Alexandria Mini-Transit-System Concepts

a downtown transit distributor system

BARTON-ASCHMAN ASSOCIATES INC. WASHINGTON D.C. 1975
for the Northern Virginia Transportation Commission

FOREWORD

This study has been undertaken by Barton-Aschman Associates, Inc. under the auspices of the Northern Virginia Transportation Commission with funding contributed by the Urban Mass Transit Administration of the Federal Department of Transportation.

The active participation throughout the study of many agencies, groups and individuals is acknowledged. Particular appreciation is extended to the staffs of NVTC, the Alexandria City Manager's Office and the Department of Planning and Community Development, for their constant advice and the contribution of invaluable detailed knowledge of the study area; also, to the staff of the Metropolitan Washington Council of Governments, Department of Transportation Planning for their cooperation in the use of the TRIMS model, and to the Washington Metropolitan Area Transit Authority for much of the background information on the proposed Metro stations.

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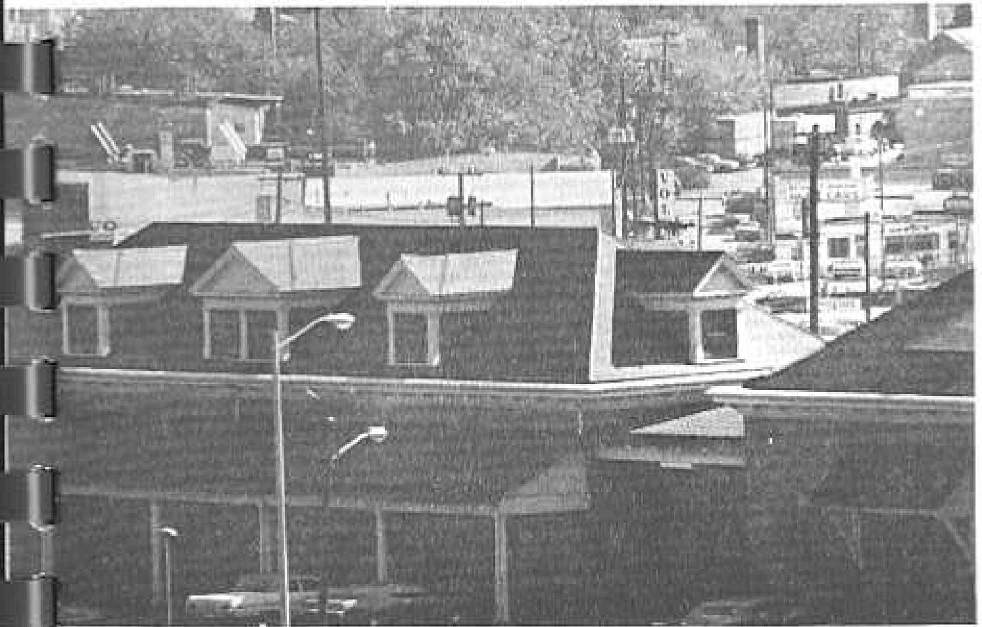


1 Introduction

1.1 The Problem

The City of Alexandria, faces a familiar problem in planning for its transportation needs over the next few decades. The dilemma is essentially one of "How much and where will public transit be needed". The advent of Metro service, currently programmed for 1979 introduces a major new option to the existing range of transportation choices, and it has not until now been clear what effect Metro would have on the patterns of movement in the downtown area. Whereas movement patterns in the central area are north-south, to and from Washington, D. C,, it is clear that Metro service to the Braddock Road and King Street stations will reorient much local traffic into east-west movements to and from these stations.

The decision to locate the Metro line approximately 1 mile west of the downtown area was a complicated one, but essentially involves the choice between a more easterly route which would have disrupted many neighborhoods, and the present route which takes advantage of an existing railroad right-of-way The King Street and Braddock Road stations will provide for bus access, and kiss/ride car parking but no permanent

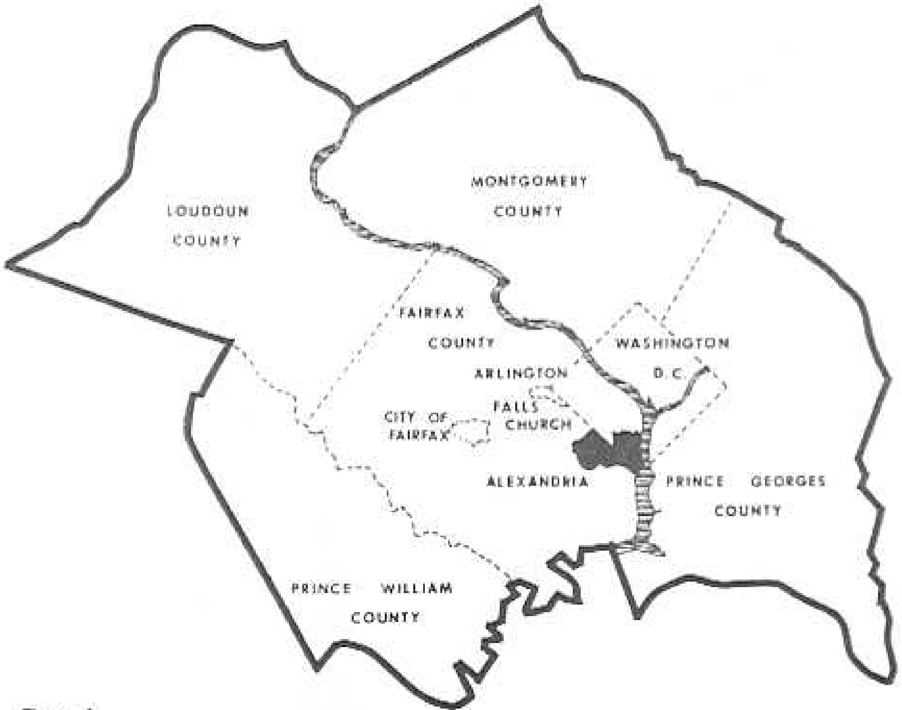


Figure 1
ALEXANDRIA and the METROPOLITAN AREA

parking. In addition, there are questions concerning the internal transit needs between various parts of the central area. Alexandria is changing. It has experienced massive spurts of growth on the North Waterfront and rejuvenation of significant parts of its retail areas in recent years. Indications are that more growth in jobs and homes can be expected, as well as increasing numbers of tourists. What will be the future needs for movement between neighborhoods and shops; between homes and local jobs; between tourist attractions? Furthermore, is there a viable alternative to local public transit service as provided by Metrobuses, which can better satisfy transportation demands on a smaller scale?

This study attempts to come to grips with these questions and to answer them in terms of an efficient small-vehicle system which is sensitive to the historic urban fabric of Alexandria as well as serving a demonstrable demand. The cooperation of the Northern Virginia Transportation Commission (NVTC) which funded the study, the staff of City of Alexandria's City Managers Office, Planning and Community Development Department, Public Works and Traffic Departments has been greatly appreciated throughout. Also, the willingness of many community representatives and other public officials to discuss a variety of issues raised by the study has been of inestimable value.

1.2 Definitions

During the course of this report many terms are used which may not be commonly understood by persons unfamiliar with the planning and transportation planning process. Many of these are at the end of this report

1.3 Study Purpose

This report contains the findings of Phase I of a two-part study. The study was conceived in two parts in order first to determine what "generic" type of transit system would best suit the needs of the study area, and secondly to detail that system in terms of specifications for implementation and operation.

The purposes of the study are set out below in five major study areas. Of these, the first four are accomplished in Phase I as represented in this report.

- To forecast the future pattern and level of demand for transportation in the central area, based on a range of land use assumptions.
- To determine whether a small-scale transit system would be feasible to move these trips within the central area, and out to the Metro Stations.
- To investigate a variety of small transit systems and to select a type of system based on level of demand, urban design, operational and community acceptance criteria. The systems to be investigated included Fixed Guideway, Specialized Bus, and Light-Rail. Large-Scale Metrobuses were excluded from the analysis.
- To recommend a series of corridors within which the demand could be satisfied while at the same time having positive benefits for the community and supporting desireable land-use patterns.
- To detail the final system as to vehicle specifications, specific routes, timetable, fare structure, operational and maintenance personnel, capital and operating costs.

1.4 Study Methodology

The study area has been defined as being bounded on the west by the Southern Railroad line, on the north by the northern limits of development along the George Washington Parkway, on the south by the Beltway and Telegraph Road, and on the east by the Potomac River. The Railroad, Beltway, and Potomac River all present physical barriers to movement and channel traffic through a few portals into and out of the study area.

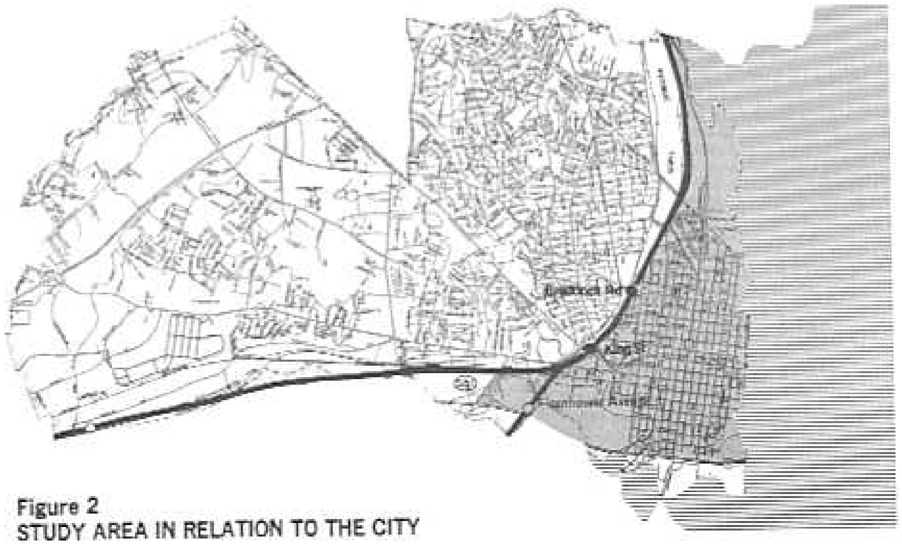


Figure 2
STUDY AREA IN RELATION TO THE CITY

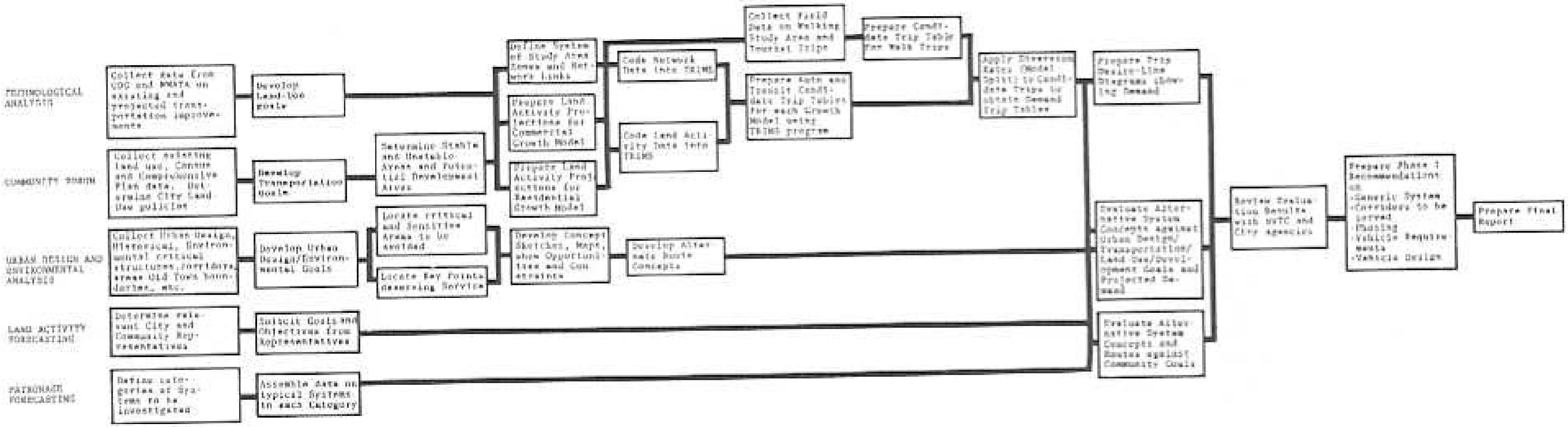


Figure 3
WORK SEQUENCE DIAGRAM-PHASE 1

The design year for the study is 1992. This coincides with the final year for which regional population and land use projections have been made by the Metropolitan Washington Council of Governments (COG). The significance of this date will be made clearer in due course.

Phase I of the study commenced with a series of studies in the areas of Urban Design, Land Activity Forecasting, Transportation Patronage Modelling, Community Input and Technological Analysis. It was considered important to determine the feasibility of a Mini-Transit system not only on the basis of demand projections, but also in relation to its aesthetic, socio-economic and environmental effects on the study area.

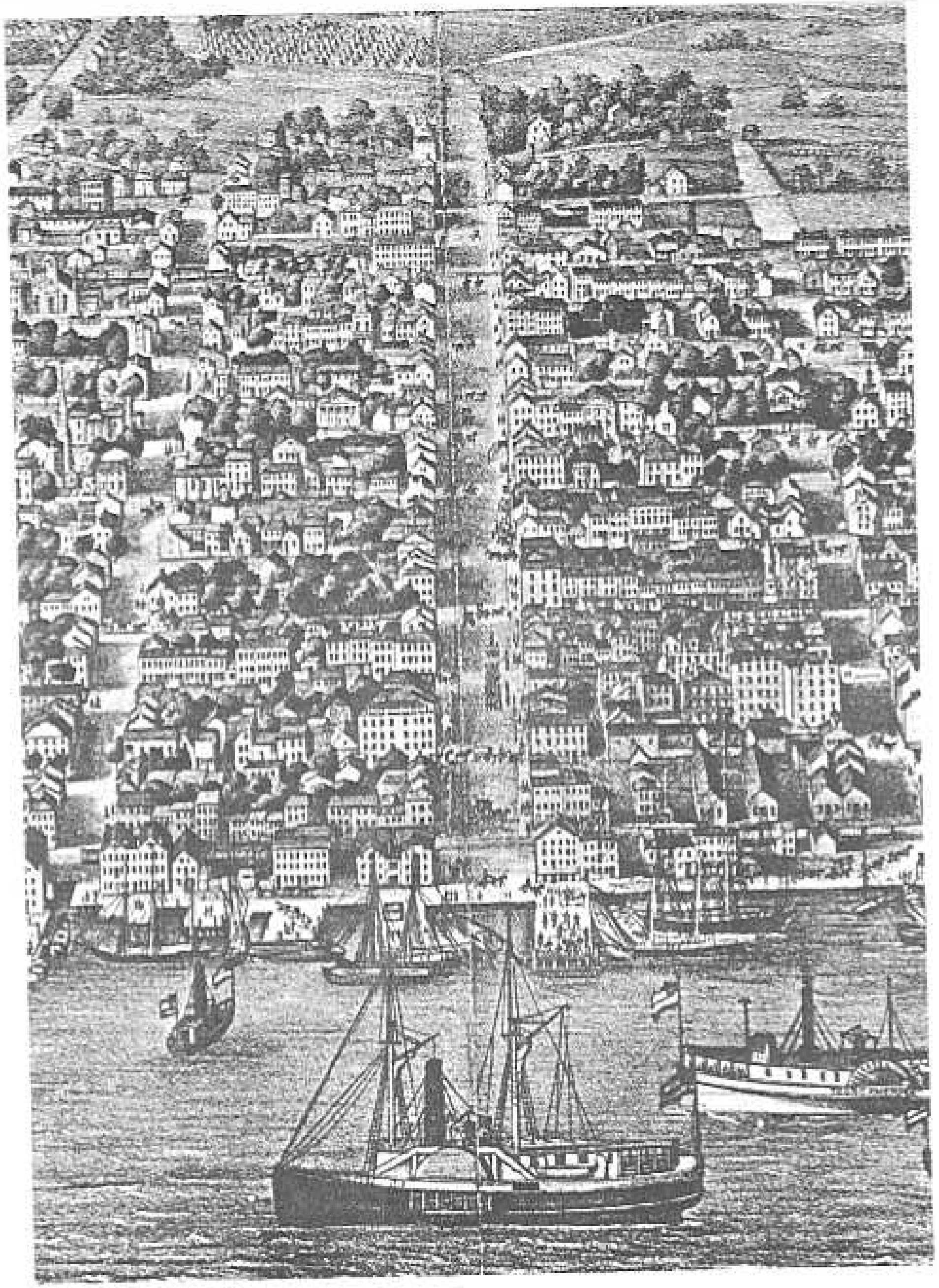
In order to determine how many daily trips would probably be made in the study area in 1992, it was first necessary to make certain assumptions as to the future pattern of land uses, the density of development, and growth of population, jobs, and income.

Since 1992 is almost 20 years into the future a single precise pattern of growth cannot be forecast. It was therefore decided to base the study on two alternative growth patterns which would represent the probable extremes. A Residential Growth Model was thus prepared which projected a bias toward residential development in those parts of the study area where growth was anticipated. A Commercial Growth Model on the other hand projected a bias towards office, retail and industrial employment. In both models, several City departments were consulted extensively, and currently planned or committed development was included in each model. The Patronage Forecasting process was then able to project the volumes of trips for each Growth Model assumption which would be attracted to a Mini-Transit system. The process made use of a computer model developed by COG to estimate a fine-grain pattern of trips for a small area within the overall growth projections for the region. A work Sequence Diagram is shown on Page 5 It culminates in an evelauation process which matches the demand for transit service with the technology currently available and attempts to select an appropriate type of system which will have minimal impact on the architectural and historic environment of Old Town and will be acceptable to the disparate community interests involved.

No detailed recommendations are, or should be, made at this stage, since the scope of the report is to display the range of feasible options. The generalized system design which is presented here consists of the approximate level of demand, the generic vehicle type, and corridors requiring service. By narrowing down the wide range of possibilities in this way, it will be possible to focus in Phase II on the detailed design, implementation and operating procedures for the system.

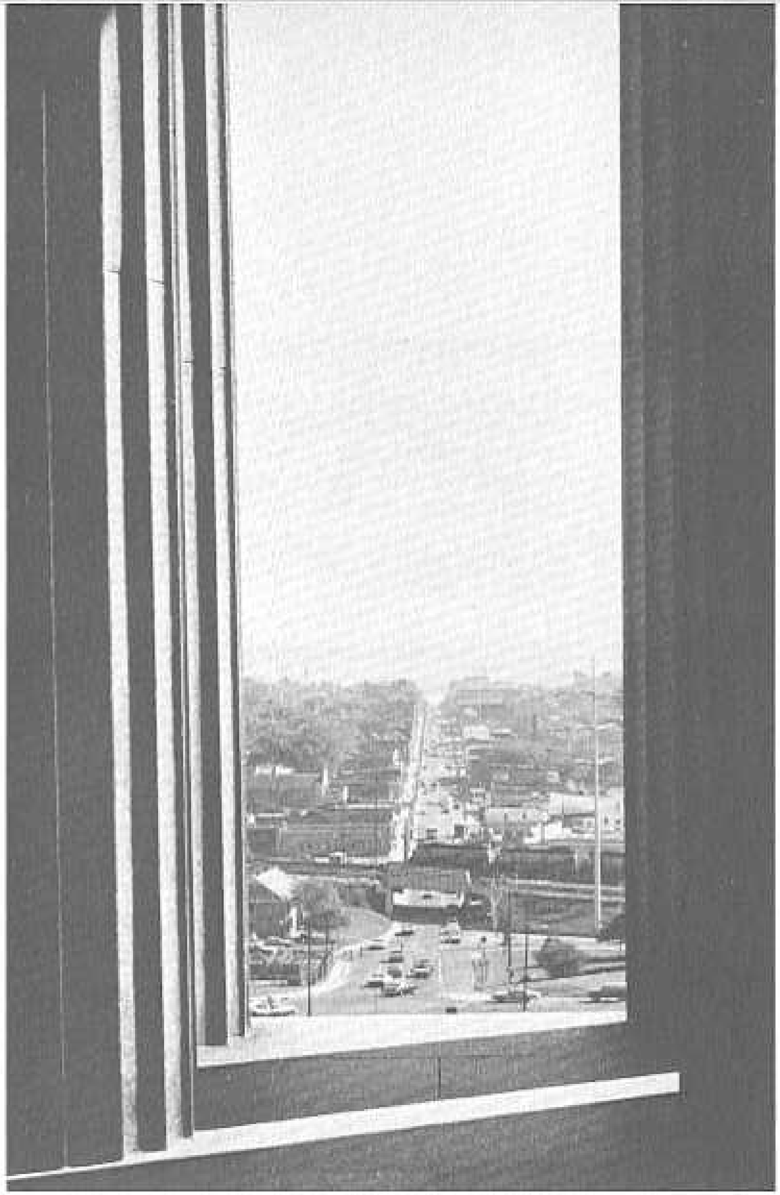
1.5 Historical Perspective

The Old Town of Alexandria founded in 1749, had achieved its commercial heyday by the turn of the nineteenth century. Its importance as a port for Washington, D. C. was soon established due to the depth of the Potomac channel here close to its western bank. The waterfront was bounded by warehouses and even as recently as the mid 1960's lower King Street had the air of a wholesaling and industrial district, rather than the newly transformed boutique shopping area which it now is.



During the Civil War Alexandria's significance as a port and one of the few strategic railheads available to the Confederate troops re-established the town's importance. The railroad from the waterfront led west along what is now Wilkes Street. After the Civil war the railroads were extended. The old Southern Railroad ran on an alignment which approximates North Henry Street and a new warehousing district sprang up west of Old Town. The influences of these times continue today in the form of large moving and storage company warehouses on N. Fayette Street. In 1905, the present alignment of the Southern Railroad established, and King Street again became the major east-west thoroughfare, linking Old Town and the waterfront to Union Station. Subsequently, the original railroad alignment became the route for highway U.S. 1 through the western downtown area. Over the decades, the railroad and highway arteries have become major barriers between downtown and western Alexandria, between the affluent Old Town on the waterfront and the lower income "tract 16" neighborhoods. In the early 1960's, Interstate highway construction hastened the rush to the suburbs, and Shirley Highway proved to be no exception. The downtown area has long been losing population to the western suburbs with their high accessibility to Washington, D. C. Furthermore, the trend to smaller families has meant that the fashionable houses of Old Town have been increasingly bought by both younger and older couples with fewer or no children. It is interesting to compare this trend with the continuing high numbers of children in the neighborhoods west of Washington Street.

During the 1960's, the concept of a regional rapid rail transit was developed and the 98-mile system was finally adopted in 1968 by a regional, multi-jurisdictional compact. The route as planned through Alexandria was to parallel the Southern Railroad right of way, with stations at Monroe Street and King Street. Subsequently, however, efforts were made to amend the route and bring it closer to the downtown area, possibly in "cut and cover" construction below the Patrick/ Henry corridor. This route proved to be impractical for various reasons, not the least among which were cost and the enormous disruption and relocation of homes and businesses. The Metro route thus reverted to its original alignment, with stations approximately 3/4 to 1 mile from the downtown area and a cross-town transportation problem. The location of the original Monroe Street station has changed several times, and its present location adjacent to the Braddock Road underpass, resulted in its name being changed. For a variety of reasons, the demographic picture of downtown Alexandria appears to have turned around from a decline in population and employment opportunities in the late 1960's to a growth situation at present. Many developers have recognized the potential of combining the high accessibility of Metro stations with the popularity of high-density condominium construction. With the burgeoning energy crisis, there appears to be a shift from sprawling suburban living with high auto-commuting costs, to close-in living with commensurate amenities of the urban area. The Alexandria House and Watergate developments on the North Waterfront are indicative of this trend, and are both locatedwithin 1/2 mile of the future Braddock Road Station. There is evidence too, to suggest that run-down and vacant properties in the vicinity of King Street Station will soon be subject to intensive redevelopment activities predicated upon the accessibility of Metro.



2 Goals and Objectives

2.1 Goals

In outlining the need for this study, NVTC has stated that, "The study must address how to provide a transit connection between Alexandria Metro stations and 'Old Town', consistent with the area's character and development plans"

The overall goal of a transit system for central Alexandria is to improve accessibility generally throughout th area, and this goal may be stated more specifically as follows:

- Establish Access from central Alexandria to Regional Transit (Metro) and thereby encourage region-wide travel by transit rather than automobile.

- Encourage and control development within the framework of the Comprehensive Plan by providing superior access to planned development areas.
- Discourage reliance on the automobile and thereby reduce congestion and the demand for parking spaces and highway improvements on valuable central area land.
- Improve internal accessibility between residential, employment, and retail areas, and community services in central Alexandria.

The basic premise implicit in this study as requested by NVTC is that these sub-goals may be acheived by establishing a small-scale transit system which optimizes user-convenience, operational efficiency and is in itself not merely an alternative transportation mode, but rather a highly desirable one in terms of its inherent design and compatibility with the community it serves. From this point, the term "Mini-Transit" has been applied to the system

2.2 Objectives

Many of the preceding goals may be restated as objective functions corresponding to each of the five study elements outlined in Sections 1.3 and 1.4. It will be apparent that several objectives cannot be used for evaluation at this stage, since they rely on more detailed information to be developed in Phase II. Nevertheless they are included for the sake of comprehensiveness.

(a) Urban Design/Environmental Quality

1. Minimize Visual Intrusion in critical residential and historic areas by maintaining important views and vistas and respecting the scale and integrity of streetscapes in the Historic District.
2. Minimize air pollution and noise from transit vehicles.
3. Minimize energy consumption by transit vehicles.
4. Reduce traffic congestion on major local streets and if possible prevent major traffic build-up in residential areas en-route to Metro Stations.
5. Enhance the image of Alexandria as a town concerned with the quality of its architecture and institutions.

(b) Land Use/Development

6. Maximize ease of travel between existing and proposed activity centers in the central area.
7. Minimize the amount of land required by the Mini-Transit System for stations and structures.
8. Minimize land required for parking and street improvements by reducing reliance on automobile use in the central area.

9. Support and encourage development in accordance with the principles of the Comprehensive Plan by limiting transit functions to defined corridors.

(c) Patronage and System Usage

10. Provide system capacity commensurate with normal daily peak demands.

11. Maximize accessibility to Mini transit service over a wide area.

12. Minimize waiting, transfer, and riding time on the system through convenient scheduling throughout the day.

13. Maximize the flexibility to revise routes and/or expand system in response to variations in demand.

14. Minimize pedestrian/vehicular and inter-vehicular conflicts.

(d) Technology

15. Maximize reliability of equipment.

16. Minimize operating costs and, therefore, fares.

17. Minimize capital costs of equipment, including vehicles, structures, and maintenance facilities.

18. Minimize property acquisition due to physical limitations of equipment in making sharp turns, etc.

(e) Community Acceptability

19. Maximize personal security of users.

20. Provide a pleasant and comfortable riding environment.

It should be noted that potential conflicts occur between objectives. For example the objective of "Minimizing air pollution" may contradict the objective of "Maximizing the reliability of equipment" since those vehicles which have been recently developed in response (among other things) to environmental concerns cannot yet compare with the proven reliability record of diesel engined bus. In addition, some of the objectives do not permit a quantitative evaluation of the available systems. They depend on subjective judgements which cannot be made here.

Finally, certain of the objectives may be satisfied equally by all systems, such as the objectives of "Reducing traffic congestion on local streets." "Maximizing ease of travel between existing and proposed activity centers."

Ideally it would be desirable to weight the objectives in terms of their relative importance. Within the scope of this study, such a task would have been impractical. Two objectives appear to be of paramount importance, and this has been supported by discussions with city and community representatives. These objectives are:

1. Minimize visual intrusion in critical residential and historic areas.

10. Provide system capacity commensurate with normal daily peak demand.

It seemed appropriate, therefore, to treat these two objectives in effect as controls, which every system must satisfy to warrant further consideration.

The System Evaluation process is described in Chapter 10.

3 Summary of Conclusions

3.1 Patronage Forecasting

The range of trips projected for the Mini-Transit System in 1992 varies from 30,000 to 40,000 trips per day. The reasons for the range lie in the fact that projections are based on two alternative Growth Models, one Residential, the other Commercial in nature. (See Chapter 4.) The two Growth Models allow for both liberal and conservative assumptions concerning changes in population, housing, jobs, and income during the study period. The commercially biased model resulted in a martinally greater number of trips. Of the total number of trips in the study area in 1992 by all modes, a proportion will be diverted to the Mini-Transit mode. Again liberal and conservative assumptions are made in the diversion (or modal split) process. The following table shows the total 1992 level of demand for each combination of Growth and Model Split.

