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BIBLIOGRAPHY OF LITERATURE ON CURRENT TRENDS IN LAND-USE TRANSPORATION INTERACTIONS

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SUMMARY OF SELECTED LITERATURE ON LAND-USE TRANSPORTATION INTERACTIONS AND ALTERNATIVELY FUELED BUSES

Volume 1: Land Use and Transportation Interactions

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Contents of Volume 1:
Land Use/Transportation Interactions

1 INTRODUCTION 1

2 LAND USE AND TRAVEL BEHAVIOR 2

3 RESEARCH AND PLANNING ACTIVITIES DIRECTLY ADDRESSING LAND USE/TRANSPORTATION RELATIONSHIPS 4

4 LAND USE/TRANSPORTATION ANNOTATED BIBLIOGRAPHY . . . 8

5 GLOSSARY 29

6 REFERENCES 31

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INTRODUCTION

Continuing challenges in attaining National Ambient Air Quality Standards and the passage of the Clean Air Act Amendments of 1990 have inspired renewed efforts to identify and implement innovative new control strategies. In most urban areas, motor vehicles contribute approximately 50 percent of emissions involved in ozone and approximately 90 percent of carbon monoxide nonattainment problems. Increased reliance on alternative fuels, increased understanding and use of the interdependence of land use and transportation, and alternative technologies such as electric vehicles are among the many innovative strategies under discussion. This volume provides a preliminary bibliography of literature relating to land use/transportation/air quality interactions. Volume two of this set provides a review of literature relating to alternatively-fueled buses.

It is important to note that there is a specific focus for each subject area and that the scope of this bibliography is not intended to cover either the vast body of related research (i.e. land use and urban planning in general), or to comprehensively review all material relating to land use/transportation/air quality interactions. Rather it is intended to provide a source of information on the scope and nature of current research. Therefore, for example, literature on transportation/economic effects (which have direct effects on travel behavior and air quality), as exemplified by a 1989 Transportation Research Board Conference on transportation and economic development, is not included in this review. State and local agencies wishing to use such strategies should also plan to draw on sources other than those reviewed here.

The remainder of this report is organized as follows: (1) a summary discussion of the importance of land use/transportation interactions and examples of research relating to strategies utilizing these interactions, (2) bibliography of land use/transportation material, including brief abstracts (one to two paragraphs) of each reference, (3) summary of alternatively fueled buses, and (4) bibliography of alternatively fueled bus studies, including abstracts. Items one and two are incldued in volume one; items two and three are included in volume two. Each volume is separately bound.

LAND USE AND TRAVEL BEHAVIOR

The interdependence of land use and travel behavior, while self-evident, is rarely considered explicitly or interactively in land use and transportation planning activities. For example, land use models forecasting future population and land uses are exercised based on a given set of assumptions on the future roadway network and transportation system. Transportation models are run to examine numerous transportation scenarios using output from land use models (based on one transportation scenario). Such practices are encountering increased criticism, in the form of law suits[1] and new studies on how to better integrate transportation models with air quality models[2]. The conformity requirements in the Clean Air Act, particularly as amended in 1990, require more detailed assessments of transportation/air quality relationships than have been common in the past. Additionally, "Indirect Source Control" approaches such as those contained in the Clean Air Act, encourage quantification of mobile source emissions associated with "a facility, building, structure, installation, real property, road, or highway which attracts, or may attract, mobile sources of pollution" (section 110a). Such requirements, coupled with the need for significant reductions in mobile source emissions to comply with air quality standards, are making control strategies that rely on land use/transportation/ interactions more and more attractive.

In addition, continued urban "sprawl" and similar trends in land-use are having unprecedented and unexpected impacts on travel behavior, many of which are not easily quantified or analyzed using existing modeling tools and algorithms. Many researchers are beginning to believe that urban sprawl and the growth of 'edge cities' constitute new paradigms in transportation/land use interactions that are not represented in current land use or transportation models. Presently, only one project within the U.S. is attempting to develop a modeling tool that explicitly incorporates interactions between land-use, urban design, and transportation behavior. Much research is focused on examining particular aspects of the relationship, and on some of the potential implications for developing algorithms to predict how a change in land use might affect travel behavior.

As discussed in the introduction, this review does not attempt to summarize the vast body of literature on land use modeling, urban design and planning, growth management, congestion management, economic effects of land use policies, site specific studies, and

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[1] The lawsuit by Sierra Club and Citizens for a Better Environment against the San Francisco Bay Area's Metropolitan Transportation Commission (MTC) over the MTC's modeling of land use/transportation interactions in a conformity assessment is a well known example.

[2] For example, the National Association of Regional Councils is sponsoring a study by Grieg Harvey and others to review transportation analysis capabilities known colloquially as the "Best Practices" study. A paper entitled: Toward Improved Regional Transportation Modeling Practice" (Harvey and Deakin, 1991) is the first written product resulting from that study. A study more explicitly focused on land use/transportation/air quality interactions known most commonly as the 1000 Friends of Oregon study (1000 Friends of Oregon, 1991), is reviewed later in this bibliography.

the like, although each of these is an important component of land-use/transportation relationships. Here, selected recent or dated but seminal articles and activities that directly address land-use/transportation interactions on a regional scale are summarized. The bibliography and accompanying summary of some current activities and research projects provides a flavor of the controversies and issues under study. As the review is not intended to be comprehensive, a number of relevant articles are not reviewed here. In addition, it is very likely that within the next year and beyond, much new literature and work will be accomplished in this subject. Areas using this review should check with regional metropolitan planning organizations and local EPA offices to identify any additional recent work.

Most of the literature for this review was identified through an on-line computer search of the Institute of Transportation Studies library at the University of California at Berkeley and reference lists from recent technical conference papers.

RESEARCH AND PLANNING ACTIVITIES DIRECTLY ADDRESSING LAND USE/TRANSPORTATION RELATIONSHIPS

In the past several years, and in particular since the passage of the Clean Air Act Amendments of 1990 and the Intermodal Surface Transportation Efficiency Act of 1991, transportation, environmental and land use planning agencies at the municipal, regional, and State level are increasingly coordinating their planning efforts. Such efforts range from multi-agency working groups such as the Philadelphia Area Modal Integration Committee or the San Francisco Bay Area's "Jumpstart" program to research projects aimed at identifying the impacts of various "urban forms" on traffic and air quality, to full-fledged long term plans integrating goals such as better air quality, lower traffic congestion, and adequate infrastructure to meet anticipated population growth. As discussed above, regulatory requirements pertaining to conformity planning and indirect source review are also important motivating factors for increased consideration of land-use and transportation relationships as they pertain to air quality. This section summarizes a number of these efforts in order to provide a flavor of their nature and range. The bibliography section follows this summary.

