Chapter 2: Transportation, Air Quality, Greenhouse Gas & Energy Analyses

This chapter presents the results of simulating each of the alternatives described in the previous chapter through the year 2010. The analyses show that by focusing land uses in moderately dense, mixed use, pedestrian designed locations served by transit and supported by demand management policies, the LUTRAQ alternative makes a substantial difference in travel behavior and air quality. The LUTRAQ alternative significantly reduces the need to own multiple vehicles, or even any vehicle at all. The alternative also reduces vehicle miles traveled and increases walking, bicycling, and transit use. Air pollution, greenhouse gas emissions, and energy consumption are also reduced.

Auto Ownership

The LUTRAQ study area today is more auto dependent than the region as a whole. Only 1.2 percent of person trips in the study area are by transit, compared to 3.4 percent of the person trips in the region. This is at least partially a result of the social and economic characteristics of study area residents, who are more affluent than residents in much of region. In addition, these residents are less well served by transit and live in developments that are lower in density and less pedestrian friendly than more centrally located portions of the region. Thus, it is significant that the LUTRAQ alternative reduces auto ownership rates in the year 2010 over what they would be without changes in land use policies or transportation investments.

Table 2-1: Auto Ownership

Percentage of Homes Owning:	No Build	Highways Only	Highways/ Parking Pricing	LUTRAQ	LUTRAQ (TOD Only)	LUTRAQ/ Congestion Pricing	LUTRAQ/ Congestion Pricing (TOD Only)
0 Auto	2.9	3.0	3.0	4.9	9.1	5.6	9.7
1 Auto	26.5	26.8	26.8	29.2	35	30.2	35.6
2 Autos	47.6	47.7	47.7	44.8	40.1	43.7	39.6
3 Autos	23	22.5	22.5	21.1	15.8	20.4	15
Average Autos/ Household	1.91	1.9	1.9	1.82	1.63	1.79	1.6

Table 2-1 shows the estimated percentage of households that would own various numbers of autos under each of the alternatives. The Highways Only alternative would not change auto ownership rates, but the LUTRAQ alternative would reduce the average number of autos per household by five percent compared to the No Build alternative. The number of households with only one car, or no car at all, would increase with the LUTRAQ alternative.

The main reason for these changes in auto ownership can be seen in the TOD columns of Table 2-1 that show the auto ownership levels in the transit oriented development (TOD) areas of the LUTRAQ alternatives. About 35 percent of TOD households would choose to own only one car, and over 9 percent would choose not to own a car at all. Only 55 percent of households in the TODs would own two or more cars compared to 70 percent in the study area with the No Build or Highways Only alternatives.[1]

Mode Choice

Mode choice is also strongly influenced by the alternatives. The No Build and Highways Only alternatives would continue the auto orientation of the study area while the LUTRAQ alternative would shift many trips to non-automotive modes. Table 2-2 displays the projected mode shares for 2010 by trip purpose. Figures 2-1 to 2-3 show the results graphically.

It is important to note that the Highways Only alternative would actually decrease auto mode shares slightly as compared to the No Build alternative, especially for work trips. This is most likely the result of including some transit capital improvements in the alternative.

With the LUTRAQ alternative, residents of the study area make more than twice as many work trips by transit than with the No Build or Highways Only alternatives. Carpooling also increases substantially with the LUTRAQ alternative while it declines with the Highways Only alternative.

This shift away from the automobile under the LUTRAQ alternative is primarily the result of two factors. One factor is the TOD development pattern. The share of works trips by walk/bike and transit would be much higher in the TOD areas in the LUTRAQ alternative than in the study area as a whole, as shown in Table 2-2. The significant improvements in transit accessibility and the pedestrian environment, as well as the density and mixture of uses in the TODs, would encourage much greater use of alternatives to the automobile. In the TOD areas, walk, bike, and transit would account for about 30 percent of all home-based trips and 33 to 38 percent of all work trips. These figures, while substantially higher than those in the rest of the study area, are similar to measures of current travel behavior in the pedestrian friendly areas of the City of Portland. This success in reducing auto travel implies that organizing future development beyond 2010 according to transit-oriented development principles could further reduce automobile reliance county wide.

1. TODs are designed with 57.5 percent of housing in multi-family units compared with 37 percent in all of Washington County in 2010. Apartments and condominiums are smaller and attract different households than single family homes. Thus, part of the benefit of TODs is to concentrate smaller households that are likely to own fewer cars near transit stations. In all, the effects of applying the principles of good planning (by locating transit-oriented households near transit) are as important as the effect of applying principles of good design (mixed uses and pedestrian orientation). *See* 1000 Friends of Oregon, *Making the Land Use, Transportation, Air Quality Connection,* Vol. 6, *Implementation* (Portland, Oregon, 1995), Appendix D.

