WHITE PAPERS AND OTHER BACKGROUND RESEARCH AND RELATED DOCUMENTS PACKET

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OREGON DEPARTMENT OF TRANSPORTATION

OREGON ECONOMIC & DEMOGRAPHIC REGIONS WHITE PAPER

JULY 2020

OREGON DEPARTMENT OF TRANSPORTATION

Oregon Economic & Demographic Regions White Paper

Prepared for:
OREGON DEPARTMENT OF TRANSPORTATION

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July 2020

Contents

EXECUTIVE SUMMARY

This white paper combines the demographic and economic regions evaluation of how these two key factors have and will continue to influence the transportation system use and needs within the State of Oregon. The purposes of this white paper are to define historical and projected drivers that affect demand for transportation in Oregon and Evaluate relative strengths and weaknesses of utilizing future regional versus statewide specific policies.

The results of this white paper are intended to be use for:

1. **Informing how statewide transportation plans,** policies, and strategies may reflect or impact regional economic and demographic contexts;
2. **Recommending potential study regions** for specific policy consideration; and,
3. **Identifying potential themes and scenarios** to be consider during the updates to the 2006 Oregon Transportation Plan (OTP) and 1999 Oregon Highway Plans (OHP).

The white paper includes a summary brochure, executive summary, a main report, and a technical appendix. The summary brochure is intended to inform advisory committee members for the OTP/OHP update of the key findings related to demographic and economic trends and drivers. The executive summary and report provide a deeper understanding of the subjects, and the technical appendix provides a detailed compendium of the information used to support the findings of the white paper.

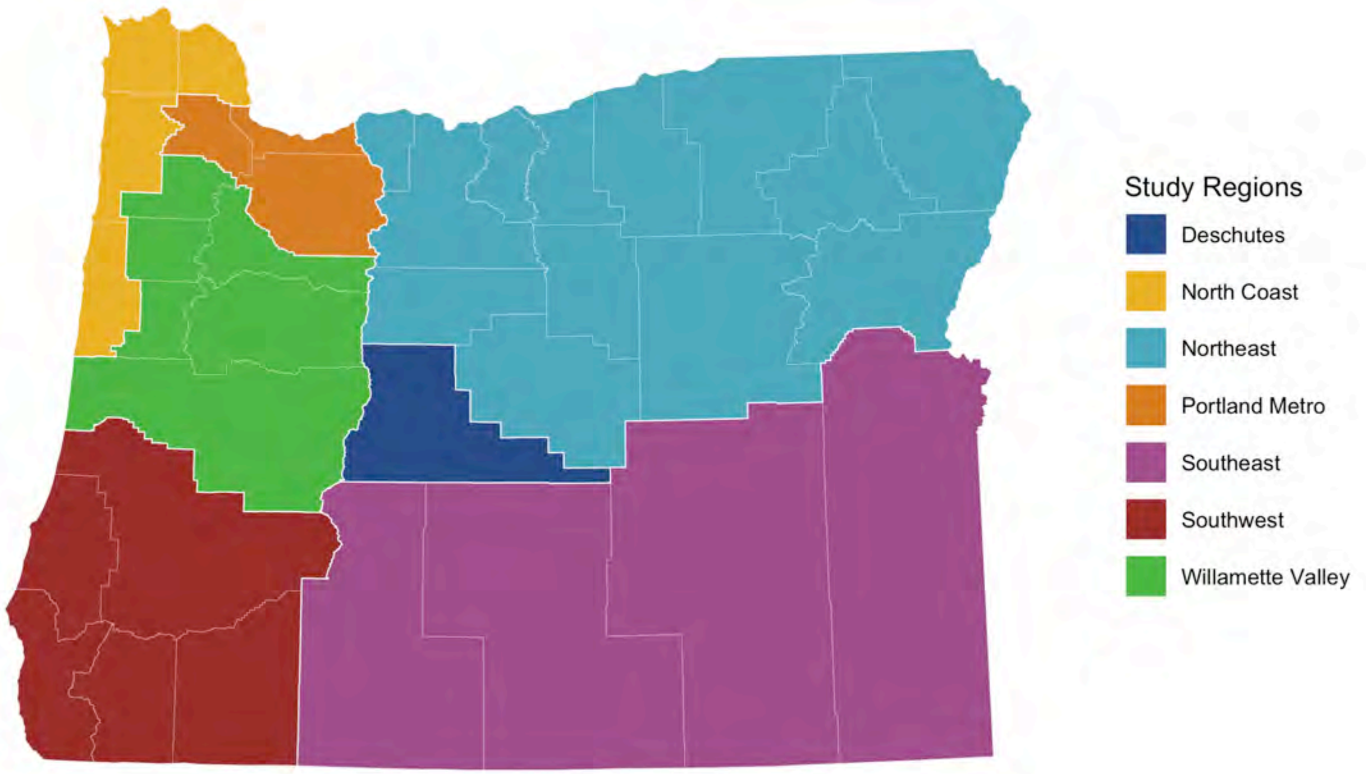
Bringing a regional perspective to Oregon's transportation planning

Oregon is revising its Transportation and Highway plans (OTP/OHP), which are intended to guide the state's future transportation investments. Based on several factors explored during this study, this paper recommends considering a regional approach in the OTP/OHP for the following reasons:

- **Oregon's transportation infrastructure is foundational.** Regional economic health and individual quality of life depend on its function. Oregon's state-owned transportation system connects almost every community in the state. Each of the state's regions have unique challenges based on their population, geography, access, and existing infrastructure.
- **Investment decisions must be made intentionally.** An explicit understanding of the interactivity of the system with other key systems that support societal well-being increase system efficiency. Efficient transportation networks reduce costs to move labor, goods, and services through the network.

Recommended Study Regions

Source: ECONorthwest



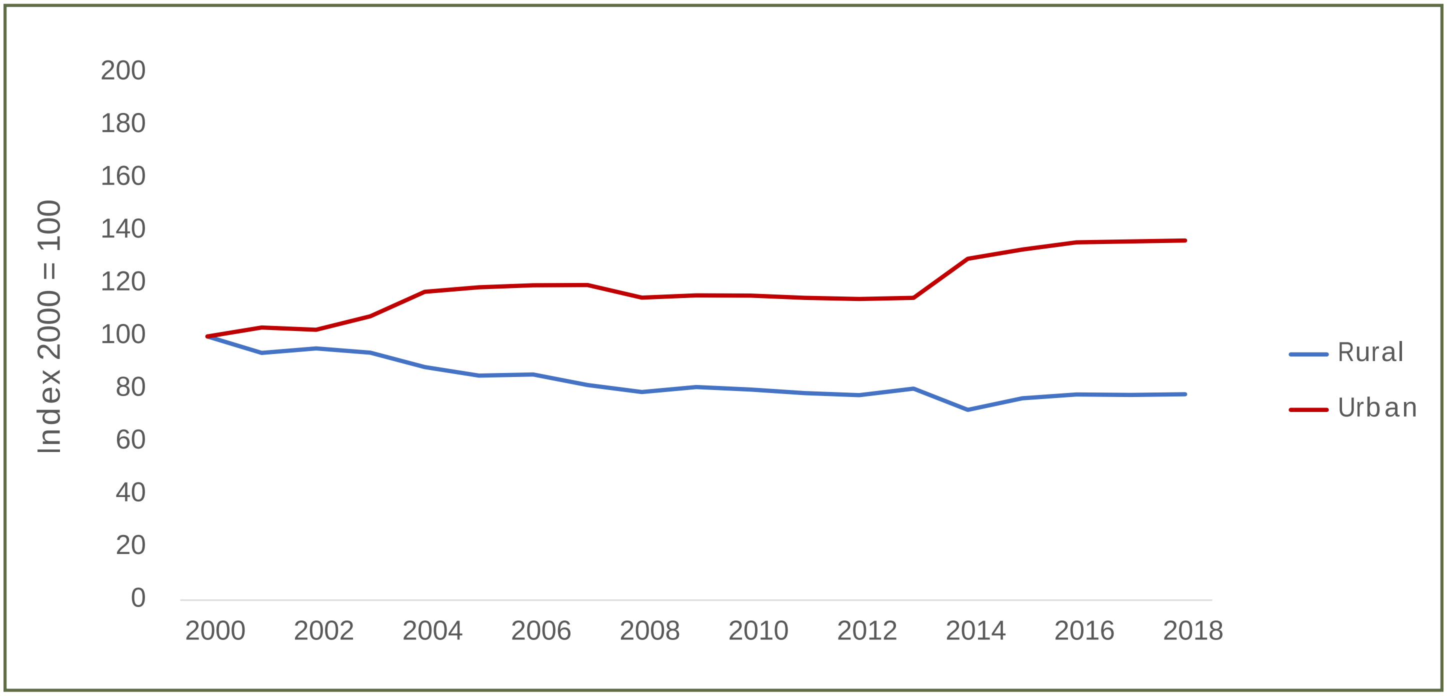
- **Transportation systems are key to local economic development.** Improvements should take into consideration changes in demographic and economic activity in a region that will influence the demand for, and the type of investments needed. Additionally, regional and local planning allows for coordination between public agencies to ensure that unique transport and accessibility needs are accounted for in the planning process.

EMPHASIZING REGIONAL INDICATORS OF TRANSPORTATION DEMAND IN OREGON

Structural drivers

Oregon VMT and GDP growth, 2000 to 2018

Source: Federal Highway Administration, Bureau of Economic Analysis



Transportation demand is integrally related to the growth of the regional economy. Investments in transportation infrastructure are an important input to understand the productivity of a region's economy. However, the relationship between transportation demand and growth in economic activity is complex, and as a result, there is not consensus around the strength or directionality of the relationship. There are four thoughts about the relationship of transportation demand and the economy:

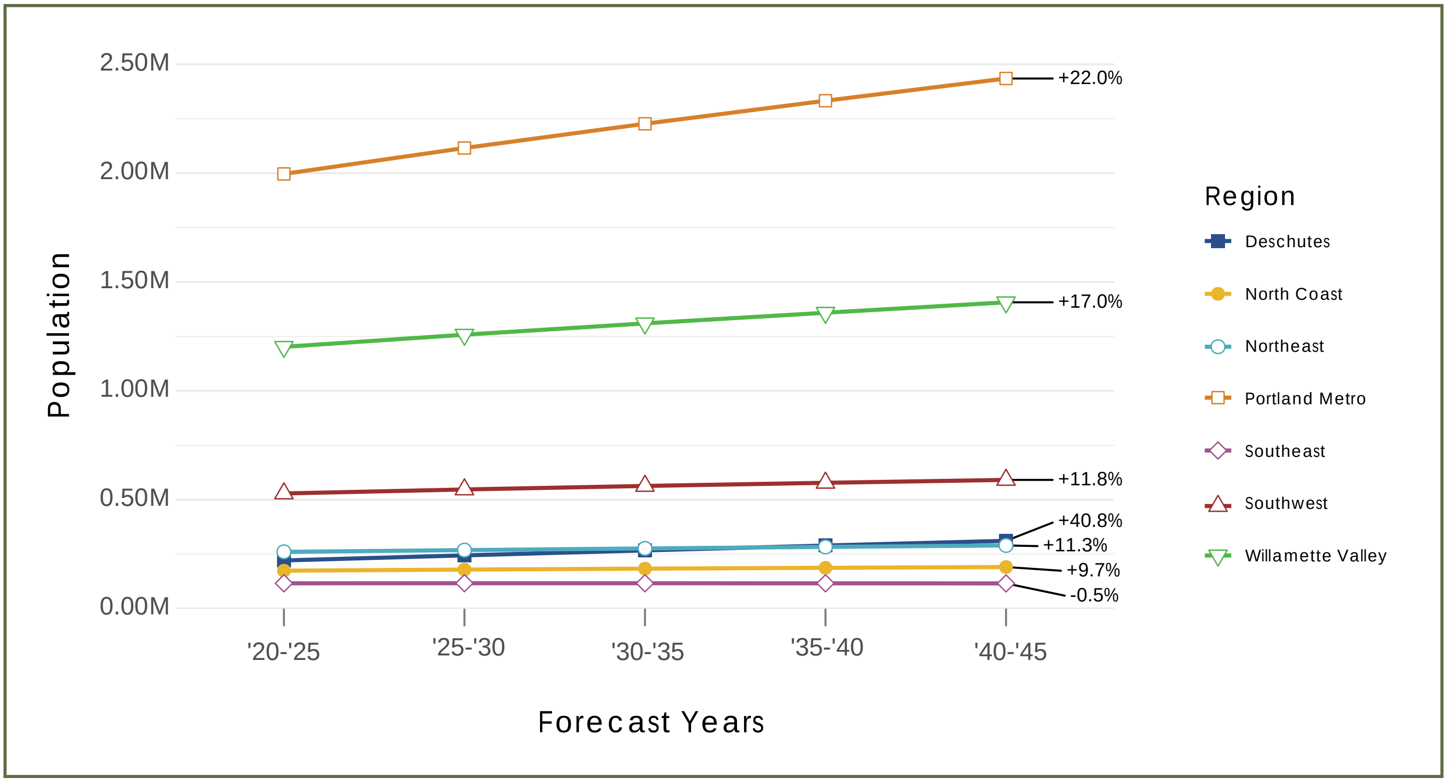
- Changes in transportation demand "cause" changes to economic activity
- Changes in economic activity "cause" changes to transportation demand
- The relationship between transportation demand and economic activity is bidirectional
- There is no direct relationship

Based on the existing literature and our professional experience, we believe the appropriate framework the OTP/OHP is to assume the relationship is bidirectional. That is, transportation demand and economic growth are interrelated. Policies can be nuanced in objectives, for example attempting to meet the goals of reducing transportation demand while benefitting the regional economy.

Population and labor force changes

Forecasted population growth by region 2020 to 2045

Source: Portland State University, Population Research Center.



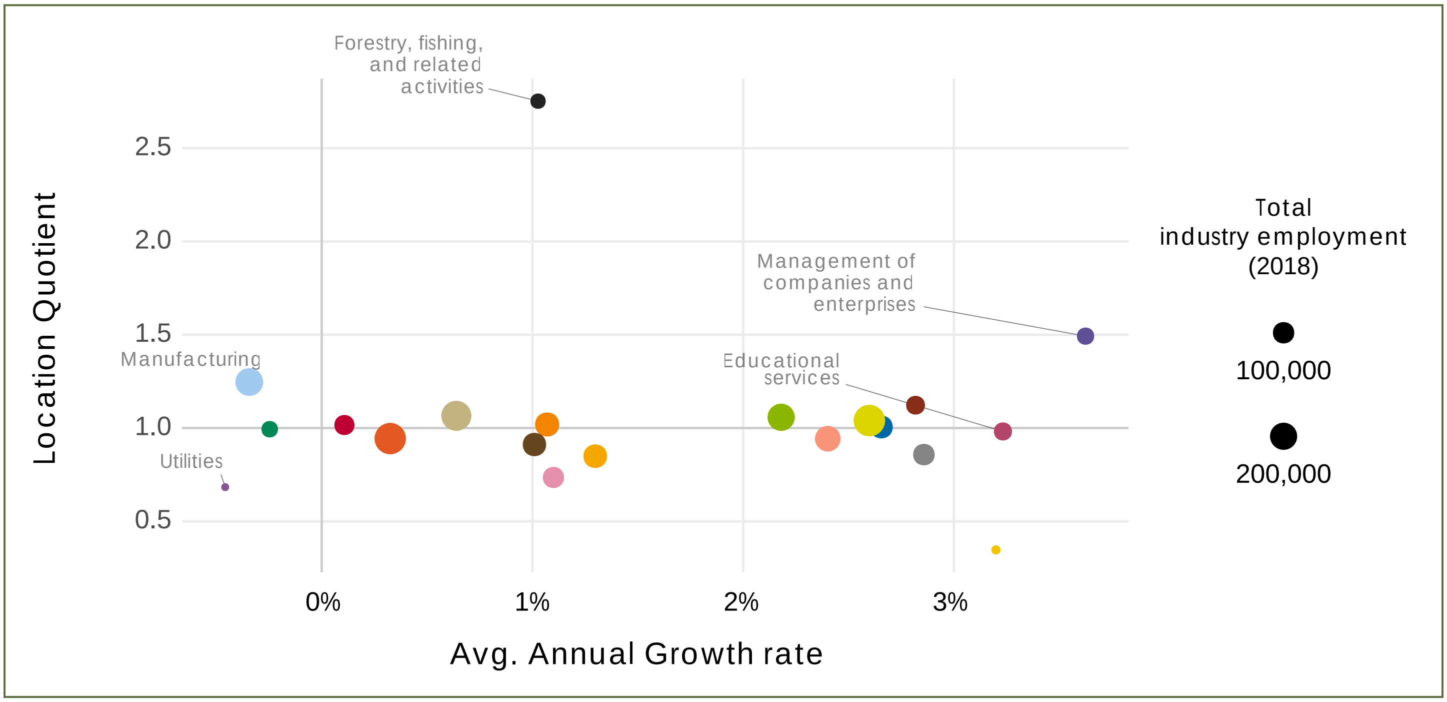
Though there are many important components of demography, this white paper focuses on several key indicators that closely align to regional transportation demand. Population growth, an aging population, and urbanization are the three factors this white paper considered to be most relevant to OTP/OHP planning and scenario development. During this study, we determined that there are several key findings relevant to the upcoming OTP/OHP process:

- Oregon's population has grown rapidly. Since 2000, Oregon's population has increased rapidly, growing by 24 percent (around 815,000). Almost all that growth has been clustered in regions along the I-5 corridor. The State of Oregon projects that another 341,000 individuals (~8 percent) living in the state by 2029, with most of that growth occurring due to in-migration.
- An aging population has implications for regional labor force and mobility needs. Outmigration has left many rural areas of the state with an aging population and slower expected growth in the labor force. This segment of the population will be more reliant on an efficient transportation network to access lifeline services. Additionally, slower growth in the labor force can result in lower income growth and fewer businesses, which contribute to outmigration.
- Urbanization has both benefits and costs for Oregon. Increasing commuting patterns suggest that people are moving to the Portland Metro to take advantage of economic opportunities. The concentration of traffic in the region is increasing congestion levels on the existing infrastructure and decreasing reliability of the network. Additionally, rapid population increases are exacerbating housing affordability issues in the state, which affect congestion as people are forced to commute further from affordable locations.

Changes in Oregon's industrial composition

Industry Concentration and Growth in Oregon, 2010–2018

Source: U.S. Bureau of Economic Analysis

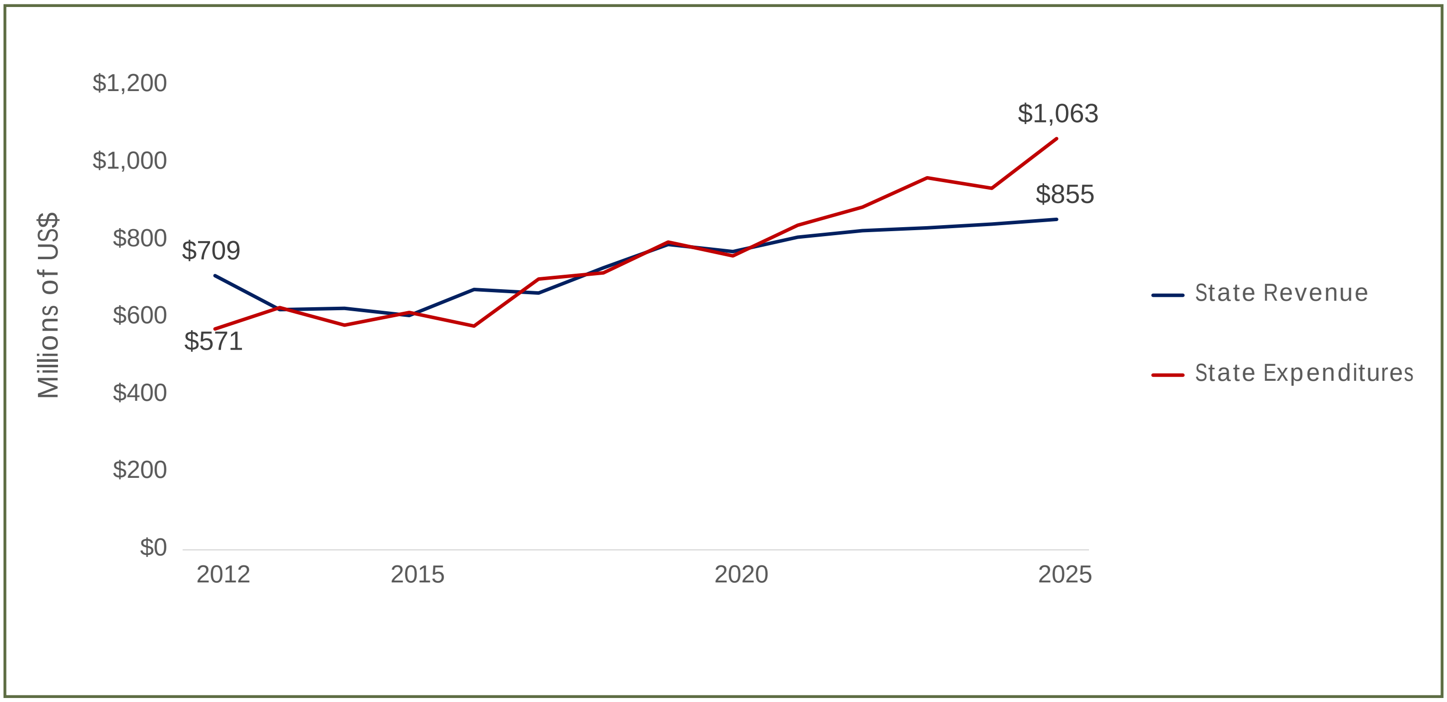


Industry composition is important to understanding how regional economies are changing over time. From a broader lens, change in industrial composition affect how a region's economy will respond to negative shocks or downward swings in the business cycle. Understanding industry mix is also important within the context of OTP/OHP because it will impact the demand for transportation compared to the current system demand statewide. This study found several trends that are relevant for the OTP/OHP:

- Oregon is shifting toward a service-based economy. Oregon's economy has traditionally been reliant on trade-dependent industries including natural resources and manufacturing, which led to wider swings in employment during recessionary and expansionary periods. More recently, Oregon has seen increasing specialization in professional services and technology.
- Oregon's economy is also becoming more diverse. While rural regions of the state face ongoing and future challenges with changing economic conditions that impact the local labor force, the Portland Metro and Central Oregon are becoming increasingly diverse Industrial diversity is important because it helps a region's economy withstand economic shocks.
- Despite these changes, some of Oregon's economic regions face headwinds. The economic shock from the COVID-19 pandemic demonstrates that there are growing the disparities in Oregon's regional economies. Many benefits of economic diversification have accrued to the Portland Metro. Regions around the state that are dependent on natural resources and tourism as primary industries are expected to experience much slower recoveries.

