U.S. Department of Transportation

An Analysis of Rapid Transit Investments

The Buffalo Experience

July 1981

The cover photo, showing light rail rapid transit construction on Main Street in Buffalo, New York, is provided by and reprinted with the permission of the Buffalo Evening News.

An Analysis of Rapid Transit Investments: The Buffalo Experience

Final Report
July 1981

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16. Abstract The role that a new fixed rail transit facility play in the 1980's is a question asked by many sectors. The public sector wants to be assured that its current co-objectives of capturing a significant share of the travel market, and having a significant positive impact on land use are met. The private sector wants to be sure that all of the attributes associated with such development will come to function as it makes its investment decisions. Finally the technical people - local and regional planners and operators want to ensure, through careful planning and analysis, that the public and private investment decisions are maximized.

To address the concerns of all these groups, this study was designed with the following objectives:

1. To define the nature (extent and timetable) of the transit investment and to establish the private sector response.
2. To determine the interactive nature of policies, public sector and private sector, that may conflict with or reinforce the transit investment.
3. To define and use analytic techniques to measure the impact of the investment strategies.
4. To apply the above to the case study of Central Business District (CBD) revitalization in Buffalo, N.Y.

A methodological framework within which these objectives were very qualitative and quantitative techniques was developed.

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Kenneth Cook assisted in final editing. Eileen Bermel gave her usual excellent effort in assisting with the daily administration of the project, and preparation of the manuscripts.

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Introduction, Objectives and Themes

The role that a new fixed rail transit facility will play in the 1980's, is a question asked by many sectors of the population. The public sector wants to be assured that its current co-objectives of capturing a significant share of the travel market, and having a significant positive impact on land use are met. The private sector wants to be sure that all of the attributes associated with such development will come to function as it makes its invest ment decisions. Finally, the technical sector - local and regional planners and operations, want to insure, through careful planning and analysis, that the public and private investment decisions are maximized.

To address the concerns of all these groups, this study was designed with the following objectives:

1. To define the scope of rapid transit investments.

2. To determine the interactive nature of both public and private investment that may conflict with or reinforce the transit investment

3. To define and use analytic techniques to measure the impact of the investment strategies.

4. To apply the above to the case study of Central Business District (CBD) revitalization in Buffalo, N.Y.

A methodological framework was developed taking the LRRT given, and delineating four impacts - transportation, land use, economic and retail. To simplify the analysis, the impact studies were limited to economic, land use, and retail factors. The constraints placed on the investment, and the resulting impacts are defined by the history of major trends - population, employment and transportation, and on the effect these trends have had in the spatial allocation of people, jobs and activities that have been established by these trends. In the examination of the investment in Buffalo, N.Y., measurement of the impacts were considered in the CBD, and in non-CBD areas. The study has assumed that the investment is part of a strategy to target the CBD for revitalization and that with population and economic constraints, investments outside this targeted area may become competitive thus restructuring the full potential development of the CBD. A set of project themes has emerged that place the analysis of such investment impacts in clear perspective. These themes were:

.Within the context of the analysis of transit related investments, accessibility must assume a new dimension. Accessibility must be defined not only in terms of time, but in terms of quality of activities those activities that have the potential to stimulate ridership on a rapid transit system. The incorporation of the quality of land use (who uses the land, to what extent a level of development and for whom) into transit impact analysis gives more realistic approaches to such analyses.

.In the interpretation of projected changes in transit ridership, accessibility, and activities, based upon a large light rail transit investment, there are a number of specific constraints that must be

defined, measured, and evaluated? The constraints addressed in this study are those of the limits of population and employment in a declining region. Shifts away from manufacturing to service based work mark the labor changes. These declines and shifts influence land use in ways appreciably different from regions in which population is increasing.

- Fixed light rail transit represents a unique investment. It is unique because a transit investment focuses attention on activities that surround the system, enhancing their attractiveness. Because of the potential capacity of a transit system, large numbers of riders can be directed to specific station areas that have the potential for intense development. Such development can capitalize on shifting patterns of employment and land use. However, because of the constraints noted above, there are likely to be intra-regional conflicts created by competition for jobs, retail activities, commerce and residential development. Thus, the unique locational and directed land use aspects of a transit investment make it imperative that any associated development reaches its maximum potential.

- The decision to fund a system (i.e., the UMTA commitment t provide 80% of the funds to construct a Light Rail Transit System) creates, in a declining area, a short term confidence by local investors. This is extremely important in a declining area, for which CBD revitalization is considered to be a prime objective. The Public Sector is perceived of as a true partner in development, and their vote of approval ensures local investors of a safe market.

Organization

This study has been organized to provide qualitative and quantitative evidence to support the major findings, and serve as a guide to those making investment decisions regarding transit under conditions of local constraints of local constraint.

The first chapter of the report summarizes the project objectives and background, and provides a discussion of the most critical findings.

Chapter 2 presents transit policies and their histories and present role in regional development. In particular, the importance of a region's role in defining its own development needs through appropriate use of national and state policies will be analyzed.

The importance of constraints, i.e., dealing with local conditions in a declining metropolitan area, for the development of an understanding of transit impact is the subject of Chapter 3.

Chapter 4 introduces the analytic techniques used in the study. An elaboration of the models is developed to fit the methodological framework. the reader interested more in policy analysis or general applicability may wish to scan this chapter.

Chapter 5 represents the results of the model analysis. Although a companion to Chapter 4, the casual reader need not have faciliarity with the models developed in Chapter 4 to appreciate the findings.

Chapter 6 summarizes the study and it places the work in the context of current policy analyses that arise surrounding high capital transit development projects.

Methodology

A set of quantitative and qualtiative techniques were used for the analysis of the economic impacts of the transit system. These techniques included:

1. Accessibility Model - The purpose of this model was to measure the change in total accessibility within the Buffalo area, by zones, and especially to the CBD, due to the introduction of the LRRT system. Following the conventional approach, accessibility was defined as a combination of interzonal travel time and zonal activity levels. Moreover, in order to provide more insight, accessibility was divided into service and work type accessibility.

2. Shopping probability model - One major indicator of the impact of transit investment, expecially in the CBD area, is the level of retail activity. That is, it is expected that the construction of a LRRT system connecting the city fringe with the downtown will enhance shopping in that area. To evaluate these impacts of the transit system it was necessary to develop and calibrate a model which simulates an individuals propensity (or probability) to shop at a given shopping facility given their socio-economic characteristics, the set of all retail facilities and their physical and economic attributes. Afterwards, exogenous changes in the explanatory variables such as reduced travel times or increase in retail floor space attributed to the LRRT investment will be introduced to capture their effect on the simulated shopping behavior.

3. Urban Activity Model - This model was the most used in this study. In very general terms, the model simulates the distribution of population and employment in a metropolitan area and then, given some exogenous changes, predicts the consequences of these changes upon population, employment and land use distributions. As was explained at the outset it was hypothesized that the large investment in light rail transit will impact, in addition to travel patterns, land use city wide. Thus, there was a need for a model which can simulate and evaluate changes in the land use system of the entire area. The specific model used for this purpose is an iterative model of the Garin-Lowry (GLMOD) type. A complex computer program was developed to meet the particular needs of this study.

4. Data Needs - The models developed for analysis form a comprehensive package that can provide the analyst and policymakers with a variety of tools to investigate the LRRT impact. The use of such models demands much in the way of data sources. Local planners and decision makers should be aware that the construction of such a massive and comprehensive, but necessary data set can only be accomplished through a great deal of regional cooperation. The data sets developed for the study included pre and post LRRT travel time matrices, population, employment, retail and land use data developed on a zonal basis.

Critical Findngs

The most critical, general findings from this study evaluating these impacts are presented in the following paragraph.

Scale of Investment

A transit investment (of large scale) is a critical element in downtown revitalization. Such an investment can be considered as a necessary, but not sufficient condition for the focusing of investments in a particular area. In Buffalo, New York the nearly $0.5 billion to be inested in a Light Rail Rapid Transit (LRRT) system has attracted other, associated public funds to be used as leverage for major amounts of private investment. Among community decision makers, the LRRT has been singled out as the major piece of development that may stabilize and revitalize the CBD.

Constraints on Investment in Declining Areas

Underlying demographic and economic trends are important because they govern the relative importance of each investment decision.

These trends define the constraints that are applied to the analysis of the evaluation of transit impacts. In a declining area, that is an area in which the economic base and population are getting smaller rather than larger, it is unlikely that regional income will grow. Each investment, public and private, must be evaluated in concert with the transit investment to insure that maximum returns will feasibly occur. Investments that effect land use activities and their distribution will have an impact on transit ridership. Investors examining the potential development adjacent to the transit system, especially in the CBD, consider transit riders as a potential market. Investment and ridership can be mutually reinforcing.

In the study area, typical of many Northeast Cities, there has been a shift from manufacturing to service sectors. These shifts occur across the regions with specific impacts on land use associated with the employment category. A shift to service oriented employment (government, finance, insurance, etc.) has created new emphasis on location of the employment in the CBD. The biggest segment of the population effected by the shift are women. The increasing number of women in the workforce has begun to have an effect on traditional household travel patterns and car ownership. In urban areas where this phenomenon is pronounced, the CBD has the potential to serve this new and growing market of workers, further enhancing the transit investment.

Based upon the transit construction, and the intensity of development surrounding it, service based industries located at non central parts of the region consider moving to the CBD. This consideration occurs because of intense CBD planning that packages a number of programs (Block Grant, EDA, UMTA) can create investment incentives not previously existent in the CBD to developers. Interaction with the new enlarged labor force, and the perception of accessibility are additional factors that influence this consideration.

Impacts of Suburbanization

The phenomenon of suburbanization is so strong that competing regional redevelopment strategies, even of major proportions, may not reach their desired growth except under the most focused and intense development conditions.

The patterns of the last two decades cannot be overcome quickly or surely by changes in the transit system. The transit system can create a focus on a region, and developers can take advantage of employment shifts within the region. However, because of the strength of the constraints noted above, growth cannot occur throughout the region simultaneously. Thus any development in direct competition with downtown, must eventually have an adverse impact on overall CBD development strategies.

Reinforcing and Conflicting Policies

External policies of both public and private sector are of two types - reinforcing and conflicting. These are not neutral, or uniformly benign policies.

This arises because of the nature of constraints, noted above, that surround CBD development. For example, in Buffalo, N.Y. the transit project is designed with a number of objectives, two of which are: (1) to stimulate and accomodate an increasing share of the travel market and (2) to serve as a prime factor in CBD redevelopment. Policies that the region adapts can reinforce these trends, towards CBD revitalization, or can reinforce relocation of jobs and activities to suburban sites. While the regional output could stay the same regardless of which policy takes place, such shifts to the suburbs would have detrimental effcts on the CBD.

The quantitative analysis provided the necessary data to generate the above findings. In addition to this hard analysis, a survey of decision makers (30 local officials and planners) was used to establish the direction of community (private investment), based on the LRRT. Based on these techniques, the following conclusions can be stated:

A number of attractiveness models, and an accessibility model have been utilized in conjunction with an urban activity model - the use of these models demonstrate that it is possible to evaluate the impact of the LRRT. These include travel time (cost), other transportation related variables, land use variables and socio-economic variables. Because the problem of analysis of investment impacts of the transit system is uniquely different from estimating factors influencing mode choice, these variables had different meaning and significance than ordinarily found in a transportation analysis.

Variables that control retail activity linked to the transit include quality of the activity, parking, and safety. Currently, the CBD in Buffalo is not "attractive" enough to offer competitive pull in the suburban malls. While recognizing the strengths of the CBD, shoppers go more frequently and in greater numbers to suburban malls.

In addition accessibility (meaning time accessibility) is not the only, nor even the most important variable that should be measured by transit improvements. Decreases in travel time do not mean as much as parking, safety, and the quality of activities that are available. Accessibility must be defined in terms of time and quality of activities.

Specifically, the use of these techniques established:

-Economy of Downtown: The LRRT is expected to have a positive impact upon the economy of the downtown. This is seen in two ways. First, it will increase service employment. Secondly, it will stimulate private investments.

-Accessibility to Downtown: The accessibility of downtown to all other zones will not change substantially.

-Shopping at Downtown: If, as projected, the LRRT will have positive impact on downtown attractiveness, a larger share of regional retail trade will be captured by the CBD, all other factors remaining constant.

-Potential for Private Development: Increasing the attractiveness of the area will encourage private development, mainly in retail and service sectors.

Conclusions

When rapid transit systems are constructed in urban areas that are not growing, it is essential that all involved in policymaking insure that the investment be optimized.

The decision to invest in a rail system must then be a unanimous and strongly supported regional decision, one whose effectiveness and impacts have been delineated, and one whose benefits to the region can be seen to be clearly superior to any alternative decision.

The decision must not be made solely on the basis of ridership, or travel costs. The travel cost advantages to a single rider are often marginal The decision should also be based on overall regional economic impact - impact on labor shifts or growth, impacts on housing location, impacts on non-work activities.

As a single guideline for policy decision, a study of rail rapid transit benefits should ask and determine the following:

1. What are the transportation benefits?

2. Is there regional support?

3. What are the associated land use and activity changes?

4. What is the timetable for these changes and are they effected by the transit investment?

5. Will there be long term (post construction) changes in the labor force, created or influenced by the transit decision?

6. Will the transit system effect the intra-regional mobility of labor?

This study examining the Buffalo Light Rail Rapid Transit System now under construction provided answers to the above questions on economic impact The Study showed clearly that, in a region of decline (urban areas of the Northeast, and North Central States), the economic and demographic indicators must be defined and used as planning constraints. This is, the bounds to what development can take place must be defined and shown.

In Buffalo, the transit investment was seen to be one investment that had the potential to minimize such competition. In that sense, the Light Rail Rapid Transit System is a necessary but not sufficient investment to catalyze new economic development. Transit (light or heavy rail) forces a focus on land use and development. Relocation of bus stops, or creation of express bus systems do not have this capability. Bus systems are usually followers of development, while rail systems shape development.

Rapid transit systems must be linked, therefore, to areas where there is demonstrated growth potential. Growth potential (in regions of decline) can be measured by:

.changes in the employment force

.changes in the composition of the labor force

.auto and transit policies

.the regional ability to deal with transportation land use development in non-targeted regions

The effects of transit on land use (and the reverse) are long term. In areas where there is no growth there will not be line-wide or region wide changes. Policymakers must be aware that there are a number of existing transit-land use models that must be evaluated over time. It is unrealistic to invest X dollars in one year and expect a quick return the next. The stage must be set for a combined infusion of support and reinforcement, at first with public sector participation and later, with private sector participation. The analytic models used in the study showed how sensitive each area in the region could be to demographic and economic change, yet how localized transit effects would be. But these analytic models assumed that certain changes (e.g., population shifts, employment shifts) had taken place. Analytic models look at one point in time. Time must pass for those situations to come about.

Thus, policymakers should expect for there to be a period of elapsed time before returns on the public investment will occur. Simultaneously, planners should designate the time frame over which they expect changes to occur and should clearly delineate the level and source of expected change.

This study has shown that a larger capital rail transit investment has implications that range must further than ridership evaluations.

CHAPTER 1

INTRODUCTION

1.1 Background

On April 1979, ground was broken for a new six and one-half mile Light Rail Rapid Transit System in Buffalo, New York. This single act had national significance for a number of reasons:

- It was the physical culmination of decisions eminating from a complex and changing planning process begun in the early 1960's.
- It represented a significant public investment for a transportation system for which user benefits were not the sole or even major justications.
- It demonstrated that a strong citizen participation process coupled with a strong coordinated community planning effort could result in a well designed system.
- It became a symbol of new federal initiatives program for the late 1970's - revitalization of urban central cities through well planned public investment.

It is the last point to which this study is directed. While initially (1962-1964) conceived of as a link in a revitalized regionwide transportation network, the Buffalo Light Rail Rapid Transit System (hereafter referred to as LRRT) is currently seen as the single most important and unifying component of a revitalized Central Business District (hereafter referred to as CBD). How the returns (i.e. the public value received) on this large ($450 million federal and state grants) public investment can be measured and evaluated from the problems to be discussed in this study will determine the CBD's rate of revitalization.

In the early 1960's planners noted many trends in our older urban areas. The most significant of the trends, suburbanization, was one aided by federal housing and transportation programs. One underlying assumption at that time was that the growth of these northeastern cities would continue unabated, although perhaps at smaller rates in the 1980's and thereafter. Further, it was assumed that the Central City would sustain its traditional role as the regional focus for commerce and general business. The 1970 and 1980 census of population indicated how wrong these assumptions were. Growth of the city did not continue, and cities in the Northeast were faced with major declines in population and their economic base. The exodus from the central city to the suburbs coupled with the losses of population and industry caused the central cities to lose much of their significance within their regions.

The question of evaluation of a transit investment, raised in the opening paragraph, must then be asked under the constraints of current (1981) conditions. In particular, how can transit generate benefits to the region,

and be part of a region or program to cope with the costs of decline, while simultaneously generating support for its own operation.

As transit is a derived demand, that is, it serves the activities to which it goes, strong links must be created between a new transit system and the most stable or growing regional activities. In a declining region, a major transit investment should generate returns through a catalytic effect on new office development, retail activity, commercial activity, and even residential activity. Transit investment, as a public investment, becomes then only one, but perhaps the most critical one, of a number of policies, public and private and local and regional as well as federal in concert with each other to insure the most successful return.

It is within the context of the evaluation of transit investment in a region with major population and economic losses that this study was made. A set of project themes emerged that place the analysis of such investment impacts in clear perspective. These themes are:

- Within the context of the analysis of transit related investments, accessibility assumes a new dimension. Accessibility must be defined not only in terms of time, but in terms of quality of activities-those activities that have the potential to stimulate ridership on a rapid transit system. The incorporation of the quality of land use (who uses the land, to what extent or level of development, and for whom) into transit impact analysis gives a more realistic approach to such analyses.

- In the interpretation of projected changes in transit ridership, accessibility, and activities, based upon a large light rail transit investment, there are a number of specific constraints that must be defined, measured and evaluated. The constraints addressed in this study are those of the limits of population and employment in a declining region Shifts away from manufacturing to service based work mark the labor changes. These declines and shifts influence land use in ways appreciably different from regions in which population is increasing.

- Fixed light rail transit represents a unique investment. It is unique because a transit investment focuses attention on activities that surround the system, enhancing their attractiveness. Because of the potential capacity of a transit system, large numbers of riders can be directed to specific station areas that have the potential for intense development. Such devlopment can capitalize on shifting patterns of employment and land use. This might be put in a stronger context. However, because of the constraints noted above, there are likely to be intra-regional conflicts created by competition for jobs, retail activities, commerce and residential development. Thus, the unique locational and directed land use aspects of a transit investment make it imperative that any associated development reaches its maximum potential

- The decision to fund a system (i.e., the Urban Mass Transportation Administration (UMTA) commitment to provide 80% of the funds to construct a Light Rail Transit System) creates, in a declining area, a short term confidence by local investors. This is extremely important

in a declining area, for which CBD revitalization is considered to be a prime objective. The Public Sector is perceived of as a true partner in development, and its vote of approval ensures local investors of a safe market. This short term confidence results in investment decisions that may have taken place over a longer time period, or, with equal probability, may have taken place at other locations in the region. The resulting intensity of development revitalization, enhances the transit system through the potential ridership generated.

.Finally, a critical fact in this study is that the decision to fund a specific system was made. In the case study example of Buffalo, N.Y., the study does not address whether any alternative system or alternative investment may have proven to be better. Specifically the study addresses the investment impacts of a committed system, and develops methods of analysis based on that system.

1.2 Objectives and Study History

What role can a new fixed rail transit facility play in the 1980's? This is a question asked by many sectors of the population. The public sector wants to be assured that its current co-objectives of capturing a significant share of the travel market and having a significant positive impact on land use are met. The private sector wants to be sure that all of the attributes associated with such development will come to function as it makes its investment decisions. Finally, the technical sector - local and regional planners and operators want to ensure, through careful planning and analysis, that the public and private investment decisions are maximized.

To address the concerns of all these groups, this study was designed with the following objectives:

1. To define the scope of the rapid transit investment.

2. To determine the interactive nature of both public and private, that may conflict with or reinforce the transit investment.

3. To define and use analytic techniques to measure the impact of the investment strategies.

4. To apply the above to the case study of Central Business District revitalization in Buffalo, N.Y.

A methodological framework within which these objectives can be addressed is shown in Figure 1.1. The framework takes the LRRT as given delineates four impacts - transportation, land use, economic and shopping- and evaluates the changes on the CBD. The objectives, as noted above, are interdependent. Figure 1.1 shows that a transit investment has impact on more than just ridership or transportation system use. To simplify the analysis, the impacts studied here are limited to economic, land use, and retail factors. The constraints placed on the investment and the resulting impacts are defined by the history of major trends - population, employment and transportation and on the effects these trends have had in the spatial allocation of people, jobs and activities that have been established by these trends. In the examination of the investment in Buffalo, N.Y.,

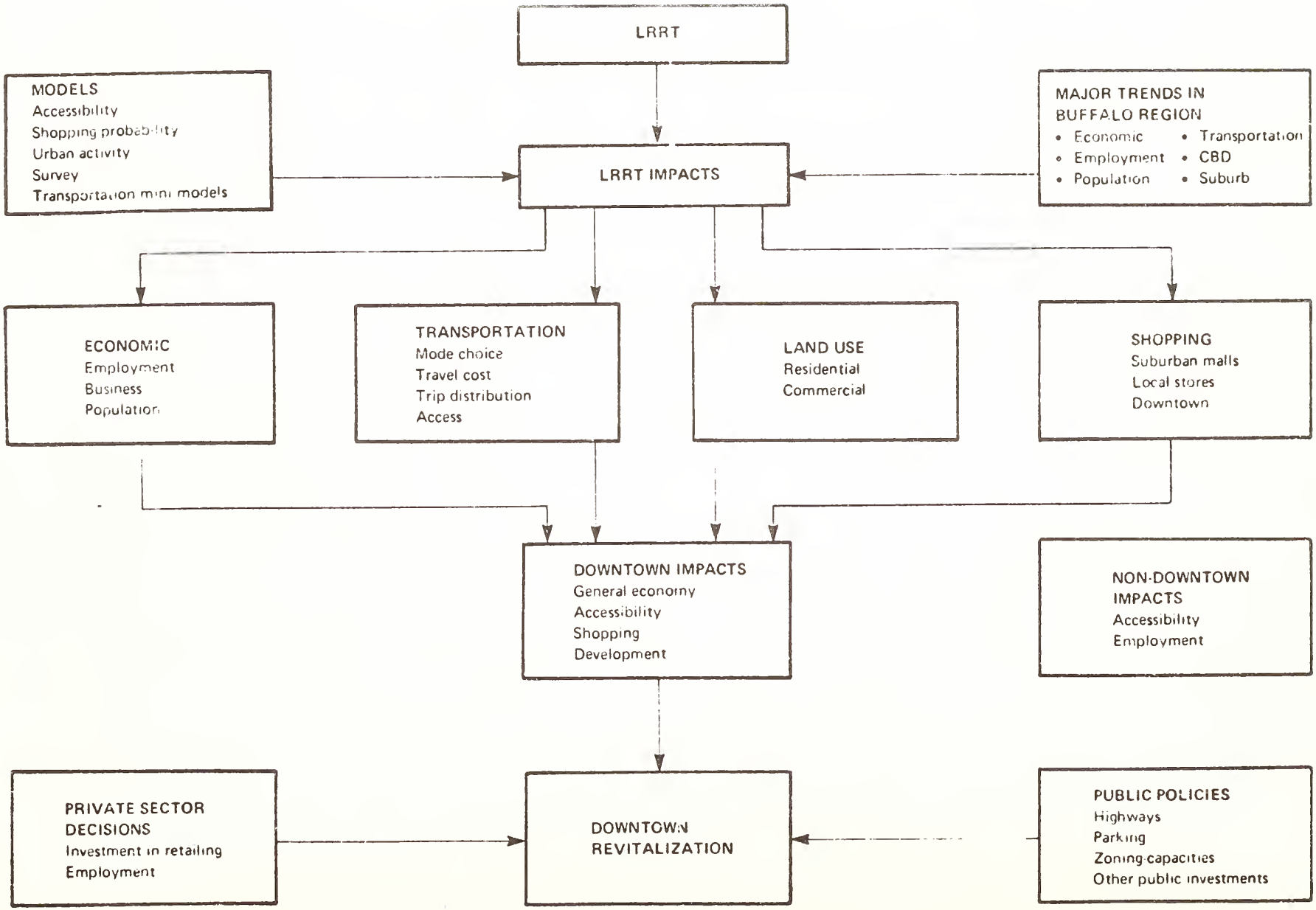


FIGURE 1.1 METHODOLOGICAL FRAMEWORK OF JOINT DEVELOPMENT ANALYSIS

measurement of the impacts were considered in the CBD, and in non-CBD areas. The study has assumed that the investment is part of a strategy to target the CBD for revitalization and that with population and economic constraints, investments outside this targeted area may become competitive, thus restructuring the full potential development of the CBD. The spatial impacts of previous transportation investment and development patterns for the Buffalo Metropolitan Area are clearly noted in Figure 1.2.

In Figure 1.2 it is shown that the Light Rail Rapid Transit is constructed within the Central City with a focus on the CBD. The LRRT is superimposed on an existing highway network that has evolved over the past two decades. While initially CBD oriented, the outer ring of the highway network has influenced patterns of development in the first ring suburbs to such an extent, that much of the traditional central city activities, residential, retail, offices, are now located in this first ring.

In subsequent chapters, the strong competitive pull of this ring will be discussed. To understand the nature of the competition and to demonstrate the way in which constraints are applied to the transit investment, it was essential to understand the nature of planning and investment changes that have occurred in the last two decades.

1.3 Study Context

In the evaluation of strategic plans of the 1960's it was usually possible to assign dollar values to derived monetary benefits (travel time, accidents, etc) and evaluate alternatives on that basis. In 1981, in many of our urban areas, such benefits, while necessary, are no longer sufficient to justify large capital projects. This is especially true when examining major transit projects. A number of factors have evolved that have changed the nature of project evaluation:

1. Transit ridership, expecially on new systems, has been difficult to forecast

2. Travel time, once the most critical of all travel variables, is now being replaced by actual user travel cost. The rapidly increasing cost of running and operating a car (created by increasing gasoline prices and escalating car purchase and maintenance prices) has generated increased transit use.

3. The costs of transit operation have also increased, necessitating higher operating subsidies for transit systems.

4. The costs of building, maintaining and operating transit systems are going to be assumed, in greater amounts, by local, and state, rather than federal governments.

One critical variable has been added to this complex picture. In urban areas facing economic decline, local policymakers have been encouraging investments that might create stability where economic lag have occured. The current stress on industrial and economic development are examples of such thinking.

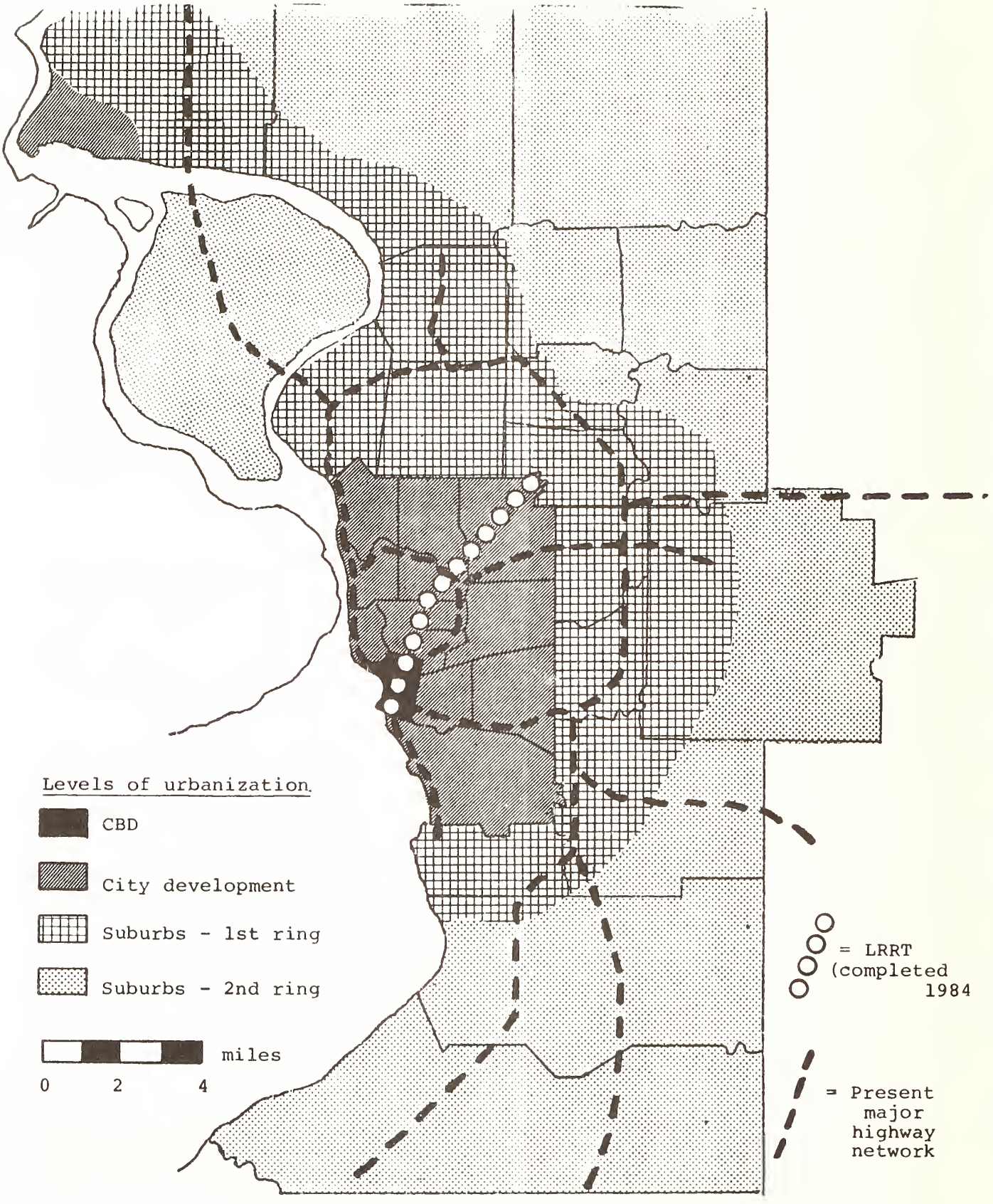


FIGURE 1.2

DEVELOPMENT PATTERNS - BUFFALO METROPOLITAN AREA, 1980

Many regional planners believe that the ability to stabilize the tenuous economic position of a declining metropolitan area resides in the ability to stabilize a declining Central City. Transportation system changes, so important in the redistribution of activities within regions in the past two decades, are viewed in this light as being critical in the redevelopment of the (CBD). The success of the investment in such system changes, when directed towards CBD revitalization then must be measured by the ability of a region to achieve these specific objectives, as well as by the more traditional transportation variables of time and cost.

