RSG INC.
TRANSPORTATION

Economic Impact of Bicycling and Walking in Vermont

Working Paper 2:

Transportation System Costs; and Real Estate Costs

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Draft

DATA ■ ANALYSIS ■ SOLUTIONS

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1.0 INTRODUCTION

The purpose of this study is to estimate the total economic benefits of walking and biking in Vermont during a typical year. The results will be used to help educate decision makers, the business community, planners, advocates and other stakeholders; and may suggest policy changes and other actions that should be pursued to further the economic and other benefits of these two non-motorized modes of transportation. The project tasks and status are summarized in Table 1.

Table 1: Project Tasks and Status

Task	*Description*	*Status - June 2011*
1	Project Initiation	Complete: Project kick-off meeting held in September 2010
2	Data Collection and Approach and Public Meeting 1	Working Paper 1: Analysis Approach (December 9, 2010) Public Meeting 1: Held on February 17, 2011
3	Transportation System Cost Analysis and Real Estate Impact	This memorandum
4	Economic Analysis Impact/Output Model	To be completed with results summarized in Working Paper 3
5	Final Report and Public Meeting 2	To be completed
6	Public Information Video	To be completed

Working Paper 1 (December 9, 2010) described the overall study methodology and identified potential data sources. Working Paper 1 also included a preliminary estimate of walking and biking trips in Vermont in 2009 and presented information on the out-of-pocket per mile costs for individuals (consumer costs) and the costs that are passed on to society as a whole (public costs). This memorandum presents the final estimate of walking and biking trips and applies a refined list of unit costs to calculate the annual consumer and public savings that can be attributed to walking and biking. This memorandum also estimates the effect of a walkability score on residential real estate values using data from 18,500 homes sales in Vermont between 2006 and 2009 and other related factors.

2.0 WALKING AND BIKING TRIPS IN VT

The methodology for estimating the transportation system cost savings associated with walking and biking consists of (1) estimating the amount of walking and biking that occurs annually in the state and (2) calculating the cost savings due to avoided automobile miles of travel and the additional costs associated with miles walked and biked. This section of the memorandum addressed the first step and presents an estimate of the number of annual miles traveled in Vermont by foot and on bikes. The second step is addressed below in Section 3.0.

Based on the 2009 National Household Travel Survey (NHTS), Vermonters travelled approximately 69 million miles on foot and 28 million miles by bike during 2009. The NHTS utilized a telephone survey to document the trip making characteristics of survey participants in a 24 hour period. It documents:

- Purpose of the trip (work, shopping, etc.);
- Means of transportation used (car, bus, subway, walk, etc.);
- How long the trip took, i.e., travel time;
- Distance travelled;
- Time of day when the trip took place;
- Day of week when the trip took place; and
- If a private vehicle trip:
  - number of people in the vehicle , i.e., vehicle occupancy;
  - driver characteristics (age, sex, worker status, education level, etc.); and
  - vehicle attributes (make, model, model year, amount of miles driven in a year).

The survey's sample size is 1,690, from a total of 252,280, households in Vermont. The sample includes 13,119 person trips per day. Of these, 1,486 were walking trips and 146 were biking trips. The survey responses were weighted based on socioeconomic and demographic characteristics to estimate the total statewide values presented in Table 2.

Table 2: Final Estimate of Walking and Bike Trips in Vermont in 2009

Measure	All Trips	Walking	Biking
Number of Trips per Person/Day	3.70	0.42	0.04
Number of Trips per Household/Day	7.76	0.88	0.09
Annual Trips in Vermont	801,164,769	87,155,983	9,285,656
% of Total Trips	100%	10.9%	1.2%
Average Miles Travelled per Trip	7.92	0.83	2.53
Total Annual Miles Travelled	8,344,827,820	68,248,876	28,337,598
Percentage of Total Miles Travelled	100%	0.8%	0.3%

Transportation system costs are different in urban and rural areas due to different conditions such as congestion, parking, vehicle occupancy, and travel speeds. Therefore, the 2009 NHTS data have also been used to develop estimates of miles of travel for walking and biking within urban and rural areas (*Table 3*). The 2009 NHTS defines an urban area as having 1,000 or more persons per square mile.

Table 3: Final Estimate of Walking and Biking Miles for Rural and Urban Areas in Vermont in 2009

Mode	Urban	Rural	Total
Walk	27,099,269	41,149,606	68,248,876
Bike	9,409,342	18,928,256	28,337,598
Totals	36,508,611	60,077,862	96,586,473

These estimates have a margin of error of +/- 2.38% for the entire state, and +/- 4.17% and +/- 2.91% for urban and rural areas respectively (Table 4).

Table 4: Margin of Error for Survey Sample (95% Confidence)

Description	Vermont Urban	Vermont Rural	All Vermont
Number of Households in Sample (n)	553	1,137	1,690
Margin of error	4.17%	2.91%	2.38%

The margin of error (or sampling error) is based on the sample size according to the following equation (95% confidence level):

- Sampling Error = 1.96 X SQRT(.5*.5/n), where n is the sample size.

