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Transit Options For The Twin Cities Metropolitan Region

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Transit Options for the Twin Cities Metropolitan Region

Prepared for:

The Twin Cities Area Metropolitan Transit Commission

January 1971

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DMJM / MPR

DANIEL, MANN, JOHNSON, & MENDENHALL

MIDWEST PLANNING AND RESEARCH, INC.

Twin Cities Area
Metropolitan Transit Commission
550 Cedar Street
Capitol Square Building
St. Paul, Minnesota 55101

January 27, 1971

Gentlemen:

We are pleased to submit herewith our report covering Phase IIIA-1 of the Twin Cities Area Metropolitan Transit Planning Program in accordance with the contract between the Metropolitan Transit Commission and the joint venture of Daniel, Mann, Johnson and Mendenhall and Midwest Planning and Research, Inc. This is the first part of the two part work program outlined in the MTC May, 1970 Study Design Report accomplished for the purpose of providing a comprehensive information base on which future decisions for the region can be made by the Commission, the Metropolitan Council, the State Legislature, and other participating agencies.

This report summarizes the statistical data and findings contained in a series of seven "Technical Reports" reviewed with the Transit Development Committee, the Commission and others during the course of the contract period. These reports were prepared for the purpose of in-depth examination of key elements of the study supplementary to this report. Included in this report are analyses of regional growth and mobility needs, service concepts and systems evolution, transit options and test systems, benefit-costs comparisons and financing programs.

In the process of the work program we have conferred extensively, as you desired, with groups and agencies throughout the Metropolitan Area. The helpful assistance of these interested citizens and officials, and the staff personnel of the Metropolitan Transit Commission and Metropolitan Council is gratefully acknowledged and has contributed significantly to the completed work.

Very truly yours,

DANIEL, MANN, JOHNSON & MENDENHALL

David R. Miller
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Executive Vice President

GLOSSARY OF TERMS

BUSWAY — A fast link transit mode using high performance buses on exclusive lanes in separate rights-of-way.

CENTRAL BUSINESS DISTRICT (CBD) — The major business district of a city — in the Twin Cities area, there are two CBD's, City of Minneapolis and City of St. Paul.

COLLECTION AND DISTRIBUTION SYSTEMS — Part of the family of vehicles used to provide circulation within high activity areas and to provide convenient passenger access to fast link stations. Such system may employ small buses or automated people mover systems such as moving sidewalks or the various small vehicle systems operating on fixed guideways.

CORRIDOR (Transit) — A geographical area characterized by large travel movements and established as a transit planning area for the fast link and associated feeder service.

DIAL-A-RIDE, PERSONAL SERVICE TRANSIT — A type of transit service where travellers would register a demand for service, usually by telephone, and the bus (mini-bus or smaller) would respond to such calls.

EXPRESS BUS — A conventional bus operating in limited stop service on a busway or in mixed traffic on freeways or arterials.

FAMILY OF VEHICLES — A transit service concept which employs a range of vehicle systems and types permitting the service to be factored to the density and character of the area served.

FAST LINK — That part of the transit system designed to provide regional service at higher speeds and with limited stops at designated station points. Vehicle systems can range from buses in mixed traffic on freeways or expressways through buses on special lanes to automated vehicle systems on their own rights-of-way.

FEEDER SYSTEMS — Part of the family of vehicles used to bring passengers to or from fast link stations in low or medium density areas. These systems may include conventional buses and/or demand responsive systems (Dial-a-Ride) which can also provide local service within the service areas or to the Major Diversified Centers.

FIXED GUIDEWAY TRANSIT — A fast link transit mode using exclusive rights-of-way and capable of fully automated operation.

HEADWAY — The time interval between passages of consecutive vehicles or trains moving past a given point in the same direction.

INTERFACE — The transfer activity and facilities required of transfers between transportation modes; i.e., bus to rapid transit, etc.

MAJOR DIVERSIFIED CENTERS — A large concentration of retailing, service, cultural, entertainment, and office facilities located within a relatively compact area, blended with high density residential development and perhaps certain types of manufacturing, storage, and research facilities.

MAXIMUM LOAD POINT — The point on a route where the total number of passengers is a maximum for a 24-hour period in both directions.

MINI-BUS — Small vehicles with capacity up to 30 passengers.

MODAL SPLIT — The breakdown of total travel according to the actual modes used - usually between automobile and transit.

MODE — The method of transportation used - usually to distinguish between automobile and transit.

PEAK HOUR, RUSH HOUR, A.M. Peak, P.M. Peak — The 60 minute period during an average weekday when the greatest number of people travel past a specific point on a specific route.

PEOPLE MOVER SYSTEM — Type of transportation system used for short distance travel, usually for internal movements in high density activity centers, characterized by easy access, frequent service, close station spacing, and low and moderate speeds. System generally includes minibus, moving sidewalk or moving belt with vehicle, and automated small vehicles.

PERSONALIZED RAPID TRANSIT (MODIFIED) — A small car (4-8 passenger) vehicle system on fixed guideway with off-line stations and operating from origin to destination without making intermediate stops. This same system when operated by linking vehicles together into train units and making station stops along the route during peak hour periods is referred to as the Modified Personalized Rapid Transit.

RAPID TRANSIT — Mass transportation distinguished from other transit by its operation at high average speeds over exclusive grade-separated right-of-way.

REVERSE COMMUTE — Movement from central city residential locations to employment opportunities in the suburbs.

TRAFFIC SHED — The tributary service area of a major transportation facility such as a freeway and major arterial system or a transit system.

PREFACE

Transit policies and the basic need for balanced transportation in the Twin Cities region are summarized in the following statement, quoted directly from pages 13-15 of the Metropolitan Development Guide – Transportation Section issued by the Metropolitan Council for review on January 13, 1971.

"Many people have their choice of housing, employment, and other opportunities severely restricted because of limitations in coverage and service in our existing transit system. Estimates indicate that about 15 percent of the households in the Metropolitan Area do not own automobiles. Only with adequate transit service can the 250,000 people in this group fully participate in the Area's social and economic opportunities.

Members of one-car families also experience limitations in mobility and economic opportunity because the family car must frequently be used by the major breadwinner during the work day. Large numbers of people who cannot drive, such as the elderly, the handicapped, and the young have opportunities denied them because of the lack of good transit.

Many persons who now use automobiles for work trips and thus contribute to rush hour congestion would prefer an alternate means of transportation if adequate service were available. After the middle 1970's, peak hour congestion on the major metropolitan highway system will increase significantly, especially on the approaches to the downtowns. A major development objective is continued growth in the level of activity and quality of the downtowns as major service, job, and financial centers. Poor accessibility hinders downtown growth. At the same time it is apparent that penetration of downtown-oriented corridors by new freeways will be very difficult. Therefore, first consideration must be given to development of downtown – (and through-downtown) oriented fast-link high-speed transit supported by local and feeder lines. This new transit service may run on its exclusive right-of-way, but opportunities to use existing transportation routes such as highways with exclusive bus lanes or operational priority should also be examined and adopted if they improve transit service.

Transit as a solution to congestion is especially important in high traffic volume diagonal corridors where freeways attract hard-to-handle traffic volumes.

Projections indicate that by 1985 employment in the two downtowns will increase substantially, with over half those employed arriving from the suburbs. The ability to move a high percentage of the downtown work trips by transit can result in significant relief of vehicular downtown congestion.

Service also needs to be extended to or improved at other major centers like the University of Minnesota, the Southdale area, and the Snelling-Highway 36 area. Planning for major new transit should orient both fast-link and local service to these major centers to encourage their development and to provide service for the people who work, shop, or transact business there.

The transit system depends upon people's access to it. Fast-link transit is needed to increase regional mobility and shape regional development, but is just one member of a "family of transit" that should also include feeder service and local circulation. People without cars and beyond walking distance from a fast-link stop must have some way of getting from their homes to the fast-link stop or the whole transit system has little utility for them. The vast proportion of the Area's residents will not live within reasonable walking distance of a fast-link stop; thus feeder service that ties local areas to the fast-link becomes crucial.

People also need to go from home to school or to the neighborhood shopping center – none of which may be on the fast-link. For this kind of a trip a local transit service is needed probably using the same kind of vehicle as the feeder service.

Some parts of the urbanized area with large lot development and a low-density population may lack enough potential users to warrant feeder or local circulation service. Other transit concepts, such as a personalized circulation service which collects people on request and takes them to a nearby transit terminal, may offer some alternative to use of private autos.

In order to get maximum utility from our investment in highways and transit and to assure the best use of each, development of a highway-transit system must be planned and designed as a single, complementary transportation system and should proceed from a common set of transportation objectives and data for a specified time period, such as the twenty-year planning period used by highway planners. Ideally, what is needed is a transit system that could accommodate the personal movement patterns of each individual with speed, comfort, and convenience without a detrimental environmental impact. Research and experimentation working toward this end is underway. If such a transit system is to be other than a mere duplication of the present auto-thoroughfare system, it must be capable of operating within sharply-limited rights-of-way, be compatible with the urban environment, reasonable in cost and use, and capable of being focused on major areas of activity in order to encourage the major centers development pattern. At this time only conventional transit technology based on a fast-link feeder concept fulfills those conditions and has also been proven operational on a large scale. New system and service concepts should continue to be analyzed and transit planning ought to be as flexible as possible so operationally proven new ideas can be incorporated.

POLICIES:[1/]

17. Improve the existing transit system throughout the Metropolitan Area, with expanded coverage, more frequent night and weekend service, and selected multi-directional service to major employment, shopping, educational, recreational, cultural and air travel facilities.

18. Base plans for major, new transit facilities on a "family-of-vehicles" concept.

19. Use fast-link transit to serve principal movement channels in the metropolitan system, to serve diagonal movement channels that focus on the downtowns if such channels are necessary, and to improve access to other major centers.

20. Develop and improve local movement systems in built-up areas through the provision of feeder service to metropolitan fast-link routes, through experimentation with transit operation techniques, and through the application of new and existing technology.

Coordinate planning and design of all transportation modes on the basis of common transportation objectives and data for a common time period."

[1/] Of 31 policies contained in the Guide, numbers 17-20 relate most directly to transit.

Acknowledgments

Senior staff members from the Metropolitan Council, the City of Minneapolis and the City of St. Paul assisted the MTC staff in directing the program. In addition to those persons listed herein, we gratefully acknowledge the assistance of those many individuals, agencies, communities and counties who aided in the gathering of information and data necessary for the development of this study.

TWIN CITIES AREA METROPOLITAN TRANSIT COMMISSION

LES BOLSTAD, JR. (CHAIRMAN)
Appointed by the Governor

THEODORE R. BROUILLETTE
Representing
the City of Minneapolis

DEAN FENNER
Representing
Ramsey County

EDWARD HJERMSTAD
Representing the Counties of
Carver, Dakota and Scott

BERNARD T. HOLLAND
Representing
the City of St. Paul

WARREN C. HYDE
Representing
Suburban Hennepin County

JAMES P. MARTINEAU
Representing
the City of Minneapolis

JACK R. MEYER
Representing the Counties
of Anoka and Washington

LORING M. STAPLES, JR.
Representing
Suburban Hennepin County

TRANSIT DEVELOPMENT COMMITTEE

DEAN FENNER (CHAIRMAN)

THEODORE R. BROUILLETTE

JACK R. MEYER

OTHER MAJOR PARTICIPANTS

TRANSPORTATION PLANNING PROGRAM (TPP)

This is an interagency transportation planning program administered by the Metropolitan Council, having the following committees:

Management Committee
Policy Advisory Committee
Technical Advisory Committee*

* The Technical Advisory Committee through its Transit Planning Task Force has been an active participant.

ADVISORY COMMITTEE ON TRANSIT

A forty-one member advisory committee appointed by the members of the MTC and chaired by Dr. Warren Ibele.

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SYNOPSIS

INTRODUCTION

Two basic options appear available to accommodate the travel demands that increasing urbanization and concentration of growth in the Twin Cities area will surely impose: build additional freeways in already heavily built-up areas in the face of increasing resistance to freeway construction; or, provide an acceptable and convenient alternate to the automobile for intraurban travel. The Metropolitan Transit Commission, (MTC) created in 1967, has been charged with the responsibility of developing a comprehensive plan for public transit service responding to the second alternative. This most recent study presents an information base upon which decisions and action programs can be made by the appropriate agencies.

This synopsis is a brief abstract of the report which follows. For a concise summary of the study findings the reader is referred to Chapter Nine, and for more detailed technical back-up, to the series of Technical Reports identified on page 3 of the Introduction.

REGIONAL GROWTH PATTERNS

A sound projection of future growth must be the basis for predicting the future need for and viability of a public program which will be called upon to provide service extending 30 or more years into the future. This projection involves both the magnitude and distribution of growth factors which influence and in turn are influenced by the type and extent of the system serving it.

The projections used in this study were developed especially for the project and made use of the most current and reliable data available, including the 1970 Census to the extent that data could be obtained in time for meaningful results.

The projected population for the seven county area by the year 2000 has been determined to be approximately 3.4 million. This represents an average annual growth rate of about two percent. The reduction stems primarily from an expected lower birth rate attributable to a number of social factors. While this rate is somewhat lower than that experienced over the past decade, it is still above the projected national average.

To house this expanded population base will require an estimated 600,000 additional dwelling units, approximately doubling the current stock, to produce a total of 1.2 million units. Of the new units, about 400,000 will be in new multiple family structures.

While the majority of population growth is expected to occur in suburban areas, there is also a projected turn-around in the central cities from a population loss over the past decade to a net gain between 1970 and 2000. Suburban growth is projected to continue heaviest in the Minneapolis suburbs, with accelerating growth in the St. Paul suburbs between 1985 and 2000 (see Figures 2-5 and 2-6, page 7).

Coincident with population growth, employment opportunities are projected to expand even more rapidly. By the year 2000, employment is expected to reach 1.8 million from a 1970 base of 853,000. Significantly, from the standpoint of transit potential, the fastest growth is expected to be in the office type employment categories which are expected to account for approximately 44 percent of total employment by 2000 compared to 37 percent today. This growth in office space demand will require a total of 37.3 million square feet of new office space added to the present stock of 20 million. The majority of this new space is projected to locate in the central cities, although significant growth is also expected in selected suburban centers. (See Figure 2-2, page 6).

This growth in population and employment with its concomitant growth in retail and commercial activity will have an influence upon the regional form. The "Major Centers"Concept proposed by the Metropolitan Council has been adopted for this study. The concept is judged to be a favorable form for a desirable life style and also as a form which can both aid and be aided by transit.

REGIONAL MOBILITY REQUIREMENTS

The Twin Cities region is currently served by a good system of freeways providing reasonable mobility to a highly auto oriented urban development. The acquisition of the Twin City Lines by the MTC offers promise of major improvement in the existing bus transit system in the near future for those who cannot or choose not to drive automobiles. Serious questions, however, exist as to the ability of these systems to meet the mobility challenge in the future.

The number of person trips made in the region can be expected to increase in much greater numbers than population since each individual can be expected to make, on the average, about 3 trips per day. At this rate, some 10 million person trips per day can be expected in 2000 compared to approximately 3.4 million in 1958. Clearly, this increase in travel will require completion of the committed freeway and highway programs as well as major improvements to public transit.

Coupled with this general growth in travel demand are the needs of a sizable and growing minority of people who, for one reason or another, either cannot or choose not to drive an automobile. These include the elderly, the young, the economically disadvantaged, second workers and others in one car families, students, handicapped persons, etc. who must rely on public transit or suffer severe mobility constraints.

SERVICE CONCEPTS

A departure from the essentially single-mode transportation system in use today is required to realistically meet the challenge of future mobility requirements. This means incorporation of a safe, reliable, convenient transit system which is regional in scope. Just as the automobile cannot meet all the mobility requirements, neither can a single transit mode. Therefore, a transit service concept based upon a "family of vehicles" offers the only realistic approach to a true regional system.

In such an approach, vehicles and service concepts can be tailored to the needs of the trip to be made and the character of the area served. Services provided under this concept include: collection-distribution systems for residential neighborhoods, providing local bus service and convenient access to a regional fast link system; a fast link regional system for longer trips, employing both express buses and fixed guideway systems as appropriate; and collection-distribution systems for use in high activity areas, providing internal circulation service and access to fast-link terminals. (See Figure 4-1, page 15 for application of this concept to a typical transit corridor).

Transit equipment used in these systems could include buses of various sizes operating on both scheduled routes and in a demand responsive mode (Dial-a-Ride), automated vehicle systems with size and speed capabilities appropriate to the application, and various "people mover" systems.

EVOLUTION OF SYSTEMS

An extensive review was conducted of the current status of transit system and equipment development sponsored by both governmental agencies and private interests. In current government sponsored programs, the preponderance of research as far as urban rapid transit is concerned, is in areas of component development related to improvement of existing technology. Considerable effort is also being placed in small vehicle transit, primarily directed at the internal circulation and distribution function in concentrated activity centers. Other major expenditures in research are being directed at high-speed ground transport on the interurban scale.

Virtually all of the component research (propulsion and power supplies, automated vehicle control and surveillance, communication, ticket vending, etc.) are equally applicable to any transit technology. A number of demonstration projects are planned to test operability and acceptability of systems and operating concepts in several areas of the country under the auspices of the Federal government. Results of current and future tests will provide some of the necessary answers as to cost and technical feasibility of many of the new systems proposed. However, these are time consuming activities and no reliable predictions can be made at this time as to when such "new technology" systems might be ready for application in an urban area. Furthermore, new transit technology will continue to be developed and, regardless of what point in future time is selected to begin implementation of a system, further improvement and refinement will be emerging.

These facts lead to the logical conclusion that transit system development in the Twin Cities will be an evolutionary process, incorporating technological improvements as they become available and proven.

TRANSIT OPTIONS AND TEST SYSTEMS

To develop insight into the potential for transit in the Twin Cities, the region was divided into 10 transportation planning sectors on the basis of logical traffic sheds. Within each of these sectors, at least one major corridor can be identified. Within each corridor, several potential routes for fixed guideway application appear feasible. In the definition of the sectors and corridors, the proposed Metropolitan Council major diversified centers concept was one of the considerations (See Figure 6-1, page 27).

Two basic transit options were applied to serve travel need in these corridors. The first, defined as Option A, employs an all-bus approach employing innovative bus concepts to serve as the regional transit system. Three levels of capital investment were used in defining bus options. The other basic option, use of fixed guideway transit, was also divided into sub-options, designated B and C, relative to the extent of system in place by fixed points in time. Hence, these are phasing options rather than system concept options. (See Figures 6-3, 6-4, 6-5 for graphic illustrations of test system options). By applying fixed guideway transit to various corridor combinations in the B series, added insight into system effectiveness and relative benefits were obtained.

Fast link transit was applied to all corridors in test systems B and C. In the B series, this employed express bus and/or busway in corridors where fixed guideway was not used. Table 6-1, page 33, shows the projected annual operating results expected for the various test systems during the year 1985 with system costs expressed in terms of 1970 dollars. The effects of escalation in both costs and revenue are shown in Table 6-3, page 37.

BENEFIT COST COMPARISONS

Major transit improvement must produce a reasonable return on the large investment required to be justifiable in context with other desirable and necessary public improvements in the region. These returns may be in the form of economic benefits, but of at least equal importance are the essentially social benefits offered by improved mobility. In the benefit analysis for this study, non-economic factors have been developed comparing the effect of each test system against the all-bus system. Economic benefits were developed in a similar manner and hence the benefit analysis is relative rather than absolute.

In these direct comparisons, the fixed guideway options produce significantly greater benefits than do the bus options in all categories (See Figure 7-3, page 46). These effects are greatest in increased mobility gains to transit dependent residents, commuter savings, and urban structuring impact attributable to transit.

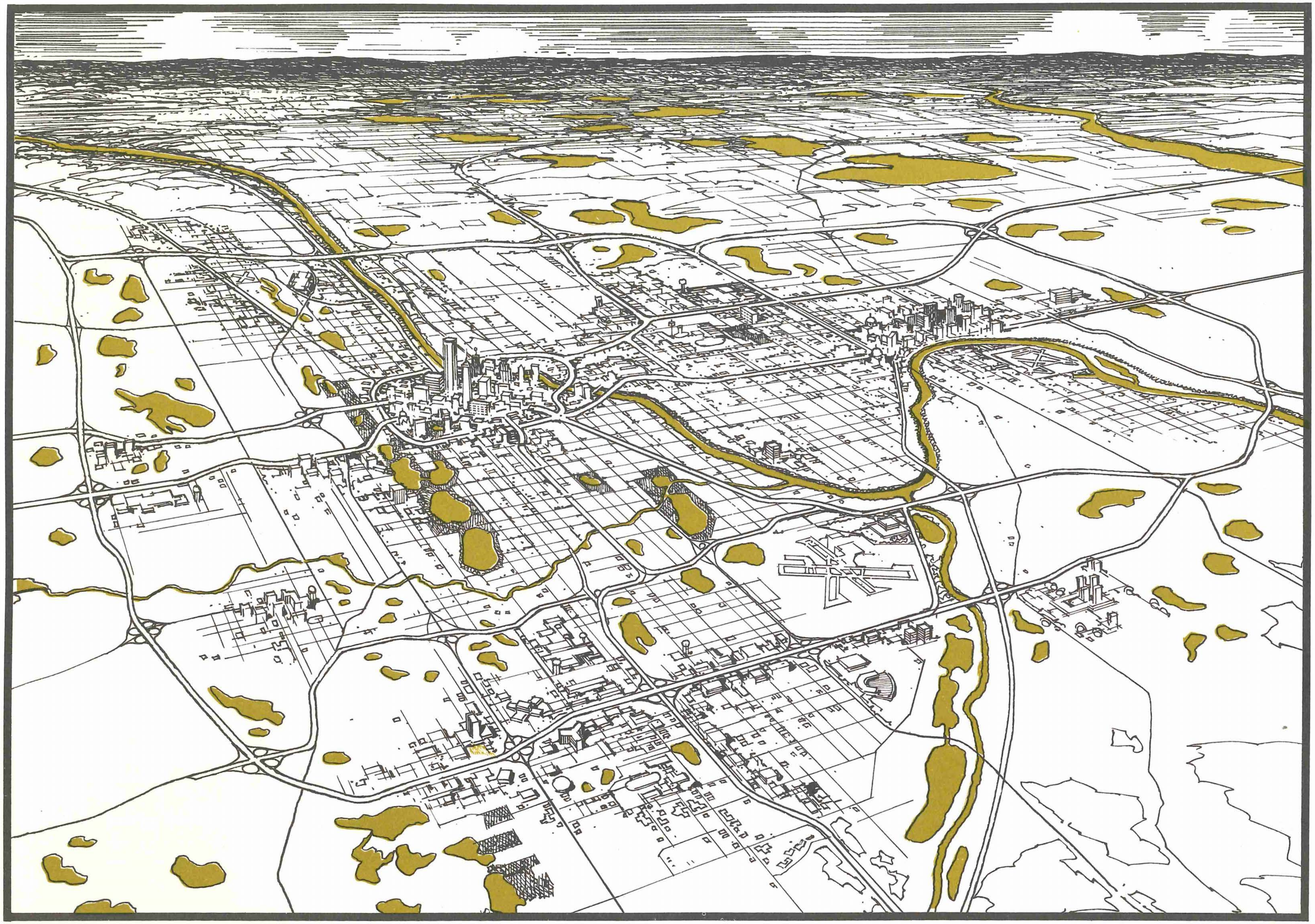
In any of the systems, the transit user would be the primary recipient of benefits. The average commuter who diverts to transit will, for example, realize about $800 in annual cost savings. However, because of the higher level of service and speed offered by the fast link systems, more people are attracted to transit and hence many more people actually benefit.

PROGRAMS FOR LONG RANGE FINANCE

Traditional financing methods such as major bond issues for constructing public transit systems have, in several recent cases, proved unacceptable to local residents. Therefore, in this study new methods and techniques have been explored in depth and several potential methods have been suggested based upon the principle of allocating costs according to benefit received.

Under this concept, certain transportation-derived income and other tax gains would be incorporated into an Intermodal Development Fund for the development of all new transportation facilities. (See Table 8-3, page 51). Such funds could be allocated to highways and transit on the basis of need and the area served (See Table 8-4, page 53) without disturbing the dedication of traditional highway funds. In addition, other courses based upon capturing a part of the financial benefit derived from the incorporation of the transit system are identified (See Table 8-6, page 55).

To this, should be added Federal and State government participation to the maximum extent practicable. In the case of Federal participation, current legislation calls for provision of $10 billion for transit improvements over the next 12 years. On a per capita basis the Twin Cities area could expect to receive an estimated $200 million for development of the public transit system. Allowance for rising construction costs, increased support of transit and a firm commitment of local funds could result in a significantly higher participation by the Federal Government. Several areas currently planning transit systems are basing their financial program on two-thirds Federal participation. Therefore, it would not be unreasonable for the Twin Cities to adopt a similar approach.



Artist rendering of the Twin Cities Region.

1 INTRODUCTION

A transportation crisis exists in many of the nation's urban areas where freeways and arterial routes can no longer meet the full mobility needs of the region and at the same time maintain a satisfactory urban environment and improve the quality of urban life for all residents. The Twin Cities region is rapidly approaching this point. The sheer size of the population to be served, increasing automobile ownership and extended use of the automobile to satisfy this metropolitan area's mobility needs, are all generating highway travel at a rate not experienced in the previous history of the region. The Twin Cities area, shown in Figure 1-1, now has 49% of the state's population compared to 36% thirty years ago. By the turn of the century, it is predicted that 60% will live in seven out of the 87 counties of the state with population densities increasing beyond those illustrated in Figure 1-2.

Given the scale and pattern of growth, basic options available to the region to avoid a serious worsening of the transportation problem appear to be: (1) construct additional freeways, primarily for rush hour traffic, or (2) develop a supplementary mode of travel more convenient and more acceptable to the region. Local community leaders have accepted the challenge of the second alternative and have taken several steps toward its realization.

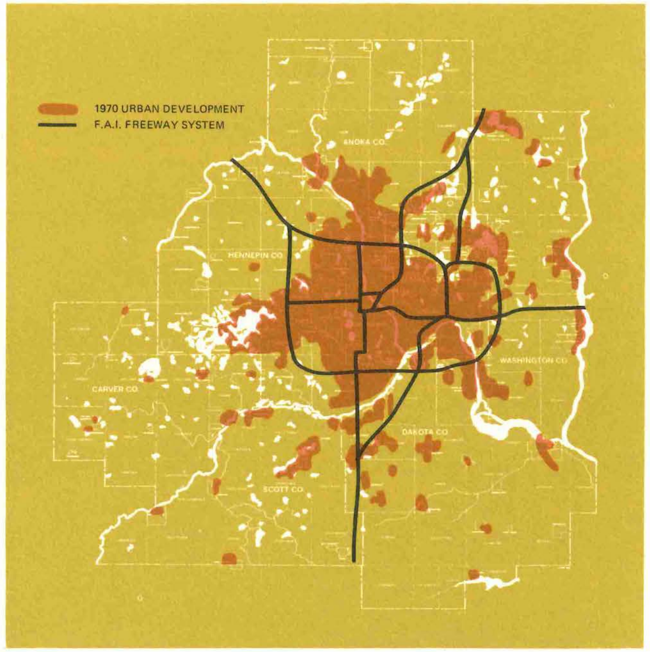


Figure 1-1 Extent of 1970 Urbanization

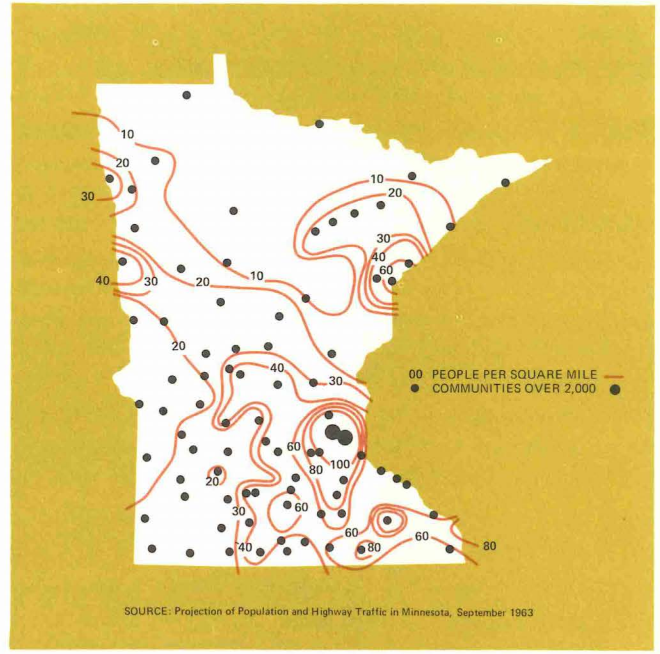


Figure 1-2 Minnesota Population Distribution

In 1967, the Minnesota Legislature created the MTC and charged it with the responsibility of developing a comprehensive plan for transit service within the Twin Cities area. [1] Traffic congestion, pollution from the automobile, accident rates and escalating highway construction and maintenance costs are cited in the enabling legislation as an overriding public concern. Thus the necessity exists for supplemental systems to ease the intra-regional travel demands if the potential economic growth rate and the mobility needs of the population are to be met.

In carrying out its mandate the MTC has already taken two far-reaching steps that create a framework for the current transit program. First was a decision to acquire and rehabilitate the major privately owned bus company. Acquisition of Twin City Lines was concluded in September of 1970 and a major 13-point bus improvement program is already underway. [2] The 13-point bus improvement program, to be implemented over the next 5 years, is intended to reverse the downward trend in bus patronage and upgrade the quality of service.

The second step was to undertake long-range improvement studies [3] to determine how the region could best provide adequate public transit service. One of the most important conclusions reached as a result of these studies was the decision to base future transit planning on a "family of

1/ Laws 1967 - c892 Section 2, and MSA 473A.02

2/ See Simpson & Curtin reports prepared in 1969 for the Twin Cities Area Metropolitan Transit Commission for Bus Improvement Program

3/ Alan M. Voorhees & Associates, Inc. Technical Report Number 3 Long Range Transit Development vehicles" concept. This concept, in its most simple terms, recognizes that transit must perform several different functions in serving the metropolitan region.

Fast link systems are needed to provide a practical alternative to the automobile for longer trips between major diversified centers as well as to and from the central cities. Local networks within lower density areas are needed to provide both access to the fast link system and local service. High density areas in central cities and regional centers will require more concentrated service in the form of collection and distribution systems. These same systems can provide internal circulation and access to fast link interchange points. This multi-function approach is the unifying thread throughout this study and provides a common basis for all the options developed.

LOCAL AND REGIONAL PLANNING FRAMEWORK

The transit role must be identified within a total regional framework. A number of local and regional agencies are directly involved including: the Metropolitan Council, a regional agency charged with the responsibility of guiding the form of future growth; central cities, suburban municipalities, and county governments each with their unique needs; and various state agencies such as the Minnesota Highway Department with broad interest in transportation needs. Within this context, the Metropolitan Council is the key agency in development of a transportation concept plan for this area embodying all aspects of regional development. Each of the other agencies should play an important role through direct participation in plan formulation and implementation.

