IF YOU BUILD IT, WILL THEY COME?

The Future of Light-Rail in the Central Puget Sound Region

by

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ABSTRACT

If You Build It, Will They Come?
The Future of Light-Rail in the Central Puget Sound Region

Whitney Katherine Buschmann

The transportation sector has significant environmental impacts seen at local, regional and global levels. These include air and water pollution, habitat degradation, and human health effects. Many of these problems can be ameliorated simply by providing convenient alternatives to the automobile.

The purpose of this thesis is to contribute to the examination of the proposal by Sound Transit, the designated Regional Transit Authority for the central Puget Sound region in Washington State, to implement a second phase of light-rail in the area. Despite the environmental benefits of mass transit, it is not reasonable to build a transit system under the assumption that "if you build it, they will come." For one thing, failed mass transit efforts in the past have led to a regional culture dominated by the automobile.

Numerous studies attest to links between travel behavior, on the one hand, and population and employment density, land use patterns, activity location, and transit infrastructure, on the other. This thesis focuses primarily on density. It incorporates a literature review and uses a Geographic Information System (GIS) to analyze population and employment density in central Puget Sound. Based upon this analysis, there is a great deal of evidence to suggest that current conditions in the vicinity of the light-rail create an environment that is not conducive to facilitating the levels of ridership Sound Transit has projected.

An integrated set of policies aimed at the improvement, expansion, and encouragement of more efficient forms of transportation and the discouragement of less efficient modes can make significant headway towards the establishment of a successful urban transit network including light-rail and other modes of public transportation.

Although this thesis has a specific focus - the examination of regional transportation issues that are present today in central Puget Sound, many of the issues and the themes discussed herein will be relevant for years to come.

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I. INTRODUCTION

Multiple environmental problems can be ameliorated simply by providing convenient alternatives to the automobile. Because of insufficient progress in this regard, automobile use continues to increase, along with average auto trip length. For the environment this has meant an increase in air and water pollution, habitat degradation, and a host of other problems.

The Sound Transit Proposal

A solution for the central Puget Sound Region of Washington State is currently under consideration, the installation of an extensive public light-rail system. Sound Transit, the designated Regional Transit Authority for central Puget Sound, has begun construction on the first phase of light-rail that will link downtown Seattle to the Seattle-Tacoma International airport. The first phase also includes expanding the light-rail north through Seattle's Capitol Hill and University District neighborhoods, though funding for this portion of the project has been only partially secured. In November 2007 voters in the urbanized areas of King, Pierce and Snohomish counties will decide if the light-rail will be expanded south to Tacoma, north to Lynwood, and east to Bellevue.

Undesirable Effects of Automobile Use and Automobile Congestion

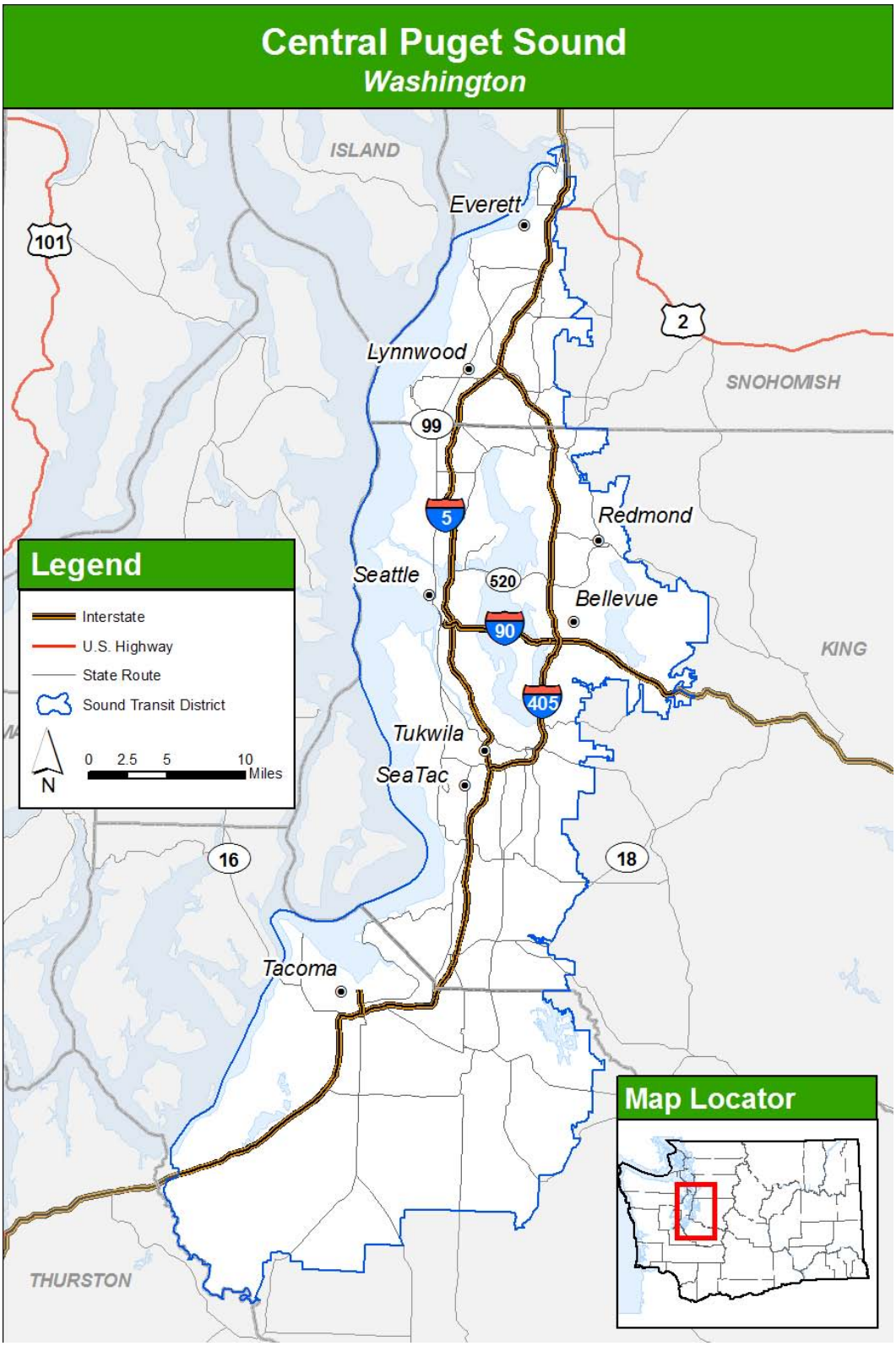
Travel in congested areas has a variety of direct and indirect costs. These include lost time for personal travel, increased vehicle operating expenses, and increased vehicle fuel. The economy struggles with lost productivity due to increased time for business travel, difficulty in attracting new businesses, and increased travel time for truckers and shippers, which in turn leads to higher prices for customers. A study of 85 urban and urbanized areas in the United States determined that, in the areas studied, the cost of congestion amounted to $63.1 billion in 2003 (3.7 billion hours of wasted time and 2.3 billion gallons of wasted fuel). This was up from $61.5 billion in 2002. The average annual cost per traveler was $794 – ranging from $1038 per traveler in the largest urban areas to $222 in the smallest urban areas. Areas with populations over 3 million accounted for about two-thirds of the congestion cost . Traffic congestion costs the Puget Sound Region an estimated $844 million annually, or $465 per traveler each year in wasted time and fuel .

The Puget Sound region has some of the worst traffic congestion in the United States. The primary cause of the escalating congestion is an increase in traffic with a fixed capacity of roads. The Washington State Department of Transportation tracks performance data for 35 important commutes in the Central Puget Sound region. In 2005, 34 of these routes experienced increased travel times during peak periods, slower speeds, longer peak periods and more unreliable travel times than in 2003 (Washington State Department of Transportation 2006).

It can also not be ignored that the geography of the Central Puget Sound region presents a variety of challenges for transportation (see Figure 1). Due to the hourglass shape of Seattle, sandwiched between Lake Washington and Puget Sound, and the concentration of residences and jobs in certain parts of the city, much traffic moves through the narrow land-mass on Interstate 5. Beyond Seattle, significant water bodies, namely Puget Sound and Lake Washington, present more challenges for transportation: east-west transportation relies significantly on bridges on State Route 520 and Interstate 90.

The region's current population of 3.8 million people is expected to grow by 1.4 million, almost 40%, by 2020 , adding 800,000 new jobs . The region will need to accommodate over 60% more travel, putting increasing stress on a transportation system that may already be at or beyond capacity . In addition to the negative effects this population growth will have on travel, increasing pressure will also be placed on the environment.

Figure 1: Central Puget Sound, Washington State
The geography of the Central Puget Sound region presents a variety of challenges for transportation.



The Environmental Effects of Automobile Use

The transportation sector has significant environmental impacts seen at local, regional and global levels. The entire cycle of fuel production, conversion and use leaves undesirable by-products in the environment - from unburned or altered fuel components to products of combustion to heavy metals. Fuel combustion produces carbon monoxide and carbon dioxide, as well as nitrogen oxides, largely responsible for global climate change and smog, respectively. Additional effects of automobile use include noise pollution, congestion, solid wastes, stormwater discharges to waterways, habitat disruption and destruction, and injuries.

Emissions

Anthropogenic (human-caused) changes in the earth's climate are due primarily to the greenhouse gases that are produced by the combustion of fossil fuels for energy. This is especially true in central Puget Sound, where changes in land cover are less of a factor than in some other regions. Greenhouse gases trap more ultraviolet radiation from the sun in the earth's atmosphere, resulting in a warming effect in many areas, which is a major part of global climate change. Carbon dioxide (CO_2) emissions constitute about 84% of total greenhouse gas emissions in the United States – 98% of this is the result of burning fossil fuels. In the United States the annual growth rate in CO_2 emissions for all energy sectors has closely tracked the annual population growth (1.2% annually for each, since 1990) .

According to the US Government's Energy Information Administration (EIA), in 2001 50% (42.2 million metric tons) of US carbon dioxide emissions came from the transportation sector, making transportation the largest contributing end-use sector to total emissions (see Figure 2).

Figure 2: Total Energy-Related Carbon Dioxide (CO_2) Emissions by End-Use Sector (1949-2005)
Measured in million metric tons of CO_2 ("P" indicates preliminary data)
Data source: US Energy Information Administration, 2005

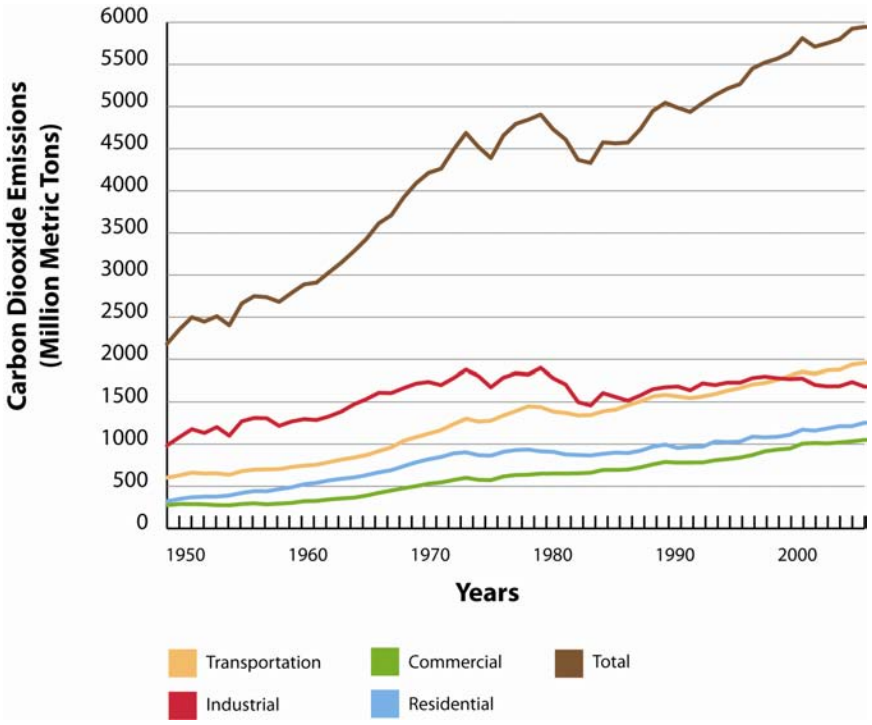
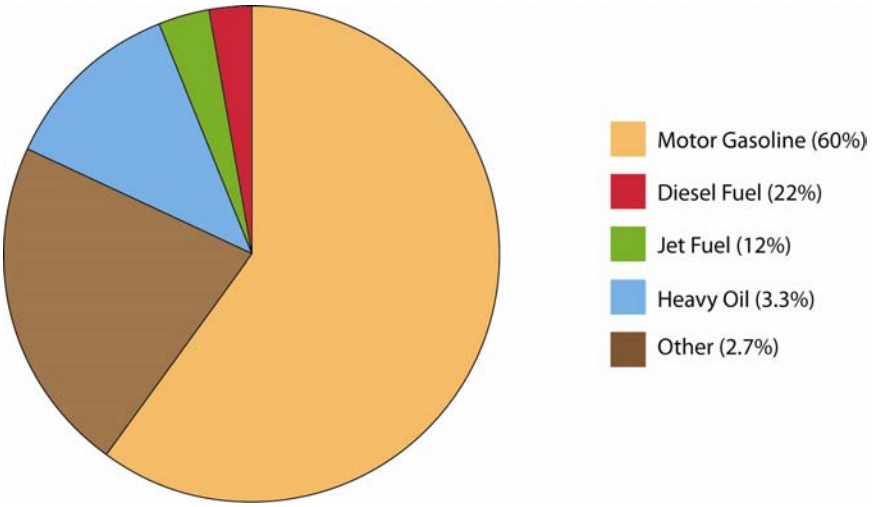


Figure 3: **Sources of CO_2 Emissions in the Transportation Sector**
Data source: US Energy Information Administration, 2005



Estimates for 2005 indicate that carbon dioxide emissions in the transportation sector increased by 1%, though between 1990 and 2004 the average growth in transportation emissions has been 1.5%. The EIA asserts that the slower growth in emissions between 2004 and 2005 can be attributed primarily to higher energy prices as well as weather-related disruptions along the Gulf Coast of the United States. Consumption of petroleum products accounted for 98% of transportation sector emissions: motor gasoline at 60%, diesel fuel at 22%, jet fuel at 12%, and heavy oil (largely for maritime use) at 3.3% (see Figure 3) .

