Appendix 1

Bringing the full costs of auto use into growth management decision making in the GTA

The following quote from an Ontario Ministry of Transportation Report of August 1999 on Transportation Planning for the GTA and Hamilton Wentworth is typical of many recent general reports.

" Achievement of a nodal structure will help realize the benefits of reduced automobile dependency, shorter average trips, greater choice of travel modes and housing/neighborhood types and, overall, more sustainable transportation and development …Continuing low density, largely single use development of greenfields and suburban areas is in conflict with the nodal concept….. The overall cost of congestion in the GTA has been reported to be approximately 2% of GDP. The role and importance of transportation in supporting competitiveness of the city region in the new economy is vital "

"The primary resources used by transportation are petroleum, of which 72% of Ontario's total consumption is attributable to transportation …. Air pollution, as an environmental impact of transportation has received the highest level of attention, perhaps because its effects on humans are very direct. Ground level smog, for example has been linked to a broad spectrum of adverse health effects including premature death, decreased lung function, premature aging of lung tissue, increased hospital admissions and aggravation of symptoms associated with respiratory diseases……In addition to health impacts on humans air pollution contributes to a wide variety of other environmental problems including climatic change, increased ultraviolet radiation and acid rain……..the development of new technologies to further reduce vehicle emissions has not kept up with auto travel growth. Auto use in the GTA is expected to increase by over 50% during the next 20-30 years. As such it is reasonable to expect that the impact of air pollution in the GTA and other places will become increasingly noticeable and severe" (pages 1.10-1.11)

These so called 'external' costs (costs borne by the public but not attributed to transportation), and 'internal' costs (costs borne by the individual), associated with auto travel are recognized as important in countries around the world. Specific impacts like the costs of accidents, air pollution, and congestion, and land impacts associated with auto use have been linked to issues of urban form in many recent MTO, GTSB and other planning reports. This link within the GTA between patterns of development and such costs was quantified by the GTA task force in 1995, which concluded half the annual costs of sprawl ($ 500 million) were external costs. The GTA task force based this estimate in large part on a report prepared by IBI.*

These auto externalities are commonly expressed in terms of cents per vehicle km., since more auto travel results in more accidents, pollution, and congestion.

* IBI base their estimates of external costs which they used for the GTA task force on a separate 1995 Report titled "Full Cost Transportation Pricing Study ", which they had completed on behalf of the Transportation and Climate Change Collaberative, a group of senior individuals representing a broad group of stakeholders and funded by the Ontario and National Round Tables on the Environment and Economy, Environment Canada and other agencies.

Late last year in preparation for a number of OMB hearings in Uxbridge, I completed a fairly lengthy report attempting to review the estimates that experts in various jurisdictions including Ontario had made regarding the impacts of accidents, air pollution and congestion, and from that quantify the additional impacts of accommodating growth in Uxbridge as contrasted with accommodating growth that was closer to urban areas and employment and involved less auto travel.

The following submission is based in large part on this earlier work.

1 – Additional auto travel resulting from sprawl versus nodal development pattern

The University of Toronto's Transportation Tomorrow Survey, (TTS)* conducts a detailed survey every five years of travel patterns in each GTA municipality. Based on this, one can make fairly accurate estimates of annual per capita vehicle km. traveled residents in various parts of the GTA and compare them. Attached in note 1 to this appendix are summary pages from the Transportation Tomorrow survey findings; an explanation of the adjustments made to these findings; and a few further references which cast further light on my rationale. I have tried to be scrupulous in making any adjustments to arrive at an annual comparison of vehicle km. traveled, and before doing so have asked for and received advice from the Transportation Tomorrow Survey personnel at the University of Toronto.

The following travel projections of average annual vehicle miles traveled are based on the most recent available 1996 TTS data. For consistency, population numbers were also taken from that source.

Region/Municipality	Population	Average Annual vehicle km. per resident
Uxbridge	**14,700**	**9,366**
Durham Region	**450,400**	**6,934**
York Region	**567,700**	**6,191**
Peel Region	**812,500**	**5,379**
Halton Region	**328,300**	**6,675**
Four region total	**2,158,900**	**6,114**
City of Toronto	**2,305,600**	**3,036**
GTA Total	**4,464,500**	**4,517**
Toronto pre amalgamation	**633,500**	**2,487**

* See www.jpint.utoronto.ca

Using the above data, following are 2 future scenarios for the year 2021 both involving the addition of 2 million new GTA residents to the above population forecasts.

- In the first scenario continued sprawl was assumed. The close to six and a half million residents were assumed to maintain the 1996 vehicle km. average of 4,517.

- In the second 'nodal' scenario it was assumed 1million people would be added in Toronto, for a total of 3,305,600 and that as a result of this additional density over the 20 year period and more opportunity to use public transit, walk etc, that the current average annual vehicle km. use in Toronto would decrease from the 1996 average of 3,036 veh. km. to the 1996 average in pre amalgamated Toronto of 2,487 km.

