73

Technological Innovation Studies Program

Research Report

An Assessment of Market Potential for
Intermediate Capacity Transit System
in North America

by

Dr. S. K. Bhattacharyya
Ottawa, Ontario

July 1980

#73.

Rapport de recherche

Programme des études sur les innovations techniques

Industry Trade and Commerce
Industrie et Commerce

Technology Branch
Ottawa, Canada

Direction de la technologie
Ottawa, Canada

An Assessment of Market Potential for
Intermediate Capacity Transit System
in North America

by

Dr. S. K. Bhattacharyya
Ottawa, Ontario

July 1980

#73.

AN ASSESSMENT OF MARKET POTENTIAL FOR INTERMEDIATE CAPACITY TRANSIT SYSTEM IN NORTH AMERICA

BY

DR. SUSHIL K. BHATTACHARYYA

4-25 Bayshore Drive, Ottawa

Ontario

July 1980

With assistance from

MR. PATRICK H. HALLETT

and

DR. REKHA BHATTACHARYYA

for

TECHNOLOGY BRANCH

DEPARTMENT OF INDUSTRY, TRADE & COMMERCE

GOVERNMENT OF CANADA

ACKNOWLEDGEMENT

We gratefully acknowledge the co-operation and counsel received from those individually listed below while absolving them from any shortcoming of this study; their contributions have been most helpful.

Mr. Norman Gardner	Industry, Trade & Commerce, Ottawa
Mr. Maurice Audettee	Transport Canada Research and Development Centre, Montreal
Mr. William G. Lambert	Alberta Transportation, Edmonton
Mr. A.R. Gordon	Metropolitan Planning Department Toronto
Mr. Lloyd Mccomb	Transport Canada Research and Development Centre, Montreal
Ms. Vickey Silvey	Office of Technology Assessment, Washington, D.C.
Mr. Steven A. Barsony	Office of AGT Applications, UMTA
Mr. Vincent R. De Marco	Washington, D.C.
Mr. Ross W. Adams Mr. Howard Evoy	Office of Socio-Economic and Special Projects, Technology Development and Deployment, UMTA, Washington, D.C.
Mr. Clyde E. Pyers	Maryland Department of Transportation, Baltimore, Md.
Ms. Nina Mostyn	Community Redevelopment Agency, City of Los Angeles
Mr. Dave Macdonald	South East Michigan Transportation Agency, Detroit
Mr. John Suhervier	Cambridge Systematics, Cambridge, Mas
Mr. Anthony G. Chambliss	Mitre Corporation, McLean, Virginia
Dr. Arthur Priver	Transportation Systems Centre, Cambridge, Massachusetts

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF ILLUSTRATIONS

EXECUTIVE SUMMARY

In the United States, Urban Mass Transportation Administration and its predecessor agency has been involved in research, development and demonstration of automated guideway transit (AGT) systems since early 1960s. Design and development of engineering prototype and operational systems were undertaken by industry, both independently and under UMTA contract. In Canada, starting in 1972, Urban Transportation Development Corporation of Ontario has been designing and developing a type of AGT technology known as Intermediate Capacity Transit System with capability for various types of applications. The Canadian system, though similar in many respects to American systems, is claimed to have a leading edge in the North American Market. This study funded under the Industry Innovations Program of Industry, Trade and Commerce, Government of Canada, examines the market for the ICTS system in North America during the period 1980-89. The principal accomplishments of the study are as follows:

1. This report summarizes the developments of AGT technology in terms of its development and deployment in North America. It also summarizes the results of related research by various public and private agencies in order to provide the necessary background for the study.

2. Using a Macro-level approach, it identifies the urban areas in the United States with potential for three different types of application areas;

activity centre, corridor and areawide. This list of candidate cities is finally matched with a preliminary estimate of market size arrived at the on-going AGT market study in the United States. The Canadian market size is estimated on the basis of results obtained in the previously conducted ICTS feasibility studies and the latest Urban Transportation Alternatives Studies of the candidate cities.

3. The study identifies the following market for ICTS in Canada and the United States during the period 1980-89:

   (I) Los Angeles, Miami, Detroit, and St.Paul Hamilton 1980-1984

   (II) Baltimore, Indianapolis, Jacksonville, St.Louis, Norfolk, Quebec City, Montreal, Vancouver (Transpo 86 Complex), Toronto International Airport and Ottawa-Hull. 1985-1989

4. It summarizes the funding needs for transit, in general, in the United States and outlines the current policy for funding DPM systems in the United States. The market ICTS system in North America has been estimated at $1.5 billion during the period, 1980-1989.

CHAPTER I

AUTOMATED TRANSIT SYSTEM DEVELOPMENT IN NORTH AMERICA

1.0 Introduction

Over the last decade and generally since World War II, the urban transit industry has been suffering an economic decline in the Western Hemisphere. The available literature on this subject suggests that the trends in urban development and automobile ownership are the principal causative factors.

Urban areas in the United States and Canada have changed significantly in form, shape, population distribution and concentration of activities. These changes have tended to scatter activities, thus creating diffused trip patterns. Most of this diffused travel is currently satisfied by the private automobile, while the use of public transit has declined. Transit is a labour intensive industry. Labour costs in transit operation vary between sixty and seventy per cent. With the gradual erosion of labour productivity and the political decision of relative stability in transit fare, operating costs have been escalating making the industry dependent on various governmental subsidies.

Although technology cannot provide direct solutions to many of the economic and institutional problems of urban transit, it is clear that the resources of the government should be used to maximize the contribution of modern technology toward solving these problems. There is an awareness at the local and national levels that the transit patronage has to be increased by making transit more attractive in terms of the quality of service.

The Urban Mass Transportation Administration (UMTA) of the United States Department of Transportation has been involved in research, development and demonstration of automated guideway transit (AGT) systems since the early 1960s. Design and development of engineering prototype and operational systems were undertaken by industry, both independently and under UMTA contract.

The first full-scale experimental AGT project--the Transit Expressway--was constructed at South Park near Pittsburgh. This led to development of similar AGT systems in limited environments such as airports, universities, and amusement parks. During this period, many studies were undertaken to determine the potential for application of AGT systems to meet the transportation needs of metropolitan areas of various sizes. These studies included financial, economic, governmental, and societal aspects of new systems as well as the availability of technology and materials.

Results of UMTA sponsored AGT research and development programs suggest AGT technology is capable of improving urban transit service compared to conventional transportation modes.

Potential travel benefits to users include reduced trip time due to short wait times and exclusive guideway operation, increased travel comfort and convenience, and less dependence upon the automobile for mobility. Benefits to the system operator include increased vehicle and labour productivity and operating costs reductions through elimination of vehicle operators and station attendants.

In addition to direct travel benefits, AGT is an effective tool for achieving other urban goals and objectives. Because the system comprises electrically powered vehicles, it reduces the direct demand for gasoline and assists in achieving environmental goals such as air quality. AGT's permanence and high modal attractiveness may potentially stimulate future economic growth and desired land use patterns by encouraging people to walk, live, shop, and visit areas served by the system.

With the announcement of Downtown People Mover Program (DPM) by UMTA in 1976, a number of manufacturers in the United States and West Germany have been enhancing their research and development efforts in order to gain DPM and other contracts in the United States. The list of manufacturers include, Boeing, Otis, Rohr, Westinghouse, Universal Mobility, Ford, and DEMAG/MBB. The latest entry into this AGT technology is the Intermediate Capacity Transit System, designed by the Urban Transportation Development Corporation of Ontario (UTDC) offering superior design at a cost comparable to the American systems.

1.1 Study Scope and Objectives

The overall objective of this study is to examine in general terms the potential market for AGT system applications where ICTS could compete with other AGT systems. The statement of work identifies the project objectives as three-fold:

a. To assess the applicability of AGT systems in the United States and Canada by analyzing passenger demand and associated socio-economic data in medium to large urban centers during the period 1980-89.

b. To prepare a summary of financial needs and provision for urban transit systems with special reference to AGT systems.

c. To prepare a summary of routes of AGT systems, either approved for installation or at the planning stage.

In order to achieve these objectives, a detailed analysis should be undertaken of the latest urban transportation plans of all medium and large cities in North America. Besides, transportation systems, evaluation studies must be undertaken on a sampling basis using the cost-benefit methodology. Unfortunately, the level of effort allocated to this study precludes such an in-depth investigation. In assessing the market potential for ICTS a research approach will be followed with due consideration to the following factors:

- Urban area socio-economic characteristics
- Urban travel demands
- AGT system characteristics

In assessing the size of the market, an objective view will be taken on the basis of capital funding available in the United States and Canada for deployment of such systems. The selection of a type of AGT system for an application site depends on a number of factors, such as route length, system type, guideway, vehicles, hardware and control mechanism, buyer preference and procurement guidelines of the capital funding agencies. Any attempt to estimate the share of ICTS market in the absence of such detailed information will have to be based on arbitrary judgement. It is understood that UTDC has already completed such target-oriented market studies as a part of their marketing program. No attempt will be made in this study to repeat a similar type of marketing study.

1.2 Historical Background and Definitions

Concepts which include the use of vehicles capable of automatic operations on exclusive guideways are classified as Automatic Guideway Transit (AGT) systems. Various types of AGT systems have been developed in the United States. In Canada, the only automated system, known as Intermediate Capacity Transit (ICT) system has been designed by the Urban Transportation Development Corporation (UTDC) of Ontario. Since the technology deployed in ICTS is very similar to other AGT systems, we shall continue to refer the former as a type of AGT system. It is claimed that AGT systems are capable of improving service qualities and of reducing operating costs. However, they require high capital investments. The most expensive components of such systems are the guideway and station structures. The cost of vehicles and command and control is a small percentage of the total cost. AGT systems may realize significant economies in guideway and station cost.

Another important area where improvements in AGT performance can be achieved is in passenger carrying capacity. Current operational AGT systems achieve relatively modest capacities (3000-5000 seats per lane per hour) as a result of small vehicle size (6-12) and relatively long headways (8-18 seconds). While such capacities can effectively meet transportation demand in limited configurations, greater capacities are required for more extensive networks in urban areas. Improved capacity would also ensure that AGT systems would realize their potential cost-effectiveness advantages. High capacities permit more revenue passengers to use the extensive guideways and stations thus increasing return on investment.

The only high capacity AGT system in Canada which is currently awaiting full scale demonstration is known as ICTS designed by UTDC of Ontario. The system capacity can be extended up to 25,000 passengers per hour per direction. Experts in the urban transit field have identified the concept of ICTS to augment transportation in medium and large sized urban centers.

1.2.1 Types of AGT Systems

Three major types of AGT systems have been identified (59).

Single Line Transit (SLT)

Single Line Transit, which is also referred to as shuttle loop transit, is the simplest type of AGT system. Vehicles move along fixed paths with few or no switches. The vehicles of a simple shuttle system move back and forth on a single guideway; vehicles in a loop system move around a closed path, stopping at any number of stations. They may or may not make intermediate stops. The vehicles may vary considerably in size and may travel singly or coupled together. Examples of SLT systems include those in operation at Tampa International Airport, Houston International Airport, and Seattle-Tacoma International Airport.

Group Rapid Transit (GRT)

These systems serve groups of people with similar origins and destinations. The principal differences between GRT and the SLT are that GRT tends to have shorter headways and a more extensive use of switches. GRT stations may be located on sidings off the main guideway, permitting through traffic to bypass. GRT guideways may merge or divide into branch lines to provide service on a variety of routes. Vehicles with a capacity of 10 to 50 passengers may be operated singly or in trains. Headways range from 3 to 60 seconds. GRT systems are in operation at Dallas/Fort Worth Airport and Morgantown, West Virginia.

Personal Rapid Transit (PRT)

The term PRT is restricted to systems with small vehicles carrying either one person or groups of up to six usually travelling together by choice. Plans for PRT systems typically include off-line stations connected by a guideway network. Under computer control, vehicles switch at guideway intersections so as to follow the shortest uncongested path from origin to destination without intermediate stops. Most proposed PRT systems call for vehicles to be operated at headways of 3 seconds or less. Cabintaxi in Germany is a prototype PRT system; there are no systems in passenger service.

1.2.2 AGT Systems Profile

To date, the operational AGT systems in the United States have provided reliable and sage service for over 200 million passengers in a variety of operating environments. Of the twenty-three domestic AGT systems presented in Table 1.1 eight are located at airports, two at shopping centers (Fairlane and Pearlridge), three at universities (Duke University, University of West Virginia, and Georgia Institute of Technology), and ten at recreation sites. Fourteen of these American systems are operating; five are under construction; two have been completed, but are not yet in service; one is operating as a test facility; and one is no longer in service.

TABLE 1.1

AGT SYSTEM PROFILE (1)

SYSTEM	MANUFACTURER	YEAR COMPLETED	SINGLE LANE MILES OF GUIDEWAY	NUMBER OF VEHICLES	NUMBER OF STATIONS	CAPITAL COST ($ MILLIONS) 2	O&M COST/ PASSENGER ($) 2
California Exposition Sacramento, CA	Universal Mobility	1968	1.3	4-8 veh. trains	2	2.3	0.27 (1974)
Hershey Park Hershey, PA	Universal Mobility	1969	0.8	4-6 veh. trains	2	1.5	NA
JETRAIL, Love Field Dallas, TX	Stanray Pacific	1970 (discontinued in 1974)	1.4	10	3	2.5	0.16 (est.)
Tampa Airport Tampa, FL	Westinghouse	1971	1.4	8	8	8.7 3 (est.)	0.03 3
Magic Mountain Los Angeles, CA	Universal Mobility	1971	0.8	6-6 veh. trains	3	1.8	NA
Houston Airport Houston, TX	Rohr	1972	1.2	6-3 veh. trains	8	4.0 3 (est.)	0.25 3
Seattle-Tacoma Intn'l Airport Seattle, WA	Westinghouse	1973	1.7	12	8	22.7 3 (est.)	0.07
Carowinds Charlotte, NC	Universal Mobility	1973	2.0	4-8 veh. trains	1	3.0	NA

Source: (59)

TABLE 1.1 (Continued)

SYSTEM	MANUFACTURER	YEAR COMPLETED	SINGLE LANE MILES OF GUIDEWAY	NUMBER OF VEHICLES	NUMBER OF STATIONS	CAPITAL COST ($ MILLIONS)	O&M COST/ PASSENGER ($) [2]
Dallas/Fort Worth Airport Ft. Worth, TX	Vought	1974	13	51 pass. 17 utility	28 pass. 25 utility	53.4 (1971)	.75 (1977)
King's Island Cincinatti, OH	Universal Mobility	1974	2.0	7-9 veh. trains	1	3.5	NA
Bradley Intn'l Airport Hartford, CT	Ford	1975 (not in service)	0.8	2-2 veh. trains	3	4.5	NA
King's Dominion Richmond, VA	Universal Mobility	1975	2.0	6-9 veh. trains	1	4.6	0.18 [3]
University of West Virginia Morgantown, WV	Boeing	1975	5.4	45	3	65.5	0.36 [4]
Walt Disney World Orlando, FL	Community Transportation Division	1975	0.87	30-5 veh. trains	1	10.6 [3]	0.07 [3]
Busch Gardens Williamsburg, VA	Westinghouse	1975	1.3	1-2 veh. train	2	4.0	0.05 (est.)

TABLE 1.1 (Continued)

SYSTEM	MANUFACTURER	YEAR COMPLETED	SINGLE LANE MILES OF GUIDEWAY	NUMBER OF VEHICLES	NUMBER OF STATIONS	CAPITAL COST ($ MILLIONS) 2	O&M COST/ PASSENGER ($) 2
Fairlane Town Center Dearborn, MI	Ford	1976	0.5	2	2	5.5 [3]	0.16 [3]
Pearlridge Shopping Center Honolulu, HA	Rohr	1976 (not in service)	0.23	1-4 veh. train	2	NA	NA
Georgia Institute of Tehcnology Atlanta, GA	Georgia Institute of Technology	Test facilities only	0.6	2	3	NA	NA
Duke University Durham, NC	OTIS/TTD	Under Construction	0.5	2 pass. 1 cargo	2 pass. 1 cargo	NA	NA
Miami Airport Miami, FL	Westinghouse	Under Construction	0.5	2-2 veh. trains	2	6.7	0.06 (est.)
Atlanta Airport Atlanta, GA	Westinghouse	Under Construction	2.3	17	NA	35.0	NA
Bronx Zoo New York, NY	Rohr	Under Construction	2.3	54	NA	2.5 (1973)	NA
Minnesota Zoo Minneapolis, MN	Universal Mobility	Under Construction	1.3	18	NA	5.0	NA

[1] Source: "Preliminary Data Base for Existing Automated Guideway Tansit Systems, "The MITRE Corporation/METREK Division, M77-58, July 1977, unless otherwise noted.

[2] Cost estimates generally reflect costs at date of initial operation unless otherwise noted.

[3] Domestic AGT System Assessments, Stanford Research Institute, 1977.

[4] "Independent Assessment of Morgantown Personal Rapid Transit System," N. D. Lea & Associates, Inc., 1977.

1.2.3 DPM Systems

People Mover systems refer to the simplest type of AGT technology--SLT systems. The vehicles used in these systems range in capacity from less than 20 to over 100 passengers. The vehicles are generally constructed of aluminum or fiberglass and are lighter than conventional rapid rail transit cars. Size and weight differences allow for narrower guideways and smaller stations.

The guideways may be located on elevated structures, at street level, or below ground and are constructed of steel or reinforced concrete. Power collection is generally accomplished by power rails on the guideway and power collectors on the vehicle. Where switching is necessary, it is accomplished either by a vehicle mounted mechanism or by moveable beams or sections of the guideway. Many variations of the technology are possible to include combinations of shuttle and loop operation.

Computers control the operation of the system. In general, the complexity of the control system increases as the operational capabilities of the system grow. A staff of employees is used to monitor operations, assist passengers, maintain and service equipment, and perform administrative requirements.

The system should be capable of operating in cities with population ranging from 27,000 to 8.0 million with weekday riderships ranging from 3000 to 80,000 passengers. It is expected that investments in DPM systems will serve as a catalyst for urban revitalization, reinforcing current public and private renewal efforts for including new development. This view is reaffirmed by the findings of a survey undertaken by the American Public Transit Association (APTA) Inner City Task Force (97) The survey indicates that many city officials believe medium guideway transit, such as DPM systems, can promote urban revitalization, concentrate on new development, and meet new transportation needs to downtown districts and surrounding neighbourhoods.

The market for downtown application constitutes only one segment of the potential market for AGT technology in North America. The other applications have already been proven by the encouraging results of the existing operational systems at the airports, and other activity centers. On-going market research recently undertaken in the AGT Socio-Economic Research Program of the UMTA will provide a detailed analysis of the market for all classes of AGT technology in a variety of urban applications.

1.2.4 General Requirements of AGT Systems and its Market Implications

To successfully introduce this new technology into the urban transportation environment, the general requirement is that the resulting service provide effective competition to the existing urban transportation systems. Subject to this requirement, the UMTA Office of Technology Development and Deployment has been studying several aspects of AGT technology.

Parameters of these studies include:

a. System Size - from small scale local circulation systems in activity centers, up to metropolitan areawide systems.

b. System Characteristics - from scheduled service with shared vehicles to demand responsive with exclusive use of vehicles.

c. Degree of Technological Innovation - from improved components and subsystems for existing transit systems to new guideway, station, and vehicle designs; new control concepts; and new system configurations.

The market for AGT systems depend to a large extent on its adaptability to the following groups of functions:

a. Feeder Service to Line-Haul Transit - DPM systems distribute trips between major transportation facilities and activity centers in medium to high density urban locations.

b. Replacement for Conventional Bus Circulation System - DPM Systems provide high quality circulation service at lower operating costs than downtown conventional bus.

c. Alternative to Private Automobile - DPM systems provide an alternative to automobile use for urban residents and employees for trip purposes such as shopping, business and recreation.

d. Urban Goods Movement - DPM systems can be used for urban goods movements and to provide urban services such as trash hauling during hours when the system may otherwise be idle.

1.2.5 Development of Intermediate Capacity Transit System in Canada

In 1972, the Government of Ontario announced a new urban transportation policy for Ontario. In that policy, necessary steps were undertaken to develop a Canadian industrial capability in advanced transportation systems. In June 1973, Urban Transportation Development Corporation was set up to design and market the system. Recognizing the need for a medium capacity advanced system, UTDC has, in consultation with municipal planning and transit operating agencies, formulated the system requirements for the system. ICTS has been developed primarily to serve the intermediate capacity range from 5,000 to 25,000 passengers per hour per direction (pphd).

> The ICTS systems fall into 2 groups. One group uses multiple passenger vehicles, typically 10 to 40 people. It is termed People Mover Transit (PMT) and operates in a fashion similar to conventional transit following a fixed route with stops on demand or at every station. The other uses small vehicles sized for a family or group (2 to 8 people) which operate on demand with a hopefully non-stop run from the original station to the selected destination station. This latter group is termed Personal Rapid Transit (PRT). Variants of this group are the dual-mode concepts whereby small cars, usually battery-electric are manually driven on existing streets to a guideway on-ramp where they operate automatically to a preselected destination off-ramp before proceeding on street to the destination.(89)

Due to the flexibility of the ICTS design, it can also provide commercial viable operation with high levels of service well outside of the basic range (5,000 to 25,000). Three prototypes of the system have been built and fully tested at the experimental tracks at Kingston, Ontario. The system is currently awaiting full scale demonstration on Hamilton routes. However, little is known to date concerning its operation, economy, and impacts on urban environment. In the United States, a very rapid development has been taking place in order to promote the use of DPM system in cities with considerable financial help from the Federal Government. In Canada, participation from the Federal or other Provincial Governments has been less than spectacular in the Canadian market. It is, perhaps, appropriate at this point to evaluate the potential of ICTS in the world market before the provincial or the federal government could be lobbied for participation. This study will be limited to North American market only. It is expected that a second study will soon be followed to assess the potential of ICTS in Europe, Australia and Japan and other countries.

1.3 Report Outline

The organization of the report is as follows:

The intent of the introductory chapter is to provide historical background information of Automated Guideway Transit (AGT) programs, systems, and suppliers. Data are presented on general system characteristics of all AGT systems currently operational in the United States. The methodology for AGT application is described in Chapter 2. The various stages of the urban transportation planning process, including the system selection techniques, will be highlighted first. Later the methodology for AGT market estimation will be outlined.

Chapter 3 deals with the estimation of market potential for AGT systems in North America. It begins with a review of previous studies on AGT systems in Canada and the United States. Next, the methodology is presented together with a description of socio-economic data of selected urban areas in North America. Later, an account is given of the market estimate arrived in this study and that by other studies sponsored by UMTA.

A major element in the development of an urban transportation investment strategy is the availability of capital needs. Chapter 4 will be devoted to an assessment of funding needs for transit in the current decade.

The fifth and final chapter provides a summary of findings and major conclusions arising out of this study.

1.4 Study Limitations

Limitations to the findings of this study as reported here include:

a. This research focusses on determining where application of AGT technology may be feasible rather than the desirability of alternative modes vis-â-vis one another.

b. Given the very limited level of effort, the market for AGT technology has been based on macro level indicators of passenger demand and transportation systems. The results of socio-economic studies carried out by the Office of Technology Development and Deployment, UMTA, provided informed judgements in estimating the size of AGT market in the United States.

c. The findings of this study have not been coloured by rather optimistic market assessments of any manufacturer of AGT system, notably the Urban Transit Development Corporation of Ontario.

CHAPTER 2

METHODOLOGY FOR AGT APPLICATIONS

2.1 Introduction

A comprehensive methodology for automated guideway transit applications is yet to be developed largely due to lack of widespread applications. All the systems which are currently operational are located in the United States at airports, shopping centers, universities and recreation sites. These applications did not require detailed demand forecasting. However, recent proposals submitted to UMTA for deployment of automated transit systems were based on comprehensive transportation study including transportation systems evaluation or alternatives analysis. The methodology which we shall employ will possess some salient characteristics of the urban transportation planning process. In order to understand its full implication we shall first provide a brief overview of the urban transportation planning process. The remaining sections will be devoted to the description of the methodology employed in this study for ICTS applications.

2.2 Urban Transportation Planning Process

This section describes some of the demand estimation procedures used in the long-range urban transportation planning process, More detailed information can be found in (84).

2.2.1 Major Transportation Planning Stages

The long-range transportation planning process involves a series of iterative and sequential steps relative to analyzing travel demands, systems performance, and community impacts. Figure 2.1 shows the various demand-related steps in this process so defined by UMTA and FHWA. The process may be characterized by four general phases:

1. Inventories - This phase provides the base for subsequent steps. It includes inventories of economic activity, population, land-use, urban travel, and existing transportation facilities.

2. Analyses of Existing Conditions and Calibration of Forecasting Techniques - This phase develops models and analytical procedures for use in forecasting future land-use and travel.

3. Forecasts of Future Conditions - This phase forms the heart of the demand forecasting process.

   (a) Future forecasts of population and economic activities (usually expressed in terms of employment and income) serve as inputs to land use analysis and spatial allocations of population and urban activity.

   (b) Trip Generation bridges the gap between land-use and travel by providing the means by which the number of trips that begin or end in a given analysis area can be related to the land-use or socio-economic characteristics of that area.

(c) The generated trip ends form the measures of trip 'production' and trip 'attraction' (for origins and destinations) that are used in trip distribution (along with measures of spatial separation developed from the highway and transit networks) to estimate origin-destination patterns.

(d) Modal Choice Analysis allocates trips between public and private transport. Trip assignment procedures allocate movements to specific paths on the highway and public transport systems.

4. Systems Analysis - This phase evaluates alternative land-use and transportation systems. Measures of transportation system usage and performance provide important inputs into economic and environmental analysis.

These various steps should be viewed as highly integrated and iterative. From a behavioral perspective, it is difficult to separate decisions to travel from the choice of destination or mode. Figure 2.2 shows how the various elements interrelate, while Table 2.1 describes in general terms the various data requirements for each model component group.

In urban areas where major transit investments are anticipated, the model structure should allow projections of person-travel during specific periods of the day, i.e., morning peak, evening peak or off-peak. Accurate and realistic network analysis procedures are essential to assure that system (producer) and user costs are properly estimated.

FIGURE 2.1

URBAN TRAVEL DEMAND FORECASTING PROCESS

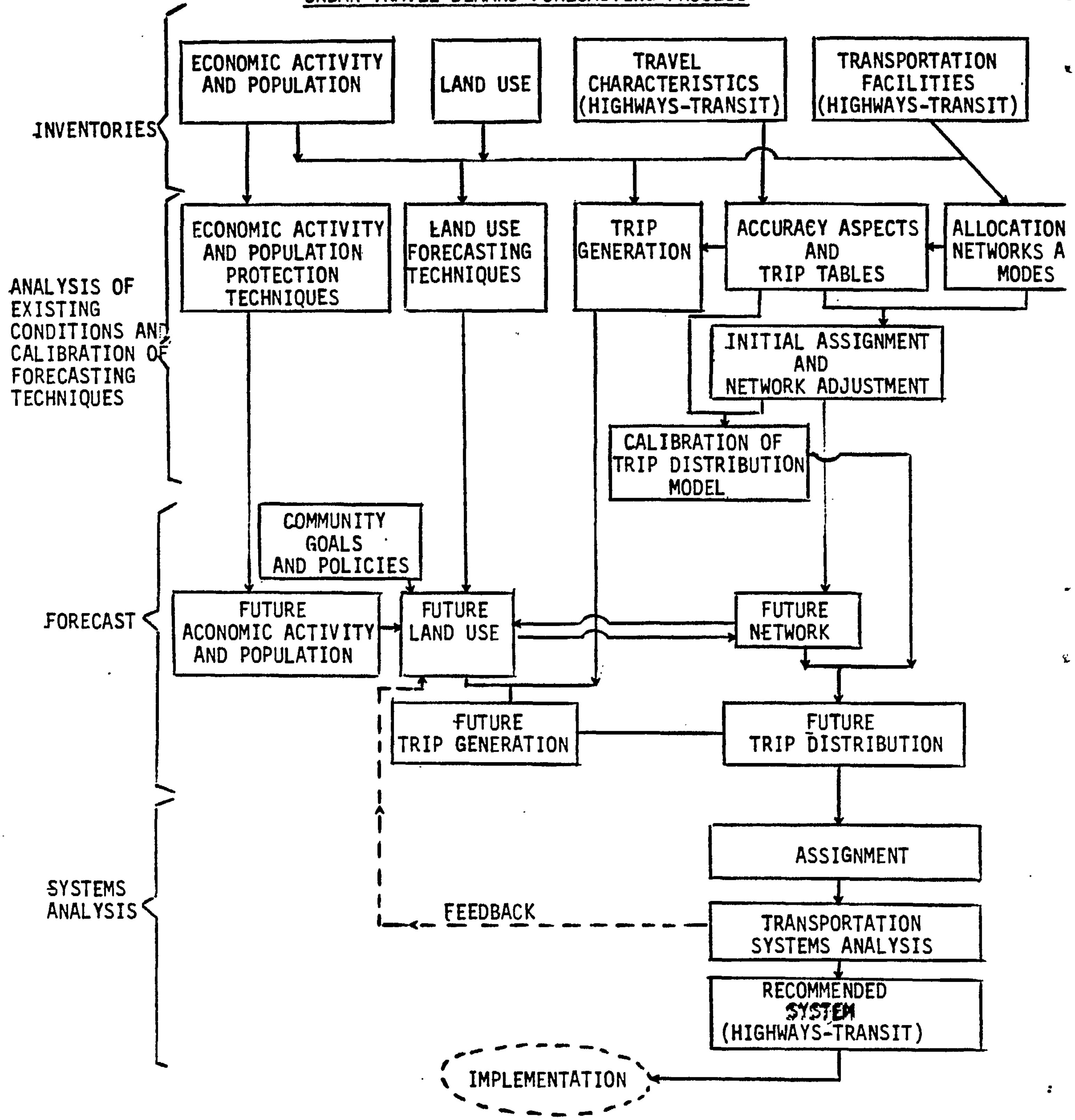


FIGURE 2.2

TRANSPORT DEMAND FORECAST AND EVALUATION SYSTEM

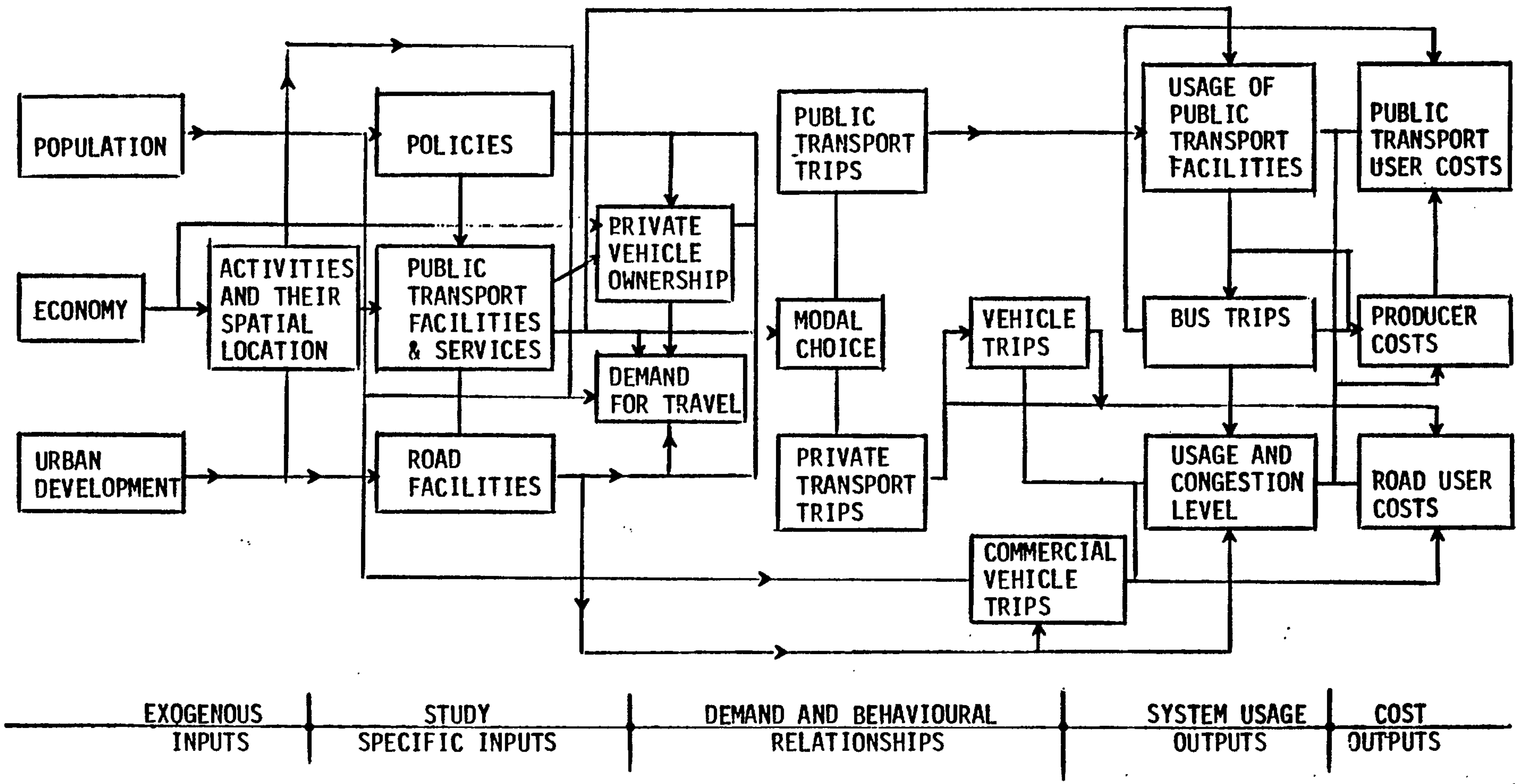


TABLE 2.1

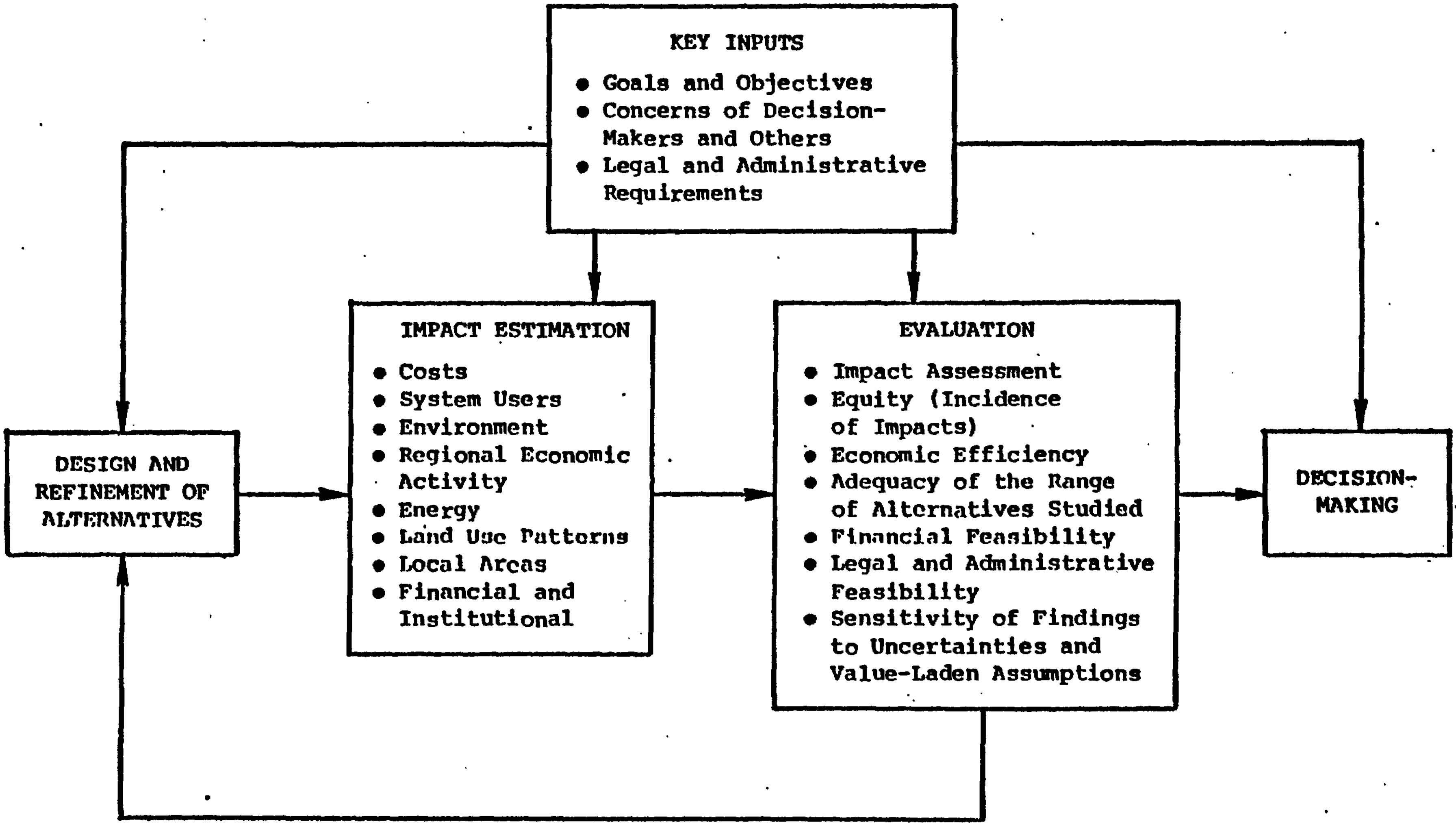
Model Components and Their Application

COMPONENT	DATA TYPE AND APPLICATION FOR MODEL COMPONENTS	APPLICATION
Exogenous inputs	Urban Development and Activity Levels, i.e., population, employment, schools, hospitals, etc., by spatial location	Travel Demand, i.e., Trip Generation and Attraction
	Economic growth, i.e., household income	Demand for Private Vehicle Ownership, Travel Demand
Study-Specific Inputs	Pricing Policies, i.e., cost of operating private vehicles, parking charges, restraint measures, fare structure for public transport services	Private Vehicle Ownership, Travel Demand
	Road Transport Network Alternatives, i.e., facilities with their speed and capacities	Travel Conditions and Costs by Private Transport Usage
	Alternative Public Transport Facilities, i.e., services, routings, fares and frequencies	Travel Conditions and Costs for Public Transport Usage
	Unit Costs for Public Transport Operations	Producer Costs for Public Transport Operation
Demand and Behavioural Relationships	Travel Demand in response to income levels, vehicle availability, cost of travel, availability of services	Travel Demand patterns
	Route, Mode and Submode and Destination Choice in response to available alternatives, cost and service differentials and ability to select	Demand for Travel by Mode on Specific Facilities and during specific Time Periods
Travel Demand Patterns and System Usage	Loadings on mode and submode specific facilities and services during each time period	Service and Facility Utilization and Congesti Levels
User Cost Outputs	Travel Time and Cost Data for individual, mode-specific travel demands, i.e., each origin-destination pair	Evaluation of User Benefits and Costs
Producer cost Outputs (System Costs)	Equipment needs and operating cost statistics for operation of services required under given usage levels. Gross Revenues	Evaluation of Producer Benefits and Costs. Analysis of Financial Results

SOURCE: B. Wildernuth, 'Public Transport in Singapore, An Analytical Approach to Evaluate its Problems and Alternatives,' presented at Australian Road Research Board Highway Engineering Workshop, August, 31, 1976.

