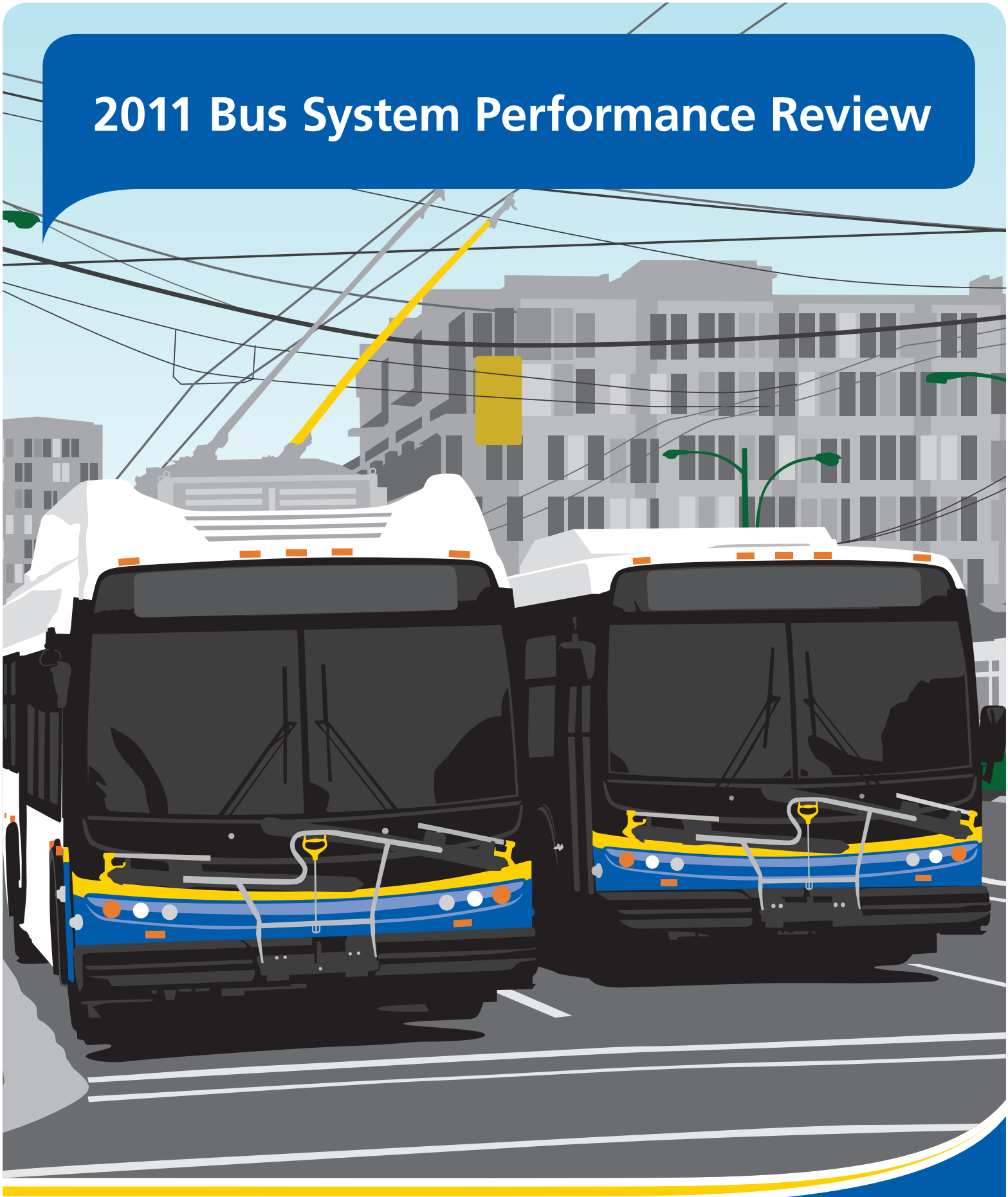
2011 Bus System Performance Review



Prepared by TransLink's Service Planning Department in support of the ongoing management of Metro Vancouver's transit network

TRANSLINK

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Purpose of the 2011 System Performance Review

As part of the ongoing management of the transit network, TransLink regularly reviews and modifies transit service to increase system efficiency and effectiveness. In 2010 and 2011, as part of a focused effort to meet the goals and objectives of the 2010 Funding Stabilization Plan, TransLink underwent an initiative to optimize current levels of transit resources in order to meet the needs of customers, communities and TransLink's financial objectives. The initiative improved customer service while maintaining overall service levels across the region. Resources were redirected to the places and times where they were most needed: where crowding was most significant, where markets for transit service were developing and growing, and where higher revenue could be generated.

The Service Optimization Initiative introduced changes to bus-based transit services beginning in December 2010, extending into 2011 with projects implemented in April, June, and September 2011. Projects were focused on lower impact changes to service frequency, hours of operation and vehicle type. Resources were also made available for re-investment through scheduling efficiencies. Some projects were of a higher impact nature, with changes to network structure and interlines.

The 2011 System Performance Review is intended look at trends in bus system ridership and productivity; to report on bus system performance in 2011, compare that performance to 2010, and provide a basis for making evidence-based decisions on strategic resource re-investment.

The review of the bus-based transit network is conducted on three different levels: system-wide, sub-regionally and route-by-route.

System-wide Analysis

The purpose of the system-wide analysis is to identify trends in system performance. Analysis at the system level provides an opportunity to determine average system values for key performance indicators like boardings per revenue hour, capacity utilization and financial effectiveness. It also allows for the identification of ranges of performance associated with the top, middle high, middle low and bottom 25% of all service system-wide. These values will inform further analysis of the system on a sub-regional and route-by-route basis.

Sub-Regional Analysis

While the transit system functions as a coherent network, in some cases it is useful to review performance on a sub-regional basis. Through a sub-regional analysis we can gain a better understanding of ridership and productivity trends at a more detailed level. This can be particularly useful when identifying more localized impacts of major additions to the transit network, like the Canada Line, a new B-Line service, or the ongoing transition of an area through an area transit plan process e.g. the South of Fraser as it transitions from a focal point network to a grid-based network.

Route-by-Route Analysis

Analysis on a route-by-route basis gives us a detailed indication of how individual components of the transit system are performing. A route-by-route analysis allows observation of the impacts of service changes made in the past and identify future opportunities for strategic re-investment. The criteria by which individual transit services are evaluated is directly related to the performance thresholds determined through the system-wide analysis of ridership and productivity trends. In this manner, the analysis of the transit system on all three levels, system-wide, sub-regionally and by route, are consistent and coordinated.

Report Definitions and Assumptions

This report was developed based on a number of assumptions and relies on a number of important definitions. This section outlines those assumptions and definitions that are most critical to understanding this material.

Key Definitions

System-wide

For the purpose of this report, system-wide performance refers to the bus-based system. This report does not include information on SeaBus, SkyTrain, West Coast Express or HandyDART. The report includes information about TransLink services operated by West Vancouver Transit and other contractors where adequate ridership information is available. In the future, with the introduction of improved technology and business practices, gaps in ridership data will be filled, allowing an even more complete and thorough analysis of all bus-based services.

Sub-Region

Sub-regions are primarily used in TransLink's Area Transit Planning process for the purpose of recognizing regional differences and aligning local plans with transit planning. Dividing the Metro Vancouver area into sub-regions allows for enhanced local involvement in transit planning and creates a vision for the future within the sub-regional context, addressing land use, transit supply and supporting infrastructure.

Revenue Hours

Revenue hours are defined as running time plus recovery time but not deadhead (this applies to all references to revenue hours and boardings per revenue hour).

Cost Per Service Hour

A service hour is the unit by which the supply of transit service is measured. One service hour is equal to one vehicle on the road for one hour a day. Cost per service hour is the cost to provide one hour of bus service. Cost per service hour can vary by time of day; for the purpose of this report, the average cost per service hour is defined as follows:

	2009	2010	2011
Average Cost per Service Hour – Conventional Bus	$117.52	$120.13	$116.69
Average Cost per Service Hour – Community Shuttle	$47.47	$50.43	$52.22

These values were derived in collaboration with TransLink Finance and represent the latest figures available at the time this report was generated. The average cost per service hour includes variable costs, semi-variable/fixed costs and allocated costs, but not TransLink administrative costs.