It was further assumed that 1 million new residents would be added outside Toronto in a more nodal fashion for a total of 3,158, 900, and that as a result of this greater nodal density and the opportunity this created for transit and non auto trips, the current 4 region average annual veh. km. average of 6,114 would be reduced to the current GTA average including Toronto of 4,517.

Scenario one involves 6.7 billion additional vehicle km. annually than the nodal scenario.

It doesn't matter if the two scenarios are completely accurate. I suspect that both may be underestimates. Since under the sprawl scenario 75% of new residents would be added in the suburban Regions where auto use is far higher than Toronto. And in the absence of a shift to more nodal growth, many of these new residents would be accommodated largely in greenfields farther from amenities than their counterparts even in the suburbs, I feel auto use would almost inevitably be considerably higher than the current averages used in scenario 1, which are held down by the relative size of Toronto.

On the other hand it can also be argued, (to my thinking with less merit), that the nodal scenario above might involve a bit larger shift from auto use than could realistically occur over that period.

Regardless however the 6.7 billion km. figure above, seems to me to be a realistic projection of what future differences between sprawl and nodal options might be.

2 - Quantifying the Societal impacts of the auto impacts of sprawl

In terms of quantification, in the interests of simplicity I will deal only with the areas addressed by IBI in the previously referenced report which formed the basis for their work for the 1995 GTA task force. IBI include what they called a 'basic' estimate of the estimated costs of auto emissions, and the publicly borne health care and policing costs of accidents, (3.18 cents per veh. km.), and an 'enhanced estimate which included as well the costs of congestion and parking and land associated with auto use in urban areas, (14.94 cents per veh. km.).

a - Accidents - As far as accidents are concerned, IBI based their estimate on a Report prepared for the Ministry of Transportation in collaboration with Abt Associates entitled The Social Cost of Motor Vehicle Crashes in Ontario. * and came up with a figure of .11 cents per veh. km! I have used this source as well. The difference is that in their estimate IBI basically used only the public costs incurred – basically the OHIP and policing costs and eliminated any impacts on individuals. For example, using this methodology, dividing these costs shown for fatalities, (some $3.1 million), by the fatalities in the period, (1145), resulted in an average cost per fatality of $ 2726! I cannot imagine that any level of government making decisions which affect life and the quality of life would quantify human impacts for that purpose in this way.

If IBI had used the full cost of more than $ 9 billion cited in the Ministry of Transportation Report, rather than $209 million, their per vehicle km. estimate would have been 4.78 cents per vehicle km. Since these figures were based on 1990 numbers, I feel 10% should be added to this number to cover inflation, resulting in a figure of 5.256 cents per vehicle km. These full costs include an estimate of individual costs based on a willingness to pay analysis, which the MTO report authors felt was " the correct assessment to use in assessments of how much of society's resources should be devoted to reducing the human consequences of motor vehicle crashes.", (see page 9 of that report).

The only instance then in which I am substituting my judgment instead of IBI is to assume the full costs, not just the public costs should be used and to add 10% for inflation.
This resulting 5.256 cents per km. figure is again very much in the range of estimates from other jurisdictions. In their 1994 Full cost transportation Pricing Study which was the basis for their work for the GTA task force, IBI quote European studies as projecting costs of 3.4 – 8 cents per vehicle km. Todd Litman of the Victoria Transport Policy Institute whom IBI also referenced estimates 'internal' accident costs at 4.7 cents and 'external' accident costs at 3.3 cents for a total of 8 cents. **.

In fairness to IBI, I should point out that the objectives of the detailed report they had prepared, from which they derived the numbers they used for the GTA task force involved comparisons of government subsidies, analysis of user pay approaches etc., purposes for which it made sense not to include any individual impacts. However if one is developing figures to use in comparing the impacts of various land use decisions surely human consequences need to be factored in as well as OHIP costs.

b Air Pollution - IBI's estimate for air pollution used for the GTA task force was 3.07 cents per vehicle km. Following is a summary of IBI findings, (see previous reference p- 3.18), from what they considered to be the most relevant reports on air pollution. These findings are in cents per passenger km. but have also been translated into cents per veh. km.

* See note 2 to this appendix for relevant material from the IBI and Abt reports.

** Todd Litman, Victoria Transport Policy Institute, Transportation Cost Analysis: Techniques estimates and implications. July 1999. This is an excellent comprehensive report covering a very broad range.

