

**City of Vancouver**  
Downtown Streetcar  
Benchmarking Report  
December 2004

**Halcrow**  
**TSi Consultants**

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# **City of Vancouver**

## Downtown Streetcar Benchmarking Report

### **Contents Amendment Record**

This report has been issued and amended as follows:

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Issue	Revision	Description	Date	Signed
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# 1 Glossary

- (a) **ADA:** *Americans with Disabilities Act.* Similar acts apply in Canada, the UK and Australia to disabled access to transit systems. Note many historic streetcar designs and stations do not meet ADA requirements and have been specially adapted to comply or sought special dispensation.
- (b) **ATP:** *Automatic Train Protection:* A safety system which prevents trams from running through red-light signals.
- (c) **DBOM:** *Design, Build, Operate and Maintain.* A style of procurement commonly used in conjunction with the PFI initiative in the UK but now adopted in other countries. Bids are solicited from private sector proponents for the design, build, operate and maintenance of an infrastructure asset. Financing is typically a mixture of public and private section funding.
- (d) **‘Drive-on-sight’:** For on-street running trams/streetcars are driven in the same way as cars and must obey all traffic signals, speed limits etc. This type of operation is called ‘drive-on-sight’. For segregated rights-of-way signalling systems are used to control the movement of trams allowing higher speeds.
- (e) **FTA:** *US Federal Transportation Authority*
- (f) **LRT:** *Light Rapid Transit.* There are varying definitions but generally considered as modern tram cars/streetcars capable of on-street running on mix traffic alignments. LRT/Streetcar also have crash-worthiness standards suitable for street operation.
- (g) **On-Street running:** An expression used to describe tram operation in a mixed traffic environment where no dedicated right-of-way exists. Trams/Streetcars are normally operated using drive-on-sight.
- (h) **P&R:** *Park and Ride.* Tram/LRT stations with a large number of parking lots normally located on strategic highway.
- (i) **PCC:** Presidents Conference Committee. A standard Art-Deco streetcar design widely adopted throughout North America. Other common designs include the Peter Witt.
- (j) **RAV:** *Richmond – Airport – Vancouver Rapid Transit System.* Proposed transit system to connect Richmond/Vancouver Airport with downtown.
- (k) **Segregated right-of-way (ROW):** A segregated ROW allows trams to run at higher speeds and is not shared with other traffic using dedicated signalling systems.

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## 2 Introduction

### 2.1

#### ***Background***

#### 2.1.1

The objective of this technical note is to provide the City of Vancouver with information on the characteristics of LRT/streetcar systems that might be comparable with that planned for downtown Vancouver. The systems presented in this report are a mixture of restored streetcar and modern LRT systems. Some have a very strong tourist appeal such as San Francisco's F-line whilst others are modern urban transit system such as Portland's streetcar line.

#### 2.1.2

The systems reviewed in this benchmarking report are as follows:

- San Francisco F-Line
- New Orleans
- Portland (Streetcar)
- Sacramento
- Toronto
- Sydney
- Melbourne
- Nottingham
- Manchester
- Vancouver (for reference)

#### 2.1.3

The first part of this technical note presents a detailed description of each system together with photographs and system maps where possible. A table summarising technical data is also given for each system. Note detailed ridership information is not readily available other than the number of daily boards.

#### 2.1.4

The second part of the report provides combined summary tables for reference and a short discussion of the implications for Vancouver's proposed streetcar system.

## 3 San Francisco F-line

### 3.1 *Introduction*

3.1.1 San Francisco has an extensive public transit system including LRT, streetcar and metro systems. San Francisco has two historic tram operations: the cable car system and the F-line streetcar. This section concentrates on the F-line.

3.1.2 A unique feature of the F-line is that it is one of the only systems operated using historical, refurbished, streetcar vehicles. The historic streetcar vehicles give the F-line a very strong tourist appeal connecting important tourist areas within San Francisco.

3.1.3 The F-line was built in four separate stages eventually connecting the downtown area with Fisherman's Wharf. The line was finally completed in March 2000. It uses 24 rehabilitated streetcars. 17 of the cars are Art-Deco Presidents Conference Committee (PCC) cars and the remaining 7 cars are imported Peter Witt-style streetcars from Milan. The F-line is just over 8-km long and runs from the Castro district downtown to the historic Fisherman's Wharf area (see figure 3.1). The route is not fully segregated and is shared with other road traffic in Market Street. There are 32 stops, approximately every one block and most are accessible by means of ramps or passenger lifts for wheelchair access. The system is operated using overhead contact wire.

3.1.4 All of the streetcar vehicles have been refurbished after being purchased from a variety of different sources, although they were built to similar designs. The vehicles were then repainted in a variety of different colour schemes to reflect the various US cities that once owned and operated streetcars (see figures 3.2 and 3.3).

3.1.5 The system has been a success in terms of ridership which has steadily increased year on year. The F-line now carries on average 20,000 passengers per day with a much higher ridership in the summer months, underlining its tourist appeal. The system is now carrying twice the forecast ridership with overcrowding becoming a problem at certain times of the day. Muni (San Francisco Municipal Railway) has recently purchased a further 11 more PCC cars to increase capacity. These additional vehicles will be introduced in 2005.

Figure 3.1: F-Line system map



*Figure 3.2: PCC 'Streamliner' design*



*Figure 3.3: Peter Witt Design*



<i>Table 3.4 San Francisco F-Line Characteristics</i>	
System type e.g. LRT/transit/streetcar	Conventional tramway
Average age of vehicles (historic versus modern)	Restored streetcars PCC design and Peter Witt design
Number and type of cars e.g. low floor/articulated/historical	24 St Louis Car PCC ex-Philadelphia (1948); 3 St Louis Car PCC double-ended (1948, rebuilt 1994); 17 are in service painted in PCC colours of Muni. Further PCC cars have been purchased to increase capacity. Also 7 Peter Witt design cars in service
Vehicle dimensions (width, height, length)	Standard PCC design or Peter Witt Design
Capacity of cars (seated and standing)	Standard PCC design or Peter Witt Design
Accessibility (disabled accessibility) e.g. platforms and boarding	Stations are accessible by ramps or lifts. Note PCC fleet has been modified to achieve ADA compliance.
Length (segregated and at-grade)	5 miles/8km joint running in market street and segregate running from Market Street to Fisherman's Wharf.
Type of signalling/traffic management	Drive on sight.
Number of stations	32 stops
Type of platform at station – if any	Low level platforms
Frequency/headway	6-10 min
Hours of operation	05:00/00:30
Technical characteristics of maintenance facility (total area, floor size, # of bays)	Information not publicly available
Organisation and Institutional Setting	Public Ownership and Operation. San Francisco Municipal Railway (MUNI)
Integration with other Transit Systems	Basic fare allows travel on any MUNI vehicle (the "Metro" streetcars, historic streetcars and buses) except for MUNI's cable cars.

## 4 New Orleans

### 4.1

#### *Introduction*

#### 4.1.1

The transit system in New Orleans is operated by New Orleans Regional Transit Authority (NORTA). NORTA is a political sub-division of the state of Louisiana created in 1983 to take control of New Orleans' transit system previously in private ownership but losing money. The streetcar system is well used by commuters and tourists. NORTA markets one-day and three-day tourist passes called VisiTour which are sold through a wide variety of outlets including hotels. VisiTour passes allow unlimited use of the streetcars and buses.

#### 4.1.2

New Orleans has three streetcar lines: Canal, Riverfront and St Charles. The St Charles line was the only one to survive when most of the original system was shut during the 1960s. Once the St Charles line was transferred to public ownership in 1983 NORTA began restoration including the original Perley Thomas vehicles dating back to 1923 and to 1924 (see figure 4.1). Refurbishment of the line included the Carrollton maintenance facility and 35 streetcars. The maintenance facility has recently been further expanded to accommodate an additional 23 vehicles for the Canal line. Despite the heritage attraction of the Charles Streetcar line it is well patronised by commuters as well as tourist carrying on average 20,000 riders per day. One problem with the heritage Perley Thomas streetcar design is that it is not ADA compliant and as a result no more historical vehicles can be added to the fleet (streetcars for the Riverfront and St Charles lines are ADA compliant). The Charles line has 52 stops extending over a 11.2km route, the majority of which is in the central median with the remainder, about 10 blocks, street running in shared alignment. Trams are driven 'on-sight' with no signalling system. One unusual feature of the system is the use of broad gauge rather than standard 1435mm gauge.