Key Performance Indicators

Boardings per Revenue Hour[1]

Boardings per revenue hour is an industry-standard key performance indicator (KPI) that measures the total volume of ridership as compared to the supply of transit service. Boardings per revenue hour accounts for total passenger activity and considers the length of time a vehicle is on the road. A disadvantage of this measure is that it does not take into consideration the size of the vehicle or the operating cost of different vehicle types. There are different expectations for the productivity of articulated buses as compared to standard buses as compared to community shuttles. More importantly, there are different operating costs for conventional buses as compared to community shuttles. The boardings per revenue hour measure does not account for these differences. As such, boardings per revenue hour should be used in conjunction with other KPI's to give a more holistic view of service performance. This is particularly important when assessing efficiencies achieved through conversions between vehicle types.

Peak Passenger Load

Peak passenger load is an expression of the relative "fullness" of the transit vehicle i.e. how many people are on board a particular bus at a particular time, or on a particular trip, at the busiest location on a route. This key performance indicator is useful for analysis on a route-by-route, trip-by-trip, or time period-by-time period basis, but loses value when aggregated to a sub-regional or system-wide level. Peak passenger load considers the size of the vehicle, but not the length of time the vehicle spends in revenue service. Nor does it capture passenger turnover, a critical consideration when looking for opportunities to optimize transit services.

Capacity Utilization

Capacity utilization is a key performance indicator that measures the total number of passenger boardings compared to the total number of spaces provided by the transit system. Capacity utilization can be used on a system-wide basis, on a sub-regional basis or on a route-by-route basis to measure the degree to which customers are consuming the number of spaces provided by TransLink services. Capacity utilization considers the size of the vehicle and measures passenger turnover. In many cases it is possible for capacity utilization to be greater than 100%. This indicates a service that is generating multiple passenger boardings and alightings using the same number of spaces. A disadvantage of capacity utilization is that it does not consider the length of time a vehicle is on the road. As such, it favours longer services, with a greater number of stops, which have a greater opportunity to generate passenger activity along the route. Vehicle capacity was based on the Transit Service Guidelines for maximum number of passengers by bus type and time period.

Cost per Boarded Passenger

The cost per boarded passenger measures the cost of providing revenue service compared to the total number of boardings that service generates [Annual Service Cost / Annual Boardings]. The annual service cost differentiates between vehicle types and utilizes the costs per service hour discussed above.

[1] Boardings per revenue hour is different from boardings per service hour (service hours include deadhead). This accounts for any differences between the values in this system performance review and values reported through the TransLink Transportation and Financial Plan.

Key Assumptions

Data

All data was collected from the APC system during the September 2011 quarter. This is consistent with past years.

External Factors

In addition to service changes there are a number of external factors that may affect transit ridership. Some of these include the fare increase effective April, 2010, continued uptake of Canada Line capacity, changes in fuel prices, changing macro economic conditions, changes in land use, expansion of the U-Pass program, mode shifts resulting from exposure to transit during the 2010 Winter Olympics, and others. None of these external factors are assessed in this review.

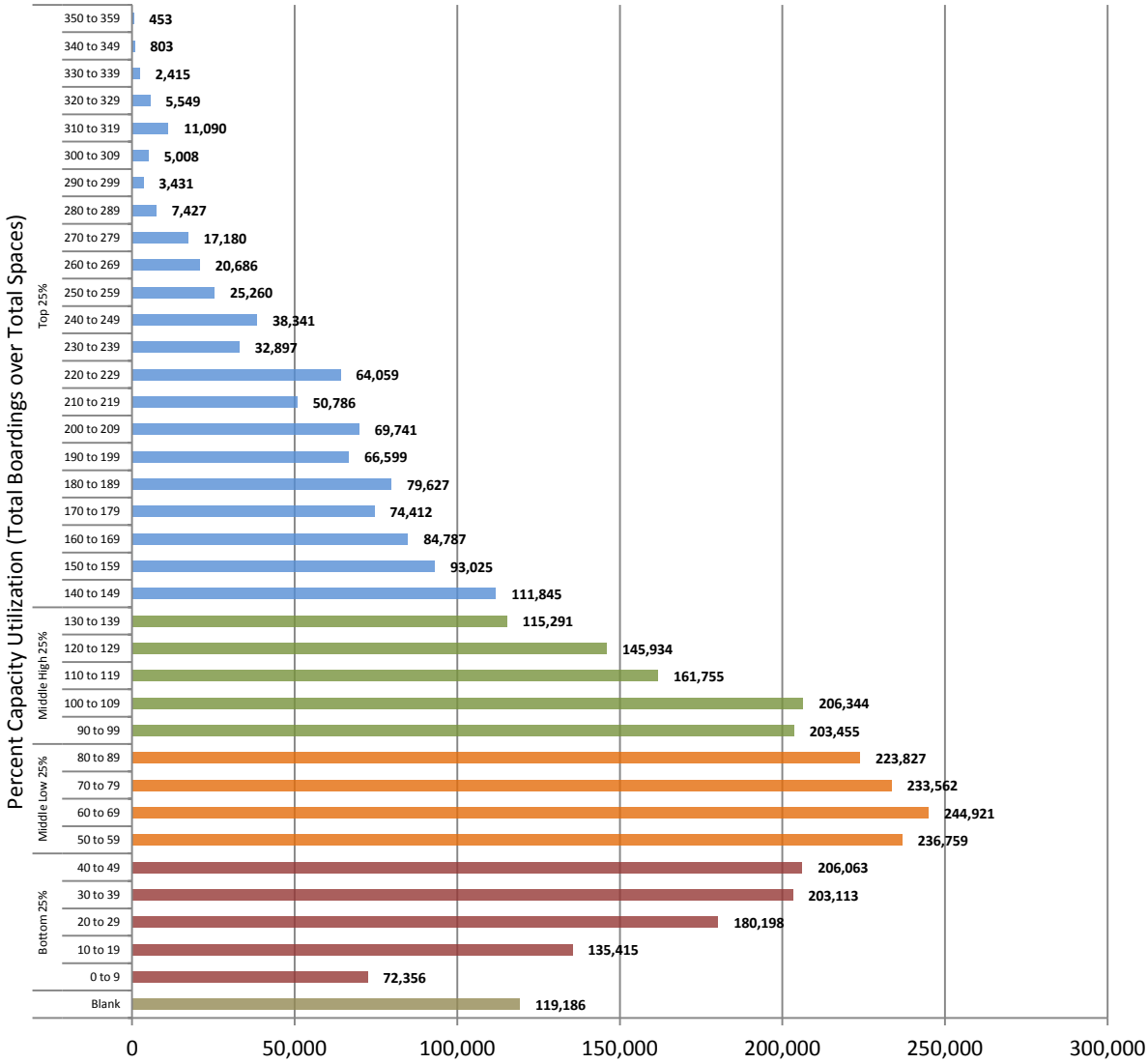
System-wide Performance

The system-wide analysis identifies trends in system performance at the macro level. This provides an opportunity to determine average system values for key performance indicators like boardings per revenue hour, capacity utilization and financial effectiveness. It also allows for the identification of ranges of performance associated with the top, middle high, middle low and bottom 25% of all bus services system-wide. These values will inform further analysis of the system on a sub-regional and route-by-route basis. The results of the system-wide performance analysis are outlined on the following pages.

Capacity Utilization

Figure 1 below illustrates the total volume of annual revenue hours by productivity band as defined by ridership utilization of existing capacity.

Figure 1: Total Volume of Annual Revenue Hours by Capacity Utilization



The September 2011 data shows that median system-wide capacity utilization for 2011 is 88%, up from 87% in 2010, which was a further increase from 84% in 2009 (see Figure 2). This represents a 4.8% increase in system-wide capacity utilization between 2009 and 2011. This increase comes at a time when the transit system was in a state of funding stabilization, where service levels were generally constant. The increase in capacity utilization is likely the result of two factors: 1) an increase in the number of passengers using the transit system, and 2) ongoing optimization of the transit system through vehicle re-allocations, changes in service frequency, hours of operation and network architecture. Blanks refer to time periods where ridership data was unavailable or sample sizes too small to be statistically valid.