Comparison of Automobile External Cost estimates for air pollution
1994 Canadian cents per passenger Km.(as reported by IBI)

Component	European Studies	Miller & Moffet Rural/urban	Litman	DRI/ McGraw-Hill	IBI
Air Pollution (Includes climate change)	1.5 – 5	4.3 – 9.9	3.7	.3 – 4.9	2.19
Per veh km. (1.4 vehicle occupancy assumed)	2.1 – 7	6 - 13.9	5.2	.42 – 6.9	3.07

It should be noted that the DRI estimates above are national U.S. averages developed by applying rural and urban miles to their external cost estimates, so the low end of the range does not apply to the far more urban GTA comparison we are making. IBI's estimates of $2.19 and $3.07 seems to include approximately .77 and 1.08 cents for climate change with 1.42 and 1.99 cents covering health costs of air pollution.*

In addition Litman (see pages 3.10-1. – 3 10-11 in previously cited Report), references the following data on air pollution costs. Again all have been translated into Can$ per vehicle km.

Apogee Research study - Boston 6 cents – 11 cents (peak, off peak, Expwy, Non expwy)
- Portland 8 cents – 15 cents
Office of Technology assessment - 1.8cents – 9 cents

Miller and Moffet - 5 cents - 9 cents

Small and Kazini - 3cents(for tail pipe particulate and ozone only), reducing to 1.5 cents after the year 2,000. This estimate was done for Southern California. Emission costs in other urban regions estimated at about one third of these values. The study omits CO and non-tailpipe particulate emissions, and authors emphasize analysis is partial and road dust may add 4 cents per veh. km. and global warming costs may be significant.

Litman conclusions - 4.2 cents plus 1.1 cents for greenhouse effect
Range of estimates .9 – 19 cents

Litman also stresses that " Pollution control equipment has reduced emissions per vehicle mile, but residual tailpipe emissions (especially from cold starts and evaporation) and particulates from tires, brakes and road dust result in significant costs"(3.10-11). **

* See IBI pages 4.22 – 4.23.table 4.20. I say seems because it is not always clear how IBI built up their overall estimate. Also IBI does not quantify CO (carbon monoxide) emissions because "of short life of the substance". I will check further. Surely one cannot conclude, as IBI seems to imply, that Carbon monoxide from autos has no health impact because of this short life.

** Litman also references the EPA PART5 vehicle emission model in commenting that "Vehicle tire and break lining wear are estimated to produce about the same quantity of small particulates as tail pipe emissions, and road dust is estimated to produce considerably more."(3.10-2) Furthermore Litman references an article in the Journal of Clinical Immunology, in stating that, "The chemical composition of the fine latex particles produced by modern automobile tires appears to be highly allergenic, both alone and in combination with other pollutants"(3.10.9)

It is interesting to relate these ranges to the health impacts of air pollution alluded to in the Ontario Medical Association and Toronto Board of Health reports completed last year.

Highlighting this variable reinforces again just how conservative and narrow it is to just look at public external costs as opposed to the private costs, and pain and suffering etc., and counter any arguments that might be advanced in other areas that the numbers overestimate the impacts.

Following are a few quotes from these Reports:

" A study to be released next week by Toronto's public health department says that air pollution kills roughly 1,000 people a year in Canada's largest city and puts another 5,500 in hospital. Many of the deaths and illnesses result from pollution levels far below legislated targets, the study says, especially in the case of nitrogen dioxide much of it from car exhaust."*

"Smog will cost the Ontario economy and health care systems more than $1 billion this year says the Ontario Medical association…'The costs of poor air quality are extremely high …These are the direct out of pocket expenses for taxpayers, employers and employees in this province … this could be prevented if we had clean air' (association President DR. Albert Schumacker). The real costs are likely higher said Dr. Ted Boadway the association's executive director of health policy. Researchers were unable to compile the cost of visits to doctor's offices because of the complexity of the Ontario health-care systems codings…. Broadway emphasized the conservative nature of the study and its use of the lowest numbers available when researchers came up with a range of estimates in any of the 80,000 pieces of information used to create a computer data base. The study was also limited by its examination of just two air pollutants: ozone and microscopic solids…. The study estimated that 500 people will die prematurely from smog-related illnesses in Toronto this year, with health care costing

$150 million and economic losses of $128 million. By comparison a Toronto study last month estimated 1,000 people will die prematurely in the city. That study included more air pollutants like carbon monoxide, a significant part of smog largely contributed by automobile engines."

"Broadway explained the full cost is even higher when the pain and suffering and deaths caused by smog are calculated in a way similar to monetary awards in civil court cases for people who suffer injuries in a car accident. That boosts the annual loss up to $10 billion, the study estimated"

"Researchers also used the computer program to project the impact of the Province's anti smog plan that the Progressive Conservative Government recently decided to have implemented by 2010. The study shows there will be more deaths after the smog plan is in place than there will be this year" **

* Globe and Mail, May 19, 2,000 A19. Full Report can be viewed at www.city.toronto.on.ca/health/hype/air.htm

** all quotes as reported in Toronto Star June 28, 2,000. For full report see OMA website www.oma.org

A back of the envelope example may help demonstrate. The OMA study estimated that **two pollutants only** - ozone and microscopic solids resulted annually in 835 deaths and health care and lost productivity costs of $522 million in the GTA. annually. This estimate didn't even factor in the cost of visits to doctor's offices in this estimate because the figures were not available.

