CN grouped all domestic intermodal traffic for each

¹²⁷ *Technical Report – Sampling Methodology*, QGI Consulting March 2009.

¹²⁸ This represents the estimated number of unique shippers contained in the sample some of whom use the services of both CN and CP. Calculated separately for the two railways the sample included a total of 391 shippers.

¹²⁹ Calendar year 2007 was selected as the reference year for sampling as it provided a full year of data for each railway.

¹³⁰ CN initially submitted all the requested data on July 31, 2009 and at QGI's request subsequently revised the data to capture an enhanced level of detail and submitted revised data to QGI on September 30, 2009.

individual shipper into a single origin group called “domestic terminals”. Therefore whereas the sample may have contained multiple keys for an individual shipper reflecting multiple origin terminals CN provided total budget and actual shipment data monthly for that shipper as a single data record representing total domestic traffic for that shipper at all origin terminals. CN also aggregated shipper specific import-export traffic by port rather than individual port terminal.

CP

The 455 sample keys submitted to CP consisted of 308 non-intermodal and 147 intermodal keys. The 308 non-intermodal keys represented 203 unique shipper-commodity combinations. CP submitted data for 93 or 46% of these. The principal gap for non-intermodal traffic was for grain where CP submitted no shipper specific data but rather aggregated the budget and actual shipment data on an origin-destination region basis. This resulted in CP submitting 19 distinct grain keys as compared to the 93 shipper-commodity-origin specific keys contained in the sample. For intermodal traffic the 163 sample keys represented 84 customers and 147 unique shipper-origin combinations. CP provided data for 53 or 63% of shippers and 113 unique shipper-origin combinations. In some instances CP also aggregated import-export traffic by port rather than individual port terminal.

Representativeness of submitted data

The sample developed by QGI was representative of the total rail traffic base for both CN and CP. As the tables below show, despite the attrition experienced in the submission of data and the changes in the data structure required due to data availability within the railways’ information systems, the data provided remains representative across the principal business segments for each railway.

Figure 115 Distribution of cars by major group for each railway

Data Received - 24 months						
<u>Railway</u>	<u>Automotive</u>	<u>Bulk</u>	<u>Fertilizers</u>	<u>Grain</u>	<u>Intermodal</u>	<u>Merchandise</u>
Canadian National Railway	3.9%	5.1%	1.3%	9.1%	49.6%	30.9%
Canadian Pacific Railway		14.1%	1.3%	13.7%	61.9%	9.0%
	2.1%	9.3%	1.3%	11.2%	55.3%	20.7%
Sample - 2007 Reference Year						
	<u>Automotive</u>	<u>Bulk</u>	<u>Fertilizers</u>	<u>Grain</u>	<u>Intermodal</u>	<u>Merchandise</u>
Canadian National Railway	4.8%	2.9%	1.4%	7.7%	48.6%	34.6%
Canadian Pacific Railway		17.5%	5.9%	13.0%	65.4%	15.5%
	2.9%	8.7%	3.2%	9.8%	55.2%	27.1%
Sample Frame - 2007 Reference Year						
	<u>Automotive</u>	<u>Bulk</u>	<u>Fertilizers</u>	<u>Grain</u>	<u>Intermodal</u>	<u>Merchandise</u>
Canadian National Railway	4.4%	8.2%	1.2%	8.9%	44.2%	33.0%
Canadian Pacific Railway		16.0%	1.7%	15.3%	62.7%	17.4%
	2.7%	6.1%	1.4%	11.4%	51.4%	27.0%

Integrity of data

As was done for the transit time and car supply analyses the order fulfillment data was screened to determine how much of the data could be used for the analysis.

Total data submitted by the railways prior to screening by QGI included 7,407,540 cars for the 24 month service review period. Consistent with the transit time and car supply analyses, data related to the CN strike period (the month of February 2007) was excluded from the analysis for both CN and CP. This resulted in the removal of 268,530 cars or 3.6% of the data.

The data was then reviewed to identify data that reflected inaccurate reporting, or extreme and unusual values that were not representative of normal performance and may provide misleading results. This review identified a number of specific situations including:

- keys with no budget values but containing actual shipments; such instances in the data are limited when data is aggregated at an annual level although much more prevalent when the data is examined monthly;
- keys with budget values but containing no actual shipments;
- keys where there is neither a budget or actual shipments for individual months;
- keys where actual shipments are either significantly larger or smaller than the budgeted values as well as the reverse

Each of these cases is taken into account in statistical and mathematical calculations for different elements of the analysis – i.e. calculation of percentage variance to budget.

Railway budgets reflect a combination of input factors including shipper demand estimates, historical shipment patterns, commodity specific market intelligence and macroeconomic assumptions. Budgets are typically developed in the late summer / early fall for the following calendar year. The budget process may not anticipate changes in customer sourcing and production patterns or changes in individual commodity markets that can impact total volumes or shift market share between individual shippers. Even the best forecasts will therefore be only an estimate of actual volumes realized. Recognizing that forecast error is expected, no data was excluded from the analysis on the basis of the four situations highlighted above.

Car Order / Supply Data

Data Acquisition

The sampling process¹³¹ completed by QGI yielded summary data sets consisting of 431 keys for CN and 320 keys for CP consisting of a total of 824,094 shipments for 242 individual shippers¹³² combined for the two railways. This represented 73% of CN's and 71% of CP's Canadian originated freight traffic for the selected car types for calendar year 2007.¹³³ Although calendar year 2007 was selected as the reference year for sampling purposes the time frame for the service review analysis consists of a 24 month period from October 1, 2006 to September 30, 2008. It was anticipated that total car order and supply records for the service review period would be approximately twice the sample size or approximately 1.6 million records.

The car order/supply sample keys were submitted to CN and CP on March 13, 2009 with a request for detailed order, supply and loaded release data to be provided for all cars in the sample for the period October 1, 2006 to September 30, 2008. Final and accurate car order and supply data was not received by QGI until January 28, 2010. Most of the delays were due to difficulties experienced by CP in the consolidation of data from multiple information systems.

As was done with the transit time data, the car order and supply data submitted by the railways was examined to assess its quality and completeness with respect to the sample requested. Validation of received data against the sample requested was done to confirm that the count of records received was consistent with the sample, that all expected data (orders, supply, and loaded shipments for each sample key) were present, and where omissions were identified to investigate the reasons for the missing data.

Data integrity

Data received versus requested

The railways submitted detailed car order, supply and shipment data for 473 or 70% of the 751 requested sample keys. Although more prevalent for CP, both railways encountered some difficulty in matching order and supply data at the requested customer-origin level for a number of reasons including missing data, shipments originating on short lines and at commodity reload centers and inconsistencies in data structure between data tables in railway information systems. In some instances, sample keys were grouped together or new keys created to preserve the representativeness of the data for analysis relative to the sample. This resulted in 475 keys available for analysis for the two railways combined prior to data integrity screening.

¹³¹ *Technical Report – Sampling Methodology*, QGI Consulting March 2009.

¹³² This represents the number of unique shippers contained in the sample some of whom use the services of both CN and CP. Calculated separately for the two railways the sample included a total of 300 shippers.

¹³³ Calendar year 2007 was selected as the reference year for sampling as it provided a full year of data for each railway.

As was noted earlier in the discussion on transit time CN unlike CP sought shipper consent for release of detailed data to QGI. CN did not provide data for 59 or 14% of sample keys requested due to missing shipper consents.¹³⁴

Figure 116 Percentage of requested sample keys for which railways supplied data¹³⁵

<u>Railway</u>	<u>Box Car</u>	<u>Covered Hopper</u>	<u>Flat Car</u>	<u>Gondola</u>	<u>Total</u>
CN	74%	67%	66%	62%	68%
CP	54%	57%	59%	59%	57%
	68%	61%	64%	61%	63%

Beyond the shipper consent issue CN did not provide data for 74 of the requested sample keys. The reasons for CN's shortfall in data submission were related to cars moving in customer specific assigned pools and private equipment (33) that are not supplied using standard car order processes, data integrity issues (24) and traffic originating at commodity reload centers (17) where orders and supply are not shipper specific.

Figure 117 Breakdown of reasons for missing CN sample flows

<u>Category</u>	<u>Box Car</u>	<u>Covered Hopper</u>	<u>Flat Car</u>	<u>Gondola</u>	<u>Total</u>
Assigned Pool / Privates	4	20	6	3	33
No Data / Data Integrity	5	13	5	1	24
Reload	3	1	13		17
Total	12	34	24	4	74

CP did not provide data for 95 or 43% of the requested sample keys for many of the same reasons. Data integrity issues were most prominent accounting for a shortfall of 56 keys. Other reasons for missing data included customer assigned pools and private equipment (28) and cars re-billed from stations en route that did not reflect the actual origin loading point and thus were not appropriate for inclusion in the analysis.

Figure 118 Breakdown of reasons for missing CP sample flows

<u>Category</u>	<u>Box Car</u>	<u>Covered Hopper</u>	<u>Flat Car</u>	<u>Gondola</u>	<u>Hopper</u>	<u>Total</u>
Assigned Pool / Privates	2	18	6	1	1	28
No Data / Data Integrity	2	49		4	1	56
Re-Bill Traffic		11				11
Total	4	78	6	5	2	95

As noted earlier it was decided during the sampling process that private rail car equipment and equipment moving in customer assigned pools would be excluded from the car order – supply analysis. The data provided by the railways for sampling, however, did not identify equipment used in assigned pool service and CP's data did not include

¹³⁴ Included in this total are 7 shippers that were no longer in business.

¹³⁵ Calculation excludes 59 keys not provided due to missing shipper consents.

equipment ownership information. These factors, therefore, could not be screened out during sampling. Similarly traffic loaded through multi-user reload centers was not able to be identified in the summary data. Car order and supply activities at such locations are difficult to analyze as orders are often submitted to the railways by the reload operator and is not shipper specific. Because of these ordering practices it is not possible to relate orders to the individual customers who subsequently ship the traffic.

Representativeness of submitted data

The sample developed by QGI was representative of the total rail traffic base for both CN and CP. As the tables below show despite the attrition experienced in the submission of data the reduced sample remains representative across key dimensions of analysis.

