Victoria Transport Policy Institute
1250 Rudlin Street, Victoria, BC, V8V 3R7, CANADA
www.vtpi.org info@vtpi.org
Phone & Fax 250-360-1560
"Efficiency - Equity - Clarity"

Smart Transportation Investments II

Reevaluating The Role Of Public Transit For Improving Urban Transportation

By
Todd Litman
Victoria Transport Policy Institute

14 September 2006

Abstract

This report investigates the role that public transit can play in reducing traffic congestion and achieving other transportation improvement objectives. It evaluates criticism that urban transit investments are ineffective at reducing traffic congestion and wasteful. This is a companion to the report, *Smart Transportation Investments: Reevaluating The Role Of Highway Expansion For Improving Urban Transportation.*

Introduction

Several recent articles criticize urban rail transit investments on grounds that they are ineffective at reducing traffic congestion and financially wasteful (Stopher, 2004; Taylor, 2004; O'Toole, 2006). This paper evaluates this criticism and investigates the role that public transit can play in reducing traffic congestion and achieving other planning objectives. This is a companion to the report *Smart Transportation Investments: Reevaluating The Role Of Highway Expansion For Improving Urban Transportation* (Litman, 2006b).

Context

Most industrialized countries have high levels of motor vehicle ownership and extensive roadway systems that provide a high level of service under most conditions. Motorists can drive to most destinations with relative speed, comfort and safety, except under urban-peak conditions. The main transport problems facing most communities are urban-peak traffic congestion; inadequate mobility for non-drivers; and external costs of vehicle use, including road and parking facility costs, accident risk imposed on others, and various environmental impacts resulting from motor vehicle facilities and use.

The question facing policy makers and planners is whether it is best to address these problems by further expanding urban highways to accommodate more vehicle travel, or instead to emphasize alternative forms of mobility, particular high quality, grade-separated rail transit designed to attract discretionary travelers (people who would otherwise drive). Many experts argue that major urban transit investments are justified.

Critics argue that transit investments are *not* cost effective, due to their high cost per reduced peak-period automobile trip and therefore cost-inefficient at reducing traffic congestion (O'Toole, 2003; Stopher, 2004). This debate partly reflects differences in how congestion is defined and measured. Traditional planning tended to evaluate transport primarily in terms of motor vehicle *traffic*, using indicators such as *roadway level of service* (LOS) ratings, *average traffic speeds*, and *travel time indices*, which only reflect roadway travel conditions. From this perspective, transit investments are only valuable to the degree that they reduce motorist delay.

However, modern planning tends to use more comprehensive analysis methods that evaluate transport system quality based on *mobility* (the movement of people and goods) and *accessibility* (the ease of reaching desired goods, services and activities). Modern planning also tends to give more consideration to other planning objectives besides congestion reduction, and to a wider range of accessibility improvement strategies, including various mobility management strategies and smart growth land use policies. More comprehensive planning tends to place a higher value on public transit investments, particularly when implemented in conjunction with supportive policies such as road and parking pricing, commute trip reduction programs, and transit oriented land use development.

Transit Congestion Reduction Benefits

High quality public transit reduces traffic congestion costs in three ways (Litman, 2005):

- High-quality, time-competitive transit tends to attract travelers who would otherwise drive, which reduces congestion on parallel roadways (described in the box below). Various studies indicate that automobile travel times tend to converge with those of grade-separated transit.

How Transit and HOV Reduces Traffic Congestion
When a road is congested, even small reductions in traffic volume can significantly increase travel speeds. For example, on a highway lane with 2,000 vehicles per hour a 5% reduction in traffic volumes will typically increase travel speed by about 20 miles per hour and eliminate stop-and-go conditions. Similar benefits occur from traffic volume reductions on congested surface streets.

Urban traffic congestion tends to maintain equilibrium. If congestion increases, people change route, destination, travel time and mode to avoid delay, and if it declines they take additional peak-period trips. Reducing the point of equilibrium is the only way to reduce long-term congestion. The quality of travel alternatives has a significant effect on the point of congestion equilibrium: If alternatives are inferior, few motorists will shift mode and the point of equilibrium will be high. If alternatives are attractive, motorists are more likely to shift modes, reducing the equilibrium. Improving travel options can therefore increase travel speeds for both those who shift modes and those who continue to drive.