TABLE 1

	Commercial Model	Residential Model
High level of diversion to Mini-Transit	40,200	37,800
Low level of diversion to Mini-Transit	32,600	30,500

CONCLUSION 1

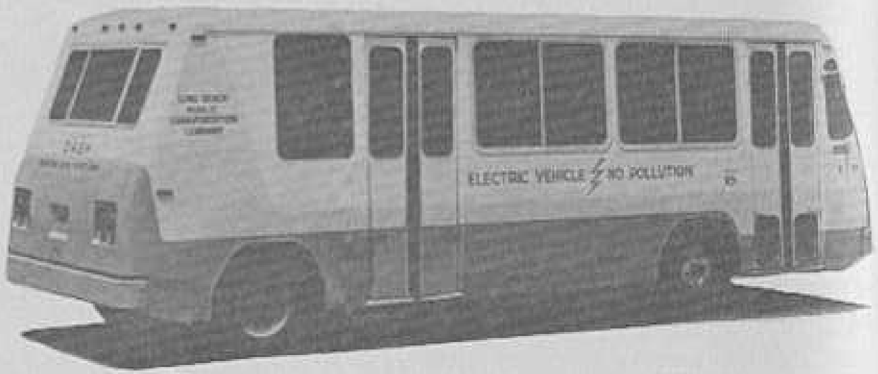
The range of demand indicates that there are sufficient trips to justify a transit system in the central area of Alexandria. under all foreseeable circumstances of growth to 1992.

3.2 Vehicle Types

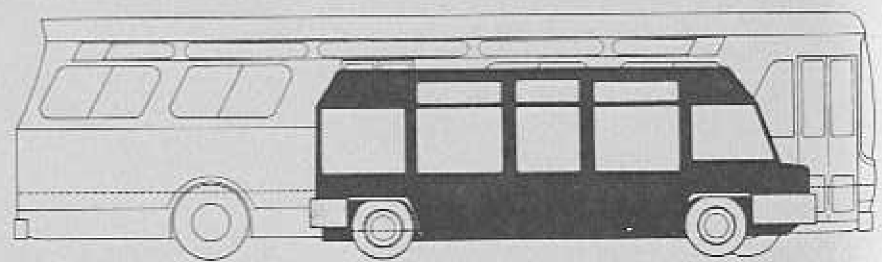
Four major types of systems have been analyzed including 15 different vehicles, all of which are operational in some degree from prototype to full commercial use. A number of systems are designed to handle the volumes of riders expected in Alexandria, including all the small buses and other ground vehicles such as street cars. The low capital cost of a system running on city streets compared with the large capital outlay of all elevated systems makes the "on-grade" vehicles preferable. The ability to change routes and to expand the system on occasion also mitigates against fixed guideway systems. The small, specialized bus systems are admirably suited to carry the projected volumes and very flexible in operation. Furthermore, the introduction of a small bus system over the next 20 years would not preclude the construction of a fixed guideway system in the longer range future, should conditions warrant it after 1992.

CONCLUSION 2.

A small fleet of mini-buses is well suited to accommodate the 30,000 to 40,000 daily trips which are anticipated by 1992. Even the highest peak hour volumes in 1992 do not of themselves justify the fixed guideway system. All further analysis should be directed to developing an implementation and operating plan for a small bus system.



Electrobus



Ginkelvan

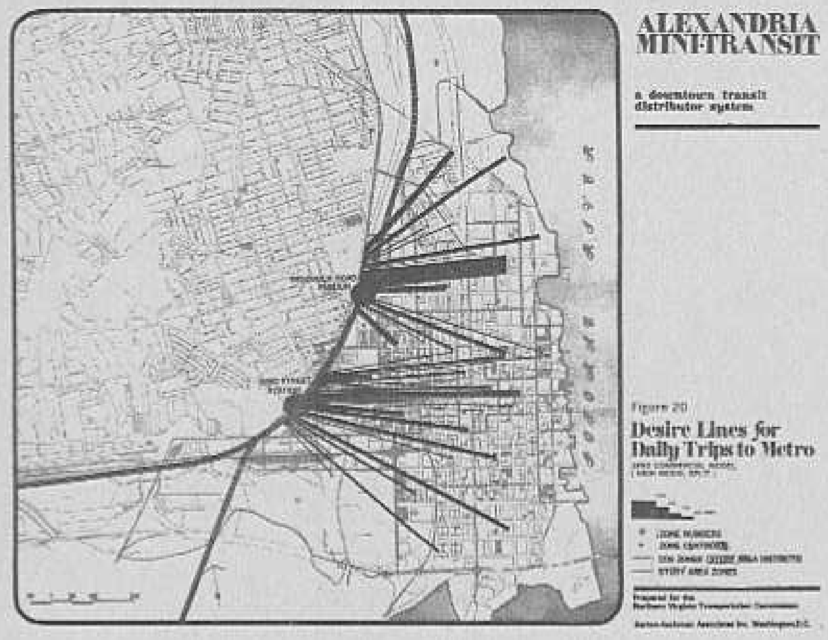


Figure 20
Desire Lines for Daily Trips to Metro

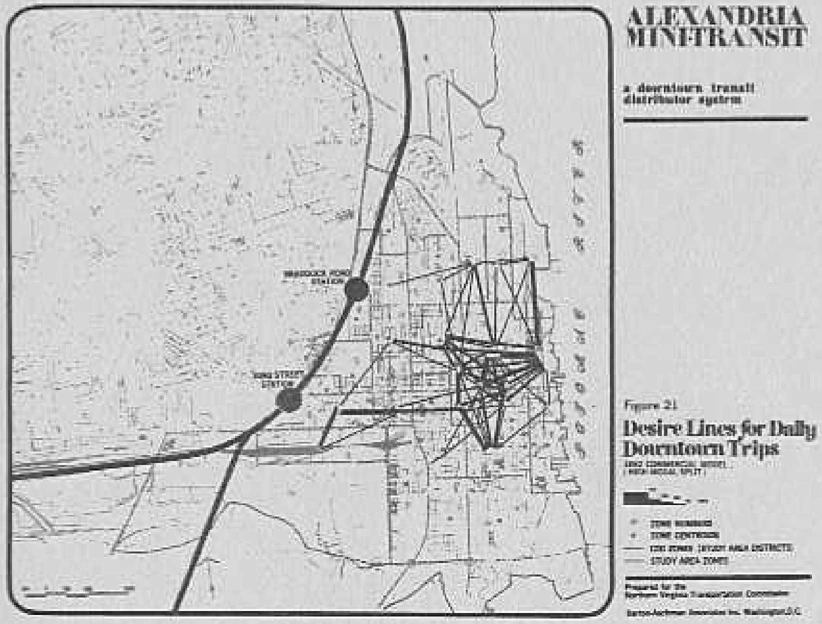


Figure 21
Desire Lines for Daily Downtown Trips

3.3 <u>Service Area</u>

Desire line patterns for a Mini-Transit system show heavy volumes <u>approaching</u> both Braddock Road and King Street Stations. The daily approach volumes are shown in Table 2

Table 2	Braddock Road		King Street	
	High Modal Split	Low Modal Split	High Modal Split	Low Modal Split
Residential Model	4100	3300	3900	3000
Commercial Model	4000	3200	4200	3200

The highest level of interzonal demand is between the North Waterfront and Braddock Road Station.

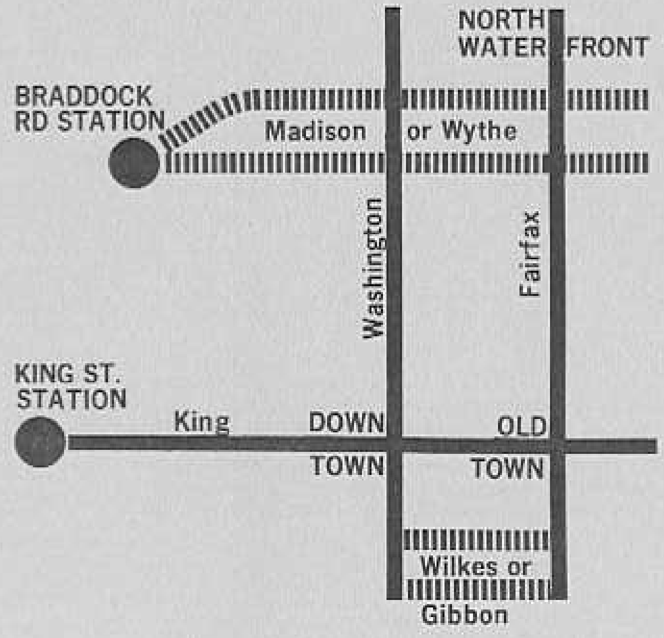
Elsewhere, the non-Metro oriented trips are highest between zones adjacent to King Street east of Washington Street. The distribution of internal trips is generally restricted to the area bounded by First and Second Streets in the north, Henry Street in the west and Gibbon Street in the south.

It is anticipated that Metrobus service to and from the west would be curtailed at King Street, and Braddock Road Stations, so that the Mini-Transit system and Metrobus would not be competing for the same riders.

Additonal input on the question of routes and service areas was received from local community representatives and the Downtown Merchants Association who favored service on King Street, and felt that routes should generally follow streets with present Metrobus service to avoid impacting residential areas.

CONCLUSION 3

Service on either Madison or Wythe; Fairfax; Washington; Wilkes or Gibbon;and King Street would give a good coverage to the study area while concentrating on the centers of maximum demand, and would not cause undue impact to residential areas.



3.4 Phasing

Some form of shuttle service on King Street and Madison/ Wythe Streets would satisfy the major demand for transportation to Metro stations. In the downtown area, trip-making is highest between zones adjacent to King Street. There is a strong feeling among several civic organizations that a King Street shuttle would serve a pressing current need.

The selection of a ground level transit system should not inhibit other longer term decisions on transit service in the area. Therefore, it is conceivable that three distinct phases of transit services should be considered.

- Pre-Metro shuttle service on King Street.
- Mini-bus service coincidental with the introduction of Metro service.
- Long-range replacement of certain bus routes with a PRT system.

CONCLUSION 4

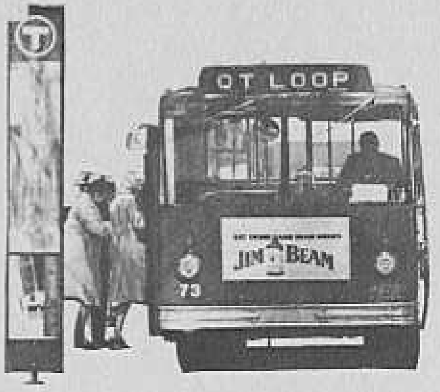
Early introduction of portions of the Mini-Transit system would encourage transit riding habits and serve current needs. The full system should be timed to coincide with Metro's opening, and should be developed with the option of modifying service levels in response to demand. A PRT system may be justified on certain routes in the long-term.

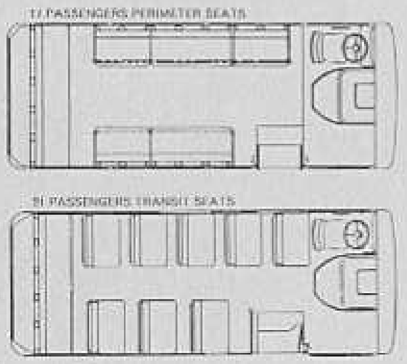
3.5 System Capacity Required

Examination of peak travel demands indicates that the highest passenger volumes will be found adjacent to the King Street and Braddock Street stations. The peak volumes under the Residential Model assumptions occur on the links approaching Braddock Road station, whereas the peak volumes under the Commercial Model occur on the links approaching King Street station. Assuming a small bus with capacity for 25 passengers running at 12 mph over a 5 mile trip loop between the stations the number of buses required can be estimated.

CONCLUSION 5

To satisfy peak hour demand, between 18 and 30 small 25-passenger buses will probably be required depending on the modal split assumptions. This will allow between 90 second and 60 second headways respectively. These figures are tentative, and will be subject to more rigorous scrutiny in Phase 2 of the study, when operating, scheduling and costs will be analyzed in more detail.



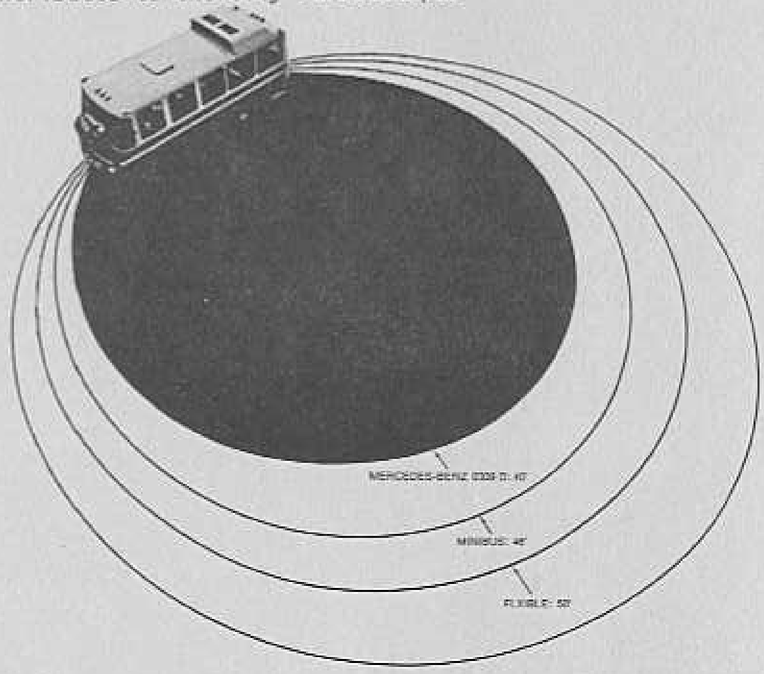


3.6 Vehicle Design

While the elevated "new technology" is certainly attractive in terms of vehicle aesthetics and novelty, there appear to be several variants of the mini-bus concept which also have distinct imageability. The attractiveness of the vehicle itself is of tremendous value in projecting the city's concern for good design among tourists and non-residents. The traditional streetcar achieves this. It may be worth tolerating the impacts of an overhead wire and some traffic disruption in favor of its sheer imageability and tourist-value for the town.

CONCLUSION 6

The ultimate selection of a Mini-Transit vehicle should give strong weight to considerations of comfort, pleasant interior design, and particularly the attractiveness of the vehicle as it contributes to the city streetscape.

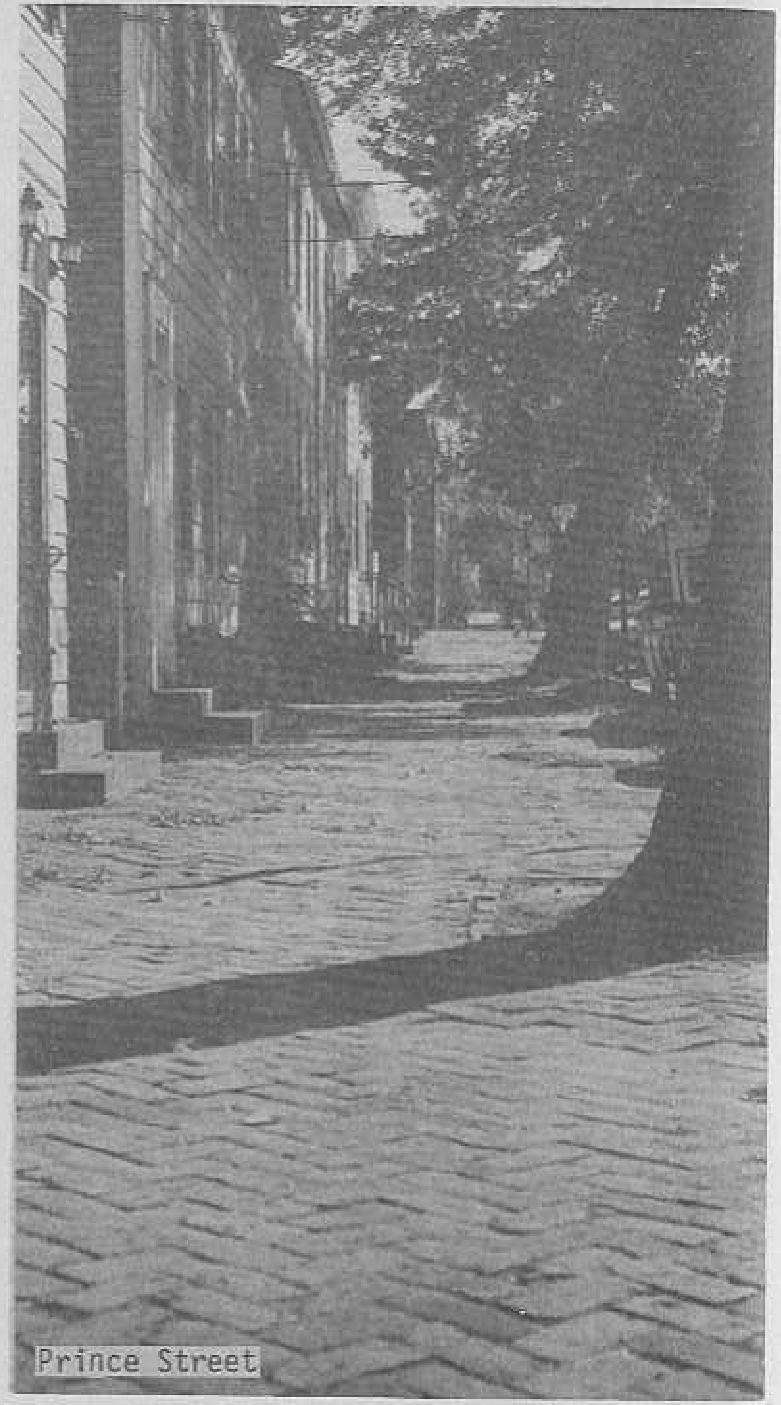


3.7 Urban Design and Community Input

The reactions of all groups who were exposed to the study objectives and concepts were generally favorable. In terms of the aesthetic impact, the concensus appeared to be opposed to any form of elevated guideway system. This was supported by the findings of the study that there appeared to be no method of penetrating the Old Town area with an elevated structure without serious visual impact on significant buildings and views.

CONCLUSION 7

Initial public reaction supports the view that a fixed, elevated guideway system would be incompatible with the historic and residential environments of the study area.



3.8 Recommended System

The purpose of this phase of the study has been to narrow down the range of options to arrive at a feasible Mini-Transit System for which the detailed design will be prepared in Phase 2. The basic recommendations at the conclusion of Phase 1 are as follows:

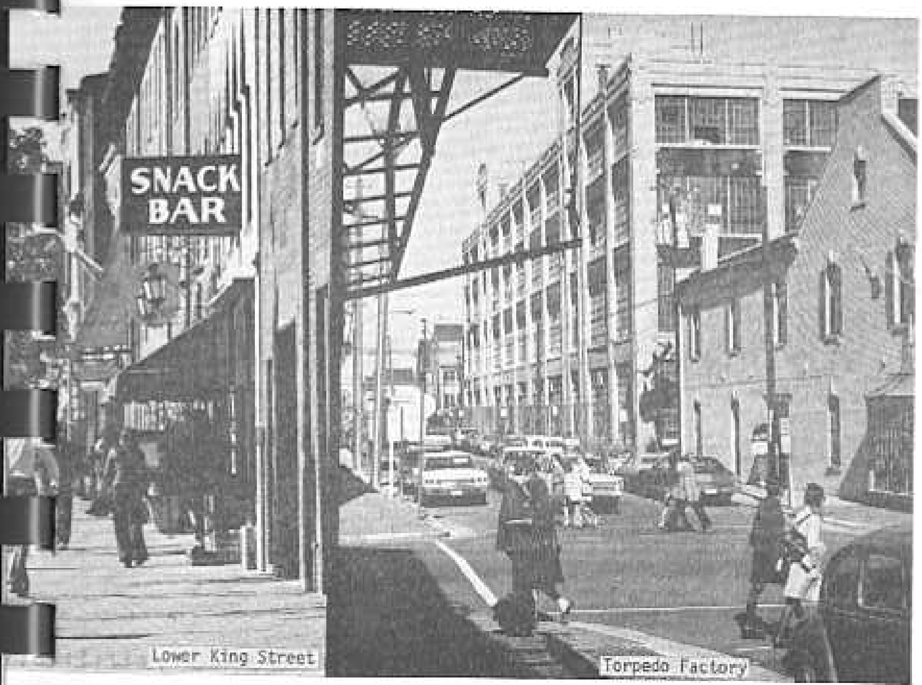
1. On the basis of demand estimates, technological evaluation, urban design considerations, and community input, a small bus system within the central Alexandria area will be necessary in order to prevent savere congestion in the vicinity of the proposed Metro-stations and will provide a highly desirable service throughout the area.

2. The number of small buses required will vary within a probable range of 18 to 30, depending on the growth assumptions, precise routes, fare structure, and capacity of the vehicles.

3. The service area for the recommended system should concentrate on four main corridors:

   - King Street
   - Braddock Road Station to North Waterfront
   - North and South Washington Street
   - North and South Fairfax Street

4. The study should proceed into Phase 2 on the basis of the foregoing recommendations in order to develop final routes, vehicle design specifications, manpower and maintenance requirements, cost/revenue plans, and a management plan.



4 Urban Morphology and Design

4.1 Composition of Neighborhoods

As a preliminary step toward subdividing the study area into zones, an analysis was conducted of the functional areas and neighborhoods which constitute downtown Alexandria. Naturally, the boundaries are imprecise and the character of each area is far from homogeneous. Figure 3 shows the neighborhood boundaries as identified for this study. Their general character is often a function of future potential rather than existing function.

In determining the zonal boundaries within the study area careful consideration was given to existing and future land uses, to the District boundaries as used in the COG demographic forecasts and to the needs for greater detail (and therefore smaller zones) within the central area and around the Metro station sites. Figure 4 shows the final system of zones within the COG system of Districts.

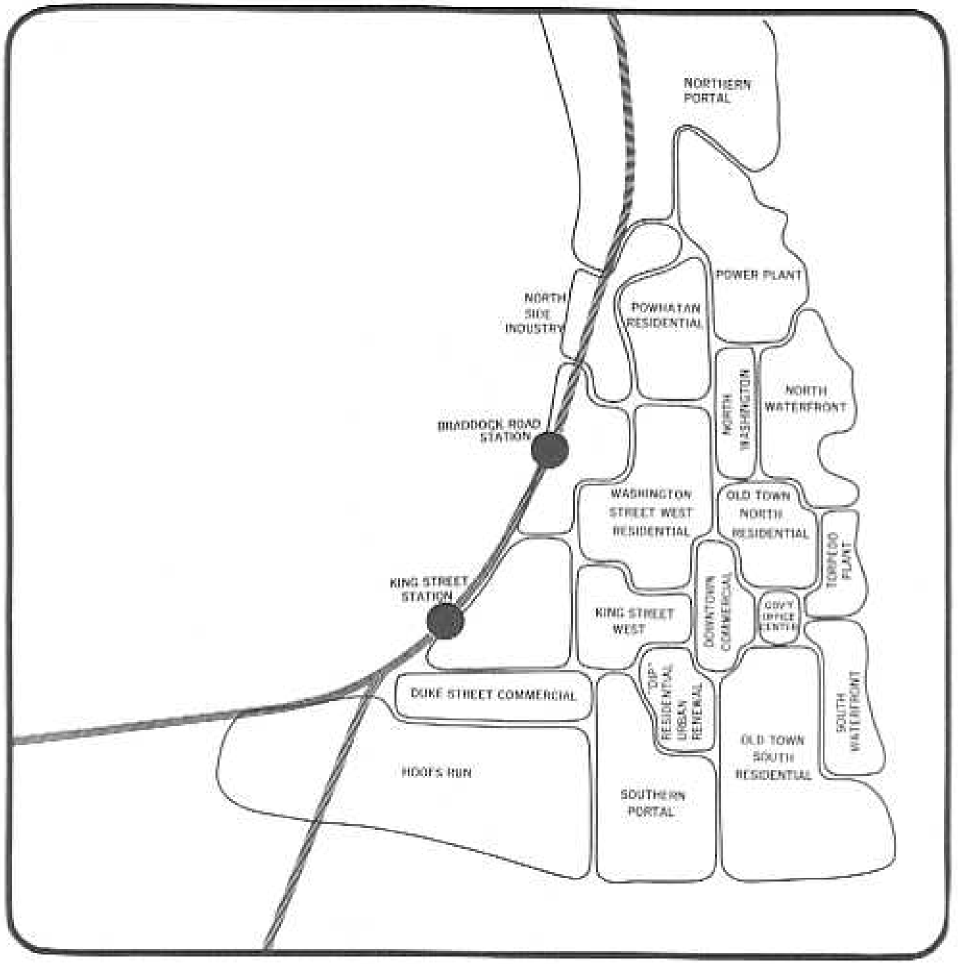


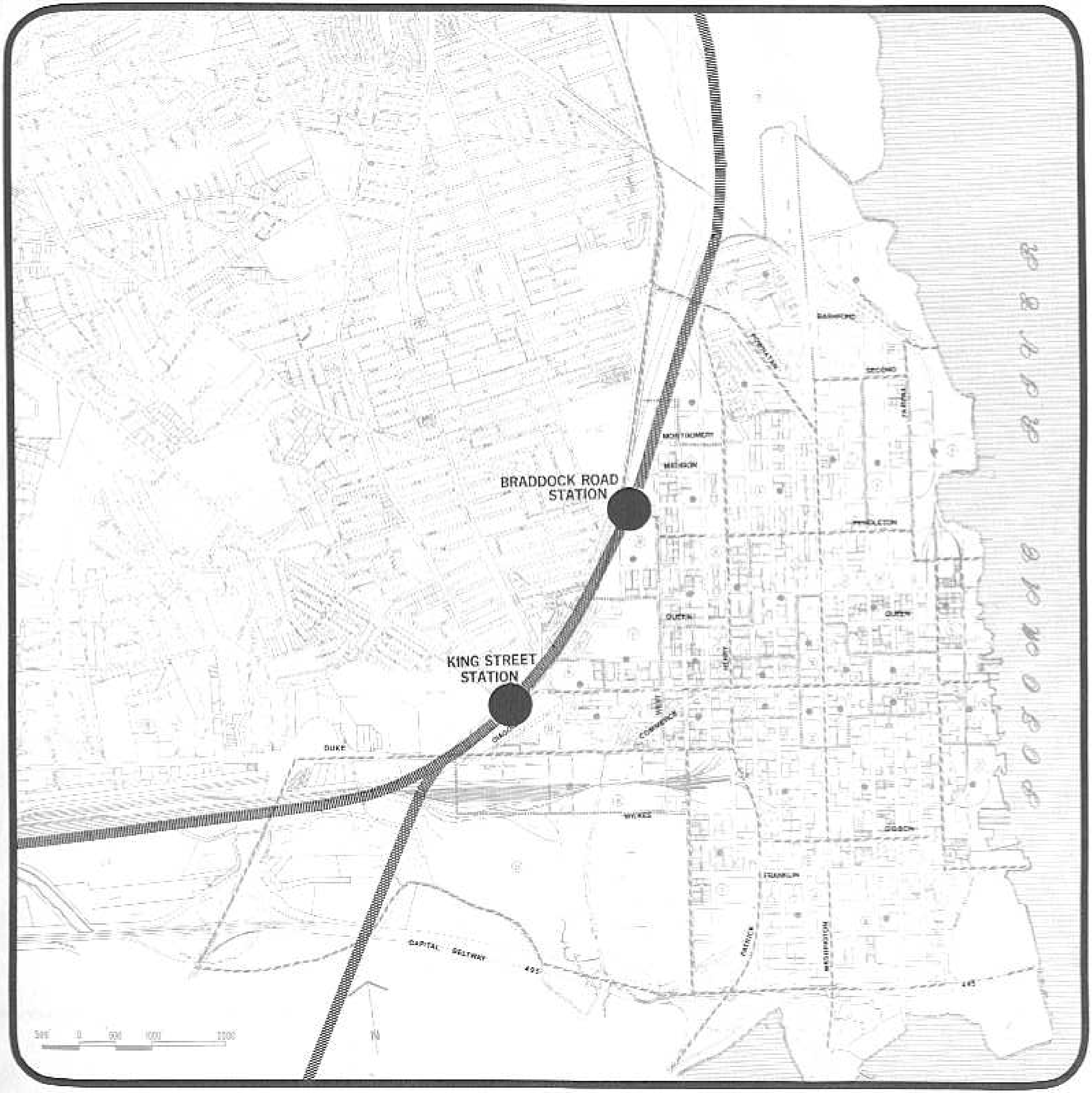
Figure 3 STUDY AREA NEIGHBORHOODS

Perhaps the most notable feature of the study area is the widely disparate nature of its neighborhoods. Upper income areas coexist with public housing, high rise condominiums are within 2 or 3 blocks of the historic district, thriving boutiques are found next to industrial plants, and areas of vacant land and used car lots are within a few blocks of the commercial core. The variety of environments which make Alexandria unique also contribute to the considerable difficulty in forecasting travel demands for such a heterogeneous community.

4.2 Community Facilities

An analysis of the distribution of all types of community facilities reveals a few concentrations of activities which might warrant routing the Mini-Transit system to serve them, particularly at off-peak periods. The two major traffic generators appear to be grocery stores and schools. Of the former, the Giant Food on North Asaph Street and the A & P on Duke Street are both on the periphery of the study area. Major schools in the central area are Parker Gray, Jefferson-Houston and Robert E. Lee. In addition, the George Washington Secondary School is located adjacent to the study area on Braddock Road.