For the 2009 VT NHTS, the margin of error for the following key data elements is the same:

- number of trips per person day
- number of walking trips per person day
- number of biking trips per person day

95% confidence is selected as it is standard to describe the certainty of an estimate at this level. In narrative form 95% confidence means the following:

- When conducting the NHTS survey for Vermont with the sample size used, 95 times out of 100 a response will be obtained that are within 2.38% (+/-) of the derived estimate. In this case, the analysis indicates 68,248,876 annual walking miles in Vermont in 2009. We are 95% confident that the actual value is between 66,631,911 (2.4% lower than the estimate) or 69,875,841 (2.4% higher than the estimate). These data, along with the similar estimates for bicycling, are shown in Table 5.

Table 5: Range of Walking and Biking Miles in Vermont in 2009 (95% Confidence)

Description	Walking	Biking
Average	68,248,876	28,337,598
Low Estimate	66,621,911	27,662,066
High Estimate	69,875,841	29,013,129

For the purpose of this analysis, the average estimate of walking and biking trips will be utilized keeping in mind that they will affect transportation system cost estimates by +/- 2.4% statewide, +/- 4.2% in urban areas, and +/- 2.2% in rural areas.

3.0 TRANSPORTATION SYSTEM COSTS

This section of the working paper applies transportation system unit costs to the miles travelled to calculate the net savings related to walking and biking trips in Vermont.

Transportation system costs include consumer and public cost components. Consumer costs are borne by the individual traveler such as vehicle operating costs (fuel, maintenance, insurance, etc), long-term mileage based cost (depreciation per mile, user costs from tickets and crashes, etc), and the cost to purchase and finance a car, bicycle or other vehicle. Public costs are passed on by the individual to society overall, such as impacts of tail pipe emissions including green house gases, crashes, parking, the value of time lost in congestion, and health. Additional detail on each of these components is provided below.

The potential transportation system cost savings are based on (1) the avoided consumer and public costs of automobile travel and (2) the added the consumer and public costs of walking and biking. The potential transportation system cost savings related to walking and biking presented below are based on the assumption that that all walking and biking trips replace automobile trips. This assumption has the following limitations:

1. If was not possible to walk or bike the trip may not be made (rather than shifting to travel by automobile). The result would be a reduction in trips if individuals do not have a car or the ability to drive; or if individuals choose not to travel for discretionary trips. If one assumes some trips are eliminated, the estimate of avoided costs presented below is high. However, there are other costs that cannot be explicitly accounted for due to reduced accessibility (if walking or biking were not possible) such as loss of independence, isolation, decreased access to jobs and services, and decreased economic activity. Thus, this limitation adds both upward and downward uncertainty into the analysis that from a total cost perspective minimizes its overall effect on the results.
2. The analysis of avoided costs assumes that an automobile trip would be the same distance as the walking or biking trip it replaces. However, travel time, rather than distance is often the determining factor when choosing a destination. For example, based on the 2009 NHTS data, the average distance for a trip made on foot in Vermont is 0.79 miles and takes approximately 16 minutes. During the same amount of time, an automobile traveling at an average speed of 30 miles per hour has a range of approximately 8 miles. If an individual has no choice but to drive, they may choose destinations further away, with less travel time. This limitation would result in underestimating the amount of avoided vehicle miles of travel replaced by walking and biking.

The first limitation is neutral while the second limitation results in a conservative (or low) estimate of avoided automobile costs.

Definitions for the transportation related costs are indicated in Table 6. The definitions and unit costs were developed by the Victoria Transport Policy Institute (VTPI) and are published in the 2009 *Transportation Cost and Benefit Analysis; Techniques, Estimates and Implications*. RSG reviewed potential sources for unit costs from the Transportation Research Board (TRB), American Association of State Highway and Transportation Officials (AASHTO), Institute of Transportation Engineers (ITE), various bicycle and pedestrian organizations, and other sources. The unit costs presented by VTPI are recent and cover all modes of travel including automobiles, walking and biking. The methodologies for estimating costs are also consistent where appropriate across modes. For example, the travel time unit costs for automobiles, walking and biking are based on the same median hourly wage rate.

Table 6: Transportation System Cost Definitions

Cost Category	Definition	Cost Allocation		Cost Type	
		Consumer	*Public*	*Fixed*	*Variable*
Vehicle Ownership	Fixed costs of owning an automobile or bike	X		X	
Vehicle Operation	Variable vehicle costs, including fuel, oil, tires, tolls and short-term parking fees.	X			X
Travel Time	The value of time used for travel.	X			X
Internal Crash	Crash costs borne directly by travelers.	X			X
External Crash	Crash costs a traveler imposes on others.		X		X
Internal Health Ben.	Health benefits of active transportation to travelers.	X			X
External Health Ben.	Health benefits of active transportation to society		X		X
Internal Parking	Off-street residential parking and long-term leased parking paid by users.	X		X	
External Parking	Off-street parking costs not borne directly paid by users.		X		X
Congestion	Congestion costs imposed on other road users.		X		X
Road Facilities	Roadway facility construction and operating expenses not paid by user fees.		X		X
Land Value	The value of land used in public road rights-of-way.		X		X
Traffic Services	Costs of providing traffic services such as traffic policing, and emergency services.		X		X
Transport Diversity	The value to society of a diverse transport system, particularly for non-drivers.		X		X
Air Pollution	Costs of vehicle air pollution emissions.		X		X
Green House Gas (GHG)	Lifecycle costs of greenhouse gases that contribute to climate change.		X		X
Noise	Costs of vehicle noise pollution emissions.		X		X
Resource Externalities	External costs of resource consumption, particularly petroleum.		X		X
Barrier Effect	Delays that roads and traffic cause to nonmotorized travel.		X		X
Land Use Impacts	Increased costs of sprawled, automobile-oriented land use.		X		X
Water Pollution	Water pollution and hydrologic impacts caused by transport facilities and vehicles.		X		X
Waste	External costs associated with disposal of vehicle wastes.		X		X