Figure 119 Distribution of cars by major group for each railway

Data Received - 24 months				
<u>Railway</u>	<u>Box Car</u>	<u>Covered Hopper</u>	<u>Flat Car</u>	<u>Gondola</u>
CN	33.6%	30.8%	21.2%	14.5%
CP	18.5%	64.7%	7.8%	9.0%
Total	27.5%	44.3%	15.8%	12.3%
Sample - 2007 Reference Year				
<u>Railway</u>	<u>Box Car</u>	<u>Covered Hopper</u>	<u>Flat Car</u>	<u>Gondola</u>
CN	30.6%	30.4%	24.3%	14.7%
CP	15.5%	67.0%	8.7%	8.8%
Total	24.7%	44.8%	18.1%	12.4%
Sample Frame - 2007 Reference Year				
<u>Railway</u>	<u>Box Car</u>	<u>Covered Hopper</u>	<u>Flat Car</u>	<u>Gondola</u>
CN	29.2%	32.3%	22.1%	16.4%
CP	14.4%	64.9%	7.4%	13.2%
Total	23.3%	45.3%	16.2%	15.1%

Figure 120 Distribution of cars by origin region

Data Received - 24 months								
<u>Railway</u>	<u>AB</u>	<u>BC</u>	<u>MB</u>	<u>NB</u>	<u>NS</u>	<u>ON</u>	<u>PQ</u>	<u>SK</u>
CN	17.9%	29.7%	6.5%	1.2%	1.6%	8.9%	17.4%	16.8%
CP	23.2%	7.5%	10.5%	1.8%	0.0%	13.7%	8.1%	35.2%
Total	20.0%	20.8%	8.1%	1.4%	0.9%	10.8%	13.7%	24.2%
Sample - 2007 Reference Year								
<u>Railway</u>	<u>AB</u>	<u>BC</u>	<u>MB</u>	<u>NB</u>	<u>NS</u>	<u>ON</u>	<u>PQ</u>	<u>SK</u>
CN	17.6%	29.7%	5.8%	1.9%	1.7%	10.5%	17.0%	15.7%
CP	26.5%	7.5%	9.9%	0.3%	0.0%	18.9%	8.3%	28.6%
Total	21.1%	21.0%	7.4%	1.3%	1.1%	13.8%	13.6%	20.8%
Sample Frame - 2007 Reference Year								
<u>Railway</u>	<u>AB</u>	<u>BC</u>	<u>MB</u>	<u>NB</u>	<u>NS</u>	<u>ON</u>	<u>PQ</u>	<u>SK</u>
CN	17.3%	26.6%	5.6%	2.8%	2.0%	10.9%	18.4%	16.4%
CP	25.0%	8.5%	11.0%	0.4%	0.0%	21.1%	7.6%	26.4%
Total	20.4%	19.4%	7.8%	1.8%	1.2%	15.0%	14.1%	20.4%

Figure 121 Distribution of cars by shipper size

Data Received - 24 months				
<u>Railway</u>	<u>Large</u>	<u>Medium</u>	<u>Small</u>	<u>Very Small</u>
CN	87.7%	9.8%	2.2%	0.3%
CP	80.1%	13.5%	3.8%	2.5%
Total	84.7%	11.3%	2.9%	1.2%
Sample - 2007 Reference Year				
<u>Railway</u>	<u>Large</u>	<u>Medium</u>	<u>Small</u>	<u>Very Small</u>
CN	84.2%	11.3%	3.7%	0.8%
CP	75.4%	18.4%	5.3%	1.0%
Total	80.8%	14.1%	4.3%	0.9%
Sample Frame - 2007 Reference Year				
<u>Railway</u>	<u>Large</u>	<u>Medium</u>	<u>Small</u>	<u>Very Small</u>
CN	78.4%	12.4%	5.8%	3.4%
CP	69.5%	20.2%	6.6%	3.7%
Total	74.8%	15.5%	6.1%	3.5%

Integrity of data

As was done for the transit time analysis QGI screened the data to assess the quality of order, supply, and loaded release data to determine how much of the data could be used for the analysis.

Total data submitted by the railways prior to screening by QGI included 1,350,024 net car orders for the 24 month service review period. As was done for the transit time analysis, data related to the CN strike period – specifically the period from February 4 to March 3, 2007 – was excluded from the analysis for both CN and CP. This resulted in the removal of 55,008 orders or 4.1% of the data.

The data was then reviewed to remove data that reflected inaccurate reporting, or extreme and unusual values that were not representative of normal performance and may provide misleading results.

QGI applied three screening criteria to the Merchandise data at an individual key level. First, keys where no order data was present were removed. Second, QGI assessed the data by examining the ratio of empty placements (supply) to net orders. All keys with a ratio greater than 1.20 – i.e. where empty cars supplied exceeded customer orders by 20% or more – were removed from the data. Situations such as this indicate that rail cars are either being placed for loading outside of the normal car order process – e.g. assigned pools and private cars – or orders are not being recorded accurately. Lastly the data was examined using a ratio of loaded releases to empty placements again with an established threshold of 1.20. All keys where this ratio exceeded the threshold were also removed from the data. Where loaded shipments by customers exceed the supply of empty cars suggests that empty placement events are not being reported correctly. Application of these screening criteria resulted in the removal of 96,733 car order records or 7.2% of the data. The table below provides a summary of screening results by railway for each condition tested.

Figure 122 Percent of car order records removed through screening

Screening Criteria	Major Group	Railway	Box Car	Cov. Hopper	Flat Car	Gondola	Total
CN Strike Period	Grain	CN	-	3.8%	-	-	3.8%
		CP	-	3.7%	-	-	3.7%
	Merchandise	CN	4.4%	2.5%	4.7%	3.9%	4.3%
		CP	3.8%	3.5%	4.8%	4.3%	4.1%
Data Quality	Merchandise	CN	1.1%	29.7%	0.0%	0.0%	1.5%
		CP	18.3%	1.8%	30.7%	13.5%	16.8%

As shown in the table above the most significant impact of data trimming using these criteria has been on the CP merchandise data where nearly 17% of the data was removed from the analysis.

Due to the need to trim a significant portion of the CP merchandise data we have assessed the remaining data to ensure that it remains representative of the sampling frame. As the tables below indicate the remaining data

continues to be generally representative across key dimensions of analysis including equipment type, shipper size, and origin province.

The most significant impact to the data is with respect to geographic representation. Trimming for data quality has removed much of the data for Quebec shippers and has increased the relative weights for Ontario and British Columbia whereas Alberta, Saskatchewan and Manitoba remain in line with the sampling frame. This is mitigated by the fact that the original sample for Quebec was heavily weighted (75%) to box car and covered hopper car traffic which continues to be well represented in the remaining data.

Figure 123 CP Distribution of Cars by Equipment Type

	<u>Box Car</u>	<u>Covered Hopper</u>	<u>Flat Car</u>	<u>Gondola</u>
Initial data received - 24 months	40%	23%	18%	19%
Sample - 2007 Reference Year	32%	31%	18%	18%
Sample frame - 2007 Reference Year	29%	29%	15%	27%
Remaining data after trimming	43%	19%	13%	26%

Figure 124 CP Distribution of Cars by Shipper Size

	<u>Large</u>	<u>Medium</u>	<u>Small</u>	<u>Very Small</u>
Initial data received - 24 months	66.3%	21.9%	7.6%	4.2%
Sample - 2007 Reference Year	61.3%	28.5%	9.4%	0.8%
Sample frame - 2007 Reference Year	53.4%	29.8%	11.3%	5.5%
Remaining data after trimming	49.3%	32.9%	9.7%	8.1%

Figure 125 CP Distribution of Cars by Origin Province

	<u>AB</u>	<u>BC</u>	<u>MB</u>	<u>NB</u>	<u>NS</u>	<u>ON</u>	<u>PQ</u>	<u>SK</u>
Initial data received - 24 months	23.3%	16.0%	1.8%	3.8%	0.0%	29.5%	17.4%	8.1%
Sample - 2007 Reference Year	30.3%	15.8%	2.1%	0.7%	0.0%	28.1%	17.4%	5.6%
Sample frame - 2007 Reference Year	24.3%	17.3%	3.2%	0.7%	0.1%	33.6%	15.7%	5.2%
Remaining data after trimming	24.1%	24.6%	3.4%	0.0%	0.0%	39.0%	3.2%	5.6%

QGI validated the railway supplied car order and supply data with a select number of grain and merchandise customers for both railways. In selecting customers to validate the data QGI sought to include shippers for each major car type for both grain and merchandise and both large and small shippers. Three grain shippers each of whom use both CN and CP including both hopper car and box cars were selected to validate data from a total of twelve different origins. Three merchandise shippers using flat, gondola and box cars were selected including one CN shipper, one CP shipper and one shipper that used both railways. These shippers were asked to validate data for a total of 7 origins. In each case the shippers were provided with weekly summaries of the order, supply and loaded release data and asked

to validate the railway data against their own records. QGI representatives then met individually with each shipper to discuss their findings.¹³⁶ While shippers identified some minor anomalies in the timing of order and supply data from week to week all were in agreement that the railway supplied data was representative of their experience and consistent with their own records.

Transit Time Data

Data Acquisition

The transit time sample flows were submitted to CN and CP on February 16, 2009 with a request for detailed transit data to be provided for each car trip in the sample for the period October 1, 2006 to September 30, 2008. Subsequent to this CP was provided with a second request on May 20, 2009 for an additional 38 flows selected through supplementary sampling for data previously excluded by CP pending receipt of customer consents for the release of data¹³⁷.

From the time QGI submitted detailed data requests to the railways it took CN 137 days and CP 200 days to complete submissions of data to QGI. A number of factors contributed to the delays incurred in data submission including: obtaining of shipper consents for release of data and difficulties encountered by both CN and CP in extracting the data from their information systems. Each of these issues is described briefly below.

Shipper consents

CN's Executive established as a condition of releasing shipper specific transit time data the receipt of individual shippers' consent to do so. CN initiated the shipper consent process on March 9, 2009 and completed it on April 10, 2009. Using the list of shippers included in QGI's sample CN contacted individual shippers by fax and email requesting that they authorize CN to release transit time and car order data to QGI specifically for the purpose of the rail freight service review. Shippers provided their consent either by responding to the email or by signing the attached consent form and returning it to CN. Three separate communiqués were issued by CN over the course of one month in an attempt to obtain as many shipper consents as possible. QGI, with CN's consent, subsequently followed up with selected shippers by telephone.

Beginning with a list of 373 shippers in the QGI sample CN and QGI were able to obtain consent from 258 shippers. Of the 115 shippers that did not provide consent 12 refused, 8 companies were no longer in business and 95 companies did not respond to CN's request. While the CN shipper consent process did introduce some unexpected delays to

¹³⁶ Four of the shipper meetings took place in person and two were done via telephone. One of the shippers that agreed to participate determined after reviewing their internal records that their information was not robust enough to support the review of the railway data.

¹³⁷ CP originally excluded traffic data for 9 bulk and automotive shippers based on the existence of contractual service agreements in place with those shippers.

the data acquisition process this was minimized somewhat by CN submitting data to QGI incrementally on a weekly basis as consents were received and data was processed.

CP, with the exception of the nine bulk and automotive customers noted earlier, did not require shippers to provide their consent prior to releasing the data to QGI. Of the nine CP customers from whom consent was requested only one declined to participate.

Difficulties in data extraction

Following an initial delay of 25 days related to the shipper consent issue CN began to stream data to QGI as consents were received and data was processed. Beginning on March 13, 2009 CN transmitted approximately one file per week, with the final submission July 3, 2009. QGI is not aware of any significant technical difficulties encountered by CN in the data extraction process. The delays encountered resulted from time spent by CN in validating data prior to submitting to QGI. The results of this front end work by CN can be seen in the overall quality of the data submitted which is discussed in a later section of this report.

By comparison, CP encountered significant difficulties in extracting and structuring the data for submission to QGI. These difficulties included the need to match data from multiple information systems in order to select the detailed data records that were associated with QGI's sample and the need for CP to develop programming logic for the calculation of the time intervals associated with an individual car trip. CP delivered its first test data on June 5, 2009, 109 days after receiving the detailed data request from QGI. QGI worked closely with CP throughout the months of June and July 2009 validating the accuracy and quality of transit time data. CP completed transmission of the transit time data to QGI on September 4, 2009.

Data Screening

During the data submission process QGI reviewed the railway data in two areas. The first stage of screening was designed to confirm that the time intervals being provided were correctly calculated and consistent with the interval definitions provided by the railways. The calculations were confirmed by randomly selecting individual car trips from the submitted data and obtaining from the railways the detailed car trip events used to calculate the time intervals. QGI re-created the time interval calculations and confirmed that the railway calculations were accurate and consistent with the time interval definitions.

The second stage of screening involved assessing the quality of the detailed data as it was received from the railways. This process had three objectives: to confirm that the number of detail records received was consistent with the record counts contained in the sample; to confirm receipt of all expected data (for each sample key) and where omissions were identified to investigate the reasons for the missing data; and to test the quality of the time interval data.

Data Integrity

Data received versus requested

The railways submitted detailed transit time data for 2,584 or 90% of the 2,866 requested transit time sample flows.