The proximity of George Washington and Parker Gray schools to the Braddock Road Station, could result in additional use of the Mini-Transit system. Many school facilities are used in the evenings for adult education classes and community meetings. One further concentration is to be found at the Jefferson Houston School which also houses the Alexandria Department of Recreation and a Community Center. Mention has been made by community representatives of the need for a shuttle service between the Alexandria



ALEXANDRIA MINI-TRANSIT

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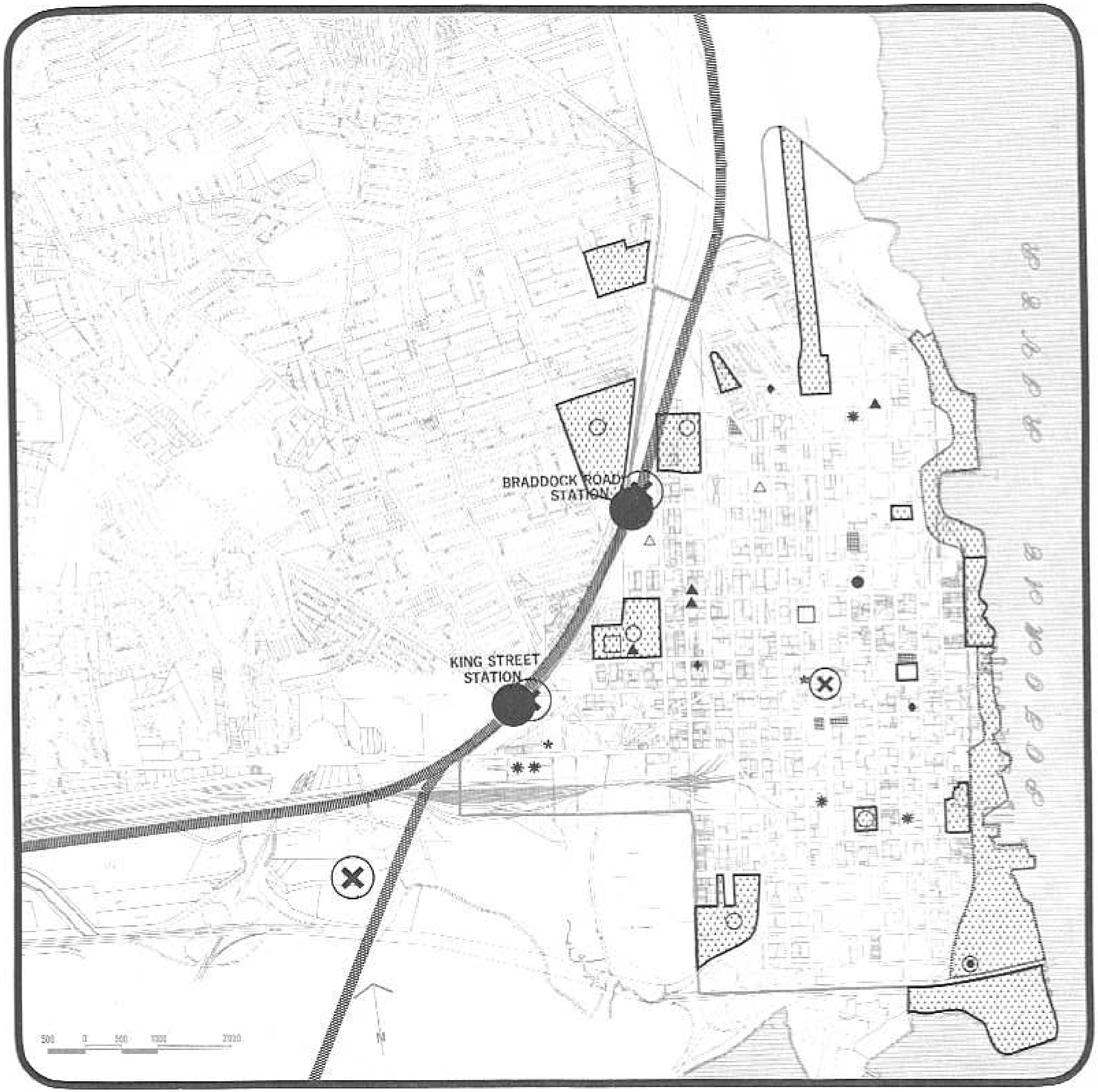
Figure 4

Study Area Zones

- ZONE NUMBERS
- ZONE CENTROIDS
- COG ZONES (STUDY AREA DISTRICTS)
- STUDY AREA ZONES

Prepared for the
Northern Virginia Transportation Commission

Barton-Aschman Associates Inc. Washington,D.C.



ALEXANDRIA MINI-TRANSIT

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Figure 5

Location of Community Facilities

- PROPOSED MAJOR PLAY AREAS
- RECREATION AREAS
- PROPOSED RECREATION AREAS
- GROCERY STORES
- DRUG STORES
- COMMUNITY CENTERS
- PROPOSED COMMUNITY CENTERS
- SCHOOLS
- DEPT. OF RECREATION/LIBRARY
- OTHER PUBLIC BUILDINGS (CITY HALL, POST OFFICE, HEALTH DEPT., ETC.)
- FIRE STATIONS
- POLICE HQ.
- TRANSIT INTERCHANGES (METRO AND BUS)

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500 Block King Street


Parker-Gray School

Duke St. Shopping


Old Town

Clinic on the site of the old Alexandria Hospital at Washington and Duke Streets, and the Alexandria Health Department on St. Asaph Street. Also the Director of the Ramsey House has expressed the urgent need for a shuttle between Ramsey House and the Bicentennial Center. Special service to these facilities would not appear to be justified in view of their wide dispersion, although many of them will effectively be served by virtue of their being in an area of high employment.

4.3 The Old and Historic District

The Historic District of Alexandria is perhaps its single most precious asset, both culturally and commercially. It covers almost one third of the study area from Princess and Queen Streets on the north to the Beltway on the south, and from Alfred and Patrick Streets to the river, with extensions along North Washington Street and Prince Street. Its precise boundaries as laid down in City Ordinance No. 1338, are shown in Figure 6 .

Within the Historic District, building heights for new structures are restricted to 50 feet, overhead telephone and electric cables are gradually being relocated underground, and landscaping projects have transformed many blocks back into pedestrian environments. As yet there are no auto-free streets in Old Town, although the two blocks which retain their original cobbles effectively prohibit many vehicles from entering.

The Russell Wright Report, completed in 1970, identifies three classifications of Architectural Significance for structures throughout the downtown area, including significant blocks or rows of buildings. The report recommends the extension of the Historic District

This is the only rigorous analysis of structures in the Historic District, and, as the author is at pains to point out, it concentrates on Architectural rather than Historic Significance.

4.4 Urban Design

Much of the quality of design in the buildings and streets of downtown Alexandria is directly attributable to the presence of the Old and Historic District. Improvements have recently been made to Washington and lower King Streets, and most of the streets and alleys in Old Town display a charm which results from the consistency of its architecture, the use of materials and detailing of facades. The proximity of buildings to the streets lends a human scale to the streetscape. and the street landscape has matured with the architecture. Residential densities are approx. 20-25/acre. New buildings, even offices, tend to pattern themselves on the Georgian style, to harmonize with the flavor of Old Town.

The "Paul Spreiregen" report was published in 1971 as "An Urban Design Study for Alexandria." Its major topics for study were, 1. The Natural Environment; 2. The Man-Made Environment, and 3. The Assets and Liabilities of the various Neighborhoods comprising the city. In the downtown area, Mr. Spreiregen identified a series of neighborhood boundaries, important landmarks and important structures. It is the "Man-Made Environment" which is of greatest concern to this study of a Transit System for downtown Alexandria. The Spreiregen report addresses the need for linking Metro Stations by transit feeder lines to nearby communities and illustrates several potential systems which would harmonize with the area, including cable cars, trolleys and a rear platform Paris bus.

The impact of an overhead transit system such as PRT vehicles moving on a fixed guideway will be very different from that of a minibus. For this reason, the urban design considerations in this study generally fall within three categories:

1. The appropriateness of an overhead transit structure (assuming it to be cleanly designed) to a particular streetscape or neighborhood.

2. The appropriateness of overhead wires (for electric power) to a particular streetscape or neighborhood.

3. The appropriateness of transit vehicles of any type to a particular streetscape or neighborhood.

In general, an overhead structure supporting transit vehicles would have columns spaced every 50 - 75 feet with concrete beams. The catenaries for powering an on-grade electric streetcar or trolley would generally require poles every 100 feet or so, with arms supporting the wires projecting into the center of the street. These technical aspects are discussed in more detail in Chapter 8. The major landmark in this area, and indeed throughout most of the town is the Masonic Memorial. This hilltop structure dominates the King Street vista from Alfred Street west, although in this strip, the overhead wires and poles are particularly obnoxious. The potential of this vista has not been fully realized, but nevertheless was a major factor in considering an overhead Mini-Transit system in this part of town. Prince Street on the other hand is lined with pleasant homes and mature

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a downtown transit distributor system

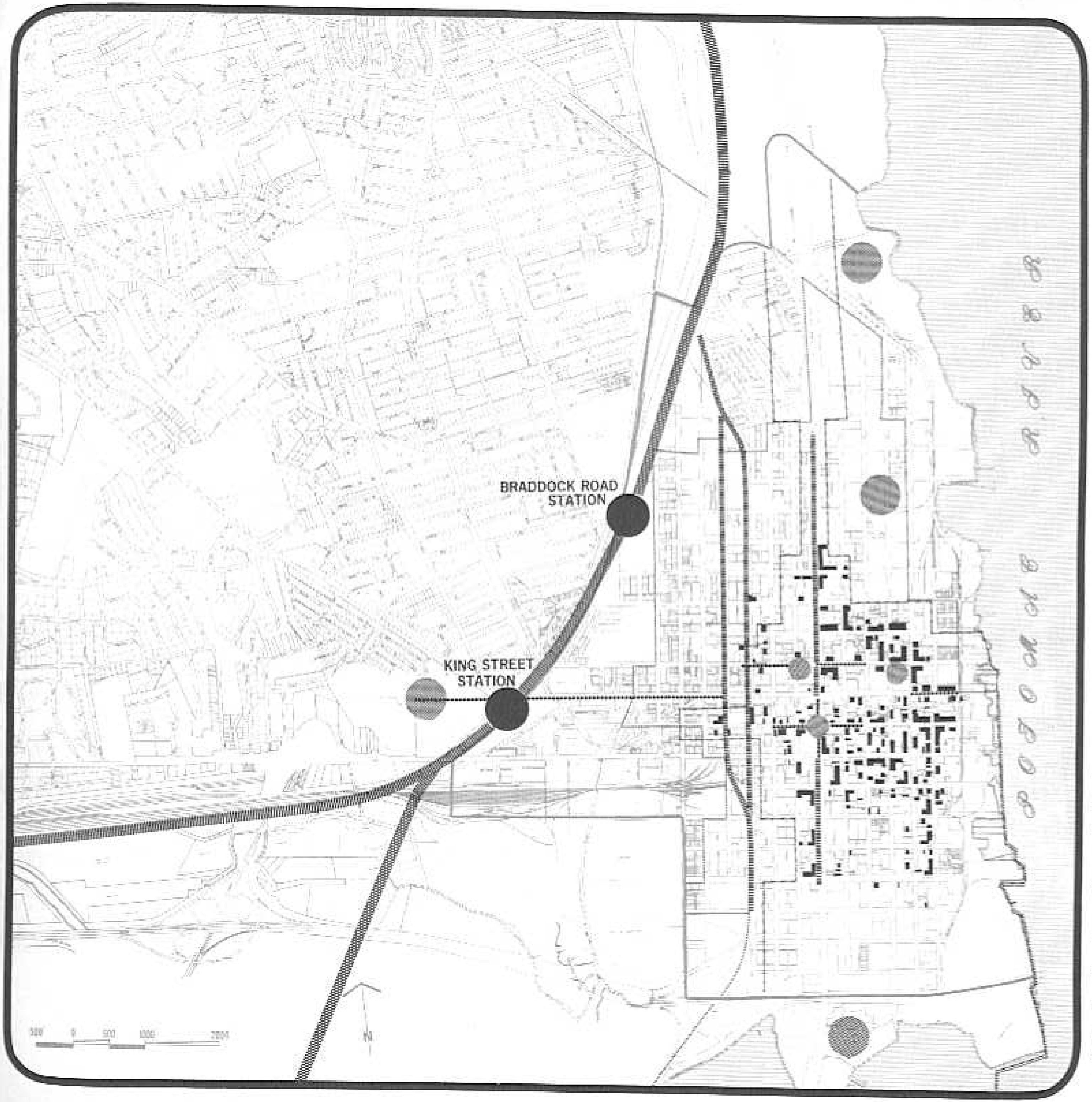

Figure 6

Urban Design Factors

- BUILDINGS OF MAJOR ARCHITECTURAL SIGNIFICANCE
- LANDMARKS
- IMPORTANT VISTAS
- STUDY AREA OF RUSSELL WRIGHT REPORT
- BOUNDARY OF OLD AND HISTORIC DISTRICT
- BARRIERS TO MOVEMENT

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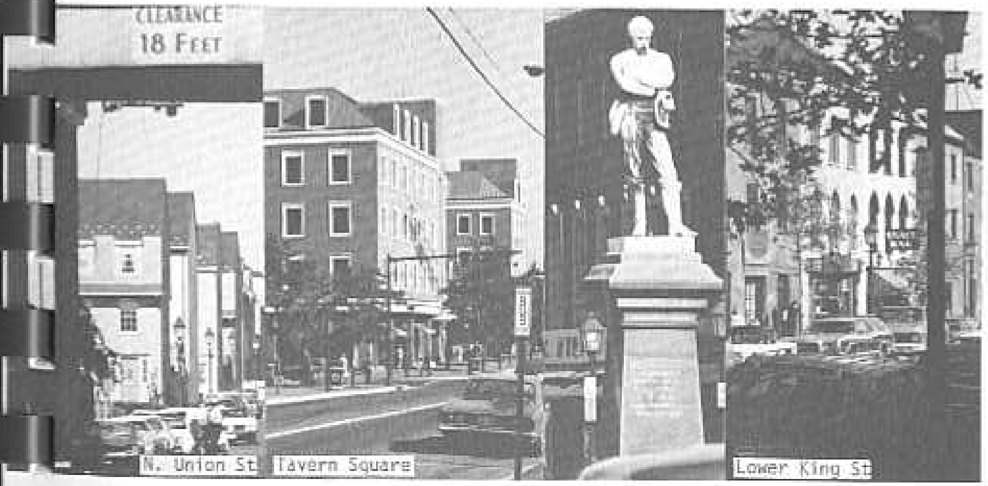
trees and constitutes the major thrust of Old Town westward. Duke Street presents yet another type of environment. Over the next 20 years, large-scale redevelopment could occur on th south side of Duke Street, west of U.S. Route 1, in the form of commercial uses. An overhead Mini-Transit System could conceivably be designed integrally with such development projects. Duke Street possesses no buildings of major architectural significance. Cameron Street, on the other hand, is essentially residential in nature and links well at its western end with the Metro station. However, it would not be an appropriate street for high frequency transit use, due to its residential character in the east. The historic Christ Church at the intersection of Cameron and Washington would make overhead wires undesirable here. Independent appraisals of the various corridors within the downtown area have been conducted and are summarized as follows:

The Western Portal - King and Duke Streets

Outside Old Town, the streetscapes deteriorate with little attempt to control signs, overhead cables and transformers, or consistency in architectural style or street materials. Only the height restrictions have maintained a uniformity of scale throughout most of the area. On Upper King Street and Duke Street, many blocks of vacant land and deteriorating used car lots give the western portal to the town a decaying image. Further east, between Patrick/Henry and Washington Streets, King Street is lined with three and four story structures and has the busy atmosphere of a downtown shopping street. King Street itself would not be adversely affected by overhead wires. However, an overhead guideway could not be incorporated into the streetscape without serious visual impact as well as reduction of light and problems in locating columns on the narrow sidewalk.

The Pendleton-Montgomery Street Corridor

Typical streets in this area include two-story brick public housing blocks and small wooden clapboard houses, with warehousing on North Fayette Street. With street widths of 66 feet and typical setbacks of 30 feet or more, the scale of the streets is largely horizontal. An overhead transit structure would be overpowering as well as inappropriate to the residential character here although it would be entirely suitable to some of the industrial blocks, such as between Patrick and Henry. The acceptability of an overhead trolley wire should be a subject for neighborhood discussion. Pendleton Street carries most of the traffic from North Washington Street to Braddock Road. Wythe Street does not at present connect to Braddock Road at its western end, although it is likely to become one leg in a one-way pair. If this connection were made, traffic access of all kinds to Metro would be made easier. Madison and Montgomery Streets presently operate as a one-way pair. There are no architectural structures in this area of major significance although several good examples of 19th century row housing occur.



North Waterfront

The high-rise structures now appearing on the North Waterfront will in themselves present no problem to the incorporation of an elevated transit system. However, careful design and location should prevent the obstruction of views from upper story apartment windows. The transitional area from North Washington over to North Pitt and Royal Streets constitutes an architectural no-man's land, characterised by single-story structures housing fast food outlets, supermarkets, and gas stations surrounded by parking areas. Perhaps the only older building in the area worth noting is the Alexandria Roller Skating Rink with its distinguishing arched roof. North Fairfax Street presently traverses much vacant land on the North Waterfront. To the west is land awaiting development and to the east are the bus storage area and tank farms on riverfront parcels whose title is still in question between the competing claims of Alexandria and the Federal Government. Neither Fairfax, Pitt nor Royal Streets would experience major impacts in this area from either an overhead structure or trolley wires. Probably the only type of structure which can be contemplated in any part of Old Town is an overhead wire on King Street, which is essentially non-residential, and possesses few mature trees. One possible route under investigation is the line of the railroad track on Wilkes Street, passing through the tunnel under Fairfax and Lee Street to the waterfront.

Lower King Street and Old Town

The frontage of King Street itself between Washington and City Hall contains Tavern Square and Bankers Square, the Holiday Inn (under construction) and shops in the 600 block. In general, overhead wires would not detract from the streetscape, although this might undercut the present moves to place electric and telephone wires underground. Overhead wires still remain in Union and Lee Streets adjacent to King Street as well as Prince and Duke Streets in this area. The opportunities for penetrating Old Town with an elevated system are virtually non-existent. Only on King Street itself is there a significant lack of structures of primary and secondary importance as cited in the Russel Wright report. An overhead system in this corridor would not block the view of significant buildings. However, there is no complementary route out of the area and furthermore, there would be considerable public opposition to such a plan Throughout most of Old Town, the growth of mature trees over the streets is itself sufficient to prevent an overhead structure or even trolley wire from further consideration.

4.5 Barriers to Movement

Several barriers inhibit movement in the study area, some of them physical, some psychological. Washington Street constitutes a physical barrier to east-west movement, particularly pedestrian because of the problems in crossing at light-controlled intersections. This may explain for example why many people disembarking from south-bound buses go into Penney's store to shop, whereas relatively few travelers in the reverse direction appear to use shops on the opposite side of the street. Similarly U.S. 1 as it runs north-south on Patrick and Henry Streets is a barrier due to the volume of traffic and the speed which it is able to achieve as a result of synchronizing the traffic signals.

Other psychological barriers appear to exist between Washington Street and Fairfax. There are high volumes of pedestrian traffic downtown and on lower King Street, but very little interchange takes place between the two zones. The stretch of King Street in front of Market and Tavern Squares is often deserted. Between the North Waterfront apartment complexes and North Washington Street, the unfriendly "parking lot environment" is a potential deterrent to foot traffic.

Finally, a psychological barrier apparently exists between neighborhoods on the east and west sides of Washington Street. There is very little interaction between the Black community and Old Town, whether because of cultural differences or differing commercial needs. On the other hand, the community of Old Town generally has very little reason to travel west of Washington Street, except in the case of children traveling to and from the Jefferson-Houston, George Washington, and Parker Gray schools. Furthermore, the child population of Old Town has been declining for some time and many parents are moving their children to private schools.

In a very practical sense, the transit distributor will enable many people to cross these physical and psychological barriers and hopefully encourage greater daily interaction between communities and resources on both sides of the town.

5 Land Use and Growth

5.1 Land Use Forecasting

In order to forecast the number of trips to be made within the study area in 1992, it was necessary first to obtain a picture of the growth of population, jobs and income within each Zone. Under different sets of growth assumptions it will be apparent that the study area could develop in a number of ways. Consequently two alternative growth plans have been developed which are designed to reflect the extremes of growth over the next 20 years. These are termed the Residential Growth Model and Commercial Growth Model.

The rationale behind using two growth assumptions lies in the fact that the type and number of trips typically generated by residential development varies considerably for commercial development. The average household generates approximately 6-8 trips per day by auto or transit, and an additional 4-6 walking trips. Typically, 75% of these will be home-based, with only 25% between business and retail uses.

Further differences occur in the trip length and mode of non-home-based vs. home-based trips. For instance most of the non-home-based or business oriented trips occur at the mid-day period and are walking trips. Conversely, most of the home-based trips are longer auto trips. It was considered important that these differences be reflected in the two growth models.

The 1992 land activity projections were developed as required by the TRIMS model, namely on a Zone by Zone basis and the Alexandria City Planning Staff provided valuable assistance in identifying potential growth areas.

In developing each Model, data was obtained from a wide variety of sources:

- The Alexandria Comprehensive Plan (1971, approved 1974)
- Washington COG Growth Projections (1968-1992)
- Census Data on a block basis (1970)
- "Development Potentials at Metro Stations Sites" - an economic report by Gladstone Associates (1974)
- Survey of Business and Employment in Downtown Alexandria - Alexandria Chamber of Commerce (1972)
- City of Alexandria Information Bulletins.

The most important of these data sources are discussed futher in Sections 5.2 and 5.3.

5.2 The Comprehensive Plan

The most recent Comprehensive Plan was prepared by City Planning Staff members in 1971, and presented to the City Council for action on January 1, 1972. The Plan was not formally adopted until November 1974.

The area with which the Transit Study is primarily concerned is Planning District I. The current population within this area is approximately 24,000 persons. In a number of respects Planning District I has fulfilled the projections which were made in the Comprehensive Plan. The opportunities for new growth in the North Waterfront and DIP*areas are being realized. Old Town is likely to remain stable for the long range future. The Comprehensive Plan predicts a long term population growth to a level of 47,000 persons, and employment growth to 37,000, although no date is specified.

Among the Comprehensive Plan recommendations for this area are:

- Retain retail activities on King Street from Washington Street to the Potomac.
- Encourage revitalization in the middle section of King Street.
- Re-examine the possibility of downtown functions moving closer to King Street Metro station.
- Protect Washington Street as a gateway to the central area.

*The urban renewal area south of the CBD

- Encourage the relocation of industry out of the central area to areas with better accessibility.

- Encourage redevelopment of the waterfront with residential, office development and continuous pedestrian walks.

- Upgrade the area west of Washington Street by redevelopment, restricting through traffic and improving the character of the area.

The Comprehensive Plan envisages new mixed uses adjacent to both Metro stations as well as on the North waterfront, with an industrial enclave remaining in the vicinity of the railroad yards at Duke Street in the south west and the Potomac Yards in the north west.

In general, the thrust of this plan has been followed in preparing land use projections for this study.

5.3 Metropolitan Washington COG Projections

The population and growth projections made for Planning District I in the Comprehensive Plan contrast sharply with the regional projections made by the Metropolitan Washington Council of Governments, which are much lower. COG projects 14,200 population and 17,700 jobs in the study area by 1992, significantly fewer than the Comprehensive Plan estimates. (See Table 3).

The differences in these projections, even allowing for the slightly larger area covered by the Comprehensive Plan give cause for further investigation. They appear to stem from four basic factors:

- The COG projections were made in 1968, based on regional land use trends for the previous decade.

- The impact of Metro on local land use patterns, particularly in station areas, was not fully anticipated by COG. Indeed, the Metro system routes were not finalized until 1968. A surge of new development is now expected in the vicinity of many Metro stations.

- The "spurt" of development on the North Waterfront was made possible by actions of the Alexandria City Council, which could not have been anticipated by COG.

- The renewed interest in retail activities particularly in Old Town is a phenomenon which is still difficult to trace to specific causes, but has nevertheless resulted in a massive rejuvenation of Lower King Street. Some of these shops are now experiencing the highest activity rates of any in town, and this too was impossible to predict five or six years ago.

Other factors have been at work even more recently to halt the rapid decline in Planning District I population:

- The high price of housing in the Washington area market has persuaded many renters to remain in inner city areas rather than become home-owners in the suburban fringes.

- The energy crisis has at least slowed the move to the suburbs, if not turned the migration pattern around in some areas. Due to the high costs of automobile commuting, many families are moving back into the city.

- The flight to the suburbs has traditionally been a movement away from inner city schools. Over the post war years Old Town has lost many of its families and they have been replaced by both younger and older couples with fewer children. Now that this process has been largely accomplished, the drain of population has ceased and Old Town shows a relatively stable population base.

COG projections of population and employment are made in four-year increments for each of 151 Zones which make up the metropolitan area. These projections for Alexandria in 1976 and 1992 were used as a basis for comparison, but it was felt prudent to prepare independent forecasts, as described in Section 5.1.

Table 3

	POPULATION	EMPLOYMENT
City of Alexandria Comprehensive Plan District I Long term* projections (made in 1971)	47,000	37,000
Washington COG 1992 projections (made in 1968)	14,200	17,800
Barton-Aschman 1976 Base Year Projections	23,600	14,200
Barton-Aschman 1992 Residential Model	25,900	17,500
Barton-Aschman 1992 Commercial Model	23,600	20,700

The detailed assumptions for changes in each zone under both 1992 Residential and 1992 Commercial Models are contained in Appendix A (available from NVTC)

Figures 8,9,10,11 show the anticipated 1992 patterns of population and jobs for the Residential and Commercial Models.

* No date specified.

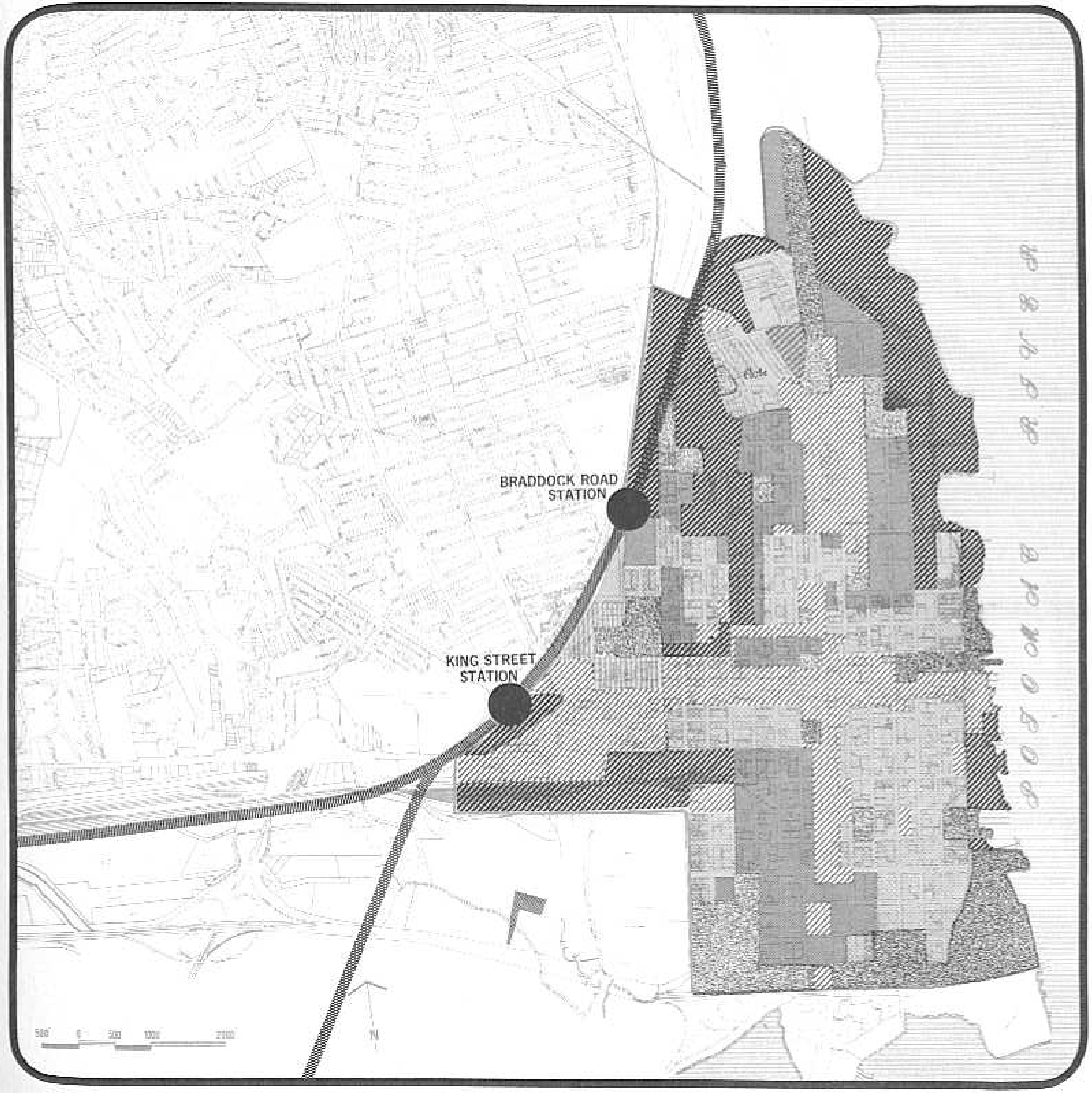


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Figure 7

Existing Land Use

- SINGLE FAMILY DWELLINGS TOWN HOUSES
- MULTI-FAMILY DWELLINGS
- COMMERCIAL (INCLUDING GOVERNMENT OFFICES) HOTELS, SHIPPING FACILITIES
- INDUSTRIAL
- INSTITUTIONAL OPEN SPACE, SCHOOLS

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5.4 1992 Land Activity Projections

As described in Section 5.1 two alternative projections of land activity were prepared: the Residential Growth Model and the Commercial Growth Model.