2.2.2 Urban Transportation System Evaluation

To date, no comprehensive evaluation framework for urban transportation system has been developed. Methods vary from region to region at the local, state/province and Federal levels in the United States and Canada. However, from a review of previous studies, the following conceptual framework emerges (Figure 2.3).



CONCEPTUAL FRAMEWORK FOR EVALUATION

Figure 2.3

The components of a comprehensive evaluation methodology are listed below for illustration purposes:

Impact Assessment

- Identification of differences among alternatives
- Identification of trade-offs in choosing among alternatives

Equity

- Distribution of benefits and costs among members of society
- Identification of group share in costs

Economic Efficiency

- Computation of costs and benefits of each alternatives in monetary values
- Effect of non-monetary costs and benefits on conclusions about economic efficiency

Adequacy of the Range of Alternative Studied

- Details of alternatives studied and not studied.

Financial Feasibility

- Availability of capital funding by source

Legal and Administrative Feasibility

- Implementation aspects of feasible alternatives with details of laws and administrative guidelines

Sensitivity Analysis

- Effects of varying scenarios on the outcome

2.3 Methodology for AGT Applications

The feasibility and market for AGT systems will depend on the extent to which AGT technology meets the transportation service needs of urban areas, its ability to attract ridership as compared to other modes and its ability to achieve operating cost savings through automation. Evaluations of the feasibility of the AGT systems are being undertaken in several projects of the AGT Socio-Economic Research Program of the United States Department of Transportation. These assess the factors which may influence the potential performance of AGT technology and evaluate the effectiveness of AGT technology as compared to other transportation modes. A reasonable estimation of the potential market in North America for urban AGT systems can only come from a clear understanding of the components that determine the feasibility of AGT for various urban applications.

The range of operating and performance characteristics of AGT technology suggest it can provide transportation services in several types of applications. In order to determine the suitability of AGT performance characteristics to meet the transportation needs of urban areas, several studies were conducted by the Office of the Technology Development and Deployment of the U.S. Department of Transportation. These studies examined the following aspects:

2.3.1 Types of Application Areas

A review of available literature indicates three major types of transportation areas:

- o activity centre
- o corridor
- o areawide

Parameters which define the transportation service requirements of each application area include:

- o population
- o daytime population density
- o employment
- o geographic distribution
- o level of trip making
- o user needs
- o operator needs

Selective baseline characteristics of the application areas are shown in Table 2.2 and discussed below.

Activity centres are characterized by relatively high density land use configurations and significant concentrations of daytime population. Types of activity centres identified are central business districts, major diversified centers in suburban locations, and industrial campuses (medical, government, or university complexes). Most activity centres are multi-node with 4 to 8 major concentrations of trip ends. The majority of travel involves short circulation or distribution trips; most trips are made by walking.

Corridors are relatively narrow linear portions of an urban area served by major transportation facilities (highway and/or transit) carrying a high volume of daily person-trips. Baseline lengths of 15 and 25 miles have been established for high volume corridors and 15 to 20 miles for medium volume. Typically, corridors are radial from the central business district of the urban area.

Areawide applications cover entire urbanized areas or large subareas requiring transportation service. Focussed areawide applications are characterized by a relatively high percentage (10% or more) of commuting trips oriented to the central business area with central city residential population densities of 7000 to 9000 persons/square mile. Multiple center areawide applications typically have fewer central business district-oriented trips and lower central city residential population densities (3000 to 4000 persons/square mile).

2.3.2 Scope of the AGT Application Methodology

The methodology framework described here is limited to urban locations with a reasonable public market for AGT technology. Application areas where the methodology is not suitable are listed below:

- Areawide and corridor applications with the very large populations and densities - Most are already served by high capacity fixed guideway systems (rapid rail or light rail systems). High travel volumes in these applications would not be adequately served by AGT technology.

- Areawide and corridor applications with relatively small populations and densities -
  Due to low travel volumes these are not promising candidates for any capital-intensive fixed guideway system.

- Circumferential corridors -
  Approximately 80% of all urban transportation corridors in North America are radially oriented. Analyses of radial corridors are largely transferable to circumferential corridors.

- Special activity centres -
  The individualized design and operating characteristics of airports, shopping centres, or recreational parks do not lend themselves to generic analysis. Frequently such AGT installations would be privately owned.

Modal Characteristics

Urban transportation services may be provided by six basic modes: AGT or ICTS, bus-rail, para-transit, automobile, and pedestrian. Submodes within each modal group are identified (for example, AGT or ICTS submodes consist of SLT, GRT, AGRT, PRT) with corresponding system, operating and service characteristics (Table 2.3). Characteristics of AGT, conventional bus and rail transit modes cover a range of values indicating their flexibility to provide a range of transportation service levels.

TABLE 2.2

APPLICATION AREA REQUIREMENTS FOR TRANSPORTATION PERFORMANCE

		ACTIVITY CENTER			CORRIDOR		AREAWIDE	
		CENTRAL BUSINESS DISTRICT	MAJOR DIVERSIFIED CENTER	INSTITUTIONAL CAMPUS	HIGH VOLUME	MEDIUM VOLUME	FOCUSED	MULTIPLE CENTER
BASELINE CHARACTERISTICS	DAILY POPULATION (000)	140 - 300	35 - 100	35	540 - 667	375 - 500	750- 1,500	750 -1,500
	DAYTIME POPULATION DENSITY (000/Mile²)	200 - 250	150 - 200	50 - 100	3.2 - 5.7	2.6 - 5.0	4.0 - 4.5	2.5 - 4.0
	EMPLOYMENT DENSITY (000/Mile²)	50 - 100	25 - 50	35 - 50	1.3 - 2.3	1.0 - 1.6	2.5 - 3.0	1.7 - 2.0
	TRIP DISTRIBUTION [1]	MULTINODE	MULTINODE/ FOCUSED	MULTINODE	RADIAL	RADIAL	FOCUSED	MULTINODE
	DAILY PERSON TRIPS (000)	1,127 -2,279	238 - 704	202 - 241	477 - 512 [2]	236 - 270 [2]	1,650 -3,329	1,726 -3,456
USER NEEDS	AVERAGE SPEED (MPH,Door-to-Door)	10 - 20	5 - 20	5 - 15	20 -45	20 - 45	20 - 40	20 - 40
	STATION SPACING (Miles)	1/18-1/2	1/18-1/2	1/18-1/4	1/2-2	1/2-2	1/2-2	1/2-2
	SERVICE FREQUENCY (Minutes)	<8	<8	<8	<15	<15	<20,<15 to CBD	<20
OPERATOR NEEDS	LANE CAPACITY (Passengers Per Hour Per Lane)	<15,000	<10,000	<5,000	<15,000	<8,000	<15,000	<10,000

(1) Multinode activity center or areawide applications are characterized by three or more major concentrations of trip ends; focused applications have significant concentrations of traveller trip-ends at one or two locations.

(2) Daily Person Trips at Peak Load Points

Source: (63)

TABLE 2.3

RANGES OF PRIMARY CHARACTERISTICS FOR GENERIC MODES

Characteristics	System			Operating				Service						
Modal Group/	Station Spacing (1)			Line Capacity (2)				Average Speed (3)			Service Interval (4)			
Generic Mode	<.5	.5-2	>2	<3	3-8	8-18	>18	<10	10-20	>20	<1	1-10	>10	
ACT														
SLT	o	o		o	●	●			●	o		●		
GRT	o	●			●	●			●	o		●		
AGRT	o	●			●	o			●	o	o	●		
PRT	o	o			●	o				o	o	●		
Bus														
Exclusive Busway			o		o	●	o			o			o	
Busway / Carpool			o	o	●	●	o			o			o	
Bus--Mixed Freeway		o	o	●	●					o			o	
Bus--Mixed Arterial	o	o		●	o				●			●	o	
Bus--Priorty Street	o			o	●			o	o			●	o	
Bus--Mixed Street	o			●	o			o	o			●	o	
Trolley Bus	o			●	o			o	o			●	o	
Minibus	o			●				o				●	o	
Rail														
Rapid Rail		●				●	●		o	o		●		
Commuter Rail		●			o	●	o			o			o	
LRT--Excl. ROW		●				●	o		o	o		●		
LRT--Semi-Excl. ROW	o				o	●	o		●	o		●		
Street Car	o				o	o		o	o			●		
Para-Transit														
Car Pool				o	o					o			o	
Van Pool				o	o					o			o	
Dial-a-Bus									●				o	
Shared-Ride Taxi								o	●	o		●		
Jitney	o			o					●			o		
Automobile														
Auto--Freeway				●	o					o	o			
Auto--Street				o				o	●	o	o			
Taxicab								o	●	o	●	●	o	
Pedestrian														
Moving Walkway	o			o	o			o			o			
Walking								o			o			

Note: (1) miles; (2) 1,000 passengers per, peak direction, per lane; (3) miles per hour; (4) minimum interval in minutes.
Legend: ● Value covers the range; o Value only partially covers the range.

Source: (63)

- Key characteristics of U.S. urban areas and major classes of transportation modes
- Public transportation service needs of representative urban areas
- Matching of service needs of representative urban areas with the basic service capabilities of transportation modes
- Evaluations of the attitudes toward AGT of impact groups

The results of these studies will form the basis of the methodology for AGT application.

2.3.4 Mode/Application Matching

For any urban transportation decision making mobility requirements of urban application areas are matched with service capabilities of urban transportation modes. Table 2.4 indicates the potential suitability of all transit modes and the automobile for providing transportation service in all major types of application areas. The matrix indicates the relevance of AGT system installation in three major types of applications areas.

TABLE 2.4

MODES/APPLICATIONS MATRIX

MODE \ APPLICATION	ACTIVITY CENTER			CORRIDOR		AREAWIDE	
	CBD	MDC	CAMPUS	HIGH VOLUME	MEDIUM VOLUME	FOCUSED	MULTIPLE CENTER
AGT	●	●	●	●	●	●	●
BUS	●	●	●	●	●	●	●
RAIL	●	●	●	●	●	●	●
PARA-TRANSIT	●	●	●	●	●	●	●
AUTOMOBILE	●	●	●	●	●	●	●
PEDESTRIAN	●	●	●				

Source: (63)

2.3.5 Methodological Considerations of AGT Market Potential Assessment

The effectiveness of AGT in providing transit service in specific applications relative to conventional transit modes can primarily be analyzed by following the steps described in paragraphs 2.3.2 through 2.3.4 as well as by examining the associated capital, O & M, and life-cycle costs. While these measures are relevant and essential in making a decision regarding the effectiveness of a system, social, economic and environmental factors must also be considered, since they are essential in determining the justification of any system for a particular application.

In the United States, two projects, Generic Alternatives Analyses and Markets conducted effectiveness analyses of AGT systems for appropriate types of application areas . The Generic Alternatives Analyses project, examined the effectiveness of transportation alternatives in representative hypothetical urban applications including activity centre, corridor and areawide applications. This analysis forms a set of general modal cost-effectiveness domains among various transportation modes, based on an array of travel demand, supply and potential impact measures.

These results are useful in determining appropriate modes for local alternative analysis. However, for the purpose of assessing the market potential of AGT the following three approaches must be used:

Approach 1: An estimate of the potential sites can be made by examining the following parameters: population, employment, geographic distribution, level of trip making, and user and operator needs.

Approach 2: Detailed attitudinal studies must be carried out in order to investigate the acceptability of AGT in an urban environment.

Approach 3: Site-specific alternatives analyses using an approach similar to that of Generic Alternatives Analyses must be conducted. In these case studies, the socio-economic characteristics reflect the "real world" situations and planning assumptions. The site-specific nature of the analysis also permits consideration of factors not possible in the hypothetical analyses (visual intrusion and alignment constraints). It must be noted that the transferability of these results to form broad general conclusions on modal acceptability for other possible applications to candidate sites obtained by applying Approach 1 is limited by the following factors:

Assumptions: The results only reflect the basic assumption made regarding the system selection and system evaluation. Differences in local costs in construction, etc., and local attitudes preclude the immediate transfer of generic results to any other area.

Local Goals and Objectives - Local goals and objectives may differ by urban area. Final decision making regarding modal applicability depends on numerous factors and impacts which often cannot be quantified or generalized (Figure 2.4)

Salient Features of Approach 3

While Approach 3 is essential in evaluating the acceptability of a proposed transportation facility, it is the Approach 3 which is used in determining quantitatively the effectiveness of the facility. An effective procedure for comparing proposed fixed guideway facilities to alternative plans should have the following features:

- o Predict all costs, according to the best estimates of various rates of inflation affecting each component, and properly discounted over a sufficiently long period of time.

- o Predict increasing ridership over newly opened section of a new transit facility, levelling of at a value higher than attracted to a bus option providing inferior service.

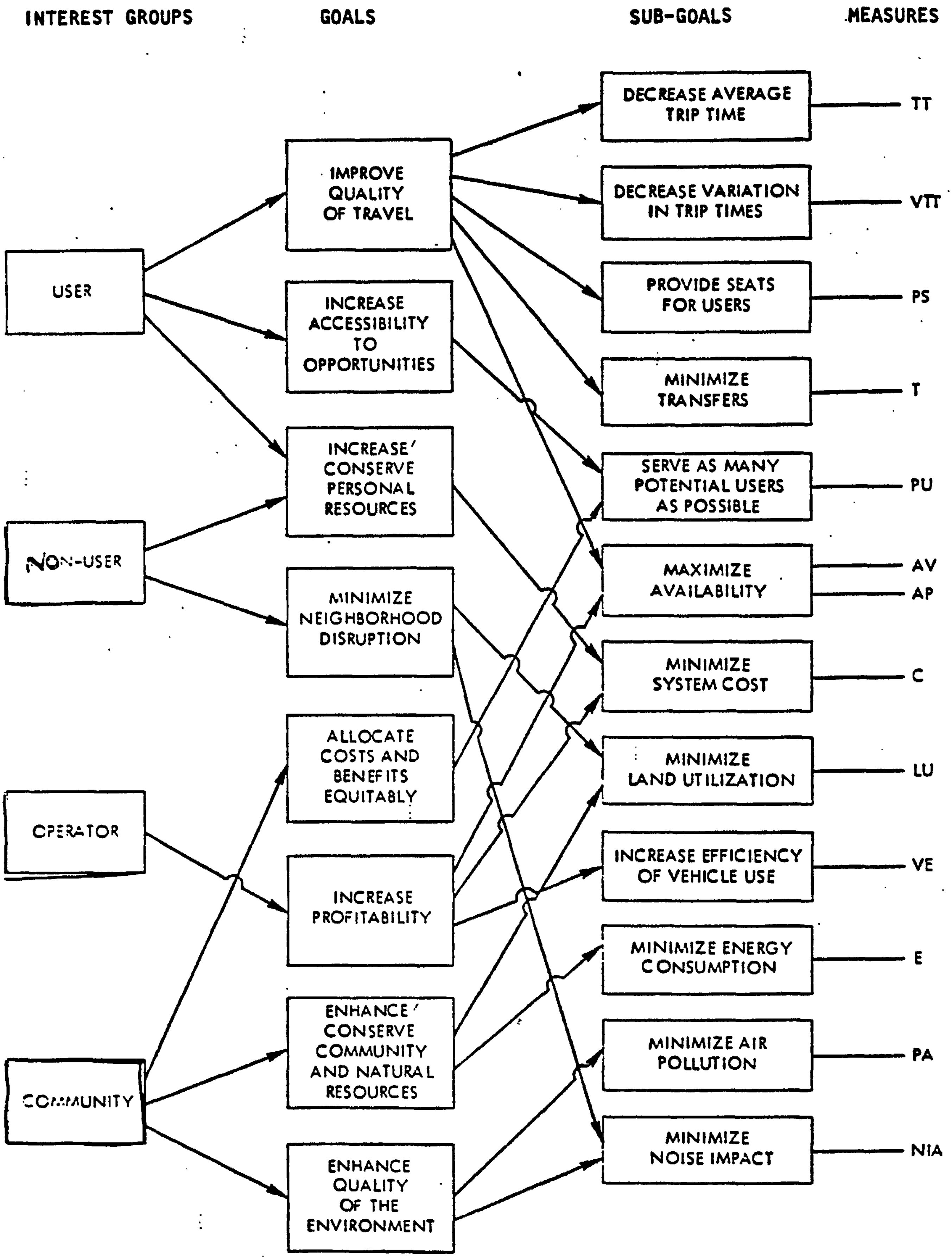


Figure 2.4 RELATIONSHIP OF MEASURES, GOALS, SUBGOALS, AND INTEREST GROUPS
Source: (54)

- Reflect the ability of permanent transit facility to generate demand.

- Show that population growth of a region improves the prospects for a successful new transit installation.

- Show that in the absence of adequate transit service, sprawling growth can impair the potential for transit ridership.

- Identify the most desirable staging of building a new transit system in terms of the interaction of these factors.

A methodology incorporating these features is demonstrated in (55). It has been gathered from the Project Manager of the UMTA AGT Market Study that the basic features of the above three approaches have been used in estimating the market potential for AGT Systems in the United States. (The report of this study will be released in December 1980.)

2.3.6 Research Approach

It is important to bear in mind that this study was designed to assess the market potential for AGT systems from a study of travel demand, user and operator needs. The level of effort in this study is approximately one fortieth of the UMTA AGT Market Study. The overall research strategy involves the identification of appropriate studies; indepth review of identified studies; communication with officials, consultants and others who had any part in the studies or activities related to the studies, and analysis of the consolidated data.

These efforts are broken down into the following specific tasks:

1. Identification of Existing Data Sources

   This task involves the collection of the following data for principal urban areas in the United States and Canada: Population, employment, type of urban area, travel characteristics of users, and characteristics of existing modes of travel and level of capital funding.

2. Review of Existing Studies

   An exhaustive literature search was conducted at the outset to identify studies which included some consideration of AGT. This activity resulted in the identification of the studies of the following types:

- Development of AGT technology, its data base, capital and life-cycle costs (11-21,25,40,43,49,57,66,73,86,89)
- Assessments of existing AGT systems in the United States (27,36,38,44,45,46,53,65,77,83,93)
- Downtown People Mover Program and its implementation guidelines (51,58,54,61,62,67,83,87,88,90)
- AGT Application methodology and Impact Studies (24,48,54,55,63,64,71,79,80,82,91)

3. Discussions with Officials and Others

In the United States, the responsibility for developing, introducing and carrying out socio-economic research of AGT technology is delegated to the following offices:

- Office of New Systems and Automation
- Office of AGT Applications
- Office of Socio-Economic and Special Projects

In Canada, the Technology Division of the Research and Development Centre of Transport Canada is responsible for supporting research and development effort concerning the ICTS system. In addition, a large number of people is involved in the preparation of AGT related transportation plans at the state/province and local levels. This activity was, therefore, divided into two phases: personal inquiries by mail, and visits to specific offices by the principal investigator.

a. Personal Inquiries

Personal interviews were made of a number of persons carefully selected to represent federal and local agencies which were known to have conducted AGT research and deployment analyses. Recognizing that only a few offices could be visited for in-depth interviews, the personal inquiries approach was adopted to provide an enlarged data base and diverse opinions.

b. Visits and Personal Interviews

The principal investigator visited Washington, D.C., Detroit, Montreal and Toronto and interviewed twelve (12) public officials and consultants who had been involved in AGT related activities. A partial list of the agencies is given below:

- UMTA, Washington, D.C.
  - Office of New Systems and Automation
  - Office of AGT Applications
  - Office of Socio-Economic and Special Projects
  - Office of Transit Assistance
- MITRE Corporation, McLean, Virginia
- Southeastern Michigan Transportation Authority, Detroit, Michigan
- Transport Canada Research and Development Centre, Montreal
- Ministry of Transportation and Communication, Government of Ontario, Downsview, Ontario
- Public Relations Office
Urban Transportation and Development Corporation
Toronto

4. Analysis of Findings

The objective of this task was to analyze the collected data and results of the previous tasks in order to assess objectively the potential market for AGT systems where Canadian ICTS may compete with other systems.

CHAPTER 3

AN ASSESSMENT OF THE APPLICABILITY OF ICTS IN NORTH AMERICA

3.1 Introduction

The market for AGT technology will depend upon a number of factors like public acceptability, institutional constraints, performance and economic characteristics aside from the demand considerations. Once the demand considerations dictate the need for the AGT technology to be considered for alternative analyses, other factors are evaluated for each site specific system selection process. Although the scope of the study is limited to demand considerations only, the principal findings of a number of site specific studies will be applied in order to assess the market for AGT system in North America. Accordingly, this chapter will be organized along the following lines.

First, a review of previous studies will be presented outlining the development of AGT systems in the United States and Canada. Second, an account will be given of key socio-economic and transportation characteristics of key urban areas in order to establish the market for AGT systems in general terms. Later, results of a number of site specific studies, discussions with a number of key officials in the United States and Canada will be utilized in order to estimate the market.

3.2 Status of AGT Technology in the United States

The Urban Mass Transportation Administration and its predecessor agency has been involved in research, development, and demonstration of automated guideway transit (AGT) systems since the early 1960s. Design and development of engineering prototype and operational systems were undertaken by industry, both independently and under UMTA contract.

The first full-scale experimental AGT project--the Transit Expressway--was constructed at South Park near Pittsburg. This led to development of similar AGT systems in limited environments such as airports, universities, and amusement parks.

During this period, many studies were undertaken to determine the potential for application of AGT systems to meet the transportation of metropolitan areas of various sizes. These studies included financial, economic, governmental, and societal aspects of new systems, as well as the availability of technology and materials.

UMTA's current Automated Guideway Transit program is directed toward providing an empirical and analytical foundation for deployment of AGT systems. The major program emphasis includes:

- o <u>system development and demonstration</u> - data acquisition, advanced system development, feasibility studies;
- o <u>technology development</u> - critical technical problem solution, simulation, economic efficiency, subsystem tests, planning design data;

- <u>socio-economic research</u> - social acceptance, applications market assessment, level of service.

Figure 3.1 portrays the development of principal AGT programs over the period 1962-1980, where Table 3.1 provides a description of AGT system profile by type of supplier.

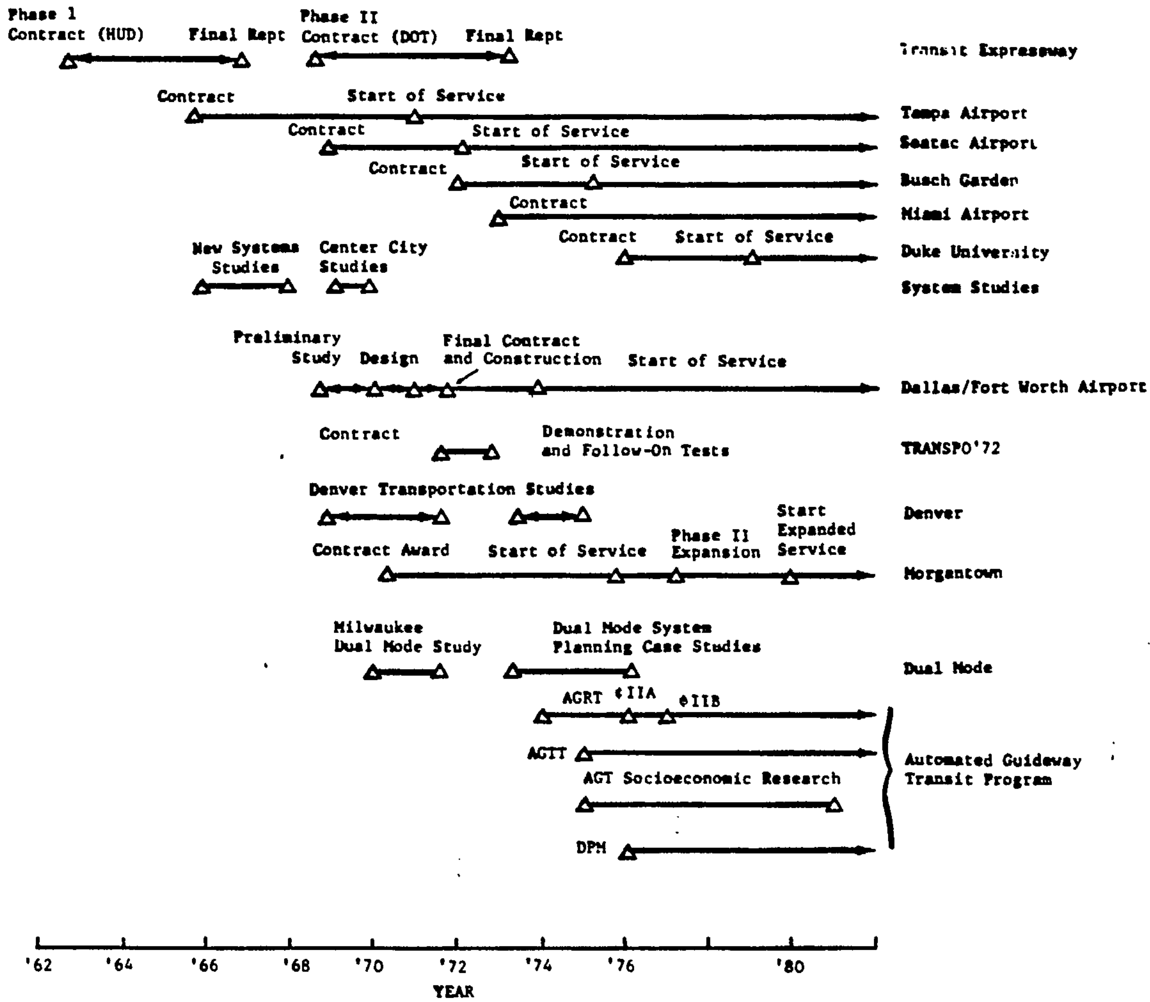


Figure 3.1 - PRINCIPAL AGT PROGRAMS

Source: (25)

TABLE 3.1

AGT SYSTEM PROFILE

System	Year of Operation	Cost	Number of Vehicles	Single Lane Miles of Guideway	Ridership
Boeing - West Virginia Univ. Morgantown, WV	10/75	$64.2 M	45	5.4	459 K (3/76)
Demag/MBB - Ziegenhain, W.G.	3/76	$800 K	1	0.4	NA
Ford - Bradley Int'l Airport Hartford, CO	Not in service	NA	2	0.7	NA
Fairlane Town Ctr. Dearborn, MI	3/76	$5.1 M	1	0.5	230 K (3/76)
Otis/TTD - Duke University Durham, NC	Not in service	NA	5	0.59	
Rohr - Bronx Zoo New York, NY	Not in service	$2.5 M (1973 dollars)	54	2.3	NA
Pearlridge Shopping Ctr. Honolulu, Hawaii	Not in service	NA	4	0.2	NA
Houston Int'l Airport Houston, TX	10/72	$1.0 M[1]	18	1.0	6.3 M (3/76) (Est.)

TABLE 3.1 (Continued)

System	Year of Operation	Cost	Number of Vehicles	Single Lane Miles of Guideway	Ridership
Universal Mobility - Minnesota Zoo Minneapolis, MN	Not in service	$5.0 M+	18	1.3	NA
Kings Dominion Richmond, VA	3/75	NA	54	2.0	0.9 M (3/76) (Est.)
Kings Island Cincinnati, OR	5/74	NA	43	2.0	3.1 M (3/76) (Est.)
Carowinds Charlotte, NC	6/73	NA	32	2.0	1.8 M (3/76) (Est.)
Magic Mountain Los Angeles, CA	5/71	NA	36	0.8	11.8 M (3/76) (Est.)
Hershey Park Hershey Park, PA	7/69	NA	18	0.8	7.6 M (3/76) (Est.)
California Expo Sacramento, CA	5/63	NA	32	1.3	1.6 M (3/76) (Est.)
Fuji Highland, Japan	/68	NA	18	2.3	NA
Expo 67 Montreal, Canada	/67	NA	672	7.3	23.5 M

TABLE 3.1 (Continued)

System	Year of Operation	Cost	Number of Vehicles	Single Lane Miles of Guideway	Ridership
Vought - Dallas/Fort Worth Airport Dallas/Fort Worth, TX	1/74	$64 M	68[2]	13.0	5.1 M (2/76)
WEDway - Disneyland Anahaim, CA	/67	NA	197	0.75	29 M (9/75)
Disney World Orlando, FL	7/75	NA	160	0.87	3.4 M
Westinghouse - Atlanta Airport Atlanta, CA	Not in service	$35 M	17	2.3	NA
Miami Airport Miami, FL	Not in service	NA	4	0.5	NA
Busch Gardens Williamsburg, VA	5/75	NA	2	1.4	1.5 M (3/76 (Est.)
Seattle-Tacoma Int'l Airport Seattle, WA	7/73	$14.0 M	12	1.7	24.2 M (3/76) (Est.)
Tampa Int'l Airport Tampa, FL	4/71	$ 8.25 M	8	1.4	39 M (4/75)
			1537	52.22	

NA - Not Available
[1]Exclusive of Guideway and Right-of-Way
[2]51 pass. vehicles, 17 freight vehicles

SOURCE: (25)

The number of AGT systems currently in operation, under construction, or proposed in the United States is shown in Figure 3.2. The trend has been to gather sufficient experience with the new technology in universities, airports, recreation areas, shopping centres and hospital complexes. The systems proposed for deployment in urban areas, known as Downtown People Mover Systems will be discussed later in this chapter.

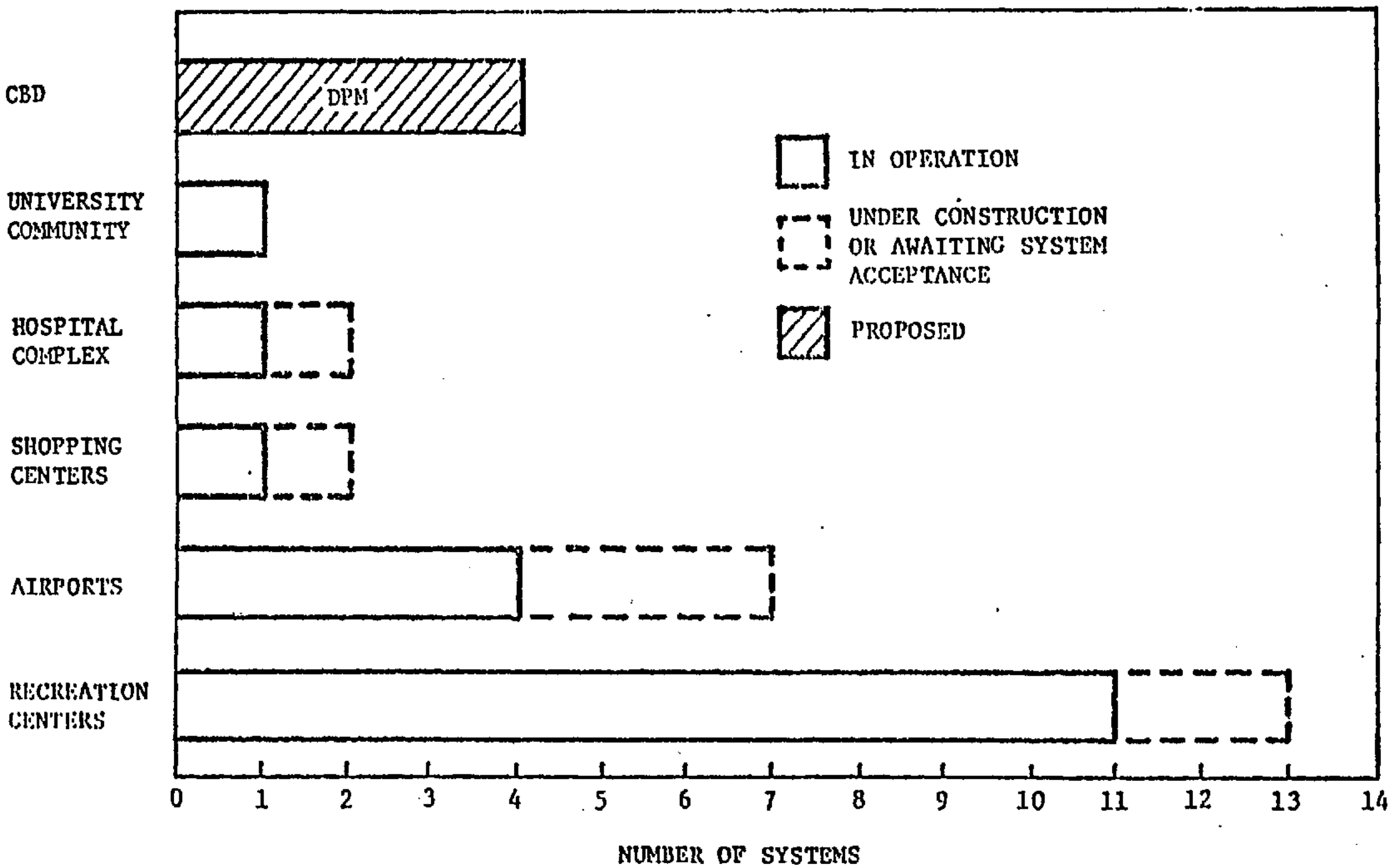


Figure 3.2 - AGT SYSTEMS CURRENTLY IN PUBLIC USE, PROPOSED, OR UNDER CONSTRUCTION

Source: (25)

3.3 Market Potential for AGT Systems in the United States

In this section, we shall deal with the market potential for AGT systems in the United States. First, a macro level analysis is conducted to select the urban areas where AGT systems could be deployed from the travel demand and socio-economic considerations. This list of urban areas is then augmented by the results of the related studies:

1. Review of Local Alternatives Analyses involving AGT.
2. Review of Downtown People Mover Proposals: Preliminary Market Implications of AGT.
3. Automated Guideway Transit Socio-Economic Program Findings, 1976-1979.
4. Market for Domestic AGT Systems (Preliminary results of an On-going Study)

The market estimate for AGT systems in North America is presented in the last section.

3.3.1 A Macro-level AGT Deployment Analysis

Travel demands may be described in terms of four major demand characteristics. One significant travel demand characteristic is the size of the analysis area. Analysis areas vary in size from major portions of entire metropolitan areas to localized parts of small-area activity centers. Aggregate trip-making volume is a second important characteristic of demand. The average daily number of trips in an analysis area is a measure of this type. Disaggregation of demand magnitude by specifying magnitudes for each of several smaller time intervals results in a third demand characteristic--temporal variation. Disaggregation by subdividing the overall demand analysis area into smaller units and then specifying demand magnitudes between pairs of units allows demand to be described in terms of spatial variations--a fourth major demand characteristic.

An examination of these demand characteristics suggests a top-level classification of demands into two groups: metropolitan areas (or substantial portions of metropolitan areas) and activity centers (small areas of high travel intensity). Since any comparison of a demand area chosen from one group with an area chosen from the other group is expected to indicate great differences in all four of the major demand characteristics, the basis for establishing the two groups is sound. However, the variations in one or more characteristics among members within each group suggest that each group may be readily divided into more homogeneous subclasses.

Since the travel patterns in a metropolitan area are strongly influenced by the presence of one or more central business districts, a measure of relative CBD trip attraction or orientation was used as a demand classification parameter. The measure of CBD orientation used in the Systems Operation Studies[54] is the percentage of all daily work trips in an urbanized area which terminate in the CBD. Another useful measure of spatial distribution is the relative amount of reverse commutation; that is, the proportion of central city dwellers who work in the suburbs. If high and low values are considered for each of the two measures of spatial distribution, the following four basic demand types are defined:

- o Low CBD Orientation, Low Reverse Commutation
- o Low CBD Orientation, High Reverse Commutation
- o High CBD Orientation, Low Reverse Commutation
- o High CBD Orientation, High Reverse Commutation

In this context, "high" refers to a characteristic measure above the mean value for the 35 largest Standard Metropolitan Statistical Areas (SMSA) in the United States, while "low" refers to a value below the mean. The mean values are 10.06 percent for CBD orientation and 8.49 percent for reverse commutation. The first demand type, in which both measures are low, suggests a metropolitan area potentially more difficult to serve with capital-intensive transit systems than the other three types. Therefore, the last three demand classes comprise the range of metropolitan area demands to be considered for AGT system deployment.

Table 3.2 indicates the type of AGT system deployment by urban area type in 35 largest urban areas of the United States. In 1976, 38 cities of various types submitted formal proposals for DPM type AGT systems. A list of cities by type of DPM system is given in Table 3.3. Finally, in Table 3.4 we present a list of cities where various type of AGT applications were considered in their respective urban transportation studies. Before we discuss the market estimate in the United States, it is important that the development in the DPM program is presented first.