#### 4.1.3

The Riverfront streetcar line was opened in 1988. The Riverfront line is operated with replica Perley Thomas streetcars but built with modern components. The line has 10 stations and uses part of an original railway right-of-way. The line has short, low level concrete platforms to facilitate easy boarding and is also ADA compliant.

*Figure 4.1: New Orleans St Charles Line Streetcar*



- 4.1.4 The Canal line, opened in 2004, runs over a new 8.85km line built in the central median with a 1.6km branch. The Canal line was forecast to carry 31,000 riders per day by 2015 serving both local residents and tourists, but recorded 30,000 riders in the first day of operation and 125,000 in the first week.
- 4.1.5 An innovative feature of the Canal streetcar line are 24 modern streetcar vehicles based on a historic streetcar design (see figure 4.2). The vehicles are designed to resemble the Perley Thomas model which originally ran on Canal Street in the 1920s. The vehicles resemble the Perley Thomas design still in use on the St Charles line but are built to modern standards including air conditioning, a modern low-noise braking system and ADA-compliant accessibility lifts.
- 4.1.6 Following the opening of the Canal Street project, New Orleans is planning another new line known as the Desire Corridor.
- 4.1.7 A summary of operating characteristics can be found in table 4.3.

*Figure 4.2 New Orleans Canal Streetcar*



<i>Table 4.3 New Orleans Streetcar Characteristics</i>	
System type e.g. LRT/transit/streetcar	3 lines historic streetcar design using trolley wire
Average age of vehicles (historic versus modern)	35 Perley Thomas cars dating back to 1923-1924 operate the St Charles line 24 new cars (2004) for the Canal St line plus a further 7 cars for the Riverside line based on the Perley Thomas design (1997)
Number and type of cars e.g. low floor/articulated/historical	35 historical (1923-1924) 7 cars Perley Thomas design 24 new cars also based on the Perley Thomas design
Vehicle dimensions (width, height, length)	Standard Perley Thomas design
Capacity of cars (seated and standing)	Standard Perley Thomas design
Accessibility (disabled accessibility) e.g. platforms and boarding	Only the Riverside and Canal lines are ADA compliant; the St Charles line has dispensation to operate. Some platforms have bus style shelters
Length (segregated and at-grade)	Canal streetcar line - 5½ miles/8.8km St Charles streetcar line – 10.6 miles/17km Riverfront streetcar line – 2 miles/3.2km Total of 18.1 miles / 29km Streetcars operate along a central median in downtown area. The Riverfront line follows a former rail route and is segregated.
Type of signalling/traffic management	Drive-on-sight
Number of stations	52 stops on the St Charles line 10 on the Canal Street line 10 stops on the Riverfront line
Type of platform at station – if any	Low, short platforms for the Riverside and Canal streetcar lines
Frequency/headway	Daytime 6 - 18 minutes, evenings 18 – 6 minutes
Hours of operation	First car 04:00-07:18 am, last car 22:36-04:04
Technical characteristics of maintenance facility (total area, floor size, # of bays)	1 general purpose facility for under 200 vehicles at Carrollton maintenance facility
Organisation and Institutional Setting	Public Ownership and Operation under the New Orleans Regional Transit Authority (NORTA)
Integration with other Transit Systems	\$1.25 for a streetcar or bus fare in the NORTA system and \$0.25 for a transfer.

## 5 Portland Streetcar

### 5.1

#### *Introduction*

#### 5.1.1

Portland has two LRT systems the MAX light rail and the Portland streetcar. The data presented in this chapter only refers to the Portland Streetcar. Note that a historic streetcar vehicle does runs as a tourist attraction on the MAX light rail system between Lloyd Centre and downtown Portland on weekends during the summer.

#### 5.1.2

The Portland Streetcar system had been under discussion since 1988 when the first citizen's committee was formed to investigate building a downtown streetcar system. Construction began in 1999 with operations commencing in July 2001. The initial route is a 4.8km long continuous loop contained wholly within the downtown area. The loop connects Portland State University with the Good Samaritan Hospital (see figure 5.1). The system has a total of 32 stops located approximately every 3-4 blocks. Stops are made on-request by passengers. The system uses GPS satellite tracking to advise passengers of the next tram time thus avoiding the need to run to a published timetable.

#### 5.1.3

The system has seven LRT vehicles manufactured by Skoda-Inekon in the Czech Republic (see figure 5.2). Five are in current use, supplemented by 2 historic tram cars formerly used on the MAX system. The two spare Skoda-Inekon vehicles will be used on the River Place Marina extension (see below). The seven Skoda-Inekon vehicles are narrower, shorter and lighter than those used on the MAX LRT system. The vehicles were designed deliberately small to reduce the cost of expensive construction work fitting them into existing street alignments. They are designed to run in mixed traffic within the downtown area, and can use conventional raised platforms and curbside loading/unloading. Ridership is performing above forecasts with projected boardings of 3,000 per day compared to 6,000 per day actual boardings.

#### 5.1.4

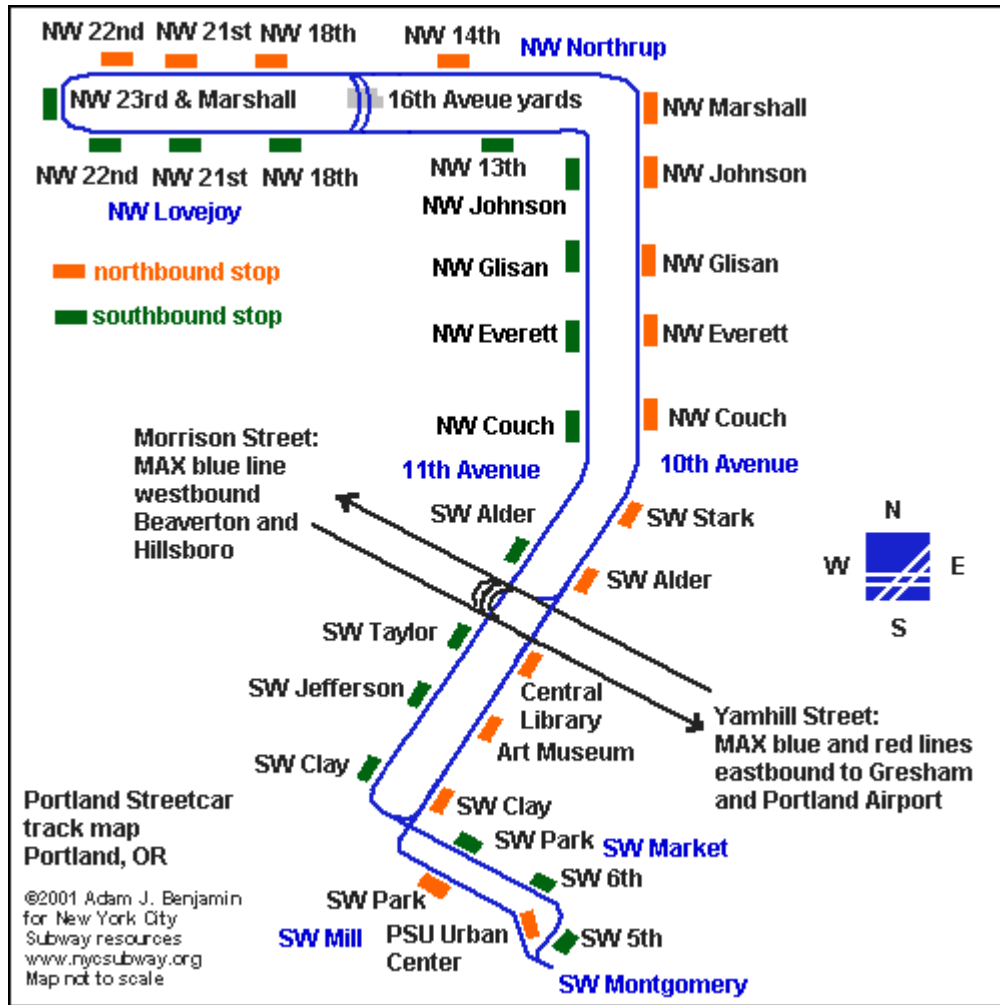
Construction work is on-going to extend the system to River Place Marina. The 0.6 mile extension is extension connects the marina with the Portland State University using a single line section. The new extension is scheduled to open in mid 2005. There are also other plans to extend the system into the South Waterfront District beyond

River Place Marina. Construction on the Gibbs extension is expected to start in January 2005. Plans are also afoot for an eastside extension.