Table 2-2: Mode Choice (by percentage of trips)

	No Build	Highways Only	Highways/ Parking Pricing	LUTRAQ	LUTRAQ (TOD Only)	LUTRAQ/ Congestion Pricing	LUTRAQ/ Congestion Pricing (TOD Only)
HOME BASED TRIPS							
Home Based Work Trips							
Walk/Bike	2.8	2.5	2.5	3.5	5	4	5.7
Auto	89.7	88.7	82.2	78.3	66.7	74.9	62.1
Drive Alone	75.8	75.1	61.7	58.2	49.6	55.3	45.7
Carpool	14	13.6	20.4	20.1	17.2	19.6	16.4
Transit	7.5	8.8	15.3	18.2	28.2	21.1	32.1
Home Based Non-Work Trips							
Home Based Other Trips							
Walk/Bike	3.3	3.1	3.1	3.9	6	4.4	7
Auto	95.6	95.8	95.4	94	90	93.3	88.9
Transit	1.1	1.1	1.5	2.1	4	2.3	4.2
Home Based School Trips							
Walk/Bike	19.4	19.4	19.4	19.4	19.4	19.4	19.4
Auto	29.6	29.7	29.6	29.6	29.6	29.6	29.6
Transit/School Bus	51	50.9	51	51	51	51	51
Home Based College Trips							
Walk/Bike	3.2	3.2	3.1	6	4.3	7.1	4.8
Auto	80.9	80.1	85.2	78.4	77.4	77.8	76.3
Transit	15.9	16.7	11.7	17.3	16.6	17.4	16.6
Total Home Based Non-Work Trips							
Walk/Bike	6	5.8	5.8	6.5	9.9	6.9	10.4
Auto	84	84.2	84.1	82.6	71.1	82	71.8
Transit	10	10	10.1	10.9	18.9	11.1	17.9
Total Home Based Trips							
Walk/Bike	5.1	4.9	4.9	5.6	8.7	6.1	9.2
Auto	85.6	85.4	83.6	81.4	70.1	80	69.3
Transit	9.3	9.7	11.5	12.9	21.2	13.9	21.5
NON-HOME BASED TRIPS							
Non-Home Based Work Trips							
Walk/Bike	0.4	0.4	0.4	0.9	1.7	1.1	2
Auto	98.9	98.9	98.9	98.1	96.5	97.7	96.2
Transit	0.7	0.7	0.7	1	1.8	1.1	1.8
Non-Home Based Non-Work Trips							
Walk/Bike	0.3	0.3	0.3	0.5	0.9	0.7	0.9
Auto	99.1	99	99.1	98.7	98	98.5	97.9
Transit	0.6	0.7	0.6	0.7	1.1	0.9	1.2
Total Non-Home Based Trips							
Walk/Bike	0.3	0.3	0.3	0.7	1.2	0.8	1.4
Auto	99	99	99.1	98.5	97.4	98.2	97.1
Transit	0.6	0.7	0.6	0.8	1.4	1	1.5
TOTAL ALL TRIPS							
Walk/Bike	3.8	3.7	3.7	4.3	6.8	4.7	6.9
Auto	89.1	89	87.7	86	77.2	84.8	77.4
Transit	7	7.3	8.6	9.7	16	10.5	15.7