TABLE 3.2

Types of AGT Applications in 35 Largest Urban Areas of the United States

City Characteristics	Urban Area Characteristics: Urbanized Area Size (000Sq. m)	Urbanized Area Population (000)	Urban Structure	AGT Deployment Variables: CBD Orientation (% of Urbanized Area Work Trips/Urbanized Area to CBD	Reverse Commutation (% of Urbanized Area Work Trip Central Urbanized Ring	Type of AGT Applications Considered in Local Alternative Analysis: DPM/ City Centre Circulation	Regional	Corridor	Activity Centre, Airport Etc
1. New York	2425	16207	Multi	14.73	4.40	X			X
2. Los Angeles	1572	8351	Multi	4.21	12.23	X	X	X	X
3. Chicago	1277	6715	Multi	8.92	7.58	X			
4. Dallas- Ft. Worth	1070	2016	Multi	12.74	5.51	X	X		X
5. Detroit	872	3971	Multi	6.20	11.88	X			X
6. Philadelphia	760	4021	Multi	8.08	5.16			X	
7. Minneapolis-St. Paul	721	1704	Multi	12.89	8.44	X	X	X	X
8. San Francisco-Oakland	681	2988	Core	15.62	5.09			X	X
9. Clevland	646	1960	Multi	9.72	8.89	X			
10. Boston	644	2653	Multi	8.67	5.05	X			
11. Pittsburgh	596	1846	Core	11.07	5.92	X		X	
12. Houston	536	1678	Core	15.98	5.38	X			X
13. Washington	496	2481	Core	13.57	5.00	X	X	X	X
14. Kansas City	493	1102	Multi	7.19	9.24	X	X		X
15. St. Louis	461	1883	Core	4.39	6.05	X			
16. Milawakee	457	1252	Core	9.01	13.00			X	
17. Atlanta	437	1173	Core	11.04	8.44	X			
18. Seattle	413	1238	Multi	7.80	6.11	X		X	X
19. Phoenix	388	863	Core	6.41	9.29				
20. Indianapolis	381	820	Core	17.65	11.47				X
21. San Diego	381	1198	Multi	4.39	8.11	X	X	X	
22. Cincinnati	336	1111	Multi	11.56	9.95		X	X	
23. Baltimore	310	1580	Core	7.80	11.88	X	X		X
24. Tampa-St. Petersburgh	292	864	Multi	7.30	9.49				
25. San Jose	277	1027	Core	3.28	17.31				
26 Portland	267	826	Core	9.56	8.25	X	X		
27. Miami	259	1220	Core	4.76	12.34	X			X
28 Providence	244	795	Core	7.35	9.19				
29. Columbus	236	741	Multi	12.97	12.03	X		X	
30. Dayton	224	686	Core	10.09	5.50				
31. San Antonio	223	773	Multi	11.11	6.67	X		X	
32. Buffalo	214	1085	Multi	9.63	10.16		X	X	
33. Denver	213	1047	Core	10.30	6.78	X	X	X	X
34. Louisville	210	739	Multi	15.56	9.26	X			
35 New Orleans	184	962	Core	20.31	6.88	X			

Notes: Core = Core Concentrated

Table 3.3

List of Candidate DPM Proposals by City

City	Population (000)	DPM (1) Function
Albany, NY	116	a
Altoona, PA	63	b
Boston, MA	641	b
Clearwater, FL	52	b
Duluth, MN	101	b
El Paso, TX	322	b
Ft. Lauderdale, FL	140	a
Knoxville, TN	175	c
Lake Charles, LA	78	a
Louisville, KY	362	a
Marietta, GA	27	a
Nashville, TN	448	a
New Orleans, LA	593	c
Niagara Falls, NY	86	a
Orlando, FL	99	b
San Antonio, TX	654	a
Santa Monica, CA	88	a
Springfield, IL	92	b
Trenton, NJ	105	a
Anaheim, CA	167	b
Atlanta, GA	490	b
Baltimore, MD	906	c
Bellevue, WA	61	c
Cleveland, OH	751	a
Dallas, TX	844	a
Detroit, MI	4042	a
Houston, TX	1200	a
Indianapolis, IN	745	b
Jacksonville, FB	529	b
Los Angeles, CA	2800	c
Memphis, TN	624	b
Miami, FL	335	b
New York, NY	7900	a
Norfolk, VA	290	c
Sacramento, CA	354	c
Seattle, WA	581	c
St. Louis, MO	622	a
St. Paul, MN	310	b

(1) Category a refers to systems providing CBD circulation, category b refers to systems providing circulation between distinct activity centers, category c refers to systems providing circulation between the CBD and major commenter facilities.

Source: (59)

Table 3.4

TYPE OF AGT APPLICATIONS CONSIDERED BY CITY IN LOCAL ALTERNATIVES ANALYSES

Cities Considered AGT	DPM/City Center Circulation	Regional	Corridors	Activity Centers/ Airports, etc.	Total
Denver	x	x	x	x	4
Los Angeles	x	x	x	x	4
San Diego	x	x	x		3
Las Vegas			x	x	2
Santa Clara		x			1
Honolulu	x		x	x	3
San Francisco			x	x	2
Sacramento	x				1
Seattle	x		x	x	3
Portland, OR	x	x			2
Aspen, CO			x	x	2
Detroit	x			x	2
Chicago	x				1
Twin Cities	x	x	x	x	5
Cincinnati		x	x		2
Cleveland	x				1
Columbus, OH	x		x		2
Milwaukee		x	x		1
Kansas City	x			x	3
New York City	x			x	2
Wash., D.C.	x	x	x	x	5
Boston					1
Pittsburgh	x		x		2
Baltimore	x	x		x	3
Philadephia			x		1
Norfolk, VA	x				1
Buffalo, N.Y.		x	x		2
Trenton, N.J.	x	x			2
Hartford, CT	x			x	2
Atlanta	x				1
Dallas	x	x		x	3
El Paso	x				1
Jacksonville	x	x			2
Miami x				x	2
San Antonio	x		x		2
Orlando	x		x	x	3
Houston	x			x	2
Memphis	x				1
St. Louis	x				1
TOTAL 39	30	15	18	18	81

Source: (53)

3.3.2 Downtown People Mover Project

Background

The Downtown People Mover Project (DPM) initiated by UMTA in April 1976, is designed to demonstrate the application of people movers in the urban environment. The project aims at evaluating patronage and community acceptance, the reliability, maintainability, safety and economic characteristics of such systems. In other words, it is intended to demonstrate whether relatively simple automated systems can provide reliable and economic solution to the local circulation problems in congested downtown areas.

Letters of interest in the DPM Project were submitted by 65 urban areas. Of these cities, 38 submitted formal proposals. A three-step site selection process based on the minimum criteria announced in the 6 April 1976 news release (see Appendix) was undertaken by UMTA:

a. Preliminary review of planning, ridership, local support, and cost information contained in the proposals.

b. Cost-benefit evaluation of information obtained in the proposals: and

c. Analysis of UMTA site visits and additional supporting information requested from the cities by UMTA.

After the first step, 19 cities remained as preliminary final candidates for DPM Project. Eleven finalists remained after the second step: Baltimore, Cleveland, Detroit, Houston, Indianapolis, Jacksonville, Los Angeles, Miami, Norfolk, St.Louis, and St.Paul. On December 22, 1976, UMTA announced its selection of Cleveland, Houston, Los Angeles and St.Paul as demonstration cities. In addition, Detroit, Baltimore and Miami were advised that their DPM proposals were sufficient merit to permit their funding from existing federal transit commitments to those cities chose to request such action and subject to specific conditions established by UMTA for each city.

Subsequently, Congress advised (through the Conference Report (HR 7757) on the Department's Fiscal Year 1978 Appropriations) that in addition to the above cities, UMTA should consider funding additional DPM projects in the cities of Jacksonville, St.Louis, Baltimore and Indianapolis. The Congressional direction, however, did not provide merits of the finalists proposals, the Department determined that Baltimore, Indianapolis, Jacksonville, Norfolk and St.Louis could be awarded technical study grants, if these cities applied, to perform feasibility studies to further refine their proposed projects.

As a result of the evaluation process and criteria by which the DPM demonstration cities were selected by the Department and/or designated by Congress, the prior planning efforts of the participating cities are recognized as meeting the requirements for the transportation alternative analysis normally required for a major transit construction project. Other statutory requirements for capital assistance on major transit investments remain applicable to the DPM program.

After reviewing local needs, Baltimore decided that it could not divert sufficient funds from its rapid rail project and elected instead to proceed with a technical feasibility study. In addition, Cleveland's Mayor requested the withdrawal of the Cleveland DPM project grant application and elected not to participate in the program. The cities of Detroit and Miami elected to proceed with their respective DPM projects under previously committed funds. Subsequently, Houston elected to terminate its DPM preliminary engineering activities and withdrew from the demonstration program.

On April 22, 1980, UMTA announced its current 'Policy on Downtown People Movers' with the same initial goals and objectives. The purpose of this policy, which is reproduced below, is to concisely state the Department's policy with regard to investment in DPMs, deployments of multiple technologies and fiscal controls.

A. Investment in DPMs

The Department's policy with regard to present and future DPM investments is as follows:

(1) First Tier DPM Cities:

The first tier DPM cities are divided into two categories:

(a) Tier I. The cities of Los Angeles and St.Paul are the remaining demonstration projects in this category from those selected in the December 22, 1976 announcement. They have been awarded capital grants to conduct their Phase I DPM efforts, preliminary engineering.

Award of a Section 3 capital grant to either of these cities for Phase II, project construction, will depend upon the following factors:

- *Availability of Federal funds;*
- *Satisfactory cost and project viability results from the preliminary engineering efforts of that city; and*
- *Successful completion of all grant statutory requirements by that city, including securing the local share and obtaining all required environmental clearances.*

The Federal commitment to these Tier I DPM demonstration projects is $220 million, as announced on December 22, 1976.

(b) Tier IA. The cities of Detroit and Miami are to be funded in accordance with normal Section 3 new start category procedures. These cities have been awarded capital grants to conduct their Phase I DPM efforts, preliminary engineering. Award of a Section 3 capital grant to either of these cities for Phase II, project construction, will depend on the following factors:

- *Availability of Federal funds;*
- *Satisfactory cost and project viability results from the preliminary engineering efforts of that city;*
- *Successful completion of all grant statutory requirements by that city, including securing the required local share and obtaining all required environmental clearances; and*
- *Meeting any specific conditions required by UMTA as a prerequisite for participation in the DPM program.*

Federal funding for the Detroit DPM will come from the $600 million overall commitment made to Detroit by the Department in October 1976 to meet its regional transportation needs. In the event that St. Paul drops out of the DPM demonstration program, Detroit will be designated as a Tier I replacement to permit the demonstration of operational capabilities of a DPM in a cold weather city. In this event, funds for the Detroit project would come from within the $220 million commitment for Tier I demonstration projects.

UMTA has made a written commitment to Miami for $19.2 million for their DPM, as start of the Agency's fixed guideway commitment to them. In the event that additional authorizations are enacted, UMTA may commit for Miami to approximately $50 million. To complete the entire basic l-op of 1.9 miles of double guideway, Miami has indicated its willingness to overmatch the Federal share.

(2) Second Tier DPM Cities:

The cities of Baltimore, Indianapolis, Jacksonville, Norfolk and St.Louis have been awarded technical studies grants to conduct feasibility studies and to further refine their DPM projects. If the results of these technical studies so warrant, grants for Phase I, preliminary engineering, will be provided upon proper application and the successful completion of all statutory requirements. Award of preliminary engineering grants for these projects does not imply a Federal commitment to fund construction. Construction funding of any of these Tier II projects will be provided from the Section 3 new start category and will depend on the following factors:

- *Availability of Federal funds;*
- *Satisfactory cost and project viability results from the preliminary engineering efforts of that city;*
- *Successful completion of all grant statutory requirements by that city, including securing the local share, and obtaining all required environmental clearances; and*
- *An indication that sufficient progress has been made with the implementation of the Tier I projects to permit evaluation of the DPM concept.*

(3) Other DPM Projects:

With regard to Federal funding of additional cities beyond the Tier I and Tier II DPM cities, UMTA will require such cities to conduct an analysis of transportation alternatives prior to any submittal of an application for capital grant assistance. Further, UMTA will require such cities to await the successful operation of at least one of these initial demonstration projects with favorable results before authorizing capital investment of any additional city beyond those above.

B. Deployment of Multiple Technologies

It is UMTA's objective to derive maximum benefit from the Downtown People Mover demonstrations by assuring that a representative spectrum of present technologies are deployed. At present there are more than five manufacturers who could supply DPM systems for these DPM deployments, with each capable of performing one or more of the DPM projects. To ensure that these projects result in the demonstration of different technologies and to ensure that after these DPM projects are completed a viable and competitive set of DPM suppliers remain available for future DPM deployments, UMTA will require that the first three of the DPM demonstration projects deploy three different technologies. The areas where these technological distinctions are sought include, but are not limited to: (1) vehicles - size, propulsion, braking and suspension; (2) guideways - dimensions, construction methods and materials; and (3) communications and control - control system design approach, switching, training, stopping and service characteristics.

UMTA will, therefore, require that the DPM grantees include the following procurement qualification in their system procurement bid packages for the selection of system suppliers:

(1) For the first site ready for deployment, the system suppliers may propose any available technology;

(2) For the second site ready for deployment, the system suppliers may propose any available technology except the technology previously selected for the first site;

(3) For the third site ready for deployment, the system suppliers may propose any available technology except the technologies previously selected for the first and second DPM sites; and

(4) For the fourth and subsequent sites, the system suppliers may propose any available technology.

(5) For all sites, procurement bid packages will include a number of evaluation factors which will place emphasis on experience in manufacturing and installing an operational people mover system, such that it would be highly unlikely that a system not already in operation would be selected. Life cycle cost will also be an evaluation factor.

The above procurement qualification is necessary to assure the achievement of National objectives of the DPM program. Such an approach conforms to the Congressional intention that DPM demonstration projects should "...employ various types of systems so that appropriate comparison can be made of different technologies."[1] All qualified manufacturers will have an opportunity to compete on each procurement. No technology is excluded unless that technology has been already selected for one of the first two demonstration sites and any proven technology may be offered for the fourth and subsequent sites.

C. <u>Fiscal Controls</u>

The Department has determined that fiscal controls must be placed on the DPM program to ensure that the capital cost of any DPM project does not become open ended. As a matter of policy UMTA requires other fixed guideway capital assistance projects to include a "full funding" limit as part of the grant contract to establish the maximum Federal contribution towards the capital cost of the project. This "full funding" limit may be raised to account for unusual cost-of-living index escalations or Acts of God. Such a fiscal control approach is not appropriate for the DPM program due to the program's demonstration nature and due to certain constraints placed by the Department on the DPM cities during the Phase I - Preliminary Engineering. These constraints include:

- *Specification resulting from the preliminary engineering is a performance specification;*
- *The grantee cannot preselect a system technology;*
- *The government desires to implement multiple system technologies;*
- *Due to the above requirements, at the end of preliminary engineering, the grantee does not have a firm estimate on a specific system but only a working estimate that is a composite of available system data.*

The Department has determined that a "modified full funding" limit be established to define the maximum contribution of the Federal government and to provide incentive to the cities to keep costs reasonable and under control. Under this "modified full funding" limit approach the maximum Federal contribution will be determined as follows:

---

[1] House Report No. 95-383 on DOT and Related Agencies Appropriations Bill for Fiscal Year 1978, Page 41, dated June 2, 1977.

(1) *Upon the successful completion of preliminary engineering and the completion of all statutory requirements including the securing of local share and obtaining environmental clearances, a preliminary "modified full funding" limit for the Phase II - Construction contract will be established. This funding limit will be subdivided as follows:*

(a) *City/Grantee - costs associated with city/grantee activities, such as project management and administration, subterranean preparation, street and utility relocation, special construction for joint development, initial start-up operations, etc.;*

(b) *Turnkey Contractor Activity*

(b.1) *Hardware - costs associated with the turnkey contractor's activities for such items as systems engineering, integration, test and acceptance, vehicles, communications and control, maintenance facilities and equipment, initial operations, training, manuals, etc.;*

(b.2) *(Selected) System Specific A&E Design - costs associated with the turnkey contractor's activities for civil design for such items as guideways, stations, maintenance and central control facilities, electrification and guideway heating (if required), etc.; and*

(b.3) *"Brick and Mortar" - costs associated with the turnkey contractor's activities for civil construction for such items as guideways, stations, maintenance and central control facilities, electrification and guideway heating (if required), etc.*

(2) *Upon the selection of the turnkey system supplier, the initial capital grant set aside limit for D(1)(b) (Turnkey Contractor Activity) may be revised upwards to a maximum of 10% or downward, based on actual negotiated contract cost.*

(3) *Upon the completion of the system specific final design and receipt of civil construction bids (fixed price), the capital grant set aside limit for D(1)(b.3) ("Brick and Mortar") may again be revised upwards to a maximum of 10% or downwards, based on the lowest construction bids. This revised limit will become the "modified full funding" limit that represents the maximum Federal contribution to the DPM project.*

(4) *If during the course of the Phase II (Construction), UMTA determines that an added scope activity is required in the system supplier hardware contract (for Item D(1)(b.1) above) to assure improved safety or probability of successful operation over and above the contracted performance. the "modified full funding" limit for D(1)(b.1) (Hardware) may be revised upwards to a maximum of 10%. UMTA will budget the reserve funds required for these potential UMTA-directed discretionary changes.*

(5) *The "modified full funding" limit may also be adjusted to account for unusual cost-of-living index escalation, Acts of God, extraordinary costs due to compensation in eminent domain takings, or costs directly caused by Federal legislation or regulations where the effective date of the legislation or regulations is after the Phase II, Construction grant award.*

3.3.3 Market Estimate for AGT Deployment in the United States

The market for AGT technology will be influenced by the extent to which they compare favourably to conventional transit systems with respect to performance, level of service, costs and impacts. The over-riding factors, however, are as follows:

- o availability of Federal and local funding,
- o regulatory and policy constraints,
- o uncertainty and political support, and
- o public acceptability of unmanned systems.

A macro-level analysis of the potential market for AGT technology currently being carried out by Cambridge Systamatics a cost effective market size between 42 and 49 sites (Table 3.5). These estimates compare favourably with rather crude estimates shown in Tables 3.2 through Table 3.4.

The following interpretation of the market segmentation is based on Mitre's study (53).

Activity Center Applications

Activity centers, particularly central business districts (CBD), are the most promising short-term urban applications of AGT technology. The Review of Local Alternatives Analyses project found most local officials (70% of those contacted) believe there is a real role for AGT circulation and distribution service in these applications. Successful examples of AGT installations at airports, shopping centers,

TABLE 3.5

AGT U.S. NATIONAL MARKET ESTIMATE[1]

Market Estimates for CBC, Corridor and Areawide Systems are Based on Travel Time Savings, Reductions in Auto Use and Bus Operations, and System Capital and O&M Costs. Additional Economic and Land Use Related Benefits May be necessary to Achieve Benefit/Cost Ratios of Unity or Greater

Application	Potential Sites[2]	Cost Effective Market (B/C Ratios ≥1.0)	Representative Economic Benefits Required
ACTIVITY CENTER			
Central Business Districts	48[a]	3-20	$25 to $50 million
Airports	23[b]	12[3]	Not Estimated
Major Diversified Centers	10[c]	5[3]	Not Estimated
Medical Centers	15[d]	1[3]	Not Estimated
CORRIDOR	39(Cities)[e]	18-25(sites)	$25 to $100 million
AREAWIDE[1]	39(Cities)[e]	3-5 (Cities)	$50 to $300 million
TOTAL	18.4	42-49	

(1) Does not include existing AGT systems.

(2) Potential sites meet the following minimum criteria:
- a - SMSA population ≥ 500,000 and two additional cities which submitted DPM proposals.
- b - Daily enplaned passengers ≥ 14,000 (CY 75) and without existing AGT systems.
- c - Four million plus square foot floor area with at least two major retail nodes.
- d - One thousand plus beds with additional research and educational facilities.
- e - SMSA population ≥ 500,000 without extensive rail systems.

(3) Benefit/Cost ratio not calculated for application due to unique site-specific conditions. Market based on the number of sites with high probability of implementation; i.e. transportation need for the system and no severe institutional or financial constraints.

(4) Areawide market is not mutually exclusive from corridor applications.

SOURCE: (63)

and amusement parks as well as UMTA support of the Downtown People Mover Program have been a major stimulus to local interest in activity center installations.

Existing technology options provide performance and service levels acceptable for most major activity center applications. In site-specific case studies undertaken in the Markets project, local officials indicate a willingness to sacrifice high service improvements (i.e., higher speeds or off-line stations) to gain lower capital and O&M costs and reduce visual intrusion, system integration, and operation, and maintenance problems.

Urban activity center market results of CBD's, airports, major diversified centers, and institutional campuses are discussed below. Highly specialized activity centers such as industrial centers and recreational centers are not considered in this initial analysis due to their individualized designs. These additional installations could, however, provide a significant market cushion for AGT systems.

Central Business Districts

Studies of downtown automated circulation systems in the mid-1970's and the response of 38 cities to UMTA's Downtown People Mover Program provide evidence of real local interest in AGT installations in central business district applications. Preliminary market analysis of CBDs in over forty cities indicate a cost-effective market of three to 20 cities, including the Downtown People Mover demonstration sites.

A number of economic, policy, and environmental incentives can support the potential market for CBD applications of AGT technology. By providing high accessibility in these locations, an AGT system may reinforce urban revitalization goals by fostering new private and public development projects, increasing the tax base, and encouraging new shopping, recreational, employment, and residential activity patterns. Savings from downtown bus service reductions can offset AGT system capital costs. In larger CBDs, AGT systems can achieve lower O&M costs than a bus system providing comparable circulation and distribution service. In short, a simple AGT system can return benefits exceeding the cost of the system.

UMTA funding of the Downtown People Mover Projects and the interagency urban revitalization grant funds recently approved as part of the Surface Transportation Act encourages consideration of AGT technology by local communities. UMTA policy regarding incremental alternatives analyses, joint private/public development in cities, and comprehensive urban planning increase the possibility of AGT mode evaluation and selection in CBD-oriented alternatives analyses. Furthermore, to the extent it reduces auto and bus use in the CBD, an AGT system may result in localized noise and air quality improvements and contribute to energy conservation.

Despite the optimism of local officials and planners, potential barriers to AGT implementation are present. Potential community impacts from elevated structures (visual intrusion and disruption) may prove to be obstacles to AGT system implementation in densely developed CBDs where rights-of-way are typically narrow and activity levels are high. Where bus service reductions are not feasible, a considerable portion of the infrastructure cost savings resulting from AGT installation will be negated. Cities in financial difficulty may find it difficult to obtain local political and financial support for capital investment in AGT.

Airports

Airports are a proven market for AGT as several systems have been constructed at airports to facilitate circulation within and between terminals. Provisions of internal public transportation systems are becoming increasingly necessary as the physical dimensions of airports grow and/or space constraints require that additional terminals be constructed in remote locations.

Of the approximately 30 largest airports, seven have (or will shortly have) operational AGT systems. Approximately eight airports have recently undertaken major construction without making provisions for AGT systems. It appears 12 out of the remaining 15 airports are potential candidates for future AGT deployment. Experience at Houston, Orlando, and SEATAC airports indicate that AGT systems can be attractive at the relatively smaller airports in conjunction with planned airport expansion or renovation.

Major Diversified Centers

The size of the potential AGT market in major diversified center applications has not been formally analyzed in the Markets project. Judgemental evaluations of the potential AGT market are mixed. As a result of dispersed urban development patterns, some observers feel major diversified centers may be a key market for AGT technology, especially if petroleum shortages curtail driving. In contrast, case studies of major diversified centers in the Markets project indicate the economic incentives may not be sufficient to encourage private sector investment in AGT systems, especially in mature diversified centers.

Results from the Markets project indicate potential AGT deployment for major diversified centers appear to be chiefly limited to activity centers with at least two major shopping and at least two major non-retail nodes. There are approximately 10 major diversified centers that could generate sufficient ridership demand for an AGT system; however, because of AGT's capital costs, the market potential is likely to be limited without substantial subsidies. A national market estimate of approximately five AGT systems at major diversified centers appears reasonable.

AGT systems installed in major diversified centers can generate both public and private benefits. The local community may realize reduced traffic congestion, localized environmental improvements, and increased tax revenues. Where the AGT system improves the marketing image of the major diversified center, development sites can be expanded and retail sales increased. Capital savings on parking structures and internal roadways may occur. Institutional constraints are minimal. Visual impacts can be resolved most successfully and at least cost in these locations, especially in new developments where the system can be totally integrated into development planning.

However, many of the potential benefits and cost savings cannot be realized unless the major diversified center is linked with the regional line-haul transit system. The case studies indicate private developers expressed mixed interest in implementing AGT for internal circulation in conjunction with a regional/corridor AGT system.

Private property ownership is the key factor influencing the AGT market in diversified centers. Despite community benefits, public agencies, including UMTA, are hesitant to commit public funds for joint construction or operation of an AGT system with the private sector. Current government policies hinder the development of an AGT market in these applications. Since improved internal circulation may not be essential to the economic vitality of the major diversified centers, developers may not perceive sufficient benefits for them to carry the total cost of AGT installation.

Institutional Campuses

The AGT market at institutional campuses (i.e., universities, medical centers) is not examined in detail in the AGT Socio-Economic Research Program. Results of the feasibility studies undertaken in the Markets project for medical centers and in the Generic Alternatives Analyses suggest this market is small.

AGT systems at institutional campuses are not likely to be economically feasible unless special site conditions are present, which cannot be addressed in a macro-level market analysis. Ridership and travel benefits provided by an AGT system are likely to be similar to that of a less costly bus system.

Corridors

Corridor applications appear to be a viable market for AGT technology. Inclusion of AGT technology in corridor alternatives analyses as early as 1971 indicates local interest in AGT technology as a line-haul mode. Most local officials contacted in the Review of Local Alternatives Analyses project believed corridor applications of AGT technology to be feasible, especially if they evolved logically from activity center applications.

The Markets project identified 18 to 25 corridors in the U.S. where AGT systems appear to be transportation cost-effective as they provided similar or superior travel benefits and attracted slightly more ridership as compared to busway and light rail systems. In these corridors, estimates of AGT ridership ranged from 5 to 25 million annual passengers.

Incentives to the corridor market for AGT technology are potential O&M cost savings, improved noise and air quality, and possible level-of-service improvements (shorter wait times, fewer intermediate stops). The capital costs, aesthetics and urban impacts of AGT systems in corridor applications appear to be comparable to that of other fixed guideway modes. Inclusion of AGT technology in UMTA's alternatives analyses guidelines and requirements for incremental alternatives analyses may encourage AGT mode selection in medium and high volume corridors in the U.S. The market potential for line-haul applications of AGT technology will be enhanced where it can be integrated with an AGT circulation/distribution system.

AGT Market Estimate for the period 1980-1989

Since the submission of the draft report on 'AGT Market Estimates in the United States' to the Office of the Socio-Economic Research and Special Projects, UMTA, there has been a major revision in the United States Policy on urban mass transportation. It appears that the final report on market estimates, when it is published in December 1980, may contain a much reduced market size for AGT systems. Following a discussion with the UMTA Office of Transit Assistance, and UMTA Office of AGT Applications, a more realistic picture of AGT market has emerged for the period 1980-1989:

	AGT System Type	Site	Implementation Period
1.	DPM	Los Angeles	1980-1984
2.	DPM	Miami	1980-1984
3.	DPM	Detroit	1980-1984
4.	DPM	St. Paul	1980-1984
5.	DPM	Baltimore	1985-1989
6.	DPM	Indianapolis	1985-1989
7.	DPM	St. Louis	1985-1989
8.	DPM	Jacksonville	1985-1989
9.	DPM	Norfolk	1985-1989

The route lay-out and other system economics data for these and other DPM proposals are given in Appendix A.

3.4 Market for AGT Technology in Canada

Even before the first prototype design of the Intermediate Capacity Transit is completed, a series of feasibility studies were sponsored by the Transport Canada Research and Development Centre. A total of eleven volumes of studies were carried out by De Leuw Cather Canada Ltd. in order to examine the deployment of ICTS utilizing the existing rights-of-way in the cities of Halifax, Quebec, Montreal, Ottawa-Hull, Toronto, London, Hamilton, Windsor, Calgary, Winnipeg, Regina, Calgary, and Edmonton(32). In addition, Bombardier Ltd. of Montreal had examined the site characteristics of ICTS applications in Volume 1 of their eleven volumes of study (10). IBI Ltd. of Toronto examined the environmental implications of ICTS applications in five Canadian cities (46).

Table 3.6 summarizes the travel, population and corridor characteristics of candidate cities in which ICTS has some market potential. From an examination of rights-of-way, expected demand and political considerations the cities with good potential are limited to the following sites:

- o Hamilton (committed to ICTS)
- o Quebec City
- o Ottawa-Hull
- o Vancouver (Transpo 86 site), and
- o Montreal

The other cities have marginal potential or have committed to other transit modes.

TABLE 3.6

CHARACTERISTICS OF CANDIDATE CITIES

CAPABLE OF SUPPORTING ICTS OPERATIONS

City	Population Growth 1975-85	Employment Growth 1975-85	City Structure	Person Trip characteristics AM-Peak - 1985: % trips to CBD	% trips from CBD	Total transit trips	Current/proposed Transit operations	ICTS Candidates	Pass Demand 1985 - high - low	Accessibility*: CBD	Inner	Outer	Remarks
Quebec	500,000 - 600,000	136,000 - 200,000	CORE	24%	5%	54,200	some experimental express bases in reserved lanes	*Charlesbourg (rail)	4500 - 8250 3250 - 6500	f	f	f	Greatest Potential
								Cote de Beauport (rail)	-				
								St. Roy (rail)	-				
								Lorettevile (hydro)	-				
Montreal	2.8 mil. - 3.3 mil.	980,000 - 1140,000 (relatively minimal CBD employment growth)	MULTI	N/A	N/A	N/A	Suburban commuter trains Metro-city of Montreal some express bus services in reserved lanes	Chateauguay (rail (rail)	4000 - 4500 3000 - 3500	g	f	f	Good Potential
								Lakeshore (rail)	6750 - 7250 5750 - 6000	g	f	f	
Hamilton	475,000 - 579,000 (1986)	192,000 - 258,000 (1986)	CORE	18%	6%	33,400	Studying rapid transit potential for year 2000	Hamilton mountain (new roadbed in tunnel required)	5500	g	g	feeder service	Decision to proceed with prelim. engineering announced.
Vancouver	1,082,352 - 1.6 - 1.8M (1971)-(1991)		CORE				COMMITTED TO LRT						

TABLE 3.6 (Continued)

CHARACTERISTICS OF CANDIDATE CITIES

CAPABLE OF SUPPORTING ICTS OPERATIONS

City	Population Growth 1975-85	Employment Growth 1975-85	City Structure	Person Trip characteristics AM-Peak - 1985: % trips to CBD	% trips from CBD	Total transit trips	Current/proposed Transit operations	ICTS Candidates	Pass Demand 1985 - high - low	Accessibility*: CBD	Inner	Outer	Remarks
Ontario - Hull	644,000 - 850,000	313,400 - 400,000	CORE	49% (current 1975)	3%	38,280	Extensive conventional bus operations; express buses; functional plan developed for exclusive busways.	Scott Street corridor CN Beachberg/CP Prescott CP Gatineau pt. line Note: None of these corridors actually penetrates Ottawa CBD - new links req'd 1.5 - 2.0 miles	5250 - 6500 4500 - 5500 4000 - 4750 2750 - 3500 4000 - 4750 2250 - 2500	p f p	g f g	f g g	Best Potential
Calgary	450,000 - 618,000 (with 1972 city limits	180,000 - 247,000	CORE	N/A	N/A	N/A	(Committed to LRT)						
Edmonton	498,000 - 630,000	N/A	CORE	43% (year 2001)	N/A	47,000	(committed to LRT extensions with current LRT in operation)						Could be upgraded to rapid transit
Windsor	216,000 - 245,000	86,000 - 97,400	MULTI	N/A (dispersed employment associated with auto industry not confined to CBD)	N/A	N/A	3 corridors proposed in 1972 Transportation study for exclusive busway or ICTS - no action as yet	CN Rail corridor CP rail corridor	1250 - 2750 1250 - 2000	Excellent			Unfavourable potential

TABLE 3.6 (Continued)

CHARACTERISTICS OF CANDIDATE CITIES CAPABLE OF SUPPORTING ICTS OPERATIONS

City	Population Growth 1975-85	Employment Growth 1975-85	City Structure	Person Trip characteristics AM-Peak - 1985			Current/proposed Transit operations	ICTS Candidates	Pass Demand 1985 - high - low	Accessibility*			Remarks
				% trips to CBD	% trips from CBD	Total transit trips				CBD	Inner	Outer	
Winnipeg	570,000 -1974 680,000-1986	210,000 - 270,000	CORE	N/A	N/A	N/A	proposed rapid transit busways in 8 radial corridors plus higher capacity rapid trans. Portage Ave/Main corridor	CNR Letellier/ Rivers	3500- 6250 1500 - 2500	g	g	g	Under Study for ICTS
								CPR Winnipeg branch	4500 - 5500 2750 - 3250	f	f	f	Indirect route
								CPR Emmerson	2500 - 4500 1250 - 2000	g	g	g	Greatest growth
								Portage Ave/ Main Corridor	4000 - 5500 2250 - 3500	g	g	g	Identified as rapid transit corridor
Halifax - Dartmouth	257,000 - 323,000	91,500 - 130,000	DUAL CORE	N/A	N/A	N/A	proposed system of express buses and ferry services to 1991 (no rapid transit porposals) - bus priority schemes	CNR Bedford (rail)	2500 -6000 1500 - 3500	p	p	p	All require new links to CBD across harbour
								Bedford (hydro (rail)	2750 - 6750	p	f	p	
								Sackville (hydro/ rail)	2500 - 6000	p	p	p	
								Dartmouth north arterial	2250 - 4500	p	p	g	Penetrates residential
London	248,000 - 333,000	95,000 - 120,000	CORE	N/A	N/A	N/A	Bus improvement schemes including exlusive roadway; no rapid transit warranted until pop. over 400,000	all potential ICTS routes well below the minimum req'd					

*f - fair
P - poor
g - good

Source: (32)

Some Remarks Concerning Potential ICTS Cities

Quebec City: Quebec has at least two corridors and rights-of-way which are promising in terms of characteristics and acceptability. It appears, however, that no action is being taken without committed federal support. Another favourable condition for Quebec is that a good potential supplier for ICTS equipment currently is in Quebec.

Ottawa-Hull: There is an exceptional opportunity for an elevated ICTS installation between Ottawa-Hull. A strong two-direction trip demand exists and such an installation would be both operationally and politically beneficial, the latter aspect demonstrating a federal commitment to Ottawa-Hull as a capital region.

Other downtown areas would dictate an underground ICTS due to public policies for visual intrusion preservation of historical/architectural character, and limited above ground right-of-way width. (Longer term demand calls for a subway in any event.)

Corridors serving the western are promising as ICTS application. Even though the decision has been taken to use articulated buses/busways, there is excellent potential for conversion to higher capacity rail-type operation in future. The eastern section via Montreal Road is too narrow at present, but with planned redevelopment ICTS could be well integrated.

Hamilton: The Hamilton mountain to downtown ICTS preliminary engineering has already begun. It is hoped that the federal government will honour its earlier commitments to fund this demonstration in order to develop the Canadian expertise and provide an operational ICTS example.

Vancouver

The City of Vancouver has recently developed a proposal outlining the need for a Downtown People Mover System (98). The proposed system would connect the TRANSPO 86 site on False Creek with Burrard Inlet Sites, including the Convention Centre, with the downtown core, which contains all the hotels, parking facilities, shopping and other tourist attractions as well as connecting to the West End. The DPM would, thus, form a linkage between the sites and all of the modes of transportation.

The proposal is currently being considered by the TRANSPO 86 Board and the City Government. If approval, in principal is given, the proposal will have to be refined in consultation with the GVRD, UTA and the City before it is submitted to the Provincial and Federal Government for financial assistance.

CHAPTER 4

AN ASSESSMENT OF FINANCIAL NEEDS AND PROVISION FOR AGT SYSTEMS IN NORTH AMERICA

4.1 Introduction

Urban transportation financing in Canada has been historically limited to provincial and local agencies whereas in the United States federal government has been playing a significant role in both the capital and operating assistance. The deployment of capital intensive transportation systems has always been possible with the aid of higher levels of government. In the case of AGT systems the candidate cities will be approaching to federal government in the United States and respective provincial governments in Canada. It is, therefore, relevant to examine the urban transportation needs and provision in both the countries, for the period 1980 - 1990 in order to assess the capital needs and provision for the deployment of AGT systems.

4.2 Urban Transportation Funding Needs in the United States

It has been a short time that the transit industry has progressed in proving its need for federal assistance. With the passage of the Urban Mass Transit Assistance Act in 1964, the federal government declared it to be a public policy to support mass transportation financially. The aid to mass transportation became a tripartite undertaking, with the federal, state and local governments making their respective contributions in accordance with their capabilities. The main elements of the existing mass transit funding programs are presented in tabular form in table-4.1. Table-4.2 provides the details of UMTA capital grants awarded from 1965 through 9/30/79. The annual commitment in the recent years in the capital grant alone has exceeded 2 billion dollars.

TABLE-4.1

MAIN ELEMENTS OF MASS TRANSIT FUNDING PROGRAMS

Program	Description	Who May Apply	Area Coverage	Match	Method of Allocation
UMTA Section 3	Capital Assistance	Public Bodies	Urban areas over 50,000 population	80/15/5 Federal/ State/Local	Discretionary by project
UMTA Section 4	Capital Assistance	Public Bodies	Other than urbanized areas (under 50,000 population)	80/13/5	To be determined
UMTA Section 5	Capital and operating assistance	Public Bodies	Urban areas over 50,000 population	80/15/5 Capital 50-Federal/ 50-State/Local operating	Formula basis to urban areas
UMTA Section 6	Demonstration Projects	Open	Open	Flexible - up to 100% Federal share	Discretionary by Project
UMTA Section 9	Technical Studies	Public Bodies	States or Metropolitan Planning Organization areas	80/15/5	Discretionary by Project
UMTA Section 16 (b)(1)	Elderly and Handicapped Transportation Capital Assistance	Public Bodies	Urban areas over 5,000 population	80/15/5	Discretionary by Project
UMTA Section 16 (b)(2)	Elderly and Handicapped Transportation Capital Assistance	Private non-profit organizations	Urban areas over 5,000 population	80 Federal 20 Local	Apportioned to States on formulas basis, Distributed within NYS on discretionary-by-project basis
FHWA Section 147	Demonstration Projects	Public Bodies, Non-profit public purpose organizations, Indian Tribes	Rural and small urban areas	Flexible	Discretionary by Project

TABLE-4.1 (Cont'd.)

