Land Use-Transportation Linkage

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Washington State Transportation Commission
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Foreword

This white paper summarizes the research findings of a study by the Innovations Unit of the Washington State Transportation Commission on the ~~to~~pic Land Use-Transportation Linkage. The study was authorized by the Long and Short Term Goals Subcommittee of the Commission in March 1991. This research focuses on the impact of land use policies on transportation systems, demand for transportation services, mode choice, trip generation, and other transportation attributes. A three-part research process was employed, beginning with a Literature Review and synthesis of recent relevant reports, surveys, books, articles, ordinances, and legislation that are associated with land use-transportation linkage issues. This was followed by an Information Collection phase to inventory existing land use-transportation linkage policies and practices. In the Data Analysis phase, the results of this inventory were then used to extract, define, and illustrate key land use attributes that affect, and are affected by, transportation systems and policy. Jurisdictions selected for study included six counties and eight cities within the state of Washington with a combined population of over 3.3 million, and were chosen to provide a representative sample of land use and transportation ordinances and policies that govern diverse population centers and growth patterns in Washington state. Notable policies and projects elsewhere in this state and throughout the U.S. were also included, as well as selected policy and project examples from Canada and other countries.

This white paper consists of five parts. In **Part I,** introductory remarks define the goals of this study as well as the scope and methodology of the research. **Part II** describes selected Washington state policies and legislation that address the land use-transportation linkage issue. **Part III** is devoted to a summary of existing and recently proposed city and county codes, ordinances, and statements of policy that pertain to land use and transportation, with emphasis on practices in Washington state. The summary is organized into nine land use issues, and progresses from individual land use concepts to larger development-level land use themes, concluding with metropolitan and regional planning strategies. They include the following topics:

Individual Themes
- Residential Densities
- Employment and Activity Center Densities
- Parking Requirements
- Transportation Programs

Project-Scale Themes
- Mixed Use Developments
- Site Design Provisions
- Master Planned Developments

Metropolitan/Regional Themes
- Jobs-Housing Balance
- Metropolitan/Regional Planning

Each topic summary consists of three parts:

1) **Linkage to Transportation:**
   How is the topic linked to transportation issues?
2) **Policies and Practices:**
   What is the present state of policy and practice associated with this topic?
3) **Future Policies and Research:**
   What are some examples of policies and research efforts that would be potentially beneficial in the future?

In **Part IV**, six case studies are presented. These examples include existing and planned developments and policy approaches, and are intended to illustrate the interrelationships of individual land use issues. The white paper concludes in **Part V** with a summary table of this research. The table describes each of the nine individual land use topics of this study, with descriptions organized into the following categories:

Linkage to Transportation:	How the land use topic relates to transportation
Related Land Use Topics:	Other land use issues that are closely related to the topic
Typical Current Practices:	An overview of typical practices associated with the topic in Washington and nationwide
Recent Trends:	Recent progressive trends associated with the topic
Future Policy Needs:	Examples of potential transportation-related policies
Future Research Needs:	Examples of potential transportation-related research to supplement and advance the available body of knowledge
Notable Research:	Major research associated with the topic (full citations are included in the bibliography of this white paper)

Work is continuing on additional data collection and detailed policy analysis, as well as the development of recommended policy directions and future actions by the Commission. Future reports by the Innovations Unit will summarize the results of this follow-on research.

Related Reports

This white paper is a condensed summary and update of earlier technical research that is documented in a companion report, Land Use-Transportation Linkage: Background Research, Findings (Innovations Unit Report 92.2).

Acknowledgments

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I. Introduction

Land use and transportation are receiving widespread attention as major issues in this state. Concerns over environmental preservation, urban sprawl, and the future quality of life have brought land use planning issues to the forefront of public consciousness. Similarly, transportation planners and the general public have been grappling with the problems of increasing automobile use, traffic congestion, air pollution, and the resulting safety and health hazards, as well as the challenge of effectively supporting and improving multimodal transportation alternatives.

In recent years, the linkage between land use planning and transportation planning has been prominently featured in academic studies, political discussion, and government legislation. This linkage includes any land use practices and policies that affect personal mobility or the attractiveness of more efficient modes of transportation, as well as any associated energy and environmental impacts. In Washington state, the State Transportation Policy Plan explicitly recognizes the impact of land uses on the state's transportation system, and recommends consistent goals and coordinated actions between the two components. The plan urges the state to promote community, regional, and statewide planning efforts that directly connect transportation with land use.

Recognition of this linkage has also increased with the growing emphasis on growth management, and particularly with the passage of the Growth Management Act (GMA) of 1990 by the Washington State Legislature. The Growth Management Act specifically identifies the importance of the transportation element in land use planning and growth management, and mandates that the most populous and fastest-growing areas of our state establish transportation plans that operate in concert with future land uses. This Act also includes a concurrency requirement, which directs developers to make a commitment to mitigate the transportation impacts of a proposed land use and to ensure that level-of-service standards for the community's transportation system will continue to be met.

As both distinct and interrelated issues, land use and transportation have risen to positions of prominence in the public and legislative agendas. Policy makers, transportation professionals, and urban planners at all levels will benefit from objectively researched information on existing practices, issues, and potential linkage options in order to support sound decision-making processes that integrate transportation and land use concerns, meet the requirements and intent of growth management legislation and policy, and develop long-term solutions to the future transportation challenges of this state.

This white paper summarizes information on existing and potential practices and policies associated with major land use-transportation linkage issues. The linkage between land use and transportation is not

only a complex one, but is also a two-way street, with land use affecting transportation and vice versa. This white paper will focus on the potential benefits that transportation-supportive land uses can have on personal mobility and overall transportation effectiveness, beginning with a comprehensive literature review and study of state-of-the-art land use-transportation linkage practices in this state and elsewhere. This paper then identifies and analyzes individual linkage concepts, and describes the potential benefits of specific approaches that exploit the land use-transportation connection to improve mobility, promote enlightened land use, and enhance the overall quality of life.

Scope of Research

Research for this paper focused on the impact of land use policies on transportation systems, demand for transportation services, mode choice, trip generation, and other affected attributes of transportation. Jurisdictions selected for land use policy research included six counties and eight cities within the state of Washington: Clark, King, Kitsap, Pierce, Snohomish, and Spokane Counties, and the cities of Bellevue, Bremerton, Everett, Renton, Seattle, Spokane, Tacoma, and Vancouver. These areas have a combined population of over 3.3 million, and were selected to provide a representative sample of land use and transportation ordinances and policies that govern diverse population centers and growth patterns in Washington state. Notable policies and projects elsewhere in Washington state and throughout the U.S. were also included in the study. Selected policy and project examples from Canada and other countries were also included.

Methodology

The contents of this white paper are based on research that was performed in three parts. Part 1, Literature Review, was a study and synthesis of recent relevant reports, surveys, books, articles, ordinances, and legislation that are associated with land use-transportation linkage issues. Part 2, Information Collection, was a survey of existing policies and practices concerning land use and transportation linkage in Washington state. Research data was collected on direct transportation linkage policies, as well as land uses that indirectly influence transportation, in fourteen major metropolitan and emerging suburban and exurban areas throughout this state. Relevant developing trends elsewhere in the United States and Canada were also reviewed. In Part 3, Data Analysis, the results of this inventory were used to extract, define, and illustrate key land use attributes that affect, and are affected by, transportation systems and policy.

II. State Land Use-Transportation Policies and Legislation

Several recent legislative acts and policy plan statements in the state of Washington have explicitly included provisions which relate land use planning to transportation planning. Among the most notable are the 1990 Growth Management Act and its amendments, the 1990 and 1991 High Capacity Transportation Acts, the 1991 Transportation Demand Management Act, and the State Transportation Policy Plan. The following is a brief synopsis of each act or plan.

Growth Management Act and Amendments

Growth management is a term which includes a broad range of actions that are intended to manage or control urban and regional growth. Early programs were initiated by local jurisdictions that sought to control growth by placing moratoria or limits on residential building permits. Now, growth management programs address both the control and planned accommodation of growth, and have become a major planning issue at the state, regional, and community levels.

In 1990, the Growth Management Act (GMA), was passed by the Washington state Legislature. This action was preceded by previous growth management legislation in California (ongoing legislation beginning with AB 1301 of 1971), Oregon (Land Conservation and Development Act of 1973), Florida (Growth Management Act of 1985 and Local Government Comprehensive Planning and Land Development Act of 1987), New Jersey (State Planning Act of 1986), Maine (Comprehensive Planning and Land Use Regulation Act of 1988), and Vermont (Growth Management Act 200 of 1988).(1)

The Growth Management Act identifies among its objectives the following:

- Ensure improvement of public facilities concurrent with new development
- Provide coordinated multimodal transportation services
- Encourage economic development statewide
- Protect and enhance the environment
- Encourage citizen involvement
- Ensure that public facilities meet community-defined level-of-service standards

The GMA provides the following requirements and mechanisms to meet those objectives:

- Boundaries on urban growth
- Critical area designations
- Consistency with comprehensive plans
- Annexation limited to urban growth areas
- Designations of future land use

- Impact fee provisions
- Regional coordination tools (e.g. Regional Transportation Planning Organization)

The Growth Management Act requires all counties that meet threshold requirements of population or growth rate (50,000 people and a population increase of at least 10 percent during the past 10 years, or a population increase of 20 percent regardless of population), as well as all cities within those counties, to develop comprehensive plans by July 1, 1993, and to approve consistent zoning within 12 months after approval of the comprehensive plan.(2) King, Pierce, Snohomish, Clark, Kitsap, Thurston, Whatcom, Skagit, Island, Chelan, Yakima, and Clallam Counties are required to plan under growth management by these criteria. Other counties may optionally participate, and Jefferson, Mason, San Juan, Benton, Douglas, Ferry, Franklin, Kittitas, Pacific, Pend Oreille, Walla Walla, Garfield, Columbia, and Grant counties have voluntarily submitted to GMA requirements by majority vote of their County Commissioners. At present, 26 of the state's 39 counties, representing over 84 percent of the state's population, are mandated, or have chosen, to develop comprehensive plans based on GMA provisions.

A key element of the comprehensive planning process described in the GMA is the development of a long-term community-generated vision for city and regional development, and the linkage of those visions to implementation plans. A comprehensive plan, based upon the community vision, must include the following plan elements: land use, housing, capital facilities, utilities, rural (counties only), and transportation. The general nature of these elements is summarized as follows:

- **Land Use Element:** This segment of the plan defines the distribution and location of general land uses, population densities, and ground water/runoff patterns and protection strategies. This plan estimates future growth, and describes the desired pattern of land use in the community, as defined by the vision or goals of the community. The community land use vision described in this element provides the basis for the development of the transportation system.

- **Housing Element:** This element would include an evaluation of the existing housing inventory and projected needs, the definition of housing-related goals and policies, and identification of appropriate land for housing.

- **Capital Facilities Element:** All capital facilities are identified and inventoried. Forecasts of future facilities needs are made, proposed locations and capabilities of those facilities are indicated, and a six-year financing program is defined. The proposed land use plan may be modified depending upon the availability of facilities funding. The transportation system is a key element of a community's capital facilities.

- **Public Utilities Element:** An inventory of all public facilities, including location and capabilities, will be made. Because transportation systems and public utilities often share rights-of-way, there is a need to coordinate development of each component.

- **Rural Element:** The rural element describes land uses in rural areas that are not otherwise considered to have an urban, agriculture, forest, or mineral designation.

- **Transportation Element:** The transportation planning element is based upon, and must be consistent with, the desired land uses specified in the land use element. This element includes the following sub-elements and tasks:

  - *Land Use Assumptions*
    Identify present and desired land uses;

Develop population and business estimates (size and location)

- *Community Transportation Level of Service Standards*
  Coordinate service standards across political boundaries
- *Inventory of Existing Services and Facilities*
  Include all transportation modes
- *Current and Future Deficiencies*
  Compare future demand with future services;
  Identify desired strategies to solve shortages
- *Analysis of Financing*
  Estimate expected funds;
  Develop multi-year financial plans;
  Compare desirability of increased funding vs. changes in land use assumptions
- *Reevaluation and Concurrency*
  Adopt ordinances to enforce concurrency;
  Perform periodic re-evaluation of service standards, community vision, and land use assumptions
- *Action Strategies*
  Identify and summarize all components of the strategy;
  Define transportation improvement techniques to be used, including low-cost system efficiency improvements, transportation demand management, and system expansion
- *Intergovernmental Coordination*
  Evaluate regional effects of community plans;
  Participate in coordinating activities and organizations

The GMA also provides for impact fee and real estate excise tax options to help cities and counties fund public infrastructure needs generated by new development, as well as administration grants, technical assistance, and mediation support. To encourage regional coordination, the creation of Regional Transportation Planning Organizations (RTPOs) are authorized to help ensure regional conformance with state requirements, and to perform and designate lead planning responsibilities.

This legislation included the formation of a Growth Strategies Commission to recommend specific measures that build upon provisions of the Growth Management Act. In October of 1990, the final report of the Growth Strategies Commission made further recommendations on the following issues:

- Coordinated growth planning
- Protection of the environment
- Protection of greenbelts/greenways and prevention of sprawl
- Protection of agricultural and forest lands
- Preserving significant lands and resources
- Sharing economic growth
- Developing urban growth areas and providing services
- Providing affordable housing
- Linking land use and infrastructure (e.g. transportation)
- Resolving NIMBY (Not In My Back Yard) issues
- Compliance

The report directly addressed the linkage between land use and transportation by advocating, among other things, an implementation approach that uses state leadership and leveraging of transportation network funding and development to provide incentives toward progressive, coordinated, regional growth management.

The 1991 Legislature passed additional legislation (HB 1025) to supplement the GMA. This legislation defines comprehensive plan requirements associated with the siting of essential public facilities, protection of sensitive areas and resource lands, county-wide planning policies that cover incorporated and unincorporated areas within its boundaries, and state agency compliance with local comprehensive plans. The bill modifies the restrictions in the GMA that confine urban development to "urban growth areas", by allowing a separate category of mixed-use developments known as "fully contained communities" that may be approved even if they are not located in urban growth areas. Also added are regional hearing boards to resolve disputes, reinforcement of the concept of "presumption of validity" of city

and regional plans, and authority to the governor to withhold tax dollars to cities or counties that do not conform to the planning process. Additional funds are provided to assist with data collection and organizational costs.

The 1991 amendments also require three counties of the Puget Sound region (King, Pierce, and Snohomish) to coordinate their planning with one another through the comprehensive planning process. Current efforts of these counties to coordinate land use and transportation planning are also discussed in the Metropolitan and Regional Planning section of this white paper.

High Capacity Transportation Act

The High Capacity Transportation (HCT) Acts of 1990 (ESHB 1825) and 1991 (ESHB 2151) provide potential revenue sources for state programs associated with high-capacity transportation systems, including passenger and freight rail, high-occupancy vehicle (HOV) support, and high-capacity transit. These bills allow, among other things, local option taxes to support funding of HOV lanes and high-capacity transit in this state. These revenue options are accompanied by supportive land use considerations; for example, the Acts require that:

> Regional plans and local comprehensive plans shall address the relationship between urban growth and an effective HCT system plan and provide for cooperation between local jurisdictions and transit agencies.
>
> Interlocal agreements between transit authorities, cities and counties shall set forth conditions assuring land uses compatible with development of HCT systems. These include developing sufficient land use densities through local actions in HCT corridors and near passenger stations, preserving transit rights-of-way, and protecting the region's environmental quality.(3)

Transportation Demand Management Act

Programs to control the demand for transportation are being increasingly utilized as one component of a comprehensive package of land use and transportation solutions. The Transportation Demand Management Act of 1991 (SSHB 1671) is aimed at reducing automobile congestion, air pollution, and energy consumption by requiring major employers (those with more than 100 employees) to develop programs with a goal of achieving an initial 15% reduction in single occupancy vehicle (SOV) usage by 1995, a 25% reduction by 1997, and a 35% reduction by 1999. The bill applies to employers in counties with populations exceeding 150,000, and all cities within these populous counties. Within the three-county region of King, Pierce and Snohomish Counties alone, 1,713 employers and 670,000 employees are expected to be covered by the provisions of this bill.(4)

State Transportation Policy Plan

The State Transportation Policy Plan (STPP) is the result of an ongoing policy planning process that was developed by the Washington State Transportation Commission and the state Department of Transportation. This process combines studies of evolving policy issues with public forums and citizen input to develop and enhance statewide transportation policy. The 1990 report of the State Transportation Policy Plan states that "(l)and use and transportation policies must be coordinated and mutually supportive, because land use development determines how well our transportation system works, and transportation facilities are a key factor in influencing patterns of growth." It recommends that the state define the role of state and local planning, describe the contents of comprehensive plans and their transportation elements, and require that effects of development on the transportation system be considered prior to development approval. The 1990 report went on to identify Land Use/Transportation Linkage issues as a major STPP study topic. The research described in this white paper is being coordinated with associated ongoing state

policy planning activities in the Research and Intermodal Planning Offices of the Washington State Department of Transportation.

III. How Land Use and Transportation are Related

This section summarizes existing and recently proposed city and county codes, ordinances, and statements of policy that pertain to land use and transportation, with emphasis on practices in Washington state. The discussion is organized into nine land use issues, and progresses from individual themes to larger development-level land use concepts, concluding with metropolitan and regional planning strategies. These themes are presented in the following sequence:

Individual Themes
- Residential Densities
- Employment and Activity Center Densities
- Parking Requirements
- Transportation Programs

Project-Scale Themes
- Mixed Use Developments
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Each topic is described in three parts:

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Residential Density

Linkage to Transportation

In typical land use regulations, residential densities are specified by the minimum allowable lot size per dwelling unit, which is equivalent to a maximum allowable density. In a residential development, the number of dwelling units per acre (DU/acre) of residential property (not including streets and open space) is known as the net residential density. Attempts to quantify the relationship between net residential density and transportation were initiated with the 1977 study Public Transportation and Land Use Policy by Boris Pushkarev and Jeffrey Zupan. Pushkarev and Zupan developed a supply and demand model of land use-transportation interaction which sought to establish the residential densities necessary to sustain cost-effective local transit service. Their analytical findings were consistent with actual transit/density relationships in major U.S. cities:

1. At densities between 1 and 7 dwellings per acre, transit use is minimal
2. A density of 7 dwellings per acre appears to be a threshold above which transit use increases sharply
3. At densities above 60 dwellings per acre, more than half the trips tend to be made by public transportation.(5)

The summary of findings in Public Transportation and Land Use Policy (particularly the density threshold values) has been referenced frequently in subsequent research papers and publications. It is important to note, however, that there are many factors which affect the density thresholds necessary to support various forms of transit, such as the density of associated employment or activity centers (i.e. the work trip destination), the distance between the residential area and the destination, household size and income, transit fares, service, and frequency, the percentage of the residential population that is in the work force, and other variables. Pushkarev and Zupan explicitly acknowledged this when they prefaced their work by noting, "It should be emphasized that the number of variables which affect the answer to the question 'What density of transit service can be supported by what density of urban development?' is very large..."(6)

Despite the complexities involved in quantifying residential density thresholds that support transit service, there is supporting evidence that cost-effective transit service (e.g. local bus service) benefits from residential densities associated with compact single family housing, or moderate density single family housing with some multi-family units at a higher density. In 1979, the Tri-County Metropolitan Transportation District of Oregon (Tri-Met) published a research and planning guide entitled Planning with Transit. Tri-Met's study of its service area, which is centered in Portland and extends northward into Washington state (Clark County), sought to quantify the relationship between residential density and transit ridership. They

noted that the older areas of Portland with net residential densities of 9 to 15 units per acre were effectively served by transit due to their density, regular street patterns, and proximity to downtown. However, nearby suburban areas such as Beaverton, Lake Oswego, and other surrounding counties were developed with residential areas averaging 3-5 units per acre; Tri-Met found that these areas were difficult to support with quality transit service.(7)

A comparative analysis of overall population density relative to gasoline consumption and transit ridership in U.S., Australian, Canadian, Asian, and European cities, was the focus of 1989 research by Peter Newman and Jeffrey Kenworthy. Newman and Kenworthy found a strong negative correlation between population density and gasoline consumption (i.e. gasoline consumption increases with decreased population density), and a strong positive correlation between population density and transit ridership (i.e. transit's ridership share increases with increased population density). They concluded that when compared to cities throughout the world, major U.S. cities were characterized by low population density, high gasoline consumption, and low levels of transit ridership.(8) Table 1 compares the citywide density of the three largest Washington state cities with other major U.S. cities; the densities of Northwest cities are seen to be relatively low when compared to large eastern urban areas. Table 2 illustrates the relative densities of world cities, and the associated travel mode choices (in this instance, density is being measured by population plus jobs per unit area).