Aligning changing demand with transportation financing

Forecast of State Highway Fund Balance (May 2020)
Source: Oregon Department of Transportation



Existing tax revenue instruments will be increasingly inadequate for financing Oregon's transportation infrastructure in the future. As part of the OTP/OHP, we recommend that Oregon consider new approaches for evaluating statewide and region transportation demand while balancing costs and revenues to maintain and enhance existing public assets. Additionally, developing alternative financing mechanisms that serve multiple goals of efficiently raising revenues while moderating demand should be an important consideration for developing a sustainable transportation system.

Bringing these indicators together for scenario planning

To help decision-makers understand their choices about policies and investment choices for operating and maintaining the transportation system, it will be critical to understand how exogenous (and uncertain) forces will affect the drivers of transportation demand and supply. While the following four themes don't provide specific answers, they enforce discipline in the process of exploring choices, so that policies can be as thoughtful and comprehensive as possible.

- Land use and density. Changes in how land is used and where people life will affect the way people choose to travel
- Changing nature of freight. Changes in purchasing modes are driving new services that rely heavily on the transportation network.
- Structural economic changes. Emerging industries and decline of traditional industries in Oregon will impact the types of investments that will need to be made to support future economic growth.
- Economic Resilience. Investing in transportation infrastructure that is resilient to natural disasters and climate change will help the state's economy recover more rapidly after a major event such as a Cascadia Subduction Zone earthquake.

Implications for OTP/OHP

Based on the findings developed through this white paper, the following implications are recommended for consideration during the OTP/OHP update:

Transportation planning through a regional perspective

- Many of Oregon's demographic and economic changes have been regional and have policy implications for long-term transportation planning
- The State of Oregon should consider including a data-driven approach to incorporate regional analysis in the OTP/OHP process
- Our recommendation is to use PUMAs as a guide to aggregate regions to ensure reproducibility and harmony across for all metrics used in the OTP/OHP process

Drivers of transportation demand in Oregon

- Understanding the distribution of population growth is key to identifying the demographic changes that lead to effective regional policies and infrastructure investment
- All regions in Oregon are facing diverse transportation challenges. The increasing demands on urban infrastructure, along with health and safety concerns for rural residents should be considered as part of the OTP/OHP process.
- The changing mix of industries growing and declining around the state will also affect the type of transportation investment that will be needed. The OTP/OHP should account for these regional changes to understand how to build scenarios that can help prioritize investments.

Economic factors impacting the supply side

- Total lane miles have remained flat for the state's facilities, while population growth and environmental changes have placed increasing stresses on the state's aging roads and bridges.
- Changing consumer preferences will impact the efficacy of existing revenue instruments and will not be to be enough to maintain enough investment in the state's transportation infrastructure in the future.
- With declining revenues and increasing demand, the OTP/OHP process should emphasize strategies that guide prioritization of transportation investments and demonstrate which investments result in the largest public benefits.

INTRODUCTION

This white paper combines the demographic and economic regions evaluation of how these two key factors have and will continue to influence the transportation system use and needs within the State of Oregon. The purposes of this white paper are to define historical and projected drivers that affect demand for transportation in Oregon and Evaluate relative strengths and weaknesses of utilizing future regional versus statewide specific policies.

The results of this white paper are intended to be use for:

1. **Evaluate relative strengths and weaknesses** of utilizing a regional-focus to compare statewide-specific policies.
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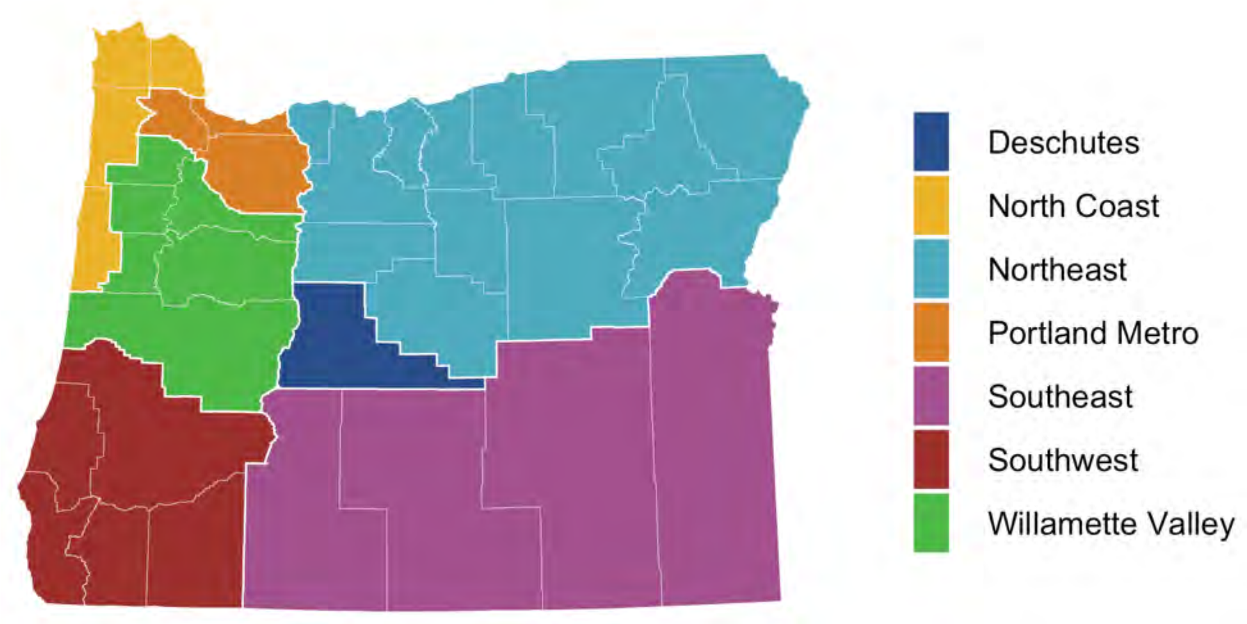

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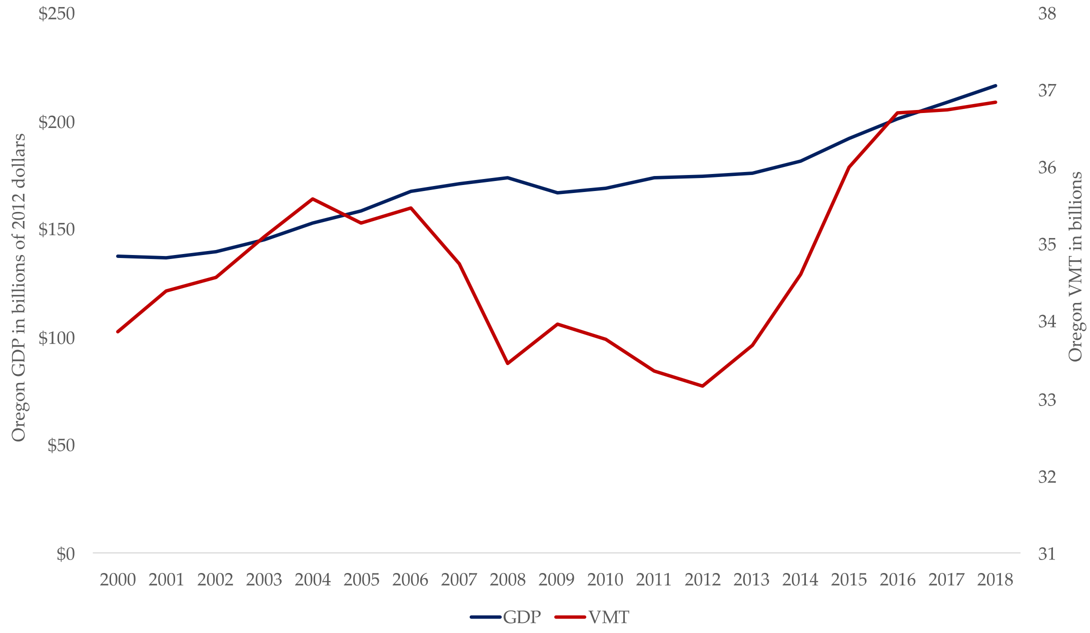

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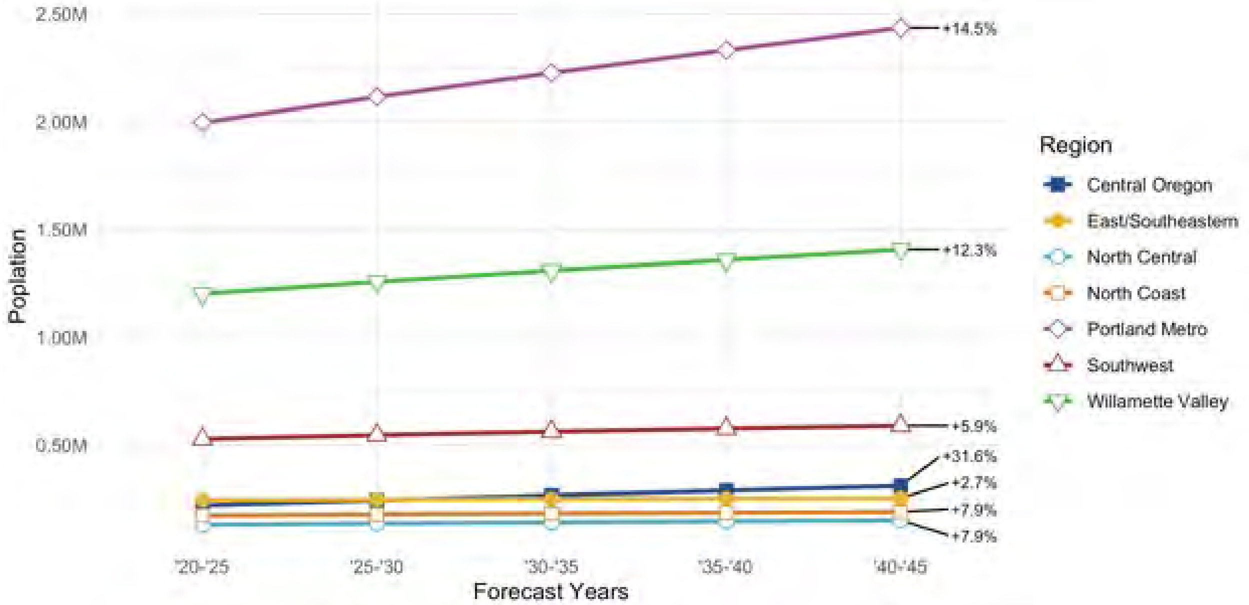

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[1] Oregon's short-term population forecast through 2029. https://www.oregon.gov/das/OEA/Pages/forecastdemographic.aspx

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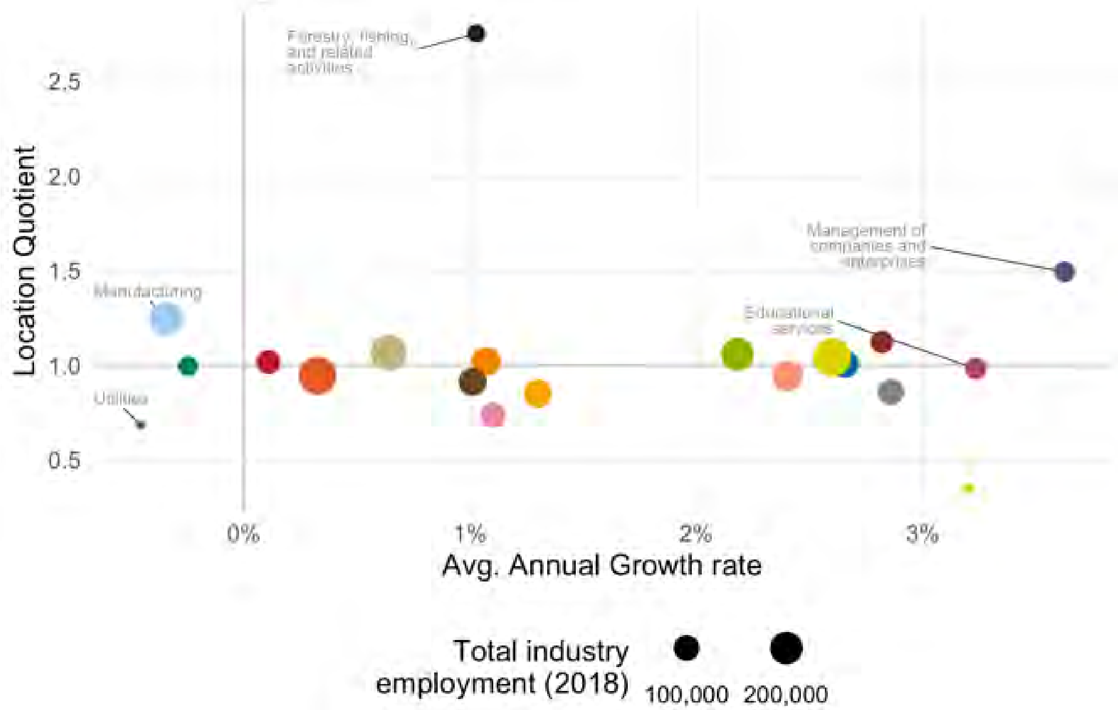

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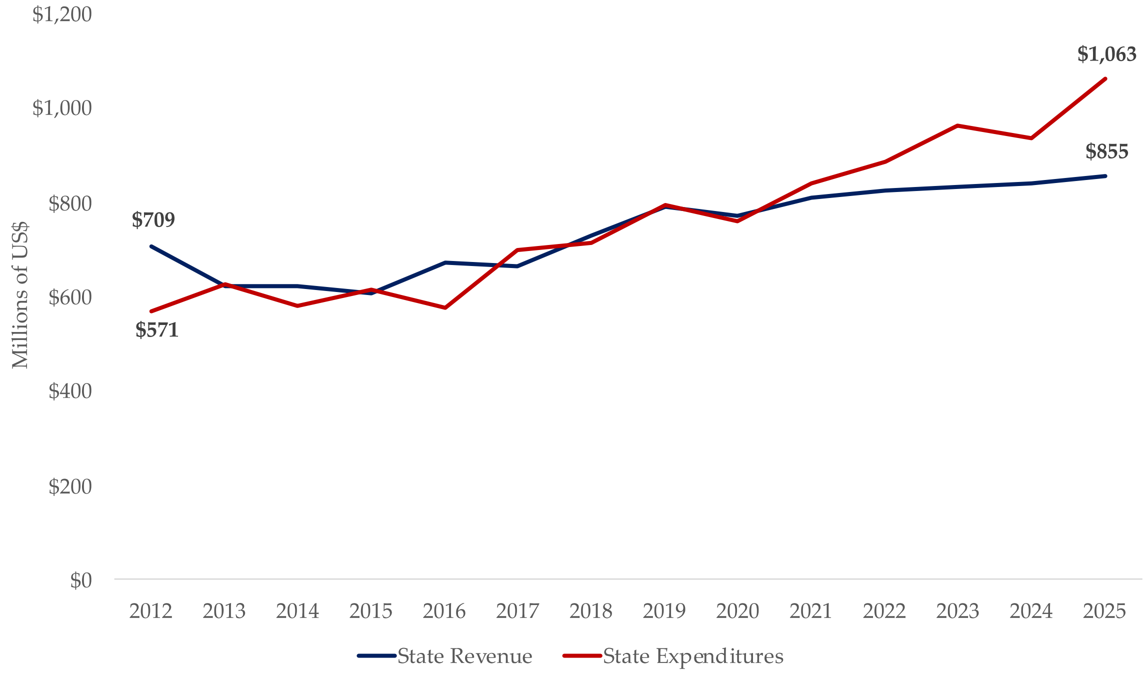

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- Total lane miles have remained flat for the state's facilities, while population growth and environmental changes have placed increasing stresses on the state's aging roads and bridges.
- Changing system user needs will impact the efficacy of existing revenue instruments and will not be to be enough to maintain enough investment in the state's transportation infrastructure in the future.
- With declining revenues and increasing demand, increasing costs, and an aging infrastructure, the OTP/OHP process should emphasize strategies that guide prioritization of transportation investments and demonstrate which investments result in the largest public benefits.

CHAPTER 1. TRANSPORTATION PLANNING THROUGH A REGIONAL PERSPECTIVE

Oregon is preparing to review and update its long-range Transportation and Highway plans, which serve as a guide for establishing priorities for transportation investments. Since the last update in 2007, Oregon has experienced two major recessions that had a transformative effect on the state's economy, moving further away from traditional industries in extraction, toward an economy based in services. During that time, the state has seen a rapid growth in population that has put pressures on much of the state's existing infrastructure from housing to highways. This white paper is intended to serve as a supporting document for the Transportation and Highway Plans by describing recent demographic and economic trends affecting demand for the state's highway infrastructure, along with anticipated challenges for financing the operations and maintenance of that infrastructure.

Oregon's transportation infrastructure is foundational. Regional economic health and individual quality of life depend on its function. Assessing investments in transportation systems in this context is inherently challenging. Benefits of investments accrue over time, and for many improvements, over the long term. And, over the long-term, the drivers of transportation demand will change in ways that may have little to do with the transportation system itself.

Nonetheless, investment decisions must be made intentionally, with an explicit understanding of the interactivity of the system with other key systems that support societal well-being, and with a goal of increasing system efficiency. Efficient transportation networks reduce costs across many economic sectors by minimizing the time needed to move labor, goods, and services through the network. To optimize investments over a planning horizon, scenarios are a helpful planning tool to understand and quantify the tradeoffs (benefits and costs) of different policies and investments and inform decisions about which investments best increase efficiency of the overall system.

This chapter explores the feasibility and effectiveness of taking a regional approach when planning for transportation needs, given the complexity of this system interactivity. ODOT currently has several administrative and advisory regions to provide support for local and regional issues related to the state transportation system. Previously, Oregon's Highway and Transportation Plans (OTP & OHP) provided guidance for regional transportation plans but did not explicitly analyze regional changes in transportation demand. Would an evaluation at the regional level improve planning outcomes?

Although the benefits and costs of transportation investments are often thought of in aggregate, there are plenty of reasons to explore transportation policy at the regional levels. Benefits and costs accrue differently in different regions, based on local economic, demographic, and other system variables. And, because transportation systems are key to economic development, transportation improvements should take into consideration changes in demographic and economic activity in a region that will influence the demand for, and the type of investments needed. Additionally, regional and local planning allows for coordination between public agencies to ensure that unique transport and accessibility needs are accounted for in the planning process.

This chapter outlines the rationale for considering the OTP and OHP through a regional lens to improve the decision-making and scenario planning that will inform regional and local transportation plans, better account for benefits and costs, and better inform decisions about improving system efficiency.

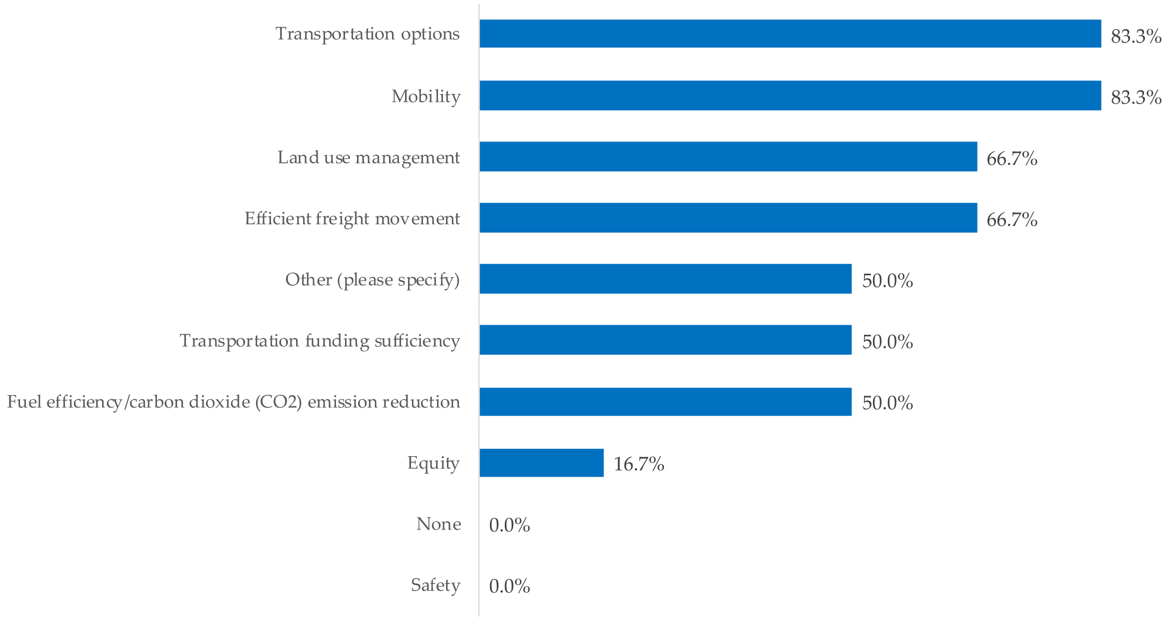
Transportation policy analysis - state vs. region and local

Oregon's state-owned transportation system connects almost every community in the state. Ensuring that this large multimodal system supports the state's diverse transportation needs is complex. Each of the state's regions have unique challenges based on their population, geography, access, and existing infrastructure. Maintaining a robust multimodal system that intersects with the distinct challenges across Oregon's communities requires a thoughtful approach to allocating the state's scarce resources.

