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"Efficiency - Equity - Clarity"

UBC TREK Program Evaluation
Costs, Benefits and Equity Impacts of a University TDM Program

by

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Abstract
The University of British Columbia is implementing TREK, a transportation demand management (TDM) program to encourage more efficient travel to the university campus. The program's objectives are to reduce 24 hour single occupant vehicle (SOV) traffic volumes by 20% below 1997 levels by November 2002, and to reduce truck traffic by improving freight delivery coordination. This report examines the feasibility and cost effectiveness of this program based on estimates of the programs costs and benefits.

Experience with other TDM programs indicates that the TREK's stated objectives are feasible, although it is uncertain whether they will be achieved with the currently proposed package of measures. The costs of this program include administrative expenses, additional student fees, and transit service subsidies. Benefits include savings to students who would otherwise purchase transit fares, and reductions in parking costs, congestion, roadway costs, accident risk and environmental impacts. The TREK program supports regional TDM objectives, including improved transit service and non-motorized travel facilities, more efficient land use, and reduced automobile travel. The benefit/cost ratio is estimated to be significantly greater than 6, indicating that the program is very cost effective.

Introduction

The University of British Columbia is implementing TREK, a transportation demand management (TDM) program to encourage more efficient travel to the university campus.[1] The program's objectives are to reduce 24 hour single occupant vehicle (SOV) traffic volumes by 20% below 1997 levels by November 2002, and to reduce heavy truck traffic. This report examines the feasibility and cost effectiveness of this program.

The program as it is currently proposed includes the following components:

- Unlimited prepaid transit service for all students (a valid UBC student body card would serve as a BC Transit pass), and discounted monthly transit passes for university staff.
- More frequent transit service and a campus shuttle bus system.
- Ride matching programs and preferential parking for car- and vanpools.
- Improved bicycling and pedestrian facilities.
- Information and marketing campaigns to encourage the use of alternative modes.
- Various support services, such as coordinated planning and parking management, and guaranteed ride home for staff.
- Programs to coordinate and manage freight deliveries to the campus.
- Various other benefits, including merchant discounts.

The programs' costs, as currently proposed, include a $20 per month transit pass fee paid by all students, annual administrative expenses averaging about $500,000 per year funded by UBC, and an incremental subsidy to finance additional transit service, the funding of which is currently under negotiation. These estimates are subject to change as the program develops.

Context

The University of British Columbia is located on Point Grey at the western end of Vancouver, BC, isolated from the rest of the city by a the Pacific Spirit Park (previously called the University Endowment Lands), a large block of undeveloped land. Four arterials connect the campus with the rest of the city. UBC is the second largest commuter destination in the Vancouver region (after the city's central business district), with more than 100,000 weekday person trips during the school year. Over the next 25 years enrollment and campus trips are expected to grow at 2% per annum. The university's Official Community Plan Bylaw requires UBC to develop and implement a comprehensive and integrated transportation management strategy. UBC is also committed to providing a "sustainable community and campus: safe, livable, and environmentally friendly," and to "improving services to students."

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[1] For program details see the *UBC Transportation Strategic Plan* and other information at www.trek.ubc.ca.

Travel Impacts – Feasibility of Achieving Objectives

Can the TREK program achieve a 20% reduction in single-occupant vehicle trips? Experience with other campus TDM programs indicates that trip reductions of this magnitude are possible.[2] A program at the University of Wisconsin-Milwaukee reduced student driving by 26%.[3] A University of Washington program reduced total vehicle trips to campus by 16% during its first year of operation, and by 1998 the number of vehicles coming to campus during the morning peak period decreased 19 percent over 1990 levels, despite growth in the campus population.[4] Other types of TDM programs that offer significant transit discounts have similar impacts.[5]

Although transit fare discounts are likely to be the largest single incentive for mode shifting, the TREK program has other strategies to reduce automobile travel. Rideshare matching, preferential car- and vanpool parking, improving walking and cycling conditions, improved information services, promotion and marking, circulation shuttle buses, and a guaranteed ride home program are all likely to contribute smaller but still significant mode shifts.[6]

Several factors can influence the effectiveness of TDM programs. If transit vehicles become crowded, dirty or unreliable due to increased use, the full potential mode shift may not occur. If TDM efforts significantly reduce traffic congestion, some of the mode shift may be offset by additional automobile trips due to latent demand, although much of this may consist of trips shifted from off-peak, and therefore not representing new automobile trips. If other regional TDM programs are implemented (such as road pricing and land use reform) there may be synergetic effects that increase the TREK programs effectiveness. If additional travel demand reductions are desired, other TDM strategies not included in this analysis could implement by UBC and TransLink.[7]

In particular, there may be a justification for increasing parking prices. Current campus parking fees are set to recover operating and recent capital expenses. Parking structures are depreciated at only 2% per year (which assumes that they will last 50 years or more) and land used for parking is treated as having zero value, although there are many competing uses for campus land. As a result, current fees are below the true opportunity cost of parking.