Figure 126 Percentage of sample keys for which railways supplied data

<u>Railway</u>	<u>Automotive</u>	<u>Bulk</u>	<u>Fertilizers</u>	<u>Grain</u>	<u>Merchandise</u>	<u>Intermodal</u>	<u>Total</u>
CN	81%	97%	77%	91%	85%	65%	82%
CP	94%	100%	100%	100%	100%	98%	99%
Total	88%	99%	91%	95%	91%	85%	90%

The principal reason for CN's shortfall in data submission is related to the issue of shipper consents which accounted for 218 or (81%) of the 270 missing keys with intermodal and merchandise customers accounting for 183 of the 218. Other factors contributing to the shortfall included data integrity issues (8%), companies no longer in business (7%) and a number of flows that were determined to be local switch movements that were not appropriate for this analysis.

Figure 127 Breakdown of reasons for missing CN sample flows

<u>Category</u>	<u>Automotive</u>	<u>Bulk</u>	<u>Fertilizers</u>	<u>Grain</u>	<u>Merchandise</u>	<u>Intermodal</u>	<u>Total</u>
Data Integrity	2			2	13	5	22
No Shipper Consent	3	1	8	23	76	107	218
Non Line Haul	1			1	8	1	11
Out of Business				1	16	2	19
Total	6	1	8	27	113	115	270

Representativeness of submitted data

The sample developed by QGI was representative of the total rail traffic base for both CN and CP. As can be seen in the tables below, despite the attrition experienced in the submission of data the reduced sample remains representative across key dimensions of analysis.

Figure 128 Distribution of car trips by major group for each railway

Data Received - 24 month						
<u>Railway</u>	<u>Automotive</u>	<u>Bulk</u>	<u>Fertilizers</u>	<u>Grain</u>	<u>Intermodal</u>	<u>Merchandise</u>
CN	3.8%	11.6%	1.1%	8.5%	45.8%	29.3%
CP	3.2%	34.9%	1.3%	8.7%	39.6%	12.4%
Total	3.5%	22.6%	1.2%	8.6%	42.8%	21.3%
Sample - 2007 Reference Year						
<u>Railway</u>	<u>Automotive</u>	<u>Bulk</u>	<u>Fertilizers</u>	<u>Grain</u>	<u>Intermodal</u>	<u>Merchandise</u>
CN	3.5%	10.3%	0.9%	7.6%	48.5%	29.1%
CP	2.9%	32.2%	1.3%	10.3%	40.9%	12.5%
Total	3.2%	19.7%	1.1%	8.7%	45.2%	22.0%
Sample Frame - 2007 Reference Year						
<u>Railway</u>	<u>Automotive</u>	<u>Bulk</u>	<u>Fertilizers</u>	<u>Grain</u>	<u>Intermodal</u>	<u>Merchandise</u>
CN	4.4%	8.2%	1.2%	8.9%	44.2%	33.0%
CP	5.2%	14.6%	1.4%	12.5%	51.8%	14.5%
Total	4.8%	11.0%	1.3%	10.5%	47.5%	25.0%

Figure 129 Distribution of car trips by origin region

Data Received - 24 months								
<u>Railway</u>	<u>AB</u>	<u>BC</u>	<u>MB</u>	<u>NB</u>	<u>NS</u>	<u>ON</u>	<u>PQ</u>	<u>SK</u>
CN	22.7%	25.9%	2.7%	0.4%	8.4%	23.8%	11.4%	4.8%
CP	11.5%	46.1%	2.5%	0.1%	0.0%	21.0%	10.5%	8.2%
Total	17.4%	35.4%	2.6%	0.3%	4.5%	22.5%	10.9%	6.4%
Sample - 2007 Reference Year								
<u>Railway</u>	<u>AB</u>	<u>BC</u>	<u>MB</u>	<u>NB</u>	<u>NS</u>	<u>ON</u>	<u>PQ</u>	<u>SK</u>
CN	19.3%	26.9%	2.7%	0.8%	7.5%	22.9%	15.5%	4.3%
CP	12.0%	44.5%	2.7%	0.1%	0.0%	20.5%	11.3%	8.9%
Total	16.2%	34.4%	2.7%	0.5%	4.3%	21.8%	13.7%	6.2%
Sample Frame - 2007 Reference Year								
<u>Railway</u>	<u>AB</u>	<u>BC</u>	<u>MB</u>	<u>NB</u>	<u>NS</u>	<u>ON</u>	<u>PQ</u>	<u>SK</u>
CN	18.1%	23.4%	3.4%	2.2%	5.4%	23.2%	16.4%	8.0%
CP	14.5%	29.4%	4.3%	0.1%	0.0%	24.3%	16.7%	10.7%
Total	16.5%	26.0%	3.8%	1.3%	3.1%	23.7%	16.5%	9.1%

Figure 130 Distribution of car trips by shipper size

Data Received - 24 months				
<u>Railway</u>	<u>Large</u>	<u>Medium</u>	<u>Small</u>	<u>Very Small</u>
CN	86.8%	10.6%	2.1%	0.6%
CP	82.0%	11.7%	5.3%	1.1%
Total	84.5%	11.1%	3.6%	0.8%
Sample - 2007 Reference Year				
<u>Railway</u>	<u>Large</u>	<u>Medium</u>	<u>Small</u>	<u>Very Small</u>
CN	85.4%	10.5%	3.7%	0.4%
CP	83.8%	10.9%	4.9%	0.3%
Total	84.7%	10.7%	4.2%	0.3%
Sample Frame - 2007 Reference Year				
<u>Railway</u>	<u>Large</u>	<u>Medium</u>	<u>Small</u>	<u>Very Small</u>
CN	81.8%	12.3%	3.6%	2.3%
CP	79.7%	12.4%	4.6%	3.3%
Total	80.9%	12.4%	4.1%	2.7%

Appendix 2 Car Supply Performance

Figure 131 Grain Car Order Cancellations

	Class I vs Shortline origins			
	CN / CP	Shortline		
Cars Ordered	530,423	17,842		
Cars Cancelled	71,600	1,941		
Percent Cancelled	13%	11%		
	Origin Network Status			
	Non-Core	Core		
Cars Ordered	391,770	156,495		
Cars Cancelled	53,966	19,575		
Percent Cancelled	14%	13%		
	Province of Origin			
	BC	AB	MB	SK
Cars Ordered	6,706	142,161	93,103	306,295
Cars Cancelled	938	20,875	10,759	40,969
Percent Cancelled	14%	15%	12%	13%

Figure 132 Grain Car Annual Order Fulfillment

Net order fulfillment is the percentage of cars placed against the total demand by grain customers where demand is equal to the net number of cars ordered (total orders – total cancellations).

Net Order Fulfillment				
Average weekly car order				
	>50	25 - 50	10 - 24	<10
CN	97%	99%	98%	100%
CP	96%	98%	96%	100%
	97%	99%	97%	100%
Net Order Fulfillment				
Competitive Access				
	No	Yes		
CN	98%	99%		
CP	96%	102%		
	97%	100%		
Net Order Fulfillment				
Origin Network Class				
	Non Core	Core		
CN	99%	97%		
CP	96%	97%		
	97%	97%		
Net Order Fulfillment				
Origin Province				
	BC	AB	MB	SK
CN	96%	96%	99%	99%
CP	n/a	96%	98%	96%
	96%	96%	99%	97%
Net Order Fulfillment				
	Non Shortline	Shortline		
CN & CP	97%	101%		

Figure 133 Grain Car Weekly Net Order Fulfillment

Weekly net order fulfillment is equal to the total percentage of shipper locations that received at least 90% of the net cars ordered (orders – cancellations) for each week.

90% order fulfillment				
Average Weekly Car Order				
	>50	25 - 50	10 - 24	<10
CN	56%	55%	58%	63%
CP	53%	54%	51%	32%
	54%	55%	55%	50%
90% order fulfillment				
Competitive Access				
	No	Yes		
CN	57%	58%		
CP	51%	54%		
	53%	57%		
90% order fulfillment				
Origin Network Class				
	Non Core	Core		
CN	58%	53%		
CP	51%	50%		
	55%	51%		
90% order fulfillment				
Origin Province				
	BC	AB	MB	SK
CN	60%	57%	59%	56%
CP		48%	54%	51%
	60%	53%	56%	53%
90% order fulfillment				
	Non Shortline	Shortline		
CN	56%	63%		
CP	51%	55%		
	54%	61%		

Figure 134 CN Car Order Changes after Cut-Off

Average weekly car order								
	>50	25 - 50	10 - 24	<10				
Sum of order changes	7,278	10,001	6,804	6,253				
Absolute value of order changes	25,132	19,037	10,674	7,059				
Orders before cut-off	276,222	172,402	67,376	18,444				
Average weekly car order								
	>50	25 - 50	10 - 24	<10				
% Order changes (absolute value)	9%	11%	16%	38%				
% Order changes (net value)	3%	6%	10%	34%				
Competitive Access								
	No	Yes						
% Order changes (absolute value)	10%	10%						
% Order changes (net value)	5%	4%						
Origin Network								
	Non-Core	Core						
% Order changes (absolute value)	10%	10%						
% Order changes (net value)	5%	4%						
Origin Province								
	BC	AB	SK	MB	ON	PQ	NB	NS
% Order changes (absolute value)	10%	10%	15%	9%	7%	12%	14%	10%
% Order changes (net value)	3%	5%	4%	6%	3%	8%	11%	7%
Origin Railway								
	CN	Shortline						
% Order changes (absolute value)	11%	7%						
% Order changes (net value)	4%	5%						

Figure 135 CN Overall Car Supply Performance

Average percentage empty cars supplied annually versus car orders placed before cut-off

Average weekly car order							
>50	25 - 50	10 - 24	<10				
84%	86%	86%	88%				
Competitive Access							
No	Yes						
88%	83%						
Origin Network							
Non-Core	Core						
86%	87%						
Origin Province							
BC	AB	SK	MB	ON	PQ	NB	NS
86%	85%	68%	74%	84%	91%	89%	82%
Origin Carrier							
CN	Shortline						
86%	84%						

Figure 136 CP Overall Car Supply Performance

Average percentage empty cars supplied annually versus car orders placed before cut-off

Average weekly car order

>50	25 - 50	10 - 24	<10
80%	67%	72%	76%

Competitive Access

No	Yes
70%	86%

Origin Province

BC	AB	SK	MB	ON
84%	72%	36%	70%	81%

Note: Assessment of performance for shortline origins was not possible as there were not sufficient valid records with shortline origins in the CP car supply sample data.

Appendix 3 Technical References

TRANSIT TIME ANALYSIS

1. General Terms

a. Flow Size

Flow size is defined as the number of cars moved in an individual flow during a Service Review Year (October to September) calculated for each Service Review Year. A flow is defined as a unique combination of shipper-origin-destination-commodity.

Size Category	Number of Cars per Service Review Year
1	More than 5000
2	1001 to 5000
3	501 to 1000
4	101 to 500
5	30 to 100
6	1 to 29
7	Zero (0)

b. Shipper Size

Shipper size is defined as the number of Cars moved by each shipper regardless of origin in the Calendar year 2007 based on original summary data provided

Size Category	Number of Cars (2007 Reference Year)
Large	More than 5000
Medium	1001 to 5000
Small	301 to 1000
Very Small	0 to 300

c. Service Review Year

The twelve (12) month period from October 1 to September 30th.

d. Service Review Week

Seven day week defined from Sunday to Saturday

2. Time Interval Definitions

a. Carload

Time Interval Code	Time Interval Description
A	Constructive Placement to Empty Placement
B	Empty Placement to Release Load
C	Release Load to Depart on Train
D	Loading Offline Time
E	Railway On Line Time
F	Railway On Line Yard Time
G	Arrival Destination to Constructive Placement
H	Constructive Placement to Actual Placement
I	Arrival Destination to Actual Placement (No CP)
J	Unloading Offline Time
K	Actual Placement to Release Empty

b. Intermodal

Time Interval Code	Time Interval description	Time Interval
1	Origin In-Gate Date Time to Origin Train Departure Date Time	In Gate – Depart Time
2	Origin Train Departure Date Time to Destination Train Arrival Date Time	Transit Time
3	Destination Train Arrival Date Time to Destination De-ramp Date Time	Arrive – De-ramp Time

3. Data Mapping of Railway Supplied Time Intervals

The following tables identify how the data records supplied by CN and CP were mapped to a common database structure.

a. Carload

Canadian Pacific Railway

Staging Table Column	CP import table column
Time Interval A	Not provided
Time Interval B	PACT_E_TO_NOBL_RLOD
Time Interval C	NOBL_RLOD_TO_PFPS_DFLC
Time Interval D	OFFLN_LOADNG_TM
Gross Online Road Time (CP only)	TOT_ONLINE_ROAD_TIME
Time Interval E (calculated) ⁽¹⁾	TOT_ONLINE_ROAD_TIME minus TOT_ONLINE_YRD_TIME minus ARRI_TO_PCON_PACT
Time Interval F	TOT_ONLINE_YRD_TIME
Time Interval G ⁽²⁾	ARRI_TO_PCON_PACT
Time Interval H	PCON_TO_PACT
Time Interval I ⁽²⁾	ARRI_TO_PCON_PACT
Time Interval J	OFFLN_UNLOADNG_TM
Time Interval K	PACT_TO_RMTY

- (1) CP provided TOT_ONLINE_ROAD_TIME which included Online Yard time and Arrive to Place (constructive or actual)
- (2) If Time Interval H is present then CP Time Interval ARRI_TO_PCON_PACT is stored in Time Interval G otherwise the value is stored in Time Interval I.