Source: "2009 Transportation Cost and Benefit Analysis; Techniques, Estimates and Implications"; VTPI

Table 7 and Table 8 present the unit costs for urban and rural areas respectively. The VTPI developed unit costs in 2007 dollars for urban peak hour, urban off-peak and rural driving conditions. The 2007

dollars were adjusted by 1.03 to reflect 2009 dollars based on the Consumer Price Index[1]. The unit costs for automobile travel are based on an average automobile which is defined by VTPI as a medium sized car that averages 21 mpg overall (16 mpg city driving, 24 mph highway driving) and is driven 12,500 miles per year. Based on preliminary information provided by the UVM Transportation Center, the fuel efficiency of the Vermont fleet in 2010 was 22.9 miles per gallon[2], which is reasonably consistent with VTPI's assumption. VTPI's annual operating unit cost for automobiles is based on an American Automobile Association study that used an average price of gas of $2.30 per gallon[3]. This cost is consistent with gas prices in Vermont which averaged $2.32 per gallon in 2009[4]. Another key factor in the cost analysis is the value of travel time. The 2007 VTPI unit cost for travel time is based upon a median hourly rate of $15.00 per hour ($15.45 in 2009 dollars). The 2009 median hourly rate for all occupations in Vermont was $15.75[5], which is also reasonably consistent with the wage rate assumed by VTPI.

Because the NHTS data provide a reliable estimate of walking and biking travel for urban and rural areas in Vermont, the potential cost savings for each area has been estimated separately and then combined into a total for the state as follows:

- Table 7 (page 8) presents unit costs for average urban conditions in Vermont in 2009 dollars. Values for urban travel conditions in Vermont were created for each unit cost from a weighted average of the VTPI default values for urban peak and urban off-peak conditions based on 2009 data from VTrans continuous traffic count stations for urban highways throughout the state[6]. The VTrans data indicate that 10.7% of travel in Vermont urban areas occurs during the peak hour. Therefore, the VTPI urban peak unit costs were weighted by 10.7% and the urban off-peak by 89.3% to reflect average urban travel conditions in Vermont.
- Table 8 (page 9) presents the unit costs for rural travel. No additional modifications were made to the VTPI rural unit costs beyond the adjustment from 2007 to 2009 dollars.
- Table 9 and Table 10 (pages 10 and 11) present the total annual costs for each transportation system cost component for Vermont urban and rural areas respectively. With the exception of travel time (discussed below), the total for each cost component was calculated by multiplying its unit cost by miles traveled. The tables calculate the transportation system savings related to walking and biking by summing the avoided costs associated with automobile travel (presented as a negative number in the tables) and the added costs of walking and biking. Health benefits associated with walking and biking are presented as negative values because they create savings, while all other walking and biking unit costs are positive because they reflect expenses related to travel by foot and bike.
- The travel time estimate associated with automobile travel is the one cost component that has not been directly calculated by applying the unit costs to the miles of travel. As previously discussed, the analysis assumes that miles travelled by walking and biking

[1] http://www.usinflationcalculator.com/inflation/consumer-price-index-and-annual-percent-changes-from-1913-to-2008/

[2] Sears, Justine and Karen Glitman, The Vermont Transportation Energy Report, University of Vermont Transportation Research Center, 2010 (this will be up on the web in September)

[3] American Automobile Association, "Your Cost of Driving, 2009 Edition", http://www.aaaexchange.com/Assets/Files/200948913570.DrivingCosts2009.pdf

[4] Based on monthly average gas prices compiled by VTrans http://www.aot.state.vt.us/conadmin/fuelpriceadju.htm

[5] May 2009, Occupational Employment Statistics (OES) survey. The survey is conducted twice a year measuring occupational employment and wage rates for wage and salary workers in nonfarm establishments in Vermont.

[6] "Continuous Traffic Counter and Grouping Study and Regression Analysis Based on 2009 Traffic Data", VTrans Traffic Research Unit

replace an equal number of automobile trips of the same distance and therefore result in avoided transportation system costs. However, travel time by car includes both on-road travel, and time for parking, walking to final destinations, and other inefficiencies (referred to as terminal time). Travel times for automobile trips have therefore been adjusted to include 10 and 5 minute terminal times for trips in urban and rural areas respectively.