Four basic tasks were undertaken in the land activity forecasting process:

- Statement of Growth Assumptions.
- Collection of land use data and review of other economic assessments.
- Preparation of alternative land use plans for Residential and Commercial Growth.
- Quantification of alternative land use plans.

Three types of Zone were identified as being likely to experience Major Change, Moderate Change, or Stability.

Major Change Zones include those which are likely to experience major growth as well as those with substantial declines in activity. Those in the vicinity of King Street Metro Station typify the former, whereas the latter category might include the South Waterfront where industrial uses will probably give way to parkland. Those areas within a 1000 foot radius (easy walking distance) of Metro stations are liable to undergo major change within the study area, although in the case of Braddock Road Station growth is unlikely to be substantial due to local residents' opposition. The North Waterfront zones area expected to continue their current rapid growth.
6.2 (b)

Stable Zones include Old Town, where preservation is of paramount concern. Also, the residential areas west of Washington Street have been subject to neighborhood improvement programs, as a result of a city policy of maintaining the livability of these areas. Interim Report II in the Gladstone Associates series projects that retail square footage in all of Alexandria will remain more or less unchanged through 1992, due to more efficient use of sales space. At most the amount of retail square footage will increase by 10% throughout Alexandria.

Moderate Change Zones are those where no significant projects are anticipated and where no major cause can be identified which would be likely to produce large-scale changes at a later date.

Essentially, the Zone by Zone growth forecasting process was accomplished in four steps:

1. A base year of 1976 was established to allow all committed development projects to be completed. This was based on 1970 Census and City of Alexandria data.
2. Growth rates for population and employment in each Zone were obtained by comparing COG data for 1976 and 1992.
3. In the case of Major Change Zones, these growth rates were modified, often drastically.
4. The growth rates were applied to the 1976 base year data.

Finally, the aggregated growth for all Zones was compared with the Comprehensive Plan projections and with COG projections. The 1992 Population and Employment assumptions for each model are shown on the following pages.

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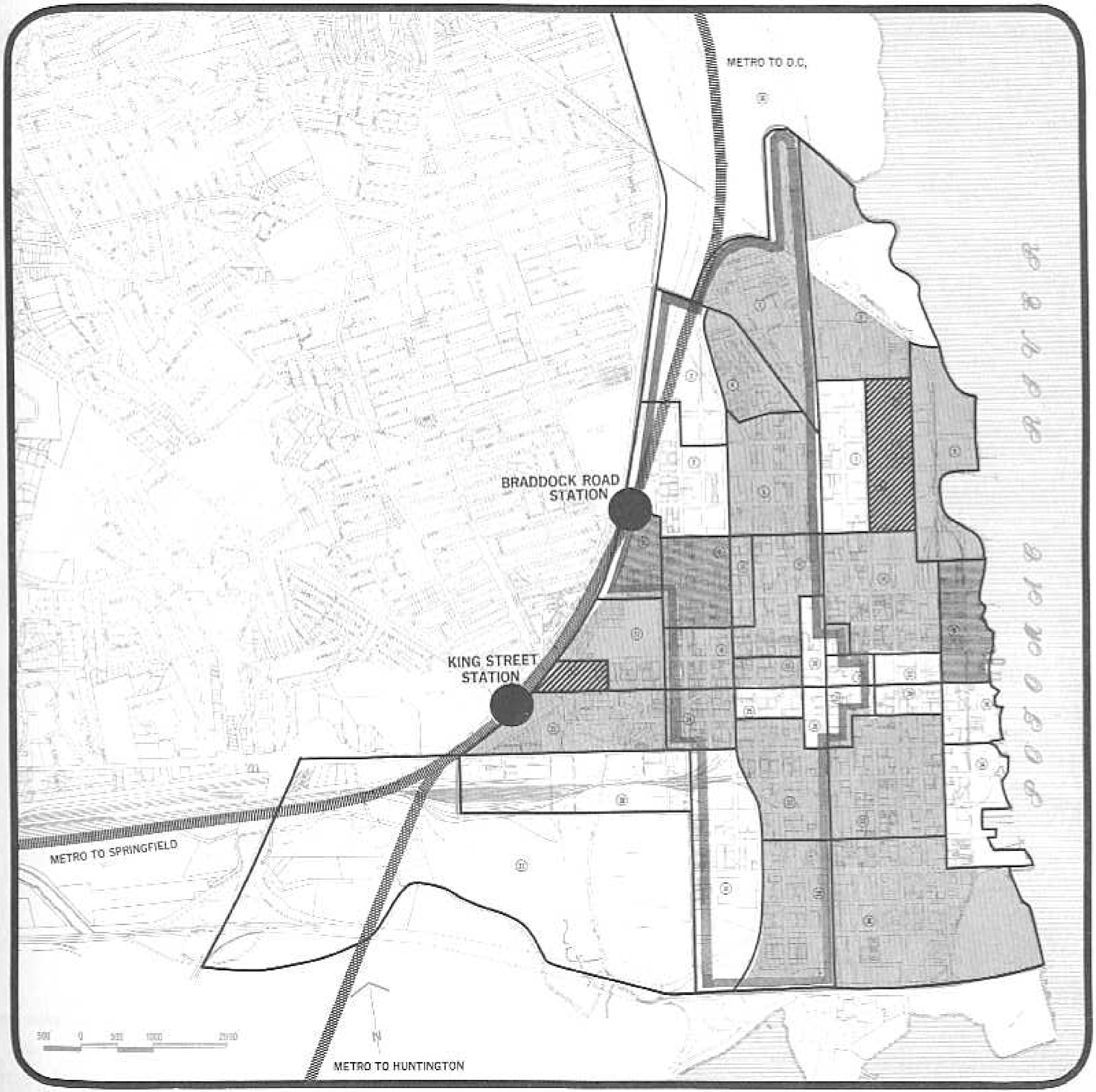

Figure 8

1992 Residential Growth Model

POPULATION DENSITY PER ACRE

- 0-50
- 50-1000
- 100-150
- 150+
- LOW INCOME ZONES

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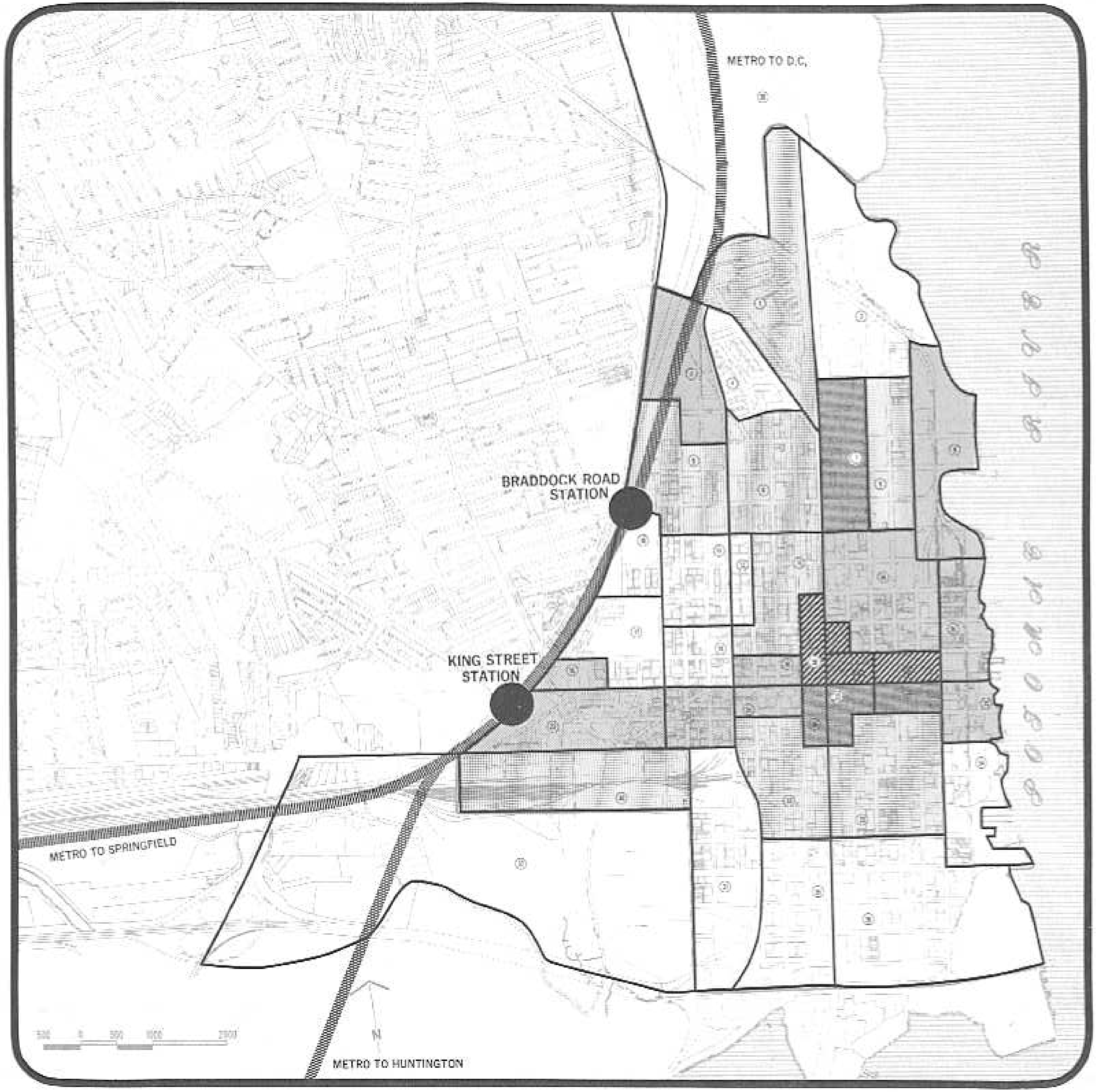

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Figure 9

1992 Residential Growth Model

JOBS PER BLOCK

- 0-20
- 20-50
- 50-100
- 100-200
- 200 +

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Figure 10

1992 Commercial Growth Model

JOBS PER BLOCK

- 0-20
- 20-50
- 50-100
- 100-200
- 200+

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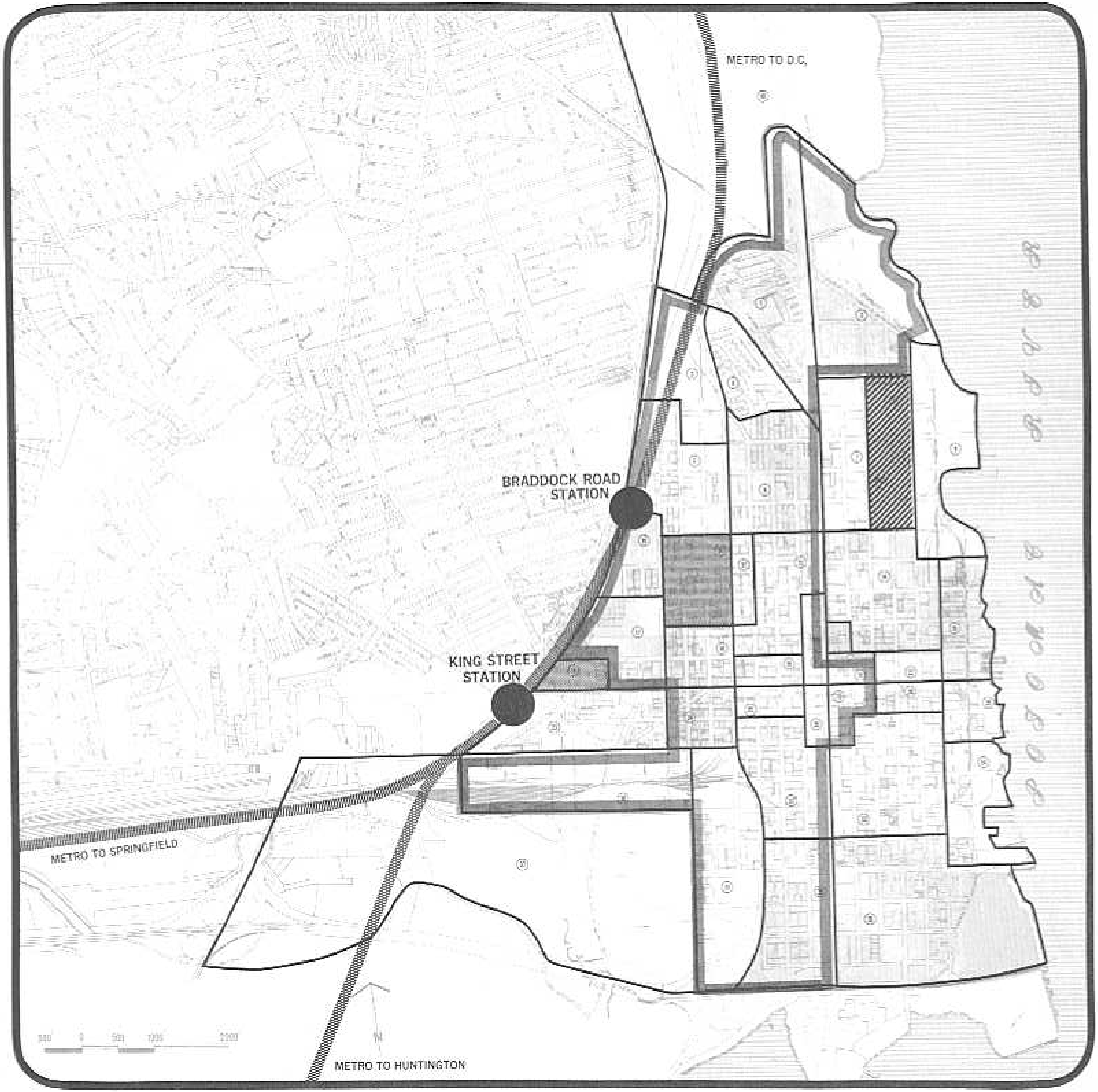

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Figure 11

1992 Commercial Growth Model

POPULATION DENSITY PER ACRE

- 0 - 50
- 50 - 100
- 100 - 150
- 150 +
- LOW INCOME ZONES

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6 Methodology for Travel Demand Forecasting

6.1 Categories of Trips

Three categories of travel were analyzed in the development of candidate trip tables for the Mini-Transit System These are schematically illustrated in Figure 12 and are described below:

(a) Internal-Internal: Trips having both an origin and destination within the study area were all considered as candidate trips. These trips are mostly accommodated today by auto or by walking. Typically, a trip between a downtown zone in Alexandria and the north water front area would be considered an internal trip.

(b) Internal-External: Trips with one end (origin or destination) outside the study area can be categorized as internal-external trips. As an example, a trip originating at the north waterfront residential zone within the study area and terminating in downtown

Washington, D.C. would be considered an internal-external trip. These trips are being accomplished by automobile and Metrobus today. With the introduction of Metro-rail service, many of these trips will be oriented to the Metro stations. Certain fractions of design year transit trips (internal-external) were considered as candidates, depending on how well the location of the trip end outside the study area will be served by the proposed metro-rail system. This adjustment process is described in Section 6.7.

(c) External-External: Trips with both an origin and a destination outside the study area were not considered as likely candidates for the Mini-Transit System and as such were excluded from the analysis. A trip originating at Huntington or Mount Vernon and terminating in downtown D.C., but passing through the present study area would be considered an external-external trip.

6.2 Trips by Mode

Three basic types of trips by different modes constitute the major elements of a candidate trip matrix for the year 1992. Candidate trips, for the purpose of this study, have been defined as those trips that may be diverted to the proposed system once it is operational. It was implicitly assumed that while the proposed system may not generate any significant number of new travel activities, the major impact of the system will be in its ability to divert or attract trips from other competing modes in the study area. Thus, the task of developing the candidate trip table consisted of (1) estimating the 1992 trip desires by mode, and (2) merging these into one composite trip table. Trips by different modes which were considered to be candidates for the Mini-Transit System were as follows:

	PRIMARY MODE		
	Auto	Transit	Walk
Internal-Internal	●	●	●
Internal-External		●	
External-External			

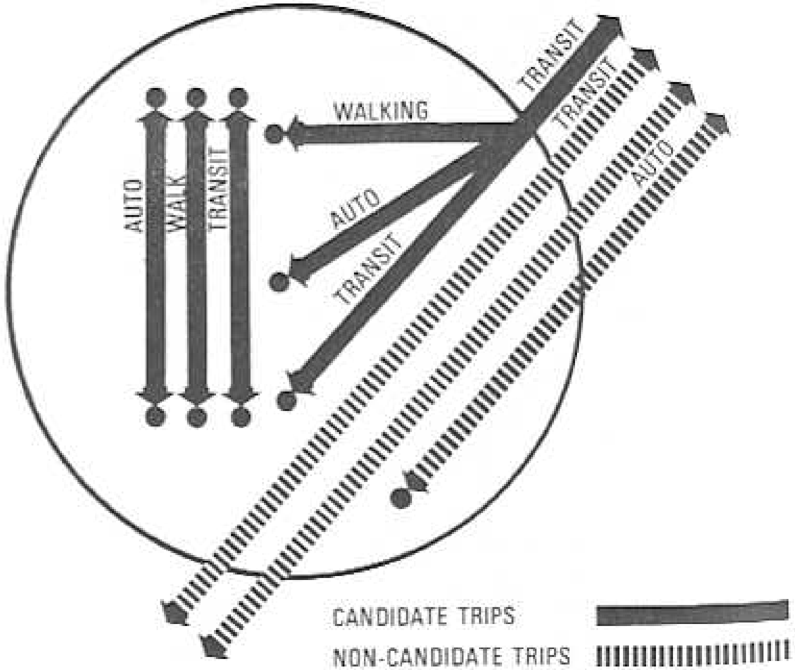


Figure 12
CANDIDATE TRIPS FOR MINI-TRANSIT

(a) Transit Trips: Candidate trips include internal-internal as well as internal-external trips.
(b) Auto-Person Trips: Only the internal-internal trips constitute candidate trips. Internal-External auto trips are those in which the choice of mode has been made in favor of the automobile in spite of the availability of Mini-Transit service to Metro. These trips are thus not considered to be candidates.
(c) Walking Trips: Internal-internal trips only.
(d) Tourist Trips: Internal-internal trips only.
The following sections, 6.3 through 6.8, will present a detailed description of the methodologies used to develop the different trip tables outlined in (a), (b), (c) and (d) above. Section 6.9 is on the development of the likely trip table for the Mini-Transit System. This part of the study made extensive use of the Transportation Integrated Modeling System (TRIMS) package developed by the Metropolitan Washington Council of Governments.

6.3 The TRIMS Model (Transportation Integrated Modeling System)

(a) Model Description: The TRIMS program developed by the Washington Metropolitan Council of Governments* was used for estimating future candidate trips for the proposed Mini-Transit System for the auto-driver portion and transit portion only. The model utilizes a regional highway and transit network as well as Land Activity data for each zone in the region. However, for small areas within the region, the network and land activity data can be modified.

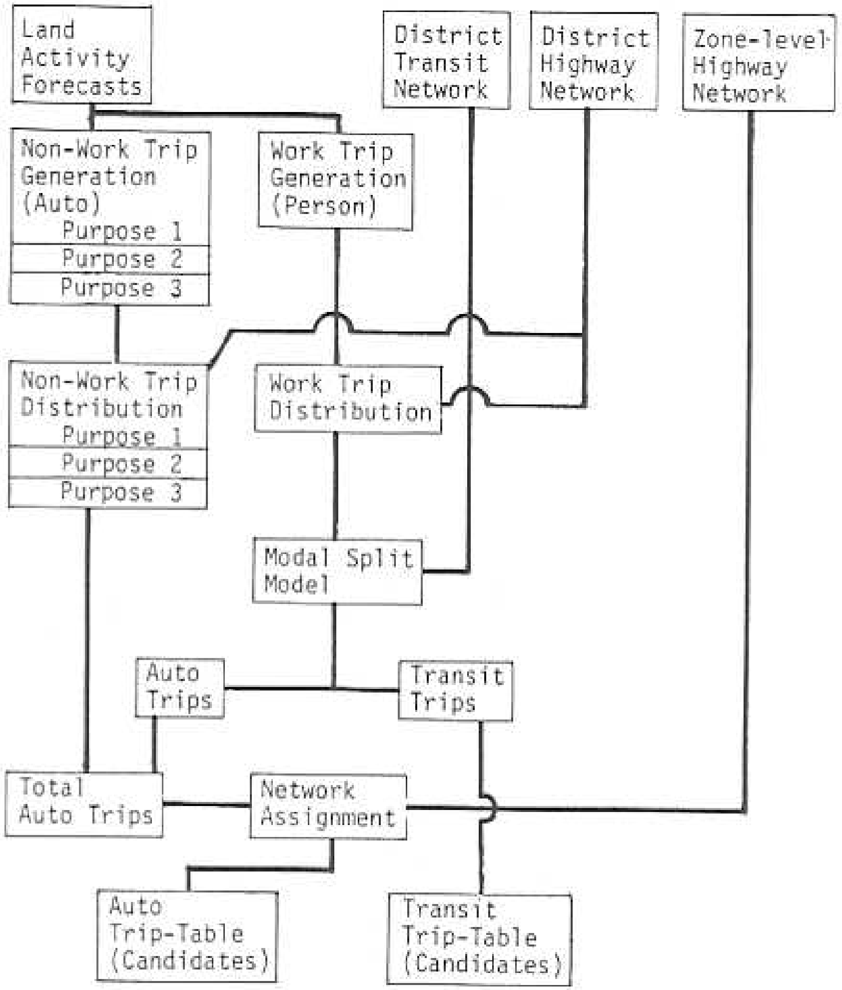
The process of estimating travel demand within the model consists of:

- Trip generation using the Gravity Model technique;
- Modal split between Auto and Transit trips;
- Trip distribution between each zone;
- Assignment of trips to a travel network.

The basic demand modeling is performed at the district level; there are 134 internal districts and 17 external stations within the entire Washington Metropolitan Region. The model has the capacity to focus on a small area within the region, and to produce Auto Trip Tables at the district level which can be split into a zonal trip table within the model. Transit trip tables are also produced at the district level but must be disaggregated to the zone level by hand.

The overall sequence of the different phases of the model has been illustrated in Figure 13. Essentially the modeling process takes place in two parallel channels, representing two basic trip purposes, namely work and non-work. In one channel, work-trip distribution is accomplished on a "person basis"; then a modal-split model is applied to separate transit from auto trips. The auto-person work trips thus produced, are subsequently adjusted for a proper car-occupancy factor to yield auto-driver trips.

*TRIMS model developed by Metropolitan Washington Council of Governments, was presented at FHWA Urban Transportation Planning Computer User's Seminar, Scottsdale, Arizona, May 1974.
See also "TRIMS - A Procedure for Quick Response Transportation Planning" by W.E. Mann, Metropolitan Washington Council of Governments; paper for presentation at Transportation Research Board, Washington, D.C. January, 1975.



Purpose 1 = Home-based shopping trips
Purpose 2 = Other home-based trips
Purpose 3 = Non-home-based trips

Figure 13

BASIC 'TRIMS' MODEL OPERATIONS

In the other channel, non-work trip distribution is accomplished for auto trips only. The resulting auto non-work trip table is merged with the auto work trips and assigned to the highway network. Non-work transit trips are not accounted for in the basic TRIMS model, but must be factored in at a later point.

(b) Input-Output: The necessary program inputs consist of:

(1) population, household income, and four categories of employment data by districts and zone;
(2) a highway and transit network;
(3) other system characteristics on a district level, such as parking costs, highway, and transit access time;
(4) different model parameters such as "Friction Factors", "K Factors", modal-split curves, and car-occupancy curves.

The outputs are:

(1) a district level transit trip table (P-A format);
(2) a zone-level auto-driver trip table (P-A format);
(3) trip end summaries;
(4) trip length frequencies;
(5) a trip table compressed by jurisdictions;
(6) a traffic assignment on the highway network.

(c) Advantages of "TRIMS" program: The main advantage of using the "TRIMS" package was its ability to forecast the auto and transit candidates for the Mini-Transit System using a program which had already been calibrated to the Washington Metropolitan Area and which was backed by COG's extensive file of land activity and network data. The only data collection which was necessary was limited to the study area itself since the model has the capability of accepting alternate growth forecasts for small areas within the overall metropolitan framework.

6.4 TRIMS Modifications for Alexandria

The COG regional map contains 134 internal Districts and 17 external Stations (Figure 14). Of these, Districts 51, 52 (part), and 68 (part) are within the study area. The 134 Districts are further subdivided into approximately 1200 internal Zones, of which a total of 16 are contained within the three study area Districts.

The study area was divided into 16 new districts that are identical in area to the 16 COG Zones, and these 16 districts were then further subdivided into 38 Study Area Zones (SAZ's). The criteria for creating these SAZ's included: homogeneity of land uses; a need for a whole number of blocks within each zone. and finally, the requirement that all District boundaries be coincidental with Zone boundaries.

This resulted in smaller zones and thus greater detail in the downtown area. It was recognized that it would be almost impossible to attain absolute homegenity of land uses within each Zone. The matrix of 38 Zones was designed to yield information on future travel desires that would be refined enough for estimation of candidate trips for the Mini-Transit System. Figure 15 illustrates the location of the Districts and Zones within the study area, as well as 13 external stations through which all Internal-External trips must pass.

6.5 Data Preparation for "TRIMS" Package

(a) Combining Peripheral Districts: As indicated earlier, the three original COG Districts were split into 16 Districts for the purpose of "TRIMS" program and this required the creation of 13 additional Districts in the study area.