Canadian National Railways

Staging Table Column	CN import table column
Time Interval A	CP To EP
Time Interval B	EP To RL
Time Interval C	RL To DT
Time Interval D	Loading Offline
Time Interval E	Online Road
Time Interval F	Online Yard
Time Interval G	AD To CP
Time Interval H	CP To AP
Time Interval I	AD To AP_No CP
Time Interval J	Unloading Offline
Time Interval K	AP To RE

b. Intermodal (CN and CP)

Intermodal Event Time	CN import table column	CP import table column
Origin In-Gate Date Time	Origin In-Gate Date Time	First Event
Origin Ramp Date Time	Origin Ramp Date Time	Not Provided
Origin Train Departure Date Time	Origin Departure Date Time	Second Event
Destination Train Arrival Date Time	Destination Arrival Date Time	Third Event
Destination De-ramp Date Time	Destination De-ramp Date Time	Fourth Event
Destination Out-Gate Date Time	Destination Out-Gate Date Time	Not Provided

4. Trip Type Definitions

All data records provided by the railways were categorized into trip types as defined in the tables below.

a. Carload

Type Key	Type Name	Origin Type	Destination Type
1	Local	CN/CP	CN/CP respectively
2	Interline Forwarded	CN/CP	Other Connecting Road
3	Shortline Local	Shortline	CN/CP
4	Shortline Interline	Shortline via CN/CP	Other Connecting Road

5	Shortline Destination	CN/CP	Shortline
6	Shortline Bridge	Shortline via CN/CP	Shortline

All origin and destination stations in data identified as shortline stations (flag = 1) or non shortline stations (flag = 0).

b. Intermodal

Type Key	Type Name	Commodity Group	Station Criteria
7	Export	Import/Export	Any
8	Import	Import/Export	Origin is a Port Station
9	Domestic	Domestic	Any

5. Trip Type Definition Logic

a. Carload

Canadian National Railways

Trip type 1: Local

If origin shortline flag = 0 and destination shortline flag = 0
then trip type = 1

Trip type 2: Interline Forwarded

If origin shortline flag = 0
and Time Interval G = 0
and Time Interval H = 0
and Time Interval I = 0
then trip type = 2

Trip type 3: Shortline Local

If origin shortline flag = 1 and destination shortline flag = 0
then trip type = 3

Trip type 4: Shortline Interline

If origin shortline flag = 1
and Time Interval G = 0
and Time Interval H = 0
and Time Interval I = 0
then trip type = 4

Trip type 5: Shortline Destination

If origin shortline flag = 0 and destination shortline flag = 1
then trip type = 5

Trip type 6: Shortline Bridge

If origin shortline flag = 1 and destination shortline flag = 1
then trip type = 6

Canadian Pacific Railway

Trip type 1: Local same as CN

Trip type 2: Interline Forwarded

If origin shortline flag = 0 and destination is a non CP (FSAC < 1000 or FSAC > 9999) and non Canadian location set the trip type to 2. Exclude CP US stations in these states IA,IL,MN,ND,NJ,PA,WI and these individual station FSAC 's : 3935 , 3929, 3992, 3959, 3946

Trip type 3: Shortline Local same as CN

Trip type 4: Shortline Interline

If origin shortline flag = 1 and destination is a non CP (FSAC < 1000 or FSAC > 9999) and non Canadian locations set the trip type to 2. Exclude CP US stations in these states IA,IL,MN,ND,NJ,PA,WI and these individual station FSAC 's : 3935 , 3929, 3992, 3959, 3946

Trip type 5: Shortline Destination same as CN

Trip type 6: Shortline Bridge same as CN

b. Intermodal (CN and CP)

Trip Type 7: Export

All records in Commodity Group Import/Export are marked as trip type 7

Trip Type 8: Import

All records in Commodity Groups Import Export with origin station with Port Flag = 1 (true) are marked as trip type 8

Trip Type 8: Domestic

All records in Commodity Group Domestic are marked as Domestic

6. Determination of Applicable Time Intervals by Trip Type

a. Carload

Railway Supplied Time Interval Codes											
Type Code	A CP to EP	B EP to RL	C RL to DT	D Loading Offline	E Line Time	F Yard Time	G AD to CP	H CP to AP	I AD to AP (no CP)	J Unloading Offline	K AP to RE
1	Y	Y	Y		Y	Y	Y	Y	Y		Y
2	Y	Y	Y		Y	Y					
3			Y	Y	Y	Y	Y	Y	Y		Y
4			Y	Y	Y	Y					
5	Y	Y			Y	Y				Y	
6			Y	Y	Y	Y					

b. Intermodal

Type Code	Type Name	In-Gate to Depart	Train Depart to Train Arrive	Train Arrive to De-Ramp
7	Export	Y	Y	
8	Import		Y	Y
9	Domestic	Y	Y	Y

7. Statistical and Other Performance Calculations

a. Statistical Values

Mean (average)	Sum of the values divided by the number of elements in the set.
Standard deviation	Measure of dispersion in a frequency distribution, equal to the square root of the average of the squared differences between the individual observations in a population and the arithmetic mean of the population.
Coefficient of variation	A statistical measure of the dispersion of data points in a data series around the mean. Calculation: (standard deviation / mean) * 100
z score	Statistical measure that quantifies the distance a data point is from the mean of a data set in units of standard deviation of the set. Calculation: (value - mean) / standard deviation
Median	The middle number in a given sequence of numbers, taken as the average of the two middle numbers when the sequence has an even number of numbers.

b. Other

Speed (Carload)	1	Speed measured in miles per hour from train departure at origin to train arrival at destination. Calculation: $S(1) = \frac{\text{Haul Miles}}{\text{online road time} + \text{online yard time}} = \text{Haul miles} / \text{Time Interval E+F}$
Speed (Intermodal)	1	Speed measured in miles per hour from train departure at origin to train arrival at destination. Calculation: $V(1) = \frac{\text{Haul Miles}}{\text{Transit Time}} = \text{Haul miles} / \text{Time interval 2}$
Line Speed		Speed measured in miles per hour from train departure at origin to train arrival at destination excluding all intermediate yard time. Calculation: Haul Miles / Line Time (Time Interval E)

8. Calculation Matrices for Individual Trips

a. Carload

	Calculation Name	Table Column Name	Trip Types	Calculation (Time intervals used)
--	------------------	-------------------	------------	-----------------------------------

i	Transit Time	Transit Time	ALL	E + F
ii	Yard Time	Time Interval F	ALL	F
iii	Line Time	Time Interval E	ALL	E
iv	Total time	Total Time	1	(C+E+F+G+H) or (C+E+F+I)
			2	C+E+F
			3,4,6	D+E+F
			5	B+E+F
v	Loading time	Loading Time	1,2	B
			3,4,6	D
vi	Unloading Time	Unloading Time	1,3	K
	Shortline Unloading Time	Destination Unload Offline	5	J
vii	Destination times			
	Arrive to Constructive Placement	Destination ADCP	1,3	G
	Constructive Placement to Actual Placement	Destination CPAP	1,3	H
	Arrive to Actual Placement (No CP)	Destination ADAP	1,3	I
	Arrive to Actual Placement (with CP)	Destination ADAPCP	1,3	G+H
	Destination Railway Time ⁽¹⁾	Destination Railway Time	1,3	Either G or I whichever has value (CP or no CP)
	Destination Total Time ⁽²⁾	Destination Total Time	1,3	Either (G+H) or I whichever has value
viii	Speed			
	Line Speed	Line Speed	ALL	Haul miles / E
	Speed 1	Speed1	ALL	Haul miles /E+F
ix	Dates			
	Placement Date	EP Date	1,2,5	Start Date – B
	Release Load Date / Interchange receipt date	First Event Date	ALL	Start Date
	Depart Date	Depart Date	ALL	Start Date + C
	Arrive Date	Arrive Date	1,2,3,4,6	Start Date +C+E+F
			5	Start Date + E+F
	Actual Placement Date	AP Date	1,3	Start Date + C+E+F+G+H+I
	Constructive Placement Date	CP Date	1,3	Start Date +C+E+F+G
x	Z score	<column name>_Z		<column name>(value - mean)/stdevp

(1) Destination Railway Time is defined as either Arrive to Constructive Placement or Arrive to Actual Placement, whichever is relevant for the individual trip. It is intended to capture the Railway's responsibility time at destination.

(2) Destination Total Time is defined as the total time elapsed from arrival at destination station to actual placement at receiver with or without constructive placement.

b. Intermodal

	Calculation Name	Column Name	Calculation
i	Transit Time	Transit Time	3
ii	In-Gate Depart Time	In-Gate Depart Time	1 + 2
lii	Arrive De-ramp Time	Arrive De-ramp Time	4
iv	Speed1	Speed1	Haul Miles / Transit Time
v	Z score	<column name>_Z	<column name> (value - mean)/standard deviation

Each calculated value defined in the tables above will have an associated Z score calculated and stored in a column with the same name as the source column name with an added '_Z'. Z-Scores are calculated only for valid values in their respective populations.

9. Calculation Matrices for Populations

a. Carload

	Calculation Name	Trip Types	Calculation (Time intervals used)	Mean	Standard Deviation	Coefficient of Variation	Median
i	Transit Time	ALL	E + F	X	X	X	X
li	Loading time	1,2	B	X	X	X	X
		3,4,6	D	X	X	X	X
lii	Unloading Time	1,3	K	X	X	X	X
	Shortline Unloading Time	5	J	X	X	X	X
iv	Destination times						
	Arrive to Constructive Placement	1,3	G	X	X	X	X
	Constructive Placement to Actual Placement	1,3	H	X	X	X	X
	Arrive to Actual Placement (No CP)	1,3	I	X	X	X	X
	Arrive to Actual Placement (with CP)	1,3	G+H	X	X	X	X
	Destination Railway Time ⁽¹⁾	1,3	Either G or I whichever has a value (CP or no CP)	X	X	X	X
	Destination Total Time	1,3	Either (G+H) or I whichever has value	X	X	X	X
v	Speed						
	Line Speed	ALL	Haul miles / E	X	X	X	X
	Speed 1	ALL	Haul miles /E+F	X	X	X	X

(1) Populations are defined as each unique combination of shipper-origin-destination-commodity grouped by service review year and trips type. Valid values are defined as all non-null, non-zero and non-negative values. For each calculation only the valid values are included in the base (denominator) population for all Means, Medians, Deviations and Coefficients of variation.

b. Intermodal Transit time Calculation matrix for each population

	Calculation Name	Column Name	Calculation	Mean	Standard Deviation	Coefficient of Variation	Median
i	Transit Time	Transit Time	3	X	X	X	X
ii	In-Gate Depart Time	In-Gate Depart Time	1 + 2	X	X	X	X
iv	Arrive De-ramp Time	Arrive De-ramp Time	4	X	X	X	X
vi	Total time	Total Time	1+2+3+4+5	X	X	X	X
vii	Speed1	Speed 1	Haul Miles / Transit Time	X	X	X	X

10. Time Interval Quality Code – Railway Supplied Values

Time intervals were validated for quality for inclusion in the performance analysis. Each time interval was evaluated individually to ensure that the value was non-null, non-negative and non zero. Each valid time interval for each car trip record was assigned a quality code integer as described below. The sum of these integers defines (for programming logic) which specific interval values were deemed valid and usable in subsequent data processing steps in creating the data sets for analysis.