Policies and Practices

In 1915, at the Fourth National Conference on Housing, landscape architect and city planner John Nolen presented research on residential density in a lecture entitled "Land Subdivision and Its Effect Upon Housing". Nolen summarized ongoing nationwide analyses of residential lot sizes:

> Until recently, aside from a few large cities, and other important but nevertheless exceptional developments, the characteristic housing in American towns and cities has seemed relatively good, so far as the subdivision of land and city planning could affect it one way or another. The actual lots as built upon have been, usually from 20 to 40 feet in width, and 100 feet or more in depth...the standard of the best English garden city development.(9)

TABLE 1. Gross Population and Housing Unit Densities for Selected U.S. Cities

City	Population Density (Persons/acre)	Residential Density (Housing units/acre)
New York City	37.6	15.7
Chicago	20.6	8.2
Boston	19.0	8.3
Los Angeles	10.9	4.3
Seattle	9.1	4.5
Tacoma	5.2	2.4
Spokane	4.9	2.3
San Diego	4.8	2.0

(Source: County and City Data Book, 1988)

TABLE 2. Density and Mode Choice

City	Land Use Intensity (Pop+Jobs per acre)	Private Auto (%)	Public Transportation (%)	Walking and Bicycling (%)
Phoenix	5	95	2	3
Perth	6	84	12	4
Washington D.C.	8	81	14	5
Sydney	10	65	30	5
Toronto	24	63	31	6
Hamburg	27	44	41	15
Amsterdam	30	58	14	28
Stockholm	34	34	46	20
Munich	37	38	42	20
Vienna	45	40	45	15
Tokyo	69	16	59	25
Hong Kong	163	3	62	35

(Source: Newman and Kenworthy, p. 36 and p. 42)

FIGURE 1. Typical Residential Density in Urban Seattle

Indeed, a 40 x 100 foot lot was considered generous for the first quarter of the twentieth century. Figure 1 shows a typical bungalow in Seattle on a 40 x 100 foot lot. Later in the twentieth century, however, the increasing prominence of the automobile, an anti-urban bias, and a host of other socioeconomic factors, formed our current situation wherein many U.S. metropolitan areas are now characterized by low density, suburban developments. The multiplicity of

causes of low density suburban sprawl makes a solution equally complex.

In 1965, the Douglas Commission attempted to inventory residential zoning densities in the U.S. Although their efforts were hampered because, "few metropolitan planning agencies or other regional groups have attempted to make consolidated area zoning maps or compile data on the total zoning pattern in the area..." (research limitations that incidentally still exist today), the Douglas Commission concluded that 1/4 of U.S. metropolitan areas with populations of 5,000 or greater did not permit a single family home on a lot less than one-half acre. The low residential densities were not endemic solely to rural settings; for example, the Commission lamented the zoning of Greenwich, Connecticut, "a community of about 65,000 within mass-transit commuting distance of New York City, (where) more than four-fifths of the total undeveloped area is zoned for minimum lots of 1 acre or more..."(10) In 1980, research published in Land Review found that the average residential lot in the U.S. was 12,800 square feet, or slightly over a quarter of an acre.(11)

In the areas of Washington state that were included in this study, present zoning of non-agricultural residential densities range from a low of 0.1 units per acre in the Rural Residential zone in Spokane County and the Suburban Cluster (SC) zone in King County, to a high of 145 units per acre in the Residence Highest Density (RMV 150) zone in Seattle (an even higher density of 195 units per acre is permitted in this zone if the project also includes low income, elderly housing).

More typically, lot sizes for single family zones in this study range from 5,000 sq. ft. to 15,000 sq. ft., corresponding to net densities of 2.9 to 8.7 units per acre. Typical densities for multi-family zones range from 10 to 54 units per acre. Only Seattle and Spokane permit multiple-family residential densities to exceed 100 units per acre.

All but one of the 14 study jurisdictions also have provisions for so-called Planned Unit Developments (PUDs). While different jurisdictions use different names such as "Planned Developments" or "Planned Overlay Zones", the PUD concept generally refers to a "floating" zone which places special requirements on a development; in addition, if amenities are provided by the developer, the zoning provisions may offer in exchange a density bonus over and above the allowable base density of the underlying zone. Eight of the 13 jurisdictions with PUD provisions allow an increase in residential density under such a bonus system. Because PUDs are related to a number of other important land use-transportation concepts, a separate discussion of the PUD approach to residential density and amenities is described in the section titled Master Planned Developments.

TABLE 3. Examples of Small Lot Zones

Jurisdiction	Minimum lot size (square feet)
Riverside County, Ca	3,600
Dade County, Florida	4,000
San Antonio, Texas	4,200
Las Vegas, Nevada	4,000

(Source: Sanders et al. p.6)

There has been a renewed nationwide interest in smaller residential lot sizes, driven by demographic and market factors such as the decrease in average household size in the United States and the need for more affordable single-family housing. Table 3 illustrates some examples of recently-adopted, small-lot single family zones in U.S. jurisdictions. In Washington state, the need to change overall patterns of residential density was explicitly recognized in the 1985 King County Comprehensive Plan, which established a policy defining "Urban Areas" as regions in which the county, "should seek to achieve an average density of 7 to 8 dwelling units per acre...", corresponding to lot sizes of approximately 5400 to 6200 square feet.(12) Table 4 summarizes the evolution of the smallest allowable single family lot in King County, Washington.

TABLE 4. Summary of Minimum Allowable King County Lot Sizes

Date	Lot Size
1937 (zoning established)	4,800 sq. ft.(13)
1938	6,000 sq. ft. (adopted) (14)
1967*	7,200 sq. ft.(15)
1991*	5,000 sq. ft. (King Co., 1988)

(* date of zoning code, not dates of adoption)

The City of Bellevue recently adopted a small lot (4,800 sq. ft) zone in July 1991. Previously, their smallest single family lot zone was 7,200 sq. ft., while the original 1954 Bellevue zoning ordinance required an 8,500 sq. ft. lot as a minimum for single family residences.(16)

The Spokane County zoning code includes a unique transportation-related bonus provision within their zoning code which allows higher densities within the Urban Residential zone (UR-22) in order to "provide for higher density development in locations close to employment, shopping, major transportation routes and the sanitary sewer." The following density bonuses are granted in addition to the base density of 22 units per acre that is allowed by the underlying zone:

a. "Three and one-half (3.5) units per acre for direct hookup to the Sanitary Sewer prior to occupancy...
b. "One-half (.5) unit per acre for location of development within one-quarter (1/4) mile walking distance of available public transit..
c. "One-half (.5) unit per acre for location of development where off-site convenience shopping facilities are functionally accessible within reasonable walking distance (approximately one-half mile)...
d. "One-half (.5) unit per acre for primary means of access to the development is via an arterial." (17)

This example introduces several land use-transportation linkage concepts, including leveraging residential density incentives to encourage pedestrian-friendly site design and attractive transit service, developing a mixture of nearby land uses (e.g. shopping) to reduce automobile trips, and encouraging site designs that improve access. These concepts will be discussed in more detail in later sections of this paper.

Even with explicit policies and zoned densities, however, there remains the problem of actual developed density versus allowable zoned density. Traditional zoning policies establish only a maximum allowable density, with little to prevent eventual development at a lower density. To address this problem, one Puget Sound jurisdiction is considering the adoption of a "minimum density overlay", or density "floor", which would require the developed density to be 85% of the underlying zoned density.(18)

An issue associated with more compact residential development is market acceptance, and specifically the perception that density is associated with a reduction in the "quality" of a neighborhood. A recent study indicates, however, that these perceptions may be a response not to density per se, but to certain characteristics that are perceived to accompany higher density developments, and that these attributes need not be an inherent component of increased residential density. In their article "Density Perception on Residential Streets" published in the Berkeley Planning Journal, James Bergdoll and Rick Williams note that

> Planning departments use density to control and evaluate development. Developers strive for densities which create an adequate return on their investment. The public often judges projects based on common values about appropriate densities. Anything higher than 'low density' is usually seen as 'too dense'. But is density, measured as dwelling units per acre or floor area ratio, really the important quality of the built environment?...Density is a controversial and important topic because many people have a very negative impression of dense places. These people may not be objecting to or running from the density itself, but

from its perceived correlates - for example, higher crime rates, visual clutter, less privacy, often dull or ugly architecture, or lower socioeconomic conditions...

Bergdoll and Williams go on to describe research to compare perceived residential densities to actual densities along three older residential streets in San Francisco that have similar densities, street dimensions, and building heights. They focus their attention on the hypothesis that architectural features are strongly correlated with perceptions of density, and that therefore, attention to design features can affect those perceptions:

> Three physical characteristics seem to be very strongly associated with perceptions of lower density: 1) less facade area or smaller buildings; 2) greater building articulation (that is, recesses between the buildings and variations in the facade plane, and, 3) a greater number of 'house-like' dwellings (e.g. with gable roof)...Housing at higher densities could be achieved with minimal changes in desirability or perceived crowding, and would conserve natural resources and reduce housing costs. If new residential developments were designed to appear less dense, people might accept higher density development more readily. (19)

Future Policies and Research

Residential policies that are potentially supportive of public transit include incentives to build housing units adjacent to, and within, employment and activity centers, development of comprehensively planned residential communities at higher densities, and "infill" development incentives to increase residential density within already-developed portions of cities and counties. Educational and promotional programs are also desirable to objectively address the attributes and opportunities of more compact urban living environments.

Continuing research on the effects of zoning controls (e.g. minimum density requirements) on development and affordability is desirable. A study of the future impacts of demographic trends, such as decreasing household size, on the housing market, would also be beneficial.

Employment and Activity Center Density

Linkage to Transportation

The term employment center refers to any massing of workers; the traditional Central Business District (CBD) and large suburban office parks are examples of employment centers. The term activity center includes all typical employment centers, but could also include a regional shopping center, a university campus, or any other large concentration of people and activities, whether primarily employment-related or not.

The decentralization of employment centers away from the traditional CBDs has become a typical phenomenon throughout the country. Planners and researchers are increasingly interested in the transportation impacts of widespread suburban employment and activity centers, as well as the effects of the central business districts, and are actively studying attributes such as activity center densities in non-CBD zones. The American Planning Association summarized the suburbanization of employment centers in an introduction to a recent article by University of Washington Professor Gary Pivo:

> In the past few decades we have witnessed an explosion of suburban office development, but we are only beginning to understand the pattern of development that is emerging...Urban villages, office corridors, and other popular theories prove to be too simple to capture the actual complexity in the case studies. A more complex pattern is evolving in which the majority of office space is located outside the regional CBD, with some scattered away from freeways, but most located in a large number of small and moderate-sized, low intensity clusters along freeway corridors.(20)

An attempt to quantify the transportation implications of this phenomenon was made in 1977 by transportation planners Boris Pushkarev and Jeffrey Zupan. Although their book Public Transportation and Land Use Policy is often cited as the primary research which relates residential density and public transportation, their study also established correlations between the density of employment centers and public transportation ridership. Pushkarev and Zupan analyzed transit ridership relative to the density of employment, using **total square footage of floor area** in the employment center as a surrogate measure of that density, and illustrated their findings by using the following hypothetical land use planning options to describe the potential influence of employment center density on transit ridership:

> 1. ...Suppose 10 million square feet are to be added to a growing urban area. One option is to put the floorspace into two highway-oriented nonresidential clusters, each 5 million square feet in size. Another is to create a new downtown of 10 million square feet. In the second case, per capita trips by transit within a 3 to 5 mile radius

will be 50 to 70 percent higher than in the first case, keeping residential density the same.

2. ...Suppose the options are to double the size of a downtown from 10 to 20 million square feet, or to double the residential density within a few miles of it from 15 to 30 dwellings per acre. The former will increase per capita trips by transit three to four times more than the latter...(21)

As with residential density correlations, direct relationships between employment density and transit share are of course dependent upon a host of local conditions.

In 1978, research by consultants Parsons Brinckerhoff focused on the relationship between employment center density, this time expressed in **employees per** acre, and transit ridership, in the Puget Sound region. In a comparison of downtown Seattle (500+ employees per acre), the Regrade/Seattle Center area (150 employees per acre), the University District (60 employees per acre), Northgate, Southcenter, and Bellevue (25 employees per acre), and the Crossroads Eastside area (20 or less employees per acre), Parsons Brinckerhoff found a strong correlation between increased transit ridership and increased employment center density, noting that transit's ridership share was particularly strong in activity centers with densities above 50 employees per acre in combination with overall populations of 10,000 to 15,000 employees or more.(22) A similar analysis of employment center density by Seattle Metro in 1985 confirmed the findings of Parsons Brinckerhoff that correlate an increase in transit ridership share with higher overall employment/activity center densities.

In a 1986 article entitled "Urban Transit in Canada: Integration and Innovation at Its Best", transportation planner Robert Cervero summarized the success of public transportation systems in major Canadian cities. Cervero concluded that "the overriding factor behind transit's success in Canada is, plain and simple, the superior levels of service, combined with the careful integration of transit and land use planning."(23) As an example, Cervero noted the success of the Scarborough Town Center, an employment center of 6,000 workers that is linked by an advanced light rail transit (ALRT) system to Toronto. To encourage high density development that in turn supports transit service, building sites close to the ALRT station are zoned at a comparatively high floor area ratio (FAR) of 4. (The FAR of a building is defined as the ratio of the total square footage of a building relative to the overall building site area. For example, a one-story building that covers its entire lot would have an FAR of 1, as would a two-story building covering half its lot, while a five-story building that covers half its lot would have an FAR of 2.5. Figure 2 illustrates the FAR concept. Floor area ratios are used as a surrogate measure of employment density, and enable a more direct and meaningful comparison of differing zoning code measures from community to community.) Estimates of transit's share of trips to Scarborough Center are 75% for workers and 60% for shoppers.(24) Ridership share throughout the entire transit system in metropolitan Toronto is the highest per capita of any North American system (approximately 200 transit trips per person per year); the Toronto Transit Commission (TTC) provides services to support this level of ridership while achieving an operating revenue/cost ratio of 70% via farebox collection.(25)

Other recent research has extended the analysis of employment center density as expressed by floor area ratio. It should be noted that a single building with a high FAR is not necessarily sufficient to support transit; an employment center requires a "critical mass" that combines a large total number of workers with a high overall employment density. Robert Cervero's 1991 research emphasizes the importance of attaining a critical threshold of employment mass as a way to not only support cost-effective public transit, but also provide sufficient numbers of employees in closely-situated buildings so that workers with similar schedules and travel patterns may be matched for vanpooling, carpooling, and other forms of paratransit, thereby further reducing single occupancy commuting. For example, with other variables held constant (supply of

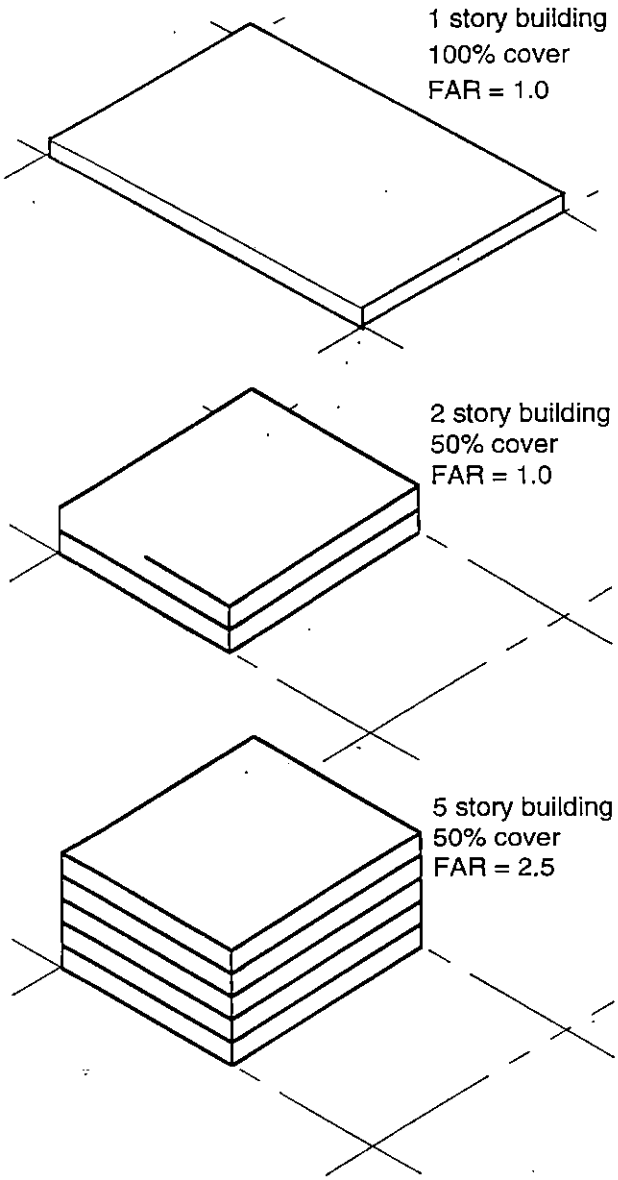


FIGURE 2. Floor-Area Ratio (FAR) Concept

parking, etc.) his study showed that a 1,000,000 square foot office building averages 0.84 more passengers per auto than a building with 500,000 square feet.(26)

Policies and Practices

Early zoning ordinances in large cities were established to reduce or control the density of CBD development. In 1949, after experiencing periods of dense office and apartment construction, the city of New York commissioned a two-year study of potential density revisions throughout the city, and developed FAR maximums based on existing levels of construction activity and elaborate graphical analysis of allowable FARs. More recent nationwide trends toward higher employment density provisions tended to be limited to central business district zoning; the concept that greater employment densities may be necessary or desirable in outlying suburban employment and activity centers as well ran counter to the traditional prominence of the central CBD. With the 1980s research of Robert Cervero and others, however, the importance of density in suburban employment and activity centers is now fully recognized, and has produced an emerging interest in urban environments that emphasize multiple dense employment and activity centers, linked by transit systems. These concepts are discussed in the Metropolitan and Regional Planning section of this white paper.

Within the Washington jurisdictions that were part of this study, maximum employment and activity center density is specified by zone and floor-area ratio; for example, FARs for office, office park, industrial park, and industrial land uses range from 0.5 to 15. The highest allowable CBD FAR is 15 in the "B - Business" zone in Tacoma. Seattle's highest CBD FAR was 20, but was lowered to 14 in 1989 as a result of the "CAP" (Citizen's Alternative Plan) initiative that established building limits in the CBD.

While studies of CBD densities are useful, most central business districts of large cities are already developed to a level capable of supporting considerable transit service. Given the growth in commuting to and within suburban destinations, the study of employment density policies in non-CBD zones such as office, industrial, or manufacturing is equally important. In this study, typical FARs in manufacturing and industrial zones are in the range of 2 to 2.5. In King County, for example, a maximum FAR of 2.5 is allowed in the Light Manufacturing (ML), Manufacturing Park (MP), and Heavy

TABLE 5. Maximum FARs for Selected Zones in Washington Jurisdictions

Zones	Cities		Counties	
	Lower Range	Upper Range	Lower Range	Upper Range
Regional Commercial / Retail	4	6	2	3.5
Downtown CBD Zones	1.0*	15	NA	NA
Light Industrial	1.6	10**	1.3	2.5
Heavy Industrial	2.5	10**	2.5	2.6
Office and Industrial Park	1.5	1.8	1.5	2.5

(Source: Innovations Unit pp. 29-30)

* Lowest CBD base density without density bonuses
** Exceeds next highest FAR in this study by 3
NA Not Applicable

Manufacturing (MH) zones, while Seattle's zoning code also allows a maximum FAR of 2.5 in the Industrial Commercial, (IC), General Industrial (IG1 and IG2), and Industrial Buffer zones. Table 5 summarizes the maximum allowable employment densities for selected zones in Washington jurisdictions.

It should be noted that the findings summarized in Table 5 are based in part on estimates of equivalent floor area ratios, since some zoning codes use setbacks and height limits to define employment density. In addition, it is the overall employment density of an activity center, and not just the individual building densities, that affects its ability to support public transportation services. Nevertheless, the typical floor area ratios in the preceding table are consistent with the FAR benchmark of 2.0 that Cervero described as a minimum threshold of employment density to adequately support transit service (based upon studies by the Chicago Regional Transportation Authority).(27) As with residential densities, however, the employment density threshold value that is needed to support public transportation depends upon the conditions of the area and the nature of the transit service.