The burning of fossil fuels also produces sulphur dioxide (SO_2) and nitrogen oxides (NO_X). These two air pollutants have serious health and environmental impacts. Sulphur dioxide can cause impairment of respiratory function, aggravation of existing respiratory diseases, cardiovascular disease, and increased mortality. Individuals with existing respiratory diseases like asthma, bronchitis, or emphysema, and those with cardiovascular disease, as well as children and the elderly are the most sensitive. Such individuals may experience symptoms including wheezing, shortness of breath, and coughing. Nitrogen oxide (NO) is the main nitrogen oxide gas emitted during combustion and can be converted to nitrogen dioxide (NO_2), a corrosive and highly oxidizing gas that, in the presence of sunlight, contributes to ozone formation, or "smog," and particulate matter. Small particulates are able to deposit deep in the lung, aggravating existing respiratory diseases and damaging lung tissues. Individuals with chronic lung or heart disease, influenza, or asthma, as well as children and the elderly are particularly sensitive and may exhibit symptoms similar to those caused by sulphur dioxide. In the Puget Sound Region automobiles and buses produce 76% of the NO and 57% of the volatile organic compounds that combine with NO to form NO_2 and ozone. In King County almost 10% of children and 7% of adults have asthma . In many areas emissions from industrial sources have stabilized or decreased, while those from automobiles continue to rise .

Greenhouse gas emissions are a function of three key variables: vehicle miles traveled (VMT), fuel economy, and fuel carbon content. Achieving significant reductions in greenhouse gas emissions from transportation requires a comprehensive set of complementary measures including slowing VMT growth, reducing vehicle greenhouse

gas (GHG) emission rates, increasing the use of low-GHG emission fuels, and improving freight efficiency . Results of a household-based study indicate that households in the most interconnected areas of Seattle generated less than one-half the VMT of households located in the least connected areas of the region, and these findings hold true after controlling for household size, income, and vehicle ownership . On a regional level research has shown that sprawl is the strongest influence on VMT per person – exceeding the influence of metropolitan population and per capita income .

Runoff

Stormwater runoff is difficult to control, owing to its geographical spread and the variety of pollutants it carries. The most common pollutants in runoff from roads and highways are heavy metals, inorganic salts, aromatic hydrocarbons, and suspended solids that accumulate on the road surface as a result of regular highway operation and maintenance activities. Salting and sanding practice, for example, may leave concentrations of chloride, sodium, and calcium on the roadway surface. Wear and tear of vehicles results in the dropping of oil, grease, rust, hydrocarbons, rubber particles, and calcium on the highway surface. These materials are washed off the highway by precipitation.

Runoff from highways is one of the primary avenues by which toxins can reach fresh and marine waters. Surface waters (streams, rivers, ponds, lakes) are exposed to contaminants released directly into the air as well as those released through highway runoff. Contamination of groundwater occurs gradually as contaminants slowly percolate downward though the soil. Certain contaminants, such as, dissolved forms of copper and zinc are toxic to fish and are difficult to remove using most conventional, passive stormwater treatment systems. Improperly managed stormwater also contributes to erosion, flooding and habitat destruction.

In December 2005 Washington State Governor Christine Gregoire unveiled an initiative to clean up Puget Sound by the year 2020 and formed the Puget Sound Partnership, a public/private union, to head the effort. Nearly $9 billion is expected to be spent between now and 2020 on Puget Sound-wide protection and restoration. A focal point for the Partnership is stormwater management, which the group has identified as the most

widespread of environmental challenges in the Puget Sound Region. Of the money the State of Washington plans to spend on cleaning up Puget Sound, stormwater management, especially from state highways, ranks second from the top. Additional funding is provided by the federal government and by county and local governments .

Habitat

Habitat protection and restoration in the Puget Sound Region has been outpaced by population growth and development and the resulting changes to land cover and shorelands. More than 40 species in the Puget Sound region are on the federal and Washington State lists of threatened, endangered, or candidate species that require special protection. This list includes Chinook (King) salmon, Orca (Killer) whales, and other species of fish, marine mammals, birds, and wildlife. One of the primary threats to these species is loss and degradation of habitat. Other threats include changes in water quality and quantity, over-harvest, disease, and competition or predation from non-native species (Manning 2006).

Forest cover has been replaced in many areas by cities, roads, business, parking lots, and homes. The resulting increase in impervious surfaces leads to reduced absorption of rainwater. As a result, high winter stormwater flows damage habitat in rivers and streams. The loss of water retention in the soil from impervious surfaces also further reduces streamflows during the dry season that are necessary to support fish and wildlife (Manning 2006).

Moving Forward: The Role of Public Transit

At times in the Puget Sound region, as elsewhere, there appears to be a conflict between the goals of the citizens, regional economic growth, and the needs of the natural environment. But this is an illusion. In fact, health of the natural environment is important to the state's economy. Some benefits of the natural environment are directly measurable. Annual values for recreational fisheries, commercial shellfish, and recreational shellfish are $10 million, $59 million, and $19.2 million respectively. In addition, the Puget Sound Region provides $5.2 billion in tourism revenue, with nearly 400,000 people engaging in recreational activities around Puget Sound at least once each year (Manning 2006). Given the observed downward trends in ecosystem health and the predicted increase in regional population, steps need to be taken to protect, restore and ensure the health of the natural environment and key sectors of the state's economy.

Debates occur in the literature and in the popular press over whether public transit is the key to reducing emissions and other negative environmental consequences of dependence on the automobile. Some argue that, particularly in North America, public transit is used for only a small percentage of actual trips. This is due in large part to suburbanization, which has led to people traveling further between origins and destinations. Employment that was historically concentrated in the downtown core has spread outward, forcing public transit to juggle maintaining a minimum level of service to the central city with demand for new routes to dispersed employment locations in the suburbs, which are more costly to provide . Of the 20 largest urban mass transit systems in the United States, 15 saw ridership decline in the 1990s, about half by 10% or more . In 1998, 1 in 20 commuters used public transit. This figure reached 1 in 5 in 15 US cities and 1 in 3 in only 5 US cities . Loss of riders leads to funding issues where public transit systems are forced to decide what they can and can't offer. As urban sprawl continues many cities are forced to make decisions about the fate of public transit. This can mean increasing subsidies in order to accommodate the increasing inefficiency of transit at suburban densities or disposing of seldom-used routes in order to shuffle funding to more dominant routes . This has implications not only for the future of mass transit but for the cities themselves.

Where land use patterns can support it, public transit trips can take up a significant portion of total transportation. The highest shares of riders are found in cities like New York and Toronto where urban land development has been influenced by existing rail infrastructure. A question then arises over whether existing patterns of land use can be reformed for the improved support of an expanded public transport system. Debates continue to occur in the transportation planning literature over whether the link between urban design and travel behavior are causal or merely associative.

Policies to decrease environmental damage associated with automobile use have, until recently, focused on automobile technology and the design and management of roads. In the long run transportation must be considered not only in terms of technology but also with regard to land use patterns and population growth. In order for light-rail to be successful in central Puget Sound these factors need to be addressed.

Evaluating the Potential for Success

Light-Rail Ridership

Considering the complexity and expense of this undertaking, it is essential that the likelihood of success of the proposed light-rail system be carefully examined. The success of public transit is typically defined in terms of ridership numbers. A critical mass of riders is required for transit service to be made practical and accessible for the users while still being financially sustainable for the operator. Sound Transit has estimated that by 2020 the initial light-rail segment between downtown Seattle and Tukwila will carry more than 42,500 riders daily. By connecting the urban centers of downtown Seattle, Capitol Hill, and the University District, the north link extension, also part of the first phase, is expected to add 107,500 riders daily when it is completed in 2030. Sound Transit expects the second phase, up for vote in November 2007, to put an additional 174,200 riders on the light-rail system (Sound Transit 2007).[1]

To achieve high ridership transit riders must share origins (where they live, for example) and destinations (where they work, shop, recreate and so on). One of the primary

[1] The first phase of the light-rail is being funded through a 0.3% motor vehicle excise tax and a 0.4% retail sales tax, approved by voters in 1996, in addition to federal grants, bonding and, once operation begins, fares from riders. The second phase would be funded by a sales tax increase of 0.5% in addition to existing taxes and bonding (Sound Transit 2007).

indicators of ridership or transit success is population density, both in terms of residence and employment. An apartment building, for example, will generate greater transit ridership than a rural housing development. Likewise, a suburban office park will generate fewer riders than a high-rise office building in a city's downtown core. Whether an area supports high residential or employment density depends in large part on land use patterns. Land that is zoned for low-density residential living, for example, does not allow for the population density necessary to support transit. Also of significance is urban design, which concerns the arrangement, appearance and functionality of towns and cities.

There are still many other factors that can affect transit success. People with disabilities, people of different cultures, people traveling by different modes of transportation, experience their surroundings in different ways, and these daily experiences have some bearing on the likelihood that they will take public transit. Likewise, demographics, including age, gender and income levels, play a role, as does the existing transit infrastructure, vehicle taxation rates, and whether or not the political culture values transit.

Likelihood of Success of Sound Transit, Phase 2: If You Build it, Will They Come?
The purpose of this thesis is to contribute to the examination of the Sound Transit proposal for the second phase of light-rail. It is not reasonable to build a transit system under the assumption that "if you build it, they will come." For one thing, failed mass transit efforts in the past have led to a regional culture dominated by the automobile. Giuliano concluded that transportation improvements play a limited role in shaping the urban form of major metropolitan areas in the United States: it is only part of the extensive infrastructure that has shaped urban and regional form in these areas for decades . Transportation improvements may shape land use patterns only if the costs to residents are significant (such as a very congested downtown) or if development decisions seriously affect accessibility (such as rapidly growing suburban areas).

Numerous studies at both the household and regional level attest to links between travel behavior, on the one hand, and population and employment density, land use patterns,

activity location, and transit infrastructure, on the other. This thesis focuses primarily on density, examining the relationship between residential and employment population densities and transit ridership in the central Puget Sound Region. The study incorporates a literature review and uses a Geographic Information System (GIS) to analyze population and employment density in the region. Based upon this analysis, there is a great deal of evidence to suggest that current conditions in the vicinity of the light-rail, namely existing population and employment densities, create an environment that is not conducive to facilitating the levels of ridership Sound Transit has projected.

That said, achieving significant use of light-rail and other public transit service, as well as walking and bicycling, does not require that Central Puget Sound achieve a New York City-level of density or infrastructure. An integrated set of policies aimed at the improvement, expansion, and encouragement of more efficient forms of transportation and the discouragement of less efficient modes can make significant headway towards the establishment of a successful urban transit network including light-rail and other modes of public transportation. Improvements in land use planning, such as clustering development, can support multi-modal transportation choices.

This thesis provides evidence to support these assertions. It is intended to serve as a snapshot in time – an examination of regional transportation issues that are present today in central Puget Sound. Six months from the writing of this document the fate of the current light-rail proposal will have been determined; however, many of the issues and themes discussed herein will be relevant for years to come.

Organization of Paper

This paper includes a review of literature on successful transit systems. The literature review is followed by a GIS analysis of residential and employment population densities in areas to be served by Sound Transit. The paper also includes a study of successful transit efforts in other cities as a means of finding similarities which may account for their success. These similarities are then applied to the central Puget Sound region.

This introductory chapter has provided an overview of the consequences of automobile use, particularly as they relate to the natural environment. These consequences include anthropogenic climate change and impaired respiratory function in humans, both of which result from the emission of greenhouse gases (carbon dioxide, sulphur dioxide and nitrogen oxides), pollution of surface (freshwater lakes and rivers) and marine waters from highway runoff, and habitat degradation. Clearly, the natural environment could benefit from reduction in auto use in central Puget Sound.

However, people may not choose to use public transit even if built. Chapter 2 identifies the variables that contribute to whether or not mass transit succeeds in a given area, that is, whether people choose to use it instead of automobiles. Of chief importance is population density, both in terms of where people live (residential density) and where people work (employment density). For example, a dense urban area can facilitate a higher level of public transit ridership than a sprawling, sparsely populated suburban one. Also important are land use mix and urban design. A mix of high-density residential and commercial development helps to facilitate the development of population centers that are able to provide high levels of ridership on public transit. Urban design concerns the shaping of urban public space as a method by which to encourage people to walk, bike or take public transit. Demographic factors, including age, race, and income, as well as existing transportation infrastructure and public policy, also play a role.

Chapter 3 outlines the methodology that was employed to develop this thesis. A review of the literature identified population density thresholds, below which public transit becomes impractical for the user and financially unsustainable for the operator. A Geographic Information System (GIS) was used to analyze population and employment

data from the 2000 US Decennial Census.

Chapter 4 provides case studies of several cities that have been recognized for their comprehensive public transportation systems: Toronto, Canada; Portland, Oregon, and San Diego, California. Toronto has a regional government that provides all major public services including public transit and has significant influence on land development, taxation and other factors with the potential to influence public transit. San Diego has a regional government with growth-management and development strategies that help to facilitate transit. Portland's regional government also allows for the creation of effective land use planning policies. The political climate also bears similarities to Seattle's.

Chapter 5 introduces the reader to Sound Transit's proposal for light-rail in the Central Puget Sound region. Chapter 5 takes the issues addressed and lessons learned in Chapters 2, 3, and 4 and systematically applies them to the Sound Transit project as a means of addressing what might be done in order to improve its effectiveness.