Table 7: Transportation System Unit Costs for Urban Travel (2009 Dollars per Mile Traveled)

Cost Category	Automobile				Bike				Walk			
	Total	*Consumer Fixed*	*Consumer Variable*	*Public*	*Total*	*Consumer Fixed*	*Consumer Variable*	*Public*	*Total*	*Consumer Fixed*	*Consumer Variable*	*Public*
Vehicle Ownership	$0.28	$0.28	-	-	$0.07	$0.07		-	$0.00	$0.00		-
Vehicle Operation	$0.18	-	$0.18	-	$0.03	-	$0.03	-	$0.05	-	$0.05	-
Travel Time	$0.10	-	$0.10	-	$0.39	-	$0.39	-	$1.29	-	$1.29	-
Internal Crash	$0.09	-	$0.09	-	$0.09	-	$0.09	-	$0.09	-	$0.09	-
External Crash	$0.06	-	-	$0.06	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Internal Health Ben.	$0.00	-	-	$0.00	($0.10)	-	($0.10)	-	($0.25)	-	($0.25)	-
External Health Ben.	$0.00	-	-	$0.00	($0.10)	-	-	($0.10)	($0.25)	-	-	($0.25)
Internal Parking	$0.08	$0.08	-	-	$0.01	$0.01	-	-	$0.00	$0.00	-	-
External Parking	$0.06	-	-	$0.06	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Congestion	$0.03	-	-	$0.03	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Road Facilities	$0.03	-	-	$0.03	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Land Value	$0.04	-	-	$0.04	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Traffic Services	$0.01	-	-	$0.01	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Transport Diversity	$0.01	-	-	$0.01	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Air Pollution	$0.05	-	-	$0.05	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Green House Gas	$0.02	-	-	$0.02	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Noise	$0.01	-	-	$0.01	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Resource Externalities	$0.04	-	-	$0.04	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Barrier Effect	$0.02	-	-	$0.02	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Land Use Impacts	$0.09	-	-	$0.09	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Water Pollution	$0.01	-	-	$0.01	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Waste	$0.00	-	-	$0.00	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Totals (Dollars per mile)	*$1.21*	$0.36	$0.36	$0.48	*$0.40*	$0.07	$0.41	($0.08)	*$0.95*	$0.00	$1.19	($0.24)

Table 8: Transportation System Unit Costs for Rural Travel (2009 Dollars per Mile Traveled)

Cost Category	Automobile				Bike				Walk			
	Total	*Consumer Fixed*	*Consumer Variable*	*Public*	*Total*	*Consumer Fixed*	*Consumer Variable*	*Public*	*Total*	*Consumer Fixed*	*Consumer Variable*	*Public*
Vehicle Ownership	$0.28	$0.28	-	-	$0.07	$0.07	-	-	$0.00	$0.00	-	-
Vehicle Operation	$0.15	-	$0.15	-	$0.03	-	$0.03	-	$0.05	-	$0.05	-
Travel Time	$0.06	-	$0.06	-	$0.39	-	$0.39	-	$1.29	-	$1.29	-
Internal Crash	$0.09	-	$0.09	-	$0.09	-	$0.09	-	$0.09	-	$0.09	-
External Crash	$0.06	-	-	$0.06	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Internal Health Ben.	$0.00	-	-	$0.00	($0.10)	-	($0.10)	-	($0.25)	-	($0.25)	-
External Health Ben.	$0.00	-	-	$0.00	($0.10)	-	-	($0.10)	($0.25)	-	-	($0.25)
Internal Parking	$0.04	$0.04	-	-	$0.00	$0.00	-	-	$0.00	$0.00	-	-
External Parking	$0.03	-	-	$0.03	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Congestion	$0.00	-	-	$0.00	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Road Facilities	$0.02	-	-	$0.02	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Land Value	$0.04	-	-	$0.04	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Traffic Services	$0.01	-	-	$0.01	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Transport Diversity	$0.01	-	-	$0.01	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Air Pollution	$0.00	-	-	$0.00	$0.00	-	-	$0.00	$0.00	-	-	$0.00
GHG	$0.02	-	-	$0.02	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Noise	$0.01	-	-	$0.01	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Resource Externalities	$0.04	-	-	$0.04	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Barrier Effect	$0.01	-	-	$0.01	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Land Use Impacts	$0.04	-	-	$0.04	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Water Pollution	$0.01	-	-	$0.01	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Waste	$0.00	-	-	$0.00	$0.00	-	-	$0.00	$0.00	-	-	$0.00
Totals (Dollars per mile)	*$0.90*	$0.32	$0.30	$0.28	*$0.38*	$0.07	$0.40	($0.09)	*$0.95*	$0.00	$1.19	($0.24)

Table 9: Annual Transportation System Cost Savings due to Walking and Biking for Vermont Urban Areas (2009)