Outside of Oregon's borders, this approach to transportation planning has seen an increase in interest with an increasing number of Regional Transportation Organizations that help support statewide planning processes for non-metropolitan areas. Within Oregon, there has also been more interest in formalizing the inclusion of regional approach coordination for the statewide transportation and highway planning process, part of which is the impetus for this white paper. The size of the state's transportation network combined with the diversity of the state's communities makes selecting which policies to evaluate at a regional or local level challenging.

Initial exploration by ODOT staff suggests that there is some agreement about which policies could be effectively explored through a regional lens and incorporated into the statewide transportation and highway planning process. As part of this project, ODOT staff were surveyed to see which policies they believe are most appropriate to consider at the regional level. Results indicate that transportation options (e.g. tolling), mobility, and land-use decisions all benefit from consideration of regional and local needs to help inform statewide decisions around future planning.

Figure 1. Responses to which policy topics are most likely to be regionally based
Source: Oregon Department of Transportation, results of survey of ODOT staff, 2020



The results of the survey help us understand the types of policies that may be effectively explored at a regional level, but they do not provide any specific guidance on how to construct regions within Oregon. There are political, economic, and analytic reasons answering this question is challenging. For the purposes of this white paper, we allow the availability and limitations of existing data to inform and narrow the possible regions. This ultimately allowed for discussions about whether and how a regional approach to transportation planning could be analytically incorporated in the state's transportation and highway planning process. In the following section, we describe our process for evaluating the rationale and approach for developing study regions.

Preferred approach for developing study regions

As a first step, we developed a set of study regions, to explore how regional data could be organized and used to influence transportation planning. Although there was no formal framework established for this evaluation, we used several metrics to guide our thinking about whether and how to incorporate regional and local trends into this analysis. These also guided our approach to developing regions:

- First, and arguably most important, evaluating the demographic and economic data used to understand changes in transportation demand to determine if trends can be differentiated from historical data and if projections differ going forward. The characteristics of households and businesses in a region that lead to expected changes in transportation demand should have enough variation across regions to determine the need for regional policies.

- Second, the metrics used to measure regional characteristics need to align across any proposed study regions. This ensures that any demographic or economic characteristics used to compare existing or future demand for transportation are comparable across regions.
- Third, data need to be publicly available. Although this can limit the scale and quality of data used for the analysis, it ensures transparency and reproducibility as part of the public process, and ultimately for use in future projects such as OTP/OHP.

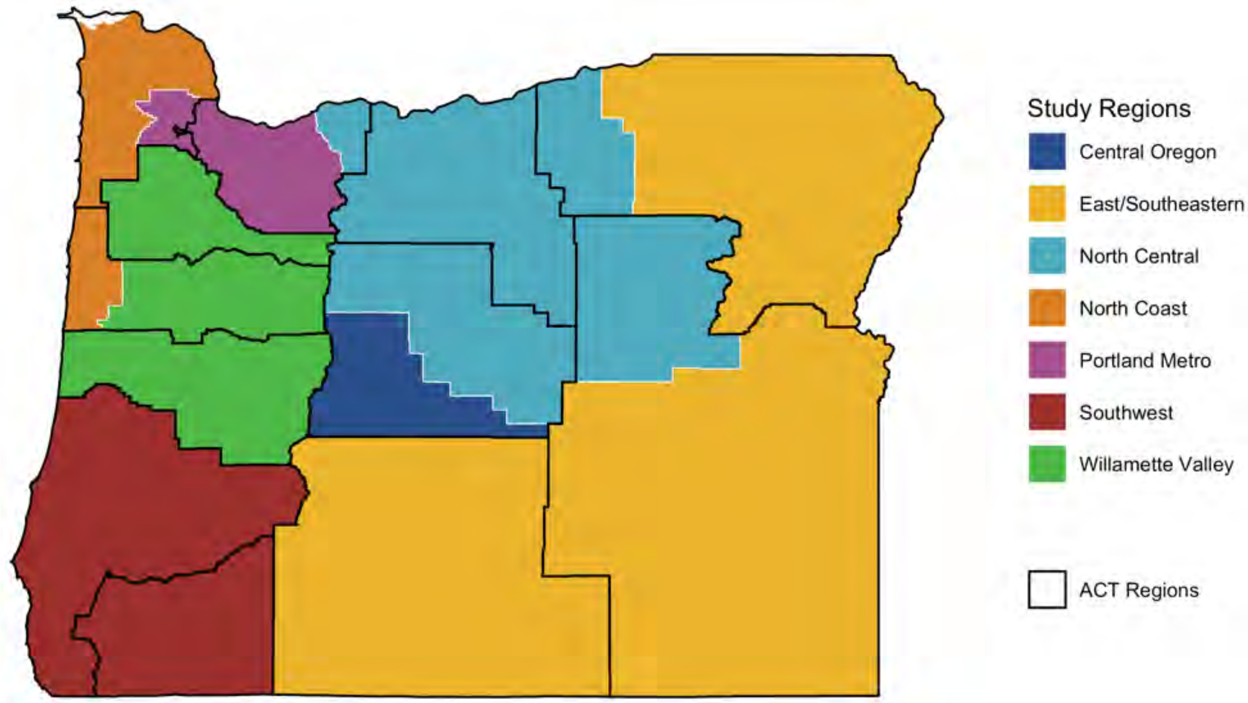
Using Public Use Microdata Sample (PUMS) for study regions

After evaluating the conditions described above, we determined that U.S. Census boundaries would be most effective for developing regions to study demographic and economic characteristics. For this analysis, we relied on the 1-year (2010 through 2018) U.S. Census American Community Survey (ACS) microdata called Public Use Microdata Sample (PUMS) to calculate household and population data. The PUMS microdata is an ideal dataset for this analysis because it allows us to calculate detailed population-level and household-level estimates across regions and over time.

The most specific geography available with PUMS data is a PUMA, or Public Use Microdata Area. These regions are realigned based on population growth to correspond with the Decennial Census. For the most recent Decennial Census, the U.S. Census generally defines these regions as having a population of roughly 100,000 individuals. In high population regions, PUMAs closely correspond with counties. Smaller regions are slightly more difficult to work with because a rural PUMA may include several counties, or parts of multiple counties.

As of the 2010 Census, Oregon has 31 PUMAs; the analysis was limited to stand-alone or combined PUMA geographies. Many of the geographically larger PUMAs are concentrated in smaller population centers that share the same transportation infrastructure. For this analysis we considered multiple regional configurations, ultimately selecting to aggregate PUMAs to seven regions, which broadly align with Oregon's economic areas as defined by the Governor's Regional Solutions. Although this approach has some limitations, it allowed us to aggregate demographic and economic data from various datasets to the same regions. The result is a set of data that allow us to identify trends in key indicators that are important to transportation planning.

Figure 2. Study regions with ODOT Area Commissions on Transportation (ACT) regions
Source: U.S. Census and Oregon Department of Transportation



The regions selected for this analysis are broader than ODOT's Area Commissions on Transportation (ACT) regions, which are used to advise the state on regional and local transportation issues. Although they do not align, our proposed study regions do overlap with many ACT regions, which allow ODOT to incorporate information obtained from those advisory groups into the broader analysis on regional economic and demographic trends. The benefit of this approach is integrating qualitative and quantitative information to better evaluate current and future transportation needs around the state.

Using PUMAs to understand regional commute patterns

A key aspect of regional transportation planning is understanding how the existing transportation network is being used. Although there are several tools to do this, one key measure is to examine regional commuting patterns. These commute trips are important because they have a direct relationship to the regional economy and where households tend to locate relative to their place of employment. Population decentralization beginning in the mid-20th century led to an increasing reliance on the transportation network and impact the types of investments needed to support the highway system.

As a result, commute patterns can provide important context for policies directly related to transportation planning, such as mobility, mode use and congestion. However, understanding how these policies broadly intersect with population centers helps inform a broader set of policy decisions around land-use, housing, and natural resource management. When viewed holistically, these relationships help decision-makers the ability to prioritize investments between and within regions that can yield the most benefits for citizens.

As part of this analysis, we used Longitudinal Employer-Household Dynamics (LEHD) data from the U.S. Census data to identify patterns in commuting and how they have changed since 2002 within each of the study regions developed for this white paper. The maps below display identified intraregional patterns based on analysis of the LEHD data in 2017 and the charts show the largest changes in commuting patterns over a 15-year period. These clusters show the interrelatedness of communities in population centers based on commuting ties and help provide context for understanding how commute distances and job density intersect.

Figure 3. Regional Commute Patterns – 2017
Source: Longitudinal Employer-Household Dynamics (LODES), 2017.

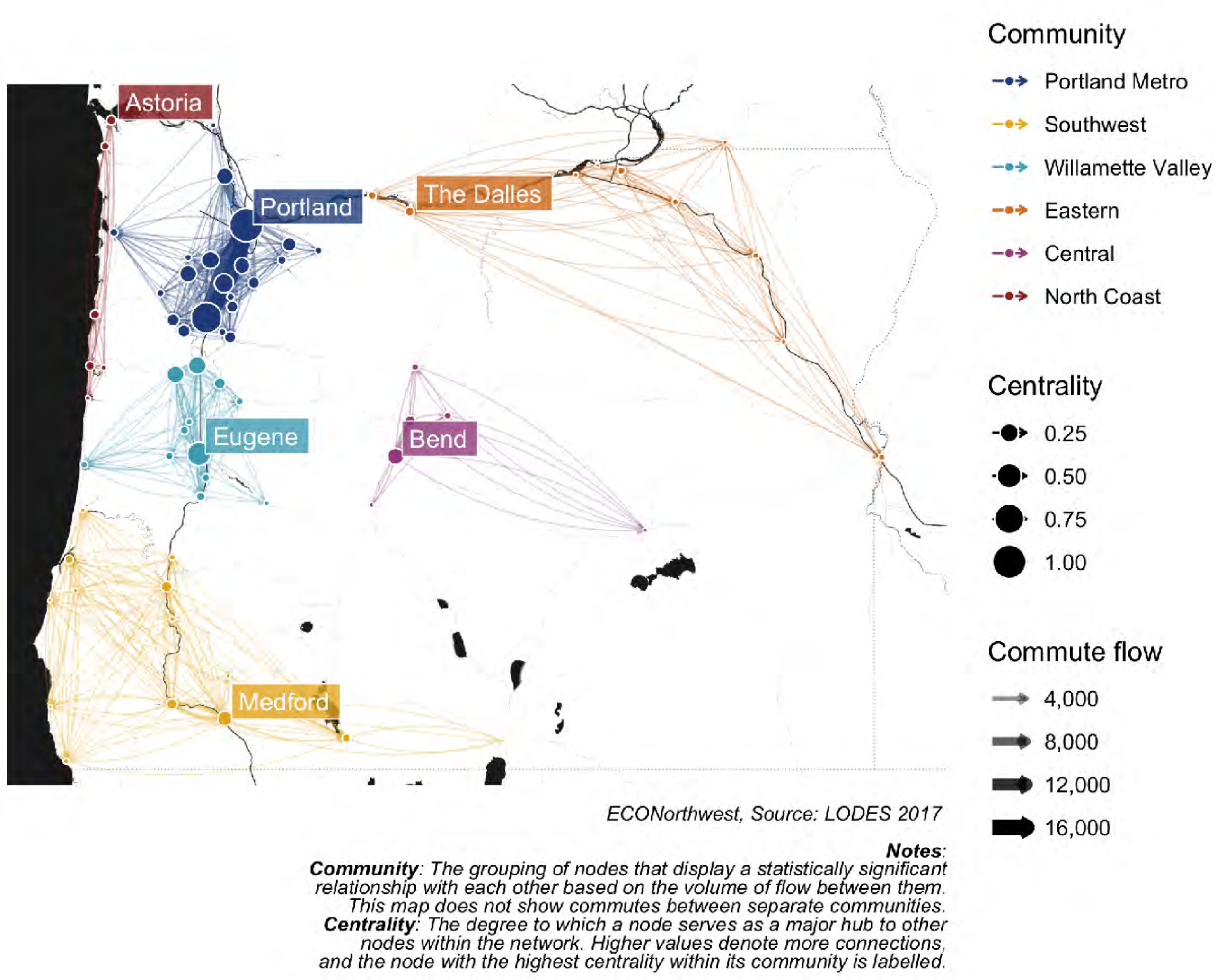
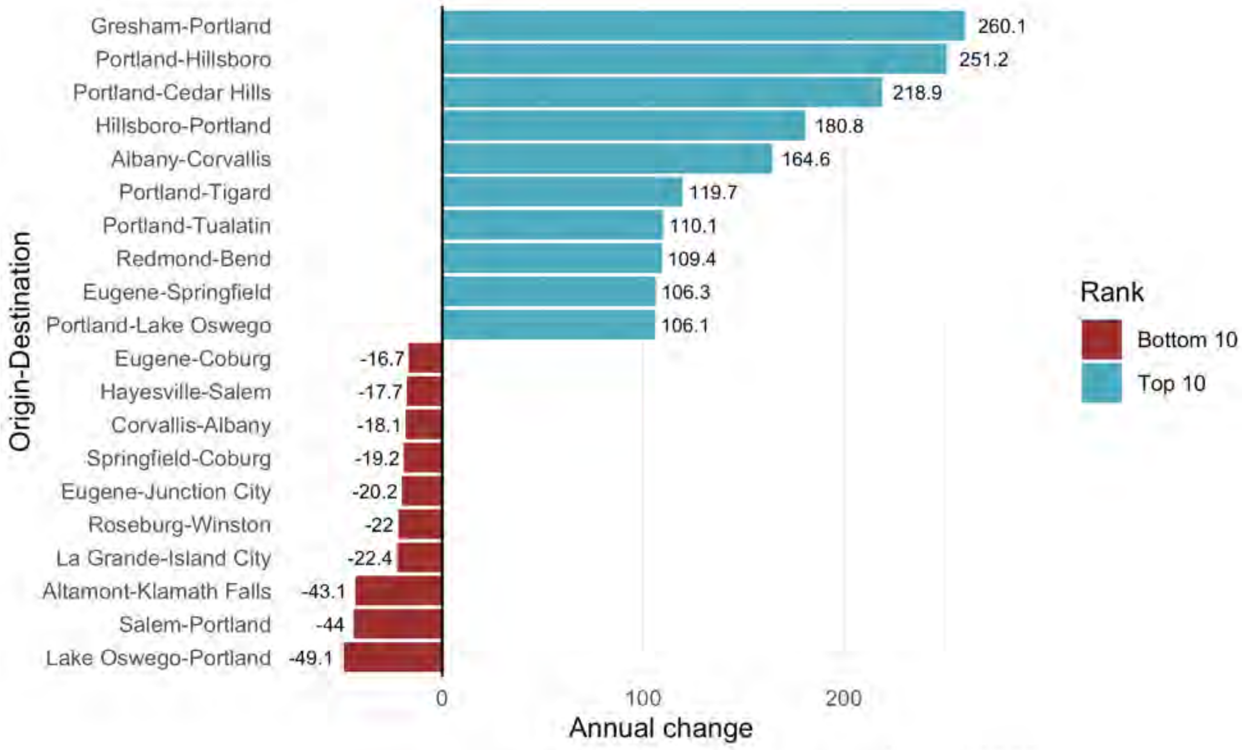


Figure 4. Annual Average Change in Commute Flows in Oregon 2002 to 2017
Source: Longitudinal Employer-Household Dynamics (LODES), 2017.



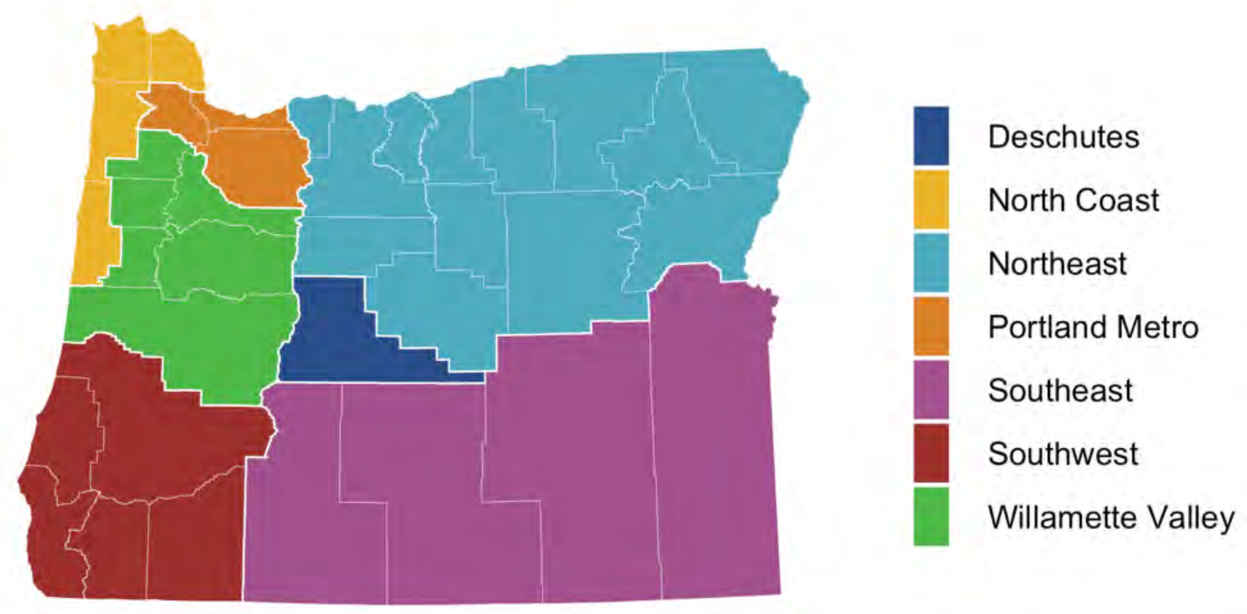
In the following chapter, we explore changes in demographic and economic changes in Oregon that affect the commuting patterns displayed above, along with other drivers of demand for the transportation network. Because of data availability, many of those characteristics are examined through the lens of household and employment information. However, understanding the transportation industry itself is an important component of transportation planning, we include a brief discussion of freight transportation in the section on economic drivers. In Chapter 3, we discuss expected challenges of financing Oregon's transportation infrastructure. Chapter 4 pulls the previous three chapters together to describe scenarios that ODOT can use to policies and capacity investments for different growth scenarios.

Recommendations on regional analysis

One of the primary objectives of this white paper is to provide guidance on the benefits of conducting scenario and policy analysis at the regional level for the forthcoming OTP and OHP studies. Based on the evaluation conducted in this study, there is reliable data that allows for differentiation between regions and value to applying a regional lens to the OTP and OHP studies. Additionally, the demographic and economic data are enough to help support a robust approach to scenario planning that can weigh the benefits and costs for various planning strategies and ultimately identify scenarios that improve the efficiency of the state's transportation system.

Over the course of this analysis, we determined that an alternative grouping of PUMAs may be more effective for the OTP/OHP planning process. Figure 5 displays the recommended regional configuration for OTP/OHP. The primary difference is the aggregation of northeast Oregon Pumas and Southeast Oregon PUMAs into single regions, rather than the earlier approach used for this white paper. The reason that this configuration is preferred is that it better aligns economic areas with existing transportation networks. Additionally, it also aligns with other work being performed by other State agencies examining transportation networks and housing. We believe that this change will allow ODOT to better align their long-range transportation planning with other critical efforts being performed with other State agencies, such as Oregon Housing and Community Service, which is currently studying the relationship of housing affordability and mobility needs.

Figure 5. Recommended Regional Configuration
Source: ECONorthwest



Implications for OTP/OHP

- Many of Oregon's demographic and economic changes have been regional and have policy implications for long-term transportation planning
- The State of Oregon should consider including a data-driven approach to incorporate regional analysis in the OTP/OHP process
- Our recommendation is to use PUMAs as a guide to aggregate regions to ensure reproducibility and harmony across for all metrics used in the OTP/OHP process

CHAPTER 2 – DRIVERS OF TRANSPORTATION DEMAND IN OREGON

This chapter identifies key demographic and economic trends that will affect transportation needs in Oregon through 2050. Rapid growth in Oregon's population has been part of a broader story of economic success for the state since the Great Recession, with the economy growing faster than the national average during that time. Although this growth has provided many benefits to the state by increasing wealth and employment opportunities, rapid growth also comes with costs. For the transportation network, growth has meant more people relying on the existing road infrastructure to commute or move goods and services. Increasing utilization, in turn, had other social costs such as growing noise and pollution, along with crashes and congestion.