To understand and define the impact of a prepared LRRT system, it was essential to develop a comprehensive data set combining population, economic, land use and transportation data.

1.4 Previous Studies

Much of the data, and the preliminary development of analytic techniques to deal with the data, were developed in a companion study (1.1). The prime objective of that study was to develop indicators that could predict changes in the economic conditions of the CBD (and region) based upon (1) the development of the Light Rail Rapid Transit System in Buffalo, N.Y. and (2) associated, or joint, development associated with the transit. While the application was specific, the methodology and indicators are considered to be generic. In Table 1.1, the types of data, and the types of qualitative and quantitative models used are listed.

The initial data collection established the strength of the constraints and showed clearly the conditions under which the transit investment would have major impact. The most important of these were:

- The phenomenon of suburbanization is so strong, that competing redevelopment strategies, even of major proportions, may not succeed, except under the most focused and intense development conditions. In the example of Buffalo, it may prove to be fortuitous that the focus of development from the transit is in the CBD. Had a longer system been constructed, an additional competing focus would have been in the center of a major suburban growth region. The system is like an arrow pointing at the CBD. Some local planners believe that development should be targeted there in concert with the transit development.

- The importance of the combination of population decline and job category shifts must be realized. The private investment potential to be realized from public investment primers is a function of the limited size and nature of the regional markets, if possible, and redistribution of activities within the region.

- The use of the traditional travel determinant, travel time, as being the principal variable controlling land use decisions based on transit investment was brought into question. Other variables, particularly those describing the quality of land, were singled out for further analysis in this study. It should be noted that travel time is downgraded as a control variable because trip lengths are relatively short. While travel time savings in percentages might seem long, they are often only several minutes. Thus, to the traveler, other variables become more critical.

TABLE 1.1 DATA AND ANALYSIS METHODS DEVELOPED FOR USE IN TRANSIT IMPACT ANALYSIS

DATA

- Population
  - Trends
  - Distribution
- Labor Force and Employment
  - By category
  - By sex
  - By age
  - Distribution, location
- Land Use
  - By category
  - Densities, gross, net
  - By trend
- Retail Activity
  - Trends
  - Distribution
  - Sales/sq.ft.
  - Employees
  - Square feet of retail area
- Transportation
  - Network Characteristics (interzonal)
    - Now, future, cost matrices
  - Light Rail Characteristics
  - Travel behavior
- Local Investment
  - Timetables and amounts
  - Public, private

ANALYTIC METHODS

- Transportation - Land Use - population - Economics Model
- Accessibility Model
- Shopping Choice
- Surveys

.The new LRRT is perceived, together with proposed joint development projects, as a positive gain for the CBD. Not only was interest created in using transit, but a number of assoicated activities were cited as pulls for the population. These perceptions were derived from a qualitative study that showed how investment decisions are also tied to perceptions of future activity as well as quantitative cost-benefit balance sheets.

The data from the previous study, together with the development of the analytic techniques, served as the basis for the evaluation done in this study.

1.5 Organization

This report is organized to lead the reader through the critical parts of the analysis and clearly show how the impacts of investment are established, and can be used. The report provides information that can be of use to public oficials, planners, engineers, and private sector concerns.

The most critical, general findings from this study evaluating these impacts are presented in the following sections:

1.6 Scale of Investment

A transit investment (of large scale) is a critical element in downtown revitalization. Such an investment can be considered as a necessary, but not sufficient condition for the focusing of investments in a particular area. In Buffalo, N.Y. the nearly $0.5 billion to be invested in a Light Rail Rapid Transit (LRRT) System has attracted other, associated public funds to be used as leverage for major amounts of private investment. Among community decision makers, the LRRT has been singled out as the major piece of development that may stabilize and revitalize the CBD.

1.7 Constraints on Investment in Declining Areas

Underlying demographic and economic trends are important because they govern the relative importance of each investment decision.

These trends define the constraints that are applied to the analysis of the evaluation of transit impacts. In a declining area, that is an area in which the economic base and population are getting smaller rather than larger, it is unlikely that regional income will grow. Each investment, public and private, must be evaluated in concert with the transit investment to ensure that maximum returns will feasibly occur. Investments that effect land use activities and their distribution will have an impact on transit ridership. Investors examining the potential development adjacent to the transit system, especially in the CBD, consider transit riders as a potential market. Investment and ridership can be mutually reinforcing. The demographic and economic trends help to establish limits on values against which these investments can be tested. Such trends must be clearly understood, not only as gross regional figures, but as they may be distributed within the region.

The importance of the combination of population decline and job category shifts must be realized, especially the presence of more (married) women in the work force.

From a study of these trends and shifts, it is possible to identify those conditions that will benefit the transit investment directly through ridership, and indirectly through spatial redistribution of activities. In the study area, typical of many Northeast Cities, there has been a shift from manufacturing to service sectors. These shifts occur across the regions with specific impacts on land use associated with the employment category. A shift to service oriented employment (government, finance, insurance, etc.) has created new emphasis on location of the employment in the CBD. The biggest segment of the population affected by the shift is women. The increasing number of women in the work force has begun to have an effect on traditional household travel patterns and car ownership. In urban areas where this phenomenon is pronounced, the CBD has the potential to serve this new and growing market of workers, and in turn promote greater transit use.

Growth of CBD as influenced by the above trends may create dislocation in other parts of the region. Noting that regional employment has declined, increases in employment in the CBD might denote regional shifts of a state's labor force. It is not clear that this is what has taken place in Buffalo, N.Y. Rather a new group described above, has entered the labor force, countering the suburbanization of other sectors of employment still taking place. However, based upon the transit construction, and the intensity of development surrounding it, service based industries located at other parts of the region now consider moving to the CBD. This consideration occurs because of intense CBD planning that packages a number of programs (Block Grant, EDA, UMTA), that can create investment incentives not previously existant/available in the CBD to developers. Interaction with the new enlarged labor force, and the perception of accessibility are additional factors that influence this consideration.

1.8 Impacts of Suburbanization

The phenomenon of suburbanization is so strong that competing regional redevelopment strategies, even of major proportions, may not reach their desired growth except under the most focused and intense development conditions. This finding, described in an earlier study was reinforced by additional analysis in this project.

The patterns of the last two decades cannot be overcome quickly or surely by changes in the transit system. The transit system can create a focus on a region, and developers can take advantage of employment shifts within the region. However, because of the strength of the constraints noted above, growth cannot occur throughout the region simultaneously. Thus any development in direct competition with downtown, must eventually have an adverse impact on overall CBD development strategies. This sequence discussed in these last findings leads to one of the most significant implications arising from the study.

1.9 Reinforcing and Conflicting Policies

External policies of both public and private sector are of two types reinforcing and conflicting. These are not neutral, or uniformly benign, policies.

This arises because of the nature of constraints, noted above, that

surround CBD development. For example, in Buffalo, N.Y. the transit project is designed with a number of objectives, two of which are: (1) to stimulate and accomodate an increasing share of the travel market (2) to serve as a prime factor in CBD redevelopment. The potential of transit to attract a large share of the travel market will be attributed less to decreased travel time than to increased transportation opportunities along the transit corridor. Increased opportunities arise from real increases in the labor force at locations adjacent to the transit (which is now (1981) occuring in the CBD) as well as increasing non-work opportunities (for example, convention centers, hotels, theaters) near the transit. Policies that the region adopts can reinforce these trends, towards CBD revitalization or can reinforce relocation of jobs and activities to suburban sites. While the regional output could stay the same regardless of which policy takes precedence, such shifts to the suburbs would have detrimental effects to the CBD. Redevelopment of a declining area involves a number of risks. At this time (1980) the public sector is assuming a great deal of those risks. Policies should be examined as regional policies with local objectives, and sets of policies should be developed to optimize the objectives.

1.10 Organization of Study

In the next chapter, Chapter 2, transit policies and their histories and present role in regional development will be discussed. In particular, the importance of a region's role in defining its own development needs through appropriate use of national and state policies will be analyzed.

The importance of constraints, i.e., dealing with local conditions in a declining metropolitan area, for the development of an understanding of transit impact is the subject of Chapter 3.

Chapter 4 introduces the analytic techniques used in the study. An elaboration of the models is developed to fit the methodological framework. Figure 1.1 forms the substance of this Chapter. The reader interested more in policy analysis or general applicability may wish to scan this chapter.

Chapter 5 presents the results of the model analysis. Although a companion to Chapter 4, the casual reader need not have familiarity with the models developed in Chapter 4 to appreciate the findings.

Chapter 6 summarizes the study and it places the work in the context of current policy analyses that arise surrounding high capital transit development projects.

CHAPTER 2

TRANSIT POLICIES AND ECONOMIC DEVELOPMENT

2.1 Background

"Local land use policies have often been instrumental in facilitating transits land use impacts. At the same time, the transit improvement itself has sometimes provided the rationale needed for the acceptance of such policy changes". (2.1) In their summary of transit investment impacts in a number of cities, Knight and Trygg captured the most recent justification for the investment in the Buffalo Light Rail Rapid Transit System.

In the 1960's transportation investments were carried out using the argument that user benefits, primarily travel time savings, more than compensated for the investment costs. By 1980, systems whose planning originated in the 1960's were being justified on the acceptance that non-user benefits must also compensate for the investment costs. Transit impacts on development and economic activity within a region must be calculated, with those calculations being used for estimation of the transit impact. Further, in the late 1970's, the use of leverage, that is using public sector funds (such as transit investment) to stimulate a larger amount of private sector funds, has become one of the variables in the investment justification equation. In this sense, Knight and Trygg have stated explicitly how regional policymakers use transit to provide land development in designated area.

As with all planning theories, the model might not match the reality. As mentioned in the previous chapter, Buffalo, N.Y. is an example of a region in the U.S. that must make transportation changes under specific population and economic constraints. Thus, while using transit to "provide the rationale" for intense (CBD) development, it may be possible that other regional projects will deter from the full realization of this objective.

And, to state the transit case very simply: transit relies on the activities surrounding it to generate the transit trips. Factors that promote activity growth simultaneously promote transit ridership. Factors that inhibit activity growth will also not allow transit ridership to reach its full potential. Thus, in the latter case, regional policies that detract from stimulating growth in a new transit corridor will make it difficult for transit to be justified even on a user cost basis.

It will be shown that external policies (those not directly concerned with the transit) can have a major impact on the transit investment. In a declining area the constraints of population and economic changes can literally drain support away from land development and other investments targeted to the transit. It is essential to understand the source of such policies their uses and effects, to fully appreciate the climate in which transit development takes place.

This chapter examines the conditions under which the LRRT system in Buffalo, N.Y. has been designed and is being constructed. A brief overview of transit policy in the U.S. in the past two decades (1960-1980) will be used to set the context for the complex evaluation of the transit system.

A discussion of the development implications of the transit follows. This discussion contains examples of similar transit development in other cities. At this point, the concept of reinforcing and conflicting policies is established to underscore the complexity of measuring transit impacts when other regional development policies are taking place. This discussion, while looking at the Buffalo example, is meant to be generic. It is intended to show that in evaluating public transit investments in declining urban areas:

> The investment must be targeted, and the implications of the investment, land development, employment location, location of service facilities (e.g., retail) must be clearly determined. Regional policy must be established to control development that may create conflicts with the large transit investment; otherwise, the long term impacts of the transit investment will be far less than necessary to insure the investment objectives - renewed economic confidence in the targeted areas.

2.2 Introduction to the LRRT and its Progress

The 6.4 mile (LRRT) in Buffalo, N.Y. is to be completed in 1984. The system will incorporate features of heavy rail systems into light rail operations at an estimated cost of $439 million. The northern terminus will be at the South Campus of a major urban university (State University of New York at Buffalo), and the line will cross the city in a southwesterly direction to its other terminus at the lower boundary of the city's (CBD) (Figure 2.1). There will be 14 intermediate stations along the route, which is colinear with the major urban arterial, Main Street. The stations are at key surface transportation interfaces, near densely settled residential areas, or in the vicinity of high concentrations of employment in the CBD.

The system is viewed as a major catalyst in stabilization or revitalization of the CBD. Even though Buffalo faces economic and population losses, there are several factors that would make public investment of this magnitude, $434 million, in this system beneficial to the area. These factors include redevelopment for service and commercial use in the CBD, an increased CBD employment, and, a growing focus on transit use to offset higher car operating costs.

The transit system was designed to reduce on-vehicle transit times in this corridor from the current 30 minutes during rush-hour to about 16 minutes, while not noticeably affecting auto travel times. (2.1)

Preliminary estimates indicate approximately, that in 1985, 176,000 one-way trips will be made on the entire transit system (bus and rail) each weekday. (2.2) Just over 70,000 of these trips will be originating in the CBD indicating that many opportunities to generate new activities will occur at the major transit stations. (Transit will generate one third of the total daily ridership).

Original design of the system called for a twelve mile line serving the suburban town of Amherst and the University's North Campus, instead of the 6.4 miles currently under construction. This original proposal is an example of a regional policy, which has created a number of foci of development, the strongest being the CBD and the furthest ring of suburbs.

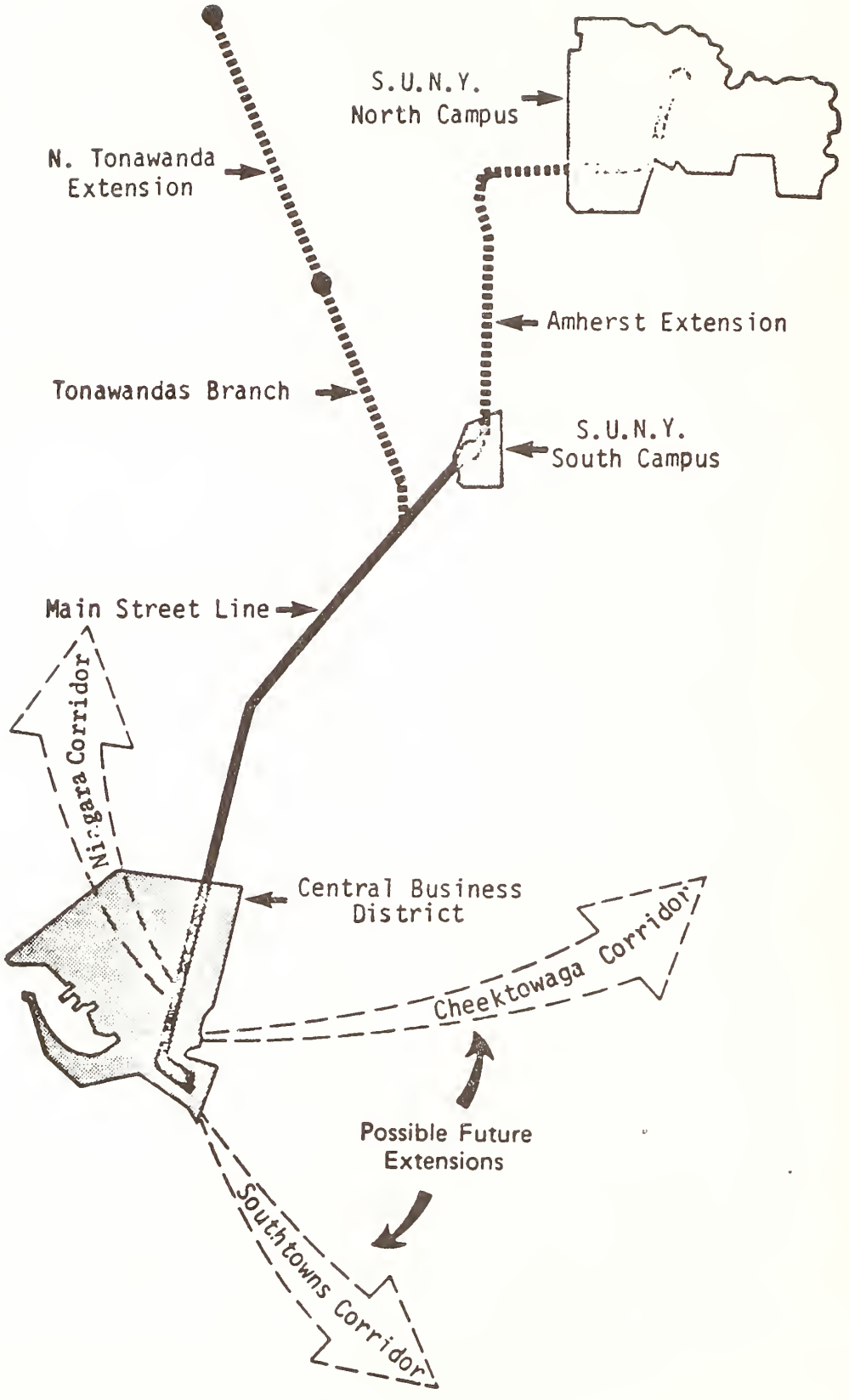


FIGURE 2.1 LOCATION OF LIGHT RAIL RAPID TRANSIT SYSTEM

2.3 Impact of the LRRT on the CBD

The construction of a new fixed rail system is an example of the public capital investment portion of a transportation economic developed process. The return anticipated from this combined public (transit) - private (associated land use) investment includes an increase in the economic vitality of the downtown area of a declining northeastern industrial city.

The economic investment impacts of the Light Rail System in Buffalo N.Y. were evaluated using three components.

1. Impacts of the federal and local investment in the LRRT system itself during the period 1978-1983 (Table 2.1 gives the investment timetable);

2. Impacts of other public investments related to the construction of the LRRT; and

3. Long term impacts of corridor and regional changes that might occur because of the rail investment. This would include both public and private investment in CBD and near-by stations.

The assumption made here is that the transit is the catalyst for the current resurgence of new downtown construction. To support and amplify this hypothesis, a series of structured interviews were conducted with thirty regional leaders. While not a statistical sample, these responses are important. These people are responsible for directing, inducing, planning for or investing in the growth of the region. Thus, the responses to the transit project reflects the decisions to be made by local investors. The results of these interviews are summarized below.

Interviews with community leaders give qualitative evidence of the type of catalytic effect the transit has. The belief, or perception that a system will have marked impact leads to a confidence in investment. This confidence in turn, must be supported by actual investment commitments. Such commitments have been made in Buffalo, N.Y. The size and nature of development, linked to the transit and CBD revitalization, is given later in this chapter. Table 2.2 and Table 2.3 presents a detailed summary of the community leader interview.

Approximately 60 percent of the community leaders believed that present efforts to revitalize the downtown, centered around the Light Rail, showed definite signs of success. When asked for personal ideas for downtown revitalization, forty five percent of those interviewed noted current investments should be sustained. Fifteen percent singled out the importance of the rapid transit. The factors leading to revitalization that were considered important included new employment, current and planned improvements and, again, the transit system. More than half the respondents saw a conflict between CBD and regional development. The arguments surrounding this conflict were explicit. Forty seven percent believed that the regional strength came from a strong core. Fifty three percent felt that increased growth in the CBD (retail sales, jobs) will occur at the expense of other areas in the region. Forty percent of the respondents believed the transit system will generate more CBD business and all of the respondents noted positive aspects of the LRRT on CBD growth. Eighty five

TABLE 2.1 TRANSIT INVESTMENT TIMETABLE

YEAR	EXPENDITURE ($MILLIONS)	TOTAL EXPENDITURE
1979	35.4 (8%)	35.4
1980	86.2 (20%)	121.6
1981	136.9 (31%)	258.6
1982	92.5 (21%)	351.0
1983	78.4 (18%)	429.2
1984	10.4 (3%)	439.8

TABLE 2.2

LOCAL DECISIONMAKERS AND INVESTORS - INTERVIEW LIST

1. Robert Adam, AM&A's Department Store
2. Joseph A. Alutto, Dean, SUNY at Buffalo, School of Management
3. Paul Barrick, Director of Planning, City of Buffalo
4. Robert Bartolo, American City Corporation
5. John Berlin, Building Owners & Managers Assoc.
6. Charles O. Brown, Deputy Commissioner, Erie Co. Division Planning
7. Sheldon Berlow, Berlow Real Estate
8. Robert Cleary, Niagara Mohawk
9. Ralph Diblle, Buffalo News
10. Mayor James Griffin
11. Daniel Hoyt, N.F.T.A.
12. Gerald Kelly, Greater Buffalo Development Foundation
13. Bruce Kloc, Courier Express
14. John J. LaFalce, Congressman
15. John T. Liebel, Jr., Nancdata
16. John Murphy, HengerersDepartment Store
17. Henry J. Nowak, Congressman
18. Michele Penca, City of Buffalo
19. Lawrence Quinn, Community Development, City of Buffalo
20. Louis Reif, National Fuel Gas
21. Kevin Roache, N.Y. Telephone Co.
22. Daniel A. Roblin, Jr., Chairman, Roblin Steel
23. Charles Rosenow, Erie County Industrial Development Agency
24. Claude Schucter, Chairman, M & T Bank
25. Edward Small, Niagara Frontier Transportation Committee
26. Daniel Szymoniak, Executive V.P., Greater Buffalo Board of Realtors
27. Peter A. Wastie, American City Corporation
28. Joseph Tocke, New York State Dept. of Transportation
29. Guy Ericksen, Buffalo Chamber of Commerce
30. George Smyatek, NYS Department of Labor Statistics

TABLE 2.3 DECISION MAKER INTERVIEWS ON LRRT IMPACT - SELECTED RESPONSES

.HOW DO YOU FEEL ABOUT PRESENT EFFORTS TO REVITALIZE THE CBD? (INCLUDING THE VARIOUS PUBLIC AND PRIVATE ENTITIES INVOLVED)

Answers	% of Respondents
Doing very well, definite progress	59.3
Not a coordinated effort	22.2
The Buffalo Common Council is an obstacle	11.1
"They should talk less, act more"	3.7
No response (don't know)	3.7
	100.0

.WHAT ARE SOME OF YOUR PERSONAL IDEAS FOR REVITALIZING DOWNTOWN BUFFALO?

Answers	% of Respondents
Continue with present major efforts e.g., LRRT, Waterfront, entertainment district	44.4
Emphasize bring in new hotels	3.7
Rapid transit is very important	14.8
Increase residential base downtown	3.7
Improve image & esthetics of downtown	11.1
Other	23.3
	100.0

.WHAT ARE THE BEST THINGS THAT COULD BE DONE TO HELP REVITALIZE BUFFALO?

Answers	% of Respondents
Create new diversified employment	33.3
The improvements already being planned for downtown	22.2
Transit system	11.1
Other	33.4
	100.0

.DO YOU SEE A CONFLICT BETWEEN CBD AND REGIONAL DEVELOPMENT?

Answers	% of Respondents
No: without a strong downtown, greater Buffalo is nothing. The suburbs' strength comes from a strong central city concept	47
Yes: Increasing retail sales in the CBD and bringing jobs to Buffalo will be taking it away from other areas of the region	53

TABLE 2.3 Continued

.WHAT POSITIVE CHANGES DO YOU THINK THIS LRRT WILL BRING TO DOWNTOWN BUFFALO?

Answers	% of Respondents
Will generate more business downtown	40.7
Will increase accessibility to downtown	18.5
Should/will decrease auto use	3.7
Will add excitement to downtown	18.5
Other	18.6
	100.0

.HOW WILL THE LRRT AFFECT YOUR BUSINESS OR ORGANIZAITON?

Answers	% of Respondents
Will help bring more people back to the city	33.3
Will bring us more business, and bring about redevelopment (organizational goal)	11.1
Will not affect organization	14.8
Will provide better mode of transportation for employees	7.4
Create headaches (e.g., traffic diversion)	3.7
No response	29.6
	100.0

.WHAT DO YOU FORESEE FOR THE FUTURE OF BUFFALO 10-15 YEARS FROM NOW?

Answers	% of Respondents
Very bright, attractive new retail commercial center downtown, including mall, transit weatherization of downtown, rebirth of downtown as principal office space area in metro region	40.7
As above but not quite as emphatic	44.4
Stabilizing population losses, some small amount of redevelopment	3.7
Don't know	7.4
No response	3.7
	100.0

.WHAT DO YOU FORESEE FOR THE SUBURBS SURROUNDING BUFFALO 10-15 YEARS FROM NOW?

Answers	% of Respondents
Stabilization of population and commercial development	51.9
Slight increase of population and commercial development	33.3
Definite continual gorwth to suburban areas	3.7
Lots of problems and a probable decrease of population back toward the city	7.4
No response	3.7
	100.0

percent projected the ten year future of the CBD as an "attractive new retail commercial center...including transit..." Thus, those directly, responsible for investment (bankers, developers, planners, political leaders) confirmed their commitment to the CBD and transit's role in its restructuring.

These qualitative descriptions provide a reinforcement for investors who then provide the more tangible aspects of new projects. A list of capital projects leading to the community leader optimism is given in Table 2.4. It can be noted that the largest components of private investment are for hotels and office space. Office space development reflects the growth of the service sector. Hotel space complements service sector needs (i.e., an industry that arises because of the service component). The sustained high level of growth in the suburban areas still illustrates the level of competition between these areas within the region. But, even during the first year of transit construction (5 years until completion) $253 million of related construction has or is taking place in the CBD. This puts the current private investment level ahead of the public investment level. It is anticipated that 8% of transit investment will occur in year one, and 20% in year two, as was depicted above.

The linkage of the transit investment timetable and the scheduling of private projects shows that a synergistic effect of public and private investment can occur. The private investments all were announced at about the same time, after the opening of the Buffalo Convention Center ($20 million public investment) and the start of Light Rail Construction ($90 million public funds for initial contract awards.)

Based upon the resurgence of service oriented employment, and the desire to locate this employment in the CBD a potential for new development for both employment and employment related services in the CBD is high. There is currently a 98 percent occupancy rate in the city's 58 most sought after office buildings. (2.7) In response to a growing market for CBD office space approximately 480 thousand square feet of downtown office space are planned to be available by 1982 to supplement the 1.4 million currently utilized. Much of this development is linked to transit planning. Suburban development is also being carried out. This development does not carry as great dollar values or square footage as the city's, but it shows an inherent advantage that has always made the suburbs more attractive. While city investment has a private to public ratio of 1 to 2, the suburban areas experience ratios of 40 to 1. The reasons are obvious. The projects are much smaller in scale (needing less capital), and the risk is perceived of as being smaller.

2.4 Conflicting and Reinforcing Urban Policies

Transportation may be an important link in the functioning of an urban system, but returns from a large public investment in transit cannot be taken for granted. One question which confronts planners regarding the forecasting of economic impacts from a new transit investment must be addressed.

> Will government policies or programs at all levels of government have reinforcing or conflicting influences on the transit investment and its subsequent relationship to economic development?

