THE EFFICIENCY OF URBAN TRANSPORT IN CANADA

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INTRODUCTION

This paper presents some of the results of a project carried out from 1969 to 1971 by N. D. Lea & Associates Ltd. for the Canadian Ministry of Transport and the Central Mortgage and Housing Corporation.

The objectives of the study were to evaluate the existing federal involvement in urban transportation, to consider the economic and social implications of possible changes in this involvement, and set out some priorities for research and action. The results give a broad brush indication of the magnitude of possible urban transport improvements in Canada and the savings attainable through such improvements.

In order to achieve these objectives, it was necessary for the various transport options to be evaluated in both economic and social terms. The economic evaluation is essentially a question of cost, whereas the social evaluation involves questions of quality of life and impact on the community.

For purposes of this presentation, we have reduced the economic evaluation to the question: "How much does urban transport cost?" in dollars per capita, including all items of cost which show in the GNP. These include such things as:

- road capital and maintenance costs;
- vehicle purchase and maintenance cost;
- vehicle operating cost;
- wages of drivers and of crew.

However, it would be inappropriate to express the social considerations, such as the quality and impact of transportation, in dollars and we have, therefore, used other indicators.

We have, for example, one piece of information directly available for gauging quality: namely, the amount of unpaid time which is consumed in transport, which we expressed in man hours per capita per year. Another quality consideration is availability which was expressed as the percentage of population who have the particular transport available to them. Accessibility is similarly given as an index of the number of places of interest that can be reached within a reasonable time over a particular transport system.

There are two additional items concerning the quality of transportation the comfort and convenience of the service. There are two major aspects to the impact of transportation. The first is safety - the effect of transport on loss of life and maiming of bodies. The second is the effect on the environment in terms of visual impact, noise levels and air pollution.

Personal rapid transit (P.R.T.) systems, or programmed modules, as we prefer to call them, were only one of a dozen improvement possibilities so evaluated, but we consider that this is the sort of evaluation required to put programmed modules into perspective.

The Analysis

During this project, we evaluated many urban transport policy options in social and economic terms. This included evaluation in terms of the dollar per capita cost of transportation, the quality of transportation as experienced by the users and the impact upon non users in terms of sight, sound and smell.

For the analysis, we required a national perspective, which was simulated by considering urban Canada to be made up of thirty-two small cities, seven medium-sized cities and three large cities; small being between 25,000 and 300,000 population in 1966, medium 300,000 to approximately 1 million in 1966 and large being Vancouver, Toronto and Montreal. Winnipeg (509,000 in 1966), Hamilton (449,000) and Edmonton (401,000) are examples of the

medium-sized cities, while Kitchener (192,000), Saskatoon (116,000) and Thunder Bay (98,000) are examples of cities in the small group.

From this basis, we intensively studied three representative or generalized cities:

City A: representative of the 32 small cities;
City B: representative of the 7 medium cities;
City C: representative of the 3 large cities.

The transport facilities of the generalized cities are shown in Figures 1, 2 and 3 in terms of link-node networks (Figure 3 shows only the central area of City C). They show both existing and proposed future facilities for each city.

Computers were used to simulate the social and economic effect of the present transport system and of the transport systems which can be expected in 2001 if present trends and policies are continued. This was called the neutral path. Then new policies and concepts were developed which were considered to be improvements. Their social and economic effects were assessed as the change from the neutral path condition.

Improvement Concepts

Ten improvement concepts were tested in this way:

1. Trucking
2. Motor Vehicles
3. Access Roads
4. City Form, Shape and Grain
5. Traffic Operations
6. Arterials and Freeways
7. Transportation Corridors
8. Public Transit
9. New Technology (including programmed modules)
10. Pricing

The findings are presented in a final report which was published recently by the Queen's Printer, and seven related technical memoranda. Let us now consider one by one the ten concepts for improving urban transport.

1. IMPROVEMENTS TO URBAN TRUCKING

It is an error of judgement to think of roads as being built solely for the automobile. It would be better to think of them as built for ambulances, moving vans, flat beds, fire engines, garbage trucks, oil trucks, dump trucks, buses and pick-up and delivery vans. The tremendous variety of vehicles that can move on the road has contributed greatly to the attractiveness of trucking which has now captured practically 100% of urban goods movements.

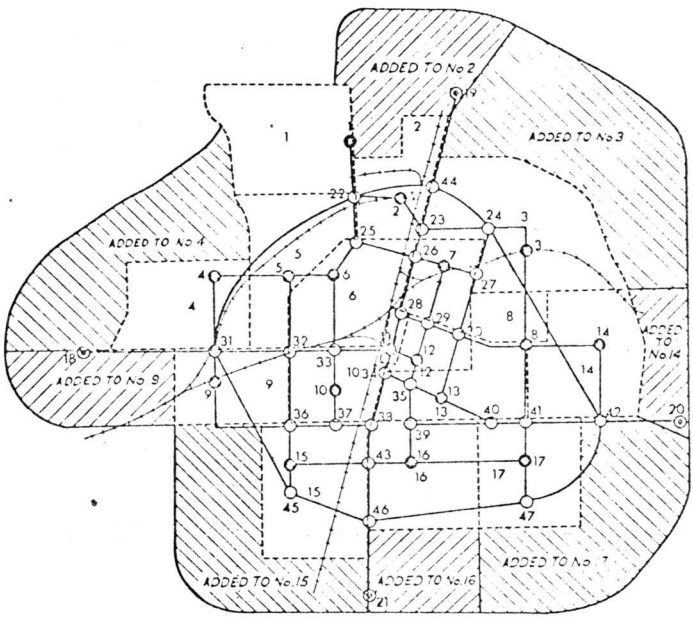
With increased affluence, we have more goods to move and higher truck driver wages to pay. Trucking already accounts for about one-half the total cost of urban transportation. Major economic benefits, of the order of $39 per capita per year by 2001 are attainable through this forgotten half of urban transport, as shown in Table 1.