1000 Friends of Oregon: Making the Land Use, Transportation and Air Quality Connection

A number of studies are currently being conducted for the specific purpose of developing a better understanding of land use and transportation interactions. The most well known of these is the 1000 Friends of Oregon Study: Making the Land Use, Transportation, Air Quality Connection (LUTRAQ). LUTRAQ is a national demonstration project to develop methodologies for changing local land use policies and development designs to increase the use and economic feasibility of alternatives to automotive travel. The project purpose is to "develop methodologies for changing local land use policies and development designs to increase the use and economic feasibility of alternatives to automotive travel". The project is using a proposal for a $200 million bypass freeway around the Portland, Oregon metropolitan region as a case study and is developing methods for "using alternative land use development patterns as a method of reducing travel demand, and using land use as a dynamic, interactive variable in transportation modeling procedures". The project will provide a model of how land use policy can be used to address transportation and air quality problems in large metropolitan areas. Findings from the project were used to educate policy-makers working on re-authorization of the Surface Transportation Act, and are being used to guide implementation of the CAAA, to bolster new state land use planning programs, to influence other highway proposals in the U.S., and the analyze alternative solutions to transportation problems in the Portland region.

The first report in the LUTRAQ project (CSI, 1991) reviews 14 interactive transportation and land use modeling systems from around the world. The summary describes the theoretical basis, operational characteristics, and recent applications of each model. The second chapter of the report surveys the state of the practice in transportation and land

use forecasting at the metropolitan level in the United States, concluding that land use forecasting has remained essentially the same for 20 years. Chapter 3 provides a description and analysis of the transportation and land use forecasting system in use in Portland, Oregon, concluding that while this system has some state-of-the-art enhancements, it still has many of the shortcomings of other such systems in that (1) the ways in which people's choices of where to work are determined by congestion and travel costs; and (2) the ways in which designs oriented to pedestrians, bicycles and transit can influence decisions about where and how to travel. Additional reports are expected to be released in late October, 1992.

Sierra Club/Citizens for a Better Environment (CBE) Suit Against San Francisco Bay Area's Metropolitan Transportation Commission (MTC)

A well known suit brought by Sierra Club against an MTC conformity analysis focused largely on land use/transportation/air quality effects. While Sierra Club and CBE had a number of objections to the manner in which MTC performed the analysis, a key objection related to the fact that MTC did not model the potential growth inducing effects of additional highway capacity. In declarations for Sierra Club, a consultant maintained that (1) there was evidence that even in highly developed regions, capacity additions increased accessibility and therefore increased growth, and (2) that there were newly developed models capable of quantifying these impacts. In a March 11 1991 decision, the District Court for Northern California found that "MTC's decision not to analyze capacity-related growth at this juncture is reasonable under the circumstances. First, there is scant empirical evidence demonstrating an identifiable link between adding or not adding highway capacity, in an already substantially developed region, and population influx from outside the region that would not otherwise occur...we cannot conclude that MTC's failure to analyze capacity-related growth will not significantly detract from its conformity determination". The court also found that "as a practical matter, there is no existing computer model designed to capture the dependence of regional growth upon changes in highway capacity".

Maricopa County, Arizona: Urban Form Impacts on Mobility, Air Quality and Other Factors

Some regions are beginning to look explicitly at how a region's structure and form affect transportation and air quality. For example, an ongoing study being performed by the Maricopa Association of Governments encompassing the Phoenix metropolitan area in Arizona is examining the impact of several specific "urban forms" on mobility, air quality, infrastructure costs, economic development, and quality of life (MAG, 1992). Urban forms under analysis include trend growth, corridors, major centers, multiple centers, dispersed growth, satellite cities, and balanced growth. Factors to be considered in developing urban form options include densities, infill, nodal concentrations, job/housing balances, transportation, development continuity, and open space. Each urban form will be described in terms of factors such as population density, percent of

employment in the central business district, degree of clustering, job/housing balance, and the like. Transportation modeling will be conducted to examine the impact of the various urban forms on vehicle miles travelled, vehicle hours travelled, congestion levels, mode splits, trip lengths, travel speeds, emissions, and other issues such as public and private costs for infrastructure and services, economic impacts, crime, access to open space, etc. The study results will be used to better inform planning processes within the region.

Vision 2020: Growth and Transportation Strategy for the Central Puget Sound Region

As interdependencies between land use, transportation, and the environment become more and more of a central concern affecting many different planning agencies, regional long range plans mat begin to be explicitly designed to consider and meet a variety of needs. One forward-looking area has already started this process, in a plan called Vision 2020 (PSCOG, 1990). The plan is a long-range growth and transportation strategy for the central Puget Sound Region (encompassing the Seattle metropolitan area) that seeks to further goals such as economic growth and environmental values. The plan addresses how the Seattle region will cope with an extra 1.4 million people and 860,000 new jobs that are expected in the region by 2020. This growth is compounded by continued use of private autos as the primary means of transportation, parking subsidies, and traditional preferences for local government control. The plan recognizes that many different levels of government must cooperate to adequately deal with such growth and contains a six-part strategy for managing growth within the region. Elements of the strategy include: (1) creating a regional system of central places framed by open space, (2) strategic investment in a variety of mobility options and demand management to support the regional system of central places, (3) maintenance of economic opportunity, (4) conservation of environmental resources, (5) mitigate potential, adverse effects of concentrating development by early action, and (6) refine Vision 2020 based upon collaboration among all agencies in the region to ensure a common vision.

Indirect Source Control: Sacramento Metropolitan Air Quality Management District (SMAQMD)

As discussed above, the Clean Air Act encourages quantification and reduction of mobile emissions resulting from indirect sources such as new shopping malls, residential developments and the like. A number of States have developed more explicit guidelines, including California, in the California Clean Air Act. Many areas are proposing various kinds of indirect source control programs, which explicitly consider many kinds of land use/transportation/air quality interactions. For example, Sacramento, the capital of California, and an urban area out of attainment for ozone, carbon monoxide, and particulate matter, developed a variety of innovative control measures to reduce emissions from mobile sources. Volume VI of their 1991 air quality attainment plan is devoted to indirect source control. The program utilizes the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA) to evaluate new and

modified sources for air quality impacts and possible mitigation measures. SMAQMD proposed a set of near-, mid-, and long-term indirect source control measures such as land use entitlement permits, provision of on-site amenities, freight consolidation, development guidance, light rail facilities support, bicycle, bus, pedestrian, and parking facilities in the near term. In the mid- and long-term, measures include parking space emission fees, offsite passenger, baggage, and ticket terminals, parallel arterials at peak hours, multi-modal centers, tax subsidies for developments near transit, performance zoning, and taxes or fees prorated by distance of development to transit.

JUMP Start: Joint Urban Mobility Program in San Francisco Bay Area

While not a land use or growth planning process, the JUMP Start program contains many of the elements becoming more common in successful long term land use/transportation plans: cooperation among many levels of government. The program embodies what some officials have termed a new paradigm for transportation: "...the old paradigm - i.e., of transportation for the purpose of opening up land - is now being replaced by a new paradigm: transportation investments, capital investments, made to meet social, environmental and urban mobility goals and, above all perhaps, economic objectives" (Larson, 1992). Composed of representatives from the Federal Highway Administration, the Federal Transit Administration, the EPA, the California Department of Transportation, the California Air Resources Board, the California Highway Patrol, the California Transportation Commission, the Metropolitan Transportation Commission (the MPO for the San Francisco Bay Area), local transit operators, congestion management agencies, the local air district, the Association of Bay Area Governments, and the region's ridesharing agency, JUMPStart began from a desire for a new institutional framework to oversee a program of multijurisdictional and/or multimodal projects to reduce congestion and improve air quality. Such projects range from the installation of electronic toll equipment on local bridges to the installation of traffic operations systems to monitor traffic flows to universal transit passes. The program also hopes to address such emerging technologies as intelligent vehicle/highway systems.