Furthermore as also quoted earlier, the Toronto Health Department included more air pollutants including carbon monoxide in their estimate of premature deaths from air pollution in Toronto and came up with double the estimated deaths in Toronto, (they did not estimate deaths in the entire GTA, nor did they estimate costs.)

If one assumed that 25% of the most serious pollutants come from passenger vehicles*, operated by GTA residents and divided 25% of the $522 million OMA estimate into the estimated 20.199 billion annual veh. km. traveled by GTA residents **, the per vehicle km charge from this source alone would come out to .646 cents per veh. km.

Furthermore if one doubled the OMA estimate to reflect the wider range of air pollutants reflected in the Toronto Health Department Study and to cover off some of the other items left out of the OMA analysis such as doctors visits***, the per km. charge would rise to 1.292 cents per veh. km. And finally if one were to use the OMA estimate for pain and suffering which they calculated in a way similar to monetary awards in civil cases for people who suffer injuries in a car accident, and again use 25% of that, to reflect the motor vehicle impact then **the per Km. health cost for the 2 air pollutants alone would be 5.41 cents, 1.7 times the IBI estimate for all air pollution including health and environmental impacts.**

Introducing a GTA specific study like the OMA study, which does not limit external costs to costs incurred by governments, again provides a good mechanism for questioning the IBI approach. The IBI approach may well make sense given that one of the major objectives of their study was that it be used as a basis for implementing user pay and full cost pricing for major transportation modes in Ontario. However when the objective is to assist in making choices between land use alternatives surely a different conclusion should be drawn. Why shouldn't pain and suffering and death of GTA residents be introduced when major land use decisions that can add to that pain, suffering and death are being made?

To conclude how does one s up and come up with a number or a range? Unlike areas like accidents or congestion, the costs of which are rising, tailpipe emission standards have improved and will continue to do so. On the other hand air pollution impacts from cars, come not only from tail pipe emissions but road dust and other particulates etc., whereas IBI talks of their estimate as an emissions estimate only.

* For rationale behind this number see Note 3 to this appendix.
** 1996 TTS total GTA daily auto driver trip lengths times 365. (the sum of Toronto, York, Durham, Halton, Peel). See note 1 for rationale.
*** And in most instances of suffering and lost productivity due to air pollution, people don't even consult Doctors, they suffer in silence.

I would suggest that the lowest number that should be contemplated is IBI's 1995 estimate of 3.07 which adjusted by 10% for inflation would be 3.377 cents per veh. km. Personally I would be more comfortable in using Litman's projection noted above of 5.2 cents, so will use a range of 3.38 – 5.2 cents to reflect this impact.

c Congestion, parking, and land associated with auto use in urban areas.

IBI's estimate for the GTA task force for these items was 11.76 cents per veh. km. which updated for inflation would be 12.936 cents per vehicle km.

Reviewing the literature, this does not seem inapropriate.

As far as Litman is concerned, who seems a prime source for IBI, his more recent reports suggests a congestion figure of 15.9 cents for urban peak and 1.8 cents for urban off-peak, and cites a range of 1.8 to 5.6 cents. (See Litman 3.5-8,- these and following numbers are all converted to Can cents per veh. km.)

The U.S. Department of Transportation in their 1997 cost allocation study suggests ranges for rural and urban highways and for all highways combined. Median values for these ranges are 1.2 cents (rural highways), 5.8 cents urban highways, and 3.74 cents for all highways. (see table V-23, also Litman page 3.5-3).

With regard to other externalities Litman suggests a range of 2.9 – 9.6 cents for parking externalities, that is parking subsidies and free parking, and a further 1.9 – 19 cents per veh. km. covering a wide range of other land use impacts, (see 3.4-9, 3.14-16).

Of all the categories costed in this appendix, this group particularly congestion is very location specific. So while there is something to be learned from estimates in other jurisdictions, GTA information is by far the most valuable.