Figure 2: Three-Year Trend in System-wide Capacity Utilization

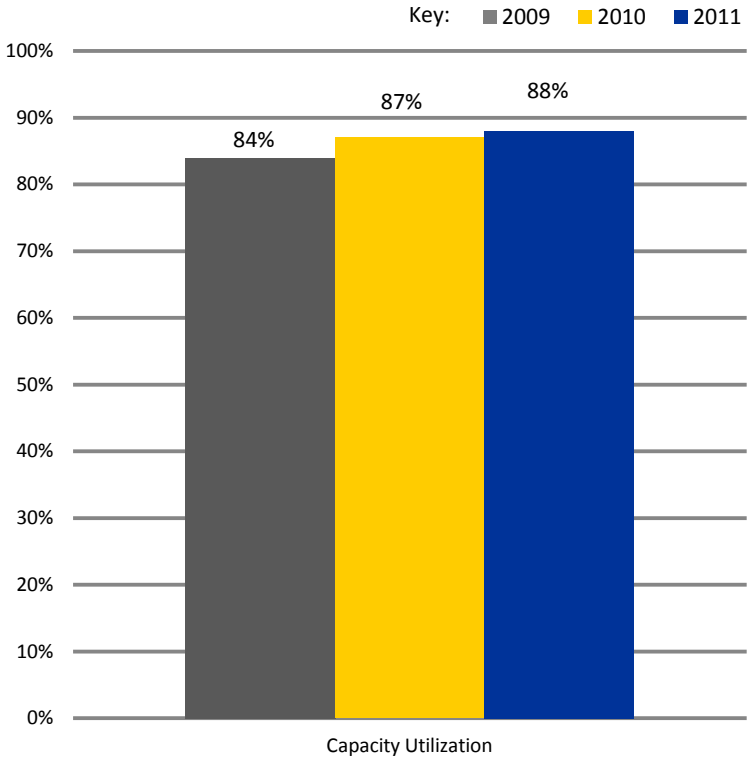


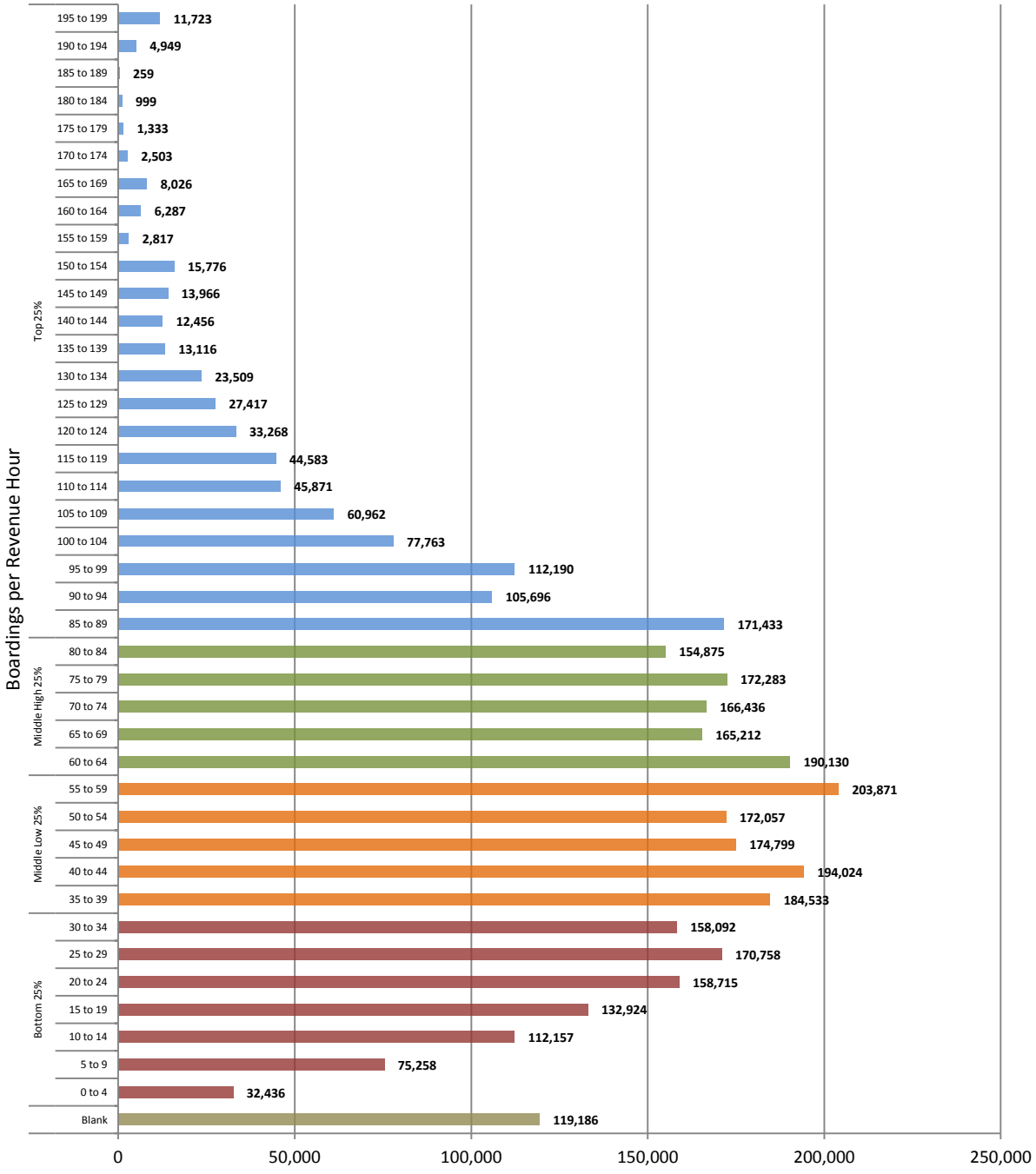
Figure 1 also demonstrates the performance ranges associated with the top, middle high, middle low and bottom 25% of service. These are highlighted in the table below:

Performance Indicator	Value	Productivity Range
Capacity Utilization	Greater than or equal to 140%	Top 25% of all transit services
	89% to 139%	Middle High 25% of all transit services
	52% to 88%	Middle Low 25% of all transit services
	Less than or equal to 51%	Bottom 25% of all transit services

Boardings per Revenue Hour

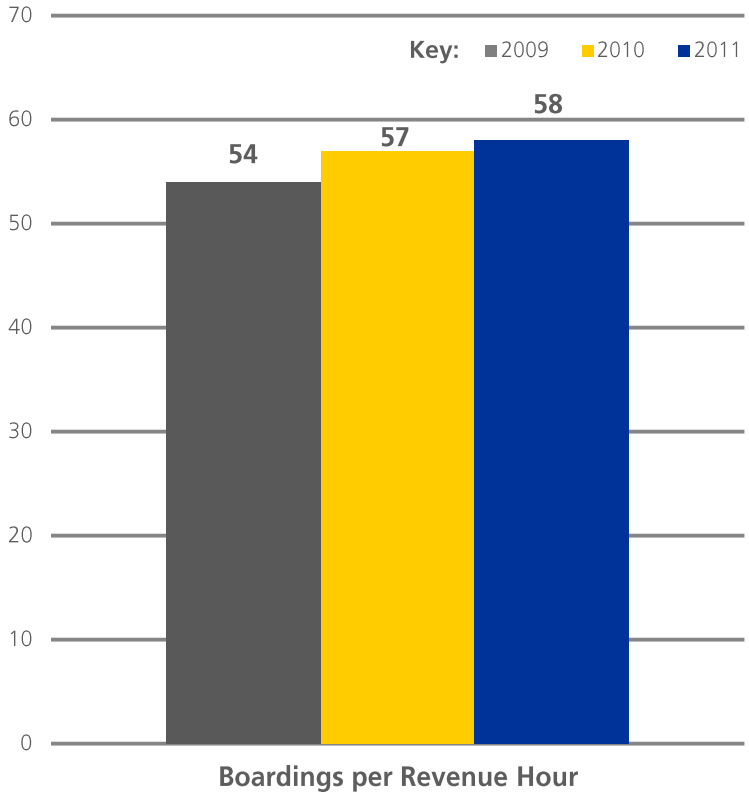
In addition to Capacity Utilization, the performance of the transit system is evaluated against boardings per revenue hour. Figure 3 below shows the overall productivity of the system according to this key performance measure.

