Excerpts showing observed passenger volumes for bus systems and light rail systems in North America. This document created by John Niles of Public Interest Transportation Forum.

TCRP Web Document 6
(Project A-15) Contractor's Final Report

Transit Capacity and Quality of Service Manual

Conclusion: Many bus systems demonstrate higher peak passenger carrying capacities than light rail systems. For example, buses on 6th Avenue in Portland, Oregon deliver 8,500 passengers per hour in the peak period, while MAX light rail delivers 1,980 per hour.

Prepared for
Transit Cooperative Research Program
Transportation Research Board
National Research Council

Complete manual available for Internet download at
http://www4.nationalacademies.org/trb/crp.nsf/All+Projects/TCRP+A-15
A copy of this web page is incorporated at the end of this document.

Submitted by
Kittelson & Associates, Inc.

In association with
Texas Transportation Institute
Transport Consulting Limited

January 1999

Observed Bus and Passenger Flows

Streets and Highways

Exclusive busways.

Observed bus volumes on urban freeways, city streets, and bus-only streets clearly show the reductive effects of bus stops on bus vehicle capacity. The highest bus volumes experienced in a transit corridor in North America, 735 buses per hour through the Lincoln Tunnel and on the Port Authority Midtown Bus Terminal access ramps, in the New York metropolitan area, are achieved on exclusive rights-of-way where buses make no stops (and where an 210-berth bus terminal is provided to receive these and other buses).[R13] Where bus stops or layovers are involved, reported bus volumes are much lower. Exhibit 1-13 shows bus flow experience for a number of North American cities.

Exhibit 1-13
Observed Peak Direction Peak Hour Passenger Volumes on U.S. and Canadian Bus Transit Routes (1995-97)[R6,R13,R17]

Location	Facility	Peak Hour Peak Direction Buses	Peak Hour Peak Direction Passengers	Average Passengers per Bus
New Jersey	Lincoln Tunnel	735*	32,600	44
Ottawa	West Transitway	225	11,100	49
New York City	Madison Avenue	180	10,000	55
Portland, OR	6th Avenue	175	8,500	50
New York City	Long Island Expy.	165	7,840	48
New York City	Gowanus Expy.	150	7,500	35
Newark	Broad Street	150	6,000	40
Pittsburgh	East Busway	105	5,400	51
Northern Virginia	Shirley Highway	160	5,000	35
San Francisco	Bay Bridge	135	5,000	37
Denver	I-25	85	2,775	33
Denver	Broadway/Lincoln	89	2,325	26
Boston	South/High Streets	50	2,000	40
Vancouver, BC	Granville Mall	70	1,800	26
Vancouver, BC	Highway 99	29	1,450	50

*no stops

Bus malls.

When intermediate stops are made, bus volumes rarely exceed 120 buses per hour. However, volumes of 180 to 200 buses per hour are feasible where buses may use two or more lanes to allow bus passing, especially where stops are short. An example is Hillside Avenue in New York City. Two parallel bus lanes in the same direction, such as along Madison Avenue in New York, and the 5th and 6th Avenue Transit Mall in Portland, Oregon, also achieve this flow rate. Up to 45 buses one-way in a single lane in 15 minutes (a flow rate of 180 buses per hour) were observed on Chicago's former State Street Mall; however, this flow rate was achieved by advance marshaling of buses into 3-bus platoons and by auxiliary rear-door fare collection during the evening peak hours to expedite passenger loading.

Several downtown streets carry bus volumes of 80 to 100 buses per hour, where there are two or three boarding positions per stop, and where passenger boarding is not concentrated at a single stop. (This frequency corresponds to about 5,000 to 7,500 passengers per hour, depending on passenger loads.)

Historic streetcar volumes.

These bus volumes provide initial capacity ranges that are suitable for general planning purposes. They compare with maximum streetcar volumes on city streets in the 1920s which approached 150 cars per track per hour, under conditions of extensive queuing and platoon loading at heavy stops.[R3] However, the streetcars had two operators and large rear platforms where boarding passengers could assemble.