The Metropolitan Transit Commission and its consultants have had close cooperation throughout the study from staff of the Metropolitan Council and staff members of local

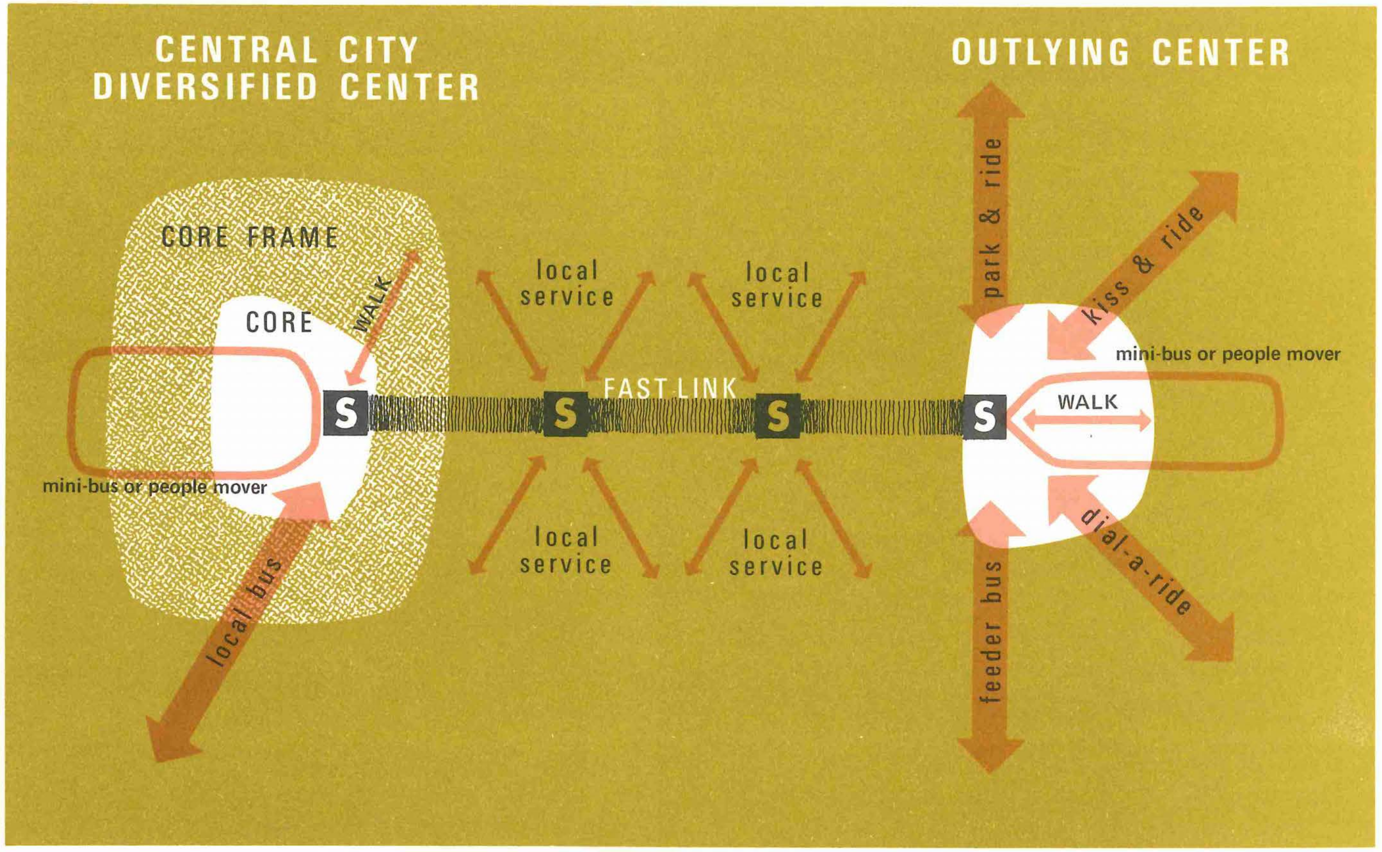


Figure 1-3 — The "family of vehicles" concept provides a realistic approach to true area-wide service, in that it offers a choice of service modes which can be selected so as to tailor service to the function to be provided. Within this concept, the "fast link" element offers the best potential for regional service where higher speed and close headways can attract a greater percentage of longer trips. This element may employ fixed guideway systems or express buses as appropriate.

Automated "people mover" systems will provide a high level of service for all trip purposes within the downtowns and other areas of major activity while also functioning as collector-distributors in conjunction with the fast link elements. These systems can accommodate many of the short trips oriented to the central business districts and regional centers from the adjacent higher density frame.

In areas of medium density, scheduled bus service on established routes will provide the most effective transit service. Service to centers from low density tributary areas will require a different mode which in some cases may be provided by dial-a-ride service. These types of service may also be applied to on-line fast link stations.

communities. Communication of needs and objectives at both the local and regional level has been a significant input. Regional development policies set forth by the Metropolitan Council have been accepted for the purposes of this study and integrated into the transit planning process.

PURPOSE AND SCOPE OF STUDY

The Phase III A-1 study program was designed to provide the Metropolitan Transit Commission with information necessary to identify and evaluate the role that public transportation could play in future growth and development of the seven-county Twin Cities Metropolitan Area.

A unique aspect of the current transit study program is that the consultant team has been asked to provide an information framework upon which decisions on future transportation system can be based. This differs from the usual request made to consultants to recommend a specific course of action. In this context, the study focuses attention upon issues, identifies alternatives and predicts the consequences of actions and options.

The Scope and Purpose of the current study may be described as providing answers to the following questions:

- Does the Twin Cities area need a new form of transit; If so, what form or forms could it assume?
- What principal options for regional development and transit service are available to this local area, taking into account the anticipated scale of future growth and lifestyle preferences of residents?
- What would be the likely impact of transit under each of the options? What benefits would accrue to the region, the immediate local area and the individual receiving service?
- How do the options compare with each other in terms of cost incurred?
- What resources are available to the local area for adequate financing and an equitable spread of the fiscal burdens?
- How can technology be best adapted to meet this local area's travel demand over the next 30 years; what opportunities are there for extending transit service to low density areas, providing fast link connection to activity centers, and developing an adequate level of service within high activity areas?
- When will critical decision points occur to assure time for follow-through on development objectives and community needs?
- What are the likely consequences of the various decisions?

From the foregoing it is evident that the principal thrust of the study is toward identification of urban development as well as transportation options open to the region and a full description of the consequences of each, both in absolute terms and in comparisons between them. It is the intent of the program to provide a comprehensive information base on which future decisions for the regions can be made by the Transit Commission, the State's legislative body and other participating agencies.

No detailed engineering, identification of specific routes or station locations for transit system, or transit hardware (except buses) have been included in Phase III A-1 of the planning program. These elements are a logical "next-step" in the planning process for a system tailored to local area needs and will depend upon a decision for a definitive course of action. The final section of the report, however, clearly points to decisions regarding a future program.

CONTENT OF THE STUDY

Succeeding chapters examine regional growth and regional development goals, the need for mobility, short-range and long-range solutions to meet mobility needs, the role that new technology will most likely play, benefits and costs for the transit options defined and finally, an evaluation of financial resources and alternate ways in which locally provided funds for construction and operating costs can be shared on an equitable basis.

This report is essentially a technical summary of the program and is supported by the following reports:

Technical Report Number 1
Transit Corridor Refinement and Fast Link System Concepts

Technical Report Number 2
The Future Role of Buses in the Twin Cities Area

Technical Report Number 3
Review of Technology and Federal Urban Transit Programs

Technical Report Number 4
Public Transportation in Major Diversified Centers

Technical Report Number 5
Evaluation of Regional Growth and Development Impact

Technical Report Number 6
Financial Plan

Technical Report Number 7
Benefit-Cost Analysis

The reader of this report is referred to these technical reports for additional information as to the criteria used for evaluation, methodology for generating specific sets of data, reasons for selection of certain outlying major centers for testing need and viability of transit service within such centers, and procedures and assumptions used in the benefit-cost analysis of the various transit options.

2
REGIONAL GROWTH PATTERNS

Any transit study which is intended to determine transit needs and define solutions 20 to 30 years into the future must be based on appropriate projections of the amount and location of growth that will take place in the region. The important growth factors include both population and employment together with their attendant demands for housing, office space, retail-commercial and other activities. The projections used here and detailed in Technical Report Number 5 have been prepared specifically for this study. They are not assumptions nor simple projections of trend lines but are based upon a reasoned appraisal of future potentials of the region.

Further, whatever transit system is employed will produce identifiable impacts on the allocation of this growth. The purpose of this analysis is to identify the magnitude and distributional shifts in growth attributable to implementation of various transit options.

MAGNITUDE OF REGIONAL GROWTH

The magnitude and distribution of growth in the Metropolitan Area in the next 30 years will determine to a large part the amount of public service and facilities required to serve the population. The Twin Cities Metropolitan Area is rapidly approaching major decision points if it is to guide and control that growth in accordance with stated goals and objectives. Key factors that will influence and be influenced by these decisions and the estimated impact of the transit systems are detailed in Technical Report Number 5, Evaluation of Regional Growth and Development Impact.

POPULATION BASE

The population of the Twin Cities Metropolitan Area as determined by the 1970 Census was 1,874,000, up 22.9 percent over 1960. This represents a decline from the growth rate of the previous decade. Recognizing this reduction in rate and several important demographic features, it is expected that the rate of growth will continue to decline and level out at an average annual rate of approximately 2 percent over the next 30 years. This reduced rate will result in a year 2000 population of approximately 3.4 million people.

The two primary components of population growth are net natural growth (excess of births over deaths) and in-migration. Factors influencing these components in the Twin Cities region over the past decade are largely common to national trends. Foremost in the reduced growth rate is the lower birth rate attributable to factors ranging from the increasing social concern over national and world wide population growth to new attitudes on birth control and family planning.

The relatively high levels of total in-out migration experienced by the Twin Cities area over the past two decades combined with the estimated small positive net in-migration indicate that the metropolitan region is serving as a staging point for rural to urban population shift. However, this shift may be expected to level off as the total pool of rural population in the upper midwest, from which the Twin Cities draws, is reduced and stabilized. Therefore, net in-migration is projected to decline and could become negative in the future unless off-set by an in-migration from less attractive employment centers elsewhere. While a lower growth rate was projected for this study, the rate is still substantially above the national rates projected by the Census Bureau through 2000.

EMPLOYMENT BASE

Over the last ten to fifteen years, economic and employment growth in the Twin Cities region has been limited by the available labor supply. This is substantiated by the fact that total employment has been growing at almost twice the population growth rate, and the fact that the Twin Cities unemployment rates have been about 50 percent of national rates even during the current economic slowdown.

Despite the reduction in population growth rate, the employment base is projected to increase, producing a higher percentage of the total population who expect to be employed. The factors which are combining to produce this marked increase include: (1) an increase in total numbers of young adults, attributable to both high birth rates from 1940-1960 as well as in-migration of a younger population from rural areas; (2) a continuation of the increase in female employment, attributable to changing social attitudes regarding the role of women, and general inflationary pressures in household budgets; and (3) the labor shortage in the Twin Cities area due to economic growth outstripping population growth. These factors are expected to continue through the 1990's and the labor force participation rate is expected to increase to a level of 54 percent by 1995, reflecting an employment level in the year 2000 of approximately 1.8 million.

HOUSING AND OFFICE SPACE PROJECTIONS

Residential and commercial office space are the two major land use activities whose location is most strongly affected by the type of transit service available in the region. The total office space required and the magnitude of the multiple family housing market will provide a basis upon which to estimate the effect of transportation on patterns

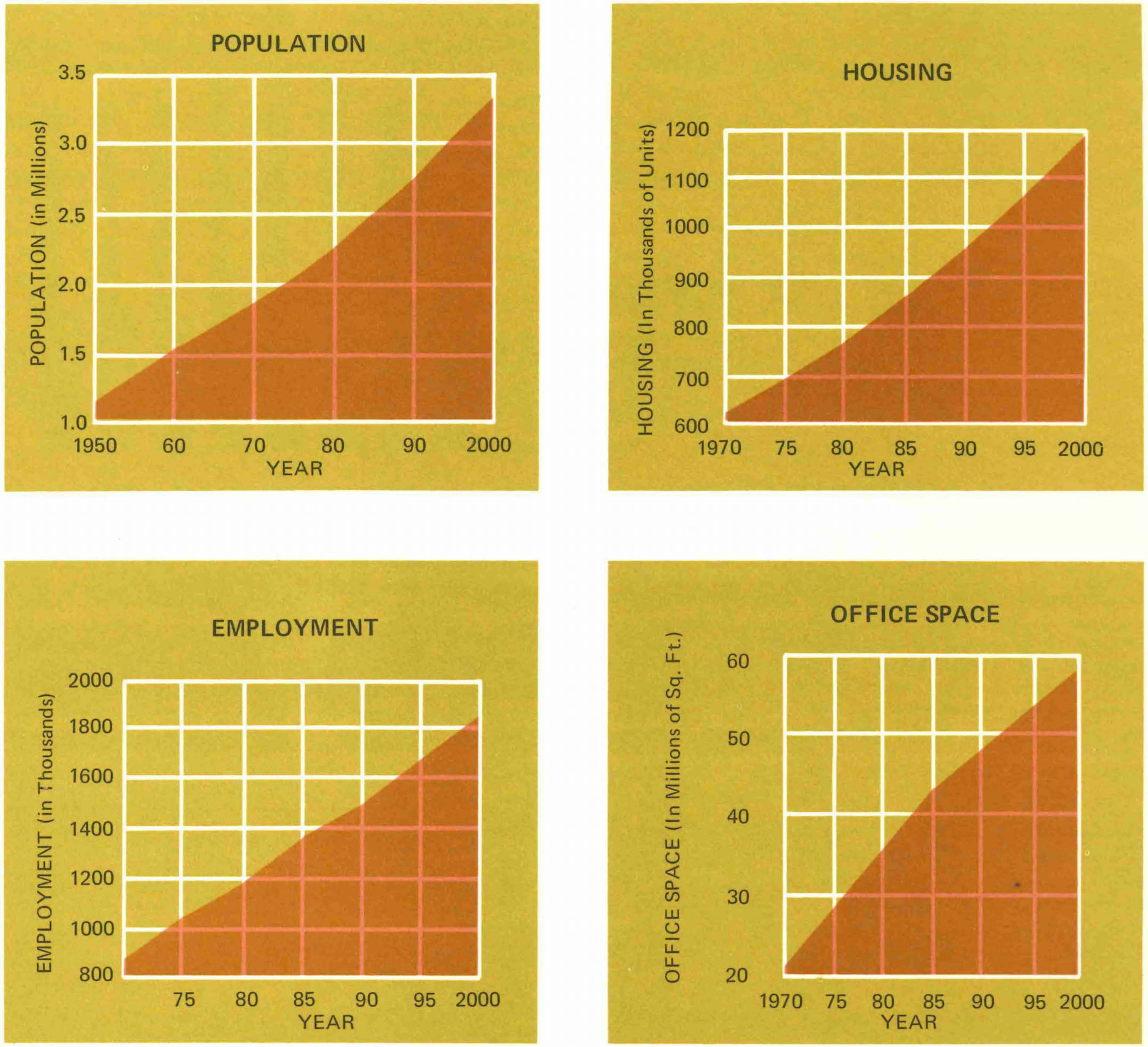


Figure 2-1 Twin Cities Area Projected Growth for Selected Economic Indicators (Source D.R.A.)

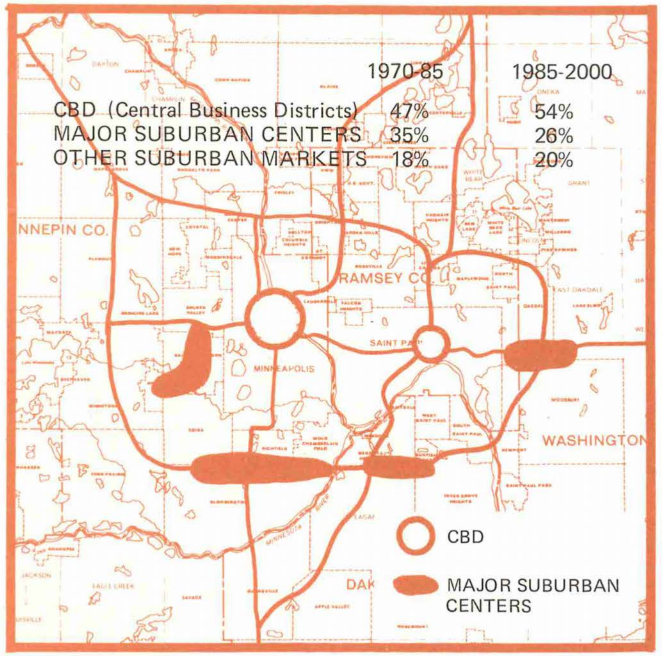


Figure 2-2 Projected Distribution of New Office Space

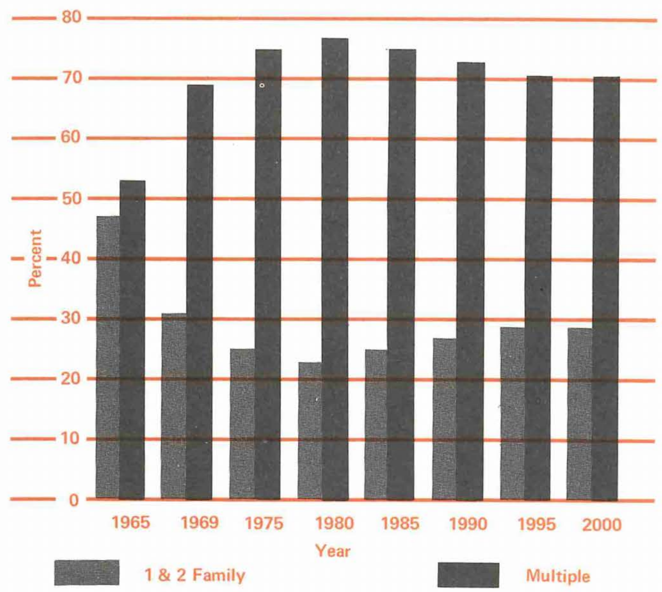


Figure 2-3 Projected Distribution of New Housing Starts by Type

of regional development. This effect will occur through attraction of development to locations with good accessibility to transit service.

It is expected that an annual increase of 1.5 million square feet of office space will be constructed through 1985 as a result of the market "catching-up" after a long period of constrained supply. Once an equilibrium situation is achieved, growth in the office market will parallel growth in other areas of the metropolitan economy. Therefore, during the period between 1985-2000 the rates of growth are expected to level off at about one million square feet per year. Growth in new office construction should, by the turn of the century, result in 37.3 million square feet added to the existing 20 million square feet.

Past history in Twin Cities residential development demonstrates a marked preference for single family housing. This preference is clearly evidenced by the fact that 81 percent of the housing stock in 1960 was in one and two family homes. For a metropolitan area the size of the Twin Cities, the percentage of housing of this type is quite high. In the late 1960's however, a combination of local market factors created a "boom" market for apartment construction. Major factors in this increase in apartment demand reflects a high in-migration of young adults; a maturing of the post World War II generation; and a rapid escalation of financing and construction cost of single family housing.

The shift to an emphasis on multiple family construction has been further reinforced by the reduced birth rates resulting in a lowering of the average number of persons per dwelling unit from 3.2 persons per dwelling unit in 1960 to 3.0-3.1 [1/] in 1970. This is expected to continue downward to 2.80 between 1985 and 1995. The smaller unit space requirement created by these reductions has provided a substantial market for multiple family units. In general, it is estimated that the split between multiple and single family unit construction starts will stabilize at about the present level of 70 percent multiple vs. 30 percent single family by 1995. In the interim period, this ratio is expected to be even greater in favor of multiple development reflecting a catching up period. The rates of new housing starts expected are shown in Figure 2-3. Based on these projections, the housing stock of the Twin Cities region will effectively double in size during the next 30 years providing a total housing stock of approximately 1.2 million units of which approximately 400,000 are expected to be new multiple family units which make up the potential for residential location impact related to transit.

ALLOCATION OF GROWTH

The maps on Figures 2-4, 2-5, 2-6 show the subregional areas used for purposes of allocating projected population growth. The ten subregions indicated on these graphics provide units of sufficient size to reflect past population trends as well as providing a sound basis for projection. The area encompassed by the subregions is anticipated to be the most highly urbanized by the year 2000, although it was found that approximately 30 percent of the region's growth between 1970 and 2000 will occur outside of these limits. The location of this 30% would be relatively unaffected by the regional transit system. See Technical Report Number 5 for more detailed discussions of growth and distribution.

During the period 1960 to 1970 the Twin Cities area grew from 1.5 million to 1.9 million persons. This growth was

---

1/ 3% discrepancy between regional housing inventory totals and preliminary 1970 census results (20% sample) totally suburban. During this period the two central cities were typical of the national trend showing a declining population approximating 49 thousand in Minneapolis and nearly 3.5 thousand in St. Paul. Figure 2-4 shows the share of population growth experienced by the separate suburban areas during this period. Most evident is the share of growth captured by the Minneapolis north and south suburbs compared to the relatively modest share of growth in St. Paul suburban areas.

It should be noted that during this period a substantial amount of office space was added to the region with the greatest share occurring in the Minneapolis and St. Paul CBDs as well as a new "boom" area south of Minneapolis near Interstate 494 and Trunk Highway 100.

By and large, the growth trends of the 60's will continue to influence the Twin Cities area growth between 1970-1985. It is anticipated that the northwest, north, west and Minneapolis south subareas will continue to capture the greatest share of development. (See Figure 2-5). Increased accessibility throughout the region afforded by the completion of the freeway system will tend to cause some minor shift of development to Dakota and Washington Counties in the 1970 to 1985 period, with major development taking place in those areas between 1985 and 2000.

The trend of employment growth following the residential growth to the south and southwest has created a new major urban center at Interstate 494 and Trunk Highway 100. This new center of activity will facilitate further growth to the south, west and to some degree the northwest in areas outside of the ten subregions after 1985 (See Figure 2-6). Approximately 722,000 persons will be living outside of the shaded areas of the maps but in the seven-county metropolitan area by 2000. Of these, approximately 480,000 will have been added during the 1970 to 2000 period. Due to the new center at Interstate 494 and Trunk Highway 100 and approaching saturation of many of the close-in Hennepin County suburbs, much of the growth outside of the defined subregions is expected to occur in west Hennepin County, northern Scott County and eastern Carver County. St. Paul's suburban growth until 2000 is capable of being captured in the St. Paul south and southeast subareas. (See Figure 2-6).

A reversal of the population decline of the central cities is

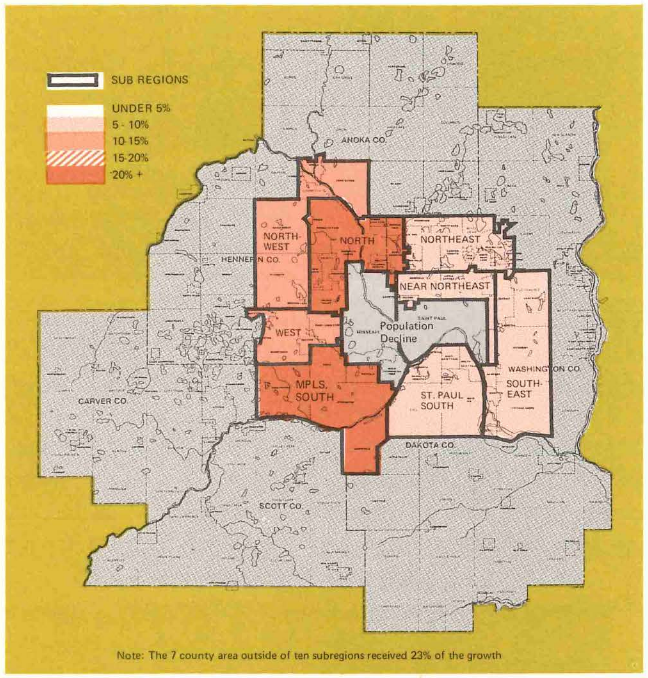


Figure 2-4 Distribution of New Population Growth: 1960-1970

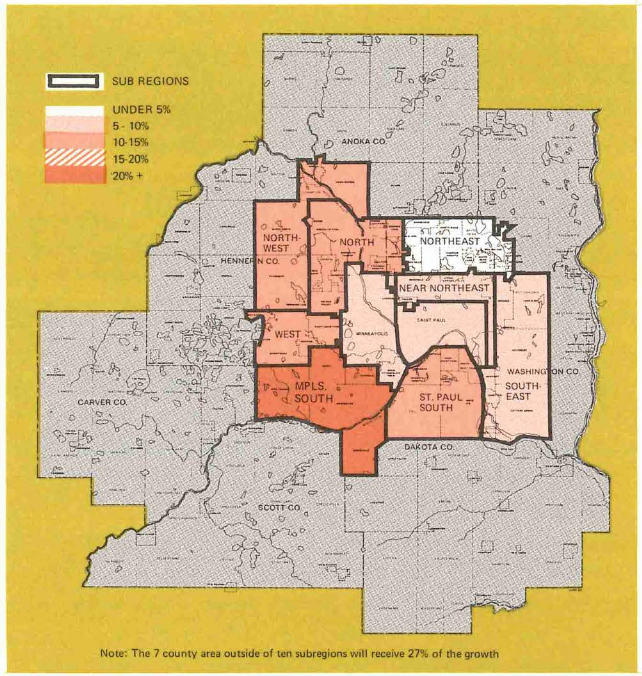


Figure 2-5 Projected Distribution of New Population Growth: 1970-1985

(Unaffected by Transit Impact)

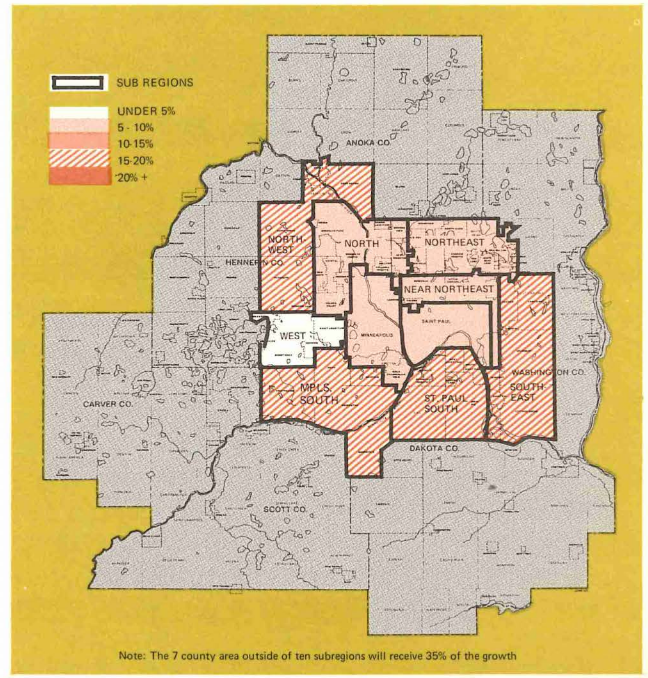


Figure 2-6 Projected Distribution of New Population Growth: 1985-2000

(Unaffected by Transit Impact)

predicted for the next thirty years. It is anticipated that the reversal will occur between 1970 and 1985 and both cities will grow considerably by the year 2000, with Minneapolis reaching 500,000 persons and St. Paul 360,000. A number of factors are expected to contribute to this reversal including the effects of urban renewal activities and the attraction of younger families with children to the large number of single family homes now housing one or two elderly people.

SELECTION OF A COMMUNITY STRUCTURE

The preceding discussion has shown the magnitude of total growth and a gross population allocation based upon a continued use of the existing transportation modes. It must be recognized that this represents an unstructured allocation and does not reflect a particular type of development pattern nor the resulting lifestyle. As stated in the Metropolitan Development Guide:

> *"The nature of this life pattern will depend on the opportunities available to acquire goods and services and to participate in education, cultural activities, and recreation. Without effective planning and guidance, it is possible that the Twin Cities metropolis of the year 2000 will be a low-density, loosely structured region with many scattered small clusters of shops, offices, schools, hospitals, theaters, and government facilities. It will be an urban environment that requires a lifestyle of maximum travel and inconvenience, and, in addition, one that restricts opportunities for people who are unable to travel extensively. Such a region will require inordinate amounts of time simply to acquire food and clothing, visit a dentist, take out library books, visit a hospital, or attend a college class. This loose urban environment would probably make automobiles or some other personal vehicle absolutely essential, since trips will be frequent and to many destinations. Easy comparison shopping, the quick business trip combined with lunch, and the lifestyle of a highly urbanized environment would be difficult or impossible for most people."* 1/

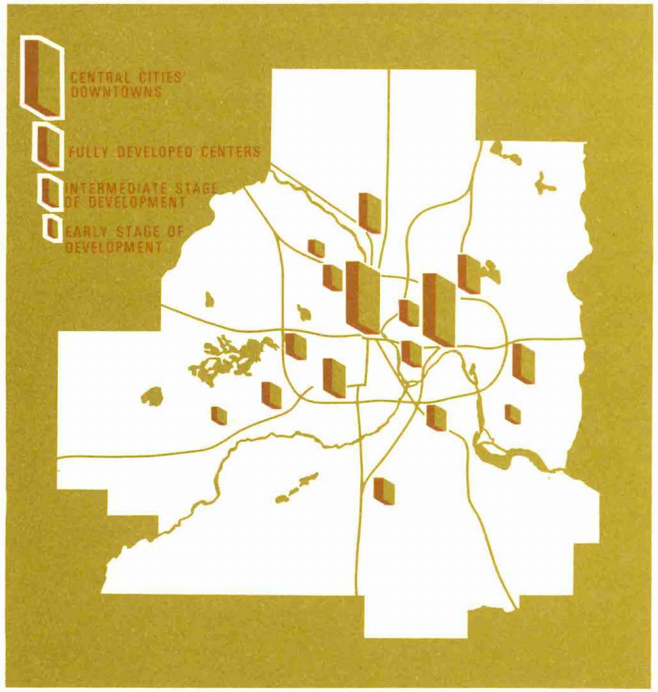


Figure 2-7 Diversified Centers to Serve 2.8 Million People

The emergence of a multiplicity of metropolitan wide problems resulted in the creation of the Metropolitan Council by the 1967 Minnesota State Legislature. The Council was charged with the responsibility of coordinating the growth of more than 200 political units into a functioning urban structure. In recognition of an emerging spread city pattern and resultant lifestyle implied in the quoted paragraph, the Council in the summer of 1969 tentatively adopted the concept of "Major Diversified Centers". The Metropolitan Council is presently in the process of developing that guide and the necessary implementation tools required to facilitate that urban structure.

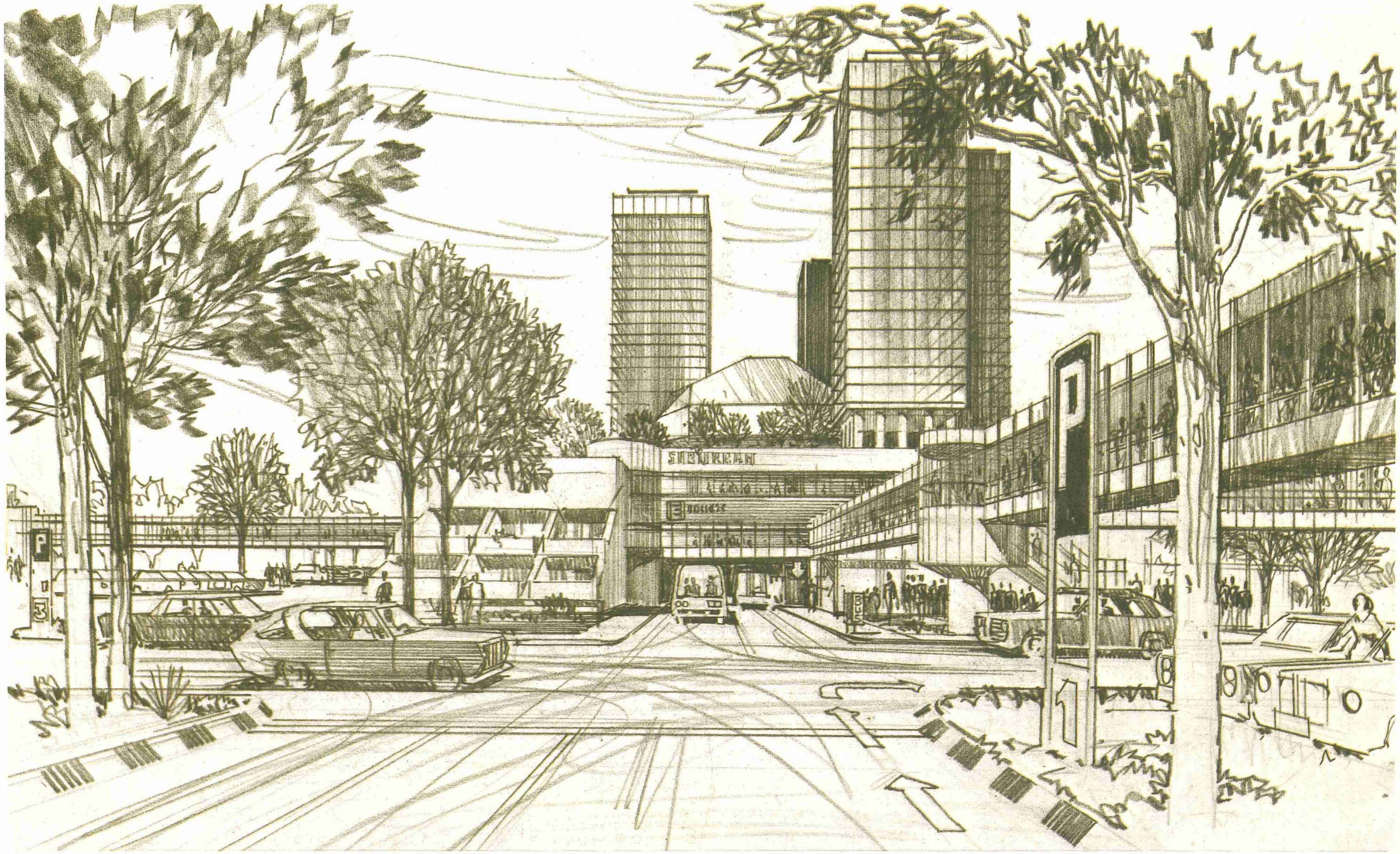
The "Major Centers" section of the guide defines a "Major Diversified Center" as:

> *"A large concentration of retailing, service, cultural, entertainment, and office facilities located within a relatively compact area, blended with high density residential development and perhaps certain types of manufacturing, storage, and research facilities."* 2/

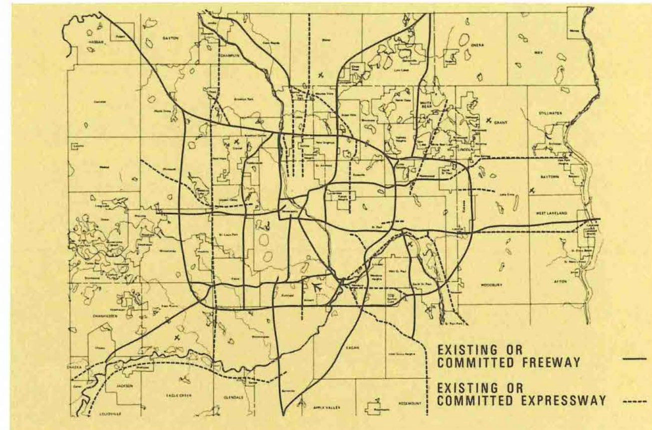
Even without coordinated action, concentrations of development have appeared which will provide a basic framework for the diversified centers growth pattern. Several of these emerging diversified centers have started to develop around certain high quality regional shopping centers. These outlying shopping centers and employment concentrations, in conjunction with the resurgence of the central cities CBDs, establish nodes of activity concentrating trip ends to a sufficient degree to accommodate levels of patronage that will support rapid transit. Figure 2-7 shows the locations of the centers presently under development and the approximate location of projected future centers.