Annual Miles Traveled [1]:	25,053,947	9,409,342	27,099,269	
Cost Component	**Avoided Auto Travel Costs**	**Added Biking Associated Costs**	**Added Walking Associated Costs**	**Net Change**
Vehicle Ownership	$ (7,051,150)	$ 642,567	$ -	$ (6,408,584)
Vehicle Operation	$ (4,445,854)	$ 253,132	$ 1,486,101	$ (2,706,621)
Travel Time [2]	$ (25,834,381)	$ 4,252,156	$ 32,299,776	$ 10,717,551
Internal Crash	$ (2,151,638)	$ 808,076	$ 2,327,290	$ 983,729
External Crash	$ (1,425,784)	$ 29,208	$ 84,119	$ (1,312,458)
Internal Health Ben.	$ -	$ (924,906)	$ (6,729,515)	$ (7,654,421)
External Health Ben.	$ -	$ (924,906)	$ (6,729,515)	$ (7,654,421)
Internal Parking	$ (2,073,868)	$ 48,679	$ -	$ (2,025,188)
External Parking	$ (1,555,401)	$ 34,075	$ -	$ (1,521,325)
Congestion	$ (803,624)	$ 18,498	$ 33,648	$ (751,478)
Road Facilities	$ (674,007)	$ 19,472	$ 56,079	$ (598,456)
Land Value	$ (881,394)	$ 19,472	$ 56,079	$ (805,843)
Traffic Services	$ (355,150)	$ 10,709	$ 30,844	$ (313,597)
Transport Diversity	$ (181,463)	$ -	$ -	$ (181,463)
Air Pollution	$ (1,373,937)	$ -	$ -	$ (1,373,937)
Green House Gas (GHG)	$ (445,882)	$ -	$ -	$ (445,882)
Noise	$ (337,004)	$ -	$ -	$ (337,004)
Resource Externalities	$ (1,052,488)	$ -	$ -	$ (1,052,488)
Barrier Effect	$ (409,589)	$ 9,736	$ -	$ (399,853)
Land Use Impacts	$ (2,151,638)	$ -	$ -	$ (2,151,638)
Water Pollution	$ (362,927)	$ -	$ -	$ (362,927)
Waste	$ (10,369)	$ -	$ -	$ (10,369)
Totals	$ (53,577,546)	$ 4,295,967	$ 22,914,907	$ (26,366,672)

(1) Avoided Auto Miles = Walking and Biking Miles divided by 1.46 average persons per car for urban travel

(2) A separate calculation has been made for travel time that accounts for the time it takes to park and walk to final destinations (terminal time)

Table 10: Annual Transportation System Cost Savings due to Walking and Biking for Vermont Rural Areas (2009)

Annual Miles Traveled [1]:	40,051,908	18,928,256	41,149,606	
Cost Component	**Avoided Auto Travel Costs**	**Added Biking Associated Costs**	**Added Walking Associated Costs**	**Net Change**
Vehicle Ownership	$ (11,272,157)	$ 1,292,616	$ -	$ (9,979,541)
Vehicle Operation	$ (5,967,613)	$ 509,212	$ 2,256,610	$ (3,201,791)
Travel Time [2]	$ (19,216,008)	$ 7,398,520	$ 51,555,180	$ 39,737,692
Internal Crash	$ (3,439,666)	$ 1,625,562	$ 3,533,936	$ 1,719,833
External Crash	$ (2,279,296)	$ 58,755	$ 127,733	$ (2,092,809)
Internal Health Ben.	$ -	$ (1,860,583)	$ (10,218,611)	$ (12,079,194)
External Health Ben.	$ -	$ (1,860,583)	$ (10,218,611)	$ (12,079,194)
Internal Parking	$ (1,657,670)	$ 39,170	$ -	$ (1,618,500)
External Parking	$ (1,036,044)	$ 19,585	$ -	$ (1,016,459)
Congestion	$ -	$ -	$ 51,093	$ 51,093
Road Facilities	$ (663,068)	$ 19,585	$ 85,155	$ (558,328)
Land Value	$ (1,409,020)	$ 39,170	$ 85,155	$ (1,284,694)
Traffic Services	$ (290,092)	$ -	$ 46,835	$ (243,257)
Transport Diversity	$ (290,092)	$ -	$ -	$ (290,092)
Air Pollution	$ (165,767)	$ -	$ -	$ (165,767)
Green House Gas (GHG)	$ (621,626)	$ -	$ -	$ (621,626)
Noise	$ (290,092)	$ -	$ -	$ (290,092)
Resource Externalities	$ (1,409,020)	$ -	$ -	$ (1,409,020)
Barrier Effect	$ (331,534)	$ -	$ -	$ (331,534)
Land Use Impacts	$ (1,719,833)	$ -	$ -	$ (1,719,833)
Water Pollution	$ (580,185)	$ -	$ -	$ (580,185)
Waste	$ (16,577)	$ -	$ -	$ (16,577)
Totals	$ (52,655,360)	$ 7,281,010	$ 37,304,476	$ (8,069,874)

(1) Avoided Auto Miles = Walking and Biking Miles divided by 1.5 average persons per car for rural travel

(2) A separate calculation has been made for travel time that accounts for the time it takes to park and walk to final destinations (terminal time)

Table 11 combines the total costs for the urban and rural areas into a statewide number resulting in an estimated transportation system cost savings of approximately $34.5 million per year due to walking and biking.