Figure 3: Total Volume of Annual Revenue Hours by Boardings per Revenue Hour and Productivity Range



As with Capacity Utilization, the number of boardings per revenue hour is trending upwards – from a median of 57 in 2010 to 58 in 2011. System-wide boardings per revenue hour have increased by approximately 7% since 2009. This upwards trend could be attributed to an increase in overall ridership, with some influence from TransLink's ongoing service optimization program, which re-allocates service hours from unproductive services to services that generate higher productivity. The three-year trend in system-wide boardings per revenue hour is included below:

Figure 4: Three-Year Trend in System-wide Boardings per Revenue Hour



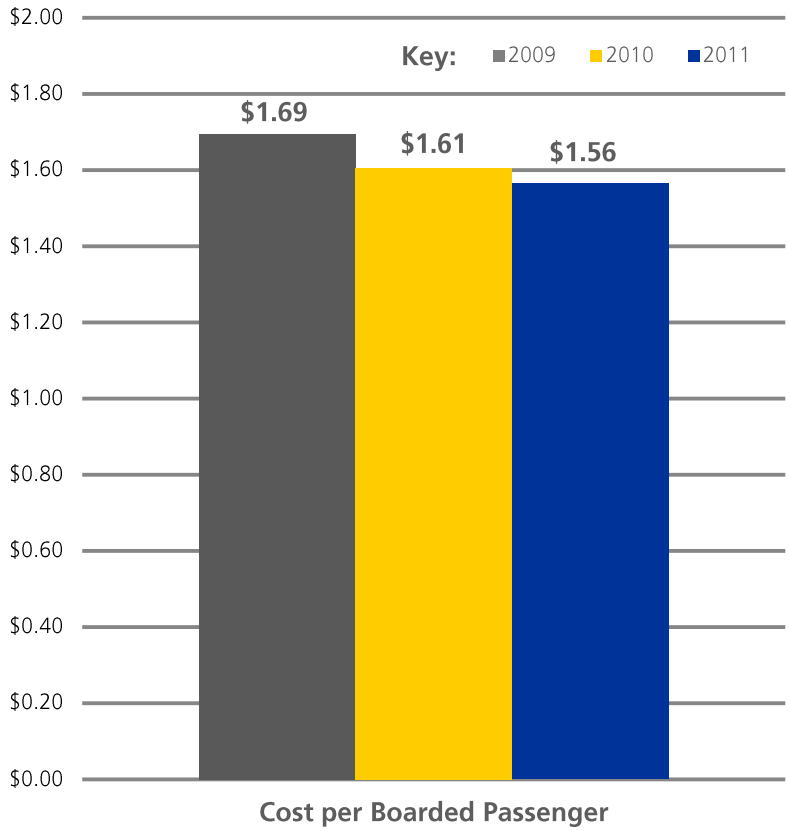
The performance ranges associated with system-wide boardings per revenue hour are outlined in the table below:

Performance Indicator	Value	Productivity Range
Boardings per Revenue Hour	Greater than or equal to 83	Top 25% of all transit services
	59 to 82	Middle High 25% of all transit services
	35 to 58	Middle Low 25% of all transit services
	Less than or equal to 34	Bottom 25% of all transit services

Cost per Boarded Passenger

New in this 2011 report is the cost per boarded passenger KPI, which measures the cost of providing revenue service compared to the total number of boardings that service generates. The September 2011 data show that the median system-wide cost per boarded passenger for 2011 is $1.56, down from $1.61 in 2010, which decreased from $1.69 in 2009 (see figure 5). This represents a 7.6% decrease in system-wide cost per boarded passenger between 2009 and 2011. This downwards trend could be attributed to an increase in ridership, reduced operational costs, and TransLink's ongoing service optimization program, which re-allocates service hours to accommodate increased ridership utilizing existing resources. The three-year trend in system-wide cost per boarded passenger is shown below:

Figure 5: Three-Year Trend in System-wide Cost per Boarded Passenger



Overall Findings on System-wide Performance for 2011

Overall, the findings of this report are consistent with the upwards trend of system ridership and productivity measured through TransLink Transportation and Financial Plans. Reports from TransLink Finance show that revenue ridership has grown 6.6 percent, and total transit revenue has grown 5.0 per cent 2011 over 2010. Between 2010 and 2011, system-wide boardings per service hour grew 1.7 per cent and bus-only boardings per service hour increased by 3.1 percent. It is important to note that records from TransLink Finance reflect values recorded over the entire year, whereas this system performance review makes a direct comparison between fall 2010 and 2011. A different value for productivity recorded between these two sources indicates the system made productivity gains in the spring, summer and winter quarters.

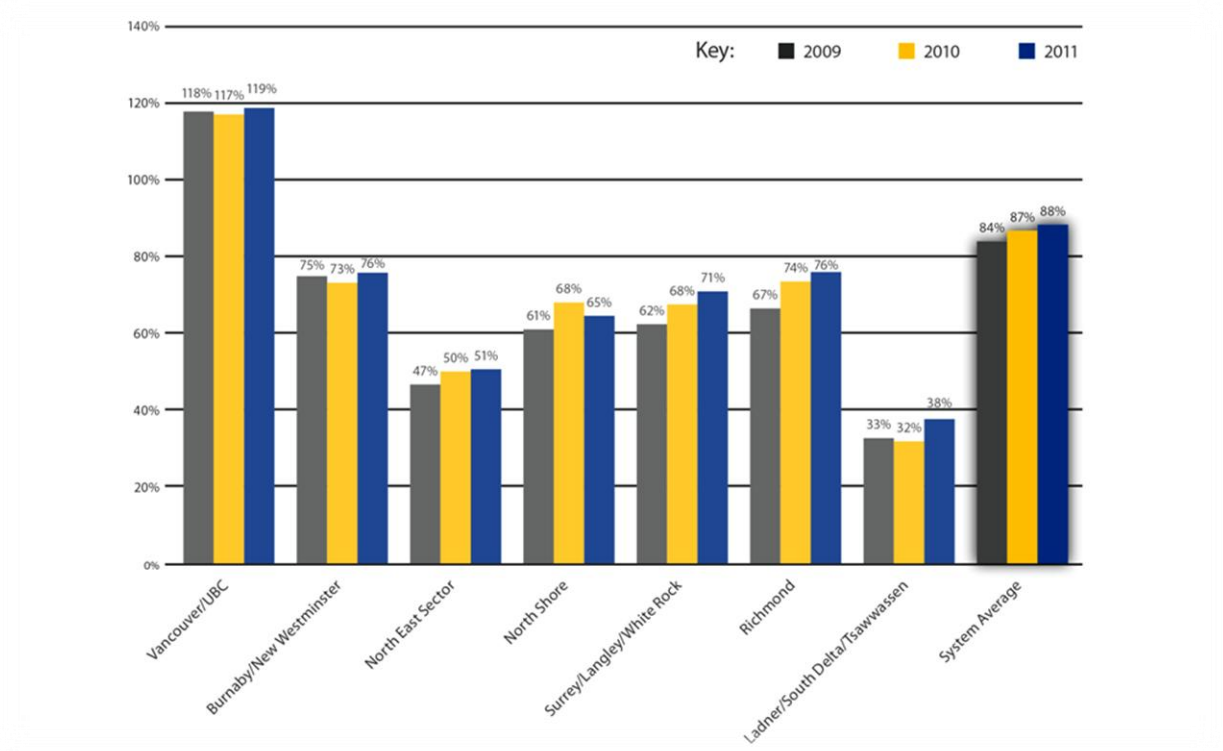
Sub-Regional Performance

In addition to analyzing performance on a system-wide basis, the performance of individual sub-regions is also tracked. Doing so allows for a more detailed look at the impact service changes are having on particular parts of the region. For example, in 2009 TransLink introduced the Canada Line, a new grade-separated fixed rail system that replaced the 98 B-Line, and other services, in Richmond and Vancouver. The introduction of the Canada Line allowed TransLink to feed bus services directly into the rapid transit system, shortening trip lengths, removing route sections that produced little passenger turn-over and re-investing resources back into the bus system. As a result, capacity utilization in the Richmond area increased from 67% in 2009 to 74% in 2010. The impact of the Canada Line was also felt in the South of Fraser and North Shore which experienced significant increases in capacity utilization (9.7% and 11.4% respectively).