1/ Metropolitan Development Guide – Major Centers - Policies, System Plan, Program, January 13, 1971, pp. 5-6

2/ Ibid pg. 15



Artist drawing illustrating the development intensity expected within a future major diversified center where a high level of transit service is provided. With more persons arriving by transit, the uses will be arranged to better accommodate pedestrian traffic.



Committed Freeway System (System 16)

3

REGIONAL MOBILITY REQUIREMENTS

The regional growth and development pattern of the Twin Cities region has produced a low density, predominantly single family residential pattern with two strong central cities. Typically, there has been a movement of retail commercial activity following population growth toward suburban areas with the development of auto-oriented shopping centers. In a few cases, some office development has also occurred in these centers, but the major portion of office space has remained in the central cities. New industrial locations have also developed in the outlying areas because of land availability at lower cost.

The automobile is the dominant transportation mode with the bus system providing supplemental transportation, primarily for captive riders. To accommodate increasing auto traffic, a relatively fine grained freeway and expressway network has been planned with a large portion of it completed or currently under construction. So far, freeway construction has been able to provide a reasonably high level of mobility to the region's residents, however, a number of critical problems are beginning to emerge. As in virtually every major city in the United States, a growing and increasingly vocal resistance to further freeway construction is developing. It is considered highly unlikely that this resistance will decline in future years but rather may be expected to intensify as concern for the environment, air pollution, safety and congestion become increasingly widespread.

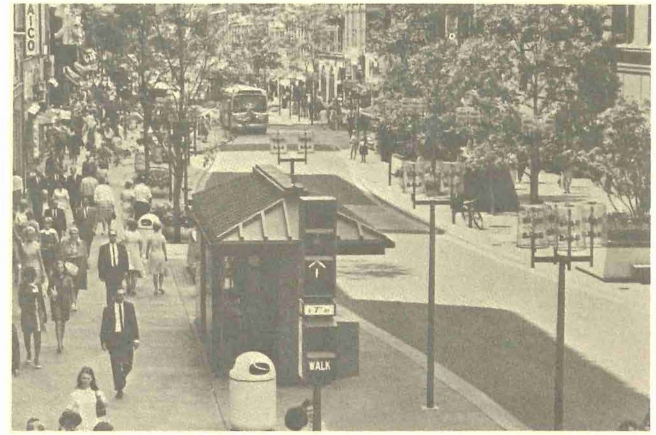
Further complicating this condition is the anticipated growth of the Twin Cities region. As evidenced in the preceding section of this report, the largest portion of growth between now and 1985 is expected to occur in many of those areas where resistance to new freeways is greatest. Included are the northwest and southwest quadrants of Minneapolis.

Over this same span of time, employment is expected to increase at a faster rate than population. Total civilian employment is expected to grow from 853,000 in 1970 to 1,342,000 in 1985 and to 1,815,000 by the year 2000. Those employment classifications with heavy orientation to the central city areas (service and financial industries and government) show the greatest increase, moving from 36.7 percent of total civilian employment in 1970 to 41.1 percent in 1985 and 43.6 percent by the year 2000. Thus, it is clear that access to the central cities will become even more important in the future than it is today because of the growth in population outside the central areas coupled with increasing concentration of employment within them. In the Twin Cities, this situation is also influenced by natural barriers. Both central cities are bordered on one side by the Mississippi River with the result that free access is available from only a portion of the area. Access from the balance of the area is constrained by bridge crossings which greatly increase traffic density at those points. In the outlying areas of employment concentration, this condition is minimized in most cases by the ability to obtain full 360 degree access.

Mobility requirements will also be affected by the increase in total regional labor participation rate. This rate has steadily increased to 47.3 percent in 1970 and is projected

Rush Hour Freeway Traffic

Downtown Congestion



The Nicollet Mall

to grow to 53.5 percent by 1985. The significance of this factor is that the number of commuter trips, which are most critical in terms of transport capacity, will grow more rapidly than the population growth. The net result is an increase in multi-car families and/or increased dependency upon public transit. This latter point is particularly important in that the increase in participation rate is primarily attributable to the female labor force which is traditionally oriented heavily toward office and retail employment and more prone to transit use. In the case of retail trade employment, it is reasonable to expect modest increases in the central city areas even though the largest growth in this field occurs in the outlying centers.

REGIONAL POLICY FACTORS

Specific development policies can also play a significant role in determining the mobility needs of a region. In the Twin Cities, the Centers concept adopted by the Metropolitan Council will have an important impact upon the natural distribution forces discussed in preceding paragraphs. The policy guide represents a major policy position with respect to the future structure of the region.

While each of the proposed centers is intended to incorporate office space and institutional uses, the most dramatic impact is likely to be in location of new residential development and retail trade. Centers, when implemented under the present auto-oriented transportation system, will have a minimal influence on regional allocation of development. The predominant influence will be essentially in the service area of the center. What this means is that retail outlets will continue to develop in outlying areas as population shifts. Population growth will follow amenities and orient itself toward freeway access.

Future development of housing units has been projected to be heavily multiple family with apartments constituting approximately 70 percent of all new starts. Under the centers concept and the accompanying land use controls, it is reasonable to assume that much of this development will concentrate at the centers, provided adequate transportation facilities are also included. The type and capacity of the transportation system will influence the level of concentration attained as well as the level of policy control which can reasonably be applied. Continuation of almost total reliance on the automobile mode of transportation could produce a significant constraint upon development of the centers to their full potential.

The growth of the central cities and the regional centers under an auto-dominant transportation system will produce major pressures for increased surface street capacity and off-street parking. Thus, policies guiding these factors will play an important part in the future mobility requirements as they relate to utilization of transit.

In any event, the vast majority of future growth of the total region is expected to occur in those major areas indicated in the previous section. The primary effect of policy guides and transportation facilities will be to influence the structuring of growth within major areas. The type of transportation provided will influence, to a lesser extent, the shift or reallocation of growth between areas.

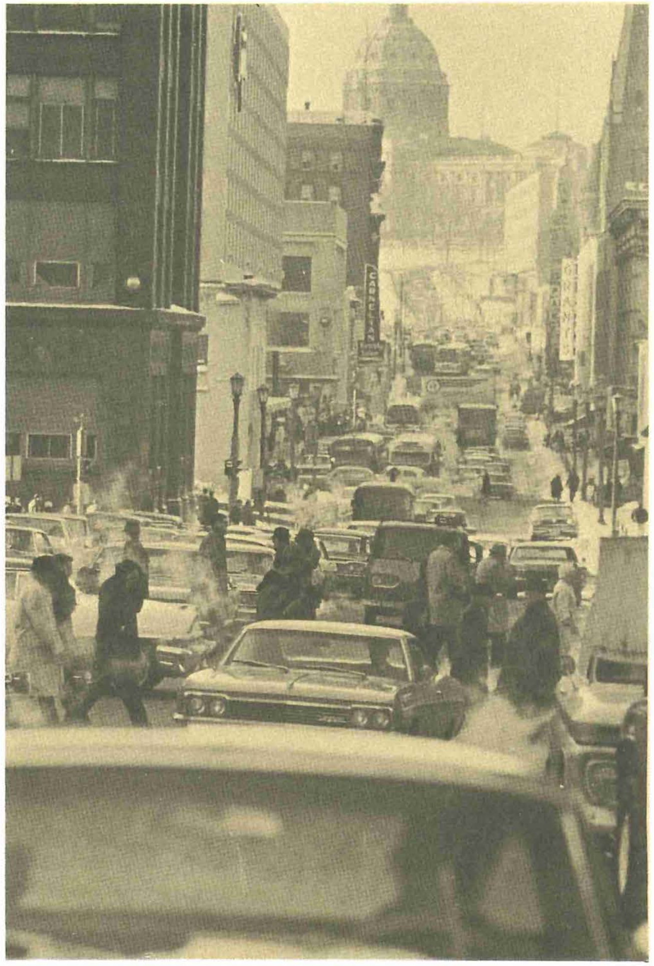
CLIMATIC CONSIDERATIONS

Reliability and safety are two very important aspects of the future transportation system serving the Twin Cities area. The region's winter climate is a major factor in these two considerations. Snow and freezing rain are common events which can produce major increases in travel time and greatly increase travel hazard. As the region grows both in physical size and population, trips can be expected to increase in length and number with the prospect of even greater time loss due to delays in transportation.

Another climate influenced factor involves waiting time for public transit which is most affected by headways and reliable scheduling. In this respect, bus systems in mixed traffic are subject to the same delays during periods of hazardous driving as are automobiles.

TRANSPORTATION DEFICIENT GROUPS

A great deal has been written about the needs of special groups who, for one reason or another, require special consideration in transportation capability. Included are such groups as the aged, the very young, the handicapped, low income families, the working poor, minorities and second workers in one car families. A prior report [1/] prepared for the Twin Cities Area has dealt, at length, with the identification and problems of these residents. Identifying the total number of people in these categories is difficult because many will be found in more than one group. In general, however, they reside in or near the central cities and often find their employment opportunities moving outward toward the suburban areas



Minnesota's Climate Constraints to Mobility

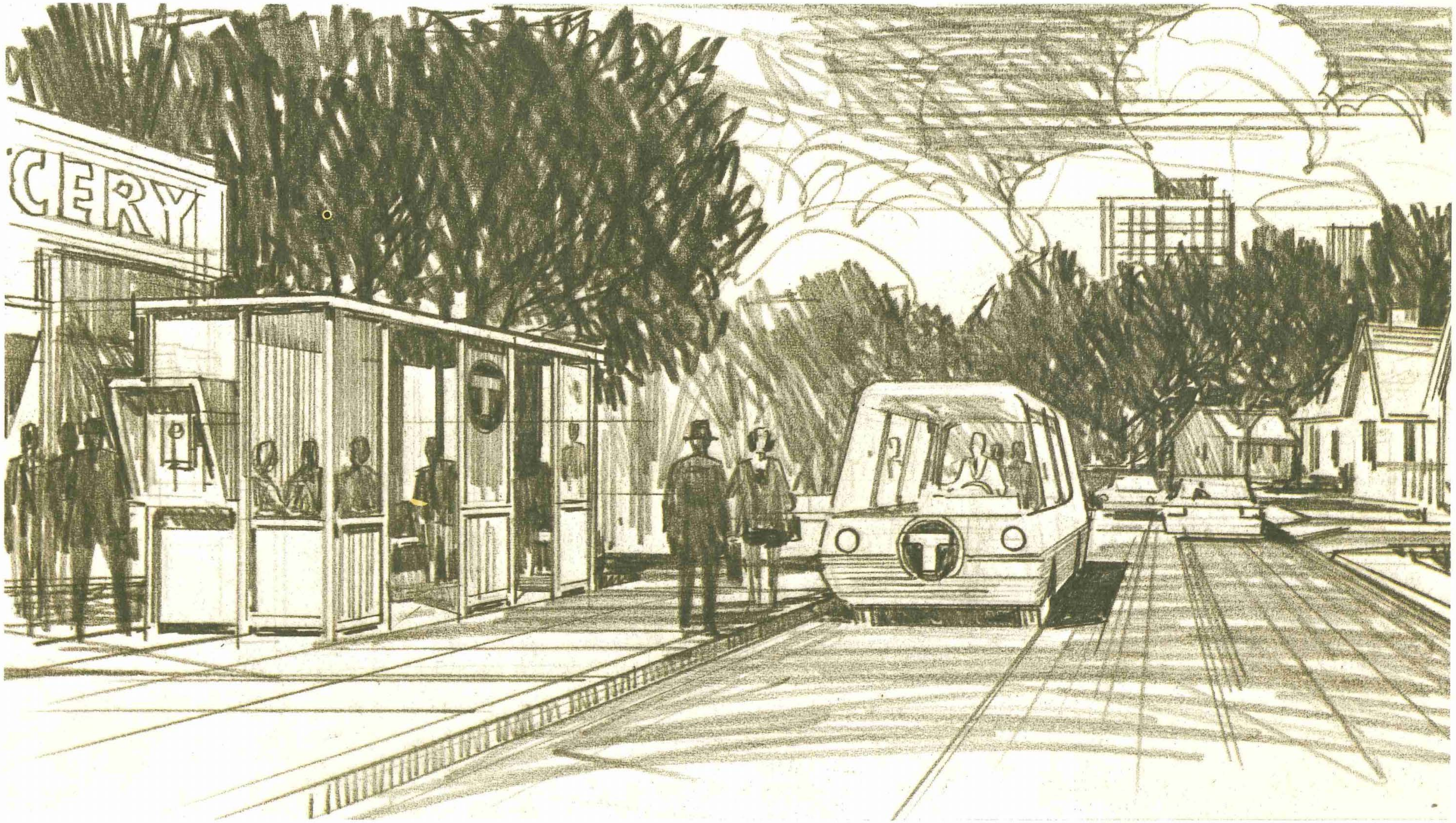
where public transportation is traditionally inadequate. The net result is a disproportionate amount of time and/or income spent on transportation.

As the Twin Cities region grows and the employment opportunities in the necessary skill levels continue to move outward, this problem will become even more acute unless reasonable provisions for a "reverse" commute movement is included in the future public transit system. While the number of families at the poverty level, for example, may decline in the future, there will continue to be a significant number of families for whom auto ownership will be a burden. Similarly, even though family size and average age is projected to decline, the absolute number of aged persons will increase. Many of these persons will be confined to a fixed income and not able to absorb increasing travel costs. Handicapped persons represent another potentially increasing group experiencing transportation deficiencies. The concern for traffic safety is increasing at all levels of government and it is reasonable to expect more restrictive laws governing licensing of drivers which could produce added hardships.

These are but a few of the probable challenges to be met by the transportation system in the Twin Cities region if it is to adequately meet the mobility requirements of its people and economy in the future. In summary, the future transportation system will be called upon to answer a number of challenges. Included are:

- Reaction to the mobility needs of the residents in terms of safe and reliable transportation.
- Provision for a useful tool for shaping, and structuring future growth in a desired manner.
- Improvement in the accessibility to jobs, and social amenities for transportation deficient groups, particularly through improved "reverse commute" capability.
- Making maximum use of appropriate modes of transportation to provide an efficient system at minimum total cost to the region and its individual residents.

1/ Technical Report 3 - Development of a Long Range Transit Program for the Twin Cities Area, Alan M. Voorhees & Associates, Inc., November 1969



The improvement of mobility in the Metropolitan Area is related to the number of persons attracted as transit riders. The small bus designed to serve low density areas and shelters that make waiting for the bus more pleasant are service improvements anticipated to increase ridership.

4

SERVICE CONCEPTS

If the mobility needs of the Twin Cities region are to be met, it will require that the total transportation system include both the freeway system and a public transit system which will provide acceptable service for a substantial part of the market. Bus patronage in the Twin Cities, as in most other cities with bus service, indicate a rapid and continuing drop in transit usage over the last decade. One obvious reason is that the present transit system has not provided the service or access to opportunities that the public desires. At the present time, transit patronage consists primarily of riders who have no other choice, who do not have available or cannot use an automobile. To improve this condition will require that transit be made more competitive with the private automobile both in speed and convenience. The alternative option, total reliance upon the automobile, will require major expansion of the freeway system in the face of increasing community resistance. It would also entail expanded parking facilities both in central cities and in the developing major centers at high cost to both the community and the user. At the same time, while increasing mobility for the majority of the regions residents, it would provide only the most marginal opportunities for the sizable minority who for one reason or another do not, or cannot, own an automobile. Faced with these options, the regional agencies have elected to incorporate a major transit element in the planning process for the future development of the Twin Cities region. They have further indicated a preferred basic concept incorporating both improved local service and fast link transit.

This basic concept for regional transit has been one of the most significant products of previous transportation planning. It incorporates the decision to base future transit planning on a "family of vehicles" which is necessary to enlarge the region's public transportation service area and to focus the system in such a way as to increase employment, shopping, cultural, and other opportunities for all residents. The system concept consists of an integration of conveyances or subsystems including: (1) rapid transit operating on its exclusive right-of-way (fixed guideway or busway) as the backbone of the system to provide fast link service in the heavily populated corridors between selected major centers, (2) express buses operating in mixed traffic for fast link service in less congested corridors, (3) local and feeder bus service to provide service to the centers as well as along outlying arteries, and to complement fast link service and, (4) circulation/distribution service within certain major centers.

The family of vehicles concept holds that each component service warrants a "best" solution, and that the total solution is a best combination of the components. It provides the flexibility to design subsystems as needed to:

- Provide the user with a feasible and attractive means of travelling from his origin to destination via transit.
- Respond to travel demand.
- Provide reasonable levels of service to various types and densities of developing areas.
- Incorporate emerging technology as it becomes available.

Figure 4-1 shows a graphic representation of the "family of vehicles" applied to a typical corridor. It should be pointed out that this concept actually relates as much to service concepts as vehicles since it is in fact a representation of a total transit service ranging from the local level via buses or a form of personalized transit through the regional level via the fast link systems.

From the standpoint of regional mobility, the fast link component forms the backbone of the system. It connects points of high activity such as the regional centers and the CBDs. It is the element of the system which must attract peak hour commuters to transit if the transit system is to have any effect in reducing either highway congestion or the need for more highways. To do so requires competitive speed compared to the automobile during peak hours. Current vehicles applicable to this component in order of descending speed, capacity, and reliability include: the several types of fixed guideway automated transit; buses operated in exclusive lanes; buses operated on metered freeways; buses in mixed traffic.

To be of maximum usefulness, the fast link component must be readily accessible. Since there is a direct relationship between average speed and station spacing, these locations must be carefully selected to provide the maximum balance between speed and access. Station points also represent an important interface between local and regional transit. As indicated in Figure 4-1, various access modes will be used to bring passengers to the station. One of the most important of these at outlying stations is the private automobile and therefore park-ride and kiss-ride facilities must be included at appropriate stations. Other access modes include: the feeder bus; Dial-a-Ride service at selected locations; and walking.

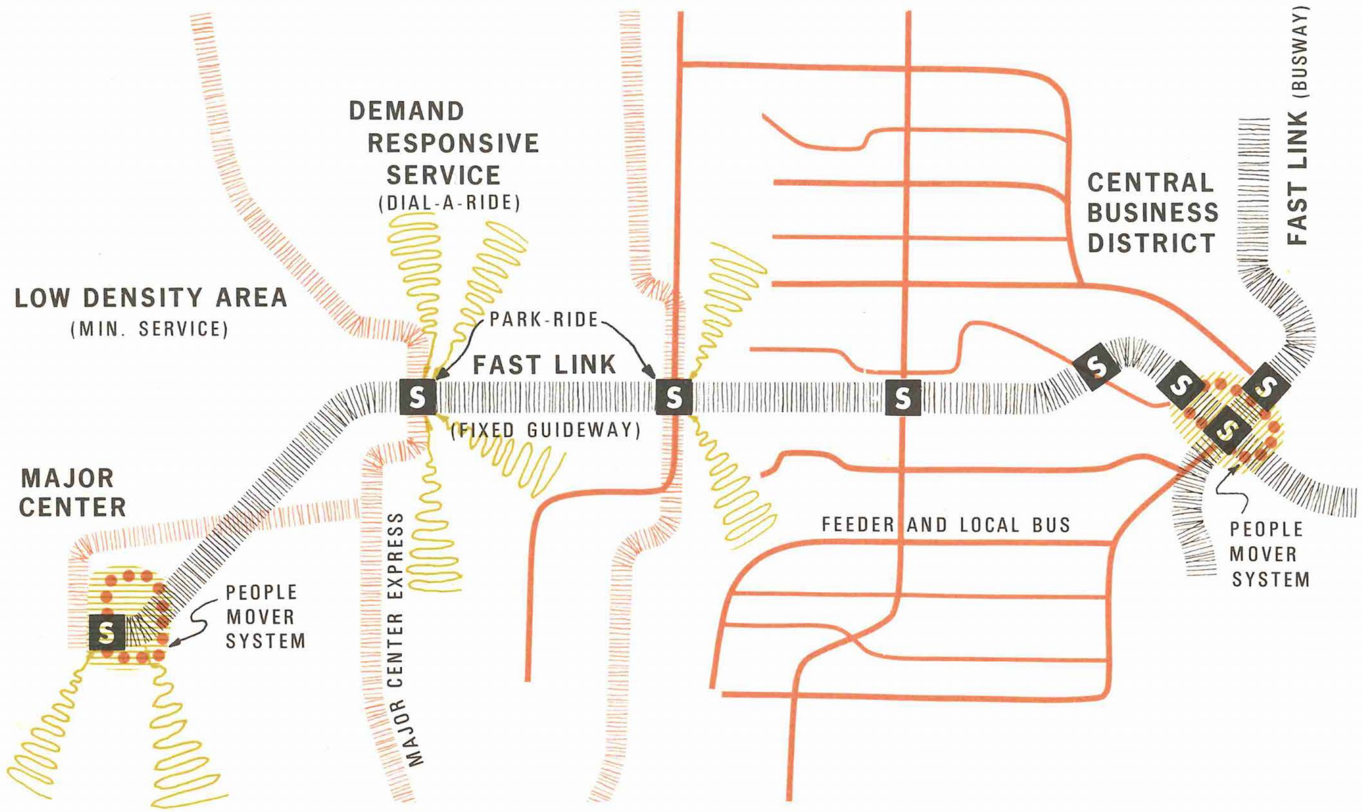


Figure 4-1 Family of Vehicles Concept Applied to a Typical Transit Corridor

In outlying centers, a number of widely varying transit needs may be expected. These will include the local service for relatively short trips to the centers from the surrounding areas, desire for access to or from the fast link system, and internal circulation and distribution. These services may best be provided by a mix of vehicles and operating methods which can be tailored to a specific center and its unique needs. A typical diversified center service is shown in Figure 4-2 and discussed separately.

In the central cities, the needs are similar to those of a diversified center only larger in scale. Local service is still necessary to accommodate both internal circulation and the shorter trips from close in areas where a transfer to fast link transit is either not available or unpractical because of trip length. However, this local service, operating generally over scheduled routes, should also serve the fast link station to accommodate reverse commute and other movements. Even more service and capacity is necessary on distributor systems within the central city areas than in the centers. These systems may be called upon to extend farther into the areas surrounding the central business districts to serve both high density residential areas and special generators not in fast link routes.

Essentially, while the fast link system is the key to regional transit, this discussion and diagram clearly indicate that the local service and collector-distributor functions are the keys to access and, therefore to the success of the fast link.

TRANSIT SERVICE FOR MAJOR DIVERSIFIED CENTERS

Any transit system which is to meet metropolitan objectives and aid in the development of the major diversified centers must be tailored to meet the needs of the center's trade area. In this regard, the family of vehicles concept provides an opportunity to apply a wide variety of service systems and hardware types to meet the situations found in each major diversified center.

The major diversified centers are intended to contain three major elements: the core, the frame, and surrounding tributary area. [1/] Each of these elements has differing transportation and transit requirements which are a function of the desired characteristics intended for each area. Figure 4-2 shows a hypothetical major diversified center with its tributary area and schematic application of the various elements of the family of vehicles serving the center. The relationship of transit to the various major diversified center elements may be described as follows:

THE CORE

The core is a concentrated area of functions including retail trade, office, cultural, entertainment, hotels, high density housing and recreation facilities that are structured to encourage interaction of pedestrian movement between them. Both the inter-center connectors and the local transit service in the tributary areas focus on the core itself. The internal movements within the core are a function of the design and the activity mix of the center. Many alternatives to provide for the internal movements [2/] are available including, among others, moving sidewalks, vertical elevators and escalators, pedestrian walkways and skyways, mini-bus, or grade separated automated people-mover systems.

THE FRAME

This area includes many of the same activities found in the core, but with a greater emphasis on high density housing. The general development structure is somewhat less concentrated and automobile movements are more easily accommodated than in the core. Transit service within this area can be provided by various concepts of bus operations. These concepts may include dial-a-ride, peak hour feeder service or regularly scheduled local transit service. In addition, if the density and structure within the frame warrants, the people mover systems can be extended into the frame to further increase access to the core.

THE TRIBUTARY AREA

The tributary area in essence consists of the center's trade area and contains primarily medium and low density housing with dispersed service and other facilities that were not located within the core or frame. It is not anticipated that 100 percent coverage of all of the tributary areas will be provided with transit service. However, an appropriate level of service will be provided to afford adequate mobility and access to other segments of the transit system and to the activity centers. All or part of the tributary area could be provided with transit service by dial-a-ride or regularly scheduled transit service. Those areas not served with transit will still have the opportunity to use park-ride or kiss-ride facilities located at the centers.

During this study two major diversified centers were selected to analyze the effects of circulation system concepts as applied to the core and frame of these centers. A detailed study to determine the required level of service within the tributary areas was not performed, other than some examination of activity center connector service.

One of the major objectives of the major diversified centers analysis was to determine the effect of transit on regional

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[1/] See the Metropolitan Development Guide — Major Centers - Policies, System Plan, Program, January 13, 1971

[2/] See Technical Report Number 4 - Public Transportation in Major Diversified Centers for a more detailed discussion centers planning. Following are some of the conclusions drawn as a result of this analysis:

* Long range *policy decisions* are required in order that the general planning parameters can be derived for detailed design.

  - Determine the role of various transportation modes in the outlying centers.
  - Provide a financing policy for improvement of common facilities such as parking facilities, pedestrian ways, etc.

* Develop a *physical plan* for the growth of the center and changes in circulation emphasis.

  - Reserve or acquire rights-of-way for all modes of transportation with designation of the level of horizontal operation.
  - Provide the ability to facilitate land reuse when and where necessary to accommodate a new emphasis in transportation mode.
  - Establish density or use intensity ranges for the various time increments in order to facilitate sizing circulation subsystems.
  - Design the center to facilitate use of first stage facilities in the second stage of development.

* Develop an *economic growth plan* for transition to accommodate the desired use structure at each increment of time.

  - Provide the ability to acquire, at appropriate times, the sites for public functions at a cost competitive with other site options.
  - Provide the ability to renew the center in order to maintain its competitive vigor.
  - Provide a plan implementation process that is capable of staging development that is in concert with the land value escalation created by the preceding development.

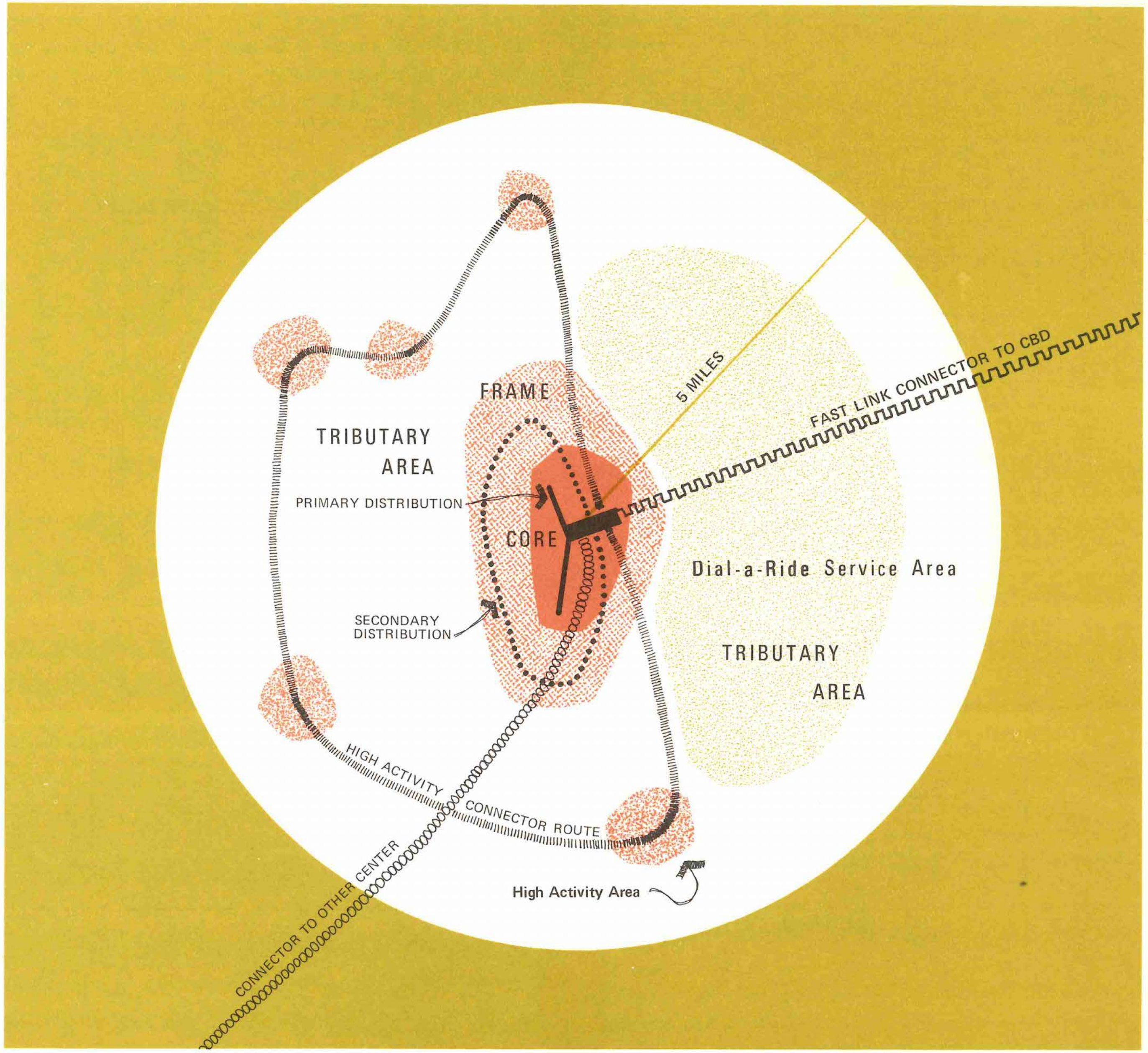
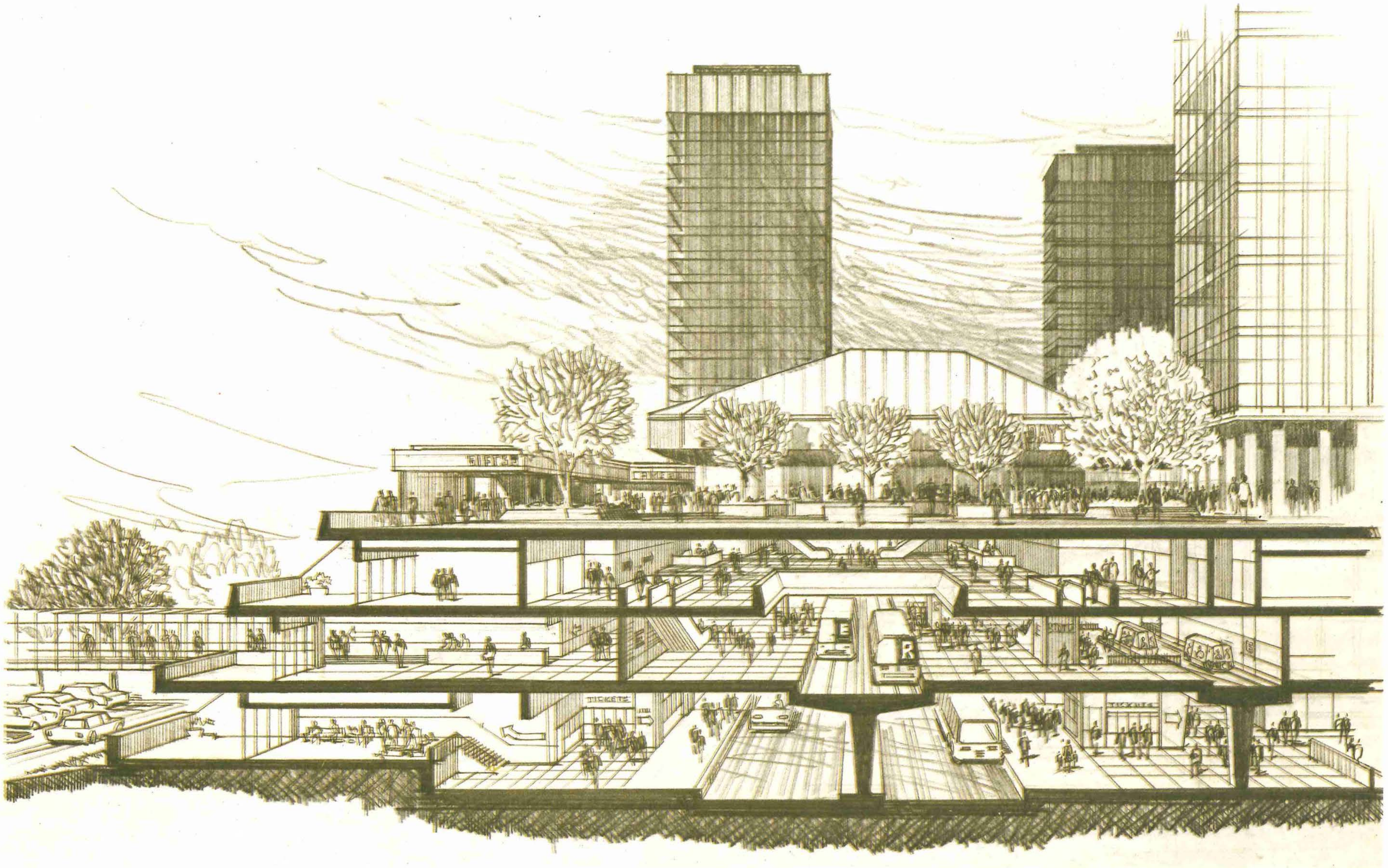


Figure 4-2 Transit Service Systems in a Major Diversified Center



The artist's section through a transit station in a major diversified center illustrates the interface of pedestrian circulation, park and ride lot, bus terminal, rapid transit and people mover systems with the major center facilities.