To attract discretionary riders (travelers who could drive), transit must be fast, comfortable, convenient and affordable. In particular, grade-separated transit (on separate rights-of-way) provides a speed advantage that tends to attract motorists. When transit is faster than driving, a portion of motorists shift until the highway reaches a new equilibrium (that is, until congestion declines to the point that transit's time advantage is smaller). The actual number of motorists who shift may be small, but is enough to reduce delays. Congestion does not disappear, but it never gets as bad as would occur if the parallel grade-separated transit service did not exist. Several studies have found that the faster the transit service, the faster the travel speeds on parallel highways (Mogridge, 1990; Lewis and Williams, 1999; Vuchic, 1999). Comparisons between cities also indicate that total congestion delay tends to be lower in areas with good transit service (STPP, 2001; Litman, 2004a).

Shifting traffic from automobile to transit on a particular highway not only reduces congestion on that facility, it also reduces vehicle traffic discharged onto surface streets, providing "downstream" congestion reduction benefits. For example, when a highway widening with transit improvements, the analysis should account for the additional congestion on surface streets that would be avoided if the transit improvement attracts highway drivers out of their cars.

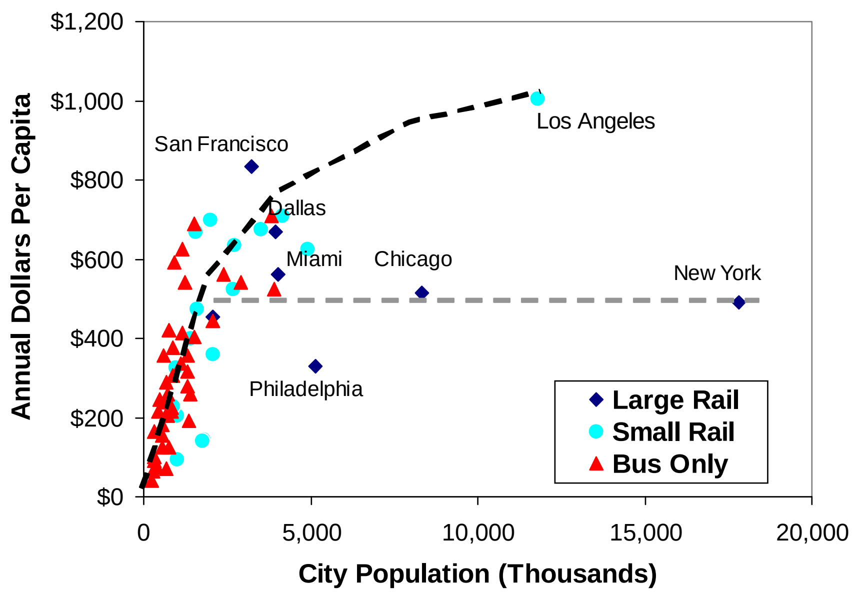
- Rail transit can stimulate transit oriented development (TODs) – compact, mixed-use, walkable urban villages where residents tend to own fewer cars and drive less than if they lived in more automobile-dependent neighborhoods ("Land Use Impacts On Transport," VTPI, 2005). Before-and-after studies indicate that households often reduce their vehicle travel when they move to transit-oriented locations (Podobnik, 2002).
- Quality transit service can reduce travel time costs to people who shift mode. Even if transit takes more minutes, many travelers consider their cost per minute lower than driving if transit service is comfortable (passengers have a seat, vehicles and stations are clean and safe, etc.), allowing passengers to relax and work ("Travel Time Costs," Litman, 2006a).

Winston and Langer (2004) found that motorist and truck congestion delay declines in cities as rail transit mileage expands, but increase as bus transit mileage expands, apparently because buses attract fewer motorists, contribute to traffic congestion, and do little to increase land use accessibility. Garrett (2004) found that congestion growth rates tend to decline in cities after light rail service begins. In Baltimore the congestion index increased an average of 2.8% annually before light rail, but only 1.5% annually after. In Sacramento the index grew 4.5% annually before light rail, but only 2.2% after. In St. Louis the index grew an average of 0.89% before light rail, and 0.86% after. Between 1998 and 2003, Portland's population grew 14%, but per capita congestion delay did not increase, possibly due to rail transit investments that significantly increased transit ridership during that period (TTI, 2005). Other studies find similar results (LRN, 2001).