The changes needed are operational improvements, such as the consolidation of shipments and of terminal facilities, so as to improve load factors (achieving benefits of up to $26/capita/year); and the replacement of the present inadequate shipping and receiving facilities, particularly in the downtown sector of many of our cities (benefits up to $13/capita/year).

2. IMPROVEMENTS TO MOTOR VEHICLES

The effect of the present and potential improvements to motor vehicles will be experienced chiefly in terms of their impact upon the environment and in terms of levels of safety.

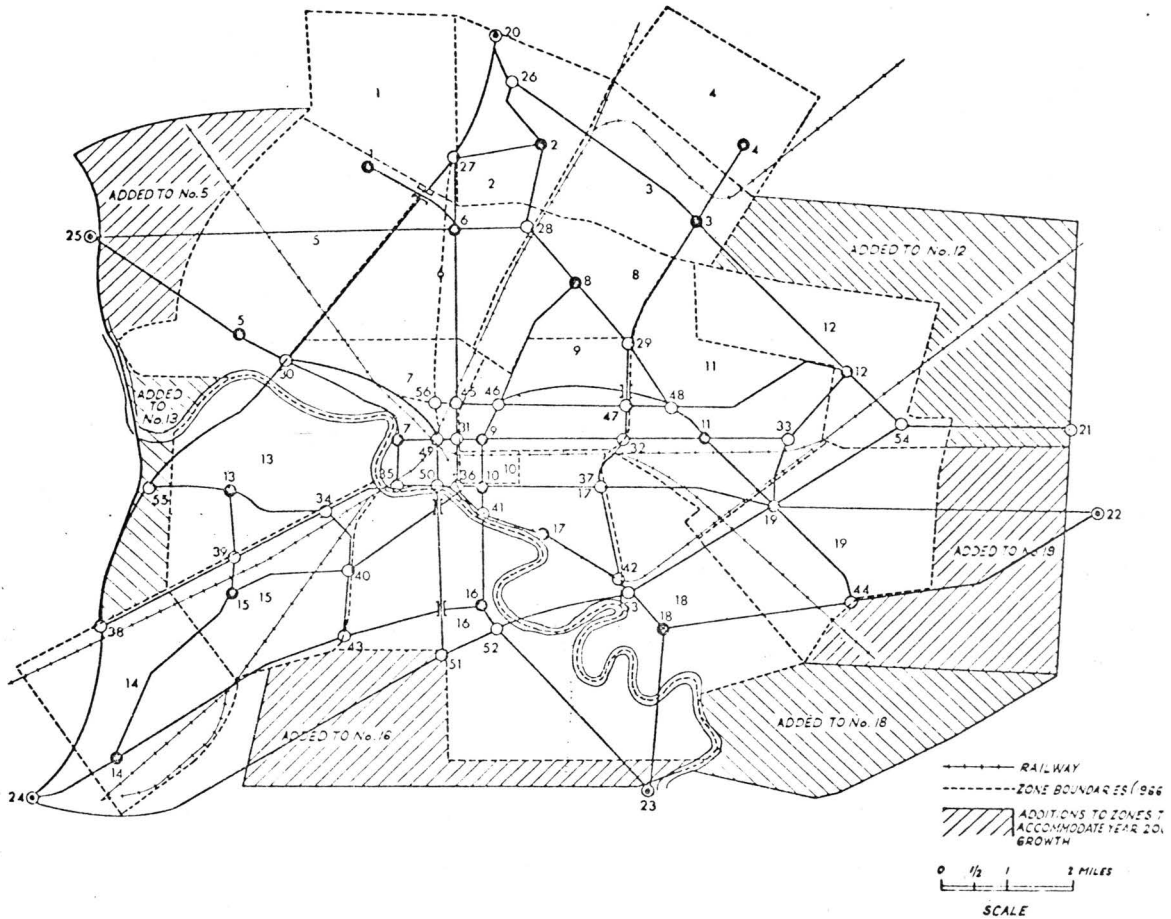
Figure 1



CITY —A—

DRAWING A 10

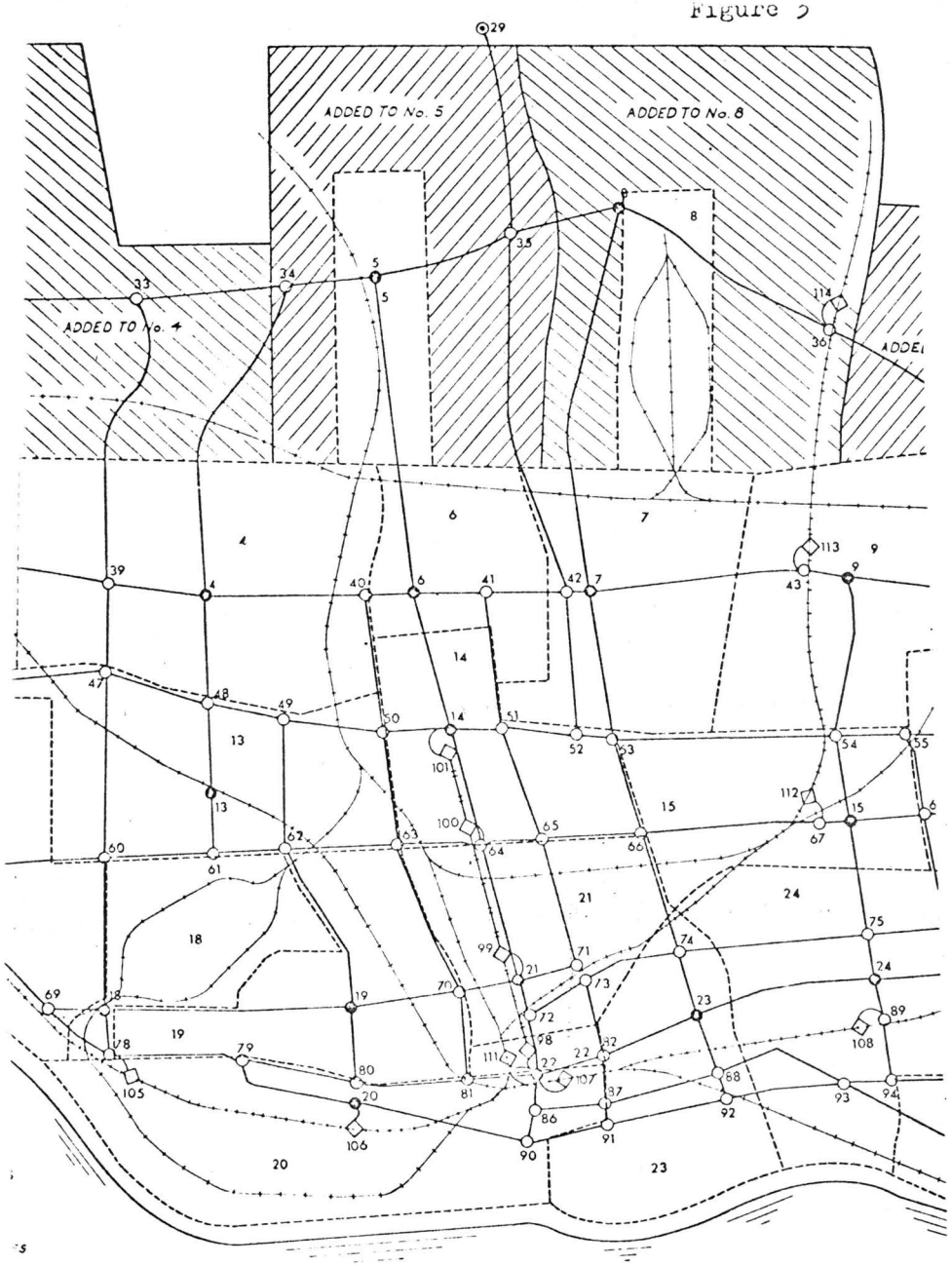
Figure 2



CITY -B-

DRAWING B10

Figure 5



CITY -C-

DRAWING C 10

TABLE I

SUMMARY OF EFFECTS OF MORE EFFICIENT TRUCKING

DESCRIPTION OF IMPROVEMENTS			Consolidation of shipments, terminals and trucking.	Improve shipping-and-receiving facilities
NEUTRAL PATH CONDITION			Truck terminal quality and truck load factors remain as 1966.	Percentage of time for shipping and receiving remains as now.
APPROXIMATE CONFIDENCE LIMITS			- 50% + 75% to + 200%	- 50% + 75%
TIME STREAM	EARLIEST LIKELY YEAR FOR SIGNIFICANT BENEFITS		1985	1985
	AMOUNT OF 1985 BENEFITS AS % OF 2001		40	30
EXTRA CAPITAL INVESTMENT REQUIRED ($ BILLIONS TO 2001)			Nil - only normal replacement and expansion of terminals	Small - mostly normal replacement and expansion.