5
EVOLUTION OF SYSTEMS

Many new transportation system concepts have been proposed. They range from changes in operational and service policies using existing or readily available equipment operating on present and planned roadways, to the introduction of system concepts. New technology could be incorporated to operate in the fast link transit mode or to provide collection-distribution service in low density areas and in major activity centers.

The ultimate objective is to provide convenient, comfortable, economical public transportation which has a high public acceptance and a minimum intrusion on the urban environment in terms of noise, air pollution and aesthetics. A well conceived plan will provide for maximum utilization of present and future investment in facilities and equipment, as well as the introduction of technologically new systems as they develop.

To realistically accommodate both service and economic needs now and in the future will necessitate an evolutionary approach to development of a public transit system. Regardless of the point in future time or system in use, there will continue to be technological improvements which will warrant serious consideration for specific application within the total system. The rate at which this evolutionary process will occur will be paced by both community desire and available funds. Subsequent discussion presents the anticipated evolution of transportation systems for both the fast link and circulation-distribution application beginning with current state-of-the-art technology.

FAST LINK TRANSIT SYSTEMS

The fast link transit system is a specialized urban transportation mode. As the name implies, it is intended to provide an efficient transportation link with limited stop service between concentrated activity centers within the metropolitan complex. Fast link service can be provided with either express buses or with rapid transit systems operating on a fixed guideway.

EXPRESS BUS SYSTEM

The performance and efficiency of express buses used to perform the fast link function can be enhanced by improvements in operating policy and by technological improvements to the equipment. Maximum operation on freeways or expressways along the route is implied.

General Motors Experimental Bus

Service improvements which can be accomplished by sequential operational changes may be summarized as follows:

- Conventional buses operating on freeways in mixed traffic.
- Provision for freeway on-ramp metering with preference given to the bus.
- Restricted freeway lane limited to buses and car pools.
- Exclusive freeway bus lanes with off-line stations. These stations can consist of shelters and interface with feeder bus, park-ride, kiss-ride, collection-distribution system and pedestrian movements.

There are a number of technical improvements in bus equipment that also should be considered:

- High speed, fast acceleration buses, designed for freeway operation.
- Low emission or pollution free propulsion units. Possibilities include clean diesel or internal combustion engines, hybrid-electric propulsion and closed cycle steam engines.
- High capacity buses - both articulated and longer or higher vehicles have been proposed.
- Driver actuation of traffic signals for off-freeway operation. Several devices are available which enable the driver to hold a green light or change red to green.
- Automated freeway operation (driverless). Computer-controlled headway and merging capability is within the state-of-the-art and could be applied to separated lane bus operation. Lateral guidance control remains to be developed, and automated vehicle inspection equipment must be designed.

Several of the concepts presented here are presently the subject of demonstration projects, while others are now in a development phase.

FIXED GUIDEWAY SYSTEMS

The average speed of buses operating in the fast link or express mode can vary widely because of external influences. As a result, adherence to a predictable schedule can be most difficult during inclement weather and under peak-hour traffic conditions. Therefore, fixed guideway rapid transit should be considered for the fast link service between the CBDs and connecting them with the outlying major activity centers in the Twin Cities area. The system, if adopted, should be tailored to the needs of the area. It should be modern, capable of fully automated operation, provide a high standard of safety, reliability, operating efficiency and maintain a minimum average speed of 40 mph over the entire link. The system should be sized to handle one-way peak hour capacities in the order of 5,000 to 15,000 passengers per hour expected in the Twin Cities area by 2000.

The fixed guideway rapid transit system developed for the Twin Cities service will probably differ significantly from the systems of Montreal or San Francisco in vehicle size and type. A number of methods for developing new systems for fast link service could be considered such as:

1. Scale down current systems used in BART, Montreal, etc. to medium size equipment.

2. Develop a standarized system for medium size cities through a joint program by several cities. Such a program would produce common rolling stock, modular stations and structural systems, and ancillary subsystems.

3. Plan for an existing medium capacity system such as the Westinghouse Sky-Bus.

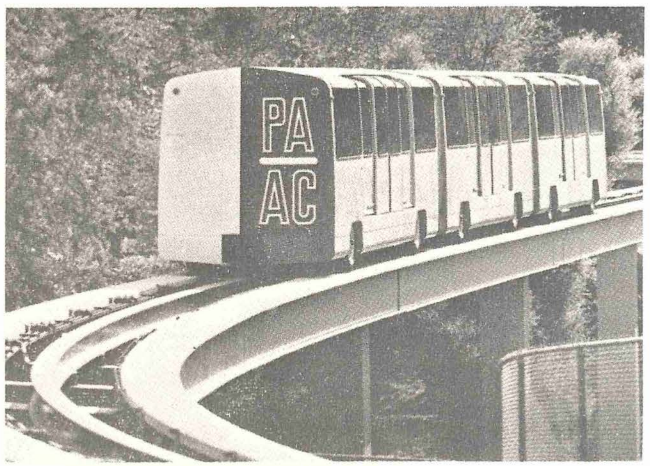
4. Await development of a small vehicle circulating system and redesign for high speeds at short headways.

5. Design high-speed small (4-8 passenger) vehicle system (Modified Personalized Rapid Transit).

New technology common to all approaches is available for major items such as power supplies, automatic vehicle control, ticket vending and collection, surveillance, and dynamic braking. Additional research, development and demonstration funds are needed in all areas to reduce costs and/or increase reliability.

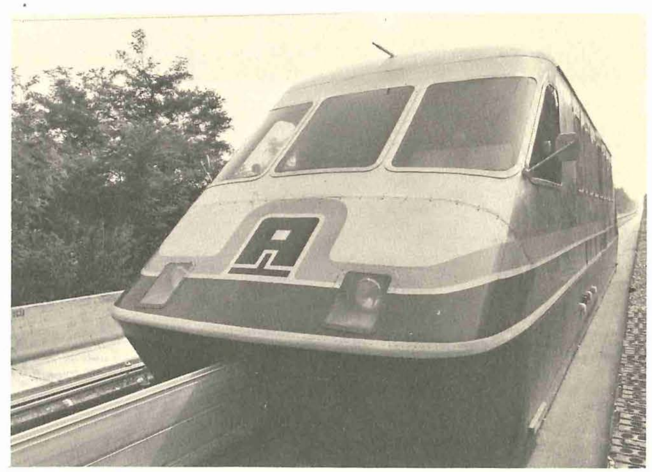
Currently the Federal government's efforts in new systems are being directed into component development. Major increases in both time and money directed to research and development by both the Federal government and the private sector will be necessary to make items 4 and 5 above feasible. These include: propulsion systems (linear motors or pneumatic propulsion); command and control systems for close headways, unique station movements, and vehicle programming; vehicle interior surveillance and protection; high speed switching; and automated vehicle maintenance inspection.

Methodologies 1, 2 and 3 appear practical at this time and could be candidates for federal funding for technical studies and demonstration programs leading to capital grant projects.



Westinghouse Transit Expressway

Bay Area Rapid Transit District Vehicle



Tracked Air Cushion Vehicle With Linear Induction Motor

COLLECTION-DISTRIBUTION SYSTEMS

The collection-distribution systems are designed to provide transportation for varied origin-destination pattern characteristics of travel in low density urban areas and in or into areas of high activity. These systems must provide easy access and frequent service at low to moderate speeds with close station spacing. They should also function as feeders to and from the fast link rapid transit stations.

LOCAL AND FEEDER SERVICE IN LOW DENSITY AREAS

Local bus service normally operates on fixed routes and schedules in urban residential sections of the area. Its function is to satisfy the demand for trips of usually five miles or less, acting as a feeder to fast link transit stations or access into the regional centers. With proper justification in terms of social benefits, user requirements, and revenue production, the service could be provided in the demand mode which would allow for changes in route, schedule or both.

There are several technological possibilities for improvement of performance, service and efficiency of buses designed for local and feeder operation. They are as follows:

- Design of a bus with lower floors, and doorways which provide easier entrance and exit.
- Low emission or pollution-free propulsion units. As in the case of express buses, these may be clean diesel or internal combustion engines, hybrid-electric or closed cycle steam engines.
- Driver actuation of traffic signals as described for off-freeway express bus operation.
- Demand actuated, computer controlled traffic signal network designed to provide preferential treatment to buses.

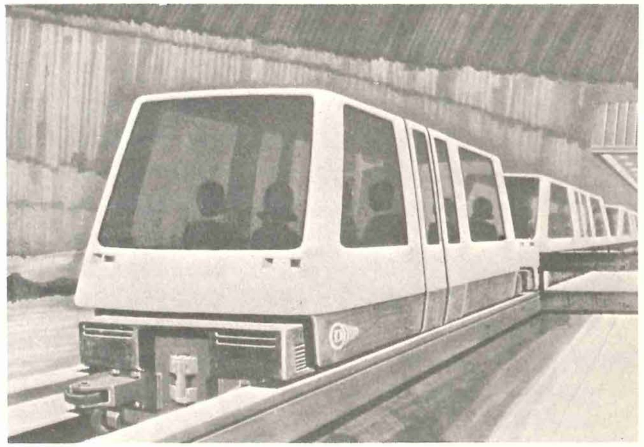
The latter two options would require further study and analysis in concert with traffic engineering departments to determine the effect on the movement of all other vehicular traffic.

The demand for public transportation in low density areas poses a special problem because of the low volume service requirement. Such areas are best served by small vehicles operating in either a scheduled or demand responsive mode capable of providing the type and level of service appropriate to these areas. Several opportunities for solution exist and are described as follows:

- Mini-buses operating on fixed routes and schedules adjusting to the level of demand.
- Provision of two-way radio communication between the vehicle and a dispatcher. This provides the capability of demand responsive operation allowing for flexibility in route and schedule. The bus is routed by the dispatcher to or near the origin and destination of the rider in response to a phone call. This is a manual version of the dial-a-ride concept.
- Full dial-a-ride operation. This requires the introduction of an automated bus locater communication capability along with computer controlled routing and dispatch.

These systems can function both for circulation service within the area as well as feeders to major activity centers or to rapid transit stations. Both the mini-bus and simplified version of dial-a-ride service have been the subject of recent and planned demonstration projects.

Alden Self-Transit System



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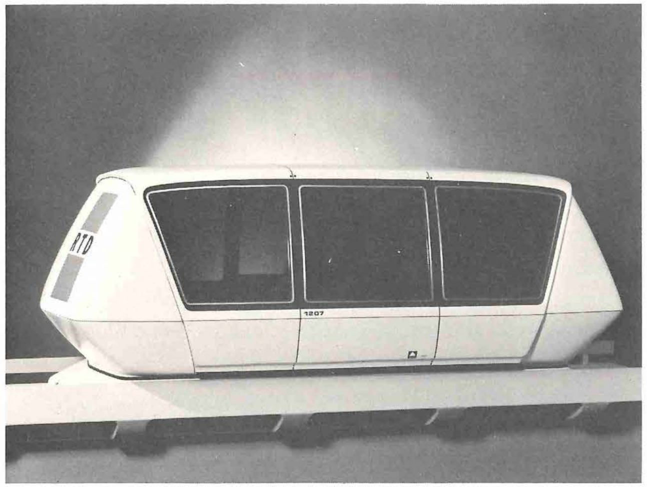
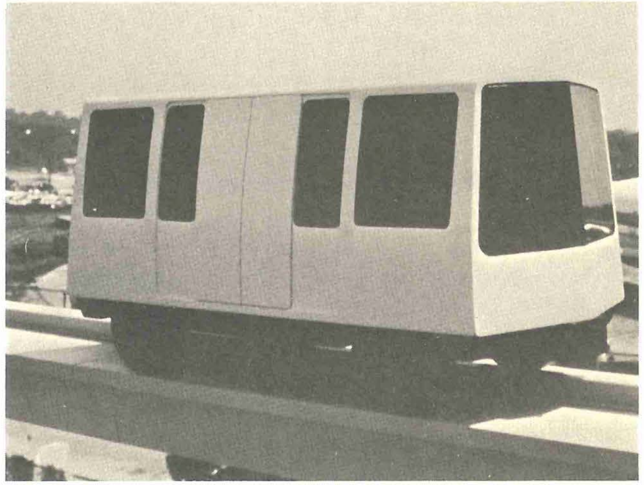
ACTIVITY CENTER TRANSPORTATION SYSTEMS

Transportation systems considered for this application have the specific objective of improving short distance travel in areas of concentrated activity. Generally, they may be envisioned as a replacement for the network of conventional buses which are presently employed to satisfy this function. They can also provide collector-distributor service to local transportation systems operating outside of the major activity center and to fast link rapid transit stations. While numerous conceptual designs have been proposed, few have been developed beyond the prototype stage and none have been demonstrated in an actual urban environment. A logical technological evolution of a system capable of adequately performing these functions may be as follows:

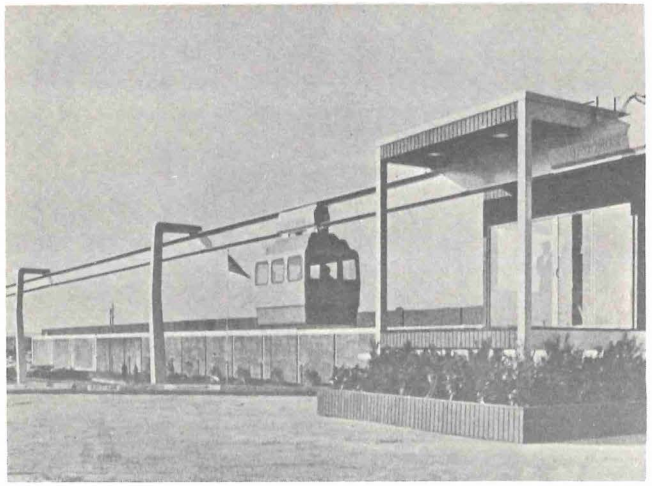
- The mini-bus operating on a fixed route through the service area at reasonably close headways and with frequent stops.
- An automated computer-controlled system of small vehicles operating on a fixed guideway at fairly close headways. The system would operate with frequent stops in either a loop or shuttle mode.
- The next step would be the introduction of wayside stations, switching performed at main line speeds, and the addition of a switching-merging capability into the control system. The vehicles would enter or depart from the station in response to the desire of the passenger, either on-board or at the station, and the availability of seating space in the vehicle.



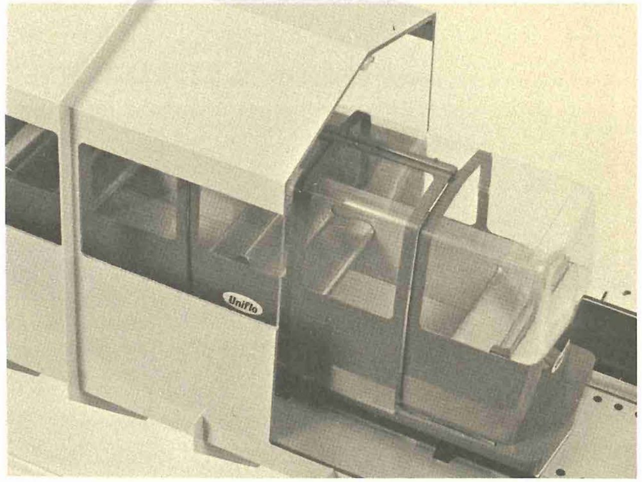
Transportation Technology, Inc. - Air Bearing Vehicle



Westinghouse Small Vehicle



Varo Monocab



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- Further sophistication is achieved by expansion of the system into a network of interconnected loops providing service throughout the area. In addition to the capabilities stated above, the control system would provide for optimum routing throughout the network between any origin-destination points as well as automated vehicle storage and retrieval into and from a garage area on the network periphery.

Automated systems with a potential capability for operation in the manner described above are within the present state-of-the-art. Several are under development using various combinations of suspension, propulsion, control switching, braking and guideway designs and techniques. It should be mentioned here, that vehicle technology may have a relatively small influence on system cost. When all concepts are subjected to the same requirements of speed, capacity, service quality, safety, architectural design and environmental constraints, the time and cost of development, implementation and operation may not be significantly different.

While the problem is not being presently addressed by the developers except as a long-range objective, there is a possibility that the performance of some of these systems may eventually be improved to the degree that they might satisfy the longer-haul fast link transit requirements in certain applications.

TRANSPORTATION SYSTEM FACILITIES, SUPPORT EQUIPMENT AND FUNCTIONS

In addition to the vehicles and guideway, or busway, there are other facilities and functional elements which have a significant effect on both the efficiency and cost of transportation system operation. The introduction of new techniques and technology in facilities design, and the performance of these functions can materially contribute to reductions in capital and operating costs. Public acceptance, with a resulting higher level of patronage, can also be enhanced by providing for freedom of movement, personal security and uncomplicated procedures within and external to the transportation system.

FACILITIES AND SUPPORT EQUIPMENT

Some of the items which can be considered for introduction into the transportation system are:

- Standardized bus shelters. These can be of modularized design to accommodate variations in size due to passenger demand.

- Modularized station design. Envisioned here is a semi-production line construction of transit station modules which can be combined to provide for variations in station size, layout and architectural design.

- Utilization of new materials and construction techniques. Developments in this field are applicable to both transit system guideways as well as stations and other systems support facilities. There is a possibility that considerable reductions in capital and maintenance costs can result.

- Automated diagnostic maintenance equipment. The development of equipment to perform a diagnostic analysis of the status of vehicle and guideway components can provide data indicating the need for preventive maintenance. The result can be increased system operational safety along with reductions in maintenance cost.

- Self-checking system control and communication equipment. This feature, which includes the functional status of the basic control and communication equipment as well as the status and location of vehicles, coupled with redundancy provisions, can be incorporated thus affording additional system safety and assuring a minimum of system down-time.

SUPPORTING FUNCTIONS

Included here are functions which tend to minimize delay and inconvenience to passengers as well as supplying a capability for station and passenger surveillance and security.

- Passenger information and display. Both visual and audio presentation of arrivals, departures, routes, stations stops, loading gates, schedules, etc. reduce confusion and accelerate movement of passengers through the station area. In the case of passenger demand activated systems, clear instruction on the procedures for system operation should be provided, particularly for the benefit of unfamiliar riders.

- Automated fare collection. This can encompass ticket vending for single or multiple trips, coin or currency changers, entry and exit identification through the use of encoded tickets, and eventually automated billing procedures for frequent users.

- Station surveillance and passenger protection. Closed-circuit television can be an efficient and a reliable tool for this function. Monitor screen attendants can observe station activity and provide minimum reaction time to matters involving security, equipment malfunction or situations of potential danger to passengers. Additional passenger safety can be provided by physical barriers between the loading platform and the guideway, and an adequate number of vehicle entrances and exits. This implies a vehicle control system capable of accurately positioning the vehicle with respect to the ramp-side loading gates.

POTENTIAL FOR TRANSPORTATION SYSTEM DEVELOPMENT IN THE TWIN CITIES AREA

The acceptance of the concept of major diversified centers in Metropolitan Area development and a "family of vehicles" system to provide regional public transportation affords a unique opportunity for evolutionary transit system planning and implementation. While the ultimate objective is to provide the type and level of service designed to best meet the needs of the community, tailored to the character of the area, the opportunity does exist for a staged implementation program. It is also possible to test the ability of innovations to satisfy these diverse requirements without total commitment to a specific system option or a massive investment in capital funds.

For example, a collection-distribution system designed to evolve from the mini-bus concept to the completely automated system network described earlier, could be initially installed on a small scale in one of the planned centers at an early date. This evolution could consider the transition to a fixed guideway people-mover such as the Goodyear Carveyor, which does not require automated headway control, operates in a loop and can couple the loops by pedestrian transfer at the station or loading - unloading platforms. Conversion could then be made at a later date to a system incorporating computer controlled headway, subsequent addition of wayside stations with automated switching and merging, and eventually interconnection of loops into a network with optimum origin - destination routing capability. The system would be capable of expansion at any time during the evolutionary process to afford service throughout the center as it develops and grows. It also can be operated in the absence of a fast link fixed guideway system, but with a view to interface with this service when it becomes available.

Similar development of fast link service could be achieved by conversion of exclusive lane busways to guideways for automated rapid transit when funding, passenger demand and technology warrants the implementation of this transition. Terminal facilities initially provided for express bus operation could also be planned for later conversion to accommodate the introduction of the fixed guideway system.

Incorporation of an evolutionary approach into the transportation system plans affords the opportunity for an increasing level of public transit service, transitional system modernization and a continuing test of public acceptance during the period of new system technology development.

The development of a new transportation system from the basic concept to an operating system is accomplished through the performance of a series of development engineering, prototype construction, test and demonstration tasks. The time and costs required to complete these tasks vary with system design, size, service policy, technological and network complexity, vehicle speeds and headway spacings. Also where unique concepts

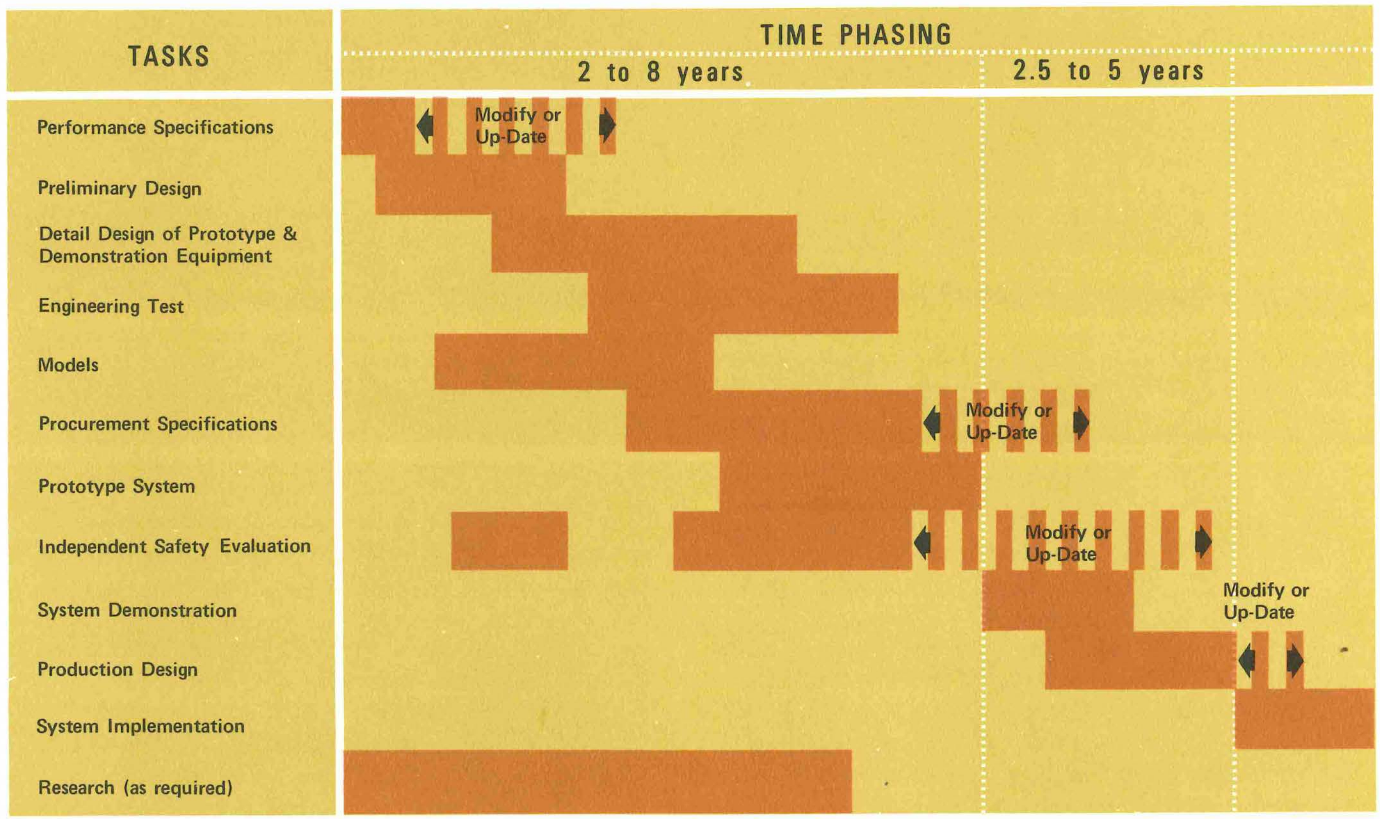


Figure 5-1 A Typical System Development Process

(vehicle suspension, propulsion, etc.) are incorporated, the requirement for basic and/or applied research may be imposed which can have a significant effect on development time and cost. A typical system development process is shown in Figure 5-1. Unfortunately, the large investment of time and money required to design, test, demonstrate and qualify a public transportation system has made private industry more than reluctant to embark upon such a program without a firm customer commitment and an assured market. By the same token, the potential customers, all of the large and medium sized metropolitan areas and regions in the United States, are not willing to commit huge sums of the taxpayers' money on a system that is undeveloped, unproven and entails a high risk in terms of local public investment. Therefore, both industry and the responsible public transportation agencies look to the Federal government for assistance in research, development, and demonstration projects as well as providing funding assistance in new system capital investment required for implementation.

The Urban Mass Transportation Administration (UMTA) under the recently signed $3.1 billion mass transit bill, will have substantial funds available for capital improvements.

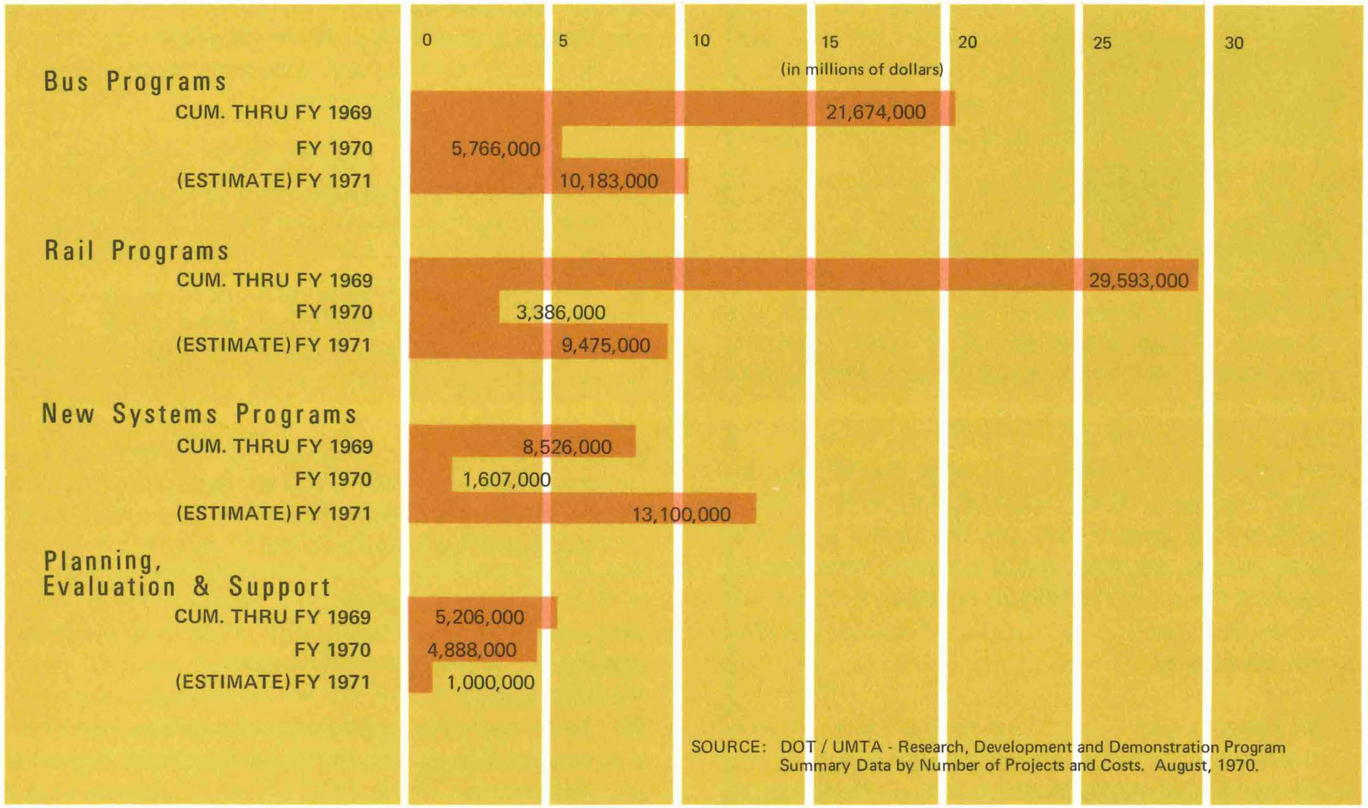


Figure 5-2 Allocation of Urban Mass Transportation Administration Funds for Transit Research, Development, and Demonstration Programs

There are indications that a Research, Development and Demonstration Program (R.D. & D.) will be prepared to support these improvements at approximately $0.5 billion over the next twelve years. Assuming equal distribution of funds over this period, over $40 million would be available annually. This would be a significant increase in Federal funding for transit R. D. & D. Projects when compared to funding over the past years (See Figure 5-2).

With the increasing Federal Highway Administration interest in movement of people rather than vehicles, it is reasonable to expect that they will support additional programs aimed at improving bus system operations. Where airport access is involved, additional support may be available through the Federal Aids to Airports Program under the Federal Aviation Administration.

Transportation system planning in the Twin Cities Area should include provisions for demonstration projects which qualify for Federal government funding support as well as funds for capital improvements and new system implementation.