Table 11: Summary of 2009 Annual Transportation System Cost Savings in Vermont due to Walking and Biking

Area	**Avoided Auto Travel Costs**	**Added Biking Associated Costs**	**Added Walking Associated Costs**	**Net Change**
Urban	$ (53,577,546)	$ 4,295,967	$ 22,914,907	$ (26,366,672)
Rural	$ (52,655,360)	$ 7,281,010	$ 37,304,476	$ (8,069,874)
Total	$ (106,232,906)	$ 11,576,977	$ 60,219,383	$ (34,436,546)

Travel time is the largest cost component of walking and biking and has a significant impact on the total estimated cost savings. Because the total cost of travel time is significantly greater for walking and biking (compared to auto travel for the same distances), the analysis creates the appearance that consumer, out-of-pocket costs are greater for trips made in Vermont on foot or bike by $7.5 million

per year (Table 12). If the value of travel time is assumed to be neutral, the estimated consumer cost savings related to walking and biking would be $43.0 million per year and the total annual savings due to walking and biking would increase from $34.5 million to $84.9 million. The value of travel time is categorized as a consumer cost because it reflects the perceived value of time for individuals while travelling. Because perception does not equate to real out-of-pocket costs, assuming travel time is neutral is arguably a reasonable assumption and will be discussed further with the advisory committee.

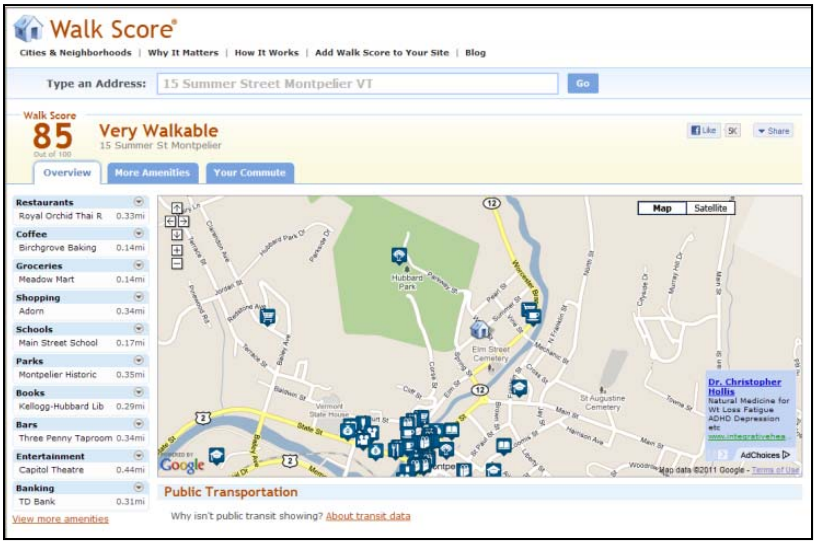
Table 12: Effect of Travel Time Cost Component on Transportation System 2009 Annual Transportation System Cost Savings due to Walking and Biking

Travel Time Cost Factor Assumption	Total Savings	Consumer Related Savings	Public Related Savings
Included	$ (34,436,546)	$ 7,484,965	$ (41,921,511)
Neutral	$ (84,891,789)	$ (42,970,278)	$ (41,921,511)

4.0 EFFECT OF WALKABILITY ON REAL ESTATE VALUE

The effect of walkability on real estate values for houses in Vermont has been estimated using the statistical methodology described in *How Walkability Affects Home Values in U.S. Cities* (CEOs for Cities, August 2009). The CEOs for Cities study was designed with an orientation toward real estate properties in urban areas, however, the methodology was applied more broadly in this project to include real estate property throughout the urban and rural areas of Vermont. A statistical methodology is used to quantify how house size, number of bedrooms, number of bathrooms, age, type (single or multi-family), median household income, distance to the central business district, job density and walkability affect sales price; making it possible to isolate the contribution of walkability to residential real estate value.

Figure 1: Walk Score Calculation Example



Each property included in the analysis was assigned a walkability score using the methodology developed by WalkScore.com. A property's walkability score is based on the walking distance from the property to each of 9 different amenity categories, including shopping establishments, banks, schools, and entertainment (Figure 1).

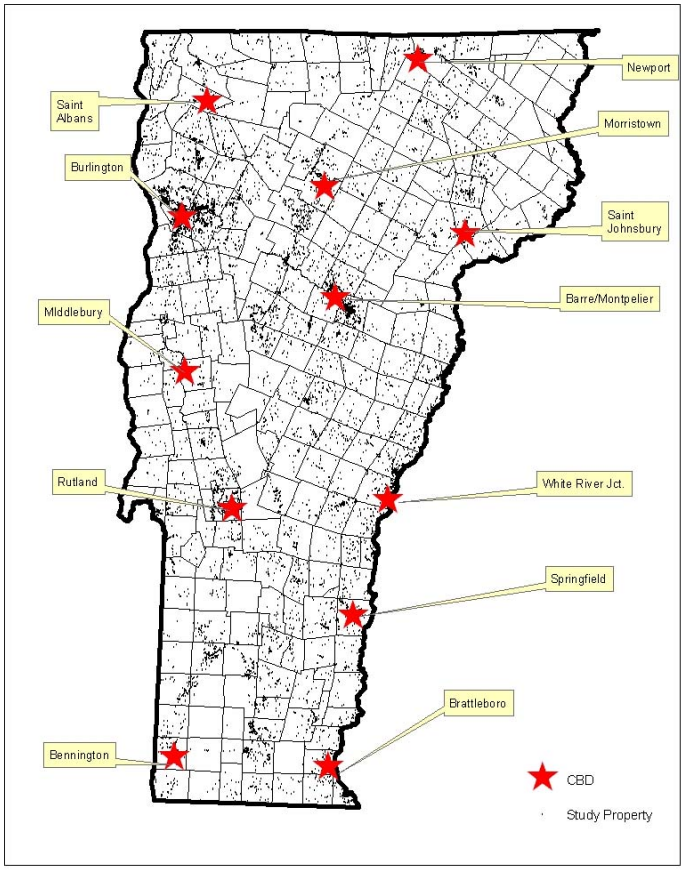
Thus, each Vermont property in this analysis was assigned a walkability score based on the Walk Score methodology, which ranges numerically in Walk Score values from 0 to 100, and qualitatively from "car-dependent" to a "walker's paradise" (Table 1).