Figure 2-1: Percentage of Work Trips by Mode

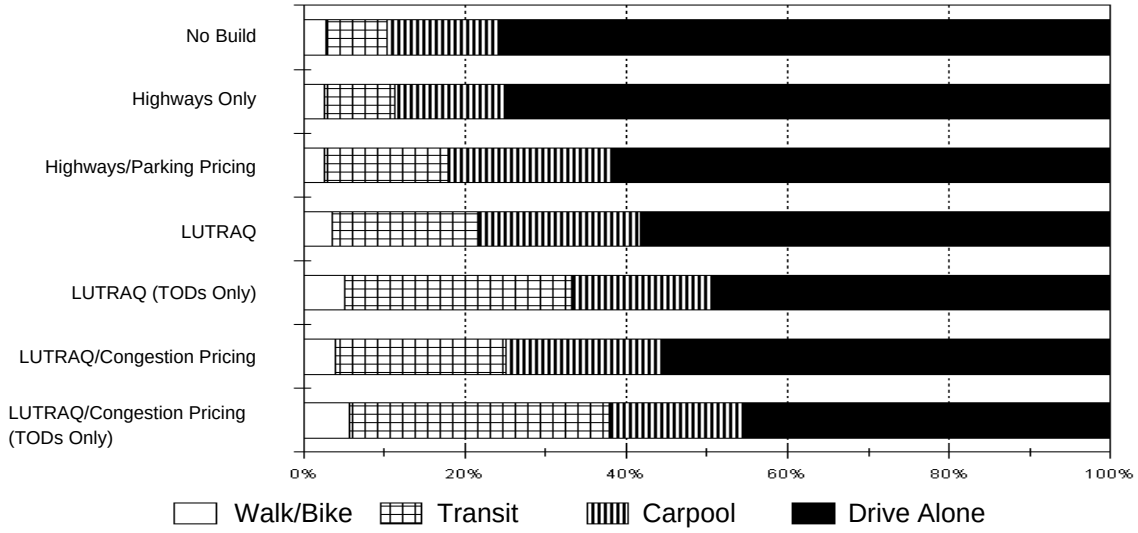


Figure 2-2: Percentage of Non-Work Trips from Home by Mode

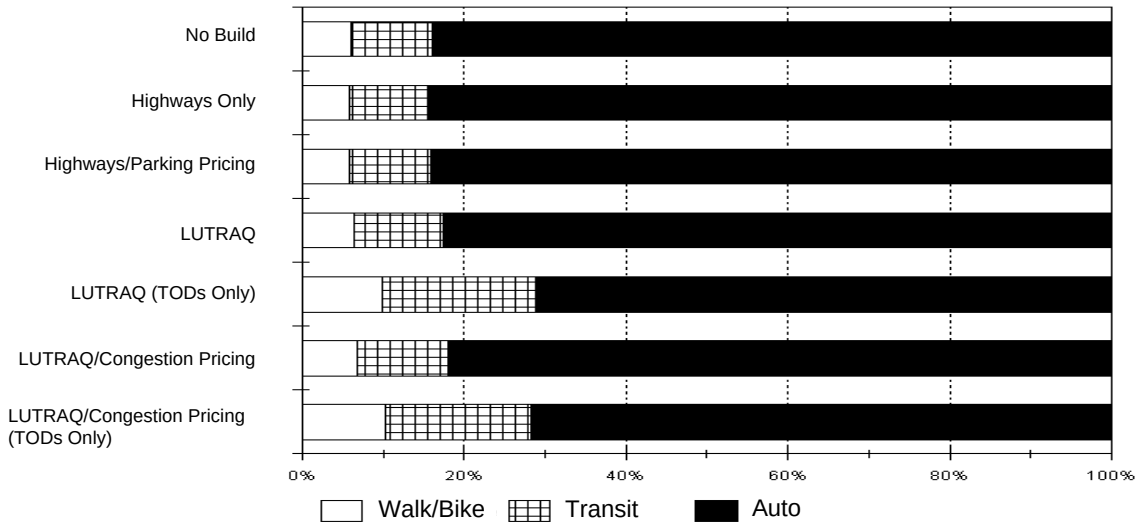
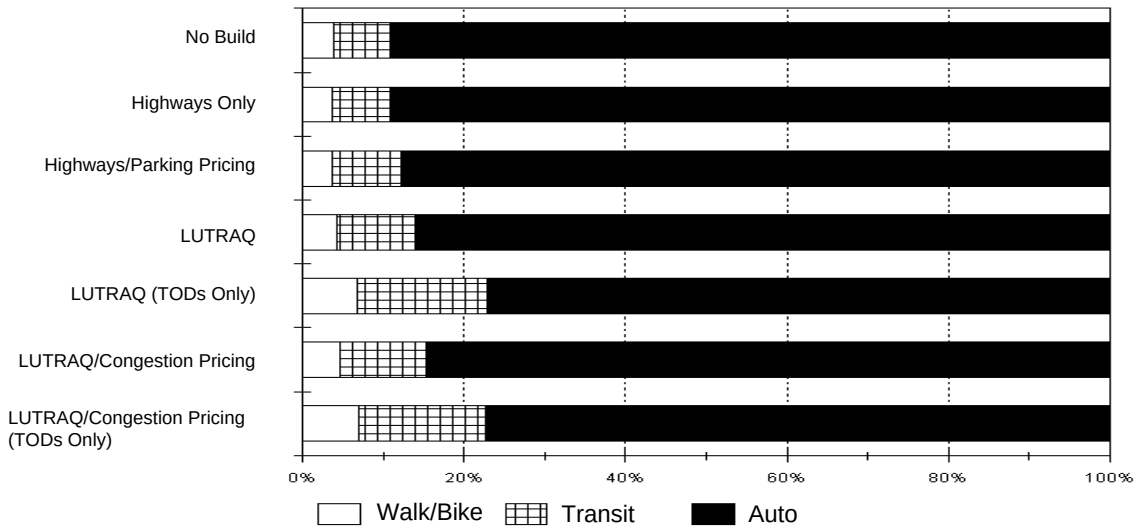


Figure 2-3: Percentage of All Trips by Mode



The other factor influencing the LUTRAQ alternative's performance is the effect of the parking charges and subsidized transit passes included in the alternative. This effect can be seen by comparing the Highways Only and the Highway/Pricing alternatives, as the pricing alternative contains the same parking charges and transit pass subsidies as the LUTRAQ alternative. Adding parking pricing and transit passes to highway building nearly doubles transit usage for work trips and increases carpooling about 50 percent.

The relative effects of land use and pricing policies can also be seen by comparing the mode shares for two earlier versions of the LUTRAQ package. Table 2-3 shows mode shares for the LUTRAQ/No Pricing and LUTRAQ/Parking Pricing alternatives, and the Base Case to which they can be compared. The LUTRAQ/No Pricing alternative contains only LUTRAQ's transit oriented land use plan and expansions to the light rail system. This package increases the use of transit for the work trip by 30 percent in the study area, but has minimal impact on carpooling. The LUTRAQ/Parking Pricing alternative adds the parking charge/transit pass component to the land use/transit package and boosts transit ridership an additional 36 percent. In addition, the LUTRAQ/Parking Pricing alternative has 50 percent more carpooling trips than the Base Case. In both these alternatives the rates of transit use are highest in the TODs.

In all, the analysis indicates that 48 percent of the increase in non-automobile mode shares for work trips is attributable to the pricing measures, while the balance (52%) is due to the land use/transit changes. Hence, according to the model, the effect of land use/transit is slightly greater than the impact of pricing. On the ground, however, both sets of measures are likely to have a synergistic effect that the model is unable to predict. In other words, under actual conditions, the sum of land use/transit plus pricing is likely to be greater than the parts.

During the analysis of the LUTRAQ alternative, it became apparent that the model was predicting lower walk and bike mode shares than expected. Upon further investigation, it was determined that the data used to calibrate the Metro model—a 1985 travel survey of the Portland area—under reported walk/bike trips, particularly for non-work and non-home based trips in pedestrian friendly areas. Walk/bike shares in the San Francisco Bay area, for example, are significantly higher than those reported in the Portland survey. This problem implies that the Portland travel model does not include all walk/bike trips. While the numbers of auto and transit trips are correct, the estimated number of total non-motorized trips is probably too low.