Program	Description	Who May Apply	Area Coverage	Match	Method of Allocation
FAUS	Capital Assistance	Public Bodies	Urban areas over 5,000 population	70 Federal, State and Local Flexible	Formula basis to urban areas

Source: (81)

TABLE 4.2

URBAN MASS TRANSPORTATION ADMINISTRATION
CAPITAL GRANTS BY FISCAL YEAR AND PROGRAM
1965 THROUGH 9/30/79

(number of new projects in parentheses)

FLY		*SECTION 3		SECTION 5 CAPITAL		URBAN SYSTEMS		INTERSTATE TRANSFERS		TOTAL CAPITAL GRANTS
1965 - 1970 Inclusive	(148)	$ 681,227,695		$ -		$ -		$ -	(148)	$ 681,227,695
1971	(49)	284,786,042		-		-		-	(49)	284,786,042
1972	(66)	510,000,000		-		-		-	(66)	510,000,000
1973	(95)	863,708,000		-		-		-	(95)	863,708,000
1974	(120)	870,299,997		-	(2)	34,566,597	(1)	51,000,000	(123)	955,866,594
1975	(166)	1,196,600,868	(14)	9,062,495	(5)	15,676,374	(2)	65,728,784	(187)	1,287,068,521
1976	(103)	1,092,190,977	(27)	25,514,821	(8)	23,437,755	(3)	337,494,988	(141)	1,478,638,541
T.Q.	(20)	253,909,023	(10)	6,741,960		-	(4)	215,553,758	(34)	476,204,741
1977	(137)	1,249,999,998	(76)	39,443,964	(7)	41,996,625	(1)	392,301,016	(221)	1,723,741,603
1978	(181)	1,400,000,000	(73)	50,112,435	(8)	30,441,481	(3)	556,350,728	(265)	2,036,904,644
1979	(151)	1,225,000,000	(167)	255,644,819	(10)	21,280,229	(11)	599,662,294	(339)	2,101,587,342
Total	(1236)	9,627,722,600	(367)	386,520,494	(40)	167,399,061	(25)	2,218,091,568	(1668)	12,399,733,723

*Including advance land acquisition loans and Section 16(b)2 grants. See Table 1A for breakdown by mode.

Source: UMTA Office of Transit Assistance,
Washington D.C. May, 1980

In 1974, U.S. Department of Transportation prepared a report of Mass transportation needs on the basis of long-range plans submitted by the states (94). In that report, capital investments proposed by the states for the period 1972 and 1980 amount to $58.2[1] billion for all urbanized areas, and $36.4 billion for the nine largest urban areas.[2] The New York area alone plans $16.2 billion in capital investments for this period. Rail transit and commuter railroad costs account for 75 percent of the national total of proposed investments and 90 percent of the nine largest urban areas.

In 1977, a statewide assessment of public transportation needs was done by a committe on public transportation nominated by the American Association of State Highway Transportation Officials (3). The committee contracted all fifty states, Puerto Rico and the District of Columbia, to obtain each state's statement of present and future needs. In terms of the data compiled, the Federally required and locally prepared metropolitan area Transportation Improvement Programs (TIP) and their Annual Element were used as base for the projects and cost information for public transportation requirements in urbanized areas over 50,000 for the one year and five-year periods. In addition, each state was asked to provide an assessment of public transportation requirements over a ten-year period. The Federal funding already committed (this appeared to represent approximately a two-year period) and the remaining Federal funding needed over the remaining eight years of the ten-year period was requested. The cost estimates were broken down into capital and non-capital with capital further divided into fixed guideway, regular route bus and other types of transit. Similar information was asked for the urban areas under 50,000 and rural portions of each state.

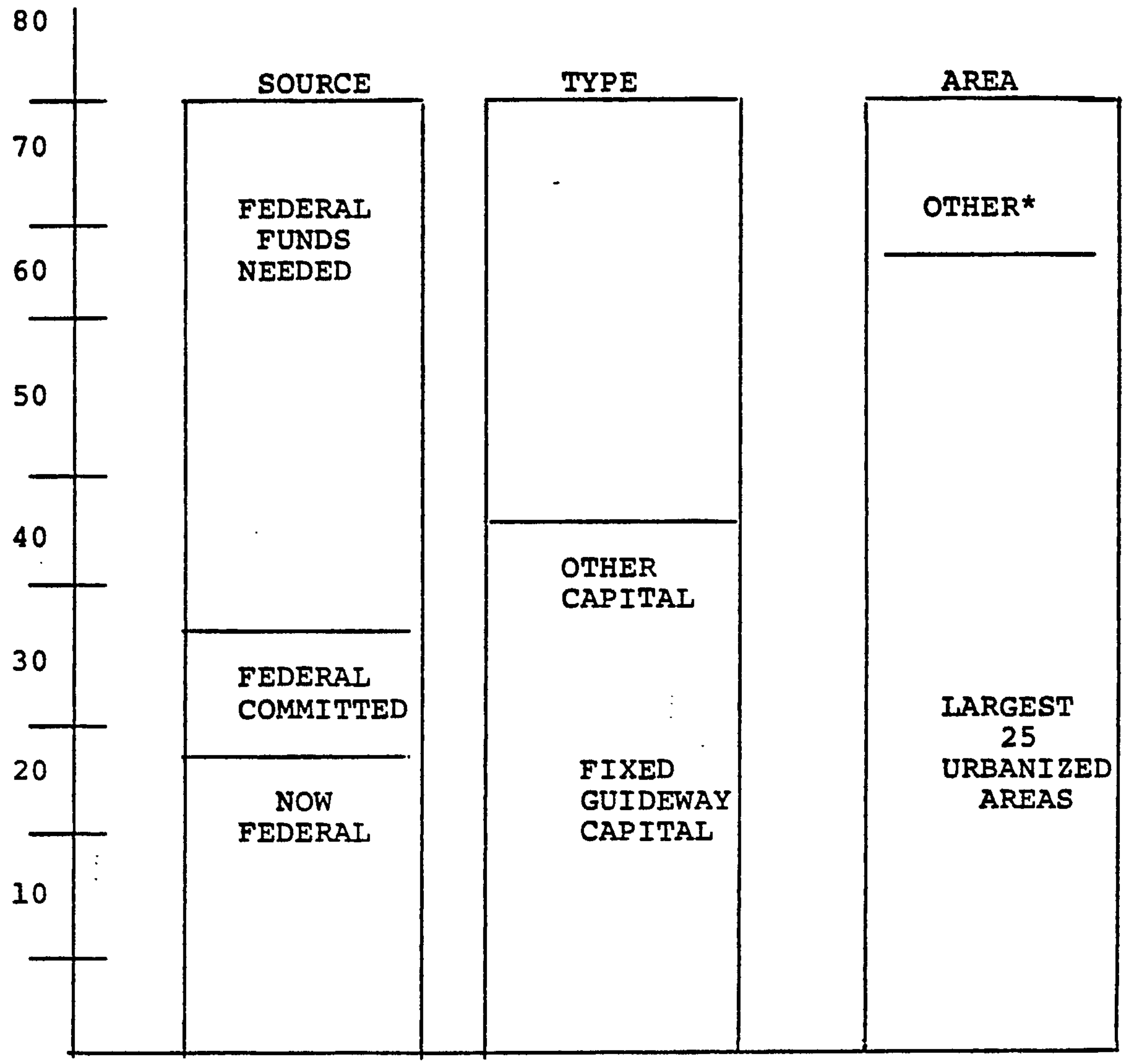
[1]All estimates of capital costs are in terms of 1971 dollars.

[2]New York, Chicago, Los Angeles, Philadelphie, Cleveland, Detroit, San Francisco and Washington, D.C.

Estimates of Federal funding needs are based upon the current nominal Federal to local matching ratios of 80/10 and 50/50 for capital and operating assistance respectively.

FIGURE 4.1

Summary of Public Transportation Funding Requirements by Source, Type and Urbanized Area Size 1977-1987 (Four states missing)



*Includes non-urbanized areas

Source: - (3)

Figure 4.1 summarized overall public transportation funding requirements from all sources for the United States during the next ten years. A total of $79 billion in funds is required which includes $45.5 billion in new programs from Federal sources. Fixed guideway expenditures consist of approximately $30 billion which predominately will be spent in the largest urbanized areas. Operating funding requirements over this time period are also about $30 billion in the largest 25 urbanized areas.

For the 25 largest Urban Areas (over the million population), the total ten year public transportation needs were approximately $68 billion. The current Federal funding considered committed from all sources was approximately $7.7 billion (two years approximately). The additional Federal funding requirement over the ten year period was estimated at approximately $40 billion. These urbanized areas contained all of the fixed guideway improvements, estimated for the ten year period to be $30 billion out of the $68 billion. For this type of improvement, Federal funding was estimated at $4.8 billion committed and $20 billion needed.

TABLE-4.3

PUBLIC TRANSPORTATION NEEDS
FOR 25 LARGEST URBANIZED AREAS
(Thousands of Dollars)

TYPE OF PUBLIC TRANSPORTATION NEED	ANNUAL ELEMENT	TIP (5 YEARS)	TEN YEAR NEEDS	FEDERAL FUNDING COMMITTED (2 YRS.)	FEDERAL FUNDING NEEDED (8 YRS.)
Fixed Guideway	2,775,447	13,963,612	29,891,834	4,796,255	20,076,463
Regular Rte. Bus	857,361	3,497,994	7,378,419	591,878	5,429,323
Other Transit	135,041	368,924	715,034	45,583	535,560
Total Capital	3,767,849	17,830,530	37,985,287	5,433,716	26,041,256
Operating Assistance	1,887,884	11,436,759	29,946,125	2,292,649	13,826,738
TOTAL TRANSIT	5,655,733	29,267,289	67,931,412	7,726,365	39,867,[illegible]94

Source: (3)

The statewide funding assessment by AASHTO is not based on considerations of energy situations in the current decade. In addition,the political climate in the United States is largely responsible for realocation of Federal funds among various sectors of Defence, Transportation etc. UMTA is currently preparing urban transit capital needs for the period, 1980 - 1989. However, from a private communication with an official of UMTA it appears that the Federal government will spend about $57 billion in capital and operating grants.

TABLE 4.4 URBAN TRANSIT
FUNDING PROJECTIONS
BY UMTA-PRELIMINARY
ESTIMATES

Type of Program/ /Items	Current Administration (1980-85)	General Forecasts (1980-89)
Capital Section 3 Assistance	$ 14 Billion	$ 28.8 Billion
Operating Section 5 and Capital Assistance	$ 10 Billion	$ 28.8 Billion

Source: • UMTA, Office of Transit Assistance, Washington, May, 1980

4.3 Capital Needs and Provision for AGT Deployment in the United States

It is difficult to assess the capital needs for the deployment of AGT systems in the United States as the capital required is dependent on the number, and type of application sites and the component of individual system costs. The capital cost of an individual system depends on a number of factors: the dollar base used, the assumptions made regarding specific component costs (guideway, vehicle, command control and communications equipment etc.); the size and capacity of the systemp the types of items included in the estimates(right-of-way, station amenities, related transportation facilities to be constructed with the system under consideration etc.) and geographical considerations. In order to illustrate the nature of capital and other costs a summary of system economics for the 38 proposed DPM systems is included in Table 4.6

In regard to Federal commitment to the AGT systems, a decision has been made to install DPM systems in four cities at a cost of $476 million:

Site	Total Capital Investment (Federal/ State/Local) ($ Million)
Loss Angeles	175
Miami	76
Detroit	110
St. Paul	115

With the commitment of local, State and Federal funds all the four cities will begin construction of the People Mover in 1980 and begin operation in 1984 at the latest. The cities of Baltimore, Indianpolis, Jacksonville, St. Louis and Norfolk have been awarded preliminary engineering funds to further refine their proposed projects. It is expected that the detailed engineering and construction work in these five cities will commence in 1985 at the earliest, provided successful operational experience is obtained in the first tier cities (Los Angeles, Miami, Detroit and St. Paul). It is reasonable to estimate that in the United States, a total of approximately $1 billion will be spent on DPM systems alone over the period, 1980-89. The deployment of other types of AGT systems (other than DPM) in this decade is not being considered seriously by UMTA.

TABLE 4.5

SYSTEM ECONOMICS OF CANDIDATE DPM PROPOSALS: (1)

CITY	TOTAL CAPITAL COST (2) (millions of dollars)	CAPITAL COST PER SINGLE LANE MILE (2) (millions of dollars	ANNUAL OPERATING AND MAINTENANCE COST (2) (millions of dollars)	OPERATING AND MAINTENANCE COST PER VEHICLE MILE (dollars)	OPERATING AND MAINTENANCE COST PER PASSENGER (3) (dollars)	PROPOSED INITIAL FARE (cents)
Anaheim, CA	43.5 - 47.5	12.4 - 13.6	2.1	1.20	0.28	25 - 50
Atlanta, GA	60.0	10.0	2.2	1.60	0.15	25
Baltimore, MD	25.0	7.5	0.88	1.53 - 2.44	0.17	15
Bellevue, WA	24.7	15.9	0.25	NA	0.03 - 0.07	Free
Cleveland, OH	52.1 (4)	26.0 (4)	1.7 (5)	3.25 (5)	0.13 (5)	Free
Dallas, TX	45.0	18.0	1.4	NA	0.15	25
Detroit, MI	55.4 (4)	24.1 (4)	1.8 (6)	1.68 (6)	0.19 - 0.25 (6)	15
Houston, TX	39.0 - 40.0	17.7 - 18.1	1.2	2.33	0.19	10 - 25
Indianapolis, IN	50.2	12.9	0.42	0.54	0.06	10
Jacksonville, FL	41.1	10.9	1.3	NA	0.09	15
Los Angeles, CA	167.0 (5)	26.1 (5)	2.6	1.31	0.14	10
Memphis, TN	48.0	7.0	NA	NA	NA	
Miami, FL	73.8	11.2	1.7 (6)	NA	NA	NA
New York, NY	71.6 (5)	12.3 (5)	2.45 (5)	2.55 - 5.04 (5)	0.08 - 0.15 (5)	5
Norfolk, VA	30.7	9.0	0.5	NA	0.09	Free
Sacramento, CA	34.9	5.2	0.68	1.19	0.13	25
Seattle, WA	26.0	NA	0.2	NA	NA	NA
St. Louis, MO	43.5	5.9	2.2	1.60	0.41	25
St. Paul, MN	48.2	9.3 - 10.8	1.9	1.90	0.15	10

NA = Data Not Available
(1) Ranges are explained in proposal description
(2) Millions of 1976 dollars except where noted.
(3) Calculated from Available data.
(4) 1978 dollars
(5) 1980 dollars
(6) 1975 dollars

Source: (59)

TABLE 4.5 (Continued)

SYSTEM ECONOMICS OF CANDIDATE DPM PROPOSALS (1)

CITY	TOTAL CAPITAL COST (2) (millions of dollars)	CAPITAL COST PER SINGLE LANE MILE (2) (millions of dollars)	ANNUAL OPERATING AND MAINTENANCE COST (2) millions of dollars)	OPERATING AND MAINTENANCE COST PER VEHICLE MILE (dollars)	OPERATING AND MAINTENANCE COST PER PASSENGER (3) (dollars)	PROPOSED INITIAL FARE (cents)
Albany, NY	10.0 - 35.0	8.75 - 11.9	0.55	1.00	NA	10
Altoona, PA	10.0 - 11.0	8.8 - 9.6	0.15	NA	0.13	NA
Clearwater, FL	61.2	8.3	0.57	NA	NA	25
Duluth, MN	72.5	2.9	0.90	1.53	NA	NA
El Paso, TX	18.8 - 25.5	6.6 - 73	0.66	2.00	0.06	NA
Ft. Lauderdale, FL	8.6	4.8	0.10	0.30	NA	NA
Knoxville, TN	17.3	6.9	0.19	0.80	0.10	NA
Lake Charles, LA	NA	NA	NA	NA	NA	NA
Louisville, KY	24.0	12.0	0.27 - 0.43	0.60 - 1.00	0.60 - 0.11	10
Marietta, GA	3.0 - 7.0	0.6 - 1.3	0.60	NA	NA	NA
Nashville, TN	11.5 - 34.8	10.0 - 14.9	0.40	0.90	0.36	20
New Orleans, LA	53.1 - 58.5	8.6 - 8.8	2.0 - 2.3	0.63 - 0.73	0.13 - 0.73	15
Niagara Falls, NY	21.0 - 37.0	6.3 - 11.1	1.7	NA	NA	50 - 1.75
Orlando, FL	12.2	7.9	0.26	0.54	.13	20
San Antonio, TX	27.8 - 47.1	13.3 - 16.9	0.65	2.85	NA	25
Santa Monica, CA	NA	NA	NA	NA	NA	NA
Springfield, IL	11.7	7.3	NA	NA	NA	NA
Trenton, NJ	13.0 - 29.0	4.8 - 10.4 (4)	0.68 - 0.80	0.68 - 0.81 (48)	0.17 - 0.23 (4)	NA

NA = Data No Available
(1) Ranges are explained in proposal descriptions
(2) Millions of 1976 dollars except where noted
(3) Calculated from available data
(4) 1975 dollars

Source: (59)

4.4 Transit Financing in Canada

In Canada, urban transit subsidies have historically been limited to regional/local agencies. In recent years, however, costs have escalated due to increased services coupled with changing population patterns, and regional/local governments have been unable to cover the increased urban transit deficits. Due to the nature of the Canadian federal system, which places urban transit under provincial jurisdiction, some provinces (those in Western and Central Canada and Nova Scotia and Newfoundland in the Maritimes) have, in the 1970's developed programs to help offset the operating and capital costs of urban transit and to enable municipalities to achieve their objectives of offering acceptable levels of public transit service to that portion of the population which depends upon it and of encouraging the use of public urban transit systems in preference to the private automobile.

Country-wide Federal involvement in urban transit subsidies occurred as recently as April 1978, when a federally-funded program directed towards offsetting capital costs was announced. Previous federal urban transit subsidies had been directed to specific projects.

In Canada, then, as in the U.S.A., the higher levels of government are becoming increasingly involved in the financing of urban transit deficits, which are becoming progressively larger over time. However, in Canada the role of the federal government has been much smaller (in comparison to either the U.S.A. or the European countries), due to the style of federalism that characterizes this country.

A summary presentation of the various subsidy programs appears in Table 4.6. Although this table is, it is to be hoped, largely self explanatory, some additional comments may be appended.

First in terms of the theoretical classification, all of these subsidy programs are provider-side-oriented, rather than being user-side-oriented; the only partial exceptions to this generalization (in a sense) are the subsidy programs in Quebec and Saskatchewan, where the emphasis is placed on incentives for ridership growth. This feature gives an orientation similar to that which would occur if the program were user-side-oriented; the only partial exceptions to this generalization (in a sense) are the subsidy programs in Quebec and Saskatchewan, where the emphasis is placed on incentives for ridership growth. This feature gives an orientation similar to that which would occur if the program were user-side-oriented. Secondly, it is to be noted that there is an enormous variation in the scale of the provincial subsidy programs. This is to be expected, of course, given the differing population sizes of the Canadian provinces; however, even after taking this factor into account, the provincial subsidies still differ greatly. Thus to take but two examples, the province of Alberta has a smaller population than that of British Columbia*, yet it spends more than fifteen times as much; the province of Ontario has roughly ten times the population of Nova Scotia, yet it is already spending over forty times what Nova Scotia proposes to spend in the immediate future. Turning to the three broad categories of subsidy programs (operating costs, capital costs, and other), we note that there is an enormous variety in the programs of the eight provinces which currently subsidize operating deficits (or propose to); only Newfoundland and Nova Scotia on the one hand, and Manitoba and British Columbia, on the other, run identical programs.

---

*These statements referred to, are explicit provincial subsidies. However, similar transit deficits in Vancouver and Victoria are covered by a provincial agency (B.C. Hydro) which has combined these in the financing of its overall activities.

TABLE 4.6

PROVINCIAL AND FEDERAL PROGRAMS OF

SUBSIDIZATION OF URBAN PUBLIC TRANSIT

(1978)

Government	Operating Cost Subsidies	Capital Cost Subsidies	Other
Newfoundland	$3 per capita-the operating deficit of St. John's ($300,000 in total) only.	-	-
Nova Scotia	$3 per capita toward operating deficits	50% of equipment acquisitions; possible aid to transit construction	Up to 100% of planning and experimental projects, aid to disabled under consideration
	($2.4 million per year projected in 1978-79)		
Prince Edward Island	-	-	-
New Brunswick	(P o l i c y U n d e r S t u d y)		
Quebec	45-55% of operating deficits, depending on ridership; special incentives for ridership increases	10% of any bus; 30% of a Quebec manufactured bus; up to 1/3 of the cost of acquiring transit systems	60% of the servicing cost of the Metr Public Debt Services 100% of studies relating to urban transit.
	(total program; $86.3 million in 1977-1978)		
Ontario	50% of theoretical deficits (based on population size). Special incentives related to rapid population frowth and the introduction of new facilities ($45.7 in 1976)	75% of approved capital projects	Subsidies for planning projects and to 100% of demonstration projects.
	(total program; $105 million in 1975-1976)		

TABLE 4.6 (Cont'd.)

Government	Operating Cost Subsidies	Capital Cost Subsidies	Other
Manitoba	50% of approved deficits ($8.4 million in 1977/78)	60% of vehicle costs, as restricted 50% of Streets and Right-Of-Way Grants ($17 million in 1977/78)	Regional Streets Maintenance Grant; aid to experimental studies varying from 25 to 76%
	(Total program; $29.5 million (estimated) in 1977-1978		
Saskatchewan	Fixed rate ($0.03) per passenger carried ($634,000 in 1977-78)	50% of rolling stock; 75% of eligible transit construction	75% of costs of studies and demonstration projects; 50% of operating deficits for handicapped transport
	(Total program; $1.78 million in 1977-1978)		
Alberta	50% of deficit up to $3.33 per capita for 1976-1980 ($3.4 million 1976-77 budget)	six-year fund of $97 millions for ordinary capital expenditures; slightly larger program for arterial roads	Research and Development projects; 50% of federal contribution to railway relocation studies
	(Total program; $40.6 million, per budget, in 1976-1977		
British Columbia	50% of operating deficits	100% of approved capital costs	Urban Transit Authority Board to have a jamor role in co-ordination
	(Total program; $2.5 million in 1977)		
Canada	-	$2 per capita per year to be channelled through the provinces, 1978-1983 ($46 million per year)	Assistance (through Municipal Works Assistance Program) in the construction of the Toronto and Montreal subways.

Source: (8)

There are three pure types of operating deficit subsidy programs: a percentage of the deficit actually incurred, a per capita subsidy program, and a subsidy related toridership. Mixed forms occur in practice, of course, and the possibility of budget ceilings (as in the case of Alberta and some years in Ontario) introduces the possibility of another constraint on the process. As already noted, the Quebec and Saskatchewan programs for subsidizing operating deficits, based importantly as they are on ridership factors, would appear to introduce substantial incentives for economic efficiency as conventionally measured. The Ontario program, which is based on an expected or theoretical deficit, might also do this as well, at least to the extent that the managements of the local transit systems must struggle to prevent the experienced revenue/cost ratios from falling below target levels. On the side of capital cost subsidies, there is less economically meaningful variation, although rates of subsidies to vary considerably, as do the allowable items of physical plant (including equipment) of a transit system that may quality for the subsidy. We note in the case of two provinces (Manitoba and Quebec) elements of provincial protectionism that might be questioned from the point of view of economic efficiency, even in the context of the national economy. As for the capital cost subsidies themselves, these can be regarded as reflecting the "natural monopoly" character of urban transit, where fixed (overhead) costs tend to be large relative to variable (out-of-pocket) costs and so both average fixed costs and average total costs tend to be falling throughout the relevant range. The provision of subsidies on capital costs (the most important element of fixed costs), by both the provinces and the federal government, recognizes the sound principle that pricing for economic efficiency should ideally be based on marginal cost (excluding fixed costs). Finally, the other subsidy programs present an almost bewildering variety of provincial concerns; although demonstration projects and planning studies are a common concern throughout Canada, sensitivity to the needs of the handicapped, to intra-provincial co-ordination apparently varies a great deal among the Canadian provincies.

The federal government has identified urban transportation as an area of responsibility within the juridiction of the other levels of government. In support of this policy, no financial assistance has been provided for the operation of urban transit. In the middle of 1960, however, federal monies were granted for the construction of subways in Toronto and Montreal under the Municipal Works Assistance Program. Recently, a $230. million program of assistance (Urban Transportation Assistance Program) was designed to allow the provinces and other levels of government to undertake urban transportation projects which satisfy the following objectives:

(i) To improve safety at railway crossing

ii) To improve the efficiency of the urban transportation system

iii) To improve the standard of urban environmental quality

iv) To improve efficiency of land use

v) To conserve energy.

It is esentially a capital subsidy program. Each province shall receive a total of $10. per capita over the period FY 1978-1983.

Capital Investment in ICTS Project

The only project which would provide opportunity to obtain operational experience of ICTS is the much publicised Hamilton Mountain rapid Transit Project. It is estimated that the Hamilton Project will cost about $70 million. On January 4, 1980 Government of Ontario announced that it would award $3.5 million to the Region of Hamilton-Wentworth in order to proceed with the preliminary engineering of the project. Since September 1978 Ontario has suggested that it and Federal Government (Department of Industry Trade and Commerce) each pay 45 percent while the local government and private business would pay the balance.

At the time of writing the report no decision by the Federal government to actively participate in this project has been announced. A successful operation of this project is essential for marketing ICTS system outside Canada.

CHAPTER 5

SUMMARY OF FINDINGS AND CONCLUSIONS

5.1 Introduction

It is important to reemphasize here that the primary objective of this study was to investigate the market potential for the Canadian made automated guideway transit system, known as Intermediate Capacity Transit System developed by Urban Transportation Development Corporation of Ontario, is currently awaiting mandatory certification requirements by the United States Department of Transportation. Once this certification is obtained this system would be a candidate for deployment in U.S. cities in competition with the American made systems. Although the ICTS system is not in revenue operation, UTDC claims that their system is sufficiently flexible and advanced in design to acquire sizeable market share in North America. In this market assessment study, we evaluated the size and nature of market for automated guideway systems in general. To what portion of this market will be acquired by ICTS in the future is clearly beyond the scope of this study.

However, the market size estimated in this study is the total market potential for ICTS system during the period 1980-1989.

While leaving the details of the study in the foregoing chapters, we summarize the principal findings and conclusions in the following sections.

5.2 Research Approach

The scope of this study was rather broad and varied in relation to the level of effort allocated. Nevertheless, the following research approach was adopted:

- First an extensive literature search was carried out in order to identify studies which included some considerations of AGT. This activity resulted in the identification of studies of AGT applications or evaluations of which six were found to have evaluations of various types of AGT. These studies provided valuable inputs to this study.
- Second, travel demand and socio-economic data of 35 largest urban areas in the United States were collected in order to determine the possible AGT deployments. This list of candidate cities was then matched with the assessment of Downtown People Mover Proposals and the preliminary estimate of AGT market in the United States by Cambridge Systamatics. The market for AGT systems in Canada was based on a number of ICTS studies carried out by De Leuw Cather and Bombardier Ltd.
- Third, Personal inquiries were made of a number of key officials carefully selected to represent current official policies in both United States and Canada.

The Principal investigator visited Washington, D.C., Montreal, Toronto and Detroit and interviewed twelve (12) local public officials, agency staff members who had been involved in or were familiar with planning implementation or policy making in the United States and Canada.

5.3. AGT Market and Implementation Issues

Since AGT systems must compete with conventional transit modes on the basis of service characteristics and overall economies, it is quite possible that cost comparisons will be made. The data developed from the assessments of the ten operational AGT systems indicate that there are potential applications where AGT systems would be competitive with conventional transit systems on the basis of O & M cost. This is apparent from the following average unit costs.

	O&M Cost per Vehicle-Mile	Passenger Trips per Vehicle-Mile	O&M Cost per Pass. Carried
Average for 10 AGT Systems	$1.13	6.8	0.17
Weighted Average for 28 Bus Transit Systems	1.63	3.3	0.49
Weighted Average for 4 Light Rail Transit Systems	2.34	5.3	0.44
Weighted Average for 9 Rail Rapid Transit Systems	2.31	4.0	0.58

Source: (27)

Besides, the four cities, where DPM systems would be installed in the near future in the United States, are predicting that none of the systems will be dependent on Federal/State or Local Governments for operating subsidies, unlike the bus or conventional rail systems. Notwithstanding these economic advantages over the conventional transit modes, the market for AGT technology is likely to be determined more by institutional constraints and public perceptions of the advantages and disadvantages of AGT systems as compared to other transit modes than by technology and performance characteristics. Approximately 60 percent of the local officials interviewed by the study team in the Local Alternatives Analyses Project,53 indicated institutional and political concerns as more important than technical considerations in evaluating and selecting AGT systems for urban applications. The study team identified eight key issues which were of concern to planners, local officials, and others engaged in the study of public transportation alternatives in each of the cities studied. These issues are separated into two categories, as follows:

Issues of Primary Importance

- availability of Federal and local funding
- regulatory and policy constraints
- public and political support
- visual intrusion (aerial structure)
- technical risk

Issues of Secondary Importance

- crime and vandalism
- impact on urban form

Resolution of these concerns will, undoubtedly, influence the application of AGT technology as an urban transportation mode and the future direction of UMTA's AGT research and development efforts in the United States. Several analyses of these issues were performed in the Generic Alternatives Analyses (53), Review of Local Alternatives Analyses (53) and Markets projects (63). The results seem to indicate that although UMTA policy can minimize institutional barriers and research and development projects can reduce acceptibility concerns related to AGT technology, satisfactory solutions to many of these concerns depend on the local political climate, community attitudes, and other site-specific factors. These analyses are, to a large extent, subjective as they are not based on any real life urban AGT installations. The Downtown People Mover Projects will provide the first real opportunities to assess the influence of these factors on the market for AGT systems.

While most of the issues described above are equally relevant in the Canadian market, there are certain special issues which are fundamental to AGT deployment in Canada. They are described below:

- o Transit ridership in the principal Canadian cities are much higher than comparable American cities. (8) From demand considerations very few Canadian cities can justify Downtown People Mover Systems. Certain urban corridor and activity center applications AGT technology could be deployed.

- o The single most important factor inhibiting the deployment of AGT technology, is the non-availability of Federal capital assistance. Current Provincial capital grant funding levels do not favour AGT mode selection by local community in most applications. Where AGT systems are selected, existing funding levels at the provincial and local level are not adequate to support their construction.

5.4 Benefits of AGT Technology

AGT technology has the potential to be a dynamic, positive force in achieving numerous urban public planning objectives:

- . travel benefits to both users and nonusers,
- . planned land use and urban development,
- . local economic viability,

. environmental protection, and

. energy conservation.

Achievement of these objectives is dependent upon several interrelated site-specific factors:

. service concept provided by the system,

. system design, operating, and service characteristics,

. socio-economic environment of the service area, and

. local public policy and attitudes.

Since these factors can vary significantly, their influence on urban planning can be accurately determined only on a site-specific basis. The generalized potential for AGT to achieve urban planning objectives as compared to conventional modes assumes successful implementation of AGT systems in favorable urban environments with supportive local policy.

Travel Benefits

AGT systems can provide significant travel benefits to both its users and the general public as compared to conventional transit modes:

a. Because of the range of AGT technology and performance characteristics, AGT systems can be adapted to serve most urban travel patterns and to provide high levels of mobility and accessibility:

i) Circulation/distribution service in major activity centers, especially when integrated with automobile fringe parking and/or regional transit systems.

ii) Medium to high volume urban corridors connecting two or more major trip generators.

iii) Areawide applications in medium to large urban areas with dispersed as well as concentrated travel patterns.

b. AGT systems offer premium level-of-service to users:

i) In major activity centers, AGT offers convenient, frequent, comfortable service protected from adverse weather conditions with discernable time savings over walking for trips in excess of a quarter of a mile.

ii) Coridor and areawide applications may be served with more direct station-to-station service (few intermediate stops) and possibly without transfer.

c. AGT has the potential of providing greater service flexibility than other fixed guideway modes. AGT designs incorporating routing flexibility and the use of demand responsive service can increase both the attractiveness and efficiency of service over current conventional transit.

d. Infrastructure cost savings from AGT systems may result from reductions in conventional transit system service and the need for additional highway capacity.

e. AGT may have nonuser travel benefits. AGT system implementation may alleviate congestion on surface streets by replacing mixed traffic transit operations and reducing the use of the automobile.

Obviously, however, many of these travel benefits are the direct result of deploying a non-conventional mode of transit designed to offer premium service characteristics. The value of such benefits must be carefully weighed against the cost of achieving them. Again, more precise measures of benefits versus costs are necessary before more conclusive evidence of AGT potential can be offered.

Planned Land Use and Urban Development

The high level-of-service provided by a fixed guideway transit system such as AGT can be a driving force behind guiding land use and stimulating urban development:

a. A fixed guideway transit system such as AGT can exert a positive influence on the shape and density of urban development by concentrating travel activity around system facilities. Since permanent guideway structures reveal a long-term commitment to local land use goals, additional development may occur which will reinforce desired land use goals.

b. Imprementation of an AGT system in a CBD may improve or stablize the office and retail market of the CBD relative to the region. An AGT system can induce new development and attract growth from other locations within the region. The latter effect, however, may not necessarily be a positive or desirable aspect depending on local priorities.

c. Corridor and areawide development opportunities may be less concentrated unless the AGT system demonstrates superior accessibility than other forms of regional transit, such as bus, and strong incentives are established at station locations.

Enhanced Economic Viability

AGT systems can enhance the economic viability of an urban area in several ways:

a. Increased urban mobility as a result of higher service levels provided by an AGT system can create new shopping, entertainment, business, and residential opportunities and result in increased private retail sales.

b. Increase in sales, household income, and property values through greater accessibility from an AGT system can add to the tax base and be translated into increased revenue for local governments.

c. Use of value capture techniques, such as joint development, in conjunction with AGT system installation, can recapture economic benefits accruing to privately owned facilities from the operation and use of the system.

Again, the extent to which these benefits represent new economic returns or shifts from other areas will depend on individual site characteristics.

<u>Environmental Protection</u>

AGT systems can be environmentally favorable compared to conventional transportation systems:

a. Electrically powered AGT systems can improve the air quality of the service area by transfering any associated pollutants outside of the service area. However, resistance to significant shifts of pollutants such as might result from a large scale areawide system might be expected in some areas. Additional air quality improvements will result where corresponding decreases in bus transit services or reductions in automobile use are achieved.

b. Noise levels for AGT systems compare favorably with other transportation modes and with proper design will be within the most severe noise level constraints of urban areas.

Energy Conservation

AGT can play a significant role in conserving energy:

a. AGT systems can reduce petroleum dependency due to its electrical propulsion, particularly where electricity is supplied by non-petroleum products, and possible reductions in the use of petroleum consuming buses and automobiles.

b. AGT may foster high density, mixed use urban development conducive to energy conservation by providing the necessary transportation services at a high level-of-service.

Feasibility of AGT Systems in Urban Applications

The market for AGT technologies will be influenced by the extent to which they compare favorably to conventional transit systems with respect to performance, level-of-service, costs, and impacts. Results of the AGT Socio-Economic Research Program to date suggest existing AGT technology has the potential for providing superior performance at lower costs, and reduced negative and enhanced positive impacts in a variety of application area types as compared to conventional transit modes. However, major obstacles to AGT implementation may be posed by local institutional and public acceptability concerns. Site-specific considerations will influence the relative costs and benefits of AGT system applications and determine the level of political and funding support for AGT technology. Ultimately, the market for AGT will be determined by the financial support provided by UMTA and the success of initial urban installations in the Downtown People Mover Program.

A macro-level analysis of the potential market for AGT technology in key application areas was performed in the AGT Socio-Economic Research Program under the Markets project. This analysis is based on a gross numerical estimate of the urban areas where the benefits and costs of AGT technology appear more favorable than conventional bus and rail systems. While this approach does not allow for detailed evaluation of the factors affecting the feasibility of AGT in a specific location, it provides an order of magnitude assessment of the potential AGT market leading toward a rationale for continued UMTA support of AGT technology research and development and Federal funding assistance.

5.5 Market Estimate for AGT Technology in North America

The market estimate for deployment of AGT technology in Canada and the United States are presented in table 5.1 In arriving at this estimate,discussions were held with a number of key officials of capital funding agencies of U.S. Department of Transportation and Provincial Ministries of Transportation. The assumptions made in the estimation process are as follows:

- No serious disruptions will occur in the supply of petrolium fuel by the OPEC countries between now and 1985. The annual price hike of petrolium fuel over the period 1980 - 85 will follow the pattern of the recent past without causing a major shift of U.S. current Transportation Policy
- In the 70's capital costs of new transit projects were poorly estimated. In both the cases of BART and Washington metro capital and operating costs were grossly under-

TABLE - 5.1

MARKET ESTIMATE FOR DEPLOYMENT OF AGT TECHNOLOGY IN NORTH AMERICA DURING THE PERIOD, 1980-89

A. ACTIVITY CENTRE			
1. Central Business District	Los Angeles, Miami, Detroit and St. Paul	Approved 1980-84	$ 476 million
	Hamilton approved (1980-85)		N.A.
	Baltimore, Indianapolis Jacksonville, St. Louis Norfolk	Potential (1985-89)	$ 500 million
	Quebec City, Montreal	Potential (1980-89)	N.A.
2. Major Diversified Centre	Vancouver (Transpo 86 Complex)	Potential (1980-85)	N.A.
3. Airport	Toronto International Airport	(1980-85)	N.A.
B. CORRIDOR	Ottawa	Potential	N.A.

estimated (92). Consequently, UMTA has determined that fiscal controls must be placed on the approved DPM program to ensure that the capital cost of any DPM project does not become open ended.

Activity centers, particularly central business districts, are the most promising short - term applications of AGT technology. Discussions with the UMTA officials resulted in the identification of nine (9) approved and potential sites for DPM systems over the period, 1980 - 89. In Canada, there are two potential sites in Montreal and Quebec city, besides the approved site at Hamilton. In Vancouver a Walt-Disney type AGT system is being seriously considered at TRANSPO 86 site.

Airports are a proven market for AGT as several such systems have been constructed at U.S. airports to facilitate circulation within and between airports. At Toronto International Airport, a third terminal will soon be built thus making it a potential site for AGT deployment.

Corridor applications appear to be a viable market for AGT technology. The city of Ottawa may provide a real opportunity for such an application.

5.6 Future of ICTS in the North American Market

The total market for AGT technology is probably worth $1.5 billion over the ten year period, 1980 1989. UTDC is in the process of bidding for Miami and Detroit People Mover Systems Among the four sites currently approved by UMTA. It is not intended to conjecture the potential share of ICTS market. Nonetheless, every indication is there that the Canadian ICTS will have a strong foothold in the lucrative AGT market in North America, provided UTDC is successful in winning one of the two projects, Detroit or Miami.

5.7 Suggestions for Further Work

This study has identified the size of the AGT market in North America where ICTS can successfully compete. It appears that the ten year market for AGT technology in North America is rather small. It is, therefore, imperative that any governmental help to this industry should be based on an assessment of global market. There is every reason to believe that the market in countries of Western Europe and the Middle East is much larger. A study to gauge the market potential of ICTS outside of North America should immediately be conducted before any aid is provided to this industry.