TABLE 2.4

BUFFALO SMSA CAPITAL INVESTMENT 1978-1984

PROJECT/LOCATION	PRIVATE (MILLION) INVESTMENT	PUBLIC (MILLION) INVESTMENT	STATUS AND EMPLOYMENT
Buffalo			
NFTA LRRT System	-----	UMTA $430	Under Construction. Open 1984.
Buffalo CBD			
Hilton Hotel and Office Complex	$20 from local bank	-----	Offices -65,000 sq.ft. hotel-est 500 jobs. Open spring 1980.
Navel Park	-----	$30 thousand additional	1979. Built with Public Funds
Snopping-Entertainment Center (P)	$12	-----	3 Years
Erie Community College	-----	$16-Post Office donated by Fed.	In planning stage
Xerox Corp. Office	-----	-----	150 employees moved to CBD in 1979.
Buffalo Convention Center	-----	$20	Open 1978
Hyatt Hotel-Buffalo Savings Bank	$95 total	-----	Est. 400 jobs. 40,000 sq.ft. retail; 350,000 sq.ft, Office. Begin construction spring 1980
ECIDA Light Industrial Park	Est. $10-15	Low Cost Land Transfer and loans with stocks as equity	Initially 500 jobs. Under construction
Pioneer Pyramid-Waterfront Offices	$15	-----	1981-82. 132,000 sq.ft. Office and retail
Theatre District Renovation	-----	$250 thousand	City-owned buildings.
Waterfront Residential and Retail Development	$100	-----	Initially 275 units. Begin constr. 1980.
Waterfront Restaurant	$1.2	-----	Seats 300.
CBD subtotal	$253 million	$466 million	
Erie County-Suburban			
City of Tonawanda			
Downtown Plaza	Est. $3.1	HUD- $780 thous.	4 to 1 ratio Private/Public funds expected.
Apartment-Retail Complex	$12	$3	Federal and State contributions.
Town of Amherst			
Audubon New Community	$28	Audubon project initiated by State UDC	855,000 sq.ft. office and industry. This is initial phase.
Retail Mall (P)	$7	-----	200,000 sq.ft.
Office and Restaurant Complexes (P)	$60	-----	In planning stage.
Blvd. Mall Expansion	-----	-----	From 50-75 stores. 1979.
Marriott Hotel	$13	-----	Construction 1980-1981 Est. 360 jobs.
Niagara Falls			
Aircraft Plant (P)	$50	-----	5000 jobs. 1980. Negotiations in process
Suburban subtotal	$173 million	$3.8 million	Guaranteed 6400 jobs, 1.4 million sq.ft. rentable space

This section examines a number of policies and programs that can create either benefits or disbenefits to development strategies that originate or occur because of a major, high capital, transit investment. Again, putting these policies in perspective and using Buffalo, N.Y. as a case study, it should be noted that

1. The high capital transit investment may generate other related investments as noted above. But the transit investment itself may not be the only major investment in the region. Other investments may also be occuring, each justified on the basis of highly local costs and benefits. However, it may be that no overall regional cost benefit analysis for all projects, taken in toto, has been made.

2. If the transit is justified partially because it will be used as a primer for CBD revitalization, other federal, state and local policies and programs that assist in meeting this objective, together with meeting the growth of demand for the transit system, will be considered reinforcing.

3. If the transit is justified, partially because it will be used as a primer for CBD revitalization, other federal, local and state programs and policies that create competing development in other regions, drawing away from CBD redevelopment, and from growth for the transit system will be considered conflicting.

In the past several years there have been a number of programs, at federal, state and local levels that could be used to assist local development. Table 2.5 summarizes a few of these programs, listing the source agency and the program type. It is possible for a region to adopt many of these programs without assigning a specific priority to a particular one. Also, as it will be noted it is possible to package programs to reinforce and coordinate development, and simultaneously encourage development in other parts of the region that may conflict with such local policy objectives as CBD growth. It cannot simply be assumed that a rail system will cause any specific growth without coordinated planning. There are implicit assumptions by urban planners that a new, well planned rail investment will encourage proper placement of new residential and commercial ventures. Zoning tax abatement and other public tools that are required to be used to work with the new system are left to local officials.

Examples of reinforcing planning can be given in projects that have been started with funds from HUD, EDA, and DOT programs. In a declining area like Buffalo, targeted for massive urban aid, these agencies have the capability of promoting or denying projects, solely on the basis of grants, loans or bonds underwritten for them. In a declining area, it is unlikely that private sector funds will flow without such incentives. However, the programs of these agencies are not always coordinated, thus local officials must create "packages" of programs to generate the private developers interest.

By building a rapid transit line below grade through outer residential areas, at-grade in the CBD where it will be the focus of a pedestrian/transit mall, and by creating a feeder bus network throughout the region which will serve the CBD oriented rail system the transit planners have responded to the wishes of the city population. The transit mall in particular will

TABLE 2.5
PROGRAMS USED FOR CBD REVITALIZATION

FEDERAL	
DEPARTMENT OF TRANSPORTATION	MAJOR PROGRAMS
Urban Mass Transportation Administration (UMTA Regional Office)	Transit Construction Grants and Joint Development
Federal Highway Administration	Highway Construction Grants and Joint Development
Housing and Urban Development	Urban Initiatives Grants and Loans If Suburban
Economic Development Administration	Acquisition and Development Loans If Suburban
LOCAL BUFFALO REGION	
Buffalo City	Attract Developers and Coordinate Funding
Erie County Industrial Development Agency	Coordinate Site Acquisition, Attract Business and Loans
N.Y. State Department of Transportation	State oversaw recent completion of Elm-Oak Arterial Highway
Niagara Frontier Transportation Authority	Light Rail Construction and Implementation
Niagara Frontier Transportation Committee	Priorities of Transportation Investment Impact and Alternatives Analysis
Erie Niagara Counties Regional Planning Board	Land Use Plans

facilitate the use of joint private/public development, and should attract investment otherwise going to other areas within the region. Such investment a major hotel - office complex is currently underway, and is totally linked to the transit system.

An example of conflicting policies at the local planning level can be given. Final construction of a major arterial highway on the eastern edge of the Buffalo CBD was recently completed as part of the long term highway planning in the region. This multi-lane at-grade road serves as a connector to the main expressway leading out of Buffalo to the northeast and southwest. Although the N.Y. DOT feels that the arterial will in no way conflict with the proposed Light Rail System, this conector increases auto accessibility to the CBD.*

According to NYS/DOT, the new highway will ease rush hour congestion in the corridor and will help in handling traffic diverted from an auto-free zone on Main Street, when the Light Rail and associated transit mall open (2.8) The two transportation projects, however, will parallel one another, and the highway will allow easier access, i.e., reduced travel time, than is presently available to the CBD. This ease of access may actually place more autos on those few side streets that will still cross the path of the rail system in the CBD. The irony of the situation is that both the transit and highway plans came from planning assumptions generated in the 1960's. Seen as complementary projects in a dense growth corridor at that time, they may now emerge as conflicting projects, each diverting from the maximum potential of the other.

At the local levels, two agencies, The Erie County Industrial Development Agency (funded by federal EDA programs) and the New York State Urban Development Corporation (UDC), (a state development authority), generated development through a number of regulated mechanisms. The most widely used is bond authority. The proceeds from bond issuing can be used for industrial and residential development. Currently these funds are used within the entire county and are not targeted to a particular region - i.e., the CBD. During the early 1970's, the UDC was mainly responsible for a large scale residential development and industrial park, which began in the suburban Town of Amherst. The area, called Audubon Community (residential) and Audubon Industrial Park, is attracting significant investment from private sources. Audubon is five miles north of the northern terminus of the current transit system. This planned development is attracting millions of dollars of private investment into the suburbs, and is concentrating it in one well served area. The Urban Development Corporation and Town of Amherst have taken small industries from the City of Buffalo, because of more attractive sites, infrastructure, and expansion funding.

2.5 Other Regional Development: Buffalo, N.Y. Area

Current and proposed CBD development has already been described

*The role of highways in regional accessibility is discussed in a later chapter. It should be noted that the highway network as conceived of in the 1960's and implemented in the 1960's, 1970's and 1980's with and through Federal and State highway programs made travel throughout the region by highway exceedingly fast.

TABLE 2.6

INVESTMENT PROJECT TYPES AND TIMETABLE

(II)	COMPLETION						
Buffalo	1978	1980	1981	1982	1983	1984	TOTAL
Rail System						$430 million	$430
Hotel		$20 million*		$95 million*			115
Office				$15 million			15
Retail/Entertainment			$1.5 million		$12 million (P)		13.5
Residential			$100 million*				100
Public Facilities	$20 million	$30 thous.	$ 16 million				36.03
Industrial		$15 million →					15
TOTAL	$20	$35.03	$117.5	$110	$12	$430	$724.53
Suburban							
Hotel			$13 million				13
Office				$60 million (P)			60
Retail			$11 million				11
Residential			$15 million*				15
Public Facilities							0
Industrial		$78 million →					78
TOTAL		$78	$39	$60	0	0	$177

*May include Office and/or Retail Space

(P) Proposed

above concerning downtown Buffalo. The amounts of funds associated with this development are given so as to give a clearer view of the city vs. suburb breakdown of the current economic development prognosis of the area (Table 2.6).

Conflicting interests will always exist in making decisions that affect citizens in more than one municipal jurisdiction. Possible extensions to the initial 6.4 mile LRRT line in Buffalo are currently being studied (1981). Put simply, the current LRRT system will go in two directions towards CBD, and towards the suburbs. While the major focus is now on the CBD, it is possible to divert the attention of developers to other attractive sites particularly in the most rapidly growing suburbs. The city of Buffalo now has an opportunity to begin revitalization efforts and consolidate development programs before any new extension is begun. Future Corridor Concepts Study may be able to point to the best choice for possible extensions based upon criteria that might include impact in the CBD and development potential in the suburbs.

2.6 Experience in Other Cities

Buffalo is not the only city attempting to make an economic comeback, or, the only one planning to implement a new Light Rail Transit system. What makes this city special is that it is doing both at the same time, and is thereby the focus of an UMTA effort to use each to supplement and reinforce the other.

In describing the socio-economic climate in Buffalo, the city was likened to many northeastern cities. Any direct comparison would be misleading, being that each city has individual characteristics which do not carry over between regions. For this reason, similar efforts in other cities have been summarized in Table 2.7. This table gives examples of private and public sector contributions to joint land and transit development. Each city has taken an approach to development that is constant with its own current growth, or revitalization needs. Consistent throughout, though, is the intent of local planners, in each area, to capitalize on transit development, and, in particular, the economic development potentials that transit development can integrate.

A study of processes and policies which guide transit development interaction, conflicting and reinforcing forces have been identified. These forces are of two origins. The first is the natural desire of people to live fruther from the cities. This is generally construed as destructive force for America's cities. Federal and local policies are the other set of conflicting and reinforcing forces which affect the success of public urban investments. The investments themselves are usually reinforcing, but one project can detract from another. An attempt was made here to show that this was not the intent of federal decisionmakers. Even so, these policies must be adapted to mesh with the needs of the cities, and to allow the gains associated with new transit construction and development to be concentrated and mangified. Allowance of this magnification will aid overall regional health and stability

Money is always the first answer given by city officials and transit planners, when they are asked what will help them strengthen this region. This is true, money is needed to build on infrastructure and sustain it. More important though is consistency. Regional goals must be firmly established set and funding levels adhered to, until a project has been completed or an urban area is functioning as a healthy regional center, capable of working with its suburban environ to create and enhance regional stability.

TABLE 2. 7

EXAMPLES OF JOINT DEVELOPMENT

EXAMPLES	YEAR OPENED	COST $ (000,000)	FUNDING SOURCE(S)	CURRENT AND FUTURE IMPACTS: LAND USE	CURRENT AND FUTURE IMPACTS: TRANSPORTATION
- Philadelphia, THE GALLERY (8th St., Market St.)	1977	110	-Private/public ratio: 1.17 -City, State: Redevelopment Authority (RDA) Federal: HUD, UMTA	-Four-level retail mall, 124 stores and restaurants -1,231 new jobs; $2 million in new tax revenues	-850 car parking garage -Renovated 8th St. - Market St. station serving two rapid transit lines -Provision for a proposed center city commuter tunnel linking all parts of the rapid transit network into one system
-Washington, D.C., FARRAGUT NORTH (1101 Connecticut Avenue)	1978 (offices) 1979 (retailing)	12	-Private: 100% -Public: 0% except for the transit facility	-14 story office, retail building (10 office, 4 retail)	-Direct, below-grade access to the Farragut North Metrc station -Parking spaces: none -Station data: daily ridership = 12,000, 1979; 47,000, 1990.
FARRAGUT WEST (International Square)	1977	80	-Private: 100% -Public: 0% except for the transit facility	-13 story office, retail building (11 office, 2 retail), built in three phases (completion dates in 1977, 1979, 1983)	-Direct connection to the Farragut West Metro station as of 1983 -Parking spaces: 1,031 by 1983 -Station data: daily ridership = 22,000, 1979; 32,000 1990.
DOWNTOWN		More than $57 million		-Expansion of Woodward & Lothrop Department Store, which has a direct Metro connection -Proposed $57 million office, retail, restaurant complex	

Table 2.7 cont.
CURRENT AND FUTURE IMPACTS

EXAMPLES	YEAR OPENED	COST $ (000,000)	FUNDING SOURCE(S)	LAND USE	TRANSPORTATION
DOWNTOWN (continued)				-Urban renewal projects tied to the Metro	
TOTAL METRO SYSTEM			-Private: $970 million (to present); $5 billion (anticipated)		
-Boston WASHINGTON STREET STATION	1978	40.8	-Private: $38 million -Public: UMTA, $2.8 million (through MBTA)	-Renovated bi-level subway station linking 2 renovated and consolidated department stores and enclosing retail concessions in a fare-free underground concourse.	-The development is directly served by 2 rapid transit lines; up to 60,000 passengers use the station in peak hour -A third rapid transit line is one block away, a fourth four blocks away
-San Francisco-Oakland BART	1972			-Marginal development due to BART. Some office construction was determined by BART with respect to location.	-BART caters to people's commuting needs. Other, older systems combine the commuting aspect with the movement of people within the city.
-Los Angeles, DOWNTOWN PEOPLE MOVER (DPM)	Early 1980's			-The DPM is estimated to generate $9 million annually in private benefits, including office rents, retail sales profits, and parking cost savings.	
-Minneapolis, NICOLLET MALL	1968			-Transit mall -8 blocks of downtown retail streets -Number of downtown retail shoppers have increased substantially	-Exclusive bus lanes; traffic has been controlled, transit ridership has improved.

Table 2.7 cont

EXAMPLES	YEAR OPENED	COST ($000,000)	FUNDING SOURCE(S)	CURRENT AND FUTURE IMPACTS: LAND USE	CURRENT AND FUTURE IMPACTS: TRANSPORTATION
-Portland TRANSIT MALL	1970's			-Focal point for downtown development. 11 blocks of two parallel streets. Has supported the growth of 1.7 million square feet of completed and planned office space since 1976. -Expansion and renovation of older retail stores, plus 40 new stores and restaurants	-Reduced auto congestion, improved environmental quality
-Denver, TRANSITWAY/MALL	1980's			-In response to redevelopment of downtown and the easing of traffic conditions. -New restaurant and entertainment facilities planned, together with a major growth in office space. -Estimated that the mall could increase downtown retail sales by 7-10%.	-Only public shuttle buses and pedestrians will have access. Shuttle bus transfer points will reduce congestion by terminating commuter buses before they enter the CBD.

CHAPTER 3

CONSTRAINING INFLUENCES ON IMPACTS OF TRANSIT INVESTMENT

3.1 Importance of delineating trends

To comprehend the potential impacts which the LRRT may generate in the Buffalo, N.Y. region, and specifically in the CBD, it is essential to have an understanding of the socio-economic and demographic trends which have helped shape the structure of the region. These trends, described in greater detail below, can either enhance growth and revitalization efforts, or can act as constraints on such strategies.

A theory will be developed to illustrate the economic inter-relationship of the geographic sub-areas in the area. It will be shown that the transit investment creates certain development implications. By examining regional constraints, such as population decline, and economic shifts, the theory will serve to illustrate the impacts of reinforcing and conflicting policies, especially at the local level on the long term benefits of the transit system.

This chapter will begin with a discussion of recent population and economic trends in Buffalo, NY. The discussion is somewhat detailed because of the implications that regional population shifts can have on transportation strategies.

3.2 Demographic and Economic Trends

One variable which most describes the state of a region's developmental vigor and health, is population. In Buffalo, this variable reflects the region's economic downturn during the past two decades (1960-1980). Table 3.1 and Figure 3.1 show the trends in the area's population and employment levels since 1950.

It can be seen that the city population decreased from a high of 580,132 in 1950 to a low of 357,002 in 1980. While many of these people left the region altogether, a large portion simply left the city for the outlying, suburban areas. Erie County, meanwhile, increased in population by 13% during the same time period. But, during the last decade, 1970-1980, the county lost 100,000 residents. Figures 1.2 (Chapter 1, p. 6) and 3.2 depict the extent of the area's (sub)urbanization process, as well as the pattern of residential densities.

Changes in population are of course influenced by concurrent employment changes. Shifts have been occurring in the employment trends of the city, the region, and the nation.

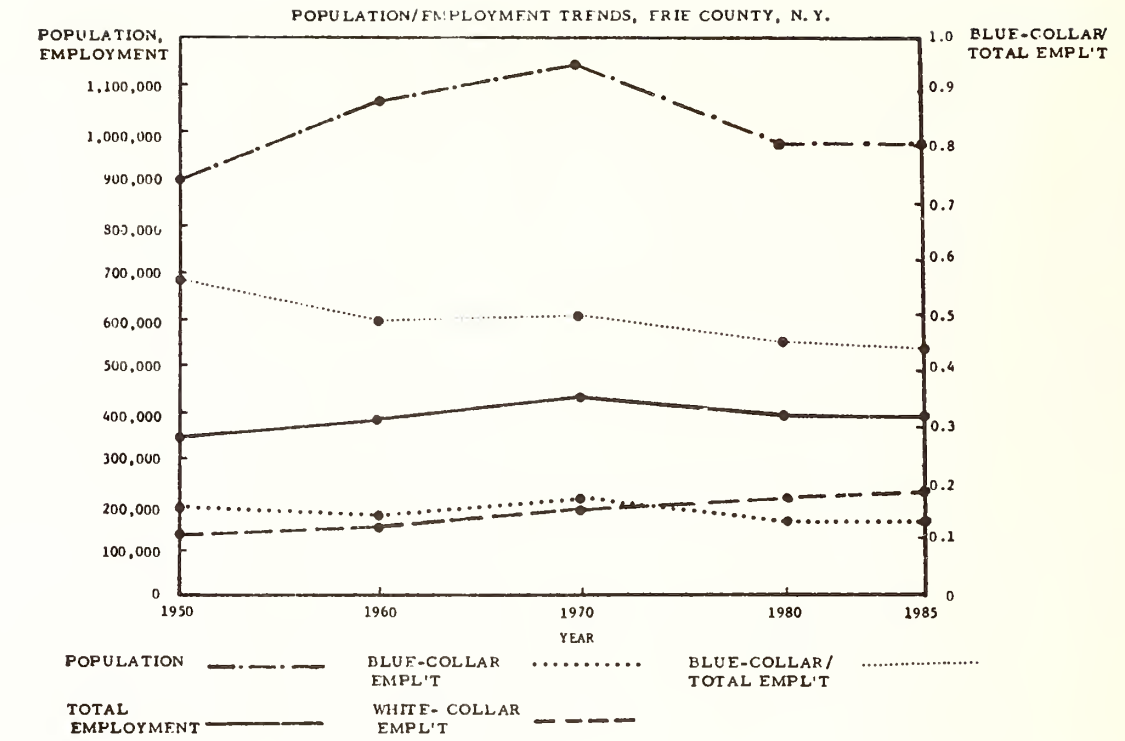
The labor force was examined at the national and local levels to determine whether the regional trends reflect national trends. By examining the rate at which labor shifts occur compared to national trends, it is possible to estimate the significance and impact of such shifts. Thus, if the region looses manufacturing jobs at a rate faster than the national, there is obvious outmigration and relocation of population. The momentum of such shifts that is, the speed with which they occur, make it possible to infer whether such shifts can be reversed or slowed in the short run.

Nationally, over the last decade employment in heavy industry has experienced an average increase of approximately 56%. Locally these same industries have lost employment at an average rate of 30%. Total losses in the number of business firms for the city are shown in the table following:

TABLE 3.1 POPULATION - EMPLOYMENT TRENDS

	BUFFALO					ERIE COUNTY				
	POPULATION	TOTAL EMPLOYMENT	% UNEMPLOYMENT	BLUE COLLAR EMPLOYEES	WHITE COLLAR EMPLOYEES	POPULATION	TOTAL EMPLOYMENT	% UNEMPLOYMENT	BLUE COLLAR EMPLOYEES	WHITE COLLAR EMPLOYEES
1950	580,132	232,371	6.7	132,726	93,626	899,238	350,011	5.7	199,025	142,505
1960	532,759	198,285	8.5	105,626	77,929	1,064,688	389,062	6.7	195,210	170,472
1970	462,768	171,880	6.0	97,266	72,852	1,113,491	422,179	4.7	214,122	204,998
1980	357,002	187,467		80,003	107,464	1,013,373	403,148		185,863	217,285

SOURCE: U.S. Census, Population and Housing, 1970.
Erie and Niagara Counties Regional Planning Board, 1975.



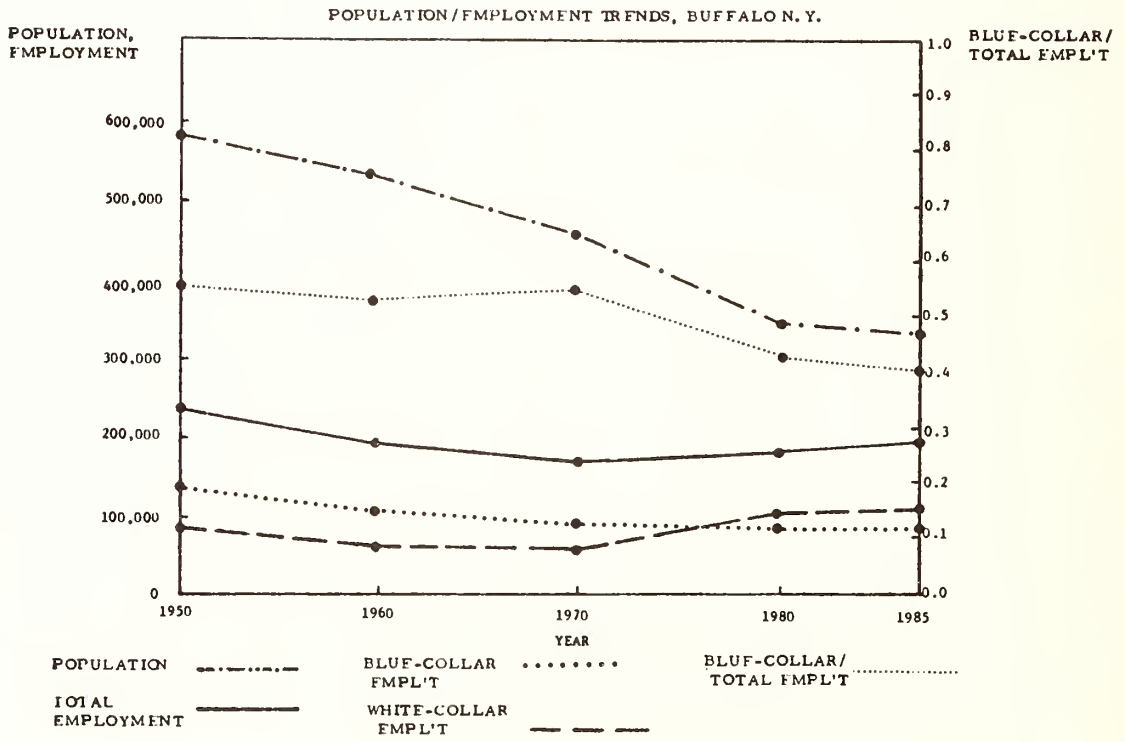
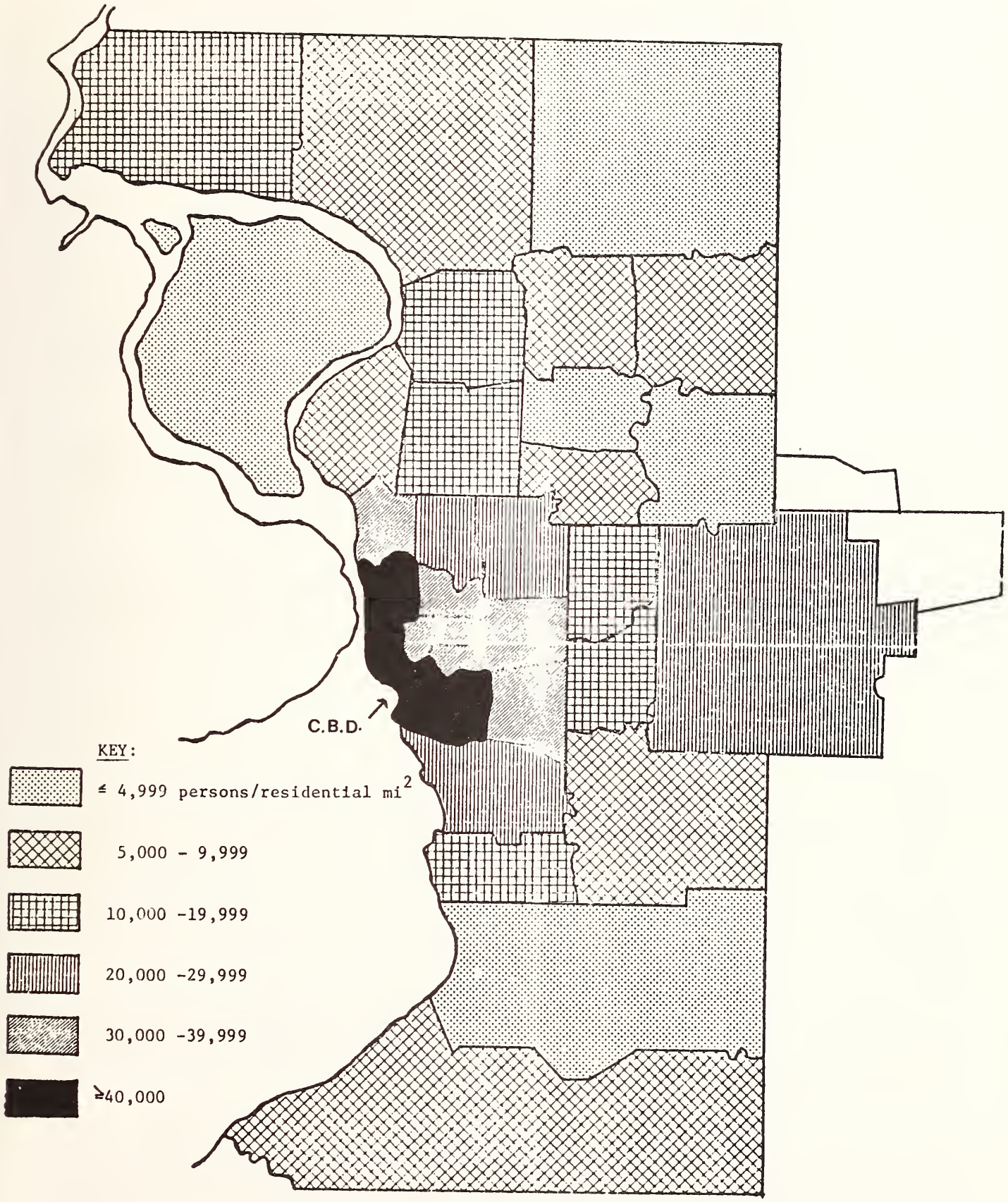


FIGURE 3.1: POPULATION/EMPLOYMENT TRENDS--BUFFALO, ERIE COUNTY



POPULATION DENSITIES - RESIDENTIAL LAND ONLY (persons/residential mi^2)
BUFFALO, N.Y. STUDY AREA, 1972

FIGURE 3.2

NUMBER OF BUSINESS FIRMS IN CITY OF BUFFALO*

	1972	1976	Net Decline
Total Business & Professional	14,925	12,716	2,209
Total Manufacturing	1,034	888	146
Durable	537	488	49
Non Durable	479	400	79

*R.L. Polk Data 1972 & 1976

The results of a Greater Buffalo Development Foundation Study (3.1) of a sample of U.S. cities of similar size show Buffalo's CBD share of city employment in 1970 to be higher than any of the sample geographic averages. Buffalo also has the highest CBD/SMSA shares of employment (compared to the average of similar sized areas).

Buffalo's CBD is thus a large source of area employment. The CBD had 38,065 employees in 1970, the most highly concentrated area of employment in the SMSA. Employment in the CBD in 1977/78 was estimated to be 55,000--60,000. (3.2). While employment was declining in the region, there was a net gain in the CBD.

Between 1960 and 1970 service sector employment increased 37% nationally. During this time period comparable service employment increases of 31.8% in the Buffalo SMSA and 30.7% in the city of Buffalo occurred while city employment as a whole shrunk 18%.