Other Projects and Trends

A study similar to the JUMPStart program, the Baja Project, was performed in Tucson, Arizona. The study used transportation modeling techniques to examine the potential impacts of a variety of possible land use and growth options. The eastern U.S. also has a variety of similar planning programs such as the New York City "CPR" program (Congestion and Pollution Relief), and New Jersey's Project Clean Air.

Another similar study was performed as part of a comprehensive planning effort in northeastern Virginia's Prince William County (Dickey and Leiner, 1981). The planning process utilized a sketch planning procedure (TOPAZ) to allocate potential future land use activities to various districts within the county, and transportation modeling to assess the transportation, congestion, air pollution and other impacts of potential future land use patterns. The study showed that concentrating future growth in current populated areas

can cut travel costs, although increased congestion will also result. Among the more interesting findings was that there were a wide variety of possible land use patterns that had similar travel and congestion implications.

Some Trends Toward Increased Density

There are also some interesting new trends in land use, with potentially wide impacts on transportation. Many of these involve increased density of development, often with particular emphasis by individuals choosing these options in offsetting the consequences of urban sprawl. The rise of the neo-traditional neighborhood is a prominent example. Neo-traditional neighborhood designs (NTDs) are generally characterized by (1) a town center within five minutes walking distance for the majority of residents, (2) streets laid out in regular, geometric patterns so that there are alternate routes to every destination, (3) streets are treated as complex public spaces with many visual stimuli (close in trees, buildings), (4) narrow streets, (5) interspersed building uses (small houses, restaurants, corner stores, and offices, (6) civic buildings are generally placed along the squares so that important buildings are in important locations. The designs are attractive from a number of standpoints. For residents, the neighborhoods provide alternatives to sterile suburbs, shopping malls, and long commutes to the grocery store. For planners, the designs may encourage reductions in vehicle miles travelled and in regional congestion and air pollution. The first such project to be built was Laguna West in Sacramento, California. Since then a large number of projects to build NTDs have been started (see Table 1).

In addition, a number of "cohousing" developments have sprung up in various parts of the U.S. The developments are, in part, reactions to the isolation of traditional suburban life as well as the demands of working/shopping/cooking/cleaning that a single-family household must attend to regularly. In cohousing, a number of families or individuals buy a set of condominiums or townhouses. Communal dining and recreation areas are provided, as well as private areas in each individual housing unit. As commonly structured, owners will rotate, for example, the responsibility for cooking for the community. Each community member has the option of attending the communal dinner or not. Possible traffic effects are obvious: in a community of 20, approximately one shopping trip would be made in place of 20, on an evening when all community members attended the communal dinner.

LAND USE/TRANSPORTATION ANNOTATED BIBLIOGRAPHY

Adams, J.S., 1970. "Residential Structures of Midwestern Cities" Annals of the Association of American Geographers 60.

In this classic paper Adams defines four transportation-related eras in the American metropolis: (1) walking-horsecar era (1800 - 1890), (2) electric streetcar era (1890 - 1920), (3) recreational auto era (1920 - 1945), and (4) freeway era (1945 -). He diagrams a rough outline of how urban forms develop in each of

these eras. In particular, he theorizes that the streetcar era and the freeway era each gave rise to an elongated urban sprawl type form.

Adler, T. J., C.T. Leiner. 1991. "Traffic Effects of Creating a City Center in a Suburban Community," Compendium of Technical Papers, Institute of Transportation Engineers Annual Meeting, September 22-25, Milwaukee, Wisconsin. ITE Publication Number PP-023.

The city of South Burlington, Vermont has developed a plan for creating a high-density core area in what is otherwise a suburban community. One of the key issues in the planning of this project has been the extent to which such a project would impact traffic flow. Earlier, sketch-level traffic studies found that significant adverse effects on traffic flow could result from the project. This paper describes results of a more detailed traffic impact study, conducted using a regional highway network model (TMODEL2). The results highlight both methodological issues in how traffic impact studies are conducted and substantive issues regarding the impacts of centrally-located, high-density, multi-use developments.

Two major conclusions presented this paper are:

1) Network-based regional travel demand models can produce very different findings from those produced by manual traffic impact analyses, and

2) The traffic impacts of a central-located, high density, mixed-use development may be overstated by conventional analyses.

Although the proposed project was shown to increase the total number of trips in the corridor and in the region, the model predicts a decline in VMT and in average trip lengths.

Applied Management & Planning Group, 1990. "Traffic Congestion and Capacity Increases". Prepared for Sierra Club Legal Defense Fund, Inc., and Citizens for a Better Environment. August, 1990.

This document was prepared in support of the Sierra Club's suit against a conformity assessment performed by the San Francisco Bay Area's Metropolitan Transportation Commission (MTC) (see summary section at the beginning of this bibliography). The document discusses the relationship between traffic congestion and increased transportation capacity. The paper addresses three questions: (1) whether capacity increases in a congestion constrained system (where many facilities are overloaded for substantial parts of the day) produce long-term relief of congestion and reductions in emissions, (2) whether such issues are adequately addressed in then current environmental documents, and (3) whether the Bay Area's then current transportation forecasting procedures were capable of providing quantitative estimates of the impacts of capacity increases. The paper

cites a number of studies and papers supporting the idea that increased capacity in a congested area simply encourages more travel by individuals who were previously travelling less than they wanted to, or using alternate but less convenient routes. The main conclusion in the paper is that almost any project which would add capacity to an existing congested facility will be assessed as having no negative impacts on air quality if growth inducement is not considered.

Baerwald, T.J. 1978. "The Emergence of a New Downtown" Geographical Review 68. p 308-318. American Geographical Society.

This paper presents a well-known time series chart of land uses along a suburban corridor south of Minneapolis (I-494). The chart graphs density of single family residences, apartment buildings, industrial use, retail/service use, auto dealers, hotels, office buildings, governmental uses, and vacant land between 1953 and 1976. The series clearly shows the increase in both density and use characteristics over time. In 1953, sparse development consisting mostly of single family residences served by a few retail/service uses and a small industrial base. By 1976, vastly increased density and mix of all types of land uses are evident. The pattern shown in the chart is considered a typical sequence of land use development.

Barber, G. 1986. "Aggregate Characteristics of Urban Travel" The Geography of Urban Transportation, Susan Hanson, Ed. Guilford Press, 1986.