GTSB Reports and the Provincial Transport Ministry reports quoted tell us that congestion is now imposing an economic cost of approximately $2 billion on the GTA. The Transport Ministry indicates this number came from the 1987 Metropolitan Toronto Goods Movement Study a technical report prepared by the Metro Roads and Traffic Department. In a nutshell this study estimated that the shipping cost of moving goods annually where origins or destinations, or both, are within the GTA was $6.4 billion annually, and that 30% of that cost, or almost $2 billion was due to congestion, even in 1987, (see p- 1-13,1-14). This total did not include trips through but not stopping in the GTA. *

*The study did not limit itself just to metro but looked as well at other urbanized areas of the GTA including Pickering and Markham. The study further projected that if past trends continued, and without offsetting measures, by 1997 more than 50% of the cost of moving goods would be due to congestion and this **increase alone** would cost more than $15 billion (in 1986 $), within the GTA, with Metropolitan Toronto likely to account for 75% of the Total. (see p - 1-14). Of course as the Report points out things don't stay the same. Such increases inevitably lead to further relocation/rationalization within the industry

Again as a rough rule of thumb let's take half of this figure; to take trucks and non-GTA resident traffic out of the equation and to be conservative in our estimates. One billion divided into the approximately 20.199 billion auto vehicle km. generated by GTA residents in a year (these are the 96 estimates referred to earlier), results in a per km. charge of 4.95 cents. Adjust this 1987 figure by 20% for inflation alone and it becomes 5.94 cents per vehicle km.

And ask any transportation planner if he or she feels congestion will be far greater in the next 10-20 years in the GTA, than it was when this study was completed, and one will get near unanimous agreement that it will be worse.

Remember as well, that as mentioned, this goods movement estimate did not even include the congestion impact on goods moving through the GTA but not stopping there. Nor quite apart from home commuting and the impact on the quality of life of commuters, did it attempt to quantify the economic impacts of congestion on loss of time business travelers incur on the myriad of GTA business to business trips by individuals during the day, where goods movement was not a component.

All Greater Toronto area reports project congestion costs are increasing and will likely increase significantly even if roads are added and measures to deal with it are partly successful. This is one of the fastest growing urban areas in North America. Furthermore as argued earlier, given congested roads already, surely additional auto intensive development far in excess of GTA averages will have a **far more then proportional** impact on congestion.

Accordingly it would not be surprising if congestion alone would not account for almost all the inflation adjusted 12.936 cent per vehicle km. estimate projected by IBI to include congestion as well as parking and land associated with auto use in urban areas.

Cost impacts of parking and auto use in urban areas is an area which unlike the others I have not studied in any detail, and so do not have much to offer and will therefore accept at present the IBI estimate above.

To conclude, IBI's estimate updated for inflation of 12.936 cents per veh. km. for external congestion, parking, and external costs associated with land associated with autos in urban areas is a most conservative estimate for the GTA.

3 Summing it all up

If one adds up accidents (5.256 cents), air pollution (3.377 – 5.2 cents), and congestion, parking and land associated with autos in urban areas, (12.936 cents), one comes up with a total range of 21.6 – 23.4 cents per veh. km.

Remember that apart from accidents the 21.6 cent number is IBI's projection updated for inflation. It is important to note that there are many external costs not touched on here. Noise impacts, and land and water pollution and hydrologic impacts are just two examples.

Furthermore, the GTA is cut off from the south by the lake, and the vast majority of the land that Toronto can expand onto is either prime farmland, land close to stream and valley corridors, or on the Oak Ridges Moraine – all land that is important to preserve. So the GTA is unlike some urban areas where the surrounding area might be more marginal land. When IBI and the GTA task force attempted to quantify auto externalities and the added societal cost of sprawl versus nodal forms of development, absolutely no effort was made to quantify the fact that sprawl resulted in the loss of many thousands of additional acres of farmland.

Professor Robert Wright notes the estimate that the GTA lost 3035 hectares or 7500 acres annually from 1976 – 1997.* Unless patterns of growth change this loss will continue, with another 150,000 acres of farmland lost over the next. 20 years.

I can see disagreeing about the value to put on the permanent loss of prime farmland and green space in the GTA. Surely however **attributing no value to such loss cannot be justified.**

To conclude, while we presently **recommend a range of 20 – 25 cents per veh. km. we** feel it is most conservative, and feel that other categories such as farmland and greenspace lost, and environmental impacts on land and water, as well as air should be evaluated and included.

And when one applies this 20 – 25 cent per veh. km. range to the estimated additional 6.7 billion odd extra veh. km. traveled annually in the GTA by the year 2021, if sprawl is allowed to continue, and more nodal patterns of development are not implemented, (see projection in 1 above), this amounts to an **additional annual cost in the GTA of $ 1.3 – 1.7 billion.**

And taking into account Uxbridge travel patterns, (9,3666 annual veh. km. per resident), **adding 10,000 new residents in Uxbridge, or a similar more remote part of the GTA, would cost an additional $ 9.7 – 12 million annually, than accommodating that same 10,000 in a more nodal fashion reflecting GTA travel averages**, (4,517 annual veh. km. per resident)!