BIBLIOGRAPHY

(1) Adams, George J. (1976). "Review of Conventional Transit Systems with Rail and Automated Fixed Guideway Systems". Proceedings of the Fourth Intersociety Conference on Transportation, Los Angeles, California.

(2) Altschuler, Alan, (1976). "The Federal Government and Para-Transit", in Paratransit, Washington, D.C.: Transportation Research Board.

(3) American Association of State Highway Transportation Officials. (1977). Ten year Public Transportation Requirements, Washington, D.C.

(4) Anderson, Edward J. (1979). "Cost Effective Automated Guideway Transit in the Central City", High Speed Ground Transportation Journal: 25-38

(5) Bramberg, W., Elms, C.P., Hosenthien, H.H. and Voss, W. (1979) "Assessment of the Mueller Aerobus System, the System installed and operated for the Bundesgartenschan 1975, Mannheim, Germany. Report No. UMTA-IT-06-0189-79-2

(6) Barnum, Dabold T. and Gleason, John M. (1979) "Measuring the Influence of Subsides on Transit Efficiency and Effectiveness", Indiana University Northwest, Indiana and University of Nebraska, Omaha, Nebraska.

(7) Benjamin, David E., (1979). "Guidebook for the Provisions of Evacuation and Rescue Services in Automated and Guideway Trnasit", Vought Corporation, Dallas, Texas.

(8) Bhattacharyya, S.K. (1979). "Urban Public Transit Subsidy Levels and Effects", A working paper prepared for the Ministry of State for Urban Affairs, and Urban Transportation Research of Transport Canada, Ottawa.

(9) Bombardier Ltée. (1977). Etude conceptuelle d'un Système de transport urbain a capcité intermédiaire Rapport technique 10: Analyse ēconomique et financière.

(10) Bombardier Ltée (1977) "Etude conceptuelle d'un système de transport urbain à capacité intermédiaire: Rapport technique 1, Normes: Détermination des spécifications

fonctionnelles", pour le Centre de Recherche et de Développement, Transports Canada, Montréal.

(11) Bombardier Ltée (1977). "Etude conceptuelle d'un système de transport urbain à capacité intermédiaire: Rapport technique 2, Exploitation: Etude des modes d'exploitation", pour le Centre de Recherche et de Développement, Transports Canada, Montréal.

(12) Bombardier Ltée (1977). "Etude conceptuelle d'un système de transport urbain à capacité intermédiaire: Rapport technique 3, Véhicule", pour le Centre de Recherche et de Développement, Transports Canada, Montréal.

(13) Bombardier Ltée (1977). "Etude conceptuelle d'un système de transport urbain à capacité intermédiaire: Rapport technique 4: Traction: Motorisation et équipments électriques", pour le Centre de Recherche et de Développement, Transports Canada, Montréal.

(14) Bombardier Ltée (1977). "Etude conceptuelle d'un système de transport urbain à capacité intermédiaire: Rapport technique 5: Automatisme", pour le Centre de Recherche et de Développement, Transports Canada, Montreal.

(15) Bombardier Ltée (1977). "Etude conceptuelle d'un système de transport urbain à capacité intermédiaire: Rapport technique 6: Stations: Fonctions et configurations des stations", pour le Centre de Recherche et de Développement, Transports Canada, Montréal.

(16) Bombardier Ltée (1977). "Etude conceptuelle d'un système de transport urbain à capacité intermédiaire: Rapport technique 7: Infrastructure", pour le Centre de Recherche et de Développement, Transports Canada, Montreal.

(17) Bombardier Ltée (1977) "Etude conceptuelle d'un système de transport urbain à capacité intermédiaire: Rapport technique 8: Insertion: Insertion sur emprises ferroviaires et routières", pour le Centre de Recherche et de Développement, Transports Canada, Montreal.

(18) Bombardier Ltée (1977). "Etude conceptuelle d'un système de transport urbain à capacité intermédiaire: Rapport technique 9: Déneigement", pour le Centre de Recherche et de Développement, Transports Canada, Montreal.

(19) Bombardier Ltée (1977). "Etude conceptuelle d'un système de transport urbain à capacité intermédiaire: Rapport technique 10: Analyse économique et financière", pour le Centre de Recherche et de Développement, Transports Canada, Montreal.

(20) Bombardier Ltée (1977) "Etude conceptuelle d'un système de transport urbain à capacité intermédiaire: Rapport de synthèse 1: Spécifications fonctionnelle du système et solutions envisageables", pour le Centre de Recherche et de Développement, Transports Canada, Montréal.

(21) Bombardier Ltée (1980)
"Concept Definition Study of an Intermediate Capacity Transit System".
Volume 1, 2 & 3.
Transport Canada Research and Development Centre, Montreal.

(22) Burns, F.W., Hynes, R.J., Lerchenmueller, W. (1978). AGRT Phase IIA, Executive Summary Automated Transportation Systems, Boeing Aerospace Company, Washington, D.C.

(23) Canadian Pacific Consulting Services Ltd. (1976) "Urban Railway Inventory: Halifax, Québec, Montréal, Ottawa-Hull, Hamilton, Kitchener-Waterloo, London, Windsor, Winnipeg, Regina, Calgary, Edmonton", for the Transport Canada Research and Development Centre, Montréal.

(24) Center for Metropolitan Planning and Research (1975). Analysis of Urban Transportation Needs with Implications for AGT Systems, Baltimore, M.D. PB No. 267006.

(25) Chambliss, A., Dickenson, L., Willingham, F. and Zumwalt, B. (1979).
Automated Guideway Transit Technical Data,
Urban Mass Transportation Administration,
U.S. Department of Transportation, Washington, D.C.

(26) Chan Yupo (1979). Review and Compilation of Demand Forecasting Experiences: An Aggregation of Estimation Procedures,
Pennsylvania State University.

(27) Cooke, F.A.F., Elms, C.P., McGean, T.J. and Merritt, H.W. (1978). "Summary of Capital and Operations & Maintenance Cost Experience of Automated Guideway Transit Systems". Prepared by N.D. Lea & Associates, Inc. Huntsville, AL - Washington, D.C.

(28) Cohen, Harry S., Stowers, Joseph R. and Petersilia, Michael P., (1978).
"Evaluating Urban Transportation Systems Alternatives",
DOT - P - 30 - 78 - 44.

(29) Colob, T.F. Canty, E.T. and Gustafson, R.L. (1972). "Classification of Metropolitan Areas for the Study of New Systems of Arterial Transportation", General Motors Research Laboratories.

(30) Colcord, Jr. Frank C. and Lewis, Ronald S. (1974). "Urban Transportation Decision-Making (Toronto: Case Study)" NTIS No. PB257999

(31) Colcord, Jr. Frank C. (1974). "Urban Transportation Decision-Making (Summary)" NTIS No. PB 257995

(32) DeLeuw Cather Canada Ltd. (1977). "A Study of Existing Rights-of-Way for Intermediate Capacity Transit in Canadian Cities", (11 volumes: Halifax, Québec, Montréal, Ottawa-Hull, Toronto, London, Hamilton, Windsor, Calgary, Winnipeg, Edmonton), for the Transport Canada Research and Development Centre, Montréal.

(33) De Leuw, Cather & Company and ABAM Engineers, Inc., (1978) "Guideway and Station Review," Washington, D.C.: U.S. Department of Transportation,

(34) Deleuw Cather, Canada Ltd. (1979). "The Potential for High Capacity Buses in Canada" Report prepared for Urban Transportation Research Branch, Transport Canada, Ministry of State for Urban Affairs.

(35) Deleuw, Cather & Company, (1979). "Characteristics for Urban Transportation Systems"; A Handbook for Transportation Planners, Chicago, Illionois PB No. 301319

(36) Department of Transportation, Urban Mass. Transportation Administration, (1976). "Automated Guideway Transit" Workshop on Performance Measures evaluation Techniques and goals.

(37) Feaver, Douglas B., (1979) "White House Sets Policy on Urban-Transit Grants". The Washington Post.

(38) Finn, N. (1974) "Intermediate Capacity Transit Evaluation" A thesis submitted for the degree of Master of Science in Engineering, Department of Civil Engineering, University of Calgary, Calgary, Alberta.

(39) Frankena, Mark W. (1077)
Urban Transportation Economics and Canadian Public Policy, Department of Economics, University of Western Ontario, London, P 19.

(40) Gary, D.A. (1977)
"Advanced Group Rapid Transit System", Executive Summary. prepared by Otis Elevator Company, Transportation Technology Division, Denver, Colorado.

(41) Globe & Mail, January 4, (1980) Toronto, "Rapid Transit Design Gets $3.5 Million More"

(42) Grefe, Richard, et, al. (1977) "The Impact of BART on the Competitive Advantage and Efficiency of Bay Area Business Operations" San Francisco: Metropolitan Transportation Commission.

(43) Hawker Siddely Canada Ltd. (1974) "Advanced Technology Study: Intermediate Capacity Transit:, (2 volumes: Mechanical, Electrical) for the Transport Canada Research and Development Centre, Montréal.

(44) Henderson, Yen A.M., Sakasita, M., Roddin, M., Cronin, R. and Ellis, H. (1977).
"Assessment of The Passenger Shuttle System (PSS) at Tampa International Airport". Report No. VMTA-IT-06-0135-77-U

(45) Hueholt, R.L. (1976). "Economic, Safety, Energy and Service Advantages of Automated Transportation" Proceedings of the Fourth Intersociety Conference on Transportation, Los Angeles, California.

(46) IBI Group (1976)
"Intermediate Capacity Transit System - Urban Design Study" Toronto, Ontario.

(47) Institute of Public Administration, (1979).
Financing Transit
Alternatives for Local Government.

(48) Johns Hopkins University, (1975) "Analysis of Urban Transportation needs with Implications for AGT Systems" U.S. Urban Mass Transportation Administration.

(49) Kershnen, D.L. (1979)
Network Analysis of Advanced Group Rapid Transit Systems.
The Johns Hopkins University
Applied Physics Laboratory, Maryland.

(50) Knight, Robert L. and Lisa Trygg (1977).
"Land Use Impacts of Rapid Transit:
Implications of Recent Experience",
De Leuw, Cather & Company, Inc.

(51) Kudick, W. (1976) "Medium Capacity Transit System Alternative for Los Angeles Region", Proceedings of the Fourth Intersociety Conference on Transportation, Los Angeles, California.

(52) Lake, E., et al. (1976) "Classification of American Cities for Case Study Analysis", Office of Research and Development, U.S. Environmental Protection Agency.

(53) Lee, R.B. Kudlick, W., Falcocchio, J.C., Cantilli, E.J. and Stefaniuk, A. (1978). "Review of Local Aternatives Analyses Involving Automated Guideway Transit (AFT)" UMTA-NY-06-0057-78-1

(54) Lee, R.A., Thompson, J.F., Oglesby, R.N. and Bonderson, L.S., (1980).
Systems Operation Studies for Automated Guideway Transit Systems - Summary Report, GM Transportation System Division GM Technical Center, Waren, Michigan.

(55) Lenard, Michael (1980)
"Comparing Guideway Transit Implementation Plans, Including the Impact on Road Traffic". Transportation Planning and Technology, Vol. 6.33-44.

(56) Levinson, Herberts. (1978)
"Characteristics of Urban Transportation Demand - A Handbook for Transportation Planners", Wilburn Smith and Associates, New Haven, Connecticut, Deleuw Cather & Co., Washington, D.C. NTIS No.: PB 293 220

(57) Lincourt, M., McLaughlin, S., Parnass, H., Richards, C. and Sugarman, B. (1974) "Urban Movement Experiment The State of the Art" General Urban System Corporation. Report prepared for the Transportation Development Agency, Ministry of Transport, Govt. of Canada.

(58) The Los Angeles Community Redevelopment Agency (1980) The Los Angeles Downtown People Mover, Executive Summary.

(59) Mabee, Nancy B. and Lumwalt, Barbara A. (1977).
Review of Downtown People Mover Proposals: Preliminary Market Implications for Downtown Applications of Automated Guideway Transit.
The MITRE Corporation, METREK Division Virginia.

(60) Metropolitan Transportation Commission (1976).
"Environmental Impacts of BART: Interim Service Findings", San Francisco.

(61) Metropolitan Dade County, Florida (1979)
The Miami Downtown People Mover, Executive Summary.

(62) The MITRE Corporation, (1977)
"Review of Downtown People Mover Project Proposals: Market Implications". McLean, Virginia.

(63) Nawrocki, Ronald and Zumwalt, Barbara A. (1980)
Automated Guideway Transit Socio-Economic Research Program Findings 1976-1979, The MITRE Corporation, Metrek Division McLean, Virginia.

(64) Nussbaum, E. and Zumwalt, B. (1976).
"Environmental Impact Issues for Automated Guideway Transit Systems"
Urban Mass Transportation Administration Washington, D.C.

(65) Office of Technology Assessment, U.S. Congress, (1975).
"Automated Guideway Transit: An Assessment of PRT and other New Systems", Washington, D.C. U.S. Government Printing Office.

(66) Olson, C.L. (1977)
Independent Study of Personal Rapid Transit Automated Guideway Transit Technology Program.
The aerospace Corporation, California.

(67) "People Mover Systems",
Prepared for Annual Meeting of the Transportation Research Board, Washington, D.C.

(68) Pikarsky, Milton and Christensen, Daphne (1976).
"Urban Transportation Policy and Management", Toronto: Lexington Books.

(69) Porter, Alan L., Park, Choon Y., Rees, Loren P., Rao, Smikanth and Larson, Thomas D. (1978)
"Effects of Federal Transportation Funding Policies and Structures", Georgia Institute of Technology, The Pennsylvania State University, Pennsylvania.

(70) "Proceedings of the First National Conference on Transit Performance", (1978) Public Technology, Inc. Washington, D.C.

(71) Pushkarev, Boris and Zupan, Jeffrey M. (1978). "Where Rail Works: An Exploration of Travel Volume - Criteria For Fixed Guideway Transit", Memeograph, Regional Plan Association, New York.

(72) Pyers, Clyde E., Cichy, Gerald R. and Stein, Martin M. (1979) Transportation Investment Needs: Traffic Quarterly, 33: No. 3, 363-379.

(73) Randolph, Jr. D.G. (1976). "Suggested Improvements for the Development and Implementation of New Urban Mass Transportation Systems", Proceedings of the Fourth Inter-society Conference on Transportation, Los Angeles, California.

(74) Richards, Larry G., et. al., (1978) "Perceived Safety and Security in Transportation Systems as Determined by Gender of the Traveler", Presented at Women's Travel Issues Conference, Mimeograph Washington, D.C.

(75) Roads and Transportation Association of Canada Proceedings, (1977) RTAC Urban Transit Symposium RTAC Fopum 1: No. 3

(76) Roesler, W.J., Haberman, S. and Chiu, H.Y. (1979) "A Quantitative Evaluation of Service - Dependability Modeling Approaches for Automated Guideway Transit", The Johs Hopkins University Applied Physics Laboratory, Laurel, M.D.

(77) Ruse, Marriott J., Correspondence with Howard D. Evoy, (1979) Office of Socio-Economic and Special Projects, Urban Mass Transportation Administration.

(78) Shladover, Steven E. (1976). "An analysis of the Competition Between Automated Guideway Transit and Walking for Activity Centre Circulation", Proceedings of the Fourth Inter-Society Conference on Transportation, Los Angeles, California.

(79) Sidley, Norman A., and Robert Shellow (1974) "Patron Security Issues in Automated Small Vehicle Fixed Guideway Systems", DeLeuw Cather & Company, Inc.; Bather-Rengrose Wolsfield, Inc.; Honeywell Inc.

(80) Siegel, L. et. al., (1977). "An Assessment of Crime and Policing Responses in Urban Mass Transit Systems". The MITRE Corporation, McLean, Virginia.

(81) Silo, Mark (1975). "Summary of Federal Public Transportation Assistance Programs", New York State Department of Transportation, Albany, New York.

(82) Sterns, Mary D. and Schaeffer, K.H. (1977). "Impact Evaluation of Morgantown -PRT 1975-1976 Ridership: Interim Analysis", Transportation Systems Center, Boston, MA.

(83) Theumer, H.A. and Elms, C.P. (1979). "Assessment of the Busch Gardens Automated Anheuser - Busch Shuttle Systems" Report No. UMTA-IT-06-0188-79-4

(84) U.S. Department of Transportation (1976). Urban Transportation Planning System: Reference Manual and User's Guide, Office of Planning Mettrodology and Technical Support, Urban Mass Transportation Administration, Washington, D.C.

(85) U.S. Department of Transportation Urban Mass Transportation Administration (1977). "People Mover Profile" Transportation Systems Ceter, Technology Sharing Program Office, Cambridge, MA.

(86) Urban Mass Transportation Administration U.S. Department of Transportation, (1977) "Innovation in Public Transportation". A Directory of Research, Development and Demonstration Projects, Washington, D.C.

(87) U.S. Dept.of Transportation (1977) Downtown People Mover Program Implementation Guidelines, Office of AGT Applications Washington, D.C.

(88) Urban Mass Transportation (1979) Downtown People Mover Program Implementation Guidelines, Office of AGT Applications, Washington, D.C.

(89) Urban Transportation Development Corporation Ltd., (1974). Intermediate Capacity Transit System Development Program, Preliminary System Design (Vol. 3)

(90) Urban Mass Transportation Administration, U.S. Department of Transportation, (1978). Proceeding of Automated Guide-way Transit Technology Development Conference, Massachusetts, Cambridge.

(91) Urban Mass Transportation Administration, U.S. Department of Transportation, (1979). "Draft Environmental Impact Statement: The Los Angeles Downtown People Mover Project".

(92) Wachs, Martin and Ortner, James (1979). "Capital Grants and Recurrent-Subsidies: A Dilemma in American Transportation Policy", Transportation 8, 3-19.

(93) Watt, C.W., Elliott, D., Dunoye D., Dooley, T., KWOK, W.S. and Hill, H. (1980). "Assessment of Operational Automated Guideway Systems - Airtrans (Phase 11)" Report No. UMTA-MA-06-0067-79-1

(94) Weiner, Edward (1976). "Mass Transportation Needs and Financing in the United States, Transportation 5: 93-110.

(95) Yudd, Larry, (1974). "Employee Protection Requirements in the Urban Mass Transportation Act of 1974", Working Paper, U.S. Department of Labor.

(96) Zumwalt, Barbara, (1979). "Urban Impacts of AGT: Implications from Existing Transit Systems", The MITRE Corporation, McLean, Virginia.

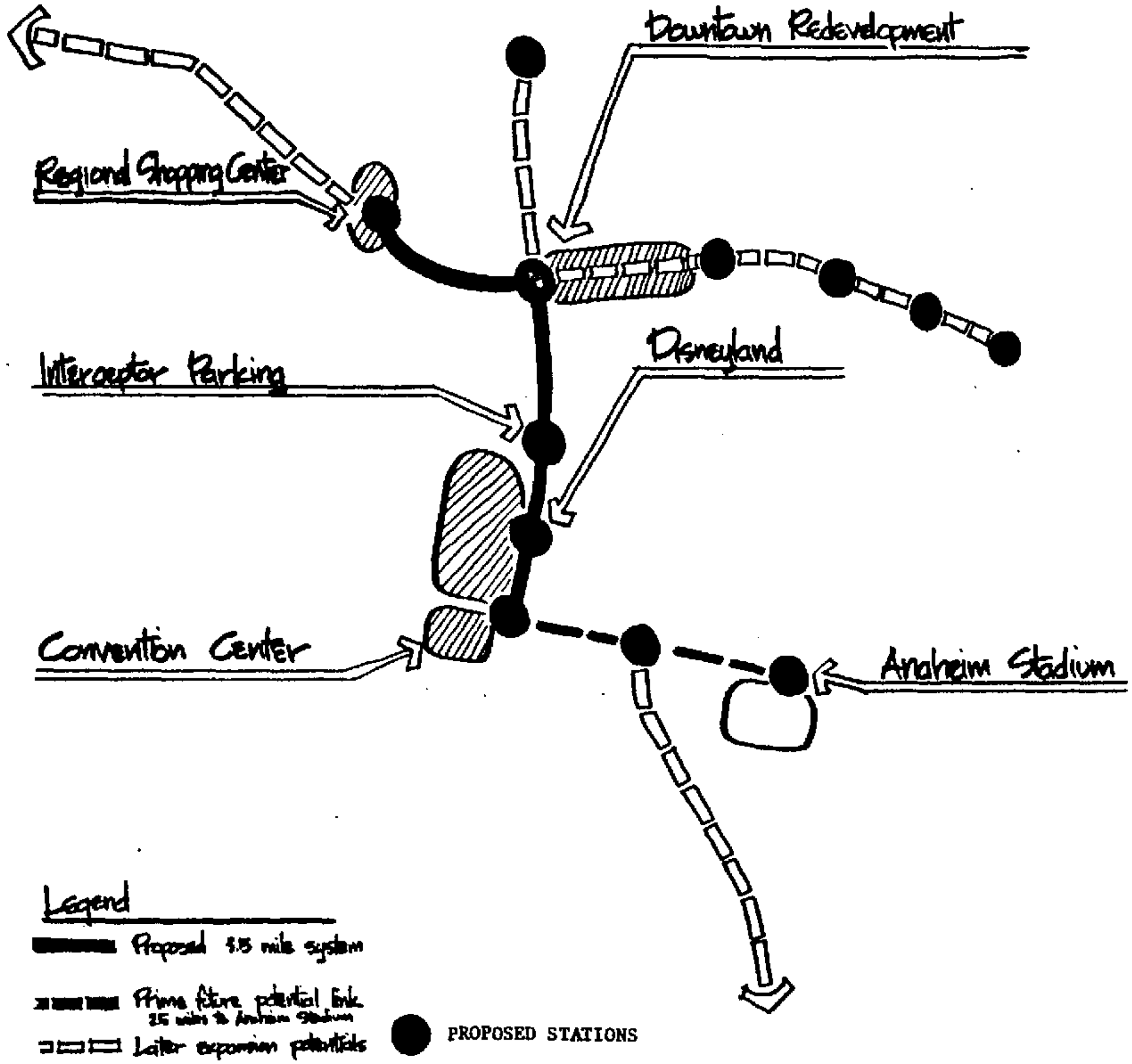
(97) American Public Transit Association (1977) "Survey Shows Cities Want Fixed Guideway Transit", Passenger Transport, Volume 35, No. 24 June.

(98) City of Vancouver (1980) Transpo '86 Access and Demonstration Project, prepared by Engineering Department.

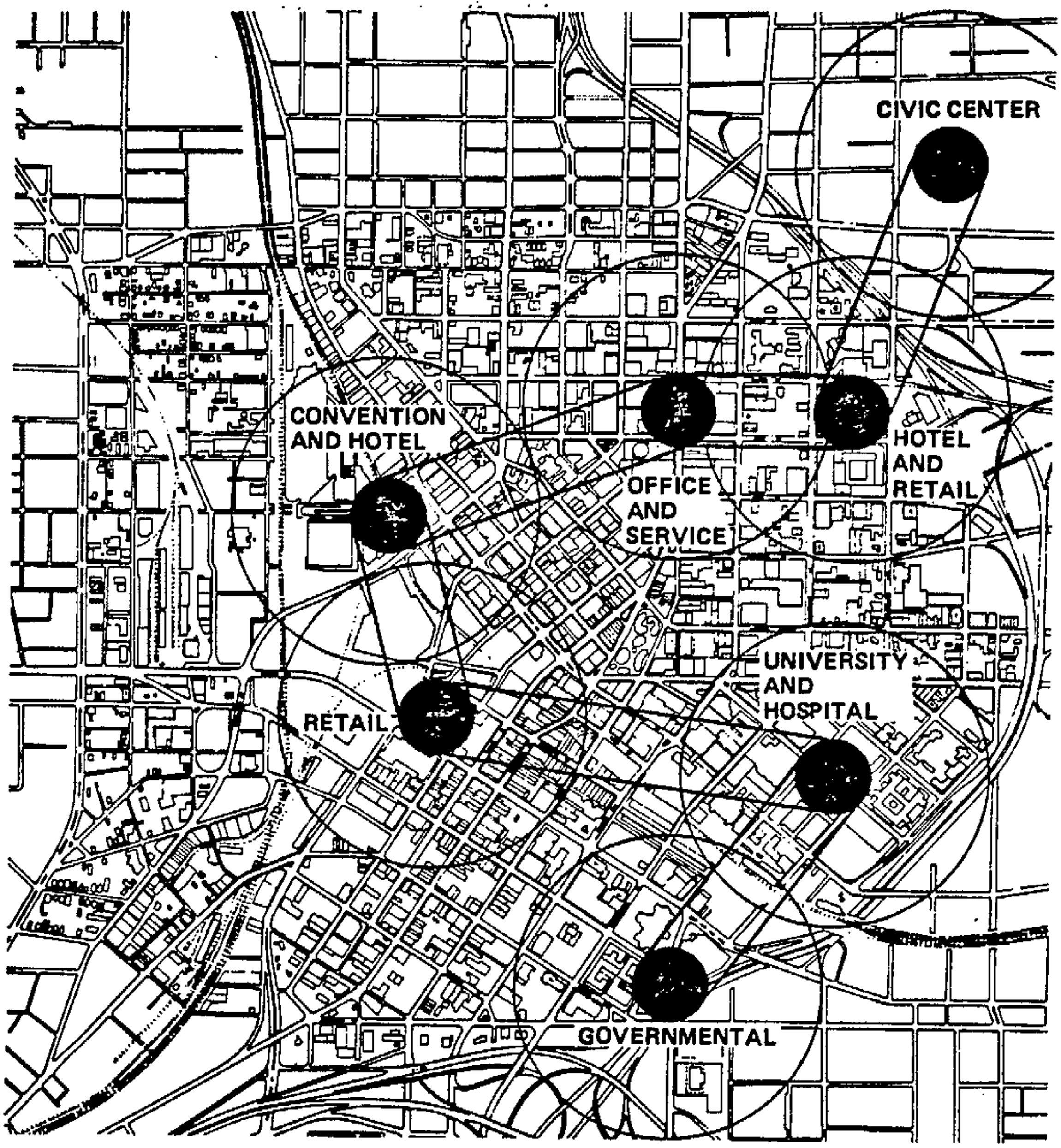
A P P E N D I X 'A'

UNITED STATES

Anaheim, California


Downtown Redevelopment
Regional Shopping Center
Disneyland
Interceptor Parking
Convention Center
Anaheim Stadium
Legend
Proposed 3.5 mile system
Prime future potential link
2.5 miles to Anaheim Stadium
Later expansion potentials
PROPOSED STATIONS

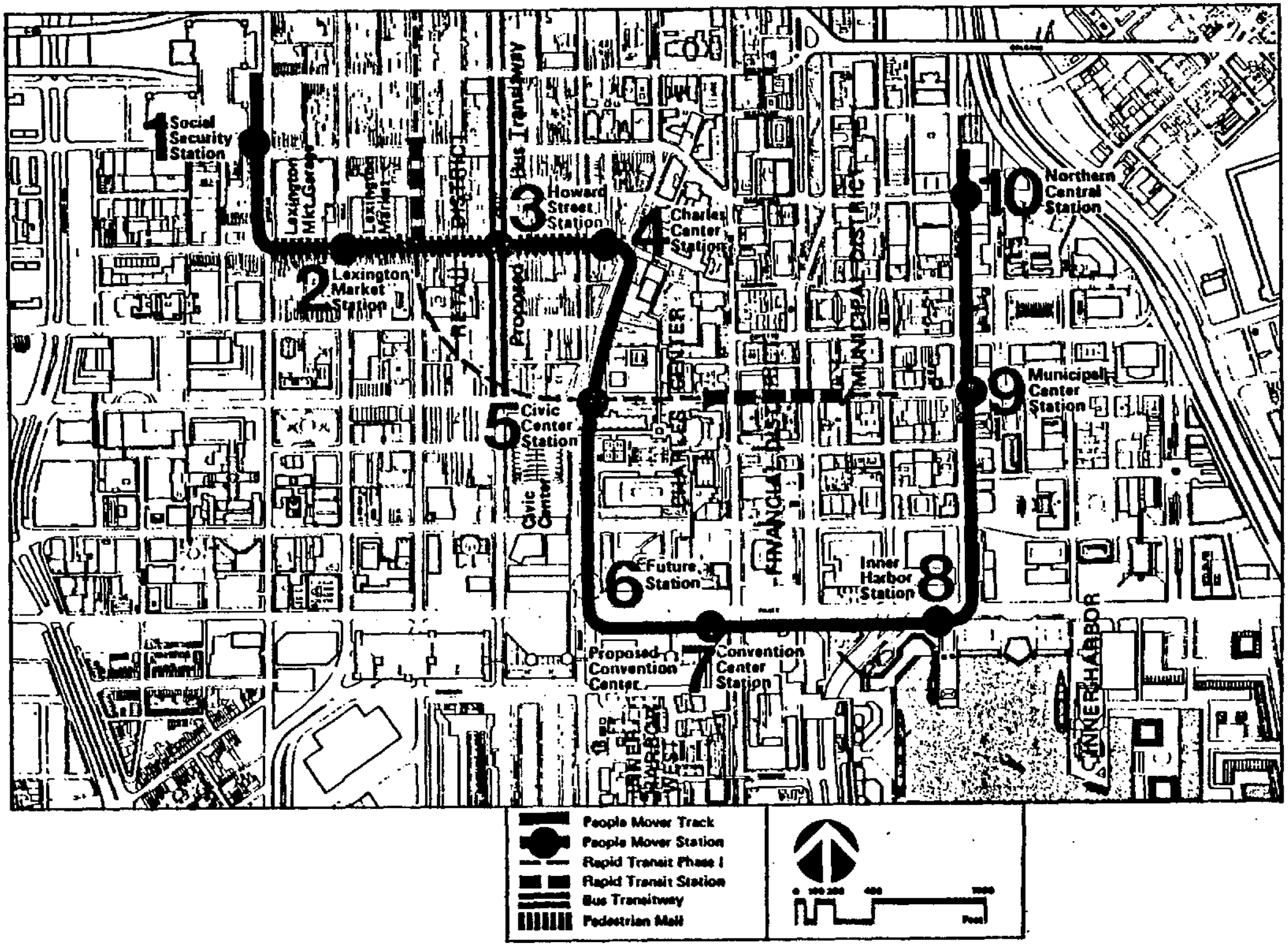
Atlanta, Georgia



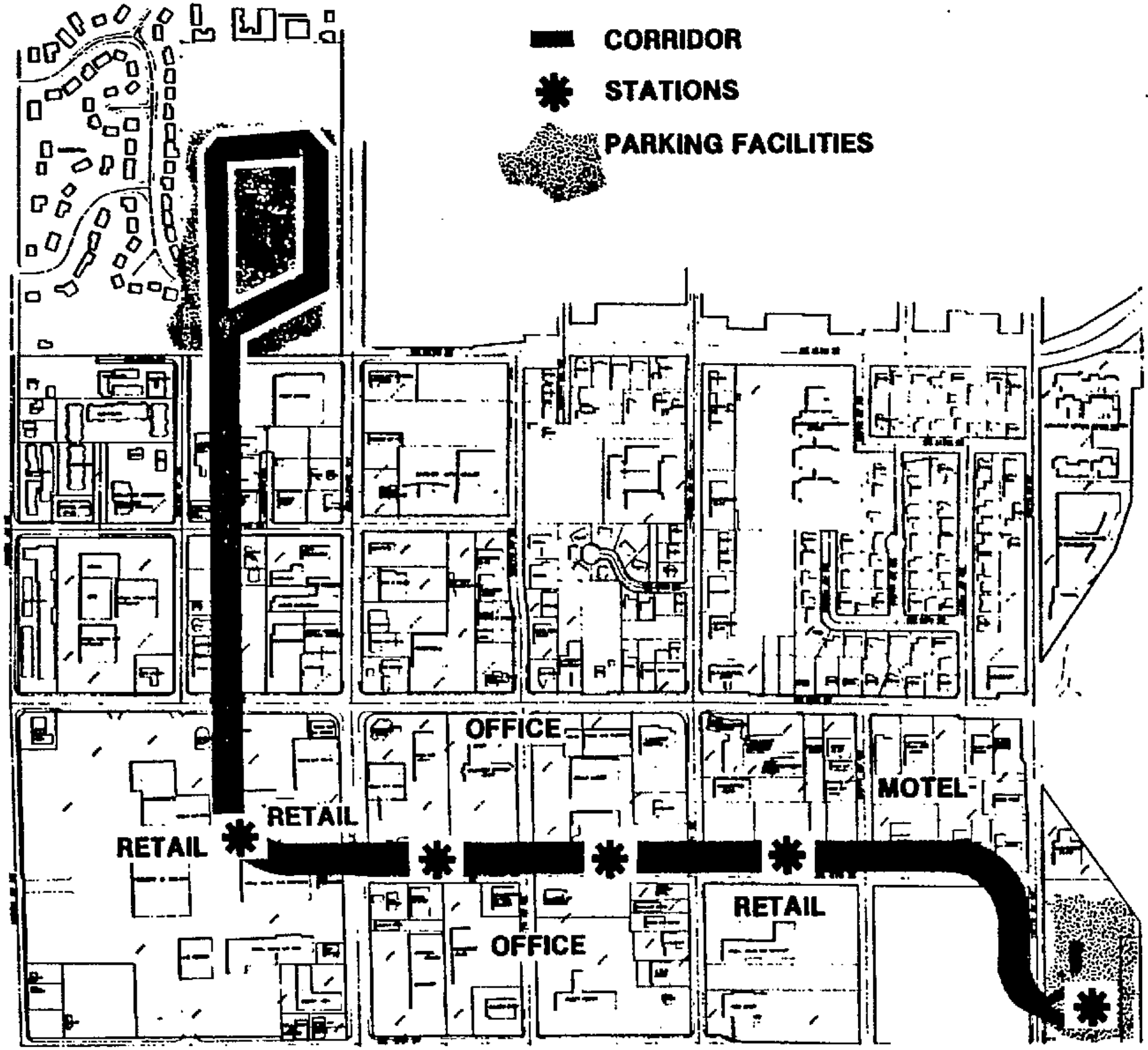

PROPOSED STATIONS

A-4

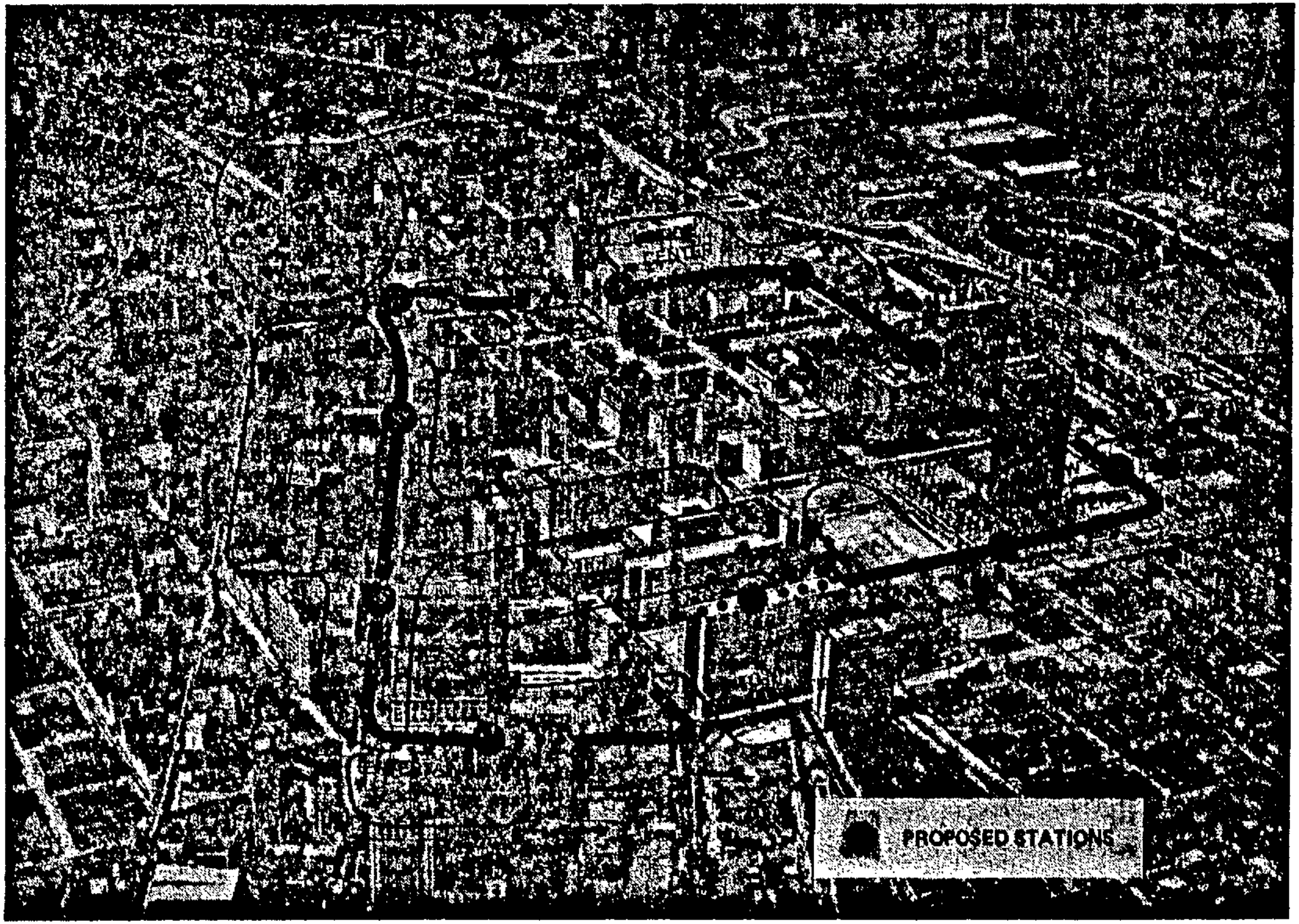
Baltimore, Maryland


1 Social Security Station
Lexington Mkt Garage
2 Lexington Market Station
3 Howard Street Station
Proposed Bus Transitway
4 Charles Center Station
5 Civic Center Station
Civic Center
6 Future Station
7 Convention Center Station
Proposed Convention Center
8 Inner Harbor Station
9 Municipal Center Station
10 Northern Central Station
FINANCIAL DISTRICT
MUNICIPAL DISTRICT
RETAIL
INNER HARBOR
People Mover Track
People Mover Station
Rapid Transit Phase I
Rapid Transit Station
Bus Transitway
Pedestrian Mall
Feet