To correct for this under reporting problem, a set of adjustments to the model's walk/bike trip outputs were developed. This increased walk/bike shares for the LUTRAQ alternatives and correspondingly decreased auto and transit shares, as shown in Table 2-4. It is important to note that these adjustments are made solely to provide more realistic estimates of the walk/bike mode shares. The estimates of the number of auto and transit trips, as well as figures computed from these trips—such as traffic volumes, vehicles miles of travel, etc.—are not affected. Details of the walk/bike share adjustments are described in Appendix C.

Table 2-3: Effect of Pricing on Mode Choice (by percentage of trips)

	Base Case	LUTRAQ/ No Pricing	LUTRAQ/ No Pricing (TOD Only)	LUTRAQ/ Parking Pricing	LUTRAQ/ Parking Pricing (TOD Only)
Home Based Trips					
Home Based Work					
Walk/Bike	2.8	3.5	5.4	3.5	5.4
Auto	89.5	86.5	80.6	83.6	74.4
SOV	76	72.7	67.5	63.9	56.5
Carpool	13.5	13.8	13.1	19.7	17.8
Transit	7.7	10	14	12.8	20.2
Home Based Non-Work					
Home Based Other					
Walk/Bike	3.3	3.9	6.4	3.9	6.4
Auto	95.7	94.6	90.3	94.6	90.3
Transit	1	1.5	3.3	1.5	3.3
Home Based School					
Walk/Bike	19.4	19.4	19.4	19.4	19.4
Auto	29.7	29.7	29.7	29.7	29.7
Transit/School Bus	50.9	50.9	50.9	50.9	50.9
Home Based College					
Walk/Bike	3.2	4.3	6	4.3	6
Auto	80.1	82	80.6	82	80.6
Transit	16.7	13.7	13.4	13.7	13.4
Total Home Based Non-Work					
Walk/Bike	6	6.5	8	6.5	8
Auto	84.1	83.3	82.1	83.3	82.1
Transit	9.9	10.2	9.8	10.2	9.8
Total Home Based					
Walk/Bike	5.1	5.7	7.3	5.7	7.3
Auto	85.6	84.2	81.7	83.4	80
Transit	9.3	10.2	11	10.9	12.7
Non-Home Based Trips					
Non-Home Based Work					
Walk/Bike	0.4	0.6	2	0.6	2
Auto	98.8	98.5	96.1	98.5	96.1
Transit	0.8	0.9	1.9	0.9	1.9
Non-Home Based Non-Work					
Walk/Bike	0.3	0.4	0.8	0.4	0.8
Auto	99	98.9	97.9	98.9	97.9
Transit	0.7	0.7	1.3	0.7	1.3
Total Non-Home Based					
Walk/Bike	0.3	0.5	1.2	0.5	1.2
Auto	98.9	98.8	97.2	98.8	97.2
Transit	0.7	0.8	1.5	0.8	1.5
Total All Trips					
Walk/Bike	3.8	4.5	5.7	4.5	5.7
Auto	89.1	87.6	85.8	87	84.5
Transit	7	8	8.5	8.6	9.8

Table 2-4: Mode Choice Adjusted to Compensate for Walk/Bike Under-Reporting (by percentage of trips)

	No Build	LUTRAQ	Adjusted LUTRAQ	LUTRAQ (TOD Only)	Adjusted LUTRAQ (TOD Only)	LUTRAQ/ Congestion Pricing	Adjusted LUTRAQ/ Congestion Pricing	LUTRAQ/ Congestion Pricing (TOD Only)	Adjusted LUTRAQ/ Congestion Pricing (TOD Only)
Home Based Trips									
Home Based Work									
Walk/Bike	2.8	3.5	4.6	5	6.1	4	5.1	5.7	6.8
Auto	89.7	78.3	77.4	66.7	66	74.9	74.1	62.1	61.4
SOV	75.8	58.2	57.5	49.6	49	55.3	54.6	45.7	45.2
Carpool	14	20.1	19.9	17.2	17	19.6	19.4	16.4	16.2
Transit	7.5	18.2	18	28.2	27.9	21.1	20.8	32.1	31.8
Home Based Non-Work									
Home Based Other									
Walk/Bike	3.3	3.9	9.3	6	12.8	4.4	9.8	7	13.8
Auto	95.6	94	88.7	90	83.5	93.3	88	88.9	82.4
Transit	1.1	2.1	2	4	3.7	2.3	2.2	4.2	3.9
Home Based School									
Walk/Bike	19.4	19.4	26.1	19.4	42.7	19.4	26.1	19.4	42.7
Auto	29.6	29.6	27.2	29.6	21.2	29.6	27.2	29.6	21.2
Transit/School Bus	51	51	46.7	51	36.1	51	46.7	51	36.1
Home Based College									
Walk/Bike	3.2	6	6	4.3	4.8	7.1	7.1	4.8	7.1
Auto	80.9	78.4	78.4	77.4	77.4	77.8	77.8	76.3	76.3
Transit	15.9	17.3	17.3	16.6	16.6	17.4	17.4	16.6	16.6
Total Home Based Non-Work									
Walk/Bike	6	6.5	11.8	9.9	20.7	6.9	12.2	10.4	20.8
Auto	84	82.6	78.5	71.1	65.5	82	77.9	71.8	66.1
Transit	10	10.9	9.7	18.9	13.8	11.1	9.9	17.9	13.1
Total Home Based									
Walk/Bike	5.1	5.6	9.9	8.7	17.2	6.1	10.3	9.2	17.4
Auto	85.6	81.4	78.2	70.1	65.6	80	76.9	69.3	64.9
Transit	9.3	12.9	12	21.2	17.2	13.9	12.9	21.5	17.7
Non-Home Based Trips									
Non-Home Based Work									
Walk/Bike	0.4	0.9	7.8	1.7	13.1	1.1	10	2	15.9
Auto	98.9	98.1	91.3	96.5	85.4	97.7	89	96.2	82.5
Transit	0.7	1	1	1.8	1.6	1.1	1	1.8	1.6
Non-Home Based Non-Work									
Walk/Bike	0.3	0.5	3.2	0.9	10.2	0.7	4.5	0.9	9.6
Auto	99.1	98.7	96.1	98	88.8	98.5	94.6	97.9	89.3
Transit	0.6	0.7	0.7	1.1	1	0.9	0.8	1.2	1.1
Total Non-Home Based									
Walk/Bike	0.3	0.7	4.8	1.2	11.4	0.8	6.6	1.4	12.3
Auto	99	98.5	94.4	97.4	87.3	98.2	92.5	97.1	86.4
Transit	0.6	0.8	0.8	1.4	1.3	1	0.9	1.5	1.3
Total All Trips									
Walk/Bike	3.8	4.3	8.5	6.8	15.6	4.7	9.3	6.9	15.8
Auto	89.1	86	82.5	77.2	71.6	84.8	81	77.4	71.5
Transit	7	9.7	9	16	12.8	10.5	9.7	15.7	12.7