Example: If only time intervals B and C for a specific records are valid the Interval Quality Code = 6 (the sum of 2 and 4)

Time Interval	Assigned Integer Value
Time Interval A	= 1
Time Interval B	= 2
Time Interval C	= 4
Time Interval D	= 8
Time Interval E	= 16
Time Interval F	= 32
Time Interval G	= 64
Time Interval H	= 128
Time Interval I	= 256
Time Interval J	= 512
Time Interval K	= 1024

11. Quality Code – Calculated Values

The values below that are calculated using the individual time intervals are also evaluated for quality using similar logic to that used for evaluating the time intervals. Valid values are non-null, non-negative and non zero. These codes are then used in subsequent data processing steps to determine which calculated values are to be included in the data sets for analysis. Example: If only Yard Time and Line Time are valid the Calculation Quality Code = 6

Calculated Value	Assigned Integer Value
Transit Time	= 1
Yard Time	= 2
Line Time	= 4
Total Time	= 8
Loading Time	= 16
Arrive Destination to Constructive Placement (ADCP)	= 32
Constructive Placement to Actual Placement (CPAP)	= 64
Arrive Destination to Actual Placement (ADAP)	= 128
Arrive Destination to Actual Placement – incl. constructive placement (ADAPCP)	= 256
Unload Offline	= 512
Unloading Time	= 1024
Line Speed	= 2048
Speed1	= 4096
Destination Railway Time	=16384

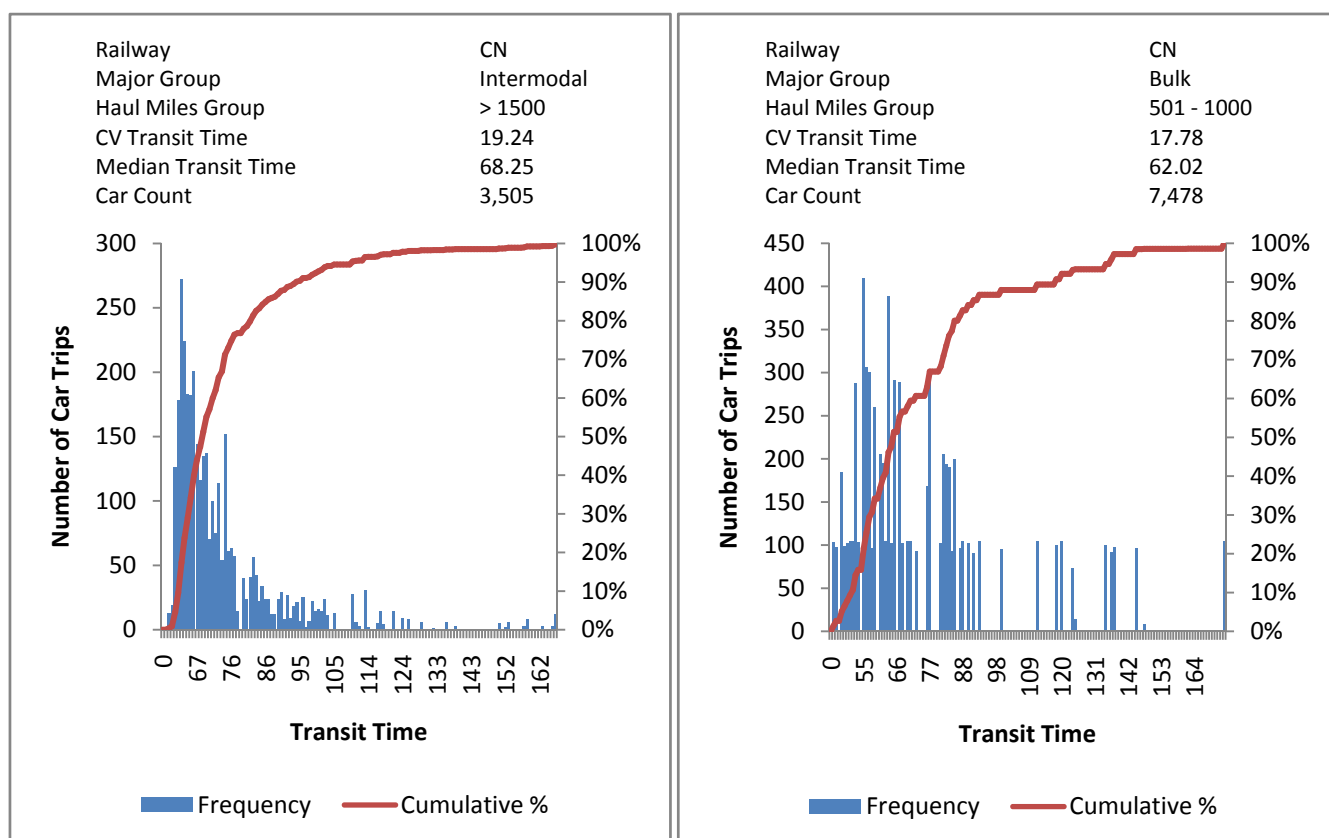
12. Data Trimming Criteria

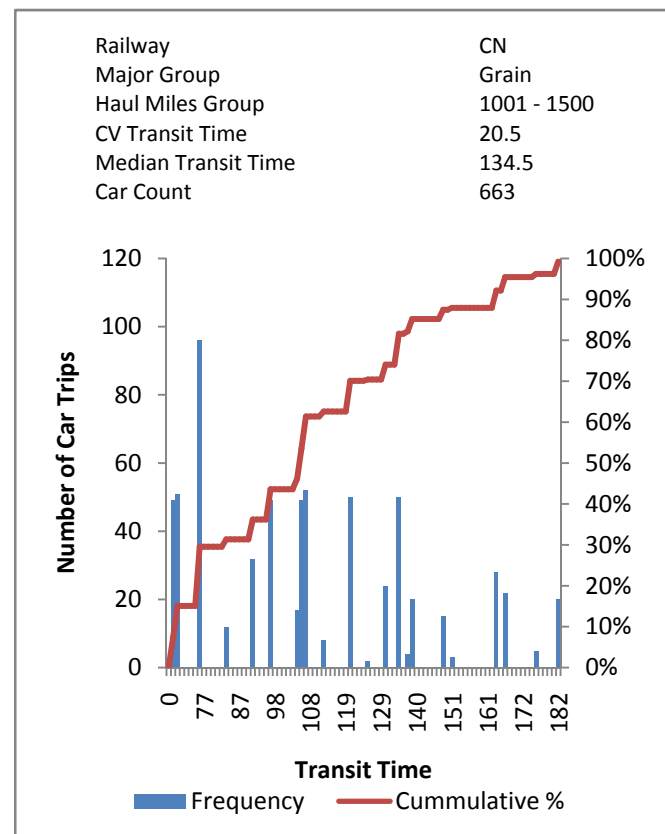
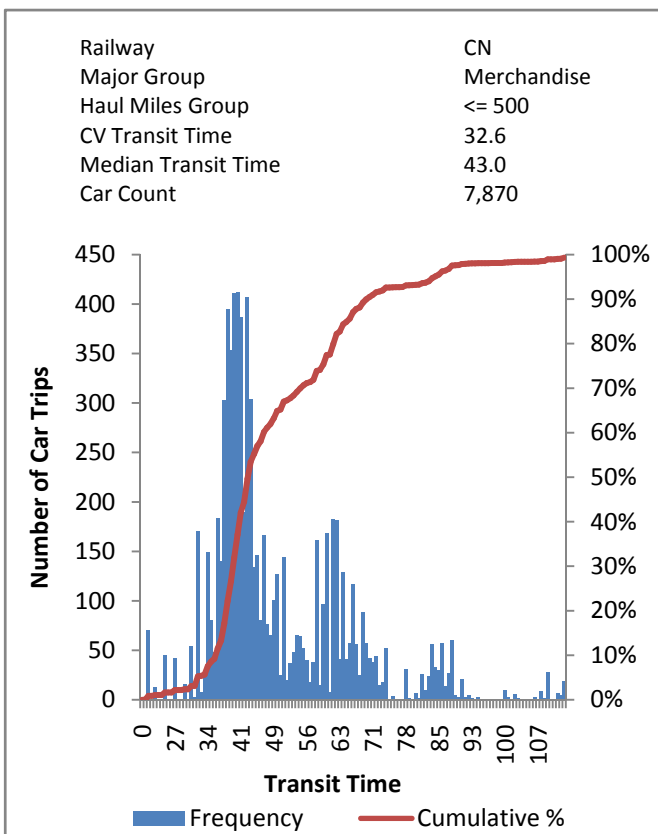
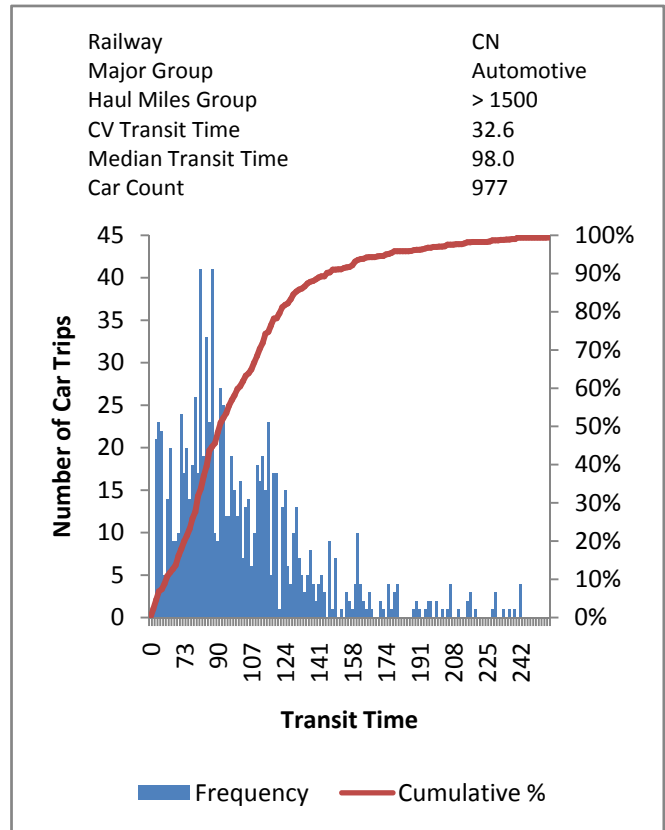
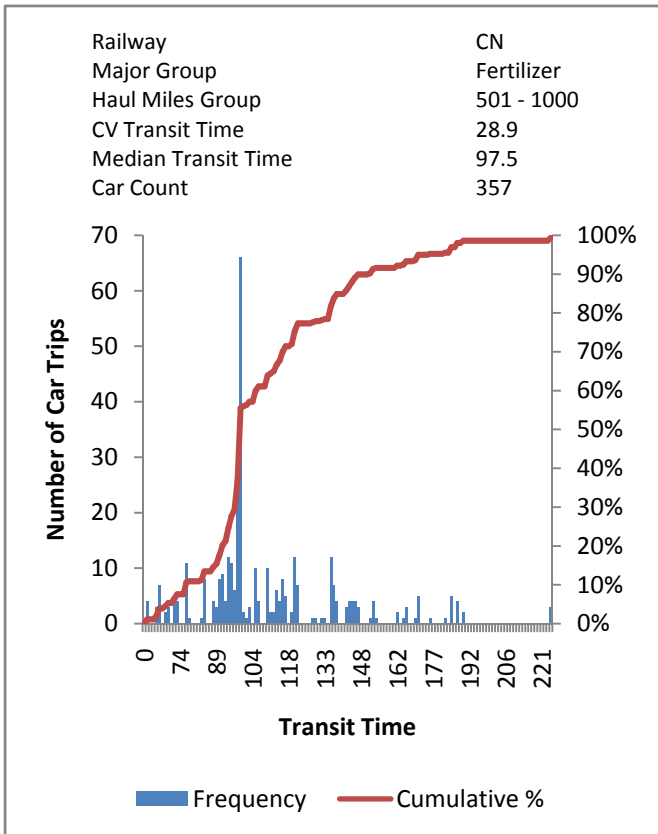
- a. All CN and CP Carload and Intermodal Transit time records for the period February 4, 2007 and March 3, 2007 (Service Review Year 1, weeks 19 to 22 inclusive) are excluded – CN Strike Period.
- b. All transit time records with a Line Speed in excess of 50 miles per hour are excluded.
- c. For transit time calculations only, records with an initial Z score greater than or equal to 3 or smaller than or equal to – 3 are excluded before Z scores are finally calculated.
- d. Only records with valid transit time values (i.e. >0) are included in the calculation of Median, Mean, Standard Deviation and Coefficient of variation for each key in each Service Review Year.
- e. All loading and unloading times for CN and CP originated / terminated traffic greater than 168 hours excluded.
- f. All destination total times for CN and CP terminated traffic greater than 168 hours excluded.
- g. All intermodal terminal time greater than 168 hours excluded.