This paper describes some of the overall patterns of traffic flow that can be observed in North American cities and provides a good introduction to a number of transportation planning concepts. The paper notes that particular city characteristics, including city size, city functions, geographical setting, and proportion of growth of the city that occurred in each of the principle transportation technology eras (see Adams, 1970, reviewed above) are the principle factors that affect travel flows. The author also notes that travel flows can be analyzed in terms of five particular characteristics: (1) trip purpose, (2) temporal distribution of travel, (3) travel mode (i.e. auto, bus, bicycle), (4) trip lengths, and (5) spatial patterns, using statistics such as trip lengths and travel times by trip purpose, trip temporal distribution by vehicle type, and the like. Such data are most reliably gathered from the large scale urban transportation studies carried out in the 1955-1970 period such as "CATS" (Chicago Area Transportation Study), "PATS (Pittsburgh Area Transportation Study).

Bhatt, Kiran, Thomas Higgins, 1989. "An Assessment of Travel Demand Approaches at Suburban Activity Centers," Prepared for the U.S. Department of Transportation (Contract No. DTRS-57-88-C-00113) by K. T. Analytics, Inc., July, 1989.

This report describes case studies of transportation system management (TSM) and parking management (PM) strategies used to mitigate the congestion problems created by the shift of employment centers from a central urban location to suburban office complexes. It briefly summarizes the suburban mobility problem

and presents a synthesis of recent experience for approximately 40 different suburban TSM programs. During the study, the authors interviewed TSM and PM program coordinators and managers, local agency staffs, developers and transportation association staffs and managers. Drawing on specific examples, determinants of effectiveness and implementation pitfalls are identified. Conclusions include lessons for localities about effectiveness, administration, cost, finance, and monitoring. Included in the findings is an observation that some land uses appear to lend themselves better to TSMs than others. For example, it often appears that TSM and PM programs have more success at larger companies rather than multi-employer centers although there are some examples of successful programs for smaller employers. They also find that "policy instruments in support of TSM and PM programs, such as ordinances and developer agreements are important for initiating programs, bringing equity to regulations, and demonstrating public committment. However, neiher the instruments nor their stringency are strongly correlated with effective programs". Research needs, local and federal policy lessons, and evaluation suggestions are also provided.

Brannan, R.C., E. Seltzer, M.A. Wert. 1991. "Coordinating Portland's Urban Growth Plan and the Western Bypass Study," Compendium of Technical Papers, Institute of Transportation Engineers Annual Meeting, September 22-25, Milwaukee, Wisconsin. ITE Publication Number PP-023.

The Western Bypass is a proposed transportation project in southwestern Portland, Oregon that has been identified as the solution to circumferential travel needs. Concurrent with the Western Bypass Study, the Metropolitan Service District (METRO) is developing regional urban goals and objectives designed to address the broader issues of transportation and urban development associated with this project in order to formulate a comprehensive regional planning system. This paper provides an overview of a number of issues related to the relationship between transportation and land use, both in general and in the specific case of Portland. Oregon's land use and transportation planning processes are discussed, and key planning issues are summarized. The paper goes on to describe the urban growth goals and objectives of Portland and Oregon in general. The paper concludes with a discussion of the Western Bypass Study, presenting the issues surrounding the Bypass proposal. These issues include not only the analysis of alternative modes, demand management strategies, environmental impacts, and roadway improvements, but also regional issues including protection of rural resources, access management policies, economic development, regional air quality, and transit-oriented land-use issues, among others.

Cartier, C., 1988. "Commuting in America," ITS Review, Volume 11, Number 4, August, 1988.

This conference report summarizes the key note address delivered by Alan Pisarski to the California Transportation and Public Works Conference of 1988. Pisarski is well known for his commentary Commuting in America produced for the Eno Foundation (1987). This report was undertaken to produce a factual base

for the assessment of commuting problems, and to uncover new trends in American commuting. One of Pisarski's key points in both the report and address was that perhaps the greatest myth in American commuting is that congestion is a result of journeys to work from the suburb to the central business district of major metropolitan areas. Pisarski asserts that the dominant commute pattern today is the suburb-to-suburb commute, which is projected to gain an even greater share of future commuting. Pisarski points out that while auto commuting has increase from 70 to 85 percent, alternatives such as transit, working at home, and walking, have declined. The growth in jobs is exceeding the growth in population, which, Pisarski states, indicates that population alone cannot be used as a barometer for planning. Pisarski concludes by urging a revision of the planner's view of American commuting patterns.

Cervero, Robert, 1984. "Managing the Traffic Impacts of Suburban Office Growth," *Transportation Quarterly*, Vol. 38, No. 4, October, 1984.

This article examines the transportation implications of office growth on the urban fringe. Noting that the "emerging settlement pattern...doesn't square well with current transportation systems in many American cities", the author explores the transportation impacts and possible strategies for coping with resulting congestion problems and promoting orderly development. The paper reviews the geographical extent of suburban office growth in Atlanta, Dallas, San Francisco, Denver, Los Angeles and Phoenix. The reorientation of commuter travel to outlying subcenters places extreme pressure on the freeways and arterials serving the central cities and ensures large growth in nonradial directions oriented towards dispersed subcenters. Such development patterns can make transportation control measure strategies such as ridesharing or parking management difficult to implement successfully. The strategies addressed include: innovative land-use and site planning; the integration of transit and ride-sharing provisions into new suburban office developments; and private sector management and investment responses. Another publication by this author, "America's Suburban Centers - a Study of the Land Use Transportation Link" was published by the University of California at Berkeley in Januay 1988 is not reviewed in this bibliography but provides further detail on many key concepts.

Garreau, J. 1991. "Edge City: Life on the New Frontier". Doubleday Books, 1991.

This book discusses and analyzes some significant changes in the manner in which urban areas are growing: "Americans are creating the biggest change in a hundred years in how we build cities. Every single American city that *is* growing, is growing in the fashion of Los Angeles, with multiple urban cores". The attitudes and values behind the ways we use, develop and travel across the land are at the root of the transportation effects we see now. Numerous issues that affect transportation and air quality are thoroughly and thoughtfully discussed, including themes such as "do congestion problems occur because current urban forms are too dense or not dense enough". He examines a number of questions behind many transportation trends. For example, observations about how far people are

willing to walk before getting into their cars have led to malls and office space depending on parking proximity in a unique chicken and egg relationship: to make a profit, a certain ratio of office (or mall) space to parking spaces must occur. Such ratios have themselves led to implications that sprawling suburban centers surrounded by asphalt parking lots are profitably optimum.

Garrison, W. L., et. al., 1975. "Transportation and Land Use - Three Papers prepared for California State Department of Transportation," September, 1975.

This volume is a collection of three papers prepared for the California Department of Transportation. The first of these papers identifies strategies, policies, and actions that were potential candidates for the 1975 CALTRANS transportation plan. These are divided into three categories: those strategies, policies, and actions appropriate to no-growth; those appropriate to laissez-faire growth and development; and those appropriate to situations where growth and development goals are identified and worked toward. Paper two discusses the implications of various strategies, policies, and actions. It contains separate discussions of land use and transportation issues, and provides a discussion of the implications of the strategies, policies, and actions identified for the three categories defined in Paper 1. Paper three provides a historical review of transportation/land-use relationships during four periods in the United States: Pre-1900, 1900-1950, 1950-1970, and 1970 forward (through 1975). This paper is also supplemented by a bibliography of research and more detailed references.