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[2] Jeffrey Brown, Daniel Hess and Donald Shoup, *Unlimited Access*, Institute of Transportation Studies, UCLA (Los Angeles), 1998.

[3] James Meyer and Edward Beimborn, *Evaluation of an Innovative Transit Pass Program: the UPASS*, Wisconsin Department of Transportation (www.uwm.edu/dept.cuts/upassum.htm), 1996.

[4] Michael E. Williams and Kathleen L. Petrait, "U-PASS: A Model Transportation Management Program that Works," *Transportation Research Record 1404*, 1993, pp. 73-81; website: www.washington.edu/upass.

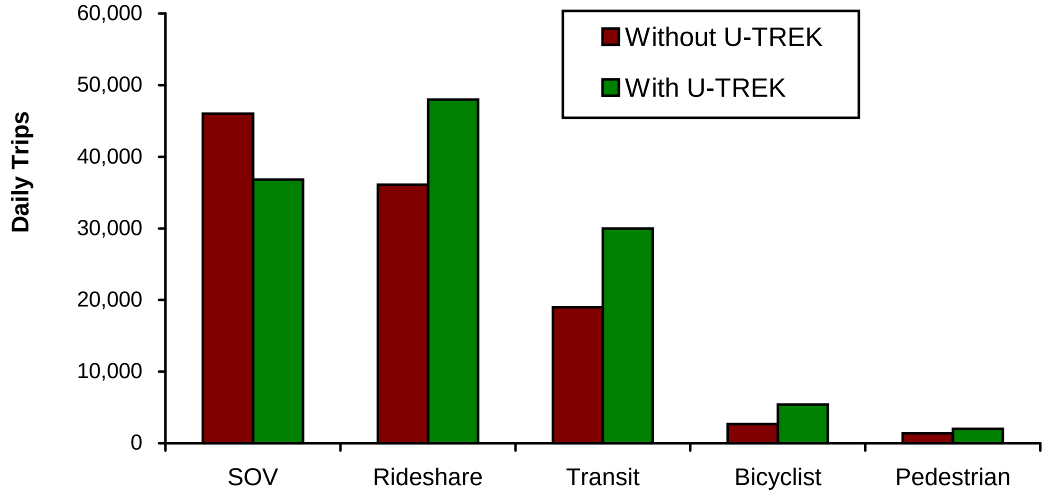
[5] Rutherford, et al., "Transportation Demand Management: Case Studies of Medium-Size Employers," *Transportation Research Record, #1459*, 1995; Judith Schwenk, *TransitChek in the New York City and Philadelphia Areas*, Volpe Transportation Systems Centre, USDOT (Washington DC; http://ohm.volpe.dot.gov), October 1995; Commuter Choice Program (www.epa.gov/oms/traq).

[6] Cambridge Systematics, *Effects of Land Use and Travel Demand Management Strategies on Commuting Behavior*, USDOT (Washington DC), DOT-T-95-06, November 1994.

[7] Todd Litman, *Potential TDM Strategies*, VTPI (www.islandnet.com/~litman) 1999.

For this analysis we assume that the TREK program would result in the mode shift shown in Figure 1.

Figure 1 **UBC Mode Split**[8]



This figure illustrates the predicted effect of the TREK program on mode split.

This analysis does not include freight management impacts. Some research indicates that there is considerable potential to reduce delivery vehicle traffic by improving logistics, but the possible effects in this situation has yet to be analyzed.[9] Although freight vehicles represent a relatively small portion of total vehicle trips they tend to impose greater externalities per trip than personal vehicles (including congestion, road and parking facility costs, air and noise pollution), so the benefits of even a relatively small reduction may be significant.

[8] Gord Lovegrove, *Social Cost Benefit Analysis of the UBC TREK Card Program*, UBC, 1999, p. 18.
[9] Transmode Consultants Inc., *Ontario Freight Movement Study*, National Round Table on the Environment and the Economy (Toronto), November 1995; Thomas Bue Bjørner, “Environmental Benefits from Better Freight Transport Management: Freight Traffic in a VAR Model,” *Transportation Research D*, Vol. 4, No. 1, January 1999, pp. 45-64.

Defining and Describing TDM Benefits

In general, transportation management programs provide two major categories of benefits. *Mobility benefits* increase travel options available to users, resulting in more travel. Transit service improvements, a rideshare program, or better walking and bicycling facilities that improve access to UBC may provide such benefits if they allow make travel cheaper or more convenient.

Efficiency benefits make existing trips more efficient by reducing costs to users, to the university, to other government agencies, or to society in general. The majority of TREK benefits are likely to be efficiency benefits. That is, most benefits can be measured in terms of cost savings. This analysis assumes that total access to UBC does not change, simply the transportation mode used.[10]

Program benefits are defined and discussed below, and values estimated when possible.[11]

1. Financial Savings to Current Transit Riders

On an average workday approximately 8,500 people use public transit to access the campus. Approximately 3,000 students currently pay $54 per month for a transit pass, while other students pay an average of $1.40 per trip for individual fares. These transit users will save under the program. This represents an annual benefit of approximately $4 million per year. These benefits accrue to current transit users.