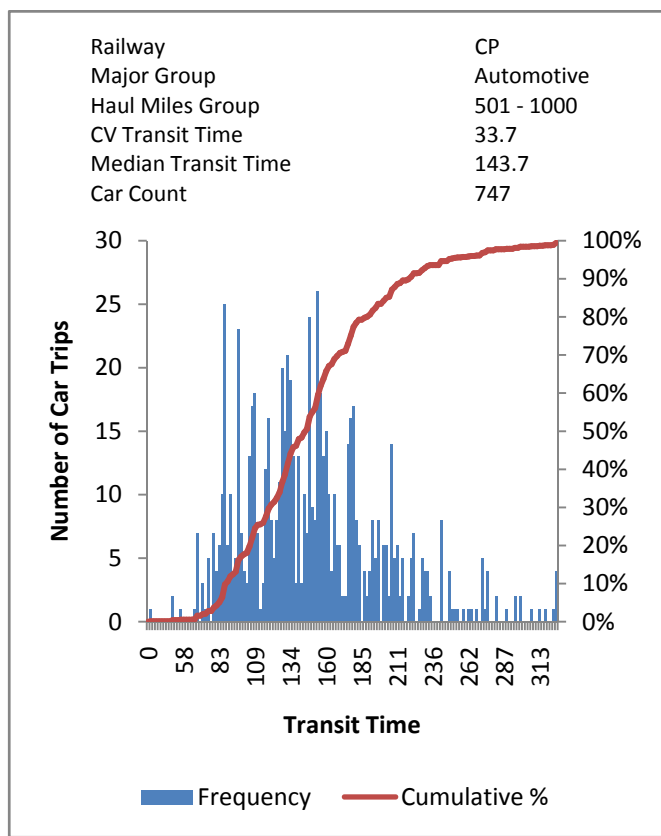
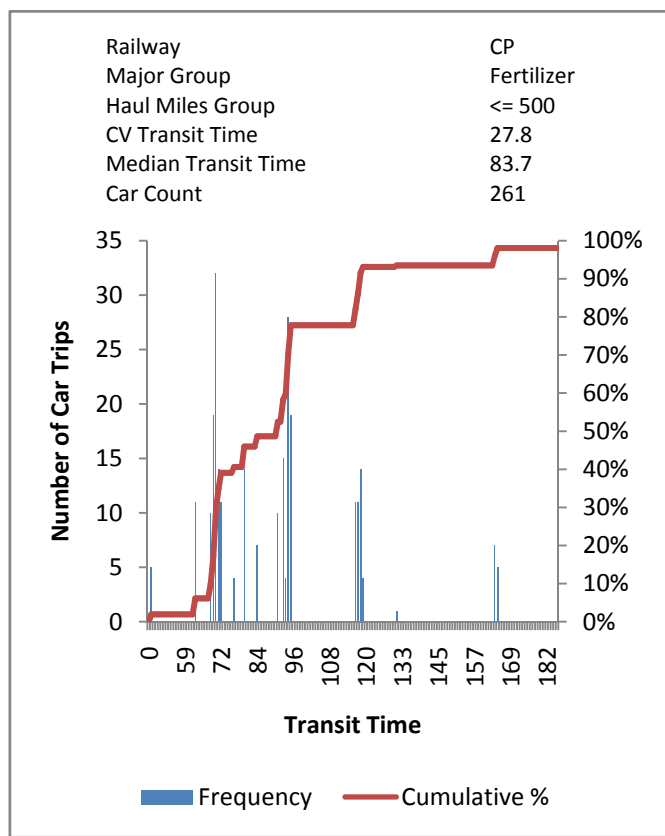
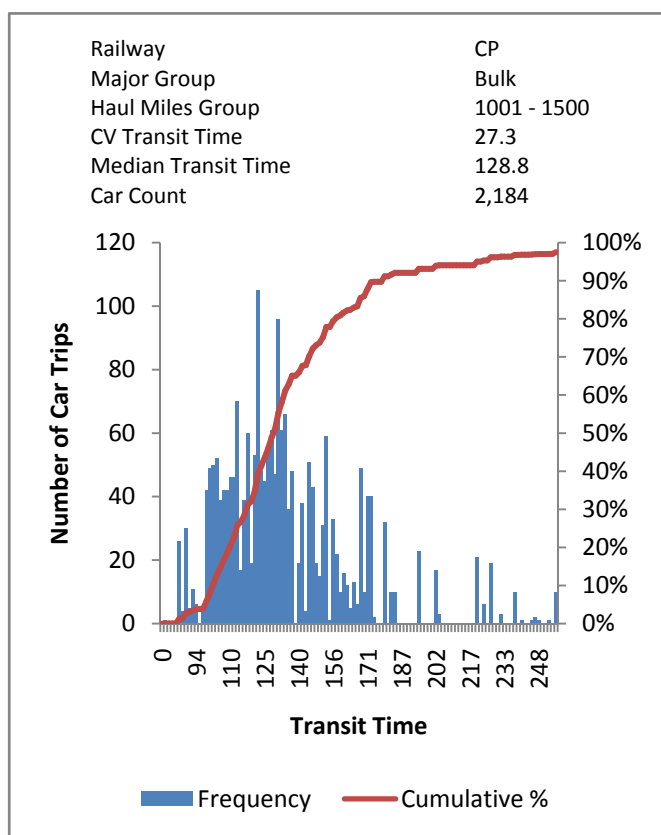
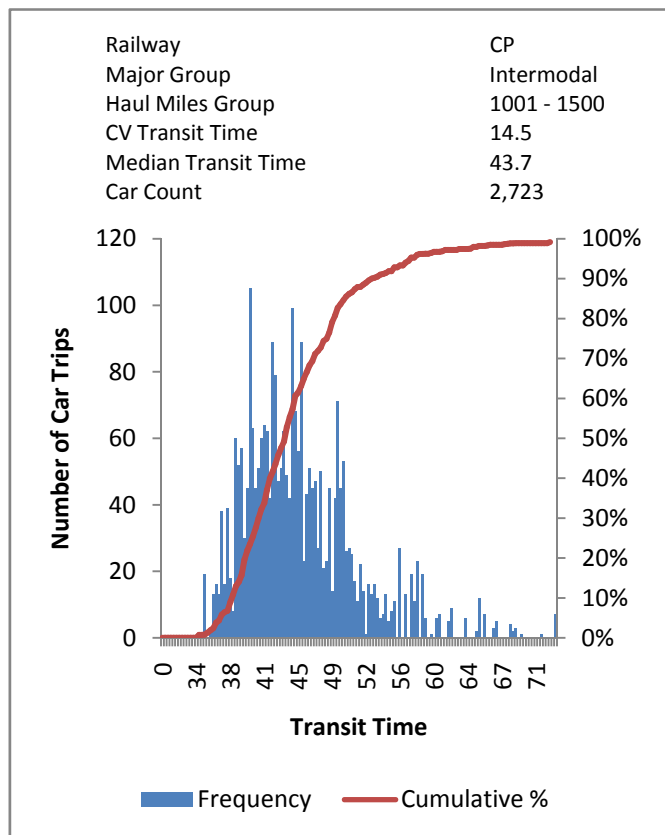
Appendix 4 Representative Flows

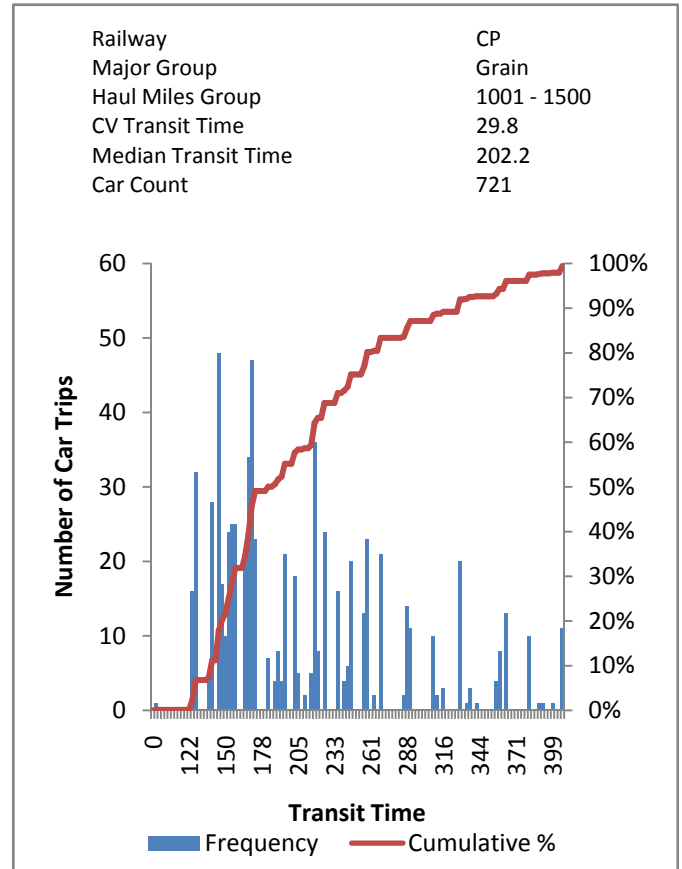
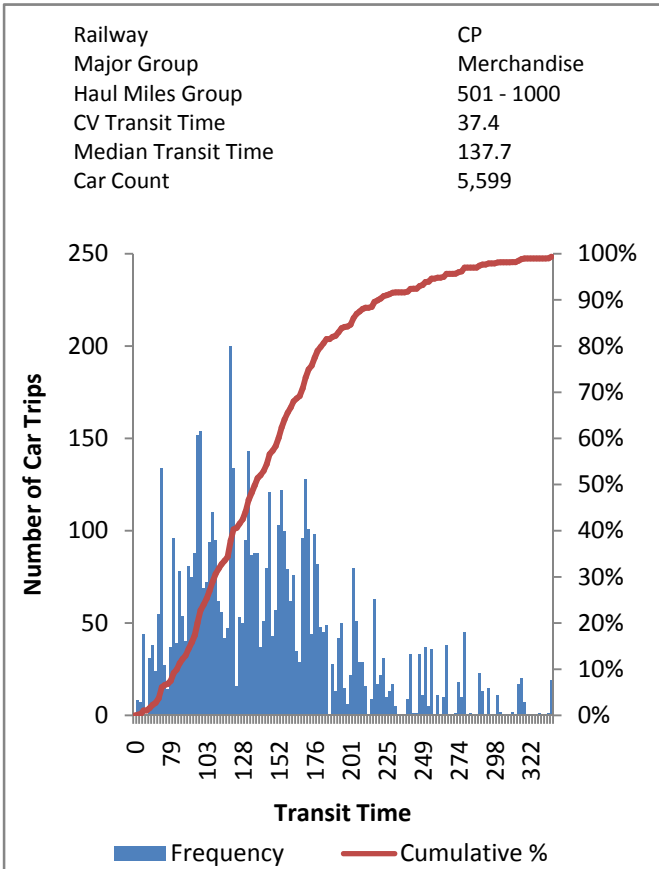
The following 12 transit time frequency distribution charts (histograms) are provided to illustrate directly the range of service performance experienced by 12 representative Canadian rail freight shippers. Each flow from the sample data and each customer has been chosen to be representative of the average performance of all customer traffic flows in the sample data, for each railway commodity group illustrated. Specifically each customer flow has been chosen to be as close as possible to the average transit time consistency of all traffic for a given railway/commodity group combination.