3.3 Women in the Labor Force

In the last 25 years, participation in the work force has greatly increased for women in the 25-54 age range. Nationwide, fifty-five percent of women in this age category are now in the labor force. However, today's women remained clustered in the same industries and occupations (primarily service and retail) as women of 35 years ago. In 1978, women constituted 52% of the Buffalo area population, increasing slightly over 1970 and 1975. It has been estimated that 228,000 women are now in the labor force in the two-county SMSA, increasing by 15% over 1970. This constitutes 40% of the total area labor force, comparing with 37% in 1970. This follows the national trend of the past 10 years. A decade ago women constituted one-third of the nation's labor force. This has now increased to nearly fifty percent.

One conclusion arising out of a shifting labor pattern as has been experienced in Buffalo, is that the distribution of personal income within the region is changing. Over time, total household income will change as individual increments become larger, and as additional individuals contribute to the household.

As total regional income increases due to increasing household income, the amount of retail sales shall increase in proportion. As the predominant retail shopper is the female head (or co-head) of a household, additional funds for retail will be spent by these women in the labor force. Because

of new time constraints in households where both heads work assessing the costs and times of travel for shopping will be more critical than it has been in the past. One method of minimizing such costs is by shopping near work. Thus, any system that facilitates retail shopping shall be of importance.

Finally, it should be noted that women constitute the greatest segment of transit riders (70.6% in 1975). Nearly thirty percent of the total daily transit use was in the Main Street Corridor. These facts illustrate the co-reinforcing nature of Light Rail in that corridor, increasing employment, especially as it attracts female wokers, and finally, the growth of peripheral activities that reduce the cost of household travel.

3.4 Transit Ridership

Figure 3.3 shows a history and projection of transit ridership in the Buffalo, N.Y. region. Based upon a 1975 survey by the Niagara Frontier Transportation Committee, the figure also notes what proportion of ridership can be expected in the Main Street Corridor. As discussed previously, the growth of employment in the CBD, coupled with the increase in women on the labor force, and the heavy use of transit by women all forecast a demand for the new LRRT system by the market segment.

Figure 3.3 shows there has been a transit decline in the region since 1968. However, projections, incorporating the above facts, have led the NFTA to assume increased ridership on the entire transit system with an increasingly leager share going to the Main Street Corridor (the light rail system). By 1990 it is expected that the Light Rail Rapid Transit System will serve approximately 80,000-100,000 passengers a day, with over one-half having their origin or destination on the CBD. If the transit system operates, as currently (1981) planned in the CBD, in a fare-free zone, there will be increased incentive for its use by the CBD population (primarily visitors and employees). This captive transit market serves as further incentive for developers to consider the economic opportunities available in the target area.

However, there are other factors that remain to be considered. The first is that transit's share of all trips in the region will remain (at least in the projected period 1985-1990) less than ten percent. Regional accessibility by car will remain high after the transit has been constructed.

Second, more than two-thirds of the population of the region will continue to live outside the Central City. Finally, noting the population constraints, the success of economic development projects linked to transit will rely on their uniqueness (i.e., ties to hotels, convention center, government business) or through demand created for space adjacent to the transit, and simultaneously to space in the CBD (service employment). Ancillary development will then grow based upon serving the needs of the CBD population, or serving the needs of those who find that transit offers a unique, and least-cost way of travelling to activities. In the CBD this will mean populations who take advantage of the fare free zone (lunch time shoppers, or theatre goes who travel to restaurants, etc.), or population drawn to downtown for specific purpsoes (tourists, hotel residents). If the CBD is to draw population from throughout the region who now carry out activities at non-CBD sites, it is possible that this will be done at the expense of those current sites. This prospect is developed more fully in the following sections of this chapter.

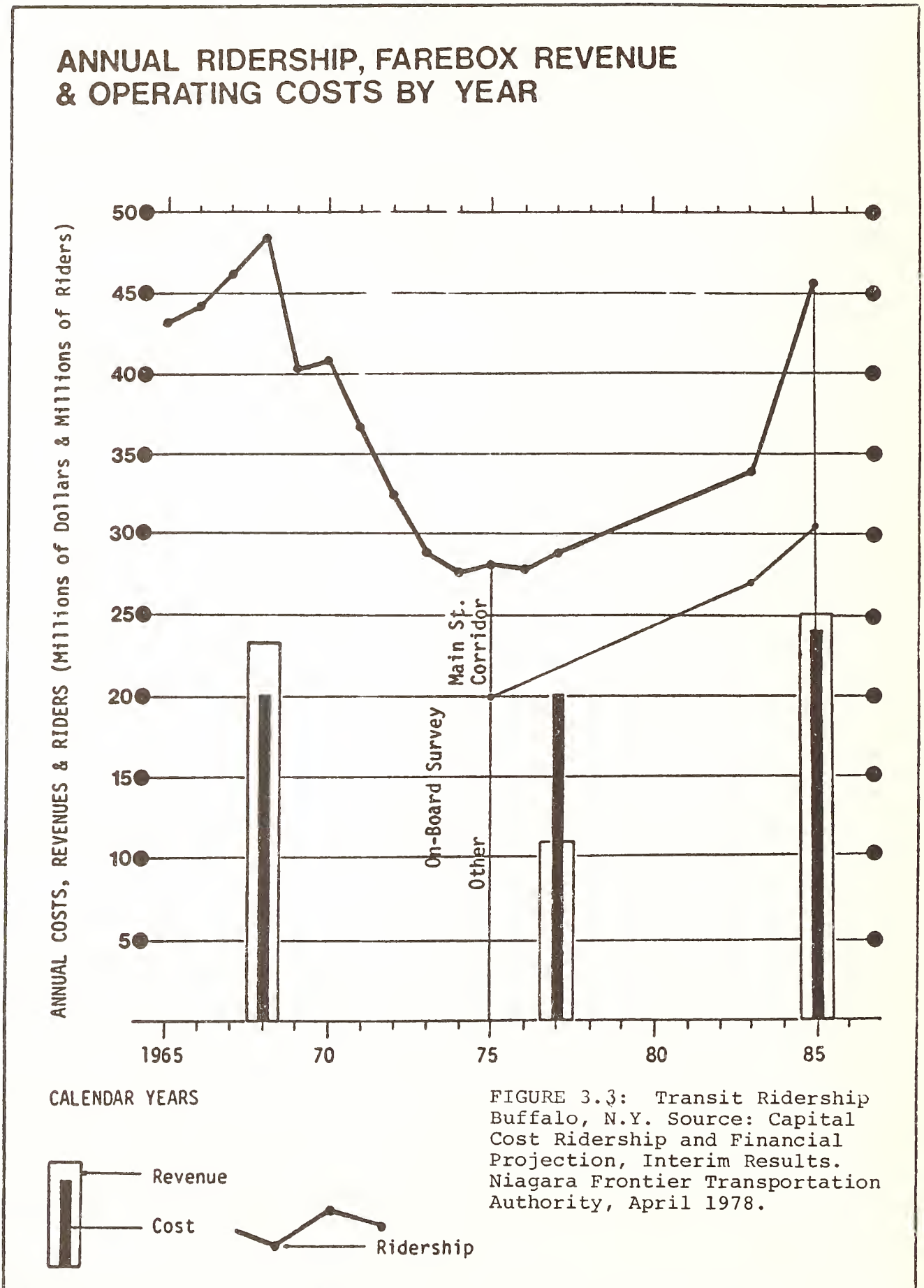


FIGURE 3.3: Transit Ridership Buffalo, N.Y. Source: Capital Cost Ridership and Financial Projection, Interim Results. Niagara Frontier Transportation Authority, April 1978.

3.5 Retail Patterns

As population and some sectors of employment has gone from Buffalo to the suburbs and beyond, so too has another economic sector which by nature is dependent on being located in proximity to the market (people): the retail industry. It was mentioned at the beginning of this chapter, that city and the CBD have historically enjoyed central roles with regard to retail and other economic activity, even though they have increasingly had to share their pre-eminence with the suburban areas over the decades. Over time, it can be seen how any new construction of retail centers has taken place at an increasing distance from the inner city area (Figure 3.4). It is also realized that the more recently a major shopping mall has been developed, the more it serves those who have access to a car. As Table 3.2 shows retail malls have increasingly become larger, both in terms of store space as well as parking spaces provided.

Even though the regional share of CBD retail sales has decreased over the years (Table 3.3), total absolute dollars of CBD retail sales have stabilized as seen in Table 3.4 below. On a per-capita city resident base, retail sales have increased in the CBD at an average annual rate of 3.9%. This is much less than the inflation rate in the period, indicating that a smaller percentage of true yearly regional income is being spent in the CBD now. The distribution of inner city retail areas is seen in Figure 3.5, while showing the area of impact which the system will create.

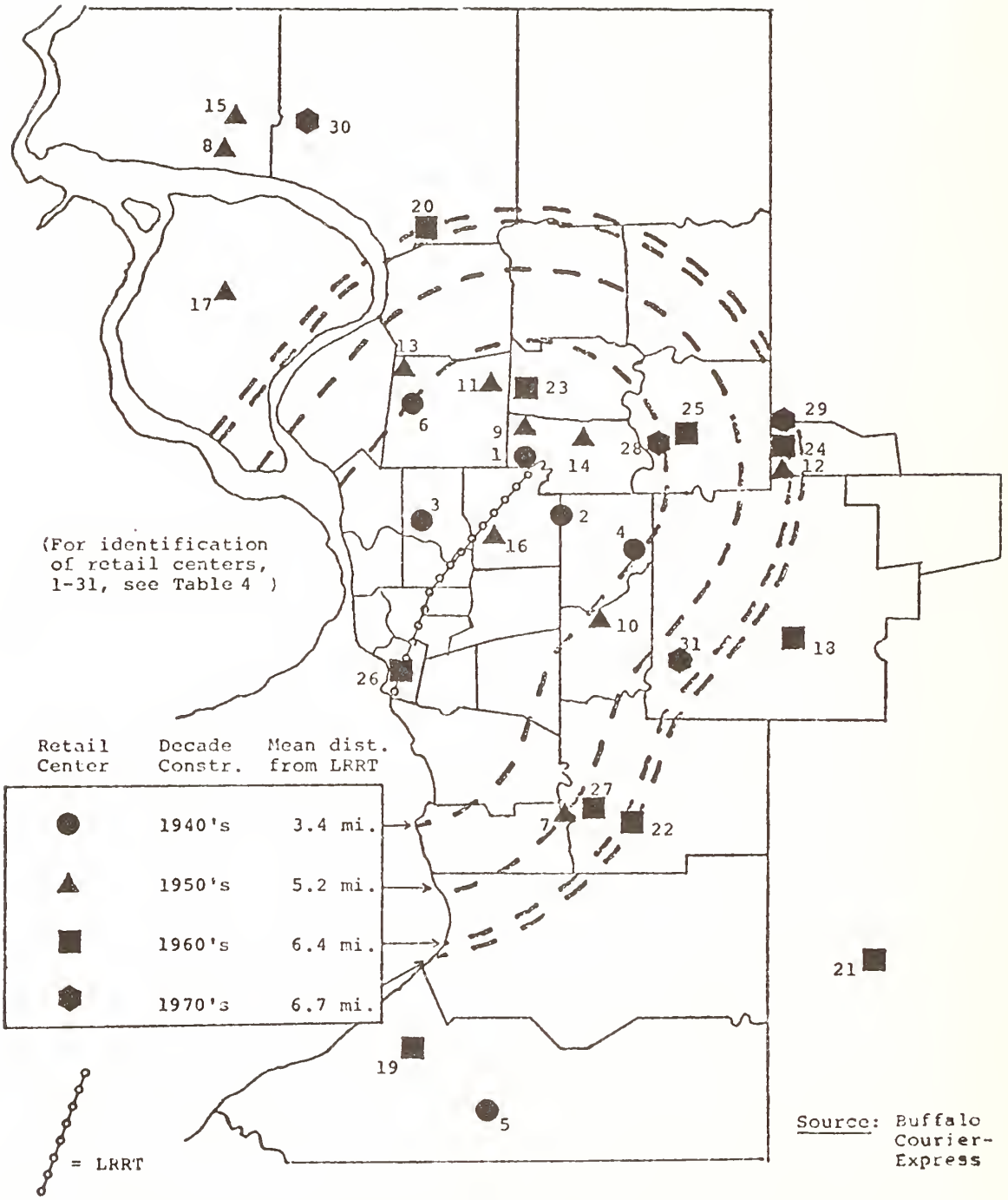
A movement towards stabilization, or, at least, a lessening of the outward movement of the retail industry would be an important step towards revitalization of Buffalo's inner city core area. The growth of office buildings, financial institutions, and related service facilities in the CBD in the past decade lends justification to current and planned efforts of re-investment in the city which are taking place, from public sources (e.g., the LRRT), as well as privately (e.g., hotels, restaurants).

The current spatial distribution of retail strength (sales, employment) an thus be seen in Figure 3.6 for the Buffalo region. As has been alluded to, the CBD zone had perhaps over the years lost much of its retail dominance to the suburban areas, but must still be considered as a major center of shopping activity, especially if designed as such in concert with the transit system.

3.6 Transportation Trends

One of the major factors which has made the suburbanization process occur more easily was the development of the highway system in the 1950's and 1960's. This was of course in response to the increased availability to the average American of an automobile and abundant, inexpensive fuel. Figure 1.2 (Chapter 1, p. 6) described the extent of (sub)urbanization in the Buffalo region together with the area's basic highway network.

The present public transportation bus network, the complement to the highway system, will be augmented by the LRRT line in 1985. Based on current and projected modal split figures presented in Table 3.5, as well as population and employment levels throughout the region, a predication of changes in overall accessibility which the LRRT is expected to generate has been made. These zonal accessibility measures were calculated for work trips and service trips.



MEAN DISTANCE FROM LRRT STATIONS OF MAJOR RETAIL CENTERS (CONSTRUCTED 1940's - 1970's), METROPOLITAN BUFFALO, NY

FIGURE 3.4

	Average Distance to Downtown (Niagara Sq)	Average Distance to Nearest LRRT Station	Average Distance to Nearest Highway	Average No. of Parking Spaces	Average Total Store Square Footage
1940's (6):	6.6	3.4	1.1	1,022	133,512
1950's (11):	8.5	5.2	0.7	1,519	223,018
1960's (10):	8.6	6.4	1.3	2,184	312,181
1970's (4):	10.2	6.7	1.7	3,321	529,844

TABLE 3.2 SEGMENTATION OF PLAZAS BY DECADE

	1954	1958	1963	1967	1972	1977
As a % of City Sales	27.1	25.3	22.9	17.8	15.1	13.1
% Change		- 6.6	- 9.5	-22.3	-15.2	-13.2
As a % of SMSA Sales	15.7	13.2	9.1	6.9	4.6	3.2
% Change		-15.9	-31.1	-24.2	-33.3	-30.4

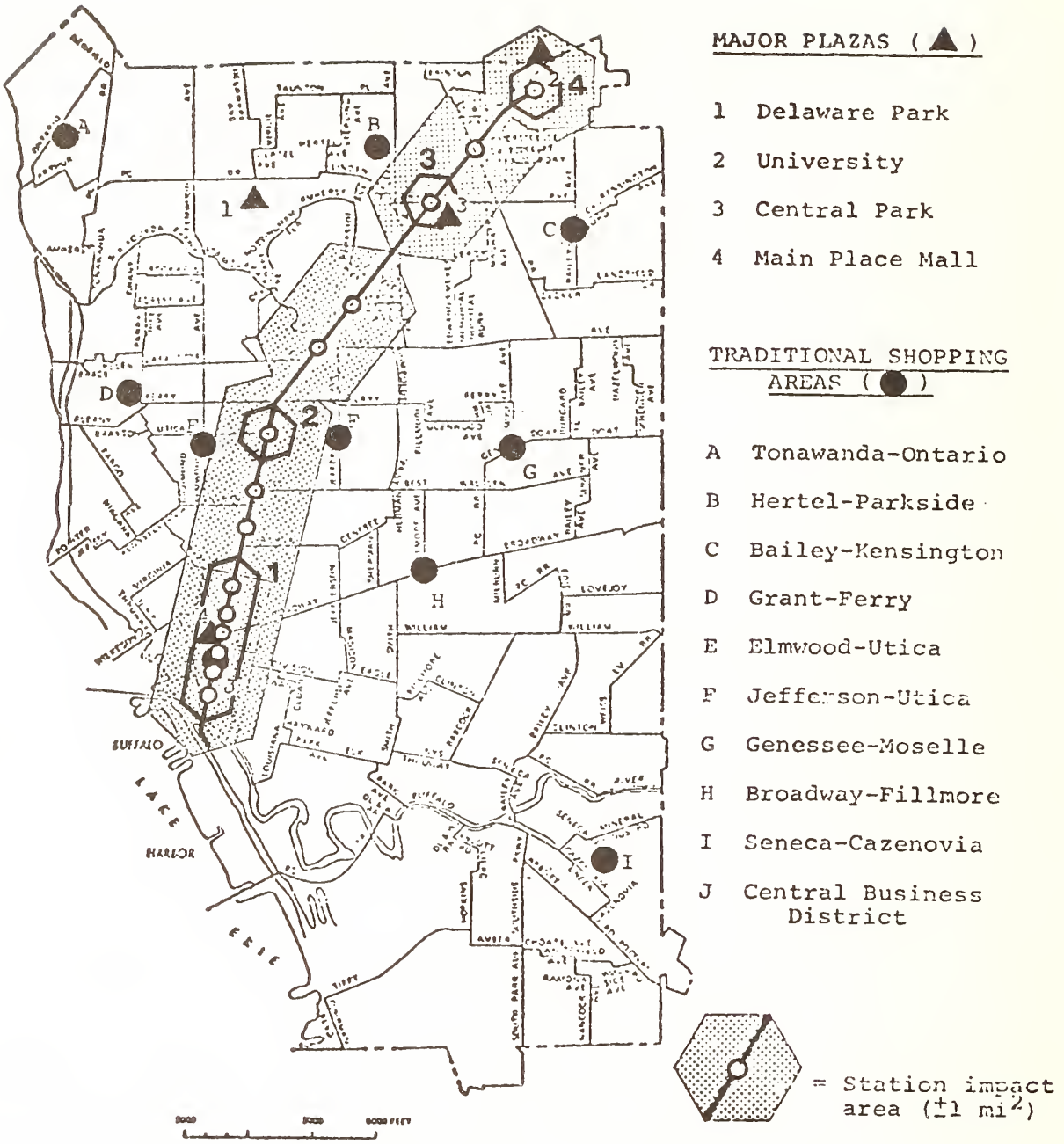
TABLE 3.3 CBD SALES AS A PERCENTAGE OF BUFFALO CITY SALES: SMSA SALES:

Sources: Buffalo Metropolitan Area Compendium of Market Data, 1977
1977 Census of Retail Trade

	1967	1972	1977
No of establishments	4,900	4,047	3,120
% Change		-17.4	-22.9
Sales	$795,905,000	$853,210,000	$935,451,000
% Change		+ 7.2	+ 9.6
No. of employees	28,428	26,921	23,217
% Change		- 5.3	-13.8

TABLE 3.4 RETAIL TRADE DATA - CITY OF BUFFALO

Sources: Buffalo Metropolitan Area Compendium of Market Data, 1977
1977 Census of Retail Trade



Prime locations for retail growth: **1** CBD stations

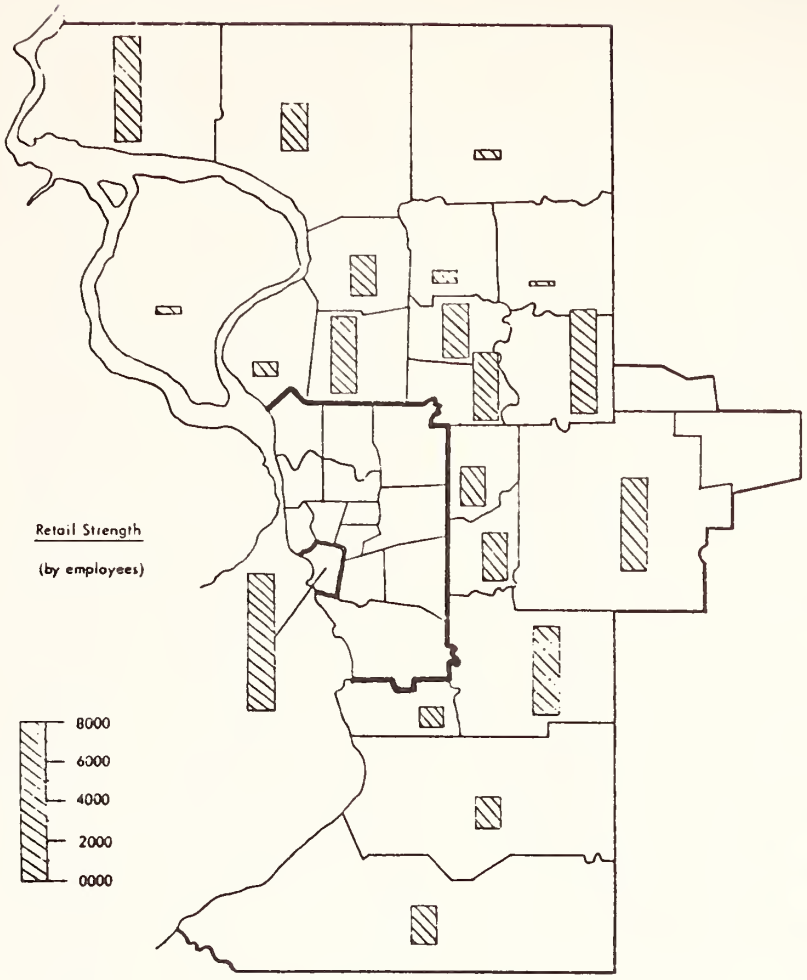
2 Utica station

3 Amherst station

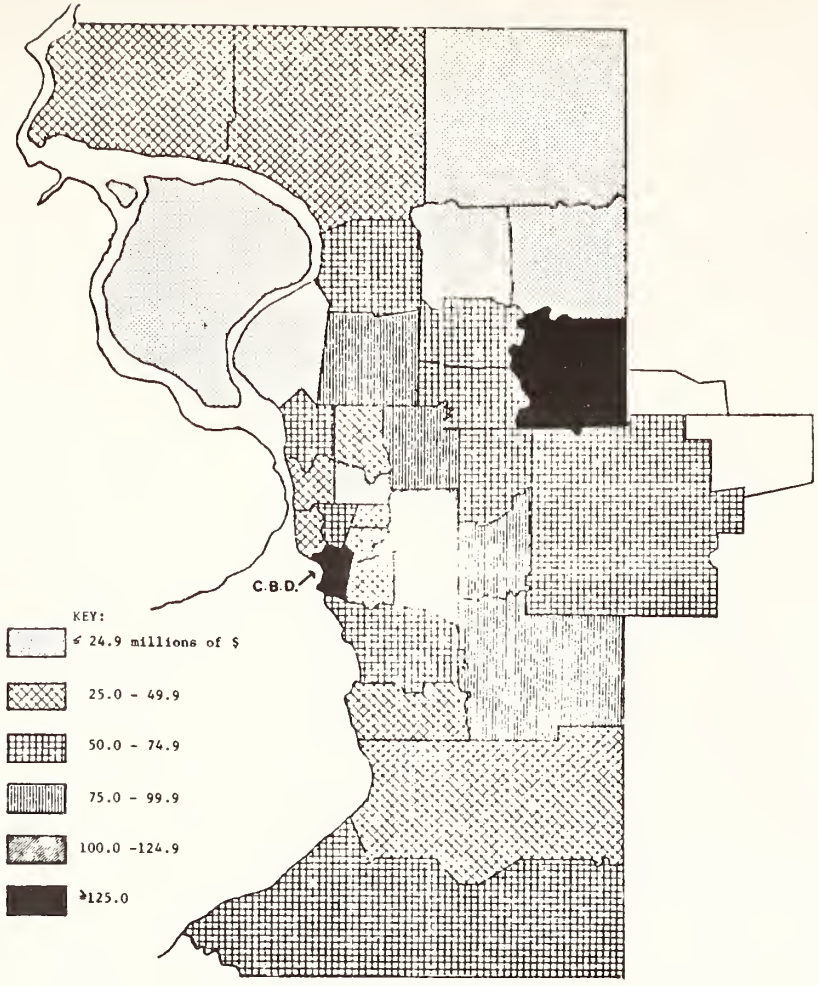
4 South Campus st'n.

FIGURE 3.5 : LRRT STATIONS WITH RETAIL GROWTH POTENTIAL

(Source: Buffalo Courier-Express
Urban Land Institute
Author's field work)



Joint Development Study Area - Retail Employees by Study Zone (1973)
(Source: 1985 SOCIO-ECONOMIC FORECASTS, NFTC, July, 1977)



ESTIMATED ANNUAL RETAIL SALES BY ZONE (MILLIONS OF $)
BUFFALO, NY STUDY AREA, 1979

FIGURE 3.6: RETAIL EMPLOYMENT AND RETAIL SALES IN THE BUFFALO REGION

Percent Transit (peak, off peak)	City	Suburban
	Per Cent	Per Cent
Present		
City	12 (5)	7 (4)
Suburban	7 (4)	6 (3)
1985 Estimate		
City	14 (7)	8 (5)
Suburban	8 (5)	7 (4)

TABLE 3.5

MODEL SPLIT: PERCENT TRANSIT USE
CITY, SUBURBS - PEAK, (OFF PEAK)

Accessibility is used in this study to designate the relative attractiveness of one part of the region to all other parts. The attractiveness is based upon the likelihood of a particular activity (work or non-work) being in a given region coupled with the ease of getting to that part of the region from all other parts. For example, for retail activities, the greater the amount of retail activity in a region, the more the accessibility would be enhanced. However, if travel time to that part of the region was, in general greater from all other parts of the region than, perhaps from a competing areas, the accessibility would be diminished. The formal (mathematical) presentation of accessibility is given in the next chapter.

Service trip accessibility measures based on the LRRT are shown for the region in Figure 3.7. Since it has already been determined that people wish to shop close to their homes these zones with a combination of high population levels and attractive retail areas were seen to gain the most in service accessibility (zones 9, 11, 12, 18, and 30). Although the CBD is a major retail center for the daytime downtown labor force, this area did not fare well in becoming more accessible for service trips due to the very low number of persons residing in zones 1 and 2. Any increase in service accessibility for the CBD would have to be predicated upon drawing from the daytime suburban shopping population. This can occur by making the downtown more attractive as a shopping area, and making the suburban shopper perceive the downtown district to be worth the effort of patronizing for shopping and other service activities.

Further, an analysis of overall accessibility by automobile and transit to certain major retail centers in the Buffalo region supports the earlier findings that travel time alone is not the best determinant of the area residents' perferences for shopping location (3.4). Although people do try to minimize their travel costs (time, effort and money (fare)), it is seen that the size and attractiveness of the retail center is by far the most important determinant for shopping location.

Table 3.6 lists seven major shopping centers in Buffalo region - the first three located in the city, the last four in the suburbs - and the associated number of households accessible to each center by auto and by transit within specified travel time intervals (5, 10, 20, and 30 minutes). From this figure it is seen how the city shopping areas are accessible to more people than are the suburban centers within the same travel time limits particularly for transit riders as the transit network is far more extensive in the city than in the suburbs.

The actual relative strength of each retail center, however, is not consistent with the overall accessibility levels. Figure 3.8 (combined with Table 3.6) shows how the strongest shopping mall (based on total retail sales), is the least accessible with respect to numbers of households. This suburban center is accessible to only about one-half as many auto drivers as are the CBD and Central Park shopping areas, for instance, but is 1.5 and 15 times stronger than these two city retail centers, respectively. Conversely, one of the more accessible plazas, Central Park, is the weakest in terms of retail sales.

Therefore, as mentioned above, other factors of size, safety, and overall attractiveness come into play in determining retail patronage. Table 3.6 parallels the data just presented by describing the overall retail characteristics of each study zone.