2. Mode Shift Benefits

When students change modes in response to positive incentives, they must be better off or they would not make this shift. As discussed later, this is true even if their travel time increases. Transport economists estimate the incremental benefit to consumers based on the "Rule-of-Half," which assumes consumer surplus equals approximately half of the price change.[12] Thus, if current transit trips cost $1.40 each (an estimated weighted average of individual trip transit fares), the estimated incremental consumer benefit of the trips shifted is $0.70.

This estimate of net consumer benefits takes into account the additional travel time associated with trips by alternative modes, vehicle operating cost savings (estimated to average 20¢ per vehicle kilometre), parking fee savings, reduced stress to car drivers, and any loss of comfort, convenience and prestige when people ride transit rather than drive. Although there are many possible factors that affect consumers' travel choices, they are all incorporated in the Rule-of-Half. These benefits accrue to new transit users.

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[10] Telecommuting is considered equivalent to a physical trip. Thus, if the TREK program allows people to satisfy their need to access UBC campus resources (library, information services, faculty, etc.) by telephone or Internet rather than actually traveling to the campus this would be counted as a "trip."

[11] For more information on benefit values see Todd Litman, *Transportation Cost Analysis*, VTPI (www.islandnet.com/~litman), 1999, which includes a review of other costing studies.

[12] Kenneth Small, "Project Evaluation," in *Transportation Policy and Economics*, Brookings (www.brookings.edu), 1999, available at http://socrates.berkeley.edu/~uctc/text/papersuctc.html.

The Value of Travel Time Changes[13]

One issue that sometimes requires particular consideration in this type of analysis is the value of travel time changes. Shifting from driving to an alternative mode often increases travel times. Does this represent an increased cost? Not necessarily.

Consumers only change mode in response to a positive incentive if they are better off overall, even if their travel time increases. The value that people assign to travel time is highly variable, depending on factors such as comfort and enjoyment. For example, some people enjoy driving and dislike riding a bus. Other people find driving in traffic to be stressful, and may consider riding a bus more desirable, even if it requires additional travel time, because they can relax engage in other activities, such as reading. Others enjoy walking or bicycling as a form of recreation and exercise, and will choose these modes even if the trips take longer, provided that road conditions are adequate. Given viable options, consumers will choose the mode with the lowest total cost (time and money) for each trip. This is economically efficient.

If a positive incentive induces a shift from driving to an alternative mode (such as a transit fare reduction, priority policies that reduce travel times for rideshare passengers, or a reduction in accident risk for pedestrians and cyclists) consumers who change mode in response must be better off in terms of their variable costs, or they would not take advantage of the offer. Conversely, if a negative incentive induces a mode shift to alternative modes they must be worse off in terms of their direct variable costs, or they would not make the shift. The Rule-of-Half allows these changes to value to consumers of these changes to be estimated.

This is not to ignore other costs, such as the additional fixed costs that students may need to pay to fund transit discounts, subsidies needed to fund increased transit capacity, or changes in other external costs. Any comprehensive analysis must take all of these impacts into account.

Since most incentives currently proposed for the TREK program are positive, any mode shift that results can be assumed to provide net consumer benefits, even if it increases some portion of their costs, such as travel time. If negative incentives are also used (such as higher parking fees), then the incremental consumer costs, also estimated using the Rule-of-Half, should be subtracted from the incremental consumer benefits to provide net consumer benefits.

[13] Kenneth Small, “Project Evaluation,” 1999.

3. Additional TREK Benefits
The TREK program provides some additional consumer benefits, including discounts at some businesses, use of campus shower facilities for non-commute purposes, increased personal security due to new campus patrols, and transportation option value (the value some consumers place on having increased travel choices, even if they don't currently use them). These benefits accrue to all UBC students, and any staff who participate in the program. These benefits are not quantified in this analysis, although their value could be estimated in the future using consumer surveys and other market research.

4. Parking Cost Savings
UBC currently has 10,653 parking spaces. This is expected to decline by about 2% over the next five years as a new building is constructed on land currently used for parking. Growing campus population and program development are expected to increase demand for parking and for land currently used for parking facilities to be converted to other productive uses.

The campus recently added a 1,000 space parking structure that cost approximately $28 million to build. This represents an annualized capital cost of about $1,500 per space (assuming 6% interest over 20 years). Maintenance and operating costs average several hundred dollars per space per year.[14] In addition, the land used for parking has a significant opportunity cost. The marginal cost of providing additional campus parking totals about $9 per day (assuming annualized cost of $1,800 per space used 200 days per year). The current $3 per day parking fee covers only about a third of these costs.