Baum-Snow and Kahn (2005) found significantly lower average commute travel times in areas near rail transit than in otherwise comparable locations that lack rail, due to the relatively high travel speeds of grade-separated transit compared with automobile or bus commuting under the same conditions. They estimate these savings total 50,000 hours per day in Washington DC, and smaller amounts in other cities. Nelson, et al (2006) used a regional transport model to estimate transit system benefits, including direct users benefits and the congestion-reduction benefits to motorists, in Washington DC. They found that rail transit generates congestion-reduction benefits that exceed subsidies.

Texas Transportation Institute data indicate that congestion costs tend to increase with city size, but not if cities have large, well-established rail transit systems, as illustrated in Figure 1. As a result, New York and Chicago have far less congestion than Los Angeles.

Figure 1 **Congestion Costs** (Litman, 2004)



In Bus Only and Small Rail cities, traffic congestion costs tend to increase with city size, as indicated by the dashed curve. But Large Rail cities do not follow this pattern. They have substantially lower congestion costs than comparable size cities.

The TTI report also calculates the congestion cost reductions provided by transit services. Transit in cities with *Large Rail* systems provides savings averaging $279 annually per capita, compared with $88 in *Small Rail* cities, and $41 in *Bus Only* cities. These savings total more than $21 billion, worth more than two-thirds of total U.S. public transit subsidies. Another indicator of transit's congestion reduction benefits is the increased traffic delay that occurs in rail-oriented cities when the transit system stops for any reason, such as a mechanical failure or strike.

This leaves little doubt that high quality transit services reduce per capita congestion costs. However, this does not mean that cities with quality transit lack congestion. In fact, congestion, measured as roadway level of service or average traffic speeds, is often intense in these cities. However, people in these cities have travel alternatives available on congested corridor, and tend to drive less, and so they experience significantly less congestion delay each year.

Transit travel is often slower on average than automobile travel, but this does not prove that transit is uncompetitive. Automobile travel speeds tend to be much lower than average on the congested urban corridors where grade-separated transit is most common. That national or regional average automobile travel speeds are higher than average rail speeds is irrelevant; what matters is their relative travel speeds on a particular corridor. The criticism that transit is slower than driving can be considered an argument for further improving transit service to increase its speeds, rather than an argument against transit.

Of course, each trip is unique. For some trips transit is not an option because it does not serve a destination, travelers need to carry special loads or require a vehicle available at work. Some travelers prefer driving because they want to smoke or have difficulty walking to transit stations. Some people enjoy driving, even in congested conditions. But that does not negate the value of transit: if quality transit is available, travelers will self-select driving or transit based on their needs and preferences. This maximizes transport system efficiency (since shifts to transit reduce traffic and parking congestion) and consumer benefits (since it allows consumers to choose the optimal option for each trip).

Major transit system expansion generally occurs in large and growing urban areas that experience increasing congestion. As a result, simplistic analysis often shows a positive correlation between rail transit and congestion. Some critics exploit this relationship to "prove" that rail transit increases congestion (O'Toole, 2004), but their analysis fails to indicate the level of congestion that would occur without rail. Critics often use indicators, such as the *Travel Time Index*, which only measure delay to motorists and so ignore delay reductions when people shift to transit, and from transit-oriented development that reduces travel distances. That index actually implies that congestion declines if residents *increase* their vehicle mileage and total travel time, for example, due to more dispersed land use, provided the additional driving occurs in less congested conditions.

Comprehensive Analysis

Critics often argue that transit investments are cost ineffective due to their relatively high cost per unit of congestion reduction, assuming that traffic congestion is the only significant transport problem. More comprehensive analysis considers other benefits, such as those listed in Table 1. As more planning objectives are considered the value of transit investments tend to increase.

Table 1 **Transit Benefits** (Litman, 2005)

Benefits	Description
Congestion Reduction	Reduced traffic congestion.
Facility cost savings	Reduced road and parking facility costs.
Consumer savings	Reduced consumer transportation costs.
Transport diversity	Improved transportation options, particularly for non-drives.
Road safety	Reduced per capita traffic crash rates.
Environmental quality	Reduced pollution emissions and habitat degradation.
Efficient land use	More compact development, reduced sprawl.
Economic development	Efficiencies of agglomeration, increases productivity and wealth.
Community cohesion	Positive interactions among people in a community.
Public health	More physical activity (particularly walking) increases fitness and health.