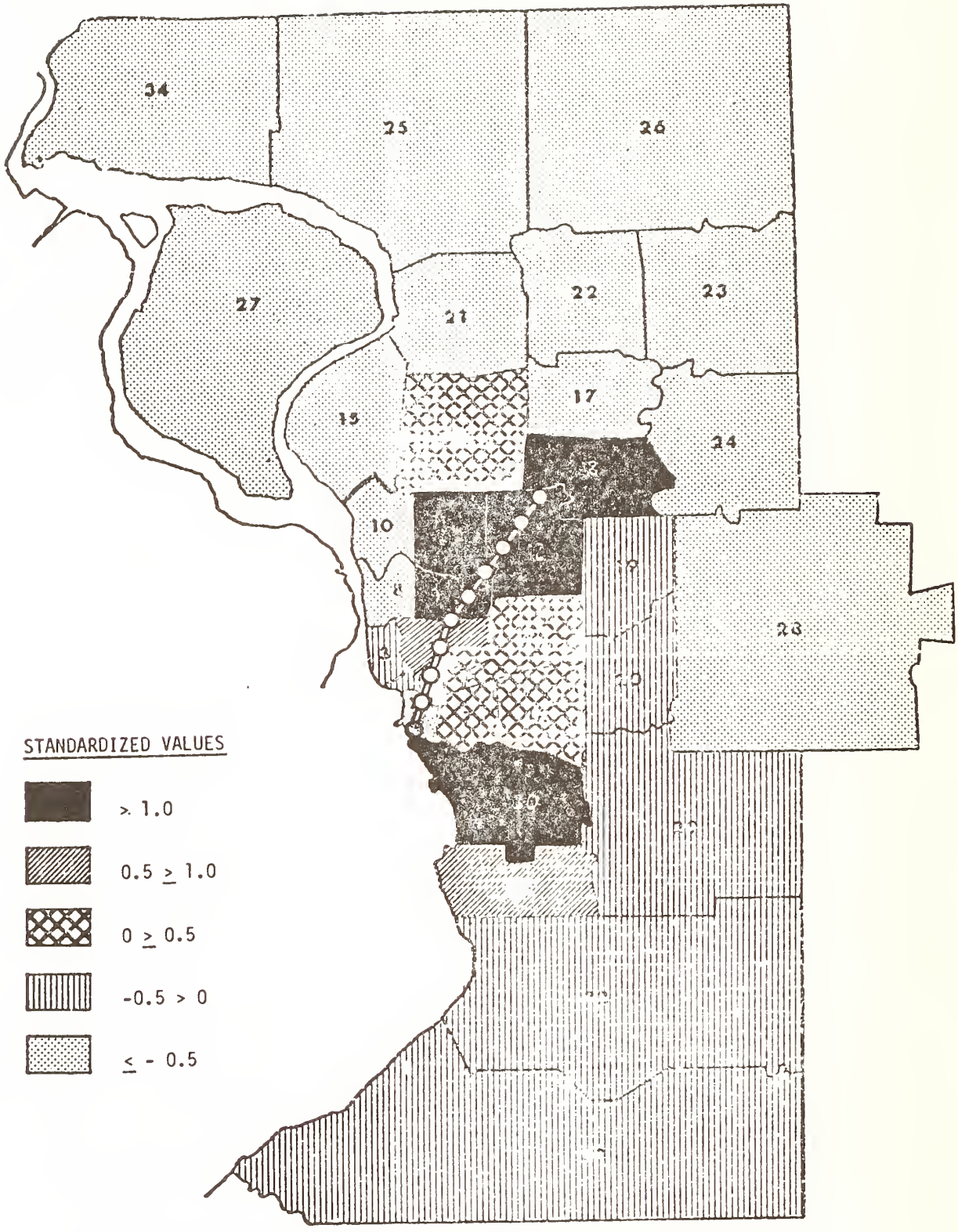


FIGURE 3.7 : CHANGES IN SERVICE TRIP ACCESSIBILITY
JOINT DEVELOPMENT STUDY AREA, BUFFALO, N.Y.

TABLE 3.6

HOUSEHOLDS ACCESSIBLE TO MAJOR RETAIL AREAS OF AUTO AND TRANSIT

Retail Area	Households Accessible by Car — Time (minutes)				Households Accessible by Transit — Time (minutes)				Ratio: H.H. (Car) / H.H. (Bus)			
	5	10	20	30	5	10	20	30	5	10	20	30
1. CBD	50,156	120,228	234,974	284,355	3853	30,684	91,696	174,253	13.0	3.9	2.6	1.6
2. Central Park	55,862	137,542	275,406	325,161	7136	33,922	76,942	107.987	7.8	4.1	3.6	3.0
3. University Plaza	53,194	138,228	231,178	275,930	7148	28,928	103,038	131,538	7.4	4.8	2.2	2.1
4. Boulevard	16,396	46,239	117,593	155,058	5870	20,501	60,209	79,979	2.8	2.3	2.0	1.9
5. Eastern Hills	12,144	39,175	128,569	148,463	2173	7,944	16,256	17,755	5.6	4.9	7.9	8.4
6. Thruway	55,591	126,809	291,490	339,106	4569	14,407	31,003	38,480	12.1	8.8	9.4	8.8
7. Seneca	39,777	91,761	214,412	299,473	4393	4,842	9,913	14,172	9.1	19.0	21.6	21.1

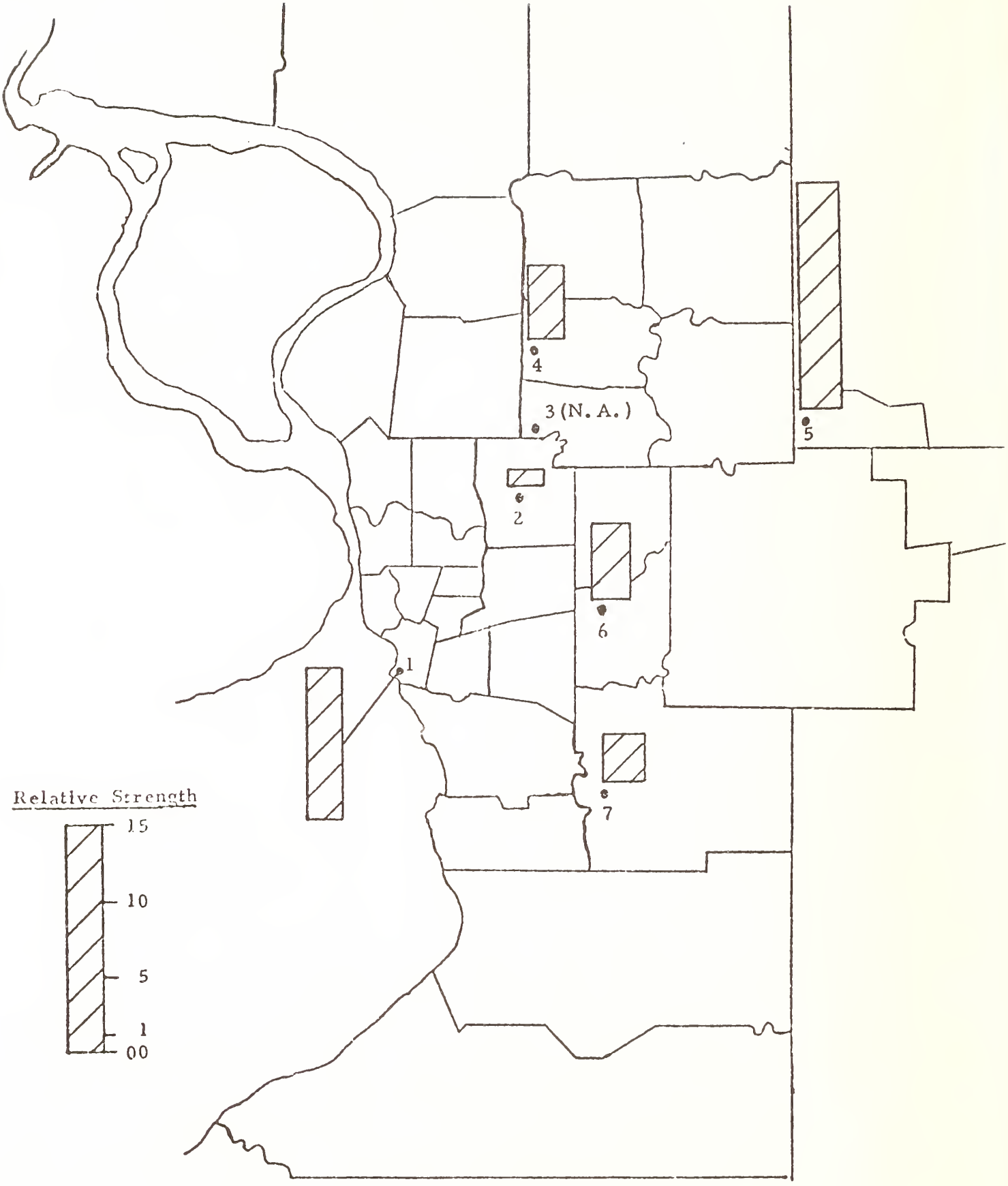


FIGURE 3.8

Relative Retail Strengths - Major Shopping Malls, Buffalo, N. Y.
(based on total retail sales per mall)

Table 3.7

RETAIL DATA FOR ZONAL ANALYSIS

Super Zone	No. of retail establishments	Total square ft. retail space in zone	Total retail employees in zone 1	Total retail sales in zone
1	268	956,000	5,389	
2	187	238,000	1,347	
CBD	455	1,194,000	6,736	125,827,000
3	165	209,550	877	33,330,000
4	326	414,020	1,735	65,852,000
5	131	166,370	705	26,462,000
6	132	167,640	705	26,664,000
7	173	219,710	915	34,946,000
8	225	285,750	1,201	45,450,000
9	107	135,890	572	21,614,000
10	328	416,560	1,754	66,256,000
11	230	292,100	1,220	46,460,000
12	425	539,750	2,250	85,850,000
13	565	717,550	3,012	114,130,000
14	503	638,810	2,669	101,610,000
30	268	340,360	1,430	54,136,000
Buf. sub Total	3,578	4,544,060	19,042	722,760,000
Buf. Total with CBD	4,033	5,738,060	25,778	848,587,000
15	62	155,000	424	20,912,538
16	478	1,553,035	4,253	78,620,000
17	159	1,215,529	2,011	68,826,545
18	188	989,744	1,638	69,077,455
19	246	1,808,100	2,235	68,837,838
20	242	1,831,000	2,235	95,621,622
21	176	655,787	2,388	50,146,368
22	40	183,640	2,326	14,026,600
23	20	91,820	303	7,013,300
24	368	2,715,623	8,091	184,230,000
25	117	437,191	2,326	36,959,364
26	9	41,319	69	6,391,950
27	50	220,700	300	20,000,000
28	448	2,401,840	5,280	70,325,000
29	309	2,047,755	4,480	75,656,000
31	345	1,205,625	1,300	42,243,000
32	127	498,800	1,183	30,756,000
33	169	955,230	2,297	56,484,000
34	793	2,570,550	5,020	176,998,000
Total Minus Buffalo	4346	21,578,288	45,989	1,173,125,580
Total With Buffalo	8379	27,243,848	71,767	2,021,712,580

1. By place of employment

Finally, it is important to reiterate one crucial fact. Current land use patterns, in particular retail locations, have occured because of highway planning decisions made as early as the 1960's. These decisions have actually accomplished the original planning objectives - reduction of travel time by car in the region. The impact of the transit system must be evaluated knowing the momentum of development generated by the highway system.

3.7 The Pie Theory

In any metropolitan area, the CBD has a certain share, or "piece of the pie", of the total area retail and service market. There are obviously variations from one SMSA to another with respect to the size of this share, but in the aggregate, since the early years of this century, the CBD retail share has declined steadily as the suburbanization process flourished, even up to the present. For instance in the early 1920's, the average CBD in the U.S. accounted for approximately 90% of an SMSA's total retail activity. In 1977, Buffalo's CBD retail sales share was 3.2% of the entire SMSA total.

In this "pie" theory, it is seen that an area's regional income (I) can be estimated to be equal to the area population (P) multiplied by a constant (K_1) for per capita income. Thus, for the Buffalo SMSA in 1979:

$$I_{SMSA} = P_{SMSA} \times K_{1SMSA}$$

$$I_{SMSA} = 1,278,800 \text{ persons} \times \$6,188/\text{person}$$

$$I_{SMSA} = \$7,913,031,714$$

(The constant, K_{1SMSA}, is here determined by dividing the SMSA effective buying income* per household with 2.8 persons per household, an average for the Buffalo region).

For the City of Buffalo, 1979:

$$I_{CITY} = P_{CITY} \times K_{1CITY}$$

$$I_{CITY} = 357,002 \text{ persons} \times \$5,492/\text{person}$$

$$I_{CITY} = \$1,960,654,984$$

(The constant, K_{1CITY}, is here determined by dividing the city effective buying income* per household with 2.5 persons per household, a city average).

$$I_{CITY} \div I_{SMSA} = 25\%$$

* Effective buying income (EBI) - personal income - personal taxes.
(Source: S&MM Magazine - Survey of Buying Power, Data Service, 1980)

In addition, retail expenditures (RE) in the region can be calculated by multiplying the area's total income (I) with a constant (K_2) for a "propensity to retail-consume". Since lower income families tend to spend proportionately more on retail purchases than do intermediate or higher income families*, the propensities to consume are different for the Buffalo SMSA and CBD according to the respective areas' breakdown of population income levels. For the Buffalo SMSA in 1979:

$$RE_{SMSA} = I_{SMSA} \times K_{2SMSA}$$

$$RE_{SMSA} = \$7,913,031,714 \times 0.37$$

$$RE_{SMSA} = \$2,927,821,734$$

For the City of Buffalo in 1979:

$$RE_{CITY} = I_{CITY} \times K_{2CITY}$$

$$RE_{CITY} = \$1,960,654,948 \times 0.45$$

$$RE_{CITY} = \$882,294,743$$

$$RE_{CITY} \quad RE_{SMSA} = 30\%$$

From this it is seen that RE can be directly acquired by multiplying the area population (P) by the product of the associated constrants ($K_1 \times K_2 = K_3$). Since an area's I and RE depend on its P, if the inner city's P^2 decreases over time, as has occurred in Buffalo and in other northeastern U.S. cities, then its inner city retail expenditures will decrease proportinately. In addition, since most people shop close to their homes and the inner city and CBD shares of the total SMSA retail market will decrease commensurately, with the areas of increasing population - the suburbs - gaining a larger portion of the total retail pie.

If the entire area's population structure were to stabilize (as may be evidenced in the Buffalo SMSA), then the retail shares would be constant. In order to attempt to reverse this decreasing city trend, or to help in stabilizing it, subsidized investments in the inner city area and CBD would need to take place.

*(S&MM magazine - Survey of Buying Power, Data Services, 1980)

What would then have a bearing on any increases in an area's population - retail expenditures, would be investments in the area coming from outside the region, e.g., in Buffalo, the LRRT system (or through intra-regional shifts in investments). Through this public investment, acting as a catalyst, or "leverage", for further public and private investment efforts, as well as through its associated multiplier characteristics, it is seen how the CBD and the rest of the transit impact area could experience growth in economic (and retail) activity, i.e., its relative share of the pie would increase, as well as its absolute share, given that the area outside the city would not experience similar investment increases and impacts.

To try to visualize any potential for CBD - inner city redevelopment, it is necessary to place the precise trends which have taken place with respect to population and employment levels, city - suburb interaction in full context.

3.8 CBD Vitality

This chapter has given a summary of the various population, employment, retail and transportation trends which have played such an important role in shaping the Buffalo metropolitan region, economically and physically, over the past three decades. Whereas development policies in the 1950's placed great emphasis on the values of suburbanization and high mobility, by the late 1960's and early 1970's, policymakers began to realize that a solution must be found for the problems of urban decline in the inner cities, with their relatively poor population. The latest approach to the problem is to formulate inner-city development policies, in the belief that (a) economic decline can be stabilized, or even reversed, (b) that a more affluent population can again be attracted to such areas; and (c) that the inner cities can recapture a large share of the region's overall economy.

Current urban (re)development policies, combined with the established framework of existing conditions and trends in Buffalo, thus presents a certain level of development potential for the city and region. Associated with this outlook must also be the general mood of the local population, i.e., those in a position to encourage and effect the necessary efforts toward economic and social growth.

It has been clearly shown that the regional economic growth is limited by the major population and employment shifts that have taken place over the last two decades. The transit investment in Buffalo has not been one that will provide a major change in regional accessibility. What will be changed by the investment are perceptions of travel, quality and land uses that can gain from the transit investment. The recent gain in service employment, that naturally creates demand for CBD space, generates a natural demand for improved transit capacity. The linking of transit and employment, taken together with an increase in the number of women in the work force have the potential to generate new retail shopping patterns.

But the CBD has not had a major share of retail in the region for the past thirty years. Referring back to the pie theory, the reduction in regional employment and population put real constraints on the share of regional income available for retail activity. It becomes evident that competing

development (Chapter 2) can cause stresses in the CBD development making its long term regeneration difficult. Atlanta, has recently gone through a decline in CBD activity that was coupled with suburban expansion of retail aimed at the upper-middle to higher income brackets.

3.9 Summary

It becomes apparent that joint public and private development can only have real impact if accompanied by appropriate reinforcing policies. Investment in public transportation projects may afford powerful leverage in arresting and reversing the economic decline and may also be used to influence the growth of specific areas within the region, most importantly the CBD. The development of the Buffalo LRRT System thus provides a good illustration of the joint development concept, especially since there are factors that make public investment in this system beneficial to the area:

1. There is renewed and sustained interest in making the CBD a focal point of employment in the region. Employment in the CBD has increased substantially in the last decade, keeping pace with the increase in service and government employment increases in the region. Developers have responded to this trend in construction of new office and hotel space.

2. Second, even with the growth and proliferation of suburban malls, the CBD is a major retail center. As described earlier, retail sales in the CBD as a percentage of retail sales in the SMSA have been declining. Several conditions, associated with development of the LRRT, can stabilize the decline. These include increased retail activity by the daytime population, increased non-retail activities to act as pulls to the area, and unique amenities generated by the transit e.g., a pedestrian mall and a fare free transit zone.

CHAPTER 4

METHODOLOGY AND TECHNIQUES OF ANALYSIS

4.1 Scope and Overview

The methodological framework of the overall joint-development analysis was diagramatically depicted in Chapter 1, Figure 1.1. The set of impacts of the LRRT project was allocated for analytical purposes to four categories. These were: economic, transportation, land-use and shopping. To analyze these impacts several types of models and complementary techniques have been developed. The purpose of this chapter is to introduce these models in their analytical structure, mode of operation and other technical aspects, including calibration, estimation and convergence. In the subsequent chapter the empirical results of these models will be presented and their implications regarding the overall impacts of the LRRT and for the joint-development problem will be discussed in the context of the entire study.

To some extent the above division of impacts into categories is arbitrary and artifical as impacts take place simultaneously, are interrelated and often can be equally classified into more than one category. Since the development and use of these models is for the purpose of evaluating the overall effect of the LRRT system on the downtown area of Buffalo, New York the models are in part specific, i.e., they are designed to evaluate a given set of LRRT impacts. It follows, therefore, that there is also a certain amount of flexibility in the specification and estimation of these models. For example, the shopping model is mainly concerned with the estimation of the effect of the introduction of the LRRT system on downtown shopping, and not with the modelling of consumers' shopping behavior in general. Retail attractiveness variables and travel related variables are included in that model. The land use model, because of its special nature, evaluates more than one impact type. In this analysis three impacts which were directly attributed to the LRRT system were examined. Non-downtown impacts were not examined.

To provide a common basis for the empirical analysis of these models, the entire Buffalo metropolitan area was subdivided into 34 zones. The input information pertinent to each of the models was organized on the basis of this common zonal division. Similarly the output of each model is expressed in terms of those 34 zones or, when necessary, their aggregation, thus enabling direct comparisons of zonal impacts.

4.2 Model Description

4.2.1 Accessibility Model (ACCESS) - A fundamental hypothesis regarding the introductin of any new transit system is that it will alter accessibility areawide and more profoundly in areas which it interconnects.

The purpose of this model is to measure the change in total accessibility within the Buffalo area, by zones, and especially to the CBD, due to the introduction of the LRRT system. Following conventional approach, accessibility is defined here as a combination of interzonal travel time and zonal activity levels. Moreover, in order to provide more insight, accessibility was divided into service and work type accessibility. As these two

trip types occur at different times as peak demand (rush-hour) and off peak travel times, trip data by mode, and time of day (i.e., peak, off peak) were used for computing change in total accessibility per zone.

The model (ACCESS) is a deriviative of Davidson's (4.1) accessibility model. Its major equations are given below. Total accessibility of a zone, x_i, is assumed:

$$X_i = X_i^I + X_i^C + X_i^T \qquad (1)$$

where

X_i^I = intrazonal accessibility of zone i.

X_i^T = interzonal accessibility of zone i by transit.

X_i^C = interzonal accessibility of zone i by auto.

If $X_i^{(1)}$ = Accessibility before LRRT and $X_i^{(2)}$ = Accessibility after LRRT, then change in total accessibility for service purpose ΔS is (for zone i)

$$\Delta S = \frac{1}{\gamma} O_i \ln \frac{X_i^{(1)}}{X_i^{(2)}} \text{ for every } i,\ i = 1, \ldots, N \qquad (2)$$

where O_i = number of households in zone i (H_i), times their trip rate (h), i.e., $O_i = H_i h_j$ γ = impedance parameter for interzonal shopping trips. For work purposes changes in total accessibility, ΔW, is (for zone i)

$$\Delta W = \frac{1}{\gamma} D_i \ln \frac{X_i^{(1)}}{X_i^{(2)}} \qquad (3)$$

where D_i = number of employees in zone i (E_i), times their trip rate (e), i.e., $D_i = E_i e$. λ = impedance parameter for interzonal work trips. Total summation over all zone at (2) and (3), will give total change in service and work accessibility, due to LRRT, areawide.

The input data needed for the accessibility model consists of current data to measure current data (pre LRRT) accessibility, $X_i^{(1)}$, and post LRRT data, to measure new accessibility, $X_i^{(2)}$. The specific data categories are listed below.

4.3 Pre LRRT input data

1. Inter and intrazonal travel times matrices (in minutes) by public transit and auto. Peak and off-peak.

2. Value of parameter auto-transit modal split.

3. Value of impedance parameters for work and shopping trips.

4. Service trip rates by households.

5. Number of employees/zone and trips/employee.

6. Level of activity for each zone, including number of employees/retail e.g., footage; floor space, retail sales. (These variables are described in Appendix B).

4.4 Post LRRT input data

1. New Bus Times (intra and interzonal). These were obtained from the NFTA, 1985 Preferred Feeder Bus Network Report.

2. LRRT Times (intra and interzonal) down the Main Street Corridor. These will have a selective effect on the zones adjacent to the system.

3. Auto time changes (inter and intrazonal).

4. New (1985) Retail Employment Figures.

5. New (1985) trip rates/employee, from NYS/DOT forecasts.

6. New (1985) households distribution, from NYS/DOT forecasts.

7. New (1985) trip rates/household, from NYS/DOT forecasts.

8. New (1985) parameter for mode split auto, bus, rail.

9. New (1985) impedance parameters for work and service trips. These were obtained from NYS/DOT forecasts.

In terms of impact on total accessibility changes per zone, travel time, transit and auto, are of greatest importance. Diagram 1 below summarizes the type of travel time matrices used in the analysis. Network assignment data were used to form the auto peak and off peak travel time matrices. Niagara Frontier Transportation Authority (NFTA) publications were used as sources of data on transit peak off-peak travel times.

4.4.1 A shopping probability model - One major indicator of the impact of transit investment, especially in the CBD area, is the level of retail activity. That is, it is expected that the construction of a LRRT system connecting the city fringe with the downtown will enhance shopping in that area. To evaluate these impacts of the transit system it was necessary to develop and calibrate a model which simulates individuals' propensity (or probability) to shop at a given shopping facility given their socio-economic characteristics, the set of all retail facilities and their physical and economic attributes. Afterwards, exogenous changes in the explanatory variables such as reduced travel times or increase in retail floor space, attributed to the LRRT investment will be introduced to capture their effect on the simulated shopping behavior.

Diagram 1: TRAVEL TIME MATRICES USED IN ACCESS

	BEFORE LRRT	
	AUTO	TRANSIT
SERVICE	OFF PEAK	OFF PEAK
WORK	PEAK	PEAK
	AFTER LRRT	
	AUTO	TRANSIT
SERVICE	OFF PEAK	OFF PEAK
WORK	PEAK	PEAK

ATOP = Auto Off

A principal problem with the modeling of individual retail behavior is the availability of individual specific choice (of retail outlet) data base. There is extensive literature on this subject and the use of disaggregate techniques when such a data base is available. Because for this project such a data base was not available, it was impossible to use disaggregate methods (such as a multi-nomial logit model) to compute the choice probabilities, and another modeling approach was consequently pursued.

An underlying assumption in this model is that trip frequency to a given shopping facility represents individual choice probability of that facility, given all other available retail outlets. Another assumption is that all individuals have a common set of classes of choice sets for the shopping purpose.

Three major determinants of retail trip frequency have been identified for analysis. They are:

1. Socio-economic attributes of the individual including income, car availability, household size.

2. Attractiveness of the retail center (see below) (such as, variety of goods and services, safety, etc.)

3. Accessibility to the center, mainly travel time.

It is assumed that specific variables serve as surrogates for attractiveness. These include floor space, number of employees, and dollar value of retail sales. Letting s denote the location of individual i then it is hypothesized:

$$V_{sr}^{i} = f(H_{sk}^{i}, A_{r}, L_{sr}^{i}) \qquad (4)$$

Where v_{sr}^{i} = number of trips by i (i = 1,...,N), located at s, (s = 1,...,S), to shopping facility, r (r = 1,...,R).

H_{sk}^{i} = a vector of k socio-economic attributes associated with individual i located at s.

A_{r} = the attractiveness of center r

L_{sr}^{i} = a measure of accessibility from s to r

f = some functional relationship.

As explained above, it is possible to develop explicit disaggregate choice models for the implicit model, if appropriate data are available. In particular one needs data on V, indicating individual i located at s, trip preferences (thus choices) among all r facilities. The data available were deficient in that regard, as only information on trip frequencies to r, by categories of individuals by their location (see below), were available. Thus, the following explicit model was used:

$$v_{sr}^{i} = q v_{s}^{i} (H_{sk}^{i})^{\alpha_k} (A_t)^{\beta} \exp(-\gamma L_{sr}^{i}) \qquad (5)$$

where the index i now represents a category of individuals located in one of the following four subarea: CBD, inner city (but not CBD), suburb and a zone containing outlying areas. The constant q to ensure that

$$\sum_{r} v_{sr}^{i} = v_{s}^{i}$$

V_{s}^{i} is the total number of trips made by category i at subarea s. The parameters α_k, β and γ are elasticity parameters (α_K associated with the Kth soci-economic attributed).

Formulation (5) is essentially a constrained gravity model. From (5) we have

$$\frac{v^i_{sr}}{v^i_s} = q\ (H^i_{sk})^{\alpha_k} (A_r)^{\beta}\ \exp(-\gamma L^i_{sr}) \qquad (6)$$

The left-hand side represents the proportions of total trips made to center r, which by definition is the probability that individuals of group i will shop at r, given location, the attractiveness of r and his socio-economic attributes.

For the purpose of applying linear regression techniques, we transform (6) to

$$\ln (P^i_r) = \ln q + \alpha_k \ln (H^i_{sk}) + \beta \ln (A_r) - \gamma L^i_{sr} \qquad (7)$$

where ln q, α_k, β, and γ are the parameters to be estimated. The specification of the variables is considered below.

4.4.2 Urban Activity Model (GLMOD) - This model is the most used in this study. In very general terms, the model simulates the distribution of population and employment in a metropolitan area and then, given some exogenous changes, predicts the consequences of these changes upon population, employment and land use distributions. As was explained at the outset it was hypothesized that the large investment in light rail transit will impact, in addition to travel patterns, land uses city wide. Thus, there was a need for a model which can simulate and evaluate changes in the land use system of the entire area.

The specific model used for this purpose is an iterative model of the Garin-Lowry (GLMOD) type. The description of the model is taken from Foot's (1978) paper. (4.2). Note that the computer program is also based on Foot's (1978) but a considerable number of changes had been made in it to meet the particular needs of this study.

The Garin-Lowry Model assumes that the main components in the structure of a subregion can be described in terms of population and employment and the interaction between them in both a spatial and a functional sense. The overall approach as well as this model have now been well documented (e.g., Cripps and Foot (1969), Batty (1972), Batty (1976)), and therefore only a brief description of the model is given.

The model is Garin's extension of the Lowry model (Garin (1966) and Lowry (1964)) and is essentially two gravity models, one for residential location and one for service location, coupled together through the economic base mechanism. The allocation of basic employment is assumed given and the households of these workers are allocated around basic workplaces by the residential submodel. Total population dependent on basic jobs in residential zones is found by application of a multiplier - the ratio of population to total employment. This population then generates a demand for services and consequently for service (locally dependent) employment. The demand for service employment is estimated by the application of a further multiplier - the ratio of service employment to population. Having estimated

demand in residential zones, service employment is then allocated to service centers with the aid of a second submodel. Employees in service locations also need to be housed, so they are returned to the residential location model and allocated to their place of residence. This whole procedure is then recycled until the system converges to equilibrium. In practice, after only few iterations, the increments of population and service employment become small enough that the remaining service employment can be immediately determined and allocated, and the model terminated.