This cost of sprawl not only does not take into account many external costs, it **does not take into account the hard costs associated with sprawl (roads sewers etc.**). Dr. Pamela Blais in her1995 paper, The Economics of Urban Form, prepared for the GTA Task Force, estimated that continued 'spread' development would result in annual **additional hard costs of $500 million and $800 million when compared to 'nodal' and 'central' forms of development. If one updates these numbers for inflation (10%), they become $550 and $880 million respectively.**

Furthermore in this report Dr. Blais states (see summary), " An urban form which seeks to minimize overall infrastructure costs would likely be a hybrid of the central concept, (making use of all available land and infrastructure within the already urbanized envelope), and the contiguous greenfields urban development assumed in the spread and nodal scenario, but at higher densities than envisaged under the spread scenario, and excluding the discontinuous development in outlying nodes contemplated under the nodal scenario. **Such a scenario would likely produce lower costs than any of the three concepts…**".

. * The Evolving Physical Condition of the Greater Toronto Area, Feb 2,000 Professor Robert Wright with financial assistance from the Neptis foundation.

Dr. Blais also notes (p-31), the **cost of the spread scenario was underestimated,** because the full extent of new roads required that could not reasonably be accommodated within the inner city fabric was not costed

Furthermore, **user costs associated with auto ownership and use, and additional time spent commuting, are also not included in these estimates**.

In my analysis I have considered external costs and some internal or user costs as they relate to air pollution and accidents. These user costs have been included because they are imposed by one user on someone else, and also because they are not chosen.

Auto expenses, user parking expenses, and travel time expenses are something the user has some choice over so they have not been included. I say 'some' choice however because if a very significant % of the GTA housing is in areas which are auto dependent, and or if the individual's employment is far from home and not accessible by transit, then the ability to avoid these auto related expenses becomes more limited.

Litman estimates fixed and variable auto costs at 26.7 – 48.7 cents per veh. km., user parking costs at 2.9-7.6 cents per veh. km. and travel time at 14.7 – 45.5 cents per veh. km.*.

If one relates these numbers to the estimated 6.7 billion additional veh. km. resulting from sprawl one can conclude that if more nodal forms of development were adopted:

- **GTA residents could annually save $ 2 - $ 3.8 billion on auto and parking expenses.**
- **GTA residents could annually save auto travel time valued at $ 1 - $ 3 billion.**

These numbers are obviously approximate. Better estimates for the GTA could no doubt be made. It is true also that given more nodal development some of the above auto saving would be spent on transit etc. There is absolutely no question though that more nodal forms which reduced auto dependency and mixed uses, bringing work, home, shopping and amenities closer to each other would save GTA residents a very great deal of money.

To conclude, many billions of dollars annually could be saved by governments and their citizens if a 'smart growth' management plan was developed and enforced in the GTA Such a plan would also not conflict with, and indeed would be very supportive of quality of life and environmental considerations.

The actual numbers presented in this report all need further study. We urge government to take action to refine them and then act upon them. This issue is far too important to ignore.

* see Litman 3.1-8, 3.2-5, 3.4-9. With regard to travel time, passenger km. numbers are multiplied by 1.4 to convert them to veh. km. Also Litman bases time values on values used by the B.C. Ministry of Transportation, in which according to Litman. "drivers time is valued at U.S. $ 4.20 per hour (50% of $ 12.00 average wage), and passengers at U.S. $ 4.20 per hour (35% of $ 12.00)."

Note 1 to Appendix 1 – Documentation / Rationale for vehicle km. forecasts

Attached as well are pages containing the latest data (1996), from the Transportation Tomorrow Survey prepared by the Data Management Group, University of Toronto Joint Program in Transportation which outlines demographics and travel characteristics in Uxbridge and elsewhere in the GTA. It estimates average weekday number of auto driver trips and associated auto driver means trip lengths for residents in each area. Attached as well is the foreword to that study explaining their methodology. (**note** - the electronic version of this report does not contain the TTS detail)

Good as this information is however, it does not go quite far enough. Firstly, the survey trip lengths are calculated by measuring the diagonal point to point distances between origin and destination and do not reflect the predominantly grid road network between those points south, then west, then south again for example if we travel from Uxbridge to Toronto. We can get closer to an accurate number by applying high school geometry and the Pythagorean theorem which states that the two right angled sides of the road grid network are 1.41 times longer than the diagonal which in this case reflects the point to point distance. On average then, we would have a far closer approximation of actual vehicle Km. on any trip if instead of using trip lengths we multiplied trip lengths by 1.41. However since this may overstate the situation, in this report we will multiply trip lengths by 1.2 to get a proxy for vehicle Km. traveled. I have checked with the Transportation Tomorrow Survey to see if would be possible to replace these figures with a more accurate figure, by having transportation data fed into a computerized designation of the road network.* Dr. Eric Miller the Director of the joint program in Transportation at the University of Toronto informed me that such an approach might be possible but that he was not convinced that the overall conclusion would change at all. We have therefore not taken this step.