Note that the FAR values in Table 5 represent a range of allowable maximum densities; however, this should be distinguished from actual built employment densities. Cervero's study of 57 suburban employment centers concluded that the average actual built development has an FAR of 0.98 and an employee density of 19.9 employees per acre, although zoning policies allowed an average maximum FAR of 2.34. (28, 29) As with residential zoning, the shortcomings of an analysis based solely on stated policy are clearly evident. Indeed, factors such as high parking requirements and relatively low land values outside of CBDs could result in built densities that are considerably less than those allowed by zoning codes.

A notable exception to the typical zoning of employment and activity centers which specify a maximum allowable density is found in Portland, Oregon, which has established a "Light Rail Transit Zone" (a so-called overlay zone) that specifies a range of minimum allowable FARs, "to create a more intense built-up environment, oriented to pedestrians."(30) In Gresham, Oregon, the "Transit Development District" zone near transit stops also specifies minimum FARs and explicitly recognizes the transit linkage. The Transit Development District is "intended to promote development that makes effective use of its close proximity and accessibility to the light rail stations and to established intensive retail, service, office and residential uses in these areas."(31)

Future Policies and Research

Future policies should explicitly consider the potential benefits of dense, more consolidated employment and activity centers. Typical CBD regulations that contain elaborate requirements and density bonuses could be extended to non-CBD and suburban zones to encourage denser developments, combined with mixed-use and other transit-friendly amenities.

The actual vs. zoned distribution of employment density in state jurisdictions should be monitored and evaluated. More research is also desirable to evaluate the impacts of policies (e.g. minimum FARs and incentive programs) on actual development patterns and densities.

Parking Requirements

Linkage to Transportation

Off-street automobile parking requirements in zoning codes represent a direct transportation linkage issue. The effect of parking requirements on transit ridership and overall development patterns was noted nearly 50 years ago in a 1942 study by the Eno Foundation. In successive articles entitled "The Relationship Between Parking and Mass Transportation Facilities" and "The Relationship Between Parking and Municipal Development and Decentralization", transportation planning pioneer William Eno noted:

> Mass transportation is cheaper than operating a private vehicle, and eliminates the worry about parking. Since the transportation companies failed, as a general rule, to supply the sort of service the public wanted, more and more people used their own vehicles until their numbers became such as to create the present parking conditions.
>
> Today, while the transportation people are trying to improve their service, they find themselves hampered...by the large number of private vehicles moving and parked on the streets. They are also hampered by the fact that the use of private cars has resulted in a dispersion of the populations. People have moved to the suburbs where it is more difficult to operate mass transportation.
>
> It has become evident that private motor vehicle transportation and congested business and industrial centers are incompatible. This incompatibility has, however, brought about a dispersion and decentralization which is premature...This premature decentralization of business has been brought about by the fact that cities, merchants, property owners and other interested parties have failed to cooperate and provide ample parking and terminal facilities...This results in secondary zones of congestion in which the parking and terminal facilities become as great a problem as they were in the old sections. A survey of Los Angeles, California, for instance has shown that about one hundred such focal points have developed in the past twenty years...(32)

Even in 1992, these 1942 descriptions of the impacts of the automobile and parking regulations seem current, although the reference to "ample parking" as a solution to the transportation problem proved to be shortsighted. During the past fifty years, the solution to the parking problem has instead been addressed by neglect or abandonment of public transportation systems, transportation networks that primarily support automobile access to suburban employment and activity centers, and regulations that require large off-street parking facilities. A recent international study found that off-street parking requirements and commercial lot development in U.S. cities generated an average of 380 parking spaces per 1,000 CBD workers, while

Australian cities provide an average of 327 spaces per 1,000 CBD workers, Canadian cities (Toronto only) provide 198 spaces per 1,000 CBD workers, European cities provide 211 spaces per 1,000 workers in the CBD, and 67 spaces are provided for every 1,000 CBD workers in Asian cities. Concomitant with the large supply of parking in U.S. cities were low levels of ridership on transit and greater dependence on single occupant vehicles.(33)

In 1989, an analysis of suburban travel behavior at 64 suburban activity centers (SACs) and nearby central business districts was conducted by the Joint Center for Urban Mobility Research at Rice University. Based on comparisons of suburban centers with CBDs, this research revealed a strong correlation between transit ridership and limits on parking. Parking spaces at the SACs averaged 3.7 spaces per 1000 square feet of office space (with a high of 5.7 and a low of 0.3 per 1,000) while parking spaces at CBDs averaged 1.3 spaces per 1000 gross square feet (with a high of 2.4 and a low of 0.8 per 1,000). The associated transit ridership share was only 2 to 5 percent in SACs, but nearly 30 percent in CBDs. Parenthetically, it should be noted that there are of course other attributes besides parking requirements that distinguish transit ridership share in suburban activity centers from that in central business districts. One example is the difference in transit system service and transit incentive programs, as seen in Table 6.

Policies and Practices

Actually, widespread implementation of off-street parking requirements is a relatively recent phenomenon. A 1947 study by the Eno Foundation surveyed 586 city zoning ordinances, and found that only 70, or 12 percent, had implemented formal provisions for off-street parking.(34) King County adopted its first zoning ordinance in 1937; off-street parking regulations were not added until 1950. Off-street parking regulations are now an integral requirement in city and county zoning codes.

Parking requirements for a particular type of activity (e.g. professional office, retail, manufacturing, etc.) are usually expressed as the minimum number of off-street spaces that must be provided per gross square footage of building floor area. For example, Vancouver, Washington requires a minimum of 2.5 parking spaces per 1000 gross square feet of floor area for business and professional offices outside the CBD, while 1 space per 1000 square feet is required for office buildings within the CBD.

In Washington jurisdictions, marked differences are evident between parking requirements in CBD zones, non-CBD zones, and county zones. Tables 7, 8 and 9 summarize the range of current parking requirements, shown as the minimum number of parking spaces required per 1000 gross square feet of floor area, for retail, office, and manufacturing land uses. To make the comparison easier to understand, these values have been converted from the actual code specifications, which are generally written in the inverse form, i.e. number of gross square feet per parking space.

TABLE 6. Percentage of Centers in the Study with Various Transit Services

Type of Activity Center	Residential Bus Service	Shuttle Bus Service	Passenger Rail Service	Employer Transit Subsidies	Transit Use Incentives
SAC	59.0%	40.4%	28.6%	31.1%	59.6%
CBD	60.0%	83.3%	68.4%	82.4%	78.6%

(Source: Joint Center p. 47)

TABLE 7. Minimum Parking Required for Retail Zones in Washington state

	Cities		Counties	
	Lower Range	Upper Range	Lower Range	Upper Range
Parking Requirement	0.40	5.00	2.85	6.67
Average Requirement	1.63		3.03	
Average in CBD	0.71		NA	
Average in non-CBD	2.40		NA	

TABLE 8. Minimum Parking Required for Business/Professional Office Zones in Washington state

	Cities		Counties	
	Lower Range	Upper Range	Lower Range	Upper Range
Parking Requirement	0.67	5.00	2.50	5.00
Average Requirement	1.66		3.03	
Average in CBD	1.05		NA	
Average in non-CBD	2.29		NA	

TABLE 9. Minimum Parking Required for Manufacturing Zones in Washington state

	Cities		Counties	
	Lower Range	Upper Range	Lower Range	Upper Range
Parking Requirement	0.67	1.67	1.0	2.5
Average Requirement	1.07		1.51	

(Source: Innovations Unit pp.37-38)

Most jurisdictions generally define minimum parking requirements and do not specify upper limits on the number of allowable spaces. However, some cities have implemented ceilings on allowable parking. Both Bellevue and Seattle specify maximum allowable off-street spaces within their Central Business Districts. In addition, Bellevue specifies maximum allowable off-street spaces for certain non-CBD uses. This concept is not yet a prevalent one, particularly outside of major metropolitan areas; in a July 1991 American Planning Association publication of parking regulations in 127 jurisdictions nationwide, Bellevue was the only listed jurisdiction that set limitations on off-street parking for new developments (that study did not, however, include a representative sample of large cities, where maximums on parking are more common).

Maximum parking provisions in zoning codes have also been considered by counties as well. In 1982, for example, JHK & Associates prepared a "Parking Policies Study" for Montgomery County, Maryland. Their cautious appraisal of maximum parking limitations was as follows:

Maximum limitations on the amount of parking which can be provided for various land uses has been employed in some jurisdictions. The underlying theory is that limitations of this supply will, in itself, create less of a demand for auto travel, thus promoting land use and transportation efficiency...Too restrictive a cap on parking may divert development to other locations which are less desirable from both a land use and transportation perspective...the cost of land and parking construction are already an effective maximum limitation on parking...one should also be cautious about such provisions in low cost suburban areas since an undersupply of parking will not usually result in diversion of trips to alternate modes but in the overflow of parking onto nearby streets. Strict limitations on parking in these suburban areas are not practical. Their primary value is in densely developed locations where alternate modes are readily available..."(35)

In another approach to parking regulation, Portland, Oregon has established a cap on the total number of off-street parking spaces to be allowed in their CBD. With the adoption of the 1975 Downtown Parking and Circulation Policy (DPCP), the cap was placed at 43,000 spaces. This policy was re-evaluated in 1986, and in 1990 the Downtown Parking Management Plan was adopted which specifies 1,300 additional off-street parking spaces over the old limit of 43,000, with an accompanying goal of 35% transit ridership by the year 2000.(36) This example from Portland also illustrates the need for ongoing evaluation and adjustment of parking policies as conditions change.

Future Policies and Research

Upper limits on allowable parking for non-CBD and suburban developments as well as CBD zones may further encourage transit ridership, and also allow developments to contain more dense employment concentrations. In order to sustain any increases in ridership that may result, however, limitations on parking supply must be accompanied by increased transit service; this requires coordination between local jurisdictions and transit agencies. The impact of parking regulations on overall development patterns should also be evaluated periodically.

Policies that curb parking availability need not be limited to new developments; incentives to reduce parking in existing commercial areas open up a potential opportunity to "retrofit" transit-friendly developments into already-urbanized regions. The complexities of redevelopment in existing retail and office projects are being addressed in current research; for example, some planners and designers are focusing on the potential to reuse parking lots, which are often excessively large, as sites for denser redevelopments. There is also a need to study the effects of in-fill on existing transit-friendly developments or features. By effectively "reusing" available space in built urban areas rather than undeveloped outlying areas, the public can benefit from more compact development patterns that support transit service, improve pedestrian access, and preserve rural areas, while developers can benefit economically from the potential redevelopment and increased commercial densification of their property.

Transportation Programs

Linkage to Transportation

Some zoning ordinances and land use policies include complementary transportation or traffic programs that address transportation problems by either reducing the transportation **demand**, or improving the transportation **supply**. Two such techniques are Transportation Demand Management (TDM) programs and Concurrency/Road Adequacy ordinances.

As the name implies, demand management uses incentives and disincentives to manage the quantity, mode choice, and distribution of travel demand, particularly single occupant vehicle trip-making. Demand or capacity management is typically accomplished by 1) encouraging use of higher-occupancy vehicles such as car pools, van pools, and buses (e.g. using service and price incentives), 2) reducing demand (by cost disincentives or land use changes), 3) providing substitutes to travel (telecommuting, services by phone), or 4) redistributing the travel demand (flextime, reduced work weeks). TDM techniques increase the useful capacity of the existing transportation system by increasing the efficiency of each vehicle (e.g. encouraging HOVs) or reducing the overall demand for the system (e.g. reducing the need for, and quantity of, trips). These approaches are particularly useful when system service improvements are needed but funds or rights-of-way to support capacity enhancements are not available. The potential of TDM policies and programs to directly affect travel behavior is a strength of this approach. Demand management is often implemented as a Trip Reduction Ordinance (TRO), "passed by a local government requiring developers, property owners, and employers to participate or assist in financing transportation management efforts. In many instances, such ordinances specify a target reduction in the number of vehicle trips expected from a development based on standardized trip generation rates."(37) Washington state's recent demand management legislation is a statewide variant of this approach. Of particular interest to this study is the complementary use of demand management techniques and supportive site designs to encourage land uses and patterns that generate less travel demand and/or encourage more HOV usage.

In contrast, the concurrency approach looks at the supply side of the transportation equation, by establishing zoning or other conditions which require that any new development be accompanied by an appropriate expansion or improvement in the transportation infrastructure to mitigate the effects of the development. These concurrent transportation improvements generally take the form of road network and signalization enhancements; increasingly, however, TDM programs and greater transit service and access are being used to mitigate traffic impacts. Concurrency ordinances are also known as Adequate Public Facilities Ordinances or APFOs. The state Growth

Management Act includes a concurrency requirement.

Demand management and concurrency regulations are sometimes accompanied by another type of transportation program known as the transportation management association (TMA). A TMA is "an organization that provides a structured environment for developers, property managers, employers, and sometimes public officials to cooperatively promote programs that mitigate traffic congestion, assist commuters, and otherwise encourage travel in a given area."(38) This public/private cooperative approach brings public agencies, private employers, and individual employees together in an effort to manage and direct transportation demand while supporting economic vitality in the region.

Policies and Practices

TROs and TMAs

One of the early transportation demand management programs was initiated by the Tennessee Valley Authority (TVA) in 1973. While the term "transportation demand management" was not used at that time, this successful program uses a combination of TDM and TMA concepts. In Autos, Transit and Cities, transportation planners Meyer and Gomez-Ibanez summarized the effects of this early program:

> Between late 1973 and early 1977, the number of commuters' automobiles arriving at TVA (including private cars, carpools, and vanpools) declined by more than one half (from 2,195 to 1,066), despite a 15 percent increase in employment (from 2,950 to 3,400). This achievement is all the more remarkable because almost 12 percent of the TVA vanpoolers previously commuted by bus, and almost 37 percent previously commuted by carpool. The annual benefits to TVA of the pooling and express bus incentive programs in savings on parking spaces alone has been estimated to be $337,820 per year against a direct cost to TVA of $125,000 per year.(39)

TMAs and TROs are now widely established throughout the U.S., although the exact extent of their use is not easily assessed. One recent study by the Urban Land Institute (ULI) concluded that there were 12 fully operational, and 22 "startup" TMAs throughout the country as of early 1989, and "at least" 23 TROs in seven states: California, Washington, Arizona, Maryland, Connecticut, New Jersey, and Virginia.(40, 41) In other research, Erik Ferguson (citing the findings of Mark Wright in the TMA Directory) noted that as of August 1989 there were "53 TMAs located in 14 states...and fully 40% came into existence in the year 1989 alone..." Approximately 40% of those TMAs were in California jurisdictions.(42) A 1990 report by the California Department of Transportation found, "an upper limit of 59 separate TROs in 46 independent jurisdictions...and 67 percent of all TROs were concentrated in the state of California." The California DOT report also identified county and regional TROs including those in Maricopa County, AZ, Montgomery County, MD, Sacramento County, CA, and the South Coast Quality Management District, CA.(43) These differing accounts of TMAs and TROs may be explained by difficulties in acquiring information on a nationwide basis, differences in the definitions of TMAs and TROs, and their increasing popularity, which results in studies being outdated by the time of publication. In any case, transportation demand management programs are becoming more commonplace; their effectiveness continues to be evaluated, however.

The TRO in the Seattle CBD illustrates some typical ordinance features: all structures containing more than 10,000 square feet of non-residential space are required to develop a transportation management program that includes a transportation coordinator who works with the City of Seattle's Rideshare office to "encourage use of public transit, carpools, vanpools, and flextime." In the Seattle CBD, transit ridership is promoted by permitting more than 1 long term parking space per 1,000 square feet of non-residential use only by special permission of the Planning Director, and by restricting parking in the CBD based on the type of use and whether the occupancy is within areas with "high transit access" or "moderate transit access."(44)

To reduce auto dependency outside of the CBD, Bellevue, Washington has instituted a TRO that is integrated into their zoning code. This ordinance applies to all new structures within office, commercial, light industrial, and some residential zones. Single family, small multi-family, and other small-scale developments are exempt from this ordinance.(45)

In nationwide publications, the Bellevue Transportation Management Association (TMA) has been widely publicized as a successful employer-based program. In a 1990 U.S. Department of Transportation study, major Bellevue employers U.S. West and CH2M Hill were also cited for instituting successful trip reduction measures. For example, among its 1,150 employees U.S. West attained a 47.6% reduction in vehicle trips, while CH2M Hill attained a 31.2% reduction in vehicle trips among its 400 employees. Downtown Bellevue has reached an overall reduction in vehicle trips of 17.8%.(46)

Concurrency/Adequate Public Facilities Ordinances

Although local governments have often adopted concurrency ordinances or APFOs (in 1973, Montgomery County, Maryland was one of the first local jurisdictions to pass an APFO), some states have explicit enabling legislation that authorizes or requires local jurisdictions to develop concurrency conditions. Maryland, New Hampshire, Florida, and Washington have such enabling legislation, while the Florida and Washington state growth management laws require concurrency of land use development and transportation systems.(47)

In Bellevue, the city implemented a Transportation Improvement Program as a city-wide concurrency policy. Its stated goal is as follows:

> ...Develop and adapt a program for the purpose of jointly funding, from public and private sources, transportation improvements necessitated in whole or in part by development and growth with the plan area...provide a a fair and predictable method for allocating the cost of reasonable and necessary transportation improvements between the public and private sectors..create a mechanism to charge and collect transportation impact fees from new development to provide a portion of the funding for reasonable and necessary off-site transportation improvements to mitigate the cumulative impacts of growth and development in the plan area.(48)

King County and Snohomish County have both established elaborate county concurrency ordinances. King County's impact fee program, known as the Mitigation Payment System (MPS), is a computerized system that determines the appropriate allocation of development fees based upon the degree to which a new development contributes to traffic levels at sites where major county capacity improvements are planned during the next 10 years. These impact fees are paid at the time of permitting, and are intended to supplement public funds. The fee program also offers incentive credits to encourage public transportation improvements and affordable housing. The This system supplements the existing Road Adequacy Standards (RAS) system, a site-specific impact fee program that applies to most developments except single family homes; this program is in the process of being revised to include level of service standards and concurrency evaluations. Snohomish County's ordinance, entitled "Title 26B Developer Contributions for Road Purposes as a Condition of Land Use Approvals", describes its purpose as follows:

> The purpose of this title is to ensure that public health, safety and welfare will be preserved by having adequate roads serving new and existing developments by requiring all developments...to mitigate traffic impacts which may include contributing a proportionate share of the cost of road improvements reasonably necessary as a result of the direct traffic impact of the proposed development.(49)

Spokane County requires a limited form of concurrency that encourages transit facilities as part of new developments. Within Business, Industrial, and Urban Residential

zones of the county, any proposal or development that generates one thousand (1,000) "average weekday trip ends" or more shall have its owners or representatives, "negotiate in good faith with the Spokane Transit Authority for the possible provision of facilities that would enhance the provision of public transit."(50)

Among the provisions of the state Growth Management Act is the specification by each community of desired level-of-service standards for its transportation system; these standards are then used to evaluate the impacts of a proposed new development or land use. The GMA states that significant impacts require concurrent mitigation by the developer, where "concurrent mitigation" is defined as a commitment by a developer to maintain desired community levels of service by completing sufficient transportation impact mitigation at the time of development, or providing a financial commitment to complete sufficient improvements within six years of development. The mitigation program may include enhancements to satisfy an increase in demand (e.g. capacity expansion or improved signaling operations), as well as other measures that effectively reduce the impact (e.g. TDM or transit service enhancement).

Future Policies and Research

New and ongoing state TDM and concurrency programs should be monitored, and the effectiveness of TDM policies and associated enforcement approaches should be evaluated. In addition, educational and promotional programs should continue to encourage higher-occupancy modes of transportation.

Mixed Use Developments

Linkage to Transportation

While the concept is not easily defined, mixed use developments (also known as MXDs) are usually thought of as any building or complex of buildings conceived as a single development which includes more than one distinct type of use (e.g. retail, housing, office). Mixed use developments have been studied by the Urban Land Institute (ULI) since 1976, with particular emphasis on large-scale developments containing three or more distinct land uses. The ULI cataloguing effort considered 1960 to be the starting point for mixed use developments; by 1975, it noted that "the mixed-use concept was catching on, and that year's first census of MXDs (by the ULI) placed their number at almost 100 in North America."(51) If the definition of mixed use is broadened to include small scale mixed uses as well as monolithic developments, MXDs were quite common in early U.S. cities, with housing or offices atop retail buildings (see figure 3); indeed, an emphasis only on large-scale mixed use underestimates the potential effect of overall patterns of mixed land uses throughout a city or neighborhood. As a result, planners now recognize mixed use as a concept that includes small-scale mixed use structures and mixed use zones with two or more uses, as well as large-scale projects.