The residential and service location submodels within the system can be any spatial interaction model, but are generally gravity models, or as they are sometimes called, entropy maximizing models (Wilson, 1970). The residential location model is of the form:

$$T_{in} = A_i E_i H_j \exp(-\gamma c_{ij}) \tag{8}$$

$$A_i = \{\sum_j H_j \exp(-\gamma c_{ij})\}^{-1} \tag{9}$$

where T_{ij} are the trips from work zone i to residence zone j, E_i is employment at work zone i to be located in the residence zones, H_j is the residential attractor for zone j, c_{ij} is some generalized cost of travel from zone i to zone j, exp is the exponential function and γ is a residential location parameter to be found at calibration. The service location model is of a very similar form:

$$S_{ij} = A_i E_i F_j \exp(-\mu c_{ij}) \tag{10}$$

$$A_i = \{\sum_j F_j \exp(-\mu c_{ij})\}^{-1} \tag{11}$$

where s_{ij} is the number of service employees demanded by the population of zone i who work in zone j. E_i is now service meployment demanded by the population of zone i to be located in service centers, F_j is the service center attractor for zone j, c_{ij} is some generalized cost of travel from zone i to zone j, exp is the exponential function and μ is a service center location parameter to be found at calibration.

Several important points about this model should be noted. First, with regard to activity type this model is a highly aggregated one. Households are not disaggregated by socio-economic characteristics while employment is categorized either as basic or service employment. While this feature of the model may be viewed as a major deficiency, it nevertheless facilitates computations. Because our major interest in this study is the overall impacts on the CBD of a transit investment we did not consider this as a major problem for the interpretation of our findings.

A second point to be noted is that this model is a static model because it does contain any time dependent variables. The internal iterations of the model are merely a solution procedure and do not represent any "real" changes. The spatial system is treated as if it is in static equilibrium. As noted by Foot (1978), because of this the model is most useful for impact analysis.

Conceptually the use of any model for impact analysis requires the performance of two distinct analytical stages, namely calibration and prediction. Since this model allows for the impositioning of lower and upperbound constraints on zonal activity level, there is an additional step in the process which is constraints procedure.

4.5 Calibration

The model is calibrated as a base year (generally the most recent year for which information is available) where the output from the model can be compared with the base year information. The comparison is made in order to find the best parameter values γ and μ on the transport cost functions in the spatial distribution models that reproduce the known situation. From initial estimates of the parameters, a Newton-Raphson technique searches iteratively for improved parameter values until eventually the equation system has been solved, with the estimated mean trip cost equal to the actual mean trip cost for journey to work, and journey to service.

4.6 Constraints Procedures

Any future allocation of population and employment could well be subject to constraints on the capacity of zones to accommodate the growth. The amount of land available for urban development will be determined either by the physical capacity of the zone of by planning policies, which might relate to social, political, economic and or environmental considerations.

Maximum and minimum capacity constraints can be imposed on the level of population and the level of service employment allowed.

4.7 Prediction

Once the model has been calibrated, the variables within the model can be altered in order to test the impact of major changes in the subregion and to simulate the outcome of public policy alternatives. The following exogenous changes were tested in this study.

a. Altering the distribution of basic employment to simulate economic policy alternatives.

b. Altering the location of new services and apply capacity constraints to simulate service center policy alternatives.

c. Altering constraints on zones for residential and service employment provision to simulate constrained planning policies, particularly environmental policies.

d. Altering the transportation network to simulate transport policy and observe how it affects the distribution of population and service employment.

e. Altering the parameter on the generalized cost function to simulate changes in accessibility in the region which might result from a change in transport policy.

f. Alter the multipliers to simulate the effect of changes in female employment rates, and the effect of a change in the overall level of services.

g. Simultaneously altering some of the above to see their combined effect.

4.8 Input Information for the Model

The following describes the principle inputs to the model:

A. Zoning System - The entire studied area is divided into zones which should be internally homogeneous with respect to socio-economic characteristics of the population.

B. Interzonal Travel Cost Matrices - In this study matrices for work trips and for service trips are specified in units of travel times, computed from actual network data. Moreover, each matrix type is further divided into peak and off-peak travel times.

C. Residential Population - The population by zone was obtained from the New York State Department of Transportation and Niagara Frontier Transportation Committee. For external zones, the model only deals with that part of the population dependent upon employees working in the region, and not the actual population of the zones (zones 31-34).

D. Basic and Service Employment - In describing the model, reference has been made to the distinction between basic and service employment, with service employment being employment directed to the production of goods and services for the residents in the region, and basic employment being the rest of the employment, that is employment directed to the production of goods and services for elsewhere. The SIC (Standard Industrial Classification) was used to make this division.

E. Residential and Service Attractors - The two submodels of residential location service location are gravity or entropy maximization models. Measures of the relative attractiveness of each zone for residential location H_j and for service location F_j are therefore required.

F. The Multipliers - The regional activity rate (total population/total employment) and the regional population serving ratio (total service employment/total population are calculated fromthe population and employment data. This information was obtained from a separate input-output model and reported in th spearate study.

G. Mean Trip Cost: Home to work and Home to Services - This information is required to perform the Newton-Raphson Automatic Calibration Procedure which determines the parameters in the residential location and service location submodels when the actual and estimated mean trip costs are equal.

$$\text{Mean Trip Cost To Work} = \frac{\Sigma\Sigma_{ij} T_{ij} c_{ij}}{\Sigma\Sigma_{ij} T_{ij}} \qquad (11)$$

$$\text{Mean Trip Cost to Services} = \frac{\Sigma\Sigma_{ij} S_{ij} c_{ij}}{\Sigma\Sigma_{ij} S_{ij}} \qquad (12)$$

where c_{ij} is the travel cost between zones i and j, T_{ij} is the number of employees working in zone i and living in zone j, S_{ij} is the number of residents of zone i using the services in zone j.

4.9 Survey Analysis

As part of the overall modelling process, two surveys were conducted. A major quantitative analysis of shopping behavior and modal choice was carried out in the region and is summarized in the next chapter. A qualitative assessment of LRRT impacts was made by local decision makers. The results of this assessment were summarized in Chapter 3.

4.10 Summary

The models developed for anlaysis form a comprehensive package that can provide the analyst and policymakers with a variety of tools to investigate the LRRT impact. Details of the analysis are presented in Chapter 5. The use of such models demands much in the way of data sources. A complete set of sources is shown in Table 4.1. Local planners and decisionmakers should be aware that the constrction of such a massive and comprehensive, but necessary data set can only be accomplished through a great deal of regional cooperation, and the expenditure of much time and money. Such cooperation on a micro-level is analogous to the cooperation necessary on the macro-level to accomplish development objectives.

Table 4.1
Summary of Information Sources

AGENCY/SOURCE	DATA	Pop. Base & Forecast	Economic Base & Forecast	Travel Behavior	Socio-Econ.	Transp. Supply Base & Forecast	Land Use	Econ. Dev.	Policy
NYSDOT	"1973 NFTC Travel Survey" (Tape)	X	X	X	X	X			X
	Employment Files		X						
NFTA	T.A. Zone Maps								X
	Metro Bus & LRRT					X			
	Schedules & Reports					X			
	Network Characteristics					X			
City of Buffalo	"Insight '76"	X	X	X	X		X		
	Waterfront Parking Plans					X			
ENCRPB	Pop. Proj.	X							
	Land Use Plans						X		
	Area Maps						X		
ECIDA	Economic Indicators & Econ. Adjustment Strategy		X				X	X	
Courier Express	Survey of Buying Power		X		X				
	"Retail Map"				X			X	
BEN								X	
US Census Bureau	Retail Trade		X						
Buffalo Area Chamber of Commerce	Business Activity		X		X				
GBDF			X					X	

TABLE 4.1 continued

Summary of Information Sources

AGENCY/SOURCE DATA	Pop. Base & Forecast	Economic Base & Forecast	Travel Behavior	Socio-Econ.	Transp. Supply Base & Forecast	Land Use	Econ. Dev.	Policy
American City Corp.							X	
M & T Bank		X						
NYS Dept. of Labor				X				
R.L. Polk & Co.	X	X		X				
NFTC	X	X		X				
US DOT/UMTA					X		X	X

CHAPTER 5

ANALYSIS OF IMPACTS AND SUMMARY OF MODEL FINDINGS

5.1 Introduction

In the previous chapter the various models which used to analyze the expected impacts of the LRRT system were described. For analytical as well as presentation purposes, these impacts were categorized as economical or investment impacts; transportation impacts; retail-shopping impacts; land-use (population and employment) impacts. The discussion in this chapter will be organized according to the aforementioned categories. Following the introduction and discussion of the models' results, the principal results pertaining to the overall impact of the LRRT on the CBD are summarized.

To facilitate the discussion and provide the reader with an idea of the study area, Figure 5.1 describes the overall division of the Buffalo metropolitan area into zones. The basic activity and land information for these zones is provided in Appendix A. Because of the large amount of output generated from the model, only the major results pertaining to the objectives of this study are presented.

5.2 Investment Analysis Results

The economic, population and employment trends in the Buffalo SMSA were described in Chapter 3. The principal finding was that all trends indicate a declining economy with major shifts in employment from highly industrial and manufacturing toward service type employment.

Against this background the investment impacts of the Light Rail System in Buffalo were evaluated using three components.

1. Impact of the federal and local investment of the LRRT system itself,

2. Impact of associated public investment directly related to the construction of the LRRT,

3. Long term impacts of corridor and regional changes that occur because of the rail investment.

While in regions of booming economy an overall investment of $750 million over 6 years may be of little significance, this is definitly not the case in a declining economy like that of Buffalo.

One major impact of these investments can be realized through changes in the labor force directly related to the LRRT construction. To estimate the number of jobs that will be created over time by the LRRT investment, the following procedure is followed. First, assume the capital expenditures to be (Table 5.1).

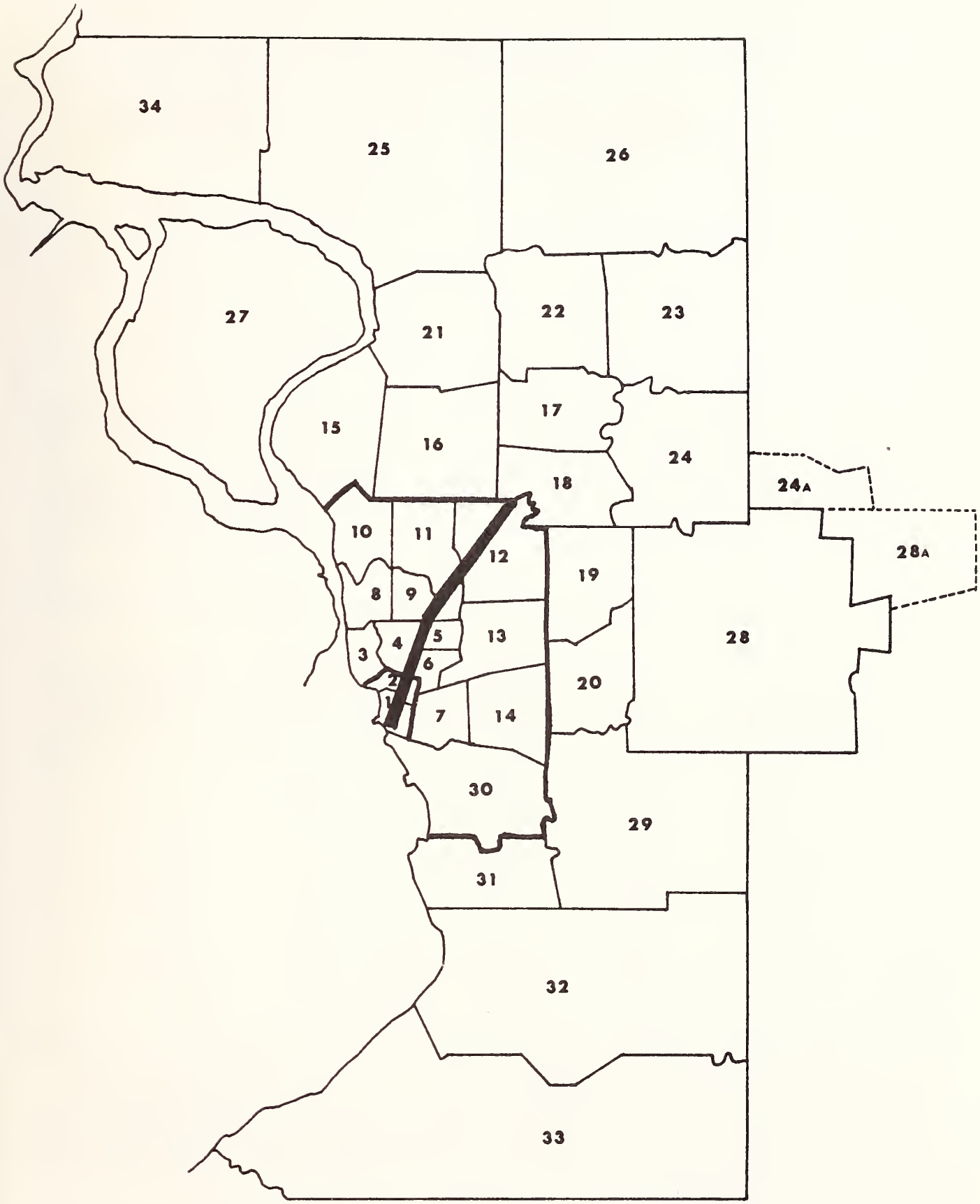


FIGURE 5.1: STUDY ZONE MAP

TABLE 5.1 CAPITAL EXPENDITURES (1978 - 1985)

YEAR	TOTAL CAPTIAL EXPENDITURES ($MILLIONS)	CUMMULATIVE CAPTIAL EXPENDITURES
1	35.4	35.4
2	86.2	121.6
3	136.9	258.6
4	92.5	351.0
5	78.4	429.4
6	10.4	439.8

Based on estimates provided by the Niagara Frontier Transportation Authority (N.F.T.A.), these expenditures are split into 35 percent labor and 65 percent materials and equipment. It is further being assumed that of materials and equipment, 50 percent shall be spent locally. Based on productivity rates of 16.3 emplooyees per $1 million labor expenditures and 20 employees per $1 million expenditures on materials[1], the direct employment impact of the LRRT investment are

TABLE 5.2 PROJECTED LABOR DUE TO INVESTMENT

YEAR	LABOR EXPENDITURE (MILLIONS)	LABOR FORCE	LOCAL MATERIAL EXPENDITURE (MILLIONS)	EMPLOYEES GENERATED BY LOCAL EXPENDITURE	CUMMULATIVE TOTAL EMPLOYMENT
1	12.4	202	11.5	230	432
2	30.2	495	28.0	560	1487
3	48.0	782	44.5	890	3159
4	32.4	530	30.1	600	4289
5	27.4	446	25.4	508	5243
6	3.6	60	3.4	68	5371
TOTAL	154.0	2515	142.9	2856	

Economic base theory suggests that new employment will generate demand for services of various types (e.g., health, education, retail, etc.). And these additional services, in turn, will create more jobs in the service sector, which in the next period will generate further demand and jobs in services. These additional increments of employment which represent the employment multiplier effect and which were initiated by the LRRT investment are computed as follows.

[1]These rates are derived from a Buffalo input-output matrix calculated by Dickson and Ganley.

Let α be the inverse activity rate (population/employment) and be population-serving ratio (service employment/population) then economic-base theory suggest that (5.1)

$$P = \alpha E^{b}(1 - \alpha\beta)^{-1} \qquad (5.1)$$

where P is total population associated with the "new" basic employment (in our case, employment generated by the LRRT, directly. Having $\alpha = 2.5$ and $\beta = 0.19$ and $E^{b} = 5371$ then P = 25,576 the dependent service employment, S = 4860. ($S = \beta P$).

If we assume that of the 5371 new labor force directly related to the LRRT only 4,000 will be new employees then P = 19,047 and S = 3619. Based on these figures it is expected that total net increase in population due to the LRRT investment will be in the range of 19,000 to 25,000 people, while the net increase in employment will be 7,000 to 10,200 (add basic to service employment).

Two more effects should be cited in conjunction with the investment long-run effects. First, in terms of income generated, the above increase in labor force is expected to generate $1,040 million in income over the 6 year period (1978-1985). Assuming income multiplier of 3.5, multiplying it by the total sum of labor and local material expenditures above (296.9 million dollars), we arrive at the total generated income. The distribution of this generated income is described below in Table 5.3

TABLE 5.3 REGIONAL INCOME GENERATED BY LRRT INVESTMENT

YEAR	LABOR & MATERIAL PAYROLL ($MILLIONS)	LABOR & MATERIAL IMPACT ($MILLIONS)
1	23.9	83.6
2	58.2	203.7
3	92.5	323.7
4	62.5	218.7
5	52.8	184.8
6	7.0	24.5
TOTAL	296.9	1039

The second effect is that of the participation of women in the labor force; it was found that high correlation exist between regional income and percent of women in the work force. Using a linear regression the following equation was estimated:

$$x \text{ women in work force} = 16.84 + 4.15 \text{ (Regional Income)}$$

For the projected 1985 regional income is $7.55 billion (Appendix 6B), the projected women labor for participation rate is 48%. This last figure is of significnt value as most women entering the labor force are expected to be employed in service employment which is largely concentrated in the CBD.

5.3 Accessibility Analysis Results

To test the effects of the Light Rail Transit System on accessibility within the Buffalo, N.Y. area and especially, to the Central Business District (CBD), a model called ACCESS described in the previous chapter has been developed and runs made.

By using existing and 1985 combined (auto and transit) travel times, activity levels which included retail sales, retail and service employment, and population data as major inputs, relative accessibility indices were obtained for each zone, with the CBD being the focus of the analysis.

Eight separate travel time matrices were developed for use in the study. These are auto and transit for work and service trips both before and after the introduction of the LRRT. The before inter-zonal travel times matrices were computed using actual network data and current information on bus service including bus frequencies, location of stops and routes. The after LRRT travel times were computed on the assumptions that the actual light rail travel time will be as those indicated by the systems planners and that bus operation along the LRRT corridor will be adjusted accordingly.[1]

The model ACCESS computes interzonal and intrazonal accessibility for work and service trips in a zonal system before and after adding the proposed LRRT into the travel time matrices. The model computes accessibility of a zone on the basis of travel times (by mode and trip purpose) and the levels of the trip generation and attraction activities. Hence, when service employment is set equal to one for each zone, its impact on the model is neutralized. The results then indicate the level of accessibility measured by time units only and for presentation purposes are labeled "time accessibility". A similar approach was applied for work trips.

The results of measuring accessibility before and after LRRT and for work and service trip purposes were used to rank the study zones from most accessible (rank 1) to least accessible (rank 34). These results are given below in Tables 5.4 and 5.5.

A number of points should be observed about these results. First, that there are indeed major differences in the accessibility of a zone for work trip purpose and service trip purposes. Work trips are carried out generally at peak times. Service (shopping mostly trips) are made at offpeak times. In addition the modal split will differ for these trips, with more transit trips taken for work at peak times.

For both trip types there are indeed differences in the resultant rankings between time accessibility and total accessibility. However, within each trip type and accessibility measure there is almost no change in the ranking of the zones before and after the introduction of the LRRT The principal implication of these results is that relative accessibility will not change

[1]This data were obtained from the Niagara Frontier Transportation Authority.

TABLE 5.4
Comparison of zone rank by Time and Total Accessibility for work trips, Before and After LRRT

ZONE	Rank Before Time Access	Rank After Time Access	Rank Before Total Access	Rank After Total Access
1	16	15	12	13
2	14	16	14	14
3	30	29	31	31
4	27	24	25	24
5	17	14	20	17
6	22	22	21	19
7	28	28	28	28
8	24	26	26	27
9	13	13	16	15
10	29	30	29	29
11	20	18	23	18
12	18	17	15	16
13	23	25	22	25
14	32	32	30	30
15	25	27	17	20
16	31	31	32	32
17	26	23	27	26
18	21	20	24	23
19	15	19	18	22
20	19	21	19	21
21	5	5	5	5
22	3	3	4	4
23	2	2	2	2
24	1	1	1	1
25	11	11	9	10
26	8	9	8	9
27	4	4	6	6
28	7	7	3	3
29	6	6	13	7
30	33	33	34	34
31	34	34	33	33
32	9	8	9	8
33	10	10	10	11
34	12	12	11	12

TABLE 5.5
Comparison of zone rank, by time and total access;
for service trips Before and After LRRT

ZONE	Rank Before Time Access	Rank After Time Access	Rank Before Total Access	Rank After Total Access
1	34	34	25	23
2	32	32	16	17
3	16	16	15	18
4	14	14	19	20
5	24	24	18	14
6	26	26	21	19
7	20	20	20	21
8	17	17	24	26
9	22	22	17	13
10	13	13	27	28
11	9	9	26	22
12	4	4	14	16
13	2	3	13	15
14	10	10	29	29
15	27	27	31	32
16	1	1	23	25
17	31	31	33	33
18	11	11	28	27
19	8	8	22	24
20	21	21	30	31
21	6	6	2	2
22	30	30	6	7
23	29	29	5	5
24	18	18	4	4
25	23	23	10	10
26	33	33	12	12
27	28	28	8	8
28	3	3	1	1
29	7	7	3	3
30	5	5	32	30
31	19	19	34	34
32	15	15	7	6
33	12	12	9	9
34	25	25	11	11

significantly after the LRRT system will commence operation. This reinforces the travel time discussions of Chapter 2 and 3. Travel times in the region are short and linked more to the highway network than to transit network. Consequently, changes in accessibility, measured through travel time changes only, will not be greatly affected. Rather, for regions like Buffalo, the accessibility changes will occur more through the land use component of the model (population, floor space). This indicates that policymakers should concentrate on the development related aspects of travel, rather than travel characteristics themselves.

Another point worth observing is that the zones which are most accessible for work are the suburban zones (see Fig. 5.1). With perhaps the exception of zone 13 for time accessibility, a similar picture emerges when examining the ranking of the service trips. The principal explanation to that is that these zones are serviced by major highways and roads and that they contain relatively high density of trip generating activities.

The CBD on the other hand (zones 1,2) is ranked medium for work trips mainly due to the bus system which provides a high level service to this area. For service trip purposes these zones are very inaccessible. This occurs because most shopping trips are carried out using private car which, in turn, entails parking problems in the CBD. The population which does the most shopping trips is located in suburban zones and is serviced quite well by shopping centers which are located nearby (recall that the CBD has only 5% of regional retail sales, or 95% of retail sales occur outside the CBD).

The magnitude of the changes in accessibility after LRRT construction is demonstrated in Tables 5.6 and 5.7, respectively. It is evident that the zones showing a high ranking in the pre-LRRT analysis (Tables 5.4 and 5.5) showed the smallest gain in their level of accessibility. The reasons are that their pre-LRRT levels of accessibility were so high that the LRRT impacts are limited. A second reason is that given the planned LRRT route, these zones are still better served using the highway system types.

It was also found that the zones through which the LRRT runs and those adjacent gained the most in accessibility. This was true for Zones 4,5, 6,9,11,12 within the city, with Zone 9 showing the largest gain. The CBD (Zones 1 and 2) showed very little gain, because much of the travel to these zones is from the south and east of the city, areas which are not served by the Light Rail System. Two zones in the first ring suburbs (Zones 16, 18) have the largest index changes, both are adjacent to the city on the north, and will have tremendous gains in feeder bus service.

The results of the Accessibility Model runs lead to the following conclusions:

First, total accessibility and time-accessibility will change but very moderately by the construction of the LRRT system.

Second, given the route of the system as currently being constructed, travel through most zones not immediately adjacent to the LRRT system will still be based upon the highway system. It is very unlikely that current modal split ratios will change significantly once the system is in full operation.

TABLE 5.6

Magnitude of Work Accessibility Before and After LRRT*

O	INTERZONAL BEFORE LRRT	INTRAZONAL BEFORE LRRT	TOTAL BEFORE LRRT	INTERZONAL AFTER LRRT	INTRAZONAL AFTER LRRT	TOTAL AFTER LRRT	CHANGE IN ACCESSIBILITY
1	332787.1	33435.6	365522.7	345113.3	33435.6	378548.9	16989.5
2	333233.8	555.6	357340.4	343854.4	722.6	367961.1	10245.2
3	302974.2	385.7	306178.1	308025.3	385.7	311229.2	782.9
4	313587.3	248.5	327318.2	322925.4	391.4	336656.4	5665.7
5	337636.3	267.8	335667.1	345620.7	421.0	350651.6	3176.8
6	329329.2	268.8	334129.4	338158.7	433.5	343959.0	5911.6
7	309016.9	480.1	318723.0	312446.2	480.1	322152.3	1545.8
8	318740.6	129.0	326642.2	319650.4	129.0	327952.0	501.5
9	338736.0	231.4	347040.6	355495.0	483.7	363895.6	5834.6
10	304541.0	111.5	315059.1	306364.9	111.5	316882.9	970.9
11	322437.7	120.0	333240.2	335149.4	269.7	345951.8	6283.6
12	330527.7	83.3	349492.6	338761.8	265.9	357726.6	7062.6
13	319854.5	231.4	333619.3	320422.8	231.4	334185.6	382.8
14	292781.4	267.8	307830.4	297513.5	267.8	312562.6	3778.8
15	317543.5	172.8	339957.0	318435.2	172.8	340848.6	935.5
16	293953.6	89.6	305746.9	297856.1	89.6	309643.4	2356.7
17	315642.5	27.9	320955.5	325869.5	97.1	331222.4	2552.9
18	322005.0	13.4	329546.2	331427.7	139.8	338969.0	3221.2
19	333184.0	120.0	338717.1	333545.8	120.0	339078.9	89.8
20	328546.1	89.6	337929.3	330461.7	89.6	339844.8	812.3
21	489548.2	861.0	498956.0	489548.2	861.0	498956.0	0.0
22	506180.7	861.0	507346.7	506176.6	861.0	507342.5	-.1
23	520004.8	861.0	520891.4	520036.4	861.0	520923.0	.8
24	520949.3	861.0	531628.6	520985.2	861.0	531665.5	11.3
25	462411.4	861.0	471150.4	462411.4	861.0	471150.4	0.0
26	475474.9	861.0	476052.9	475501.3	861.0	476079.3	.6
27	494981.9	861.0	497545.8	494981.9	861.0	497545.8	0.0
28	466995.2	861.0	512711.3	466027.6	861.0	512743.8	28.2
29	487195.0	861.0	495177.9	487974.0	861.0	496146.1	262.7
30	263559.1	172.8	295602.1	286918.9	172.8	296962.0	2281.0
31	278421.7	215.1	297333.1	282554.2	215.1	301465.7	4281.1
32	474912.4	861.0	478901.9	476983.7	861.0	480973.3	305.7
33	463482.4	861.0	468990.1	463941.8	861.0	469449.5	96.5
34	455051.1	861.0	460029.1	455051.1	861.0	460029.1	0.0

*The units of accessibility reported here are of no direct analytical value. The reader should be impressed by the incremental changes in the amount of accessibility.

TABLE 5.7

Magnitude of Service Accessibility Before and After LRRT*

ONE	INTERZONAL BEFORE LRRT	INTRAZONAL BEFORE LRRT	TOTAL BEFORE LRRT	INTERZONAL AFTER LRRT	INTRAZONAL AFTER LRRT	TOTAL AFTER LRRT	CHANGE IN ACCESSIBILITY
1	199935.1	1835.4	201770.6	218164.7	1835.4	220000.1	2295.4
2	223211.6	6355.2	229566.8	239314.4	6355.2	245669.6	6251.8
3	210754.9	19472.2	230227.2	218036.8	19472.2	237509.1	8894.2
4	197758.1	20149.0	217907.1	211108.6	20149.0	231257.7	17323.4
5	212957.4	13442.1	226399.5	237480.1	13442.1	250922.2	19773.1
6	206412.2	11062.6	217474.8	221722.1	11062.6	232084.7	10475.1
7	200932.6	16933.9	217866.4	211720.0	16933.9	228653.8	11960.9
8	188056.1	18859.0	206917.1	189562.0	18859.0	208421.0	2917.8
9	213266.9	15454.7	228723.6	241359.3	15454.7	256814.0	26259.9
10	172043.8	21614.0	193657.8	173572.3	21614.0	195186.3	2630.7
11	175653.6	25552.3	201405.9	196537.8	25552.3	222090.1	37048.6
12	187120.0	44165.6	231285.8	202709.8	44165.6	246875.4	44763.9
13	198479.4	47376.1	245855.5	202977.9	47376.1	250254.0	13338.8
14	163645.4	25174.1	188819.4	168919.3	25174.1	194093.4	11010.9
15	168586.0	9901.5	178487.5	169568.4	9901.5	179169.9	805.8
16	156512.0	54236.3	210748.3	159525.3	54236.3	214161.6	13346.0
17	161610.9	7429.2	169040.1	166593.6	7429.2	174022.8	3200.1
18	168206.1	23601.4	191807.5	184013.3	23601.4	207614.6	27813.3
19	184693.8	28329.9	213023.8	186994.9	28329.9	215324.9	4529.6
20	166197.3	16454.9	182652.1	172954.5	16454.9	189409.4	4941.7
21	312794.0	29908.1	342702.1	312794.0	29908.1	342702.1	0.0
22	314071.1	7512.3	321583.5	313949.6	7512.3	321462.0	-42.1
23	327222.5	7592.7	334815.1	328222.1	7592.7	335814.8	341.7
24	318109.0	17493.8	335602.9	319343.4	17493.8	336837.2	982.3
25	283665.1	15342.5	299007.7	283665.1	15342.5	299007.7	0.0
26	286707.7	3020.9	291728.5	289401.6	3020.9	292422.5	118.8
27	309182.9	9359.1	318541.9	309182.9	9359.1	318541.9	0.0
28	302206.8	44714.4	346921.2	303258.9	44714.4	347973.3	2175.1
29	305628.2	28480.0	334108.2	313925.2	28480.0	342406.2	5714.0
30	145262.8	31277.5	176540.3	158260.3	31277.5	189537.7	35661.7
31	134236.5	17240.1	155476.6	149566.2	17240.1	166826.4	19310.7
32	300332.5	19817.4	320149.8	307608.3	19817.4	327425.7	7463.1
33	287636.7	22043.1	309679.7	292757.9	22043.1	314801.9	6213.4
34	283726.3	11428.8	295154.1	283726.3	11428.8	295154.1	0.0

*The Units of accessibility reported here are of no direct analytical value. The reader should be impressed by the incremental changes in the amount of accessibility.