Chapter 2: VARIABLES IN THE SUCCESS OF MASS TRANSIT

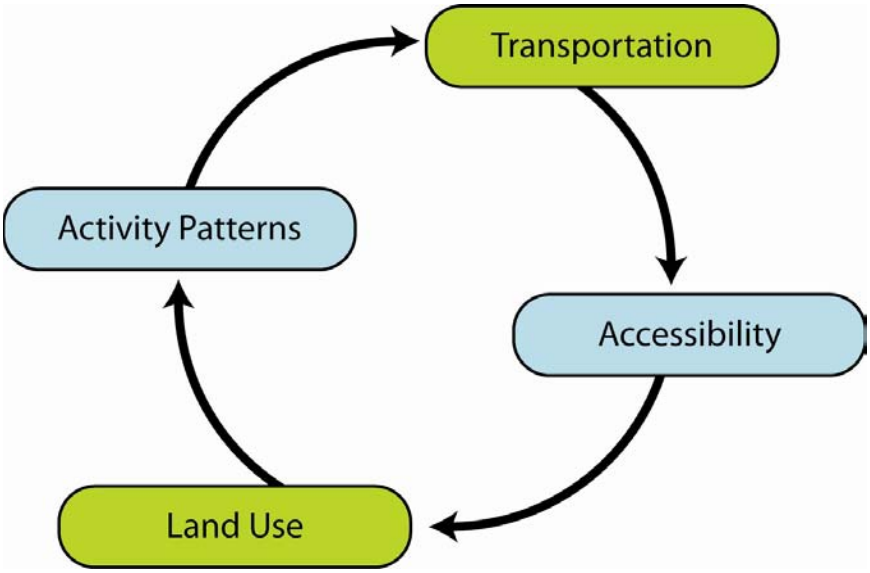
The first phase of Sound Transit light-rail runs through a number of areas in Seattle with dense population that already generate many riders on King County's Metro Bus System. This phase of the light-rail will have a built-in ridership from neighborhoods such as Rainier Valley, Beacon Hill, Capitol Hill, and the University District. The second phase of the light-rail, however, extends out of the dense urban core of Seattle through areas that exhibit much lower population densities. Additionally, this light-rail extension will require coordination among a number of different transit agencies because each county has its own public transit system, as do some municipalities.

Current conditions in the vicinity of the Sound Transit light-rail line, particularly the proposed second phase, are not wholly conducive to supporting high levels of ridership. Land surrounding transit corridors and stations needs to support a critical mass of transit users. There is a certain population density below which transit becomes impractical for users and financially unsustainable for operators without heavy subsidies. In other words, the lower the population density the more difficult it is for transit to operate. Land that is zoned for low-density residential living, for example, does not allow for the population density necessary to support transit.

Population density is affected by a variety of factors including land development patterns (such as mixed-use, typically achieved through municipal zoning regulations), neighborhood and street design, availability of parking, demographics, existing transit infrastructure, vehicle taxation rates, and political culture. The purpose of this chapter is to provide an overview of these various factors that have been identified in the literature.

Land Use

Figure 4: Transportation and Land Use
Changes to transportation technology and infrastructure can lead to effects on accessibility. Changes to land use can have an effect on activity patterns particularly in terms of the number and timing of trips which in turn affects the demand for transportation infrastructure and services (adapted from Giuliano (Hanson 2004)).



Causes of Urban Sprawl

In Western Europe land has traditionally been regulated to serve the public. This is not the case in the United States, which, along with Australia, is one of two industrialized countries with weak planning traditions . Here the goals of developers and particular groups of landowners are often favored over the needs of the general public, and problems in land use planning go unaddressed. Within this context, there are two principal courses of urban sprawl, land markets and zoning.

Land Markets

A widely accepted notion is the idea that urban sprawl results primarily from free markets in land development (Levine 2006). According to this idea, market disinterest has resulted in a lack of compact, mixed-use, walkable and transit-oriented urban environments in areas developed or redeveloped after World War II. Underpinning this notion is the idea that most Americans prefer low-density living; thus, the free market

offers little profit to those who might build compact, mixed-use, transit-friendly environments. Stemming from these assumptions are urban planning tactics that attempt to constrain the market's sprawling tendencies by employing a variety of regulatory tools aimed at encouraging development forms that the market is incapable of providing . In Puget Sound sprawl is exacerbated now by housing prices in areas such as Seattle which have out-priced many buyers, forcing them to move further from the city center.

Zoning

Empirical social science research into the impact of land use regulation on development patterns in metropolitan areas suggests that zoning and other interventions by the municipality tend to increase sprawl, leading to development that is lower in density and to communities that are more exclusive than would have arisen in the absence of such regulation . The reasons for this become apparent when one considers that municipal zoning ordinances typically limit building heights and lot coverage, set minimum parking space requirements for a development, and specify engineering standards to determine minimum roadway widths. In some areas municipal zoning codes specify single-family homes in order to preserve the homogeneity of a neighborhood. More affordable housing types, including multifamily housing, manufactured housing, apartments, and single-room-occupancy dwellings are cited as having incompatible uses and are pushed out .

Urban Form

Urban form refers to the shape of cities and towns: the design, type and location of development, protected areas, and how these areas are connected to and supported by each other. Urban structure is defined by the relationships that arise from urban form and the associated interactions of people, freight and information. Together they define the large-scale spatial network of towns and cities. Existing city structures affect the potential for new transit infrastructure.

Archetypes of Urban Form

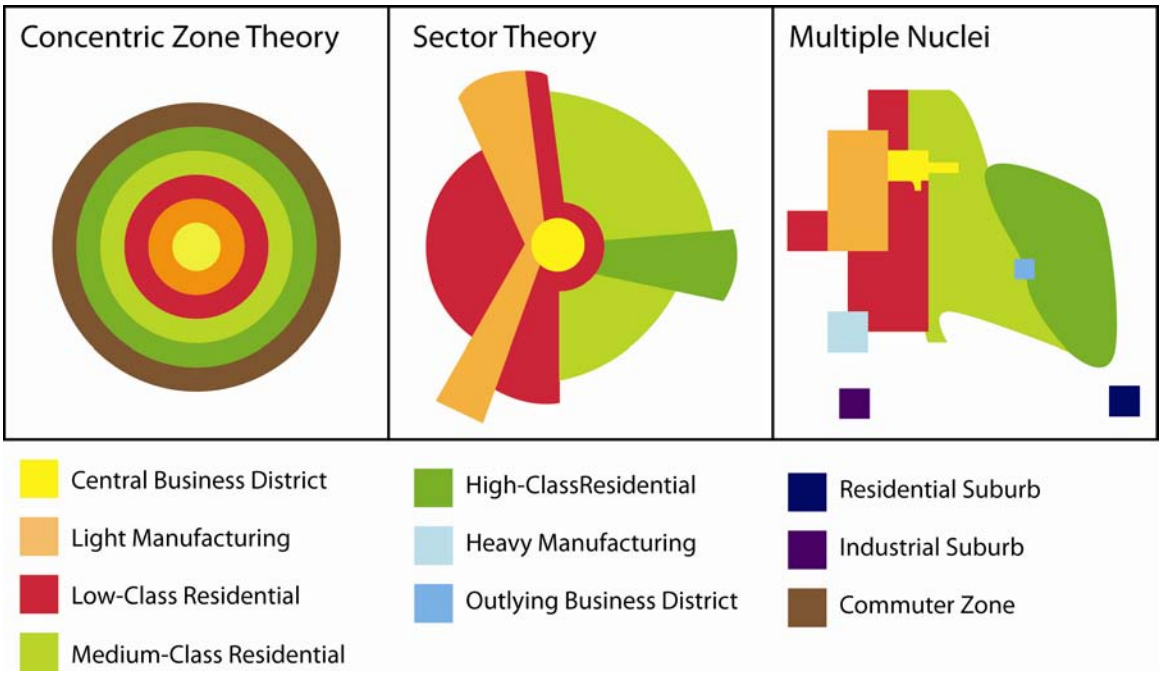


Figure 5: Archetypes of Urban Form
There are three common archetypes of urban form in the United States: the concentric zone model, the sector model, and the multiple nuclei model (adapted from Anderson 1996).

Urban form differs significantly around the world. The study of urban land use in the United States generally draws from three traditional archetypes that were developed to generalize about the patterns of urban land use found in early industrial cities in the US: the concentric zone model, the radial or sector model, and the multinucleated model (see Figure 5). The concentric city is the traditional urban form, the first model developed to explain the spatial distribution of social groups in urban areas. According to this model, the city grows outward from a central point in a series of rings, with the central ring representing the Central Business District (CBD). Contemporary CBDs tend to feature high employment density, high residential and commercial rent, the most trip ends and a dense transportation network. The CBD is surrounded by a second ring, the transition zone, or Inner City, that contains industry and lower-income housing. The third and fourth rings, zones for better residences, contain housing for working-class and middle-class respectively. The outermost ring is known as the commuter's zone, representing

suburbs with residents who commute into the CBD to work. Ernest Burgess, the sociologist who developed the concentric model, observed a correlation between the distance from the CBD and the socio-economic status of the residents. Wealthier families tended to live further away from the CBD. The city would expand outwards as it grew, thus pushing the outer rings further from the CBD .

The dominance of the concentric city waned as the growth of suburbs along major road corridors throughout the US in the 1940s and 1950s led to the emergence of sub-centers that competed with the central business district for economic activities. Other urban forms such as the radial or sector city and the multinucleated city developed. In 1939, Homer Hoyt modified the concentric zone model to account for major transportation routes. The radial city features a number of smaller major routes that extend from the central business district, with heavy land use along these transportation lines . Developed in the mid 1940s by two geographers, C.D. Harris and E.L. Ullman, the multinucleated city model features several city centers, around which activities revolve. A city that started with a central business district may develop into a multinucleated city as complementary activities, for example a university, bookstores and coffee shops, cluster together. Each has high employment density, a high volume of trip ends, and high rent .

Debate continues over what urban form is most efficient for transit. In actuality, probably none of them is ideal because all are static, not allowing for a description of the process of how land use changes over time. Historically, the compact, centralized, concentric form was thought to be ideal. A number of studies have demonstrated that CBDs are very supportive of transit, whereas the job decentralization that is characteristic of a multinucleated or dispersed pattern results in less use of transit for both work and non-work trips . Recent research, however, has indicated a preference for the multinucleated form, in part because it may provide a more realistic alternative, especially for the United States. It is unlikely that many US cities would be able to revert from urban sprawl back to a concentric city model for a number of reasons including the fact that, although downtown areas have historically played a significant role in transit's success, downtown jobs have fallen in recent decades as sub-regional employment hubs have developed . If transit is to be expanded it will likely be necessary to create transit corridors that link a

limited number of sub-regional centers that can support ridership, although not typically to the same extent as the CBDs .

Urban Form, Urban Structure and Transit

The growing size and complexity of cities and towns has created new challenges for urban form and structure, with the capacity of the transportation system tending to shape demographic and mobility growth. Travel behavior differs dramatically around the world depending largely on the spatial structure, and transportation network as well as the cultural values of the area .

Urban structure affects transit in two primary ways. First, the location of residential and employment centers affects the likelihood that people will choose transit as their mode of transportation. Second, people's willingness to walk or drive allows for the definition of transit corridors within which transit can be expected to perform satisfactorily. In planning for transit, it is important to consider not only the transit trip itself but also the trip to and from the transit station.

Interrelation of Land Use and Transportation

Transportation systems, transportation policy, and land use are intertwined, each influencing the development of the other. The precise nature of the interaction, however, is not clear.

Urban form encompasses both the development that results from land use regulations as well as the physical connections that are created by the transportation infrastructure. How exactly urban form and transportation policy one another is debated. It has long been argued that past transportation policies such as the federal-aid highway program and energy pricing have contributed to the decentralization of urban activities in cities throughout the United States and that the resulting redistribution of population and jobs between central cities and suburbs has contributed to congestion, traffic hazards, and pollution . Others contend that urban land use reflects location decisions made by individual households and employers, and that transportation is simply one of the many factors that influence these decisions.

Anderson (1996) suggests that transportation and land use are by nature difficult to reconcile due to their distinctly different motives. Whereas transportation concerns publicly owned infrastructure and services, in more laissez-faire forms of capitalism such as that in the United States, land use services are dictated largely by the private sector. Different and perhaps conflicting goals make it a challenge to coordinate them in order to regulate urban form.

Despite the difficulty in devising policies that incorporate the needs of both sectors, decisions about the location and capacity of transportation infrastructure have long-lasting implications for urban form. Policies intended to decrease urban sprawl will have little effect, at least for some time, if the infrastructure already in place was designed to support decentralization: there, sprawl is a built-in component of urban areas and, once present, is difficult to reverse.

Population and Employment Density

Research has identified residential population and employment density as the aspects of land use that are most strongly correlated with travel behavior. A decline in density is associated with decreased transit use because dispersed origins and destinations cannot be effectively served with conventional transit service. In order for transit to be feasible, riders need to share both origins and destinations. Concentrating on only one end of the trip, for example housing or the workplace, in the absence of substantial clusters at the other end, will most likely not produce high rates of commuting .

There are well-documented empirical threshold densities below which transit becomes impractical for users and financially unsustainable for operators without substantial subsidies. The literature review conducted by Holtzclaw (1994) on transit and density suggests density thresholds of about 12.14 people per gross acre[2] for intermediary bus service, 14 for light-rail, and 20 for metro. Newman and Kenworthy (1990) concluded that below 8 people per gross acre and 8 to 10 residential units per gross acre there is a noticeable increase in automobile use, and below 12 people per acre bus service becomes

[2] A gross acre is a measure of land area (43560 square feet), as distinguished from a "net acre" or the usable of cultivatable portion of an acre of land.

poor. They recommended densities above 12 to 16 persons per acre for a transit-oriented urban lifestyle. Pushkarev and Zupan (1982) indicated that a minimum of 9 dwelling units per acre was necessary for light-rail. Lowe also recommends 9 dwelling units per acre for light-rail (1992). In a study of the relationship between land use patterns and travel behavior in the Seattle metropolitan area, Frank and Pivo (1994) concluded that certain land use patterns, including greater employment and population density, land use mix, and jobs-housing balance are associated with less automobile use. They determined that, at a threshold of 50 to 75 employees per acre, and 9 to 13 persons per gross acre, transit work trips showed a significant increase. The same phenomenon occurred for shopping trips at a threshold of 75 employees per acre or 18 persons per gross acre .