Table 13: Walkability Score Descriptions

Walk Score	General Category	Description
90-100	Walker's Paradise	Daily errands do no require a car.
70-89	Very Walkable	Most errands can be accomplished on foot.
50-69	Somewhat Walkable	Some amenities within walking distance.
25-49	Car Dependent	A few amenities within walking distance.
0-24	Very Car Dependent	Almost all errands require a car.

RSG compiled the closing prices for all houses sold in Vermont from January 1, 2006 through December 31, 2009 (approximately 18,500 houses) from MLS (multiple listing service) an electronic database of real estate with information on home sales. Information was also collected from MLS at the same time on the address, number of bedrooms, number of bathrooms, year of construction, type, and square footage. WalkSore.com was used to assign a walkability score to each house using a custom-built program that accessed the website, entered the address for a specific house sale, and downloaded the resulting score[1]. Median household income, which is a proxy for neighborhood quality, was taken from the 2000 U.S. Census and the 2010 Census was used for job density. Figure 2 shows the distribution of house sales included in the analysis and the location of CBDs.

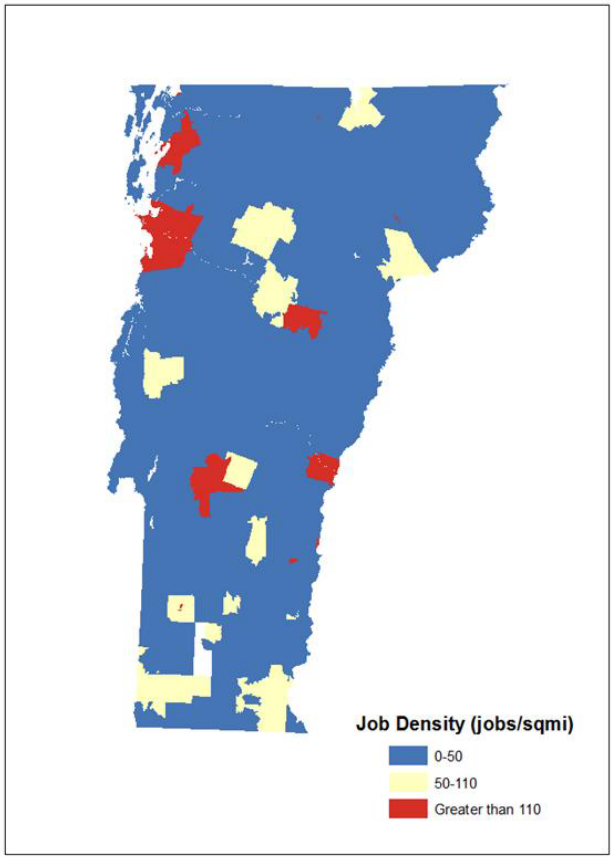
Figure 2: Location of Study Properties and Central Business Districts



[1] Walksore.com limits the amount of locations that can processed per day. The program was run over 4-6 weeks in order to process the walk score for all 18,500 locations.

A statistical model of the effect of walkability on real estate value was estimated for the entire state, with property sale price as the dependent variable, and all other attributes of the property, including the walkability score, entered as independent variables. Results of the statistical model suggest that the effect of walkability on real estate value is a function of a job density (i.e., number of jobs per square mile, based on the 2010 US Census). Thus, the effect of walkability on real estate value was estimated for three categories of properties, based on job density: 1) Greater than 110 jobs per square mile; 2) 50-110 jobs per square mile; and 3) 50 or fewer jobs per square mile (Figure 3).

Figure 3: Job Density



Results of the analyses suggest that walkability has a significant positive effect on property values in areas with job density greater than or equal to 110 jobs per square mile (generally the urban areas in Vermont). For example, an improvement in the walkability score of a property from the "Very Car Dependent" category to the "Somewhat Walkable" category is estimated to increase the value of the property by about $4,400 (Table 14).