Furthermore, although studies demonstrate that auto work and school trips are reported very accurately, other discretionary auto trips, which formed 59% of all auto trips in Uxbridge in the 1996 survey, are significantly underreported. In fact a study recommends using a correction factor of 1.33 to adjust discretionary trips upward to reflect this under reporting.**

Furthermore, the travel survey measures weekday not weekend travel, which would have quite different characteristics, and in addition does not provide as much information on trips made by non residents to more suburban regions or to a municipality like Uxbridge. Not only do such residents travel greater distances by auto than residents living in more nodal fashion, individuals visiting these areas will also travel further on average to work or visit residents in these areas. than those travelling closer to major urban centers. The larger and more far flung the GTA population and sprawl in, the more trip lengths and numbers will increase for both residents and visitors. Servicing this more far-flung population will also require more commercial traffic. s.

* Dr. Eric Miller and Dr. Amer Shalaby have taken this approach and produced actual information on vehicle trip lengths by "assigning" observed 1996 travel survey auto-drive trips to a computerized representation of the road network taking into account road congestion effects. See Travel in the Greater Toronto Area: Past and Current Behavior, Jan 2,000, Dr Eric Miller and Dr Amer Shalaby with financial assistance from the neptis foundation. Pp. 39-42. We have contacted Dr Eric Miller and others at the Transportation Tomorrow Survey, about the possibility of using a similar approach for our purposes.

** See Jan 99 Report by Peter Dalton on Discretionary Travel in the 1996 TTS Survey at www.jpint.utoronto.ca

Table 1 below was initially arrived at by multiplying weekday number of auto driver trips by mean driver trip lengths and then by 365 days to obtain the annual estimate. The numbers weren't changed, because the more accurate way of approaching it given our present knowledge results in essentially the same answer. If one were for example to multiply weekday trip length totals by 1.2 to get a conservative estimate of veh. km.; add 10% to reflect underreporting of discretionary trips;* multiply this by 230 work days to get an annual km. estimate, to eliminate weekends, and statutory and regular holidays, and even some sick days; and make some adjustment for weekend travel – for example assume that residents are outside the GTA on 4 weekends, and on the remaining 48 weekends, vehicle. km differences are half as much as a typical weekday**, the result is a slightly **greater** number than multiplying daily trip lengths by 365. And this does not even attempt to reflect additional visitor travel or commercial travel. As these estimates are refined we are confident they will be conservative.

Table 1 - Annual vehicle miles traveled by Region/Municipality

Region/Municipality	Population	Average Annual vehicle km. per resident
Uxbridge	**14,700**	**9,366**
Durham Region	**450,400**	**6,934**
York Region	**567,700**	**6,191**
Peel Region	**812,500**	**5,379**
Halton Region	**328,300**	**6,675**
Four region total	**2,158,900**	**6,114**
City of Toronto	**2,305,600**	**3,036**
GTA Total	**4,464,500**	**4,517**
Toronto pre amalgamation	**633,500**	**2,487**

* 59% of trips by Uxbridge residents are discretionary, and as mentioned earlier it has been suggested a correction factor of 1.33 be applied to these trip numbers. Discretionary trips are assumed to be one-third the length of other trips in arriving at an overall 10 % underreporting factor. I assume this estimate could be further refined by obtaining data on discretionary trip lengths/veh km traveled for Uxbridge and the Regions.

** Perhaps a slightly more accurate estimate of weekend travel could be arrived at by basing it on weekday discretionary trip numbers and distances only (e.g. eliminating work/school trips), and then increasing the discretionary trip differences by a % - say 50%-75% to reflect the fact that given additional time on weekends there are likely to be more and longer discretionary trips on weekends particularly in the country distant from major shopping and other amenities

Note 2 to appendix - IBI and MTO material related on Motor Vehicle Crashes

Attached are the following:

- Two sections from IBI's Full Cost Pricing Study
    - The first few pages of the executive summary highlighting the objectives of the study
    - two pages in the body of the study which document IBI's use of the MTO study in arriving at their estimate.

- The Table of Contents and first few pages of the MTO report on the Social Cost of Motor vehicle crashes in Ontario. Exhibit 2.3 in that highlight section displays the numbers used. I have handwritten on that schedule the numbers from that schedule which IBI included.

Note – the electronic version of this report does not contain this information)

Note 3 to Appendix - Quantifying the percentage impact of auto travel on health in the GTA

It is very difficult to evaluate how much of the health impact the OMA study and the Toronto Public Health Department attributed to air quality, can be further attributed to auto use generally, and to GTA auto use in particular. Some pollutants are more locally generated; some travel more broadly throughout the eastern U.S. and Canada. These patterns change with the prevailing winds and the seasons. Pollutants interact and the different medical studies sometimes attribute health impacts to different pollutants

The Toronto Health Department study breaks out the number of deaths attributable to individual pollutants. The Toronto Health Department Report also displays 1995 information from the Ontario Ministry of the Environment which outlines the auto source percentage of each of these pollutants emanating from human activity in Toronto.