Density in station areas and along transit corridors is an essential component of making the system successful. This "clustering" of residences and workplaces near rail stations has the most significant influence on travel behavior within a one-quarter to one-half mile radius of the station. In an examination of residential, office and shopping developments in the vicinity of five rail transit systems in California, Cervero (1993) concluded that residents living within one-quarter mile of a rail station were 5 to 7 times more likely to travel by rail than residents elsewhere in the same community. A national sample indicated that a doubling of station-area residential densities is associated with a 60 percent increase in light-rail boardings . When both trip ends are clustered around a rail station, transit use increases significantly.

Many of these studies assume that the primary mode of access to transit is walking and that people's willingness to walk to transit is limited. Untermann concluded that in urban areas most people are willing to walk 500 feet, with 40 percent willing to walk 1,000 feet and only 10 percent willing to walk a half-mile . Similarly, Cervero (1993) found that, with every 100-foot increment of distance from a rail station, ridership decreased. Other studies have indicated that the distance a person is willing to walk is strongly affected by the walking environment. Minimizing delays and inconveniences like lack of sidewalks, inadequate signage, dangerous walkways, or poor appearance may encourage riders to opt for transit. Commuters will generally walk further to reach light-rail stations than to reach a bus stop .

A number of cities have established walking distance guidelines to use in their transit forecasting models. Both Denver and San Diego use 1758 feet (approximately one-third mile) as the maximum walking distance to light-rail stations. In Newark, models for planning studies of new light-rail lines are generally based on the assumption that all zones within 2641 feet (approximately one-half mile) of a proposed station can be reached by walking. The Sacramento Regional Transit District has established walking distance and land use guidelines that recommend that development within 1500 feet (0.28 miles) of transit corridors and 2001 feet (0.38 miles) of light-rail stations provide or ensure direct pedestrian access to the transit system, and that pedestrian paths should be designed with adequate lighting, visibility and smooth walking surfaces, and protection from weather to increase the safety and attractiveness of walking to transit (O'Sullivan 1996).

Although both residential and employment centers generate transit ridership, high-density residential areas generate greater transit ridership than high-density employment centers. The proportion of light-rail station area workers who use transit is approximately one-half the number of station area residents. Additionally, the proportion of transit ridership rises as density increases. A doubling of residential densities can more than double transit use
.

In their study of the Central Puget Sound region Frank and Pivo (1994) determined that the strongest relationship between land use and transit demand was that the percentage of workers who take the bus to work is higher when the workers begin and end their trips in areas with high employment density. In the case of the central business district (CBD), both employment density and the size of the CBD influence light-rail ridership. Ridership impacts of concentrating more employment in the CBD are greater for larger CBDs. Small CBDs under 100,000 workers see a 15 percent increase in ridership given a doubling of employment. Medium CBDs of 100,000 see a 42 percent increase in ridership given a 50 percent increase in employment. Large CBDs of 150,000 see a 50 percent increase in ridership given a one-third increase in employment .

Dense areas also allow for less parking and a wider mix of land uses, both of which

facilitate a reduction in automobile usage. In a study of the San Francisco Bay Area, density and walking quality were found to be strong predictors of non-automobile travel for non-work trips . Higher population densities near transit corridors for subsidized transit were also found to increase the transit share of work trips .

Land Use Mix

Some land use mixes allow for origins and destinations to be close together, helping to facilitate walking, cycling or transit use. It is not necessary for centers to contain both jobs and housing to reduce auto use although the greatest reductions are seen in areas that have dense housing, shopping and employment. The placement of grocery stores in neighborhoods can reduce the need to drive to obtain basic goods and also allows residents to shop on the way home from the transit station. Prevedouros and Schofer found that while in the morning peak hours the vast majority of trips were between home and work, a lesser percentage of evening trips was from work to home due to trip chaining, i.e. going to a secondary destination such as running errands . Mixed-use also allows for trips to be spread more evenly throughout the day and week and creates opportunities to share resources, such as parking. For example, a parking lot used by office staff during the weekdays could serve restaurant goers in the evening and on weekends.

However, greater access does not always decrease car use. Handy found that neighborhoods close to shopping destinations generated more automobile trips. Handy's results also suggested that the effects of neighborhood design are greater than those of household characteristics when considering time, frequency and variety of trip destinations between suburban and traditional neighborhoods . Still, presence of mixed-use neighborhoods was linked to commuting via transit and non-motorized modes .

Land use mix relates primarily to work trip and mid-day travel mode choice decisions in urban and suburban employment centers. The type of businesses present in transit station areas affects transit ridership. Businesses that provide services to riders, such as retail and personal or professional services, attract more people to stations. Station areas with a significant proportion of jobs in sectors such as construction and manufacturing see lower

transit shares . Likewise, employment centers with on-site or nearby retail services result in higher rates of midday pedestrian travel and low rates of single-occupant vehicle use . The Bellevue, Washington Transit Center displayed some of the highest transit mode shares, as well as the greatest proportion of non-office uses and employment densities .

These and similar studies have resulted in the idea that the jobs/housing balance can be a tool to manage automobile congestion and increase use of transit. Several studies have indicated that, over time, jobs and housing tend to co-locate, thus preventing jobs/housing imbalances from becoming too severe. Most studies seem to concur that this is a natural evolutionary process . Job-housing imbalances are associated with longer commutes and increased dependency on the automobile. In their 1989 study of the Puget Sound region Frank and Pivo found travel distances and times to be shorter for commutes to areas with balanced jobs and housing . In sum, trip distances in areas with land use mixing, jobs-housing balance and population and employment density are typically shorter because there is not the same need to travel between different activity centers as there is with sprawling development.

Urban Design

Urban design refers to the characteristics and arrangement of land use on a small scale. Research suggests that design is relevant to travel behavior. A pedestrian-friendly downtown area is more likely to encourage transit use than a sprawling, automobile-oriented suburban one. A grid street layout, especially with higher densities and mixed land uses, typically serves to move origins and destinations closer together, thus decreasing trip distance or the need to drive at all . Design can increase the accessibility of destinations by foot as well as provide amenities to pedestrians, cyclists and transit riders. Neighborhood characteristics and walking quality have a moderate effect on transit demand, particularly for non-work trips, and neighborhoods with wider sidewalks, four-way intersections and limited on-street parking adjacent to commercial buildings tend to average less single-occupant vehicle travel for non-work purposes .

In general, the effect of urban design on travel demand is difficult to measure. Whereas residential population density is easy to measure on a precise scale, urban design relies on

dummy scales or applying such estimates as low, medium and high value. Urban design features include street and sidewalk connectivity, use of street crossings on principal arterials, the absence of topographic constraints to pedestrian mobility, improved bicycle and transit access, and landscaping that helps to improve the aesthetic appeal of the environment. There is significantly less information about urban design available at the census tract level, the scale at which population is often assessed. Likewise, there are large disparities in the quality of data available for transportation as opposed to land use and urban design. Trip records for thousands of households in a region provide detailed information whereas details on building characteristics, setbacks, parking supplies, length of sidewalks and general urban design are often not available. Part of the gap between the quality and quantity of transportation data versus that of urban design lies in the availability of funding for research. The result is that, in most areas, a rich database with which to study the impact of actual land use and urban design, as opposed to prescribed zoning ordinances, does not exist .

In a study of several hundred worksites in Southern California, certain aspects of land use mix and urban design at worksites were shown to increase transit use by 3 to 4 percent. The study indicated that the presence of shade trees and sidewalks, and the absence of graffiti and other factors do contribute to mode choice decisions. However, when these factors were examined independently from the presence of travel demand management programs at the worksites, 4 out of 5 land use characteristics were no longer statistically significant in explaining observed variations of transit use. Only the aesthetic urban settings remained statistically significant in the absence of travel demand management programs .

Also woven into design is the issue of parking. The parking environment at the workplace can have a significant effect on transit ridership. If people living and working near rail stations have free parking at work, the odds of commuting via rail drop sharply. If an employee works in a major urban center fed by rail transit and faces daily parking expenses, the probability of commuting via rail increases by as much as 90 to 98 percent, depending on whether incentives such as employer-funded transit allowances are offered . Within neighborhoods, parking fees can encourage people to walk to shops and other

non-work destinations .

Demographics

In a study exploring trip characteristics of individuals living in selected Chicago suburbs Prevedouros and Schofer identified four factors having a significant association with traffic congestion: residential location, population age, gender, and work hours. The automobile was the primary mode of transit in suburbs, with larger, younger households tending to have higher vehicle ownership. Residents in older, more established suburbs tended to work in the central city and commute via public transport. The total number of trips in a day was highest at age 40, which can likely be explained by the fact that many people are in a stage of their life where they have young, dependent children whose needs result in a larger number of trips among the adults in the household. Those in older age brackets traveled more during non-peak times such as the middle of the day. Females made more trips than their male counterparts, with females employed part-time having the highest number of automobile trips, though these trips were often shorter in duration. Females also made more trips to serve passengers, for example driving children to school or husbands to work. Suburban females used automobiles more than males, whereas females living in the central city had a greater tendency to use public transportation. Workers employed part-time generally worked closer to home than those employed full time. Unemployed people made more trips per day than employed people. The authors of the study suggest that, as the baby boom generation ages, the roads may see some relief as traffic is equalized more throughout the day. The significance of household characteristics in trip choice indicates that trends in urban form cannot be addressed in isolation from social and economic trends .

Existing Transit Infrastructure

Existing transit infrastructure, such as feeder bus service to and from light-rail stations can have a significant effect on success of transit. In the case of suburban rail stations, park-and-ride lots are often essential to capturing ridership. At the same time, compact development around station areas is important for capturing walk-on riders. This creates somewhat of a policy dilemma because park-and-ride lots typically include expansive parking lots intended to serve a large geographical area and preclude the compact

development that defines a station area.

Public Policy

Municipal Zoning

Zoning policies excluding high-density development in suburban areas have contributed to the expansion of the metropolitan boundary in order to accommodate housing demand . Roads have been pushed farther out encouraging more expansion . Urban sprawl of this nature is characteristic of many of the areas surrounding the city of Seattle.

Integrating Transportation Policy and Land Use Policy

A number of movements have focused on reversing sprawl, including new urbanism, neo-traditional design and smart growth. With an eye towards creating sustainable communities, these movements share a core belief that automobile travel demand can be minimized by altering the built environment. Portland, Oregon has focused on encouraging development that supports increased mobility, particularly via transit, walking, and bicycling, through what is termed "transit-oriented development" (TOD). This term applies broadly to numerous elements of the built environment, including buildings, site developments, street improvements, and transportation facilities. Transit-oriented development is dense, mixed-use development, designed for pedestrians and multiple modes of transportation. This method has a number of benefits, including increased economic vitality in urban centers and corridors, higher quality transit service, increased neighborhood livability, and a more efficient use of public funds. From a transportation perspective the value of transit-oriented design is based on the idea that TODs result in shorter trips, less traffic, higher transit rates, and a better balance of jobs and housing (Tri-County Metropolitan Transportation District of Oregon 1995).

Smart Growth is a set of principles that stem from a belief that current development patterns are no longer in the long-term interest of communities and that time, attention and resources should be devoted to restoring community to city centers and older suburbs (Sustainable Communities Network 2007). Resources are conserved by investment in existing infrastructure and buildings, and designing neighborhoods with a mixture of uses that facilitate multimodal transportation. The idea has existed since the 1970s but has

become more prominent in recent years. In 1996, in response to concerns from communities regarding the need for environmental protection, along with economic and community vitality, the United States Environmental Protection Agency joined several non-profit and government organizations in establishing the Smart Growth Network (SGN). The SGN developed a set of ten guiding principles for using smart growth approaches: mixed land use, compact building design, range of housing opportunities, walkable neighborhoods, community focus, preservation of open space and critical areas, development of existing communities, transportation choices, fair and cost-effective development decisions, and community and stakeholder collaboration in development .

Internalizing the Cost of Automobile Use

Debate revolves around whether land use in and of itself can influence mobility or if it is also necessary to internalize the costs of travel in order to reduce dependence on automobiles . Some urban planning policies stem from a belief that growth can not be managed via market pricing of transportation but that it must instead be managed by creating an urban form with relatively high population and employment density, mixed-use, and alternatives to driving an automobile. An opposing idea is that the way to remedy problems with transportation is through economic means such as road pricing or general taxation. This approach is rooted in the idea that the decreasing real cost of travel, transportation systems already in existence, and the shift to an information-based economy in developed nations like the United States has weakened the relationship between land use and transportation .

Policies on Home Ownership

In the United States, migration out of the central urban area accelerated after the Second World War. Suburban areas provided houses that were inexpensive compared to those in town and often on larger tracts of land. The construction of major roads connecting central areas with suburbs, and of local roads providing easy access to new housing areas, helped to promote suburbanization. Policies promoting home ownership also helped to facilitate moving away from urban areas. Direct subsidization of mortgages or mortgage insurance and tax policies allowing homeowners to deduct mortgage interest or exempt capital gains made home ownership out of town more financially beneficial than renting

in town . Suburbs tend to have a low population density, high population growth rate, and high automobile ownership .

Promoting a Transit-Oriented Culture

It is important that people believe transit is an important component of urban areas and a reliable alternative to the automobile. In Ottawa, Canada, most residents prefer to live in low-density, single-family settings, and the city does not attempt to alter these preferences. The region's transit system, however, has high levels of ridership because transit service is considered an essential neighborhood service, like roads and water. City planners ensure that transit is available within a 5-minute walk of every household .

WMATA, the transit operator in Washington, D.C., initiated a program to encourage development at its light-rail stations, building people's expectations that transit would be available for their use. Integration of transit plans with local and community land use plans was done prior to the construction of the rail system and has led to several successful station area plans .