Reducing parking demand can avoid the need to build more parking capacity and allow existing parking facilities to be converted to more productive uses without requiring the high cost of building additional parking structures. This benefit accrues to the UBC budget. There are also environmental and aesthetic benefits when the need to build additional parking is avoided, which accrue to society in general.[15]

5. Congestion Reduction/Road Cost Savings
One of the most obvious benefits of reducing vehicle trips is reduced traffic congestion. A number of studies have estimated these costs.[16] Herbert Mohring and David Anderson estimate average congestion costs for Twin City roads shown in Table 1. Another major study finds that optimal congestion charges (which are considered to represent congestion costs) ranging from about 5¢ to 36¢ U.S. per vehicle mile on congested urban roads.[17]

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[14] John Dorsett, "The Price Tag of Parking," *Urban Land* (www.udi.org), May 1998, pp. 66-70; Robert Weant and Herbert Levinson, *Parking*, Eno Foundation (www.enotrans.com), 1990.
[15] NEMO, www.canr.uconn.edu/ces/nemo; Todd Litman, *Pavement Busters Guide*, VTPI (www.islandnet.com/~litman), 1999.
[16] *Quantifying Congestion*, TRB (Washington DC; www.nas.edu/trb), NCHRP Project 7-13, 1997; *1997 Federal Highway Cost Allocation Study*, USDOT (www.fhwa.dot.gov).
[17] *Curbing Gridlock*, TRB, National Academy Press (www.nas.edu/trb), 1994, Appendix B.

Table 1 **Average Marginal Congestion Costs (1994 U.S. / Mile)**[18]

	Morning Peak	Afternoon Peak
All Road Links	20.7¢	17.0¢
Expressways	23.6¢	20.1¢

Most congestion studies only consider costs imposed on motor vehicle users. The delay and accident risk costs that vehicle traffic and highways impose on non-motorized travel is called the "barrier effect" or "severance." Some studies have quantified this cost in terms of travel delay and non-motorized trips foregone.[19] This indicates that such costs can be significant, particularly in urban areas.

The actual congestion reduction benefits of trips shifted from driving to alternative modes is somewhat difficult to measure due to generated traffic.[20] In urban areas, traffic congestion tends to maintain a self-limiting equilibrium. A shift to alternative modes may cause little long-term reduction in congestion, as additional capacity is filled by latent demand. However, it does allow other automobile trips to occur, it may allow a road capacity expansion project to be deferred or avoided, and comprehensive TDM programs may change the point of equilibrium, reducing congestion costs over the long run.

For this analysis we assume a congestion reduction benefit of 15¢ per kilometre of vehicle travel reduced, which appears to be the lower range of this cost on a busy corridor such as the access roads to UBC. Although only about half of travel shifts are expected to occur during peak periods, many Vancouver area roads are congested even during off-peak periods. This benefit accrues to road users in general, and can be considered a benefit to TransLink which has a mandate to reduce traffic congestion in the region.

6. Accidents/Road Risk

This is the benefit of reduced accident risk that results when trips are shifted from driving to alternative modes. A number of studies indicate that this benefit averages several cents per passenger kilometre. The table below illustrates one estimate of accident costs by mode, and the savings that result from a mode shift.

Table 2 **Estimated Costs and Savings Per Urban Peak Passenger Kilometre**[21]

	Average Auto	Car Pool	Van Pool	Bus
Cost	7.4¢	3.5¢	1.8¢	0.2¢
Mode Shift Savings	0.0	3.9¢	5.6¢	7.2¢

[18] Herbert Mohring and David Anderson, *Congestion Pricing for the Twin Cities Metropolitan Area*, Dept. of Economics, University of Minnesota (Minneapolis), January 1994.
[19] J.M. Clark and B.J. Hutton, *The Appraisal of Community Severance*, Transport Research Laboratory (UK; www.trl.co.uk), Report #135, 1991; Donald Rintoul, *Social Cost of Transverse Barrier Effects*, B.C. Ministry of Transportation and Highways (Victoria, www.th.gov.bc.ca/bchighways), 1995.
[20] Todd Litman, *Generated Traffic; Implications for Transport Planning*, VTPI (www.islandnet.com/~litman), 1999.
[21] KPMG, *Cost of Transporting People in the British Columbia Lower Mainland*, Greater Vancouver Regional District (Vancouver), 1993.

For this analysis we assume an average savings of 4¢ per vehicle mile avoided, which represents the lower range of estimates. These benefits accrue to ICBC and other government agencies that fund medical and disability services, and to society in general.

7. Road & Traffic Service Savings

This is the benefit from reduced road construction, maintenance, policing, and other municipal expenses associated with vehicle traffic. Transport 2021 estimates road maintenance costs to average 1.3¢ per km, and that "protective services" (based on 10% of police and 5% of fire department costs) average 0.4¢ per vehicle kilometre in 1993.[22] This is estimated to average 2.0¢ per vehicle kilometre in current dollars. These benefits accrue to TransLink and other public agencies that fund roads and traffic services.