Variation in performance across sub-regions is expected due to different levels of transit demand, urban structure and network design. For 2011, sub-regional performance was evaluated using capacity utilization and boardings per revenue hour. The results of the analysis are illustrated below.

Capacity Utilization

Figure 6: Median Capacity Utilization by Sub-Region



An analysis of capacity utilization by sub-region shows that Vancouver/UBC and Burnaby/New Westminster recovered some of the minor losses experienced in 2010. This is likely a result of ridership uptake of the new capacity offered in these areas through the service optimization initiative. The Northeast Sector, the second lowest performing sub-region in the Metro Vancouver area, is growing slowly, up 2% from 50% to 51% during the period 2010 to 2011.

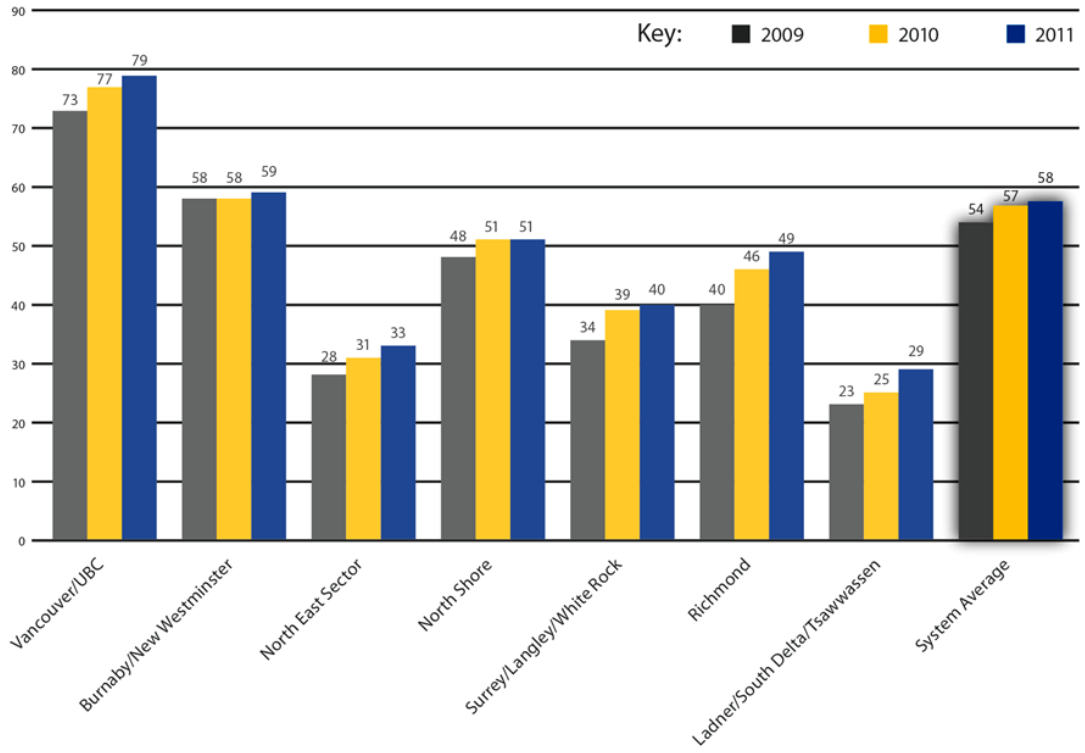
The North Shore saw a decrease in capacity utilization, perhaps the result of additional capacity being added to the sub-region in mid 2011[2]. An analysis of ridership in future years will determine if productivity on the North Shore rebounds in a similar fashion as it did in Vancouver and Burnaby/New Westminster.

After large increases in capacity utilization for the South of Fraser and Richmond areas after the introduction of the Canada Line, both sub-regions saw more modest increases between 2010 and 2011. The increased utilization of available capacity in these sub-regions is likely due to population increase in the South of Fraser and Richmond areas, as well as continued ridership uptake of past service improvements, particularly in the South of Fraser. Ladner/South Delta/Tsawwassen, historically the least productive sub-region in Metro Vancouver, saw the largest increase in capacity utilization between 2010 and 2011, up 18.6% from 32% to 38%.

[2] Service increases in the area included improvements to the 239 (to FTN) and the 246 (all trips extended to Vancouver).

Boardings per Revenue Hour

Figure 7: Median Boardings per Revenue Hour by Sub-Region



The boardings per revenue hour metric shows an upwards trend across the system, the largest increase was observed in the Ladner/South Delta/Tsawwassen area, which moved from 25 to 29 boardings per revenue hour. An increase was also recorded in Richmond which moved up 6.5% from 46 to 49 boardings per revenue hour. Vancouver/UBC, Burnaby/New Westminster, the Northeast Sector and South of Fraser all showed minor gains of 1-2 points. The North Shore stayed steady at 51 boardings per revenue hour.

Route-by-Route Performance

The route analysis defines route performance and productivity at the route level. Analysis on a route-by-route basis gives a detailed indication of how individual components of the transit system are performing. A detailed summary for each route in the bus-system, 221 route summaries in total, have been prepared (see Appendix A). The criteria by which individual transit services are evaluated is related to the performance thresholds determined through the system-wide analysis of ridership and productivity trends. In this manner, the analysis of the transit system on all three levels, system-wide, sub-regionally and by route, are consistent and coordinated.

Route Summaries

The route summaries in Appendix A contain information on ridership, cost, productivity and other performance indicators. The route summaries give a comparison between performance in 2010 and 2011. When reviewing the route summaries, a few factors must be considered:

Some Limitations…

- Does not consider the impact of external factors.
- Not every trip is sampled (figures for less frequent routes should be employed with care as sample sizes will be limited and may include outliers).
- As this is the second year of reviewing the performance of the transit system using this method does not provide enough historical data to remove outliers (once multiple years of performance data are accumulated it will be possible to identify and remove outliers).
- Due to sampling limitations, annual boardings are based on annual projections (not total number of people counted). These projections may produce outliers.
- Values are based on averages (e.g. overcrowding during a specific trip will be diluted in the averages by time period).

However…

- The summaries are based on the best data available
- The route summaries allow observation of the impacts of service changes made in the past and identify future opportunities for strategic re-investment (reducing service in underperforming services for re-investment in higher performing services).

The route summaries (Appendix A) were utilized to develop the following highlights from Service Optimization and to outline future opportunities for service changes. The specific procedures employed for the preparation of route summaries are also included in Appendix A.

Highlights from 2011 Service Optimization Projects

As part of the Service Optimization initiative, specific services and areas of opportunity were identified through a collaborative work performed by TransLink and CMBC Planning staff. Project selection was based on guiding principles and the goal of the review was to reallocate resources from lower productivity to higher productivity services. In total, the enterprise reallocated approximately 170,000 hours, on over 100 bus routes, between September 2010 and September 2011. This represents approximately 3.4% of service system-wide. The dollar value of service strategically re-invested in this time period was approximately $35.8M.