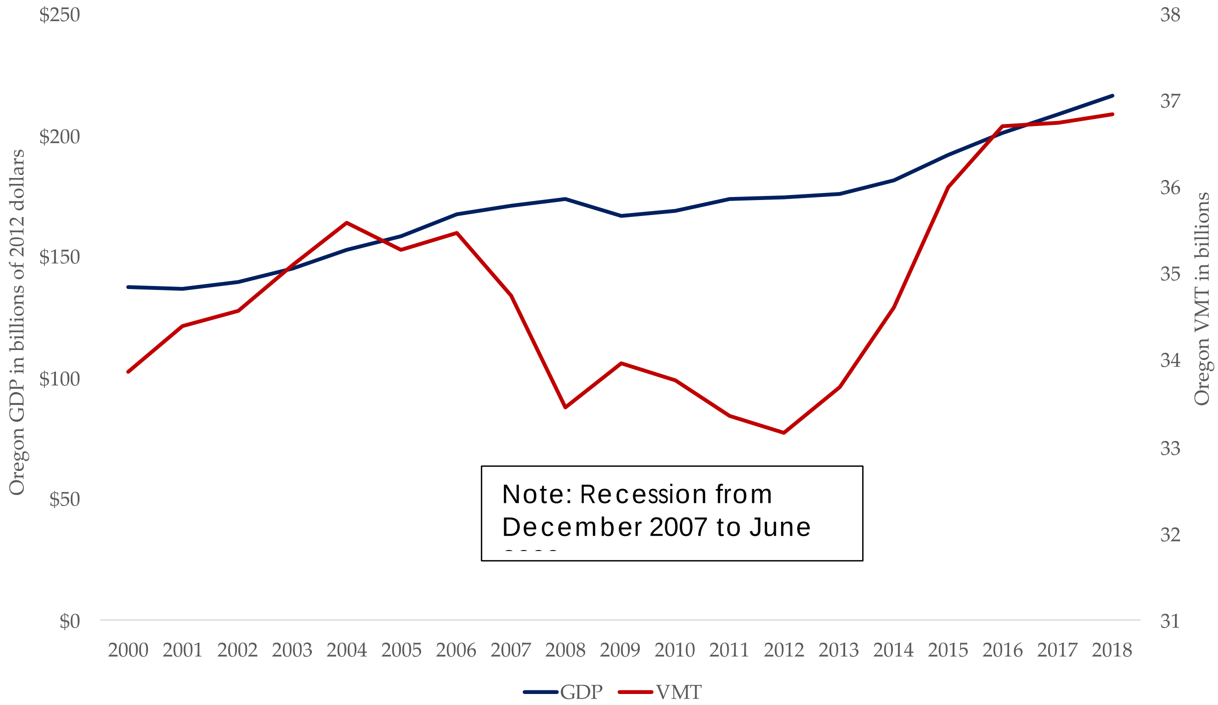
Transportation policies have traditionally relied on examining the need for increasing capacity; however, those policy solutions do not address the broader mobility needs of vulnerable individuals or encompass the externalities associated with the social costs of increasing transportation. Developing policies that account for these broader issues requires an understanding of how individuals, households, and businesses choose to travel. Understanding these key drivers of demand helps identify effective mechanisms that can be used to moderate demand and fund public infrastructure.

This chapter reviews recent demographic and economic trends in Oregon as a guide for understanding a range of potential future outcomes and their impact on transportation demand, planning, and revenue statewide. While this white paper explores a broader set of indicators (see the technical appendix for a complete review), this chapter focuses on the key indicators that are likely to be drivers of regional transportation demand that also have implications for the OHP and OTP. There are two categories of demand that will be explored further in this chapter—structural drivers and impacts from the regional economy (economic and demographic). The structure of demand section frames the relationship between transportation and the regional economy, including identifying key measures of demand, such as VMT. After a brief discussion on the structure of transportation demand, important economic and demographic indicators are identified describing how the regional economy influences demand for transportation.

Structural drivers of transportation demand

Transportation demand is integrally related to the growth of the regional economy. One drives the other, and vice versa. Investments in transportation infrastructure are an important input to understand the productivity of a region's economy. These investments in transportation networks support industry clusters that rely on that infrastructure to access skilled labor and key factor inputs. In other words, transportation networks can help create a comparative advantage for regional industry clusters.

Figure 6. Oregon VMT and GDP growth, 2000 to 2018
Source: Federal Highway Administration, Bureau of Economic Analysis



The relationship between transportation demand and growth in economic activity is complex, and as a result, there is not consensus around the strength or directionality of the relationship. Does transportation demand result in economic growth? Or does economic growth result in transportation demand? The following are the major frameworks used to describe the possible nature of the relationship, each of which results in different implications for public policy and scenario planning:

1. ***Changes in* transportation demand *"cause" changes to economic activity***
   - Suggests that the regional economy is responsive to changes in transportation demand, and therefore increases in travel demand is an essential component to economic growth Policies that emphasize transportation demand reduction may have unintended consequences
2. ***Changes in economic activity "cause" changes to* transportation demand**
   - Suggests to opposite of the first framework, whereby demand for travel is responsive and dependent on economic growth. Policies designed to reduce transportation demand may be implemented without impinging economic activity
3. ***The relationship between* transportation demand *and economic activity is bidirectional***
   - Suggests a more interrelated relationship where economic activity and transportation demand growth impact each other through feedback loops. Policies can be nuanced in objectives, for example attempting to meet the

goals of reducing transportation demand while benefitting the regional economy.

4. ***There is no direct relationship***
   - Economic activity and transportation demand are independent and do not have a direct relationship. Policies designed to change transportation demand would have no impact on economic activities

Based on the existing literature and our professional experience, we believe the appropriate framework to describe the structural relationship is bidirectional. This has important implications for scenario planning, whereby a nuanced understanding of a proposed policy is required to measure the impact of the policy in terms of impact in transportation demand and economic activity. Before describing the important economic variables that drive transportation demand, it is important to define measures of transportation demand.

VMT and Planning for the Future

Vehicle Miles Traveled (VMT) is the most commonly used measure of transportation demand used to:

- Forecast revenue (gas tax, user fees, tolls)
- Measure system usage, which drives potential maintenance (Fix-it) and capital (Enhanced) investment priorities

Increasing population does not correspond with an equivalent growth in VMT. Figure 7 displays the trends in VMT and VMT per capita in Oregon from 2000 through 2018. Since 2000, VMT per capita has continued to decline. As Oregon's Office of Economic Analysis has noted, some of this change is due to broader changes in the business cycle, however, others appear to be generational. The share of young adults with driver's licenses declined rapidly since 2000[2]. Other factors that contribute to declining VMT per capita may be the result of increasing transportation costs and policies designed to reduce car dependence or technological changes that reduce the need for travel.

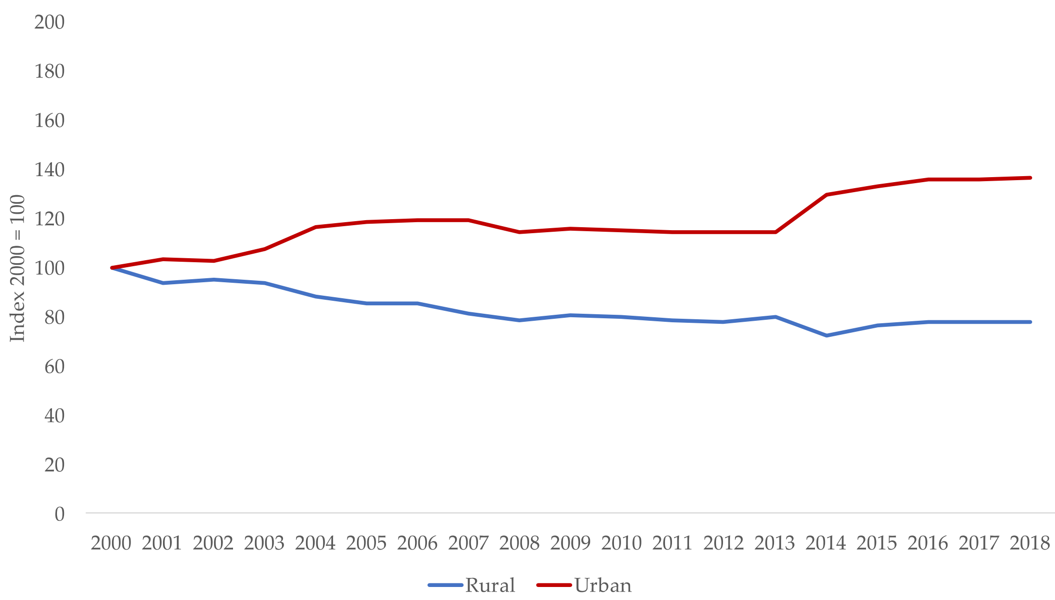
[2] https://oregoneconomicanalysis.com/2017/03/15/oregon-traffic-a-vmt-update/

Figure 7. VMT and VMT Per Capita in Oregon, 2000–2018
Source: Portland State University, Population Research Center; Oregon Department of Transportation

Although declining VMT per capita can be a positive attribute, that benefit has been offset by the rapid increases in both VMT and population in Oregon. When VMT increases while VMT per capita remains flat or declining, this indicates that more cars are using the transportation infrastructure. If existing capacity does not keep pace with the increase in demand, then congestion levels will also increase. This in turn, has subsequent effects on traffic time delays, safety and other relevant concerns for transportation planning. Those effects will be more apparent in regions where population growth is occurring fastest.

As a result, VMT is not evenly distributed across the transportation network statewide, but rather concentrated in areas of increasing population, specifically areas increasing in density. Figure 8 displays how the growth in urban and rural VMT has diverged in Oregon since 2000. Although it's unlikely that all the growth can be attributed to demographic changes in the region, the large increases in commuter flows (See Figure 4) suggests that it may be a strong driver of VMT growth.

Figure 8. Growth in Urban and Rural VMT in Oregon, 2000–2018
Source: U.S. Department of Transportation, Federal Highway Administration Highway Statistics, Table VM-2



Other Measures of Transportation Demand

Although VMT is a good broad measure for the total demand on the transportation network, it is not necessarily the best measure for the purpose of transportation planning and policy analysis. VMT does not directly correspond to measures of capacity and congestion, which are often important policy considerations that negatively impact economic activity, not to mention the quality of life of residents. Measures such as Average Annual Daily Travel (AADT) are an alternative measure better suited to evaluate peak demand and congestion on a transportation network.

In addition to the traditional VMT measure, ODOT uses the following metrics to measure congestion and reliability on Oregon's roadways:

- **Average Annual Daily Traffic/Capacity (AADT/C)**. Average annual daily traffic (AADT) divided by peak hour capacity (C) identifies where large-scale congestion occurs and enables ODOT to monitor locations over time for spreading beyond a typical two-hour peak period.
- **Travel Time Index (TTI).** This congestion measure compares the 80th percentile travel time of a trip on each highway segment at a peak hour compared to an off-peak uncongested hour. The higher the TTI, the longer the travel times and higher the congestion. For example, a TTI of 2.0 indicates that a trip that takes ten minutes in light traffic will take 20 minutes in congested conditions.
- **Planning Time Index (PTI).** This reliability measure represents the total travel time users should account for in order to be on time 95 percent of the time relative to free flow speeds. Free flow speed is defined as the posted regulatory speed limit. The lower the PTI, the more reliable the travel time will be. For example, a PTI of 3.0 indicates

that a trip taking ten minutes in light traffic should plan for 30 minutes to ensure arriving on time with 95 percent confidence.

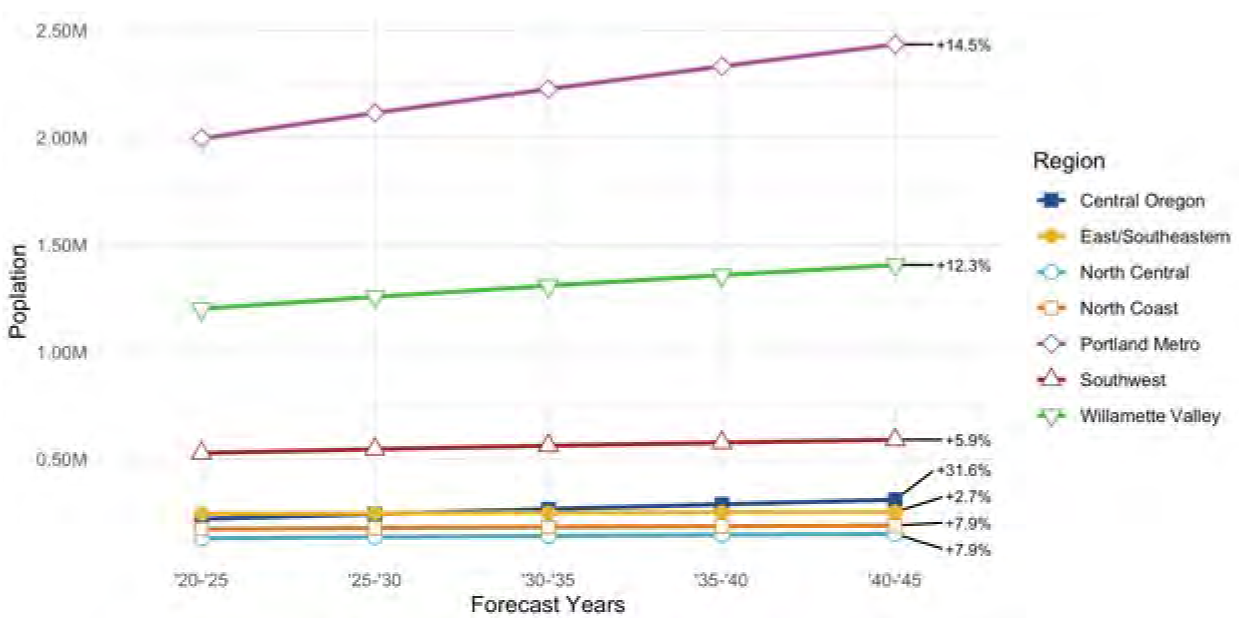
Economic and Demographic Drivers of Transportation Demand

Population Growth

Total population growth across the state is important because it is the primary variable impacting the number of vehicles expected to use the transportation network in Oregon. At the same time, it is important to measure how that growth is distributed across the state. Understanding this distribution is key to identifying the demographic changes that lead to effective regional policies and infrastructure investment.

Since 2000, Oregon's population has increased rapidly, growing by 24 percent (around 815,000). Although all regions in Oregon have experienced some population growth over the last 20 years, almost all that growth has been clustered in regions along the I-5 corridor. The rapidly increasing number of people living in the Portland Metro area and along the Willamette Valley[3]. The State of Oregon projects that another 341,000 individuals (~8 percent) living in the state by 2029, with most of that growth occurring due to in-migration.[4]

Figure 9. Total forecasted population growth by region 2020 to 2045
Source: Portland State University, Population Research Center.



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[3] Detailed regional forecast data are displayed in the technical appendix to this white paper.

[4] Oregon's short-term population forecast through 2029.
https://www.oregon.gov/das/OEA/Pages/forecastdemographic.aspx

Aging population and labor force participation

The distribution of age cohorts within the growing population provides further insight into how population growth may affect transportation demand. Like other areas of the United States, the aging of the Baby Boomer generation has increased the share of the population that is 65 years or older, recreating, and desire to continue working will influence they types of regional transportation planning required to support that population.

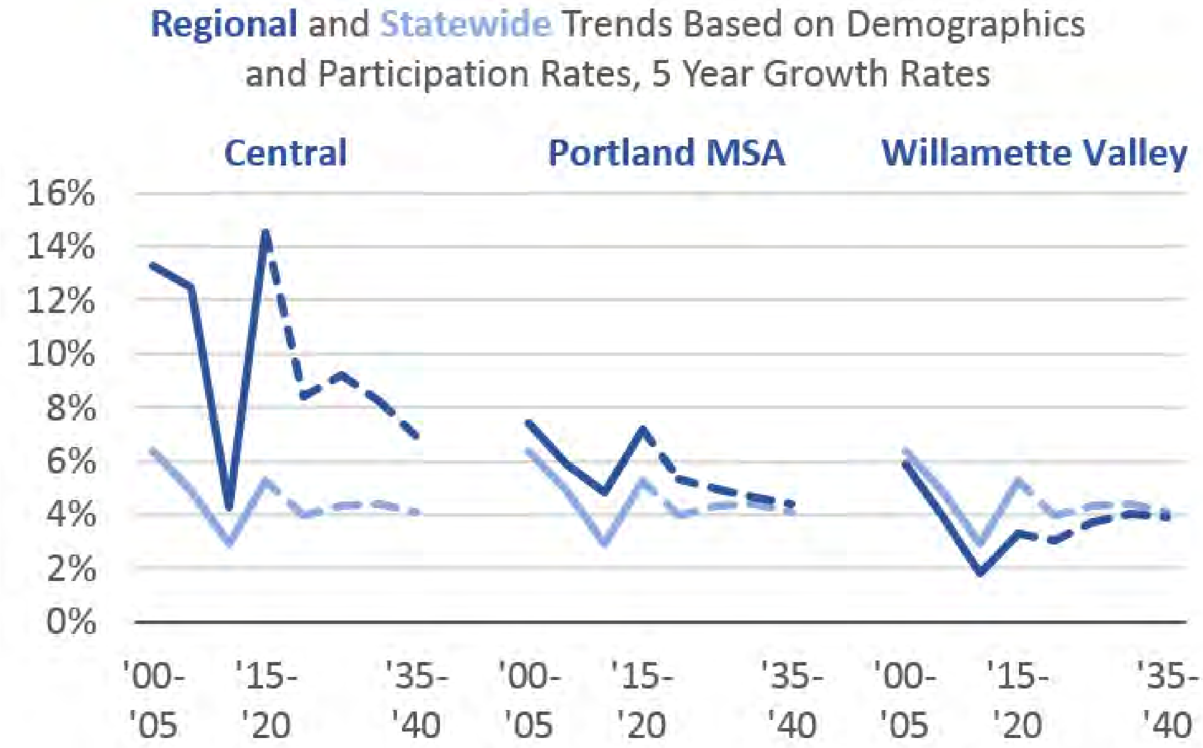
For this segment of the population, mobility challenges can be especially acute. Older citizens may lose their ability to drive and require help from family or friends or the use of public transportation. The inability to access safe and affordable modes of transportation can have a profound effect on well-being, resulting in social isolation and financial hardship.[5] In both urban and areas, these may include adjustments to public transit corridors or active transportation investments to address their unique health, financial, and social needs.

In Oregon, as in many states, suburban and rural areas are aging more rapidly than in the Portland Metro. With aging-in-place increasingly common, this presents some unique challenges for transportation planning. The availability of transportation services that can support the aging population is likely to differ between urban, suburban, and rural areas. Accounting for this variation in both need and availability of services is an important consideration for developing regional guidance on transportation planning.

Changes in population growth patterns and age distribution both have implications for the state’s labor force. Consistent out-migration in rural areas of Oregon have resulted in an aging population resulting in lower growth in the labor force. Since 2000, employment growth in Oregon has largely been clustered around the fastest growing population centers in Central Oregon, Portland Metro, and the Willamette Valley. Although forecasted growth rates are expected to decline over the next 20 years, employment in these three regions are anticipated to continue growing faster than the state average.

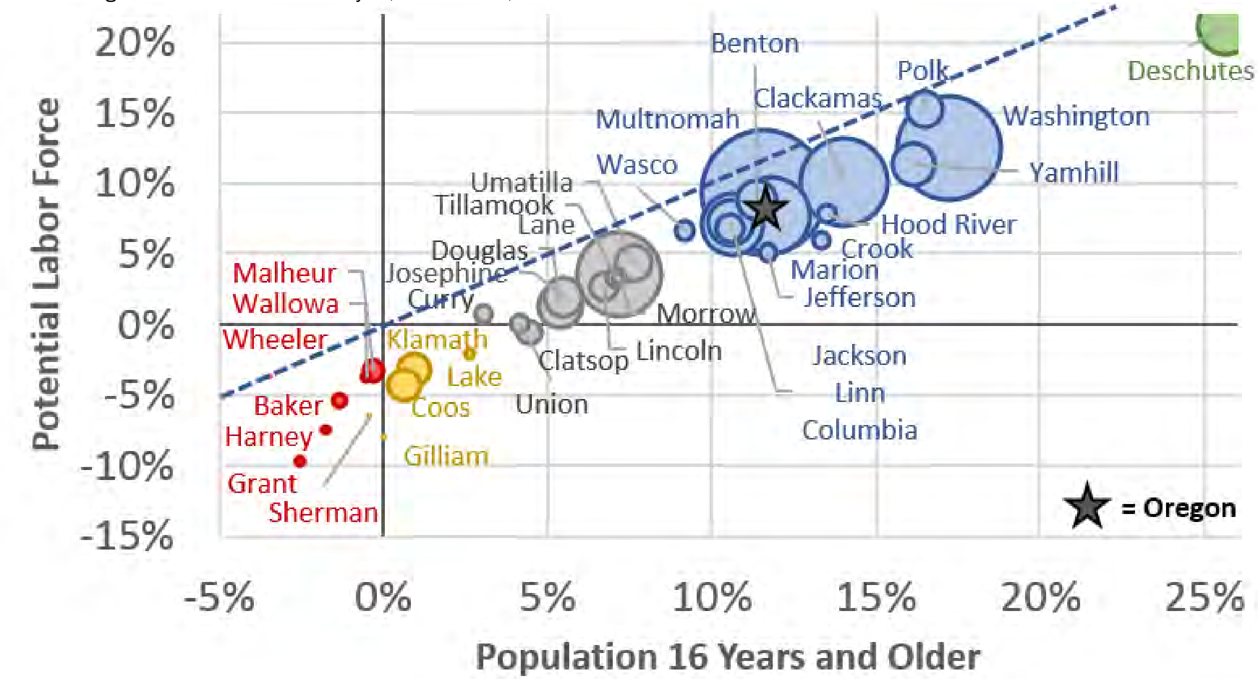
[5] DeGood, Kevin. Aging in Place, Stuck without Options: Fixing the Mobility Crisis Threatening the Baby Boom Generation. 2011. Transportation For America.

Figure 10. Labor Force Growth Rate by Region compared to State Average
Source: Oregon Office of Economic Analysis, U.S. Census, Portland State



Through 2030, 11 counties (see Figure 11) are expected to have smaller workforces than they do today, and across the state, the labor force is expected to grow less than the total population. The implications for the economies in those regions can be widespread and circuitous. A slower growth in the labor force can result in lower income growth and fewer businesses, which contribute to outmigration.

Figure 11. Labor Force Forecast from 2020 to 2030 by County
Source: Oregon Office of Economic Analysis, U.S. Census, Portland State



In urban regions such as Portland where many of the economic benefits have accrued since 2000, the cost is increased loads on aging bridges and roads and increasing time delays, all which contribute to a lower quality of life. In rural areas, with slower or negative labor force growth can lead to lower tax revenues to support local infrastructure, along with transportation investments that are reallocated to the urban corridors to mitigate acute congestion problems. This, in turn, results in mobility problems for an aging population in rural areas where transportation networks are tied to health and health care access.