ECONOMIC EFFECTS	TRANSPORT COST SAVING	TOTAL NATIONAL IN 2001	$0.8 Billions	$0.4 Billions
		PER CAPITA INCOME IMPROVEMENT IN 2001	$26/cap/yr.	$13/cap/yr.
	DISTRIBUTION OF INCOME IMPROVEMENT		all consumers	all consumers
SOCIAL EFFECTS	SAVINGS OF UNPAID TIME IN 2001		nil	nil
	ACCESSIBILITY IMPROVEMENT		nil	nil
	LIFE EXPECTANCY INCREASE		slight	nil
	ENVIRONMENT		Although consolidation will modestly improve environment, a much more substantial environmental improvement is possible through trucking by improving vehicle designs so as to decrease noise and air pollution.	

At the present time, considerable efforts are being directed to the improvement of safety features in automobiles, e.g. improved seat belt design, and stronger side beams in cars. These efforts are proceeding in the right direction and there is no reason why they should not be successful in improving the safety records provided we can get people to use them. Motor vehicles are presently responsible for a substantial amount of our air and noise pollution. Both of these are capable of solution by technological means through improved vehicle design.

3. CHANGES TO ACCESS ROADS

Every piece of property logically requires access by road, unless you want a place away-from-it-all on some island. A land-locked lot with no access road is virtually useless unless you own a helicopter. Thus, there is no way we can avoid building access roads, but we can avoid overbuilding them.