In the past ten years, cities have increasingly focused on the importance of street-level retail in office buildings. The transportation benefits of locating housing and services near and within employment and activity centers are also being recognized, as seen in research on the benefits of mixed use developments in the 1980s by Professor Robert Cervero of the University of California at Berkeley. In his 1988 book America's Suburban Centers, Cervero concluded that a mix of land uses was a major factor in supporting mass transit and deterring the use of private autos. By providing workers with housing opportunities near their place of work, travel modes such as transit, walking, and bicycling become more viable commuting alternatives to the single occupant vehicle. In addition, by improving access to a variety of services near employment sites, mixed use developments reduce the need for a car to perform mid-day errands and other "non-home based" trips.

Cervero's most recent research on this subject was published in the October 1991 issue of Transportation Quarterly. Based on a 1989 report by the National Cooperative Highway Research Program, Cervero's research analyzed the land use and travel characteristics of 83 buildings in 6 suburban activity centers. Due to inadequate mixes of land uses, the typical centers failed to generate a transit mode share of more than 1 percent. In contrast, Cervero cited Farsta and Vallingby in Sweden (outside of Stockholm), Albertslund (outside of Copenhagen), and Scarborough and North York (outside of Toronto) as, "testaments to the ability of clustered, mixed-use suburban workplaces to attract well over

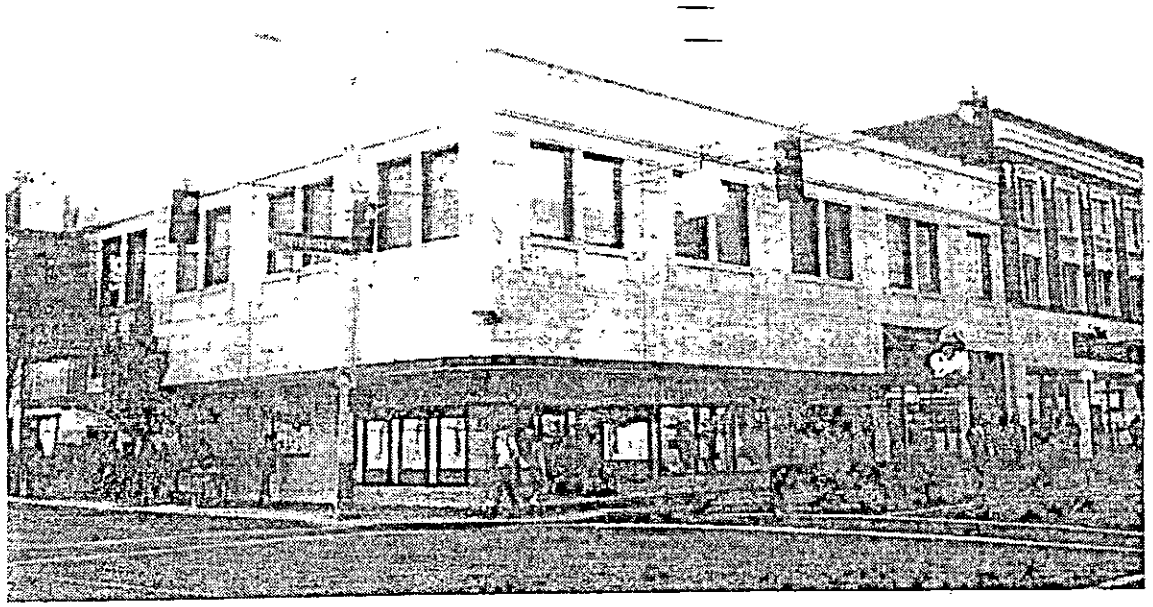


FIGURE 3. Street-level Mixed Use

one-half of their workforces into transit vehicles for the journey to work."(52)

The potential importance of a mixture of land uses was also measured in a 1991 analysis of the transportation implications of increased housing in downtown Toronto:

> In Toronto in recent years, commuting trips to the Central Area have not risen as rapidly as would be expected from the growth in downtown office space. Various explanations have been suggested...the rising residential population in the Central Area has served to reduce inbound commuting trips below what they otherwise would be...we have been able to estimate that on average since 1976, for each 100 additional dwelling units in the Central Area there has been a reduction of approximately 120 inbound trips during the morning three-hour rush period. This finding indicates the potential for the use of housing policy as a land-use planning instrument...(53)

Policies and Practices

Land use policies which control mixed use developments are difficult to analyze. While many zones are termed "mixed use", or allow a broad mix of land uses, the actual composition of built projects is not easily monitored. Once again, the question of **built developments vs. stated policy** is important to the evaluation of land use policies and ordinances.

Typical early zoning ordinances were established in a cumulative structure that allowed each zone to contain every use in all the preceding zones, in a progression from single family, to multi-family, to commercial, and finally industrial zones. Seattle's early zoning code consisted of six cumulative zones:

> The First Residence Zone: In the first residence zone the use is limited to single family dwellings, churches, schools, libraries, parks and playfields.
>
> The Second Residence Zone: In the second residence zone the uses of the first

residence zone are permitted, and in addition, structures housing more than one family, or a number of individuals are allowed.

The Business Zone: In the Business Zone there is permitted all the uses of the first and second residence zones, and in addition, wholesale and retail stores, offices and establishments serving the general public...

The Commercial Zone: In the commercial zone there is allowed all the uses of the three preceding zones, and in addition, there is permitted light manufacturing...

The Manufacturing Zone: The manufacturing zone may include all of the types of occupancy permitted in the preceding zones, and in addition there is allowed all types of industry and manufacturing excepting those that are objectionable...

The Industrial Zone: The industrial zone may be used for any lawful purpose which does not conflict with the local statutes.(54)

As zoning ordinances have become more complex, this simple cumulative structure of allowable uses has been replaced by a policy of limited, separated uses in zone such as manufacturing and industrial. By 1967, research by the Puget Sound Governmental Conference concluded that many jurisdictions were beginning to define each zone and its allowable uses on an individual basis:

> Although many zoning ordinances in the Puget Sound Region are of the cumulative type, the tendency has been to avoid this type of ordinance. As problems have occurred over noncompatible uses of land, many communities have adopted noncumulative zoning ordinances...The noncumulative ordinances separate the residential, commercial, and industrial uses from one another, and from distinct districts...many jurisdictions in the Puget Sound region have amended their zoning ordinances as problems of noncompatible land uses have occurred to exclude problem land uses from some districts, thus producing a mixture of both the old (cumulative) and new (non-cumulative) philosophies of zoning...(55)

Codes are still quite protective of single family zoning. In addition, as the density of the residential zone decreases, fewer non-residential uses are allowed. This trend results in a very limited mix of land uses in precisely those low density residential zones which are often the furthest from urban centers and essential services. Codes also allow a very limited number of land uses in manufacturing and industrial zones, even though industrial and manufacturing sites are often large-scale employment centers which could support a range of other services such as retail, banking, and shopping. Even housing may be appropriate in some light industrial office park areas.

There are often a wide range of uses allowed in the non-residential, non-industrial "middle" zones (downtowns, regional commercial centers, etc), but the market tendency to develop land to its highest financial potential may often preclude the development of some uses in these zones, where the land values are high. To combat this tendency, cities such as Seattle, Spokane, Bellevue and Tacoma have instituted bonus systems that encourage the inclusion of housing in downtown zones. For example, the Proposed Zoning Code for Spokane counts housing in the CBD as "free floors", i.e. housing is not included in the maximum allowable FAR of 13, thus allowing the same amount of commercial or office development with or without housing.(56)

Another developer incentive to encourage housing involves a contribution to a fund to build or rehabilitate housing elsewhere, as an alternative to requiring residential units within a proposed development. A 1988 Urban Land Institute survey studied ten housing linkage programs in the United States which required a fee or equivalent housing development, or an optional contribution or housing development in exchange for a density bonus (e.g. Seattle). Two of the largest housing linkage programs

have been implemented in San Francisco and Boston. For example, San Francisco's downtown housing linkage program generated $29.7 million and resulted in 4,026 new units and 1,664 rehabilitated units between 1980 and 1987.(57)

Future Policies and Research

A greater diversity of uses should be allowed in all zones, and incentives are needed to encourage mixed use developments outside of central city business districts. Essential services and housing within and near employment and activity centers are desirable to encourage transit ridership and reduce SOV trips. Research is needed to further quantify the transportation implications of mixed use developments.

There is a potential to expand the allowable uses in all zones. Careful integration of different uses can be achieved through site planning, design, and transportation management. The traffic generated by some activities is often cited as a reason for not allowing a broader range of land use activities in certain zones. However, transit-supportive designs could mitigate and channel any traffic impact.

Site Design

Linkage to Transportation

Attempts to link elements of site design with transportation are relatively recent, although this field of research is gaining strength and popularity. Three recent books written and edited by University of Washington professors are prominent studies in this field. Public Streets for Public Use (1987, edited by Anne Vernez Moudon) is a comprehensive review of the historical evolution of streets from small-scale mixed use open spaces, to the large, open traffic ways represented by the typical street grid in U.S. cities. Accommodating the Pedestrian (1984, written by Rich Untermann) was an early research effort which advocated the importance of pedestrian and bicycle networks in cities. The Pedestrian Pocket Book: A New Suburban Design Strategy (1989, edited by Doug Kelbaugh) describes the "pedestrian pocket" approach to community planning and design. In their description, Kelbaugh and others such as architect Peter Calthorpe advocate a return to more compact communities with traditional (rectilinear) street systems and transit-oriented designs that offer convenient public transportation links to the central city.

For the purposes of this research, the term "site design" includes two topics: **street systems and block dimensions** (including subdivision design), and **detailed site development and street level design** (including provisions for pedestrians and bicycles, building layout, and the orientation of building entrances).

Streets and Blocks

Early cities were called "walking cities" because the overall city plans were dense and compact to keep activities within walking distance. A 1921 article noted, "It has been found that one mile is about the maximum average distance which people will walk to and from work..."(58) With the advent of the automobile, our cities and regions have expanded into widely dispersed development patterns, reinforcing our increasing dependence on automobiles to the point where many planners and researchers agree that most people are now only willing to walk up to 1/4 mile to a destination such as a store or transit stop.

In an effort to define a more efficient, compact urban development form that supports transit, pedestrians, and bicycles, some planners and architects have proposed the Neo-Traditional Neighborhood Development (NTND) concept. (The NTND concept encompasses a number of topics included in this white paper, including residential density, mixed uses, and transit-, pedestrian-, and bicycle-friendly site design. The discussion here is specifically on the site design aspects of this neighborhood concept.) As the name implies, neo-traditional neighborhood designs address transportation by emphasizing pedestrian and bicycle-friendly neighborhood designs with regularly spaced "traditional" street network patterns

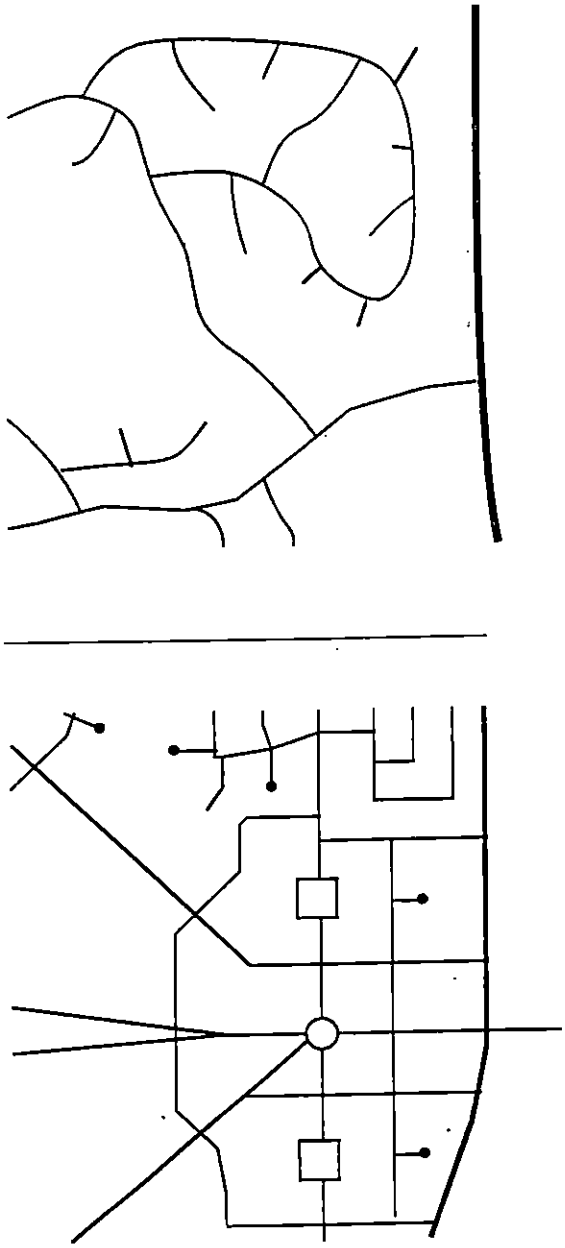


Figure 4. Conventional (top) and NeoTraditional (bottom) Street Design

such as grids (see figure 4). Transportation planner Walter Kulash evaluates the neo-traditional neighborhood street concept in the following way (Kulash refers to these designs as TNDs or Traditional Neighborhood Developments):

1. The TND has superior traffic capacity
2. The TND has lower travel speeds but comparable travel time; the lower speeds are due to the larger number of intersections, but due to the geometry of a dense network of streets, the TND reduces the travel distance for any given pair of origins and destinations..
3. The quality of the automobile trip is higher in the TND...
4. The TND is friendly to non-motorized travel...(59)

Laguna West, a new master-planned community in Sacramento County, California that is presently under development, is often mentioned as a recent example of a neo-traditional neighborhood development. A 1991 report of this project concluded that its dense block pattern and street system could result in a 20% to 25% reduction in vehicle-miles traveled when compared to typical suburban developments.(60)

Site Development and Street Level Design

Along with increasing interest in street networks and block patterns, there is also greater consideration of the potential effects of street level design details, as well as the overall layout of a site, on transportation. Design elements that encourage walking, bicycling, or public transit as alternatives to the automobile are of particular interest. Examples of pedestrian design details that enhance access to nearby services and facilities on foot include the positioning of buildings within a site (e.g. the degree to which a building is set back from nearby commercial, retail, and other services, thereby affecting walking distances), the orientation and distance of building entrances relative to public transit stops, and pedestrian amenities (e.g. plazas, covered areas). Pedestrian-supportive site design also increases the "density" of pedestrian activity and helps to evoke the feeling of a lively street environment, which further reinforces the attractiveness of walking. For example, an analysis of neighborhood commercial streets in Seattle by University of Washington professors Richard Untermann and Anne Vernez Moudon suggests that, "at least 380 pedestrians per hour (on both sides of the street) yields a healthy, solid pedestrian environment."(61)

Amenities such as dedicated paths, storage lockers, and showering/changing facilities increase the attractiveness of the bicycle as an alternative to the automobile. Michael Replogle has documented the international experience with bicycling, with particular emphasis on the use of bicycles as a "feeder" system that provides access to transit stations:

> In the suburban areas of Japan and Northern Europe, bicycle access to transit has grown phenomenally in the past decade, significantly exceeding the growth of automobile access to transit. Between 1975 and 1981, the number of bicycles parked daily at Japanese rail stations more than quadrupled to 1,250,000 and continues to grow by 21% a year. In the Netherlands, the share of rail station access trips made by bicycle has doubled since 1960; 36% of Dutch railway passengers as well as 10% to 20% of regional bus passengers bicycled to their transit boarding point in 1981...In a number of West German, Dutch, and Japanese suburban towns, bicycles account for half or more of all railway access trips.(62)

Replogle contrasted these findings with bicycle use in the U.S.:

> Despite the great promise shown by efforts to promote bicycle-transit linkage in the U.S., American transportation planners and managers have given little attention to the role of bicycles in expanding suburban transit markets and reducing the financial, energy, and environmental costs of transit system access systems.(63)

Policies and Practices

Streets and Blocks

The influence of site design, particularly street and block dimensions, on transportation and urban design is well represented in a recent discussion of the 600-foot superblocks in downtown Bellevue:

> Around the time of incorporation in 1954, its (Bellevue's) planners sternly scored the city into 600-foot superblocks wrapped by 6-plus lanes of arterial roads. It won a prize, says local planning consultant Don Miles, for providing ample parking deep into the future...It was the kind of place where you'd drive everywhere - no sidewalks, no landscaping...
>
> Changes came in the late 1970s, when Bellevue, like other towns in this self-conscious state, looked at the despoliation of the suburbs and the countryside that was happening elsewhere...The result was a surge of citizen activism. In 1979, a downtown plan was adopted, setting policies for land use, transportation and design. The plan was followed in 1981 by the regulations that would transform it into action. Parking ratios were cut in half. Setbacks were eliminated. Height limits were set., and incentives for open space, ground floor retail, and public amenities were outlined...(64)

Typical subdivision regulations that control the street and block dimensions for new developments are different in each jurisdiction; these regulations generally specify minimum and maximum block dimensions, allowable lengths of cul-de-sacs, and other street dimensions. In Washington jurisdictions, for example, maximum allowable block dimensions are as large as 1320 feet. Some jurisdictions actually encourage curvilinear streets, cul-de-sacs, looped-streets, and other indirect street geometries as opposed to the more traditional street patterns advocated by Walter Kulash and others.

Street designs that take into account transit service and access are a more recent phenomenon. In 1990, for example, Sacramento County, California published Transit-Oriented Development Design Guidelines, a model set of subdivision and site development standards. Authored by Calthorpe Associates (the designers of the Laguna West neo-traditional development) in association with Mintier and Associates, these standards propose the creation of "TODs", or

transit-oriented developments. As its name implies, the TOD approach makes transit the primary consideration in the overall design and development process by encouraging pedestrian pockets of compact communities that are linked by transit services; each TOD is then designed with an overall street orientation that facilitates internal circulation as well as access to transit services by walking or bicycling. In the Laguna West design, for example, residential densities are established based on their proximity to a central Town Center which includes a transit station. Residential densities average 20 units per acre in areas close to the Town Center, with an overall average of 14 units per acre for the entire development.

Site Development and Street Level Design

For central business districts in large cities, the importance of street-level design and pedestrian systems is explicitly recognized in current land use policies. Bellevue, Spokane, Vancouver, Everett, and Seattle have elaborate requirements in their zoning codes which require pedestrian amenities including special pedestrian walkways, protection from the rain, plazas, and street-level retail in new buildings.

This emphasis on pedestrian networks, first seen in CBD zones, is also beginning to appear in non-CBD and suburban developments. In 1986, Seattle established "Pedestrian-Designated Zones, P1 and P2" (Seattle City Ordinance 112777) as overlay zones which require pedestrian-oriented development along non-CBD commercial streets. These zones require retail sales, service, and office uses in the street levels along 80% of the length of a building facade. In the P1 zone, parking is not allowed on the lot along the pedestrian street front. In the P2 zone, parking to the side of a structure is limited to 60' along the pedestrian street.(65) Bellevue's "Community Retail Design Zone" (adopted December 1989) is a non-CBD, floating zone that extends over all underlying Neighborhood Retail and Community Retail zones in Bellevue. This overlay requires strong pedestrian connections throughout commercial and retail developments.

As a result of increasing interest in bicycling as an alternative to the automobile, along with the work of researchers such as Replogle, Moudon, Untermann and others, bicycle amenities are increasingly being included in the transportation planning process. Both bicycle and pedestrian paths are becoming an integral part of city, county, and state planning programs. In addition, cities like Bellevue and Seattle have extensive requirements for bicycle parking in their zoning codes, a recognition of the fact that without convenient and secure storage spaces, people will not use bicycles for work and shopping trips.

Future Policies and Research

Subdivision regulations and overall regional street systems should allow more direct connections to facilitate shorter travel distances for transit, bicycles, and pedestrians. Requirements for pedestrian systems in CBD zones should be extended to non-CBD and suburban zones. In general, land use policies should promote and accommodate walking and bicycling as viable alternatives for work, shopping, and recreational trips.

Master Planned Developments

Linkage to Transportation

The term "master-planned development" is not easily defined, although it has become a common term in the urban planning profession. It can include at least two types of developments: Planned Unit Developments (PUDs) and Master Planned Communities (MPCs).