Urbanization and Housing Affordability

This concentration of population growth is part of a broader urbanization trend globally, however the implications for transportation planning are local and regional. As mentioned earlier, most of the Oregon's population growth is occurring along the I-5 corridor with those increased concentrated in the Portland Metro area.

Urbanization has benefits and costs to society. While increasing commuting patterns suggest that people are moving to the Portland Metro to take advantage of economic opportunities, the concentration of traffic in the region is increasing congestion levels on the existing infrastructure and decreasing reliability of the network. ODOT's recent findings in their 2018 Traffic Performance Report for the Portland Metro Region found that hours of vehicle delays increased by 20 percent between 2015 and 2017 and the number of hours the roads are congested increased by 13.4 percent over that same period.[6]

Figure 12. Weighted average commute distance by destination region, 2002 – 2017
Source: Longitudinal Employer-Household Dynamics (LODES), 2002-2017.
Note: Distances are geodesic straight-line distances between block groups, and commutes are limited to only those occurring entirely within Oregon.

While congestion may be less of a concern for resident who live outside of the Portland Metro, those that travel into the Metro area for work may still be affected. Figure 12 shows that many residents outside the Portland Metro need to commute longer distances to access urban centers where jobs have migrated. For those individuals facing long drives into and out of congested areas, reliability, time delay and safety are all important considerations and regional transportation policies should consider that connectivity to the congested network.

Jobs and housing balance is often times what is sacrificed as affordability decreases in a region. Households trade off housing that is more affordable for increased travel distance to their place of employment. The cost of housing is an important driver of transportation demand—as housing becomes less affordable, travel distances and times increase. Higher transportation costs increase the overall cost of housing, which should be thought of as the combined cost of housing and transportation. Cost burdening (where households spend more than 30% of their gross income on housing) is at a high rate across the state. When adding in transportation costs, locations that

[6] Oregon Department of Transportation. Portland Region 2018 Traffic Performance Report. December 2018: https://www.oregon.gov/odot/Projects/Project%20Documents/2018TrafficPerformanceReport.pdf

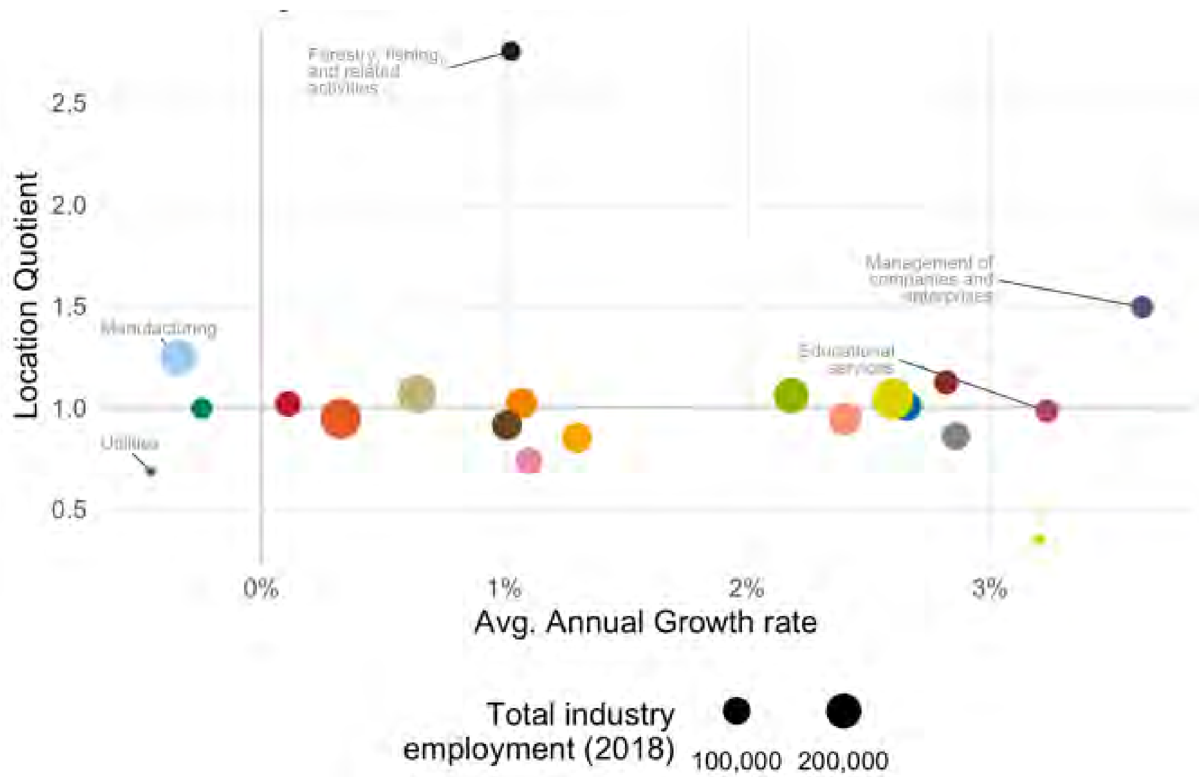
appear within reach for a household, often times are no better off than closer locations when considering travel costs (and time). When applying for a home mortgage or rental unit, the ratio of income to housing cost is capped. Transportation costs are not factored in, the result is often times inequitable access to housing for low income households and communities of color. This has broad implications for regional mobility, as well as for regional economic productivity.

Industry Composition and Resiliency

Industry composition is important to understanding how regional economies are changing over time. From a broader lens, change in industrial composition affect how a region's economy will respond to negative shocks or downward swings in the business cycle. Until the 1990's, Oregon's economy was concentrated in procyclical and trade-dependent industries including natural resources and manufacturing, which led to wider swings in employment during recessionary and expansionary periods.

Although those industries continue to serve as an important driver of employment, especially in regions outside of the Portland Metro, Oregon's economy has become more diverse, with growing sectors in professional services and technology. Figure 13 displays how Oregon's employment concentration has changed since 2010. The trend over the last decade indicates that industrial sectors with the highest concentration (location quotient), which have long served as drivers of Oregon's economy have experienced the least growth. Since 2000, much of the growth has occurred in the service sector, with increasing specialization in management and professional services. Location quotient (LQ) is a measure of how concentrated an industry is in the state compared to the national average. An LQ larger than one indicates a higher concentration in that industry than the national average, conversely values smaller than 1 indicate less industry concentration.

Figure 13. Industry Concentration and Growth in Oregon, 2010–2018
Source: U.S. Bureau of Economic Analysis

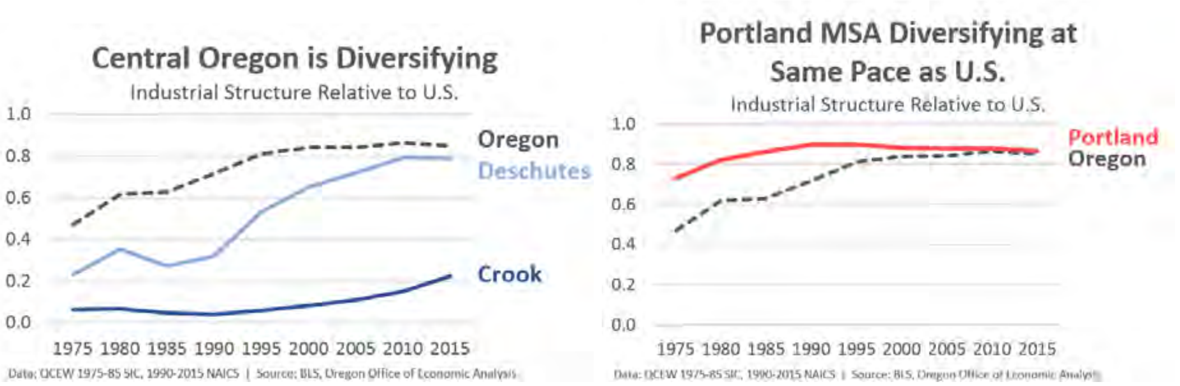


Looking ahead, the Oregon of Economic Analysis (OEA) expects that many of the industries where Oregon has traditionally been highly specialized will continue to see slower growth (see Figure 14). Statewide, OEA expects that the emerging (fourth quintile) industries are expected to see the highest rate of growth, indicating that regionally some sectors of strength are expected to grow rapidly, while some of the lagging sectors are also expected to grow to more closely aligned with national concentrations. This broadly parallels the expectations about slower growth in the labor force in regions outside of the urban corridors, which continue to be highly dependent on natural resources and manufacturing to support the local economic base.

Figure 14. Statewide Employment Forecast 2018-2028 by Industry Concentration
Source: Oregon Office of Economic Analysis

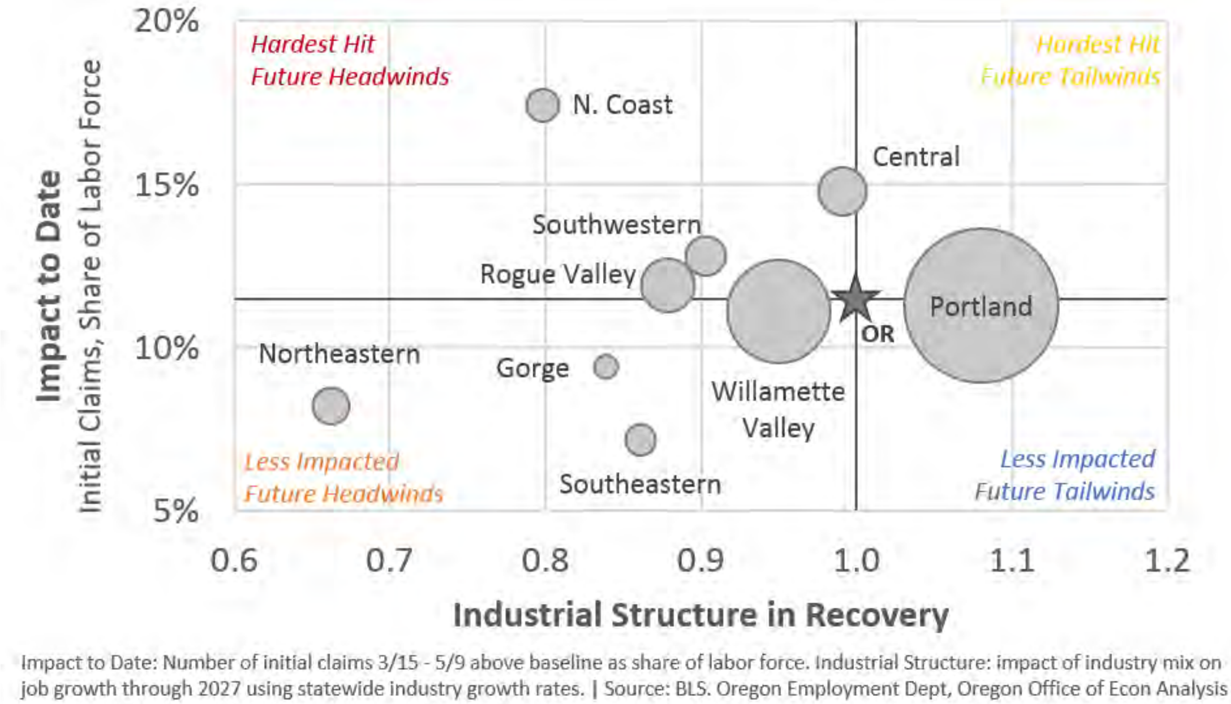
While rural regions of the state face ongoing and future challenges with changing economic conditions that impact the local labor force, the Portland Metro and Central Oregon are becoming increasingly diverse (see Figure 15). Industrial diversity is important because it helps a region's economy withstand economic shocks. Regional diversification compared to state and national concentrations) is important within the context of OTP/OHP because it will impact the demand for transportation compared to the current system demand statewide.

Figure 15. Pace of Industry Diversification by Region relative to State Average
Source: Oregon Office of Economic Analysis



The current Covid-19 pandemic gives us an opportunity to evaluate the regional impact of a catastrophic economic shock (see Figure 16) and the disparities in Oregon's regional economies. While industrial diversification has made Oregon more resilient than in recent economic downturns, much of those benefits accrue to the Portland Metro, Central Oregon, and the Willamette Valley that rely on the business and professional services sector where Oregon sees increasing growth and specialization. Conversely, Northeast Oregon which is highly specialized in traditional natural resource extraction and manufacturing is anticipated to see limited future opportunities for growth by OEA.

Figure 16. Covid-19 Job Losses by County compared to Industry Diversification
Source: Oregon Office of Economic Analysis



Recommendations on regional transportation demand

Oregon's demographic trends and economic structure have changed rapidly since 2000 and is expected to continue into the foreseeable future. The uneven growth around the state reveals a diverse set of challenges for communities across the state. In order to effectively address the unique mobility needs for each region, we recommend incorporating regional indicators that are highly correlated with key drivers of transportation demand. We believe the indicators we include here are important because they can effectively be tied into scenario planning for the OTP/OHP process, however, they are not exhaustive and do not directly incorporate some of ODOT's planning goals, such as equity, which are tied to economic outcomes, but are being explored in other white papers.

Implications for OTP/OHP
- Understanding the distribution of population growth is key to identifying the demographic changes that lead to effective regional policies and infrastructure investment - All regions in Oregon are facing diverse transportation challenges. The increasing demands on urban infrastructure, along with health and safety concerns for rural residents should be considered as part of the OTP/OHP process. - The changing mix of industries growing and declining around the state will also affect the type of transportation investment that will be needed. The OTP/OHP should account for these regional changes to understand how to build scenarios that can help prioritize investments.

CHAPTER 3. ECONOMIC FACTORS IMPACTING THE SUPPLY SIDE

The emphasis of this white paper is on structural factors that drive increased demand for transportation. Increased demand leads to a variety of social costs, including greater levels of pollution, congestion, and increased time delays. Solutions to these social problems cannot be solved without also considering the supply of transportation infrastructure. The supply side of transportation is complex because public investment in fixed assets is often produced through taxes and bonding in the public sector, and often lags changing consumer demand.

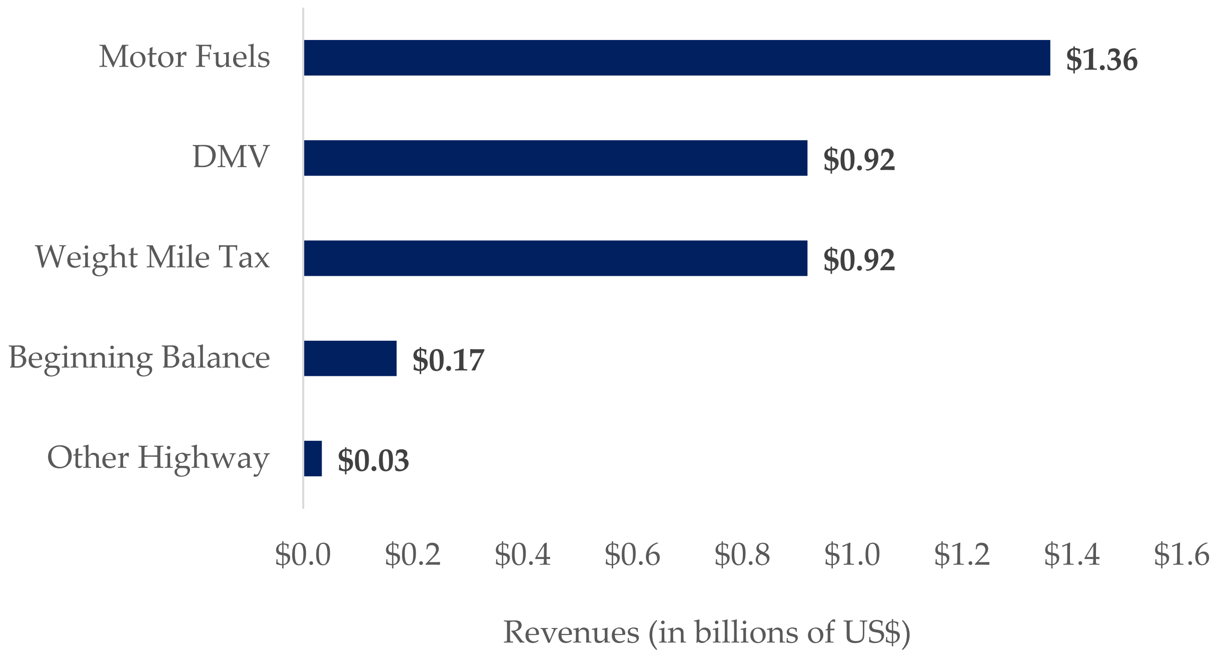
Unlike other goods and services, consumers pay for transportation infrastructure indirectly, which obscures the costs of provisioning roads from the amount of transportation demanded by consumers. Many drivers believe that their tax dollars cover the full cost of transportation infrastructure. Economists frequently discuss how to appropriately value public goods in a way that improves social benefits—transportation financing has a long history of being at the center of that debate.

It is important to be able to evaluate demand for transportation (statewide and regionally) within the context of revenue streams expected to maintain and enhance supply. Infrastructure will deteriorate and investment trade-offs should be evaluated. Tolling, congestion pricing, privatization, and innovative tax instruments have all been proposed as solutions for increasing revenues and the supply of transportation infrastructure, while also moderating demand. Evaluating the broad range of potential solutions for increasing investment in transportation infrastructure is outside the scope of this white paper, however, it does help frame the challenges faced by State DOT's who are charged with managing increasing load (VMT) on their facilities.

Financing highways in Oregon

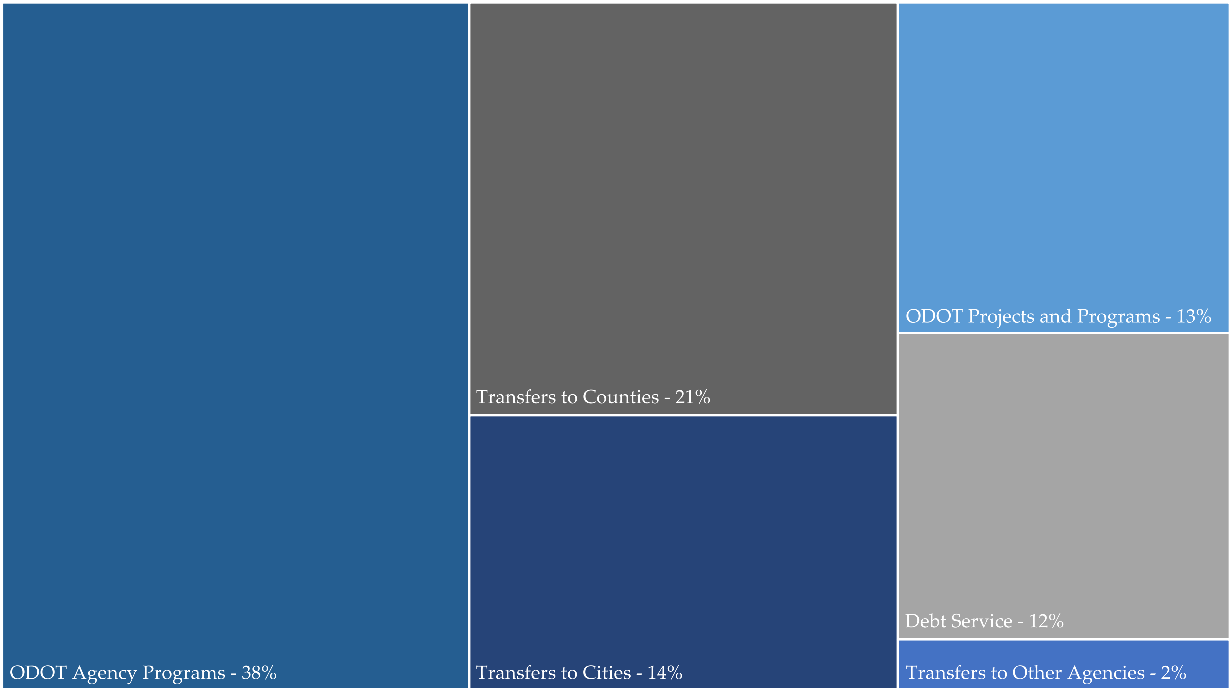
Like other states, Oregon receives federal funding for highway construction projects based on a set formula for distributing federal fuel tax and heavy vehicle taxes. The majority of the funding for state roads comes from state fuels taxes and registration fees, though a smaller share derives from taxes on cigarettes, lottery funds, and other state fees. In 2017, the Oregon State Legislature also created revenue sources from the sale of new cars, payroll taxes, and new bicycles. The Legislature also approved a sliding registration fee based on fuel efficiency to help offset revenue losses to the fuel tax. Figure 17 displays the anticipated distribution of the $3.4 billion in highway revenue approved by the Oregon Legislature for the 2019-2021 budget.

Figure 17. State highway revenue for the 2019-2021 budget
Source: Oregon Department of Transportation



The Oregon State Constitution requires revenues generated through the State Highway Fund be spent on road construction and maintenance, along with mobility improvements in the highway right-of-way. Oregon governs the State Highway Fund using the concept of cost responsibility. Broadly, this means that the state collects a fair share of revenue from each highway user class that are proportionate to the costs they impose on the state highways. Functionally, the revenues are distributed through the state's Statewide Transportation Improvement Program, which incorporates cost responsibility and long-rage planning goals from the OTP and OHP, with a public review process for selecting and allocating funding to transportation investments. Figure 18 displays how the Oregon Legislature intends the $3.4 million in Highway Fund revenues be dispersed during the 2019-2021 biennium.

Figure 18. State highway fund disbursements for 2019-2021
Source: Oregon Department of Transportation



Headwinds in financing Oregon's highways

Despite Oregon's intentional approach to investing in the state's transportation infrastructure, Oregon faces several challenges in the future. Since year 2000, Oregon's population has seen dramatic growth from 3.4 million residents to 4.2 million residents (a 22 percent increase). Over that same period, VMT increased from 33.9 billion miles to 36.8 billion miles (an 8.8 percent increase). During that time state-owned lane miles have remained flat.