5.1.5

Characteristics of the Portland Streetcar system are given in Table 5.3.

Figure 5.1: Portland Streetcar Map



*Figure 5.2: Portland Streetcar Vehicle built by Skoda-Inekon*



*Figure 5.3: Portland Streetcar showing low-level platforms*



*Table 5.3: Portland Streetcar Characteristics*

System type e.g. LRT/transit/streetcar	Streetcar system entirely within the downtown area. Fares are integrated with TriMet passes.
Average age of vehicles (historic versus modern)	3-years old for Skoda-Inekon vehicles and 12-years old for replica Brill heritage streetcar units.
Number and type of cars e.g. low floor/articulated/historical	7 Skoda-Inekon LRT vehicles delivered in 2001. 2 Gomaco Brill replica cars (1991/92) The two streetcars are for tourist purposes rather than transportation vehicles.
Vehicle dimensions (width, height, length)	2.46 meters wide and 20 meters long. They are narrower and lighter than those in use on the MAX system.
Capacity of cars (seated and standing)	Each vehicle can accommodate up to 140 passengers.
Accessibility (disabled accessibility) e.g. platforms and boarding	Curbside boarding and station ramps for wheelchair access.
Length (segregated and at-grade)	Length: 4.8km operated on a continuous loop in downtown area.
Type of signalling/traffic management	Streetcars must be driven in the same way as cars and obey all traffic signals laws. Average speed is 15 mph/24kph.
Number of stations	16 in both directions.
Type of platform at station – if any	Ramped access for wheelchairs.
Frequency/headway	No published timetable – operated on a “turn up and go” basis with GPS used to give waiting time at stations. But generally 14-minute headways on weekdays and Saturdays, and 20-minutes on Sundays.
Hours of operation	Weekdays 5.30am until 11.30pm (1.30 Fridays) and 7.50am – 1.30pm Saturdays, and 7.30am – 10.30pm Sundays.
Technical characteristics of maintenance facility (total area, floor size, # of bays)	Yard under I-405 (elevated portion) serves as a storage and maintenance area. For heavy maintenance there are connections with the MAX system and vehicles can be taken to Elmonica or Ruby Junction MAX yards.
Organisation and Institutional Setting	Public Ownership and Operation. Tri-County Metropolitan Transportation District of Oregon
Integration with other Transit Systems	Fares allow inter-modal transfer between Tri-Met buses and light rail, as well as on the Portland Streetcar (which is owned by the City of Portland).

## 6 Sacramento

### 6.1

#### *Introduction*

#### 6.1.1

Sacramento is the state capital of California. The city's system is operated by the Sacramento Regional Transit District (RT). RT is also responsible for all bus operations. The Sacramento system was built in 1987 following the cancellation of a freeway project and used Interstate Transfer funds originally budgeted for the highway. The Sacramento system is a conventional LRT with a mixture of segregated and on-street running sections. Initial construction costs were kept low by use of a reserved freeway right-of-way together with a number of single-line sections and the use of former railway alignments/rights-of-way. Some sections of the system are now being double-tracked to provide more capacity. The segregated running sections are operated at higher speeds and with automatic signalling. The original system had a total length of 26.9 miles/43km and connected the eastern and north eastern suburbs with the downtown area (see figure 6.2). The system has a total of 42 stations.

#### 6.1.2

Ridership has risen steadily since opening carrying 8.5 million passengers in 2002, or 39,000 average weekday trips. The LRT system is aimed at commuting, leisure and recreational trips into downtown Sacramento. The system does not have a high tourist usage despite the use of historic streetcars on downtown sections (see below).

#### 6.1.3

There are plans to extend the system with a 10.2 mile extension to Folsom and a 0.55 mile extension to the downtown Sacramento Amtrak station. Work started on both extensions in 2001 with completion expected in December 2003. The entire Folsom extension is due to open in 2005 (2 years late) and is expected to add 6,000 daily passengers. The Folsom extension links the Rancho Cordova area with downtown Sacramento and is planned to open in a number of stages. As part of the extension plans additional 40 LRT vehicles are being purchased from Spanish manufacturers CAF to complement the existing fleet of 36 Siemens vehicles which have been in use since the system opened in 1987. Figure 6.1 shows a new CAF vehicle. There is also a southern extension to Meadowview. This is a 6.3 mile extension and was opened in September 2003. The ultimate objective is to extend the south line a further 4.9 miles/7.8km to Elk. Another extension is also planned to the Airport, see figure 6.2.

6.1.4 The system uses a mixture of overhead catenary designed for higher speed running on the segregated sections and trolley wire in the downtown areas. The use of trolley contact wire for downtown sections allows historic streetcars to be operated. Historic streetcars cannot be used in on sections with overhead catenary. Maintenance is done at a 12-acre site which has capacity to service up to 85 LRT vehicles. A new maintenance facility is being added on the Folsom extension to provide more capacity.

6.1.5 An interesting feature of the Sacramento system is the number of LRT stations with Park and Ride. 13 stations have a total of 6,042 parking lots, with a further 450 planned for Hazel Avenue on the Folsom extension. There is no charge for parking. Most stations have ramps or lifts for disabled/senior access.