Chapter 3: RESIDENTIAL AND EMPLOYMENT DENSITY IN THE LIGHT-RAIL AREA

This thesis focuses primarily on residential and employment population density as a means of analyzing the potential effectiveness of Sound Transit's existing (Phase 1) and proposed (Phase 2) light-rail lines. A Geographic Information System (GIS) was used to display and analyze the spatial distribution of where people live and work in the central Puget Sound region.

Data Analysis

Geographic Information Systems (GIS)

A GIS is an integrated set of computer hardware and software that is used to collect, analyze and display geographically referenced information, that is, information, or data, that has a defined location on the face of the earth (ESRI 2007). At the simplest level a GIS can be thought of as a high-tech map. However, a GIS also allows for the storing, integration, analysis and editing of geographic data. The technology is used across many disciplines for problems ranging from environmental impact analysis to determining real estate locations for new businesses.

Data Selection

This investigation employed data from the year 2000 decennial census. The official US census, which calls for an actual enumeration of the people every ten years as a method to determine the number of seats each state receives in the House of Representatives, contains a considerable amount of information . The information is displayed at a variety of different levels including the census tract and the census block, both of which are addressed below.

In measuring population and employment density it is important to consider issues of scale in order to develop appropriate modeling techniques. One of these is the extent of the area considered, and the other is the level of resolution of the data used in data collection and analysis. In analyzing an urban area researchers can select from a variety of extents including states, regions, cities, and neighborhoods. The corresponding units

of spatial analysis can range from individual land parcels to the regional level. GIS technology allows for the analysis of very small spatial units for data collection and analysis over very large geographical areas .

The extent chosen for this study was King, Pierce, and Snohomish counties as this is the area through which the light-rail runs. Two units of analysis were chosen – the tract and its subset, the census block. The census block level would be a more ideal level for this analysis but employment data were available only at the tract level. The tract, a frequently used scale of analysis, is a small, somewhat permanent statistical subdivision of a county, containing an average of 4,000 people. It is designed to be homogenous in terms of population characteristics, economic status, and living conditions. A subdivision of the census tract, the census block is the smallest geographic unit for which the census bureau collects extensive data. Blocks frequently follow individual city blocks bounded by streets. In rural areas, however, blocks may include many square miles and may have some boundaries that are not streets.

Analyzing the census tract and the census block can yield different information. For example, the use of these different geographic units of analysis will show different proportions of populations living above certain densities. Hess, et all (2001) posed the example of King County, Washington – 1990 census tract-level data show that 40,000 people are living at densities of 25 people/hectare (10 people/acre) or above. This data also indicated that most of these higher-density tracts are located near the center of the city of Seattle. An analysis of the same area (extent) at the census block-level shows more than 400,000 people are living at 25 people/hectare and above. Additionally, block-level analysis shows that these higher-density blocks are not only near Seattle, but are spread throughout the urbanized part of the county. This example demonstrates that both the total number and the spatial distribution of people living at specific densities are sensitive to the size and boundaries of the spatial unit of data analysis.

For the purpose of analyzing light-rail, where density within ¼ mile of the station area is important, it is necessary to use as fine-scale analysis as possible. Whenever possible, block-level data is used.

Results

Residential Population Density

The residential population density thresholds identified by Holtzclaw (12 to 14 people/acre), Frank and Pivo (9 to 13 people/acre), and Newman and Kenworthy (12 to 16 people/acre) were used to determine whether the central Puget Sound region is likely to generate the levels of ridership needed to make regional light-rail service feasible . An analysis of residential population density at the Census Block level indicates that the requisite density for supporting public transit exists in the vicinity of the first phase of light-rail lines and stations (see Figure 7). As the light-rail extends north, east and south in the proposed Phase 2, however, residential population density decreases significantly. The data demonstrate that there may not be the necessary density to support the light-rail extension, particularly east of Seattle.

Employment Population Density

The employment population density thresholds identified by Frank and Pivo (50 to 75 employees/acre) were used to determine the feasibility of public transit in central Puget Sound . An analysis of employment population density at the Census Tract level indicates that the requisite employment density is present in the downtown centers of Seattle, Tacoma, and Bellevue (see Figure 8). Had this data been analyzed at the Census Block data (which was not available) I would have expected to see the requisite employment density present in other employment centers, perhaps the University of Washington and Northgate Mall in Seattle, and Microsoft in Redmond.

In looking at employment and residential population combined, it is clear that ample light-rail ridership is available along the Interstate 5 corridor in Seattle, in downtown Bellevue, and in downtown Tacoma (see Figure 9). As the light-rail extends further from these areas density decreases and the success of public transit becomes more questionable (see Figure 10).

Figure 6: Sound Transit District

The Sound Transit District extends from north of Everett south to the Pierce/Thurston County line, and east through Bellevue and Sammamish. Voters within the district pay a 0.3% motor vehicle excise tax and a 0.4% retail sales tax, part of which goes towards funding the first phase of light-rail. The second phase would be funded by a sales tax increase of 0.5% in addition to existing taxes and bonding.

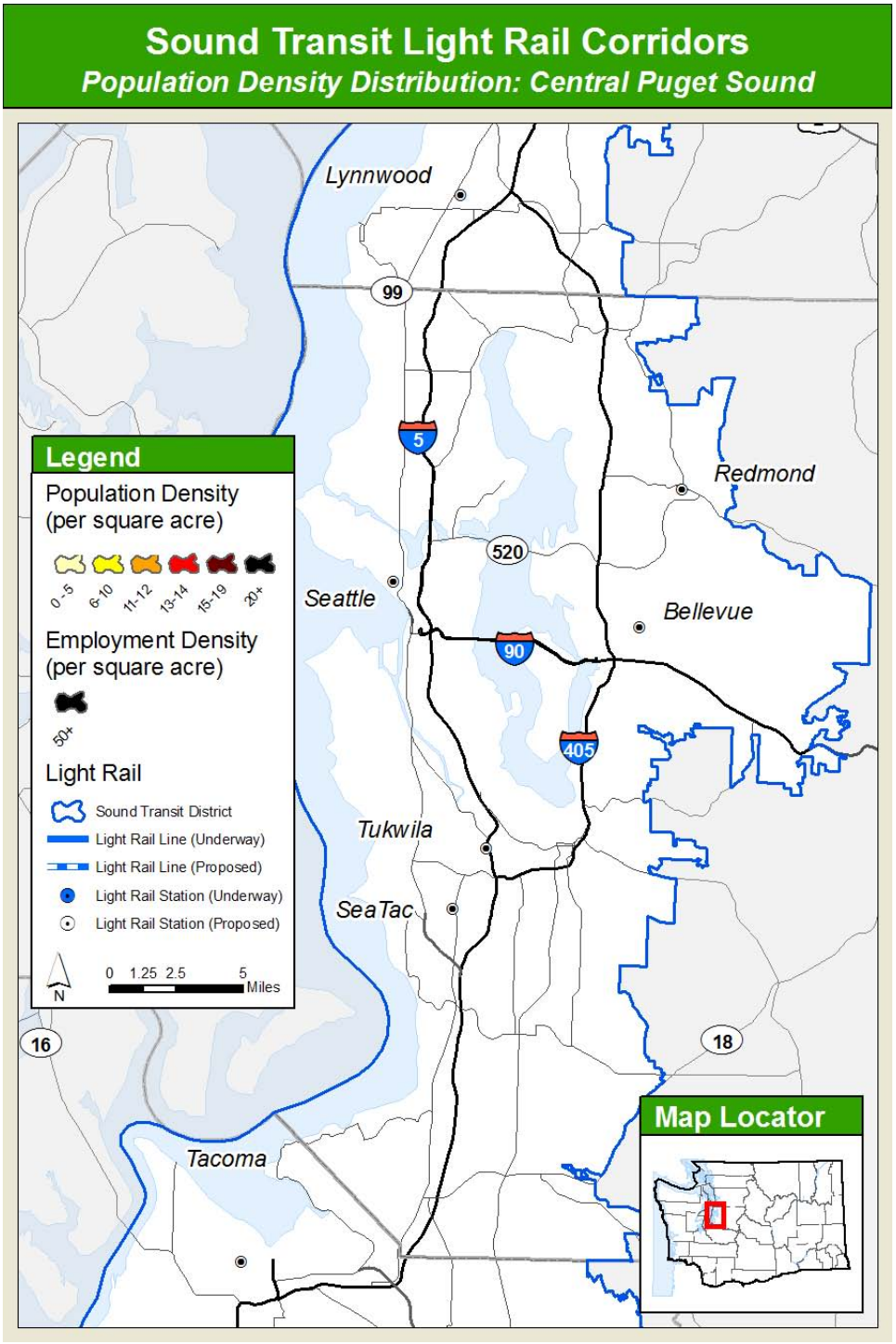


Figure 7: Residential Population Density in the Sound Transit District
At the Census Block level residential population density figures indicate transit-supportive density along the Interstate 5 corridor in Seattle and downtown Tacoma.

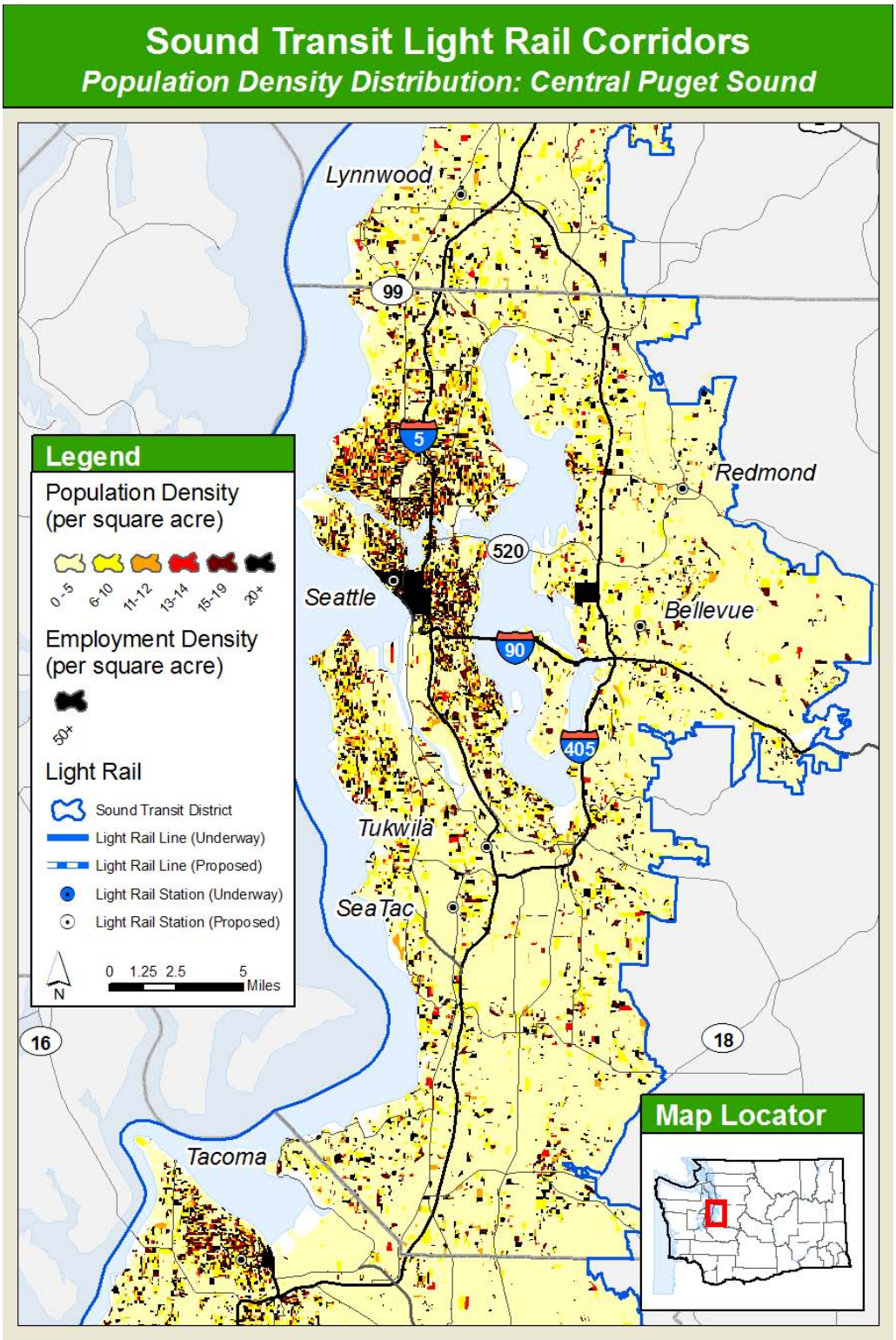


Figure 8: Residential and Employment Density in the Sound Transit District
At the Census Tract level employment population density figures indicate transit-supportive density in the downtowns of Seattle, Bellevue, and Tacoma.