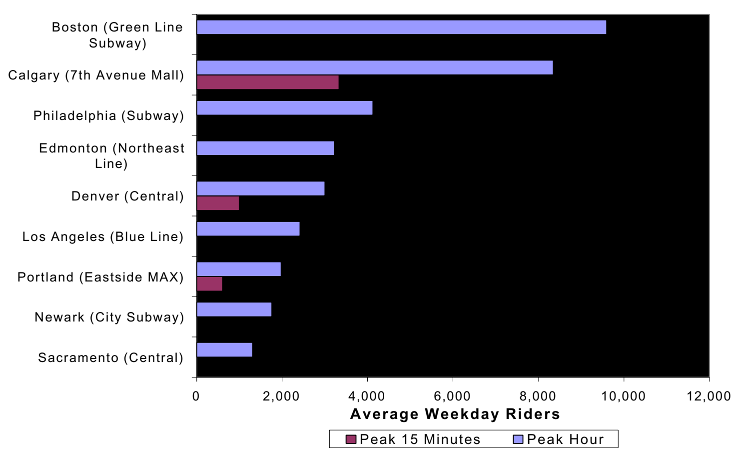
Exhibit 1-23
Observed U.S. and Canadian LRT Passenger Volumes:
Peak Hour at the Peak Point for Selected Lines (1993-96 Data)(R20)

City	Location (may be trunk with several routes)	Trains/ h	Cars/ h	Avg. Headway (s)	Pass/Peak Hour Direction	Pass/m of Car Length
Calgary	South Line	11	33	320	4,950	6.8
Denver	Central	12	24	300	3,000	4.7
Edmonton	Northeast LRT	12	36	300	3,220	4.0
Los Angeles	Blue Line	9	18	400	2,420	5.4
Boston	Green Line Subway*	45	90	80	9,600	5.3
Newark	City Subway	30	30	120	1,760	4.6
Philadelphia	Norristown	8	8	450	480	3.3
Philadelphia	Subway-Surface*	60	60	60	4,130	5.0
Sacramento	Sacramento LRT	4	12	900	1,310	4.9
Toronto	Queen at Broadway*	51	51	70	4,300	6.1
Portland	Eastside MAX	9	16	400	1,980	5.1

*Trunks with multiple-berth stations.
NOTE: In a single hour a route may have different lengths of trains and/or trains with cars of different lengths or seating configurations. Data represent the average car. In calculating the passengers per meter of car length, the car length is reduced by 9% to allow for space lost to driver cabs, stairwells, and other equipment. Data not available for the heavily used Muni Metro subway in San Francisco.

Exhibit 1-24 provides an indication of the maximum peak passenger volumes carried on a number of light rail systems for which data are available. The exhibit illustrates the peak passenger volumes carried over the busiest segment of the LRT system; in many cases, this represents passengers being carried on more than one route.

Exhibit 1-24
Peak Hour and Peak 15-Minute Directional Flows for Selected U.S. and Canadian Light Rail Transit Trunks (1995)(R15)



NOTE: Data not available for the heavily used Muni Metro subway in San Francisco.

Some streetcar and light rail lines carried substantially higher passenger flows in the peak years of 1946-1960. Post-World War II streetcars operated at as close as 30-second headways both on-street (Pittsburgh) and in tunnels (Philadelphia). Peak-hour passenger flows approximated 9,000 persons per hour. San Francisco's Market Street surface routes carried 4,900 peak-hour one-way passengers per hour before they were placed underground. Now, the observed number of peak-hour passengers at the maximum load point usually reflects demand rather than capacity. Peak 15- to 20-minute volumes expressed as hourly flow rates are about 15 percent higher.

Transit Cooperative Research Program - Completed Project

Project A-15, FY 1996
Development of Transit Capacity and Quality of Service Principles, Practices and Procedures

Res. Agency:	Kittleson & Associates, Inc. Comments on TCQSM 1st Edition to http://transit.kittelson.com
Principal Invest:	Alan Danaher
Effective Date:	November 1, 1996
Completion Date:	January 31, 1999
Funds:	$250,000

The transportation profession lacks a consolidated and generally accepted set of transit-capacity and quality-of-service definitions, principles, practices, and procedures for planning, designing, and operating vehicles and facilities. This is in contrast to the *Highway Capacity Manual* that defines quality of service and presents fundamental information and computational techniques related to quality of service and capacity of highway facilities. In the absence of a comparable, authoritative document, the case for transit service in a multimodal decision environment is weakened. Therefore, there is a need for a Transit Capacity and Quality of Service Manual.