Considering a range of factors to contribute to stresses on existing infrastructure, many roads will require additional preservation to extend their lifespan. Half of Oregon's bridges were built prior to 1970 and were designed to handle smaller loads than current mobility demands.[7] Recent information about a Cascadia Subduction Zone event has increased the need for seismic upgrades to mitigate risks to human life and minimize disruption to the state's economy. Rapid changes in the climate also increase vulnerabilities to the state's infrastructure from coastal erosion, rock fall, landslides and increased flooding pose risks to communities around the state.

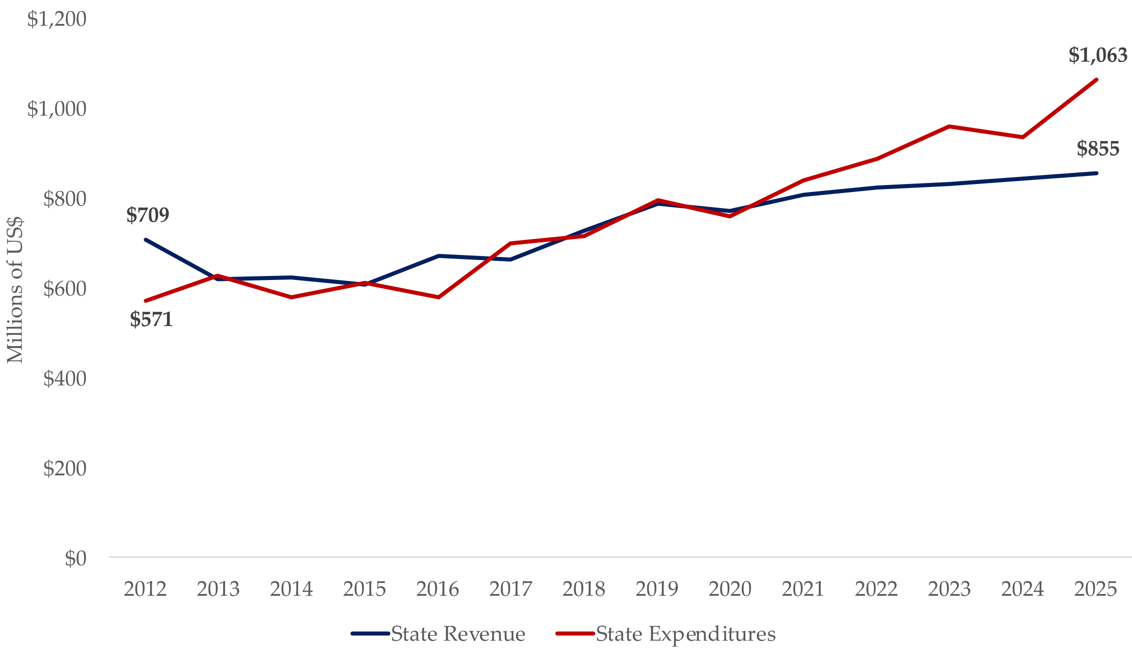
Economic and technological changes too, may require innovative tools to finance transportation infrastructure in the future. Recent changes from the Coronavirus pandemic have led to dramatic changes in mobility requirements for workers, with new technologies that have allowed many office workers to shift to remote work.

[7] Oregon Department of Transportation. 2019 Bridge Condition Report and Tunnel Data. Retrieved at: https://www.oregon.gov/odot/Bridge/Documents/Bridge-Condition-Report-2019.pdf

Though it's too soon to know how many of the changes are permanent, the ongoing impact of alternative work arrangements combined with social distancing are expected to depress revenues and require greater use of the budgetary reserves[8]. For ODOT, declining traffic statewide volumes are expected to reduce motor fuel revenues in the short run, which are important revenue source of the Highway Fund.[9] Long run shifts toward more fuel efficient and electric vehicles all are expected to reduce the efficacy of motor fuel taxes as a revenue source for transportation investments[10].

Prior to these recent shocks, long run forecasts suggest that the expected revenues from existing financing instruments will not be sufficient to cover the costs of maintaining the state's existing roads and bridges. According to a recent study, maintaining the existing infrastructure to meet today's standards would require $2.6 billion over 20 years[11]. Current forecasts predict revenues to increase by 2% annually, while costs increase by 6% annually, making operating and improving facilities particularly challenging (See Figure 19).

Figure 19. ODOT State Highway Fund revenue cash position (April 2020)
Source: Oregon Department of Transportation



8 Oregon Economic and Revenue Forecast. June 2020. Oregon Office of Economic Analysis. Retrieved from: https://oregoneconomicanalysis.com/2020/05/20/oregon-economic-and-revenue-forecast-june-2020/

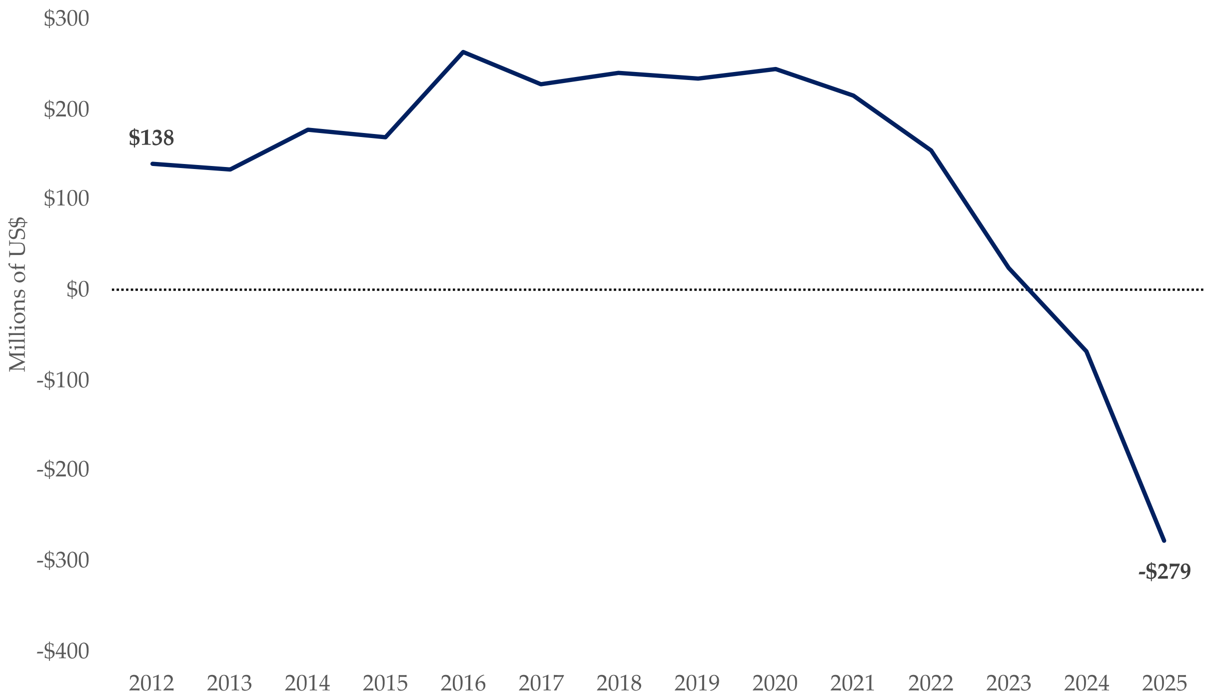
9 State Highway Fund Transportation Revenue Forecast. Oregon Department of Transportation. Retrieved from: https://www.oregon.gov/odot/Data/Documents/April-2020-Forecast-Report.pdf

10 Oregon is exploring programs like OReGO that would help the state move away from fuel taxes by implementing a pay-per-mile tax of 1.8 cents per mile for light-duty passenger vehicles.

11 Oregon Department of Transportation. Rough Roads Ahead 2. Economic Implications of Deteriorating Highway Conditions. February 2017. Retrieved at: https://www.oregon.gov/odot/Planning/Documents/Rough-Roads-Ahead-2.pdf

Increasing costs and changing conditions that dampen the effectiveness of existing revenue instruments will require new approaches to financing the state's transportation system[12]. Under the state's current forecasts, the state's highway fund is expected to be drawn down to $0 in the 2021-23 biennium, leading to a $300 million shortage through 2025. The rapid decline in available revenue, especially for operations and maintenance costs associated with transportation infrastructure will require that the State of Oregon weigh the trade-offs of delaying investments in transportation infrastructure against increasing taxes and fees during a period of economic uncertainty.

Figure 20. ODOT State Highway Fund anticipated balance (April 2020)
Source: Oregon Department of Transportation



Transportation supply and implications for OTP/OHP

In the context of the OTP and OHP, the existing tax revenue instruments will be increasingly inadequate in the future. Increasing resource scarcity for investment suggest that Oregon develop new approaches for evaluating statewide and region transportation demand while balancing costs and revenues to maintain and enhance existing public assets. Incorporating regional analysis that weigh the value of increased public benefits relative to investment costs is often a recommended approach to systematically and transparently allocating public resources. Subsequently, developing alternative financing mechanisms that serve multiple goals of efficiently raising

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[12] The Highway Fund is a dedicated fund that comes from user fees only. Oregon does not invest general funds in the transportation system, so there is not currently a revenue instrument that allows the state to adapt to rising fuel efficiency or to account for other stated transportation goals, such as reducing greenhouse gas emissions.

revenues while moderating demand is an important consideration for developing a sustainable transportation system.

Implications for OTP/OHP

- Total lane miles have remained flat for the state's facilities, while population growth and environmental changes have placed increasing stresses on the state's aging roads and bridges.
- Changing consumer preferences will impact the efficacy of existing revenue instruments and will not be to be enough to maintain enough investment in the state's transportation infrastructure in the future.
- With declining revenues and increasing demand, the OTP/OHP process should emphasize strategies that guide prioritization of transportation investments and demonstrate which investments result in the largest public benefits.

CHAPTER 4. SCENARIO PLANNING AND UNCERTAINTY

Scenario planning: helps decision-makers identify critical uncertainties associated with a range of policies and investment choices related to operating and maintaining the transportation system. Importantly, these scenarios can help policymaker understand how exogenous (and uncertain) forces will affect the drivers of transportation demand and supply. The scenarios alone cannot evaluate the efficiency of a given policy choice, but they help enforce discipline in the process of exploring choices, so that policies can be as thoughtful and comprehensive as possible.

This chapter begins the process of tying together the data about the key drivers with realistic but hypothetical understanding of the exogenous forces that will be acting on the system in the future to explore key themes that should be explored in the scenarios. For the purposes of this white paper, we organize the scenarios around major themes that should be considered for further exploration in the coming OTP / OHP update, along with a rationale for each.

Theme 1: Land use and density

Why explore this theme?

Location of origins and destinations is key; changes in those will greatly affect where capacity is needed. This relates to urbanization and population growth topics discussed throughout the report. Decisions about land use should be tied to an understanding of where transportation capacity is available, and transportation investment policies should respond to where growth is likely to occur.

How is this related to demographic and economic drivers?

This theme has a strong relationship with population growth and commuting patterns. The availability of land for development across the urban fringe and rural areas throughout Oregon drive household and business location decisions.

What transportation questions are connected to this theme?

- Roadway capacity and congestion
- Accessibility and connectivity
- Parking supply
- Connection of housing and transportation

Theme 2. Changing Nature of Freight

Why explore this theme?

Shifts in purchasing preferences are already having impacts on transportation network and will continue to do so in the future. On-demand delivery services are changing the economics of freight and contributing to increased loads on the state's highway infrastructure. In order to remain competitive in a global market, the transportation networks accessed for moving freight need to be efficient and reliable. Additionally, the growth in road use by trucks needs to be accounted for in Oregon's Highway Cost Allocation Study.

How is this related to demographic and economic drivers?

Freight is related to industrial composition and concentration and where those changes are occurring around the state. Additionally, it is relevant for any discussions about current and future commodity flows (see Technical Appendix) and how those commodities will be moved to and from regional markets.

What transportation questions are connected to this theme?

- Changes in supply chain management (growth in smaller service-based deliveries)
- Capacity / congestion
- International trade (increasing reliance on global goods and services)
- How are delivery vehicles (especially those in the 10,000 – 26,000 weight class) increasing costs and congestion on Oregon's roads?
- Changes in mode shift for freight across the multimodal network

Theme 3. Long Run Structural Changes in the Economy

Why explore this theme?

The growth of emerging industries and decline of traditional industries in Oregon will impact the types of investments that will need to be made to support future economic growth. Understanding these regional changes and demand for transportation across industries will help the state develop and effective strategy for prioritizing investments that contribute to the economic well-being of Oregon.

How is this related to demographic and economic drivers?

This theme is foundational and incorporates all the demand drivers discussed in the white paper. Long run structural changes in the economy are influenced by changes in household and industry demand for transportation, impacting revenue streams and the financing of highway and multimodal infrastructure.

What transportation questions are connected to this theme?

- Revenue
- VMT changes
- Interaction with industry clusters
- Capacity / congestion / reliability

Theme 4. Resiliency and Exogenous Shocks

Why explore this theme?

Resilience is a topic that is growing in importance across multiple disciplines. Investing in transportation infrastructure that is resilient to natural disasters and climate change will help the state's economy recover more rapidly after an event. Additionally, recent changes such as the COVD-19 pandemic are affecting how and where we work and may require consideration of new mobility challenges in the face of this and future public health crises.

How is this related to demographic and economic drivers?

Population growth, aging and mobility needs, and the location of industry clusters are all key drivers that feed into any discussions about resilience of the transportation network and the ability of the state's regional economies to respond after a major natural disaster.

What transportation questions are connected to this theme?

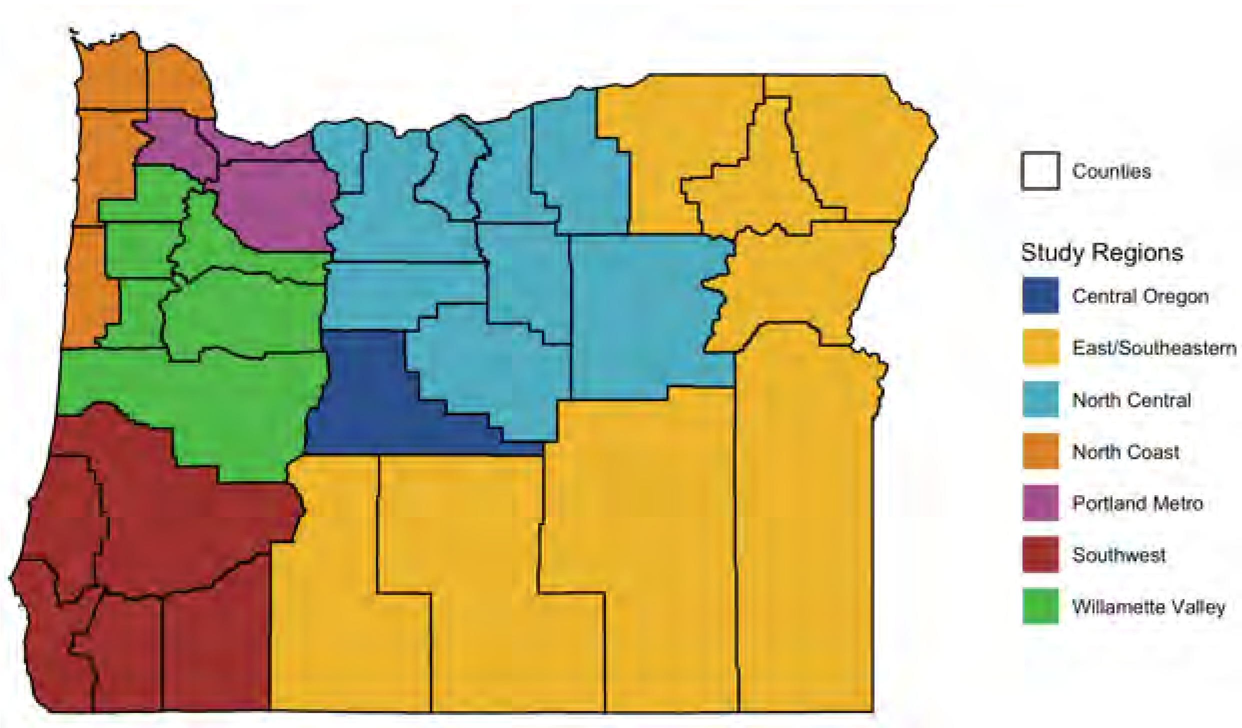
- Economic competitiveness
- Structure of the Oregon economy
- Revenue
- VMT changes
- Interaction with industry clusters
- Capacity / congestion

APPENDICES

APPENDIX A. PROJECT OVERVIEW

The following technical appendices will serve as the foundation for the technical memorandums investigating past and futures economic and demographic drivers of transportation demand throughout Oregon. In previous Oregon Transportation Plans and Highway Plans the state was evaluated singularly. That is to say, there were not specific regional analysis conducted or policy differentiation. These memos collectively will investigate regional differences, as such, the following regions will be used to compare past and future drivers for the phase 1 reports.

Figure 1. Study regions with county overlay
Source: ECONorthwest.



Census Public Use Microdata Sample (PUMS) data was used to construction regions so that annual data could be obtained along with lower margins of error. PUMS data is only available in PUMA geographies—several PUMAs were combined to create the 7 proposed regions. The effectiveness of these regions will be evaluated at the completion of the phase 1 reports.

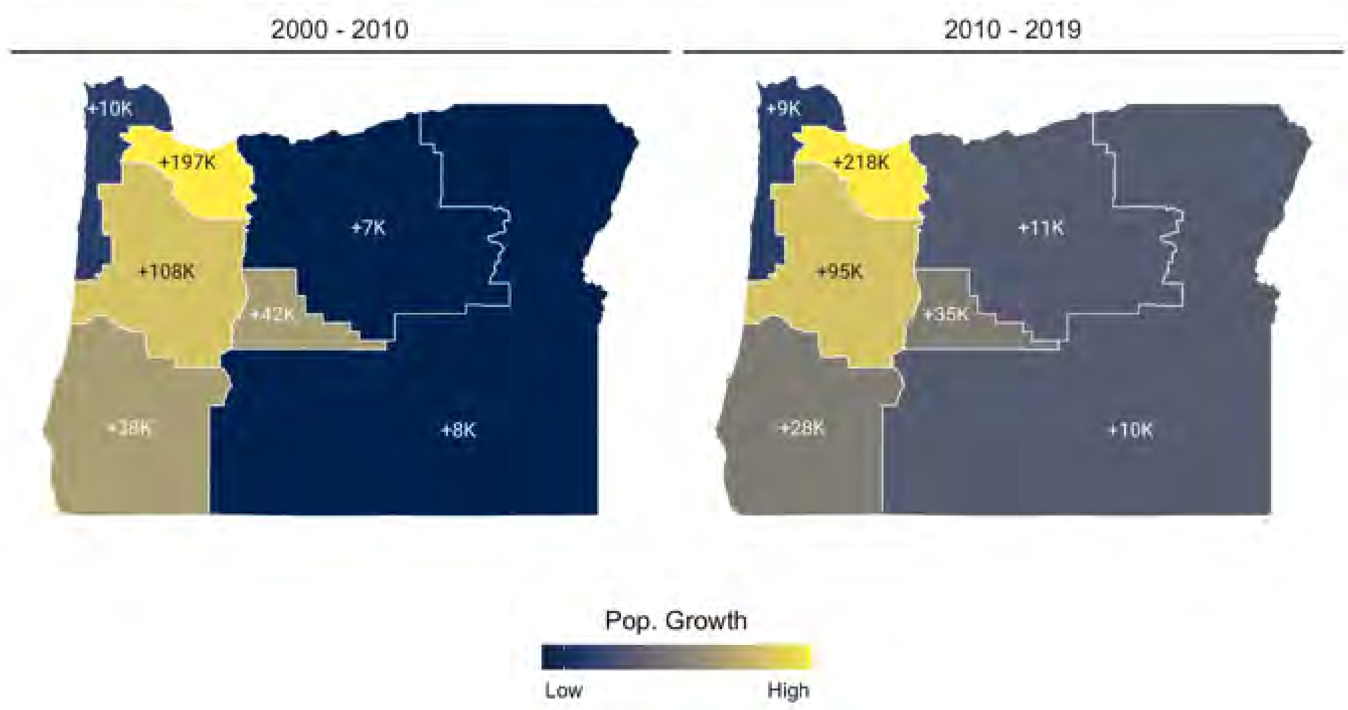
> It should be noted that subsequent to the technical analysis, a determination was made to recommend a slightly different regional configuration. This is discussed in more detail in the preceding chapters. The remainder of this technical appendix uses the regional configuration displayed in Figure 1.

APPENDIX B. DEMOGRAPHICS

Recent demographic trends

Oregon's population increased by approximately 815,000 from 2000 to 2019 period, which is a 24 percent increase. Almost all the growth has occurred in the regions along the I-5 corridor, including the Southwest, Willamette Valley, and Portland Metro regions, in addition to the neighboring Central Oregon region. Figure 3 shows population growth in the study regions for two time periods: 2000 to 2010 and 2010 to 2019. From 2000 to 2010, population growth in the I-5 corridor accounted for 94 percent of the state's total growth. Similarly, from 2010 to 2019 these regions accounted for 93 percent of total population growth.