Giuliano, G., 1988. "New Directions for Understanding Transportation and Land Use," Institute of Transportation Studies, University of California, Irvine, California (UCI-ITS-SP-88-4), March, 1988.

This paper reviews residential and employment location theories of land use/transportation relationships and the empirical research conducted to test such relationships. Noting that, "despite the large body of literature on the issue, the theoretical basis of land-use/transportation relationships has been subject to a variety of criticisms, and recent empirical research seldom supports theoretical expectations". The paper argues that these results suggest a re-evaluation of existing theory and of the role of transport costs in location choice. Part one of the paper presents a brief overview of existing theory and outlines its major weaknesses. Part two reviews empirical research that illustrates these changing conditions, and part three provides some explanations for these findings. The paper concludes with some suggestions for rethinking the relationship between land use and transportation. This paper also includes an extensive list of useful references on interactions between land-use and transportation.

Giuliano, G. 1986. "The Land Use Impacts of Transportation Investments: Highway and Transit," in The Geography of Urban Transportation, Susan Hanson, editor, Guilford Press. 1986.

In this article the author describes factors that must be considered when examining land use impacts of transportation investments, and the mutual dependence between land use and transportation changes. The second section outlines the conceptual relationship between transportation and land use. The third section reviews the major land use/transportation theories and models that have been developed, including examples of how each model has been used in transportation policy analysis. Finally, the chapter concludes with a summary of the findings of empirical studies of highway and transit impacts and draws conclusions based upon these findings.

One of the major conclusions drawn in the final section of this chapter is that transportation investments do not have a consistent or predictable impact on land use. The author asserts that the evidence shows that land use change does not necessarily follow transportation investments, but rather, availability of land for development, favorable economic conditions, and local political support have been shown to be key factors in the majority of studies.

Hotlzclaw, John. 1991. "Explaining Urban Density and Transit Impacts on Auto Use," presented by the Natural Resources Defense Council and the Sierra Club for the State of California Energy Resources Conservation and Development Commission, Docket No. 89-CR-90. January 15, 1992.

This study was conducted to evaluate potential savings in fuel, pollutant emissions, ownership costs, and overall reductions in automobile use resulting from higher residential density and neighborhood businesses, and improved transit service in the San Francisco Bay Area. A major finding of this effort is that doubling residential or population density reduces the annual auto mileage per capita or per household by 20 to 30 percent.

Using odometer readings data collected during biennial, mandatory smog inspections, the investigators calculated the annual mileage for five communities within the San Francisco region, as well as for large counties in other parts of California and for the State as a whole. A comparison of these communities showed that the higher the population, household, or local serving job density, the lower the auto ownership rates. For example, the Nob Hill area of San Francisco has 31 times higher net household density, 26 times higher gross population density and 198 time higher local serving job density than the Danville-San Ramon area (east of San Francisco in Contra Costa County), but only about 1/3 the auto ownership per capita and 1/4 the auto ownership per household. Several other comparisons yielded similar results. The author states that in San Francisco, one mile of transit replaces as much as eight miles of driving in less dense areas. The findings from the California research are supported by studies conducted in other cities such as Toronto, Chicago, and New York City, which were used data that is characterized by the author as "less reliable" than that used for the California study (no source is listed).

The study makes several recommendations:

- Improve transit service in urban centers and along transit corridors to realize a 4 - 8 mile reduction in auto travel for every mile of transit use (when combined with residential and commercial density increases).

- Reform zoning laws to allow higher density mixed-use development in city centers and along transit corridors. These reforms include:

  - allowing a minimum of 3 to 4 story apartment/condominium structures, with commercial activities on the first floor, in centers and along transit corridors

  - zoning to prohibit urban housing construction outside presently urbanized areas

  - reducing or eliminating parking requirements for residential or commercial buildings as densities exceed 5 units per net residential acre

  - eliminating the inclusion of garage spaces with residential and commercial space sales and rentals, where feasible

- Utilize the findings of this study to project auto mileage in land use, transportation, and air quality plans, in environmental assessments, and in Environmental Impact Reports/Studies.

Kenworthy and Newman, 1989. Cities and Automobile Dependance: A Sourcebook. Aldeshot, Hants, England.. Gower Technical.

Several papers and books by these two Australian authors from the Institute of Science and Technology Policy at Murdoch University were identified as potentially important references but were not available for review in this bibliogrpahy. The book "Cities and Automobile Dependance examines transportation trends in 50 cities with specific attention to how different land use patterns affect transportation patterns.. The book is available in reference sections of a number of university libraries.

Kulash, W. 1991. "Traffic Performance in Neo-Traditional Neighborhoods" Presented at the 61st meeting of the Institute for Transportation Engineers, Milwaukee, September 1991.

This paper briefly compares neo-traditional neighborhood designs (NTD) (incorporating mixed land use featuring "closely spaced commercial buildings located directly on street right-of-way lines, narrow streets, small blocks, on-street

parking, alleys, and small residential lots in close-in areas around a 'village' core") with conventional suburban developments. The focus of the comparison is on differences in traffic engineering and design concepts. For example, conventional development incorporates a strict hierarchy of roadway networks: local streets are for immediate access to properties; collector streets gather traffic from local streets and feeds it to arterials which give longer distance mobility and which are not intended to provide property access. NTDs, on the other hand, have reduced or no such hierarchy but rather focus on a network of connected streets which result in multiple possible routes and modes for a given trip. Other characteristics of NTDs are reduced lateral clearance, on-street parking, and short traffic signal cycles. The paper describes a traffic comparison of two identical 700 acre mixed use development programs: one an NTD, and the other of conventional design. The NTD reduced VMT to 57 percent of the conventional plan. The reduction is largely attributable to reduction on arterial streets since these are no longer needed. Further, the number of collector streets are greatly reduced in the NTD plan. NTDs also feature slower travel speeds than conventional designs, although total travel times are equivalent (since NTD distances are shorter). Finally, a key feature of NTD is the encouragement for pedestrian travel: simply by the geometry of dense street networks, and large activity mix, NTDs provide shorter travel distances for pedestrian trips.

Lerner-Lam, E., S.P. Celniker, G.W. Halbert, C. Chellman, S. Ryan, 1991. "Neo-Traditional Neighborhood Design and its Implications for Traffic Engineering". Presented at the 61st meeting of the Institute for Transportation Engineers, Milwaukee, September 1991.

This paper summarizes a number of NTD (Neo-Traditional Neighborhood Design, also known as NTND) projects in the U.S. The article also summarizes a number of the key traffic engineering issues encountered in these projects. The paper notes that NTD proponents argue that NTD designs lead to less reliance on automobiles than the predominant land use designs over the past 50 years, and lists some of the ways in which this may occur, as well as potential offsetting factors. For example, VMT may be reduced due to the option of making more shopping, work, and recreation trips via foot or bicycle. However, individuals commuting to or from the NTD may not change their travel patterns significantly. In contrast to the Kulash paper also reviewed in this document, the authors argue that NTD planning *cannot* be accommodated within many existing regulatory frameworks or land use regulations. Kulash cites an example in Orange County, Florida where the Orlando area is experiencing traditional urban sprawl. However, the land use regulations there "would permit the most important traffic circulation features of neo-traditional neighborhood design to be accomplished".