Planned Unit Developments

A planned unit development (PUD) is a "floating" zone of special conditions that overlays and augments the requirements of the underlying standard zoning designation in the area where it is being used. The early development of PUDs nationally was documented in a series of studies published by the Urban Land Institute (Krasnowiecki 1965, Wolfe 1968). In 1967, only 14 of 56 Puget Sound jurisdictions (cities and counties) had established PUDs.(66) PUDs are now common throughout the country; all of the Washington jurisdictions studied in this research have some form of PUD regulations, with minimum site areas ranging from 1 acre to 6 acres. The conditions imposed by a PUD may or may not be transportation-related.

Master Planned Communities

In contrast, master planned communities (MPCs) are usually considered to be more conceptually comprehensive developments that incorporate mixed uses (residential, commercial, employment), higher residential densities combined with open space preservation, and a development-level planning orientation rather than a lot-by-lot planning orientation. The term is often liberally interpreted, with the result that one or more of the aforementioned characteristics may be absent in a development that is marketed as an MPC or defined as one by ordinance. Because master planned communities are not easily classified, it is difficult to determine the extent of their use with certainty; however, 1989 research by University of Washington Professor Anne Vernez Moudon concluded that there are 14 MPCs of 700 acres or larger in the Puget Sound region which have been or are currently being developed. (Research for this white paper did not include a statewide analysis of MPC development policies). Nationwide, research by Lawrence Mann at the University of Arizona noted that 600 MPCs of 1,000 acres or larger have been developed in the United States since the 1960s.(67)

While the conceptual ideal of a more densely populated development with nearby mixed uses and a comprehensive planning orientation appears to be transit- and pedestrian-friendly, actual implementation in the marketplace may be substantially different. The relationship between MPCs and transportation was characterized by Moudon in the book Master Planned Communities: Shaping Exurbs in the 1990s:

> The design of master-planned communities is clearly anti-urban: concentration and mix of functions and

social classes are only reluctantly considered. Yet as alternatives to suburban sprawl, these communities can appear to be urban-friendly: built at higher densities, they provide more amenities than most suburban subdivisions. They also compare favorably to exurban development, which typically occurs on uncoordinated three-to five-acre tracts. Developers want high densities and are willing to pay for many of the resulting impacts. Ironically, the public and its authorities work to reduce the developers' density targets. In the end, the densities achieved rarely reach levels where urban services are likely to become available within close reach of the residential areas...

Cars remain the essential means of transportation. Pelican Bay in Florida and the Village of Woodbridge, with 7.63 and 9.3 dwelling units per acre respectively, are compact enough to permit basic public transit service...and all of the Puget Sound master-planned communities (with the single exception of Blakely Ridge, which is still in the planning stages) are below the seven units per acre experts deem necessary for cost-effective transit.(68)

Policies and Practices

Planned Unit Developments

Some Washington jurisdictions allow increased residential densities in their PUD codes by using a system that is similar in concept to the elaborate incentives of CBD zoning codes and relates to a broad spectrum of land uses. Density bonuses may be granted for such things as accessibility to transit and services, access to a public school, affordable housing, or the availability of children's day care within the development. More typically, however, PUD regulations in Washington state allow an increase in allowable residential density based primarily on providing common open space.

An unusual extension to this approach is being taken by Spokane in their proposed zoning code, which incorporates a density bonus system in its PUD regulations that includes explicit linkages to transit service, mixed-use, and access to services. The density bonuses are based on a point system, with points given for various amenities in the PUD. For example, if the developer commits a portion of the development budget to provide transit facilities, 4 bonus points will be given for each increment of $100 per dwelling unit donated to the Spokane Transit Authority, to a maximum of 20 points. Each bonus point then translates into a one percent increase in allowable density over the base zoning.(69)

Snohomish County terms their PUDs as "Planned Residential Developments". A unique transportation provision in their zoning code is defined under the heading "Retirement Housing Planned Residential Developments". In order to build such projects, developers must include a public transit stop with transit service that provides, "frequent off-peak hour and weekend service", and a "special transportation program, such as a public or private vanpool..."(70)

Master Planned Communities

To encourage higher residential densities and mixed land uses in their MPCs, King County (which uses the general term master planned development or MPD) has proposed a revision to its master planned community regulations which requires a minimum density floor as well as a mix of housing types. Regional planning and land use mixes are addressed in their proposed code revision:

All MPDs that include residential development shall provide a mix of dwelling types and densities, provided the minimum average zoned base density shall not be less than five dwellings per acre of all portions of the site area allocated for residential development, and not less than 30 percent of the dwelling units in a MPD shall be developed at a density of 12 or more units per acre.(71)

...All MPDs shall include an analysis of all existing and proposed land uses within a one-half-mile radius of the site, based on the adopted community plan map, to show the proposal's relationship with surrounding development and applicable policies. MPDs over 320 acres in size shall

provide at least a neighborhood business center in accordance with the size and spacing of the Comprehensive Plan, or demonstrate that existing or proposed development nearby will meet the convenience shopping needs of MPD residents.(72)

Fully Contained Communities

The Washington State Growth Management Act amendments of 1991 specifically define a type of large-scale master planned development called "new fully contained communities", and allow counties that plan under the Growth Management Act to consider proposals to develop a fully contained community outside of defined urban growth areas. Such proposals may be approved if, at a minimum, they meet criteria to build new infrastructure, implement impact fees, address environmental protection and protect critical areas, provide development buffers that restrict urban growth in adjacent nonurban areas, mitigate impacts on agricultural, forest, and mineral resource lands, and include the impacts of that development in comprehensive plans and population projections. In addition, specific transportation-related elements of the amendments require that:

Transit-oriented site planning and traffic demand management programs are implemented;

A mix of uses is provided to offer jobs, housing, and services to the residents of the new community;

Affordable housing is provided within the new community for a broad range of income levels.(73)

Future Policies and Research

Planned unit development regulations should be expanded to address mixed use, access to services, and other factors beyond the typical PUD requirements of open space and infrastructure. Future master planned developments should also be coordinated with transit service. Greater residential density and mixed use developments should be encouraged in MPD guidelines. Recent research of master planned developments in this state should be continued to monitor development patterns, mixes of land uses, and housing affordability.

Jobs/Housing Balance

Linkage to Transportation

The "jobs/housing balance" of a community has gained prominence in urban planning discussions. This concept is based upon the premise that an appropriate mix of housing and jobs within a particular area will 1) reduce the traffic and environmental impacts that would otherwise be generated by long commutes to work, by providing housing in close proximity to jobs, 2) improve the attractiveness and efficiency of public transit by increasing residential density and improving public transit access to employment centers, and 3) address the issue of affordability by requiring that residential units be offered in a range of prices that are consistent with neighboring employment opportunities.

Policies that include a jobs/housing goal often measure the concept in terms of a ratio of jobs to housing units within a given area. For example, a jobs/housing ratio of 1.2 (or equivalently, 1.2:1) would indicate that on balance there are 1.2 jobs for each housing unit in the specified region. Cervero has noted the shortcomings of this simple jobs/housing ratio measure, however, noting that it ignores specific characteristics of the housing and employment that may influence whether workers living in a given area will necessarily work in the same area. For example, two suburban communities of San Francisco, Walnut Creek and Mountain View, both had jobs/housing ratios of approximately 1.3 to 1.5, a balance that was generally believed to produce transportation benefits by reducing auto-based commuting. Yet, less than 25 percent of residents in both communities actually worked within their respective communities, reflecting the difficulty of matching area housing types and affordability levels with the needs and desires of the employees in that region.(74) In addition, the "optimal" balance of jobs to housing is affected by the nationwide trend toward two workers in a household; the goal of managing trip-making by more carefully matching the proximity, characteristics, and affordability of housing with the desires of employees in a given area is certainly more challenging when the needs of not one, but two workers in a household (possibly working for different employers) must be considered. The average number of workers in a typical household (a dwelling's "carrying capacity") is now being recognized as an important part of ongoing research of the jobs/housing concept.(75)

Policies and Practices

Achieving a jobs/housing balance is an integral component of the 1989 Southern California Association of Governments (SCAG) growth management plan. Planners from the SCAG estimated that, "traffic growth could be cut by one-third if about 12 percent of the region's estimated housing could be directed to job-rich areas." The SCAG's growth management plan includes transportation and land use goals as well as a jobs/housing balance goal of 1.22.(76)

The city of Bellevue addresses jobs/housing balance issues in its 1990 Comprehensive Plan. Section 21.G.125 of the plan ("Affordable Housing" describes the costs of housing relative to incomes in Bellevue, and notes the city's role in providing housing to accompany the growing employment base:

> While the City's employment is expected to grow by as much as 35% by the year 2000, our supply of vacant, developable land for housing will almost be depleted. As a regional job center, the City must assume the responsibility of providing housing for its workers with other jurisdictions in the region...
>
> In 1989, the average sales price for a home in Bellevue was $180,000. It would take an income far in excess of the area median average to qualify to purchase this median priced home. At the same time, the average rent for an apartment in Bellevue was $580 per month...
>
> Based on 1989 income data, 35% of the City's existing residents earn less than 80% of the average area median income and therefore, could not afford to purchase a home in the current market...(ZZ)

To implement the affordable housing goals of their Comprehensive Plan, Ordinance 4269 was passed in Bellevue in July of 1991. This ordinance requires affordable housing in all new housing developments; as the basis for their new ordinance, Bellevue cited the Growth Management Act which requires, "the City to consider the housing needs of all economic segments of the community." In passing Ordinance 4269, Bellevue also considered, "the rationale of permitting higher density housing through the use of affordable housing incentives to address the affordable housing needs of workers and residents in or near Bellevue."(78) As with the innovative Planned Unit Development regulations described earlier in this white paper, the Bellevue ordinance includes bonus densities for residential developments. While Bellevue's emphasis is on affordable housing for its workers, conveniently located housing and higher residential densities also affect transportation as well.

Future Policies and Research

Affordable housing policies should facilitate new housing units in "job-rich" areas, with new employment facilities directed toward "housing-rich" areas. The future impacts (on commuting and housing affordability) of two-worker households should be evaluated, and a baseline measurement of existing commuting patterns to employment and activity centers should be developed.

Metropolitan and Regional Planning

Linkage to Transportation

Throughout history, most cities, while not explicitly designed or planned, grew to form strong, singular centers. These centers served a particular symbolic and functional purpose. In Greek cities the "Agora" was the defined city center, while the "Forum" was the nucleus of the Roman city. As religious and symbolic purposes became secondary to mercantile and other secular functions, the Medieval city formed a market square as its center. In the 19th and early 20th century American city, the downtown or central business district (CBD) was the focus of the city's culture, commerce, and employment activity.

As cities have grown in geographical area and population size, the clearly-defined, singular center has given way to a number of centers. These multiple centers have formed a new metropolitan and regional pattern of settlement that is now described as "multicentered" or "polynucleated". Jerry Schneider's Transit and the Polycentric City was an early study that recognized the relationship between "polycentric" cities and transportation systems. Planning policies now attempt to address this trend by promoting viable, interconnected centers that solidify metropolitan and regional areas. A successful scheme for such a metropolitan region would bring together multiple residential and commercial concepts such as intensely developed activity centers, master planned communities, and pedestrian pockets, at the project, neighborhood, and city level, combine them with internal and external transportation circulation systems, and form a complete land use and transportation system.

As cited throughout this white paper, many recent studies have attempted to quantify the relationship between one or two specific land use policies (e.g. residential and employment center density) and transportation. The 1989 book Cities and Automobile Dependence summarized research based on a comparison of a wide range of land use variables to transportation; overall population density, employment density, density distribution, residential density, parking supply, public transit service, and dependence on single occupant vehicles. In this research by Newman and Kenworthy, U.S. cities are characterized by low population density, dispersed employment density, high parking supply, low transit ridership, and a high percentage of trips in single occupant vehicles. To reverse these conditions, Newman and Kenworthy recommended a coordinated process of land use and transportation planning to achieve "reurbanization" (densification and centralization of cities and regions):

1. More intensive land use: Reurbanization by definition intensifies land use in inner, outer, and central city areas by techniques such as infill, redevelopment, dual occupancy housing, air rights over

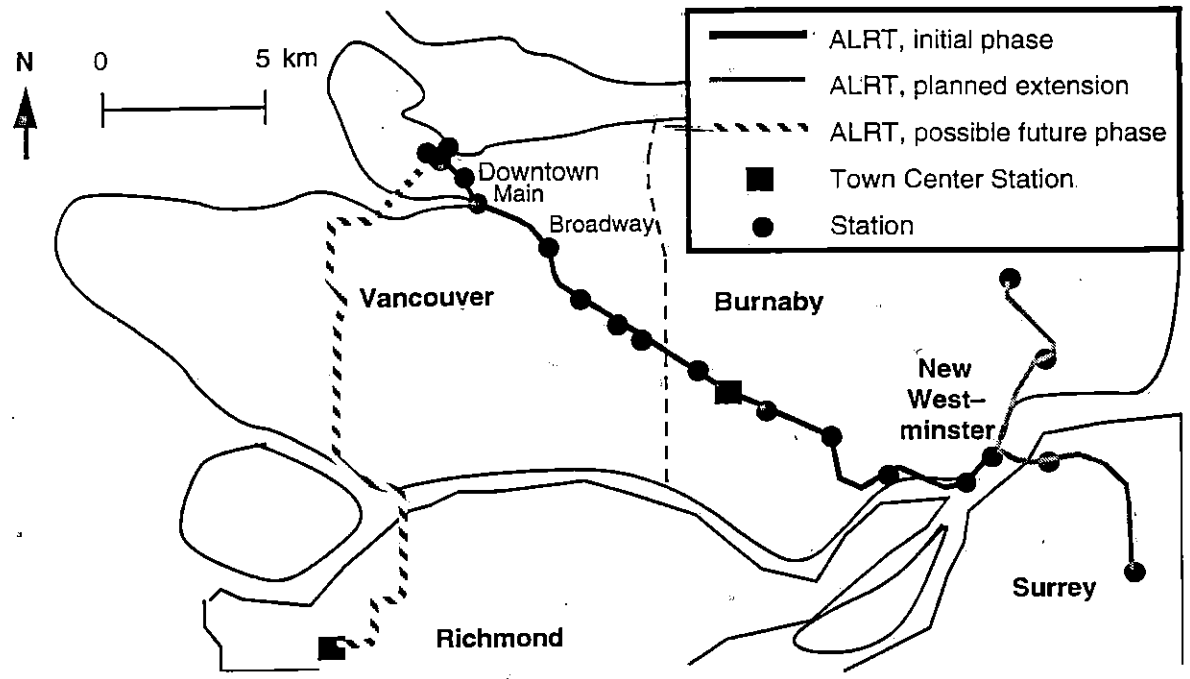


FIGURE 5. Vancouver, Canada Regional Transit Linkage

transit lines, incentives for central city housing...

2. More orientation in transport infrastructure to non-automobile modes...
3. More restraint on high speed traffic flows...where you have low density scattered land use then high speed roads appear more necessary to ensure economic transport linkages...
4. More centralized land use: Reurbanization as outlined highlights the role of the city center. It also suggests that strong sub-centres (as in Toronto) can be developed to intensify land use in inner and middle suburbs. To reurbanize is to highlight the centre and sub-centres rather than scattered land uses which can only be serviced by the automobile.
5. Better performing public transport: Reurbanization provides the opportunity for public transport to perform better. If the land use is not conducive to public transport then all the transit management techniques and customer incentives in the world can do little more than start a process which induces land use change.(79)

Policies and Practices

In the mid-1970s, the Canadian cities of Vancouver, B.C. and Toronto began the process of forming metropolitan and regional plans. In 1975 the Greater Vancouver Regional District published a plan entitled The Livable Region. This plan specified five key elements:

1. Achieve residential growth targets in each part of the region
2. Promote a balance of jobs to population in each part of the region
3. Create Regional Town Centers
4. Provide a transit-oriented transportation system linking residential areas, Regional Town Centres, and major work areas
5. Protect and develop regional open space (80)

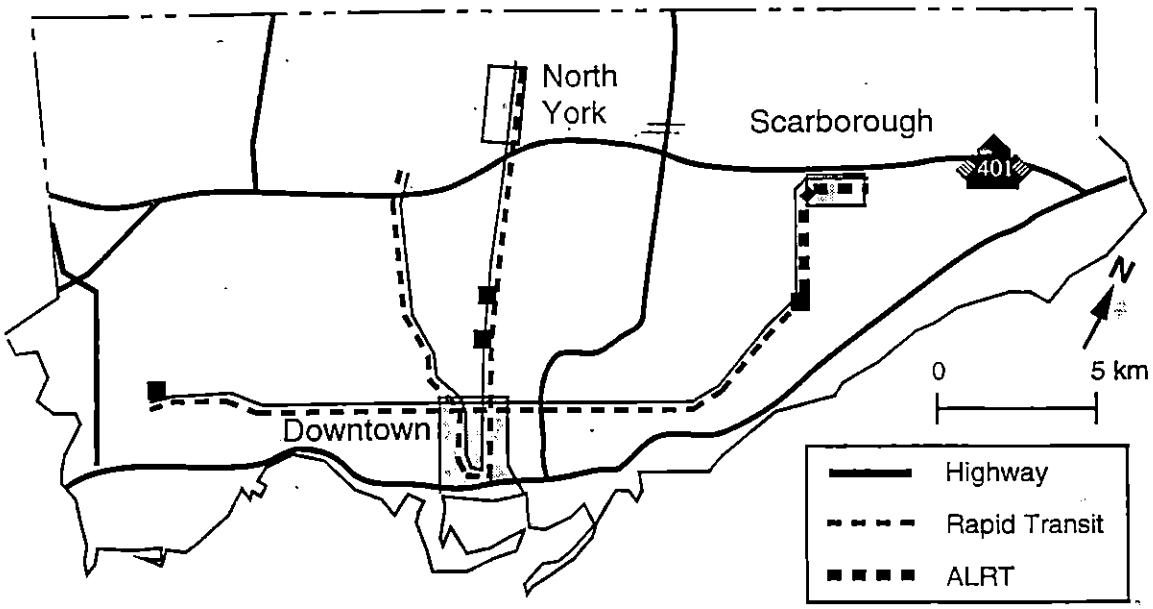


FIGURE 6. Toronto, Canada Regional Transit Linkage

Figure 5 illustrates the Vancouver area and the rail transit linkage of activity centers in the region.

In 1976 the Planning Department of the Municipality of Metropolitan Toronto completed a report entitled Metroplan: Concept and Objectives, which called for a multi-centered urban structure with centers connected by transit. The Toronto Plan is based on the following concepts:

1. It (the plan) relieves the pressures for development now on the Downtown core and concentrates the dispersed commercial enterprises into a manageable number of development nodes that can be effectively serviced by Metropolitan Toronto.
2. It ties together new employment opportunities and housing in a way that provides increased opportunity for people to live in close proximity to their jobs. (the concept of jobs/housing balance)
3. It broadens and enriches the economic and social base of the area municipalities by encouraging a range of activities that traditionally are found only in the Downtown.
4. It reinforces the transit system, and provides for improved mobility for everyone throughout 'Metropolitan Toronto'.
5. It helps to ensure that services provided by both private and public agencies are accessible to the total population.(81)

Figure 6 shows the overall Toronto network, including the link to the Scarborough regional center that was described in earlier sections on Employment Density and Mixed Use Developments.

The 1985 King County Comprehensive Plan also specifies a hierarchy of urban and rural centers:

> King County should encourage development of Urban Activity Centers to meet the needs of the region's economy and to provide employment, shopping, services...Community Centers in Urban

> Areas should be designed to meet shopping and service needs of the surrounding community...Neighborhood Centers in Urban Areas should be designed to provide everyday shopping and services to a relatively small, nearby population...King County should work with Rural Activity Centers to establish realistic areas for expansion of these towns...Commercial and industrial development in Rural Areas should locate in existing Rural Activity Centers, to provide employment, shopping, services and housing opportunities that will reinforce these towns as rural centers...(82)

At the state level, regional transportation and land use planning are explicitly addressed in the Washington State Growth Management Act. The Regional Transportation Program authorized by the 1990 GMA establishes Regional Transportation Planning Organizations (RTPOs) through the voluntary association of local governments within regions. The RTPO is responsible for developing a Regional Transportation Plan and must certify that local government transportation plans are meeting state and regional requirements. RTPOs are directed to designate a Lead Planning Agency and a Transportation Policy Board. Citizen participation is emphasized in this legislation which authorizes the entire regional transportation planning process.