Table 14: Estimated Effect of Walkability Score on Property Value – Job Density Greater than 110 Jobs per Square Mile

	Car-Dependent	Somewhat Walkable	Very Walkable	Walker's Paradise
Very Car-Dependent	$2292	$4378	$6252	$7668
Car-Dependent		$2086	$3960	$5376
Somewhat Walkable			$1873	$3290
Very Walkable				$1417

In contrast, in areas of Vermont with job densities between 50 and 110 jobs per square mile, the walkability score has no significant effect on property value. Further, in communities with 50 or fewer jobs per square mile, walkability is inversely related to property value (Table 15). For example, other things being equal, a change in walkability score from the "Car Dependent" category to the "Somewhat Walkable" category is estimated to decrease property value by about $6,700.

Table 15: Estimated Effect of Walkability Score on Property Value – Job Density Less than 50 Jobs per Square Mile

	Car-Dependent	Somewhat Walkable	Very Walkable	Walker's Paradise
Very Car-Dependent	-$7784	-$14492	-$20226	-$24391
Car-Dependent		-$6708	-$12442	-$16607
Somewhat Walkable			-$5735	-$9900
Very Walkable				-$4165

The results for areas with less than 50 employees per square mile (which as suggested in Figure 3 are the rural areas of the state) reflect the limitations of the methodology and do not constitute an accurate assessment of walkability's effect on sales price in lower density places:

- First, the CEOs for Cities study focused on larger metropolitan areas, and did not include any rural areas. It evaluated over 90,000 house sales in metropolitan areas throughout the United States with populations that range between 670,000 to six million persons. The study found that houses in these larger metropolitan areas with above average levels of walkability command a premium of about $4,000 to $34,000 over houses with just average levels of walkability in the typical metropolitan areas included in the statistical analysis. As indicated in Table 14, the walkability score also has a positive effect on property values within areas of Vermont with higher job densities, further suggesting that the methodology developed for the CEO's for Cities study is appropriate for urban areas.
- Second, the Walk Score methodology is based on proximity to multiple non-residential land uses. Arguably, persons that choose to live in rural areas value privacy, open space and other characteristics of country living and may perceive proximity to non-residential uses as a disamentity. Therefore, the negative effect of the Walk Score on sales price likely reflects these other factors, and not walkability in the true sense of the word.

Given that walkability has a positive effect on house values in areas with higher job densities, and assuming that walkability has a neutral affect in all other areas of the state, the aggregate effect on residential real estate property value is estimated at $350 million statewide. This estimate was derived by applying the average increase in the Walk Score of house sales in a zip code to the total number of housing units in the same zip code.

Although the $350 million estimate is in the form of property value, not a liquid asset like cash, homeowners that perceive their property is worth more, also spend more money (referred to as the wealth effect). The wealth effect will be considered as part of the economic input-output modeling that will be conducted by Economic and Policy Resources, Inc and results will be presented in Working Paper #3.

5.0 SUMMARY AND NEXT STEPS

This memorandum presents the final estimate of walking and biking trips in Vermont, estimates the savings in transportation system costs attributed to walking and biking, and presents an estimate of the effect of walkability on residential property value.

Findings related to the transportation system costs are:

- Vermonters travelled approximately 69 million miles on foot and 28 million miles by bike during 2009.
- Transportation system costs include consumer costs borne by the individual and public costs diverted from the individual to the public at-large.
- Walking and biking reduced total transportation system costs by $34.5 million per year (2009). This estimate assumes walking and biking replace automobile trips of the same distance resulting in avoided costs.
- The value of travel time is the largest cost component of walking and biking and has a significant impact on the total estimated cost savings. Because the total cost of travel time is significantly greater for walking and biking (compared to auto travel), the analysis suggest that the consumer, out-of-pocket costs are greater for trips made on foot or bike by $7.5 million per year and that all of the cost savings are derived from public costs.
- If the value of travel time is assumed to be neutral, the estimated consumer cost savings related to walking and biking would be $43.0 million per year and the total annual savings due to walking and biking would increase from $34.5 million to $84.9 million.

Findings related to the effect of walkability on residential property value are:

- Walkability, as defined by Walk Score, has a positive effect on residential property values within areas that have a job density of more than 110 employees per square mile. In general, this job density corresponds with the more urban and to a certain extent, suburban areas of the state.
- Within these urban/suburban areas of Vermont, the property value for a house where most errands can be accomplished on foot, is worth approximately $6,300 more than a similar house located where all trips require the use of a car.
- The methodology used to develop this estimate is not applicable in rural areas.
- The aggregate effect of walkability on residential real estate property values in the state is estimated at $350 million. This estimate is conservative because it assumes that the effect of walkability in rural areas, which cannot be estimated with the methodology, is neutral. The additional property value creates a wealth effect that will be considered as a factor in the economic input-output model.

Next Steps

Transportation system and real estate related costs are two of the cost components that will be evaluated in the economic input-output model to develop an estimate of the jobs and income that can be attributed to walking and biking in the state. The other cost components are dollars invested in building and maintaining walking and biking infrastructure, visitor spending, and revenue generated by walking and biking related businesses and events. The consultant team is currently gathering data for these other cost inputs. Working Paper #3 will compile all of data, and summarize the results of the input-output modeling to include a preliminary estimate of the total economic impact of walking and biking.