Rail transit tends to reduce per capita vehicle ownership and use, and encourage more compact, walkable development patterns, which can provide a variety of benefits to society.

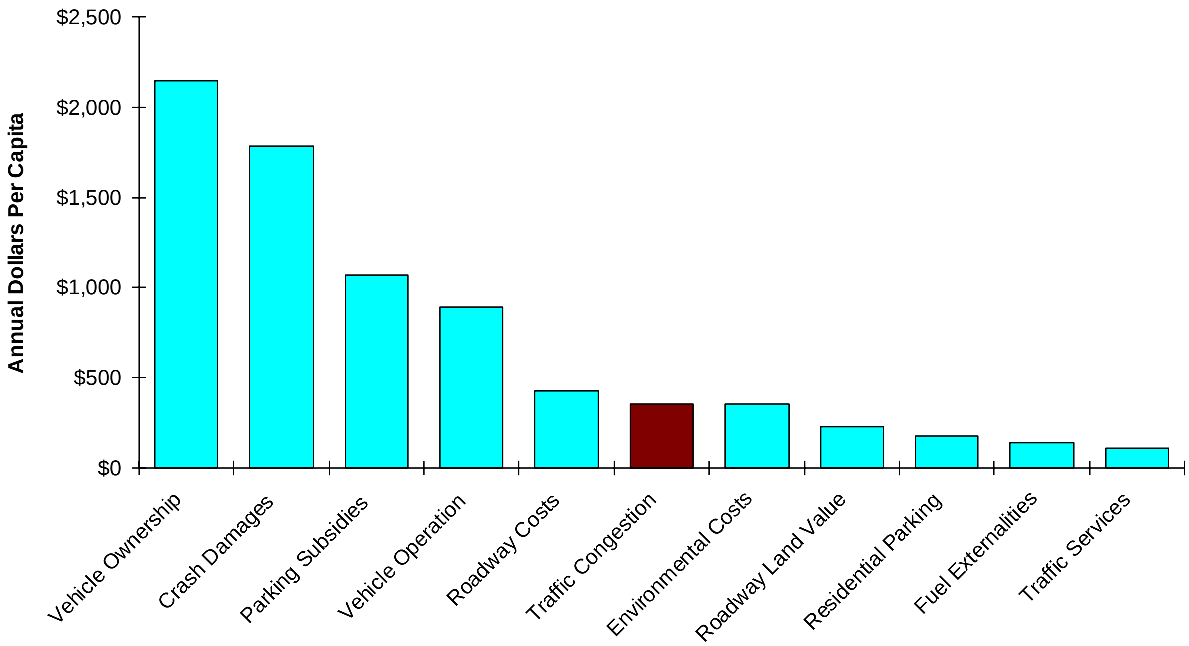
For example, comparing U.S. cities according to their rail transit service quality found that those with large rail transit systems have (Litman, 2004):

- 400% higher per capita transit ridership (589 versus 118 annual passenger-miles).
- 21% lower per capita motor vehicle mileage (1,958 fewer annual miles).
- 887% higher transit commute mode split (13.4% versus 2.7%).
- 36% lower per capita traffic fatalities (7.5 versus 11.7 annual deaths per 100,000 residents).
- 14% lower per capita consumer transportation expenditures ($448 average annual savings).
- 19% smaller portion of household budgets devoted to transportation (12.0% versus 14.9%).
- 33% lower transit operating costs per passenger-mile (42¢ versus 63¢).
- 58% higher transit service cost recovery (38% versus 24%).
- Transit-oriented development residents are more likely to achieve recommended levels of physical activity through daily walking than residents of automobile-oriented communities.

From a household’s perspective, rail transit provides a positive return on investment. Quality rail transit requires on average about $100 annually per capita in additional tax funding but provides about $500 annually per capita in direct consumer transport cost savings. In addition, rail transit tends to increase regional employment, business activity and productivity, plus it improves mobility for non-drivers, reduces the need for motorists to chauffeur non-drivers, improves community livability and improves public health.

Figure 1 illustrates the estimated magnitude of various automobile costs, including vehicle ownership and operation costs, road and parking facilities, traffic services, accidents, environmental damages, and congestion. Congestion costs are relatively modest overall. It would not be cost effective to implement a policy that reduces traffic congestion costs by 10% if it increased other transportation costs, such as vehicle expenses, roadway expanses, crashes or environmental damages, by just 3% each. On the other hand, a congestion reduction strategy provides far more benefit to society if it helps reduce these other costs, even by a small amount.