8. Pollution Reduction

A number of studies have estimated the cost per unit of pollutant.[23] Table 3 illustrates the estimated value of air pollution costs and cost savings for a shift from driving to another mode in the Vancouver Region. More recent research indicates even greater motor vehicle air pollution costs.[24]

Table 3 **Estimated Costs and Savings Per Urban Peak Passenger Kilometre**[25]

	Average Auto	Car Pool	Van Pool	Bus
Cost	3.1¢	1.5¢	1.2¢	0.5¢
Mode Shift Savings	0.0	1.6¢	1.9¢	2.6¢

Motor vehicle noise costs are estimated to average about 0.5-1.5¢ per vehicle kilometre in urban areas.[26] Noise costs tend to be relatively high for buses, although costs per passenger-kilometre tend to be lower since a bus can replace many personal vehicles, including a portion of loud cars and motorcycles.

Motor vehicles are also major contributors to water pollution and hydrologic impacts, which is estimated to average 0.1¢ to 2.0¢ or more per vehicle kilometre.[27]

Total pollution reduction benefits are estimated to average 4¢ per kilometre of reduced automobile use. This benefit accrues to society in general.

[22] KPMG, *Cost of Transporting People in the British Columbia Lower Mainland*, Greater Vancouver Regional District (Vancouver), 1993, p. 29.
[23] M.Q. Wang, D.J. Santini & S.A. Warinner, *Methods of Valuing Air Pollution and Estimated Monetary Values of Air Pollutants in Various U.S. Regions*, Argonne National Lab (www.ipd.anl.gov), 1994.
[24] ARA Consulting, *Clean Air Benefits and Costs in the GVRD*, GVRD (Burnaby), 1994.
[25] KPMG, *Cost of Transporting People in the British Columbia Lower Mainland*, Greater Vancouver Regional District (Vancouver), 1993.
[26] Noise Pollution Clearinghouse (www.nonoise.org); Dr. Peter Bein, *Monetization of Environmental Impacts of Roads*, Planning Services Branch, B.C. Ministry of Transportation and Highways (Victoria, www.th.gov.bc.ca/bchighways), 1997.
[27] KPMG, 1993; Bein, 1997.

9. Equity Impacts
Since transit users tend to have lower average incomes than motorists, the TREK program is likely to increase vertical equity overall, saving as much as 5% of living expenses of a student who spends $6,400 per year. However, some lower-income students who live on campus or commute primarily by bicycling or ridesharing may pay more than they benefit from the program, reducing vertical equity. Available data do not indicate how many students are in this category, but it is likely to be small since many campus residents and cyclists occasionally ride public transit. At $1.50 per one-way fare, just six trips by bus each month would recoup nearly all of a student's $20 incremental cost, and the program provides additional services and benefits besides transit discounts. If this issue is a concern the TREK program could include an "opt-out" option, based on appropriate criteria, or it could provide additional services that are specifically targeted to benefit such groups, such as recreation travel for campus residents.

It could be argued that this program is horizontally inequitable since it forces students who continue to drive to subsidize other students' transit passes. However, students who drive benefit from reduced traffic and parking congestion, option value, and additional TREK program benefits, such as retail discounts. TREK fees can also be considered partial compensation for currently uncompensated external costs of driving.

10. Support for Regional Transport and Land Use Objectives
The TREK program supports regional transportation and land use objectives as described in documents such as *Going Places* and *The Livable Region Plan*. Transit, rideshare and non-motorized travel tend to experience economies of scale and scope. For example, if transit ridership increases, the frequency and range of bus service increases, and as more people want to rideshare the feasibility of matching suitable partners increases. This program will improve transit service and non-motorized travel options for residents of Point Grey and along related corridors, which could lead to increased support for other transit improvements, such as bus lanes, information services and shelters.

Unlimited transit passes for UBC students and staff should encourage more transit use for non-commute trips (since all students will have this option it will be easier for students to use transit for group recreational activities, such as visiting an off-campus restaurant). It may induce some households to reduce their vehicle ownership, leading to additional automobile trip reductions. Students and staff who become accustomed to alternative modes under this program may continue these habits in other conditions. It can help reduce urban sprawl by reducing road and parking requirements, reducing traffic impacts on urban neighborhoods, and providing an economic incentive for people to choose location-efficient housing.

To put this another way, the TREK program helps create a more balanced transportation system, reduces automobile dependency and reduces the forces that encourage urban sprawl. These benefits accrue to users, TransLink, businesses and society in general.

Table 4 summarizes the cost and benefit categories, shows their estimated values, and indicates their distribution.