Mierzejewski, E.A. "Recognizing the Link Between Transportation and Land Use: Let's Get Beyond the Rhetoric". In 2nd Conference on Application of Transportation Planning Methods sponsored by Transportation Research Board. Orlando, Florida, April, 1989.

This paper reviews practical experience in two Florida transportation projects to highlight the importance of integrated land use and transportation planning. The author briefly reviews the common practice of taking a given land use forecast as an exogenous input to transportation models while overlooking "the fundamental impact of the transportation system on the placement of land use activity". The author identified two key problems with such approaches: (1) self fulfilling prophecies (the transportation system implicitly assumed in the allocation of land use activities is generally found to be the best solution to meeting the transportation demand of the specified land use), and (2) fixed land use inputs often lead to underestimation of traffic volumes on major new highway facilities. The two examples given in the paper involve the North Suncoast corridor, a 50 mile limited access highway on the west coast of Florida. Although the highway was to open up vast undeveloped land areas the traffic modeling was based on land use estimates that did not reflect the proposed new facility. The author argues that the integration of a future land use plan and the major features of the transportation network into single scenarios would be a more appropriate analytical procedure. Alternate scenarios should then be framed as alternate *combinations* of land use and transportation scenarios. The other example study is of a more site specific nature but exhibited many of the same features (several transportation scenarios, all incorporating the same land use assumptions). Key practical problems with using a more integrated approach (cost, multiple adopted land use forecasts), as well a brief history of past efforts (Boston Transportation Planning Review and the UMTA Alternatives Analysis practices) are also summarized. Finally, the paper summarizes a number of modeling methods for considering land use and transportation interactions.

MTC, 1991. Draft Environmental Impact Report for the Regional Transportation Plan, prepared for the Metropolitan Transportation Commission (Oakland, California) by JHK & Associates, April, 1991. This document evaluates the Regional Transportation Plan (RTP) of the Metropolitan Transportation Commission (MTC) and establishes MTC's policy for the development of transportation improvements and operations programs to meet the growing transportation needs of the next 20 years. Included in this document is an evaluation of the current and future land use in the region which looks at the projected land use and other related impacts of the various project elements. A "Summary of Impact Findings" provides a summary of the more detailed impact analyses described in other sections of the report. In the area of land use and population growth, several potentially adverse impacts of various plan elements are discussed, including increased pressure to develop land and to change local land use policy, resulting in a loss of agricultural and open space land.

Muller, P.O. "Transportation and Urban Form: Stages in the Spatial Evolution of the American Metropolis" in The Geography of Urban Transportation, Susan Hanson, Ed. Guilford Press, 1986.

This paper "traces a persistently strong relationship between the intraurban transportation system and the spatial form and organization of the metropolis".

Tracing historical relationships between transportation options and land use patterns, the paper discusses how the proliferation of urban freeways (together with economic growth, generous federal home loan policies, and more efficient vehicles) led to increasing decentralization away from central cities: Increased transportation facilities, in part, made it possible for growth of suburbs; growth of suburbs led to demand and supply of various goods and services outside central business districts, leading to "diversified, expanding, 'outer cities'". He also notes that a central feature of urban sprawl includes circumferential freeways designed to skirt congested urban cores from which additional freeways radially branch out to access other areas. Much development occurs along such radii. In addition, the paper notes that the time-distance radius of urban areas has remained approximately the same over time: about 45 minutes from center to edge. He notes that each breakthrough in higher-speed transport technology extends that radius into a new outer zone of suburbs. The paper also contrasts U.S. with European land use patterns, which have remained more tightly concentrated due to factors such as land scarcity, dense population, and common government control of land prices, planning, and zoning codes. The paper ends with a discussion of the growth in minicities such as that which surrounds the King of Prussia Shopping Center in Philadelphia.

Orski, C.K. "A Realistic Appraisal of Traffic Congestion", Urban Land, Volume 48, No. 10, October, 1989.

This paper was not reviewed in its entirety in this search. A summary provided in the paper on traffic congestion and capacity increases prepared in support of the Sierra Club/MTC suit is relied upon here (AMPG, 1990). The paper argues that new roads do not eliminate traffic congestion; "new roads improve accessibility, and greater accessibility increases the value of land. Higher land values, in turn, dictate a more intensive use of land, which generates more traffic, which fills up the highways".

Pas, E.I. 1986. "The Urban Transportation Planning Process" in The Geography of Urban Transportation, Susan Hanson, Editor. Guilford Press, New York.

This paper describes the history and nature of the urban transportation planning process in general. In a key subsection entitled "Land Use-Activity System Models", the author explores the nature of land use/transportation relationships. In particular, he describes the interdependence between land use and transportation. In spite of such interdependence, land use planning and models are typically separate from transportation models (largely due to the fact that land use planning and transportation planning are part of different agencies), although each uses outputs from the other's system. For example, land use forecasts are based upon particular assumptions regarding future transportation systems, while land use modeling outputs are used as exogenous inputs to transportation models.

Pisarski, A.E. 1987. "Commuting in America - A National Report on Commuting Patterns and Trends," prepared under the direction of the Steering Committee for

the national Commuting Study by the Eno Foundation for Transportation, Inc., Westport, Connecticut. This report is a study of commuting patterns and trends in the United States. It is intended to be an objective factual resource document which analyzes key trends without making policy judgments. The report includes an extensive number of tables, figures, and other statistics regarding urban and suburban growth patterns, and the changes in commuting behavior associated with these development patterns.

An Executive Summary at the beginning of the document identifies three themes that permeate the report: (1) the worker boom; (2) the suburban commuting boom; and (3) the private vehicle boom. The worker boom describes the changes in the characteristics of the work forces in the past 50 years, including the increase in the number of women in the work force and the increase in the number of workers in general. The suburban commuting boom describes the trend towards jobs being located in the suburbs, following the shift in population to the suburbs, making the suburb-to-suburb commute the most dominant pattern in the country. Finally, the private vehicle boom describes the expanding use of private vehicles as the means of travel to work.

The executive summary concludes with a synopsis of the implications for the future that the three primary themes present, including the implications for commuting demand and transportation facilities.

Pilgrim, R. D., W. Weber, 1991. "Land Use Enhancements to Increase Future LRT Ridership in the San Diego South Bay Area," Compendium of Technical Papers, 1991 District 6 Annual Meeting, Institute of Transportation Engineers, Anaheim, California, 1991.

This paper presents the analyses and results of the ***South Bay Rail Transit Extension Study***, conducted for the San Diego Association of Governments (SANDAG). This study examined the feasibility of extending rail transit into this rapidly developing area and proposes possible land use mechanisms to increase ridership. The study developed sketch planning techniques to factor the ridership forecasts to reflect the use of different land use strategies for the various South Bay rail alignment and station alternatives. The conclusions reached in this study outlined a number of factors that will directly influence the viability of such an extension. In the area of land use management, it was concluded that land-use patterns must be planned to focus activity at station site planning in order to generate increased transit ridership. In other words, active land-use planning is necessary in order for transit services to be the most effective in serving travel demands.