Figure 1 **Costs Ranked by Magnitude** ("Transportation Costs," VTPI, 2005)



This figure shows Average Car costs per vehicle mile, ranked by magnitude.

Alternative Transportation Improvement Strategies

Of course, critics can legitimately suggest that other strategies may be more cost effective than high-quality rail transit investments. Depending on ideology they may recommend roadway capacity expansion, bus transit improvements, road pricing, or some type of mobility management program to encourage more efficient travel options, including cycling, ridesharing, public transit, telework and flextime. These are all legitimate ways of reducing congestion, but are often poor substitutes for improving public transit service.

Roadway expansion can reduce traffic congestion in the short-run, but these benefit tends to decline over time due to generated traffic, and the additional vehicle travel tends to increase other costs such as downstream traffic congestion and parking demand, total accidents, energy consumption and pollution emissions (Litman, 2006b). Advocates generally exaggerate the benefits and underestimate the full costs of highway expansion.

A major study evaluated congestion reduction options for the Puget Sound region in Washington State (WSDOT, 2006). It concluded that neither highway expansion nor transit improvements alone are cost effective, considering just congestion reduction benefits, but both become cost effective if implemented with roadway pricing.

Table 2 compares the estimated congestion reduction benefits and project costs calculated in the study. Both highway expansion and transit improvements have Benefit/Cost Ratios less than 1.0. Highway expansion ranks somewhat higher than bus improvements, considering just congestion reduction benefits. But, as previously described, highway expansion tends to impose other costs, while transit improvements provide other benefits to users and society. As a result, when all of these impacts are considered transit is often most cost effective.

Table 2 **Congestion Reduction Economic Analysis** (WSDOT, 2006)

	Benefits	Costs	Ratio
Highway Expansion	$1,850	$3,100	0.60
Transit Improvements	$605	$1,350	0.45

This table indicates the midpoint estimated highway and transit congestion reduction benefits and costs, in millions of annualized dollars. Neither approach provides congestion-reduction benefits that exceed costs, but transit provides many additional benefits.

Although, bus transit is excellent for serving dispersed destinations, on major urban corridors rail tends to be more effective at attracting riders (Henry and Litman, 2006) and more cost effective overall, since trains tend to offer a more comfortable ride, are propelled by electric motors rather than internal combustion engines (so train stations tend to be more pleasant than large bus stations), and can carry more passengers per operator. Light rail service has lower operating costs compared to buses with as few as 1,200 peak-period passengers on a corridor, and is particularly appropriate for destinations with more than about 2,000 peak period passenger arrivals to avoid the unpleasant impacts from large congregations of buses at a station (Pushkarev, 1982).

Critics often claim that bus service is cheaper than rail, but as performance and comfort features are added (grade separation, larger seats, better stations, alternative fuels, etc.), bus system capital costs increase and approach those of rail, and may be offset over the long run by rail's lower operating costs. Operating costs are lower and cost recovery is higher in U.S. cities with large rail transit than those with little or no rail service, due to higher load factors and greater operating efficiency (Vuchic, 2005; Henry and Litman, 2006). Rail stations are far more effective than bus stations at creating TOD and therefore providing the additional benefits associated with improved neighborhood accessibility and reduced per capita vehicle travel. For these reasons, where ridership volumes are high and transit oriented development is a planning objective, rail may be justified despite higher initial costs.

Road pricing can reduce urban traffic congestion and eliminating the need for grade separated busways, but most cities that have implemented urban road pricing (Singapore, London and Stockholm) have rail transit to accommodate the large numbers of transit passengers that pricing creates. By providing an attractive travel alternative, rail transit reduces the price needed to reduce traffic congestion, benefiting motorists and making rail transit a complement to congestion pricing.

High Occupant Toll (HOT) lanes are *High Occupant Vehicle* (HOV, which include carpools, vanpools and buses) lanes that also allow use by a limited number of low occupancy vehicles that pay a toll. Proponents argue that these toll can finance significant highway expansion and therefore support High Occupant Vehicle use (Poole, 2003), but in practice such revenues can generally cover only a major portion of project costs without spoiling the lane's travel time advantage ("HOV Priority," VTPI, 2006).