6

TRANSIT OPTIONS & TEST SYSTEMS

The proposed Metropolitan Development Guide clearly indicates the long-range objectives for the patterns of growth desired for the Twin Cities Region. Adoption of the concept of developing major diversified centers coupled with emphasis on continued strength of the Central Business Districts (CBDs) will provide the framework for the formulation of an overall plan to achieve these objectives. The importance of transportation as a major influencing factor in effecting the desired growth pattern has also been recognized. Further, the diverse nature of the metropolitan area has resulted in a recognition of the need for a public transportation system comprising a family of vehicles which, along with the freeway and expressway system, will provide a level of service that can adequately satisfy the overall requirement for the movement of residents within the region.

This study has therefore concentrated on a detailed examination of these projected growth patterns with a view to identifying the public transit system options available for selection which can best meet the long-range regional development objectives. Comparisons of these options have been made in terms of transit service, patronage, development impact and cost.

DEFINITION OF CORRIDORS

Previous transportation studies of the Twin Cities Area have consisted of surveys to determine origin-destination trip data, land use and employment information, urban growth and travel forecasts, modal splits and estimates of transit patronage volumes. Analysis of data from these studies allowed the definition of ten (10) sub-regional sectors along with their characteristics relative to population, employment and travel patterns. Each of these sectors also includes at least one potential transit corridor within the region and may be described briefly as follows:

- Saint Paul-Minneapolis — links the two CBDs, the University of Minnesota, the State Capitol, and contains a substantial proportion of the total employment in the region. The diversified center along University Avenue, between Lexington and Prior, has major development potential and may be an important element in this corridor.

- Minneapolis south — generates the highest volume of trips in the region. It links the Minneapolis CBD with an existing outlying major diversified center and contains a high percentage of multiple residential development, the International Airport, Metropolitan Stadium, and the Sports Arena.

- Minneapolis southwest — connects the Minneapolis CBD and an existing industrial area with a strong employment base. It also contains several areas with high density potential and is a travel corridor where demand for a diagonal freeway has been identified, but where opposition to such a project developed within the community.

- Minneapolis west — centers around a future east-west freeway with a major diversified center planned for development at the west end.

- Minneapolis northwest — generates the second highest traffic volume in the region and is one of the areas, along with the south and southwest, projected to have the highest growth potential between now and 1985. It also contains the beginnings of a major outlying center and opposition to a proposed diagonal freeway to meet projected travel needs is very strong.

- Minneapolis north — bounded on the west by the Mississippi River and on both east and west by an existing industrial complex. It has a high per-capita transit use, with no planned freeway connection from the outlying area to the CBD.

- Midway north — contains an outlying major diversified center, potential for future industrial development toward the northern end, and the Saint Paul campus of the University of Minnesota.

- Saint Paul north — also has major available land for development and connects the Saint Paul CBD to the White Bear Lake development at the outer boundary.

- Saint Paul east — oriented to a major industrial center with extensive growth predictions along with a proposed major regional center with prospects for early development.

- Saint Paul south — bounded by the Mississippi and Minnesota Rivers and offers the opportunity for large industrial tract development. It also contains the proposed Eagan major diversified center.

The general guidelines followed in defining regional transit corridors within each of these areas are:

- The corridors should conveniently serve the concentrations of activity, including major diversified centers.

- The corridors should generally be located to serve high concentrations of population and areas with opportunity for favorable transit impact development.
- The corridor terminus should be convenient to freeways and expressways to offer maximum auto access to terminal stations and potential for express bus feeder extensions on freeways.
- The corridors should be located to serve renewal areas and other areas of high social needs wherever possible.
- The corridors should be located near the middle of traffic sheds wherever practical and where such location is not in conflict with other locational factors outlined above. This will provide more equal access opportunities from both sides.

Consideration should also be given to transit service to the new airport sites presently under consideration. An extension of service in the Midway north corridor could provide access to the proposed northern site, while a connection with the present airport site could serve a new airport to the south. Either can provide direct and convenient transit service to both Minneapolis and Saint Paul. The potential regional transit corridors are shown in Figure 6-1.

Under the "family of vehicles" concept, all corridors would be provided with some form of fast link transit service. Some corridors will have sufficient patronage to sustain an exclusive separate guideway system while others will not. The corridor between Minneapolis and Saint Paul is considered to be the backbone and common to any transit system test plan. Because Interstate Highway I-394 provides an excellent opportunity for the first joint highway/transit development, the corridor directly west from the Minneapolis CBD is included in any test system but as a special busway.

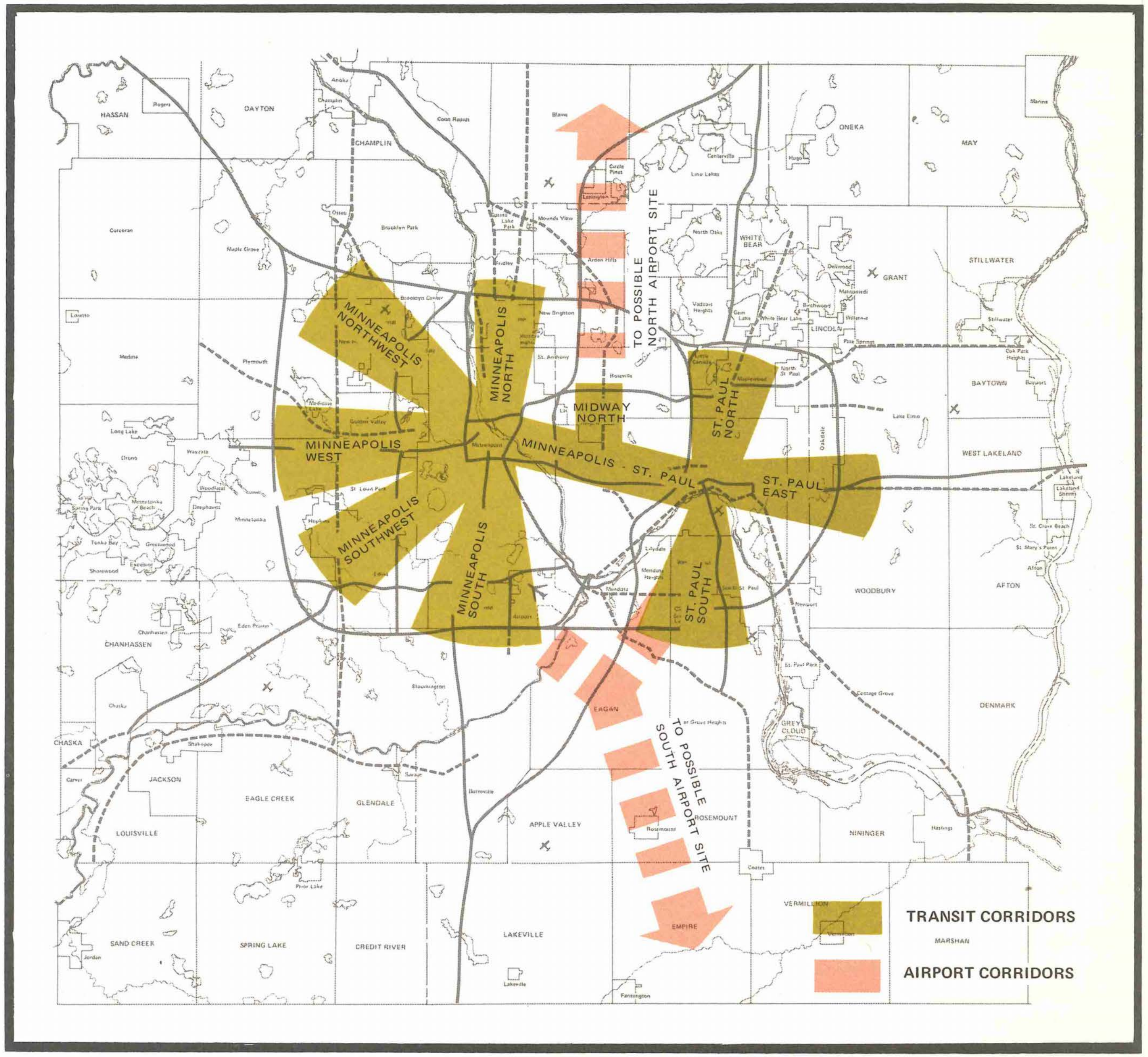


Figure 6-1 Potential Regional Transit Corridors

SELECTION OF TEST SYSTEMS

Two basic transit options to serve the Twin Cities region have been identified. One consists of continued reliance on bus transit but with expanded service and innovative operations. The other is based on use of fixed guideway fast link service with extensive feeder and distributor service. Within each of these, there are a number of sub-options relative to the character of the bus service or the location and extent of the fixed guideway service. These options also represent a broad spectrum of capital investment requirement, patronage potential, regional benefits, and development impact.

Three basic test systems have been developed to test the effects of these options. Test System A reflects the all bus option and has been structured to permit a range of capital investment. Test Systems B and C reflect the fixed guideway option and differ primarily in the extent of fixed guideway developed prior to 1985. System B represents a moderate investment with test systems ranging from 23 to 31 miles of fixed guideway. It has also been designed to provide a preliminary indication of benefit and cost relationships of various corridor combinations. System C represents a much larger system of approximately 59 miles with fixed guideway service in all corridors except Minneapolis west which retains the busway. The transit service for all test systems includes elements of the family of vehicles concept and considers both fast link transit and collection - distribution service.

INTERMEDIATE PROGRAM

One element of the future transit program is common to all test systems. Since the current 13-Point Improvement Program illustrated in Figure 6-2 will be completed in 1975, it is desirable to have an intermediate plan to fill the gap until 1980 which is assumed as the earliest point in time at which major improvements could be in operation. Under this program, additional shelters would be constructed and express bus service initiated over the existing freeway system. Operating only during the peak hours, this service would connect the two CBDs with certain of the more distant areas in the region, using buses capable of operating at freeway speeds. At seven selected locations which interface with the existing local bus routes, transfer shelters would be built. The addition of 1.68 million annual bus miles of express service is expected to attract an estimated 2.8 million passengers.

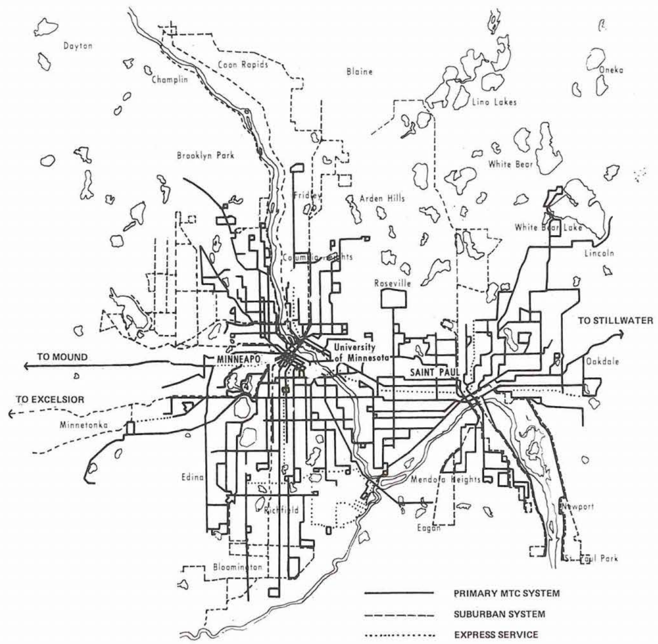


Figure 6-2 Bus Route Coverage Under The 13-Point Improvement Program

OPTION A TEST SYSTEMS

Under this option a transit program utilizing buses and expanding the existing system with capital improvements has been considered. Three levels of capital investment have been examined, with corresponding service improvement provided primarily by changes in fixed facilities and a reorientation of routes and service concepts in Systems A-2 and A-3. Figure 6-3 shows the 1985 routing of special service transit under Systems A-2 and A-3. The CBD peak hour express service would be included in Test System A-1 as well.

System A-1

An extension of the 13-Point and Intermediate bus improvement programs would require a minimal level of capital investment. Such a program would contain these features:

- A fast link system of express buses operating only during the peak hours would connect the CBDs and regional centers via the freeways. Buses would incorporate seating and climatic control improvement for passengers' comfort.
- The local bus system would extend the improvements of the 13-Point and Intermediate Programs together with certain route and schedule changes resulting from the express operations and population changes.
- Personal Service Transit would operate around the regional centers to provide service on demand. Operations in these low density areas would use buses varying in size from small vehicles to 25 passenger buses.
- Additional fixed facilities would be limited to shelters and parking lots constructed at selected locations.

- A busway would be constructed in the Minneapolis west corridor when U.S. 12 is upgraded to freeway standards.

System A-2

An improvement in facilities can be attained with a moderate level of capital investment. Routing and operational orientation would be changed to facilitate centers development. This system would provide the following elements in addition to the A-1 System features.

- A fast link system of express buses would operate over freeways and expressways offering two types of service: Major Center Express (MCX) would connect the regional centers to the CBD on a scheduled basis throughout the day using freeways and expressways. Peak Hour Express would operate between the regional centers and CBDs only during the peak hours via the radial freeways.

- A terminal station would be constructed in each CBD to provide an enclosed and climate controlled environment for transfer from express to local buses or the skyways.

- A climate controlled station would be located in each of seven regional centers which would dispatch and control the Personal Service Transit vehicles.

System A-3

Neither Systems A-1 nor A-2 include fixed facilities which approximate the service level offered by any fixed guideway system. System A-3 provides these facilities to permit bus operation to approximate a guideway system from the standpoint of passenger amenities. Routes and schedules remain similar to System A-2, but the fixed facilities have been upgraded by means of these additional features:

Figure 6-3 Option A Test Systems

- Transfer stations for the express routes would allow the bus to remain on the freeway while providing an enclosed climate controlled environment for passenger transfer to local buses operating on arterial streets at a different level.

- Exclusive bus ramps would be provided at all transfer stations and in the CBDs to allow express buses to enter and exit the freeways independent of the normal vehicle ramp traffic.

- Three added downtown stations would be constructed in each CBD to provide enclosed, climate controlled transfer between the skyways, the circulating local buses and the express buses.

- Larger terminal stations with additional capacity for future growth in patronage, would be provided at the three selected regional centers. Center selection would be based upon maturity of the center at the time of system implementation.

Figure 6-4 Option B Test Systems

OPTION B TEST SYSTEMS

Test systems, illustrated by Figure 6-4, provide transit service designed to influence the future development and population growth around the major diversified centers and the CBDs. This development pattern is supported by incorporating the following features in the family of vehicles concept in selected corridors:

- A fast link guideway system connecting major diversified centers and the CBDs would be operational in 1980 in selected corridors.
- An express bus fast link system would serve those corridors without fixed guideway fast link service.
- Expanded local bus service would be focused on the major diversified centers to provide local service and feed the fast link corridors.
- Collector-distributor systems would be provided in major diversified centers and the CBDs to complement the local bus system and promote the desired land use patterns.
- A future program would provide for replacing the express bus service by extending the guideway system in a coordinated manner, as justified by further growth in the corridor service area.

Four alternative test systems have been examined under this option to identify the most productive corridors in terms of patronage and system cost. Each alternate is described only in terms of the guideway corridors. Expanded local and express bus service similar to Test System A-2 is provided in other sectors of the region and is common to all alternates. In addition, each alternative includes the fixed guideway link between the Minneapolis and Saint Paul Central Business Districts.

BW Alternate

The initial fixed guideway transit system should logically serve the highest concentrations of activity and tap the primary areas of trip origin necessary to attract patronage. Adding the Minneapolis south corridor accomplishes this purpose and also provides service to an existing major center. This combination forms the simplest viable system for fast link guideway operations with a total length of about 23 miles and 19 stations.

Since U.S. 12 west of Minneapolis is scheduled to be upgraded to freeway standards under the committed highway program, the Minneapolis west corridor is included as a potential exclusive busway. This would be the first joint highway-transit facility to be developed in the area and would provide an excellent test to determine the future potential of busways.

Each of the other three Option B alternates uses these corridors as a base and adds a different fourth corridor.

BX Alternate

By adding the St. Paul east corridor to the BW system, service is provided to the sector of Saint Paul with the earliest development possibilities. Initial patronage potential is provided by the existing industrial complex where there are major expansion plans. A planned major diversified center will be developed in the near future and the opportunity exists to incorporate transit planning into the basic design. This system totals about 28 miles with 23 stations.

BY Alternate

With the Midway north corridor added to the BW system it is possible to connect the Twin Cities campuses of the University of Minnesota in addition to serving the major center at Roseville and the State Fairgrounds. This would require a total system of about 25 miles of guideway with 21 stations. Service to the northern airport site could be provided by an extension of the corridor.

BZ Alternate

The Minneapolis northwest corridor serves the third largest population and employment concentration and has the second highest trip desires and freeway deficiency in the region. By adding this corridor to the BW system, service is provided to the emerging Brooklyn Center and low income area in northwest Minneapolis. The system would total about 31 miles with 23 stations.

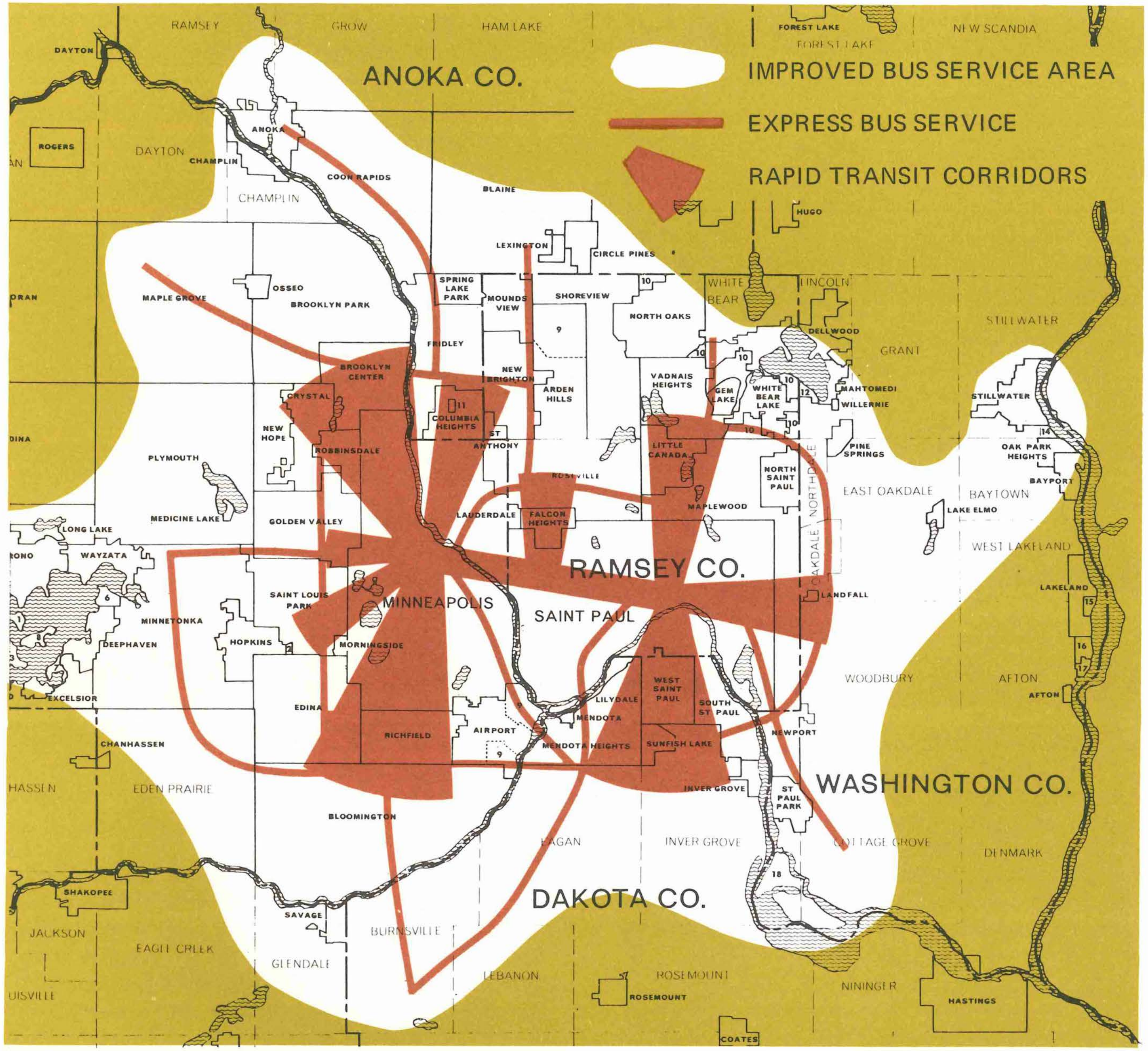


Figure 6-5 Option C Test System

OPTION C TEST SYSTEM

This test system, illustrated by Figure 6-5, is designed to provide an accelerated development of the fixed guideway fast link transit service and would consist of four elements under the family of vehicles concept:

- A fast link guideway system in all corridors except Minneapolis west to connect the regional centers and CBDs. Operation in the initial corridors would begin in 1980 and when completed in 1985, would comprise 59 miles of guideway with 42 stations.
- Express bus service extending beyond the beltway to connect outlying areas to the guideway system.
- The local bus service modified to supplement the fast link guideway system with feeder routes and personalized collection-distribution transportation to serve the low density areas surrounding the regional centers.
- Collector-distributor system installed in the CBDs and those major centers with high patronage levels.

PATRONAGE AND REVENUE PROJECTIONS

Patronage estimates on the various test systems were developed using the population and employment projections developed for this study. They reflect the expected distribution of both population and employment through the metropolitan region and the redistribution effects of transit service.

Patronage estimates for test systems in the A Option have been carried to 1985. Beyond that point, some continued increase in patronage could be expected, but at a lower rate of increase since the densest sections of the area will have already been served and the service will have matured.

The three bus system sub-options, A-1, A-2 and A-3, differ not in level or type of service but in route orientation and in capital expenditure on passenger amenities particularly in A-3. The A-1 sub-option provides a bus service concept similar to that operated today in the Twin Cities. Its routes are patterned to serve conventional suburban development that is usually characterized as 'sprawl'. The other two sub-options provide the same amount of service but some routes are reoriented to serve the more organized development characterized by the Major Centers concept.

The three bus systems could be considered to serve the same people who have merely located differently in response to development and activities which are located differently. It is reasonable therefore to assume that the same patronage will be generated by all three systems since the route miles of service are identical. Depending on the success of organizing development in Major Centers, systems A-2 and A-3 may have different patronage than A-1. But whether the difference is greater or less than A-1 cannot be known until the centers and systems have been implemented. If the centers are successful in reducing the demand to travel as hoped, the patronage may actually decline. On the other hand, if basic travel habits remain as today, the higher concentrations may produce increased patronage.

The patronage figures shown in table 6-1 are reasonable levels to expect considering the bus miles of service provided. Further, it is probable that the Commission will orient the service in response to ridership demand so that no matter which system is implemented initially, the one with greater patronage will be the one which remains.

The B option test systems represent service provided in selected corridors where demand is expected to be high or where transportation needs are greatest. They all include an exclusive busway west of downtown Minneapolis.

TABLE 6-1
ANNUAL OPERATING STATISTICS PROJECTED FOR 1985
(1970 Costs and Fare Levels)

		Option A 1/			Option B			Option
	A-1	A-2	A-3	BW	BX	BY	BZ	C
PATRONAGE (millions of passengers)		65.0		79.4	84.9	83.4	87.4	103.7
AVERAGE BASIC FARE (cents)		27.9		31.0	31.2	31.2	31.7	32.6
REVENUE ($millions)								
Basic Fare		18.1		24.6	26.5	26.0	27.7	33.8
Guideway Premium				3.5	4.0	3.8	4.7	7.3
TOTAL REVENUE		18.1		28.1	30.5	29.8	32.4	41.1
OPERATING MILES (millions of vehicle miles)								
Bus		25.5		23.5	23.2	23.5	22.7	22.2
Guideway				4.4	5.1	4.5	6.0	9.0
TOTAL VEHICLE MILES		25.5		27.9	28.3	28.0	28.7	31.2
OPERATING COST ($ millions) 2/								
Bus		16.7		14.9	14.7	14.9	14.4	14.1
Guideway				3.5	4.1	3.6	4.8	7.2
TOTAL COST		16.7		18.4	18.8	18.5	19.2	21.3

1/ Patronage, revenue, bus miles and costs for all A test systems were estimated at the A-1 level. Levels A-2 and A-3 reflect added capital expenditures and reoriented service in keeping with centers development. However, bus miles were held constant and therefore performance remained constant. Patronage increase due to improved amenities cannot be predicted reliably and was also held constant to produce conservative estimates.

2/ Operating Costs: Per Vehicle Mile
Bus System: Option A — 65.6 cents Option B & C — 63.6 cents
Fixed Guideway System — 80 cents

Test system B-W provides service in the greatest demand corridor of the region, south of downtown Minneapolis, and a line to connect the two CBDs. The south line connects the area's largest current suburban activity center with the two CBDs. The University of Minnesota is served by the crosstown line. Although most of the area's concentrated activity is served by fast links, little of the residential portion of the region has fixed guideway service.

Test system B-X provides additional service east of St. Paul. The area served is low density and is also served by an express highway, I-94. The transit route serves an existing major industrial facility but access to that plant is already good via highways. In addition, the employment is heavily white-collar with a high income level. Such people usually have more than one car available and live in suburban areas, which have good highway service and poor transit service. Because of these factors, the expected patronage increment is small.

Test system BY has the potential to provide a good facility for service between the Twin Cities campuses of the University. This is only true however if the line is properly located and if services are operated in relation to student movements. As for regional travel, this line addition does not provide much greater access for suburban areas than was available with the basic BW system. The line terminates at the edge of the Roseville activity center, which may still be sparsely developed in 1985. The line, if providing direct service to the University campuses, avoids the more dense corridor along Snelling Avenue. Also, it does not adequately serve north-south travel in the Midway area since it would not go south of University Avenue. The test route is located west of the most densely developed portion of northwest St. Paul and east of the Minneapolis north corridor. Hence, the increase in patronage attributable to this route is also expected to be small.

Test system B-Z adds a line in the corridor having one of the best patronage potentials of the region. It serves a densely developed area with low income households. It also offers a good opportunity for park-ride at both U.S. 52 and I-94 northwest of Minneapolis. Highway service in the corridor will be restricted if the northwest diagonal is not built. The line also passes near the major activity center development at Brooklyn Center.

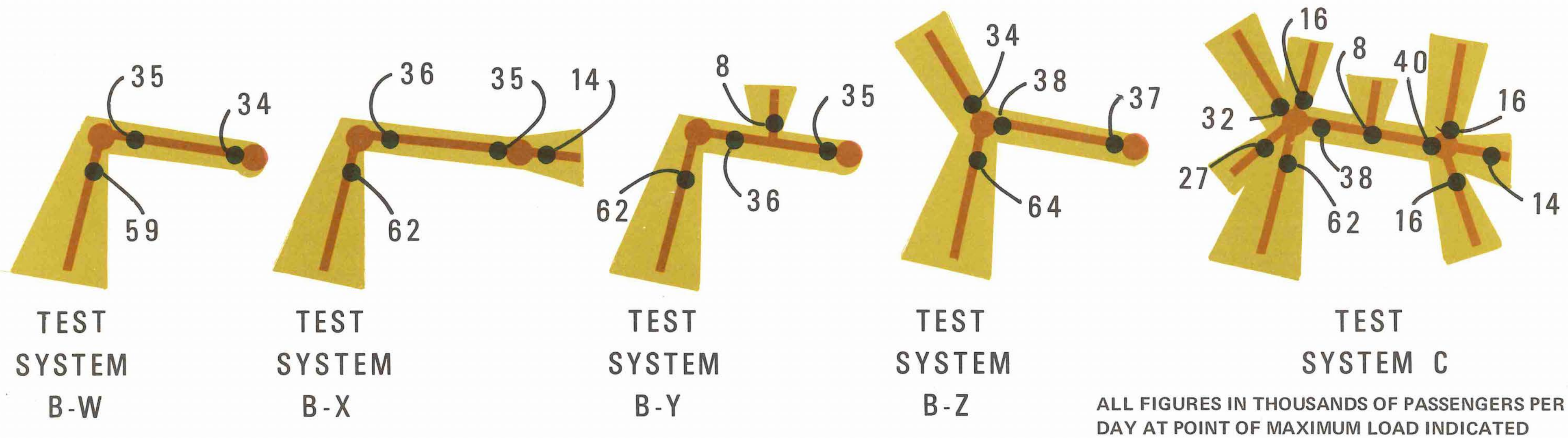


Figure 6-6 Patronage Volumes in Thousands of Persons/Day at Maximum Load Points Test Systems B and C

Test system C offers fast link fixed guideway service in all corridors. Two of the lowest patronage lines are north from Minneapolis and in the Midway area. These lines compete in a relatively low density area. The lines from St. Paul parallel freeway alignments into low density suburbs and, therefore, compete directly with highways throughout their lengths. A diagonal routing between the White Bear Lake area and the St. Paul CBD may provide a more needed service. The diagonal lines in Minneapolis however, serve corridors where highway service will be poor if diagonal freeways are not constructed. The south line from Minneapolis does well in competition with I-35W freeway because of the very heavy demand and the absence of other freeways to carry traffic.

Figure 6-6 indicates the 1985 average daily passenger volume at the point of maximum load in each corridor for the various systems tested. The volumes indicated are projected to increase between 55 and 60 percent by the year 2000 depending upon the system being tested.

Some comparisons with existing and projected transit operations using fixed guideway systems is helpful in gaining perspective for similar operations in the Twin Cities region. The new Lindenwold line in the Philadephia transit system, for example, is presently carrying approximately 35,000 passengers per day while the Cleveland airport line volume is about 4,000 per day. Projected 1985 volumes on the proposed Baltimore, Maryland system ranged from 44,100 passengers per day on the lightest line to 75,700 on the heaviest traveled route. Volumes in the proposed system in Seattle, Washington were projected to range from 43,000 to 57,400 passengers per day in 1990. These comparisons indicate that fixed guideway transit in the Twin Cities can compare favorably in patronage with those in similar sized cities either currently using or planning rapid transit.

Total patronage in the B and C systems, estimated on a systemwide (bus and fixed guideway) basis is shown in Table 6-1. Passenger revenues have been estimated based on the current average fare on the MTC bus system projected to reflect 1985 trip length. For the guideway systems, this fare structure has been modified to account for:

- Longer average trip length on guideway systems.
- A 10 cent higher fare on the guideway portion has been assumed because of the major service increase over that which is currently available. Such an assumption is reasonable because the rider will perceive a higher quality of service in return for the premium fare. Whereas such an increase in travel cost would actually produce an effect such that patronage at the higher rate would be slightly less than on an identical service at the lower rate, the patronage difference has been assumed to be marginal, and has been ignored for the purpose of this study.

OPERATING COSTS

All options use the current bus system as a base for projecting future levels of bus service and operating cost. Projected annual bus miles for the "A" Test system are based on continued increases in the 13-point program for system A-1 and major reorientation of service in levels A-2 and A-3 but operating the same number of bus miles. Bus miles for Systems B and C reflect a reorientation of the system A service to provide collector-distributor transit and express bus service in corridors not having a fixed guideway system. Total bus miles have been adjusted to reflect replacement of System A bus routes by fixed guideway systems where appropriate. Annual vehicle miles for the guideway system under Options B and C were estimated based on the number of vehicles necessary to provide adequate capacity at the maximum load points in each corridor.

Basic costs for bus operation have been developed using current 1970 data for MTC bus operations. Future bus mile costs have been adjusted to account for lower costs anticipated for express bus operations. Some variations in operating costs for each option will appear due to differences in the amount of local and express services included. Fixed guideway system operating costs are based on actual experience of rapid transit systems currently in operation in the United States.

The projected 1985 annual operating statistics, including both patronage and operating cost, for all test systems are shown on Table 6-1. These data are based on the 1970 costs and fare levels before the effects of escalation and possible fare increases are applied.

CAPITAL COSTS FOR TEST SYSTEMS

The ultimate function of any transit system is to provide the highest level of service that can justify initial capital expenditures and maintain a viable public investment. This section of the report documents a probable level of costs that will be required to construct and operate each of the systems. Operating costs and initial construction costs for each of the test systems will undoubtedly be a major factor in ultimate selection of a system best suited to meet the needs of the Twin Cities area.

Each test option has been costed first in terms of 1970 prices using the best of current technology as a cost basis. Since no preliminary design was authorized for this study, estimates are based on conditions considered typical for the corridors receiving service and on service concepts rather than a specific route. Allowance for anticipated unique factors within specific corridors has been made. Since the capital costs of different technologies may be expected to be competitive when considering similar operating concepts and service levels, there are no restrictions on the type of systems that could be considered. Costs covered in the estimate include: Fixed Facilities (roadbeds, stations, structures, parking); Right-of-way (all acquisition and demolition expenses); Engineering and Administration (14%); Contingencies (10%) and Vehicles.