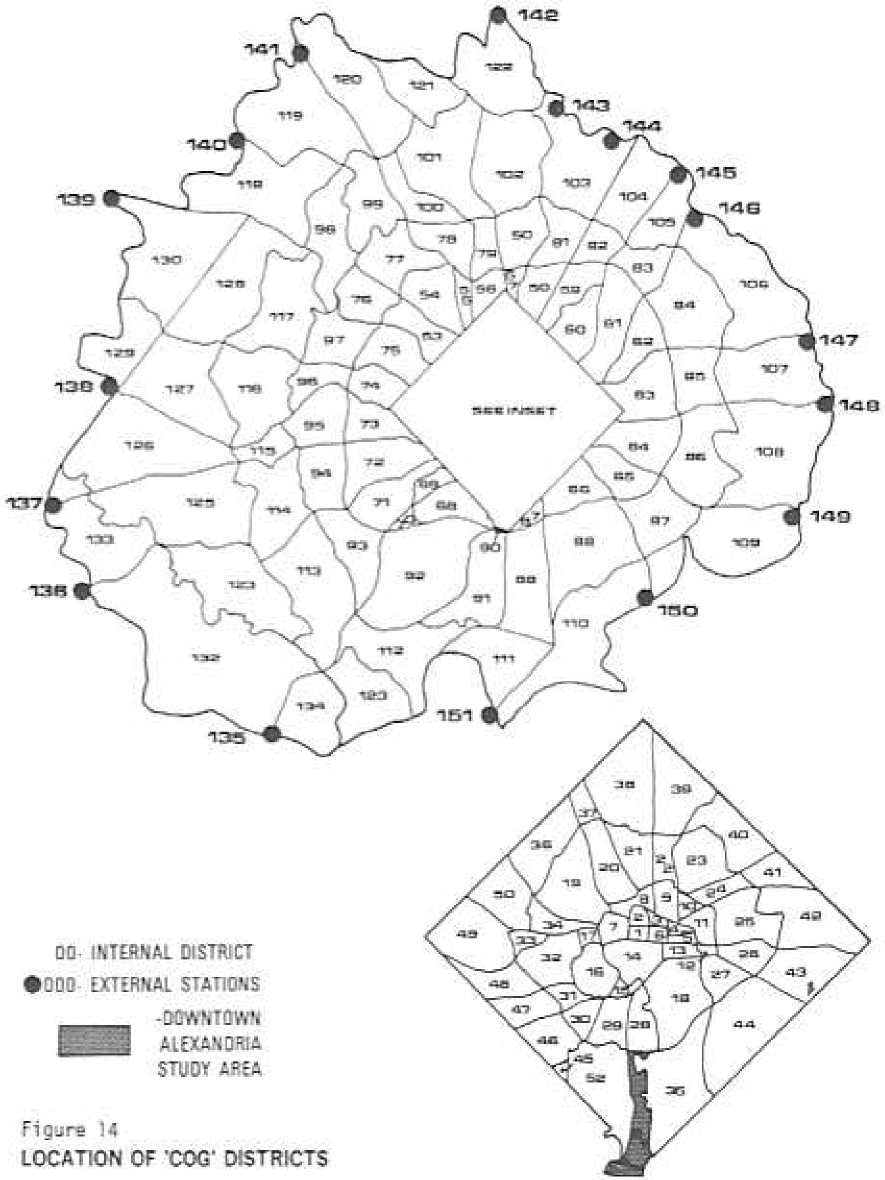
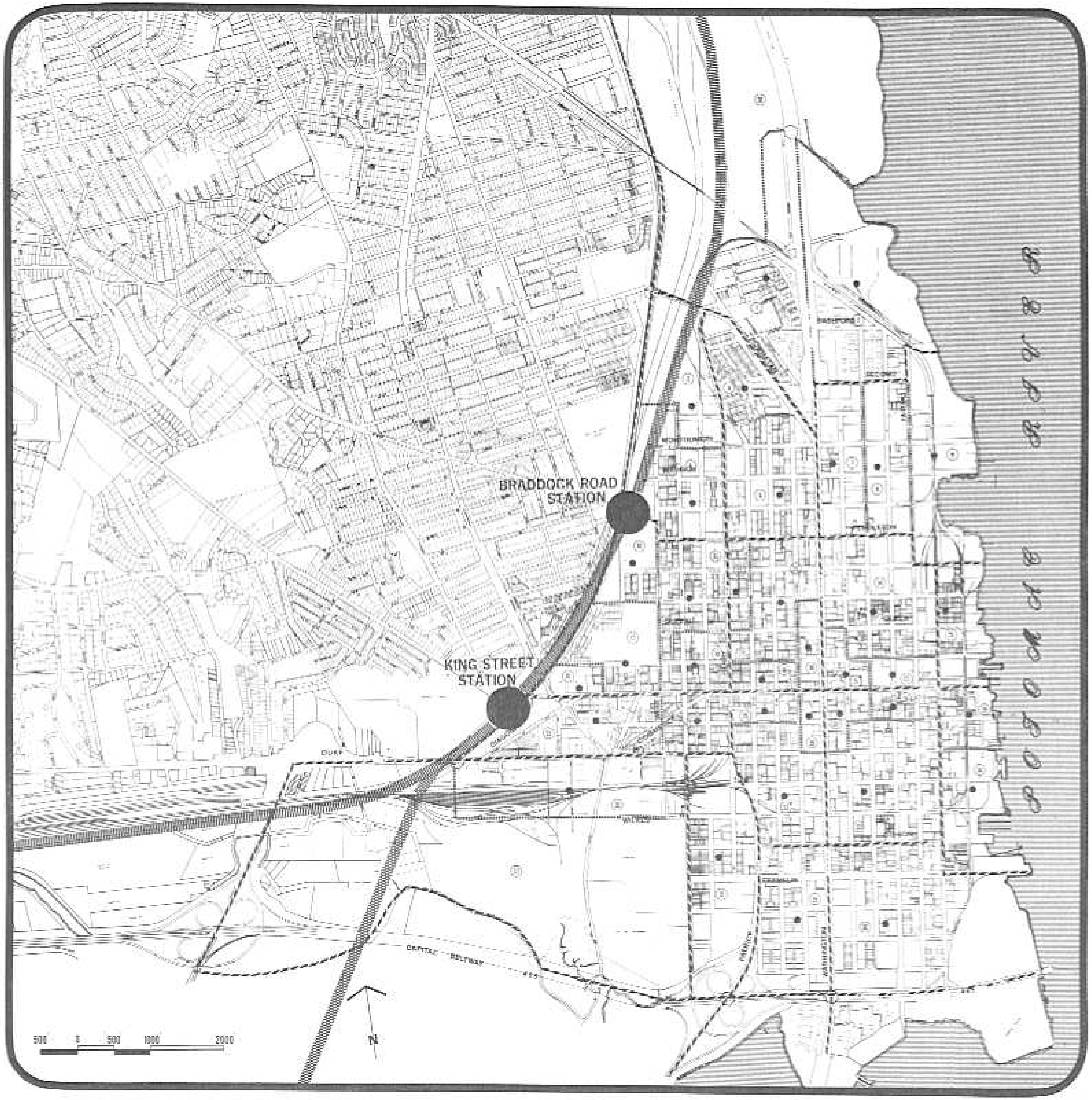


Figure 14
LOCATION OF 'COG' DISTRICTS



ALEXANDRIA MINI-TRANSIT

a downtown transit distributor system

Figure 15

Study Area Zones

- ③ ZONE NUMBERS
- • ZONE CENTROIDS
- - - COG ZONES (STUDY AREA DISTRICTS)
- —— STUDY AREA ZONES

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Since the TRIMS model can only accommodate a fixed number of Districts, it was necessary to combine certain Districts on the periphery of the region in order to "free" 13 Districts. This was done in such a manner as to have minimal impact on travel patterns in the study area. Furthermore, the majority of those Districts that were combined at the periphery of the region, were segregated from the study area by a natural barrier, such as the Potomac River.

(b) Allocating Land Activity Data: The process of estimating trip interchanges utilized the land activity forecasts for the study area, as described in Chapter 5, as well as the land activity data for the remainder of the region as developed by the COG.

Three sets of TRIMS programs were run as follows:

- With 1976 land activity data on the 1992 network; (The purpose of this run was to test the general operating capabilities of the "TRIMS" model).
- With 1992 land activity data, for the Residential Model (see Section 5.1).
- With 1992 land activity data for the Commercial Model (See Section 5.1).

Data for these two alternative Growth Models is contained in Appendix B.* The land activity data for all those portions of the region outside the study area was obtained from projections made by the COG, in consultation with the participating municipal agencies. Thus, the data in the Residential and Commercial Models for the external portions of the region is the same. Land activity data for the study area, on the other hand, was obtained from projections made as a part of this study.

The land activity data for each model has been summarized in tabular form in Section 5.9.

(c) Calculation of Transit Headway Time: Part of data required for TRIMS, is an estimate of "Transit Headway Time" for each District. This is defined as the minimum time required to travel from each District to the Metro stations via all possible modes or combination of modes (such as walking, waiting, and in-vehicle riding time). In this respect, walking and waiting time is generally considered 2.5 times less attractive than "in-vehicle" time.

This process was necessary in order to accomplish the basic modal split process which distributes trips according to a minimum time path. A tenative route and schedule for a Mini-Transit System was needed to do this. The basic assumptions as to speed, frequency of service, and stops were selected so as to be applicable to any type of Mini-Transit System.

6.6 Development of Network for "TRIMS"

Just as it was necessary to develop District and Zone level Land Activity data, so it was necessary to develop a District and Zonal Network as a basic framework for travel demand forecasting. The COG has already developed a bimodal District Level Network for its basic demand modeling procedure consisting of regional highway and transit links describing major variables such as speed, distance, one-way systems, etc. The basic COG 1992 District Level Network was used, with refinements in and adjacent to the study area. These were achieved by adding several new links, which allowed a gradual transition from the coarse grain of the regional network to the fine grain of the study area. The Zone Level Network was created by further refining the District Level Network. More major links were

* Available from NVTC

added, together with necessary connections with the zone centroids. Each link in the District and Zone Network was described as to speed, capacity, and traffic controls using data from the City of Alexandria Department of Traffic.

6.7 Primary Candidates for the Mini-Transit System

Certain adjustments were necessary to the basic TRIMS output for estimating all possible candidate trips for the Mini-Transit System. Figure 16 represents, in a flow diagram, the type of adjustments made.

(a) Transit Trips: Both Internal-Internal as well as Internal-External transit trips were assumed to constitute candidate trips for the system. It was necessary to adjust the transit trip table to include the "non-work" component of such trips, since TRIMS can only account for Transit work trips. This was done by factoring the basic trip table by the ratio of total transit trips to total work transit trips. The factors in each cell of the trip matrix were derived from the basic 1992 WMATA regional transit trip tables.

Another major adjustment to the transit trip table consisted of splitting the trip table from the District level to the Zone level. Since the auto trip table, as an output from 'TRIMS' package is produced at the Zonal level, it was necessary to convert the transit trip table to the same level. Conversion from the District to the Zone level was accomplished by apportioning the trip production ends in the ratio of Zonal population for each District and the trip attraction ends in the ratio of Zonal employment.

* Available from NVTC

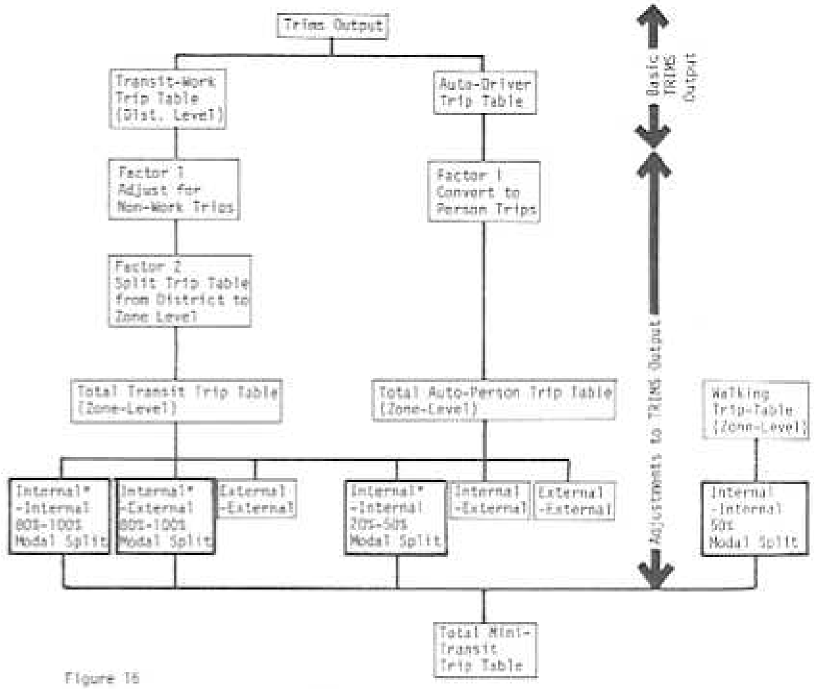

Figure 16

MODIFICATIONS TO 'TRIMS' MODEL

A third important adjustment to the transit trip table was performed by assigning the Internal-External trips to one of the two Metro Stations in the study area. This was essentially a two step process. The first step was to estimate the Metro-rail trips from the total transit trip table (Internal-External) with due consideration to the anticipated level of service via

Metro-rail and Metro-bus during the design year (1992). Transit trips between the study area and the rest of the region were divided into three categories: The first assumed that those Districts in the region which will be very efficiently served by the Metro System would attract 80% of total transit trips to the rail system, leaving 20% of the trips to travel by bus. The second category of Districts which will be moderately well served by Metro would attract 60% of the total transit trips to the rail system. And finally the remainder of the Districts which will be poorly served will attract only 20% of the total transit trips. These three types of zones are identified as Type A, Type B, and Type C respectively in Figure 17.

In the second step the resulting 1992 (Internal-External) Metro-rail trips from the study area to the rest of the region were then assigned to either King Street Station or Braddock Road Station. The assignment process took into account the relative accessibility to each Station from each Zone, as well as independent Station patronage estimates by mode of arrival, which were made available by WMATA.

On completion of these two steps it was possible to construct a 40X40 transit trip matrix of candidates for the Mini-Transit System. This consisted of the trip interchanges between the 38 internal Zones (Internal trips) as well as those between the 38 Internal Zones and 2 External Stations, namely the two Metro Stations.

(b) Auto-Trips: The Zonal trip table obtained from the TRIMS program, was reformatted to show only the Internal-Internal trip interchanges as these were considered the only likely candidates for the Mini-Transit System.

TYPE	SYMBOL	SPLIT BETWEEN TRANSIT RIDERSHIP Metrorail	Metrobus
A		80%	20%
B		60%	40%
C		20%	80%
STUDY AREA			

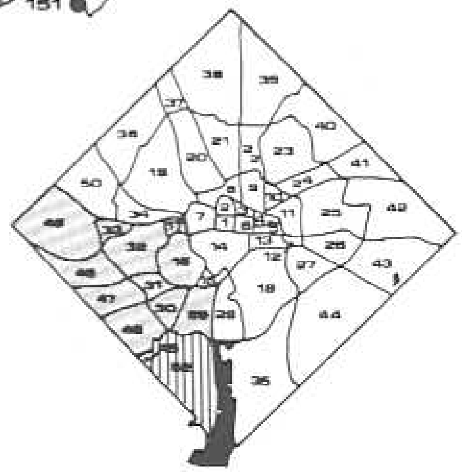

Figure 17

LEVEL OF ACCESSIBILITY BY METRO FROM THE STUDY AREA

It was also necessary to convert the auto-driver trip table into an auto-person trip table by multiplying the trip figures with an appropriate auto-occupancy factor that was derived from COG data. It was then possible to construct a 38X38 candidate trip matrix showing the trip interchanges between the Internal Zones for all auto-person trips.

The trip tables (both Transit and Auto) produced by the TRIMS package were produced in a 'production attraction' format. The final step in the process was to convert the tables to an 'Origin-Destination' format.

6.8 Other Candidate Trips for the System

Two other types of candidate trips for the Mini-Transit System were not modelled in the TRIMS program. These are Walking trips and Tourist trips. It was thus necessary to compile an independent trip-table and add them to the basic TRIMS trip tables. A brief description of the procedure followed in generating these trips is outlined below:

(a) Walking Trips: A sample survey was conducted on a typical weekday among two types of major generators of walking trips in the downtown area, namely commercial areas and office facilities. The survey consisted of recording the number of people walking into these establishments in time spans of 30 minutes, between 7:45 A.M. to 6:15 P.M. The retail and office areas, selected for such survey, were chosen such that they could represent typical trip generation characteristics by these given land uses. While this was not a comprehensive survey of the entire study area, it was considered sufficiently accurate to yield data regarding trip generation/attraction characteristics, typical of a variety of locations in downtown Alexandria. Three commercial establishments and six retail locations were surveyed in three different locations. The following average daily trip attractions (per 1000 gross square feet) were obtained for retail areas in the study area:

- Old Town, tourist activities (95 trips)
- Neighborhood shopping activities on Upper King Street (20 trips)
- Major downtown retail activities (34 trips)

The corresponding trip attraction rate for office locations was found to be 10 trips per 1000 square feet. The office locations surveyed included Government offices, professional services, insurance, real estate medical offices.

The results were compared with similar figures obtained in other areas. The current literature yielded very little information available for other similar situations. However, the survey results were considered to be within the expected range for a small downtown area. The rates of trip generation per 1000 square feet of retail and per 1000 square feet of office space were applied to the 1992 projections of retail and office space, as developed in the zonal land activity forecasts. It is known that a major proportion of walking trips have very short lengths and would continue to be walking trips even when the proposed Mini-Transit is operational. A recent survey conducted by BAA among pedestrians in St. Paul, Minneapolis CBD area indicated that approximately 60 percent of all walking trips were three blocks or less in length; and 90 percent of all walking trips were six blocks or less.

A similar survey conducted in a retail complex in the Boston CBD by BAA, indicated that retail patrons would typically walk up to 4 minutes for a shopping trip, and that the trip tends to be unattractive as the walking time exceeds 4 minutes. With the above background data, it was assumed for the purpose of this study that approximately 65 percent of all walking trips would be 1000 feet or less in length (the equivalent to 4 minutes of walking) and those would not be candidates for the Mini-Transit System. Furthermore it was assumed that virtually no walking trips are more than 3000 feet in length. The total number of walking trips attracted to each Zone was multiplied by 35 percent in order to discount the number of short trips of less than 1000 feet. These trips were then distributed to those adjacent Zones within a range of 1000 feet and 3000 feet, in the ratio of their projected 1992 population and employment. The resulting inter-zonal walking trip table was composed of candidates for the Mini-Transit System.

(b) Tourist Trips: The development of a tourist trip matrix as an element of the candidate trip table consisted of identifying the major tourist attraction centers, projecting the future attendance at these centers during the design year 1992, making some broad assumptions about the prime mode of transportation at these centers and developing a synthetic trip table from the data thus assembled.

It should be noted that only major attractions at the extremes of the tourist circuit have been included in the tourist trip table. For instance, attractions close to the Ramsey House were not included since it was considered that trips amongst them would continue to be walking trips even with the introduction of the transit system.

Current tourist growth at the Ramsey House is 50% per annum. It was assumed that daily attendance figures will continue to climb at this rate until 1976 (the Bicentennial year) and then will be subject to a much reduced rate of increase to 1992, tempered by the capacity of the tourist attractions themselves. The following daily attendance figures were assumed for 1992:

- Ramsey House - 600
- George Washington Bicentennial Center - 900
- Presbyterian Meeting House - 300
- Lee's Boyhood Home - 300

In constructing a tourist trip table from this data, it was assumed that a certain fraction of the tourists would travel to the Bicentennial Center by auto, park their vehicles and travel between the other centers using the Mini-Transit System. From Washington, D.C., visitors would use the Metro-rail System as their primary mode and would use the Mini-Transit System for their travel between the Metro Stations and the tourist centers.

6.9 Development of a Trip Table of Demand for the Mini-Transit System Distributor System

An assessment of the 'order of magnitude' of the likely trip table for the Mini-Transit System was made by applying a high and a low modal-split on each of the candidate trip tables and then combining the respective tables together. Thus, for each land use alternative, two trip tables were prepared that represented the two broad ends of the spectrum of travel demand. The trip tables thus prepared represent the two extreme results of the complex mode choice decisions of travellers in the study area, between automobile, walking, and the Mini-Transit System.

Different mode split assumptions were applied to each candidate trip table. These assumptions are discussed below:

(a) Transit: The transit candidate trip table, developed from 'TRIMS' output, represents the use of the proposed Metro-rail System as the primary mode. It was assumed that the Mini-Transit System would provide people with a desirable 'access mode' for the internal portion of these trips. Other possible modes that could provide access to the Metro Stations are: Kiss and Ride, and walking.

There is no parking at the Metro-stations, so no auto-commuting is expected. Walking trips between internal zones and the Metro-station were considered to be non-candidates, since they only originate from Zones close to the Stations, and will probably continue to walk. Thus, the only competing mode is Kiss and Ride travel. In view of the attractiveness of Mini-Transit service and the problems associated with having to coordinate the schedules of two persons to make a single trip, a relatively high range of modal split was assumed, of from 80% to 100%.

(b) Auto-Driver Trips: Of the candidate Auto-person trips, it was assumed that between 20% and 50% would actually be attracted to the Mini-Transit System. These percentages were used as low and high modal split rates. The remaining 80% and 50% respectively would continue to drive their autos for trips within the study area.

(c) Walking Trips: Theoretically, all walking trips may be diverted to the Mini-Transit System if the quality of service provided is considered "ideal". The figure is likely to be substantially lower when factors such as cost, convenience, walking distance, waiting time, etc. are considered. The assumption was made that 50% of the candidate walking trips would be diverted to the Mini-Transit System. The candidate trips are those between 1000 and 3000 feet in length.

7 Results of Patronage Forecasting

7.1 Candidate Trips

The total number of daily candidate trips by different modes, that are likely to be diverted to the Mini-Transit System is presented in Table 4 . The most pertinent features of Table 4 are as follows:

(1) Between the two land use concepts, the total number of candidate trips in the year 1992 are estimated to be in the range of 54,000 to 59,000.

(2) In both cases, the walking trips constitute the major element of the trip tables (43 and 46 percent). The commercial land use model generates a higher number of candidate trips because of more walking trips.

(3) Although there are relatively small differences between the total number of candidate trips for each land use model, the distribution of trips within the study area varies considerably. This can be seen by comparing the tables in Appendix C.*

*Available from NVTC

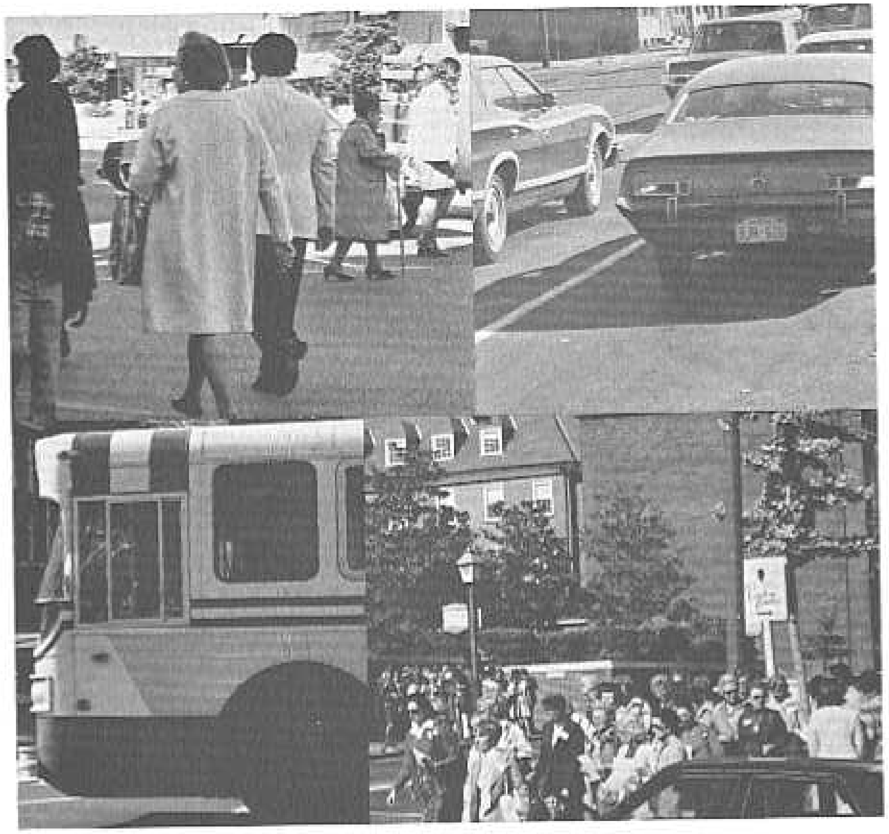

TABLE 4
TOTAL CANDIDATE TRIPS

Land Use Model	Candidate Person Trips (Daily) Auto Trips	%	Transit Trips	%	Walk Trips	%	Tourist Trips	%	Total	%
Residential	11,291	20.7	17,479	32.2	23,264	42.8	2284	4.3	54,318	100
Commercial	11,840	20.1	17,820	30.3	26,884	45.7	2284	3.9	58,828	100

7.2 Demand for Mini-Transit Service

(a) Summary of Trips by Modes: Table 5 represents a summary of the likely trips for the proposed transit system under varying land use and modal split assumptions. This table is helpful in assessing the 'order of magnitude' of the future travel demand and in identifying the range of alternative systems that would meet such demands. Table 5 indicates that the total number of daily trips using the system are anticipated to be within a range of 30,500 to 40,200 trips.

Under both of the land use models walking trips constitute the major component of the total trip table. Because of the relatively high number of candidate walk trips, changes in the modal split assumption cause a significant variation in the total travel demand. For instance, under the Commercial Model, high modal split assumption, a 100% diversion of walking trips to Mini-Transit, results in a total daily demand of almost 54,000 trips as opposed to 40,200 under the 50% diversion factor. A 100% diversion was considered unrealistic, although it is a theoretical possibility, and was not pursued further.

The number of transit trips diverted to the Mini-Transit system is higher than the number of auto trips
The reason for this is that Internal-External auto trips would continue to use the automobile, whereas it is highly probable that Internal-External transit trips would use Mini-Transit for that segment of the journey inside the study area.

TABLE 5
DEMAND FOR MINI-TRANSIT SERVICE UNDER VARYING LAND USE AND MODE SPLIT ASSUMPTIONS

Land Use	Modal Split	Daily Likely Trips*				
		Auto	Transit	Walk	Tourist	Total
1992 Residential Model	Low	(20%)- 2274	(80%)- 14,180	(50%)- 11,632	2284	30,488
	High	(50%)- 6027	(100%)- 17,479	(50%)- 11,632	2552	37,808
1992 Commercial Model	Low	(20%)- 2392	(80%)- 14,420	(50%)- 13,442	2284	32,664
	High	(50%)- 6324	(100%)- 17,820	(50%)- 13,442	2552	40,244

* Certain cells in this table are approximate due to "rounding adjustments" in the computer program.

(b) Total Likely Trip Table: The four complete tables of Total Demand for the Mini-Transit system are shown in Tables 1 through 4 of Appendix D.* They correspond to each of the four summaries in Table , namely:

- 1992 Residential Model, High Modal Split
- 1992 Residential Model, Low Modal Split
- 1992 Commercial Model, High Modal Split
- 1992 Commercial Model, Low Modal Split

Figures 18 and 19 illustrate the Daily Trip Desire Lines resulting from the 1992 Residential Model (Low Modal Split). The internal trips have been separated from trips to and from the Metro Stations. This model represents the lowest level of demand of the four models described above.

Figures 20 and 21 illustrate the corresponding Daily Trip Desire Lines resulting from the 1992 Commercial Model (High Modal Split). This model represents the highest level of demand of the four models.

The most important features of these Desire Line Diagrams are as follows:

(1) Almost all of the internal Zones have trip interchanges with one of the two Metro Stations, represented as Zones 39 and 40 in the trip table (Braddock Road and King Street respectively). The exceptions are Zones 4, 10, 16, and 23 because these are located within a walking distance of 1000 feet of either of the Stations. As such, trip interchanges between these Zones and the Stations were not included in the basic candidate trip table.

(2) Volumes of less than 100 trips per day are not shown.

(3) Zone 8, on the north water-front, has the most dense residential development of any single Zone. Zone 8 thus generates the highest number of Internal-External trips. The other major Internal-External trip generators are Zones 1, 7, and 14 for Braddock Road Station and Zones 22, 24, and 36 for King Street Station.