This section highlights a selected number of transit routes that underwent service changes in 2011 and outlines their corresponding ridership, costs and productivity outcomes. Highlights were selected to provide a broad representation of service changes across the sub-regions. The highlights are classified in four categories as follows:

- Service Re-Investments
- Conversions between Vehicle Types
- Service Reductions
- Changes in Network Architecture

Service Re-Investments

Resources saved from vehicle conversions and service reductions were redirected to the places and times where they were most needed: where crowding was most significant, where markets for transit service were developing and growing, and where potentially higher revenue could be generated. Projects under this category include service frequency increases and extensions of service span (e.g. new weekend services). Highlights of service increases include:

Route 2, Burrard Station/MacDonald – 16th Avenue/ Route 22, Knight/Macdonald

- **Optimization Opportunity -** Re-invest resources to reduce overcrowding and support increased ridership growth
- **Service Change -** Increase AM and PM peak service frequencies and add new Sunday/Holiday Service
- **Outcome -** Improved productivity, higher ridership, reduced overcrowding.

Since route 2 overlaps segments of route 22, the service change affected both services. The additional investment in revenue hours was 2,200 hours and annual service cost grew to $11.5M from $11.1M; however, cost per boarded passenger remained at approximately $3.1, due to increased ridership. Total annual boardings grew by 11% to 7.31 million and boardings per revenue hour grew to 74 from 68. The combined changes in resource investments and route productivity are summarized in the following table:

Metric	2010			2011			Change	
	Route 2	Route 22	Combined	Route 2	Route 22	Combined	Sum	%
Annual Revenue Hours	12,300	84,200	96,500	15,500	83,200	98,700	+2,200	+2%
Annual Service Cost	$1,418,000	$9,678,000	$11,096,000	$1,810,000	$9,713,000	$11,523,000	+$427,000	+4%
Annual Boardings (Projected Sum)	1,018,000	5,549,000	6,567,000	1,267,000	6,046,000	7,313,000	+746,000	+11%
Cost/Boarded Passenger	$1.39	$1.74	$1.69	$1.43	$1.61	$1.58	-$0.11	-7%
Boardings per Revenue Hour	83	66	68	82	73	74	+6	+9%

It is also relevant to highlight that the introduction of the new Sunday service alleviated overcrowding on route 22, where peak passenger loads went to 32 from 63 people during Sunday evenings, as shown in Figure 8:

Figure 8: Performance by Day of Week, Route 22 (fragment from Appendix A)

	Time	Annual Revenue Hours		Average Trips per Hour		Average Boardings per Hour		Average Boardings per Trip		Average Capacity Utilization		Average Peak Passenger Load (EB/WB or NB/SB)		Vehicle Type	
		2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Sunday/Holiday	01:00 - 06:00	86	84	1	1	9	5	7	2	14%	4%	4 / 6	2 /	Std. Bus	Std. Bus
	06:00 - 09:00	1053	1031	4	4	65	48	62	49	144%	111%	11 / 29	13 / 30	Std. Bus	Std. Bus
	09:00 - 15:00	4010	3966	5	5	78	71	98	90	196%	179%	37 / 44	30 / 40	Std. Bus	Std. Bus
	15:00 - 18:00	1955	1899	5	5	81	77	107	95	214%	190%	36 / **57**	35 / 33	Std. Bus	Std. Bus
	18:00 - 21:00	1503	1458	4	4	101	68	124	84	249%	168%	**63** / 41	32 / 36	Std. Bus	Std. Bus
	21:00 - 01:00	1523	1466	3	3	39	39	53	48	106%	95%	/ 27	18 / 25	Std. Bus	Std. Bus

Top 25% of all bus services | High 25% of all bus services | Low 25% of all bus services | Bottom 25% of all bus services | # Above Guidelines

Route 16, 29th Avenue Station/Arbutus

- **Optimization Opportunity -** Re-invest resources to reduce overcrowding and support increased ridership growth
- **Service Change -** Increase service frequencies throughout the week
- **Outcome -** Increased ridership, stable productivity

Annual revenue hours were increased to 76,200 from 70,500. Annual service cost grew to $8.8M from $8.1M, while cost per boarded passenger remained at $1.30, due to increased ridership, which grew to 6.9 from 6.4 million boardings per year. Average daily boardings during weekdays grew to 21,250 from 19,550 and during Saturdays to 15,400 from 13,950. Despite the introduction of new capacity, average capacity utilization grew to 232% from 226%.

Route 129, Metrotown Station/Edmonds Station

- **Optimization Opportunity –** Re-invest resources to reduce overcrowding and support increased ridership growth
- **Service Change -** Increased AM and PM peak service
- **Outcome –** Stable ridership, reduced productivity

Annual revenue hours were increased to 35,700 from 31,400. Annual service cost grew to $4.2M from $3.6M and average daily boardings remained at approximately 6,250 people per day, during weekdays. The combination of increased service costs and absence of ridership growth resulted in an increase of cost per boarded passenger to $2.20 from $1.90. Average capacity utilization was reduced to 104% from 119%.

Route 239, Park Royal/Phibbs Exchange/Capilano University

- **Optimization Opportunity -** Re-invest resources to reduce overcrowding and support increased ridership growth
- **Service Change -** Increase service to achieve FTN levels of service in anticipation of future growth
- **Outcome -** Small ridership growth, reduced productivity

Annual revenue hours were increased to 45,900 from 38,500. Annual service cost grew to $5.4M from $4.4M. Total annual boardings grew by 3% to 3.3 from 3.2 million/year. Cost per boarded passenger grew to $1.6 from $1.4. Boardings per revenue hour decreased to 72 from 83; capacity utilization decreased to 111% from 116%.

Route 319, Scott Road Station/Newton Exchange

- **Optimization Opportunity -** Re-invest resources to reduce overcrowding and support increased ridership growth
- **Service Change -** Improved weekday service in anticipation of ridership growth
- **Outcome -** Small ridership growth, reduced productivity

Annual revenue hours increased to 40,900 from 33,800. Annual service cost increased to $4.8M from $3.9M. Cost per boarded passenger increased to $1.32 from $1.14. Total annual boardings increased by 6% to 3.6 from 3.4 million. Average boardings per revenue hour decreased to 89 from 101; capacity utilization decreased to 100% from 110%.

Route 791 Braid Station/Haney Place

- **Optimization Opportunity -** Re-invest resources to reduce overcrowding and support increased ridership growth
- **Service Change -** Increased AM and PM peak service in anticipation of ridership growth
- **Outcome -** Small ridership growth, stable productivity

Annual revenue hours increased to 16,400 from 14,400. Annual service cost increased to $1.9M from $1.7M. Cost per boarded passenger increased to $4.07 from $3.77. Total annual boardings increased by 7% to 471,000 from 439,000. Average boardings per revenue hour, average capacity utilization and average peak load remained approximately constant at 29, 64% and 24 respectively.

Conversions between Vehicle Types

In an effort to better match transit demand with supply, opportunities were identified to convert fleet types e.g. conversions between community shuttles, standard buses and articulated buses. Most vehicle conversion projects were from standard to community shuttles. In this case, TransLink is able to provide the same level of service at a reduced cost per service hour, as well as better match vehicle capacity to ridership demand. A conversion from standard bus to community shuttle could occur during certain time periods (off-peak, for example), on specific day types (weekends) or on entire routes. Some restrictions apply in TransLink's ability to convert transit services to community shuttle, including the availability of fleet and operators, and the capacity of transit operating and maintenance centres for the storage and maintenance of the community shuttle fleet.

A large share of optimization projects in 2011 consisted of conversions between vehicle types. Highlights of these projects are as follows:

Route 388, 22nd Street Station/Walnut Grove

- **Optimization Opportunity -** Reduce service cost through conversion from standard bus to community shuttle
- **Service Change -** Convert 388 to community shuttle, weekdays, all trips
- **Outcome -** Stable ridership, reduced operating cost

Annual revenue hours were kept at the same level; average daily boardings during weekdays were maintained at approximately 500 passengers per day. Annual service cost decreased to $0.4M from $0.9M, and cost per boarded passenger decreased to $2.90 from $7.62. Peak passenger loads per period were below 14 people per trip. Boardings per revenue hour remained at the same levels; capacity utilization increased to 60% from 31%.