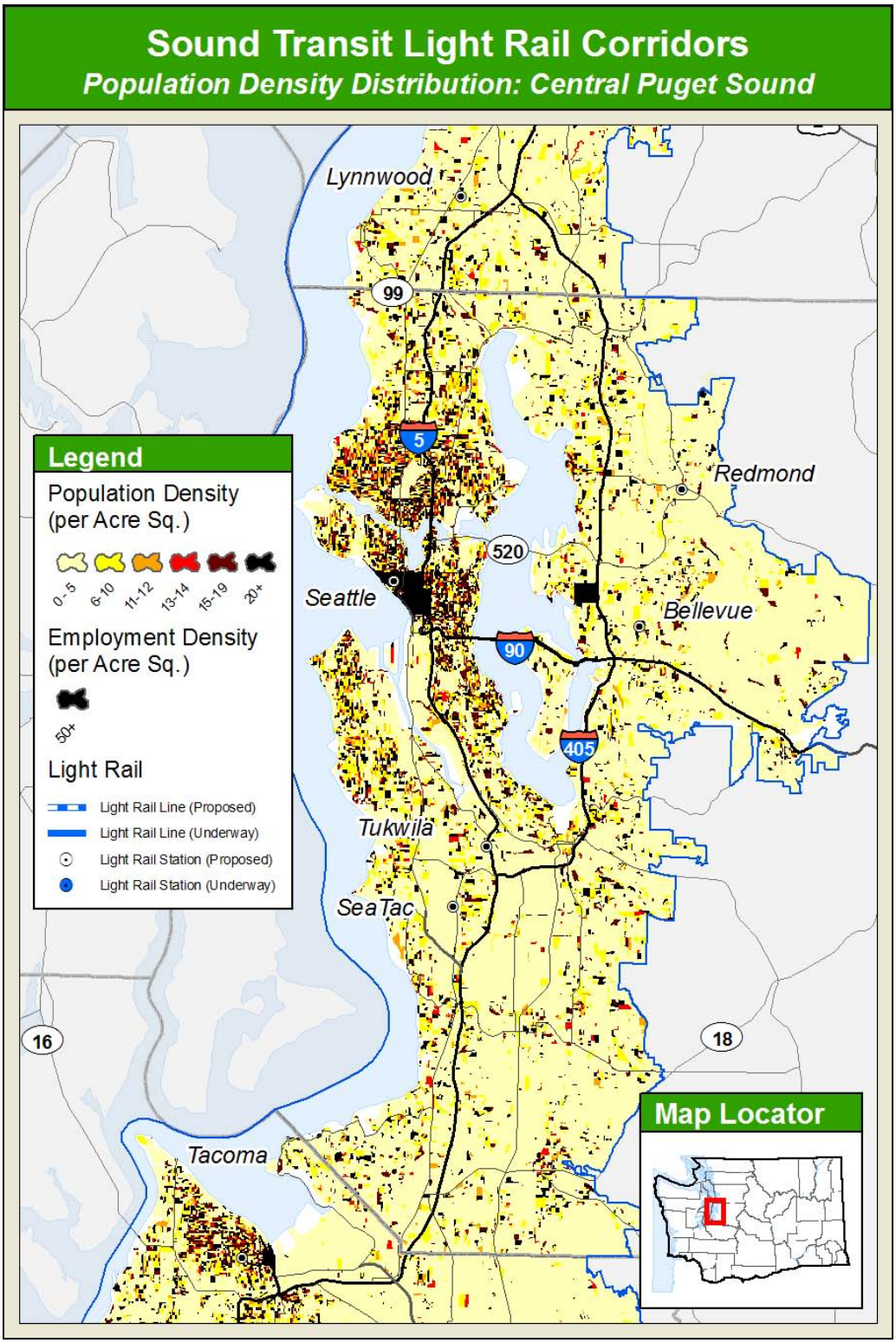


Figure 9: Residential and Employment Density in the Sound Transit District; Phase 1 of Light-Rail
Phase 1 of the light-rail runs through the highest density areas of Seattle and Tacoma.

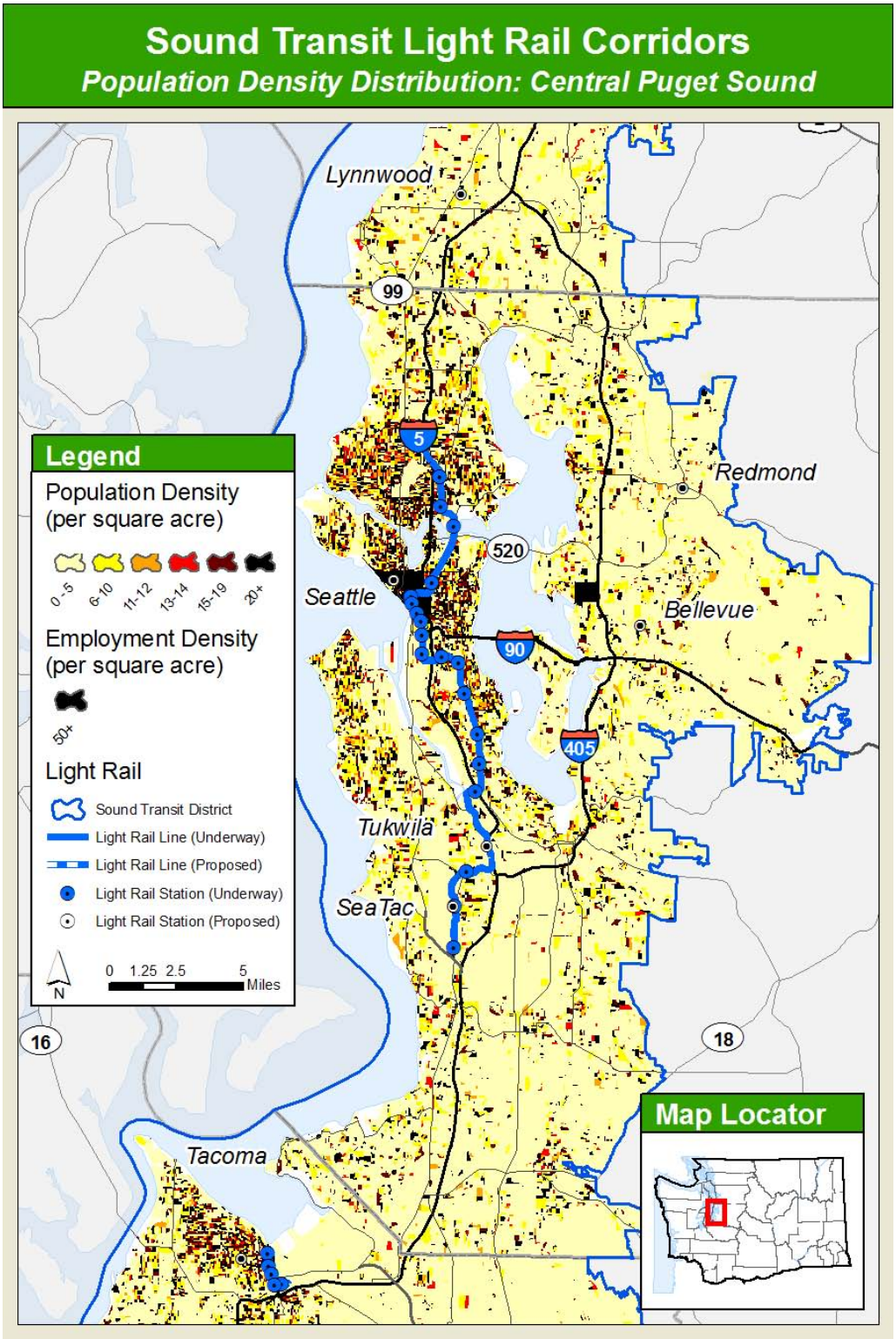
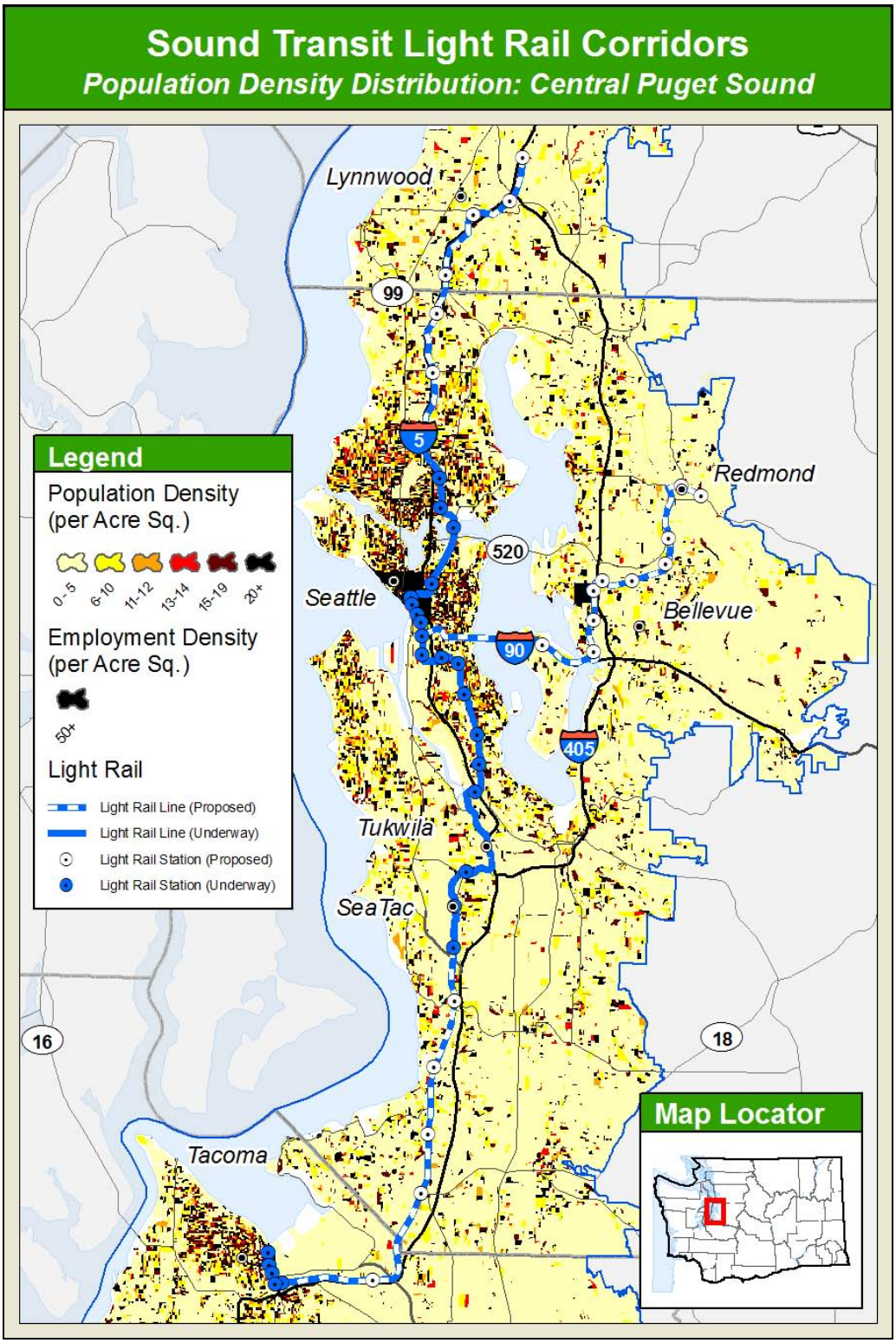


Figure 10: Residential and Employment Density in the Sound Transit District; Phase 1 and 2 of light-rail
Phase 2 of the light-rail goes through many areas that do not meet the requisite population to support density, particularly east of Seattle.



Chapter 4: OTHER CITIES WITH SUCCESSFUL MASS TRANSIT SYSTEMS

Around the country and around the world are cities that have been successful to one degree or another at implementing mass transit systems. Transit system success can typically be attributed to a number of factors including regional policies to encourage residential and commercial growth along transit corridors and in urban centers, local policies to support development around transit stations, the proper selection of transit station sites with market opportunities for development, high-quality transit service, and political support and commitment to the multimodal planning process.

Toronto, Canada

The mass transit system in Toronto is considered one of the best in North America, which is generally attributed to large investments in public transit and effective means of managing growth. The transit system has successfully expanded transit service and ridership and appears to have a major impact on land use. Transit ridership is high, resulting in close to an 80 percent recovery of operating costs .

Dense, Transit-Oriented Development

The central city is dense, livable, and pedestrian-oriented. Neighborhoods near transit centers experience faster growth, higher densities, and higher land values. In the mid-twentieth century Toronto expanded its subway system while other cities were building expressways . At that time the city also marketed air rights and available land parcels near subway stations and designed stations to accommodate developers who wanted access for office and retail space as well as apartments. The city adjusted floor area ratios and other regulations to allow higher intensity development in areas served by transit.

Regional Governance

In 1953 Toronto established a regional government, the Municipality of Metropolitan Toronto, or Metro . Metro is governed by an elected council and has centralized land use and transportation decision-making powers. The six municipalities under its jurisdiction must adhere to Metro's regional plan, which seeks to create an urban structure that can

accommodate future growth and change while minimizing adverse social and environmental impacts. The local municipalities have control over the building-permit process, but Metro must approve all developments. Metro also provides all major public services including fire, police, sewer, mass transit, and roads .

Multiple City Centers

To achieve the goals of its regional plan, Metro has identified 86 sub-centers in which development is to be concentrated. Municipal governments are required to develop plans that coordinate public services to promote and reinforce concentrations of development in these areas. The regional plan focuses on the capacity of the transportation system, with an emphasis on transit. Once this has been established, Metro addresses employment and population levels for each center. The plan also attempts to match the number and types of jobs with similar number and types of housing within centers .

Taxation

Metro has also made a number of financial decisions that have used transit as a strategic tool to lead land development. In 1964 Metro obtained public approval for a referendum to earmark a specified component of realty taxes for rapid transit construction and in 1972 altered funding and subsidy programs to favor public transit over roads .

These efforts appear to have contributed measurably to the high-density corridors and nodal concentrations of employment and population. Toronto is one of few cities that can claim to have plausibly influenced high-density corridors and nodal concentrations of employment and population by implementing comprehensive growth management strategies over a long period of time.

San Diego, California

Regional Governance

A Regional Growth Management Strategy was developed by the region's cities and approved by the San Diego Association of Governments (SANDAG). It calls for increased development in "transit focused areas" and decreased development in areas not served by transit . SANDAG has taken a number of steps toward implementing the growth strategy including a 2020 region-wide growth forecast, public outreach efforts, providing funding for transit-oriented development, and promoting fiscal reform in local governments.

The Metropolitan Transit Development Board (MTDB) is the agency responsible for coordinating the bulk of metropolitan San Diego's transit service, including the light-rail transit system, the San Diego Trolley. A key element of the Board's approach has been incorporating joint development projects that benefit the transit system as well as the communities in which they are located. Benefits of the system are measured through increased ridership potential and generation of an income stream. MTDB has capitalized on development opportunities that arose from market forces, political leadership and private investment, rather than planning development for light-rail station areas, as many transit agencies do.