Plane, David. "The Geography of Urban Commuting Fields: Some Empirical Evidence from New England" Professional Geographer, Vol 33, pp 182 - 188. Association of American Geographers, 1981.

It has been commonly conceived that suburbs serve as the "bedrooms" for workers commuting to central cities. The paper provides actual statistics on the trip-making impact of trends in decentralization in urban form. For example, Dr. Plane demonstrates that "lateral" and "cross" commutes (suburb to suburb and between urban fields, respectively) accounted for over 90 percent of travel in a New England town. Dr. Plane identifies five different kinds of work trips: (1) within central city, (2) suburb to city, (3) city to suburb, (4) suburb to suburb, and (5) between urban fields (i.e., from one city to another). He found that approximately 60 percent of work trips were from suburb to suburb.

Real Estate Research Corporation, 1974. The Costs of Sprawl - Literature Review and Bibliography, April, 1974.

In the spring of 1973, the Real Estate Research Corporation was commissioned by the Council on Environmental Quality, in conjunction with the Department of Housing and Urban Development and EPA to undertake a study of the environmental and economic effects of alternative development patterns. The Literature Review and Bibliography contains the results of an extensive literature review on the direct economic costs or adverse environmental effects associated with development in suburban fringe areas. These include a variety of publications regarding land-use/transportation interactions. Over 1000 sources were reviewed; a significant number are annotated in brief. In addition, this volume contains an essay describing the types of literature available and their usefulness in evaluating costs of alternative development patterns. Other volumes of the original report include an executive summary of the methodology, findings, and conclusions from these studies and a detailed cost analysis of alternative development patterns.

Upon completion of the initial study, the need for further research was apparent, both to refine the previous study and to add related elements not undertaken previous. The findings and conclusions of this additional research are the subject of another volume, The Costs of Sprawl -Case Studies and Further Research (October, 1975).

Scheuernstuhl, G.J., May, J.H. "Land Use, Transportation and Air Quality Relationships". In Proceedings of the National Conference on Transportation Planning and Air Quality sponsored by the Urban Transportation Division of the American Society of Civil Engineers. Santa Barbara, July 1991. (Proceedings published in 1992).

The Denver Regional Council of Governments conducted a study entitled: "Land Use, Transportation and Air Quality Sensitivity Analysis" in 1990. This paper summarizes the study. The study explored the differences that would occur in air quality in the year 2010 given the 2010 Regional Transportation Plan (which assumed trends of low density and market driven land development patterns) and a 2010 scenario which emphasized the concentration of employment growth along the seven planned major rapid transit corridors, a minimum of new highway

capacity, and the addition of a substantial bus/HOV network. The scenarios were analyzed with a UTPS type transportation modeling system. Population, employment, and person trips in the modeling area increased slightly in the high density transit scenario. VMT in the two scenarios remained approximately equal because of increased transit use and carpooling. However, the high density scenario resulted in increased congestion and slightly higher carbon monoxide levels than the base scenario. PM-10 and NO_2 concentrations were approximately the same for both scenarios. The paper concludes that land use changes assumed in the study have little or no effect on air quality, that both population and employment need to be concentrated in high density corridors, and that land use pattern changes should be considered for longer time periods than those under study (20 - 25 years).

Smith, S.A. 1989. "Travel Characteristics at Suburban Activity Centers and Implications on Land Development". In 2nd Conference on Application of Transportation Planning Methods sponsored by Transportation Research Board. Orlando, Florida, April, 1989.

This paper reviews data collected at six major suburban activity centers under a National Cooperative Highway Research Program project. Data on trips, trip purpose, and other variables were collected for Tyson's Corner in Northern Virginia, Southdale near Minneapolis, Perimeter Center north of Atlanta, Parkway Center north of Dallas, South Coast Metro in Orange County near Los Angeles, and Bellevue, near Seattle. The study found that (1) density of the activity centers did not prevent them from being very auto oriented, (2) substantial interaction among land uses was observed among the activity centers, (3)although mixed land uses are desirable from a transportation perspective, among the activity centers studied, the uses were not close enough to generate a high degree of non-auto transportation.

Urban Land Institute, 1989. "Myths and Facts About Transportation and Growth". Washington DC, 1989.

A fuller summary of this publication will be included in updates to this bibliography. Two findings identified in a paper presented at a 1991 ITE conference (Long, 1991) are: (1) "limiting density of development does not reduce traffic except in the immediate area", and (2) "lower-density residential, retail, or office projects generate more, not less, overall traffic".

USDOT, 1973. The Interrelationships of Transportation Development and Land Development -Volume 1 (Main Report), DOT-FH-11-7843, June, 1973.

The purpose of the research described in this two volume report was to attempt to better understand the phenomena which operate to produce the heavy usage and subsequent congestion which often follows the construction of urban and suburban transportation facilities. It was recognized that these phenomena were the same ones which generally govern the shape and growth of the metropolis. Computer

simulation was the method selected for this analysis. Consequently, in addition to substantive conclusions about the growth of urban areas and potential policies for shaping and/or directing this growth, a package of computer models was prepared for dissemination to other workers in this field. This package of models was intended to integrate land use models with transportation network modes, and allow analysis not only of land use patterns and transportation flows, but of the interrelationships between them. Testing of this modeling package using real-world data from the San Francisco metropolitan area implied that the use of integrated transportation planning and land use control policies could mitigate problems resulting from new capacity. This report includes descriptions of the development and testing of these models, and substantive conclusions resulting from this work.

USDOT, 1979. Bart Impact Program: The Impact of Bart on Land Use and Urban Development Interpretive Summary of the Final Report, DOT-P-30-80-08, September, 1979.

This report assesses the land use and urban development impacts of the 71-mile Bay Area Rapid Transit (BART) system. The report discusses the extent to which BART has influenced the spatial arrangement of people and activities in the San Francisco Bay Area. All aspects of development that BART may have affected or potentially could affect are examined - including households' and workers' location decisions, development decisions of housing and commercial developers, retail trade and shopping patterns, and property values and rents. Changes attributable to BART are measured against pre-BART and no-BART alternatives using a variety of analytical techniques, surveys, statistical analyses and case studies. The report concludes with an assessment of the policy implications of the BART experience at the time of this report.

USDOT, 1980. The Land Use and Urban Development Impacts of Beltways - Final Report, DOT-OS-90079, October, 1980.

This document reports the results of a study jointly commissioned by the USDOT and the U.S. Department of Housing and Urban Development. It presents an assessment of beltways' land use and urban development impacts and describes the urban and transportation policy implications. Prior research and findings of a comparative statistical analysis and detailed case studies are examined to determine (1) what effects beltways have had, (2) why beltway-induced changes have occurred, (3) who was affected by such changes, and (4) how federal and local government agencies can work with business and community group to capitalize upon the potential benefits offered by beltways and to minimize or eliminate their anticipated adverse effects. Of particular concern to the sponsoring agencies, and to the federal government in general, is the possibility that beltways may undermine central city revitalization efforts and attempts to achieve compact, energy-conserving and environmentally sound land use patterns. This report and companion document, the Guidebook, address the relationship between new highways and other factors influencing urban development and describe actions

which can be taken by local governments, working federal agencies, and the private sector to take advantage of the opportunities and avoid harmful consequences generated by beltway construction.