TABLE 6-2
CAPITAL COST COMPARISON
ALL COSTS IN MILLION DOLLARS

	"A" TEST SYSTEM			"B" TEST SYSTEM				TEST SYSTEM
	A-1	A-2	A-3	BW	BX	BY	BZ	C
TOTAL CAPITAL COST 1970 PRICE LEVEL								
Intermediate Program	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Bus System								
Fixed Facilities	8.3	11.4	30.9	10.9	10.7	10.7	10.6	9.5
Land Acquisition	5.1	9.3	17.3	8.3	7.8	7.8	7.5	1.2
Engr. & Admin.	1.9	2.9	6.8	2.7	2.6	2.6	2.5	1.5
Contingencies	1.5	2.4	5.5	2.2	2.1	2.1	2.1	1.7
Vehicles	7.0	7.0	7.0	4.1	3.7	3.7	3.6	2.5
Sub Total	23.8	33.0	67.5	28.2	26.9	26.9	26.3	16.4
Guideway System								
Fixed Facilities				271.3	323.3	291.2	339.8	627.4
Right-of-Way				17.6	18.3	18.3	32.7	44.1
Engr. & Admin.				43.6	51.6	46.6	57.0	100.0
Contingencies				35.4	42.0	38.0	46.1	81.3
Vehicles				21.8	26.4	23.6	31.7	41.0
Sub Total				389.7	461.6	417.7	507.3	893.8
GRAND TOTAL	26.0	35.2	69.7	420.1	490.7	446.8	535.8	912.4
TOTAL CAPITAL COST ESCALATED 1/								
Intermediate Program	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Bus System								
Fixed Facilities	12.6	18.1	56.3	17.2	16.9	16.9	16.6	14.9
Land Acquisition	6.8	12.1	22.9	10.6	10.0	10.0	9.6	1.5
Engr. & Admin.	2.7	4.3	10.9	3.9	3.8	3.8	3.7	2.3
Contingencies	2.2	3.5	8.8	3.2	3.1	3.1	3.0	2.6
Vehicles	10.5	10.5	10.5	6.0	5.3	5.3	5.2	3.7
Sub Total	34.8	48.5	109.4	40.9	39.1	39.1	38.1	25.0
Guideway System								
Fixed Facilities				381.1	448.9	407.9	476.1	994.6
Right-of-Way				22.1	23.1	23.1	40.5	56.4
Engr. & Admin.				58.9	69.8	63.1	76.4	150.9
Contingencies				49.7	58.4	53.2	64.3	126.0
Vehicles				34.9	42.3	37.8	50.8	68.0
Sub Total				546.7	642.5	585.1	708.1	1,395.9
GRAND TOTAL	37.8	51.5	112.4	590.6	684.6	627.2	749.2	1,423.9
ANNUAL COSTS								
Retirement of Funded Debt 2/	0.8	1.1	2.5	13.1	15.2	13.9	16.6	31.6
Depreciation Allowance (buses only)	2.9	2.9	2.9	2.6	2.5	2.5	2.5	2.4

1/ Improvements put in place over total period as needed with escalation applied to the time of construction.

2/ Assumes two-thirds Federal participation for all test systems. Local one-third share shown amortized over 40 years at 6%. Local share may include funds from various combinations of local, regional and state sources. (see Chapter 8 page 54 through 56). If the full amount indicated in Chapter 8 is realized from state sources, the annual local requirements could be reduced by as much as $5.5 million.

Escalated costs were then estimated based on the 1970 costs. In accordance with the practice of other transportation agencies, fixed facilities and right-of-way costs were assumed to rise at 5 percent annually. While this rate may eventually prove correct over the fifteen year period covered by these studies, it must be recognized that the current rate is over 7 percent and rising. If this trend continues, the actual cost could be 20 percent or more above this report estimate. Vehicle prices are expected to increase at a rate of 6 percent annually for transit cars and 3 percent annually for buses. These rates are in agreement with past trends of major suppliers and their projections for the future.

The estimated capital cost of the various test systems is shown in Table 6-2. The table indicates the cost (1) on the basis of 1970 dollars and (2) escalated to reflect estimated costs in the year of construction. Escalation factors have been applied to each year's anticipated expenditure to produce the total capital cost for the system placed in operation by 1985.

A large bus fleet is required under all test systems either as the basic system or to provide feeder and local service to the fast links. In some areas, particularly the regional centers and central cities, this service may, at some future time, be provided by automated "people mover" systems which would increase the total capital cost while offering potential reductions in operating cost. These systems could be used with any of the options tested. Because of the uncertainty in both capital cost and time of availability of these systems, the feeder and local service in this analysis has been based on buses. In order to maintain this fleet at an average age of six years (as suggested in the 13-Point Program), a replacement schedule, expressed as an annual capital cost, has been included in Table 6-2. This annual amount will increase from $2.2 million in 1976 to the amount indicated by 1985. No escalation factors have been applied to this cost since it is assumed that the fund would be invested and earning a rate at least equal to the escalation rate.

ESCALATION EFFECTS ON OPERATING STATISTICS

Table 6-3 compares the operating statistics of all test systems in terms of 1985 price levels under two assumptions of fare policy.

- Without a fare increase.
- With a fare increase of 4 percent annually which would approximate the projected long term rise in the cost of living. However, any fare increase on the established system is highly visible and will affect patronage. This result is shown in the table and patronage has been reduced even though total revenue has been increased. A patronage loss of 1/4 of one percent for each 1 percent increase in fare has been assumed.

Recent experience of the MTC bus system indicates bus operating costs rise at about 7 percent annually. This produces a 1985 cost level of $1.81 per vehicle mile. Guideway system operating costs for automated transit systems operating in North America appear to increase about 4 percent annually. This lower rate is due to increased capital investment for automated operation which reduces the portion of operating cost attributable to labor. Applying this increase, the 1985 operating cost would be $1.44 per vehicle mile for fixed guideway vehicles.

SYSTEM COMPARISONS

Three basic parameters have been used to compare the test systems representing the various transit options:

- Service provided in terms of estimated patronage
- Costs of the systems
- Impact on regional development.

From the standpoint of service, the data developed in the earlier portions of this section clearly indicates that a higher patronage level can be attained with the fixed guideway

TABLE 6-3
1985 OPERATING STATISTICS
ESCALATED WITH AND WITHOUT FARE INCREASE

		Option A [1/]			Option B			Option
	A-1	A-2	A-3	BW	BX	BY	BZ	C
No Fare Increase								
Average Fare (cents per ride)		27.9		31.0	31.2	31.2	31.7	32.6
Patronage (millions of passengers)		65.0		79.4	84.9	83.4	87.4	103.7
Total Revenue ($ millions)		18.1		28.1	30.5	29.8	32.4	41.1
Operating Cost ($ millions)								
Bus		46.2		41.1	40.6	41.1	39.8	38.9
Guideway				6.2	7.4	6.5	8.7	13.0
Total Cost		46.2		47.3	48.0	47.6	48.5	51.9
Surplus (deficit)		(28.1)		(19.2)	(17.5)	(17.8)	(16.1)	(10.8)
4% Annual Fare Increase								
Average Fare (cents per ride)		50.2		55.8	56.2	56.2	57.0	58.7
Patronage (millions of passengers)		55.3		67.5	72.2	71.0	74.2	88.1
Total Revenue ($ millions)		27.8		40.7	43.9	43.0	46.3	57.9
Operating Cost ($ millions)								
Bus		46.2		41.1	40.6	41.1	39.8	38.9
Guideway				6.2	7.4	6.5	8.7	13.0
Total Cost		46.2		47.3	48.0	47.6	48.5	51.9
Surplus (deficit)		(18.4)		(6.6)	(4.1)	(4.6)	(2.2)	6.0

[1/] Patronage, revenue, bus miles and cost for all A test systems were estimated at the A-1 level. Levels A-2 and A-3 reflect added expenditures and reoriented service in keeping with centers development. However, bus miles were held constant and therefore performance remained constant. Patronage increase due to improved amenities cannot be predicted reliably and was also held constant to produce conservative estimates.

options. Not only are there more trips made via transit, but trips are longer under the guideway systems.

Cost comparisons point up the difference in capital costs as a trade-off against operating cost. Fixed guideway capital costs are far higher than are those for the bus options even when a high level of investment is made in bus stations, shelters, etc. However, the operating cost on the guideway portions is much lower particularly when escalation of labor cost is considered. Combining the greater patronage and lower costs of the guideway systems significantly reduces expected annual operating deficits in the future. This offsets, at least in part, the higher annual debt retirement funding.

Development impact is heavily in favor of the guideway options. The principal effect is expected to be clustering of development, primarily high density residential and office space, at station areas. It also makes possible a greater concentration in the regional centers because demand for automobile access and circulation can be reduced. (See Figure 6-7). Regional shifts are expected to be small even with the guideway systems since the type of development attracted to transit will still have reasonable choices under any of the test systems using fixed guideway transit. Whatever shift does occur, however, will only occur under the influence of those systems. The all-bus options will have little direct impact on the development pattern of the region.

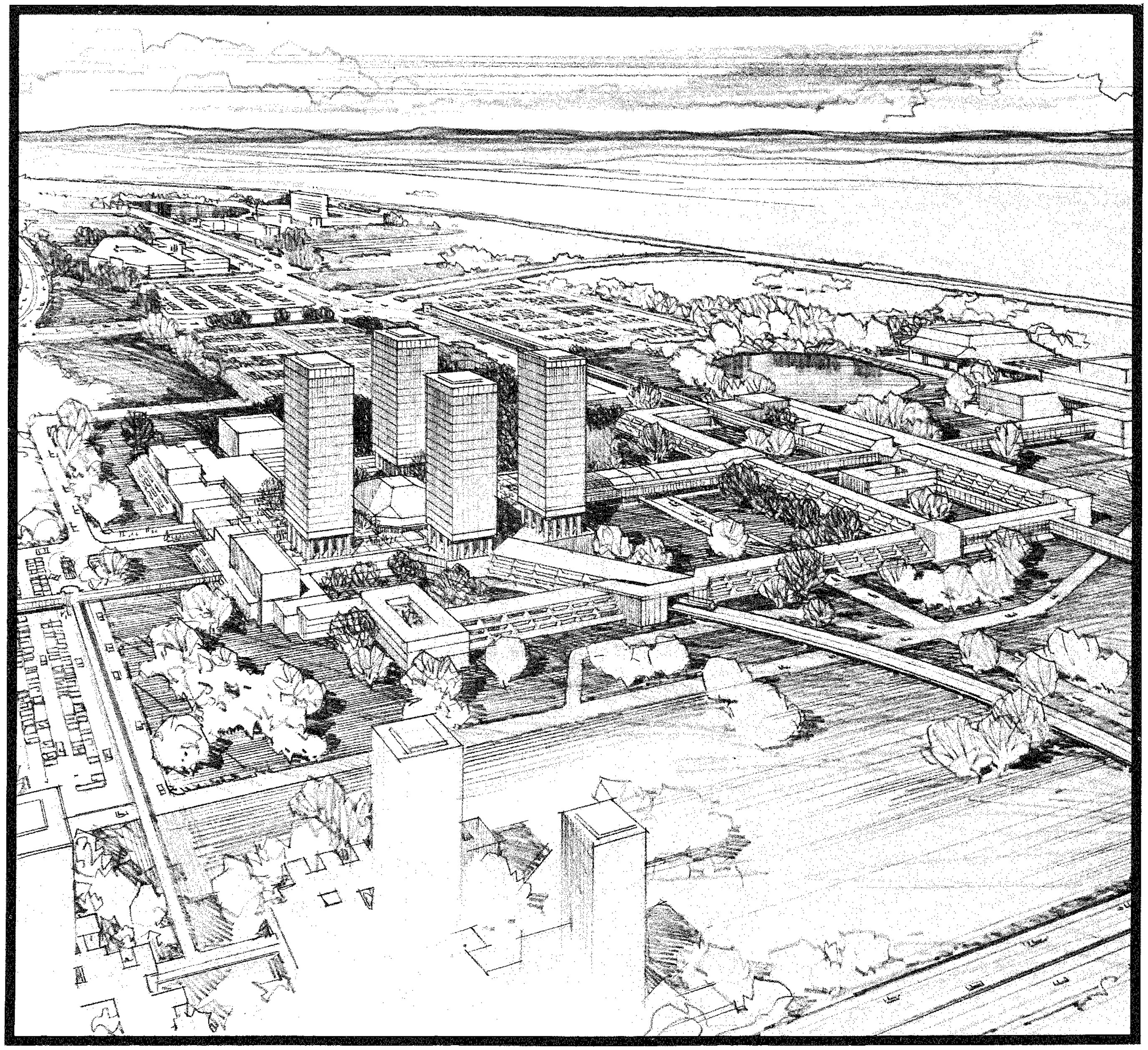


Figure 6-7 Artist's Drawing of a Potential Major Diversified Center at Year 2000

7

BENEFIT-COST COMPARISONS

One of the most critical factors in deciding to proceed on a major program involving expenditure of public money is a careful analysis of the benefit to be derived and to whom it accrues. Benefits include both quantifiable factors which can be expressed in monetary terms and qualitative factors which relate to the social and environmental values of a region and its people.

The various test systems have been carefully evaluated against each other to identify their comparative merit from both the quantifiable and qualitative benefits. Where the benefits were quantifiable, their sum by test system has been compared to the cost of that system to derive a benefit-cost ratio which provides a measure universally accepted as one criterion in public projects.

IMPROVED MOBILITY FOR THE TRANSIT DEPENDENT RESIDENT

In evaluating alternative public transit options a critical comparison should be made between the level of improved mobility each provides the captive transit rider. [1/] Currently in the Twin Cities area the greatest portion (75-85 percent) of the existing transit dependent residents live within the general boundaries of the two central cities. This is exclusive of school children who, up to age 16 at least, are dependent upon parents or public transit for transportation service. These people have limited access to the certain cultural, educational, recreational, and employment opportunities available within the region. In the future, even if they are more evenly distributed through successful implementation of the established regional planning goals, a majority of this region's transit dependent residents will still live in the central cities.

Figure 7-1 shown below indicates the present residential concentrations of captive riders on the existing bus system.

1/ This type of transit user includes those who by age (too old or too young) or by economic status cannot afford an automobile.

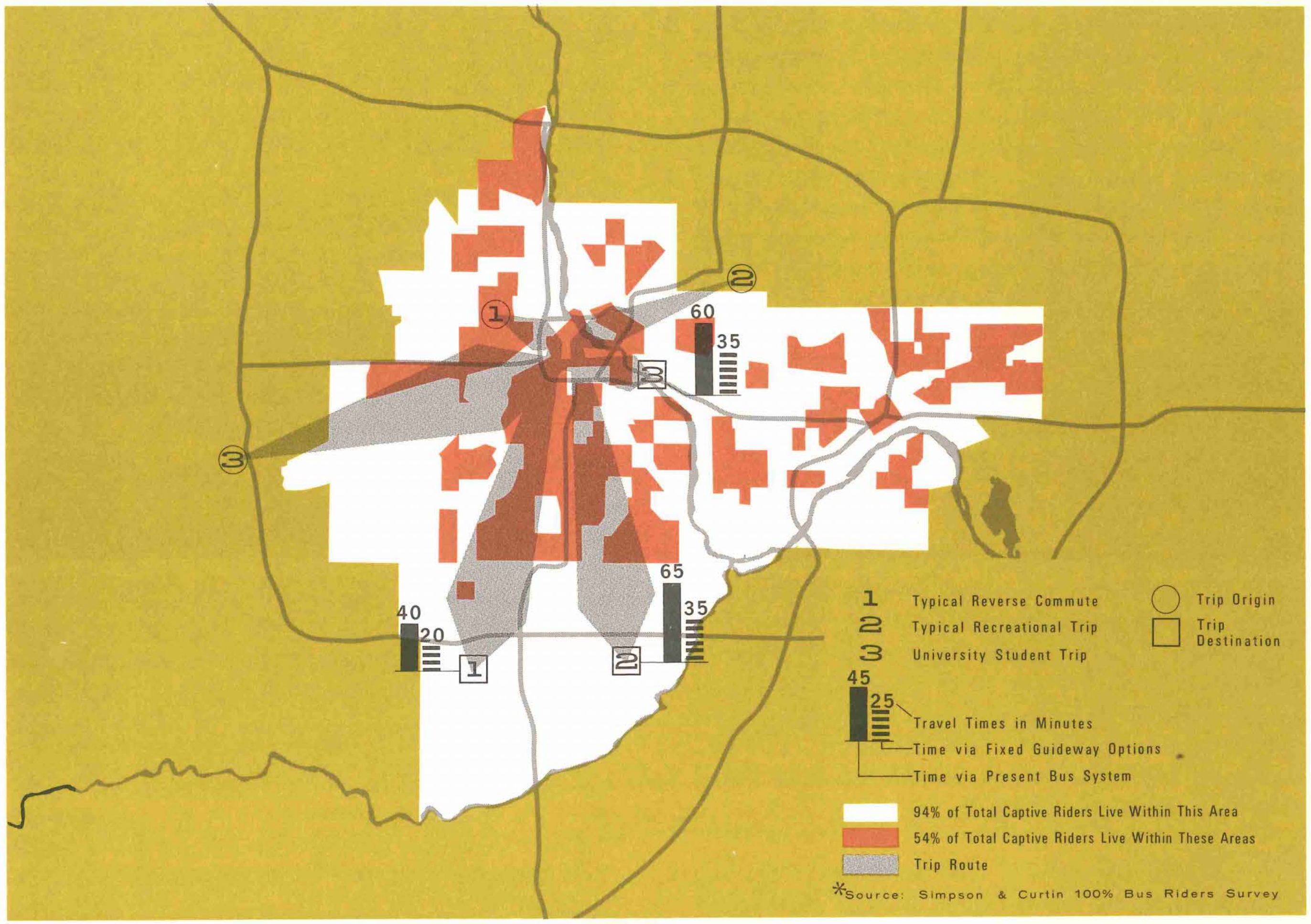


Figure 7-1 Location of captive transit riders in 1968 and comparative travel times for selected trips via fixed guideway transit versus existing bus system.

Improved public transit can reduce travel times to this region's major educational, recreational and employment opportunities. In many cases it will make these opportunities available for the first time. 1/ Figure 7-1 also compares access (travel time) on the existing transit service to the service that would be provided by the various fixed guideway test options.

It should be noted that each of the test systems include: (1) improved feeder and distribution service from residential areas to major activity centers; (2) specialized circulation systems, i.e. people-movers, within major activity centers; and (3) fast link connections between major activity centers. Of special concern is the level of improved service that can be provided for the non-commuter or off-peak hour trip. In addition, due to the added circulation service within centers and feeder service to centers, for the first time true portal to portal public transit would be made possible in many areas.

COMPARATIVE EVALUATION

To the degree each test system can provide new opportunities or reduce transfers and total transit travel times, the region receives a true "net" social benefit. Based on a comparison of these factors, Test Option C was shown to provide the highest increase in mobility to the transit dependent residents of this region.

This average time savings would amount to eleven minutes per commute trip. It also provides portal to portal service to thousands more residents for recreational, shopping or educational needs, than is possible under the planned improvements in the existing public transit service. System C also provides maximum access to suburban job opportunities for the central city residents. 2/ To maximize actual employment gains, other coordinated programs must be considered.

All of the gains cited in this evaluation would be proportional to the reduced travel time of the constant transit user. Each of the alternatives have been compared on this basis. The results as a percentage comparison of Test System C are shown in Table 7-1 below.

TABLE 7-1
INCREASED MOBILITY GAINS
AS A PERCENT OF TEST SYSTEM C

System	A	BW	BX	BY	BZ	C
Hours % of C	0%	70%	70%	70%	80%	100%

CONCLUSION

System C produces the highest level of mobility gains. However, considering the required level of capital investment System BZ is comparably a more efficient investment.

GROWTH SHAPING ABILITY

The dominant regional transportation system has historically proved to be the major "shaping force" of urban development. This fact can be illustrated by comparing the development pattern of any major metropolitan areas before and after the predominance of the automobile and related highway system.

The implementation of a major investment in public transportation potentially will have a major influence over the form the region's future urban growth will take. Specifically, existing major office centers, both CBD and suburban, are reinforced by investments in fixed guideway for public transit. In addition, what is commonly referred to as a clustering impact occurs near fixed guideway station locations. Medium to high density residential and related commercial development will also tend to concentrate at these locations.

1/ Many others would be able to delay purchase of that first automobile if there was adequate public transit service from the major residential areas to major activity centers.

2/ Actual experience in Los Angeles, Chicago, and New Jersey have shown strong positive employment gains attributable to the ghetto areas when specialized or improved transit service was provided to major employment centers, especially industrial centers.

Figure 7-2 depicts the development impact at the Eglinton Street station in Toronto during the first five years after its construction. Notice how the single family areas have been preserved while denser development clusters along the

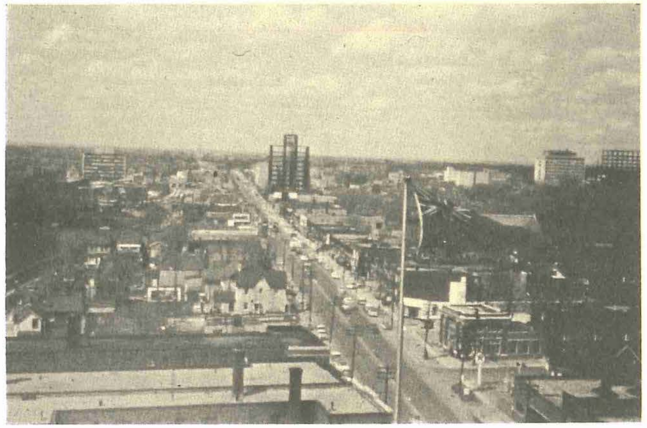
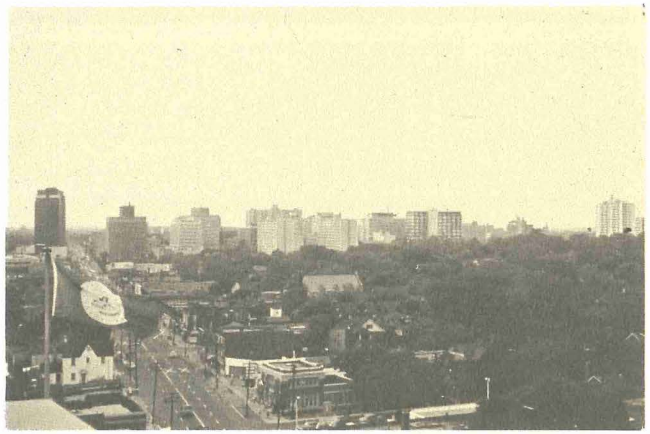


Figure 7-2 Development at Eglinton Station in Toronto before Transit (upper) and after the Transit line has been placed in service. Note that single family area in right foreground of (lower) photo has not changed even with the extensive development associated with station location.



feeder system routes. It should be noted that there is no historical evidence for a similar clustering of development near bus stations. Even exclusive right-of-way bus system alternatives have only induced impacts similar to those of additional freeway lanes.

REGIONAL SHIFT AND CLUSTERING ATTRIBUTABLE TO TRANSIT

Through the implementation of a major improvement in public transit in a given corridor, urban development, e.g. multiple family residential, that would have occurred elsewhere will be constructed near prime access locations. This type of development impact also can be estimated for commercial office and retail land uses.

In addition land uses, whether they be commercial office or residential that would have located in a subarea of the Twin Cities region will tend to locate closer to stations. Station development will also include more multi-use structures than would otherwise have been the case. The station developments will capture the normal subarea market, plus a share of the incremental demand shifted from other regions.

Table 7-3, on the following page, depicts the estimate of the level and direction of regional shifts that could be expected from implementation of the various test options under consideration.

The potential for clustering impact is directly related to the amount of fixed guideway component and related circulation element of each test option. The complementary land use policies that would reinforce this potential were assumed to be appropriate for the size of system. Therefore, the potential cluster impact would be largest with Test System C. The other impact would be approximately proportional to the size of system in percentage terms. Table 7-2 presents this relationship.

TABLE 7-2
CLUSTERING IMPACT
AS A PERCENT OF TEST SYSTEM C

Test System	A	BW	BX	BY	BZ 1/	C
	5%	25%	30%	30%	60%	100%

1/ Increased level of impact due to system being more efficient and higher level of service provided to faster growing corridors.

POTENTIAL UTILITY COST SAVINGS

The expansion of all utility services (sewer, gas, electric, telephone) for the projected 1.6 million new residents of the Twin Cities region by the year 2000 will require $4 to $5 billion in additional capital investment.

To the degree the location of future development can be predicted or guided to areas of excess utility service capacity, substantial savings could be realized in this future quasi-public investment. Therefore, the potential benefit would be directly related to the level of shifted growth and "clustered" growth a particular transit system could achieve.

CONCLUSION

The larger test options, especially BZ and C, indicate a major potential for guiding future regional growth. Land-use policies applied should minimize development at stations located between major centers. By reinforcing development potentials at stations located near major centers the adopted regional development concept would receive maximum support. Probably, this use of transit could reduce the required time for realization of the regional concept by ten to fifteen years. Realization of these goals with any of the A Options (all-bus) would require almost complete public control of future urban development.

COMMUTER SAVINGS THROUGH TRANSIT

The corridors selected for the fast link fixed guideway segment of the transportation system test options were defined so that they would provide maximum service to congested commuter traffic sheds. They connect residential areas, where most people now reside and are projected to live in the future, with current and future major employment centers.

This commuting activity generates 54 percent of the total daily trips on the regional transportation system. In addition, the daily trip to work is concentrated into two relatively short time periods during each day (7-9 and 5-7) producing the transportation system's peak loads and most severe congestion.

The trip-to-work, or commute, patterns linking Twin Cities region residential areas and employment centers have already been well established by the regional freeway-arterial system. Commuting currently is done almost exclusively by private automobile carrying an average of 1.2 - 1.3 persons per auto. This reliance on the automobile for commuting has already produced appreciable congestion on several freeway-arterial segments (e.g. I-35W) during peak traffic periods. The congestion will continue to become worse as regional population and employment increase, generating more peak period commute trips.

The experience of every major urban center in the United States has clearly shown that continuing expansion of the freeway - auto mode of providing for commute trips cannot keep pace with growth in these trips. This is particularly true around major employment concentrations in relatively rapidly growing regions such as the Twin Cities. Because of high cost (in some cases over $20 million/mile) plus public resistance to freeways (e.g. T. H. 212, in northeast St. Paul, the southwest diagonal in Minneapolis, etc.) and the low capacity limit of the freeway-auto system, growth in commute trips will outpace growth in the Twin Cities area's freeway capacity around major centers. The result will be steadily increasing peak period congestion in large sections of this region's urban areas.

TABLE 7-3
TRANSIT INDUCED SUB-REGIONAL CHANGES IN SPATIAL DISTRIBUTION OF ACTIVITY

	TRANSPORTATION SYSTEM ALTERNATIVE					
Land Use/Activity Influenced	**Option A Test Systems**	**Test System BW**	**Test System BX**	**Test System BY**	**Test System BZ**	**Test System C**
I. Commercial Office:						
Degree of Shift	1-2% 1/	7-9%	8-10%	8-10%	12-14%	15%
Direction of Shift	● Maintain Status Quo with slight increase in Minneapolis CBD	● Strong increase in I-494 Corr. 2/ ● Moderate increase in Minneapolis CBD ● Slight increase in St. Paul CBD	● Strong increase in I-494 Corridor ● Moderate increase in Minneapolis CBD ● Moderate increase in St. Paul CBD ● Slight increase in I-94 East St. Paul Corridor	● Strong increase in I-494 Corridor ● Moderate increase in Minneapolis CBD ● Moderate increase in St. Paul CBD ● Slight Increase in Roseville	● Strong increase in Minneapolis CBD ● Moderate increase in I-494 Corridor ● Slight increase in St. Paul CBD ● Slight increase in Brooklyn Center	● Strong increase in Minneapolis CBD ● Strong increase in St. Paul CBD ● Moderate increase in I-494 Corridor ● Slight increase in other suburban centers.
II. Residential:						
Degree of Regional Shift	1-3% 1/	9-10%	11-12%	11-12%	9-10%	6-8% 3/
Direction of Shift	● Dispersed slight gain to south Minneapolis Corridor 4/	● Strong increase in south Minneapolis Corridor 4/ ● Slight increase in Minneapolis (Cedar Riverside) ● Slight increase in St. Paul (University Ave.) ● Slight loss in southwest Minneapolis ● Slight loss in northwest Minneapolis	● Strong increase in south Minneapolis Corridor ● Moderate increase in St. Paul (University Ave.) ● Slight increase in I-94 East St. Paul Corridor ● Slight increase in Minneapolis (Cedar Riverside) ● Slight loss in southwest Minneapolis ● Slight loss in northwest Minneapolis ● Slight loss in South St. Paul (Eagan)	● Strong increase in south Minneapolis Corridor ● Moderate increase in St. Paul (University Ave.) ● Moderate increase in Midway Corridor north to Roseville ● Slight increase in Minneapolis (Cedar Riverside) ● Slight loss in northwest and north Minneapolis ● Slight loss in East St. Paul ● Slight loss in South St. Paul (Eagan)	● Moderate increase in south Minneapolis Corr. ● Moderate increase in northwest Minneapolis ● Slight increase in Minneapolis (Cedar Riverside) ● Slight increase in St. Paul (University Ave.) ● Slight loss in west Minneapolis ● Slight loss in southwest Minneapolis ● Slight loss in East St. Paul ● Slight loss in South St. Paul (Eagan)	● Dispersed - mostly reinforcement near major activity centers (e.g., University) and suburban centers. Land use policy will be a prime factor. Staging schedule is critical.
III. Retail:						
Degree of Regional Shift	2% 1/	8%	10%	10%	11%	12%
Direction of Shift		● Proportional to Weighted Average of Commercial Office and Residential				

NOTES:

1/ Primarily after 1985.

2/ I-494 Corridor includes Bloomington, Richfield and Edina.

3/ Assumes construction staging of BZ option by 1980 and completion of remaining system by 1985. Nearly equal access to all subregions reduces net development potential shifts.

4/ South Minneapolis corridor includes south Minneapolis, Edina, Bloomington, Richfield and Burnsville.

Source: Development Research Associates

POTENTIAL AREAS OF COST SAVINGS

Congestion on freeway-auto transportation systems imposes considerable costs on certain populations - business - governmental groups in the Twin Cities region, including:

- Wasted time for the commuter
- Increased automobile operating costs, in terms of both increased operating time and decreased operating efficiency in stop-and-go traffic
- Visual, noise and atmospheric pollution
- Loss of property tax base since freeway right-of-way is public land
- High cost of freeway construction in already urbanized areas
- Forcing the costs of additional automobile ownership on people who need to commute
- Parking cost and land use in employment centers having intense land use and high land prices
- Increased delay costs for trucking industry purposes
- Loss of many productive hours of labor input to business operations when inclement weather combined with congestion essentially blocks commuting and other movement on freeways.

One major objective of the fast link fixed guideway system tested was to provide a feasible alternative for commute trips throughout the region. A fixed guideway commuting alternative to the freeway-auto system reduces peak period congestion on freeways and substantially reduces many of the costs listed above.

An alternative that incorporates a fixed guideway subsystem will provide a beneficial option to two groups who would otherwise use their automobiles to get to work. The most important are those commuters who would make their daily work trips on the fixed guideway alternatives rather than by automobiles. In addition, some of those who would continue to make most of their work trips by automobile, would use the fixed guideway alternatives when inclement weather meant delays on the highways and streets.

The individuals that will benefit most from the fixed guideway alternative would be those who "divert" from the region's highways and streets to the alternative. By the year 2000 this group will constitute a significant portion of commuters; it will range from 33,700 daily commuters under Test System B-W to 63,700 under Alternative C. The average annual savings that each member of this group will experience is shown in Table 7-4.

TABLE 7-4
NET ANNUAL SAVINGS TO DIVERTED MOTORISTS

	Average CBD Commuter	Average Motorists
Net Savings in Automobile Operating Cost	$229	$229
Parking Cost Savings	360	182 1/
Insurance Cost Savings	133	133
Additional Vehicle Savings 2/	150	150
Average Annual Expenditure	$872	$694

1/ Approximately 55% of diverted motorists are CBD destined.
2/ Assumes 50% of diverted motorists eliminate one car.

Source: Development Research Associates

The most likely recipients of these gains will be those who locate in the high density areas expected to develop around selected stations and who work in one of the major employment centers served by the transit system. Especially important in this regard will be single persons and young families with more than one member employed.