Joint Development

Joint development involves the use of property for more than one purpose, including surface and airspace development, at a transit station right-of-way or on another property owned or under the control of the MTD Board of Directors . A joint development may consist of any use that is compatible with public transportation use. Benefits include the integration of transit into developments to meet community needs, promotion and enhancement of public transit, recovery of public capital costs and increase of return on public investment, and enhancement of the transportation corridor . The underlying philosophy behind MTDB's approach to land use integration is a belief that transit can help create livable neighborhoods and that livable neighborhoods support transit.

Portland, Oregon

The Portland metropolitan area is nationally recognized for its efforts to decrease urban

sprawl through effective land use planning policies. An organized approach toward integrating transit, parking and development has contributed to the revitalization of downtown Portland, now replete with green spaces, free light-rail service in some areas, and a transit mall downtown with covered transit stops, trip-planning kiosks and gardens. Portland serves as a good example for Seattle to draw from, due to similarities in the political culture.

Regional Governance

The area has the only elected regional government in the United States, Metro, whose goal is to ensure the compatibility of land use and transportation plans throughout the Portland metropolitan area (Seattle Department of Transportation 2007). A key component of this is that Metro can require municipalities to accept development they might otherwise choose to exclude if it is deemed that such development is consistent with the regional plan. This has resulted in significant increases in density in new development and a quadrupling of land zoned for multifamily housing, to more than 25 percent of buildable acreage .

Urban Growth Boundary

In 1973 the Oregon state legislature enacted a set of land use planning laws, which emphasize multimodal planning and require local jurisdictions to incorporate walking, bicycling, and transit use. Of chief importance was the requirement that each city or metropolitan area must have an urban growth boundary (UGB) separating urban land from rural land, the purpose of which is to control urban expansion onto farm and forest lands. The planning process for Portland's urban growth boundary began in 1977 and was approved in 1980. Since its inception the boundary has moved about three dozen times with all but three of those moves being small, about 20 acres or less. The current boundary encompasses about 400 square miles and, as of February 2000, about 1.3 million people lived within the UGB.

Oregon's planning approach reduces property rights of the property owner outside of its urban growth boundaries, and increases owners' property rights within the UGB boundaries. As a result, development and rezoning proposals to build higher-density

housing and mixed-use development in the Portland metropolitan area take significantly less time to work their way through the system than such proposals would in most other US cities. Land inside the boundary supports urban services such as roads, water and sewer systems, parks, and schools. The UGB promotes efficient uses of land, public facilities and services inside the boundary. It encourages development and re-development of land and buildings in the urban core and provides assurance for business and local government about where to place infrastructure services needed for future development. Additionally, efficiencies are created in the construction of infrastructure and services. Instead of building roads further and further out, money can be spent to make existing roads, transit services and other services more efficient. State law requires Metro to have a 20-year supply of land for future residential development inside the boundary. The boundary is reassessed every five years and expanded if necessary based on a review of land supply .

Between 1980 and 1994 the metropolitan population grew by 25 percent but the urbanized area increased by only 16 percent. Average new lot sizes in 1998 were 6,200 square feet, less than half the size of new lots in 1978. Some of this effect would have occurred regardless: other cities along the West Coast of the United States became denser over this period of time as well. To the extent that this effect was associated with Metro's planning policies it was likely due to a combination of the presence of the boundary itself and the relaxation of the restrictions within it .

In 1995 Metro adopted the Region 2040 Growth Concept, a process to evaluate different growth management strategies with a transit emphasis. Region 2040 focuses largely on increasing density along major transportation and light-rail corridors as a way of avoiding sprawl into farmlands (Oregon, 2007). The plan identifies regional centers, town centers, station communities, main streets, corridors, urban reserves and an urban growth boundary. It also includes targets for population distribution among the centers (Transportation 2007).

Region 2040 has been strongly influenced by a planning analysis which was spearheaded by the land use watchdog group 1000 Friends of Oregon. One of the chief goals of the

analysis known as the Land use Transportation Air Quality (LUTRAQ) is the reduction of the use of single-occupancy vehicles. At its core is growth management based on neotraditional design, supplemented with various degrees of reliance on transportation demand management, including transportation pricing (Dueker 1999).

Regional Transportation Plan

In addition to managing the UGB, Metro develops the Regional Transportation Plan (RTP). The plan is updated every four years and dictates the direction for regional investments in a variety of transportation options including roads, light-rail, freight, transit, pedestrian access and bicycles. Transportation projects must be in the RTP in order to receive federal and some state funding .

Pro-active Light-rail Station Area Planning

In 1980, six years before the start of light-rail service, Tri-met, Metro, the City of Portland, the City of Gresham, and Multnomah County began their Transit Station Area Planning Program, the first of its kind in the United States. In 1984 the City of Portland adopted a transit station area planning ordinance (Seattle Department of Transportation 2007). The goal was to build support for transit-oriented development along light-rail corridors and to promote opportunities that would increase ridership. The program includes market studies, coordination with regional planning efforts, station area plans and design guidelines. Tri-met has worked in cooperation with local government to ensure that zoning around the light-rail supports transit-oriented development.

In accordance with Metro's 2040 Growth Concept, the City of Portland works with the community to find solutions for improving the development of MAX light-rail stations as transit-oriented communities. The comprehensive planning process works with the needs of the surrounding community to address zoning, transportation, urban design, and development. The goal is for station areas to provide places to work, shop and live close to transit. Overly restrictive strategies result in a lack of transit-oriented development. Tri-Met and municipalities have initiated public-private partnerships for the development of master plans in the communities surrounding station areas.

Parking

Parking is used as a land use strategy to enhance transit use as well as a pricing strategy to reduce automobile driving. In 1970 the "parking lid" was put in place, limiting the supply of parking in downtown with the objective of revitalizing the area and reducing congestion . The number of parking spaces permitted in new buildings is limited and less parking is available closer to MAX (Seattle Department of Transportation 2007). The city has also adopted a policy of discouraging the construction of large parking garages and surface parking lots by imposing conditional use permits and by requiring periodic reviews .

Zoning

Municipalities rezoned lands around many station areas for higher density land uses and transit-oriented development, and some adopted temporary development controls to prevent undesirable land uses. Zoning changes have included restrictions on street configuration, parking ratios, sidewalk widths, building orientation, and minimum and maximum densities. Some municipalities incorporated these requirements into their municipal zoning codes while others established transit overlay zones around the light-rail lines and stations. (Seattle Department of Transportation 2007)

Public facilities including the Rose Garden sports arena and the Oregon Convention Center are both located at Max stations. Tri-Met has tried with limited success engaging in joint development of right-of-way parcels in combination with private property. Portland zoned for higher densities and transit-oriented development but then established interim development standards to prevent development of undesirable land uses before station area plans were completed (Seattle Department of Transportation 2007).

Taxation

Local Improvement Districts focus on improvements for pedestrians, bicyclists and transit users. They generate tax funds to be used for pedestrian walkways, plantings, bike racks and public art. Transit station development guidelines also include requirements for the pedestrian environment including the notion that buildings must locate their front door on the main street and they are required to provide pedestrian amenities in station areas. Tri-Met also established a public art program aimed at making new station areas

more attractive (Seattle Department of Transportation 2007).

Chapter 5: SOUND TRANSIT IN THE PUGET SOUND REGION

Growth in Central Puget Sound

Significant growth in employment has helped to facilitate growth in Central Puget Sound. Between 1965 and 1990 Puget Sound employment grew on average 1.4% faster than average national employment, the bulk of which has been largely attributed to expansions by the Boeing Corporation . Other major players include Weyerhauser in Federal Way, the United States Navy in Everett and Bremerton, the Microsoft Corporation in Redmond, and a variety of other business and professional services clustered in downtown Seattle. The influx of big business has also allowed for spinoffs of new businesses. The location of Central Puget Sound with respect to Pacific Rim trade and major markets in the western United States make it an ideal location for many businesses . Additionally, the University of Washington contributes to the presence of a highly skilled labor force. Other factors that have contributed to making Central Puget Sound a desirable place to live include the aesthetics of the natural environment and general quality of life.

Although the influx of population and businesses has provided an economic boom for the region, it has tended to push growth out to the edges of the metropolitan areas, facilitating rapid suburban development in outlying areas. Rising housing and land prices, particularly for housing proximate to urban centers, tend to exclude most buyers. This in turn has resulted in a rise in traffic congestion and negative effects on the quality of the natural environment, one of the Central Puget Sound region's greatest assets.

Existing Transportation Policies in Central Puget Sound

Growth Management Act

The Washington State Growth Management Act (GMA) was adopted by the state legislature in 1990 in an effort to curb urban sprawl by encouraging development in designated urban growth areas, providing efficient transportation, protecting the environment and otherwise improving the quality of life in Washington. The GMA requires each of Washington's thirty-nine counties to designate and protect critical natural resource areas and farm and forest lands and to ensure that new residential subdivisions

are equipped with the necessary public services and facilities. The twenty-nine fastest growing counties have additional requirements. These counties must agree on county-wide planning policies to guide regional development, identify lands for public purposes such as transportation corridors, establish urban growth areas based on population forecasts, and adopt and implement comprehensive plans. The comprehensive plans must provide for 20 years of growth and be approved by a Regional Transportation Planning Organization (RTPO) .

Regional Transportation Planning

The Puget Sound Regional Council (PSRC) serves as the RTPO for Central Puget Sound, which consists of Snohomish, King, Pierce and Kitsap counties. It is also designated under federal law as the Metropolitan Planning Organization for the four-county area, allowing it to receive federal transportation funds. The Council assists in policy and decision-making about regional growth management and economic and transportation issues and provides planning and advocacy to local and state agencies as well as serving as a center for collection, analysis and dissemination of information .

The PSRC has a joint memorandum of understanding with the seven transit agencies in the region, Sound Transit included, as well as an MOU with the Washington State Department of Transportation . These documents delineate organizational roles for policy and project planning (Sound Transit 2006).

Vision 2020

Vision 2020, implemented in 1990 and updated in 1995, serves as the Central Puget Sound region's integrated long-range growth management strategy. It seeks to promote the development of a coordinated transportation system that is integrated with and supported by the growth management strategy, maintaining a balance of employment, housing and community activities in urban areas, thereby preserving forests and other natural resources. Other goals include creating a more comprehensive network of streets that encourage walking, biking and transit use coupled with the development of a regional high-capacity transit system .

Destination 2030

Destination 2030 updates the region's 1995 Metropolitan Transportation Plan and serves as the transportation element of Vision 2020. The plan is intended to identify and address the region's long-range transportation needs that will arise from increasing growth in the Central Puget Sound region as well as to satisfy federal and state metropolitan planning requirements. It includes both short and long-term activities, encompassing city, county, port and transit agency growth management transportation plans, and the Washington State Department of Transportation's Multimodal and Transportation System plans.

Link Light-rail in the Puget Sound Region

An integral part of the Destination 2030 plan is Sound Transit's regional high-capacity transit system. Sound Transit is the Central Puget Sound's Regional Transit Authority. Formed in 1993 by Snohomish, King, and Pierce County Councils, it operates in cooperation with Community Transit, Metro Transit and Pierce Transit. It provides express bus service to all three counties, commuter rail between Everett and Tacoma, light-rail in Tacoma, and is spearheading the effort to implement light-rail in the remainder of Central Puget Sound.

Phase I (Sound Move)

The first phase of Sound Transit's Ten-Year Regional Transit System Plan, commonly referred to as the Sound Move, represents a mix of transit technologies (bus, commuter rail, light-rail) that are used based on needs of specific corridors . In 2003 a 1.6-mile link light-rail line opened between the Tacoma Dome Station and the Theater District in downtown Tacoma. The line offers free rides and connects to a regional transportation center that includes service on the Sounder commuter train as well as local and regional buses . Commuter rail runs between Everett and Tacoma.

Construction began in November 2003 on the initial 14-mile segment of light-rail in the Seattle area. This segment will extend from the Westlake Station in downtown Seattle to the Tukwila/International Boulevard Station just north of the Seattle-Tacoma International Airport, stopping at twelve stations in Seattle's SODO industrial area, Beacon Hill and Rainier Valley. The line is expected to open in 2009 with trains leaving

every six minutes during rush hour and every ten to fifteen minutes during midday and evening hours. By 2020 Sound Transit estimates this segment will carry almost 43,000 riders daily. A 1.7-mile extension from Tukwila to Sea-Tac airport has also been approved. Service on this segment of the line is scheduled to begin in late 2009. Phase I plans to extend the line north to Capitol Hill and the University District are in the works. The estimated cost for the initial 14-mile segment is $2.4 billion (based on year-of-expenditure dollars). Funding for link light-rail comes from local taxes (0.3% motor vehicle excise tax and a 0.4% retail sales tax), federal grants, bonding, and, once operation begins, fares from riders .

Phase 2 (Sound Transit 2)

On January 11, 2007, the Sound Transit Board adopted a draft package known as Sound Transit 2 that will be voted on by residents of King, Pierce and Snohomish counties in November 2007. It is the transit half of a Roads and Transit pair of initiatives that would create an integrated set of highway, bridge, and transit improvements in Snohomish, King and Pierce counties. Both initiatives must pass in order for either to take effect. The new transit effort would build on Sound Transit's current light-rail, commuter rail and regional bus system between 2008 and 2027. It includes 40 miles of light-rail and would extend the existing light-rail north from the University District to Lynwood, south from Sea-Tac to the Port of Tacoma, and east through Bellevue to the Overlake Transit Center. Sound Transit estimates that these investments would expand daily regional transit ridership to more than 350,000 by 2030. Between 2008 and 2027 the total program costs would be funded by an estimated $7.4 billion (2006 dollars) in new tax collection from a five-tenths of one percent sales tax increase (about $125 annually per household, in 2007 dollars), in addition to existing taxes and bonding .