To attract travelers from automobiles, HOV traffic must flow uncongested, maintaining *Level Of Service* (LOS) A or B, which means less than about 1,000 vehicles per hour on a grade-separated highway. Buses and vans typically impose about two *Passenger Car Equivalents* (PCEs) and vans about 1.2. Thus, if during peak hour there are 100 buses and 100 vans causing 320 total PCEs, there will only be space for 680 automobiles. At 25¢ per vehicle-mile this only provides about $100,000 annual revenue ($0.25/veh-mile x 680 vehicles x 2 daily peak-hours x 300 days per year), at best a third of the full cost. All too often HOV and HOT lane optimal capacity is exceeded due to political intervention or a desire to maximize revenues, degrading their quality of service and reducing shifts from driving to high occupant vehicles. It is therefore important that HOT lanes be managed to optimize HOV performance rather than to accommodate other classes of vehicles or maximize revenues.

Mobility management programs that encourage use of alternative modes can be quite effective and beneficial, but they require high quality travel options to be effective (VTPI, 2006). For example, a mobility management marketing programs that encourages travelers to try public transit will fail if the transit service is slow, uncomfortable, unsafe or stigmatized. As a result, mobility management programs are complements rather than substitutes for transit investments.

Qualitative Improvements

Conventional transport modeling measures total hours of travel and congestion delay, but often overlooks important qualitative factors related to transit convenience, comfort, security and reliability, and so tends to undervalue transit service improvements.

For example, many travelers consider time spent on a comfortable train or bus (with padded seats, safe and comfortable stations) to cost less per minute than time spent as a driver in congested traffic ("Travel Time Costs," Litman, 2006a). On the other hand, transit travelers tend to assign a high cost to waiting for a transit vehicle, to unreliable service, and to long walking distances between transit stations and destinations. As a result, transit service quality improvements can reduce travel time costs even if they do not reduce the amount of time spent traveling, because costs per minute of travel are reduced. This suggests that it could be more cost effective to shift resources currently devoted to reducing motorists' traffic congestion delays to improving public transit service quality, for example, by increasing transit frequency, providing more comfortable vehicles, providing better user information (such as real time information on transit vehicle arrival times), nicer stations, improved security and better walking conditions around stations.

Conclusions

High quality public transit reduces traffic congestion by attracting travelers who would otherwise drive. As public transit service improves on a corridor (including improved speed, convenience, comfort and affordability), congestion levels on parallel roadways tends to decline. Grade-separated rail transit tends to reduce congestion directly and help create more accessible communities where there are good travel options and travel distances are shorter, which reduces per capita congestion costs.

Many peak period travelers would prefer to drive less and rely more on alternative modes, provided they are convenient, comfortable, flexible, safe, affordable and prestigious. Since transit travel times and travel time costs vary depending on attributes such as comfort, reliability and access, transit service quality improvements can be considered equivalent to traffic congestion reductions. For example, increasing train and bus service frequency, which reduces the waiting times and crowding, or locating more worksites closer to transit stations reduces travel time costs, even if there is no increase in transit vehicle speeds.

Below is the general ranking of strategies, considering only their ability to reduce traffic congestion reduction (not considering other impacts and objectives):

1. Congestion pricing (higher road and parking fees during peak periods).
2. Other mobility management strategies (commute trip reduction programs).
3. High quality public transit (particularly grade separated transit).
4. Highway capacity expansion.
5. Smart growth land use policies.

Transit investments by themselves are not usually the most cost effect way to reduce roadway congestion. However, they become more cost effective at reducing congestion if implemented with complementary road pricing, mobility management strategies and smart growth land use policies. Conversely, transit service improvements support road pricing, mobility management and smart growth, making these more effective and politically acceptable. Congestion reduction is just one of many benefits provided by transit improvements. Other benefits provided by public transit, such as road and parking cost savings, consumer cost savings, accident reductions and improved mobility for non-drivers, are of equal or greater value than congestion reductions. When all impacts are considered, transit investments are often cost effective.

Conventional transportation economic evaluation practices tend to undervalue transit investments by ignoring many benefits including downstream traffic reduction, user savings and benefits, improved mobility for non-drivers, and support for strategic land use objectives. This is not to say that every transit project is optimal or that transit investments alone will solve every transport problem. However, various studies indicate that considering all impacts and planning objectives, transit improvements are often cost effective investments.