To realize the approximate $800 in annual cost savings, the diverted motorist will spend on the average 2 to 6 minutes longer on the commute trip. This increase for the diverted motorist declines substantially as the system reaches full operating efficiencies in the future.

CONCLUSION

System C, provides the strongest alternative for the commuters transportation needs. Because of the relative low level of congestion in the Saint Paul CBD corridor, System B-Z produces 70 percent of the peak hour reduction in congestion offered by System C.

LEVEL OF ENVIRONMENTAL PROTECTION

The investment in a major improvement in transit offers potential for a significant level of protection for the Twin Cities regional environment. These potential benefits include:

(1) Reduced Air Pollution
(2) Reduced Noise Pollution
(3) Improved Traffic Safety
(4) Reduced Pedestrian Conflict In Activity Centers

REDUCED AIR POLLUTION

Air pollution is distasteful, unattractive, and unhealthy. It is known to contribute to respiratory and other diseases. Firms operating in polluted areas must compensate their workers for these inconveniences -- a fact which can be confirmed by casual observation of the Southern California economy: similar occupations are more highly compensated in the Los Angeles area than urban areas with less polluted atmospheres such as San Diego or Santa Barbara.

Automobiles, especially in congested traffic, are heavy polluters. The proposed transit systems, by reducing the number of vehicle-miles driven within the Twin Cities Metropolitan Area, will result in a reduction of atmospheric pollutants. Since the choice of alternatives is not expected to have a significant effect on highway speeds, reduction in pollutants can be expected to be proportional to the vehicle miles saved through the implementation of an alternative. Alternative A will reduce vehicle miles least: its expected year 2000 reduction is about 52,600 miles daily. Alternative C offers the greatest reduction: it is approximately 178,900 miles daily in the year 2000. 1/ In terms of pollutants, reductions of approximately 425 pounds and 1,450 pounds of hydrocarbons daily, 560 pounds and 1,910 pounds of oxides of nitrogen, and 2,870 pounds and 9,750 pounds of carbon monoxide will result from Alternatives A and C respectively. The other systems would have intermediate effects.

This relationship produces the following ranking:

TABLE 7-5
POLLUTION REDUCTION EFFECT COMPARED TO AN ALL-BUS SYSTEM

	System A	System BW	System BX	System BY	System BZ	System C
Ranking	—	Moderate	Moderate	Moderate	Strong	Very Strong

REDUCED NOISE POLLUTION

The major metropolitan centers of North America have been subject to an annual increase in noise levels of approximately one decibel. At this rate, the present noise levels of most major urban areas will double every ten years. As in the case of air pollution, a regional transit program can contribute to the reduction of increased noise pollution by reducing the number of vehicle miles driven on the expressways and streets of the Twin Cities Metropolitan Area. Consequently, with regard to the reduction of automobile associated noises, this analysis parallels the discussion of reduced air pollution above and the alternatives rank in the same order.

Where the transit facilities will be underground, the noise they will produce will not reach the surface. Consequently, the transit improvement will definitely reduce the level of noise pollution in these areas. Facilities serving the Minneapolis and St. Paul CBDs -- two of the areas with some of the highest noise levels in Metropolitan Area -- will be underground. However, these facilities are incorporated in each of the fixed guideway alternatives and therefore no significant difference exists.

1/ Alan M. Voorhees and Associates, Inc.
2/ Calculations based on data in R. L. Duprey's Compilation of Air Pollutant Emission Factors. Durham, North Carolina; National Centers for Air Pollution Control, 1968.

IMPROVED TRAFFIC SAFETY

Implementation of each of the alternative systems will result in an increase in the number of transit passenger miles and a reduction in the number of automobile miles in the metropolitan area. Deaths per 100,000,000 transit passenger miles are much lower than deaths per 100,000,000 automobile passenger miles. Recently, deaths per one hundred million passenger miles have been 0.17 for buses, 0.09 for rail facilities, and 2.40 for automobiles and taxis.[1/] On the basis of these statistics and system operating data Table 7-6 contains an estimate of the number of lives saved in the Twin Cities Metropolitan Area under each alternative.

TABLE 7-6
ESTIMATED TOTAL LIVES SAVED TO YEAR 2000

	System A	System BW	System BX	System BY	System BZ	System C
Lives Saved to 2000	19	80	98	91	100	139

REDUCED PEDESTRIAN CONFLICT

Commercial development near station locations of fixed guideway transit systems is strongly pedestrian-oriented. In addition, the major emphasis on provision of people-mover circulation systems within major centers greatly increases pedestrian mobility. These two elements will reduce auto population and movement within centers. In turn this will result in reduced noise and smog/exhaust levels for these areas which will enhance the usefulness and attractiveness of existing and planned major centers.

COMPARISON OF ALTERNATIVES AS FEASIBLE AND WORTHWHILE REGIONAL PUBLIC INVESTMENTS

The previous discussions explain the multiple, beneficial effects of investment in improved public transit and relate those effects to the day-to-day lives of the residents of the Twin Cities area. The "state-of-the-art" of comparative benefit-cost analysis of transit investment allows a large portion of induced benefits to be quantified. To avoid unnecessary confusion only those benefits that have an established value are quantified in dollar terms in the following analysis.

Throughout the analysis, a consistent approach, using an identical benefit-cost framework was applied to each system. This benefit-cost framework has been professionally critiqued to eliminate any double-counting or inclusion of transfer benefits. The methodology used in this analysis of the test systems being considered for the Twin Cities area either has, or is being applied for public decisions in Washington, D.C., Seattle, Atlanta, San Francisco, and Philadelphia.

The individual benefit calculations are realistic and usually conservative measures of a particular type of potential gain improved transit could provide. While all the beneficial effects are quite real, some are easier to identify in measurable terms than others. Where quantification of benefits in dollar terms has been possible, estimates of benefits have been provided. (See Technical Report No. 7 - Benefit-Cost Analysis for a detailed discussion of the assumptions, procedures, and data sources used to make the estimates)

This collective measure of the "net benefits" of each test system to its "net costs" is a valuable evaluation tool. Others that merit equal consideration are non-quantifiable benefits discussed previously, and comparable burden on local fiscal resources. Together these three become the critical criteria for evaluating the feasibility of alternative test systems.

QUANTIFIED BENEFITS

In this effort, only a portion of the total benefits that will result from an investment in improved public transit were quantified while all the related costs were considered. However, in a consistent, comparable fashion all the alternatives that include a "fixed guideway"[2/] component were shown to provide major incremental benefits to the residents of the Twin Cities. These incremental gains were over and above what could be expected through expansion of the present type of bus service. In dollar terms these quantified net benefits will range from approximately $70 million discounted, constant - purchasing power dollars for test system BW to $245 million dollars for test system BZ. The net benefits come principally from four sources:

- **Transit Dependent Residents**
  Transit dependent commuters will be able to get to and from their jobs much more rapidly. Depending on what alternative is implemented they will have on the average from 15 to 25 minutes a day available for other uses. Time savings on a non-commuter trip would average 25 to 35 minutes per day. This will not be wasted time. Individuals, through slight adjustments in their daily schedules, will be able to spend this time in other activities.

[1/] 1964-1966 Average from World Almanac and Book of Facts, 1968, p. 900

[2/] Option A test systems (which includes only buses) provide differences in quality of service. However, in quantifiable terms, i.e., patronage, user benefits, they cannot be distinguished from each other.

- **Diverted Motorists**
  If a fast link system is implemented, many commuters will cease using their automobiles to get to work and will ride transit. The number that will shift by the year 2000 will be between 33,700 for Test System B to 63,700 for Test System C. These "diverted" commuters, will make slightly longer trips to work. However, they will be able to obtain large savings by not providing their own transportation by automobile. They will be able to reduce their expenditure for gas and oil, car maintenance, parking and insurance. Many will find that they will be able to reduce automobile ownership thus saving this annual depreciation cost. On an annual basis the average individual motorist commuting to the CBD will save $872 from these combined sources when diverted to transit.

- **Infrastructure (Highway Cost Savings)**
  Commuters diverting to public transit means that fewer expressways will have to be constructed to provide the same level of service to the individuals who continue to use their automobiles. From 4.7 miles of expressway (Test System BW and BY) to 26.5 miles (for Test System C) of highway construction beyond System 16 could be eliminated and still maintain the same average highway speeds. This estimate takes into account the Twin Cities regional transportation needs through the year 2000.

- **Reduced Operating Costs**
  Few probably realize how costly it will be to maintain an expanding level of bus service in the Twin Cities area. On a per passenger basis the projected operating costs of buses are much higher than fixed guideway systems, 71 cents per passenger versus 54 cents per passenger on the B and C Systems. Consequently, important public savings in the form of reduced operating subsidy are possible through shifting a large proportion of "constant" transit users from more expensive buses to less costly fixed guideway systems.

COMPARISON OF BENEFITS TO COSTS

Figure 7-3 presents a summary of the comparison of the incremental benefits and costs of each Test System. More detailed analysis certainly would result in a higher level of quantified benefits but the merit of this analysis is that each system was compared in a consistent fashion to the same base.

At this level of quantification, it is not possible to distinguish between the merits of Systems BW, BX, and BY. It is sufficient to note that their incremental benefits approximate their incremental costs. Test System BZ clearly is shown to be the most efficient system.

This comparative analysis indicates that Text System BZ yields approximately four times the net incremental benefits of System BW and approximately 1.2 times those of the largest Test System C as shown in Table 7-7. Per dollar invested, System BZ clearly provides the highest level of user benefits and will permit almost as much reduced expenditure for proposed future urban highway construction and maintenance costs as test system C. The high level of efficiency of test system BZ can be attributed to the fact that it services the most congested corridors and fastest growing sections of the region.

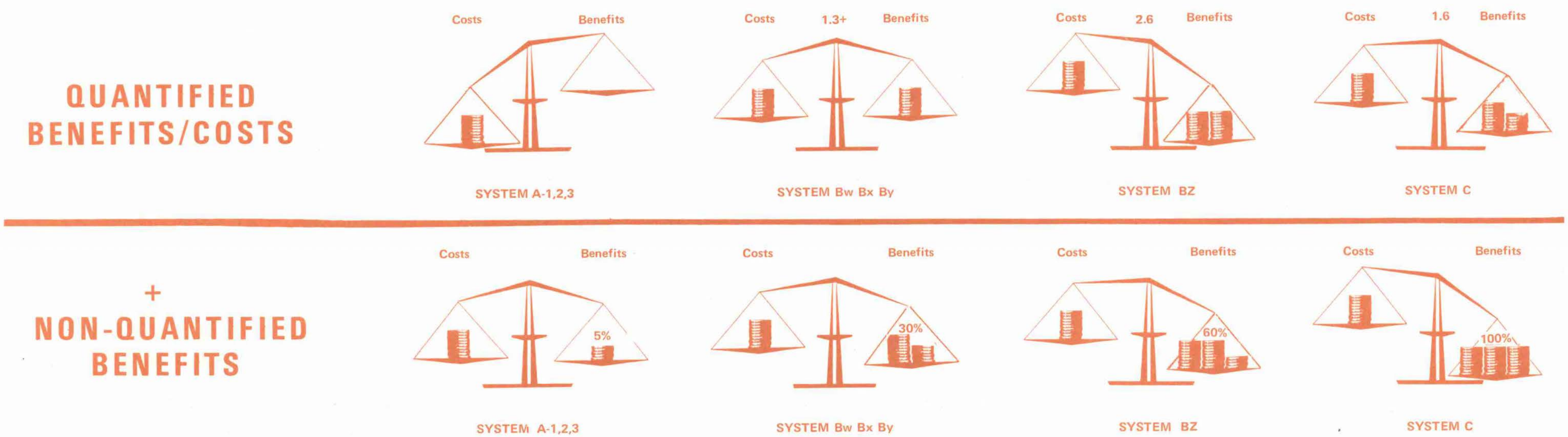


Figure 7-3 Summary of Incremental Benefits and Costs for each Test System

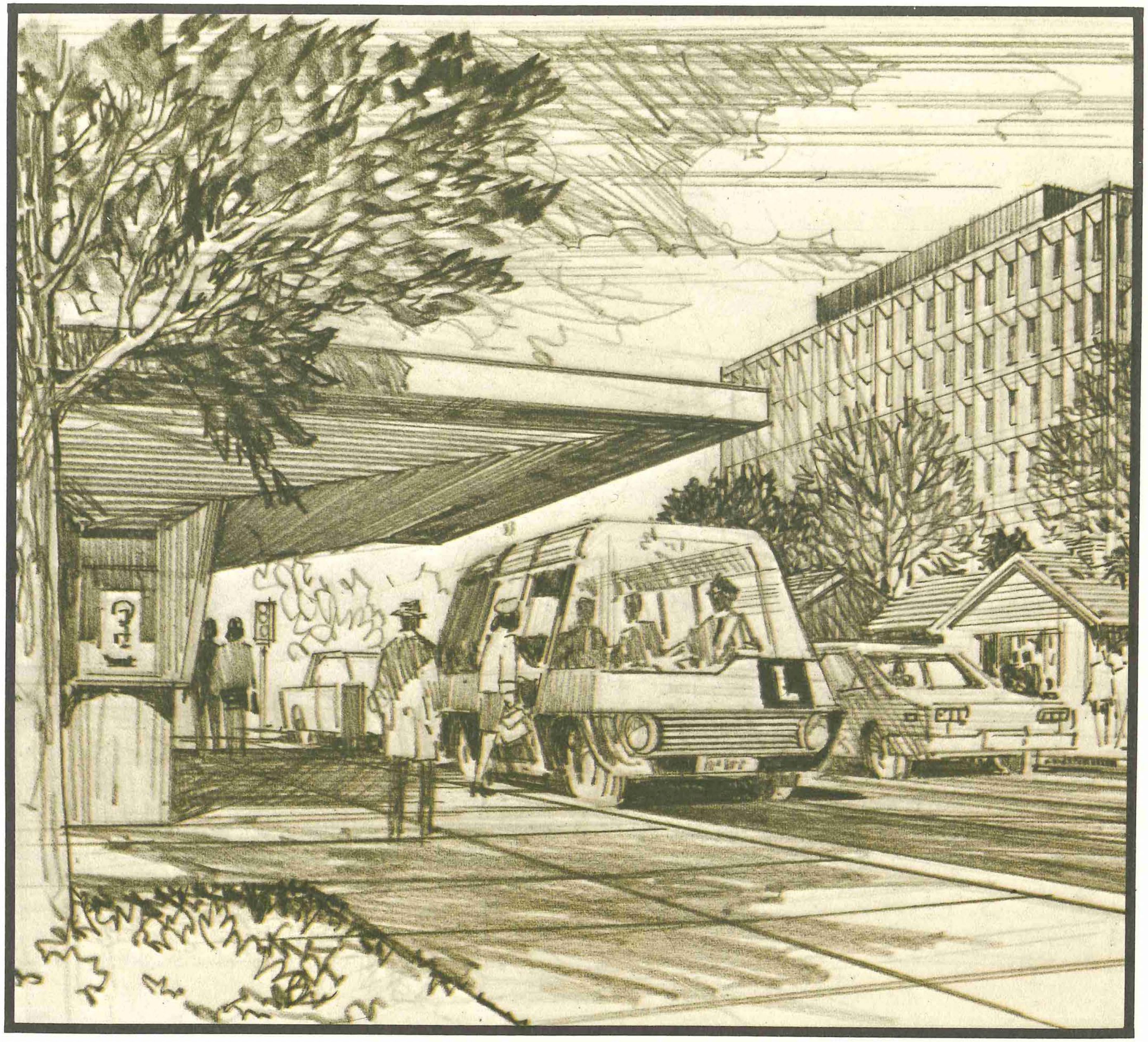
TABLE 7-7
COMPARISON OF PRESENT VALUE OF BENEFITS AND COSTS
($ millions)

System	Incremental Benefit 1/	Incremental Cost 2/	Net Incremental Benefit 3/
A-1		(Basis for Comparison)	
A-2	4/	------	------
A-3	4/	------	------
B-W	300	230	70
B-X	325	235	90
B-Y	315	255	60
B-Z	400	155	245
C	510	310	200

1/ **Incremental Benefit** – present worth of net benefit derived from each system less system A-1 benefits.
2/ **Incremental Cost** – present worth of net capital and operating costs less cost of system A-1 and all savings in highway construction cost attributable to each system.
3/ **Net Incremental Benefit** – benefit less cost.
4/ Various "A" test systems produce different quality of service but in quantifiable terms they cannot be distinguished.

BASIS FOR CHOOSING SYSTEM LARGER THAN BZ

Test system C was shown to generally provide "more" of the benefits that have not been able to be quantified in dollar terms. They include: (1) reduced air and noise pollution, (2) more and longer trips made by non-commuter constant transit users, (3) less time lost due to greater reliability in inclement weather conditions, and (4) more lives saved due to greater per mile safety record of fixed guideway transit. In addition, this option was shown to have incremental benefits that were 1.6 times incremental costs. If the regional decision makers feel that the residents of the areas would be willing to pay the required incremental investment in order to experience the superior level of these benefits, then they would be justified in choosing a system larger than BZ.



The small bus shown on the artist's drawing has a variety of service applications within the "Family of Vehicles" concept including Dial-a-Ride, downtown distribution and service to low density volume fast link corridors.

8
PROGRAMS FOR LONG RANGE FINANCING

With the September 18, 1970 acquisition of Twin City Lines, the Metropolitan Transit Commission assumed the full fiscal responsibility for the operation, maintenance and improvement of the great majority of Twin Cities area transit service. One of the basic reasons for this decision was to ensure that an adequate and reliable level of transit service would be maintained for the present and future residents of the Twin Cities region. Attaining this objective will require a program of service expansion and capital improvement. Therefore, fiscal resources beyond the operating revenues must be identified and their availability established.

To determine what the most appropriate fiscal resources and instruments would be, a majority of existing and proposed North American systems were surveyed in addition to existing and proposed State and Federal programs. These efforts were completed in close liaison with fiscal authorities and agencies involved with major capital funding in the Twin Cities.

From this local involvement two key observations were made. First, a major improvement in public transportation in the Twin Cities area will have to compete for funding with a variety of other public services with already established debt programs that must continue to be funded. As a result, taxable resources that are either not being used by these "traditional" public services or that portion of taxable resources that can be demonstrated as being created by the implementation of a public transportation system must be sought.

In short, the objective is to design a financial program which minimizes local costs, but which is adequate, equitable and implementable. It should be noted, that the financial concept design did not attempt to eliminate any local fiscal disparities that may exist outside the area of public transit. Any selected program for transit financing must, however, avoid adding disparity and, therefore, allocate costs according to the "benefit principle".

PRESENT FINANCING METHODS

Over the past several years, many other North American cities, large and small, have been involved in finding adequate funding for their transportation programs. A review of the methods used by several of these cities and transit agencies has been made for any ideas that would be pertinent to the development of the financial program for Twin Cities transit development.

From this survey it was evident that traditional transit financial tools have proved to be largely insensitive to the benefits accruing from public transportation improvements. Time savings, for example, which traditionally account for a significant portion of measurable system benefits, cannot be captured directly. In addition, the timing of the benefit and cost streams is such that even if system benefits could be captured, their magnitude is generally not sufficient in the early years of the project to cover the debt service for costs of construction. Therefore, any departure from the traditional approach to transit financing was of particular interest.

A tabular summary of results of the survey is presented in Tables 8-1 and 8-2.

The following findings of this survey of other North American system financial operations contributed significantly to the financial conclusions reached in this study.

- **Operating Expenses**
  Of eight systems in operation, two (Toronto and Delaware River Port Authority) are estimated to be in a breakeven position - the other six encounter recurring operating deficits.

- **Capital Cost Amortization**
  No operating transit system is able to make significant contributions to capital debt reduction from operating revenues. Although there is an apparent availability of fare box revenues in two of the eight operating systems, these apparent revenues have not been used to secure bonds -- i.e., pledged as the ultimate security for debt service of system debt. From interviews with leading investment banking institutions, it was concluded such "fare box" revenue bonds could not be sold. This is due in part to their historically declining magnitude and partly to the traditionally high (and volatile) operating ratios of transit systems.

In the course of this research, the individual system managers interviewed were asked for suggestions regarding strategies for financing a new public transportation system, assuming capital costs ranging upward from $400 million. The following represents a consensus of these suggestions and observations:

1. Due to the depletion of the local tax base in nearly all cities and the increasing demands made on this base, traditional public transit financing will probably be impossible for the foreseeable future. Therefore, new resources and new financial tools must be obtained.

TABLE 8-1
SOURCES OF REVENUE COVERING OPERATING EXPENSES
ON EXISTING SYSTEMS
(Distribution in Percent)

		DEFICIT ASSISTANCE					
		Metropolitan Area					
	Users	State	Property Tax	Other	Special Districts	Other Revenue Sources 1/	Other
BART (Projected)	110 2/	–	–	–	–	–	–
Washington, D. C. (Projected)	230	–	–	–	–	–	–
Toronto	100	–	–	–	–	–	–
Montreal	94	–	6	–	–	–	–
MBTA	–	7	–	–	30	–	63
Cleveland	97	–	–	3	–	–	–
Port of New York Authority	49	–	–	–	–	51	–
New York MTA	87	*3/	*	*	–	*	–
Delaware River Port Authority	100	–	–	–	–	–	–
Chicago Transit Authority	90	*	*	*	–	–	–

1/ Toll bridges, docks, airports, etc.
2/ Greater than 100% coverage by user means that system is estimated to have an operating surplus.
3/ An asterisk indicates a source of assistance but of unknown amount.

Source: Development Research Associates

TABLE 8-2
SOURCE OF CAPITAL FINANCING FOR EXISTING SYSTEMS
(Distribution in Percent)

			Metropolitan Area					
	Federal Government	State	Property Tax	Sales Tax	User (System Revenues)	Special Benefit Districts	Other Specific Sources 1/	Other
BART (Projected)	9	–	62	12	–	–	14	3
Washington, D. C. (Projected)	42	–	23	–	35	–	–	–
Toronto	7	23	49	–	21	–	–	–
Montreal	–	–	100	–	–	–	–	–
MBTA	39	40	–	–	21	–	–	–
Cleveland	67	–	31	–	–	–	–	2
Port of New York Authority	14	–	–	–	–	–	86	–
New York MTA	-	50	50	–	–	–	–	–
Delaware River Port Authority	–	2	8	–	–	–	90	–
Chicago Transit Authority	67	–	–	–	–	33	–	–

1/ Toll Bridges, Docks, Airports, etc.

Source: Development Research Associates

2. Those interviewed were optimistic regarding future Federal participation, due to the enactment of a variety of new and proposed legislation.

3. A majority of the officials interviewed were looking to significant state participation, either directly or indirectly through state departments of transportation. Of the systems examined, four had received state participation in defraying capital costs, and three received state assistance to cover operating deficits.

4. It was often suggested that financial tools and resources directly connected with the public transportation system be utilized as heavily as possible for the costs that must be borne by the local area. Tax increment bonding, revenue bonds, equipment trust certificates, and other tools were often mentioned.

   It should be pointed out, however, that most of these tools have not been attempted in connection with the systems examined.

5. Finally, for that portion of the local costs which cannot be supported by resources directly linked to the transportation system, those interviewed recommended that a wide variety of general taxes be used, rather than placing heavy reliance on a single source.

POTENTIAL FEDERAL PARTICIPATION

Based on a thorough analysis of newly enacted Federal legislation (see Technical Report No. 6, Financial Plan) the project team concluded that the Federal government will offer major assistance in defraying the local burden of capital costs. This conclusion is based upon the nature and direction of newly enacted Federal legislation and on the fact that the Twin Cities has not, in the past, received major Urban Mass Transportation monies.

If the approach to the allocation of existing or proposed Federal programs is measured on the basis of per capita share, the State of Minnesota could, for qualified transit capital improvements, expect 2% or $200 million of the $10 billion proposed for appropriation during the next 12 years.

Legislation enacted under the Urban Mass Transit Act of 1970 has established $3.1 billion in funding of which $0.8 billion is already committed. A review of all planned or seriously proposed regional systems indicated that there is today approximately $30 billion in potential requests for the proposed $10 billion - 12 year program. Thus, it is apparent that competition for future Federal funding will be intense and that a strong local program will be necessary to assure a high level of Federal participation in the Twin Cities' program.

This need for a strong program is further strengthened by the fact that, compared to other regional programs under consideration, the Twin Cities might not be viewed with the same degree of urgency. The current dispersed low density development pattern, a strong relatively uncongested freeway network, and a relatively small "transit dependent" population could contribute to a lower priority for major Federal commitment.

While these must be recognized as negative conditions, there are mitigating factors. To date, the Twin Cities area has received very little Federal support, approximately $20 million for acquisition and improvement of the existing bus line, the mini-bus (Nicollet Mall) demonstration, etc. It is the general opinion of UMTA that their funds have been well managed. These are both positive factors supporting the expectation of substantial Federal support. A working hypothesis has been developed recognizing these factors and assuming that the full $10 billion will actually be appropriated over the next 12 years and that the Twin Cities will receive funding roughly in proportion to Minnesota's population to total U.S. population.

It is assumed that the Urban Mass Transportation Administration (UMTA) will contribute approximately $200 million to the Twin Cities transportation program over a six-year construction period. This figure may be increased by as much as $100 million for the "higher" system options because of their longer construction period. It should be noted that, based on the Twin Cities metropolitan area share of the total U.S. urban population, the Twin Cities would receive about 1.4% or $140 million.

OTHER CONSIDERATIONS

Federal appropriations normally do not include allowance for inflation. In other public works programs this problem has been met by additional appropriation prior to the end of an approved program. It is reasonable to expect that the $10 billion - 12 year UMTA program could be increased prior to 1982 to cover rising demands.

Secondly, there are many factors which indicate that the political climate for increased Federal support of transit is improving. What form or level or when this will happen cannot be determined at this time. However, when considering a 30-50 year planning period this factor should not be overlooked.

Thirdly, those systems that do commit a local share of fiscal support could reasonably expect to receive a higher priority than those that do not. If the Twin Cities area would commit a significant level of local funds e.g., $250 million, over the next decade, this region would have a higher priority than the other systems currently being planned.

Therefore, this region could embark on its future transit planning activity seeking the maximum two-thirds proportion of Federal support. This policy should include:

(1) Near term (1971-75) commitment of substantial local funds.
(2) Restriction of the use of these locally committed funds to one-third local dollars per two-thirds Federal support.

Then future cooperative efforts in concert with other metropolitan areas would have the highest probability of success in achieving the guarantee of two-thirds Federal support.

POTENTIAL STATE PARTICIPATION

A significant amount of Federal and State highway monies will become available for bus and related facilities as a result of Federal Highway Administration policy and the desire of the Minnesota Highway Department to allocate its monies "cost-effectively." This stems from the desire of Federal and State highway officials to maximize the movement of people rather than vehicles. The extent of this assistance will have to be worked out on a case by case basis and is heavily dependent on the extent to which the public transportation program is related directly to the highway program.

It was determined that realistically this may amount to as much as $70 million based on our understanding of the

TABLE 8-3
PROPOSED NEW STRUCTURE FOR FUNDING
METROPOLITAN TRANSPORTATION NEEDS

Name of Fund	Use of Funds	Type of Costs Supported	Sources of Revenues	How Distributed
Transit (Existing)	Operation, maintenance and vehicle replacement	Basic Bus System	Property, income sales or excise taxes	Regional Transit needs at Metro Level
Highway	Maintenance, Reconstruction	Highways	State Highway User Funds and lesser Property Tax Revenues	Regional Highway needs at Metro or State Level
Intermodal Development Fund (Proposed)	Capital improvements which position new development	Highways[1/], Bridges, Express Bus, Fast Link, etc.	1) Portion of highway user funds 2) Wheelage tax 3) Excise Taxes 4) Property Tax (non incremental)	By Service Area/By Modal need at Metro Level

[1/] Limited to new highway construction only.

Source: Development Research Associates

elements of the transit system that should qualify under this expanded definition of a highway purpose. These elements could include bus stations, shelters, parking, and other fixed facilities.

Certain portions of the proposed system will directly assist state operations at the Capitol and the University of Minnesota. Therefore, it is assumed that the State could pick up 50 percent of the cost of these facilities or $13 million.

LOCAL FINANCIAL SOURCES

From the analysis of how other transit systems meet operating and capital costs, together with a review of costs of alternative transit systems for the Twin Cities, we have concluded that the present funding structures for regional transportation are inadequate to meet the transit needs of the future. For example, it is apparent that the $1 wheelage tax will not provide the needed revenues required annually through the 1970's just to keep the existing bus transit financially solvent.

Clearly, any major expansion of transit services would require funding beyond the ability and practicality of wheelage tax dependency.

The required local share of regional transportation costs could be more equitably distributed if the Twin Cities Area transportation needs were funded differently. Table 8-3 presents a suggested metropolitan-based transportation funding structure which could accomplish this.

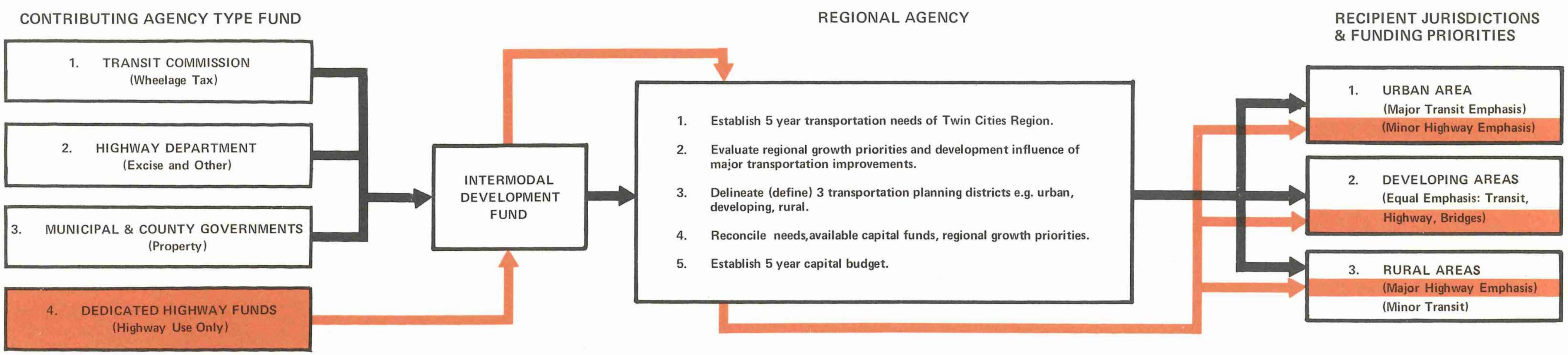


Figure 8-1 Inter-agency Intermodal Development Fund Coordination

EXPANSION OF EXISTING TRANSIT FUND

Funding for the current bus system - including the major carrier (MTC), suburban operations subsidies, and school bus operations - should be recognized as regional in nature and funded from a common source. Today approximately 50 percent of all bus trips (including those made on school buses) in the seven county area are school trips. Thus it would appear feasible to fund the basic bus systems and the subsidies necessary for suburban lines from a source common with other school subsidies, (income, sales or property tax) to increase the contributions to the existing transit fund for these purposes.

INTERMODAL DEVELOPMENT FUND

Because the transit needs of the urbanized Twin Cities metropolitan area require additional transportation modes other than those suitable for less populated areas of the State, transportation funding must be based on a recognition of these differing needs.

Accordingly, it is suggested that existing and future regional seven county transportation development dollars for capital improvements flow to a special fund which is referred to herein as the Intermodal Development Fund. To this fund would accrue those monies intended for development of new transportation links. Such links might be additional miles of highway, exclusive right-of-way for express buses, or fixed guideway transit systems.

The distribution of these funds would be based upon the type of transportation mode appropriate to serve the various needs of the population within the metropolitan area. Such modes as best serve higher density, urbanized areas would be different than those used in less populated rural areas. While development of a fast link transit system would more efficiently serve the core areas, highways might better serve the rural area and modern bus systems could serve best in the developing suburban fringes.

Although the primary definition of the three types of transportation service areas would be based upon density of development (persons per square mile), it could also include additional factors such as natural boundaries (rivers) or regional planning goals (major diversified centers).

Allocations from the Intermodal Development Fund could be defined as "those transportation expenditures which determine the direct regional growth patterns." As such, the construction of new highways, bridges and transit systems should be planned and programmed at the metropolitan level of government. The body responsible for the allocation of the funds must be representative of, and responsible to, the citizens of the seven county area.

The distribution of the funds within the region would be decided, for planning purposes, for five year periods. Consequently, transportation funding among the various modes would be assured for five years into the future.