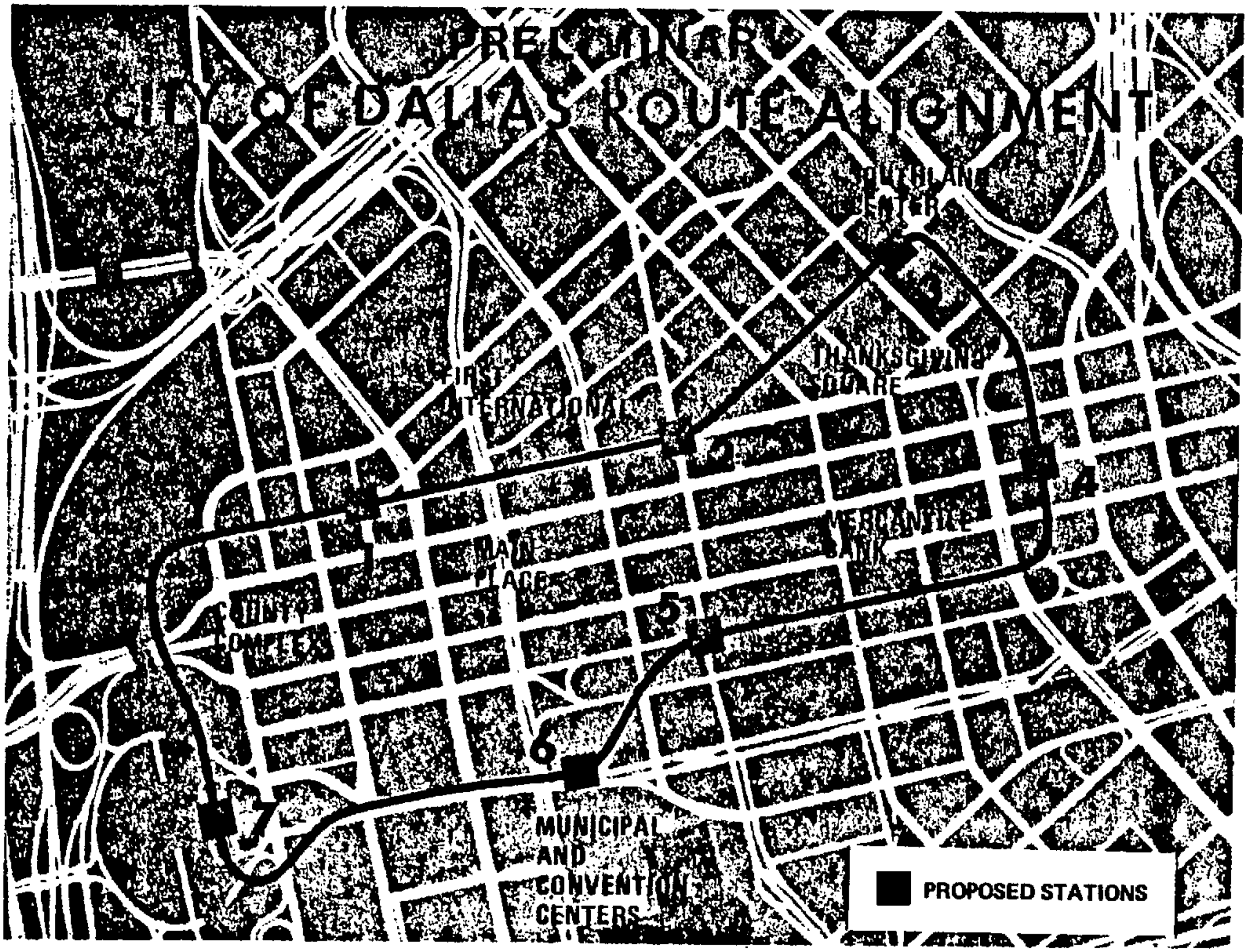
Bellevue, Washington


CORRIDOR
STATIONS
PARKING FACILITIES
RETAIL
RETAIL
OFFICE
MOTEL
RETAIL
OFFICE

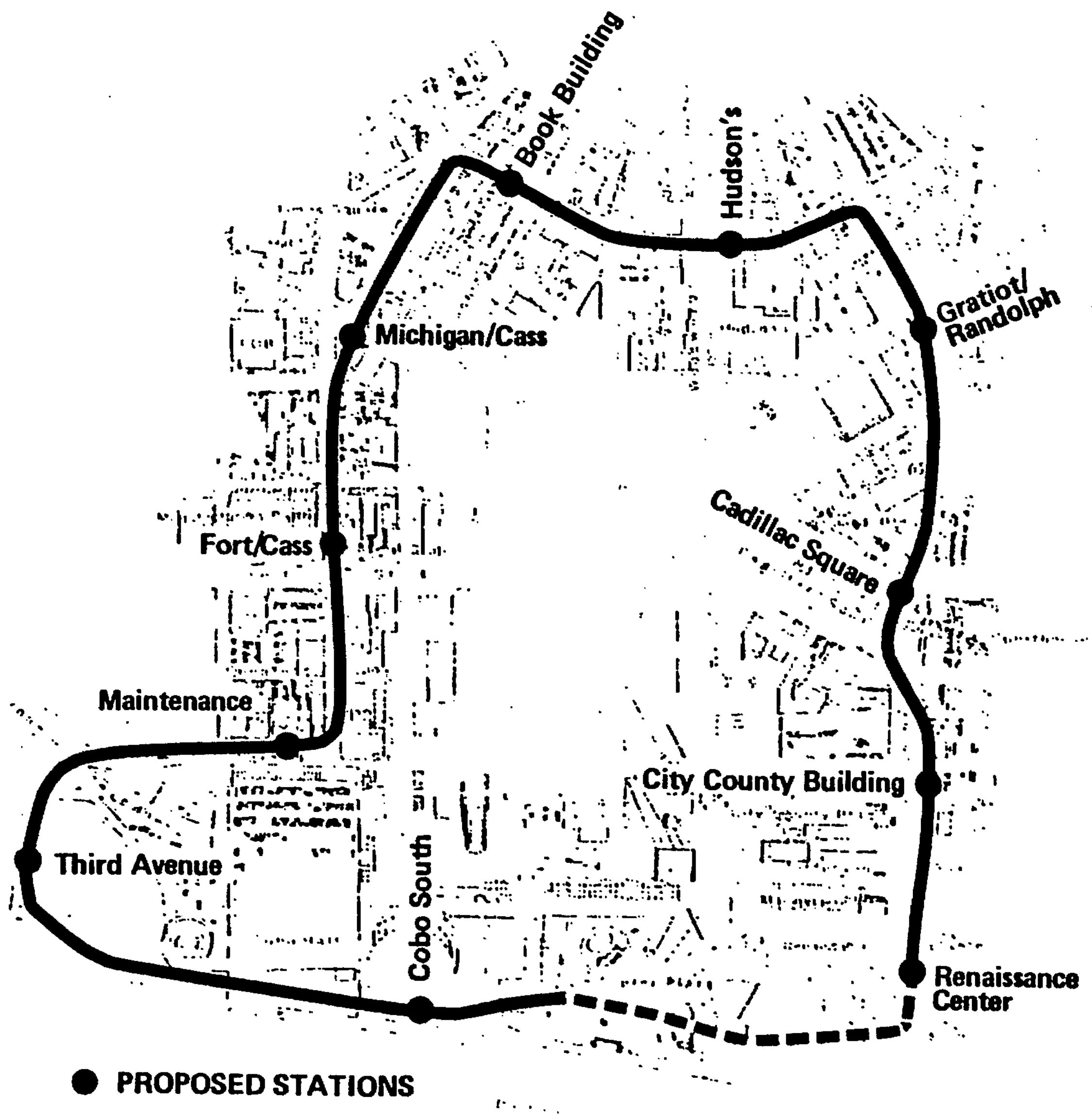
Cleveland, Ohio


PROPOSED STATIONS

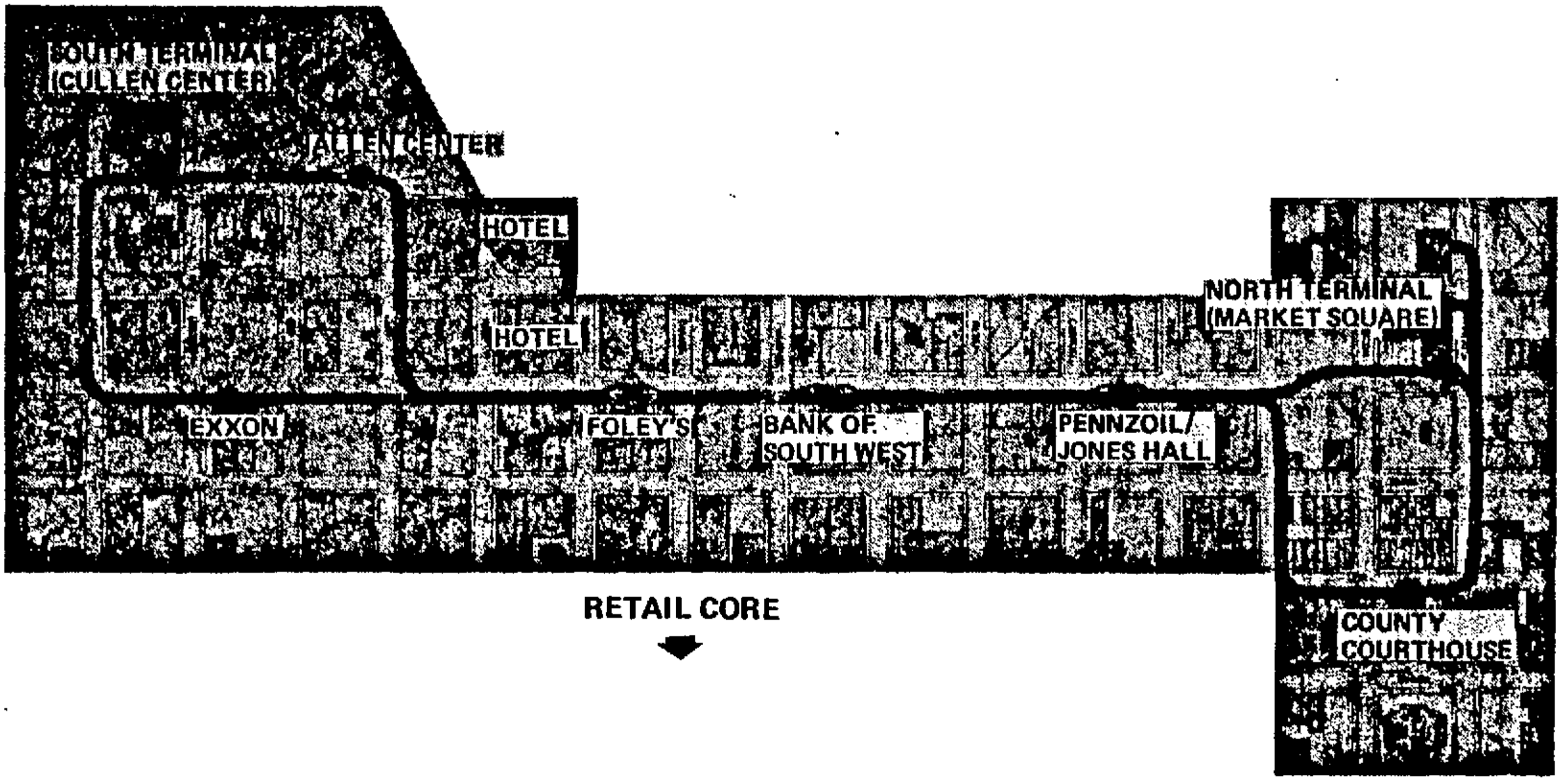
Dallas, Texas


CITY OF DALLAS ROUTE ALIGNMENT
FIRST INTERNATIONAL
THANKSGIVING SQUARE
MAIN PLACE
MUNICIPAL AND CONVENTION CENTERS
PROPOSED STATIONS

Detroit, Michigan


Book Building
Hudson's
Gratiot/
Randolph
Michigan/Cass
Fort/Cass
Cadillac Square
Maintenance
City County Building
Third Avenue
Cobo South
Renaissance
Center
PROPOSED STATIONS

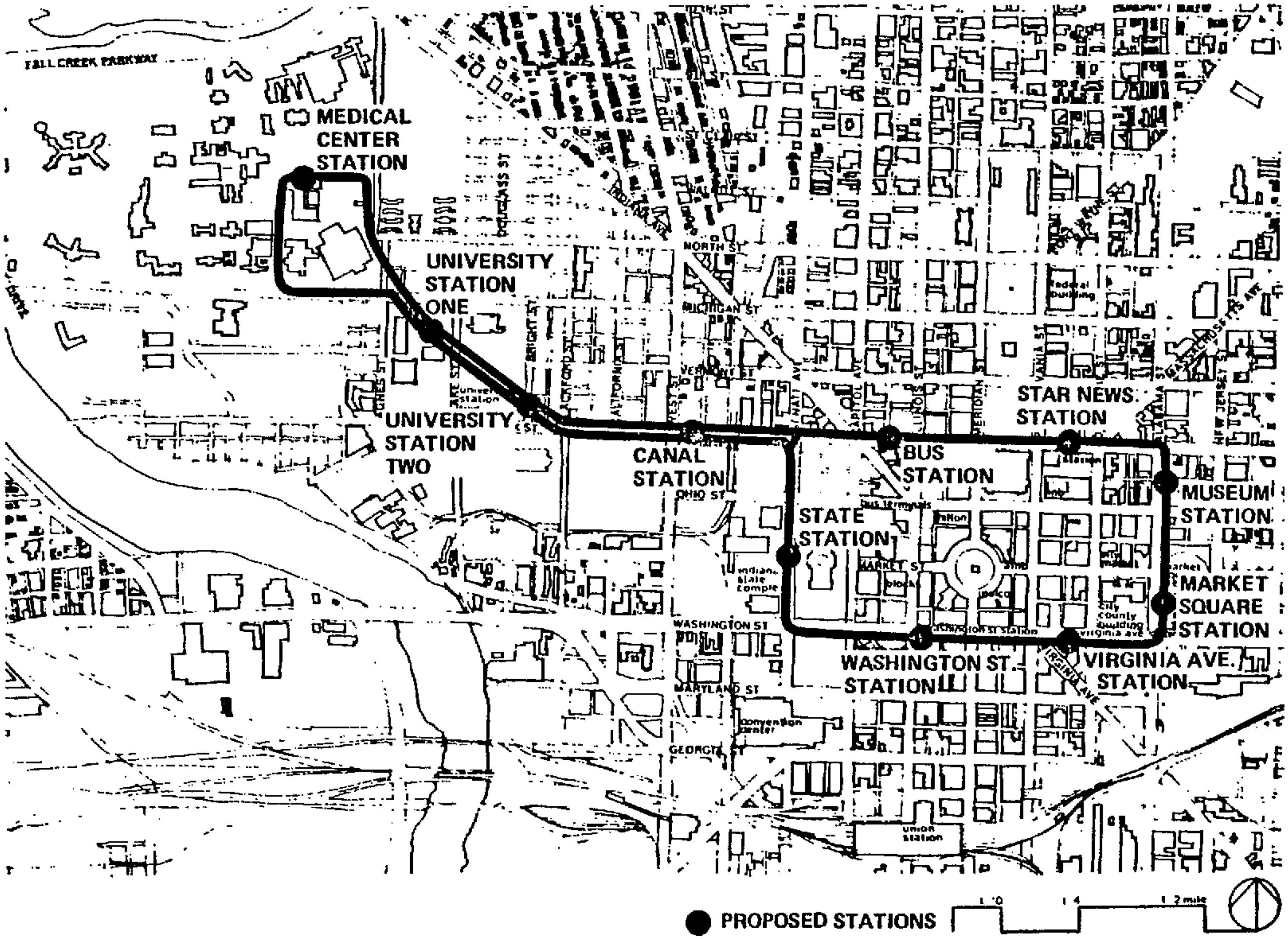
Houston, Texas



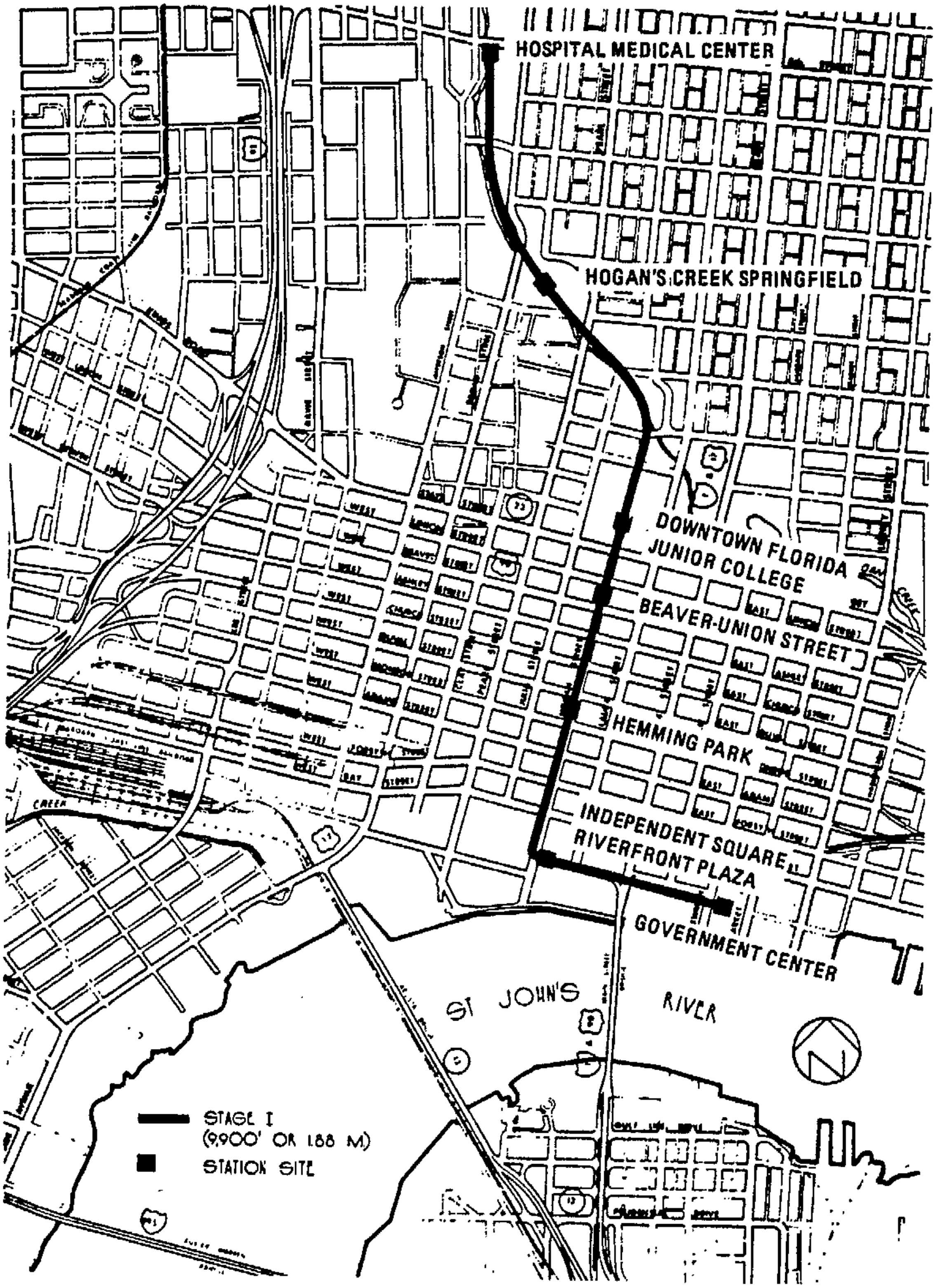
RETAIL CORE

● PROPOSED STATIONS

Indianapolis, Indiana

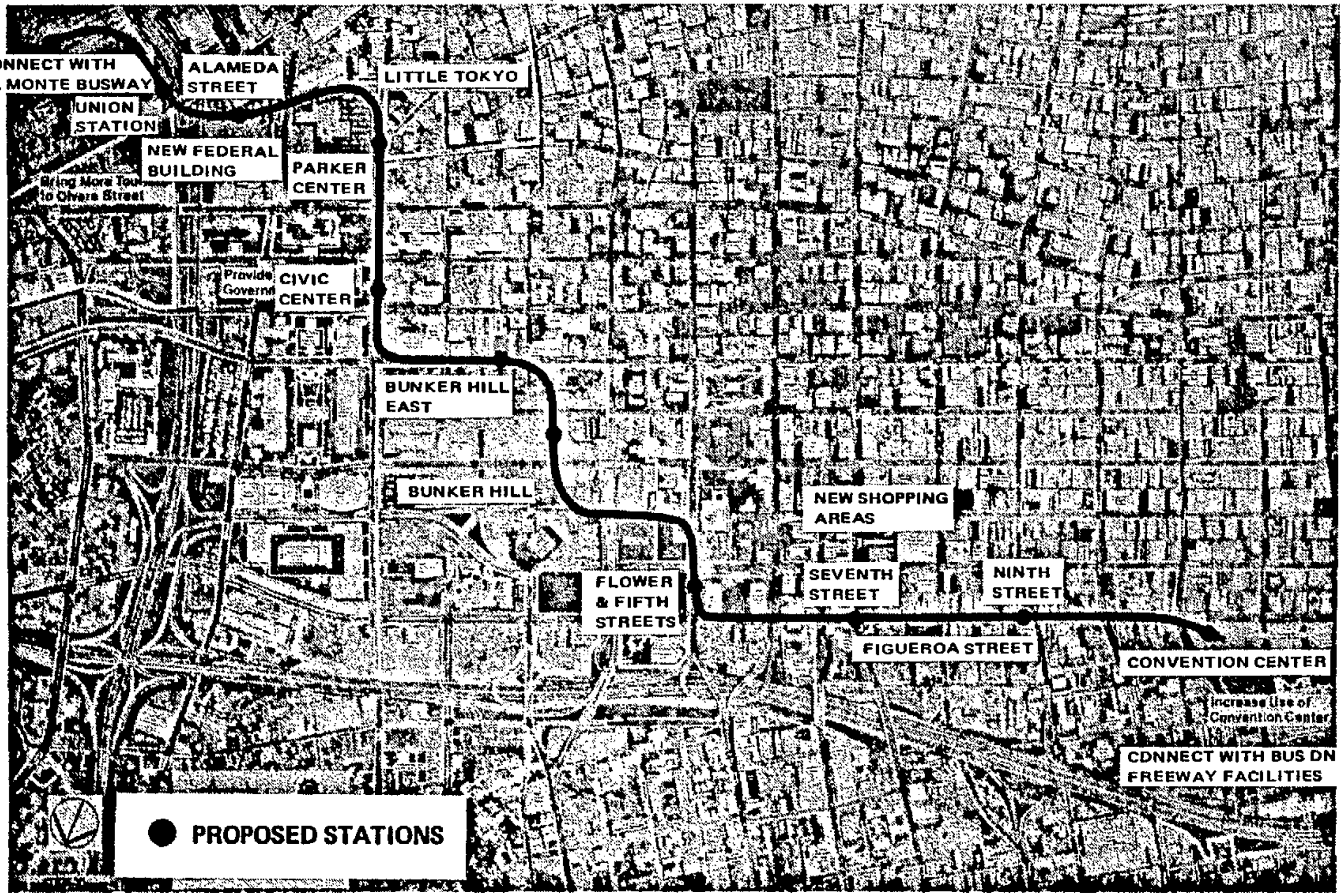

FALL CREEK PARKWAY
MEDICAL CENTER STATION
UNIVERSITY STATION ONE
UNIVERSITY STATION TWO
CANAL STATION
BUS STATION
STAR NEWS STATION
MUSEUM STATION
STATE STATION
MARKET SQUARE STATION
WASHINGTON ST. STATION
VIRGINIA AVE. STATION
NORTH ST
MICHIGAN ST
VERMONT ST
OHIO ST
WASHINGTON ST
MARYLAND ST
union station
PROPOSED STATIONS

Jacksonville, Florida

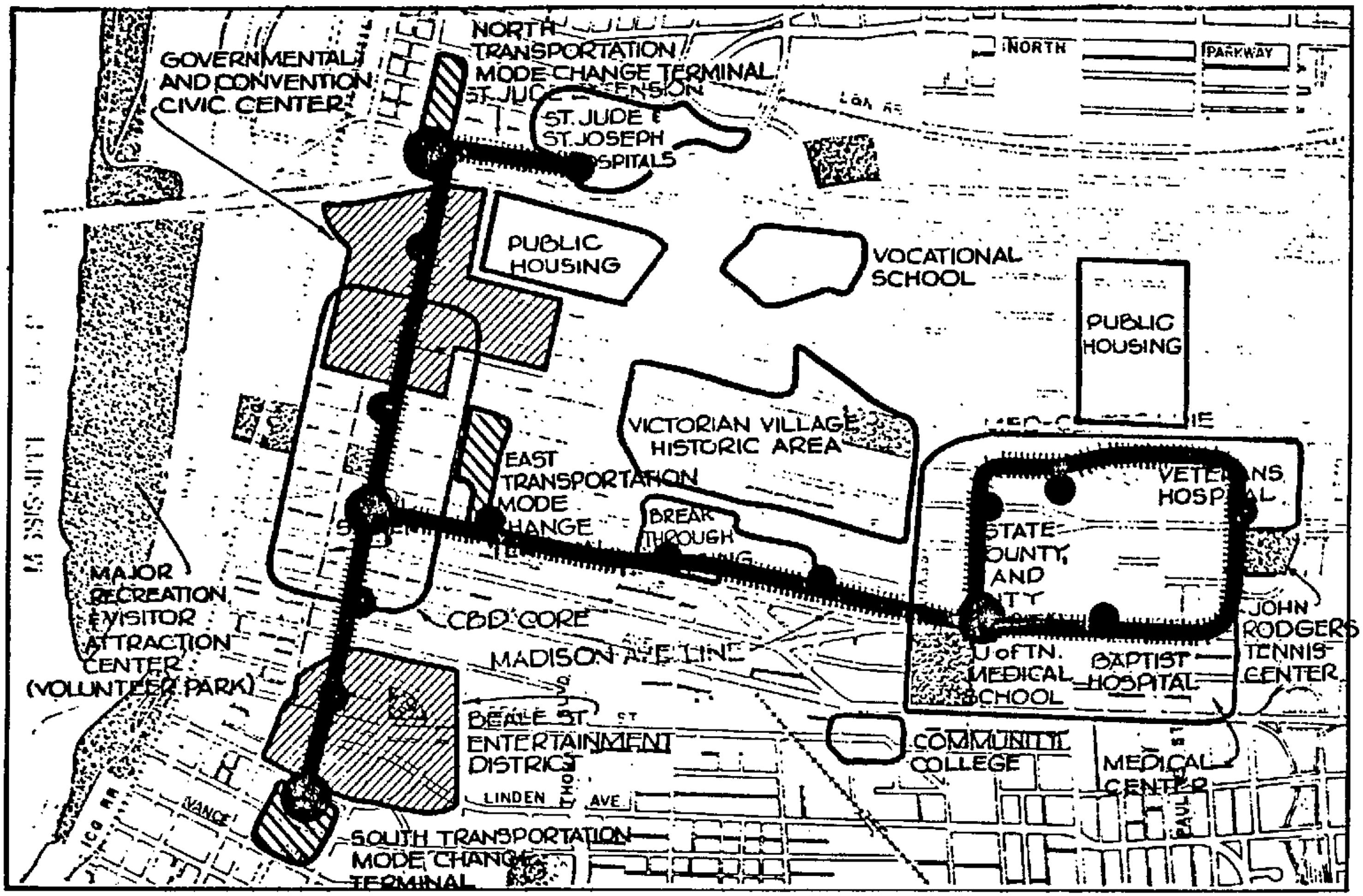

HOSPITAL MEDICAL CENTER
HOGAN'S CREEK SPRINGFIELD
DOWNTOWN FLORIDA JUNIOR COLLEGE
BEAVER-UNION STREET
HEMMING PARK
INDEPENDENT SQUARE
RIVERFRONT PLAZA
GOVERNMENT CENTER
ST JOHN'S RIVER
STAGE I (9,900' OR 1.88 M)
STATION SITE

A-20

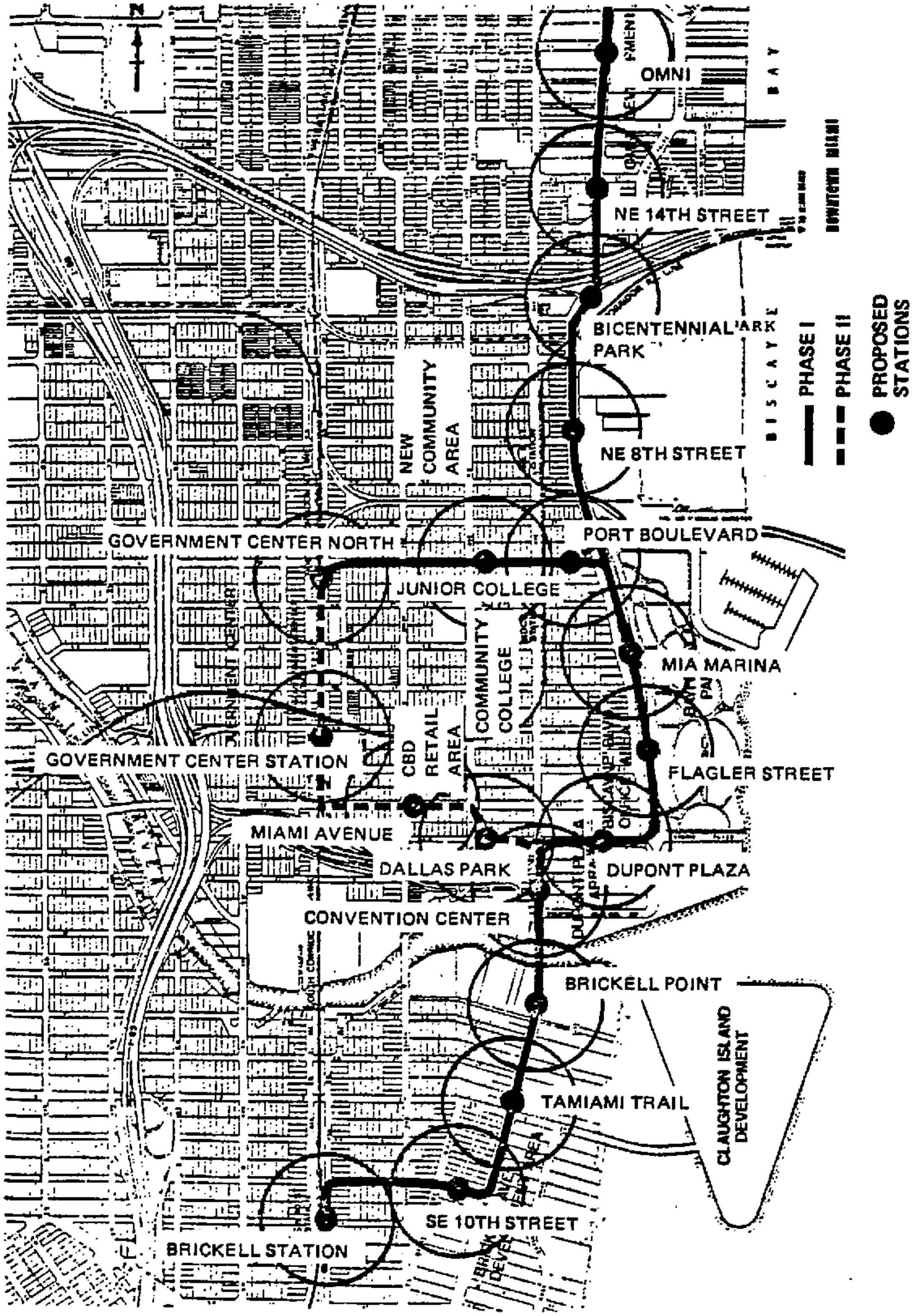
Los Angeles, California


CONNECT WITH EL MONTE BUSWAY
ALAMEDA STREET
LITTLE TOKYO
UNION STATION
NEW FEDERAL BUILDING
PARKER CENTER
CIVIC CENTER
BUNKER HILL EAST
BUNKER HILL
NEW SHOPPING AREAS
FLOWER & FIFTH STREETS
SEVENTH STREET
NINTH STREET
FIGUEROA STREET
CONVENTION CENTER
Increase Use of Convention Center
CONNECT WITH BUS ON FREEWAY FACILITIES
PROPOSED STATIONS

Memphis, Tennessee

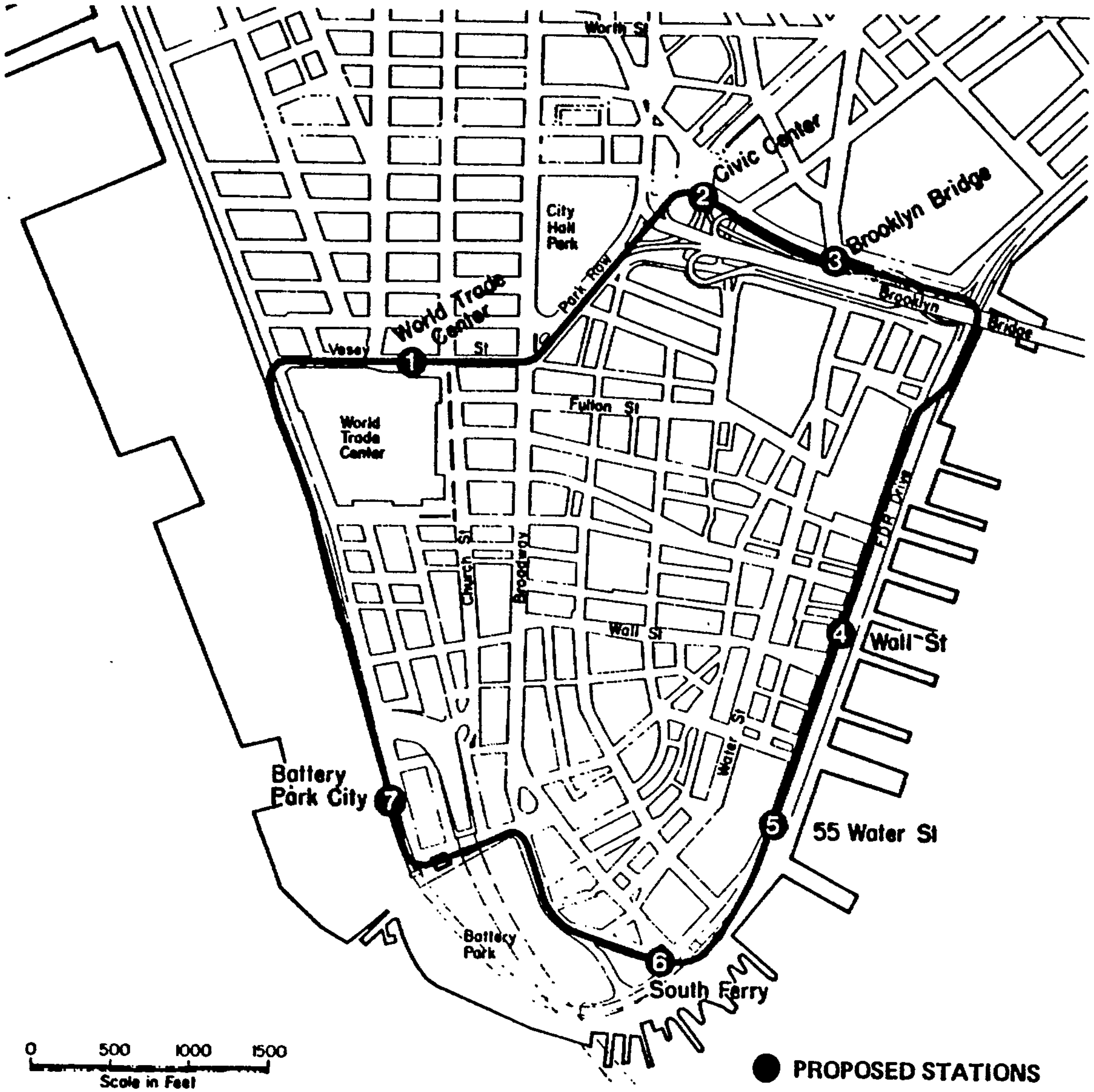

GOVERNMENTAL AND CONVENTION CIVIC CENTER
NORTH TRANSPORTATION MODE CHANGE TERMINAL
NORTH
PARKWAY
ST. JUDE & ST. JOSEPH HOSPITALS
PUBLIC HOUSING
VOCATIONAL SCHOOL
PUBLIC HOUSING
VICTORIAN VILLAGE HISTORIC AREA
EAST TRANSPORTATION MODE
VETERANS HOSPITAL
STATE COUNTY AND CITY
JOHN RODGERS TENNIS CENTER
MAJOR RECREATION VISITOR ATTRACTION CENTER (VOLUNTEER PARK)
CBD CORE
MADISON AVE LINE
U of TN. MEDICAL SCHOOL
BAPTIST HOSPITAL
BEALE ST. ENTERTAINMENT DISTRICT
COMMUNITY COLLEGE
MEDICAL CENTER
LINDEN AVE
VANCE
SOUTH TRANSPORTATION MODE CHANGE TERMINAL