Route 116, Edmonds Station/Metrotown Station

- **Optimization Opportunity -** Reduce service cost through conversion from standard bus to community shuttle
- **Service Change** Convert 116 to community shuttle weekends, all trips
- **Outcome** Stable ridership, reduced operating cost

Annual revenue hours were kept at the same levels, average daily boardings during Saturdays and Sundays were maintained at proximately 500 people per day. Annual service cost decreased to $1.2M from $1.4M. Cost per boarded passenger decreased to $2.6 from $2.8. Peak passenger loads per period did not exceed 8 people per trip.

Route 640, Scott Road Station/Ladner Exchange

- **Optimization Opportunity -** Reduce service cost through conversion from standard bus to community shuttle
- **Service Change** Convert 640 to community shuttle on weekends in the evening
- **Outcome** Stable ridership, reduced operating cost

Annual revenue hours were kept at the same levels, average daily boardings during weekends remained at approximately 600 people per day. Annual service cost was kept at around $1.70M, and cost per boarded passenger decreased to $3.65 from $3.82. Peak passenger loads were below 19 people per trip during the periods where the community shuttle was provided.

Service Reductions

Service reduction projects in 2011 included reduced hours of service (or 'service span' modifications) and reduced trip frequencies during specific times of day. The intent of these service changes was to better match service supply with ridership and free resources for re-investment in higher productivity time periods. A few service reduction highlights are:

Route 8, Fraser/Downtown

- **Optimization Opportunity –** Reduce service to better match transit supply with ridership demand
- **Service Change –** Reduce service frequencies, where appropriate, all days
- **Outcome –** Stable ridership, reduced operating cost, improved productivity

Frequencies were reduced in small increments to minimize customer impacts (e.g. Saturday evening frequency changed to 10 minute service from 8.5). Annual revenue hours were reduced to 61,600 from 64,500. Average daily boardings were maintained at the same levels throughout the week. Annual service cost was reduced to $7.2M from $7.4M. Cost per boarded passenger decreased to $1.09 from $1.12. Average capacity utilization increased to 101% from 93%. Average peak load increased to 30 from 27 people.

Route 136, Lougheed Station/Brentwood Station

- **Optimization Opportunity -** Reduce service to better match transit supply with ridership demand
- **Service Change -** Reduce service frequencies, weekdays, AM & PM peak service
- **Outcome -** Stable ridership, reduced operating cost

Frequencies were reduced in small increments to minimize customer impacts (e.g. to 20 minute from 15 minute service during peak periods). Annual revenue hours reduced to 16,500 from 18,000, average daily boardings were sustained at the same levels throughout the week. Annual service cost was reduced to $1.9M from $2.1M. Average capacity utilization increased to 38% from 37%. The following figure illustrates how ridership was kept at the same levels throughout the day, while capacity utilization was increased, particularly during the AM and PM peak service, periods where the service changes were implemented.

Figure 9: Performance by Day of Week, Route 136 (fragment from Appendix A)

Time		Annual Revenue Hours		Average Trips per Hour		Average Boardings per Hour		Average Boardings per Trip		Average Capacity Utilization		Average Peak Passenger Load (EB/WB or NB/SB)		Vehicle Type	
		2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Mon-Fri	01:00 - 06:00	417	550	2	2	14	15	12	12	24%	24%	6 / 11	12 / 9	Std. Bus	Std. Bus
	06:00 - 09:00	3071	2775	4	3	35	35	25	27	50%	56%	19 / 19	20 / 20	Std. Bus	Std. Bus
	09:00 - 15:00	3450	3450	2	2	28	33	20	22	40%	44%	13 / 13	15 / 13	Std. Bus	Std. Bus
	15:00 - 18:00	3375	2917	4	3	38	38	26	29	52%	57%	20 / 16	18 / 21	Std. Bus	Std. Bus
	18:00 - 21:00	1629	1554	2	2	31	30	19	19	38%	39%	13 / 16	15 / 15	Std. Bus	Std. Bus
	21:00 - 01:00	1829	1209	2	2	17	11	10	8	20%	16%	7 / 9	6 / 8	Std. Bus	Std. Bus

Top 25% of all bus services | High 25% of all bus services | Low 25% of all bus services | Bottom 25% of all bus services | # Above Guidelines

Route 403, Bridgeport Station/Three Road

- **Optimization Opportunity -** Reduce service to better match transit supply with ridership demand
- **Service Change** - Reduce service frequencies, where appropriate, throughout the week
- **Outcome -** Stable ridership, reduced operating cost

Frequencies were reduced in small increments to minimize customer impacts (e.g. to 12 from 10 minute service during mid-day service on weekdays). Annual revenue hours were reduced to 34,700 from 40,000. Average daily boardings increased during weekdays to 6,100 from 5,550 passengers per day. Annual service cost was reduced to $4.0M from $4.6M. Cost per boarded passenger decreased to $2.00 from $2.50. Average capacity utilization stayed at approximately 60%. Average peak load increased to 25 from 19 people. Continued monitoring is required to identify growth trends and/or future service modifications.

Network Architecture

Projects under this category involve changes to the network of bus services, which includes the introduction of new routes, discontinuation of services and significant route re-alignments. The intent of network architecture changes is to offer services that better match existing demand (or shape future demand) and create services that align with the themes of transit route design (i.e. simplicity, legibility, directness and consistency). In several cases these projects involve the simultaneous realignment of several routes. Highlights of network architecture changes include:

Route 246, Vancouver/Highland

- **Optimization Opportunity –** Serve areas of high demand, have strong anchors at both ends of the route and be as simple and legible as possible
- **Service Change –** Operate all trips to and from downtown; discontinue trips to Park Royal
- **Outcome –** Significant increases in ridership, improved productivity

Since June, 2011, all trips on the 246 operated to and from Downtown Vancouver. Annual revenue hours grew to 26,300 from 24,500. Annual service cost grew to $3.1M from $2.8M. Cost per boarded passenger decreased to $3.2 from $3.6, due to increased ridership. Total annual boardings increased by 23% to 974,000 from 792,000. Average daily boardings grew throughout the week, particularly during weekdays, to 3,250 from 2,600 people per day. The average boardings per revenue hour increased to 37 from 32. Average capacity utilization increased to 40% from 32%. Average peak load increased by 75% to 14 from 8 people. Ridership on other services to and from the North Shore were unaffected by this change; in most cases parallel services experienced growth in ridership.

Route 112, Edmonds Stn/New Westminster Stn/ C9, New Westminster Stn/Lougheed Stn

- **Optimization Opportunity –** Match service levels to ridership demand
- **Service Change –** Convert western portion of 112 route to community shuttle
- **Outcome –** Slight ridership decline, reduced operating cost

Implemented in April 2011, the 112 now terminates at New Westminster Station and the C9, a new Community Shuttle route, was introduced to serve the New West–Lougheed portion of the 112 route. The change resulted in an increase in productivity and reduced costs on the new 112. Cost per boarded passenger is down from $1.93 to $1.35. Average boardings per revenue hour is up from 60 to 86. The combined changes in resource investments and route productivity are summarized in the following table:

Metric	2010	2011			Change	
	Route 112	Route 112	Route C9	Combined	Sum	%
Annual Revenue Hours	18,900	11,100	8,600	19,700	+800	+4%
Annual Service Cost	$2,167,000	$1,293,000	$449,000	$1,742,000	-$425,000	-20%
Annual Boardings (Projected Sum)	1,125,000	958,000	111,000	1,069,000	-56,000	-5%
Cost/Boarded Passenger	$1.93	$1.35	$4.03	$1.63	-$0.30	-16%
Boardings per Revenue Hour	60	86	13	54	-6	-9%

The additional investment in service hours was approximately 800 hours; however the annual service cost was reduced to $1.7M from $2.2M leading to a reduction in cost per boarded passenger to $1.63 from $1.93. Annual boardings experienced a small reduction of approximately 5%, leading to a reduction in boardings per revenue hour from 60 to 54.