By using "adequate" rather than "excessive" standards for our access roads, savings of the order of $15 per capita per year can be effected, as shown in Table 2. Incidentally, the over-design of standards is usually due to the requirements of lending agencies or other regulating bodies.

By using good subdivision patterns to reduce unnecessarily circuitous travel and thereby the amount of travel time, further savings, of about $8/cap/year can be realized. In addition, public transit service to such areas becomes a practical proposition, whereas the spaghetti-type of layout is difficult to serve with transit.

4. CITY FORM, SHAPE AND GRAIN

We have given considerable attention to the question of city, form, shape, grain and activity distribution, but the results

TABLE 2

SUMMARY OF EFFECTS OF CHANGED ACCESS ROADS

DESCRIPTION OF IMPROVEMENTS			Lower standards	Improved patterns
NEUTRAL PATH CONDITION			Current standards continued	Current practice continued
CONFIDENCE LIMITS			- 25% + 50%	- 50% - 0%
TIME STREAM	EARLIEST LIKELY YEAR FOR SIGNIFICANT BENEFITS		1980	1980
	AMOUNT OF 1980 BENEFITS AS % OF 2001		10	10
EXTRA CAPITAL INVESTMENT REQUIRED			Negative, about $8 billion savings to 2001 which are included under "economic effects"	nil
ECONOMIC EFFECTS	TRANSPORT COST SAVING	TOTAL NATIONAL IN 2001	$0.5 Billions	$0.25 Billions
		PER CAPITA INCOME IMPROVEMENT IN 2001	$15/cap/yr.	$8/cap/yr.
	DISTRIBUTION OF INCOME IMPROVEMENT		all home owners	all living at low density
SOCIAL EFFECTS	SAVINGS OF UNPAID TIME IN 2001		nil	some
	ACCESSIBILITY IMPROVEMENT		nil	some
	LIFE EXPECTANCY INCREASE		nil	slight
	ENVIRONMENT		Some decrease in neighbourhood visual aesthetic values. Otherwise no effect.	Some decrease in local street traffic. Otherwise no effect.

were inconclusive because a proper evaluation involves many considerations that are far removed from transport. A summary of preliminary findings is outlined in Table 3.

5. IMPROVED TRAFFIC OPERATIONS

Improvements to traffic operations are the stock-in-trade of the traffic engineer, and such things as designated truck routes, pedestrian grade separations, one-way streets, freeway metering, off-street parking, computerized signalling, and channelization, have been successful in bringing very great benefits already to most Canadian cities.

There are still some places where substantial further benefits can be achieved by a more rigorous application of these techniques. These benefits are both economic and social and achieve both quality and impact improvements. The economic benefits are probably of the order of $29 per capita per year, as shown in Table 4.

6. IMPROVEMENTS TO ARTERIALS AND FREEWAYS

The study indicated that the provision of more and better arterials and freeways has perhaps the greatest potential for improving urban transportation over the next thirty years. Properly designed, these improvements can bring major economic benefits of up to $72 per capita per year plus major improvements to the quality and impact of transportation. These benefits are summarized in Table 5.

Better arterials and freeways will take through traffic away from residential streets; they can reduce air and noise pollution, and improve appearance.

If this is the case, why is there all the current anti-freeway activity? The problem is, of course, to find a place to put the new facilities without having to disrupt some community.

TABLE 3

SUMMARY OF EFFECTS OF CHANGES

IN CITY FORM, GRAIN AND ACTIVITY DISTRIBUTION

DESCRIPTION OF IMPROVEMENTS			More circular shape & fewer pockets	More concentrated CBD	Finer grain outside CBD
NEUTRAL PATH CONDITION			Present off-circular shape + pockets	as present	as present
CONFIDENCE LIMITS			-75% + 200%	uncertain	-50% +100%
TIME STREAM	EARLIEST LIKELY YEAR FOR SIGNIFICANT BENEFITS		1980	uncertain	1980
	AMOUNT OF 1980 BENEFITS AS % OF 2001		5	-	5
EXTRA CAPITAL INVESTMENT REQUIRED			$0.3 billion to $0.5 billn.	some	nil
ECONOMIC EFFECTS	TRANSPORT COST SAVING	TOTAL NATIONAL IN 2001	$0.1 billion	probably some	0.2 billion
		PER CAPITA INCOME IMPROVEMENT IN 2001.	$3	probably some	$6
	DISTRIBUTION OF INCOME IMPROVEMENT		very widely	to C.B.D. users	very widely
SOCIAL EFFECTS	SAVINGS OF UNPAID TIME IN 2001		some	probably	significant
	ACCESSIBILITY IMPROVEMENT		some	probably	some
	LIFE EXPECTANCY INCREASE		slight	slight	slight
	ENVIRONMENT		deteriorated because distance increased to "open country"	possibly better depends on design	debatable