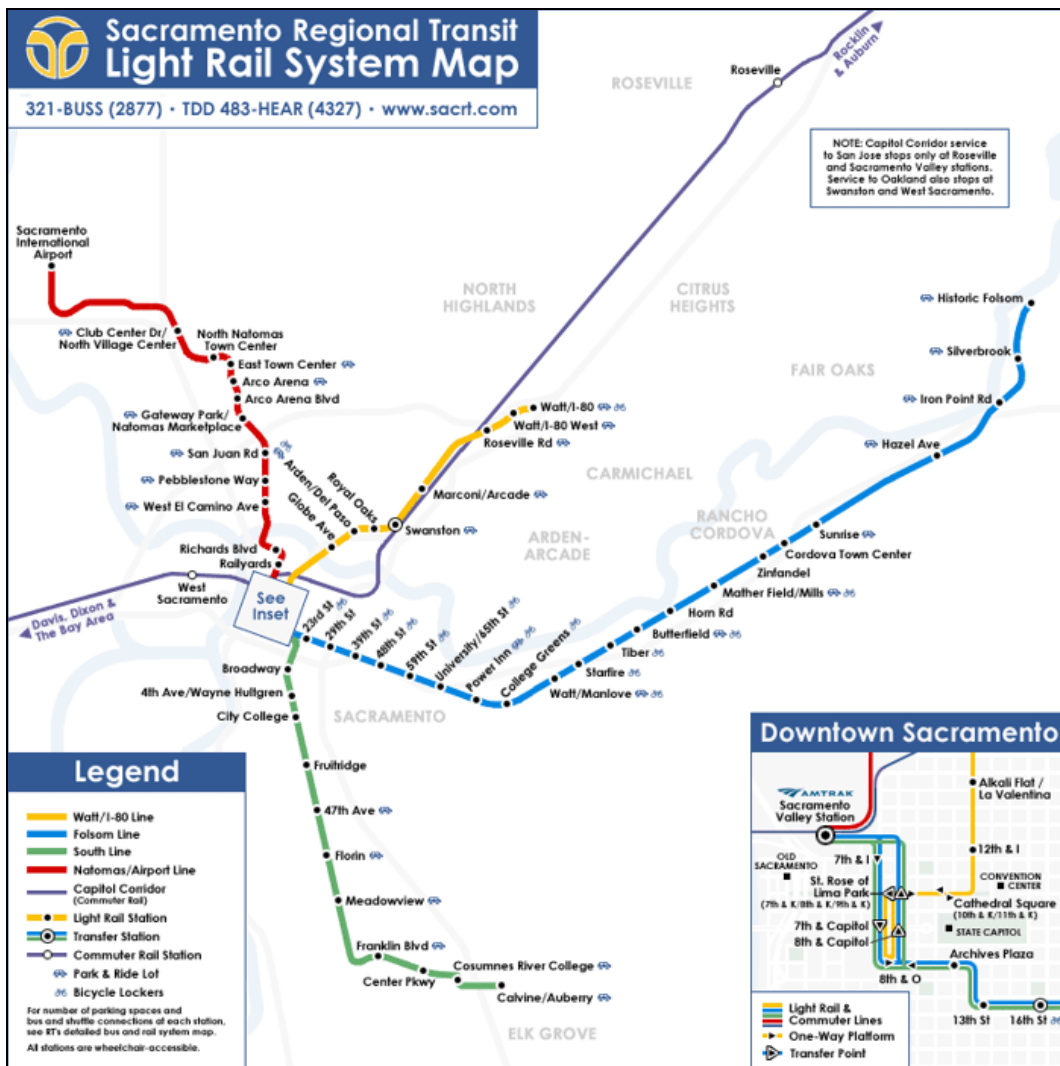
6.2 ***Historic Streetcars***

6.2.1 As noted above the downtown area has been modified to allow historic streetcars to operate. However, there is only one restored vehicle which is mainly used for special occasions. There are four other streetcar vehicles awaiting restoration.

*Figure 6.1: CAF LRT for Sacramento*



Figure 6.2: Sacramento System Map Including Proposed Extensions



Note: not all of the lines in this map are actually in service.

6.2.2 Table 6.3 gives detailed operating characteristics of the Sacramento system.

<i>Figure 6.3: Sacramento LRT Characteristics</i>	
System type	Light rail standard gauge. Mixture of segregates and on-street running
Average age of vehicles (historic versus modern)	36 vehicles date from 1987 and 40 from 2004. Historic streetcar operated in city centre on special occasions only. Plans to refurbish four other heritage vehicles.
Number and type of cars e.g. low floor/articulated/historical	36 Siemens single-articulated, bidirectional cars 40 single-articulated, bidirectional cars built by CAF for system extension.
Vehicle dimensions (width, height, length)	CAF vehicles length 84', width 8'9" & height 12' 6" Siemens vehicles length 79'6", width 8'9" & height 12'6"
Capacity of cars (seated and standing)	CAF 64 seated, 177 standing Siemens 64 seated, 80 standing
Accessibility (disabled accessibility) e.g. platforms and boarding	All 41 stations are ADA accessible. 20 offer bus transfers and 13 stations have parking lots for park and ride.
Length (segregated and at-grade)	Length: 26.9 miles/43km mostly segregated Number of routes: 1 but 10.2 mile/16.3km extension planned
Type of signalling/traffic management	3 aspect colour light signalling on segregated track with drive on sight in city centre. At grade crossings are protected by standard railroad crossing gates.
Number of stations	41 stations, more planned with various extensions.
Type of platform at station – if any	At grade boarding platforms are not required.
Frequency/headway	15 minute intervals peak, 30 minute intervals off-peak
Ridership	8.5 million passengers 2002
System compatibility	Can operate both modern and historic streetcars in downtown areas only, subject to system capacity.
Technical characteristics of maintenance facility (total area, floor size, # of bays)	1 general purpose facility for under 200 vehicles occupying a 12-acre site
Organisation and Institutional Setting	Public Ownership and Operation. Sacramento Regional Transit District
Integration with other Transit Systems	Fare allows transfer between bus and light rail routes operated by Sacramento Regional Transit District

# 7 Toronto

## 7.1

### *Introduction*

#### 7.1.1

Toronto has a large transit system including rail, streetcars, subway and buses. Streetcar services are operated by the Toronto Transit Commission (TCC). There are 11 streetcar routes, 10 of which run on shared alignments in the downtown area. The total length of the system is 152.9km. In 2002 the streetcar system had approximately 40.6 million riders. Technical details of the Toronto Streetcar system are given in Table 7.3.

#### 7.1.2

The TCC has a total fleet of 248 streetcars. The fleet comprises 196 Canadian Light Rail Vehicles (CLRV) built between 1977 and 1981 (see figure 7.1) and 52 Articulated Light Rail Vehicles (ALRV). ALRVs have a normal capacity of 155 passengers compared to 75 riders for a CLRV. The fleet of CLRV and ALRVs replaced aging PCC vehicles.

*Figure 7.1: Canadian Light Rail Vehicle (CLRV)*



Figure 7.2: ALRV



7.1.3 In 1997 TCC converted Spadina Avenue from bus to streetcar operation reporting a 15% increase in ridership as a result (Spadina Streetcar). The system was further expanded in 2000 with a 1km westward link from Spadina Avenue to Bathurst along the waterfront (Harbourfront Streetcar).

7.2 ***St Clair Avenue***

7.2.1 A key issue with the Toronto system is the use of alignments shared with other traffic in 2001. TCC produced a report examining measures to improve transit priority within Toronto to improve and sustain transit ridership, and improve competitiveness with private auto. One recommendation was to examine alignments where physically separated transit tracks could be implemented to give transit priority over private auto.

7.2.2 This resulted in a further report presented by TCC in December 2002. The initial recommendation of the December 2002 report was that further work should be done to examine a segregated right of way on St. Clair Avenue. St Clair Avenue was chosen

by TCC because it is one of the few routes in Toronto which is wide enough to accommodate both streetcar tracks and highway traffic (although the latter would be at reduced capacity). St Clair Avenue Streetcars also carry between 45% and 57% of people travelling in the corridor. In September 2004, after a lengthy debate (a 16-hour meeting!) final approval was given for the scheme to be implemented. The total cost of the scheme is \$55 - \$65 million of which \$25 million would have been required to replace existing track on a like-for-like basis without changing traffic priorities.

<i>Table 7.3: Toronto Streetcar Characteristics</i>	
System type e.g. LRT/transit/streetcar	Conventional street car operation on mainly shared alignments
Average age of vehicles (historic versus modern)	22 (All PCC phased out in late 1970s following introduction of ALRV & CLRV)
Number and type of cars e.g. low floor/articulated/historical	- 248 (2002) of which 196 are Canadian Light Rail Vehicles (CLRVs) and 52 are Articulated Light Rail Vehicles (ALRVs)
Vehicle dimensions (width, height, length)	CLRV are standard 50-foot streetcars ALRV 23.1m long articulated in the middle, 3.6m high and 2.5m wide.
Capacity of cars (seated and standing)	CLRV - 102 riders up to 132 crush loading ALRV - 155 riders up to 205 crush loading
Accessibility (disabled accessibility) e.g. platforms and boarding	Streetcars are not accessible. Plans are in hand to addresses this.
Length (segregated and at-grade)	Length: 152.9 km Number of lines: 11
Type of signalling/traffic management	Transit-priority traffic signals on all streetcar routes. Median right-of-way for streetcars on Queens Quay West and Spadina Avenue, with planning underway for King Street and St. Clair Avenue.
Number of stations	n.a.
Type of platform at station – if any	Streetcar platforms generally on near side of the signalized intersection. Some “far-side” platforms have been established to allow streetcars to take advantage of intersections where signal priority has been installed.
Frequency/headway	Peak 2.5-10 min, off-peak 5-20 min
Hours of operation	Variable operation hours with some lines running from 5:00 am to 3:00 am the next day.
Technical characteristics of maintenance facility (total area, floor size, # of bays)	Two facilities: Roncesvalles Carhouse and Russell Carhouse
Organisation and Institutional Setting	Public Ownership and Operation overseen by the Toronto Transit Commission (TCC)
Integration with other Transit Systems	Fares allow one-way continuous transfer between all TTC modes (bus, subway, streetcars and light metro transit) limited by time. "TTC Times Two" allows passengers who ride the TTC immediately before and after a GO Train/Bus trip can use the TTC transfer from their first TTC ride to board the second TTC vehicle. "Greater Toronto Area (GTA) Weekly Pass" is accepted on all TTC, Mississauga, Brampton and York Region Transit routes.