The charts show the dispersion of transit times achieved over the service review period across the horizontal access and the frequency of each level of transit time for a given railway/shipper/origin/destination pair. Note that the scales on each of the histograms are different as the size of the traffic flow, the length of haul and average transit time for a specific chart determine the scales used. The purpose of these charts is not to encourage comparison across commodity groups or railways but to allow readers to view directly – without the need for summary measures of performance – the level of service provided to this representative group of shippers.









Appendix 5 Transit Time Performance

Note: In the following Appendices wherever less than 5 sample keys were present in a cross tabulation, the data is not shown in the report in order to protect railway shipper confidentiality.

Figure 137 Performance by Shipper Size

Count of Sample Keys		Shipper Size			
Major Commodity Group	RailwayName	Large	Medium	Small	Very Small
Automotive	Canadian National Railway	19	8	12	
	Canadian Pacific Railway	8	13	20	
Bulk	Canadian National Railway	32			
	Canadian Pacific Railway	28			
Fertilizers	Canadian National Railway	13			
	Canadian Pacific Railway	12	6		
Grain	Canadian National Railway	157	15	16	12
	Canadian Pacific Railway	181	18	7	
Merchandise	Canadian National Railway	328	94	42	9
	Canadian Pacific Railway	82	84	32	12
Intermodal	Canadian National Railway	135	55	5	9
	Canadian Pacific Railway	136	52	50	25
Weighted Coefficient of Variation - Transit Time		Shipper Size			
Major Commodity Group	RailwayName	Large	Medium	Small	Very Small
Automotive	Canadian National Railway	26.6	26.8	17.2	
	Canadian Pacific Railway	31.0	44.7	25.5	
Bulk	Canadian National Railway	26.1			
	Canadian Pacific Railway	27.6			
Fertilizers	Canadian National Railway	29.8			
	Canadian Pacific Railway	34.9	32.3		
Grain	Canadian National Railway	23.7	28.8	24.4	28.8
	Canadian Pacific Railway	27.8	39.6	34.4	
Merchandise	Canadian National Railway	32.7	27.7	29.8	24.7
	Canadian Pacific Railway	32.6	35.1	32.8	42.7
Total - Non Intermodal	Canadian National Railway	29.4	27.7	26.2	27.1
	Canadian Pacific Railway	29.4	36.6	30.4	43.1
Intermodal	Canadian National Railway	19.3	15.7	23.2	20.7
	Canadian Pacific Railway	21.4	21.0	16.4	16.3

Figure 138 Performance by Flow Size

Count of Sample Keys		Flow Size - cars/containers per year					
Major Commodity Group	RailwayName	> 5000	1001- 5000	501 - 1000	101 - 500	30 - 100	< 30
Automotive	Canadian National Railway			5	17	13	10
	Canadian Pacific Railway				21	15	24
Bulk	Canadian National Railway		8	5	8	10	21
	Canadian Pacific Railway		6		7	13	99
Fertilizers	Canadian National Railway				6	8	27
	Canadian Pacific Railway				10	6	78
Grain	Canadian National Railway			6	72	118	212
	Canadian Pacific Railway			9	92	108	217
Merchandise	Canadian National Railway		26	41	167	239	715
	Canadian Pacific Railway		6	12	65	127	484
Intermodal	Canadian National Railway	12	27	27	71	69	159
	Canadian Pacific Railway	6	23	21	87	158	364
Weighted Coefficient of Variation - Transit Time		Flow Size - cars/containers per year					
Major Commodity Group	RailwayName	> 5000	1001- 5000	501 - 1000	101 - 500	30 - 100	< 30
Automotive	Canadian National Railway			31.1	23.5	19.5	
	Canadian Pacific Railway				35.7	29.6	
Bulk	Canadian National Railway		21.9	28.3	29.4	23.0	
	Canadian Pacific Railway		20.9		34.0	27.6	
Fertilizers	Canadian National Railway				34.6	22.4	
	Canadian Pacific Railway				31.3	36.2	
Grain	Canadian National Railway			21.8	27.2	22.9	
	Canadian Pacific Railway			22.5	34.5	25.3	
Merchandise	Canadian National Railway		35.9	37.6	33.0	28.5	
	Canadian Pacific Railway		48.1	33.2	34.3	33.6	
Total Non Intermodal	Canadian National Railway		31.3	34.6	30.8	26.2	
	Canadian Pacific Railway		33.1	29.7	34.4	29.8	
Intermodal	Canadian National Railway	20.6	20.1	17.9	19.0	17.1	
	Canadian Pacific Railway	21.8	14.5	21.3	20.8	19.9	

Figure 139 Performance by Origin Region

Count of Sample Keys		Origin Province							
Major Commodity Group	RailwayName	BC	AB	SK	MB	ON	PQ	NB	NS
Automotive	Canadian National Railway	16				21			
	Canadian Pacific Railway	7				34			
Bulk	Canadian National Railway		10	21					
	Canadian Pacific Railway	6		20					
Fertilizers	Canadian National Railway		13						
	Canadian Pacific Railway		18						
Grain	Canadian National Railway		46	89	34	26			
	Canadian Pacific Railway		40	112	39	17			
Merchandise	Canadian National Railway	117	72	17	25	82	132	14	14
	Canadian Pacific Railway	30	73	16	9	44	33	5	
Intermodal	Canadian National Railway	42	52	5	9	53	20		20
	Canadian Pacific Railway	55	30	12	5	89	72		
Weighted Coefficient of Variation - Transit Time		Origin Province							
Major Commodity Group	RailwayName	BC	AB	SK	MB	ON	PQ	NB	NS
Automotive	Canadian National Railway	17.1				28.7			
	Canadian Pacific Railway	28.6				33.5			
Bulk	Canadian National Railway		18.2	28.5					
	Canadian Pacific Railway	22.6		30.4					
Fertilizers	Canadian National Railway		29.8						
	Canadian Pacific Railway		34.0						
Grain	Canadian National Railway		23.9	25.0	22.6	25.4			
	Canadian Pacific Railway		31.3	29.0	28.7	24.8			
Merchandise	Canadian National Railway	27.9	27.9	29.1	30.8	30.7	37.2	28.1	31.2
	Canadian Pacific Railway	39.3	31.6	25.4	34.4	40.0	30.9	40.0	
Total Non Intermodal	Canadian National Railway	26.8	26.1	26.1	26.3	29.3	37.0	27.2	30.4
	Canadian Pacific Railway	35.2	31.6	28.8	29.6	34.9	30.9	46.5	
Intermodal	Canadian National Railway	18.9	19.9	20.1	17.7	16.4	17.4		20.2
	Canadian Pacific Railway	23.4	23.5	25.8	25.3	15.9	19.4		

Figure 140 Performance on the Core vs. Non-Core Network

Count of Sample Keys		Origin Network Class	
Major Commodity Group	RailwayName	Non Core	Core
Automotive	Canadian National Railway	9	30
	Canadian Pacific Railway	24	17
Bulk	Canadian National Railway	12	21
	Canadian Pacific Railway	22	8
Fertilizers	Canadian National Railway	17	
	Canadian Pacific Railway		19
Grain	Canadian National Railway	138	62
	Canadian Pacific Railway	141	68
Merchandise	Canadian National Railway	346	127
	Canadian Pacific Railway	106	104
Coefficient of Variation - Transit Time		Origin Network Class	
Major Commodity Group	RailwayName	Non Core	Core
Automotive	Canadian National Railway	31.4	21.4
	Canadian Pacific Railway	36.1	27.8
Bulk	Canadian National Railway	20.8	28.5
	Canadian Pacific Railway	26.5	32.2
Fertilizers	Canadian National Railway	29.2	
	Canadian Pacific Railway		33.5
Grain	Canadian National Railway	24.7	23.7
	Canadian Pacific Railway	29.8	28.0
Merchandise	Canadian National Railway	27.9	40.3
	Canadian Pacific Railway	33.2	35.2
Total Non Intermodal	Canadian National Railway	27.0	32.7
	Canadian Pacific Railway	31.3	32.1

Figure 141 Performance by Competitive Access

Count of Sample Keys		Competitive Access	
Major Commodity Group	RailwayName	No	Yes
Automotive	Canadian National Railway		37
	Canadian Pacific Railway	34	7
Bulk	Canadian National Railway	13	20
	Canadian Pacific Railway	30	
Fertilizers	Canadian National Railway	15	
	Canadian Pacific Railway	19	
Grain	Canadian National Railway	145	55
	Canadian Pacific Railway	203	6
Merchandise	Canadian National Railway	220	253
	Canadian Pacific Railway	182	28
Coefficient of Variation - Transit Time		Competitive Access	
Major Commodity Group	RailwayName	No	Yes
Automotive	Canadian National Railway		23.7
	Canadian Pacific Railway	33.5	28.6
Bulk	Canadian National Railway	21.7	28.3
	Canadian Pacific Railway	28.0	
Fertilizers	Canadian National Railway	28.6	
	Canadian Pacific Railway	33.5	
Grain	Canadian National Railway	24.6	23.9
	Canadian Pacific Railway	29.3	26.8
Merchandise	Canadian National Railway	27.4	34.6
	Canadian Pacific Railway	33.4	39.2
Total Non-Intermodal	Canadian National Railway	26.2	31.6
	Canadian Pacific Railway	31.3	35.6

Figure 142 Performance by Shortline Status

Count of Sample Keys			
Major Commodity Group	RailwayName	Class I	Shortline
Automotive	Canadian National Railway	22	17
	Canadian Pacific Railway	30	11
Bulk	Canadian National Railway	33	
	Canadian Pacific Railway	30	
Fertilizers	Canadian National Railway	15	
	Canadian Pacific Railway	19	
Grain	Canadian National Railway	176	24
	Canadian Pacific Railway	201	8
Merchandise	Canadian National Railway	395	78
	Canadian Pacific Railway	175	35
Coefficient of Variation - Transit Time			
Major Commodity Group	RailwayName	Class I	Shortline
Automotive	Canadian National Railway	26.5	20.1
	Canadian Pacific Railway	33.8	29.5
Bulk	Canadian National Railway	25.7	
	Canadian Pacific Railway	28.0	
Fertilizers	Canadian National Railway	30.3	
	Canadian Pacific Railway	33.5	
Grain	Canadian National Railway	23.6	30.7
	Canadian Pacific Railway	28.9	38.3
Merchandise	Canadian National Railway	32.0	27.5
	Canadian Pacific Railway	34.5	32.6
Total Non-Intermodal	Canadian National Railway	29.2	26.9
	Canadian Pacific Railway	31.5	32.8