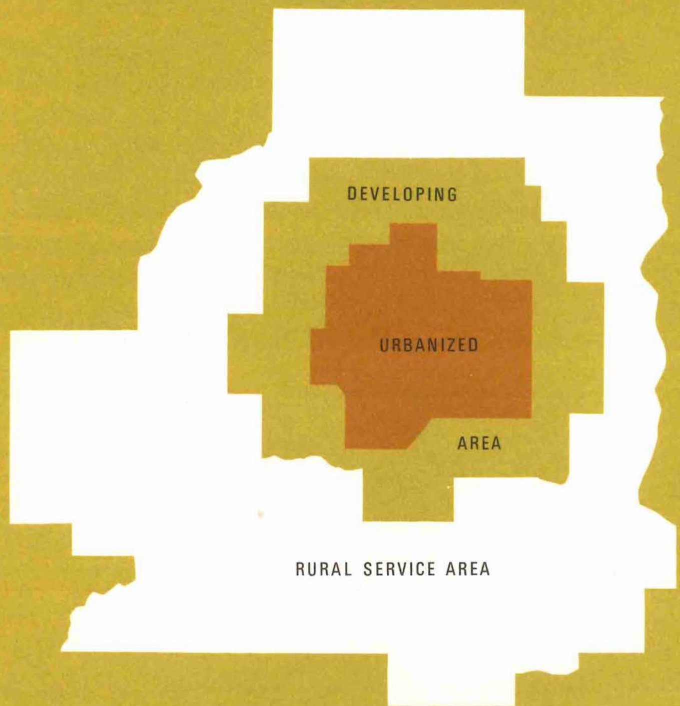
An example of how the funds would be allocated to service areas within the region (rural, developing and urbanized) and among the various modes (highways, busways, bridges,

TABLE 8-4
BASIS FOR INTER MODAL FUND DISTRIBUTION
ILLUSTRATIVE ONLY

Type of Capital Improvement	Character of Service Area		
	Rural	Developing	Urbanized
Highways, Bridges, etc. (50%)	30%	18%	2%
Fast Link, Express Bus (50%)	3%	15%	32%
(100%)	33%	33%	34%

SEVEN - COUNTY AREA

Source: Development Research Associates



TENTATIVE DEFINITIONS:

Urbanized Area:
The Cities of Minneapolis, St. Paul and contiguous urbanized areas.

Developing Area:
The area designated by the Metropolitan Council to receive future growth.

Rural Area:
Those areas primarily agricultural in nature with scattered housing and containing smaller municipalities.

fast link) is shown in Table 8-4. It is emphasized that the percentages shown are for illustration only and not intended to reflect the magnitude of transportation needs of each type of service area within the region or the relative appropriateness of the modes to that particular area.

The sources of annual revenues for the Intermodal Fund could include the present $1 wheelage tax, a portion of future excise taxes and an appropriate portion of highway funds. Currently, an estimated $44 million from property taxes and related assessments flows to the local highway departments. A portion of this, say $10 million, might gradually flow to the Intermodal Fund as new highways, bridges and highway relieving systems were proposed (see Table 8-5). The aggregate total of this fund might amount to as much as $43 million dollars in the early 1970's. By 1985, the projected expansion in the property tax base and the number of vehicles could bring the annual revenues of the Intermodal Development Fund to $79 million dollars.

This approach coordinates public investment in transportation facilities affecting regional development but does not represent an attempt to divert highway funds to transit.

URBAN TRANSIT DISTRICT ALTERNATIVE

The Intermodal Development Fund, however, does represent a significant alteration in traditional regional transportation financing techniques. Because of this, implementation of the Fund may prove infeasible over the short run. Thus, it is important to examine an alternative approach which accomplishes the same basic objectives. This alternative is an "Urban Transit District."

The purpose of the district would be to allow an equitable funding of that portion of the transportation system — the fast link portion, specifically — which produces benefits primarily to the area served. For each of the options examined, this area would probably correspond closely with those entitled "developing" and "urbanized" in Table 8-4.

Such a district would have to be enabled by the State Legislature, or, should it choose to do so, the Legislature could delegate the decision to the affected communities.

Revenues could be made available to the district through diverse sources, including property taxes (such as the Massachusetts Bay Transit Authority), sales tax (as with the Southern California Rapid Transit District), and other excise taxes. In the case of sales and excise taxes, the State Legislature would have to approve a sub-vention to the district.

As with the case of the Intermodal Development Fund, the Transit District could be utilized to finance either a fixed guideway or a bus system. The District alternative, however, does have at least two disadvantages relative to the Intermodal Development Fund:

- First, the District would preclude overall control of the different transportation needs of the various areas. Different modes would, in effect, be competing with one another as they have in the past. This makes an efficient allocation of resources more difficult and means that taxes will likely increase more under this alternative in achieving the same level of transportation service.

- Second, the District approach also inhibits the ability of the region to plan effectively. Control of the development of all modes — that is, control of funding mechanisms for each of the modes — is desirable for comprehensive and effective planning.

Thus, the Intermodal Fund appears clearly the better alternative, and all efforts should be directed toward implementing it. This conclusion is valid no matter which

TABLE 8-5
POSSIBLE SOURCES AND GROWTH OF REVENUE FOR INTERMODAL FUND
(millions)

	1970	1985
I. Available for Highway or Transit Capital Improvements		
Wheelage Tax @ $1	$ 1.1	$ 2.0
Portion of Future Excise Taxes	12 (est.)	21 (est.)
Portion of Property Tax Presently Accruing to Local Highway Departments 1/	10.0	20.0 2/
II. Available for Metropolitan Highways (from trunk highway fund)	20.0	36.0
Total - for transportation capital improvements that shape the region	$43.1	$79.0

1/ Based upon projected growth in property tax base, not an increase in rate.

2/ Funds could be replaced through re-allocation of highway user fund by a future legislature.

Source: Development Research Associates

option of transit improvement is selected. Even the "least cost option" of a higher level of public transportation service, Option A, will require substantial public funding for capital costs between $38 and $112 million. Clearly, this amount cannot be amortized from the existing $1 wheelage tax and continue to support increasing deficits in operating revenue. This underscores the need for both:

1. More revenues for the existing Transit Fund.
2. Intermodal Development Fund implementation or the establishment of the Urban Transit District.

Hopefully, steps can be initiated at an early date to achieve both objectives.

PRELIMINARY ALIGNMENT OF BENEFITS AND COSTS

Based on this analysis a program has been developed which is considered financially solvent, implementable and allocates, to the extent possible, the proportionate share of annual cost to be borne by each benefitting sector within the Metropolitan Area. The distribution of costs between the various available fiscal resources will vary with system size and impact as will the annual amounts required for repayment of capital debt. The cost distribution shown in Table 8-6 employs BZ costs for illustration only and recognizes the following sources of funding:

Federal Grant-In-Aid — These funds are estimated at $200 million for the "middle" test systems and up to $300 million for the "higher" system.

State Contribution — On a conservative basis, the State could underwrite one-half of the $26 million cost for transit stations serving state institutions.

Reimbursable Highway Costs — From discussions with Highway Department staff, review of transit impact studies for Minneapolis - St. Paul area and other local information sources, "highway relieving" reimbursable costs are estimated to be $70 million.

After the above "pay as you go" type direct-cash outlays have been made, the balance of $466 million is amortized at 6 percent over a 40 year repayment period. It is assumed that the general obligation borrowing mechanism would be utilized to obtain the most favorable financing terms. However, there is no primary reliance upon the general taxing power of the metropolitan region to repay the loan and no increase in tax burden is expected. If the bonds were amortized in equal annual installments, the annual debt service would amount to $31 million.

This annual $31 million debt service requirement could be shared among the benefitting sectors as follows.

Intermodal Fund — An estimated 50% share of the Intermodal Fund was dedicated to fast-link support. By 1985, this proposed fund would receive $79 million per year. Of this, an assumed 34 percent would serve "urbanized" area transit needs or potentially $27 million per year. For this example, $17 million was earmarked for transit purposes.

Special District Benefit Assessment — Owners of land and improvements in areas adjacent to or near fast link stations will realize benefits in the form of higher property values. Other residents will discover their property's value has increased and is more suitable for multiple family residential use. New development will be drawn to station areas to take advantage of greater pedestrian shopper activity and accessibility to larger pools of employees. The estimated new development of higher property values will be redistributed from the region to transit oriented areas. These new values will produce a property tax increase estimated to be $9 million per year in 1990. This increase or its equivalent could be captured in the form of special district benefit assessments. Quite possibly greater revenues

TABLE 8-6
POSSIBLE SOURCES OF FUNDING FOR OPTION B-Z CAPITAL AND DEBT SERVICE COSTS

ILLUSTRATIVE ONLY

Test System B-Z Estimated Costs	$749 million [a]	
Less: Estimated Federal Grant-In-Aid	200 [b]	
Non-Federal Share	$549	
Less: State Assumed Half Cost of Stations for University and Capitol Areas	13	
Metropolitan Share	$536	
Less: Direct (reimbursable) highway related facilities (bus, parking, etc.)	70	
	$466	
Annual Amortization Cost @ 6% over 40 Years	$31.0 million per year	
Example of Annual Local Share Cost Distribution with:	**Intermodal Fund**	**Transit District**
Intermodal Development Fund or Transit District	$17.0	$10.0
Special District Benefit Assessment	9.0	9.0
Retail Sales Assessment	2.0	2.0
Transit Fund (Bus Renewal)	2.5	2.5
Regional Benefit	0.5	7.5
	$31.0	$31.0

[a] Costs in construction year dollars includes engineering and contingencies.

[b] Higher system options may qualify for larger federal share because of longer construction phasing.

TABLE 8-7
HOW BENEFIT-CAPTURE MECHANISMS COULD BE ALIGNED TO COST ITEMS
(In Annual Debt Service - Millions of Dollars)

FOR ILLUSTRATION ONLY

Amortization Cost/Item	Intermodal Fund	Special Assessment	Retail Assessment	Transit Fund	Regional Benefit
Existing Bus System				X	
Expanded Bus System	X				
Parking Facilities	X				
Guideway Facilities	X				X
Fast Link Vehicles	X				X
Commercial Area Stations		X	X		
Residential Area Stations		X	X		
Yard and Shop Facilities	X	—	—	—	X
TOTAL ($31.0)	$17.0	$9.0	$2.0	$2.5	$0.5

Source: Development Research Associates

could be captured in the form of a real estate transfer tax on property whose value will appreciate after transit improvements are announced and built.

Retail Sales Assessment — Merchants at transit stations will experience gains in retail sales. A share of this gain estimated to be $2 million could be captured by means of tax on the incremental gain. The Local Improvement Law could be amended to provide for transit improvement benefit assessments. So amended, the benefit district could tax property value gains described above as well as tax incremental gross retail sales. The implementation of such a special benefit district would have to be formulated and created on a neighborhood by neighborhood basis.

Transit Fund — A portion of the cost of Systems A, B, and C is earmarked for augmentation of the existing bus service system. The cost of this item plus the replacement of the existing fleet along with some operating expenses would be paid from the existing transit fund, estimated to be $2.5 million per year for Test System B-Z.

Regional Benefit — The remaining portion of the annual debt service requirement could be allocated to the region in general. This cost allocation would recognize the many non-quantifiable benefits accruing to all citizens from transit improvements such as:

- Reduced air and noise pollution
- Greater mobility for the transportation deficit residents
- Facilitation of regional development objectives

The benefit could be captured in the form of a regional payroll tax, excise tax or property tax.

The precise allocation of annual amortization costs could be determined upon more refined estimates of station improvement cost and station (route) locations, Such an allocation is illustrated in Table 8-7, assuming an Intermodal Fund.

9

SUMMARY OF FINDINGS

In the introduction to this report a number of questions were posed. The study has been addressed to providing answers to these questions in terms of identifying options that exist, and describing consequences of each. Alternatives and consequences were quantified where possible. In addition, a number of intangible or qualitative elements relating to transportation decisions were identified. This applies both to the desirable level of service and system concept selection, as well as the time frame in which the implementation program should occur.

Preceding chapters of this report have summarized the work performed. This section draws together the major findings in direct response to the questions posed in the Introduction.

FINDINGS

1. *Does the Twin Cities area need a new form of transit; if so, what form or forms could it assume?*

Based on the projections of population growth, about 3.4 million people will reside in the region by the year 2000. There will be approximately 1.8 million jobs requiring access every weekday. There will be an additional 37.3 million square feet of office space alone constructed in the region by the year 2000 with about 50 percent of it locating in the two central business districts of Minneapolis and Saint Paul. This growth will increase travel demands significantly. Combined with these general growth predictions, the number of individuals who are mobility deficient will increase. These include the aged, the young, students, low income families, etc. - who do not or cannot drive automobiles.

Examination of bus transit statistics nationally as well as in the Twin Cities clearly indicates that current bus systems do not provide an acceptable service, and patronage has been falling rapidly while costs have been rising even faster. Past and current freeway programs for the Twin Cities have so far been able to keep pace with growing traffic demands although congestion is building rapidly.

The completion of the proposed highway network may be expected to have two, somewhat opposing, effects. In most cases, it will make suburban travel easier and faster. At the same time, increased suburban capacity is not balanced by a corresponding increase in the central areas, creating greater and greater congestion on the downtown freeways and arterial streets.

The net result, even with expanded bus service, is to create increasing pressure for more freeways on the one hand, while facing increasing environmental opposition on the other. The apparent alternative is to provide a new form of transit in the Twin Cities. In form, it could range from an innovative approach to bus transit, to introduction of a totally new vehicle system. In any case, the system must recognize the variety of needs and functions established by the various service areas within the region.

2. *What principal options for regional development and transit service are available to this local area, taking into account the anticipated scale of future growth and lifestyle preferences of residents?*

From the standpoint of regional development options the region cannot continue its present course of low density development without eroding the life style through the sheer magnitude of growth. The expansion of the urban area through current development practices will result in longer travel times to work, the frustration of freeway congestion and a general separation of the area's population from many of the urban activities. However, the Metropolitan Council has made it quite clear that a more structured and organized development pattern is required if the region is to maintain or hopefully improve the life style opportunities. The Council has identified the concept of "Major Diversified Centers" with continued strength in the two existing Central Business Districts as a development pattern which will optimize the creation of new living opportunities. Therefore, any transit system should be expected not only to increase opportunities to residents, but should reinforce the structure that maximizes those opportunities.

The preferred life style in the Twin Cities region is indicated by the fact that 81 percent of the 1960 housing stock was in one and two family units. A combination of factors has, however, produced a major shift in new construction. Currently, 70 percent of all new housing starts are multiple family units and this rate is expected to be maintained through 1995. At this rate, there will be over 400,000 new multiple housing units by that time. Transit systems providing a high degree of reliability and area-wide mobility could have a substantial effect on the location of these units.

Recognizing the future growth in population and employment, the desired regional form, and the probable allocation of new homes and office, there appear to be three primary options with respect to a service concept:

a. A greatly expanded and innovative bus concept designed to test the ability of an all-bus service to meet the future needs of the region and the growth pattern. This option would have the least direct impact in promoting the regional form preferred by the Metropolitan Council.

b. A fast link transit system incorporating a moderately sized fixed guideway system serving the central cities and selected major centers. Fast link transit in the remaining corridors would be provided by express bus service much as in the all-bus concept. Fixed guideway service can then be added in the various corridors in the future as the need becomes apparent. Combined with the fast link component would be significant improvements in local bus service and special services in the major centers and the CBDs. This option may have the strongest regional impact in shifting population growth toward those corridors with strong transit lines - while promoting development of selected diversified major centers.

c. A much greater initial application of a fixed guideway concept to provide maximum transit service throughout the region. Improvements in local service and the special service in centers and CBDs would be similar to that under the moderate system. This option will provide the maximum opportunity to cluster development at station locations since the system is more extensive. It would have less selective impact in centers development since more centers will be served early by fixed guideway transit.

Under any of these three principal options, a high degree of local service will be needed to serve the central cities and the major centers. This service can and probably will employ a wide range of systems ranging from small buses through automated "people mover" systems. System selection should depend upon the density and character of the area served.

3. *What would be the likely impact of transit under each of the options? What benefits would accrue to the region, the immediate local area and the individual receiving service?*

Transit impact under the all-bus options is considered to be minimal in its direct influence upon regional development. The region may still develop under the major centers concept, but more emphasis must be directed at providing for the automobile. The fixed guideway transit systems have been projected to show greater impact in the structuring of the region and an even greater influence on clustering of future development. While regional shifts in population and related development are comparatively small and dependent upon the extent of the system, a significant clustering effect at stations and terminals will occur. This is a distinct benefit to both the region and the resident. From the standpoint of the region, it reduces the extent of service and utility systems necessary to serve a given population. For the resident, it offers greater choice in residential style. Apartment and multi-family residential development can be expected to be attracted toward station locations thereby reducing their encroachment into established single family areas.

In any of the systems, the transit user (captive and diverted) would be the primary recipient of benefits. For example, the average diverted motorist would receive approximately $800 in cost savings annually. However, under the fixed guideway fast link systems, this savings becomes available to many more people since the higher level of service and increased transit speed will attract greater patronage. Depending on the extent of the test system, projected patronage for the systems incorporating fixed guideway fast links will vary from 22 percent to 59 percent greater in 1985 than the all-bus approach.

Increases in transit patronage will produce significant reductions in the amount of parking necessary in the major centers and the central business districts. This reduction in parking will be of benefit to the local areas through more efficient land use and to the diverted transit rider through reduced transportation associated cost.

For the non-auto user - the poor, the aged, etc. - any improvement in transit is a distinct benefit. However, the fast link systems will provide major advantages in terms of travel time and improved access to employment sources outside the central business districts.

4. *How do the Options compare with each other in terms of cost incurred?*

With respect to capital cost, the all bus approach is far less costly than is a fixed guideway system. Obviously, the costs of the fixed guideway will be dependent upon system selection and to an even greater extent, upon route configuration, i.e., whether in subway, at grade, or on aerial structure. These factors can only be determined with high accuracy when specific routes are determined, which was not included in this study. However, concept cost estimates have been prepared based upon representative conditions expected in each service corridor in order to determine "order of magnitude" costs for the various test systems.

In the case of operating cost, however, the reverse condition is true. Bus transit is heavily labor intensive when compared to a fully automated fixed guideway system. This is particularly significant in that labor costs are increasing rapidly and in bus transit, opportunities to increase productivity as costs increase are limited because each vehicle requires one driver. In fixed facility transit, even with an operator or attendant on the vehicles, his productivity in terms of passenger carrying potential can easily be 10 to 20 times greater than on a bus.

On the basis of projected patronage and operating costs, much greater deficits can be expected under the all-bus options than if the fixed facility systems are employed. Thus, even with the higher annual costs for debt retirement, the difference in total annual costs between the options is reduced by on-going and rapidly rising bus operating costs. These various findings are summarized in Table 9-1 on the following page.

5. *What resources are available to the local area for adequate financing and an equitable spread of the fiscal burdens?*

One important source of funding assistance is available through recent Federal legislation which projects $10 billion over 12 years for capital improvement in transit ($3.1 billion appropriated for 5 years). However, the competition for this money will be heavy. A review of all planned or seriously proposed regional systems indicates that there is today approximately $17 billion in potential requests for Federal money. It seems probable, however, that the Twin Cities would be eligible for major assistance since it has not received major financial assistance in the past. Under these conditions it appears reasonable to expect that the Twin Cities could receive Federal participation in the range of $200-$300 million, for first stage construction of a fixed guideway fast link system.

In addition, there are indications that the political climate for increased Federal participation in transit is improving. Although the level of future participation cannot be

TABLE 9-1
PROJECTED 1985 OPERATING STATISTICS REFLECTING ESCALATION

				Test System Options				
	A-1	A-2	A-3	B-W	B-X	B-Y	B-Z	C
CAPITAL COST ($ millions)	37.8	51.5	112.4	590.6	684.6	627.2	749.2	1,423.9
TOTAL PATRONAGE [1/] (passengers millions)		55.3		67.5	72.2	71.0	74.2	88.1
AVERAGE FARE (Cents)		50.2		55.8 [2/]	56.2 [2/]	56.2 [2/]	57.0 [2/]	58.7 [2/]
REVENUE ($ millions)		27.8		40.7	43.9	43.0	46.3	57.9
VEHICLE MILES OPERATED (millions)								
Bus		25.5		23.5	23.2	23.5	22.7	22.2
Guideway		-------		4.4	5.1	4.5	6.0	9.0
OPERATING COSTS ($millions)		46.2		47.3	48.0	47.6	48.5	51.9
SURPLUS (DEFICIT)		(18.4)		(6.6)	(4.1)	(4.6)	(2.2)	6.0
ANNUAL COSTS ($ millions)								
Debt Retirement [3/]	0.8	1.1	2.5	13.1	15.2	13.9	16.6	31.6
Depreciation Allowance (Buses)	2.9	2.9	2.9	2.6	2.5	2.5	2.5	2.4
TOTAL ANNUAL COST ($ millions)	22.1	22.4	23.8	22.3	21.8	21.0	21.3	28.0

ESCALATION FACTORS

Capital Costs —	Fixed Facilities	5%/yr.	Revenue (Fare Increase)		4%/yr.
	Land Acquisition	5%/yr.	Operating Costs —	Buses	7%/yr.
	Buses	3%/yr.		Guideway	4%/yr.
	Guideway Vehicles	6%/yr.			

1/ Patronage, revenue, bus miles and costs for all A test systems were estimated at the A-1 level. Levels A-2 and A-3 reflect added capital expenditures and reorientated service in keeping with centers development. However, bus miles were held constant and therefore performance remained constant. Patronage increase due to improved amenities cannot be predicted reliably and was also held constant to produce conservative estimates. Patronage estimates shown for all systems reflect the reduction of 1/4% for each 1% increase in fare due to the escalation from 1970 fare levels.

2/ Premium fare of 10 cents per passenger on guideway systems not included.

3/ Assumes two-thirds Federal participation for all test systems. Local one-third share shown amortized over 40 years at 6%. Local share may include funds from various combinations of local, regional and state sources. (See Chapter 8, pages 54 through 56). If the full amount indicated in Chapter 8 is realized from state sources, the annual local requirements could be reduced by as much as $5.5 million.

determined at this time, it would not be unreasonable for this region to follow the same financial approach used in some other recent transit planning programs. This would assume the full two-thirds Federal, one-third local proportion.

It is apparent, however, that whatever Federal participation is granted, a substantial commitment of local money must be made. In order to provide these monies in an adequate amount in the most equitable manner, an Intermodal Development Fund concept has been identified and evaluated. Such a fund will permit the region to make the best use of transportation and transportation associated income in the development of its future total transportation system including highway and transit as and where appropriate, without disturbing the dedication of traditional highway funds. Other sources of financial funds based upon capturing a part of the financial benefit attributable to transit are also identified.

It should also be noted that whatever option is adopted for future transit service, the Intermodal Development Fund will be equally important since even the bus systems will require financial support which is beyond the ability of the region to absorb without additional funding sources.

6. *How can technology be best adapted to meet this local area's travel demand over the next thirty years; what opportunities are there for extending transit service to low density areas, providing fast-link connection to activity centers, and developing an adequate level of service within high activity areas?*

The most probable and most imminent development of "new technology" systems appears in connection with the collection and distribution function in high activity areas. It is in these areas where those most actively involved in technology development, as well as the Federal demonstration programs, are concentrating their efforts. At least two and probably three demonstration projects are expected to be underway in the next 2-3 years directed at testing both equipment concepts and their function as distributor systems. These programs include automated small vehicle systems with station by-pass capability. This type of technology development will be directly applicable to the high activity centers if it proves workable at acceptable cost levels.

Several innovations in bus operations, notably a Dial-a-Ride concept, have been proposed and recommended for testing for operability and public reaction soon. Applications of these new service concepts, together with selected adjustments in local service and some of the new technology hardware should provide capability for local and fast link service to the major diversified centers in addition to providing distribution service within the centers.

Technology applied to the fixed guideway portions of the system is expected to be evolutionary in nature. The one possible exception (in larger vehicle sizes) is the linear electric motor combined with an air cushion suspension. This concept is currently being readied for test in Pueblo, Colorado under a Department of Transportation program. Currently no efforts are being made to develop the concept for other than high speed ground transport and extensive work remains to adapt it to urban system use.

There are existing a wide variety of first generation vehicular systems under constant improvement and to date the greatest strides forward have been in the areas of automation and propulsion. The current trend in vehicles has been toward larger sizes. This trend, however, is not necessarily applicable to the Twin Cities needs. There are also systems being developed using smaller transit mode vehicles, such as the Westinghouse Transit Expressway currently being designed for revenue service in Pittsburgh, Pa., which may be of a more appropriate scale for Twin Cities application. There also exists a wide potential for innovation and adaption of this first generation technology to a specific application.

Intraurban fast link application of second generation vehicle systems, including the various "small car" concepts, may be available at some undetermined time in the future. However, there are no current plans to test these concepts as a total urban system. It cannot be determined at this time whether or not the small scale distributor and point-to-point test program will provide adequate data for regional system evaluation.

In any event, the Twin Cities need not and should not make a vehicle system selection at this time. Concept plan development, corridor and route definition, implementation priorities, demonstration programs, and many other steps leading to a regional system can and should be undertaken before a vehicle system is selected.

It should also be noted that the "family of vehicles" concept set forth by the Metropolitan Council in its Transportation section of the Development Guide is totally applicable to this evolution of transit systems. Functionally, and philosophically, it provides for application of the newest technology to fast link development, low density service, and high activity area service.

7. *When will critical decision points occur to assure time for follow-through on development objectives and community needs?*

It is apparent that some decisions, such as a vehicle selection, can and must await further developments. It is also clear that unnecessary delays in the basic program will result in some loss of opportunity since regional growth and devlopment will continue. At the same time, many of the programs which the Metropolitan Council has indicated a desire to implement will be facilitated by transit both from the standpoint of planning and actual realization.

At least two critical transit development decisions can be identified at this time. The first is for the MTC to establish conclusions from this report that include objectives, policies, a system concept plan and a mechanism for financing rapid transit. This establishes the basic transit system and program for early implementation.

With this established, the Commission can proceed with the refinement of the fast link elements related to route and station location, preliminary design in selected corridors to provide firm cost estimates, and ultimately, vehicle system selection. These data will permit a detailed financial program to be prepared based on definitive cost and scheduling for presentation to the 1973 Legislature and as a basis for application for Federal participation.

The second critical decision point will occur in 1973, when the region and the Minnesota Legislature will be faced with a decision on funding large scale transit improvements.

8. *What are the likely consequences of the various decisions?*

Answers to these questions are incorporated in the following Test System Summary and Decision Tables.

Test System Summary and Decision Tables

OPTION	DESCRIPTION	SERVICE CONSEQUENCES
A–1	Expanded basic 13-Point Program with improvements in service added over time to serve expanding areas.	*Favorable* — 1. Permits delaying decision on fast link system while waiting for "new technology". 2. Will improve transit service primarily to central cities with some improvement to outlying areas at minimum capital cost. 3. Provides maximum ability to change, add or remove service of equal character with minimum delay. 4. Does not delay implementation of distributor systems in Major Centers with existing or new technology. *Unfavorable* — 1. Operating costs will rise much more rapidly than with other systems and greater deficits can be expected, eroding future investment capital. 2. Greater pressure for freeway expansion and more parking space. 3. Loss of most development impact attributable to transit if fixed guideway systems are probable future system (depends on delay time). 4. Regardless of the point in future time, "new technology" will always be on the horizon and delays can extend indefinitely. 5. Usage will remain heavily oriented to "captive riders" and patronage may continue to decline as affluence rises. 6. Results of bus system innovations and increased capital cost for amenities are *not* predictable.
A–2	Same as A–1 but modifying service concept to include Regional Center Service and other innovations in operation with minimal increases in capital expenditure for amenities.	
A–3	Same as A–2 but with major increase in capital expenditures for passenger amenities at stations, bus stops, and parking areas.	

OPTION	DESCRIPTION*	SERVICE CONSEQUENCES
BW	Fixed guideway system employed in connection of Minneapolis and St. Paul Central Business Districts plus fixed guideway system serving Minneapolis south corridor. Busway in future I-394 for west Minneapolis corridor and express bus in all others. Distributor systems in CBDs and major centers as appropriate and feeder service to fixed guideway combined with local service.	*Favorable* — 1. Maximizes regional transit service, as well as local service, by diverting greater percent of regional trips to fixed guideway. 2. Maximizes potential for transit attributable development impact to occur in planned fashion by appropriate corridor selection. 3. Does not delay application of new technology in distributor systems in centers or CBDs. 4. Permits incorporation of innovative and/or evolutionary technology as and when available without loss of service while waiting. 5. Minimizes demand for new and expanded freeway system both by diverting trips to transit and shifting development. 6. Minimizes increase in operating cost. *Unfavorable* — 1. High capital investment and financing requirement. 2. Requires development control in conjunction with transit implementation in order to attain maximum impact. 3. Greater time lag when adding new routes of equal character.
BX	Same as BW but with express bus service in St. Paul east corridor replaced with fixed guideway system.	
BY	Same as BW but with express bus service in Midway north corridor replaced with fixed guideway.	
BZ	Same as BW but with express bus service in Minneapolis northwest corridor replaced by fixed guideway.	

* All systems include full 13-Point Program plus further improvement to bus service between 1975-1980.

OPTION	DESCRIPTION	SERVICE CONSEQUENCES
C	Same basic capabilities and service as in Option B series except that fixed guideway service is provided in all corridors at an early date (1985 assumed for study purposes).	*Favorable* — 1. System will provide maximum regional service. 2. Greatest reduction in pressure for expanded freeway system and parking requirement. 3. Greatest impact on office space location of those systems tested. 4. Does not delay implementation of distributor systems in regional centers with existing or new technology. *Unfavorable* — 1. High capital cost and financing requirement. 2. Development impact is diluted by exceptionally wide location choices available to transit oriented development within the total available market. 3. Other unfavorable consequences common to B series.

PRIMARY BENEFIT	1985 COST (MILLIONS OF 1970 DOLLARS)	DECISION	DECISION CONSEQUENCES
Some improvements in mobility for disadvantaged persons primarily in central city areas with some improvement for suburban communities. Minimum capital cost.	A Capital 26.0, Operating 16.7 A-1 Capital 35.2, Operating 16.7 A-2 Capital 69.7, Operating 16.7 *Annual Patronage (1985)* 65 million passengers for all options. (A-2 and A-3 *may* show improvement but extent cannot be predicted)	Select A and Wait for "New Technology"	Continue present trend in marginal service with high degree of risk that "acceptable" new technology will emerge which will provide service which is *better, less expensive to build or operate,* or *more comprehensive in* coverage than with current systems.
		Select A-2 or A-3 and attempt solution with buses and distributor systems in high activity areas.	Probable improvement to *local* service but regional trips likely to remain highly auto oriented except for "captive" riders who will continue to experience disproportionate travel time unless exclusive rights-of-way are developed at costs approximating fixed guideway systems but with higher and higher operating costs. Pressures for expanded freeways to meet increasing peak hour demands will grow along with parking requirements. Very uncertain returns on capital investment combined with probable increasing levels of public subsidy required.

PRIMARY BENEFIT	1985 COST (MILLIONS OF 1970 DOLLARS)	DECISION	DECISION CONSEQUENCES
1. Improved regional mobility with major advantage for disadvantaged persons through improved travel speed (when compared to bus transit). 2. Favorable development tool. 3. Most favorable benefit/cost ratio is available within the B option range.	BW Capital 420.1, Operating 18.4 BX Capital 490.7, Operating 18.8 BY Capital 446.8, Operating 18.5 BZ Capital 535.8, Operating 19.2 *Annual Patronage (1985)* BW 79.4 million BX 84.9 million BY 83.4 million BZ 87.4 million	Select Work program based on BW or BX or BY or BZ.	Permits structuring definite transit planning program to provide "hard" answers to questions of location, route selection, system extent and cost and corridor priorities which can proceed in concert with on-going regional planning. Provides definitive direction relating transit to future development planning and policy.
		Select work program based on staged development of "B" systems.	Permits maximum flexibility in implementation program based on expanded planning horizon and offers opportunity to optimize system performance and impact.

PRIMARY BENEFIT	1985 COST (MILLIONS OF 1970 DOLLARS)	DECISION	DECISION CONSEQUENCES
1. Maximum regional mobility. 2. Positive benefit/cost ratio.	C Capital 912.4, Operating 21.3 *Annual Patronage (1985)* 103.7 million	Select basic concept based on C option.	Similar to B except that decision *may* be more acceptable as a "long range" potential than as a 1985 program because of high cost. To place total system in operation by 1985 *may* be beyond the financial capacity of the region.

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