Land Use in Central Puget Sound

Density

According to Puget Sound Regional Council, over 70% of the growth in the region up to 2030 is forecasted to be located within urban growth areas but outside currently designated urban centers. In order to promote development in designated urban centers and high-capacity transit station areas, PSRC is considering a variety of tools including regulatory reforms, financial incentives and development strategies that would allow

local planning to focus on growth but also support compact communities. These tools include streamlining and expediting the permitting process for development in these areas, allowing for the transfer of development rights that would permit rural or open space land owners to sell their right to build to landowners in urban areas, and inter-local agreements or memorandums of understanding between jurisdictions that delineate how to address mutually agreed-upon topics such as capacity and design standards. Also under consideration are financial incentives such as tax breaks for mixed-use development in targeted locations, tax abatement for multi-family housing (to encourage multi-family housing by removing property tax for a period of time), and location efficient mortgages (to provide consumers with higher mortgages based on potential lower automobile use arising from living in a dense area with transit service). Finding revenues to provide the necessary services and infrastructure to serve new development remains a missing link in growth management planning. Revenue sharing, which would allow communities to contribute a percentage of taxes to a regional pool for community projects and local goals that coincide with supporting a high-capacity transit infrastructure have been suggested .

Design

Part of the purpose of Destination 2030 was to provide more specifics on the relationship between land use and transportation planning than was addressed in Vision 2020. Analysis of urban form and basic infrastructure in urban centers in the region suggests that many areas are not well suited currently to the successful adoption and performance of both local and metropolitan transportation systems. Research has shown that block sizes within much of the region's urban growth area are often large and more suited to cars than pedestrians. Many residential and commercial areas lack physical connections, and high fences surrounding properties block direct transit routes .

Puget Sound Regional Council encourages local jurisdictions to use incentives as a means of recognizing areas that are incorporating compact development and pedestrian and transit-oriented development . PSRC has established design guidelines that can be included in site planning and development in designated urban centers and high-capacity transit station areas. The guidelines involve encouraging a mix of complementary land

uses, particularly uses that generate pedestrian activity and transit ridership, and encouraging compact growth by addressing planned density. The Council promotes elements that design for pedestrians and bicyclists by linking neighborhoods and integrating activity areas with surrounding neighborhoods, in addition to connecting streets, sidewalks, and trails. Public and semi-public uses near high-capacity transit stations in designated urban centers and activity centers are encouraged.

Seattle

Between 1998 and 2001 the Seattle Department of Transportation's Strategic Planning Office partnered with Sound Transit on planning and development work for the 1/4 –mile area around proposed light-rail stations. The city commissioned a report to identify needs and considerations for transit-oriented development in these areas. The report includes case studies of transit-oriented development in other cities and a review of existing conditions in Seattle's potential station areas including current market conditions, and neighborhood plan reviews. Also addressed are the perspectives of stakeholders, the city council, and the development community on potential development strategies for station areas (Seattle Department of Transportation 2007).

Planning for specific station areas has been built on the city's comprehensive plan, adopted in 1994, which required thirty-eight Seattle neighborhoods to develop twenty-year plans. Based on the neighborhood plans, the City Council adopted 10 station area concept-level recommendation packages in September 2000. In July 2001 the council passed station area overlay legislation to establish station area overlay districts and rezones around eight future light-rail stations with the goal of providing flexibility for current businesses, allowing new development and prohibiting certain automobile-oriented land uses near stations. The city also co-sponsored three regional transit-oriented (TOD) forums in partnership with King County, Sound Transit, and Puget Sound Regional Council .

Bellevue

Bellevue is the second largest city in King County, and is now considered a major regional employment hub. An overhaul of the city's 1981 master plan has incorporated

planning efforts aimed at developing a more transit-oriented downtown with a pedestrian friendly environment. Previously uncapped parking policies have been amended with minimums and maximums declining over a 10-year period. The Floor-Area Ratio (FAR) Amenity Incentive Program allows developers to increase building densities by 10 to 25 percent in return for providing public amenities, a technique that has been widely used throughout Bellevue .

In 1999 Bellevue adopted a Regional Transportation Vision in an effort to create a policy framework by which to advocate for comprehensive, multimodal regional transportation solutions that would help to support the city's economic and land use visions. In July 2006, the Bellevue City Council joined Kirkland, Redmond and Issaquah in recommending to the Sound Transit Board that light-rail is preferable to bus as a form of high-capacity transit between the Eastside and downtown Seattle. In December 2006, the city council requested Sound Transit reject a number of proposed rail alignments and station locations based on urban design and noise issues and environmental concerns (Degginger 2006).

Chapter 6: CONCLUSIONS AND RECOMMENDATIONS

From an environmental perspective, continued sprawl in central Puget Sound is not an option. The Puget Sound region does, however, have many options for combating sprawl.

Regional, integrated planning approach

A regional, integrated planning approach that incorporates reforms to land use, transportation and taxation is essential to making mass transit feasible in the Puget Sound region. Although the Puget Sound Regional Council is designated as the regional governing body, it does not have the authority necessary to implement the land use controls that have been successful in the cities described in Chapter 4.

The region needs to shift from enacting programs at the local level to doing so region-wide. Historically, much of the literature regarding growth management has focused on programs enacted at the local level ; however growth management issues do not confine themselves to municipal boundaries. As is evidenced by cities like Toronto, San Diego, and Portland, controls addressing the rate and location of growth at the regional level tend to be much more effective. The effects of local growth management programs are often seen at the regional level.

Development tends to decentralize away from jurisdictions with rigorous development controls and towards outlying jurisdictions that accept and even encourage new development. A set of transportation investments designed to encourage centralized development in one or a few regions may actually have the opposite effect. Unintended consequences include higher prices for housing and land that is subject to growth management regulations, and the displacement of economic growth to adjacent jurisdictions due in part to caps on commercial development and the subsequent effect on commercial rent . Rapid residential growth can result in higher taxes to pay for necessary services and infrastructure and commercial growth can lead to traffic congestion and related needs for road improvements .

A program of regional tax-base sharing can alter the distribution of economic activity as a result of changing the dependence of certain jurisdictions on property tax revenues. A policy of urban and regional containment could affect both the price and supply of land for a variety of development purposes, and could affect the mix of uses occurring within the region. Transferrable development rights may furnish excellent price incentives to the market place. Ordinances that require adequate public facilities prior to development would affect the timing and cost of future development .

Land Use Policies

Regional governments in the United States tend to lack control over land use and instead are organized around providing public services such as sanitation, water, parks, highways, airports, and public transit. This does not have to mean, however, that regional governments are incapable of influencing land use. Incentive-based policies can help to convey a regional interest in local land use, moving municipalities toward reducing regulations that exclude transit-oriented development. The Georgia Regional Transportation Authority, for example, is permitted to withhold funds from non-cooperative local governments . In other cases metropolitan transit organizations condition transit extensions on transit-friendly land use planning, as the Bay Area Rapid Transit (BART) District has begun to do. Bay area communities opting for low-density zoning find their priority for BART extensions reduced under this policy; those committing to transit-oriented development in station areas become better candidates . Incentives can also come in the form of payments to communities. The Metropolitan Transportation Commission in the San Francisco Bay Area offers payments to local governments building housing near transit stops .

Some regional governments have systems in place to deny projects but few have systems in place to require municipalities to accept development. Both the Twin Cities Metropolitan Council in Minneapolis-St. Paul and the Georgia Regional Transportation Authority have the power to deny certain projects that are inconsistent with regional environmental quality and transportation goals .

Redesigning the region's residential and commercial height, bulk and setback

requirements, its restrictive building and housing codes and residential zoning, and its mixed-use restrictions throughout Vision 2020's hierarchy of central places to serve the centering goal would signal the region's real estate developers, architects, engineers and developers to favor high-density over low-density development. This could also facilitate the job-generation forces and, at the same time, help concentrate growth .

If it is the case that municipal zoning, as it is typically utilized across the United States, creates metropolitan areas that are more spread out than they would be in the absence of such regulation, then it is feasible that land development markets are capable of producing more compact development than is generally observed .

Internalizing the Cost of Automobile Transportation

In considering how to best focus growth many look first to land use or transportation planning. Although they are a key part of the equation these factors alone will not solve the problem. The success of growth management plans depends also on the effectiveness of the region's underlying regulatory, pricing, taxing and expenditure practices. For example, shifting the incidence of property tax from improvements (i.e. structures) to land would encourage residential or nonresidential development to save on land, thus discouraging sprawl .

One of the difficulties with public transit is the fact that costs and benefits are not reflected in market valuations. When a commuter decides whether to drive or take public transit, the cost of the additional pollution created by driving will not be suffered by the individual commuter but instead will be spread over large numbers of people who breathe the marginally more polluted air. If the commuter decides to not drive they will receive only a small portion of the environmental benefit. While communities need to be responsible for some level of community public works improvements, a tax levied on the public at large may not be as useful as fees or charges for those using a given service. Developers need to be responsible for the demands their new projects impose on infrastructure. Methods by which commuters could be encouraged to take public transit in lieu of driving include toll roads, parking fees, shifting subsidies to mass transit, lower-cost mass transit during peak house, and credits or tax breaks to individuals or employers

for the use of mass transit.

Infrastructure Considerations

A major issue in the affordability of housing is the ability to afford adequate housing proximate to one's work and non-work destinations, an issue that incorporates the transportation and land use problem. Affordability is measured not by housing costs alone but by the combination of housing and transportation costs, along with the costs of inaccessibility of a particular residential location. In areas where municipal regulatory policies serve to impede a resident's ability to get what they prefer in terms of transportation and land use, or prevent low- to moderate-income households from finding affordable housing close to their work an non-work destinations, their reform becomes a central concern of transportation policy. Additionally, attention to the quality of primary and secondary schools is significant. People will live in areas with good schools, which in turn has an effect on housing and transportation.

The Micro Level

People's attitudes towards growth and their environment in general result from their routine interaction with the land directly around them. The way a building relates to the street or the amount of green space they experience daily dramatically affects residents' satisfaction with the built environment. Planners need to pay attention to these fine details, considering residents' daily experience of their immediate surroundings, if they are to address the kinds of fundamental dissatisfactions that are behind today's public pressure for land use regulations. Portland's use of transit-oriented development does just this.

Marketing / Automobile Culture

Providing quality transit service is not a simple task. As with any other service, transit must be marketed and sold to the public, a factor that is particularly important given the automobile culture of the United States. Transit service must be made attractive to the public from one end of the trip to the other. Maximizing the attractiveness of transit service requires cooperation between local, regional and state governments, private developers, and the community.

The Effect of Rail Transit on Surrounding Areas

Property Values

The presence of an established rail system tends to contribute to higher property values and rents for residential and commercial properties near station areas . In a study of Portland, being within walking distance from a light-rail station resulted in a rent premium of 10.6 percent . Residential property value benefits typically occur in desirable neighborhoods where light-rail systems and stations are well developed and well integrated into the pattern of development. The impact of rail on property values is typically seen earlier for commercial properties than for residential properties – often in advance of construction . This may be due to developers' perceptions of market preferences.

The most significant impacts are seen in areas where rail provides greater accessibility via fast, reliable, and frequent service to riders in large catchment areas. The effect on property values is diminished where rail systems operate at slower speeds and serve a limited number of destinations or are located in areas less oriented to transit. If it is to induce an increase in property values transit must have support of both the public and private sectors and be well planned and integrated into existing metropolitan areas .

Intensity of Development

Studies of major rail systems suggest that rail transit impacts the intensity of development along the transit corridor and around the station areas but the increased accessibility the system provides is only one of a number of factors that influence land development. Supply of land to be developed, local values and preferences, existing zoning ordinances and other public policies may discourage development.

The impact of rail on land use is most significant in very accessible, non-residential areas. In these areas, rail can dramatically increase accessibility and provide locations for office development with integrated transit service. The area impacted by rail transit is close to the station – typically ¼ of a mile. In station areas surrounded primarily by residential properties, rail transit does not have as significant an effect on development. This may be due in part to residents' resistance to zoning changes that would allow for commercial growth .

Station area development appears to have a positive effect on both CBDs and subregional centers. Large, well-developed rail systems allowed growth in the CBDs of Boston, Philadelphia, and Washington D.C. that would otherwise not have been possible given the number of workers who need to be transported each day. These cities have also seen successful employment centers served by transit spring up outside of the CBD. This may be good news for the United States given the realities caused by urban sprawl .

Governments can help to encourage station area development via zoning regulations and infrastructure improvements. Major investments in rail transit and related infrastructure often accelerate development in station areas. Rail provides developers with increased accessibility and a permanent fixture.

So… Will They Come?

Sound Transit and the other transit entities in central Puget Sound have a long road ahead of them but it is by no means impassible. Many of the issues facing the region have been encountered and overcome by other regions; hence, there are numerous lessons and examples to draw from. Prior to the establishment of the Tri-County Metropolitan

Transportation District of Oregon (Tri-Met) in the late 1960s, Portland's transit ridership was in decline with the city's primary transit agency, Rose City Transit, facing bankruptcy and threatening to increase fares (Tri-County Metropolitan Transportation District of Oregon 2007). Now, Portland is one of the premier examples of successful public transit in the US.

The central Puget Sound region will need to shift from imposing transit and land use controls at the local level to doing so regionally. The seven different transit agencies within the Sound Transit District will need to ensure coordination between the location and schedule for the light-rail and that of the bus systems if the light-rail is to be successful. Puget Sound Regional Council will need to work with the municipal and county governments to enact land use planning laws and regulations that are supportive of transit.

Some of these shifts have begun to happen. The state legislature expressed the need for transit by pairing the Sound Transit 2 package with the roads package on the November 2007 ballot, the idea being that if the region is to build additional roads and maintain existing roads that it also needs to invest in transit infrastructure. The legislature has also approved significant funding for cleaning up Puget Sound, as described in Chapter 1. Likely one of the biggest and most challenging obstacles to overcome is the car culture that defines the region. Perhaps efforts to make transit convenient, efficient and attractive will by themselves significantly, if slowly, loosen the hold of that culture.

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