Transit capacity is arguably more complex than highway capacity: it deals with the movement of both people and vehicles; depends on the size of the transit vehicles and how often they operate; and reflects the interaction between passenger traffic concentrations and vehicle flow. It also depends on the operating policy of the transit agency, which normally specifies service frequencies and allowable passenger loadings. Accordingly, the traditional concepts applied to highway capacity must be adapted and broadened. For this project, "capacity" is defined as "person capacity" as stated in the 1985 edition of the *Highway Capacity Manual*: "Person capacity is defined as the maximum number of people that can be carried past a given location during a given time period under specified operating conditions..."

"Quality of service" reflects the transit-user perspective and should be measured by a quantitative measurement or prediction of how a transit route, facility, or system is operating under specified demand, supply, and control conditions. The concept of quality of service for transit includes some of the same factors that affect capacity, such as vehicle size, load factor, service frequency and travel time. Travel time is influenced by factors such as stop frequency, dwell times, road and rail traffic interference, and right-of-way design. In addition to the factors that affect both quality of service and capacity, quality of service also includes such items as accessibility, comfort, area coverage, and reliability.

Considerable work has already been done on transit capacity and quality of service, but it needs to be consolidated and updated. There are also gaps in knowledge that require additional research. This project is intended to lay the groundwork for a comprehensive Transit Capacity and Quality of Service Manual and to produce an interim version. It will also contribute to the transit chapter of the year 2000 update of the *Highway Capacity Manual* and conduct new research to address the highest priority gaps in knowledge about transit capacity and quality of service.

The objectives of this research are to (1) define the content of a comprehensive Transit Capacity and Quality of Service Manual, (2) provide transit input to the *Highway Capacity Manual 2000*, (3) develop a prioritized research agenda for completing the Transit Capacity and Quality of Service Manual, (4) complete those portions of a Transit Capacity and Quality of Service Manual for which information is available and produce an interim document, and (5) conduct research on one or more high-priority research topics growing out of the research agenda.

Status: The project was completed on January 31, 1999. The project also prepared draft materials for transit-related Chapters 12 and 27 of the *Year 2000 Highway Capacity Manual (HCM)*. These materials are being reviewed and finalized by the Transit Subcommittee of the TRB Committee on Highway Capacity and Quality of Service. TRB has formed a Transit Capacity and Quality of Service Task Force, which will eventually be responsible for the contents of the *Transit Capacity and Quality of Service Manual* just as the Highway Capacity Committee has long been responsible for the contents of the HCM. Highlights of the manual were published as *TCRP Research Results Digest 35*, which is available in portable document format (PDF). Double-click on the files below to access the report. (A free copy of the Adobe Acrobat Reader is available at http://www.adobe.com.)

TCRP Research Results Digest 35

Comments are welcome.

The *Transit Capacity and Quality of Service Manual, First Edition*,is available in portable document format (PDF). Double-click on the files below to access the report. (A free copy of the Adobe Acrobat Reader is available at www.adobe.com.) **PLEASE NOTE:** Due to the very large size

of these files, it may take a long time--possibly more than 1 hour collectively--to download. We regret the inconvenience.
For a limited time, the manual is also available on CD-ROM for $25.00. Contact the TRB Publications Sales Office at 202/334-3213.

TCRP Web Document 6

Front matter, Table of Contents, Foreword, Part 1: Introduction and Concepts

Part 2: Bus Transit Capacity

Part 3: Rail Transit Capacity

Part 4: Terminal Capacity

Part 5: Quality of Service, Part 6: Glossary

For information on obtaining printed copies or online versions of any TRB publications mentioned, click here.

This information was last updated on 02/02/2001.

To create a link to this page, use this URL:
http://www4.nationalacademies.org/trb/crp.nsf/All+Projects/TCRP+A-15

Please send comments on the NCHRP & TCRP website to rderr@nas.edu.
Transportation Research Board - NCHRP & TCRP - Publications