A single county of 100,000 persons or more qualifies as a region for purposes of RTPO formation. Regions of lesser population may be formed by a minimum of three counties. Within the counties belonging to the RTPOs, 60 percent of the cities and towns (and 75 percent of the total city and town population) must be members of the RTPO. Federal designation of Metropolitan Planning Organizations (MPOs) shall coincide with the RTPOs; the organizations shall serve both functions where an MPO is already established. At present, there are eight MPOs in Washington state.

In the Puget Sound region, the 1991 amendments to Washington's Growth Management Act require coordinated planning policies in King, Pierce and Snohomish Counties. Planning for the Regional Transit Project (RTP), a proposed bus or rail network to serve the three-county region, is based on the 1990 Vision 2020 Plan as prepared by the Puget Sound Council of Governments. The Vision 2020 regional plan is based upon a multi-center pattern of development with transit links, and has similar characteristics to the Toronto and Vancouver plans mentioned earlier. Vision 2020 is covered in more detail in the Case Studies section of this white paper.

Another example of linkage between regional planning and transportation is found in the state High Capacity Transportation Acts of 1990 and 1991 which provide for "identification and implementation of high capacity transportation system alternatives" based on regional agreements. Policy development of regional transportation planning is voluntary outside the Puget Sound region, while policy development in the central Puget Sound area is explicitly required:

> Agencies in each county with a population of one million or more, and in each county with a population of from two hundred ten thousand to less than one million bordering a county authorized to provide high capacity transportation transportation planning and operating services, including but not limited to city-owned transit systems, county transportation authorities, metropolitan municipal corporations, and public transportation benefit areas, must establish through interlocal agreements a joint regional policy committee...
>
> The joint regional policy committee (JRPC) has specific responsibilities including, "the preparation and adoption of a regional high capacity transportation implementation program, which shall include the system plan, project plans, and a financing plan. This program shall be in conformance with the regional transportation planning organizations regional transportation plan and consistent with RCW 81.104.080.(83)

RCW 81.104.080 further defines "regional transportation planning" and

addresses land use policy coordination with transportation systems:

> Where applicable, regional transportation plans and local comprehensive plans shall address the relationship between urban growth and an effective high capacity transportation system plan, and provide for cooperation between local jurisdictions and transit agencies.
>
> (1) Regional high capacity transportation plans shall be included in the designated regional transportation planning organization's regional transportation plan review and update process to facilitate development of a coordinated multimodal transportation system and to meet federal funding requirements.
>
> (2) Interlocal agreements between transit authorities, cities, and counties shall set forth conditions for assuring land uses compatible with the development of high capacity transportation systems. These include developing sufficient land use densities through local actions in high capacity transportation corridors and near passenger stations, preserving transit rights of way, and protecting the region's environmental quality. The implementation program for high capacity transportation systems shall favor cities with supportive land use plans...Agencies providing high capacity transportation services, in cooperation with public and private interests, shall promote transit-compatible land uses and development which includes joint development.(84)

Future Policies and Research

Efforts to integrate land use planning with transportation planning at both the city and regional levels should be reinforced. Successful metropolitan and regional planning policies in the U.S., Canada and abroad should also be monitored; research to further evaluate the overall effects of land use policies on actual development patterns would also be helpful.

IV. Case Studies

Each individual land use topic discussed in this white paper offers a valuable perspective on the subject of effective land use-transportation policy linkage. It is important to note, however, that while the outline of this white paper is structured according to these individual subjects, any eventual policy implementation should extend beyond this structure. Policies that attempt to address the land use-transportation link by dealing with specific issues in isolation are unlikely to produce a desired result; indeed, it is more likely that such an approach would exacerbate land use and transportation planning problems. It is strongly recommended that future policies reflect the interdependence of these subject areas, and treat land use-transportation linkage as a package of complementary goals and strategies. Ultimately, the ability of a development or policy to effectively address transportation issues depends upon the success with which distinct land use-transportation linkage concepts are melded into a cohesive whole.

The following case studies illustrate ways in which several individual land use policies and concepts may be combined into a group of reinforcing techniques to support a building, development, or policy plan. Each example combines several of the individual linkage topics described in this paper; the examples include a mix of planned projects, completed developments, and planning policies.

1. Watermark Tower - Seattle

Related Land Use Topics:
- Mixed Use
- Residential Density
- Jobs/Housing Balance

The Watermark Tower was developed to revitalize a dilapidated area in downtown Seattle; it has been widely publicized in planning as well as architectural journals. The goal for the development was, "to create an urban neighborhood that would reweave the hole in the existing fabric of downtown Seattle." (85) (See figure 7)

Constructed in 1983, the 22 story Watermark Tower in downtown Seattle is an example of a mixed use building that includes three types of activities: the three street-level floors include retail shops, while the four floors above them are offices and the top fifteen floors are residential units. Approximately 6.5 percent of the Watermark's total floor area is devoted to retail uses, with 31.3 percent to offices and 62.2 percent to housing units. The sectional drawing in figure 8 indicates the vertical layering of the building's uses.

FIGURE 7. Watermark Tower

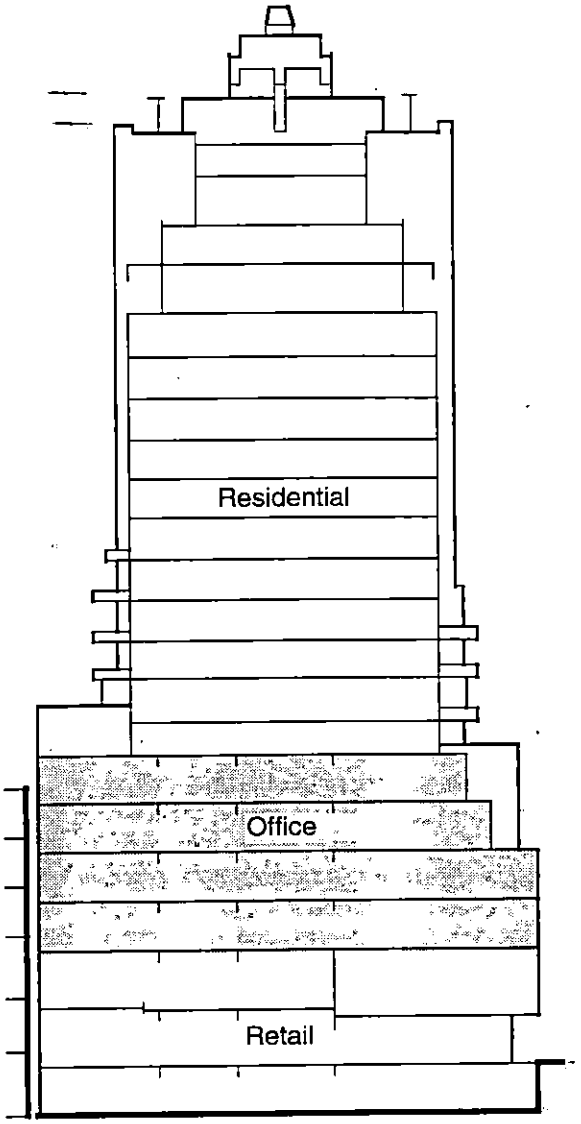


FIGURE 8. Watermark Tower - Mixed Uses

The 94 residential units range from 761 to 2,200 square feet; the diverse range of housing unit sizes is intended to attract a wide range of households. The addition of residential units complements the surrounding land uses in the Seattle CBD which are predominantly office and retail activities.

Residential density is not limited in downtown Seattle; with 94 residential units on less than a third of an acre, the resulting net density of the Watermark is equivalent to approximately 300 units per acre. The Watermark is an example of a carefully designed development that incorporates higher residential densities in a mixed use setting, all within the same building.

FIGURE 9. Riverplace (Portland, OR) Mixed Use Development
(Source: Portland Central City Plan)

2. RiverPlace - Portland, Oregon

Related Land Use Topics:
- Mixed Use
- Site Design
- Parking Requirements

RiverPlace is a mixed use development in Portland, Oregon on the west bank of the Willamette River (see figure 9). In contrast to the Watermark Tower, RiverPlace is an example of a mixed use development whose mixed uses are distributed horizontally in connected buildings, rather than vertically in a single structure. The 423,420 square foot development includes 190 residential units, a 74 unit hotel, 41,600 square feet of office space, a health club, restaurants, and 23,220 square feet of retail sales area. The multitude of activities complement each other in many ways. The health club and restaurants have different peak hours of patronage, and therefore these establishments share common parking facilities. Throughout the year, the various retail shops also have differing peak periods of patronage. A variety of activities, including a mixture of specialty shops, encourages a lively pedestrian environment year around.

RiverPlace was initiated through the Portland Development Commission, which sought to redevelop the site in accordance with the Portland Downtown Plan. The developer, Cornerstone Columbia Development Company of Seattle, has developed mixed use projects in Seattle (e.g. the Watermark Tower) and Tacoma. Seattle design professionals also played a major role in RiverPlace.

While mixed use activities are the most notable design features of RiverPlace, site design was also emphasized in the interior pedestrian ways that are linked to the waterfront. Portland, like major cities in Washington state, requires street level retail in certain percentages of the first floor of all downtown developments. This and other code requirements, combined with the South Waterfront Project Design Guidelines, resulted in a viable, pedestrian-oriented development

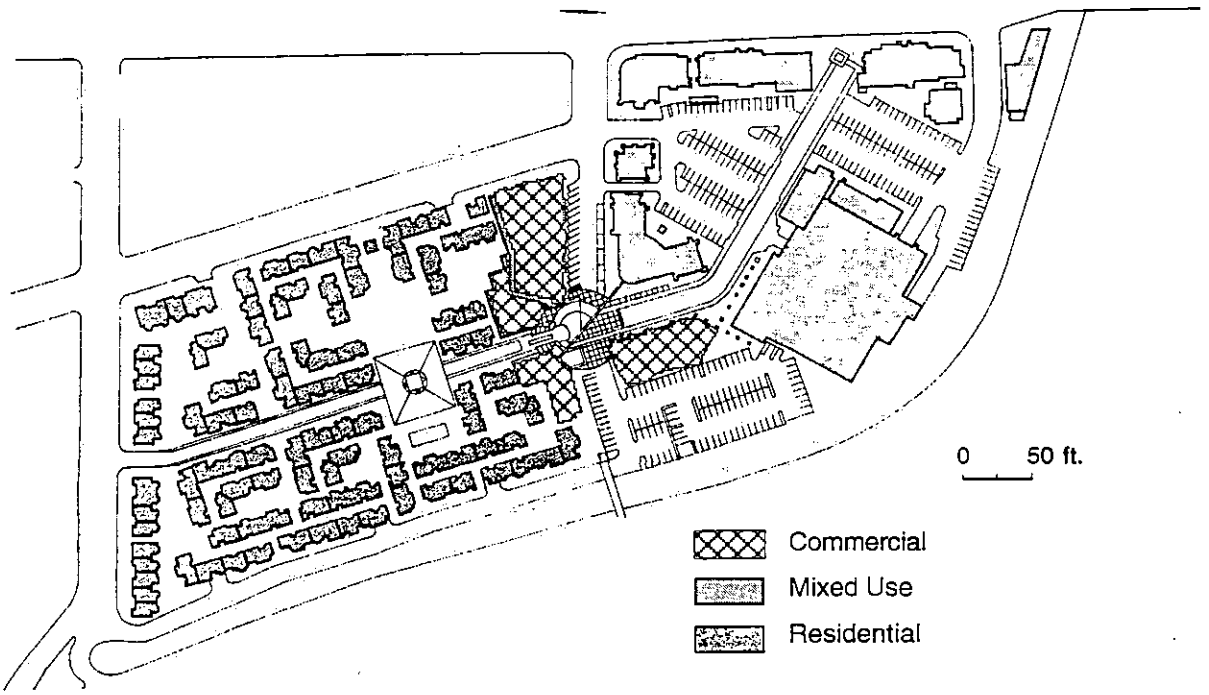


FIGURE 10. Uptown District - Site Plan

which has become a cornerstone of ongoing new development in downtown Portland.(86)

3. The Uptown District - San Diego

Related Land Use Topics:
Mixed Use
Site Design

The Uptown District development in San Diego is a 14 acre mixed use development that includes 320 residential units, a center core of mixed use buildings, and an outer complex of retail shops. The largest retail establishment is a 42,500 square foot Ralph's supermarket with an underground parking garage for 115 cars, and an escalator that is designed to carry pedestrians and their shopping carts between the market and the garage. While the Watermark tower in Seattle includes three uses in one building, the Uptown District development incorporates three uses in a larger development with defined zones of activity (see figure 10).

The central core of the Uptown District is devoted to a pedestrian way that connects the entire development. The site planning and mix of uses in the Uptown District differ from the auto-oriented, single use developments typified by many suburban shopping centers.(87) Figures 11 and 12 illustrate the mix of density, site planning, and land use at the Uptown, in contrast to a shopping center design in Washington state (figure 13).

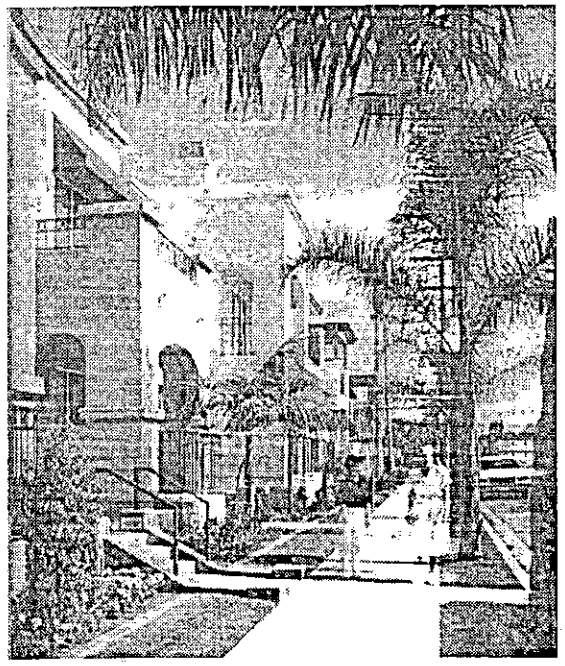


FIGURE 11. Uptown District - Residential Area
(Adapted from photographs courtesy of David Hewitt Anne Garrison Photos)

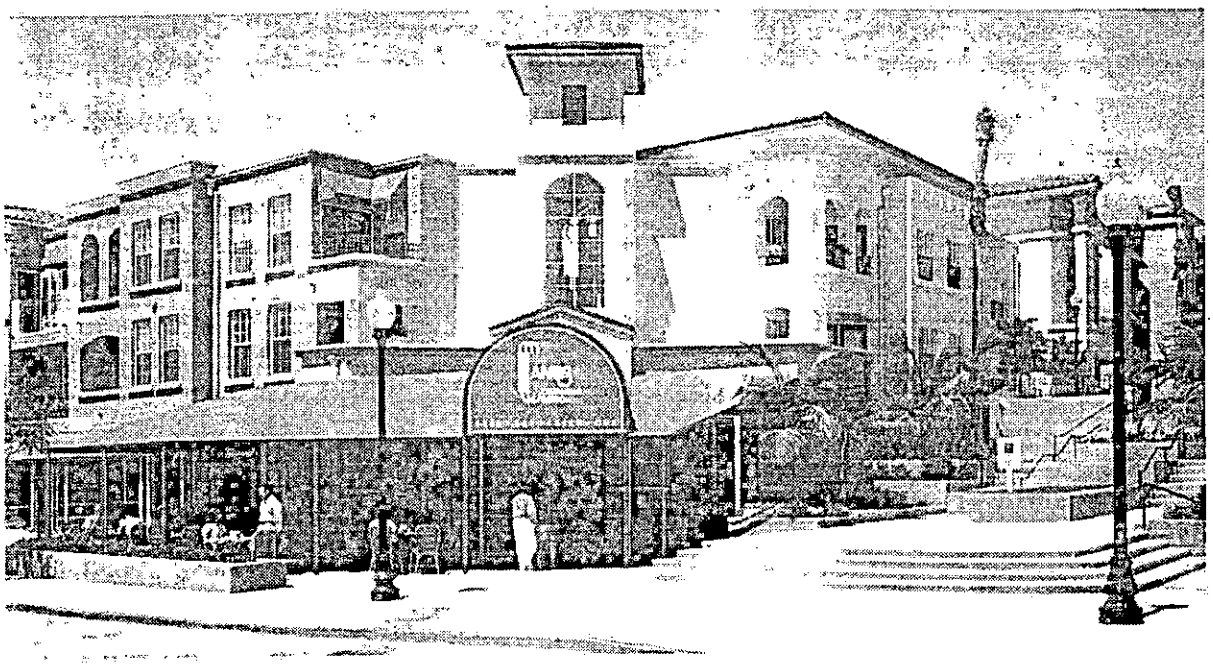


FIGURE 12. Uptown District - Mixed Use Area
(Adapted from photographs courtesy of David Hewitt Anne Garrison Photos)

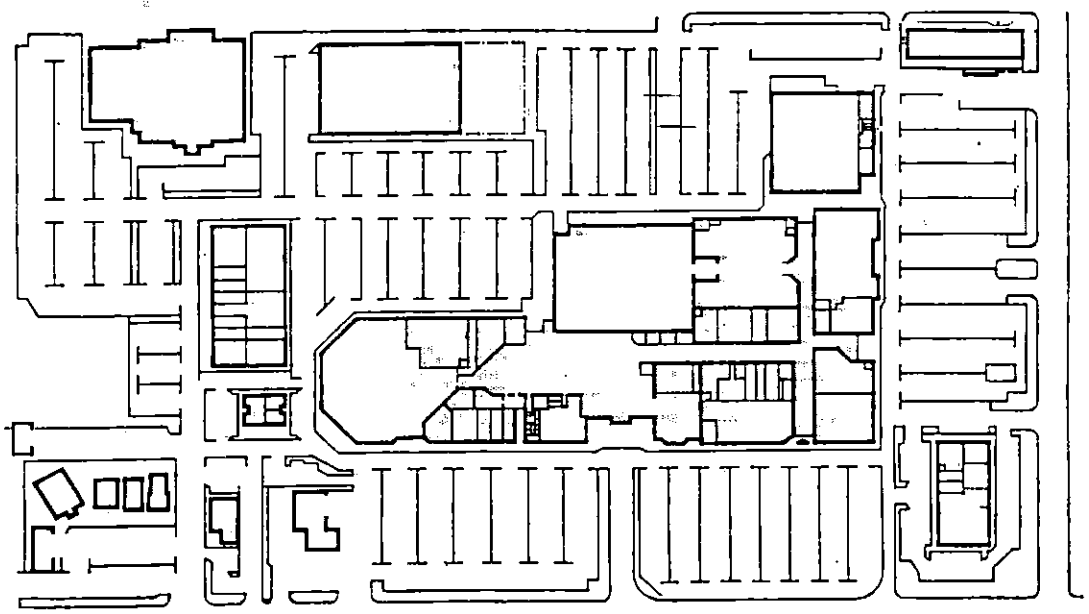


FIGURE 13. Typical Shopping Center Site Design

The Uptown District has been a successful development from the city's perspective and from a market standpoint. Before completion of the complex, all the residential units and 70 percent of the retail space was leased.

4. The Cottages - Lacey, WA

Related Land Use Topics:
Residential Density
Master Planned Developments/PUDs
Jobs/Housing Balance (Affordable Housing)

The Cottages development in Lacey, Washington consists of 31 single-family detached homes on lots averaging 2,226 square feet in area. This lot size reduction was accomplished through a planned unit development (PUD) process that allowed an "overlay zone" to an underlying zone that normally allowed minimum lot sizes of 12,500 square feet. The 2,226 square foot average lot sizes are remarkable in contrast to the 12,800 square foot developed residential lot size that was the average in 1980. (Sander et al. p. 3) The Cottages project was featured in a 1984 American Planning Association study that also cited 5 other small lot PUDs throughout the country. Table 10 summarizes the reduction in lot sizes that was obtained in those examples through the PUD process.

TABLE 10. Lot Size Reductions via the PUD Process

Jurisdiction	Nominal Lot Size	PUD Lot Size
Phoenix. AZ	6,000	4,000
Geneva, IL	10,000	6,210
Thurston Co.,WA*	**12,500**	**2,226**
Shreveport, LS	6,000	2,500
San Marcos, CA	10;000	5,000
Coon Rapids,MN	10,800	6,000

(Source: Sanders et al. p.7)
* The Cottages development is now within the city limits of Lacey, Washington.

The site plan in figure 14 illustrates the small lots of the Cottages in comparison to the typical, single family lots which surround the development. A typical lot in the Cottages and a typical lot in the surrounding single family development are shown in black to

emphasize the difference in density. Even including an inner common parking and recreation space, the overall density of the Cottages is still greater than typical single family developments. Figure 15 illustrates the unique design of the individual houses.