# 8 Sydney

## 8.1

### 8.1.1

#### *Introduction*

A new 6.7km light rail line was opened in Sydney, Australia in 1997. There are 12 stops in total and the line is market as Metro Light Rail (MLR) and operated by Connex (see figure 8.1). The total capital cost of the line was AUS\$ 65 million (approx CAN\$68 million). The Sydney LRT is part of a long-term development scheme for the urban regeneration of Pyrmont which includes the Darling Harbour area. The system has strong tourist appeal as it serves a casino in Darling Harbour. The majority of the new line was built along the disused Darling Harbour goods line. The 5.7km section on the former goods line is a dedicated right-of-way with conventional colour light signalling. Speeds of up to 80km/h are permitted on the dedicated right-of-way. The remainder of the line is along a shared alignment requiring on-street running and uses line-of-sight signalling with a maximum speed of 20km/h. In 2000 the system was further extended from Wentworth Park to Lilyfield using the former Lilyfield goods line adding a further 3.1km of track. The cost of this extension was AUZ\$16 Million

*Figure 8.1: Sydney LRT and Monorail  
(Note the western extension was completed in 2000)*



8.1.2

The line is operated with a fleet of seven Adtranz (now Bombardier) modern air-conditioned trams which have low floors suitable for wheelchair access (see figure 8.2). The trams consist of five articulated modules and can be driven from either end. Each tram can carry 200 riders.

*Figure 8.2: Sydney Trams at Central Station*



8.1.3

The system currently has an annual ridership of 4 million passengers, or circa 13,000 riders per day. However, ridership is lower than originally forecast. One anecdotal reason for lower than forecast ridership is that the system does not reach the downtown area but instead terminates at Central Station (see below) which limits the commuting appeal of the line. It is also understood that the Casino in Darling Harbour has not generated as much ridership as expected.

8.2

### ***Future Developments***

8.2.1

As stated above, one criticism of the current system is that it does not reach the downtown area. In May 2004, Metro Transport Sydney submitted a plan to extend the light rail system from Sydney Central station into the downtown shopping area. However, the scheme is controversial and bitterly opposed by retailers because of the anticipated disruption during construction. Two possible routes have been proposed.

8.2.2

Characteristics of the Sydney LRT system are summarised in Table 8.3.

<i>Table 8.3: Sydney LRT Characteristics</i>	
System type e.g. LRT/transit/streetcar	LRT
Initial line opening	1997 extended in 2000
Average age of vehicles (historic versus modern)	7 (in 2004)
Number and type of cars e.g. low floor/articulated/historical	7 (2004) full low floor trams - 7 Adtranz Variotram LRV (1997) maximum speed 80km/hour
Vehicle dimensions (width, height, length)	Length 28.28m Width 2.65m Height 3.388m
Capacity of cars (seated and standing)	Seating Capacity 74 Standing Capacity 103 Total Passengers 223
Accessibility (disabled accessibility) e.g. platforms and boarding	All trams are low floor and all stations are accessible.
Length (segregated and at-grade)	7.2 km route length of which 5.7 km is a dedicated right-of-way and 1.5 is on a street running area Number of routes: 1
Type of signalling/traffic management	Signalling system in the right-of-way is a conventional relay based interlocking system and used audio frequency jointless track circuits. Route selection is made by tram drivers at wayside panels, with the route automatically resettling after use. On-street signal system is line-of-sight, with maximum speed set at 20km/h. An Automatic Train Protection system (ATP) enforces the wayside signalling and governs the speed of the train.
Number of stations	14
Type of platform at station – if any	Raised platform to allow easy boarding
Frequency/headway	10 to 15 min (06.00 to 24.00), 30 min (24.00 to 06.00)
Hours of operation	24 hour operation
Technical characteristics of maintenance facility (total area, floor size, # of bays)	Details not publicly available but a small maintenance depot is shown in various promotional material
Organisation and Institutional Setting	Private Operation through franchise operator Metro Transport Sydney, similar to Melbourne
Integration with other Transit Systems	Metro Transport Sydney operates both Metro Light Rail and Metro Monorail, though fares must be purchased separately. Other companies operate the bus and rail systems. However, purchase of a TramLink ticket allows transport on both Metro Light Rail and CityRail.



## 9 Melbourne

### 9.1

#### *Introduction*

#### 9.1.1

Unlike Sydney, Melbourne (Australia) retained its historic tram system and today this extends for 245km with 31 major routes and 1,770 stations. In 1999 the network was divided into two operating franchises: Yarra Trams and Swanston Trams. Franchise bids were then invited from the private sector. Yarra Trams are operated by Metrolink Victoria Pty a joint venture between Transfield and Transdev. In April 2004 Metrolink Victoria Pty also took over the running of the Swanston franchise and now runs the entire tram system. 141 million trips, or circa 450,000 riders per day were made during 2002/2003. As with other systems reviewed in this report, Melbourne's network is a mixture of dedicated rights-of-way and shared alignments. The city centre section is all shared.

#### 9.1.2

Traffic congestion in Melbourne has gradually reduced the competitiveness of trams. As a result there are now plans to introduce a series of tram priority measures in the city centre to improve average speeds for transit.

#### 9.1.3

New sections have recently been added to the network including a 2.2 km extension to Market Street, Box Hill (opened in 2003) and a connection to the Docklands precinct.

### 9.2

#### *Types of trams*

#### 9.2.1

Melbourne has a fleet of 474 trams with five different classes, designated W, Z, A, B and Low-floor. The oldest of these is the W-class which was first introduced into service in 1923 (see figure 9.1). This was the first standard tram design for Melbourne. Eight refurbished W-class trams are currently run on the City Circle tram route which is free and is a popular service for tourists. A total of 23 W-class trams have been refurbished and returned to service to retain the heritage feel of the system. However, the W-class trams are not wheelchair accessible

#### 9.2.2

Recently a new generation of Siemens built low-floor trams were introduced. (Halcrow was responsible for successfully obtaining "vehicle acceptance" for these trams on behalf of Siemens from our Melbourne office). There will be a total fleet of 95 low-floor trams (late 2004). The low-floor trams are wheelchair accessible (see figure 9.2).

The new low-floor trams are gradually replacing the Z1 and Z2 class trams. Improvements have also been to tram stops with the construction of 17 “superstops” to provide better access.

*Figure 9.1: W-Class “Christmas Tram”*



*Figure 9.2: New Generation Siemens Low-floor Tram*



Table 9.3 Melbourne Tram System	
System type e.g. LRT/transit/streetcar	Tram (W-Class are similar to North American Streetcars)
Average age of vehicles (historic versus modern)	A large number of trams operating over 31 routes.
Number and type of cars e.g. low floor/articulated/historical	474 (2004) trams available for regular service/1 - 70 A-class vehicles - 132 B-class vehicles - 36 C-class low floor Citadis vehicles - 38 three section D-class low floor Combino vehicles - 21 five section D-class low floor Combino vehicles (one now in service, all to be delivered by 30.11.2004) - 53 W-class heritage trams (restricted operation on routes 30, 78, 79 and the free City Circle) - 124 Z-class trams
Vehicle dimensions (width, height, length)	n.a.
Capacity of cars (seated and standing)	n.a.
Accessibility (disabled accessibility) e.g. platforms and boarding	The first Yarra Trams Superstop, launched in 2001, a tram stop at the corner of Collins and Swanston Streets, offers easy access to mobility-impaired passengers. Initial investment has included the purchase of low-floor trams and the construction of Superstops to provide better access for the disabled and mobility impaired plus the refurbishment of vehicles to maximise passenger comfort and safety.
Length (segregated and at-grade)	Length: 245 km 31 major routes
Type of signalling/traffic management	Implementation of a two-year, AU\$30 million Tram Priority Program began in 2004. Program will begin with 8 priority routes and includes hook turns, separation curbs, changes to parking arrangements, extension of curbs at tram stops. It will include a review of traffic management, tram operations, improved technology and road rules. Tram traffic lights ("T" lights) will be installed at intersections to help trams make up lost time at some intersections.
Number of stations	1770
Type of platform at station – if any	16 “superstops” otherwise curbside loading
Frequency/headway	10-12 minutes in peak , 5-30 minutes in off-peak
Hours of operation	Operate between 0500 and 0100 Mondays to Saturdays and between 0615 am and midnight Sundays.