Third, given the results regarding the actual changes on the levels of accessibility in the zones adjacent to the LRRT route, it can be expected that for a portion of the public residing in those zones, there will be a significant increase in actual and perceived accessibility. Those inner city residents who do not own an automobile, or who are considered to be transit dependent should get the most benefit of improved accessibility within the immediate vicinity of the LRRT system.

Four, since travel times in the post LRRT period would not be significantly shortened, the only way the CBD can become more accessible is if its attraction level for service and work activities will increase. As discussed above, the important impact of the LRRT on the downtown is not in reducing travel times, but in focusing attention through the investment and land-use effects, on it. This, inturn, will increase its level of attraction which then will act to improve the CBD relative accessibility.

5.4 Retail Analysis

In the previous chapter, the nature of the impacts of transit on retail activity in the CBD and outlying regions was introduced. Additional quantitative evidence of these impacts are presented here.

The key data source for this analysis was a Survey of Downtown Attractiveness initiated in spring 1978. The survey was designed to examine four general topics:

1. present travel and shopping behavior

2. attitudes and preferences towards available shopping alternatives

3. opinions and suggestions concerning future scenarios of the role of the CBD as a regional center

4. Socio-economic characteristics of the respondents.

The survey was conducted in four small areas within the metropolitan region pre-selected by criteria such as available retail opportunities and transportation supply characteristics.

The reported behavior and attitudes of downtown shoppers, potential shoppers, and various homogenous subgroups of the population served as a base from which to evaluate retail choice as a function of a number of relevant variables, including accessibility. The most pertinent findings, to be reinforced by the quantitative analysis that follows, were:

.People currently (1979) shop close to their home (as opposed to close to work). They are oriented to the available mode. Those who have cars available, shop in suburban malls. Those who do not have cars available, shop downtown. Ninety percent of the respondents had cars available for retail shopping.

.The woman in the household is the primary shopper.

.People who shopped in downtown did so during the day. People who shop in the malls shop in the day and evening.

.The CBD is most attractive only to those who live near the CBD.

.The suburban malls are attractive to everyone, including those close to the CBD.

.The greatest advantage of shopping in the CBD are the quality and variety of goods - amenities traditionally associated with downtown shopping. These amenities are perceived as being much greater in the CBD than in the suburban malls.

The probability model presented in the previous chapter was used to estimate the probability that a household located in a given zone will shop at a particular shopping center in another zone. The explanatory variables were of three types: socio-economic, accessibility and attractiveness variables. Having estimated these relationships for the current (pre_LRRT) shopping patterns and then introducing the post-LRRT impacts on accessibility and attractiveness of centers, it is possible to estimate the shopping patterns which will emerge due to the LRRT.

The socio-economic variables used in the analysis were levels of households income and car availability. Information for these variables was obtained from a survey of shopping patterns in Buffalo noted above. Location of households and their preferred shopping centers were obtained from this survey of 246 regional residents.

The accessibility measures used in the analysis were travel times by private car and by transit. In addition, it was necessary to determine which shopping areas will be included as shopping destinations, as it was assumed that the CBD competes directly with major shopping centers, and not with local or neighborhood stores. Thus, for the analysis the Buffalo metropolitan area was aggregated into four "super" retail areas namely CBD, Other City, Suburban Malls and all others.

To determine the attractiveness measures for the probability model a separate analysis was conducted. The variables which were selected on the basis of their explanatory power are: number of retail establishments, total square foot of retail space, total number of retail employees and total retail sales. The information on these variables for the Buffalo metropolitan area by zone was presented in Chapter 5. The results of several model runs, listed below, can be summarized.

Run 1: the entire 246 observations were used. AT = floor space in eq. foot and AV = combined auto and transit travel time.

Run 2: households with income categorized as low income were used.

Run 3: households with income categorized as high income were used.

Run 4: households who shop downtown and live inside the city.

Run 5: households who shop downtown but live outside the city.

Run 6: households who shop at suburban malls and reside in suburban zones.

Run 7: households who travel less than 20 minutes for shopping.

In each of these 7 runs, the accessibility variable is insignificant. 225 out of the total 246 households are located less than 20 minutes from their selected area of shopping. Given the availability of shopping centers in the region (Chapter 3), travel time, in itself is not a prime determinant of households shopping choices in Buffalo.

For low income households who also happen to reside mainly in the inner city, income does not affect their shopping choices. But alternatively, given the locational constraints imposed on low income households their choices of a shopping area are independent of their income. This can also be seen from runs 2 and 4, where car availability, which also imply spatial mobility, is significant while income is not; for high income groups income does affect shopping choices but in inverse relationships. That is, as income increases the probability of shopping at a particular area declines; however, low income households are simply more constrained in their location choices.

5.5 Level of Attraction

The only variable which is significant for these runs is the shopping area level of attraction. This result is extremely important in the context of the present analysis because it implies that a positive impact of the LRRT on the level of attraction of the dowtown may in fact cause a greater proportion of households shopping there. The results from the investment and land-use analysis noted originally in Chapter 3 and reinforced by this analysis indicate that enhanced attractiveness will be a significant effect that the LRRT system can have on the CBD. When combining these results with those of the shopping analysis, it is noted that any increase in the share of the CBD in the regional retail activity through the LRRT is conditional upon the degree to which the system will increase the CBD attractiveness as a shopping area and not solely on the CBD relative level of accessbility. In that respect, the results of the accessibility model, which indicate that the LRRT will have little if any impact on the relative accessibility of the CBD, do not diminish the importance of the LRRT system as a potential factor in improving the CBD attractiveness, but indicate to planners and policymakers the critical importance of co-development.

5.6 Land-Use Analysis Results

Of all the models used in this study the land-use model is undoubtedly the most complicated one with respect to its outputs and method of operation. The technical and analytical features of the model have been explained in the previous chapter.

Model inputs include data describing population, employment, land use and travel in the Buffalo region. There are several input constants which are necessary for the operation of the model. Among these the interzonal mean travel time (MTC) is of greatest importance. Table 5.8 reports these values, as used in the analysis.

In the analysis both elapsed MTC and network MTC were used. One should notice the existing relatively low mean travel cost factors, for work and service, in Buffalo metropolitan areas. To an extent they explain the small impact that the LRRT system is expected to have on interzonal travel times.

As explained in Chapter 5, the model operates in two stages. In the first stage the base-year input data is used to calibrate some structural parameters including trip friction factors and zonal attraction parameters for service employment and residential location.

In the second stage external disturbances pertaining to future time are introduced into the model, assuming the calibrated parameters as in base year. The model then generates the activity distributions under these disturbances. This is a prediction stage in which the model evaluates the impacts of external changes upon activity and trip patterns.

The model was used to predict the impacts of a large number of changes which theLRRT system is assumed to generate. A complete list of the prediction runs is given in Appendix 5E-3. The results of two of these runs will be desribed. These are: the total impact of investment aspect of LRRT project (run number 4) and the overall impact of LRRT (run number 9).

5.7 Prediction of Investment Effect

One direct effect of the $430 million LRRT investment is an increase in basic employment. The additional basic employment computed above, was introduced into the model, and the resultant vectors of employment and population distributions were observed. These results, in terms of percent changes from original (base year) data, are reported in Table 5.8.

5.8 Prediction of Overall Impact of LRRT

Through the entire study it was hypothesized that the LRRT project will produce three major impact types: investment attraction levels of zones for service employment and residential location; interzonal travel times; given trip purpose. In this prediction run all these impacts were simultaneously introduced into the model. The predicted distributions of employment and population are reported in Table 5.9.

The overall results indicate that the impact of the investment factor alone is to increase service employment in the CBD (zones 1 and 2) while reducing residential population there. However, since total population in these zones is currently small (see Appendix 5E-1), this latter effect can be ignored. On the other hand, base year level of service employment in the CBD is highest in the region (45,687). Thus the 34 percent increase implies an addition of 15,330 employees which, in itself, is larger than any amount of service labor at any other zone, at the base year.

The predicted population distribution from the total impact of the LRRT (run #9), again suggests a decline of residents in CBD. A more dramatic result is the large increase in population in zones 21, 22, 23, 27 and 31, which are suburban zones. The population impacts of the investment may be felt in outer suburbs emphasizing the long-run trend of suburbanization in the region.

With regard to service employment, the results of this run again suggest that the CBD is bound to benefit most from the LRRT system. This large gain (122.6%) occurs because of the increase in attractiveness in zones 1 and 2, which corroborates the results obtained before, from the other models. Another interesting phenomenon is the high percent increase in service

TABLE 5. 8

Mean Travel Cost by Trip Type
For the Buffalo Metropolitan Area
(in minutes of travel time)

TRIP		ELAPSED MTC	NETWORK MTC
Residential			
1. Work-to-home	Long	20.25	13.49
2. Home-to-work	Long	18.57	13.36
3. (1) & (2) combined		19.37	13.42
SERVICE			
1. Home-to-other	Long	19.60	15.27
2. Home-to-misc.	Short	NE	NE
3. Home-to-shop	Short	NE	NE
4. (2) & (3) combined		12.99	8.18
5. (1),(2)&(3) combined		13.31	8.52

NE = not estimated.

In the analysis both elapsed MTC and network MTC were used. One should notice the existing relatively low mean travel cost factors, for work and service, in Buffalo metropolitan areas. To an extent they explain small impact that the LRRT system is expected to have on interzonal travel times.

TABLE 5.9
Results of Two prediction Runs of Land Use Model

	Run #4			Run #9	
ZONE	percent change in population	percent change in employment	ZONE	percent change in population	percent change in employment
1	4.3	34.4	1	10.2	-17
2	-54.2	34.4	2	-59.5	105.6
3	-20.8	35.0	3	-31.6	-2.9
4	0.03	5.7	4	5.6	22.8
5	-25.1	10.3	5	-33.6	-8.4
6	-64.9	0.4	6	-68.3	-5.0
7	-15.7	-0.2	7	36.0	18.8
8	56.5	10.2	8	34.2	-7.1
9	-2.5	19.9	9	2.9	21.8
10	14.3	19.1	10	0.2	-1.0
11	1.7	21.3	11	7.4	7.1
12	1.1	31.8	12	6.7	16.5
13	-10.2	19.6	13	26.2	20.1
14	-10.2	-4.8	14	25.4	15.7
15	48.1	37.1	15	36.9	33.8
16	-4.0	38.5	16	1.3	36.8
17	7.1	40.1	17	13.1	88.8
18	0.05	50.2	18	5.6	103.5
19	0.9	52.6	19	6.6	55.9
20	30.4	43.1	20	42.5	46.6
21	82.0	19.3	21	59.3	15.6
22	89.2	15.6	22	67.6	9.3
23	125.6	20.3	23	99.3	46.2
24	4.3	29.2	24	10.1	-15.5
25	24.8	-16.2	25	10.4	-21.7
26	78.3	-31.9	26	58.5	-30.5
27	119.8	-1.1	27	92.6	-20.3
28	-5.2	6.7	28	0.1	39.7

TABLE 5.9 Continued

Run #4			Run #9		
ZONE	percent change in population	percent change in employment	ZONE	percent change in population	percent change in employment
29	-5.2	20.5	29	0.1	25.6
30	56.4	8.2	30	38.9	-27.3
31	114.8	21.0	31	93.2	11.7
32	78.0	6.3	32	63.2	18.6
33	79.4	-5.3	33	67.3	5.0
34	1.5	-34.0	34	-11.1	-29.3

employment in zone 18, which is located at the Northern terminus (the CBD being the Southern terminus) of the LRRT route. This again may suggest a positive effect of the system on the attractiveness of zones, but because of the relatively small number of service employees at the base year at this zone, the implications of this result are limited.

The final set of results to be observed related to the impact of LRRT on zones adjacent to its route. These are zones 4,5,6,9,11,12 (Figure 5.1). The current trend of population decline will not be reversed. Model inputs use forecast year populaiton projections as constraints. As stated above major gains in population will continue to be in regional shifts between suburban zones whose attraction level for residential location is relatively very high.

These adjacent zones are also not going to benefit much from the LRRT with regard to service employment. Again the current decline in retail and service activities in these area is unlikely to be significantly changed by the LRRT system.

5.9 Overall Downtown Results of LRRT

To summarize the major findings of the results presented in this chapter. The following conclusions can be stated.

- **Economy of Downtown:** The LRRT is expected to have a positive impact upon the economy of downtown. This is seen in two ways. First, it will increase service employment. Secondly, it will stimulate private investments.

- **Accessibility to Downtown:** The accessibility of downtown to all other zones will not change substantially.

- **Shopping Downtown:** If, as projected, the LRRT will have positive impact on downtown attractiveness, a larger share of regional retail trade will be captured by the CBD, all other factors remaining constant.

- **Potential for Private Development:** Increasing the attractiveness of the area will encourage private development, mainly in retail and service sectors.

5.10 Summary

A number of land use and transportation models have been develped for use on this study. A number of attractiveness models, and an accessibility models, and an accessibility model have been utilized in conjunction with an urban activity model; the use of these models demonstrates that it is possible to evaluate alternative policies under constraints such as these noted above.

A number of variables has been tested in these models to evaluate the impact of the LRRT. These include travel time (cost), other transportation related variables, land use variables and socio-economic variables. Because the problem of analysis investment impacts of the transit system is uniquely different from estimating factors influencing mode choice, these variables had

different meaning and significance than ordinarily found in a transportation analysis.

Variables that control retail activity linked to the transit include quality of the activity, parking, and safety. Currently, the CBD in Buffalo is not "attractive" enough to offer competitive pull in the suburban malls. While recognizing the strengths of the CBD, shoppers go more frequently and in greater numbers to suburban malls.

In addition accessibility (meaning time accessibility) is not the only, nor even the most important, variable that should be measured by transit improvements. Decreases in travel time do not mean as much as parking, safety, and the quality of activities that are available. Accessibility must be defined in term of time and quality of activities. The incorporation of the quality of land use into the transit access equation will bring a more realistic approach to the measurement of the potential impacts of the LRRT.

CHAPTER 6

CONCLUSIONS

6.1 Summary

There is no question that public transit will begin to capture a larger share of total personal travel in the next decades. The rising costs of car ownership and operation have, already, made many urban residents switch from the car to the bus, or rapid transit. In cities with high enough densities of population, or consolidated corridors of travel, line haul systems (rapid transit, light and heavy rail) and ridesharing - HOV facilities - are seen as major modes that meet the demand, reduce congestion, and, of increasing importance, have impact on activities around the system.

A single major difference between bus service and rapid transit service underscores this point. Bus service is essentially a continuous service, while rapid transit can be viewed as a discrete (in space) service. Large numbers of people are concentrated at certain, specific spots for rapid transit. Bus service brings the people to where activities are, and, can follow the movement of activities over a wide geographic pattern.

Activities become linked to rapid transit stops. There is a more active land-use transportation relationship. While transit may be located in an existing dense corridor, transit induced changes in the station areas that often would not occur if no transit were there. (Why would Woodward and Lothrup pay millions to tie into two transit stops in Washington, D.C., or why was the Gallery place in Philadelphia located over a busy rapid transit stop?) It is clear then that bus service and rapid transit service are not both synonymous with the words public transportation. For this reason the evaluation of new public transit systems or improvements to existing systems must be tied very clearly to the type system investigated.

In any formal analysis of transportation systems variable sets used to compare alternative systems are not congruent. While traditional transportation variables, travel cost, total trips, etc., are part of the set that looks at the effectiveness of transit in meeting simple travel demand, land use impacts, or generated development are not variables synonymous with all modes of transit.

Rail rapid transit systems, because of their high initial capital cost, must generate returns that are more beneficial to the public then those measured by ridership. A very simple example will serve to illustrate this point. The $400,000,000 invested in the Buffalo System, with an expected life of 40 years, would be equivalent to $40 million a year, if the discount rate for money is 10%. It is obvious, that when inflation is high, the short high investment span for capital projects becomes an extremely attractive investment, for it is highly unlikely that yearly investments at that lower level would be made for any alternative transit systems. That is, it is unlikely that local or state agencies could assess themselves for $40 million per year for capital costs, as well as most other yearly costs, such as operation, maintenance and fare subsidy.

When rapid transit systems are constructed in urban areas that are not growing, it is essential that all involved in policymaking insure that the investment be optimized.

The decision to invest in a rail system must then be a unanimous and strongly supported regional decision, one whose effectiveness and impacts have been delineated, and one whose benefits to the region can be seen to be clearly superior to any alternative decision.

The decision must not be made solely on the basis of ridership, or travel costs. The travel cost advantages to a single rider are often marginal. The decision should also be based on overall regional economic impact - impact on labor shifts or growth, impacts on housing location, impacts on non-work activities.

As criteria for policy decision making, a study of rail rapid transit benefits should ask and determine the following, in addition to the determination of direct transportation benefits:

1. Is there regional support?

2. What are the associated land use and activity changes?

3. What is the timetable for these changes and are they effected by the transit investment?

4. Will there be long term (post construction) changes in the labor force, created or influenced by the transit decision?

5. Will the transit system effect the intra-regional mobility of labor?

This study examining the Buffalo Light Rail Rapid Transit System now under construction provided answers to the above questions concerning economic impacts. The study showed clearly that, in a region of decline (urban areas of the Northeast, and North Central States), the economic and demographic indicators must be defined and used as **planning constraints.** That is, the bounds to what development can take place must be defined and shown.

In a major study of the impacts of completed rail systems, "Land Use Impacts of Rapid Transit" (6.1), a number of issues that planners, policymakers and developers must focus on were summarized. These included:

Downtown Development
Growth Focusing
Regional Growth
Land use Policy
Impact of Transit Type

Using case studies from a number of cities the authors concluded:

"Rapid transit improvements might be used as one element of a coordinated package of efforts to revitalize a declining metropolitan area, but should not be relied upon solely or even primarily for such purposes" (6.1)

The study carried out in Buffalo applied a number of analytic techniques to a declining regin and showed that an in depth analysis, even prior to the completion of a system, could lead to findings consistent with the lessons learned in other areas.

Buffalo is much different from Houston, Denver or San Francisco cities that have or have proposed new fixed rail transit. In those cities, the returns are dependent upon the scale and completeness of the investment. Buffalo represents an almost textbook example of transit investment **under very tightly controlled conditions.** The land development associated with the transit occurs in discrete packages, each of which has a specific measurable and significant reigonal impact. For this reason the lessons learned from Buffalo serve as magnifications of impacts that can be seen or estimated on other cities.

In many of the declining urban areas there are now strong patterns of intra-regional competition. Encouraged by conflicting programs supported by HUD, EDA, and DOT, suburban areas compete with urban areas for the same resources.

The transit investment was seen to be **one investment** that had the potential to minimize such competition. In that sense, the Light Rail Rapid Transit System is a **necessary but not solely sufficient** investment to catalyze new economic development. Transit (light or heavy rail) forces a focus on land use and development. Relocation of bus stops, or creation of express bus systems do not have this capability. Bus systems are usually followers of development, while rail systems shape development.

Rapid transit systems must be linked, therefore, to areas where there is demonstrated growth potential. Growth potential (in regions of decline) can be measured by

a. **Changes in the employment force.** Even in declining areas, some subregions may have growths in employment. This is clearly the case for the service based industries. These can be broken into two major groups - those that must be in proximity to other service organizations, and those whose location is independent of specific locations. The former (mostly financial, government services, and wholesale and retail serving this market) will still tend to congregate in the traditional dense area - the Central Business District. Such areas are logically served by transit, so long as the ease of access by car, and the cost of access by car is not kept so low as to make transit an unattractive competitor. Employment changes in a region can be tracked, and new office construction or renovation planned for both an expended market and rapid transit access.

b. **Changes in the composition of the labor force.** The most significant change in the labor force has been the rapid increase in the number of women in the labor force. This change creates more than a new employment stature; it creates new household travel patterns, and, when the woman becomes an additional head of household working, creates new income. But it also creates new demands as the ability to carry out non-work activities. There is increased demand to shop near the place of employment, or near home.

c. Auto and transit policies. Where the car remains the perferred mode growth potential can be tied to highway system improvements as well as transit improvements. Regional policies must be developed that enhance growth where the investment is desired. Conflict must be minimized. If the CBD is targeted for development, then regional policies which would improve access to non-CBD areas where competing growth can occur must be critically examined. The retail model in this study was an example of this policy analysis. Shopping centers have developed and thrived in a suburban ring tied to expressway development in the 1960's and 1970's. Now, when money is being poured into the CBD, to attempt to generate new growth or revitalize the area, the retail component of the CBD is one of the critical elements. Retail, always a strong component of the traditional city downtown, must be unique and have its own identy to attract people from throughout the region. This was shown in our survey of shopping choice in the Buffalo region. Noting the constraints mentioned above, in a declining area there are limits to the amount of growth that can be sustained in a given area. Retail is one example of an area in which no major growth can be expected. Thus investment in the CBD cannot coexist with new investment in competing areas. Neither area can then reach its full potential.

d. **Ability to deal with non-targeted regions.** In addition to target areas, such as the CBD, rapid transit creates a focus at station areas, The station areas can be the target of intense devleopment efforts to reinforce ridership and economic activity at these sights. Use of an accessibility model showed the joint influences of travel time savings and land development in zones directly adjoined to the transit. While in Buffalo these changes were not great enough to overcome the strong pulls of zones with high auto accessibility, rapid transit changes did increase the potential level of activity in these adjacent zones. Because the growth of these zones, the attraction to these zones will be intra-regional. It again becomes apparent that public intervention must precede private development in these non-targeted station areas. Public intervention is necessary to insure the highest and best use of the land, in accordance with local objectives. As the study showed that, rapid transit developments timetable, the short time period during which speculation takes place near station areas must be regulated to a certain extent by the public sector. This need arises out of the constraints in declining areas.

It should be emphasized that the capabilities exist for all of these factors to be measured, accessed and analyzed. The data collection effort must be large, but is not overly complicated or cumbersome. Data sources for population, employment, land use, transportation and land activities are all available.

6.2 Future Considerations

For the short term future, a number of considerations must be added to the transportation economic development considerations addressed above. These include:

1. Continued disruptions in employment and labor force

2. Slow growth of new housing market

3. Reduced federal subsidy (and more competition) in targeted growth programs.

It seems apparent that the rapid growth in government employment will decline or stop in the next five years. It is not altogether certain that the reduction of federal programs will have their counterpart in state and local programs. These changes can have a dramatic effect on the distribution of labor in urban areas described above for Buffalo, N.Y. It is difficult to tell now (1981) whether this type change in the labor force will create more decentralization and out-migration. If there is outmigration of basic employment, than it is evident that service employment (and government services) will decline, with some impact on the CBD.

The slow growth of the new housing market, coupled with the increasing costs of auto ownership, should make housing in dense urban areas more desirable. This factor is already being noted in Buffalo where in city housing is appreciating at a rate much greater than suburban housing. The housing market is also appreciating rapidly at transit stations, even in the low economic areas. This phenomenon is not unique to Buffalo and dramatically illustrates the catalytic effort of rail transit, even before operation begins.

The effects of transit on land use (and the reverse) are long term. In areas where there is no growth there will not be time-wise or region wide changes. Policymakers must be aware that there are a number of existing transit-land use models that must be evaluated over time. It is unrealistic to invest X dollars in one year and expect a quick return the next. The stage must be set for a combined infusion of support and reinforcement, at first with public sector participation and later, with private sector participation. The analytic models used in the study showed how sensitive each area in the region could be to demographic and economic change, yet how localized transit effects would be. But these analytic models assumed that certain changes (e.g., population shifts, employment shifts) had taken place. Analytic models look at one point in time. Time must pass for those situations to come about.

Thus, policymakers should expect there to be a period of elasped time before returns on the public investment will occur. Simultaneously, planners should designate the time frame over which they expect changes to occur and should clearly delineate the level and source of expected change.

The most critical of the changes are employment changes. These should be monitored on an annual basis and compared with projected changes so that shifts in land use, activities, and the resultant demand for transit can be determined.

This study has shown that a larger capital rail transit investment has implications that range much further than ridership evaluations. Ridership, of course, is why transit is located in a specific network. But a large public investment requires an analysis of the non-rider impacts, one of the most improtant being economic impact. The Buffalo Light Rail Rapid Transit System, to date, has shown that a new transit system installed in a declining city can make the difference in the revival of a declining part of the city.

REFERENCES

(1.1) Paaswell, R., J. Berechman, et al, "An Analysis of Joint Development Projects". Final Report No. NY-11-0022 to Urban Mass Transportation Administration, Department of Civil Engineering, State University of New York at Buffalo, May, 1979.

(2.1) Knight, R. and L. Trygg, "Land Use Impacts of Rapid Transit Implication of Recent Experience" Report DOT-TPI-10-77-31 U.S. Dept. of Transportation, Washington, D.C., Dec. 1977.

(2.2) Niagara Frontier Transportation Authority, "Ridersidp and Operations Analysis," N.F.T.A. Metro Construction Division A Perferred Feeder Bus Network, December 1978.

(2.3) Niagara Frontier Transportation Authority, op cit.

(2.4) Niagara Frontier Transportation Authority and Alan M. Voorhees and Associates, "Metro for Buffalo: Transit Alternatives for the Buffalo-Amherst Corridor Technical Report," June, 1976.

(2.5) 1985 Socio-Economic Forecasts, Niagara Frontier Transportation Committee, 2nd edition, Buffalo, 1977.

(2.6) Paaswell, R.E., Statement at Buffalo City Council Meeting, January 19, 1980;.

(2.7) "Downtown Office Space: A New Boon?", Cindy Skrzycki, Buffalo Evening News, August 5, 1979, p. B4.

(2.8) "NFTA to Act for City in Funds Bid," Roy Dearlove, Courier Express, Buffalo, N.Y., March 11, 1980.

(2.9) New York State Department of Transportation, Region 5, Buffalo, N.Y., "Problem Definition and Projected Proposed for Construction of Elm-Oak Arterial Extension, City of Buffalo, Erie County," p. 1, 38, 27-28.

(3.1) Buffalo Downtown Data Base. Greater Buffalo Development Foundation, December 1978, Buffalo, N.Y.

(3.2) Parker-Simon, K. and R. Paaswell, "Population and Economic Data in Transit Analysis. Journal Urban Planning Division ASCE, November, 1980. pp. 43-58.

(3.3) Paaswell, R., et al, Retail Attractiveness Models, Working Paper 9, Joint Development Program, Dept. of Environmental Design and Planning State University of N.Y. at Buffalo, April 1980.

(4.1) Davidson, K.B., "Accessibility in Transport/Land-Use Modelling of Assessment," Environment and Planning, A, 1977,, Vol. 9, pp. 1401-1416.

(4.2) Foot, David (1978), "Urban Models I: A Computer Program for the Garin-Lowry Model", Geographical Papers No. 65, Dept. of Geography, University of Reading.