Miami, Florida

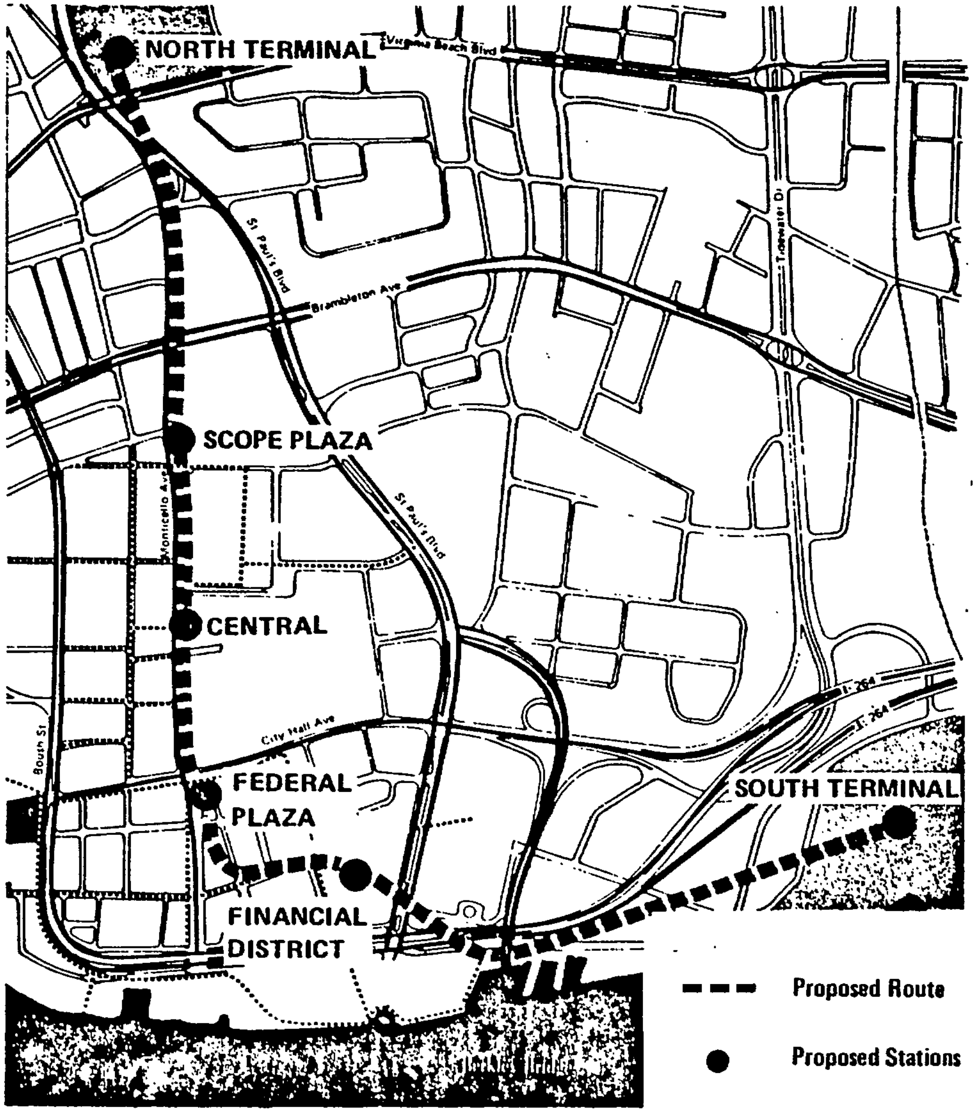


BRICKELL STATION
SE 10TH STREET
TAMIAMI TRAIL
BRICKELL POINT
CLAUGHTON ISLAND DEVELOPMENT
CONVENTION CENTER
DALLAS PARK
DUPONT PLAZA
MIAMI AVENUE
GOVERNMENT CENTER STATION
FLAGLER STREET
CBD RETAIL AREA
COMMUNITY COLLEGE
MIA MARINA
JUNIOR COLLEGE
GOVERNMENT CENTER NORTH
PORT BOULEVARD
NEW COMMUNITY AREA
NE 8TH STREET
BICENTENNIAL PARK
NE 14TH STREET
OMNI
PHASE I
PHASE II
PROPOSED STATIONS

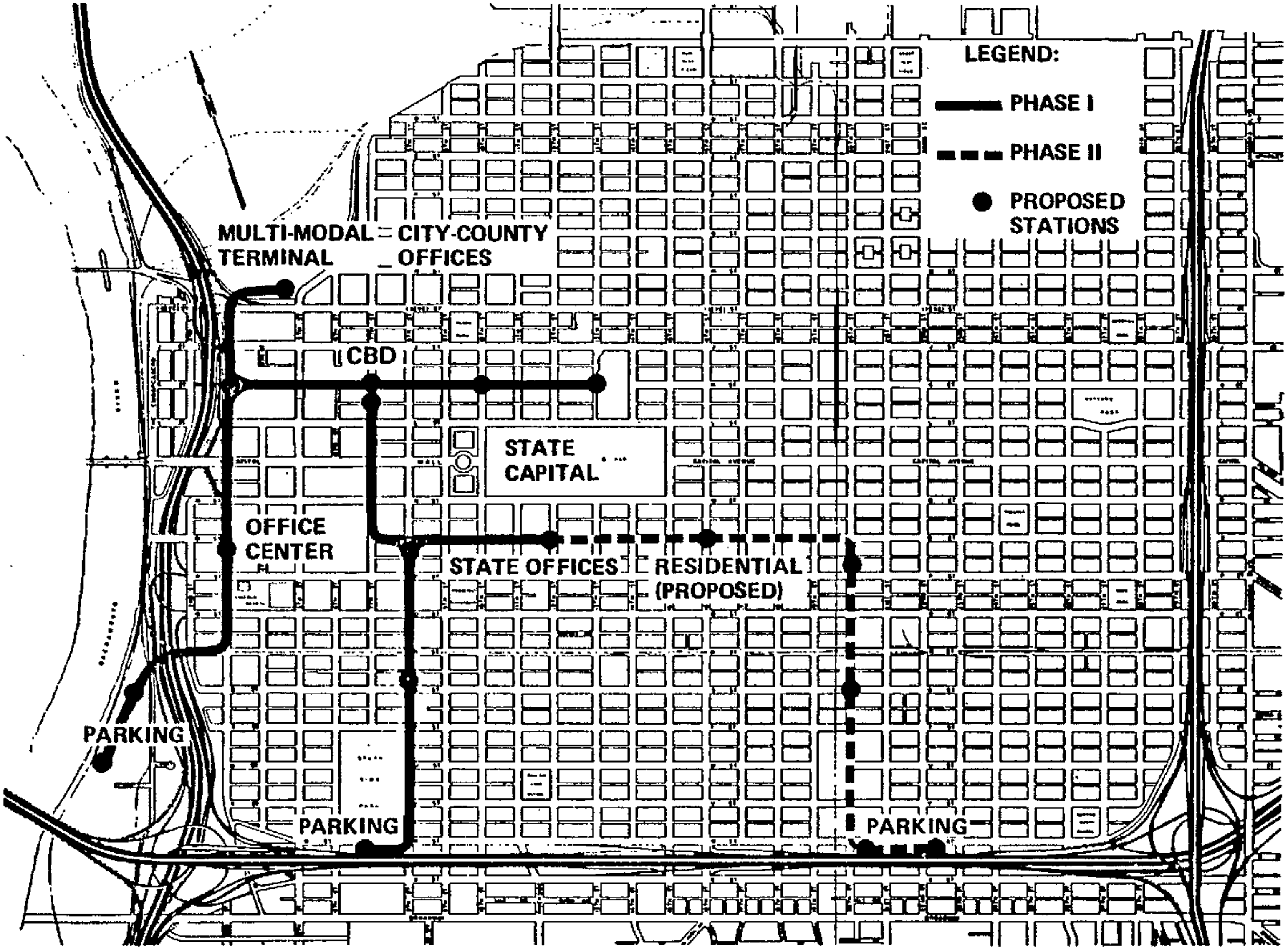
New York, New York


Worth St
Civic Center
Brooklyn Bridge
City
Hall
Park
Park Row
World Trade
Center
Vesey
St
Brooklyn
Bridge
World
Trade
Center
Fulton St
FDR Drive
Church St
Broadway
Wall St
Wall St
Water St
Battery
Park City
55 Water St
Battery
Park
South Ferry
1
2
3
4
5
6
7
0
500
1000
1500
Scale in Feet
PROPOSED STATIONS

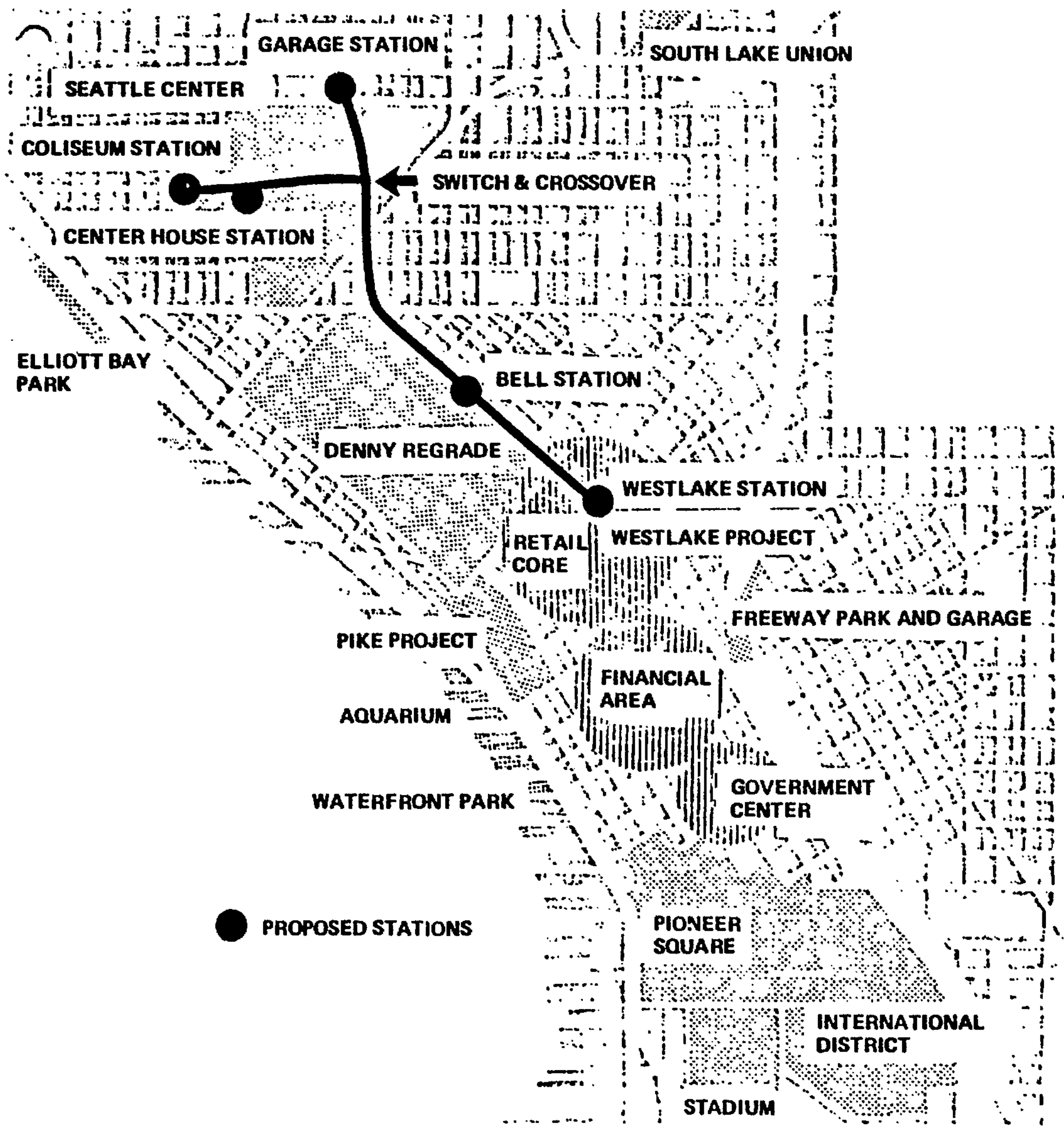
Norfolk, Virginia


NORTH TERMINAL
Virginia Beach Blvd
St Paul's Blvd
Brambleton Ave
Tidewater Dr
SCOPE PLAZA
Monticello Ave
CENTRAL
City Hall Ave
Boush St
FEDERAL PLAZA
FINANCIAL DISTRICT
I-264
SOUTH TERMINAL
Proposed Route
Proposed Stations

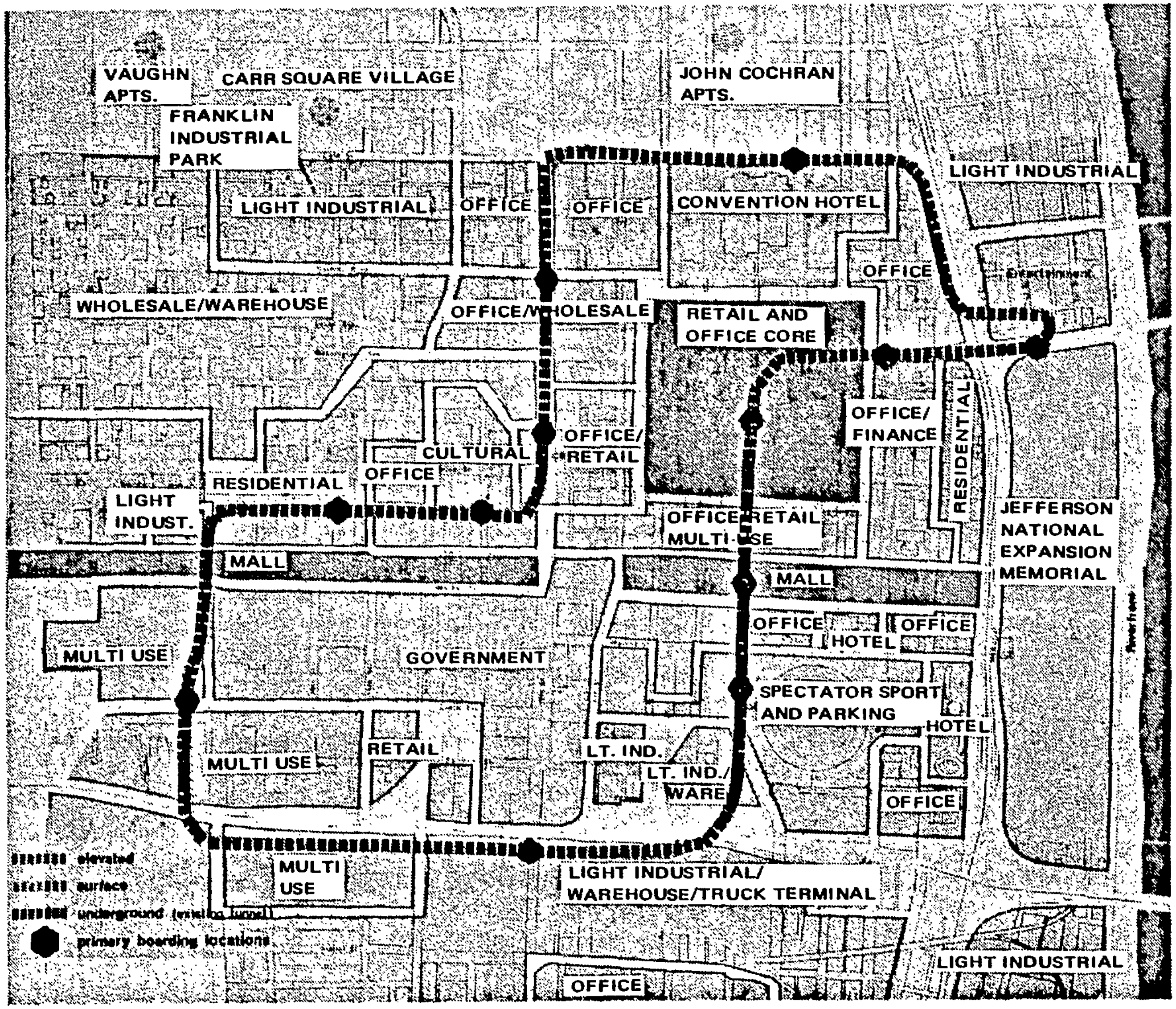
Sacramento, California


LEGEND:
PHASE I
PHASE II
PROPOSED STATIONS
MULTI-MODAL TERMINAL
CITY-COUNTY OFFICES
CBD
STATE CAPITAL
OFFICE CENTER
STATE OFFICES
RESIDENTIAL (PROPOSED)
PARKING
PARKING
PARKING

Seattle, Washington

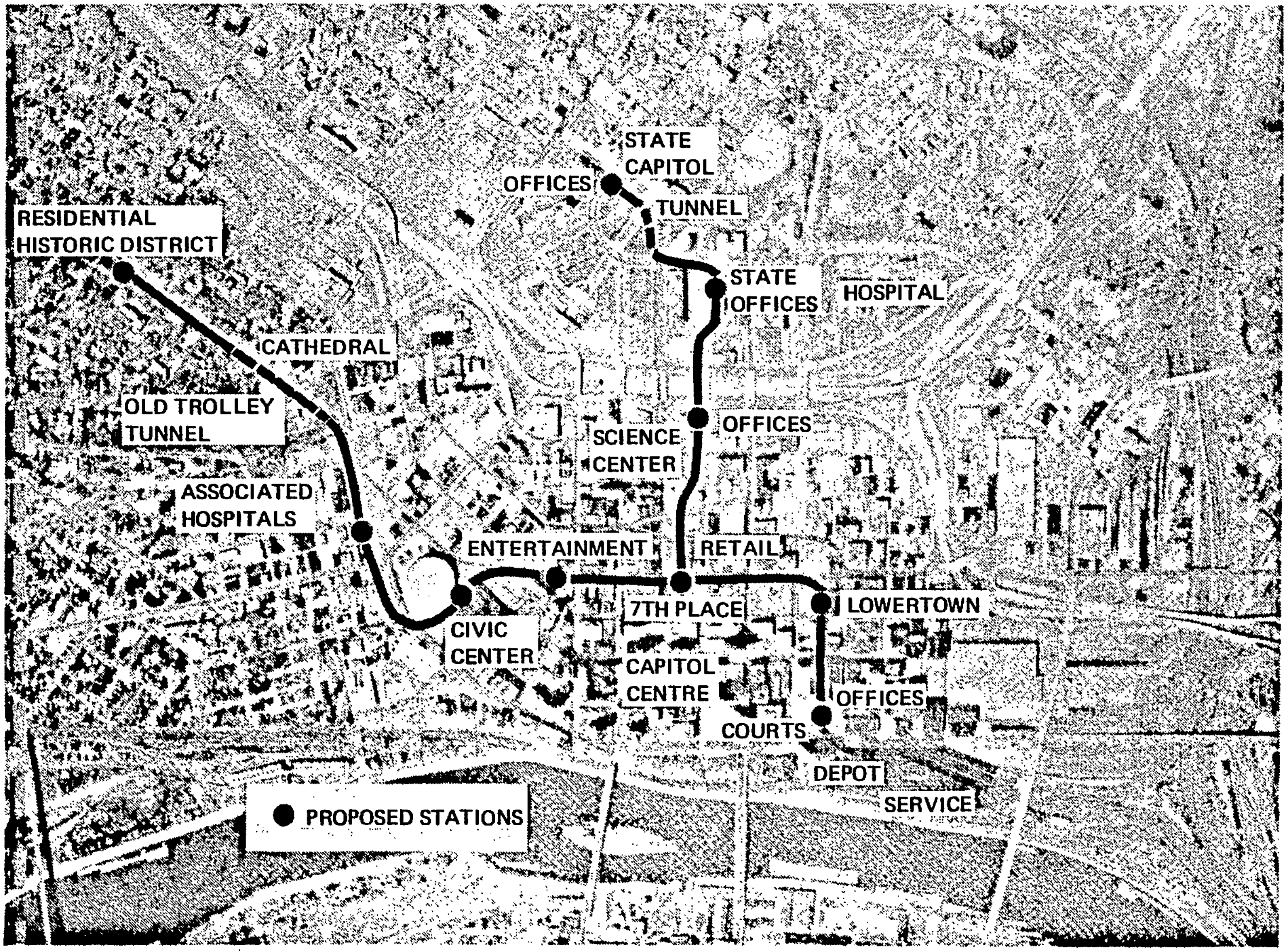

GARAGE STATION
SOUTH LAKE UNION
SEATTLE CENTER
COLISEUM STATION
SWITCH & CROSSOVER
CENTER HOUSE STATION
ELLIOTT BAY PARK
BELL STATION
DENNY REGRADE
WESTLAKE STATION
RETAIL CORE
WESTLAKE PROJECT
FREEWAY PARK AND GARAGE
PIKE PROJECT
FINANCIAL AREA
AQUARIUM
GOVERNMENT CENTER
WATERFRONT PARK
PROPOSED STATIONS
PIONEER SQUARE
INTERNATIONAL DISTRICT
STADIUM

St. Louis, Missouri



VAUGHN APTS.
CARR SQUARE VILLAGE
JOHN COCHRAN APTS.
FRANKLIN INDUSTRIAL PARK
LIGHT INDUSTRIAL
OFFICE
OFFICE
CONVENTION HOTEL
LIGHT INDUSTRIAL
OFFICE
WHOLESALE/WAREHOUSE
OFFICE/WHOLESALE
RETAIL AND OFFICE CORE
OFFICE/ FINANCE
CULTURAL
OFFICE/ RETAIL
RESIDENTIAL
OFFICE
LIGHT INDUST.
RESIDENTIAL
OFFICE RETAIL MULTI-USE
JEFFERSON NATIONAL EXPANSION MEMORIAL
MALL
MALL
OFFICE
HOTEL
OFFICE
MULTI USE
GOVERNMENT
SPECTATOR SPORT AND PARKING
HOTEL
RETAIL
MULTI USE
LT. IND.
LT. IND./ WARE
OFFICE
elevated
surface
underground (existing tunnel)
primary boarding locations
MULTI USE
LIGHT INDUSTRIAL/ WAREHOUSE/TRUCK TERMINAL
LIGHT INDUSTRIAL
OFFICE

St. Paul, Minnesota

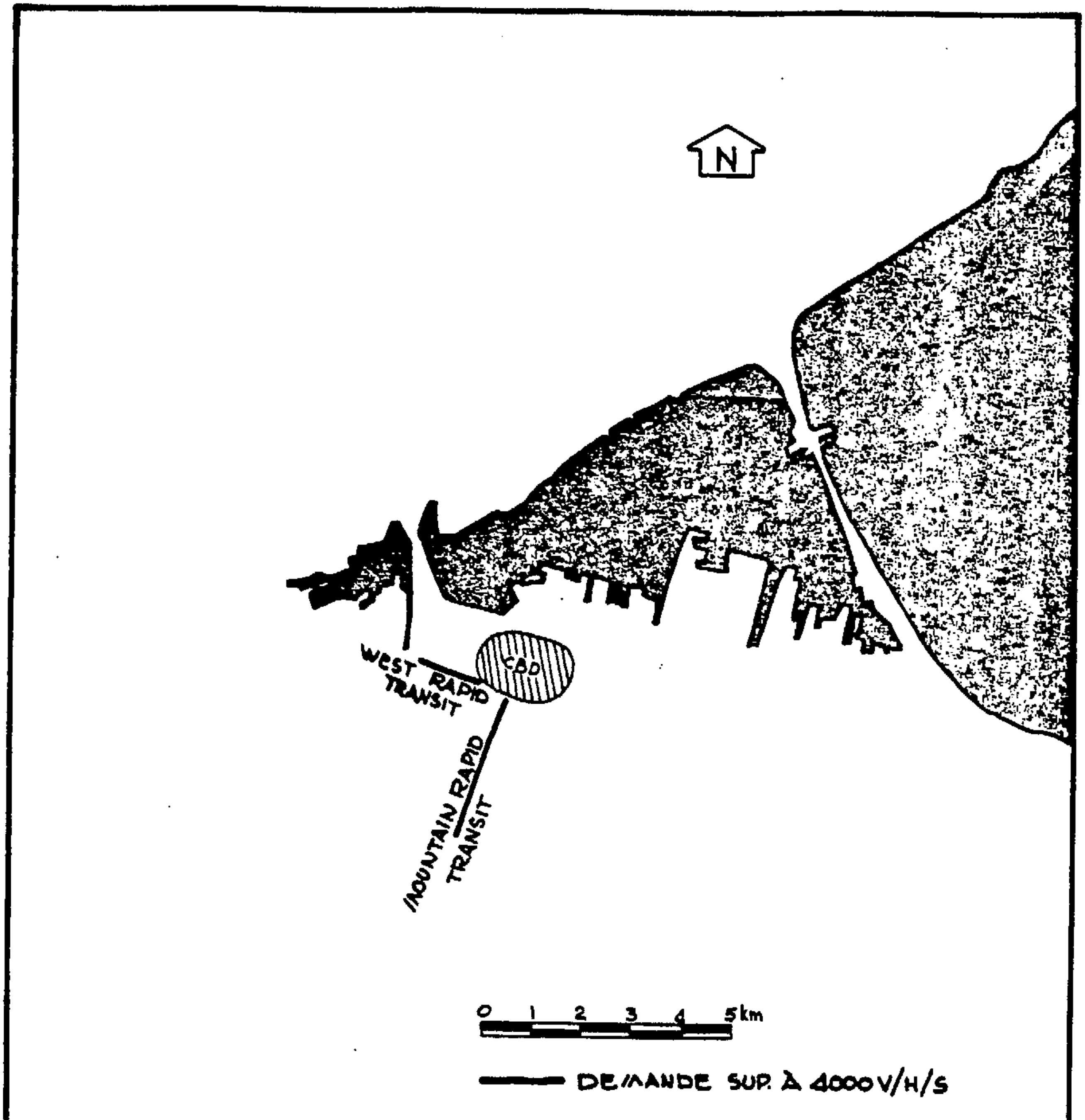

STATE CAPITOL
OFFICES
TUNNEL
RESIDENTIAL HISTORIC DISTRICT
STATE OFFICES
HOSPITAL
CATHEDRAL
OLD TROLLEY TUNNEL
OFFICES
SCIENCE CENTER
ASSOCIATED HOSPITALS
ENTERTAINMENT
RETAIL
7TH PLACE
LOWERTOWN
CIVIC CENTER
CAPITOL CENTRE
OFFICES
COURTS
DEPOT
SERVICE
PROPOSED STATIONS

A P P E N D I X 'B'

CANADA

HAMILTON, ONTARIO

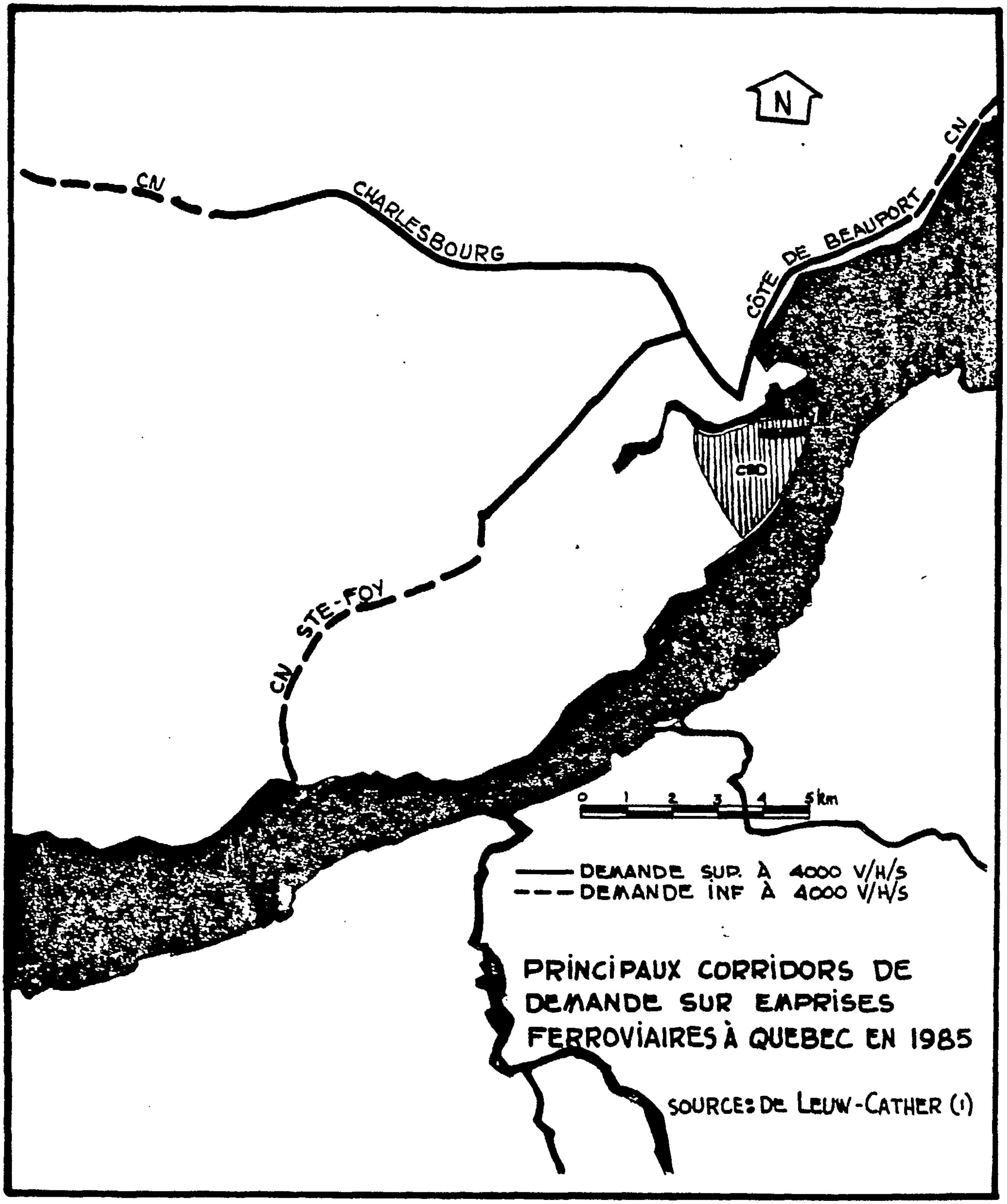
B-1



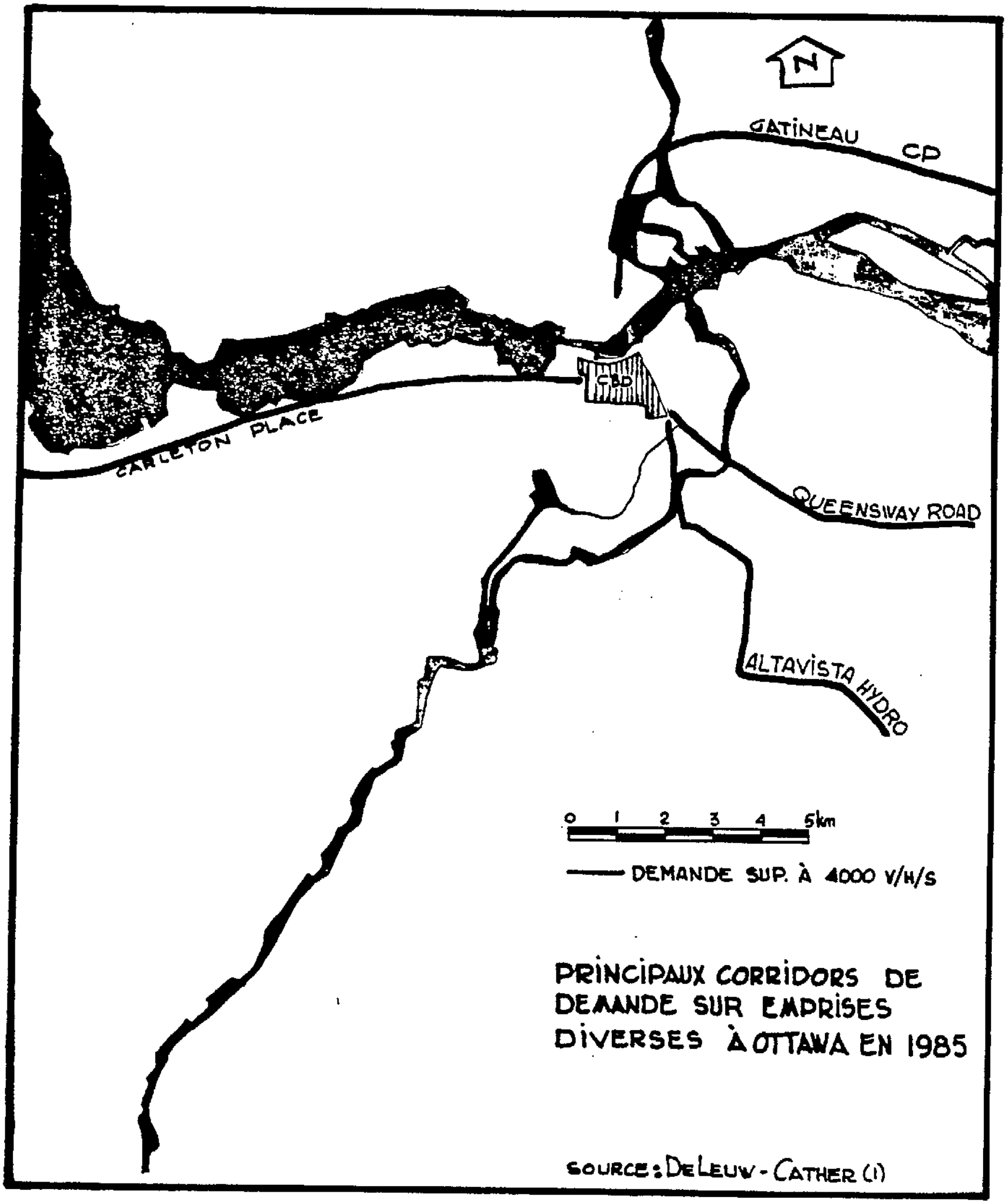
PRINCIPAUX CORRIDORS DE DEMANDE SUR EMPRISES ROUTIÈRES À HAMILTON EN 1985

SOURCE : DeLeuw - Cather (1)

QUEBEC CITY, QUEBEC


N
CN
CHARLESBOURG
CÔTE DE BEAUPORT
CN
CBD
CN STE-FOY
0 1 2 3 4 5 km
DEMANDE SUP. À 4000 V/H/S
DEMANDE INF À 4000 V/H/S
PRINCIPAUX CORRIDORS DE DEMANDE SUR EMPRISES FERROVIAIRES À QUEBEC EN 1985
SOURCE: De LEUW-CATHER (1)

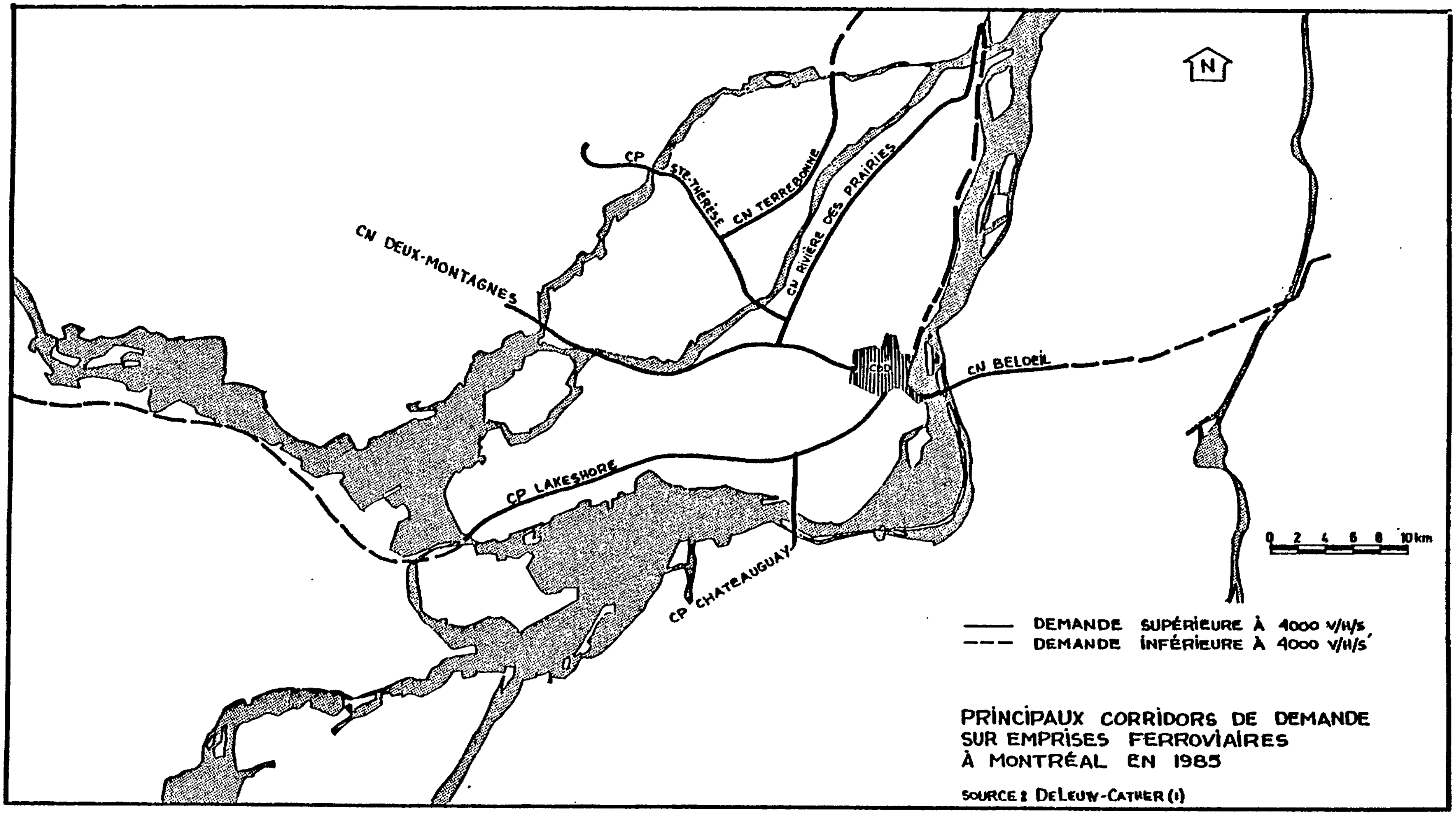
OTTAWA-HULL, ONTARIO



PRINCIPAUX CORRIDORS DE DEMANDE SUR EMPRISES DIVERSES À OTTAWA EN 1985

SOURCE: DeLeuw - Cather (1)

MONTREAL, QUEBEC



PRINCIPAUX CORRIDORS DE DEMANDE SUR EMPRISES FERROVIAIRES À MONTRÉAL EN 1985

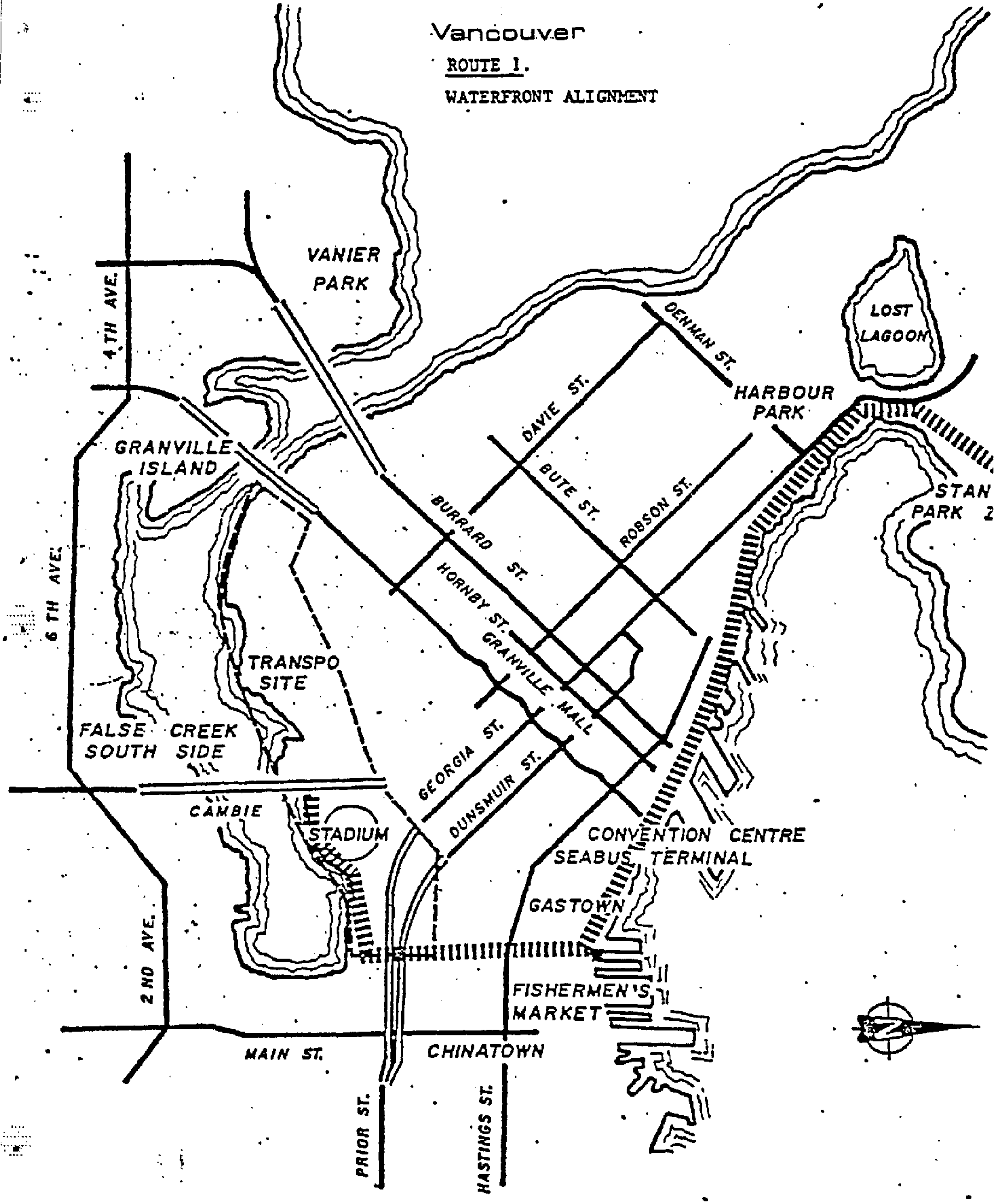
SOURCE : DeLEUW-CATHER (1)

VANCOUVER, BRITISH COLUMBIA

Vancouver

ROUTE 1.