TABLE 4

SUMMARY OF EFFECTS

OF TRAFFIC OPERATIONAL IMPROVEMENTS

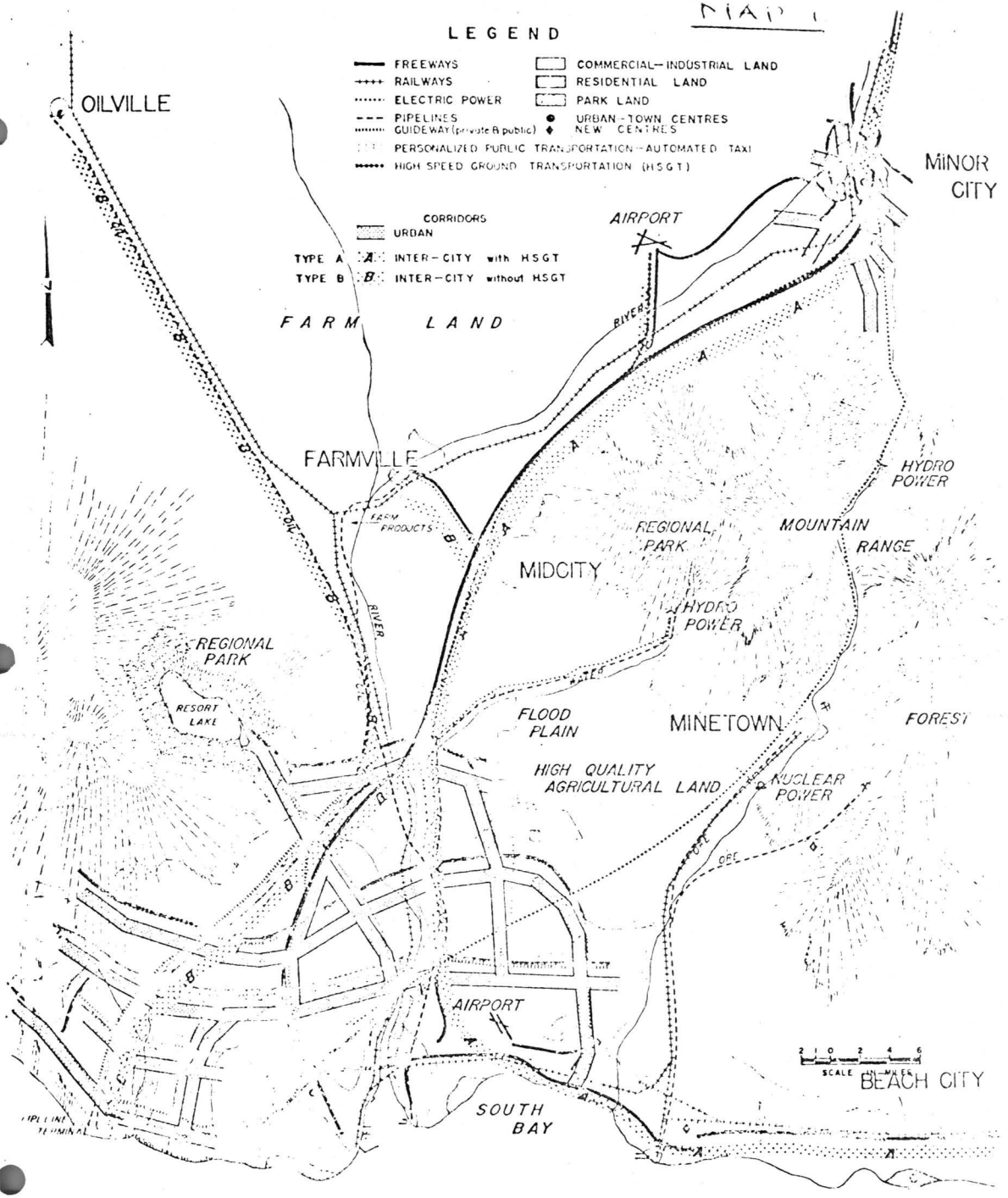
DESCRIPTION OF IMPROVEMENTS			Install computerized traffic control, freeway metering and other traffic operations improvements.
NEUTRAL PATH CONDITION			Current practice continues
APPROXIMATE CONFIDENCE LIMITS			-30% +30%
TIME STREAM	EARLIEST LIKELY YEAR FOR SIGNIFICANT BENEFITS		1975
	AMOUNT OF FIRST YEAR BENEFITS AS % OF 2001		20
EXTRA CAPITAL INVESTMENT REQUIRED			$0.35 Billions
ECONOMIC EFFECTS	TRANSPORT COST SAVING	TOTAL NATIONAL IN 2001	$0.9 Billions
		PER CAPITA INCOME IMPROVEMENT IN 2001	$29/cap/yr.
	DISTRIBUTION OF INCOME IMPROVEMENT		very widely
SOCIAL EFFECTS	SAVINGS OF UNPAID TIME IN 2001		27 man hours /cap/yr.
	ACCESSIBILITY IMPROVEMENT		substantial
	LIFE EXPECTANCY INCREASE		some
	ENVIRONMENT		significant decrease in air pollution

TABLE 5

SUMMARY OF EFFECTS OF ARTERIAL AND FREEWAY IMPROVEMENTS

DESCRIPTION OF IMPROVEMENTS			Improve the spacing of freeways and arterial roads.	Improve arterial and freeway network pattern.
NEUTRAL PATH CONDITION			Current published master plans for 1980 to 1986 are assumed to be built by 2001.	Continue as at present - basically a rectangular grid.
APPROXIMATE CONFIDENCE LIMITS			- 40% + 80%	- 40% + 80%
TIME STREAM	EARLIEST LIKELY YEAR FOR SIGNIFICANT BENEFITS		1980	1980
	AMOUNT OF FIRST YEAR BENEFITS AS % OF 2001		10	10
EXTRA CAPITAL INVESTMENT REQUIRED TO 2001			$1.8 Billions.	Very little if improvement made during planning.
ECONOMIC EFFECTS	TRANSPORT COST SAVING	TOTAL NATIONAL IN 2001	$1.8 Billions	$0.4 Billions
		PER CAPITA INCOME IMPROVEMENT IN 2001	$58/cap/yr.	$14/cap/yr.
	DISTRIBUTION OF INCOME IMPROVEMENT		very widely	very widely
SOCIAL EFFECTS	SAVINGS OF UNPAID TIME IN 2001		78 man hours /cap/yr.	24 man hours /cap/yr.
	ACCESSIBILITY IMPROVEMENT		substantial	some improvement
	LIFE EXPECTANCY INCREASE		some	slight
	ENVIRONMENT		sight, sound and smell are not necessarily affected but the mobility of the poor is likely to be decreased.	slight improvement