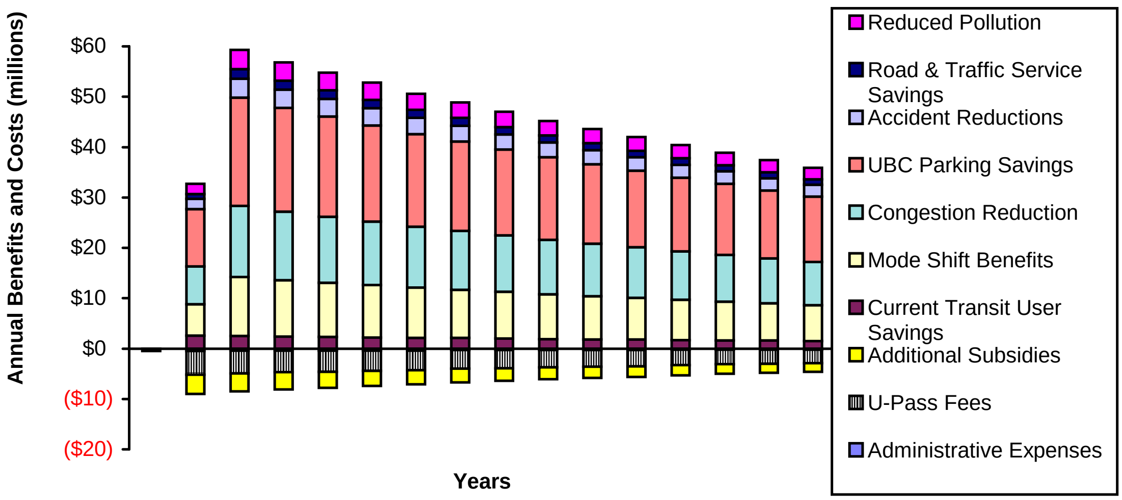
Table 4 **Summary of Cost and Benefit Categories**

Impact	Description	Estimate	Distribution
Administrative Expenses	Annual TREK program expenses.	$500,000/year	UBC
U-Pass Fees	Monthly student payment.	$20/month	Students
Additional Subsidies	Annual subsidies for increased transit service.	$4 million/year	UBC/TransLink
Current Transit User Savings	Monthly savings to students who would purchase a transit fares anyway.	$15/month	Current transit users
Mode shift benefits	Net consumer benefits to students who shift modes, based on the "Rule of Half."	½ of marginal cost savings	U-PASS users
Additional U-Pass Benefits to Users	Non-commute trips, discounts, recreational use of shower facilities.	?	U-PASS Users
UBC Parking Savings	Avoided parking subsidy per trip.	$3.52/trip	UBC
Congestion Reduction	Congestion reduction benefit of a reduced peak-period vehicle km.	$0.15/km	TransLink
Accident Reductions	Reduced external costs per km shifted.	$0.04/km	Society
Road & Traffic Service Savings	Reduced external costs per km shifted.	$0.02/km	Society
Reduced Pollution	Reduced external costs per km shifted.	$0.04/km	Society
Equity Benefits	Financial benefits to lower-income students.	?	Society
Support for Transport and Land Use Objectives	Reduced automobile dependency, economies of scale, reduced sprawl.	?	Society

Summary of Benefits and Costs

The estimated costs and benefits described above were incorporated into a spreadsheet that calculates the value of impacts for each year into the future. Assumptions used in the spreadsheet are summarized in Table 5 and the appendix of this report. Figure 2 illustrates the results. Benefits are bars above the baseline, and costs are bars below the baseline. It indicates that benefits significantly exceed costs and tend to increase over time as the campus population grows.

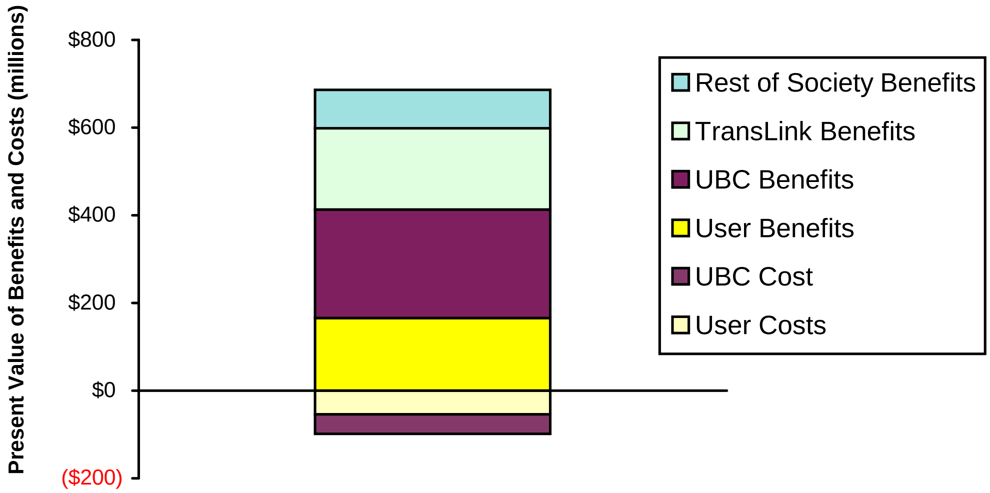
Figure 2 **TREK Program Estimated Benefits and Costs**



This figure illustrates fifteen years of TREK program benefits and costs. Benefits are bars above the baseline and costs are bars below. This analysis uses a 6% discount rate, so the magnitude of impacts declines further into the future despite overall growth in campus activities and trips.