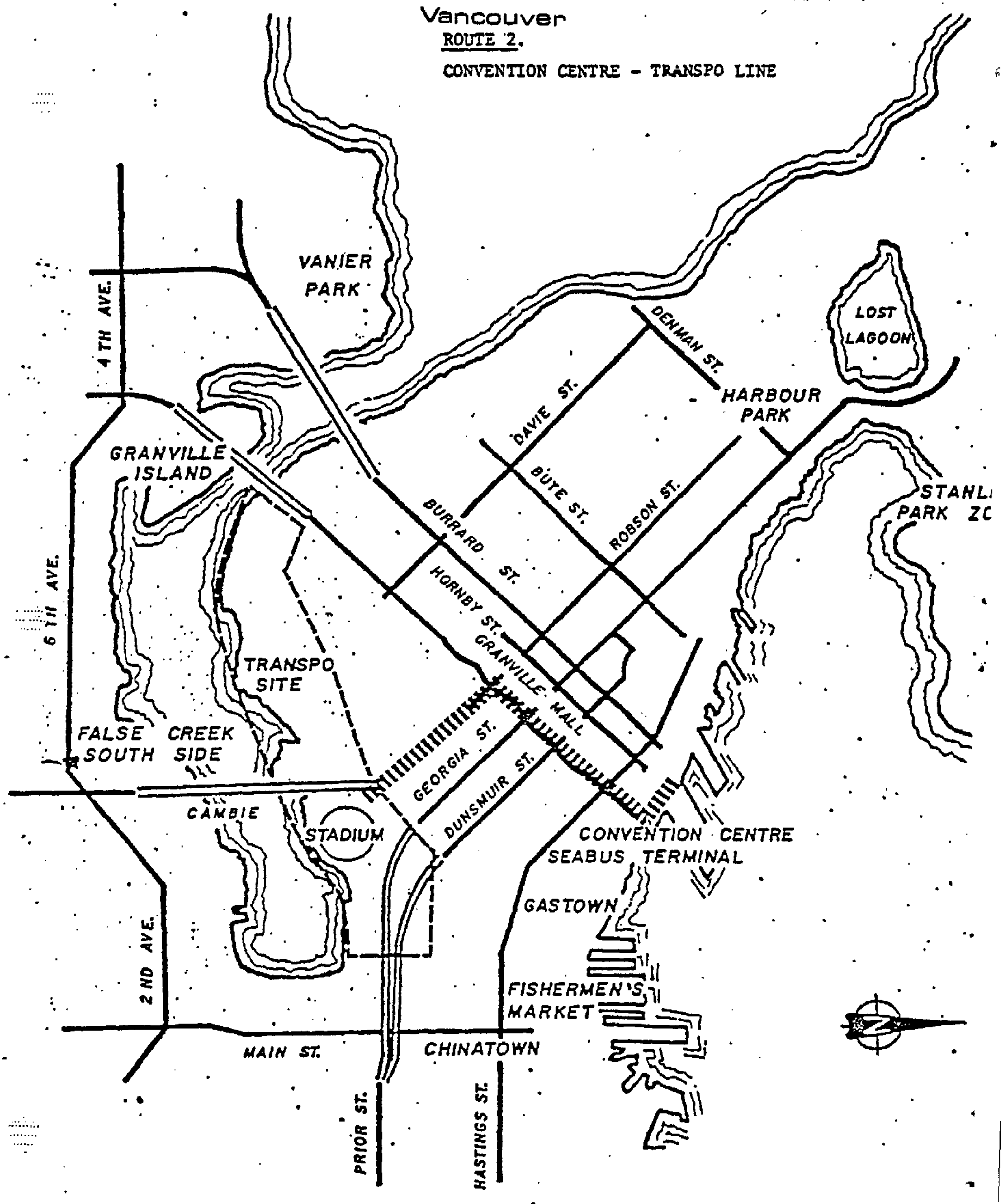
WATERFRONT ALIGNMENT

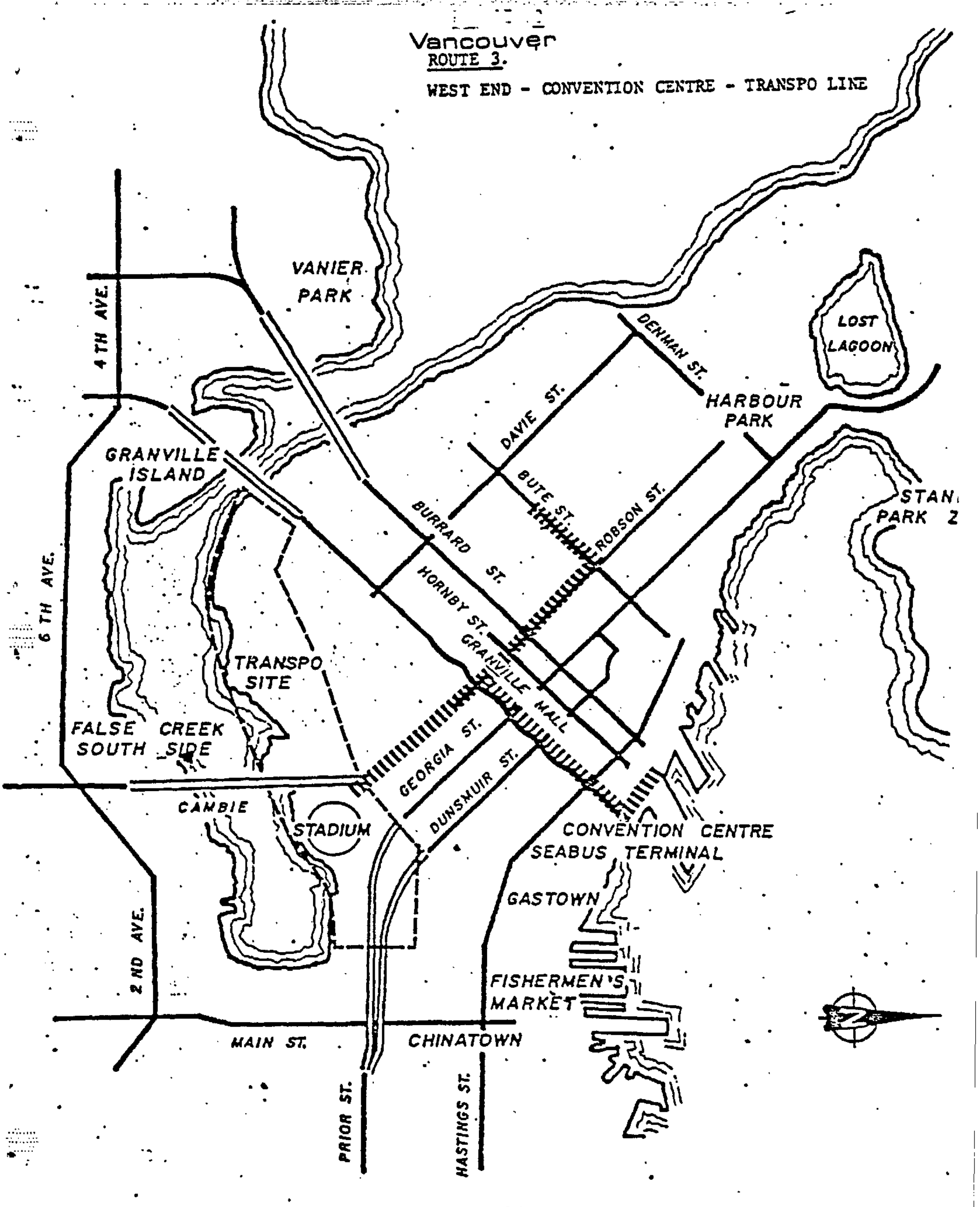


Vancouver

ROUTE 2.

CONVENTION CENTRE - TRANSPO LINE

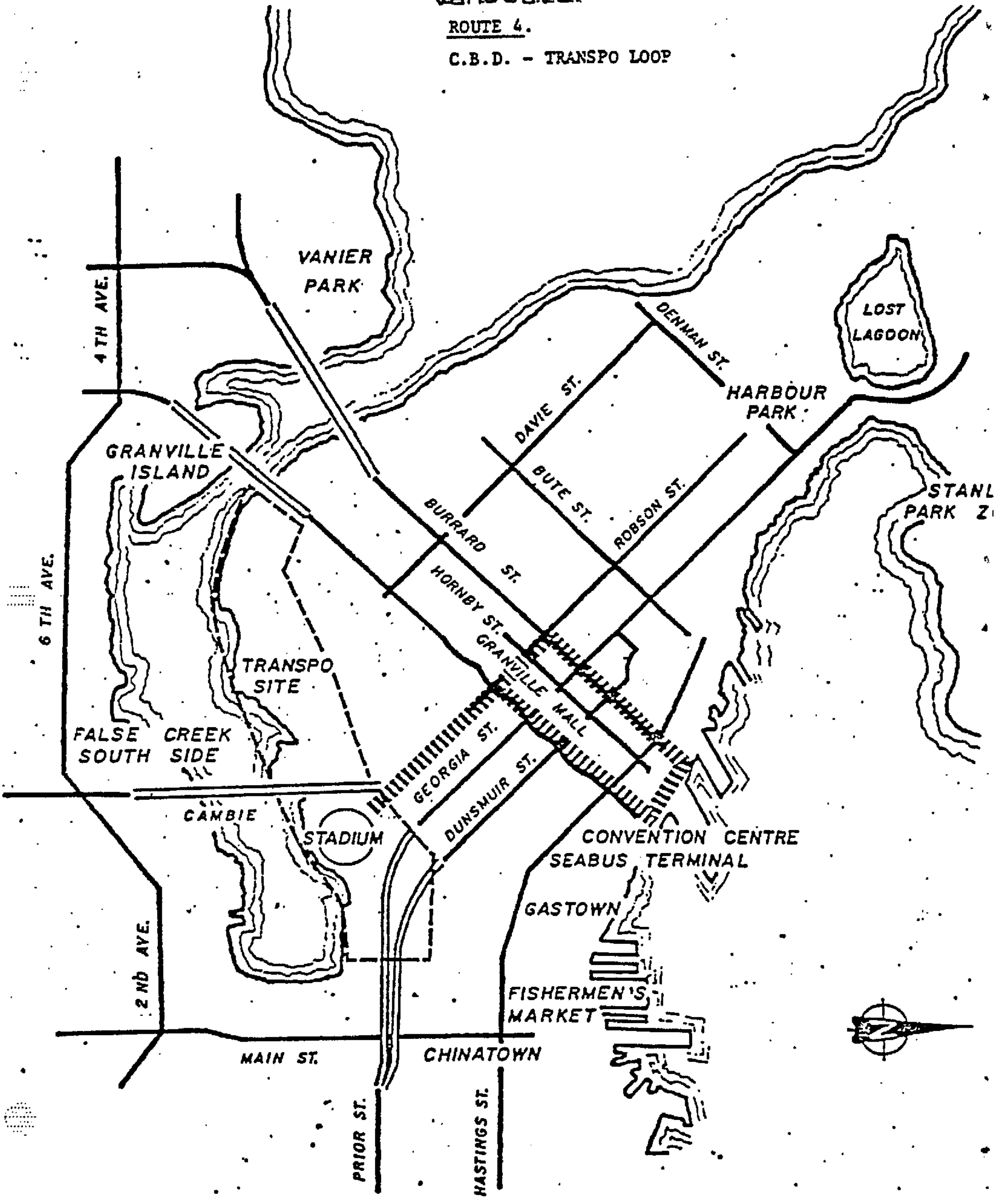



Vancouver
ROUTE 3.
WEST END - CONVENTION CENTRE - TRANSPO LINE
VANIER PARK
4 TH AVE.
LOST LAGOON
DENMAN ST.
HARBOUR PARK
DAVIE ST.
GRANVILLE ISLAND
BUTE ST.
ROBSON ST.
BURRARD ST.
HORNBY ST.
6 TH AVE.
GRANVILLE MALL
TRANSPO SITE
FALSE CREEK SOUTH SIDE
GEORGIA ST.
DUNSMUIR ST.
CAMBIE
STADIUM
CONVENTION CENTRE
SEABUS TERMINAL
GASTOWN
2 ND AVE.
FISHERMEN'S MARKET
MAIN ST.
CHINATOWN
PRIOR ST.
HASTINGS ST.

Vancouver

ROUTE 4.

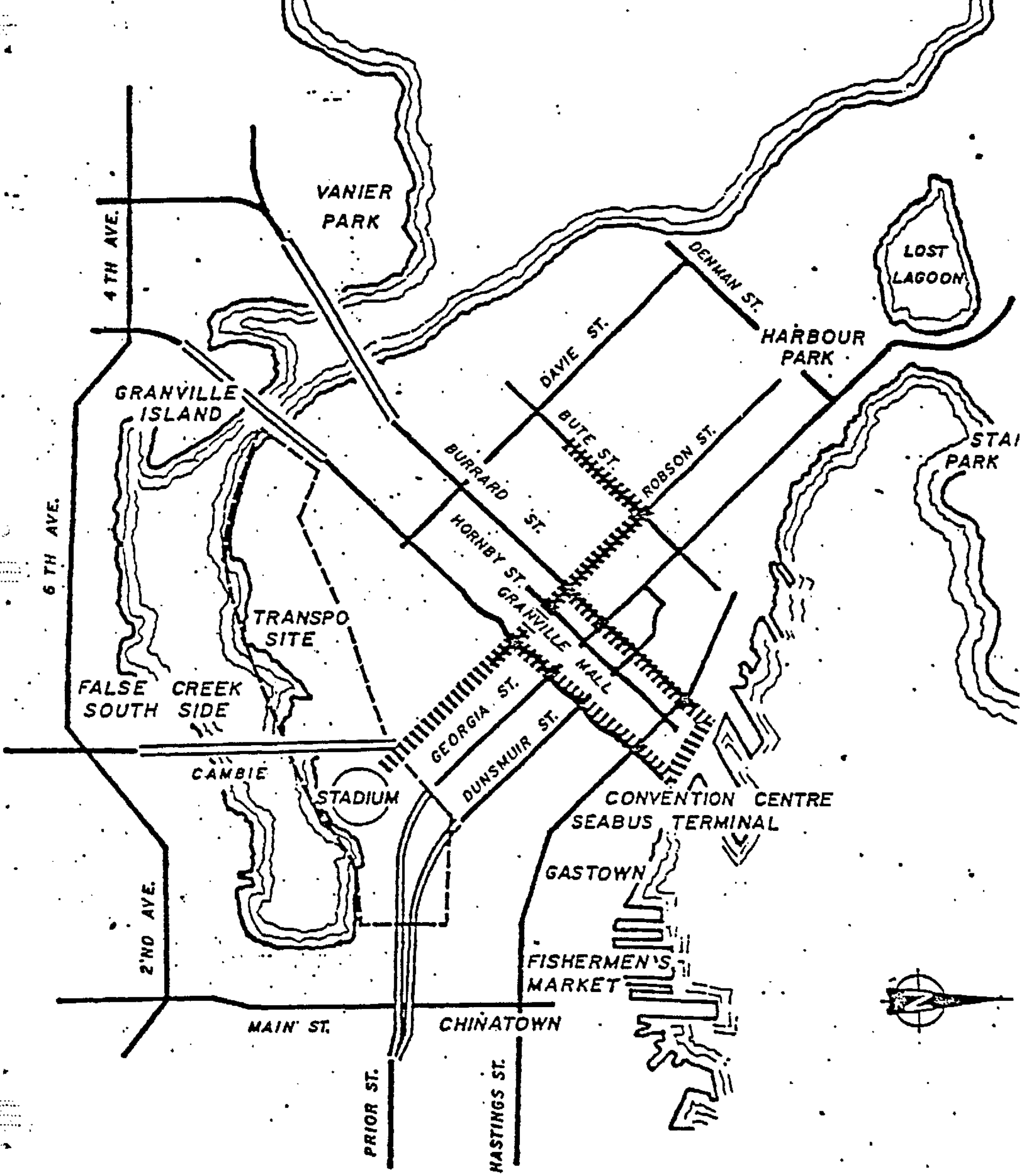
C.B.D. - TRANSPO LOOP



Vancouver,

ROUTE 5.

WEST END - C.B.D. - TRANSPO LOOP



A P P E N D I X 'C'

SUPPLEMENTARY INFORMTION

Urban Transportation Development Corporation Ltd.

April 14, 1980

FACT SHEET

HAMILTON RAPID TRANSIT PROJECT OFFICE

Location; 100 Main St. E
Century 21 Complex
Concourse Level
Hamilton, Ontario

Size: 5,000 Sq. Ft.

Purposes:

1. All preliminary planning and evaluation activities associated with the commercial application of ICTS technology in Hamilton will be co-ordinated at this office. This includes interface activities among representatives of the Regional Municipality of Hamilton-Wentworth; the city of Hamilton; consulting firms, MTC; UTDC; Federal government agencies and industrial/ commerical participants.

2. In the event that preliminary activities conclude with a decision by the municipality to implement ICTS in Hamilton, the facility will be the project office responsible for:

   a) detailed system design (infrastructure, operations)

   b) all administrative activities including construction of the system.

3. In addition, the office will permit 'store-front' access to the general public throughout the program. Municipal leaders are clearly enthusiatic about the project and we hope that, the community will also be actively supportive. Project office accessibility will permit a high degree of public participation.

Staffing: The office will house, as required, personnel from the various levels of government and private companies involved in the project.

Ministry of Transportation and Communications

Ontario

news release

FOR IMMEDIATE RELEASE

September 29, 1978

Ontario proposes provincial/federal transit demonstrations in Toronto and Hamilton

KINGSTON -- Ontario today proposed that the federal government participate with the province in a program to demonstrate commercial applications of the intermediate capacity transit system being developed by the Urban Transportation Development Corporation Ltd. (UTDC).

The Honourable James Snow, Ontario Minister of Transportation and Communications, made the proposal last week in a letter to the Honourable Jack Horner, Federal Minister of Industry, Trade and Commerce, and made the proposal public at the official opening ceremonies of UTDC's Transit Development Centre near Kingston, Ontario.

Snow said that UTDC has identified two opportunities in Ontario for demonstration systems of its advanced technology rapid transit system.

"One is a 4-mile line linking Hamilton Mountain to the downtown, for which federal participation could be $32 million of the total (estimated), $70 million facility cost, or an annual contribution from Ottawa...of $8 million," Snow stated.

....../2

"The other is a 4-mile line linking Toronto Union Station with the CNE recreation facilities via Harbourfront Park, for which we invite $30 million federal participation of the total estimated $65 million facility cost (annual cost $7 million)."

Snow requested talks with the municipalities to discuss these and other alternatives. He also noted the proposal is in keeping with recent recommendations by the federal task force on the urban transportation industry.

"The Horner task force recommendations call for the federal government to provide limited capital grant support for specific transit demonstrations or development programs as an aid to municipalities," Snow said.

He also told the gathering that such commercial demonstrations of new transit technology, with financial assistance from Ottawa, could lead to better transit for Canadian municipalities, to a larger share of export markets and to more high-quality jobs for Canadians.

"The recently announced $300 million federal Industrial Assistance Program...seems a more than appropriate source for such commercial demonstration funds," the Minister said.

Ontario is prepared to offer its participation in the demonstration systems in Toronto and/or Hamilton jointly with the federal government, Snow pointed out, however, these demonstrations would be conditional upon municipal approval.

UTDC's intermediate capacity transit system (ICTS) now in the third phase of development at the new centre, features small, quiet steel wheel trains operating on a separate guideway. Propulsion is provided by almost silent linear induction motors with provision for automatic train control.

The system, designed for areas where the high capacity of subways (40,000 passengers per hour) are not needed, will cost approximately 50 per cent less than a subway to install.

- 0 -

From: Public and Safety
Information Branch

1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Telephone: (416) 248-3501

29/9/78

Ministry of Transportation and Communications

Ontario

news release

FOR IMMEDIATE RELEASE

January 3, 1980

Snow announces pre-implementation funding for Hamilton Transit project

Minister of Transportation and Communications James Snow announced today the Ontario government will provide a special subsidy to the Region of Hamilton-Wentworth to proceed with the preliminary engineering of the Hamilton Mountain Rapid Transit project.

The decision to proceed was made because of further delays in federal participation resulting from the recent defeat of the federal government.

The Minister said he has received verbal support from both federal governments which held office since he submitted his proposal for federal financial participation in September, 1978. "However," he said, "no formal decision for funding under the various Industrial Development Assistance Programs was announced because of the termination of both governments."

Snow announced his decision after a meeting with Hamilton-Wentworth Region Chairman Anne Jones; City of Hamilton Mayor Jack MacDonald; and Controller Pat Valeriano, Chairman of Hamilton-Wentworth Transit Committee.

Snow stated that starting the engineering of the transit project was too important to wait until promised federal government funding support is committed to the project.

....../2

"We must proceed," said Snow, "and trust that whatever federal government takes office after February 18 will honor the verbal policy commitments of the two previous governments."

Approximately $3.5 million will be spent on detailed planning and engineering of the system, including selection of the final route alignment, vehicle specification, detailed guideway design and station location and design.

In addition, funds will be allocated for specific design work for the Hamilton vehicle, and the continued development and testing at the UTDC Transit Development Centre of the guideway and other system components that will be needed to meet specific Hamilton site requirements.

Snow emphasized that this stage of the project does not involve any tender of construction contracts in Hamilton.

"No construction work will proceed until Ontario receives a formal response regarding federal participation in the follow-on construction program," he said, adding, "I expect a formal reply from the new government after the February election." Any further delays in proceeding with the engineering phase will set back Hamilton's urban development plans and the province's transit development program.

The Hamilton Mountain Project offers the Canadian transit industry an essential opportunity to supply ICTS components and services on a commercial, rather than prototype, experimental scale.

It also provides Canada with a technology showcase, giving increased visibility of Canadian transit products for export markets.

Snow stated that "any federal government has an important vested interest in providing funding for the project. And participation will also confirm Ottawa's commitment to an energy conservation policy at a time when all governments recognize the need for better transit as an alternative to increased petroleum consumption."

Snow said: "The Government of Ontario will continue its urban transit program -- initiated in the early 1970's -- to provide solutions for the growing energy, traffic and urban development needs of our cities."

- 0 -

From: Public and Safety
Information Branch

1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Telephone: (416) 248-3501

3/1/80

TECHNOLOGICAL INNOVATION STUDIES PROGRAM

PROGRAMME DES ÉTUDES SUR LES INNOVATIONS TECHNIQUES

REPORTS/RAPPORTS

1. Litvak, I.A. and Maule, C.J., Carleton University. **Canadian Entrepreneurship: A Study of Small Newly Established Firms.** (October 1971)

2. Crookell, H., University of Western Ontario. **The Transmission of Technology Across National Boundaries.** (February 1973)

3. Knight, R.M., University of Western Ontario. **A Study of Venture Capital Financing in Canada.** (June 1973)

4. Little, B., Cooper, R.G., More, R.A., University of Western Ontario. **The Assessment of Markets for the Development of New Industrial Products in Canada.** (December 1971)

5. MacCrimmon, K.R., Stanbury, W.T., Bassler, J., University of British Columbia. **Risk Attitudes of U.S. and Canadian Top Managers.** (September 1973)

6. Mao, J.C.T., University of British Columbia. **Computer Assisted Cash Management in a Technology-Oriented Firm.** (March 1973)

7. Tomlinson, J.W.C., University of British Columbia. **Foreign Trade and Investment Decisions of Canadian Companies.** (March 1973)

8. Garnier, G., University of Sherbrooke. **Characteristics and Problems of Small and Medium Exporting Firms in the Quebec Manufacturing Sector with Special Emphasis on Those Using Advanced Production Techniques.** (August 1974)

9. Litvak, I.A., Maule, C.J., Carleton University. **A Study of Successful Technical Entrepreneurs in Canada.** (December 1972)

10. Hecht, M.R., Siegel, J.P., University of Toronto. **A Study of Manufacturing Firms in Canada: With Special Emphasis on Small and Medium Sized Firms.** (December 1973)

11. Little, B., University of Western Ontario. **The Development of New Industrial Products in Canada. A Summary Report of Preliminary Results, Phase 1.** (April 1972)

12. Wood, A.R., Gordon, J.R.M., Gillin, R.P., University of Western Ontario. **Comparative Managerial Problems Early Versus Later Adoption of Innovative Manufacturing Technologies: Six Case Studies.** (February 1973)

13. Globerman, S., York University. **Technological Diffusion in Canadian Manufacturing Industries.** (April 1974)

14. Dunn, M.J., Harnden, B.M., Maher, P.M., University of Alberta. **An Investigation Into the Climate for Technological Innovation in Canada.** (May 1974)

15. Litvak, I.A., Maule, C.J., Carleton University. **Climate for Entrepreneurs: A Comparative Study.** (January 1974)

16. Robidoux, J., Garnier, G., Université de Sherbrooke. **Factors of Success and Weakness Affecting Small and Medium-Sized Manufacturing Businesses in Quebec, Particularly those Businesses Using Advanced Production Techniques.** (December 1973) (Available in French)

17. Vertinsky, I., Hartley, K., University of British Columbia. **Project Selection in Monolithic Organizations.** (August 1974)

18. Robidoux, J., Université de Sherbrooke. **Analytical Study of Significant Traits Observed Among a Particular Group of Inventors in Quebec.** (August 1974) (Available in French)

19. Little, B., University of Western Ontario. **Risks in New Product Development.** (June 1972)

20. Little, B., Cooper, R.G., University of Western Ontario. **Marketing Research Expenditures: A Descriptive Model.** (November 1973)

21. Little, B., University of Western Ontario. **Wrecking Ground for Innovation.** (February 1973)

22. Tomlinson, J.W.C., University of British Columbia. **Foreign Trade and Investment Decisions of European Companies.** (June 1974)

23. Little, B., University of Western Ontario. **The Role of Government in Assisting New Product Development.** (March 1974)

24. Cooper, R.G., McGill University. **Why New Industrial Products Fail.** (January 1975)

25. Charles, M.E., MacKay, D., The CERCL Foundation. **Case Studies of Industrial Innovation in Canada.** (February 1975)

26. Hecht, M.R., University of Toronto. **A Study of Manufacturing Firms in Canada: With Emphasis on Education of Senior Officers, Types of Organization and Success.** (March 1975)

27. Litvak, I.A., Maule, C.J., Carleton University. **Policies and Programmes for the Promotion of Technological Entrepreneurship in the U.S. and U.K.: Perspectives for Canada.** (May 1975)

28. Britney, R.R., Newson, E.F.P., University of Western Ontario. **The Canadian Production/Operations Management Environment: An Audit.** (April 1975)

29. Morrison, R.F., Halpern, P.J., University of Toronto. **Innovation in Forest Harvesting by Forest Products Industries.** (May 1975)

30. Mao, J.C.T., University of British Columbia. **Venture Capital Financing for Technologically-Oriented Firms.** (December 1974)

31. Tomlinson, J.W.C., Willie, C.S., University of British Columbia. Guide to the Pacific Rim Trade and Economic Data Base. (September 1975)

32. Ondrack, D.A., University of Toronto. Foreign Ownership and Technological Innovation in Canada: A Study of the Industrial Machinery Sector of Industry. (July 1975)

33. Mao, J.C.T., University of British Columbia. Lease Financing for Technology Oriented Firms. (July 1975)

34. Watson, J.A., University of Alberta. A Study of Some Variables Relating to Technological Innovation in Canada. (June 1975)

35. Sheehan, G.A., Thain, D.H., Spencer, I., University of Western Ontario. The Relationships of Long-Range Strategic Planning to Firm Size and to Firm Growth (Ph.D. Thesis). (August 1975)

36. Killing, J.P., University of Western Ontario. Manufacturing Under Licence in Canada (Ph.D. Thesis). (February 1975)

37. Richardson, P.R., University of Western Ontario. The Acquisition of New Process Technology by Firms in the Canadian Mineral Industries (Ph.D. Thesis). (April 1975)

38. Globerman, S., York University. Sources of R & D Funding and Industrial Growth in Canada. (August 1975)

39. Cooper, R.G., McGill University. Winning the New Product Game. (June 1976)

40. Hanel, P., University of Sherbrooke. The Relationship Existing Between the R & D Activity of Canadian Manufacturing Industries and Their Performance in the International Market. (August 1976)

41. Wood, A.R., Elgie, R.J., University of Western Ontario. Early Adoption of Manufacturing Innovation. (1976)

42. Cooper, R.G., McGill University. Project Newprod: What Makes a New Product a Winner? (July 1980) An Empirical Study. Available at $10.00/copy. Send all orders payable to: Quebec Industrial Innovation Centre, P.O. Box 6079, Station A, Montreal, Quebec, H3C 3A7.

43. Goode, J.T., University of British Columbia. Japan's Postwar Experience with Technology Transfer. (December 1975)

44. Knoop, R., Sanders, A., Concordia University. Furniture Industry: Attitudes Towards Exporting. (May 1978)

45. Peitchinis, S.G., University of Calgary. The Effect of Technological Changes on Educational and Skill Requirements of Industry. (September 1978)

46. Marfels, C., Dalhousie University. Structural Aspects of Small Business in the Canadian Economy. (May 1978)

47. Wright, R.W., University of British Columbia. **Study of Canadian Joint Ventures in Japan.** (1977)

Tomlinson, J.W.C., Thompson, M., **Mexico.** (1977)

Tomlinson, J.W.C., Hills, S.M., **Venezuela and Columbia.** (1978)

Tomlinson, J.W.C., **Brazil.** (1979)

48. Chicha, J., Julien, P.A., Université du Québec. **Les Stratégies de PME et leur Adaptation au Changement.** (Avril 1978) (Available in English)

49. Vertinsky, I., Schwartz, S.L., University of British Columbia. **Assessment of R & D Project Evaluation and Selection Procedures.** (December 1977)

50. Dhawan, K.C., Kryzanowski, L., Concordia University. **Export Consortia: A Canadian Study.** (November 1978) Available at $15.00/copy. Send all order payable to: Dekemco Ltd., Box 87, Postal Station H, Montreal, Quebec, H3G 2K5.

51. Litvak, I.A., Maule, C.J., Carleton University. **Direct Investment in the United States by Small and Medium Sized Canadian Firms.** (November 1978)

52. Knight, R.M., Lemon, J.C., University of Western Ontario. **A Study of Small and Medium Sized Canadian Technology Based Companies.** (September 1978)

53. Martin, M.J.C., Scheilbelhut, J.H., Clements, R., Dalhousie University. **Transfer of Technology from Government Laboratories to Industry.** (November 1978)

54. Robidoux, J., University of Sherbrooke. **Study of the Snowmobile Industry in Canada and the Role that Technological Innovation has Played in Its Economic Performance.** (English Summary only). (Available in French)

55. More, R.A., University of Western Ontario. **Development of New Industrial Products: Sensitivity of Risk to Incentives.** (January 1979)

56. Peterson, R., York University. **A Study of the Problems Brought to the Attention of the Business Student Consulting Teams Sponsored by the Ontario Government's Small Business Assistance Programme.** (February 1979)

57. Cooper, R.G., McGill University. **Project Newprod: What Makes a New Product a Winner?** (July 1980) An Empirical Study. Available at $10.00/copy. Send all order payable to: Quebec Industrial Innovation Centre, P.O. Box 6079, Station A, Montreal, Quebec, H3C 3A7.

58. Farris, G.F., York University. **Comments on the Course: Management of Creativity and Innovation.** (February 1979)

59. Smith, J.G., McGill University. **The Renewable Energy Business Sector in Canada: Economic Prospects and Federal Government Initiatives.** (May 1979)

60. Tomlinson, J.W.C., University of British Columbia. **Cross Impact Simulation of the Joint Venture Process in Mexico.** (December 1978)

61. Grasley, R.H., York University. Dermer, J.D., University of Toronto. The Status of Innovation in the Strategies of Larger Canadian Corporations. (March 1979)

62. Kubinski, Z.M., University of Calgary. The Small Firm in the Albertan Oil and Gas Industry. (February 1979)

63. Scott, D.S., Blair, R.M., University of Waterloo. The Technical Entrepreneur. Inventions, Innovations & Business. (1979) Available at $18.95/copy. Send all orders payable to: Fitzhenry & Whiteside Limited, 150 Lesmill Road, Don Mills, Ontario, M3B 2T5.

64. Kolodny, H.F., University of Toronto. Sociotechnical Study of Productivity and Social Organization in Mechanical Harvesting Operations in the Canadian Woodlands. (May 1979)

65. Barth, R.T., University of British Columbia. A Directory of Research on Research. (May 1979)

66. McMullan, W.E., University of Calgary. Development of a Course on Innovation and Entrepreneurship. (September 1979)

67. Peitchinis, S.G., University of Calgary. Technological Changes and the Demand for Skilled Manpower in Canada. (January 1980)

68. Peitchinis, S.G., Assisted by: MacDonald, E., University of Calgary. The Attitude of Trade Unions Towards Technological Changes. (April 1980)

69. Peitchinis, S.G., University of Calgary. Technological Changes in Banking and their Effects on Employment. (January 1977)

70. Clarke, T.E., Laurie, G., Peterson, R., Pieczonka, W.A., TIME. Proceedings of the T.I.M.E. (Technological Innovation Management Education) for Canada Workshop. (September 29 & 30, 1979)

71. Palda, K., Pazderka, B., Queen's University. Background to a Target: An International Comparison of the Canadian Pharmaceutical Industry's R & D Intensity. (July 1980)

72. Kirpalani, V.H., Concordia University. MacIntosh, N.B., Queen's University. Small Firm International Effectiveness: An Exploratory Survey. (June 1980)

73. Bhattacharyya, S.K., Assistance of: Hallett, P.H., Bhattacharyya, R.. An Assessment of Market Potential for Intermediate Capacity Transit System in North America. (July 1980)

74. Ondrack, D.A., University of Toronto. Innovation and Performance of Small and Medium Firms: A Re-analysis of Data on a Sample of Nineteen Small and Medium Firms in the Machinery Industry. (May 1980)

75. Abdel-Malek, T., University of Saskatchewan. Canadian Direct Investment in Western Europe. (August 1980)

76. Peitchinis, S.G., University of Calgary. **Technological Changes and the Sectoral Distribution of Employment.** (February 1980)

77. Crozier, J.E., McMaster University. **A Survey to Identify the Attitudes and Awareness of Numerical Control Users to CAD/CAM Technology and the Technological and Economic Strengths and Weaknesses of Machine Tool Part Programming.** (November 1980)

78. Peitchinis, S.G., University of Calgary. **The Introduction of Computer-Aided Design/Computer-Aided Manufacturing CAD/CAM Systems and their Employment Implications.** (September 1980)

79. Hewitt, G.K., Concordia University. **R & D in Selected Canadian Industries: The Effects of Government Grants and Foreign Ownership.** (January 1981)

80. Litvak, I.A. and Maule, C.J., Carleton University. **Entrepreneurial Success or Failure - Ten Years later. A Study of 47 Technologically Oriented Enterprises.** (October 1980)

81. Adams, P.F., University of Alberta. **Development of a course: "Initiation of Technology Based Enterprises".** (April 1981)

82. Meincke, P.P.M., University of Prince Edward Island. **A Preliminary Study to Determine the Feasibility of Establishing an Industrial Innovation Centre on Prince Edward Island.** (March 1981)

83. Wills, R.M. **The International Transfer and Licensing of Technology in Canada.** (February 1982)

84. Ash, S.B., University of Western Ontario, Quelch, J.A., Harvard University. **The New Videotex Technology and Its Impact on Retailers in Canada.** (August 1982)

Veuillez faire parvenir votre demande à PEIT:
Please forward your request for TISP reports to:

Program Manager
Technological Innovation Studies Program
Technology Branch (61)
Department of Industry, Trade and Commerce
235 Queen Street
Ottawa, Ontario CANADA
K1A 0H5

Revised September 1982