* Available from NVTC

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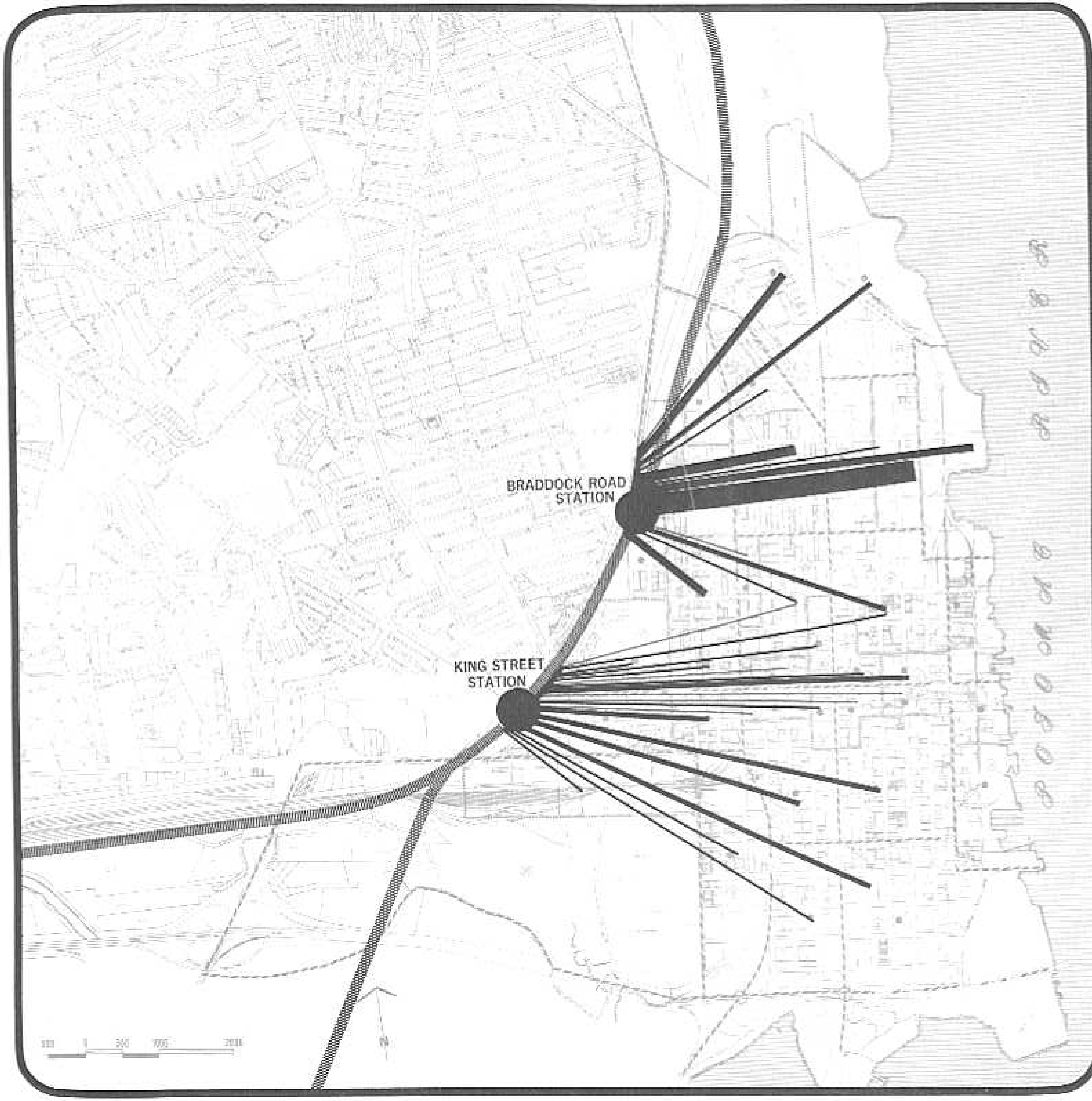

Figure 18

Desire Lines for Daily Trips to Metro

1992 RESIDENTIAL MODEL,
(LOW MODAL SPLIT)

1600 / 800 / 400 / 200 TRIPS

- ZONE NUMBERS
- ZONE CENTROIDS
- COG ZONES (STUDY AREA DISTRICTS)
- STUDY AREA ZONES

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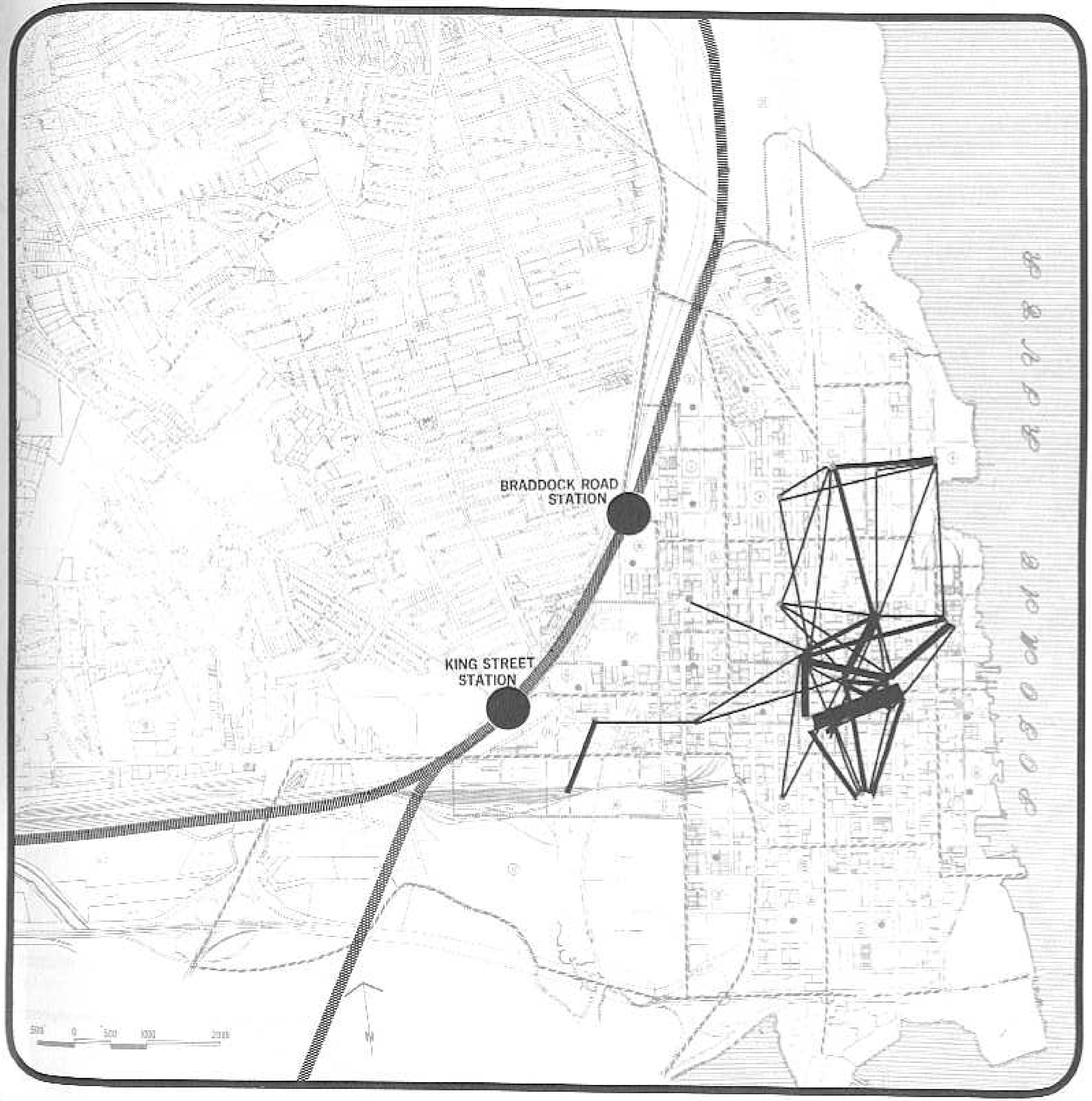

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Figure 19

Desire Lines for Daily Downtown Trips

1992 RESIDENTIAL MODEL,
(LOW MODAL SPLIT)

- ZONE NUMBERS
- ZONE CENTROIDS
- COG ZONES (STUDY AREA DISTRICTS)
- STUDY AREA ZONES

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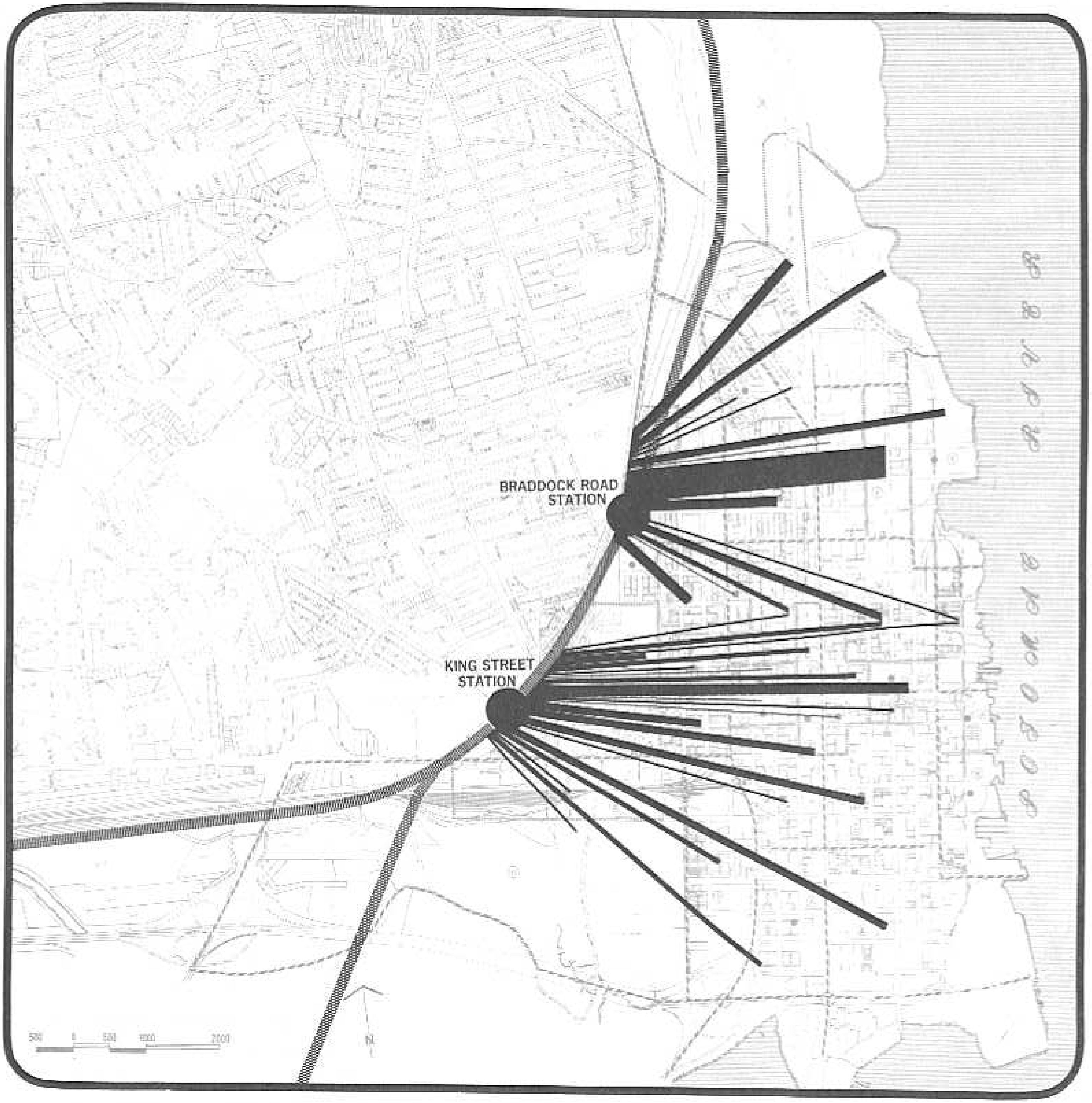

Figure 20

Desire Lines for Daily Trips to Metro

1992 COMMERCIAL MODEL, (HIGH MODAL SPLIT)

1200 800 400 200 TRIPS

- ZONE NUMBERS
- ZONE CENTROIDS
- COG ZONES (STUDY AREA DISTRICTS)
- STUDY AREA ZONES

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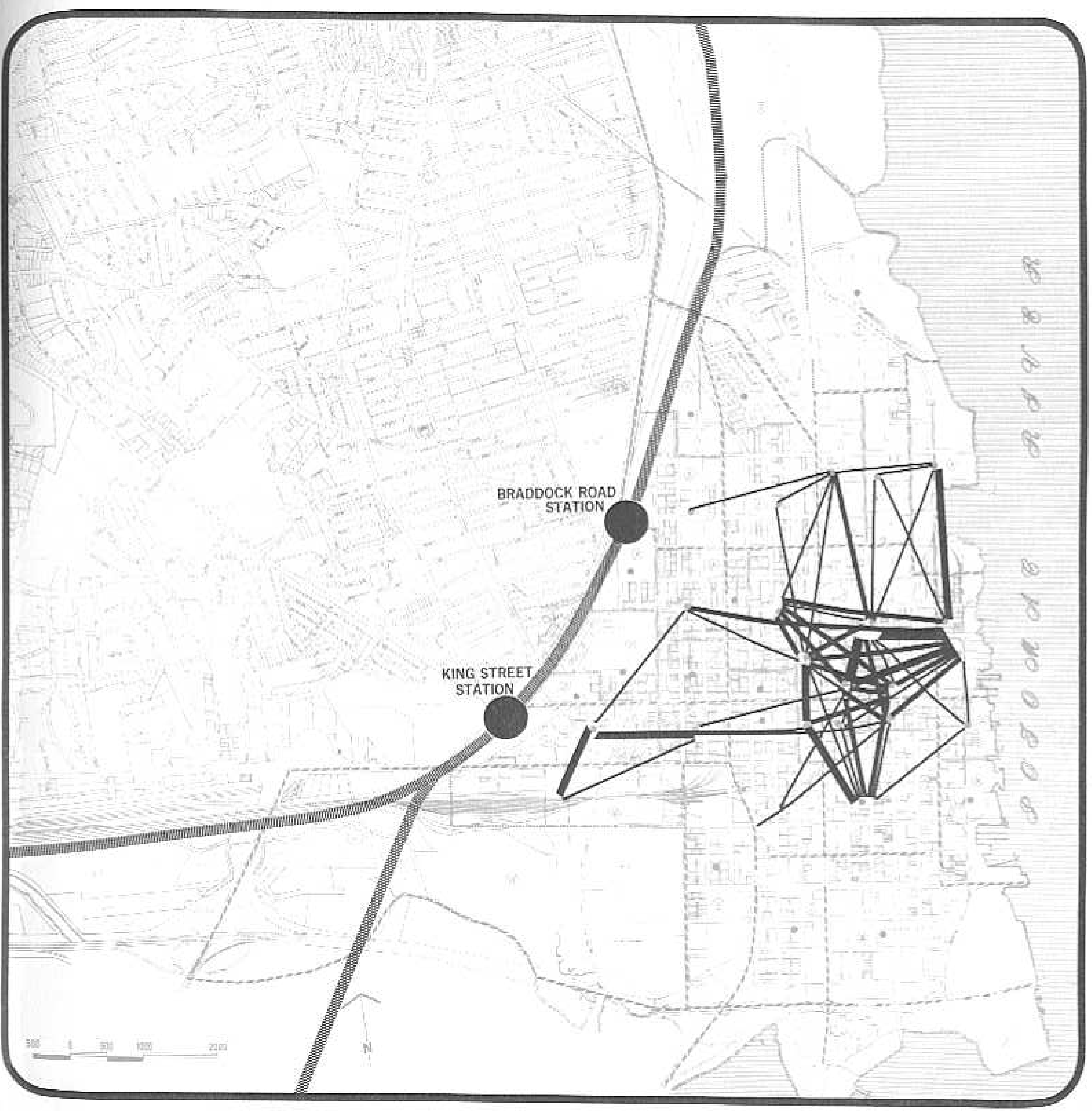

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Figure 21

Desire Lines for Daily Downtown Trips

1992 COMMERCIAL MODEL .
(HIGH MODAL SPLIT)

ZONE NUMBERS
ZONE CENTROIDS
COG ZONES (STUDY AREA DISTRICTS)
STUDY AREA ZONES

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(4) Zones 13, 14, and 15, being located almost equidistant from the two Metro Stations, will have trip interchanges with both the Stations. All other internal Zones have only one of the two Metro Stations as their access or exit point with the Metro-rail System.

(5) Zones 20, 21, 26, and 27 largely cover the King Street Business Corridors and generate a significant number of trips. A prime component of these are the walking trips. Zones 22 and 28 contain office and governmental establishments and are, in turn, generating a substantial number of internal work trips.

(6) The impact of the tourist trips, although not highly significant, will be evident from a relatively large number of trips attracted to Zones 29, 22, 26 and 33 where the major attraction centers are located.

(7) The Desire Line Diagrams for travel to the Metro Stations show a few very heavy volumes between the north water-front zones and Braddock Road Station. On the other hand, there are a number of smaller volumes between downtown zones and King Street. This is due to the fact that the downtown Zones are smaller in size and as such can be uniquely identified in the diagram. The Zones on the northern side are relatively larger and thus generate heavier volumes from each Zone.

(8) Zones 15 and 29, representing the water-front Zones, are generating some Internal-Internal trips, but a very insignificant number of Internal-External trips.

(9) Zones 1, 2, 35, and 36 appear least important in terms of Internal-Internal trips.

(10) The observations outlined above are generally true of the trip tables developed for both land-use concepts. However, under a given modal split assumption, there are significant differences in the volumes of inter zonal trips generated by the Residential as opposed to the Commercial model, thus confirming the fact that the number of trips generated by a given Zone is a function of the predominant land use in that Zone.

7.3 Extent and Level of Service

Figures through were helpful in identifying the critical areas to be served by the Mini-Transit system. This is discussed further in Chapter 11. Access to the two Metro Stations is of prime importance, while the general limits of internal trips are Henry Street on the west, Gibbon Street on the south, and First and Second Streets on the north. The large number of trips within the downtown core would require a higher frequency of service in these areas than in the fringe areas. The "peaking" of the internal trips is likely to occur during the midday due to a large number of walking trips, as opposed to the Metro Station work trips that are expected to peak during 7-9am in the morning and 4-6pm in the afternoon.
The rush-hour and mid-day travel patterns will thus require different types and levels of Mini-Transit service.

7.4 Peak A.M. Two Hour Travel Demand

The peak A.M. 2-hour travel demand was estimated from the basic trip tables using factors from WMATA and COG studies:

(a) Transit-Trips: A WMATA* study indicated that for transit work trips, the factor for peak A.M. 2-hour (7 A.M. - 9 A.M.) traffic is approximately 36 percent of daily traffic movements. The corresponding factor for all transit trips, as estimated from 1968 home interview survey data** was found to be approximately 30%. Based on the above data, it was assumed that 33 percent of all daily transit trips would take place during the A.M. 2-hour peak period. This also implies that approximately 33 percent of all transit trips would take place during the 2-hour peak period between 4 P.M. and 6 P.M.

TABLE 6
DAILY AND PEAK 2-HOUR TRAVEL DEMAND FOR THE MINI-TRANSIT SYSTEM

Land Use	Modal Split	Daily Trips	Peak AM 2-Hour
Residential	Low	30,488	6,342
	High	37,808	8,257
Commercial	Low	32,644	6,656
	High	40,244	8,616

*Traffic Revenue and Operating Costs - prepared for the Washington Metropolitan Area Transit Authority by W.C. Gilman and Co. and Alan M. Voorhees and Assoc., Inc. February 1971.

**Data made available from table produced by Washington Metropolitan Council of Governments.

(b) Auto Trips: A factor of 22 percent was used for calculating the A.M. 2-hour travel demand from the corresponding daily figure. The estimate is based upon standard traffic engineering practice.
(c) Walking Trips: A factor of 10% was used for calculating the 7-9 A.M. peak travel demand from corresponding daily travel estimates. The estimate was based on survey data collected at actual retail office locations as a part of this study. Very few walking trips are likely to be generated by retail use during the morning peak period, and the majority will be business oriented.

Table 6 summarizes the peak A.M. 2-hour traffic which is expected to use the proposed transit system under varying land use and modal split assumptions. The estimates range from a low of 6400 to a high of 8600. These numbers were used as a basis for calculating the number of vehicles, scheduling, etc. for the proposed transit system.

Table 7 show the anticipated peak 2-hour trip interchanges between each Zone and the Braddock Road and King Street Metro Stations for the lowest and highest anticipated level of demand. Typically 80% of these trip interchanges would be directed to the stations in the morning and away from the stations in the evening peak.

7.5 Effects of Mini-Transit on Local Traffic

Between the two extremes of low and high modal split assumptions, approximately 2,300 to 6,300 of the candidate auto trips are expected to be diverted to the Mini-Transit system. This represents a reduction of between 4 and 12 per cent of the total daily traffic in the study area, even including the relatively high volumes of external traffic passing through between Richmond Highway, Mount Vernon, and Washington, D. C.

Based on recent traffic counts on King Street near the proposed Metro station, and a realistic annual traffic growth assumption, the estimated 1992 peak hourly volume is expected to be approximately 1,200 vehicles (total, both directions). This represents 3 full lanes of traffic, even without the impact of Metro. WMATA is proposing to add an additional 73 buses in the peak hour in each direction on Upper King Street to satisfy transit demand from the area east of the station. The alternative of Mini-Transit, even with its greater coverage and flexibility, will only add between 40 and 70 buses to King Street in the peak hour, depending on the modal split assumptions. It must be therefore assumed that the impact on automobile traffic from small 25' long mini-buses will be less than for large 44' long Metro-buses both in terms of congestion and pollution.

TABLE 7
AM 2-HOUR TRANSIT TRIP INTERCHANGE BETWEEN
INTERNAL ZONE AND METRO STATIONS
Peak AM 2-Hour Trip Interchanges

	Residential Model (Low Modal Split)		Commercial Model (High Modal Split)	
	Braddock Station	King St. Station	Braddock Station	King St. Station
1	197	0	248	0
2	158	0	186	0
3	43	0	66	0
4	85	0	86	0
5	0	0	0	0
6	265	0	274	0
7	116	0	60	0
8	562	0	754	0
9	199	0	194	0
10	0	0	0	0
11	216	0	264	0
12	34	0	44	0
13	109	55	138	72
14	173	93	248	130
15	10	15	70	108
16	0	0	0	0
17	0	123	0	148
18	0	63	0	84
19	0	53	0	62
20	0	89	0	136
21	0	78	0	154
22	0	130	0	280
23	0	0	0	0
24	0	150	0	240
25	0	40	0	34
26	0	104	0	200
27	0	45	0	58
28	0	56	0	80
29	0	24	0	30
30	0	100	0	92
31	0	90	0	118
32	0	145	0	78
33	0	161	0	212
34	0	16	0	16
35	0	79	0	136
36	0	178	0	222
37	0	59	0	110
38	0	0	0	0
Total	2160	1946	2632	2800

8 Community Forum

8.1 Community Groups

The City of Alexandria Department of Planning and Community Development undertook to arrange a series of meetings between the Consultant, NVTC, City staff and representatives of various community groups. The purpose of the first meeting was to inform the public as to the scope and purpose of the study, as well as to promote discussion among citizens groups as to the objectives of a Mini-Transit. The meeting was held in the newly-converted Bicentennial Center in the Lyceum Building. Attendance was low and discussion was limited.

As a result, plans for a series of area-wide meetings were dropped in favor of several smaller presentations in different parts of the study area. Several of these were held, using the regular meeting times and places of each participating group to discuss progress on the study. The meetings included: The Inner City Civic Association at the Hopkins House; The King Street Merchants Association at the United Virginia Bank; and The Board of the Old Town

Civic Association. In addition, regular meetings with Planning Department Staff and with the City Manager's Office have provided valuable reactions to the study process and its early conclusions.

8.2 Information Exchange

The format of each community meeting allowed for a presentation of the objectives of the study, initial projections of needs for transportation service, and discussion of early route concepts and available systems.

The available systems were presented with the aid of photographs of a wide variety of vehicles, including

- Bendix Dashaveyor
- Westinghouse Skytrain
- Otis TTI PRT
- Kraus-Maffei
- Unimobil System Habegger
- Rohr Monocab
- Twin Coach
- Minibus
- Electrobus
- Ginkelvan
- Siemens Streetcar
- London Transport Double-deck bus

The presentation of early route concepts and technology was deliberately planned to elicit citizens' reaction and was successful in this regard. The routes shown included:

- A Simple Loop from Braddock to King Street Stations via Pendleton, Fairfax and King Street, for example. This would be a short, easily comprehended route.
- A Shoppers Express between the stations perhaps utilizing Pendleton, North Washington, and King Street with limited stops and intended as a complement to other longer routes.
- A Commuter Route giving priority service to the North Waterfront and Old Town where residents are most likely to need Metro service to get to jobs in D. C.
- A High Dependency Route where low car-ownership would mean a high dependence on public transportation.
- A Maximum Coverage Route intended to encourage development on Duke Street, to penetrate south into Old Town, as well as serving downtown, Lower King Street, the North Waterfront and North East neighborhoods. This would inevitably be a more lengthy route.

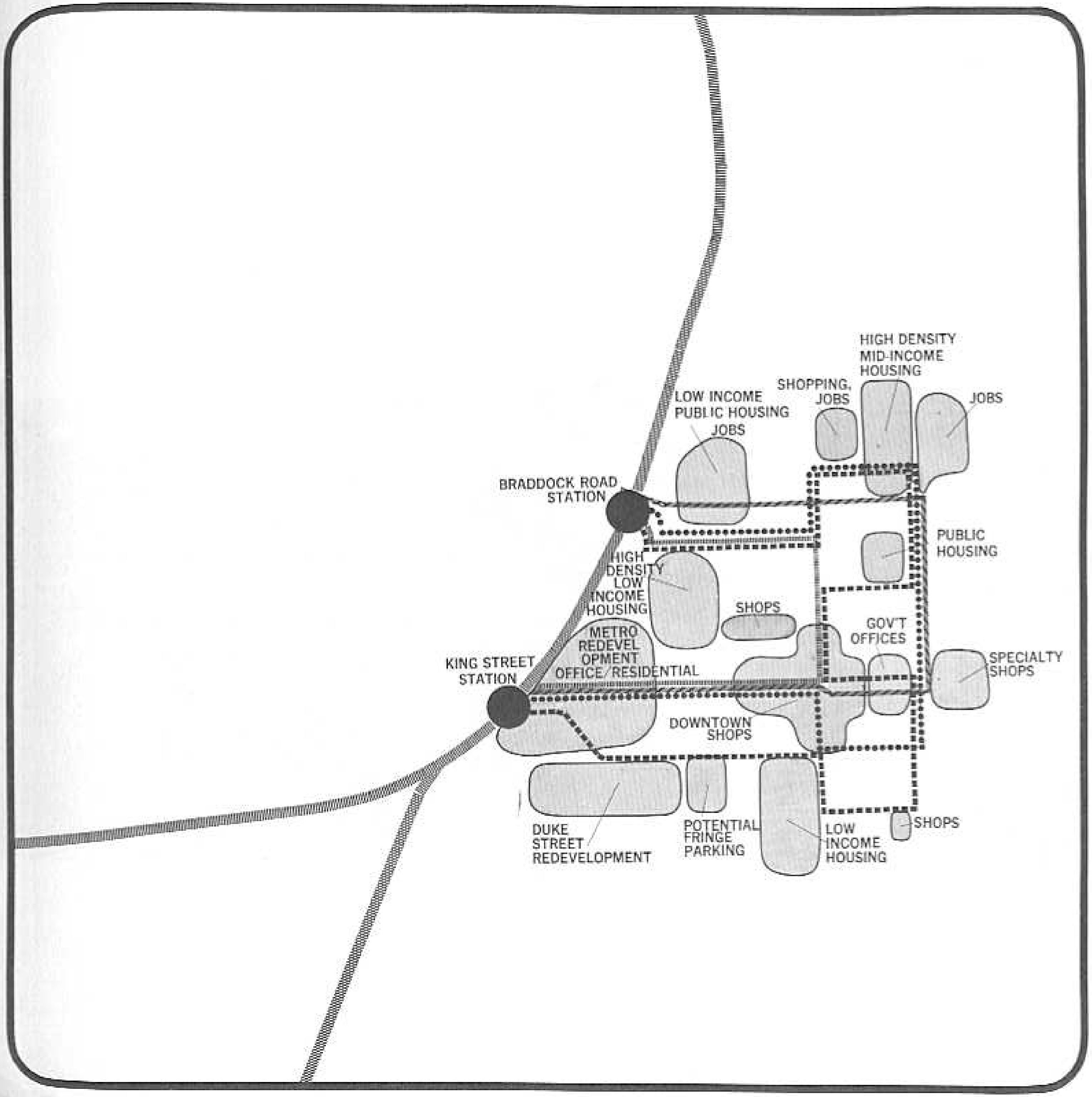
It should be emphasized that these routes were developed for discussion purposes only and do not necessarily bear any relation to actual demand.

8.3 Findings

Among the reactions to these alternatives were the following:

(1) "There is an urgent need for shuttle service on King Street now."
(2) "Elevated systems are unsuitable for Old Town or low density residential areas. They are out of scale."
(3) "It is important to serve grocery stores, clinic, health department, especially for low-income families."
(4) "Service should be attractive, frequent and free."
(5) "Routes should be simple, and easily comprehensible."
(6) "Service should extend down to Franklin Street."
(7) "Commuter Loop or Simple Loop offer best service."
(8) "Service on residential streets should be limited to those which already have bus service to minimize new impacts."
(9) "Do not eliminate curb parking in favor of bus lanes."
(10) "Streetcars pollute less"

Many of these findings have been incorporated into the System Operation conclusions in Chapter II, particularly those relating to corridors, and phasing. Probably the most widely-held view was that elevated systems would be unsuitable for Old Town. In general, however, the response to the concept of a Mini-Transit System was very favorable.



ALEXANDRIA MINI-TRANSIT

a downtown transit distributor system

Figure 22

Preliminary Routes For Discussion

KEY FUNCTIONAL AREAS

COMMUTER ROUTE

SIMPLE LOOP

EXPRESS/SHOPPERS LIMITED

MAXIMUM COVERAGE ROUTE

Prepared for the
Northern Virginia Transportation Commission

Barton-Aschman Associates Inc. Washington,D.C.

rcedes Bus

9 Technological Analysis

9.1 Scope of Analysis

Over the past five years there has been a great deal of activity in the development of new forms of urban transportation. The "Transpo '72" exhibition at Dulles Airport focused attention locally on many of these systems. A number of different manufacturers are developing transit systems for the distribution of passengers over small areas, using relatively small vehicles at frequent headways. The purpose of this analysis is to clarify some of the advantages and disadvantages of these systems and compare them to more conventional forms of transit distributor systems.

The specific task required by the study was a comparative analysis of three transit possibilities:

- A "People-Mover" system using a grade-separated facility, (or elevated guideway)
- An at-grade Light-Rail (or street-car) system
- A Specialized Bus service

The term "People-Mover" can logically be construed to mean almost any type of public transportation system. Recently, however, it has come to mean an automatic, fixed, elevated guideway system, and it is in this sense that it has been analyzed here. Since the guideways are elevated, there is no conflict with other street traffic and faster speeds are possible with no need for drivers. At one end of the spectrum of "People Mover" systems, the moving sidewalk concept was not considered; nor at the other end were rapid rail systems. Within the ground level systems, large buses and large street cars were not considered.

Two distinct types of "People-Movers" have been identified:

(1A) The Medium Capacity Guideway: Vehicles designed for transportation between high volume origins and destinations, usually operated in a fixed line on a minimum headway.

(1B) The smaller scale Personal Rapid Transit (PRT): Vehicles which respond to passenger demands for service and distribute them to a variety of destinations on demand, often by-passing intermediate points.