Route 15, Olympic Village Station/50 Waterfront Station/False Creek South

- **Optimization Opportunity –** Avoid duplication between transit services
- **Service Change –** Short-turn route 15 and interline with route 50
- **Outcome –** Reduced ridership, reduced productivity, increased cost per passenger

In April, 2011, the 15 was truncated in the False Creek area and interlined with the 50. While route 50 maintained its ridership levels, route 15 experienced significant reductions in ridership and productivity. The combined changes in resource investments and route productivity are summarized in the following table:

Metric	2010			2011			Change	
	Route 15	Route 50	Combined	Route 15	Route 50	Combined	Sum	%
Annual Revenue Hours	29,400	20,800	50,200	18,000	22,700	40,700	-9,500	-19%
Annual Service Cost	$3,374,000	$2,390,000	$5,764,000	$2,101,000	$2,652,000	$4,753,000	-$1,011,000	-18%
Annual Boardings (Projected Sum)	1,730,000	1,071,000	2,801,000	718,000	1,116,000	1,834,000	-967,000	-35%
Cost/Boarded Passenger	$1.95	$2.23	$2.06	$2.93	$2.38	$2.59	+$0.53	+26%
Boardings per Revenue Hour	59	51	56	40	49	45	-11	-19%
Average Daily Boardings (Mon-Fri)	5,400	3,300	8,700	2,250	3,450	5,700	-3,000	-34%

After implementing service changes on both routes, total savings of 9,500 hours and $1.0M in annual service costs were achieved. Due to a 35% reduction in ridership, combined productivity of the 15 and 50, in terms of boardings per revenue hour, was reduced from 56 to 45. As a result, the combined cost per boarded passenger increased to $2.6 from $2.1 dollars. The majority of the ridership loss occurred along route 15.

Further investigation is required to determine the impact of continued ridership shift to the Canada Line and service reliability issues experienced on the 15 route in late 2011.

Overall Findings on Service Optimization

The route performance analysis allows observation of the effects of service and network changes at the route level. Projects that aimed at saving resources (vehicle conversions and service reductions) resulted in increases in route productivity, cost savings, and maintenance of existing ridership levels.

Service increases were particularly successful in areas where service improvements were needed to reduce overcrowding, for example, the introduction of weekend service along route 2 which helped to alleviate overcrowding on route 22 or the uptake of extra capacity on route 16. Some service increases implemented where markets are expected to grow have resulted in slightly less productive services and may take more time to be taken up.

Network architecture changes are the most complex projects and have experienced different outcomes:

- In some cases the new services and route re-alignments have an immediate positive response and positive changes in ridership and productivity (e.g. route 246).
- A few network changes have decreased significantly its overall productivity and may need further adjustments to reflect the changing needs of the transit customers (e.g. routes 15/50).

The goal of the Service Optimization Initiative was to identify resources from lower productivity services and reallocate them where they were most needed, with minimal customer impacts. Based on the findings from this performance review, the majority of the assessed service changes accomplished this goal, and a few service changes may need more time for additional capacity to be absorbed. It is relevant to highlight that all these service changes were implemented using existing resources.

The findings of the route performance review are consistent with the outcomes of the system-wide and sub-regional reviews, and build confidence that the transit system responds with reasonable predictability to changes in network design and efforts to improve efficiency.

Future Opportunities

This section does not prescribe specific instructions on how to make future service changes; instead it discusses general ideas and examples that may be considered for the identification of future service changes, in particular, ideas for the utilization of the information contained in the route summaries (Appendix A). While the route summaries have the limitations discussed above, they could be utilized to identify routes and periods of particular interest, for example:

- With regard to overcrowding, the route summaries highlight times of day where average peak passenger loads were above the Transit Service Guidelines. These summaries could be used to identify candidate services where future resources could be applied. The following figure illustrates an example were the trips sampled during Sundays exceeded the guidelines:

Time		Annual Revenue Hours		Average Trips per Hour		Average Boardings per Hour		Average Boardings per Trip		Average Capacity Utilization		Average Peak Passenger Load (EB/WB or NB/SB)		Vehicle Type	
		2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Sunday/Holiday	01:00 - 06:00	391	394	3	3	11	19	6	8	12%	19%	4 / 5	5 / 9	Std. Bus	Std. Bus
	06:00 - 09:00	1066	1064	6	6	55	55	35	44	72%	90%	21 / 22	19 / 32	Std. Bus	Std. Bus
	09:00 - 15:00	3260	3302	6	6	104	120	90	111	182%	225%	37 / 47	44 / 50	Std. Bus	Std. Bus
	15:00 - 18:00	1613	1654	6	6	109	129	105	123	210%	246%	47 / 41	53 / 51	Std. Bus	Std. Bus
	18:00 - 21:00	1117	1065	5	4	93	128	88	117	175%	233%	42 / 45	49 / 51	Std. Bus	Std. Bus
	21:00 - 01:00	1170	1179	4	4	49	53	37	41	77%	87%	17 / 17	21 / 23	Std. Bus	Std. Bus

Top 25% of all bus services | High 25% of all bus services | Low 25% of all bus services | Bottom 25% of all bus services | # Above Guidelines

- Regarding potential future service reductions and vehicle conversions, the route summaries highlight in red periods of service that operate in the lowest productivity band. The following figure illustrates periods of time where the sample route is experiencing low ridership in comparison to the level of transit investment. For instance, there may be an opportunity to reduce trip frequencies or convert conventional buses to community shuttles during the early morning and/or late evening periods:

Time		Annual Revenue Hours		Average Trips per Hour		Average Boardings per Hour		Average Boardings per Trip		Average Capacity Utilization		Average Peak Passenger Load (EB/WB or NB/SB)		Vehicle Type	
		2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Sunday/Holiday	01:00 - 06:00	453	410	2	2	10	10	6	7	12%	13%	6 / 4	5 / 4	Std. Bus	Std. Bus
	06:00 - 09:00	932	835	4	4	17	21	12	16	23%	32%	11 / 6	14 / 7	Std. Bus	Std. Bus
	09:00 - 15:00	2047	1918	5	4	38	42	31	36	63%	73%	27 / 18	28 / 19	Std. Bus	Std. Bus
	15:00 - 18:00	1217	921	5	4	37	51	31	42	61%	85%	15 / 25	23 / 33	Std. Bus	Std. Bus
	18:00 - 21:00	888	829	4	4	30	35	21	26	42%	53%	11 / 20	13 / 24	Std. Bus	Std. Bus
	21:00 - 01:00	652	642	2	3	19	18	13	14	25%	28%	6 / 14	8 / 16	Std. Bus	Std. Bus

Top 25% of all bus services | High 25% of all bus services | Low 25% of all bus services | Bottom 25% of all bus services | # Above Guidelines

- Regarding low performing services, there are services in the system whose average peak loads are very low – less than 10 boardings per hour. The route summaries could be used as a tool to identify candidates for network management changes (services that may need route re-alignments to be more attractive). As an example, the following figure illustrates average peak loads of one of the least productive routes in the system:

	Time	Annual Revenue Hours		Average Trips per Hour		Average Boardings per Hour		Average Boardings per Trip		Average Capacity Utilization		Average Peak Passenger Load (EB/WB or NB/SB)		Vehicle Type	
		2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Sunday/Holiday	01:00 - 06:00														
	06:00 - 09:00	22	22	1	1	0	3	0	1	0%	2%	0 / 0	0 / 0	Mini- Bus	Mini- Bus
	09:00 - 15:00	66	66	1	1	3	5	1	0	2%	1%	0 / 0	0 / 1	Mini- Bus	Mini- Bus
	15:00 - 18:00	33	33	1	1	2	4	1	0	1%	1%	0 / 0	0 / 1	Mini- Bus	Mini- Bus
	18:00 - 21:00	11	11	1	1	3	3	1	0	1%	1%	0 / 1	0 / 1	Mini- Bus	Mini- Bus
	21:00 - 01:00														

Top 25% of all bus services | High 25% of all bus services | Low 25% of all bus services | Bottom 25% of all bus services | # Above Guidelines

It is relevant to comment that the route summaries are not intended to substitute, rather supplement sound planning processes and methodologies, including data analysis, defining the issue, identifying solutions, recommending a preferred alternative and consulting with stakeholders.

Acknowledgements:

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May 2012

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