MAP 1



THEORETICAL CITY

POPULATION 1 Kg MILLION
POPULATION DENSITY 6,000 persons/sq mile

YEAR "X"

EXPANDED CITY

POPULATION 6 MILLION EXPANSION RATE 3% PA
POPULATION DENSITY 6,000 persons/sq mile

YEAR "X + 46"

TRANSPORTATION CORRIDORS

With a little thought, one understands that roads and streets are the most permanent landmarks of a city. As the city develops, the buildings change but the streets remain. This becomes particularly the case in city centres where the natural growth process creates more and more traffic on the same streets. And the longer the street remains the more integrated it is to the community and the less people want it changed, or widened.

For the moment, let's set aside the tough city centre problem and take the broad perspective position which was taken in the study. Fortunately, most growth takes place in the periphery of the city, thus, if adequate facilities are provided during developmen then problems of the type creating the anti-freeway fuss need not occur. So, in order to avoid the spread of the central city congestion problem, it is very important to use more foresight in the now developing suburbs.

7. TRANSPORTATION CORRIDORS

In order to achieve the benefits of good urban aterials and freeways, it seems essential to have transportation rights-of-way reserved well before they are needed. These transportation corridors are visualized as accommodating all transportation modes - not just roads. They are the seventh and possibly the most significant long-term means of improving urban transport.

The economic benefits from transportation corridors are not large in themselves - perhaps some $8/cap/year, but the reservation of such corridors is essential if we are to overcome the problems of freeway location and achieve the benefits that would accrue therefrom.

Map 1 diagramatically illustrates the concept of transportation corridors, both urban and intercity. The corridor could contain frontage roads, pipelines, freeways, high speed ground transport, power lines and landscaped medians, all illustrated in the cross-section below. The benefits attainable from transportation corridors are summarized in Table 6.

CORRIDOR CROSS-SECTION

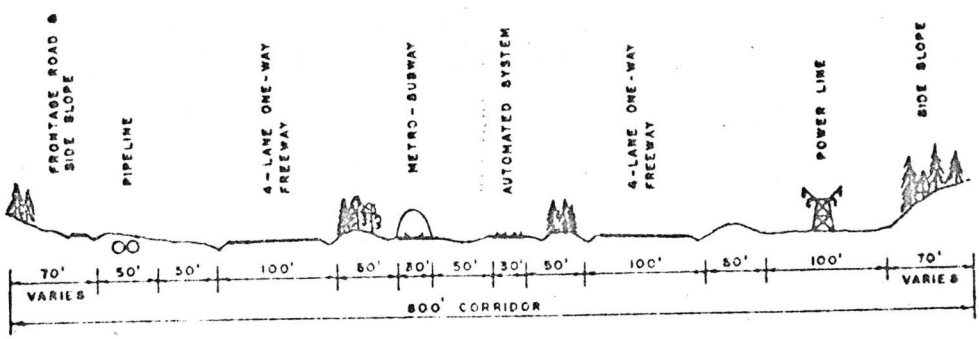


TABLE 6

SUMMARY OF EFFECTS

OF TRANSPORTATION CORRIDORS

DESCRIPTION OF IMPROVEMENTS			Before land is subdivided reserve wide corridors for transportation facilities.
NEUTRAL PATH CONDITIONS			No special corridor acquisition
APPROXIMATE CONFIDENCE LIMITS			-0% +200%
TIME STREAM	EARLIEST LIKELY YEAR FOR SIGNIFICANT BENEFITS		1980
	AMOUNT OF 1980 BENEFITS AS % OF 2001		25%
INITIAL CAPITAL INVESTMENT			$½ to $1 billion. But note that total capital investment over 30 years, including the initial sum is reduced.
ECONOMIC EFFECTS	TRANSPORT COST SAVING	TOTAL NATIONAL IN 2001	$0.25 billions
		PER CAPITA INCOME IMPROVEMENT IN 2001	$8/cap./yr.
	DISTRIBUTION OF INCOME IMPROVEMENT		very widely
SOCIAL EFFECTS	SAVINGS ON UNPAID TIME IN 2001		significant
	ACCESSIBILITY IMPROVEMENT		significant
	LIFE EXPECTANCY INCREASE		some
	ENVIRONMENT		major improvement

8. IMPROVED TRANSIT OPERATIONS

Now let's return to the central city transport problem and consider transit, which is currently the most popular solution to many of our urban transport problems. Under the title "transit operations" we considered all the transit improvements possible using current technology, such as:

> Subways and commuter rail systems, bus rapid transit, freeway bus operation, express bus services, exclusive transit lanes, exclusive bus streets, bus stop bays, diversification of service, improvement in bus design, improved maintenance techniques, improved surface bus planning, convenience facilities (shelters, etc.), improved communications, dynamic demand routing, contract management and improved pricing policies.