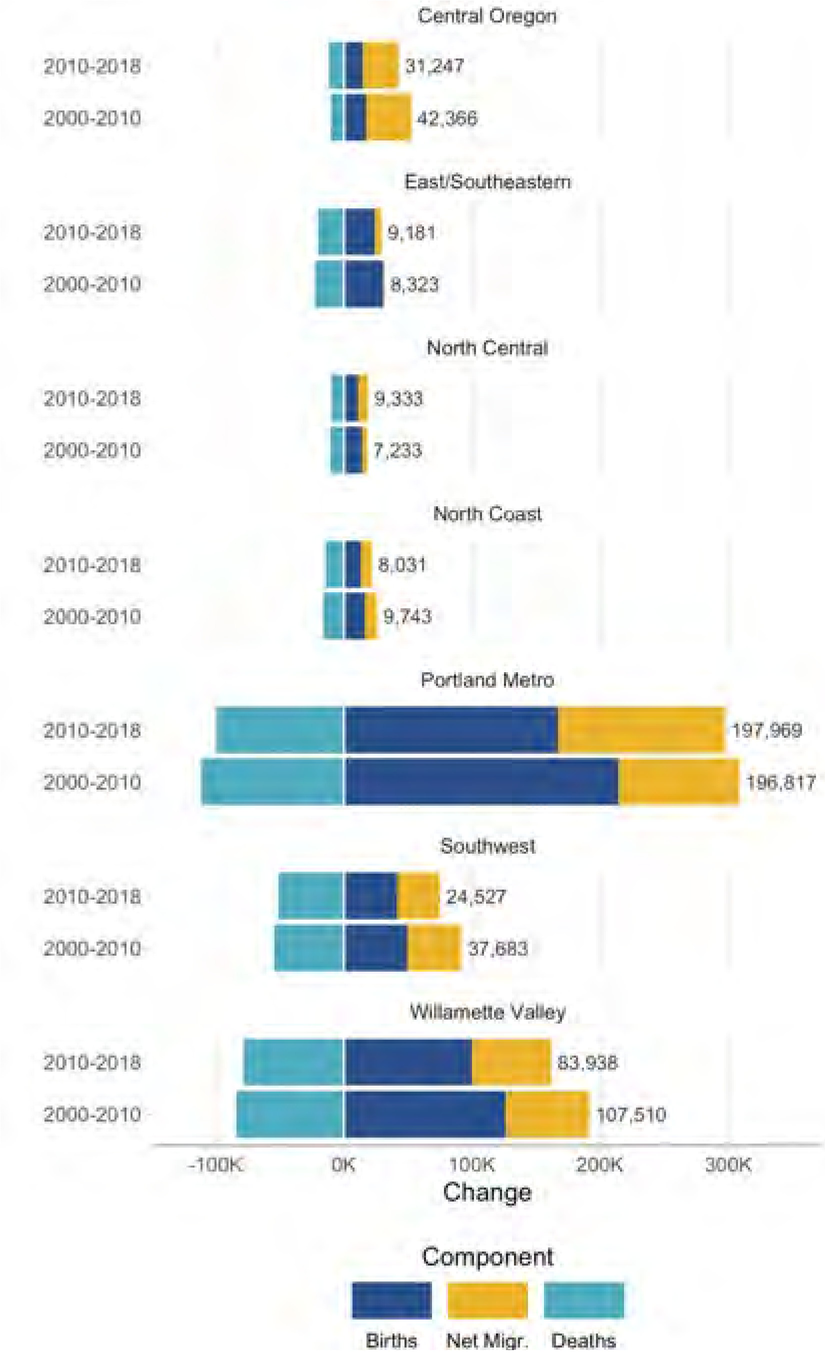
Figure 2. Population growth by region, 2000–2010 and 2010–2019
Source: Portland State University, Population Research Center.



Net migration is the primary driver in population growth across Oregon. In some regions, such as East/Southeastern Oregon, it is less pronounced; however, net migration tends to exceed a region's natural population change (births minus deaths). The Portland Metro region experienced the highest level of net migration relative to all other regions over the 2010 to 2018 period, followed by the Willamette Valley, Central Oregon, and Southwest regions.

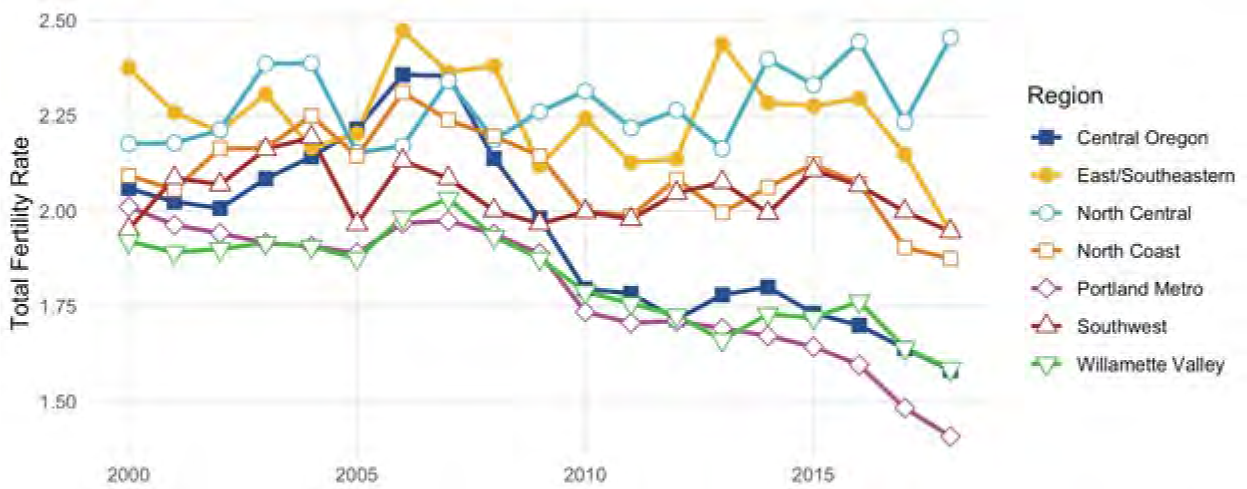
Figure 3. Components of annual population change (net migration), 2000-2010, and 2010-2018

Source: U.S. Census Bureau, Census Estimates Program, 2000-2018.



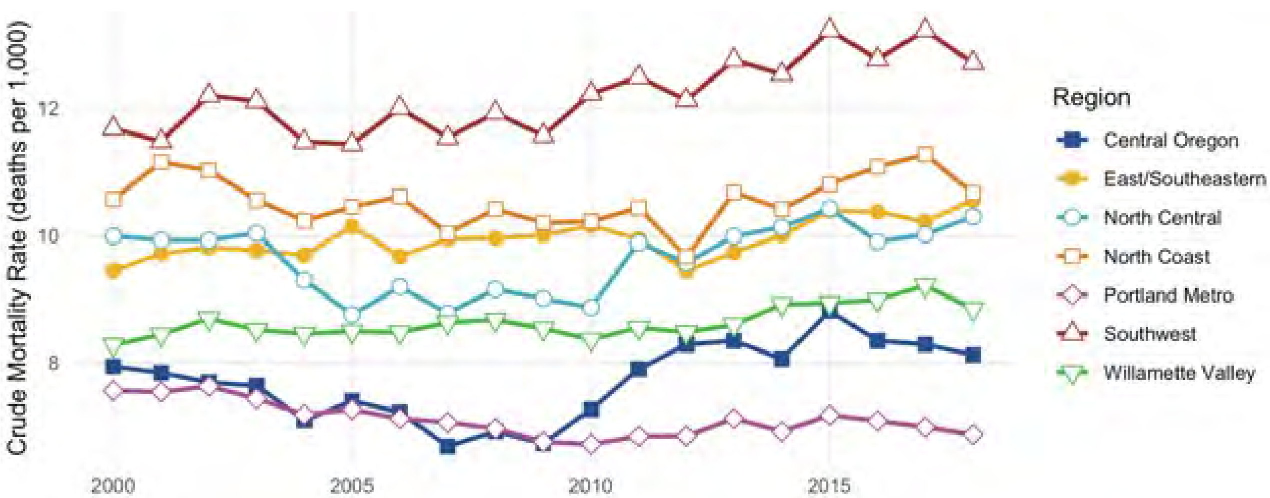
Fertility rates are one leading indicator of population growth. A standard assumption is that a fertility rate of 2.1 suggests that women are giving birth to enough babies to be able to maintain the existing population. Fertility rates have decreased in every region except for the North Central since 2000. The three highest income regions—Portland Metro, Willamette Valley, and Central Oregon—have all experienced the largest decline in fertility rates.

Figure 4. Fertility rate by region, 2000 – 2018
Source: Oregon Health Authority, PSU Population Research Center.



Mortality rates will generally trend upward as populations increase in size and age. Figure 6 displays the crude (not normalized by age across regions) mortality rate by region between 2000 and 2018.

Figure 5. Crude mortality rates by region, 2000 – 2018
Source: Oregon Health Authority, PSU Population Research Center.



The racial and ethnic mix of residents across all regions have become more diverse over the 2000 to 2018 period. Portland Metro region saw the largest change, increasing the proportion of its non-White population by 10 percentage points, followed by a nine percentage point increase in the Willamette Valley, and an eight percentage point increase in both the East/Southeastern and North Central regions.

Figure 6. Race and ethnicity by region, 2000, 2010, and 2018
Source: U.S. Census Bureau, ACS PUMS, 1-Year Estimates, 2000, 2010, and 2018.

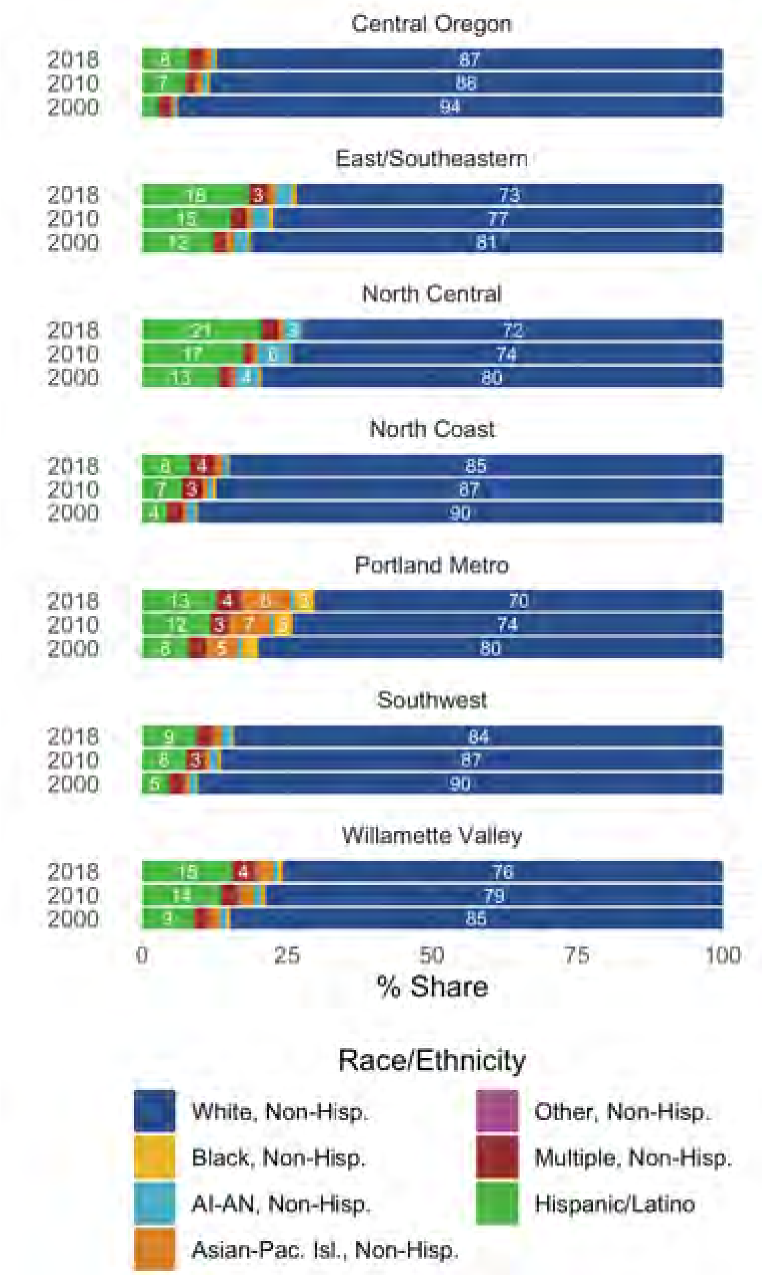
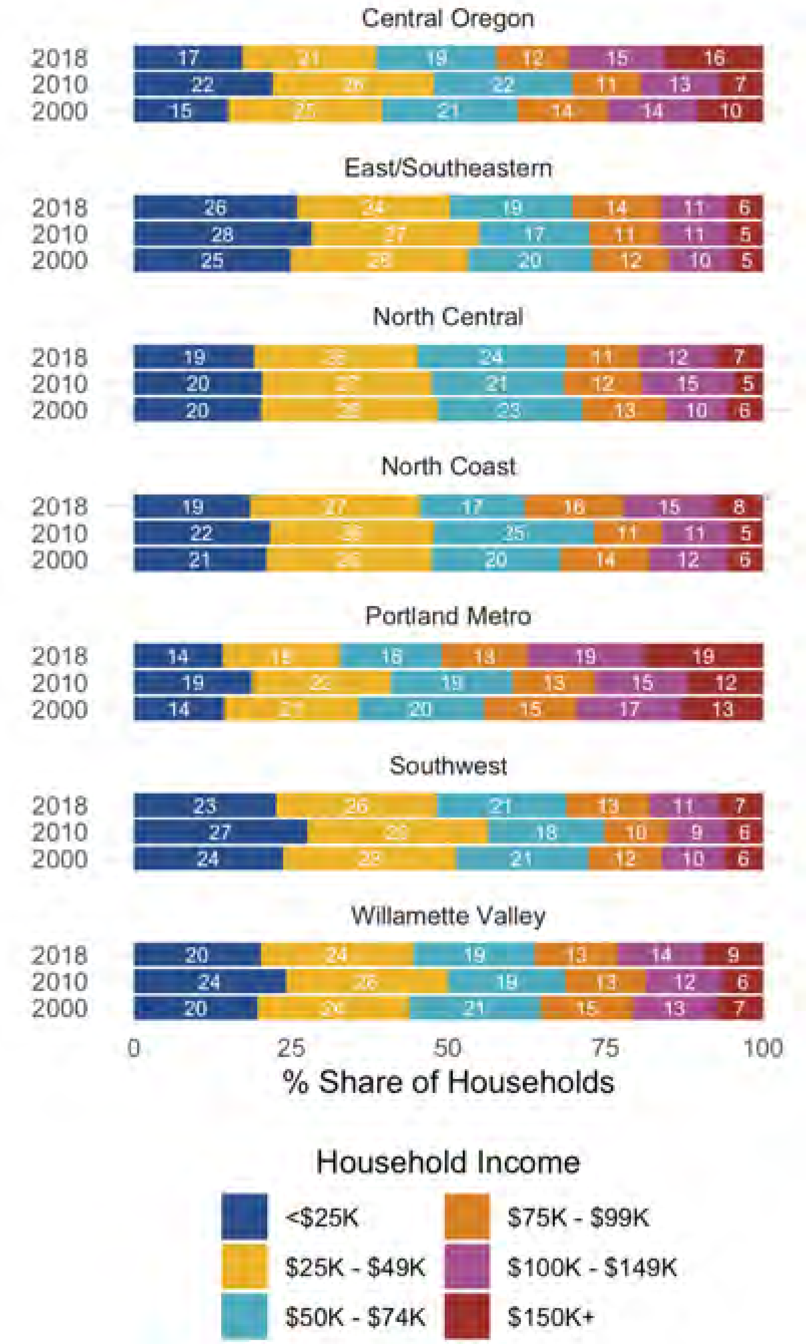


Figure 8 displays how incomes are distributed across households in each income bracket as defined by the U.S. Census. The Portland Metropolitan area and Central Oregon have seen the largest growth in households in the upper ends of the income bracket. This chart does not adjust for the cost of living, and therefore does not account for variation across regions for expenses such as housing or transportation.

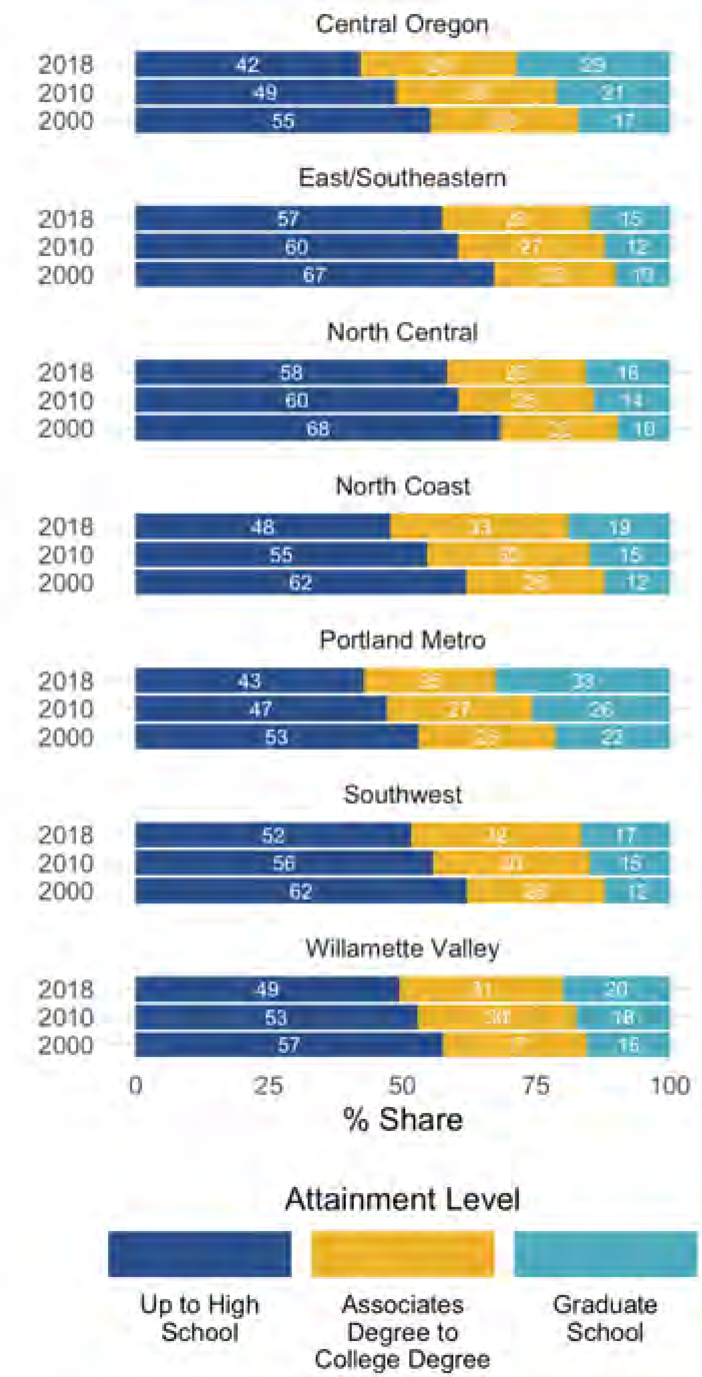
Figure 7. Income distribution by household and income bracket, 2000, 2010, and 2018 (in 2018$)

Source: U.S. Census Bureau, ACS PUMS, 1-Year Estimates, 2000, 2010, and 2018.



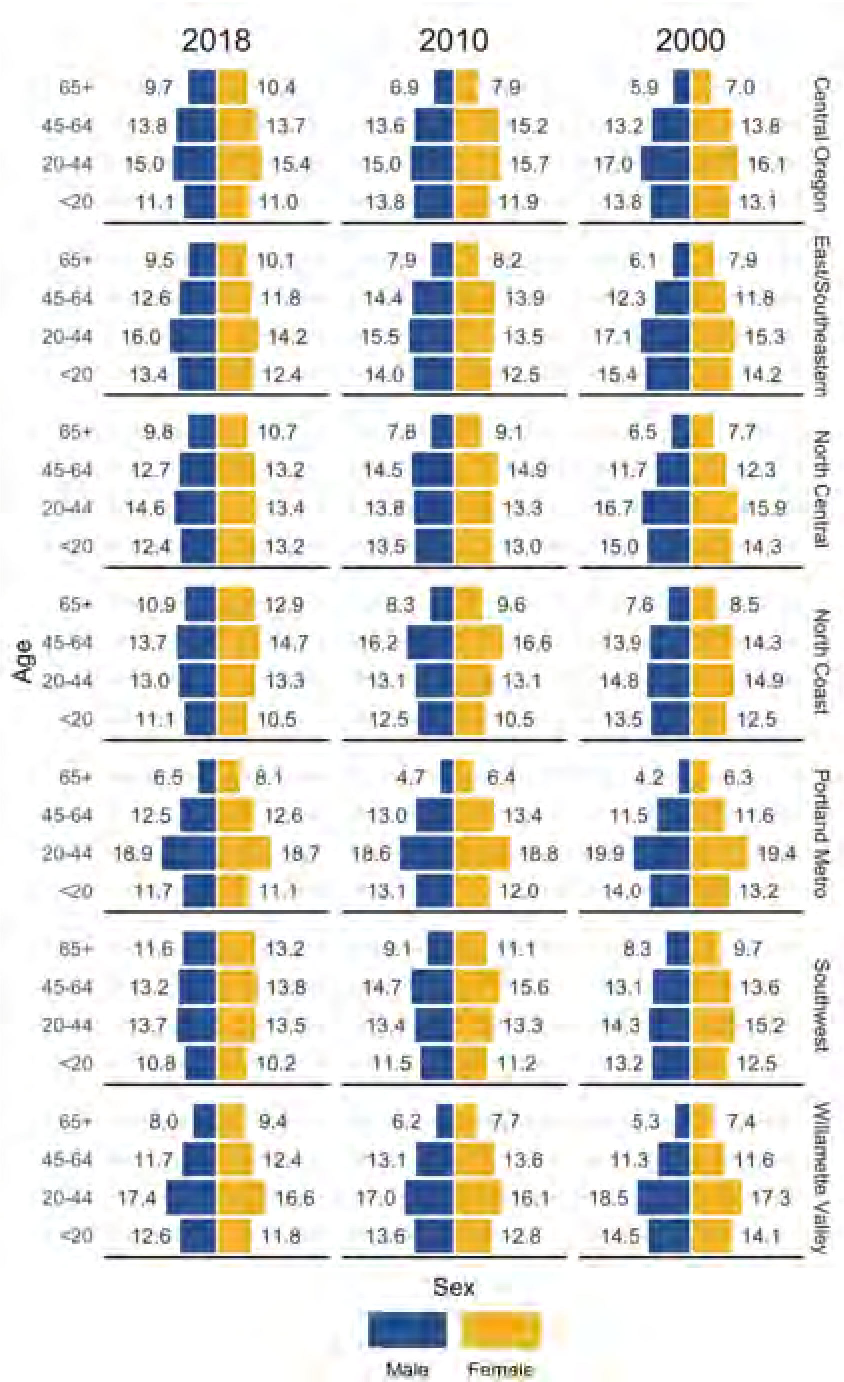
The share of residents with a postsecondary education has increased across all regions during the 2000 to 2018 period. Except for the Willamette Valley, all regions have seen a decrease of at least 10 percent in the share of residents that hold a high school diploma as their highest level of educational attainment. (See Figure 9).