USDOT, 1981. Innovative Approaches to Understanding Transportation/Societal Interactions, DOT-TSC-UMTA-81-61,1, October, 1981.

In June, 1979, a Request for Proposal (RFP) was issued by Urban and Regional Research Division of the Transportation Systems Center (TSC), under sponsorship by the UMTA. The major product called for in the RFP was a "Study Design Report" (SDR) which was to document in detail the contractor's proposed approach for analyzing the complex interactions between transportation and society. The primary intent of this report is to disseminate information on the analytic approaches developed in the seven SDRs presented by the selected contractors. Many of these SDRs address the issues of modeling the interaction between transportation and land use to reflect changes in the spatial organization of metropolitan areas as a result of transportation system changes. This is the first of two report volumes, which describes the research program itself, and summarizes the Study Design Reports. The second volume contains the seven SDRs in their entirety.

USDOT, 1982a. Transportation and Urban Economic Development, DOT-I-82-42, June, 1982.

This study attempts to synthesize available knowledge about the links between transportation and economic development in the late 1970's. The study began with a major literature review, and later proceeded into a detailed examination of several sites and a general review of the development process itself. The report discusses the economic development process, including the tools, institutions, and problems involved, and describes the role of transportation in a successful economic development program. Five case studies offer practical examples of how some cities have used transportation as an economic development tool. A general bibliography on transportation and economic development issues follows this portion of the report. Finally, the literature synthesis analyzes the literature in each transportation mode, highlighting the relationship between transportation and economic development and outlining local initiatives to link the two fields. It also discusses areas that need further attention and contains a bibliography of works on specific modes.

USDOT, 1982b. "Growth Management and Transportation," DOT-I-82-28, June, 1982.

This report is one of ten bulletins in the fifth series of Information Bulletins produced by the Transportation Task Force of the Urban Consortium for Technology Initiatives. The intent of this document is to provide a nontechnical overview, from the local government perspective, of issues and problems associate with growth management and transportation. While not an in-depth review of the

state-of-the-art of state-of-the-practice, this document serves to identify and raise issues and provide and information base from which the Transportation Task Force could select topics that require more substantial research. It presents problems, approaches, and issues related to growth management transportation, provides information about growth management programs, tools, and techniques and contacts for obtaining this information, and concludes with an annotated bibliography.

USDOT, 1982c. Trends Before Metrorail - A Metrorail Before-and-After Study Report," DOT-I-82-33, July, 1982.

This report describes the trends before the opening of the Metrorail transit system in the Washington D.C. area. A companion report, Metrorail Area Planning, describes some of the initial effects of the transit system on development and land use. The purpose of the Metrorail Before-and-After Study is to measure changes caused by the system in the Washington region. It presents the opportunity to study the effects of a major transportation improvement on travel behavior and the related effects of these travel changes on land use and economic activity. Development in the Washington region, both before and after the implementation of Metrorail, are summarized, as well as changes in regional employment, housing, and population projections before and after the project.

USDOT, 1982d. The Portland Mall Impact Study, DOT-I-83-07, December, 1982.

This final report of the Portland Mall Impact Study is a comprehensive analysis and evaluation for a wide range of impacts related to the Portland Transit Mall. This report assesses the primary (i.e., transit and traffic impacts) and secondary (i.e., noise, air, land use and development) impacts, and documents the significant impact the Portland Mall has had on revitalizing the downtown area. The report concludes with an economic analysis demonstrating the Portland Mall to be a good public investment, with benefits exceeding the cost. This study provides useful information for public and private organizations at the local and national level. At the local level, it provides information for assessing impacts on operation, maintenance, and possible extension of the Transit Mall. At the national level, it provides Portland's experience with a transit mall and possible applications to other locales by other local governmental agencies, and the transportation land use interaction that can be achieved through investment in transit.

USDOT, 1985. Transit Linked Development - A Case Study of Atlanta's MARTA System, DOT-I-85-24, January, 1985.

Although the linkage between transportation and land-use development has been recognized for decades, this report asserts that there are apparently few successful efforts to fully integrate transportation and urban development/redevelopment. This report provides further evidence to support the hypothesis that linkages do exist between transportation and land development. It asserts, however, that development is not automatic, but rather is fostered through supportive zoning,

special incentives and strong markets. This report provides a review of the literature pertaining to transportation and land-use impacts, including preliminary results from ongoing impact studies and specific analyses of land-use and joint development. It also includes a review of selected transit systems, utilizing impact studies and site visits, and a review and analysis of actual urban development impacts of major urban and light rail systems. Various tools and methodologies that have had some utility in guiding land-use impacts are assessed, and a detailed series of case studies of ten Atlanta station areas are included. The report concludes with a summary of key findings and recommendations for use by planners and policy officials of other transit systems.

Webber, M.M. 1985. "The Emerging Metropolis: Trends and Trepidations" from Mobility for Major Metropolitan Growth Centers: A New Challenge for Public-Private Cooperation. Urban Mass Transportation Administration, U.S. DOT, November, 1985 pp9 - 18.

This paper connects many traffic problems to land use and transportation practices tied to an outmoded model of urban design "we all know that the 'correct' city has a major business center marked by skyscraping office buildings, and that it declines in intensity as one moves outward toward the farmlands at the edge". The author notes that the newer cities in the West and South, which matured once the auto age had become fully entrenched, designs are far more complex; something like a "mountain range with numerous peaks and valleys". The author discusses a number of trends shaping urbanization processes, including the increased number of women in the labor force, decreases in average household sizes, higher household incomes, the rise of the suburban service economy, and technological improvements in communications, all of which are leading to a marked decrease in density and growth in "exurbs". As governments still plan based on the "proper" city model, "transportation capacity is deficient in most new exurban regions, largely because existing high-capacity facilities were initially designed to feed traffic into the city core".

GLOSSARY

BART	Bay Area Rapid Transit
CAAA	Clean Air Act Amendments of 1990
Caltrans	California Department of Transportation
CBE	Citizens for a Better Environment
CEQA	California Environmental Policy Act
CNG	Compressed Natural Gas
DOE	Department of Energy
DOT	Department of Transportation
EPA	Environmental Protection Agency
GRI	Gas Research Institute
ITE	Institute of Transportation Engineers
LEV	Low Emitting Vehicle
LPG	Liquified Petroleum Gas
MAG	Maricopa Association of Governments
MPO	Metropolitan Planning Organization
NARC	National Association of Regional Councils
NEPA	National Environmental Policy Act
NTD	Neotraditional Neighborhood Design
OSHA	Occupational Safety and Health Administration

RTP	Regional Transportation Plan
SAE	Society of Automotive Engineers
SCAQMD	South Coast Air Quality Management District
TRB	Transportation Research Board
TRIS	Technical Retreival Information Service
TSC	Transportation Systems Center
UMTA	Urban Mass Transit Administration
UTPS	Urban Transportation Plannng System
VMT	Vehicle Miles Travelled
VOC	Volatile Organic Compound

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