The results are somewhat disappointing. We found that the more attractive transit improvements have already been made in most Canadian cities and that the transit improvements still possible, using present technology, offer only modest gains, in terms of cost and of impact. As indicated in Table 7, the per capita income improvement in year 2001 would be only of the order of $3, mainly, as you would expect, to the benefit of transit users. The main social benefits would be to the disadvantaged groups.

We found that most new transit schemes are high cost and low usage. If you find this surprising, possibly you have been unduly influenced by the thinking that rail transit might substitute for roads, and that the urban transport problem is one of moving only people. A subway train can only provide access along a rigid narrow path and is basically transportation for people. Could you imagine carrying garbage on a subway? or snow, or concrete, or cabbages? Even carrying a shopping bag or a suitcase is a problem on most public transit systems. What if you were a plumber, and had to have your

TABLE 7

SUMMARY OF EFFECTS

OF TRANSIT OPERATIONAL IMPROVEMENT

DESCRIPTION OF IMPROVEMENTS			Improve transit service by a variety of methods using present technology
NEUTRAL PATH CONDITION			Current practice continues
APPROXIMATE CONFIDENCE LIMITS			Results considered moderately conservative
TIME STREAM	EARLIEST LIKELY YEAR FOR SIGNIFICANT BENEFITS		1976
EXTRA CAPITAL INVESTMENT REQUIRED			Modest
ECONOMIC EFFECTS	TRANSPORT COST SAVING	TOTAL NATIONAL IN 2001	$0.1 billion
		PER CAPITA INCOME IMPROVEMENT IN 2001	$3/cap./yr.
	DISTRIBUTION OF INCOME IMPROVEMENT		principally to transit users
SOCIAL EFFECTS	SAVINGS ON UNPAID TIME IN 2001		3 man hours/cap./yr.
	ACCESSIBILITY IMPROVEMENT		substantial, particularly for the disadvantaged
	LIFE EXPECTANCY INCREASE		some
	ENVIRONMENT		reduced air pollution

tools or equipment? Or a telephone repair man, or a salesman? There is just no way rail transit can substitute for roads.

One of the most hopeful transit possibilities is a bus scheme which we have called "Drive-Yourself-Transit". This is an expansion of the car-pool idea or the mini-bus system which is prevalent throughout cities in less developed countries of the world, and which in various forms are already being operated in Sarnia, New York, Washington and Los Angeles. We suggest that broader application of such systems, particularly for service to the more needy sectors of the community, could bring big benefits.

It would be necessary to change certain local by-laws to implement such a system. Possibly a governmental agency could make small mini-buses available to individuals who would undertake to operate them in accordance with a flexible on-call system. Well organized and socially integrated, this could provide transport to a family otherwise grounded and even make going to work, or shopping, or school a more enjoyable experience. Even so, the benefits are modest but worthwhile.

We are sorry if our findings disappoint or irritate some people by appearing to lack optimism for transit operational improvements. In fact, we consider it imperative that much effort be expended, and that great resourcefulness and imagination be used, to achieve transit operational improvements. Indeed, we have assumed that this will be done. We consider, however, that its total effect will be little more than to enable transit to retain its present share of the market.

9. USE OF NEW TECHNOLOGY

Our discussion of transit so far has dealt only with the more intensive or better use of currently available technology. We

believe that the gradual introduction and use of New Technology has the potential of major economic benefits, and also of major social benefits, through both quality and impact.

Incidentally, we have not considered Dial-A-Bus or the San Francisco BART type systems to be new technology. We have evaluated them under "improved transit operations".

The hundreds of new urban transport systems can be grouped into three general categories:

- Intermediate Volume Systems
- Programmed Module Systems
- Dual Mode Systems

(a) The Intermediate Volume Systems are rail or guideway systems functioning much the same as present subway systems but using a lighter vehicle in an attempt to keep costs down and to achieve aesthetically acceptable overhead structures. The Alweg Monorail was one of the early attempts which has achieved little success. The Westinghouse Transit Expressway was a later attempt aimed at the same market. The Scherer Monobeam and the French URBA are current contenders which have made more progress in achieving the lighter-weight.

Unfortunately, the market for such systems is quite limited, being squeezed by conventional subways on one hand and programmed modules on the other.

(b) Programmed Modules are the new systems which we find to offer the greatest potential. The concept is a small vehicle fully automated and travelling on an exclusive guideway. The user boards at one of the many stations and codes his destination station when he buys his ticket. When he places the ticket in the vehicle it

automatically takes him non-stop to his destination station. The system can achieve low costs for goods handling because no driver is needed.

In 1968, the name of "personalized transit" was given to such systems when the United States Department of Housing and Urban Development recommended a major development effort in this direction. We prefer the term "programmed module" to recognize the potential of such systems for urban goods movement.

The systems were first investigated by Brush Electric (now Hawker Siddeley) and Teletrans (now Docutel) in 1965-66. In 1970, the United States Department of Transportation commissioned "baseline descriptions" and evaluations of ten advanced transport systems. These included four that we would class as programmed module systems: Dashaveyor, Sky Kar, Varo Monocab and Transportation Technology Incorporated.

Table 8 gives our estimate of the potential benefits from new technology which is principally from programmed modules. The range of benefits shown is very wide because of the great uncertainties.

The minimum economic benefits of $32/cap/year are based upon a computer run for City B with a population of 1.2 million in 2001 and with 84 miles of single track programmed module system operating at 35 m.p.h. for people only. For this condition, the economic benefits accrue largely through savings experienced by the goods vehicles remaining on the grade streets.