APPENDIX 1

Basic Information on Study Area

Zone	Total Area(mi^2)	Unusable Land	Basic Industry Land	Retail Industry Land	Residential Land	Vacant Land	Population (1972)	Population Density (residential land only; persons/mi^2)	Capacity Population	Actual population as a Percentage of Capacity Population
1 } 2 }	1.34	0.71	0.08	0.24	0.12	0.19	7,415	61,792	19,900	37
3	1.70	0.92	0.05	0.07	0.65	0.02	26,374	40,575	48,800	54
4	1.31	0.51	0.03	0.21	0.54	0.03	19,559	36,220	18,100	108*
5	0.92	0.34	0.03	0.06	0.46	0.04	16,582	36,048	28,500	58
6	1.07	0.44	0.09	0.07	0.34	0.13	13,584	39,953	26,000	52
7	1.79	0.63	0.41	0.09	0.48	0.18	20,696	43,117	67,000	31
8	2.08	1.21	0.12	0.06	0.58	0.10	27,800	47,931	28,400	98
9	1.74	0.92	0.03	0.07	0.70	0.02	21,724	31,034	45,000	48
10	3.10	0.93	0.87	0.19	0.93	0.17	30,465	32,758	42,800	71
11	3.60	1.44	0.36	0.18	1.51	0.11	34,498	22,846	33,400	103*
12	5.01	2.00	0.35	0.25	2.25	0.15	62,761	27,894	79,100	79
13	4.16	1.29	0.67	0.21	1.83	0.17	68,304	37,325	85,100	80
14	4.67	1.12	1.59	0.19	1.17	0.61	36,680	31,350	46,600	79
15	9.69	1.07	4.17	0.19	1.65	2.62	15,962	9,674		
16	8.91	0.80	0.27	0.62	7.13	0.09	84,258	11,817		
17	6.52	2.61	0.78	0.26	2.54	0.33	11,886	4,680		
18	6.89	0.28	0.76	0.55	5.03	0.28	34,623	6,883		
19	6.19	1.73	0.25	0.12	3.84	0.25	40,486	10,543		
20	6.30	0.38	2.14	0.38	2.39	1.01	25,462	10,654		
21	10.03	1.91	1.60	0.50	4.71	1.30	50,054	10,627		
22	7.37	0.15	3.02	0.07	1.70	2.43	13,048	7,675		
23	11.58	0.93	4.52	0.12	1.74	4.17	15,222	8,748		
24	10.27	2.26	0.82	0.41	6.16	0.62	29,237	4,746		
25	34.29	2.06	25.03	0.34	4.46	2.40	28,024	6,283		
26	38.53	1.93	26.20	0.19	2.12	8.09	5,946	2,805		
27	32.85	3.94	1.64	0.33	4.27	22.67	17,278	4,046		
28	29.87	1.78	13.05	0.89	3.56	10.38	79,223	22,254		
28a	8.90	0.36	4.90	0.09	0.71	2.85				

*Actual population exceeds proposed capacity population.

APPENDIX 1 cont.

Zone	Total Area(mi^2)	Unusable Land	Basic Industry Land	Retail Industry Land	Residential Land	Vacant Land	Population (1972)	Population Density (residential land only; persons/mi^2)	Capacity Population	Actual population as a Percentage of Capacity Population
29	21.37	1.50	2.99	0.64	8.98	7.27	50,692	5,645		
30	9.87	3.75	2.86	0.20	1.97	1.09	47,791	24,259	77,000	62
31	5.69	0.40	2.16	0.23	2.11	0.80	24,914	11,808		
32	31.40	1.57	8.79	0.63	9.42	11.00	35,338	3,751		
33	48.78	2.93	15.12	0.49	7.32	22.93	40,058	5,472		
34	4.96	0.50	1.64	0.29	1.59	0.94	19,151	12,045		
City of Buffalo	42.36	16.21	7.54	2.09	13.53	3.01	436,506	32,262	645,700	68
Total Study Area	382.75	45.30	127.39	9.43	94.96	105.44	1,055,095	11,111		

Changes in Population and Employment Multipliers

Erie County trends of population to employment can be summarized as:[1]

	P/E
1950	2.57
1959	2.74
1970	2.64
1985	2.39

There has been a corresponding growth in service employment. The service employment/population ratio, B is given as:

1950	.102
1959	.109
1970	.142
1985	.197

Based on linear regression analysis, the regional income is computed:

Year	Regional Income ($Millions)
50	2,643
59	3,596
70	4,808
85	7,553

[1] 1985 trend estimates from, NFTC, Technical Memo No. 7, May 1977.

APPENDIX 1 Cont.

Base Year (1975) Employment and Population Distributions

ZONES	BASIC EMPLOYMENT	SERVICE EMPLOYMENT	TOTAL EMPLOYMENT	EMPL DENS	POPL DENS	TOTAL POPULATION	RESIDENTIAL ATTRACTOR	SERVICE ATTRACTOR	ZONES
1	7264.	28154.	35418.	54429.2	2735.4	1778.	25.	1122.	1
2	8[illegible]3.	17573.	25[illegible]6.	37[illegible].7	4162.6	5637.	7.	669.	2
3	879.	2614.	3493.	2654.7	15514.1	26374.	62.	104.	3
4	2379.	12364.	14743.	11223.7	14938.5	19559.	255.	493.	4
5	474.	4836.	5310.	5771.7	18027.9	16592.	38.	192.	5
6	4942.	9342.	14684.	13910.3	12695.3	13594.	15.	342.	6
7	4818.	5726.	10544.	5897.5	11362.0	[illegible]695.	[illegible]	226.	7
8	4184.	4965.	9149.	4395.6	13365.4	27503.	153.	15[illegible].	8
9	564.	8464.	9028.	5185.5	12495.1	21724.	249.	337.	9
10	7643.	4636.	12279.	3961.0	9327.4	30465.	131.	185.	10
11	1822.	10431.	12253.	3403.6	9582.9	34498.	451.	416.	11
12	4971.	17169.	22140.	4413.2	12527.1	62761.	626.	684.	12
13	9599.	6879.	16477.	3963.8	16419.2	65334.	182.	274.	13
14	10586.	7396.	18182.	3871.9	7854.4	35598.	98.	255.	14
15	22204.	3868.	26072.	2690.6	1647.3	15962.	130.	154.	15
16	1590.	11974.	13564.	1522.3	9456.6	94256.	1302.	477.	16
17	542.	5400.	5942.	911.3	1823.0	11886.	2[illegible]9.	215.	17
18	1409.	6932.	8341.	1210.6	5025.1	34523.	613.	276.	18
19	1617.	4525.	6142.	932.2	6541.5	40486.	467.	159.	19
20	4904.	5587.	10491.	1665.2	4041.6	25452.	227.	222.	20
21	4650.	6984.	11634.	1159.9	4399.4	50054.	413.	276.	21
22	122.	1163.	1285.	174.4	1770.4	13046.	124.	40.	22
23	212.	790.	1002.	95.5	1314.5	15222.	150.	31.	23
24	2304.	9942.	12246.	1192.4	2846.8	29237.	456.	356.	24
25	7839.	2968.	10807.	315.2	917.3	28024.	260.	118.	25
26	162.	571.	733.	19.0	154.3	5946.	60.	23.	26
27	1815.	1299.	3114.	94.6	526.0	17278.	207.	52.	27
28	17939.	14627.	32566.	84[illegible].0	2843.4	79223.	881.	583.	28
29	2277.	7542.	9819.	459.5	2372.1	50692.	595.	302.	29
30	11720.	8503.	20223.	2049.9	4842.0	47751.	311.	282.	30
31	12505.	4646.	17151.	3014.2	4378.6	24914.	248.	242.	31
32	1208.	3962.	5170.	164.6	1125.4	35338.	346.	158.	32
33	2363.	4993.	7346.	150.6	921.2	40058.	520.	199.	33
34	2566.	3590.	6156.	1241.1	3861.1	19151.	140.	144.	34
TOTAL	168096.	251004.	419100.	1095.0	2756.6	1055095.			

APPENDIX 1 Cont.
Interzonal Travel Time for Work-Time Trips (1975)

ZONES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	2.1	2.9	6.0	9.4	10.4	7.3	5.1	13.5	13.7	16.1	18.4	17.3	13.4	13.6	19.7	25.9	31.6
2	2.9	2.1	6.4	7.0	8.3	4.3	7.5	14.3	10.8	15.4	16.2	15.1	11.6	15.7	19.0	24.1	29.0
3	5.1	5.6	3.1	6.0	10.8	10.0	10.2	7.9	11.4	12.9	17.6	20.6	19.2	19.0	18.6	24.0	29.7
4	7.8	6.0	6.7	2.8	4.8	4.9	11.4	7.1	6.0	15.4	13.4	15.2	13.2	18.5	21.3	[illegible]	25.9
5	8.6	6.9	11.6	3.9	5.0	4.7	8.2	9.9	9.5	10.6	13.6	12.5	8.5	13.9	21.3	14.3	25.6
6	5.8	7.6	10.6	4.8	5.6	2.8	6.4	16.0	5.0	21.8	17.6	15.4	10.1	14.2	24.7	[illegible]	[illegible]
7	4.7	6.1	[illegible]	12.7	9.6	7.9	3.1	17.6	13.5	25.5	22.6	10.6	9.8	[illegible]	25.7	27.7	[illegible]
8	10.4	11.5	6.8	6.3	9.1	11.1	15.9	3.3	4.6	4.6	10.6	13.6	15.6	[illegible]	[illegible]	[illegible]	[illegible]
9	11.3	9.2	10.2	4.8	3.5	6.4	10.8	6.1	3.1	15.0	9.1	[illegible]	12.4	18.3	20.6	15.9	[illegible]
10	11.4	11.2	6.6	13.2	15.9	19.3	23.9	7.9	11.0	5.0	9.9	19.9	21.4	26.6	9.1	9.2	17.7
11	13.7	11.6	13.2	10.8	11.0	14.7	19.9	8.2	7.4	8.2	4.2	11.1	18.0	24.0	10.8	7.7	15.8
12	12.6	10.5	14.4	11.1	8.8	10.7	16.0	12.4	6.3	15.7	10.7	5.0	7.6	14.8	15.5	[illegible]	14.6
13	11.2	10.4	18.2	11.4	7.5	6.9	7.9	15.5	9.4	23.6	17.6	6.5	5.5	7.9	[illegible]	[illegible]	21.4
14	11.3	13.4	18.1	19.3	14.9	16.2	7.9	25.6	18.7	28.3	25.4	14.1	9.5	[illegible]	31.5	[illegible]	30.9
15	11.8	11.7	9.5	19.1	[illegible]	21.9	25.9	16.2	12.7	9.0	11.3	19.1	19.0	23.8	4.5	7.6	[illegible]
16	15.8	15.0	15.5	17.7	17.3	15.2	23.9	14.5	14.1	7.5	7.6	15.9	22.5	28.7	2.5	4.3	[illegible]
17	20.4	15.6	18.6	21.9	20.6	23.9	25.5	20.3	17.9	16.4	15.5	12.0	18.3	26.0	12.7	[illegible]	7.4
18	14.5	16.5	19.2	16.4	14.5	18.1	20.6	17.9	12.1	20.0	15.7	6.9	12.6	[illegible]	15.5	[illegible]	8.7
19	13.2	12.0	16.7	16.3	13.4	14.8	13.9	17.9	12.1	21.1	15.2	5.4	6.6	15.3	17.5	[illegible]	[illegible]
20	15.8	14.5	18.2	15.7	13.2	15.4	14.1	20.6	15.5	23.9	20.3	9.6	6.4	12.4	25.2	[illegible]	19.4
21	17.3	16.6	14.6	17.8	20.8	23.9	28.4	18.9	16.4	12.8	13.1	18.4	23.0	[illegible]	[illegible]	[illegible]	[illegible]
22	22.1	17.3	14.9	27.0	25.6	28.6	29.9	25.0	23.2	18.9	19.2	17.5	20.2	29.6	11.1	[illegible]	6.1
23	21.1	19.3	22.1	22.7	21.0	24.0	25.3	24.0	18.6	20.1	20.4	12.9	18.8	25.0	[illegible]	13.3	[illegible]
24	18.9	17.1	20.3	19.8	18.1	21.1	22.4	21.1	15.7	21.0	16.1	10.0	15.9	22.1	16.5	14.7	8.2
25	30.7	29.8	27.8	30.8	33.8	36.8	41.4	31.9	29.4	25.8	26.1	27.5	31.2	[illegible]	19.3	19.5	10.1
26	26.1	24.3	27.1	35.0	[illegible]	36.5	37.9	33.0	31.2	26.9	27.2	25.5	28.2	37.6	19.1	[illegible]	[illegible]
27	19.1	17.6	15.6	18.6	24.2	27.0	31.8	19.8	17.2	13.7	15.5	23.5	23.8	[illegible]	7.1	9.9	16.4
28	20.4	18.7	22.4	20.3	17.9	19.3	18.7	23.3	17.9	26.0	20.3	12.2	12.2	18.0	23.4	23.9	[illegible]
29	17.0	18.6	17.7	22.8	27.3	23.5	14.6	32.7	27.3	26.1	34.2	22.5	20.4	[illegible]	35.2	[illegible]	17.5
30	12.6	15.9	12.5	[illegible]	21.5	19.1	11.2	28.7	25.6	35.6	32.2	26.4	21.2	12.2	32.2	[illegible]	[illegible]
31	12.1	15.6	14.8	29.6	28.3	26.7	19.5	24.7	33.9	24.7	27.0	26.0	25.1	[illegible]	[illegible]	[illegible]	[illegible]
32	14.2	16.0	14.5	37.0	35.3	33.3	27.5	23.4	40.1	23.3	26.1	29.2	24.5	[illegible]	31.5	37.5	34.4
33	18.4	20.2	19.6	33.9	33.2	30.2	24.4	27.6	37.0	27.5	30.3	29.4	28.7	24.1	35.7	41.7	[illegible]
34	27.2	25.9	23.9	27.7	37.3	36.3	40.9	28.9	26.3	22.8	25.6	32.6	32.9	37.9	18.2	17.0	25.5

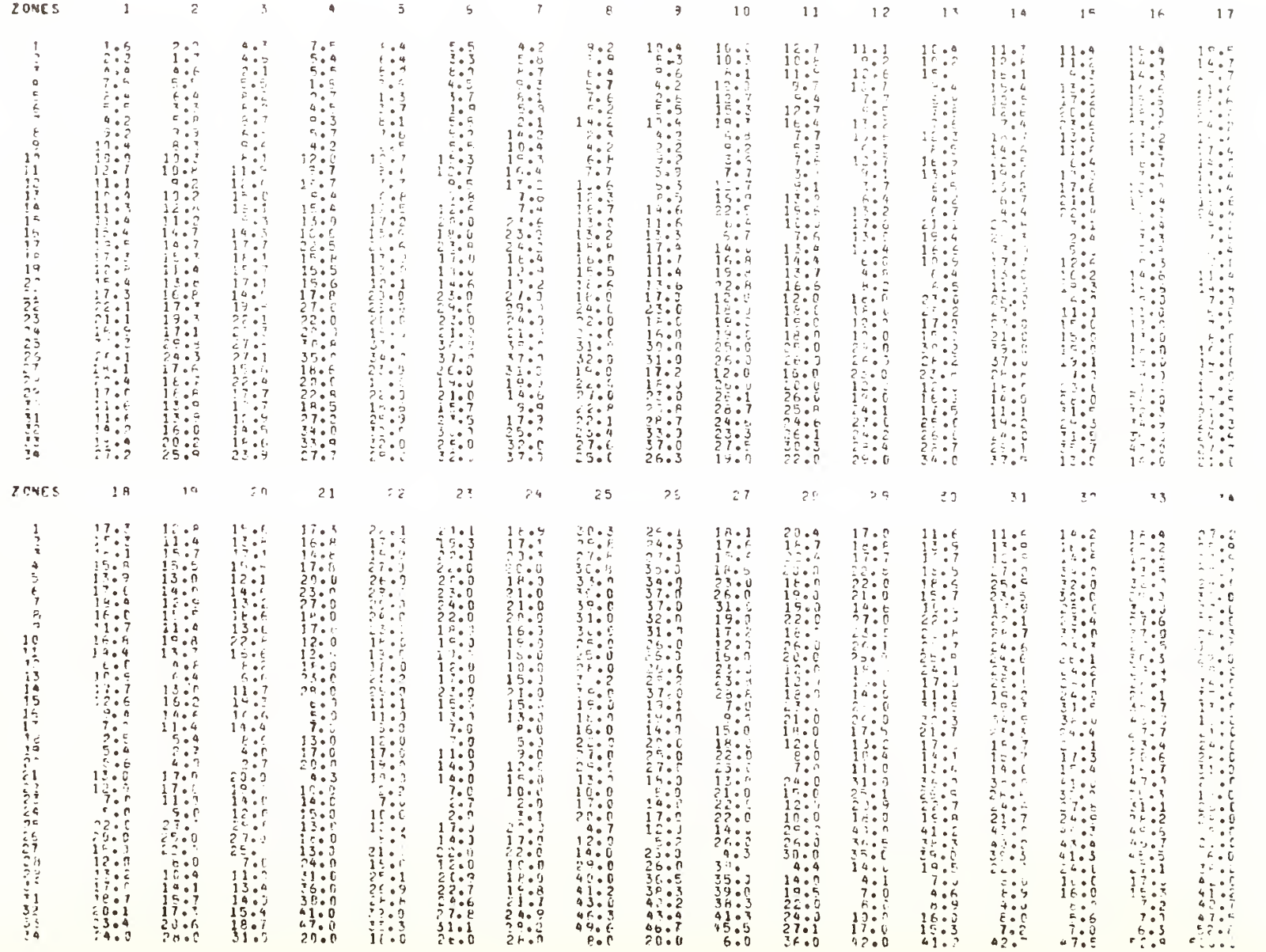
ZONES	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1	25.4	18.9	21.2	28.5	37.1	31.6	28.8	44.6	42.2	29.1	28.4	21.7	15.4	18.0	22.3	[illegible]	[illegible]
2	24.2	17.6	19.6	27.5	34.3	25.8	27.0	43.8	47.4	28.0	26.6	23.5	17.7	21.1	24.1	[illegible]	[illegible]
3	27.0	23.4	30.6	24.8	[illegible]	33.6	30.7	41.1	47.6	25.3	31.9	25.3	17.8	21.9	24.2	[illegible]	[illegible]
4	21.3	19.3	15.1	24.8	32.4	26.7	25.8	41.1	42.9	28.6	27.0	28.3	22.9	30.3	39.4	[illegible]	[illegible]
5	18.4	15.7	14.9	23.0	32.0	25.5	22.6	39.3	39.7	29.1	21.5	27.6	22.6	30.4	36.7	47.2	[illegible]
6	21.9	17.3	17.8	26.8	[illegible]	26.7	25.2	47.1	42.9	32.9	23.2	24.6	19.6	28.0	35.7	[illegible]	[illegible]
7	24.7	17.2	17.4	32.6	37.9	30.9	29.0	48.9	43.1	36.7	23.4	19.3	13.6	22.7	31.1	[illegible]	[illegible]
8	20.7	21.4	22.5	21.9	[illegible]	28.2	25.3	36.2	42.4	24.1	28.2	34.7	26.7	27.5	26.5	[illegible]	[illegible]
9	14.4	16.9	16.1	20.0	27.6	23.9	21.0	36.3	38.1	28.2	[illegible]	30.4	25.4	34.4	41.1	[illegible]	[illegible]
10	[illegible]	25.9	26.8	14.4	[illegible]	23.5	24.7	30.7	33.4	16.4	32.0	39.8	27.6	30.2	31.4	[illegible]	[illegible]
11	17.2	17.3	21.3	13.1	20.7	22.2	20.6	29.0	32.1	18.6	24.5	32.7	30.6	[illegible]	34.2	[illegible]	[illegible]
12	5.2	7.5	11.5	21.2	21.9	13.4	12.5	37.5	29.5	26.7	16.4	29.6	28.9	31.5	32.3	37.6	[illegible]
13	14.3	8.1	[illegible]	25.9	25.1	21.6	18.7	43.2	35.8	32.4	15.3	21.6	21.6	29.7	32.5	37.0	[illegible]
14	23.6	16.9	15.7	25.6	[illegible]	25.4	26.5	41.9	47.6	39.8	22.5	18.8	14.6	24.2	31.7	[illegible]	[illegible]
15	[illegible]	[illegible]	24.6	7.9	16.9	18.4	19.?	24.2	32.5	9.8	28.8	37.0	27.1	28.2	31.?	[illegible]	46.?
16	13.1	21.0	[illegible]	6.5	14.1	15.6	16.4	22.8	25.5	11.9	25.9	34.4	29.3	32.7	35.?	[illegible]	16.0
17	8.1	14.2	[illegible]	6.6	7.6	9.1	10.3	21.?	13.0	18.5	19.8	25.0	31.0	33.5	35.3	[illegible]	[illegible]
18	3.4	8.2	[illegible]	16.6	15.4	6.9	6.?	29.7	23.1	22.4	15.5	18.9	25.9	26.5	29.0	34.6	[illegible]
19	[illegible]	3.7	6.7	21.?	20.7	14.2	13.4	35.?	28.4	26.8	10.3	15.2	20.5	23.0	25.5	[illegible]	[illegible]
20	10.1	[illegible]	3.5	25.5	24.3	17.8	14.9	22.0	32.0	31.8	8.4	14.9	15.6	19.8	21.0	[illegible]	[illegible]
21	15.0	20.3	23.3	5.9	13.5	17.9	19.1	16.3	24.9	16.1	32.4	40.5	33.2	36.7	41.5	[illegible]	[illegible]
22	12.3	17.6	21.2	10.2	2.7	11.0	13.3	14.3	11.4	20.9	22.8	31.1	33.4	36.4	41.4	[illegible]	27.1
23	7.7	13.0	16.6	16.1	7.3	3.4	2.3	21.6	14.2	25.9	11.8	26.6	28.9	31.9	36.3	[illegible]	[illegible]
24	4.8	10.2	17.7	17.9	10.2	2.9	3.6	24.5	17.1	26.3	9.5	23.7	26.9	29.0	34.0	[illegible]	[illegible]
25	22.3	27.6	31.2	[illegible]	10.?	21.?	23.3	5.9	12.6	17.3	32.8	41.1	43.4	46.4	51.4	[illegible]	[illegible]
26	29.3	25.6	29.2	18.?	9.0	14.2	15.5	12.0	6.6	28.9	26.0	39.1	41.4	44.4	49.4	[illegible]	[illegible]
27	20.3	25.6	29.2	15.0	24.0	25.5	26.3	17.3	29.3	5.4	35.9	44.1	32.1	33.5	38.4	47.7	[illegible]
28	13.5	8.2	6.7	30.1	22.7	15.4	12.5	37.0	29.6	35.0	5.5	17.6	21.1	21.6	26.7	33.7	41.?
29	13.2	10.4	14.9	44.8	25.1	20.9	18.0	39.4	36.5	49.0	14.1	5.1	8.6	9.4	12.6	21.1	[illegible]
30	16.4	15.5	14.8	39.1	28.9	22.7	19.8	41.2	38.3	40.4	19.8	6.9	6.1	11.6	14.2	19.5	[illegible]
31	20.0	17.0	15.5	39.?	28.8	24.6	21.7	43.0	40.2	36.3	27.0	7.5	10.2	5.7	13.3	10.6	[illegible]
32	22.1	17.3	15.4	42.0	32.0	27.8	24.9	46.3	43.4	41.3	30.2	12.6	18.4	10.3	7.2	[illegible]	47.?
33	23.4	20.6	19.7	46.2	35.?	31.1	28.2	49.5	40.7	45.5	27.1	19.4	15.3	7.2	8.8	[illegible]	51.?
34	29.4	34.7	36.7	24.1	21.1	32.1	34.4	11.1	23.1	9.1	43.9	52.2	41.2	42.7	47.5	52.2	500.0

ROW TOTALS :
702.6 677.0 732.0 716.3 677.2 722.0 777.5 694.8 666.5 697.4 639.7 605.1 667.4 520.3 642.6 641.4 [illegible]
591.8 584.0 622.0 716.6 727.5 671.6 625.4 961.0 926.6 781.7 714.7 814.4 790.9 835.6 907.0 974.4 1522.4

COLUMN TOTALS :
465.1 47?.2 513.1 591.6 596.8 629.0 652.5 631.9 572.9 656.3 628.6 577.9 589.1 725.8 670.4 607.4 [illegible]
589.1 580.8 640.1 779.0 795.3 725.5 682.4 1094.0 1069.7 918.4 792.3 878.4 817.5 915.2 1043.9 1240.5 1575.?

APPENDIX 1 Cont.

Travel Times for Home Service Trips



APPENDIX 1 Cont.

Prediction Runs (1985 Data)

Run number	Type	Purpose
1	1985 C_{ij}^{wh}	New Travel Times for Work Trips due to LRRT
2	1985 C_{ij}^{hs}	New Travel times for shopping trips due to LRRT
3	1985 $C_{ij}^{wh} + C_{ij}^{hs}$	Combined new travel times due to LRRT
4	1985 Basic Emp. (BE)	Investment effect
5	1985 BE + $C_{ij}^{wh} + C_{ij}^{hs}$	Total impact of changes in basic employment and travel times
6	1985 Residential Attractors (RA)	Change in zonal attraction for residential
7	1985 Service Attractors (SA)	Change in zonal attraction for services
8	1985 RA + SA	Total change in zonal attraction
9	1985 BE + RA + SA + $C_{ij}^{wh} + C_{ij}^{hs}$	Overall impact of LRRT
10	1985 Pop./Emp. (P/E)	Changes in over time
11	1985 Service Emp./Pop (S/P)	Changes in B over time
12	1985 P/E + S/P	Changes in a + B
13	1985 BE + P/E + S/E	Expected changes in employment
14	1985 Pop. Max. Constraint (PMC)	Zoning on new population
15	1985 Service Max. Constraint (SMC)	Zoning on new services
16	1985 PMC + SMC	Zoning on total new activity
17	1985 $\frac{\text{Work}}{(C1)}$ Mean Travel Cost	Change in Service Trip distribution

APPENDIX 1 Cont.

Run number	Type	Purpose
18	1985 Service Mean Travel ($\overline{C2}$)	Change in Service Trip distribution
19	1985 $\overline{C1}$ + $\overline{C2}$	Overall change in trip distribution
20	1985 C_{ij}^{wh} + C_{ij}^{hs} + $\overline{C1}$+$\overline{C2}$	Total change in trip pattern

Appendix 2

AN ANALYSIS OF JOINT DEVELOPMENT PROJECTS: WORKING PAPERS

PAPERS COMPLETED

Working Paper #1: "Review of the Literature," includes Bibliography by category, Appelstein, McNally, Paaswell (Oct., 1978).

Working Paper #2: "J.D. and the Interaction of Transportation and Urban Form," Paaswell and Berechman (Aug. 1978).

Working Paper #3: "Technical Analysis of the Survey of Downtown Attractiveness," McNally and Paaswell (Oct. 1978).

Working Paper #4: "Model Formulation for Transportation and Land Use in the Joint Development Projects," Berechman, Paaswell, McNally and Morris (Aug. 1978).

Working Paper #5: "Regional and National Trends in Employment and Population," Parker-Simon and Paaswell (Oct. 1978).

Working Paper #6: "Profile of Attitudes Toward Downtown Shopping," Paaswell, Cirrincione, McNally, and Parker-Simon (May, 1979)

Working Paper #7: "Preliminary Calibration of a Lowry Model," Berechman, Paaswell, McNally and Kwoon (June, 1979).

Working Paper #8: "A Local Analysis of Joint Development," Parker-Simon and Paaswell (Nov., 1979).

Working Paper #9: "A Model of Retail Attractiveness, " Sievert, Cirrincione, McNally and Paaswell (1980).

Working Paper #10: "Retail Variable Construction and Analysis," Riese, Sievert, and Paaswell (Dec., 1979).

Working Paper #13: (Accessibility Model), Riese, (January, 1980).

Working Paper #14: "Investment Impacts of the Rapid Transit System," Paaswell and Berechman (Nov., 1979).

WORKING NOTES

"Attractiveness of Downtown, Summary of Progress: Task 2," Paaswell, Parker Simon and McNally (Feb. 1979).

"Federal Programs Relating to Urban Investment," Compiled by Riese (July, 1979).

"Community Interviews," Parker-Simon (Oct., 1979).

"Travel Time Difference Matric," Bogan (Oct., 1979).

"Land Use Distributions (in $mi.^2$) in 34 zones: (zones 1-14, 30: City Plan Units Data)," Sievert (Oct., 1979).

"Lowry Model: Prediction Runs (1985 Data) and Sensitivity Runs", Berechman, January, 1980.

"Buffalo SMSA Capital Investment 1978-1984", Riese, Feb., 1980.

"Zonal Accessibility: Service Before LRRT, Service After LRRT, Work before LRRT, Work after LRRT", Feb., 1980.

FINAL REPORT

"First Year Report," Paaswell, Berechman, Parker-Simon, McNally, Cirrioncione, Kwoon and Appelstein (May, 1979).

PROCEEDINGS

Paaswell, R. and J. Berechman, "Joint Development: Impacts of Rapid Transit and Land Development in the City of Buffalo," Proceedings of PTRC Annual Meeting, Transportation Planning Practice Seminar, University of Warwick, England, July 11, 1979.

PRESENTATION PAPERS

"Briefing Notes for October 23, 1979 Meeting," Paaswell, et al Oct., 1979.

"Population and Economic Data used in Impact Analysis: Case Study of Buffalo, N.Y.," Parker-Simon and Paaswell, presented at: State University of New York Urban Research Project, Seminar Series Program Seminar on population Counts, at State University of New York at Stony Brook, Stony Brook, New York, December 7, 1979, and also submitted to Journal of the Urban Planning Division of ASCE, 1980.

"Transit Investment and Its Returns", (with J. Berechman), presented at World Conference on Transport Research, London, England, April, 1980.

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