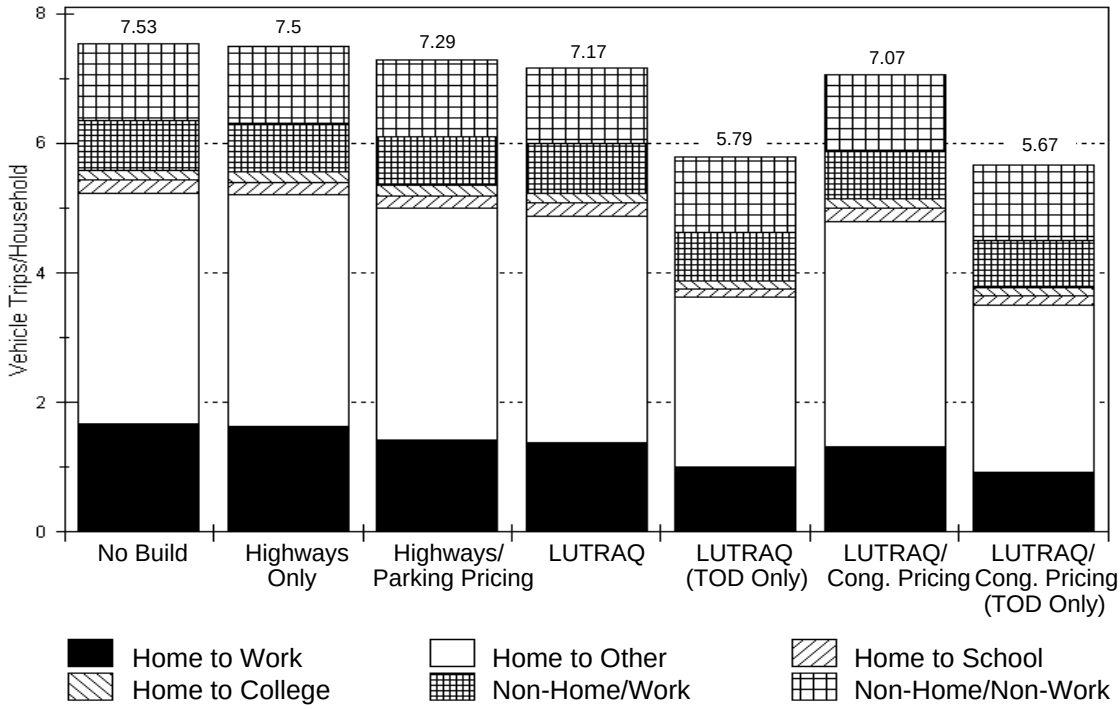
Vehicle Trips Per Household

The shift of work trips to non-auto modes for the LUTRAQ alternatives translates into fewer vehicle trips per household, as shown in Table 2-5 and Figure 2-4.

Table 2-5: Vehicle Trips per Household

	No Build	Highways Only	Highways/ Parking Pricing	LUTRAQ	LUTRAQ (TOD Only)	LUTRAQ/ Congestion Pricing	LUTRAQ/ Congestion Pricing (TOD Only)
HOME BASED TRIPS							
Work	1.67	1.63	1.42	1.38	1	1.32	0.92
Other	3.56	3.57	3.57	3.5	2.62	3.47	2.59
School	0.2	0.2	0.2	0.2	0.13	0.2	0.13
College	0.16	0.16	0.16	0.16	0.13	0.16	0.13
Total Home Based	5.59	5.56	5.35	5.24	3.88	5.15	3.77
NON-HOME BASED TRIPS							
Work	0.76	0.76	0.76	0.75	0.74	0.75	0.74
Non-work	1.18	1.18	1.18	1.17	1.17	1.17	1.16
Total Non-Home Based	1.94	1.94	1.94	1.93	1.91	1.92	1.9
TOTAL TRIPS	7.53	7.5	7.29	7.17	5.79	7.07	5.67