The two remaining system types are ground level systems:

(2) The Light-Rail or street-car category is currently a small one. Only one manufacturer in the USA is constructing street cars, which are large vehicles for the Metropolitan Boston and San Francisco transit system.

(3) In the Specialized Bus category a number of vehicles are available: both small and medium capacity; diesel and electric powered; front and rear-wheel drive; single unit and articulated. These vehicles can be operated in a variety of ways: on fixed schedules, as demand-responsive (dial-a-ride), or as jitney service. The mode of operation is not analyzed here.

9.2 Description of Alternative Systems

In order to develop a comprehensive picture of the advantages and disadvantages of various systems, a number of previous studies were reviewed, and manufacturers were contacted directly. It is apparent that in this fast-moving field the design of almost every system are continually changing, so that the characteristics of a system exhibited at Transpo '72 may no longer be valid. The same systems are often extant, but in name only. One of the most important criteria for including a system in this evaluation is that it be available and operating, preferably in a commercial situation, although some prototype projects have been included.

Each system has been described, as far as possible, according to four main considerations:

- Operating Characteristics (Speed, Acceleration, Type of Service, Vehicle Capacity, Headway).
- Physical Characteristics (Size of cars and guideway, clearance, visual impact).
- Use of Resources (Energy, Manpower, Pollution).
- Miscellaneous Advantages and Disadvantages.

The information tabulated in Figures 23 through 26 was a major input into the System Evaluation process described in Chapter 10.

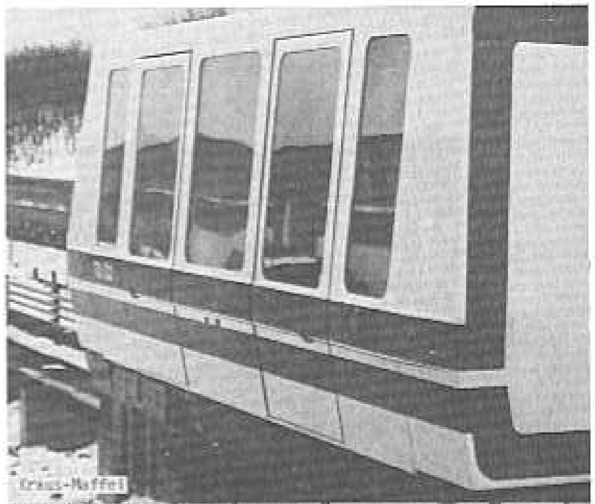
1A
Fixed Guideway Medium Capacity Systems

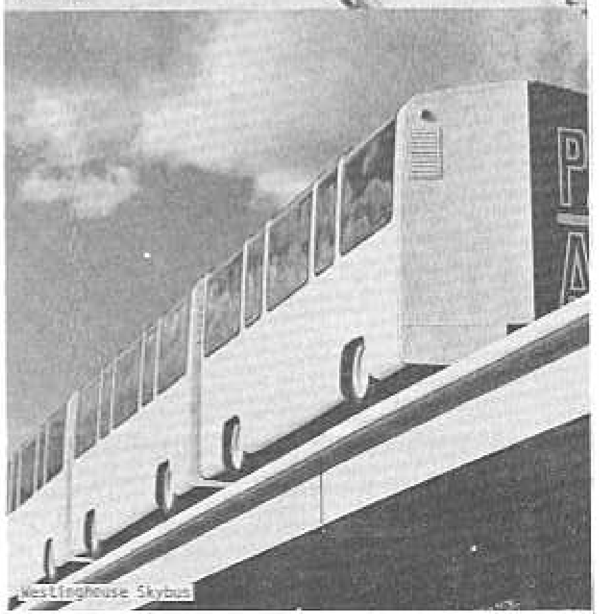
	Alden Self-Transit STARRCAR	Westinghouse SKYBUS	Ford ACT	Bendix DASHAVEYOR	LTV Aerospace AIRTRANS	Unimobile HABEGGER
Development Status	Prototype Transpo '72 Morgantown Demo. Toronto Zoo Construct	Tampa Airport Seattle Airport South Park, Pittsburgh	Prototype Transpo '72 Fairlane, Dearborn under construct.	Prototype Transpo '72 Toronto Zoo (with Alden)	Dallas/Ft. Worth Airport	15 Operational Systems Montreal Expo '67 Hershey Park, Pa. Charlotte, N.C.
Estimated Availability	Available. Dual-mode possible in 5-10 years.	Available. Dual-mode not possible.	Available. Dual-mode not possible.	Available. Dual-mode not possible.	Available. Dual-mode possible in 5-10 years.	Available. Dual-mode not possible.
Market Potential	Major activity centers. Airports. CBD's but not demonstrated.	Activity centers. Airports. Line-haul work.	Activity centers. CBD. Line-haul.	Activity centers. Airports. Industrial Applications.	Major centers. Airports.	Fairgrounds. Commercial.
Type of Operation	Demand	Demand or headway	Headway	Demand or Headway	Headway	Headway
Stations (On/Off Line)	Off-line	On-line	On/Off	On/Off	On/Off	On-line
Station spacing (avg)	500-5000 ft.	1000 ft.-1.5 mile	1000-2500 ft.	1000-5000 ft.	1000 ft.	1,000-2,000 ft.
Speed, average (max.)	15-25 mph	10-20 mph	8-30 mph	20-40 mph	8-12 mph	5-10 mph
Accel/Decel (ft/sec)	3.3	2.9	4.4	4.5	2.4	3.0
Emergency Decel (ft./sec)	9.7	7.3	10.0	8.7	6.9	6.4
Max Gradient	10% at 30 mph	6-10%	8% at 30 mph	10%	8-10%	8-10%
Curve Radius	30' typical	90'-190'	30'-250'	75' minimum	130' minimum	50 ft.
Switching	On-board Control No guideway moves.	Guideway section moves.	On-board control No guideway moves.	On-board. No guideway moves.	On-board. No guideway moves.	Guideway moves.
Vehicle Length L. H. W.	12'0" 9'0" 6'8" / 14'3" 9'0" 6'8"	30'6" 10'0" 8'6"	49'9" 8'8" 8'8"	22'0" 10'0" 7'0" / 30'0" 10'0" 8'0"	21'4" 10'0" 7'4"	14'0" 7'5" 6'0"
Clearance (H x W)	12'0" x 10'0"	16'6" x 16'0"	10'6" x 10'0"	13'5" x 8'4"	12'0" x 9'0"	Single Track 11'2"x10'8" Double Track 11'2"x16'
Structure depth (inc. walls)	3'0"	3'0"	4'8"	5'0"	5'0"	2'2"
Headway (seconds)	3-15	70-105	2-5	15-60	18	60-80
Passenger Capacity	Model 1* / Model 2					
Seated	6 / 10	28	10	12 / 35	16	8
Standing	4 / 10	28	14	20 / 35	24	7
Total	10 / 20	54	24	32 / 70	40	15
Crush Capacity	13 / 23	78	30	60 / 100	60	
System Capacity (one way)	13-34000 p./hr.	5000 p./hr.	17-43,000 p./hr.	12-43,000 p./hr.	5-10,500 p./hr.	6,100 pass hr.
Manpower required*	CC M	CC M	CC M	CC M	CC M	CC M Total 415 p.
Energy Consumption (kwh per vehicle mile)	2-3	3-4	-	3-5	1.4	8 kwh/train
Capital Cost per mile (incl. stations, vehicles, excl. Right-of-Way)	$6-10m	$6-9m	$9-10m	$3-9m	$2.5m	$15-20 m
Operating Costs per vehicle mile	20¢	-	30¢	50¢-$1.00	-	70-80¢
Environmental Pollution	None	None	None	None	None	None
Other Advantages	- Good radius for tight space. - Prefab. track. - Can add stations on existing line. - Sections can be operated prior to system completion. - Low profile guideway.	- Sections can be operated prior to system completion. - Can couple up to 10 cars. - Low profile guideway.	- Good radius for tight spaces.	- Flexible design capacity. - Good radius for tight spaces. - Can couple up to 6 cars.	- Freight module available. - Can couple up to 3 cars.	- Small section guideway - Low noise - Long guideway move time for switching. - Requires heated track for ice/snow on 2% grades. - Open cars require windows & climate control
Other Disadvantages	- Needs snow/ice melting coils. - No coupling of cars.	- Vehicle must stop to switch - Uni-directional propulsion. - Heavy vehicle. - Difficult to add stations.	- Deep section guideway. - Portions of guideway cast in place. - Difficult to add on-line stations. - No coupling of cars.	- Deep section guideway.	- Deep section guideway. - Wide curve radius.	

* CC = Central Control
M = Maintenance
P = Platform
D = Driver

* This version is actually a PRT.

Figure 23



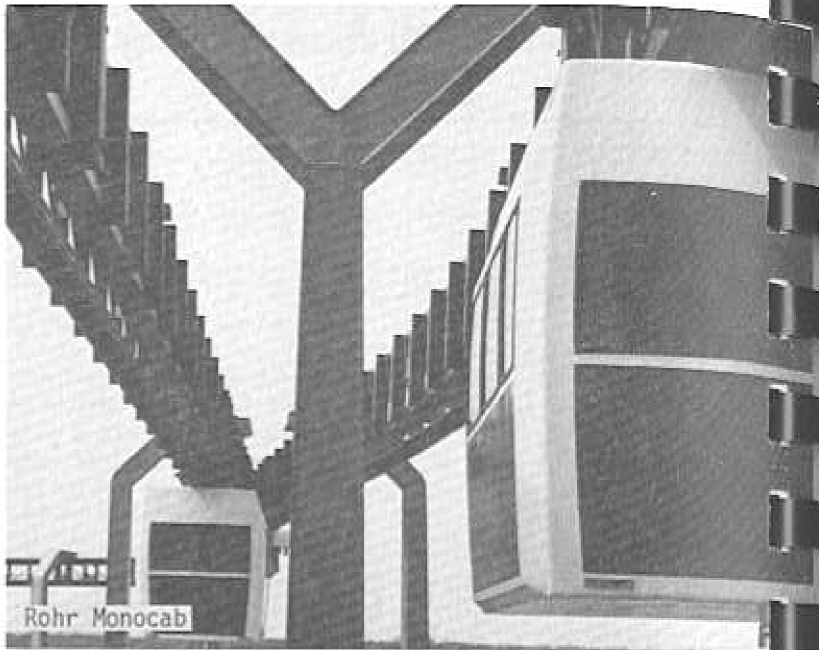


1B
Fixed Guideway P.R.T. Low Capacity Systems

	Rohr MONOCAB Suspended Monorail	Stanray Pacific JETRAIL Suspended Monorail	TTI Otis OTIS PRT Air-cushion Support	Alden Self Transit STARR CAR Wheel-supported
Development Status	Prototype Transpo '72 Las Vegas Construct.	Braniff Terminal Dallas Airport	Prototype Transpo '72 Nancy, France Construction	Prototype Transpo '72 Morgantown Demo Toronto Zoo Construct
Estimated Availability	Available. No dual-mode.	Available. No dual-mode.	Not available for Dual-Mode. 1-2 years.	Available. Dual-Mode possible
Market Potential	Fairgrounds, activity centers.	-	Linking activity centers.	Major activity centers, Airports, CBD's.
Type of Operation	Demand or Headway	Demand or Headway	Demand or Headway	Demand
Stations (On/Off Line)	Off-line	-	Off-line	Off-line
Station spacing (avg.)	.5 mile	.7 mile	.5 mile	500-2000 ft.
Speed, average (max.)	18-20 mph	15 mph	(45) mph	(15-25) mph
Accel/Decel (ft/sec)	4	3.2	3.2	3.2
Emergency Decel (ft/sec)	13	-	13	9.7
Max. Gradient	7-10%	-	6%	10% @ 20 mph
Curve Radius	40 ft.	15 ft.	35 ft.	30 ft. typical
Switching	No guideway moves.	-	On-board	On-board
Vehicle Length L Height H Width W	9'7" 8'8" 5'6"	10'0" 7'6" 7'0"	14'3" 8'2" 8'8"	12'6" 9'0" 6'6"
Clearance (H x W)	12' x 17' double track 12' x 10' single track	10' x 8'	11' x 10'	12'0" x 10'0"
Structure depth	3'0"	-	±4'	3'6"
Headway (seconds)	5-10	33	6	5-15
Passenger Capacity Seated Standing Total Crush	 6 - 6 -	 6 4 10 -	 6 - 6 -	 6 4 10 12
System Capacity (one-way)	Max 8600 p/hr. @ 5 sec. Max 4300 p/hr. @10 sec.	2,000 p/hr.	3,600 p/hr.	12,000
Manpower required*	CC M	CC M	CC M	CC M
Energy consumption (kwh per veh. mile)	.13 kwh/veh. mi.	3-4 kwh/veh. mi.	-	2-3 kwh/veh. mi.
Capital Cost per mile (inc. Stations & vehicles excl. Right-of-Way)	$4 m	$1 m	$3-6 m	$3-7 m
Operating costs per vehicle mile	18¢ ?	10¢	-	20¢
Environmental Pollution	None	None	None	None
Other Advantages	- Prefabricated guideway - Sections may be operated while system is completed	- Baggage handling	-	- Good radius for spaces - Prefab. track - Can add stations on existing line - Low-profile guideway
Other Disadvantages	- Cannot operate in winds over 35 mph	- Sway in winds - Low speed	- Air-levitation pad-wear	

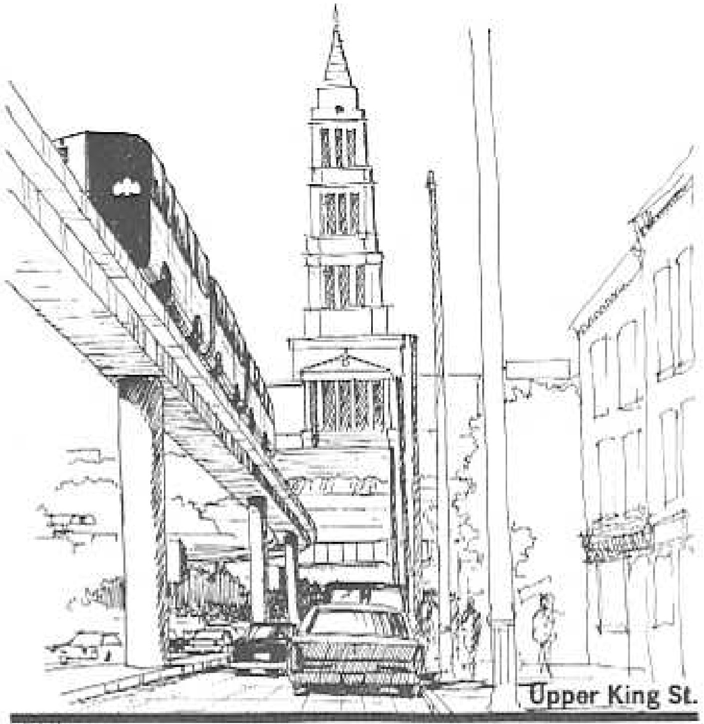
*CC = Central Control
M = Maintenance
P = Platform
D = Driver

Figure 24

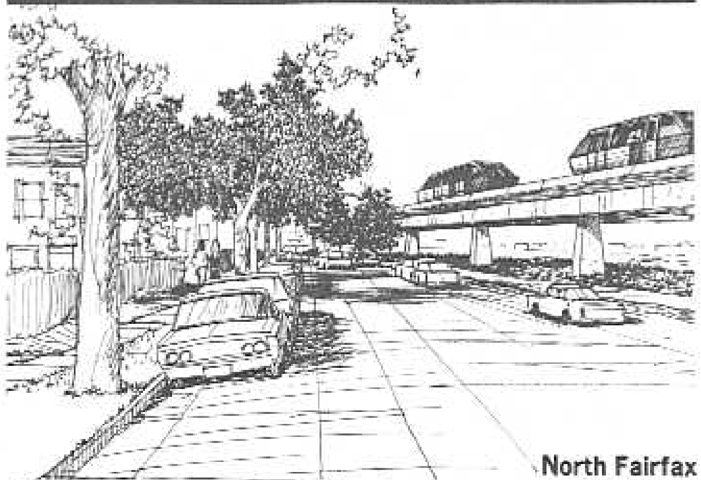


Rohr Monocab

Cabinentaxi



Upper King St.

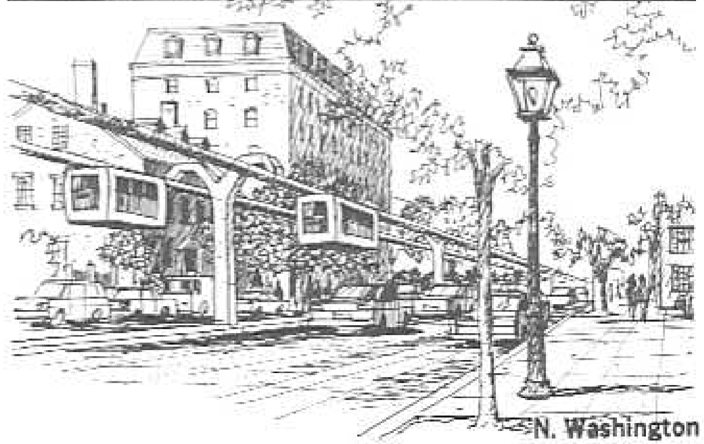


North Fairfax

Elevated Systems on City Streets

Tavern Square

Duke St.



N. Washington

2
Specialized Bus Systems

	Twin Coach TRANSIT TC25B	Minibus YOLRMOBILE			Mercedes Benz MERCEDES	Otis Elevator ELECTROBUS
Development Status	Operating: Washington, D.C. Haddonfield, N.J.	Operating: Arlington Cemetery/ Washington, D.C.			Operating: Airport Shuttle, etc.	Demonstrated, 37 Cities. Operated Long Beach, Calif. Roosevelt Island.
Estimated Availability	Available.	Available.			Available.	Available.
Market Potential	Mid-range, low capacity.	Mid-range, low capacity.			Mid-range, low capacity.	Short trips. Down town and Activity Centers.
Type of Operation	Scheduled or Dial-a-ride.	Scheduled or Dial-a-ride.			Scheduled or Dial-a-ride.	Scheduled or Dial-a-ride.
Stations/Stops (on-off line)	-	-			-	-
Station Spacing (avg)	-	-			-	-
Speed, average (max)	10-15 mph (50 mph)	5-10 mph (15 mph)	5-10 mph (35 mph)		10-15 mph (NA)	10 mph (35 mph)
Accel/Decel (ft/sec²)	-	-			-	3.5
Emergency Decel (ft/sec²)	-	-			-	-
Max. Gradient	-	-			-	25%
Curve Radius	27'4"	3-car 27'33"		Artic.* 35'	20'	30-35'
Switching	-	-			-	-
Vehicle Length L Height H Width W	35'0" 9'4" 8'0"	3-car 60'-60' 8'4"-8'4" 8'	4-car 60'-82' 8'4"-9'4" 8'	Artic.* 50'-65' 8'4"-9'4" 8'-8'6"	19' 8" 8' 5" 6'10"	24' 9" 8' 5" 7'11"
Clearance (H x W)	-	-			-	-
Headway	-	-			-	-
Passenger Capacity Seated Standing Total Crush	 25-27 10 37	3-car 93 10 103	4-car 135 40 175	Artic.* 56 99 155	 16-19 0 16-19	 21-23 20 41
System Capacity (one-way)	-	-			-	-
Manpower Required*	CC D M	CC D M			CC D M	CC D M
Energy Consumption	-	3-car 5 - 6 mi./gal. max.	4-car	Artic.	15 mi/gal	1.50 kwh/mile
Capital Cost Per Unit	$27,000	$46,000 -85,000	$58,000 -110,000	$65,000 -85,000	$24,000	$28,000
Operating Costs Per Vehicle Mile	-	$1.50			-	2-3¢ recharge
Environmental Pollution	Exhaust emissions.	Exhaust emissions.			Exhaust emissions.	None.
Other Advantages	-Good maneuvra- bility.	-Adaptability to propane fuel.			-Good maneuvra- bility. -Low price. -Long life.	-Quiet Operation -Good imageability
Other Disadvantages	-Noise of engine. -Subject to local traffic conditions. -Labor intensive. -Poor imageability.	-Noise of engine. -Subject to local traffic conditions. -Labor intensive.			-Noise of engine. -Subject to local traffic conditions. -Labor intensive.	-Batteries require replacement for recharging every 4-5 hours. -Subject to local traffic conditions. -Labor intensive.

CC - Central Control
M - Maintenance
P - Platform
D - Driver

* Articulated Bus.

Figure 25

Siemens Streetcar

Tatra Streetcar

3 Light Rail Systems

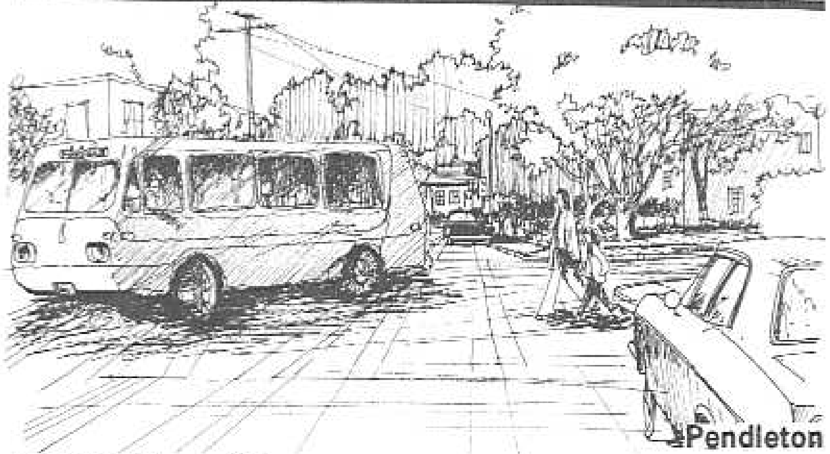
	Boeing STREETCAR	Schindler STREETCAR Be 4/4	SIG Switzerland and LTV Aerospace Corp. ECONOMY LIGHT-RAIL CAR
Development Status	-Prototype in operation. -Standard models under construction for Boston, San Francisco	Operating in Basel, Geneva, Lucerne Switzerland	Under design, based on SIG previous experience with Streetcar operation
Estimated Availability	5 year.		
Market Potential	Mid-range, high capacity.	Mid-range, medium capacity	Mid-range, medium capacity
Type of Operation	Scheduled.	Scheduled	Scheduled
Stations (On/Off line)	On/Off Line Stations	On/Off Line	On/Off Line
Station spacing (avg.)	0.5 mi.		
Speed, average (max.)	25 mph (60 mph)	(37 MPH)	37 MPH
Accel/Decel (ft/sec²)	2.8 mphps/315 mphpm (3.1 mphps/4.6 mphps) - max.		6.23
Emergency Decel (ft/sec²)	6.0 mphps		4.59
Max. Gradient	9%		7%
Curve Radius	42'		46 ft.
Switching	Conventional RR or Electrical Switch.	Conventional RR or Electric Switch	Conventional or Electric Switch
Vehicle Length L Height H Width W	71' 11' 6" 8'10"	44'5" 10'8" 7'5"	47'6" 10'4" 8'3"
Clearance (H x W)	10'3" x 9'4"		
Structure Depth			
Headway (seconds)	1.5 min.		
Passenger Capacity Seated Standing Total Crush	 52- 68 168 220-236	 53 21 74	 48 39 87 118
System Capacity (one-way)	6000-24000 pas/h		
Manpower required*	CC D M	CC D M	CC D M
Energy consumption (kwh per veh. mile)	-		
Capital Cost per mile (inc. Stations & vehicles excl. Right-of-Way)	$4-$7 million/mile $300,000		
Operating costs per vehicle mile	-		
Environmental Pollution	None.	None	None
Other Advantages	-Quiet Operation -Inexpensive operation ($/mi.)		Quiet Operation
Other Disadvantages	-Street running portions of route (if any) subject to local traffic congestion. -Labor intensive. Overhead Wire	Overhead Wire Subject to Traffic Congestion Access to Vehicle Across	Overhead Wire Subject to Traffic Congestion Access to Vehicle Across Traffic Labor Intensive

*CC - Central Control
M - Maintenance
P - Platform
D - Driver

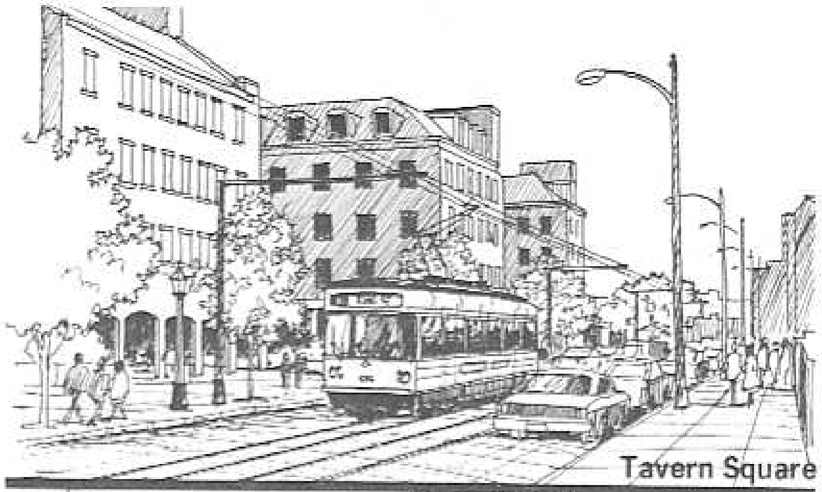
Figure 26

Old Town

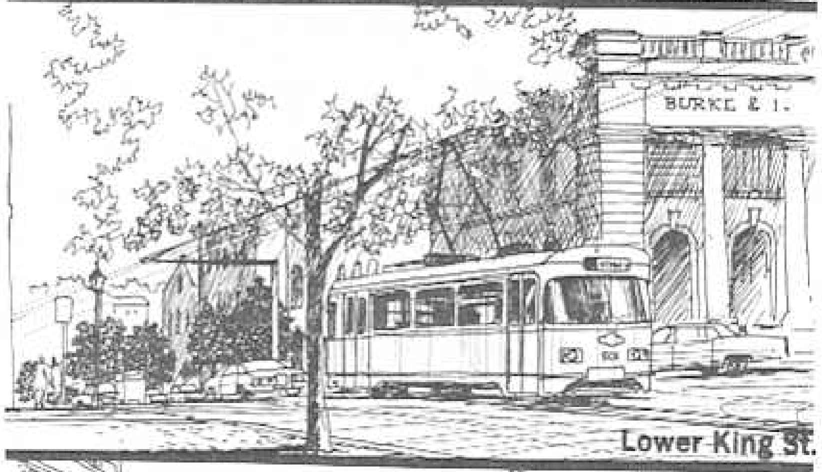
North Fairfax



Pendleton



Tavern Square



Lower King St.

Downtown

Ground-Level Systems on City Streets

Elevated Guideway Systems

The generalized advantages of these systems lie in their ability to carry large volumes of passengers with minimal labor costs, at relatively high average speeds. The major disadvantages lie in the visual impact of the guideways, the relative shortage of operating experience in commercial situations, and their high capital costs.

Light-Rail Systems

The general advantages are in their clean non-polluting operation. the undefinable charisma of the vehicles, and their ability to operate relatively well in a semi-reserved street right-of-way. Their disadvantages are similar to those of an elevated guideway system, with exception that the overhead structures are less obtrusive. They also require manual operation.

Bus Systems

The ubiquitous bus has achieved its prominence through being relatively cheap to install, flexible to operate on a variety of routes, and able to penetrate most areas where the automobile can go with minimal visual impact. On the other hand, they have the disadvantage of a polluting engine, having to operate in mixed traffic, although special bus-lanes can be created, and requiring manual operation.

10 Systems Evaluation

10.1 Methodology

The selection of an appropriate technology is the first in a two part process of selecting a generic system. The second part discussed in Chapter 11, consists of identifying appropriate routes. In evaluating the available technology, the objectives developed in Chapter 2 were applied to the three types of vehicles identified in Chapter 9, namely:

- Fixed Guideway
  - Medium Capacity Cabs and Trains
  - Low Capacity PRT Vehicles
- Small Buses
- Light Rail (Streetcars)

Each type of vehicle was assigned a rating to indicate whether it satisfied an objective well, moderately or poorly. Because of the disparity among the objectives between those that were suited to quantitative and qualitative evaluation, this broad qualitative rating system was applied as a "lowest common denominator". As noted in Section 2.2, two objectives appeared to be of paramount importance. These have been identified in large type in the Evaluation Matrix which appears as Figure 27

10.2 The Technical Evaluation Matrix

Several items in the Evaluation Matrix bear further explanation.

1. Minimize Visual Intrusion. Fixed Guideway systems with their elevated structures are totally incompatible with the scale of Old Town, and in fact with most single family and townhouse districts. King Street itself offers some small potential in that it contains fewer architecturally significant structures than other streets in Old Town, but in general, a system which avoids sensitive architectural and historic areas does not provide service where it is most needed, according to the trip desire lines illustrated in Chapter 7. Furthermore, the elevated structure would permanently destroy traditionally important views and vistas in the central area. A rubber-tired bus has virtually no permanent visual impact, whereas a streetcar would at least require overhead wires.