In the end Toronto health department estimates of the number of deaths from each of these pollutants were reduced to reflect the auto source percentage of that pollutant emanating from human activity within Toronto. The next step was much more arbitrary. The deaths from each pollutant were then reduced further by guessing at the % amount of any particular pollutant which was generated beyond the borders of the GTA. As more accurate estimates of pollutant sources emanating beyond the GTA become available these figures can be readjusted. The following table reflects the above this approach:

Pollutant	Estimated * No. of deaths	% of Toronto emissions emanating from autos**	estimated emission % from outside GTA	No.of deaths from GTA autos
Particulate Matter + SO 4	335	3.5%	50% ?	6
CO	441	57%	0%	251
NO 2 +	511	26.7%	50% ?	76
Ozone	59			
	570			
So2	119	10.5%	50% ?	6
Total	1356			339

% of total deaths from GTA autos (1356 divided by 339) - 25%

* P-8, Toronto Health Department.

** P- 16 Toronto Health Department Study, based on data from The Ontario Ministry of the Environment.

See over …..

Just a couple of other comments on the above approach. Using deaths as a proxy for financial impact underestimates significantly the health impact of ozone, since although it doesn't result in many deaths it results in many hospitalizations. Adjusting for this would reduce the % impact of autos.

On the other hand, Ozone is a secondary air pollutant that is formed when nitrogen oxides react with volatile organic compounds in the presence of sunlight, and as the Toronto Health department study states, (p-11), that "it has been determined that the most effective way to reduce ozone is to reduce emissions of nitrogen oxides". The total transportation sector produces over 80% of the nitrogen oxides emitted from human activity within Toronto. The % for auto only in the above table is 26.7% the rest coming from trucks, heavy-duty diesel and off road diesel. Placing greater numbers of people on the fringes of the GTA will not only result in more car travel but in more truck travel to service those individuals so for purposes of assessing Gan Eden impact a higher base % than 26.7% should have been used.*

As far as impacts from emissions outside the GTA are concerned, no reduction was made for carbon monoxide, because the impact is local. Nitrous oxides and the other pollutants were reduced by 50%. Some might argue that in the summer months even a reduction this large, still doesn't reflect the amount of pollution from non-GTA sources. ** However air pollution is a problem throughout the year so we need to reflect more of an annual average. ***

Furthermore, as already mentioned, the source of the most important pollutant, nitrous oxide is heavily transportation related. If in reality, some Toronto deaths and health impacts assumed to come from GTA transportation sources, really should be attributed to other transportation sources beyond the GTA, it is equally true that GTA auto sources combine with other sources to cause additional sickness and death, downwind of the GTA, in Eastern Ontario and Quebec and the Eastern U.S. These health impacts are not being quantified at all, so it is felt that attributing 25% of health costs from air pollution to GTA autos reflects the level of impact from this source and is fair even though the geographic distribution of both the source and the impact could be a bit different than assumed above.

Any suggestions on better ways of linking the health impacts documented in studies like the OMA study and the Toronto health department study to transportation and auto pollution sources would be appreciated.

* I am also checking with environment ministry officials to see if there pollution estimates for transport came from tail pipe emissions only in which case they would substantially underestimate the impact automobiles have with regard to particulate matter.

** A recent study prepared for Environment Canada, Ontario Power Generation Inc. and Hydro – Quebec projects that even in optimal 'Bermuda high' smog conditions in the summer, 84% of the contribution to Ozone formation in the GTA came from low level emissions (mobile sources and industrial facilities with low stacks), with 74% of these low level emissions coming from Southern Ontario, two thirds NOx, one third VOCs, (the study differentiated the GTA as a 'receptor' site but did not separate the GTA from southern Ontario as a source of pollutants). Unfortunately this study does not separate transportation from low stack sources but suggests that even in the summer the high stack sources particularly from cross border sources form a relatively small % of ozone contribution in the GTA. (The study indicates the situation is very different however in Southern Ontario west of the GTA, where there is a 71% contribution from low level sources and only22.2% of that emanating from Southern Ontario. See S-3)

*** As the Toronto Board of Health study states, (p-9), " Contrary to popular belief, poor air quality is not only a summer time health concern. The six air pollutants responsible for the burden of illness documented in this report are present in Toronto's air all year round. In fact, three of the six pollutants – nitrogen dioxide, carbon monoxide and sulphur dioxide—are present at higher levels in the colder months than in the summer months, and these three pollutants are responsible for almost 80% of air pollution-related premature deaths in Toronto."