Figure 2-4: Vehicle Trips per Household



The number of vehicle trips per household would decrease by 5 percent with the LUTRAQ alternative, compared to the No Build or Highways Only alternatives. Most of the changes are in trips to and from work. Within the TOD areas, vehicle trips per household are 25 percent lower for LUTRAQ and 32 percent lower for LUTRAQ/Congestion Pricing than in the study area for the other alternatives. This is likely because residents of TODs make a larger percentage of trips by walking, biking, and transit for both work and other purposes like shopping and recreation, and because their household characteristics dispose them to use autos less.[2]

Vehicle Hours of Delay

All of the alternatives reduce congestion, as measured in vehicle hours of delay, over the No Build alternative. As Table 2-6 and Figure 2-5 show, the LUTRAQ alternative reduces congestion 53.2 percent, 10 percentage points more than the Highways Only alternative. The LUTRAQ/Congestion Pricing alternative has an even greater impact because of the per mile charge for work trips, which occurs at the most congested times of day.

Table 2-6: Vehicle Hours of Delay (P.M. Peak Hour)

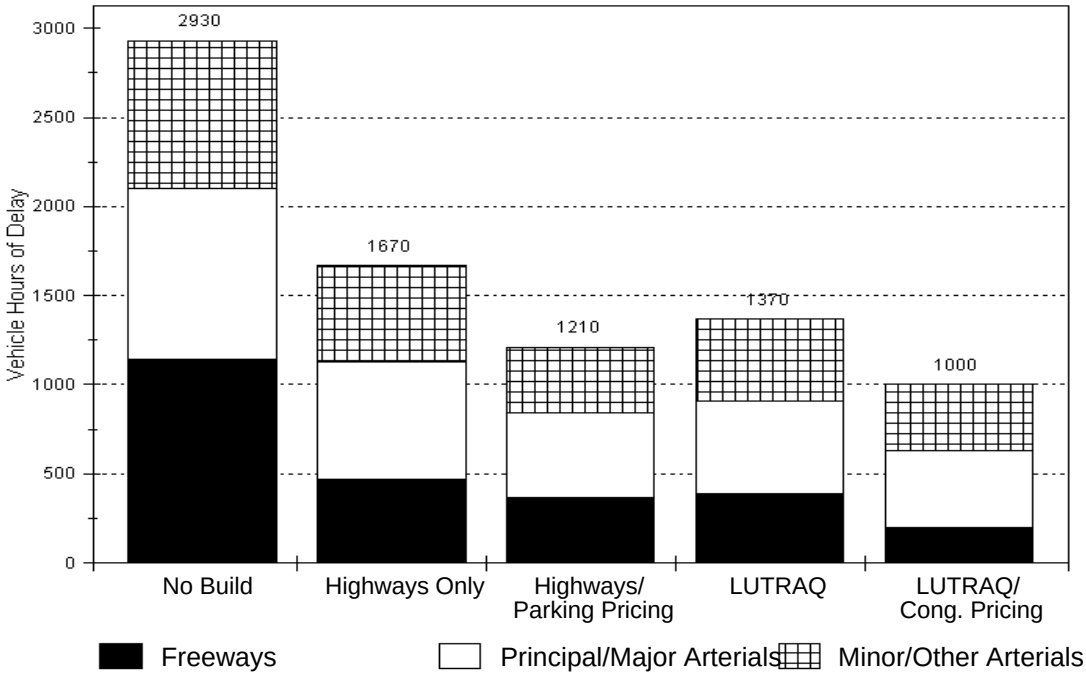
	No Build	Highways Only		Highways/Parking Pricing		LUTRAQ		LUTRAQ/ Congestion Pricing	
	VHD	VHD	Difference[1]	VHD	Difference	VHD	Difference	VHD	Difference
Freeways	1140	470	-58.8%	370	-67.5%	390	-65.8%	200	-82.5%
Principal/Major Arterials	960	660	-31.3%	470	-51%	520	-45.8%	430	-55.2%
Minor/Other Arterials	830	540	-34.9%	370	-55.4%	460	-44.6%	370	-55.4%
Total All Classes	2930	1670	-43%	1210	-58.7%	1370	-53.2%	1000	-65.9%

1. Compared to the No Build alternative.

This is the only measure of transportation behavior on which a highway alternative performs better than the LUTRAQ alternative. The Highway/Parking Pricing alternative has 160 hours, or 12 percent, fewer hours of delay than the LUTRAQ alternative. The combination of expanded highway capacity and reduced demand, especially for work trips, reduces congestion. Enhanced highway capacity (as seen in Highways Only) reduces delay by 1,260 hours or 43 percent compared to the No Build alternative. Adding parking charges and free transit passes reduces hours of delay another 300 hours, or an additional 10 percent. The LUTRAQ alternative contains the same demand management program as the Highway/Parking Pricing alternative, but does not add nearly as much highway capacity. Although a number of people shift to non-automotive modes, this is not enough to reduce congestion to the levels of the Highway/Parking Pricing alternative.

2. N.B.: The LUTRAQ alternative assumes household characteristics in 2010 that are consistent with the continuation of current economic, social, and political trends. If these trends were to vary dramatically during the study period, significant shifts in housing choices and travel behavior would be expected. For example, if household income growth were to stagnate, or if current financial incentives for home ownership were trimmed, one would expect to see a stronger multi-family housing market, and a wider range of household types choosing multi-family housing products, than was assumed for the LUTRAQ alternative.