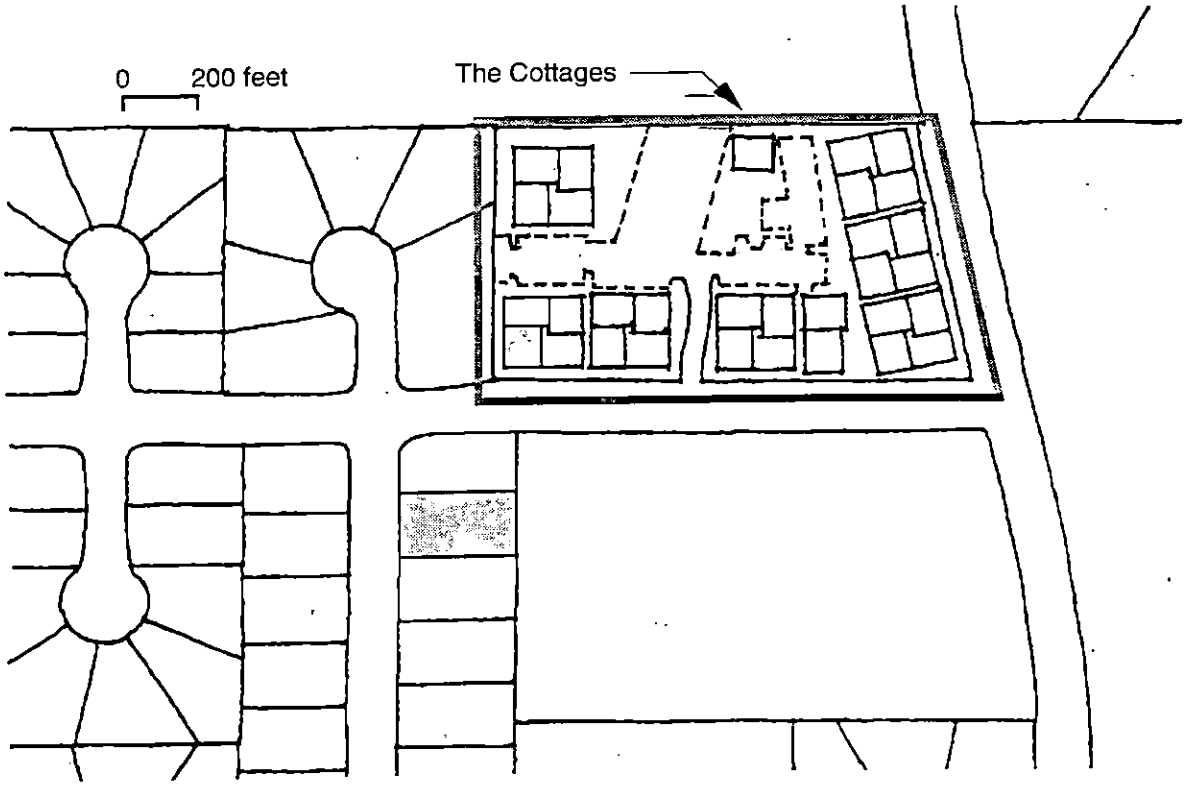


FIGURE 14. The Cottages - Small Lot Development

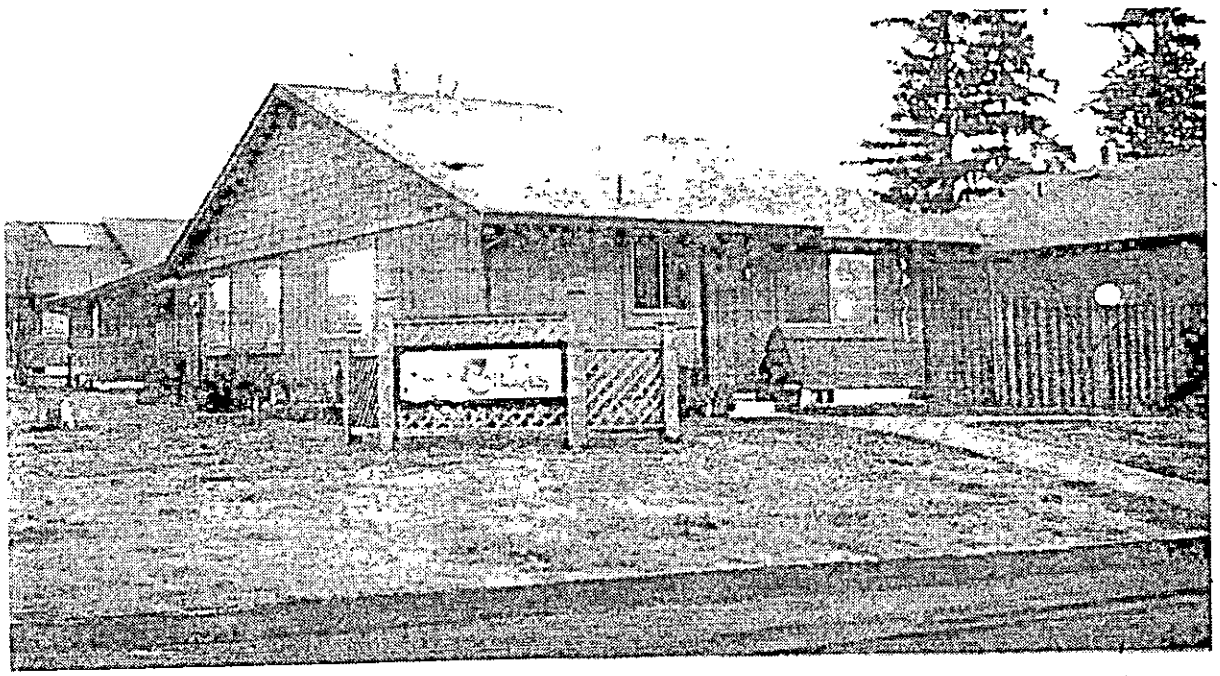


FIGURE 15. Single-family Detached Small Lot Residence

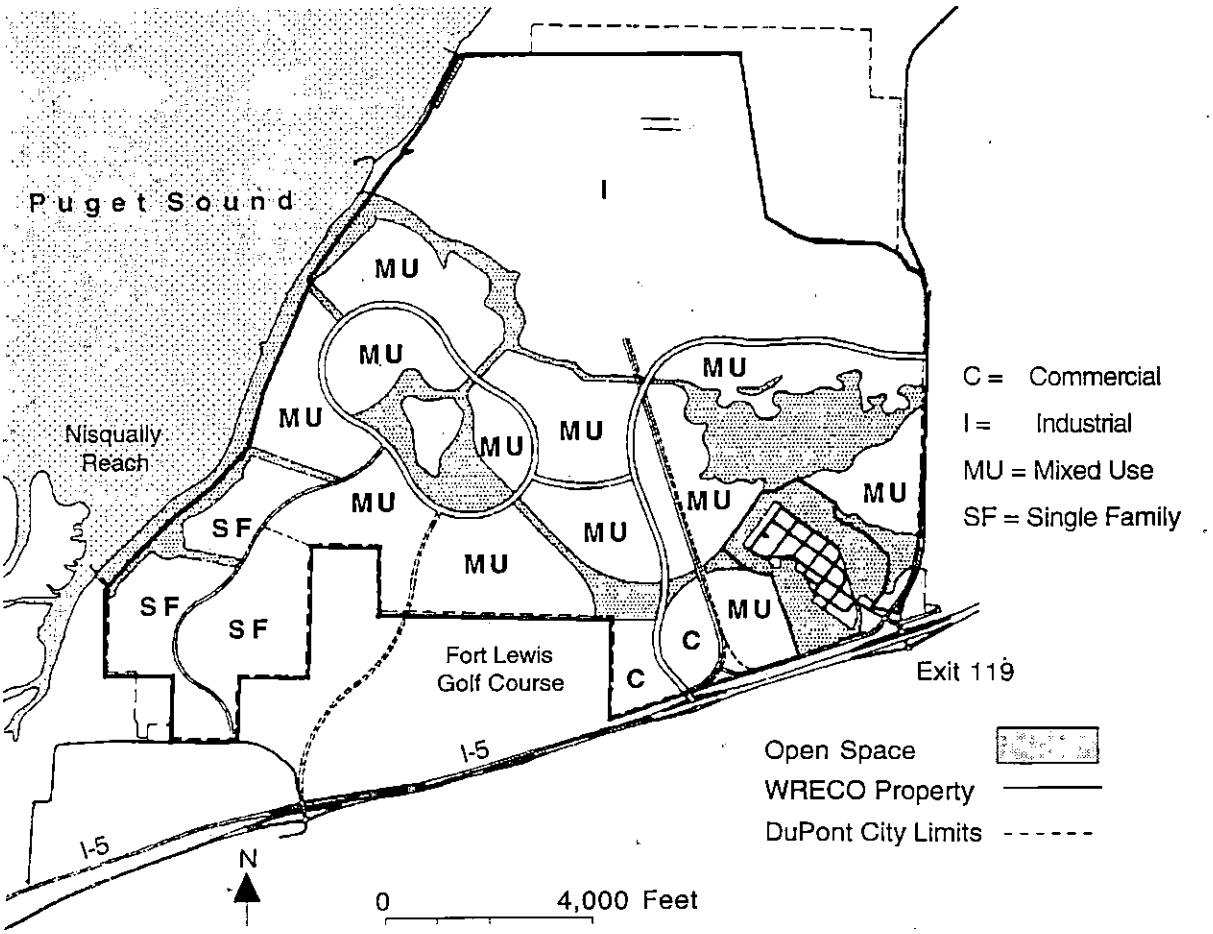


FIGURE 16. Northwest Landing Site Plan
(Adapted from drawings courtesy of Weyerhaeuser Real Estate Company and Mithun Partners)

5. Northwest Landing - Dupont, WA

Related Land Use Topics:
Master Planned Developments
Jobs/Housing Balance
Mixed Use

Northwest Landing is a proposed master planned community within the city of Dupont, Washington. The Weyerhaeuser Real Estate Company is the developer of Northwest Landing, a community that will eventually encompass 3,000 acres when completed in 30 to 40 years. The project is in the planning and design phases, although infrastructure is now under construction.

Many new residential projects, including some master planned communities, are primarily large housing developments that do not include any employment opportunities or services. However, Northwest Landing will include large areas zoned for industrial and mixed use. The mixed use zones are noteworthy in their inclusion of multi-family housing at a density of up to 10 dwelling units per acre. The Comprehensive Plan shows the diversity of land use activities planned for the community (see figure 16).

An 80 acre commercial center called the "Town Center" will be designed in the image of a traditional "Main Street", with buildings brought to the street line, and an emphasis on an inviting pedestrian

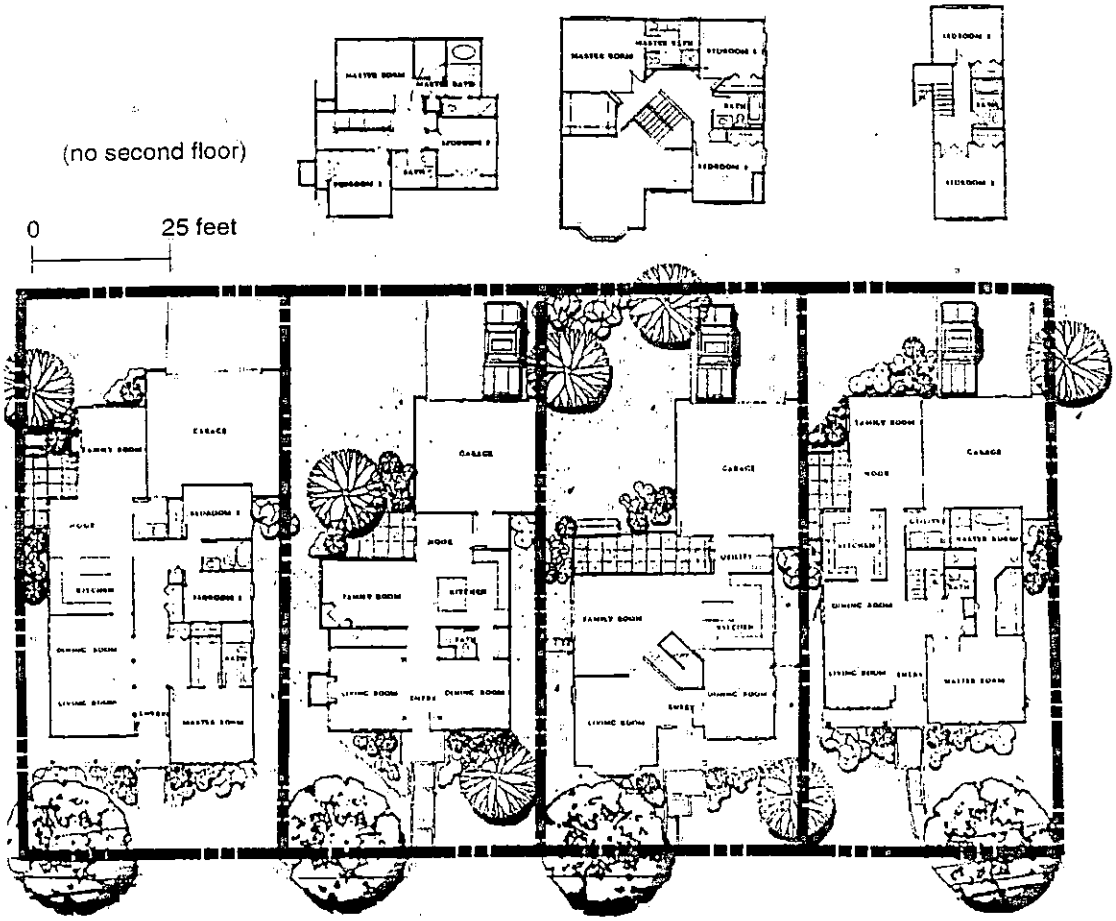


FIGURE 17. Northwest Landing - Small Lot Single-family Design
(Adapted from drawings courtesy of Weyerhaeuser Real Estate Company and Mithun Partners)

environment. When completed, 14,000 residents will live in Northwest Landing. Residential areas will include lot sizes ranging from 4500 square foot "alley lots" (access to the garage from an alley in back), to 6000 square foot "standard lots" and 8000 square foot "estate lots". Preliminary sketches of typical small lot homes for this community, prepared by Mithun Partners of Seattle, Washington, are shown in figures 17 and 18, while figure 19 indicates the intended street-level character of the residential areas.

Walking and bicycling will also be encouraged throughout the community. A boulevard with bicycle lanes is currently being developed to access the future industrial park. In addition to employment opportunities, Northwest Landing will include schools and extensive community and recreation facilities.

The community will reinforce the importance of participation by residents in day-to-day affairs. The "Northwest Landing Maintenance Association" will oversee the master development plan, administer design guidelines and provide for maintenance of commonly owned property. (89)

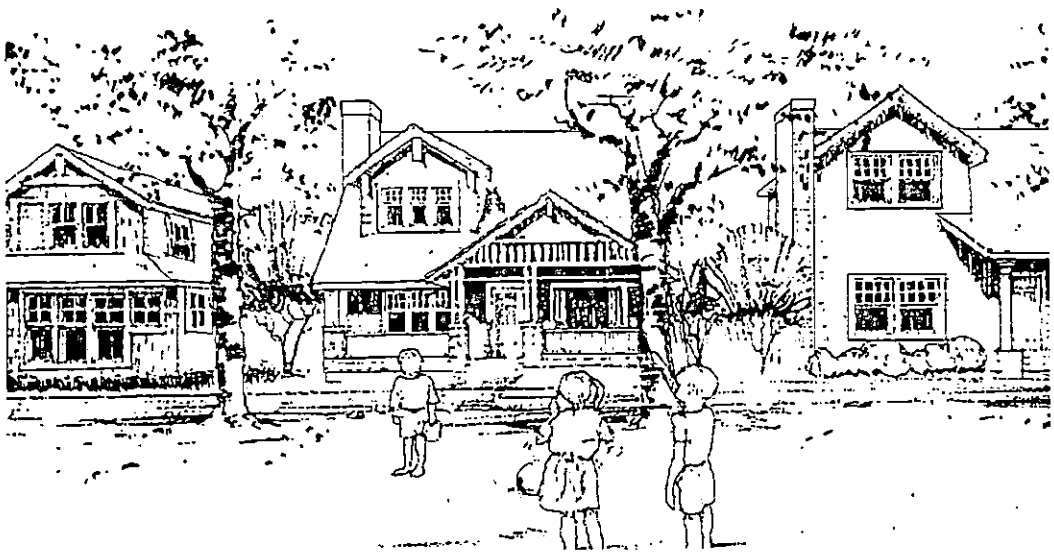


FIGURE 18. Northwest Landing - Small Lot Street View
(Adapted from drawings courtesy of Weyerhaeuser Real Estate Company and Mithun Partners)

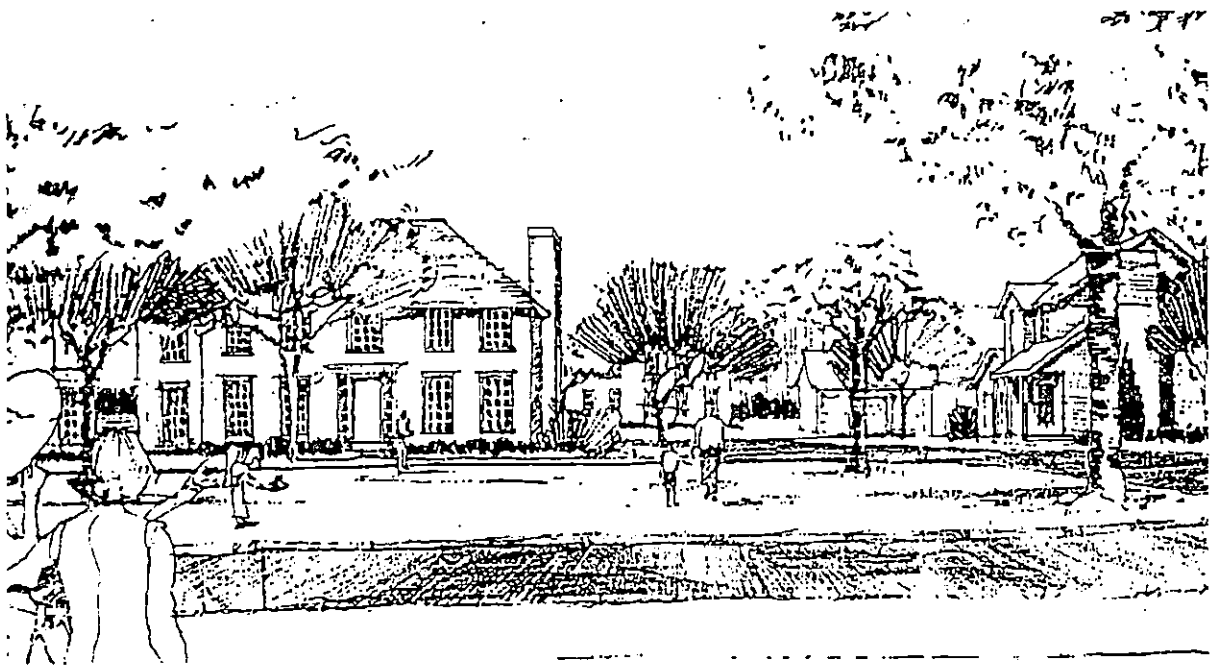


FIGURE 19. Northwest Landing - Residences with Common Area
(Adapted from drawings courtesy of Weyerhaeuser Real Estate Company and Mithun Partners)

6. Vision 2020

Related Land Use Topics:

Metropolitan and Regional Planning
Master Planned Developments (Hierarchy of Centers)
Residential and Employment Center Density
Jobs/Housing Balance

Vision 2020 was developed by the Puget Sound Council of Governments as a regional plan for the Puget Sound region. The plan envisions a hierarchy of centers throughout the area; in descending order of size, they include a Regional Center (Seattle), Metropolitan Centers (Bellevue, Everett, Bremerton and Tacoma), Subregional Centers, Activity Clusters, Small Towns, and Pedestrian Pockets (see figure 20). Along with this hierarchy of centers, the Vision 2020 Plan specifies a public transportation system to link these centers in a complete regional land use and transportation system. (90)

The Vision 2020 plan is being implemented as an integral part of Metro's Regional Transit Project to develop a regional high-capacity transit network. The objectives developed by the Metro Planning Subcommittee for future transit development in the Puget Sound region are supportive of the Vision 2020 Plan:

1. Plan and construct a transit system which, combined with other public transportation services, will enable residents and visitors to easily and inexpensively move to, among, and within the region's activity centers without resorting to use of a single occupant, private automobile.