References

Nathaniel Baum-Snow and Matthew E. Kahn (2005), *The Effects of Urban Rail Transit Expansions: Evidence from Sixteen Cities*, 1970 to 2000, Brookings Papers on Urban Affairs (www.econ.brown.edu/fac/Nathaniel_Baum-Snow/brook_final.pdf).

Lawrence Frank, Sarah Kavage and Todd Litman (2006), *Promoting Public Health Through Smart Growth*, Smart Growth BC (www.smartgrowth.bc.ca/downloads/SGBC_Health%20Report%20Final.pdf).

Thomas A. Garrett and Molly D. Castelazo (2004), *Light Rail Transit in America: Policy Issues and Prospects for Economic Development*, Federal Reserve Bank of St. Louis (www.stlouisfed.org).

Lyndon Henry and Todd Litman (2006), *Evaluating New Start Transit Program Performance: Comparing Rail And Bus*, Victoria Transport Policy Institute (www.vtpi.org).

David Lewis and Fred Laurence Williams (1999), *Policy and Planning as Public Choice: Mass Transit in the United States*, Ashgate (www.ashgate.com).

Todd Litman (2003), *Evaluating Rail Transit Criticism*, VTPI (www.vtpi.org).

Todd Litman (2004), *Rail Transit In America: Comprehensive Evaluation of Benefits*, VTPI (www.vtpi.org).

Todd Litman (2005), *Evaluating Public Transit Benefits and Costs*, VTPI (www.vtpi.org).

Todd Litman (2006a), *Transportation Cost and Benefit Analysis*, VTPI (www.vtpi.org).

Todd Litman (2006b), *Smart Transportation Investments: Reevaluating The Role Of Highway Expansion For Improving Urban Transportation*, VTPI (www.vtpi.org).

Peter Nelson, Andrew Baglino, Winston Harrington, Elena Safirova and Abram Lipman (2006), *Transit in Washington, D.C.: Current Benefits and Optimal Level of Provision*, Resources for the Future (www.rff.org/rff/Documents/RFF-DP-06-21.pdf).

Randal O'Toole (2004), *Great Rail Disasters; The Impact Of Rail Transit On Urban Livability*, Reason Public Policy Institute (www.rppi.org).

O'Toole, Randal (2006), *A Desire Named Streetcar: How Federal Subsidies Encourage Wasteful Local Transit Systems*, Cato Institute (www.cato.org/pubs/pas/pa559.pdf).

Bruce Podobnik (2002), *The Social and Environmental Achievements of New Urbanism: Evidence from Orenco Station*, Department of Sociology Lewis and Clark College (www.lclark.edu/~podobnik/orenco02.pdf).

Robert W. Poole, Jr. (2003), *A Win-Win Solution for our Freeways: High-occupancy Toll Lane Systems Ease Traffic While Raising Revenue*, Reason Foundation (www.rppi.org/winwin.html).

Boris S. Pushkarev (1982), *Urban Rail In America: An Exploration of Criteria for Fixed-Guideway Transit*, Indiana University Press (www.iupress.indiana.edu).

Reconnecting America (2004), *Hidden In Plain Sight: Capturing The Demand For Housing Near Transit*, Reconnecting America (www.reconnectingamerica.org/html/TOD/newReport.htm).

Peter R. Stopher (2004), "Reducing Traffic Congestion: A Reality Check," *Transport Policy*, Vol. 11, No. 2 (www.elsevier.com), April 2004, pp. 117-131.

Brian D. Taylor (2004), "The Politics of Congestion Mitigation," *Transport Policy*, Vol. 11, No. 3 (www.elsevier.com), July 2004, pp. 299-302.

VTPI (2006), *Online TDM Encyclopedia*, Victoria Transport Policy Institute (www.vtpi.org).

Vukan R. Vuchic (1999), *Transportation For Livable Cities*, Center for Urban Policy Research, CRPR Press (www.policy.rutgers.edu/cupr).

Vukan Vuchic (2005), *Urban Transit: Operations, Planning and Economics*, Wiley & Sons (www.wiley.com).

Clifford Winston and Ashley Langer (2004), *Effect of Government Highway Spending on Road Users' Congestion Costs*, Brookings Institute (www.brookings.edu).

WSDOT (2006), *Congestion Relief Analysis: For the Central Puget Sound, Spokane & Vancouver Urban Areas*, Washington State Dept. of Transportation (www.wsdot.wa.gov), 2006.