Figure 2-5: Vehicle Hours of Delay (P.M. Peak Hour)



The higher speeds of the Highway/Parking Pricing alternative may, however, be only a temporary phenomena. The Standing Advisory Committee on Trunk Road Assessment of Great Britain[3] surveyed the evidence on whether road capacity influences the amount of traffic. They concluded "that about half the time saved through speed increases might be used for additional travel. We interpret this as a short-term effect. The longer-term effect is likely to be greater, with a higher proportion (perhaps all) of the time saved being used for further travel (p. 47)."

The LUTRAQ alternative puts more emphasis on transit improvements and changing the environment around transit than on highways. The result is slightly higher levels of vehicle delay in exchange for much higher rates of transit ridership and walk/bike travel and lower levels of vehicle miles of travel.

Also balanced against LUTRAQ's higher congestion levels is the substantially greater degree of accessibility to jobs afforded by the LUTRAQ alternative. Under LUTRAQ, the percentage of the study area within 30 minutes travel of 500,000 jobs is 67.5%, a 25.8% increase over the No Build alternative. By contrast, only 55.7% of the area would have the same degree of access under the Highways Only alternative (a 13.9% increase over the No Build alternative). In other words, the LUTRAQ alternative trades a slight decrease in mobility (as measured by vehicle hours of delay) for a substantial increase in accessibility. *See* Table 2-7.

3. Standing Advisory Committee on Trunk Road Assessment, *Trunk Roads and the Generation of Traffic* (London: HMSO, 1994).

Table 2-7: Accessibility to Population, Jobs, and Shopping

	No Build	Highways/Parking Pricing		LUTRAQ	
			Difference[1]		Difference
% of Study Area w/i 30 Mins. of 800,000 Population	40.7	70.6	23.9%	64.4	23.7%
% of Study Area w/i 30 Mins. of 500,000 Jobs	41.8	55.7	13.9%	67.5	25.8%
% of Study Area w/i 15 Mins of 25,000 Retail Jobs	74.2	78.9	4.6%	78.1	3.9%

1. Compared to the No Build alternative.

Adding peak period pricing to the LUTRAQ/Congestion Pricing alternative shifts a larger number of commuters from driving to other modes. This reduces the amount of delay during rush hour by 210 hours from the Highway/Parking Pricing level.[4] Compared to the No Build alternative, the LUTRAQ/Congestion Pricing alternative would reduce vehicle hours of delay by 83 percent on freeways and 55 percent on all types of arterials. Compared to the Highway/Parking Pricing alternative, the LUTRAQ/Congestion Pricing alternative has 46 percent fewer hours of delay on freeways, and 9 percent fewer on primary and minor arterials.

Peak Vehicle Hours of Travel and Daily Miles of Travel

All of the alternatives would reduce peak period vehicle hours of travel within the study area over the No Build alternative. The improved speeds on highways, however, would result in increased vehicle miles of travel in the Highways Only alternative. The LUTRAQ alternative would reduce both vehicle hours and vehicle miles of travel.

Table 2-8 shows the changes in vehicle hours of travel. The Highways Only alternative would improve speeds on freeways resulting in fewer hours of travel in the peak period, but it would increase travel hours on principal/major arterials. The alternative includes many improvements to principal arterials, and this enhanced capacity would result in greater use of these routes. The transit oriented development pattern of the LUTRAQ alternatives would reduce travel times on all types of facilities. With the LUTRAQ alternative, overall vehicle use would decline by about 16 percent compared to the No Build alternative with the greatest improvements on the more local streets, followed by principal arterials, and then freeways. Adding congestion pricing would reduce vehicle hours further on all types of facilities, but especially on freeways.

Table 2-8: Vehicle Hours of Travel (P.M. Peak Hour)

	No Build	Highways Only		Highways/Parking Pricing		LUTRAQ		LUTRAQ/ Congestion Pricing	
	VHT	VHT	Difference[1]	VHT	Difference	VHT	Difference	VHT	Difference

4. Some trips would probably shift to other times of day when there would be no charge, but the Metro model, in its current form, cannot consider this change in behavior.

Table 2-8: Vehicle Hours of Travel (P.M. Peak Hour)

Freeways	6,270	5,900	-5.9%	5,610	-10.5%	5,590	-10.8%	4,930	-21.4%
Principal/Major Arterials	6,220	6,890	10.8%	6,250	0.5%	5,360	-13.8%	4,990	-19.8%
Minor/Other Arterials	8,620	7,130	-17.3%	6,380	-26%	6,840	-20.6%	6,230	-27.7%
Total All Classes	21,110	19,920	-5.6%	18,240	-13.6%	17,790	-15.7%	16,150	-23.5%

1. Compared to the No Build alternative.

Table 2-9 shows the estimated daily vehicle miles of travel for each alternative. The Highways Only alternative demonstrates that building additional highway capacity without programs to reduce demand, would increase the total miles of vehicle travel in the region even though the hours of travel decline. The LUTRAQ alternative would reduce the amount of vehicle travel by shifting more trips to non-automotive modes. The transit oriented development pattern of the LUTRAQ alternative reduces vehicle miles of travel in the study area by about 6 percent compared to the No Build alternative. Adding peak hour pricing to this alternative more than doubles the reduction in vehicle miles of travel to 13 percent.