Figure 3 illustrates the distribution of costs and benefits between users (students and staff), UBC, TransLink, and the Rest of Society. Benefits to users, UBC and TransLink are approximately equal. Benefits to the rest of society, although relatively small in this estimate, are likely to be far greater since many indirect, long-term benefits, such as increased equity and more efficient land use, are difficult to monetize.

Figure 3 **Distribution of TREK Estimated Benefits and Costs**



This figure illustrates the distribution of benefits and costs.

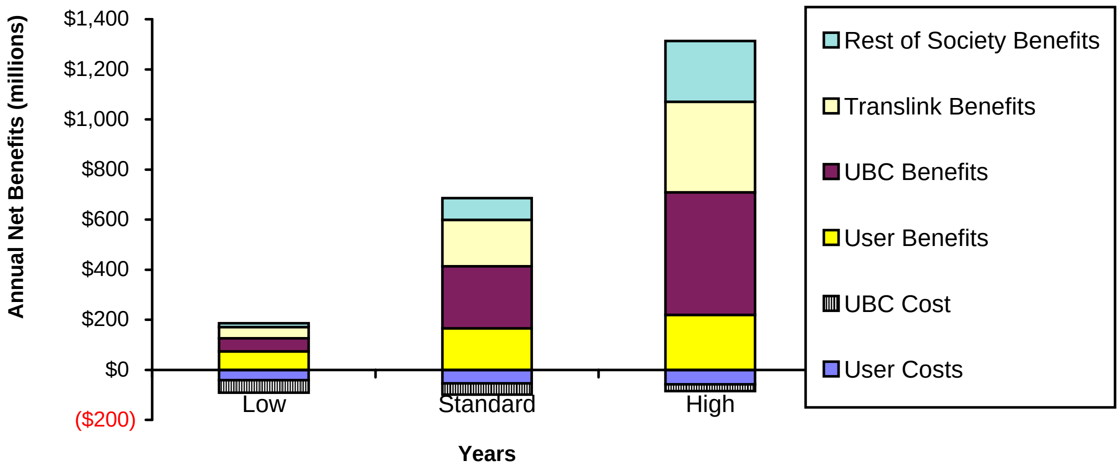
The estimated benefit/cost ratio is 6.7. As with any effort to evaluate non-market impacts, there is uncertainty about the exact magnitude of some of these costs and benefits. We believe that the "standard" values used represent middle- or lower-bound estimate of impacts, and a number of benefits that are probably significant were not included. Non-commute trips that are shifted from automobile to alternative modes due to students' unlimited transit passes, increased transit service, and improved bicycling and walking facilities are not included in the analysis. Also, potential freight traffic reductions, which could provide significant additional benefits, are not included in this analysis. As a result, the true benefit/cost ratio may be far higher.

In order to evaluate some of the uncertainty we performed sensitivity analysis using low and high benefit values summarized in Table 5. Figure 5 illustrates the resulting net benefits (benefits minus costs). This indicates that even using lower-bound estimates of benefits and higher-bound estimate of costs, the TREK program still provides significant net benefits.

Table 5 **Sensitivity Analysis Factors**

	Low	**Standard**	**High**
Discount Rate	10%	6%	5%
Daily Parking Cost Savings	$6.00	$9.00	$12.00
Annual Transit Service Subsidy	$6,000,000	$4,000,000	$2,000,000
Congestion Reduction	10¢	15¢	20¢
Accident Reduction	2¢	4¢	6¢
Road & Traffic Service Savings	1¢	2¢	4¢
Pollution Reduction and other Env. Benefits	2¢	4¢	10¢
Additional Monthly U-PASS Benefits	$0	$0	$10
Automobile Trips (Mode Shift)	-15.0%	-31.1%	-40.0%
Benefit/Cost Ratio	*1.8*	*6.7*	*15.2*

Figure 4 **TREK Program Sensitivity Analysis**



This figure illustrates program economic impacts using low-bound, standard and high-bound estimates of benefits. The results indicate that the estimate of net benefits (benefits exceeding costs) are robust.

Additional Research Needs

The following additional research issues were identified:

- It would be helpful if standard monetized values of the estimated social benefits were developed by a regional or provincial authority. This would allow more consistent evaluation of TDM programs.
- Because parking cost savings are a significant portion of benefits, UBC may want to study its marginal parking costs. This could include various perspectives, such as a short-term perspective that considers only operating costs, a longer-term perspective that includes capital costs, and a perspective that also takes into account the opportunity cost of land used by parking facilities.
- It is important to determine the true marginal cost of providing additional transit service required to maintain reliability and comfort. This analysis might include various service alternatives, such as providing special commuter express buses and jitney services.
- In order to determine how to best use TREK resources and provide the most cost effective mix of choices to users it would be helpful to perform market research that identifies the types of services and incentives that have the greatest effect on travel behavior. This could include determining parking price sensitivity, the effects of transit service comfort, and the effectiveness of promotion campaigns such as commuter contests.
- Special market research may be justified to identify the commute needs and preferences of UBC staff, and to overcome institutional barriers that favor automobile commuting over other modes. For example, it would be useful to determine what portion of staff receive parking subsidies, on what basis these are assigned, and whether it would be possible to cash out the parking so staff who use alternative modes receive a financial reward.
- The current TREK program plan has relatively mild ridesharing incentives. It would be important to identify and implement additional rideshare strategies, such as parking cash out for employees and perhaps increased overall parking fees.
- It would be interesting to survey users to identify the value that the place on TREK benefits such as merchant discounts, non-commute use of transit passes and bicycling facilities, option value, and equity value.
- It would be useful to identify how programs such as TREK effect and are effected by regional TDM and land use management programs. For example, it would be helpful to know what policy changes could encourage more students to reduce their household vehicle ownership and choose location-efficient housing (housing that is convenient for transit and non-motorized travel).
- This report deals primarily with personal travel. Similar analysis will be needed to identify freight travel management strategies and benefits.
- It would be useful to establish an evaluation plan early in the program's development so that baseline, program and user data can be collected as appropriate.

Summary and Conclusions

UBC has an opportunity to use transportation management strategies to provide more efficient and equitable transportation. The TREK program offers an opportunity to benefit students, staff, UBC, TransLink, and the rest of society by increasing travel choices and reducing motor vehicle traffic.

Experience with other TDM programs, and particularly with similar university campus transportation management programs, indicates that the TREK's stated objective of a 20% reduction in SOV trips can be achieved, although it is difficult to predict whether the TREK program as it is currently proposed will be adequate. If not, there are other strategies that could be employed by UBC or regional transportation agencies to increase the program's effectiveness. In particular, regional TDM initiatives (such as location-efficient housing and mileage-based insurance) and campus parking management (such as employee parking cash out, and increased parking fees) could increase mode shifts.

The costs of this program are borne primarily by students and UBC budgets. Virtually everybody enjoys at least some benefits. Students and staff who commute by car enjoy reduced traffic and parking congestion. Students who use transit anyway save money. Students who use other modes (ridesharing, bicycling, walking and telecommuting) benefit from increased mobility choices. The campus saves parking costs. In addition, TransLink and the rest of society enjoy benefits from reduced congestion and roadway costs, reduced accidents and pollution, increased equity, and various benefits from reduced automobile dependency and more efficient land use.

Although some travel changes may increase user travel time, this is not an increased cost because users will only shift mode in response to positive incentives if they are better off overall, taking into account financial costs, time, comfort, stress, and the opportunity for exercise. Since most currently-proposed TREK program incentives are positive, any mode shifts can be assumed to provide net consumer benefits.

This report developed monetized estimates of all identified costs and some identified benefits. A number of benefit categories are not quantified, although they appear to be significant. This analysis shows a benefit/cost ratio that is likely to be significantly greater than 6. This indicates a cost-effective investment. A number of individual benefit categories could probably each justify the costs of this program. The analysis spreadsheet that was developed can be modified as more accurate data become available, and for more sensitivity and "what if" tests.

The TREK program supports and is supported by regional TDM activities, including transit service and bicycling improvements, more efficient land use, and road pricing that encourages reduced automobile travel. The program's success depends partly on the effectiveness of these programs.

This study identified a number of additional research needs that can help increase the efficacy and cost effectiveness of the TREK program, increase participation, and measure program results.

Appendix
TREK Analysis Standard Spreadsheet Assumptions

	DATA	Data Source
Average Student Trip Days Per Year:	205.7	TREK Program
Average Number of Months Per Year Students Attend University	9	Eight months regular school year plus some summer sessions.
Discount Rate	6%	Standard Value
Marginal Cost of Providing Parking (per day)	$9.00	Report
Average Daily Parking Price	$1.95	TREK Program
Current Monthly Transit Expenditures by Transit Users	$55.29	TREK Program
Projected annual population growth rate	2.0%	
Current Students	27,000	
Current Staff & Faculty	8,000	
Total Campus Population	35,000	
Commuters Who Would Use Transit Anyway	8,500	

User Expenses

	Avg. 1-Way Trip Length (kms)	Per km	Per Trip
Automobile Trips	18	$0.20	$5.10
Transit	16		$1.40
Rideshare Passenger	17.5		$1.53
Bike	4	$0.02	$0.08
Walk	0.5	$0.01	$0.01

Mode Split	Benchmark 1997		Target 2002	
SOV	46,000	43.7%	36,800	30.1%
Rideshare	36,100	34.3%	48,000	39.3%
Transit	19,000	18.1%	30,000	24.5%
Bicyclist	2,700	2.6%	5,400	4.4%
Pedestrian	1,400	1.3%	2,000	1.6%
Total	105,200	100%	122,200	100%