Figure 143 Performance by Haul Miles Group

Count of Sample Keys		HaulMiles Group			
Major Commodity Group	RailwayName	< 500	501 - 1000	1000-1500	> 1500
Automotive	Canadian National Railway	7	6		26
	Canadian Pacific Railway	12	17	6	14
Bulk	Canadian National Railway		14		14
	Canadian Pacific Railway	5	15	8	
Fertilizers	Canadian National Railway	6	6		4
	Canadian Pacific Railway	10	9		
Grain	Canadian National Railway	24	83	77	19
	Canadian Pacific Railway	26	131	58	7
Merchandise	Canadian National Railway	165	136	60	133
	Canadian Pacific Railway	87	81	41	31
Intermodal	Canadian National Railway	16	50	20	120
	Canadian Pacific Railway	32	31	60	170
Coefficient of Variation - Transit Time		HaulMiles Group			
Major Commodity Group	RailwayName	< 500	501 - 1000	1000-1500	> 1500
Automotive	Canadian National Railway	36.2	24.8		20.1
	Canadian Pacific Railway	48.4	28.0	25.2	22.7
Bulk	Canadian National Railway		27.7		21.1
	Canadian Pacific Railway	33.9	31.2	20.4	
Fertilizers	Canadian National Railway	39.6	25.2		16.2
	Canadian Pacific Railway	34.4	32.5		
Grain	Canadian National Railway	27.4	25.2	23.3	21.9
	Canadian Pacific Railway	34.7	28.1	29.5	30.5
Merchandise	Canadian National Railway	44.2	27.3	23.3	21.8
	Canadian Pacific Railway	40.9	31.6	30.4	21.3
Total Non Intermodal	Canadian National Railway	41.7	26.5	23.5	21.4
	Canadian Pacific Railway	39.8	29.5	28.9	23.3
Intermodal	Canadian National Railway	18.2	21.3	18.2	17.4
	Canadian Pacific Railway	18.9	23.2	23.9	16.9

Figure 144 Performance by Commodity Sub-Group

Average Coefficient of Transit Time

Commodity Sub-Group	CN	CP	CN and CP
Intermodal (D)	17.2	18.5	17.9
Sulphur	18.8		20.5
Intermodal (Impex)	20.8	24.1	22.4
Lumber & Panels	23.4	29.6	24.2
Agricultural & Food Products	24.9	28.3	26.6
Grain	24.5	29.2	26.8
Coal			27.5
Pulses & Special Crops	22.5	30.8	27.9
Finished Vehicles	23.0	32.7	28.0
Potash	28.5	29.0	28.7
Woodpulp	27.2	33.0	29.7
Metal Products	27.7	36.4	30.2
Paper Products	25.7	36.9	30.3
Fertilizer	29.2	33.5	31.5
Chemicals	28.1	41.0	31.7
Ores & Concentrates	32.5	32.5	32.5
Petroleum Products	33.6	32.1	33.0
Building Materials	28.6	37.7	33.5
Other Forest Products	35.3		37.9
Plastics	83.9	24.1	68.6

The statistic that shows poor transit time consistency for CN Plastics traffic is an example of a situation where a small number of very short haul flows with low mean transit time can create misleading results with respect to the calculation of coefficient of variation. This measure of performance includes three flows of less than 20 miles each – in the Montreal Region on CN. These flows have average transit times of only 2-10 hours, however they are sometimes subject to delays of 1 – 2 days or more in transit resulting in extremely high measures of coefficient of variation. When these six switching flows are removed from the measurement, CN’s average coefficient of variation of transit time on plastics traffic is reduced from 83.9 to 30.9.

Figure 145 Performance by Destination Region and Border Crossing Points

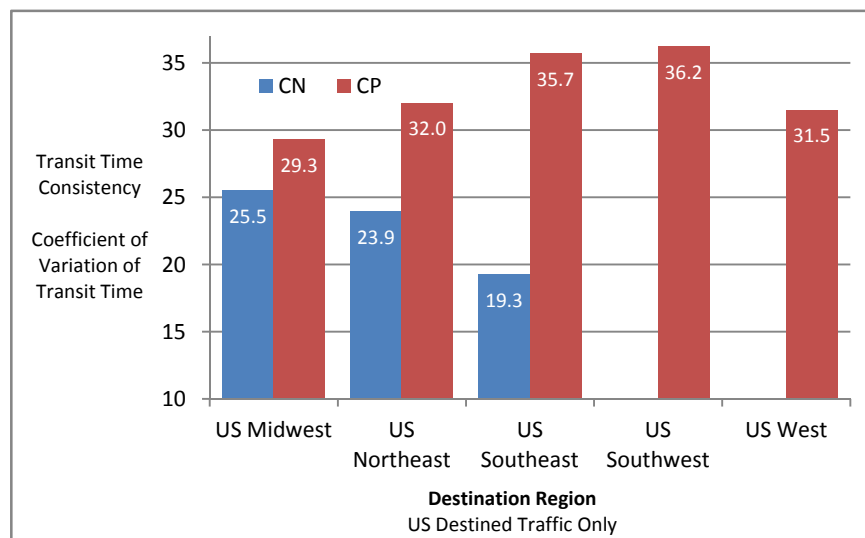


Figure 146 Transit Performance for Car Blocks

Average Split Factor for Blocks Separated in Transit

Railway	Block Size	Automotive	Bulk	Fertilizers	Grain	Merchandise	Total
CN	10 - 24	2.1	2.4	2.1	2.2	2.4	2.3
	25 - 49	2.0	2.8	2.0	2.5	2.8	2.6
	50 - 99		3.1		2.8	3.1	3.0
	> 99		2.7		3.0		2.8
CN Total		2.1	2.6	2.1	2.4	2.4	2.4
CP	10 - 24	2.3	2.3	2.1	2.7	2.7	2.6
	25 - 49	2.5	2.9	2.0	2.6	2.5	2.7
	50 - 99		2.5		2.6	2.5	2.7
	> 99		8.0		2.3		3.1
CP Total		2.3	2.7	2.4	2.6	2.7	2.7

Percent of Origin Car Blocks Split In Transit

Railway	Block Size	Automotive	Bulk	Fertilizers	Grain	Merchandise	Total
CN	10 - 24	37%	40%	24%	36%	45%	40%
	25 - 49	40%	63%		49%	67%	54%
	50 - 99		40%		27%	94%	42%
	> 99		6%		21%		10%
CN Total		37%	39%	24%	39%	47%	42%
CP	10 - 24	33%	43%	17%	42%	43%	40%
	25 - 49		21%		44%	50%	35%
	50 - 99		46%		25%		29%
	> 99		50%		21%		23%
CP Total		34%	29%	19%	38%	43%	38%

Average Percentage of Original Block Arriving with Minimum Transit Time

Railway	Block Size				Total
	10 - 24	25 - 49	50 - 99	>99	
Canadian National Railway	58%	62%	62%	76%	59%
Canadian Pacific Railway	52%	52%	56%	48%	52%
Grand Total	56%	58%	60%	61%	56%

Railway	Automotive	Bulk	Fertilizers	Grain	Merchandise
Canadian National Railway	53%	66%	63%	66%	54%
Canadian Pacific Railway	47%	46%	63%	57%	50%
Grand Total	51%	59%	63%	62%	53%

Figure 147 Delivery to Shippers at Final Destination

Average time from Arrival
to Placement at Destination
in Hours

Commodity Group	CN	CP	Total
Coal	0.2	0.1	0.1
Sulphur	4.0	3.2	3.7
Fertilizer	6.3	9.1	7.2
Chemicals	19.5	4.6	8.8
Plastics	16.8		17.5
Metal Products	19.4	12.2	18.6
Potash	19.8	15.4	19.2
Finished Vehicles	29.5	10.8	20.5
Grain	9.9	33.1	21.2
Other Forest Products	25.3	13.4	23.0
Lumber & Panels			24.2
Petroleum Products	24.4	24.5	24.5
Pulses & Special Crops	33.7	18.0	24.5
Agricultural & Food Products	33.7	20.8	30.4
Paper Products	32.1	35.0	33.6
Building Materials	42.7	30.9	40.0
Ores & Concentrates	30.8	76.6	41.5
Woodpulp	58.2	34.0	55.6

Figure 148 Loading Time Performance

Count of Sample Keys			
Commodity Sub-Group	CN	CP	Total
Grain	215	234	449
Lumber & Panels	362	101	463
Metal Products	53	32	85
Ores & Concentrates	11	15	26
Other Forest Products			40
Paper Products	32	11	43
Potash	36	79	115
Pulses & Special Crops	29	43	72
Woodpulp	43	27	70
Average Loading Time	CN	CP	Total
Grain	44	33	38
Lumber & Panels	33	32	33
Metal Products	64	36	53
Ores & Concentrates	46	56	52
Other Forest Products			45
Paper Products	48	31	44
Potash	62	17	31
Pulses & Special Crops	51	44	47
Woodpulp	50	25	40
Standard Deviation of Loading Time	CN	CP	Total
Grain	16.1	11.3	13.6
Lumber & Panels	23.0	22.3	22.8
Metal Products	32.7	23.5	29.2
Ores & Concentrates	26.0	39.6	33.8
Other Forest Products			28.9
Paper Products	29.1	21.6	27.2
Potash	31.6	13.2	19.0
Pulses & Special Crops	23.7	22.4	22.9
Woodpulp	26.1	16.5	22.4
Average of Median Loading time	CN	CP	Total
Grain	41.5	30.5	35.8
Lumber & Panels	25.3	24.4	25.1
Metal Products	59.4	32.7	49.4
Ores & Concentrates	41.5	54.8	49.2
Other Forest Products			37.2
Paper Products	39.6	25.5	36.0
Potash	58.5	11.4	26.1
Pulses & Special Crops	47.1	38.2	41.7
Woodpulp	44.6	21.9	35.8

Figure 149 Unloading Time Performance

Count of Sample Keys			
Commodity Sub Group	CN	CP	Total
Coal			5
Finished Vehicles	31	26	57
Grain	147	155	302
Lumber & Panels	231	4	235
Metal Products	40	19	59
Ores & Concentrates			9
Other Forest Products			34
Paper Products	27	19	46
Potash	28	9	37
Pulses & Special Crops	24	17	41
Woodpulp	22	11	33
Average Unloading Time	CN	CP	Total
Coal			9.1
Finished Vehicles	16.1	12.1	14.3
Grain	20.8	20.5	20.7
Lumber & Panels	26.9	22.7	26.9
Metal Products	42.2	43.6	42.6
Ores & Concentrates			59.9
Other Forest Products			46.5
Paper Products	23.6	24.8	24.1
Potash	47.2	51.6	48.2
Pulses & Special Crops	16.0	21.8	18.4
Woodpulp	24.9	27.5	25.8
Standard Deviation Unloading Time	CN	CP	Total
Coal			4.6
Finished Vehicles	11.9	6.6	9.5
Grain	11.7	9.3	10.5
Lumber & Panels	17.0	14.9	16.9
Metal Products	26.5	25.4	26.1
Ores & Concentrates			19.9
Other Forest Products			27.8
Paper Products	16.2	10.9	14.0
Potash	25.5	28.0	26.1
Pulses & Special Crops	8.7	10.2	9.3
Woodpulp	14.0	14.2	14.0
Average Median Unloading Time	CN	CP	Total
Coal			8.5
Finished Vehicles	10.9	9.8	10.4
Grain	17.7	17.7	17.7
Lumber & Panels	20.5	15.0	20.4
Metal Products	33.2	32.8	33.0
Ores & Concentrates			59.5
Other Forest Products			39.5
Paper Products	17.2	21.4	18.9
Potash	41.6	45.6	42.5
Pulses & Special Crops	12.7	17.6	14.7
Woodpulp	18.4	23.8	20.2