Table 2-9: Daily Vehicle Miles Traveled

No Build	Highways Only		Highways/Parking Pricing		LUTRAQ		LUTRAQ/Congesition Pricing	
VMT	VMT	Difference[1]	VMT	Difference	VMT	Difference	VMT	Difference
6,883,955	6,995,986	1.6%	6,856,447	-0.4%	6,442,348	-6.4%	5,976,191	-13.2%

1. Compared to the No Build alternative.

Air Quality - Carbon Monoxide and Ozone Precursors

Changes in travel behavior also produce changes in the emissions of pollutants. As Table 2-10 shows, the LUTRAQ alternative would reduce emissions for all three types of pollutants—hydrocarbons (HC), nitrogen oxides (NOx), and carbon monoxide (CO). Reductions in congestion and delay times generally reduce emissions, but NOx emissions increase with higher average speeds, and speeds would increase with the highway alternatives, as previously discussed. Table 2-10 shows that for the Highways Only alternative, NOx emissions would increase by almost 7 percent, while reductions in HC and CO would be negligible. In contrast, the LUTRAQ alternative reduces NOx by three percent and HC and CO by 6.2 percent and 6.7 percent respectively. Because the LUTRAQ/Congestion Pricing alternative would induce more shifts to non-motorized means of travel than the LUTRAQ alternative, it reduces pollutants the most. The LUTRAQ/Congestion Pricing alternative is more effective because it not only shifts people to other modes, but it

also reduces congestion so that traffic moves more smoothly.

Table 2-10: Air Pollutant Emissions (kg/day)

	No Build	Highways Only		Highways/Parking Pricing		LUTRAQ		LUTRAQ/Congesition Pricing	
			Difference[1]		Difference		Difference		Difference
HC	9,988	9,965	-0.2%	9,626	-3.6%	9,366	-6.2%	8,840	-11.5%
NO_x	14,104	15,054	6.7%	14,620	3.6%	13,744	-2.6%	12,914	-8.4%
CO	94,605	94,057	-0.6%	90,813	-4%	88,262	-6.7%	83,296	-12%

1. Compared to the No Build alternative.

Green House Gases and Energy Consumption

The estimates of greenhouse gas emissions and energy consumption are directly related to the differences in vehicle miles of travel with each alternative. Table 2-11 shows that, compared to the No Build alternative, the Highways Only alternative increases emissions of methane (CH_4), nitrous oxide (N_2O), and carbon dioxide (CO_2), and energy consumption by about 1.6 percent. In contrast, the LUTRAQ and LUTRAQ/Congestion Pricing alternatives reduce emissions and energy consumption by 6.4 and 13.2 percent, respectively. The LUTRAQ/Congestion Pricing alternative has the greater impact because the charge for work trips reinforces the other measures that reduce travel.

Table 2-11: Greenhouse Gas Emissions (kg/day) & Energy Consumption (millions of BTUs)

	No Build	Highways Only		Highways/Parking Pricing		LUTRAQ		LUTRAQ/Congesition Pricing	
			Difference[1]		Difference		Difference		Difference
CH_4	786	799	1.6%	783	-0.4%	736	-6.4%	683	-13.2%
N_20	526	534	1.6%	524	-0.4%	492	-6.4%	457	-13.2%
CO_2	4,814,705	4,893,061	1.6%	4,795,466	-0.4%	4,505,841	-6.4%	4,179,806	-13.2%
Energy Consumption	35,089	35,660	1.6%	34,949	-0.4%	32,838	-6.4%	30,462	-13.2

1. Compared to the No Build alternative.

Conclusion

The data presented here clearly indicate that building highways does not solve suburban transportation problems. Compared to other build options, such a "solution" in the LUTRAQ study area would result in increased driving, low transit ridership, dirtier air, more greenhouse gases, and higher energy consumption. In contrast, a combined approach of reorganizing land uses, providing high quality transit service, and instituting demand management measures provides an effective short-term and long-term suburban transportation strategy. For the LUTRAQ study area, implementation of these policies would lead to substantially lower dependence on the automobile, higher transit ridership, cleaner air, lower greenhouse gas emissions, and less energy consumption.

Although the LUTRAQ alternative represents a marked shift from the status quo, it does not attempt to modify urban design patterns in the entire study area, but only in selected neighborhoods near transit lines. The alternative's assumptions for the composition and mix of building types for development are also constrained by a market demand forecast that assumes the housing preferences of recent decades for different demographic segments will persist into the future. This implies continued tax subsidies for housing and automobile transportation, rising real household incomes, and continued high levels of consumer and public debt to finance housing and transportation consumption. In addition, despite experience in cities such as Davis, California and Copenhagen, Denmark showing that the development of comprehensive cycling networks can have a profound effect in diverting car trips to the bicycle and to transit, such improvements were not included in the alternative because the model used to evaluate the alternative was unable to quantify them.

Notwithstanding these limitations, the analysis presented in this volume demonstrates that transit and pedestrian oriented urban design and infill development, and the retrofit of pedestrian improvements to automobile-oriented suburbs, can have significant effects on travel behavior sufficient to eliminate the need to build new ring freeways, particularly when reinforced by sensible economic and pricing incentives, such as modest parking charges and reduced transit fares that begin to level the playing field between travel modes. One would expect even greater effects on travel behavior when these measures are combined with bicycle improvements, stronger economic incentives, more effective parking management, introduction of neighborhood vehicles, and further shifts in land use policies to favor infill housing and commercial development.