Technical characteristics of maintenance facility (total area, floor size, # of bays)	There are 8 tram depots to service the 31 routes.
Organisation and Institutional Setting	Private Operation through franchise operator Yarra Trams. Concession model following broadly the same model as the UK. State still has ultimate ownership of the assets.
Integration with other Transit Systems	Melbourne transit services are provided by private franchise operations. The Victoria State Government's Office of the Director of Public Transport (ODPT) (in the Department of Infrastructure) co-ordinates all public transport services and ensures that private operators meet their contractual obligations. Under the franchise system, revenue for a transport company comes mainly from its allocation of MetCard revenue. A Two Hour Metcard allows unlimited train, tram and bus travel for at least two hours within selected zones on the day of first validation. Surveys are conducted on a quarterly basis to gather information on ticket usage, which is then used to determine the proportion of revenue that each operator receives on the basis of the number of equivalent passenger kilometres travelled on each MetCard. Franchisees are allowed to provide additional ticket types, with revenue going directly to the operator, however these are not very popular and generally do not provide the same value for money as a Metcard.

# 10 Nottingham NET LRT

## 10.1 *Introduction*

10.1.1 This UK system was recently opened in March 2004. Halcrow were responsible for producing the ridership estimate for the winning proponents (Arrow Light Rail Ltd). Construction of the system started in 2001.

10.1.2 The project has been procured under a DBFO style contract with a 30-year concession period. The system is similar in design to the Manchester Metrolink system (see chapter 11) using a mixture of segregated and non-segregated track. The segregated sections of track have been created by sharing an existing heavy rail alignment to provide access into Nottingham city centre.

10.1.3 The 14km system connects Nottingham's main railway station with the suburbs of Hucknall and Cinderhill. The city's main railway station is located south of the city centre. The NET system improves accessibility from the north side of Nottingham to the station and provides access from the station to the city centre.

10.1.4 The system includes 4km of on-street running through the city centre before it joins a shared alignment with the Robin Hood heavy rail line (Nottingham to Mansfield/Worksop). There are a total of 23 stops with 5 stops have P&R spaces. The intention is that the P&R stops will attract car users as they enter the city and divert private cars away from the city centre. There are 15 trams which have low-floor access built by Adtranz (now Bombardier) see figure 10.1. Figure 10.2 shows the low-level platforms constructed to facilitate easy boarding. The Incentro trams use a 750c DV overhead power supply with a maximum speed between 70km/h – 80km/h.

10.1.5 Initial ridership has been very encouraging with NET announcing in August 2004 that they intend to increase the frequency of trams to provide more capacity. An estimated 750,000 riders were estimated for the first month of operation.

10.1.6 There are plans to build two other lines but they have been put on hold following the UK government's withdrawal of funding for LRT schemes.

*Figure 10.2: NET LRT Vehicle*



*Figure 10.3: NET Low-level Platforms*



Figure 10.1 Nottingham NET Characteristics

Characteristics	Comments
System type	LRT Tram vehicles built in Derby UK Phase 1 is a mixture of at-grade and segregated running 14km in total
Average age of vehicles (historic versus modern)	Opened in 2004
Number and type of cars e.g. low floor/articulated/historical	15 Bombardier Incentro five-section articulated tramcars (2004)
Vehicle dimensions (width, height, length)	Length: 33 m Width: 2.4 m Height from top of rail to top of vehicle: 3.35 m Floor to ceiling height: 2.1 m
Capacity of cars (seated and standing)	Seats: 62 Capacity: 191 per tram assuming 4 passenger per square metre
Accessibility (disabled accessibility) e.g. platforms and boarding	2 specified wheelchair locations with low level stop request and help points per tram. Trams are low-floor throughout.
Length (segregated and at-grade)	14 km route length of which 10 km are off-street and 4 km are on-street
Type of signalling/traffic management	Segregation from/priority over traffic. Ten of the 14km are away from roads, with some of the on-street running also segregated from traffic. Trams get priority over other road traffic at almost all the junctions on the route. Also note that bus services are integrated with tram to provide feeder services. On-street signalling: combined stop/proceed with road traffic, point position indicators, tram loop detection Off-street signalling: Track circuit block signalling integrated with railway level crossing signalling
Number of stations	23
Type of platform at station – if any	Platforms at flush level with tram to allow easy boarding
Frequency/headway	Peak/off peak: 6-8, 8-15
Hours of operation	06:00 to 24:00 Monday to Saturday; 8:00 to 23:00 Sundays and holidays.
Technical characteristics of maintenance facility (total area, floor size, # of bays)	One depot on Wilkinson Street that includes stabling for the full fleet of 15 tram; automatic tram wash; sanding facilities; control room with CCTV monitors, public address system, etc.; accommodation for drivers, inspectors and infrastructure maintenance staff.
Organisation and Institutional Setting	Private operator through a 30.5 year concession to design, build, operate and maintain (DBFO) system granted to proponents Arrow Consortium.
Integration with other Transit Systems	Separate fares for the tram system. However, there are a number of joint NCT bus and NET tram tickets available (CityRider, DayRider,

	GroupRider, EasyRider) which allow travel on both city buses and trams. Limited competition between bus operators and tram system.
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# 11 Manchester Metrolink

11.1

11.1.1

## *Introduction*

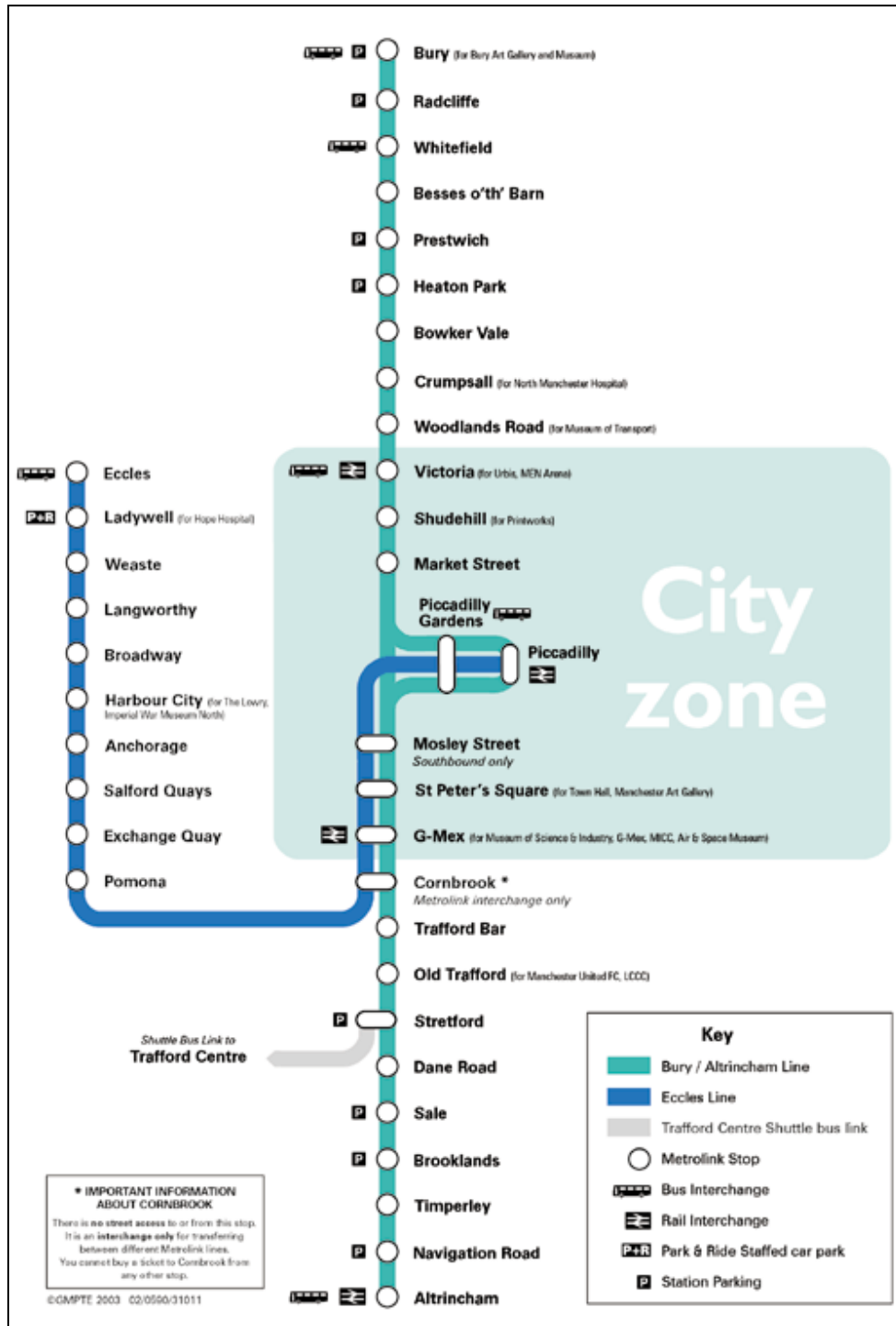
Manchester was the first UK city to implement a modern LRT system. Phase 1 consisted of the conversion of two former heavy rail lines and an on-street city centre connection. (Note: the decision to convert the two former heavy rail lines was driven by the need to replace existing life-expired rolling stock and electrification equipment, similar to decision regarding St Clair Avenue in Toronto). Figure 11.1 shows the Metrolink network Phases 1 & 2. Phase 1 was opened in 1992 and proved highly successful. The 31km route was built under a DBOM arrangement under the UK government's private finance initiative. The system was re-franchised in 1997 and new operator Serco was selected. Serco are also involved in the RAV project in Vancouver. Phase 2 extended the system to Eccles and was fully opened in July 2000. In 2001 Metrolink carried 17.2 million passengers compared to the 7.5 million who used the Bury and Altrincham heavy rail services prior to conversion to Metrolink. The heavier than expected use of Phase 1 led to considerable interest from other cities and a number of other schemes were proposed.