2. Minimize Air Pollution. The satisfaction of this objective lies in the adoption of electric-powered vehicles, as opposed to the diesel or gasoline engined buses. A battery-powered bus is now available, but for the purposes of this evaluation, the majority of buses were assumed to be polluting.

3. Minimize Energy Consumption. Information for this evaluation was taken from a study of transit systems prepared for the Southern California Association of Governments.* In general, the energy requirements of rubber-tired PRT vehicles are considerably higher than for light-rail vehicles. In turn, light-rail electric vehicles have a higher energy requirement than the diesel-powered bus. In terms of BTU per passenger-mile, the rubber-tired PRT uses 7500, as opposed to 4050 for light-rail and 3040 for a diesel bus. The four-passenger automobile for comparison rates 10,500 BTU/passenger mile.

4. Reduce Auto Traffic Congestion. The implementation of a well-designed transit system of whatever type will have a beneficial effect on automobile congestion. The effects of different systems in attracting more or less riders out of their cars are not measurable.

5. Enhance Alexandria's Image. The image of Alexandria is hard to define. We believe it has to do with the concern of Old Town residents to restore their townhouses, the concern of the Old Town Civic Association for controlling the architectural appearance of street facades, the concern of the City of Alexandria for revitalization of the downtown area, by street improvement schemes, sign ordinances, building height restrictions, and encouraging through traffic to by-pass the area. The net effect of these efforts is a relatively uncluttered central area in which the design of both old and new contribute to a harmonious whole. The judgement of whether the design of a particular transit system contributes to or disrupts this relationship is a subjective one.

Without making such a judgement at this time, it should be stated that the concept of good design here has nothing to do with old vs. new or with horse-drawn carriage vs. diesel bus. The objective of enhancing Alexandria's image will be best served by selecting a transit vehicle which has the same kind of integrity and harmony between all its parts (size, layout, use of materials, attention to detail, etc.) which the downtown area itself displays.

* "Energy Consumption by Transit Mode" Howard R. Ross Associates 1974

Figure 27

SYSTEMS EVALUATION MATRIX

Objectives	1 Fixed Guideway Systems: A Headway Systems (Medium capacity)	1 Fixed Guideway Systems: B Demand-activated PRT (Low capacity)	2 Specialized Bus Systems	3 Light Rail Systems
1. MINIMIZE VISUAL INTRUSION	□	□	■	◩
2. Minimize air pollution	■	■	□	■
3. Minimize energy consumption	□	□	■	◩
4. Reduce auto traffic congestion	◩	◩	◩	◩
5. Enhance Alexandria's image	?	?	?	?
6. Maximize ease of travel	■	■	■	■
7. Minimize land for stations/ structures	□	□	■	■
8. Minimize land for parking etc.	■	■	■	■
9. Encourage development in defined corridors	■	■	◩	■
10. SYSTEM CAPACITY COMMENSURATE WITH PEAK DEMAND	□	◩	■	◩
11. Maximize wide-area service	□	◩	■	□
12. Minimize on-system time	◩	■	□	□
13. Maximize route flexibility	□	□	■	□
14. Minimize vehicular conflicts	■	■	◩	□
15. Maximize system reliability	◩	◩	■	◩
16. Minimize operating costs/fares*	◩	◩	□	□
17. Minimize capital costs*	□	□	■	◩
18. Minimize physical problems of integrating system into area	□	■	■	■
19. Maximize personal Security	◩	□	■	■
20. Provide pleasant riding environment	■	■	◩	◩

■ Very Good
◩ Satisfactory
□ Poor

*Specific costs will be developed in Phase II of the study.

6. Maximize Ease of Travel Between Activity Centers. In this respect it is assumed all systems will perform equally well.

7. Minimize Land Acquistion for Stations, Structures. The stations for an elevated system could be over the street right-of-way, but support columns would either require medians in the center of the street, or, in some cases, property acquistion adjacent to it. Neither buses nor streetcars require additional land outside the street right-of-way.

8. Minimize Land for Parking. By attracting auto -drivers onto any transit, the need for parking spaces will be reduced.

9. Encourage Development in Defined Corridors According to the Principles of the Comprehensive Plan. In effect, this objective is the corollary of 13. The committment to a fixed guideway or structured fixed rail route would probably attract development to that route more than to a bus route, which could be changed at will.

10. Provide System with Capacity Commensurate with Normal Peak Hour Demand. This objective is deliberately not framed in the sense of "maximizing capacity". It would be impractical to provide a very high capacity fixed guideway system which would run half empty. The capacities for the PRT systems analyzed in Chapter 9 range from 2000 persons/hour to 12,000 persons/hour. A range of from 5000 persons/hour to 43,000 persons/hour is possible with a medium sized vehicle operating on fixed headways of 15-100 seconds. The 1992 peak-hour demand on the highest volume segments of a King Street to Braddock Road loop varies from 1800 to 2000 persons per hour depending on the land use and modal split assumptions. On this basis, a medium-capacity Fixed Guideway system must be discounted, although a smaller PRT system might be justified. The slower light-rail systems are indicated as being only moderately well suited because the vehicles themselves are relatively large. A mini- or midi-bus system, on the other hand is well suited to the anticipated volumes.

11. Maximize Accessibility to Mini-Transit Service over a Wide Area. The concept behind a Fixed Headway, medium capacity system is generally to serve two or more heavy patronage points on a single line. The PRT concept extends this to offer a limited range of route alternatives to and from a single point. The area which may be economically covered by PRT is thus wider. A bus system can offer even wider coverage, not being limited to a fixed guideway, and different areas may be served in response to changes in the type of demand throughout the day.

12. Minimize On-System Time. The PRT concept allows a rider to dial his destination and by-pass all intermediate stops. Assuming that waiting time is the same for all systems, PRT will offer the shortest travel time. The fixed guideway systems generally are able to operate at higher average speeds than vehicles in mixed traffic on the street.

13. Maximize Route Flexibility. The construction of fixed track or guideway does not permit an easy transition to alternative routes as may be required if for example population or employment concentrations shift over time. Neither are they immediately responsive to demands for expanding the system.

14. Minimize Pedestrian/Vehicular or Inter-Vehicular Conflicts. Elevated fixed guideway systems satisfy these objectives directly. The bus system has been given a slightly better rating due to the maneuverability of the vehicle in a potential accident situation.

15. Maximize System Reliability. The adoption of this objective as being of paramount importance would effectively freeze all technological advancement and experimentation with new modes. Since all the systems which have been analyzed in Chapter 9 are to some degree operational, this does not pose a large problem. However, the main body of recent operating and maintenance experience has been with bus systems.

16. Minimize Operating Costs and Therefore Fares. More detailed information will be developed on this in Phase II of the study. The evaluation ratings given here relate largely to the need for drivers for the on-grade systems, which thus incur heavy labor costs.

17. Minimize Capital Costs. More detailed information will be developed on this in Phase II of the study. The evaluation ratings are based on Barton-Aschman's experience and manufacturers data tabulated in Chapter 9, giving the approximate costs per mile of structure and the costs of vehicles.

18. Minimize Physical Problems of Integrating the System into the Area. The cross-sectional envelope of clearance required for PRT cabs, medium capacity Guideway vehicles, buses and streetcars is approximately the same. Most single track operations would fit into a space 12' high by 10' wide. The differences emerge in their ability to turn corners. Most medium capacity Guideway vehicles require from 50'-200' radius. Ground vehicles and PRT vehicles require 15'-40'.

19. Maximize Personal Security. Many people are reluctant to ride empty transit vehicles at night since the apparent security which a crowd of people affords is not present. Similar fears have been expressed concerning the inability to escape from a potentially disturbing situation aboard a PRT vehicle. Larger vehicles are therefore viewed as preferable, and those with the added protection of a driver rate highest.

20. Provide a Pleasant Riding Environment. From the viewpoint of the rider with several modes at his disposal, several factors enter into his choice: Time in transit and getting to the vehicle, cost, and the comfort and convenience of the ride. In order to attract erstwhile automobile drivers, the transit vehicle must be a pleasant environment, which most modern technology affords. Fixed guideway capsules are quiet, carpetted, with comfortable seating. Several buses also offer this type of environment, but in terms of optional extras. Perhaps the most deterring factor to a would-be transit rider is to sit on a hard plastic seat in a noisy van, with hard springs, utilitarian lighting and intrusive advertising. The image of the minibus tends to be that of a utilitarian vehicle, and it is thus given a lower rating. The novelty of riding a streetcar, on the other hand evokes a certain nostalgia for which the rider might conceivably put up with hard seats. This, however, is a subjective judgement and it is rated accordingly.

10.3 System Conclusions

The system evaluation process indicates that the majority (12) of the objectives are totally satisfied by a small bus system, and that only three objectives are not satisfied, namely the questions of air pollution, length of time travelling the system and the operational costs. It should be pointed out that any selected vehicle will have to satisfy the then current federal and state air quality regulations. Although a bus system would be relatively slow, virtually no point on the system would be more than 7 1/2 minutes riding time away from a Metro station and, assuming a maximum off-peak headway of 5 minutes, or an average wait of 2 1/2 minutes, it would take an average time of 10 minutes to reach Metro.

Light-rail and PRT systems rank approximately equally in the evaluation matrix, assuming that all objectives are equal. However, PRT systems do not satisfy the objective of Minimum Visual Intrusion, which was regarded as of paramount importance. Although some of the lower capacity PRT systems could satisfy some of the more optimistic projections of demand, this could not be regarded as more than a partial fulfillment of the objective of providing System Capacity Commensurate with Demand.

Fixed headway, medium-capacity guideway systems received the lowest overall ratings and furthermore failed to satisfy either of the paramount objectives.

In the areas of minimizing air pollution and encouraging development in defined corridors, the light-rail or streetcar systems were superior to buses. (There is also a suspicion that the streetcar's nostalgia or "charisma factor" may be superior to that of a small bus, although this cannot be measured)

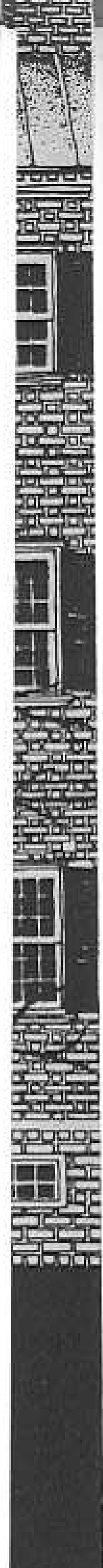
It was therefore concluded that all further analysis in Phase II should be in the area of small bus systems. This in itself presents a wide range of options from the standard "Downtowner" as operated in the District of Columbia to the articulated "Minibus" operated on the Mall by the National Parks Service; from the conventionally powered diesel bus to the battery powered "Electrobus"; from the rear-engined "Flexette" to the low platformed, front-wheel-drive "Ginkelvan".

11 Preliminary Operating Concepts

11.1 Travel Desires

The selection of specific routes was not the task of this phase of the study: rather the identification of important corridors where demand was heavy. From the patronage forecasting process there emerged several key sources of demand which should be satisfied. These travel desires are illustrated in Maps 18 through 21 . The following corridors require special attention:

a. North Waterfront to Braddock Road Station
b. Tract 16 to Braddock Road Station
c. Powhatan Street and Harbor Terrace area to Braddock Road Station
d. Old Town South and the DIP area to King Street Station
e. Downtown to Town Hall (Market Square) area
f. Bicentennial Center to Town Hall (Market Square) area
g. Old Town South to Downtown



The Internal-External movements to and from the Metro stations (Figures 18, 20) show a clear demand for service in the Madison/Wythe corridor. Service to and from King Street Station could be satisfied in a number of ways using the King/ Street or the parallel routes of Cameron, Prince or Duke Streets. However, in view of the continued importance of Upper King Street as a retail street used by neighborhoods to the north and south, and in view of the present efforts by the city and individuals to revitalize the street, it appears that King Street would be the most accessible route.

Those neighborhoods at the extreme north and south of the study area might more effectively be served by the Metrobus line from Mount Vernon to Washington D.C. rather than extending Mini-Transit service into these areas.

Internal movements within the study area (Maps 19 and 21) show a clear picture of heavy demand within the zones bounded by First and Second Streets on the North, Henry Street on the West and Gibbon Street on the south. The heaviest movements occur between zones which abutt N. Washington Street, King Street and Cameron Street.

In addition to the demand forecasts derived from the modelling process, useful feedback was also obtained from citizens and tradesmen via the Community Forums. The single most requested route from all groups was a line along King Street from the station to the waterfront. As regards North/South service, most groups were equivocal, tending to view existing one-way streets as permanent restrictions, but favoring some form of service on Washington and Fairfax Streets. The need for service between the North Waterfront and Braddock Road Station was not seen by citizens as an imperative, probably because construction and occupation of Nortn Waterfront residences is not complete, and the results are not yet being felt. On the other hand, the King Street line should be implemented as a first phase or even immediately, without waiting for Metro, according to some group representatives.

11.2 System Capacity Requirements

A simulation of peak hour demand was made in order to estimate the need for vehicles and to test the headway characteristics of a theoretical system. To do this the following assumptions were made:

- The heaviest peak hour volumes will occur on links closest to the Metro stations, and that internal trips will pose no burden on surplus capacity.
- The peak hour demand will be 65% of the peak 2-hour demand direction (to the Metro stations in the morning; away from the station's in the evening)

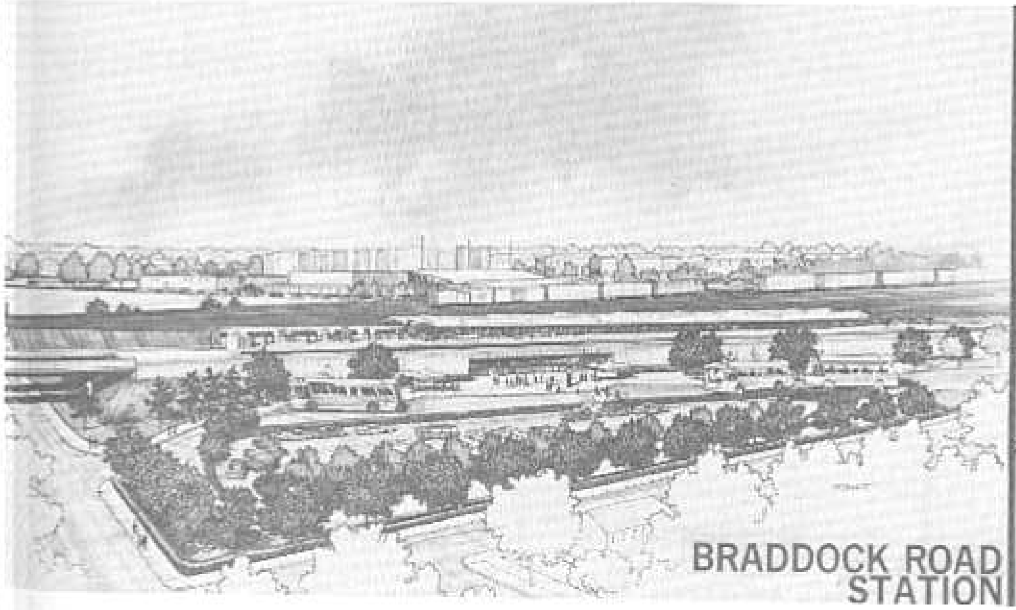
It was further assumed that vehicles would operate at 12 mph average speed on a 5 mile round trip between the stations giving a running time of 25 minutes.

It was found that the peak 2-hour volumes on the highest-volume links adjacent to each Metro station were as follows:

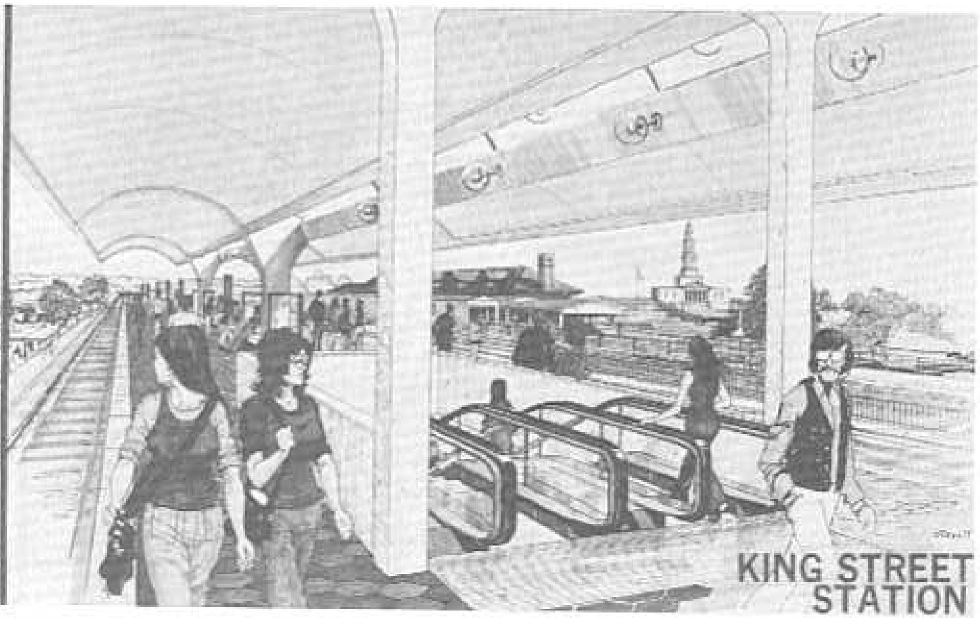
Model	Braddock Road	King Street
Res. - low mode split	2160	1950
Com. - low mode split	2100	2120 ●
Res. - high mode split	2700	2520
Com. - high mode split	2630	2800 ●

The lowest and highest pair of links are marked with an •. Since the higher volume of each pair is the operative volume in a route system which links to both stations, the anticipated range of demand was assumed to be from 2100 to 2800 passengers, or from 1090 to 1450 passengers in the peak direction at the peak hour.

Using the above assumptions of average speed and round trip length, it was calculated that 18 vehicles with a capacity of 25 persons would be required to satisfy a low peak hour demand of 1090 passengers. This would enable each bus to operate approximately 2⅓ round trips per hour, giving headways of 80 seconds. To satisfy the high peak hour demand of 1450 passengers, 24 similar vehicles would be required, operating on 60 second headways. These figures are tentative and could increase to between 24 and 30, if a 30 minute round trip and 2 spare vehicles are required.



BRADDOCK ROAD STATION



KING STREET STATION

11.3 Alternative Routes

It should be emphasised here that the route alternatives presented in Chapter 8 were developed for the primary purpose of eliciting community reactions and suggestions. The selection of a recommended route must ultimately be based on those corridors exhibiting the highest levels of demand. The adjacent maps illustrate feasible routes which will be examined in greater detail in Phase 2.

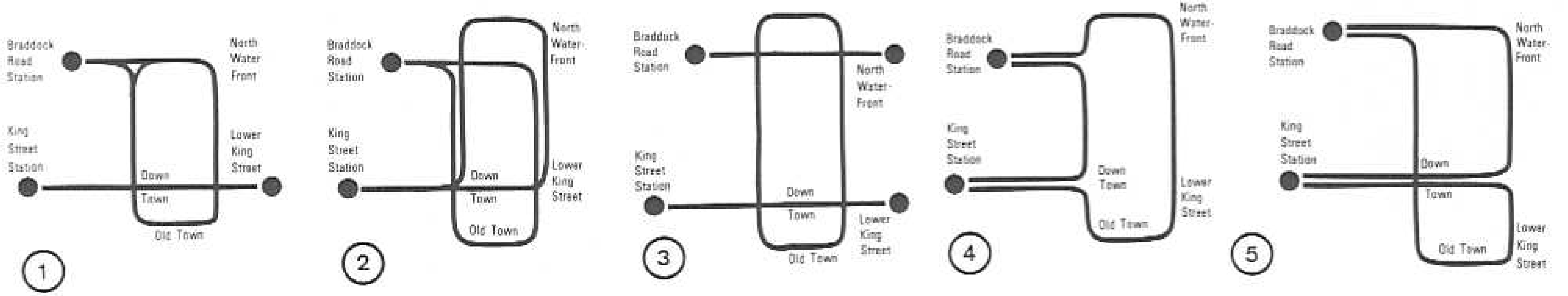
Map 1
- King Street Shuttle +
- Two-way loop from Braddock Road to Old Town South via North Washington and Fairfax Streets
- Possible circular route between North and South Old Town

Map 2
- King Street Station to North Waterfront via Fairfax Street return via North Washington +
- Braddock Road Station to Old Town South via Fairfax Street return via Washington Street

Map 3
- Pendleton/North Waterfront Shuttle +
- King Street Shuttle + Two-way
- Loop from North Washington to Old Town South via Washington and Fairfax Streets

Map 4
- Loop between Braddock Road and King Street Stations via North Washington +
- Extended loop between Braddock Road Station, North Waterfront, Old Town South and King Street Station

Map 5
- Loop between Braddock Road and King Street Stations via Fairfax Street
- Loop between Braddock Road and King Street Station via Washington Street, Old Town South, Fairfax Street, and King Street



11.4 Fringe Parking

In the course of this study, much discussion has centered on the subject of fringe parking facilities on the perimeter of the downtown area to relieve congestion and parking demands adjacent to retail and employment concentrations. Such facilities could be ideally served by a Mini-Transit System. However, in the absence of specific site recommendations by the City this could not be a determining factor in either the demand forecasting or corridor selection processes. The flexibility afforded by a small bus system would permit experimentation with one or more fringe parking facilities should this concept be adopted by the city in the future.

11.5 Conclusions

These proposed routes have several elements in common and it is these features which constitute the generalized conclusions of the route planning process in Phase I of the study. They are as follows:

a. King Street: Service between the Metro Station and Fairfax Street should be very frequent and attractive to shoppers, office workers and tourists. Service to the Torpedo Plant should be secondary.

b. North Waterfront to Braddock Road Station: Service should concentrate on peak hour service for Washington, D. C. commuters.

c. North Waterfront to Downtown: Service probably less frequent, but important during shopping peaks.

d. Old Town South to Downtown: Service probably adjusted to shopping peaks, with tourist service at weekends.

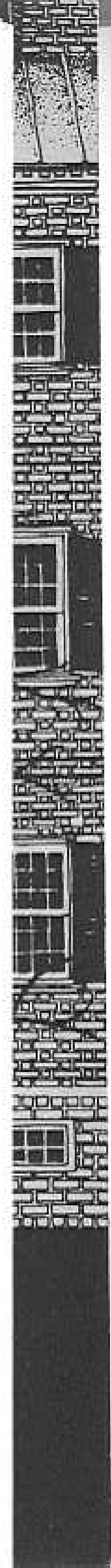
e. Service generally should concentrate on heavily travelled streets such as Washington, rather than parallel routes for reasons of exposure to motorists, and the ability to attract shoppers who use these streets.

f. Service should concentrate where possible on streets which already have transit traffic in order to minimize impacts and also to take advantage of current transit travel habits.

g. North/South service on the waterfront should be routed so as to attract riders from both east and west of the route. This means in effect, that Lee and Union Streets are located too far east, and that Fairfax Street is probably the optimal route without competing with Washington Street.

In evaluating these alternatives, consideration will be given in Phase II to:

- Matching frequency and service capacity on each leg of the route to the forecast demand
- Length of travel and wait time for riders
- Opportunities for changing routes and frequency of service at different periods of the day
- Simplicity of route for passenger comprehension
- Ability to maintain schedules under normal traffic conditions
- Costs of providing service, operating problems and minimization of "deadheading" (driving empty bus between the end of the route and the garage)



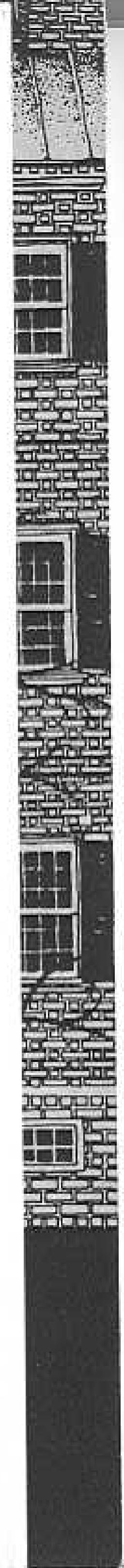
11.6 Next Steps in Phase 2

During the next phase of this study, the initial Mini-Transit System concepts will be developed in greater detail. The following tasks will be completed in order to give NVTC and the City of Alexandria all the basic information for a decision as to whether to proceed with the system and how to implement it.

- Route testing and final route layouts and bus-stop locations.
- Development of a System Operating Plan, including Management and Manpower requirements, Scheduling and Maintenance.
- Testing of alternative Revenue Plans, and preparation of Cost/Revenue estimates.
- Development of preliminary vehicle Specifications, both functional and performance.
- Environmental Impact Analysis.

The findings of this second phase of the study are to be the subject of a further report.

Definitions



Candidate Trips	When any new transportation facility is brought into operation, trips will be attracted to it which previously took other routes or other modes. The total volume of trips, irrespective of mode, can be considered as candidates if it is likely that some of them will be diverted to the new system.
"Generic" Transit System	A type or class system, which is not differentiated as to specific or proprietary name. In this study the three Generic Systems to be studied are (1)Fixed Guideway, (2)Specialized Bus and (3)Light Rail systems.
Gravity Model	A mathematical formulation of trip distribution based on the premise that trips produced in any given area with distribution themselves in accordance with the accessibility of other areas and opportunities they offer.
Growth Model	A formula for estimating changes in land use, population, etc. over a period of time based on past trends, current policies and foreseeable changes in trends and policies.
Headway	The time interval between successive arrivals of vehicles at a particular point operating on a system.
Land Activity	The data required to estimate a given zones trip-producing and attracting capability. In the TRIMS (q.v.) Model, this included Population Households, Incomes and Employment in various job categories.
Link	A section of the network defined by a mode or intersection at each end. Typical descriptions of a link are its average speed, capacity, number of lanes, etc.
Mini-Transit System	The term given to the Transit Distributor System (q.v.) in Alexandria.
Modal Split	The term applied to the division of trips between public and private transportation. The process of separating trips by mode of travel.
Mode	The means of travel: automobiles, buses, trains, walking are all modes.
Model	Any simulation of a real-world situation. In land use/transportation planning it usually refers to the forecasting of a future real-world situation.
Network	A simplified highway system (or transit system) used to calculate the time needed to travel between zones. The minimum time path is usually assumed, thus allowing the network to be "loaded" with theoretical trips.
Origin-Destination Table	A trip table showing the number of trips from the zones in which they begin to the zones in which they terminate.
Patronage Forecasting	The process of predicting the actual number of riders for the Mini-Transit system, by estimating how many people will divert from other modes (i.e. by applying the Modal Split process to the Candidate Trip Tables)
People Mover	Theoretically any means of transporting people, but usually referring to automatic computer-controlled systems running on a special fixed guideway.
Personal Rapid Transit (PRT)	A system of small (4 to 6 passenger) automatically operated transit vehicles usually operating on a fixed closed route and responding to the passenger's call and destination without stopping at intermediate points.
Transit Distributor System	A fine grain public transportation service to collect and distribute people within a relatively small area, using small vehicles.

Trip Distribution	The process of allocating trips that originate in one zone to all other zones in the study area based on the relative attractiveness of the destination zones.
Trip Generation	The process of estimating trips made in an area based on the characteristics of the area such as land use, population, employment and other economic activity measures.
Trip Interchanges, Zonal Interchanges	The trips between two points or zones, without regard to direction. In other words, the number of trips from B to A.
Trip Table	A matrix of the number of trips from every zone to every other zone. Separate trip table can be developed for various purposes, such as work, shopping, recreation, etc. as well as for various modes such as auto, transit, walking.
Study Area Zone	A portion of the study area, delineated as such for particular land use and traffic analysis purposes. These zones are as small as two blocks in size where large numbers of trips are anticipated, and up to 20 blocks or more where fewer trips are expected.

Abbreviations

BAA	Barton-Aschman Associates, Inc.
COG	(Metropolitan Washington) Council of Governments
METRO	The Rapid Transit Rail System currently being planned and constructed by WMATA
NVTC	Northern Virginia Transportation Commission
PRT	Personal Rapid Transit
SAZ	Study Area Zone
TRIMS	Transportation Integrated Modelling System (Trip Forecasting Computer Model developed by COG)
WMATA	Washington Metropolitan Area Transit Authority

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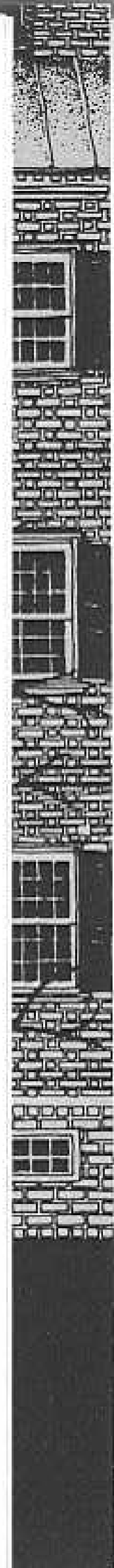

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