The great appeal of the programmed module system, however, is that, in addition to the economic benefits,

TABLE 8

SUMMARY OF EFFECTS OF NEW TECHNOLOGY

NEUTRAL PATH CONDITION			No new Technology
IMPROVEMENT STUDIED			"Programmed module" and other new technology systems.
EXTRA CAPITAL INVESTMENT REQUIRED BETWEEN 1966 AND 2001			large
ECONOMIC EFFECTS	TRANSPORT COST SAVING	TOTAL NATIONAL IN 2001	$1 Billion to several Billion
		PER CAPITA INCOME IMPROVEMENT IN 2001	$32 to $100/cap/yr.
	DISTRIBUTION OF INCOME IMPROVEMENT		Very widely with special benefits to those now disadvantaged
SOCIAL EFFECTS	SAVINGS OF UNPAID TIME IN 2001		substantial
	ACCESSIBILITY IMPROVEMENT		substantial
	LIFE EXPECTANCY INCREASE		substantial
	ENVIRONMENT		Very great improvement.

there are significant social benefits on all of the social indicators.

To get all of these social benefits plus economic benefits makes the programmed module the most attractive of all the improvements studied.

We have not calculated the upper limit of the economic benefits but we know it is very much greater than $32/cap/year.

Caution needs to be exercised in calculating the upper limit because our cost estimates are very rough and there is some danger of double counting. Nevertheless, it could easily be 2 to 3 times the $32/cap/year. The possibility of a transit system which could be self financing (which is the indication from our analysis), and bring positive social benefits on all indicators, is so appealing that large economic benefits are not needed to make the system of great importance.

With the active current interest, it is our personal expectation that, by the early 1980's, some city will have an experimental programmed module system, and then we will be able to more accurately assess the benefits of such a system. The current Morgantown and Transpo '72 project will, in our opinion, not achieve the needed demonstrations of programmed modules.

(c) Dual Mode Systems are potentially an even greater improvement because they combine the advantages of both auto and programmed module transport.

This is the type of system which has been proposed by Alden Starr Car and M.I.T. Many investigators, however,

consider that such systems will follow in time after programmed module systems and will be much more expensive. We share this view and we note that Boeing Aircraft and other recent entrants into the field appear to be shifting emphasis to a programmed module rather than a dual mode system.

10. TRANSPORT PRICING

With programmed modules 10 years away and present transit not having much more to offer, and with the public complaining about more arterials and freeways in city centres, are there any other possibilities to help for the immediate future, say for the next 10 to 15 years? We suggest that better use of charging devices for the pricing of transport facilities will be a great help.

Arbitrary prohibition of autos is impractical and unjustified but a road pricing system has some possibilities. Our concept of road pricing is to regulate both parking rates and a charge for the use of urban roads so as to discourage unnecessary use and promote more efficient road use.

One example would be a toll for a peak hour use of freeways. This would improve their efficiency by diverting those users whose benefit in using the facility is less than the cost. Another example would be a requirement for special licenses for use of streets in the downtown section of the city during certain hours.

Such pricing schemes would bring benefits particularly for a short period during which solutions are being developed. The benefits are indicated in Table 9 and are seen to be similar to those for operational transit improvements; this is not surprising as the effect of pricing schemes would tend to have similar results to transit improvements.

SUMMARY AND CONCLUSIONS

This study was intended to establish a framework to guide future research and planning and to assist in the orientation of future urban policy formulation. A first step has been made to assess the urban transport options in social and economic terms and from a national perspective. We hope that future research will be better planned and formulated as a result of this work.

The following specific items emerge as the most significant work that needs to go on in the near future if the benefits we have described are to be achieved in the longer term:

- intensified efforts to achieve metro-wide administration with responsibility and resources adequate to effectively control all modes of urban transport.

- legislation giving simplified procedures to reserve land for transportation corridors.

- pilot programme to plan transportation corridors in two specimen cities.

- priority for R & D projects to improve urban goods movement efficiency.

- a more intensive analysis of the efficiency of access road standards and layout.

- increased awareness of the significance and effectiveness of improved arterials and freeways.

- more penetrating evaluations of large investments in transit schemes using current technology.

- a more lively interest in new transit technology such as programmed modules, which in the long run appear the only system likely to bring both substantial economic

TABLE 9

SUMMARY OF EFFECTS

OF CHANGES IN PRICING

DESCRIPTION OF IMPROVEMENTS			Combination of pricing adjustments.
NEUTRAL PATH CONDITION			Roads - arbitrary pricing at about average cost. Transit - pricing at average cost less subsidies
APPROXIMATE CONFIDENCE LIMITS			-20% to +80%
TIME STREAM	EARLIEST LIKELY YEAR FOR SIGNIFICANT BENEFITS		1975
	AMOUNT OF 1975 BENEFITS AS A % OF 2001		30%
EXTRA CAPITAL INVESTMENT REQUIRED BETWEEN 1966 and 2001			nil
ECONOMIC EFFECTS	TRANSPORT COST SAVING	TOTAL NATIONAL IN 2001	$0.1 billions
		PER CAPITA INCOME IMPROVEMENT IN 2001	$3/cap./yr.
	DISTRIBUTION OF INCOME IMPROVEMENT		principally to C.B.D. & transit users
SOCIAL EFFECTS	SAVINGS OF UNPAID TIME IN 2001		slight
	ACCESSIBILITY IMPROVEMENT		slight
	LIFE EXPECTANCY INCREASE		slight
	ENVIRONMENT		slight improvement