2. Plan and construct a transit system which, combined with other public transportation services, will improve air quality, limit urban sprawl and reduce energy consumption.

3. Plan and construct a transit system which, combined with other public transportation services, will enhance our region's communities and neighborhoods. Support achievement of Vision 2020 and of local and regional land use plans not in conflict with Vision 2020. (91)

Studies of the Vision 2020 plan by Stanton-Masten Associates have resulted in suggested approximate residential densities, employment densities, and jobs/housing ratios needed in each center to support the associated transportation system. Table 11 summarizes these land use - transportation linkage characteristics for the Vision 2020 Plan, by regional center type.(92)

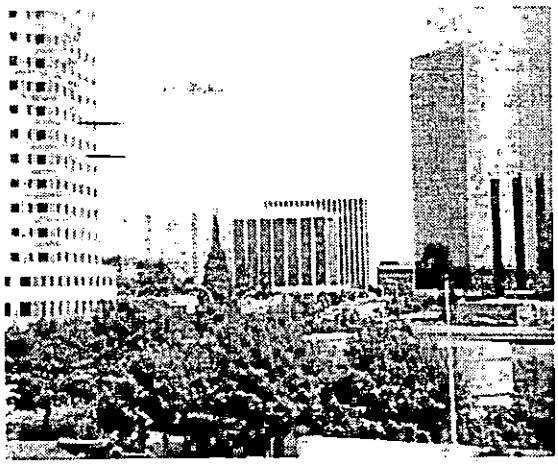
TABLE 11. Summary of Land Use - Transportation Linkages for Vision 2020 Plan

Type of Center	Net CBD/USA Residential Density*, dwelling units/acre	Net Employee Density employees/ acre	Total Employment	Ratio of New Jobs to New Households	Transit Service (minimum)
Regional Employment Center (Seattle)	20/8 (or mixed-use)	500	n/a	1.5 - 2.5	Fixed-route rapid transit/ passenger-only ferry
Metropolitan Centers	20/8 (or mixed-use)	100	40,000	0.75 - 1.5	Fixed-route rapid transit/ passenger-only ferry
Subregional Centers Phase 1 (pre 2020)	20/8	50	40,000	0.75 - 1.5	Fixed-route rapid transit/ passenger-only ferry
Phase 2 (post 2020)	12/8	30	30,000	0.75 - 1.5	Express bus before 2020; rapid transit or passenger-only ferry after 2020
Activity Clusters	12/6	Minimum employment growth to serve population needs	Minimum employment growth to serve population needs	n/a	Local bus
Small Towns	4	"	"	n/a	Daily bus
Pedestrian Pockets	20	500	2,000	n/a	Fixed-route transit/ pedestrian access emphasis

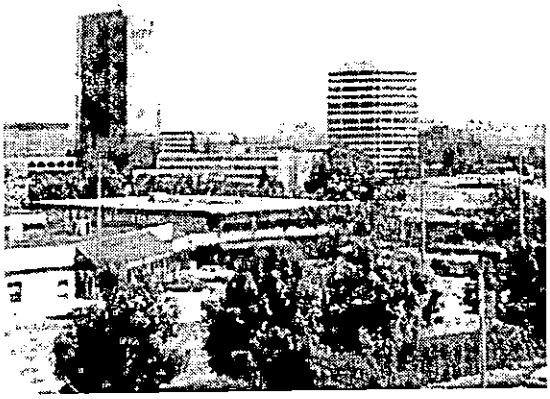
(Source: Stanton-Masten Associates, 1990)

* Central Business District/Urban Service Area

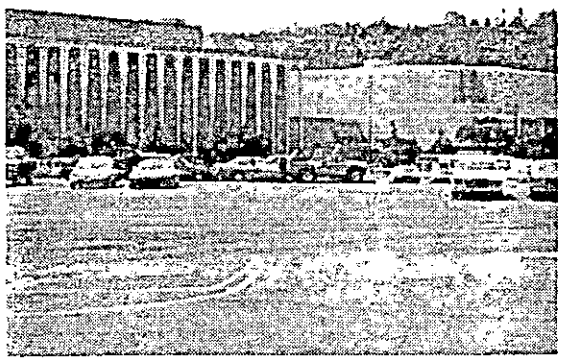
The Regional Center



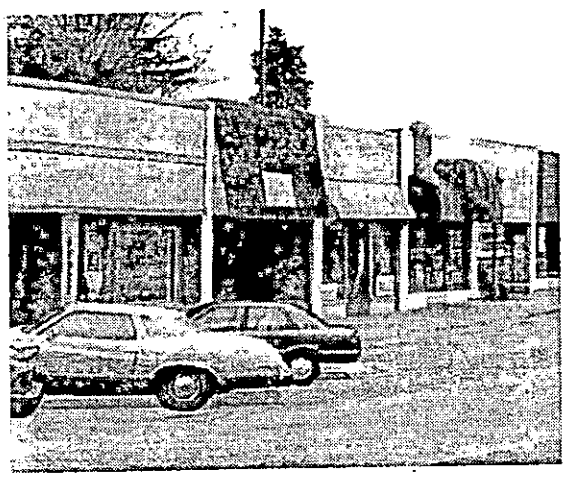
Metropolitan Centers



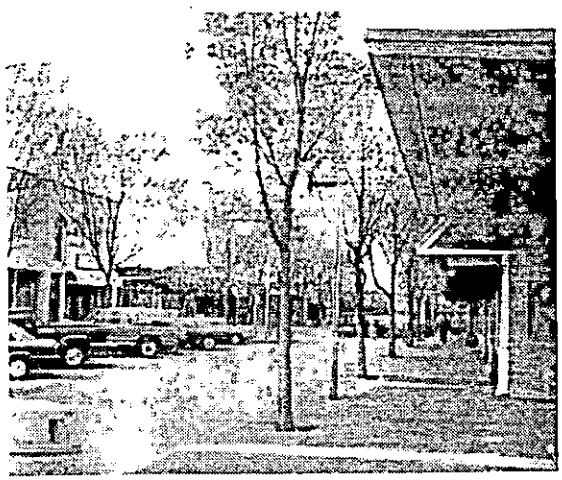
Subregional Centers



Activity Clusters



Small Towns



Pedestrian Pockets

Figure 20. Vision 2020 Multiple Centers

V. Summary of Land Use-Transportation Issues

The accompanying table summarizes the research in this white paper as well as the initial working paper prepared by the Innovations Unit. The table describes each of the nine individual land use topics of this study, with descriptions organized into the following categories:

Linkage to Transportation:	How the land use topic relates to transportation
Related Land Use Topics:	Other land use issues that are closely related to the topic
Typical Current Practices:	An overview of typical practices associated with the topic in Washington and nationwide
Recent Trends:	Recent progressive trends associated with the topic
Future Policy Needs:	Examples of potential transportation-related policies
Future Research Needs:	Examples of potential transportation-related research to supplement and advance the available body of knowledge
Notable Research:	Major research associated with the topic (full citations are included in the bibliography of this white paper)

Land Use-Transportation Linkage Research Summary

Washington State Transportation Commission
Innovations Unit
February 1992

	Residential Density	Employment and Activity Center Density	Parking Policies	Transportation Programs
Linkage to Transportation	• Low density residential developments cannot be served with high quality transit • Minimum density thresholds are necessary to support various forms of transit • Transit ridership increases with increased residential density	• Small, sparsely developed employment and activity centers are difficult to serve with high quality transit, and encourage SOV use • Transit ridership increases and SOV use decreases as the size and density of activity centers increases	• Large supplies of free parking encourage SOV use • Limits on the supply of free parking encourage transit ridership	• TDM provides a direct means of reducing SOV use • Concurrency ordinances link development to its supporting transportation infrastructure
Related Land Use Topics	• Jobs/Housing Balance • Master Planned Developments • Mixed Use Developments	• Jobs/Housing Balance • Parking Policies • Mixed Use Developments • Transportation Demand Management	• Transportation Demand Management • Employment and Activity Center Density • Site Design	• Parking • Employment and Activity Center Density
Typical Current Practices	• Increases in lot size as distance from the central city increases, forming a density "gradient" • Increases in typical single-family lot sizes since the establishment of zoning, though small-lot zones are now included in many codes	• Contrast between zoned densities that tend to be conducive to transit service, and actual built densities that are generally lower than allowed by zoning policy • Bonus incentives (usually increased FAR) offered in large city CBD developments	• Minimum off-street parking requirements based on peak anticipated SOV use • Maximum number of allowable spaces in large city CBD developments	• Recent adoption of demand reduction and adequate facilities / concurrency ordinances • Effective local employer transportation management associations
Recent Trends	• Small lot, single-family zones • Design reviews to facilitate infill of multi-family developments into existing neighborhoods • "Overlay zones" that establish minimum densities equal to a fixed percentage of the underlying zoned density	• Establishment of minimum densities (FARs) in selected districts such as transit zones • Increases in allowable densities at selected areas to concentrate the development pattern (e.g. at transit stations)	• Specification of maximum allowable parking spaces in non-CBD zones • Linkages between parking requirements and TDM program provisions	• State TDM requirements (Washington State Bill 1671) • Innovative programs by various companies and institutions (e.g. University of Washington U-PASS program)
Future Policy Needs (examples)	• Encourage development of housing adjacent to and within employment and activity centers • Develop educational and promotional programs to address the attributes of dense urban living environments	• Develop incentives to encourage dense, integrated employment centers • Develop non-CBD density bonuses that encourage dense mixed use developments • Coordinate high density developments with transit systems and stations	• Accompany limits on parking supply with increased transit service	• Develop educational and promotional programs that encourage HOV use
Future Research Needs (examples)	• Monitor effects of zoning on affordability and development • Evaluate the effects of a decrease in average household size on the housing market	• Monitor effects of policies such as minimum FARs on actual development patterns • Monitor overall development patterns of employment and activity centers	• Monitor effects of parking requirements on overall patterns of development • Research the potential of dense development or redevelopment via limits on allowed parking	• Monitor ongoing and new TDM programs and evaluate their success • Evaluate adherence to, and enforcement of, TDM policies
Notable Research	• Meyer, Kain, and Wohl (1965) • U.S. Commission on Urban Problems (1968) • Pushkarev and Zupan (1977) • Parsons Brinckerhoff et al. (1978) • Tri-Met (1974) • Jackson (1985) • Wentling ed. (1988) • Newman and Kenworthy (1989) • Bergeon and Williams (1990)	• Harrison, Ballard, and Allen (1950) • Pushkarev and Zupan (1977) • Parsons Brinckerhoff et al. (1978) • Cervero (1986a, 1988b) • Joint Center for Urban Mobility Research (1989) • Lassar (1989) • Newman and Kenworthy (1989) • Pivo (1990)	• Eno Foundation (1942) • LeCraw and Smith (1947) • Mogren and Smith (1952) • Witheford (1972) • Shoup and Pickrell (1978) • Shoup (1982) • JHK and Associates (1982) • Gruen Gruen + Associates (1986) • Newman and Kenworthy (1989) • Joint Center for Urban Mobility Research (1989) • Levinson and Weant (1990) • Association for Commuter Transportation (1990)	• Meyer and Gomez-Ibanez (1981) • Peat Marwick Main and Co. (1989) • Wright (1989) • K.T. Analytics, Inc. (1989) • Dunphy and Lin (1990) • Ferguson (1990) • COMSIS (1990)

Linkage to Transportation: How the land use topic relates to transportation
Related Land Use Topics: Other land use issues that are closely related to the topic
Typical Current Practices: An overview of typical practices associated with the topic in Washington and nationwide
Recent Trends: Recent progressive trends associated with the topic
Future Policy Needs: Examples of potential transportation-related policies
Future Research Needs: Examples of potential transportation-related research to supplement and advance the available body of knowledge
Notable Research: Major research associated with the topic (full citations are included in the bibliography of White Paper 92-1)

Mixed Use Developments	Site Design	Master Planned Developments	Jobs/Housing Balance	Metropolitan and Regional Planning
• Single use zoned developments encourage SOV use and discourage transit ridership • Mixed use zoning and developments encourage transit ridership and provide pedestrian access to services, employment, and housing	• Circuitous street and pedestrian connections reduce access to transit routes and hinder the effectiveness of public transportation • Direct transit, street and pedestrian connections allow shorter trips and encourage non-auto travel	• Typical medium to large scale MPDs and PUDs can increase traffic volume and demand for other services • Well-designed MPDs may reduce traffic impacts if they have mixed uses, are adjacent to employment centers, and integrated with transit service	• Concentrations of housing that are distant from employment centers encourage SOV use and add to congestion, energy consumption, and pollution • Affordable housing near employment centers increases the attractiveness of alternative transportation modes	• SOV use is encouraged and transit ridership is discouraged by low density dispersed development patterns common in most U.S. cities and regions • Overall regional distribution and concentration of land uses are key to the potential success of public transportation
• Master Planned Developments • Employment and Activity Center Density • Site Design • Residential Density	• Master Planned Developments • Mixed Use Developments • Parking	• Jobs/Housing Balance • Mixed Use Developments • Residential Density • Site Design	• Metropolitan and Regional Planning • Master Planned Developments • Residential Density • Employment and Activity Center Density	• Jobs/Housing Balance • Employment and Activity Center Density • Master Planned Developments • Residential Density
• Limits on the allowable mixture of uses in single family residential, industrial, and manufacturing zones	• Strong pedestrian system requirements and maximum setback requirements only in large city CBD zones • Subdivision requirements that allow large blocks and long cul-de-sacs	• Varying MPD policies, with some common requirements such as affordable housing; PUD zoning bonuses that typically allow increased density in exchange for common open space and other non-transportation amenities	• Mandatory affordable housing in some PUD and MPD policies • Density bonuses for PUD and MPD developments based on affordable housing	• County-level focus on regional issues in comprehensive plans; difficulties in implementation • Explicit RTPO responsibilities in state growth management legislation
• Incentives that encourage mixed use development including retail or housing, via density bonuses • Required retail at street level of buildings (primarily CBD)	• Strong pedestrian system requirements in non-CBD and suburban zones • Transit-Oriented Developments and Neo-Traditional Neighborhood Developments (TODs and NTNDs)	• Minimum residential density requirements in MPDs; elaborate PUD density bonus systems to encourage access to transit, services, mixed use, etc. • "Fully contained communities" (1991 Growth Strategies Act) that allow urban densities outside urban areas if certain requirements, including transportation, are met	• Washington's Growth Management Act provision that requires jurisdictions to adopt affordable housing policies • "Fully contained communities" (1991 Growth Strategies Act) that allow urban densities outside urban areas if certain requirements, including jobs/housing considerations, are met	• Recognition of the role of metropolitan and regional planning by the Growth Management Act and transportation legislation • Emphasis on multiple centers and transit systems in metropolitan and regional planning schemes (e.g. Puget Sound Vision 2020)
• Increase the diversity of allowable uses in all zones • Extend mixed use provisions to non-CBD zones • Develop educational programs to address the residential and transportation attributes of mixed use developments	• Extend strong pedestrian system requirements in non-CBD and suburban zones • Develop subdivision regulations that encourage regular street patterns and facilitate shorter travel distances and direct access to transit	• Develop requirements or incentives to encourage more residential and mixed use developments near urban employment centers and in other urbanized areas • Coordinate future development with existing and planned transit service	• Put greater emphasis on affordable housing near and within employment centers • Match housing types with the needs of the region (household type and size, income, etc.)	• Develop overall policies that encourage more compact, dense development patterns, coordinated with transit systems and stations • Encourage inclusion of transportation as an integral element of all land use policies and practices
• Evaluate effects of mixed use on transportation and mode choice • Consider potential promotional programs to encourage diverse mixed use developments	• Quantify the transportation implications of various street design layouts • Monitor recent developments that employ NTND street systems	• Monitor state MPD and PUD developments and their attributes • Evaluate transportation implications of "pedestrian pockets" and NTND concepts	• Monitor commuting patterns to employment, activity centers • Evaluate future housing needs based on changes in household size and other socioeconomic factors	• Research and monitor planning schemes in U.S. and abroad, including successful examples in Canada • Monitor effects of policies on actual development conditions
• Witherspoon et al. (1976) • Cervero (1988a, 1988b, 1991a) • Joint Center for Urban Mobility Research (1989) • Niwlan and Stewart (1991)	• Lautner (1941) • Pushkarev and Zupan (1975) • Tri-County Metro Transp. District (1979) • Replogle (1983) • Untermann (1984) • Moudon ed. (1984) • Untermann and Moudon (1990) • Kulash (1990) • City of Bellevue (1988) • Snohomish County Transportation Authority (1990) • Calthorpe Associates (1989) • Bowes et al. (1991)	• Krasnowiecki (1965) • Wolfe (1968) • Van der Ryn and Calthorpe (1986) • Porter (1988) • Moudon ed. (1989) • Kelbaugh ed. (1989) • Beimborn (1991) • Rabinowitz et al. (1991)	• Cervero (1986a, 1988b, 1989, 1991b) • Pisarski (1987) • Binger (1990)	• Meyer, Kain, and Wohl (1965) • Schneider (1981) • Cervero (1986b) • Attoe ed. (1988) • Newman and Kenworthy (1989) • Stanton-Masten and Associates (1990)

SOV Single Occupancy Vehicle
HOV High Occupancy Vehicle
CBD Central Business District
FAR Floor Area Ratio
TDM Transportation Demand Management
NTND Neo-Traditional Neighborhood Development
TOD Transit-Oriented Development
MPD Master Planned Development
PUD Planned Unit Development
RTPO Regional Transportation Planning Organization

Contents of this table are based on
White Paper 92-1, Land Use-Transportation Linkage
Washington State Transportation Commission Innovations Unit

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Selected Land Use and Transportation Acronyms

ALRT	Advanced Light Rail Transit
APFO	Adequate Public Facilities Ordinance
CAP	Citizen's Alternative Plan (Seattle city initiative)
CBD	Central Business District
DPCP	Downtown Parking and Circulation Policy (City of Portland, OR)
FAR	Floor Area Ratio
GMA	Growth Management Act
GMP	Growth Management Plan
HCT	High Capacity Transit or High Capacity Transportation
HOV	High Occupancy Vehicle
JRPC	Joint Regional Policy Committee
MPC	Master Planned Community
MPD	Master Planned Development
MXD	Mixed Use Development
MPO	Metropolitan Planning Organization
NTND	Neo-Traditional Neighborhood Development
PUD	Planned Unit Development
RTP	Regional Transit Project (King, Pierce, Snohomish Co., WA)
RTPO	Regional Transportation Planning Organization
SAC	Suburban Activity Center
SCAG	Southern California Association of Governments
STPP	State Transportation Policy Plan (Washington State)
SOV	Single Occupancy Vehicle
TDM	Transportation Demand Management

TMA	Transportation Management Association
TND	Traditional Neighborhood Development (also known as NTND)
TOD	Transit Oriented Development
TRAC	Washington State Transportation Center
Tri-Met	Tri-County Metropolitan Transportation District of Oregon
TRO	Trip Reduction Ordinance
TTC	Toronto Transit Commission
ULI	Urban Land Institute

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About the Innovations Unit

The Innovations Unit is an advisory group to the Washington State Transportation Commission that conducts technology and policy research on emerging transportation developments and opportunities in Washington state. The goals of the Innovations Unit are to

- provide long-range program development support to the Transportation Commission,
- generate unfiltered visions of a wide range of future short-term and long-term transportation technology and policy options, and
- establish a research methodology that fosters development of innovative transportation concepts.

The Innovations Unit has three objectives representing successively more detailed and focused studies:

Objective 1. Monitor emerging technologies and strategies. Compile and synthesize up-to-date information about emerging and innovative transportation technologies, strategies, and policies.

Objective 2. Research selected topics of Commission interest. Conduct detailed background research of specific technology and policy issues, under the direction of the Commission's Long and Short Term Goals Subcommittee. Produce a series of white papers outlining technology and policy implications germane to the Washington State transportation system.

Objective 3. Support in-depth technology and policy research. Conduct and/or coordinate detailed research of key enabling technologies, strategies, and policies.

The research activities of the Innovations Unit emphasize early, preparatory studies of emerging potential transportation solutions, and include interaction with elected officials, public agencies, university researchers, the private sector, and members of the public. Its activities are intended to complement and support in-depth applied research and implementation by the Washington State Department of Transportation (WSDOT) through its Research Office, and reinforce ongoing State Transportation Policy Plan activities.