*Figure 11.2 Metrolink Tram*



*Figure 11.3: Metrolink Platforms (Piccadilly Gardens)*





- 11.1.2 Phase 1 consists of 31km of track with a fleet of 26 trams operating headways of 6 minutes. The trams are Italian-built T68 light rail vehicles built in 1991 supplemented with an additional 6 type T68a vehicles built in 1999 for the Eccles extension. The vehicles are articulated two-car units (see figure 11.2). As the system is a converted heavy rail line the LRT trams cars were built to allow boarding from high level platforms, rather than on-street boarding (see figure 11.3). For trams stops in Manchester city centre this meant constructing new platforms, installing electrification masts and special insulated track. Some critics of the system have argued that the city centre sections are a blight on the urban landscape with a mass of wires, platforms and track, with little attention given to the visual impact.
- 11.1.3 There are advanced plans for further expansion (Phase 3), including a line to the Manchester Airport, Ashton-under-Lyne and Rochdale. Halcrow have been involved in the project since the early stages and are currently working for one of the proponents for Phase 3. However, expansion plans suffered a set back in August 2004 following the UK government's decision to put funding on hold on the grounds of value for money following a report by the National Audit Office. Phase 3 plans envisage a "big bang" approach to expansion of the system i.e. building a number of new lines at once rather than a piece-meal approach to provide Metrolink services to all parts of Manchester.
- 11.1.4 The system remains heavily overloaded in the AM and PM peaks leading to plans to purchase more rolling stock. Ridership is predominately geared towards commuting into central Manchester, with services heavily overloaded in peak hours.
- 11.1.5 Table 11.3 provides technical data on Metrolink.

Figure 11.3: Manchester Metrolink Characteristics

Characteristics	Comments
System type	Tram car built to UK British Rail loading gauge and platform heights Phase 1: Bury to Altrincham: Suburban heavy lines converted to light rail operation with on-street city-centre running. Phase 2: City centre to Eccles: Segregated track and on-street running.
Average age of vehicles (historic versus modern)	All modern Phase 1: approximately 11-years Phase 2: approximately 4-years
Number and type of cars e.g. low floor/articulated/historical	32 GEC ALSTOM-Firema vehicles articulated but can run in pairs. No historical vehicles in use.
Vehicle dimensions (width, height, length)	2.57m x 3.7m x 29m
Capacity of cars (seated and standing)	200 passengers with a crush load of 250
Accessibility (disabled accessibility) e.g. platforms and boarding	Trams are fully accessible to wheelchair users each platform and station. Includes ramps to raised platforms and special reserved places for wheelchairs.
Length (segregated and at-grade)	Length Phase 1 and 2: 39 km. Only city centre section is at-grade. Tender has been issued for contract to design, construct and operate extensions to Rochdale via Oldham (24 km), Manchester Airport (22 km) and Ashton-under-Lyne (10 km).
Type of signalling/traffic management	On-sight driving in city centre with track-circuit block on segregated lines to give higher line speeds controlled from a central signalling centre. Fitted with ATP.
Number of stations	36
Type of platform at station	Raised platform using former British Rail stations on Phase 1. Platforms required in city centre stations
Frequency/headway	Phase 1 - Bury to Altrincham every 6 min (peak), 12-15 min (off-peak) Phase 2 - Eccles every 12 min (peak), 12-15 min (off-peak)
Hours of operation	First/last car: 06.00/24.00 Monday-Saturday, 07.00/24.00 Sunday
Technical characteristics of maintenance facility	Maintenance Depot at Shude Hill. (A new Metrolink depot is also being built in Trafford to accommodate the expanded phase 3 system).
Organisation and Institutional Setting	Metrolink is privately operated by Serco Metrolink. Assets remain under public ownership though Greater Manchester Passenger Transport Executive (GMPTE)
Integration with other Transit Systems	A stand-alone fare system but multimodal tickets are available but not widely used

## 12

# Vancouver Skytrain & Streetcar

### 12.1

#### ***Introduction***

#### 12.1.1

Vancouver does not operate an LRT or streetcar system analogous to those reviewed in previous chapters. Vancouver has a mixture of transit systems including: Skytrain (a driverless transit system operating on a dedicated right-of-way), express B-line buses, trolley buses and normal buses. There are two Skytrain lines: Expo and Millennium. New Mark II rolling stock was built to operate on the Millennium line but is compatible with the Expo line. Both lines are fully segregated and operated on an elevated guideway. This is a unique configuration in the context of the systems reviewed in this report. Trains are operated at very high frequencies with a top speed of 90km/h. Skytrain has daily boardings of 205,000 with 32 stations. The system is operated by TransLink.

### 12.2

#### ***Vancouver Streetcar***

#### 12.2.1

The City of Vancouver is planning an LRT/Streetcar system (see figure 12.1). Phase 1 will run from Granville Island to the Waterfront Transit Hub, a distance of approximately 5km. Phase 1 will follow the existing historic streetcar alignment between Granville Island and Science World. A proposed extension to Phase 1 sees the line further extended from the Waterfront Transit Hub to Stanley Park. A possible future Phase 2 extension adds another line from Science World to Granville Street, via Pacific Boulevard. The planned system could use a mixture of modern and historic streetcars.

#### 12.2.2

Based on the systems reviewed in this report the following benchmarking principles can be applied to a possible Vancouver system:

- *Historic streetcars* have strong tourist appeal based on the evidence of New Orleans and San Francisco's F-Line. In a tourist-orientated system ridership can be increased without necessarily compromising the system's appeal to other users. The New Orleans system uses new streetcars based on historic shells but with modern components. The difficulty of using historic streetcars is that they are no longer made and second-hand vehicles would need to be refurbished, provided they could be located. The cost of refurbished vehicles

could exceed that of new modern tram cars. Modern cars have the advantage of meeting modern ADA standards (or Canadian equivalent) and have low-floors making them easy to board;

- *Dedicated rights of way.* Almost all systems reviewed have some segregated running sections to ensure that the streetcar is competitive compared with private cars. Where possible a wholly segregated system is likely to prove the most time-efficient but in an urban area, where road space is at a premium, this may not be possible. Improving priority for trams/streetcars has been an issue for a number of the systems reviewed in particular Melbourne. Toronto is also actively pursuing reallocation of highway space in the St Clair Avenue to provide better tram priority. Some systems have also benefited from the ability to reuse former railway lines reducing land acquisition costs and land take;
- *Stations/Stops.* New systems have been built with raised platforms and some have been retrofitted as is the case for Melbourne. Raised platforms allow easy wheelchair access into streetcars. Platforms are typically no more than a kilometre apart and in some cases at the end of every block;
- *Technical Aspects:* For segregated alignment sections modern colour light signalling is used and for shared sections line-of-sight driving is used. Signalling system may also be integrated with existing traffic signals to ensure streetcars are given priority. All systems (with the exception of Skytrain) use overhead electrification with 750V DC being the common standard (Note that TransLink's trolley buses use 650V DC). The majority of systems are also standard (1435mm) gauge. (New Orleans is broad gauge which is slightly wider). Some systems have been built as single track with passing places to reduce initial capital costs and measure market response. Others have been built in various stages as funding permits. For example, sections of the Sacramento system are currently being double tracked to improve capacity as ridership has increased;
- *Ridership:* The systems reviewed appear to have healthy ridership levels and in some cases demand has exceeded initial expectations. In the case of Nottingham additional services have been included to provide additional

capacity to meet demand. All publicly operated systems have integrated ticketing systems which makes them easy to use. In some cases they are free within the city centre area.

*Figure 12.1: Proposed Phases of Downtown Streetcar system for Vancouver*

## 13 Summary Tables

### 13.1

#### *Network Characteristics*

#### 13.1.1

Table 13.1 shows network characteristics for each system. Melbourne has the longest tram system with 245km and 1770 stations many within the central downtown area. Most systems operate on a mixture of segregated and non-segregated alignments. Systems with track in downtown areas are normally shared with other traffic. Those systems which are able to provide direct access into the city centre/downtown area are preferred by riders as they do not need to change to reach their destination.

#### 13.1.2

Rolling stock varies by system, with some operating historic streetcars to retain a strong tourist appeal and others using modern designed vehicles. Both modern and historic systems are equally well used. San Francisco and New Orleans appear to be the most successful examples using a historic design.

#### 13.1.3

The extent to which systems have priority over other traffic is also important. For example in Melbourne shared alignments in the city centre are heavily congested leading to extended journey times for all users. Proposed schemes in the UK have failed at economic appraisal stage because they did not offer travel time savings over existing transit services. Travel time savings could be assured if the political difficulty of introducing dedicated rights-of-way in urban areas and the need to remove existing traffic were overcome, as is the case in Toronto.

#### 13.1.4

Spacing of stations varies by system and is dependent on the physical layout of downtown areas. Most cities have a grid structure dictating the location of stops. On average stations are spaced between a few blocks and 1-2km apart. Typically systems have fewer stops on dedicated alignments to maximise speed and reduce run times, with more stops in downtown areas to maximise ridership and coverage.

#### 13.1.5

All but three of the systems operate peak and off-peak headways with peak headways generally twice that in the off-peak. Only Vancouver, San Francisco and Sacramento operate the same frequencies throughout the day. On average peak, services operate between 6 minute and 10 minute headways. Off peak services operate between 15 minutes and 30 minutes.

Table 13.1: Network Characteristics

System	Rolling stock	Route Km	Number of Lines or Routes	Segregated (km)	Non-Segregated (km)	Number of Stations/stop	Av Km between stations	Freq Peak (min)	Freq Off Peak (min)
San Francisco F-line	Historic streetcar operation	8km	1 streetcar system	Section along waterfront is segregated	Shared section in market street	31	1 block	6-10	n.a.
New Orleans	Historic streetcars built to modern standards	12.9km	3 lines – 2 operating with new rolling stock based on historic design	Not know but dedicated central median	Some shared sections	60 plus	1 block	6-18	18-36
Portland Streetcar	Modern rolling stock	4.8km	1 line in downtown	Short dedicated section at Portland State University	Mostly non-segregated	16	1 block	14	20
Sacramento	Modern rolling stock	48.7km	1 linking eastern and northeastern suburbs with extension to Folsom planned (2004)	27.5km	21.2km	42	1.1km more in downtown area	15	30
Toronto	Modern rolling stock	152.9km	11 lines	Approx 16km but plans to segregated section e.g. St Clair Avenue	Almost all system is mixed traffic	Not stated	Not stated but high density in downtown area	2.5 -10	5-20
Sydney	Modern rolling stock	7.2km	1 line on edge of downtown tourist orientated	11.8km	3.0km on street operation	14	0.5km	10 -15	30
Melbourne	Mix of modern and historic W-Class trams	245km	31 routes	Outer sections are segregated	Significant sections in city centre	1770	0.13km but high density in downtown area	10 -12	5-30
Nottingham	Modern rolling stock	14.0km	1 commuting line plus P&R stations	10 km shared railway alignment	4 km in city center	23	0.6km	6-8	8-15
Manchester	Modern rolling stock	39.0km	2 commuting lines	33km	6km	36	1.1km high density in downtown area	6-12	12-15
Vancouver	Automated Rapid Transit	49.4Km	2 – Expo & Millennium	49.4Km all segregated		32	1.5km	2-6	n.a.

13.2  
13.2.1

**System Boardings**

Table 13.2 shows basic statistics on passenger boardings or “boards”. Melbourne has the highest number of daily boards, followed by Toronto reflecting the size and coverage of these cities and their transit systems. Population statistics apply to city jurisdictions rather than catchment of individual systems or lines. Note Vancouver Skytrain has extremely high daily boardings given its city’s size.

*Table 13.2 Boards and Demographics*

<i>System</i>	<i>Estimated Daily Boardings</i>	<i>Population</i>	<i>Density pop/ha</i>
San Francisco (F-line only)	20,000	3,228,605	20.5
New Orleans	40,000	480,000	24.7
Portland (Streetcar only)	6,000	1,222,000	12.8
Sacramento	39,000	1,393,498	14.6
Toronto	270,700	4,628,000	25.5
Sydney	12,903	4,201,493	18.9
Melbourne	454,839	3,559,654	13.7
Nottingham	19,608	620,000	31.0
Manchester	54,839	2,600,000	51.6
Vancouver (Skytrain)	205,000	2,126,806	21.6

13.2.2

The boardings reported in table 13.2 are consistent with reported daily ridership for transit systems in Vancouver. Boardings for a variety of transit routes in Vancouver are as follows:

- B-line, route 99 has daily boardings of 31,000
- Route 9 (Boundary/Broadway/Arbutus/UBC) has daily boardings of 25,000
- Route 20 had daily boardings of 22,000.

13.3  
13.3.1

**Revenue and Operating Costs**

Table 13.3 gives details of revenue and operating costs for the LRT/Streetcar systems. Note that disaggregate data is not available for all streetcar systems as some are reported within a larger transit system. Some systems also have a fare-free zone in the downtown/city centre areas which reduces revenue collected.

*Table 13.3: Revenue and Operating Costs for Streetcar/LRT systems*

<b>LRT/Streetcar System</b>	<b>Number of dedicated employees</b>	<b>Annual Passenger Million CAN\$</b>	<b>Annual Operating Costs Million CAN\$</b>	<b>Rev/Cost Ratio (cost recovery)</b>
Toronto CAN\$ (1)	Not stated	62.0	106.0	58%
New Orleans US\$	113	6.0	8.5	55%
Portland US\$ (1)	545	22.5	56.3	31%
Sacramento US\$	214	19.3	24.1	62%
San Francisco US\$ (1)	1,010	23.4	114.8	16%
Vancouver Skytrain	493	60.0 (2)	67.1	89%

- (1) Figures stated here apply to whole transit system streetcar.
- (2) Skytrain numbers are estimated