Figure 8. Educational attainment, by region, 2000, 2010, and 2018
Source: U.S. Census Bureau, ACS PUMS, 1-Year Estimates, 2000, 2010, and 2018.



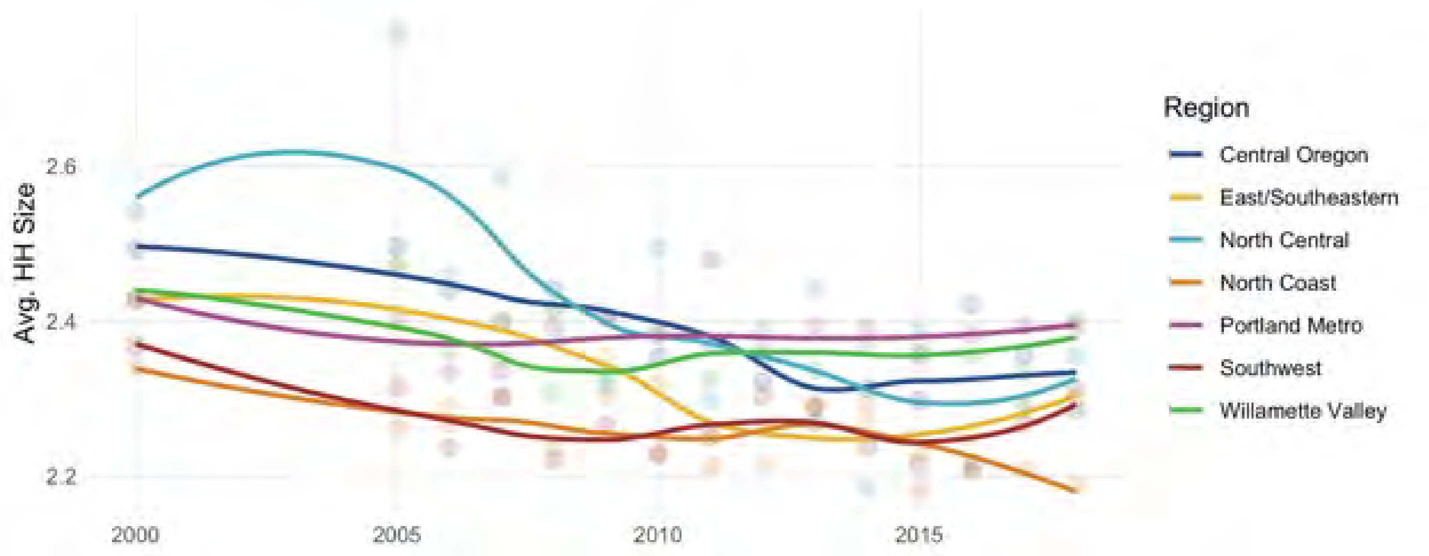
Oregon's population continues to age. Across the 2000 to 2018 time period, the share of residents 65 years and older in each region increased. Residents between the ages of 45 to 64 also increased across this period, less so than for those 65 and older (Figure 10). Age cohorts below the age of 20 and those between the ages of 20 and 44 decreased in size across every region.

Figure 9. Age cohort distribution by region, 2000, 2010, and 2018
Source: U.S. Census Bureau, ACS PUMS, 1-Year Estimates, 2000, 2010, and 2018.



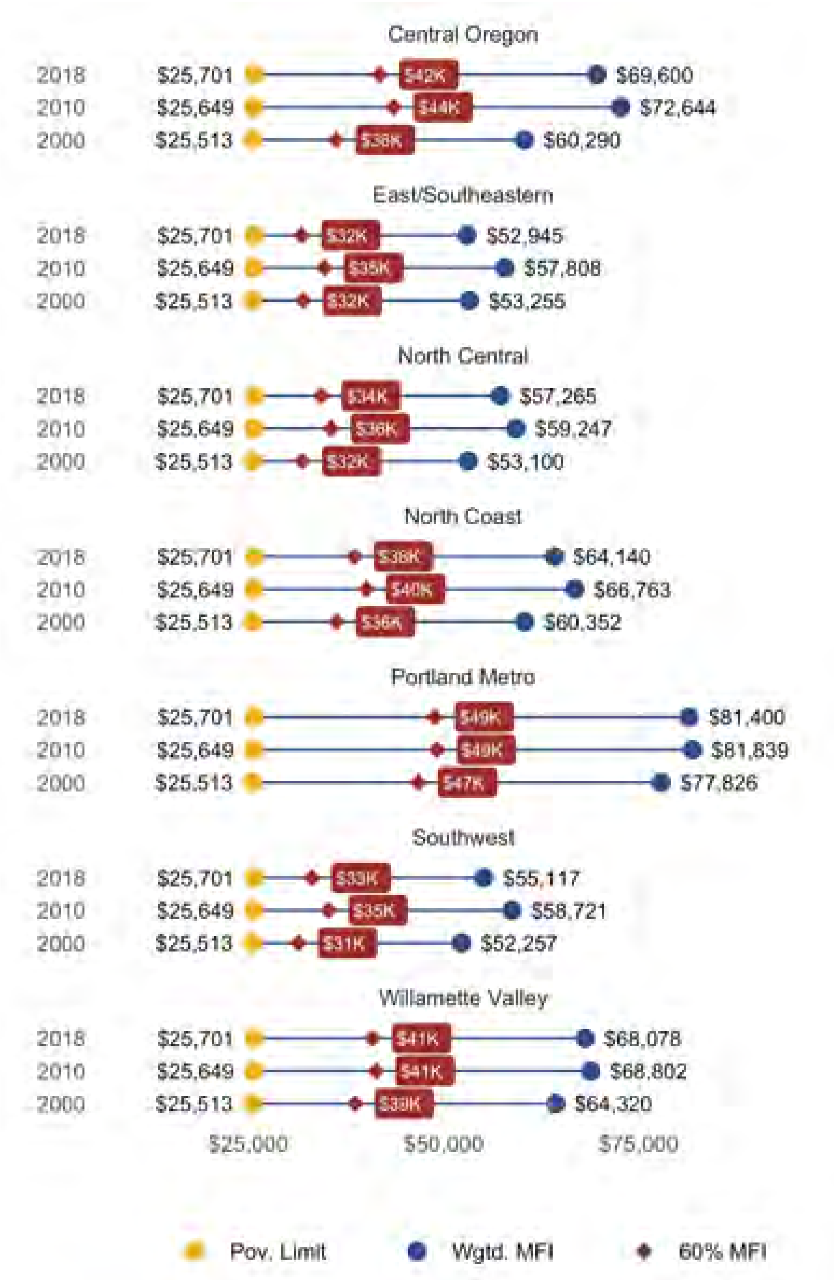
Average household sizes have declined in every region from 2000 to 2018. The Central Oregon, North Coast, and North Central regions experienced the largest declines, decreasing by approximately 0.2 persons per household (Figure 11). In the East/Southeastern and Southwest regions, the average size decreased by 0.1 persons. The Portland Metro had the smallest change, but currently has the largest average household size at approximately 2.4 people per household.

Figure 10. Household size by region, 2000 – 2018
Source: U.S. Census Bureau, ACS PUMS, 1-Year Estimates, 2000 and 2005-2018.
Note: Dots represent actual values reported in PUMS and lines smoothed averages between years.



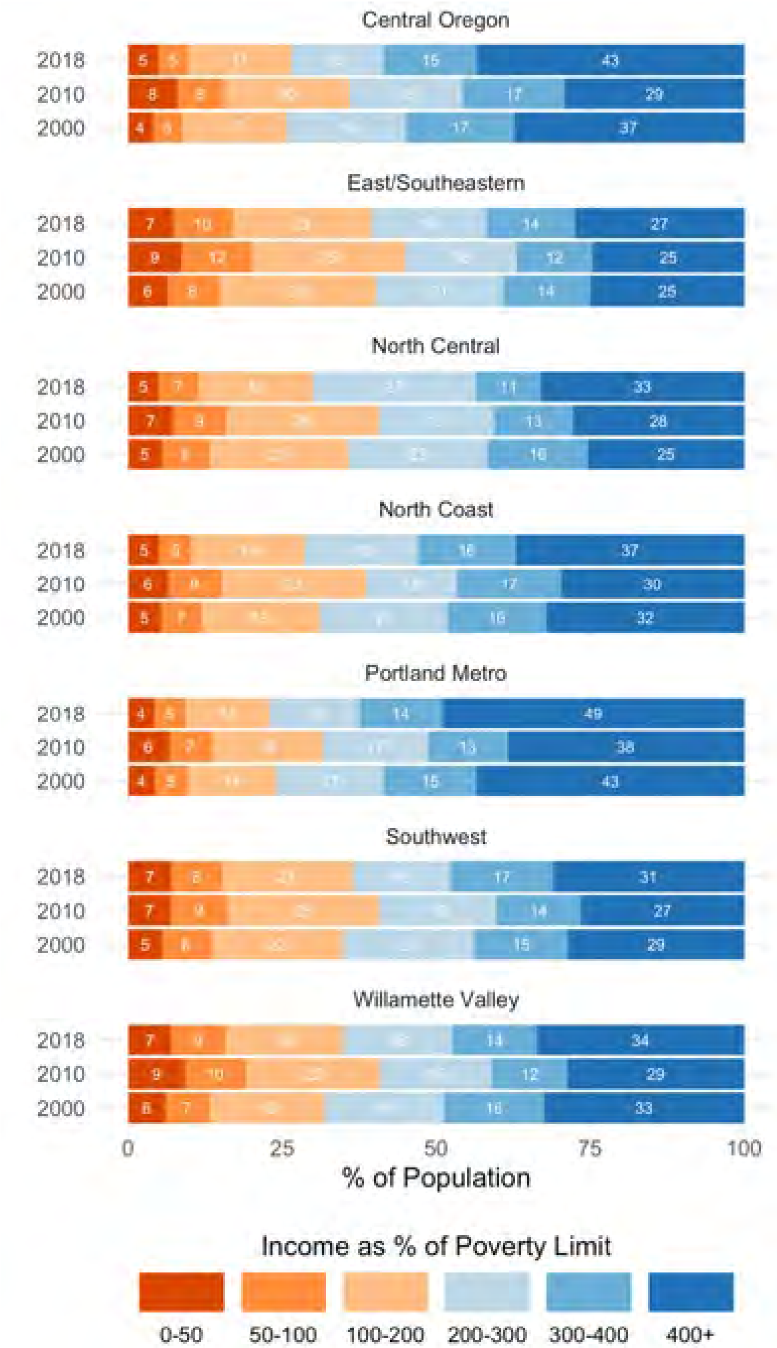
When trying to quantify the concentration of poverty and low-income households in regions across the state, there are two variables that are commonly used—median family income (MFI) and the poverty rate. MFI represents the median income for a family of 4 at the county level. Households earning 60% of less of MFI are eligible for regulated/subsidized housing and is therefore a good measure of low-income households. The second measure is the poverty rate, which is an indicator developed at the state level based on the number of people in a household and doesn't vary across regions within the state. As referenced in Figure 12, 60% of MFI is greater than the poverty rate in all regions.

Figure 11. Median family income (MFI) by region, 2000, 2010, and 2018 (in 2018 dollars)
Source: U.S. Census Bureau, U.S. Department of Housing and Urban Development.
Note: Regional MFI is calculated as the population-weighted average of county-level MFI; Poverty limits are for families of four to conform with HUD's MFI method.



In the Willamette Valley region, the share of residents earning under 100% of the Federal Poverty Limit (FPL) increased by three percentage points, while all other regions saw a decrease ranging from a two percent decrease to no change. The North Central region had the largest decrease (five percent) in its share of residents earning between 100-200% of the FPL relative to all other regions, indicating positive income mobility.

Figure 12. Poverty level by region, 2000, 2010, and 2018
Source: U.S. Census Bureau, ACS PUMS, 1-Year Estimates, 2000 2010, and 2018.

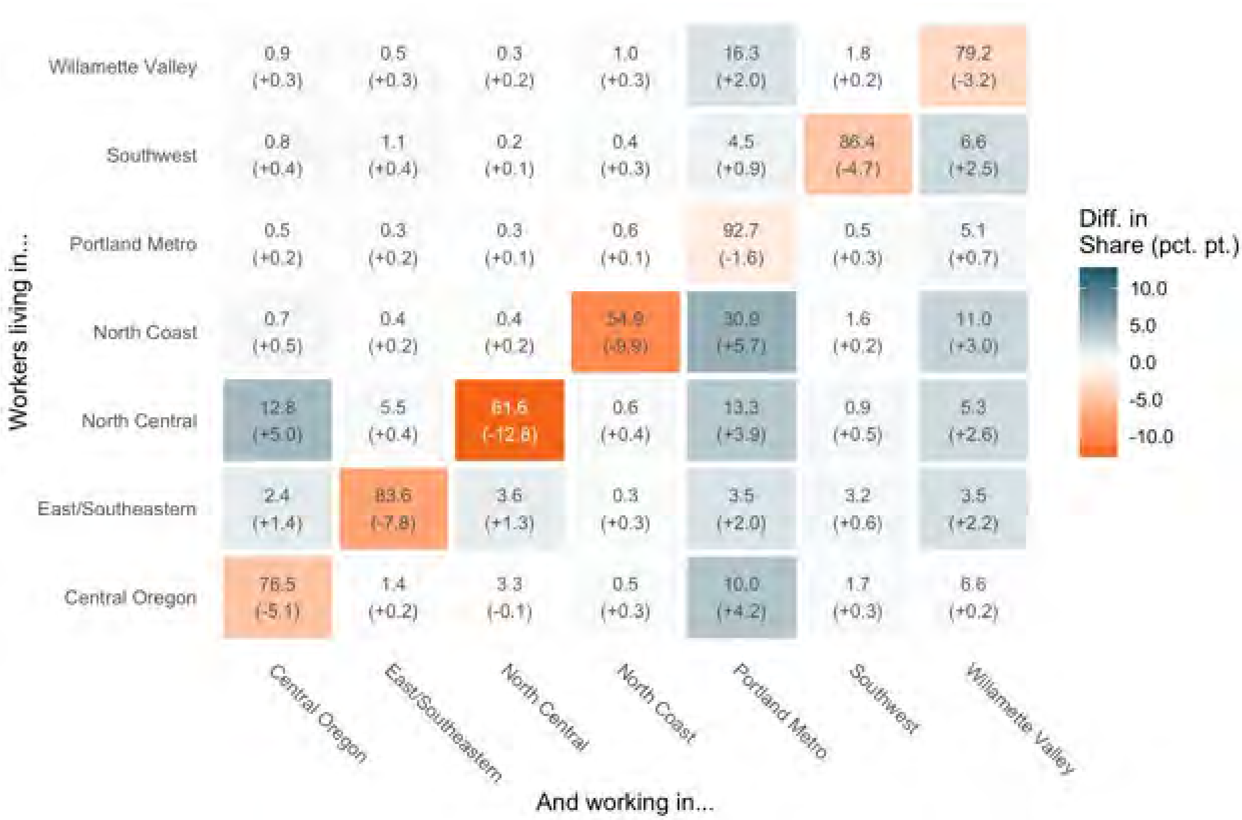


Recent transportation trends

Figure 14 displays trends in job flows across each region. The data shows where workers live relative to their places of employment, providing some understanding around how commuting patterns have changed over time. Broadly, businesses in the Portland Metro have seen the largest increase in workers living in other regions of the state. One caveat with this dataset, however, is that while it can indicate broader trends in commute patterns, it also includes workers that complete some share of their jobs remotely (e.g., telecommute) and may not need to commute often.

Figure 13. Region-to-region commute flow change (as shares of origin region's total out-flow) by region, 2002 - 2017

Source: Longitudinal Employer-Household Dynamics (LODES), 2002-2017.
Note: Commutes are limited to only those occurring entirely within Oregon.



The majority of workers statewide commute to their jobs via private passenger vehicles. In general, this trend has shifted little across the 2000 to 2018 period for all regions. The share of workers in the North Central, East/Southeastern, and the Willamette Valley regions have remained mostly the same over the analysis period. However, the Portland Metro and Central Oregon regions have seen some sizable shifts in the modes of transportation workers take to commute to their jobs. In Central Oregon, the share of employees working from home increased by five percentage points, from eight percent in 2000 to 13 percent in 2018.

Figure 14. Counties included in cross border commute flows
Source: ECONorthwest.

Figure 16 lists cross region commute patterns but does not include any cross-border commute flows. There are several large population and jobs markets near the state border. As such, it is important to quantify the amount of cross state border commuters, as those transportation facilities are often some of the major congestion points in the system. Figure 15 indicates which counties were included to in the measurement of live and workflow across state borders. We include neighboring counties in California, Idaho, Nevada, and Washington.

Figure 16 calculates the share of workers in each region that live and commute from another state from 2002 to 2017. The share of workers commuting from out of state is increasing in all regions.

Figure 15. Inbound cross-border commutes for Oregon, by region, 2002 – 2017
Source: Longitudinal Employer-Household Dynamics (LODES), 2002-2017.
Note: Out-of-state commutes were limited to counties neighboring Oregon.

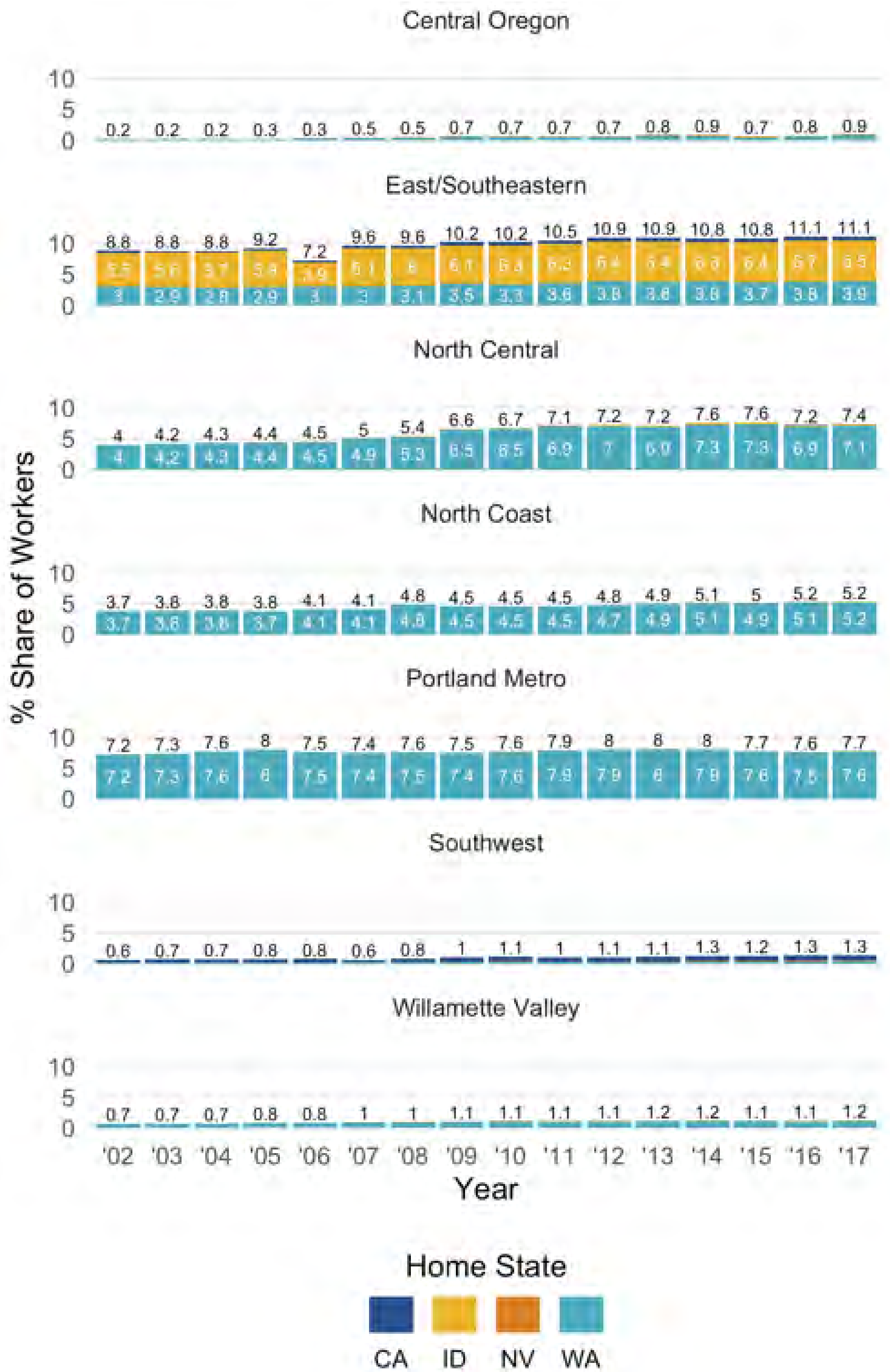
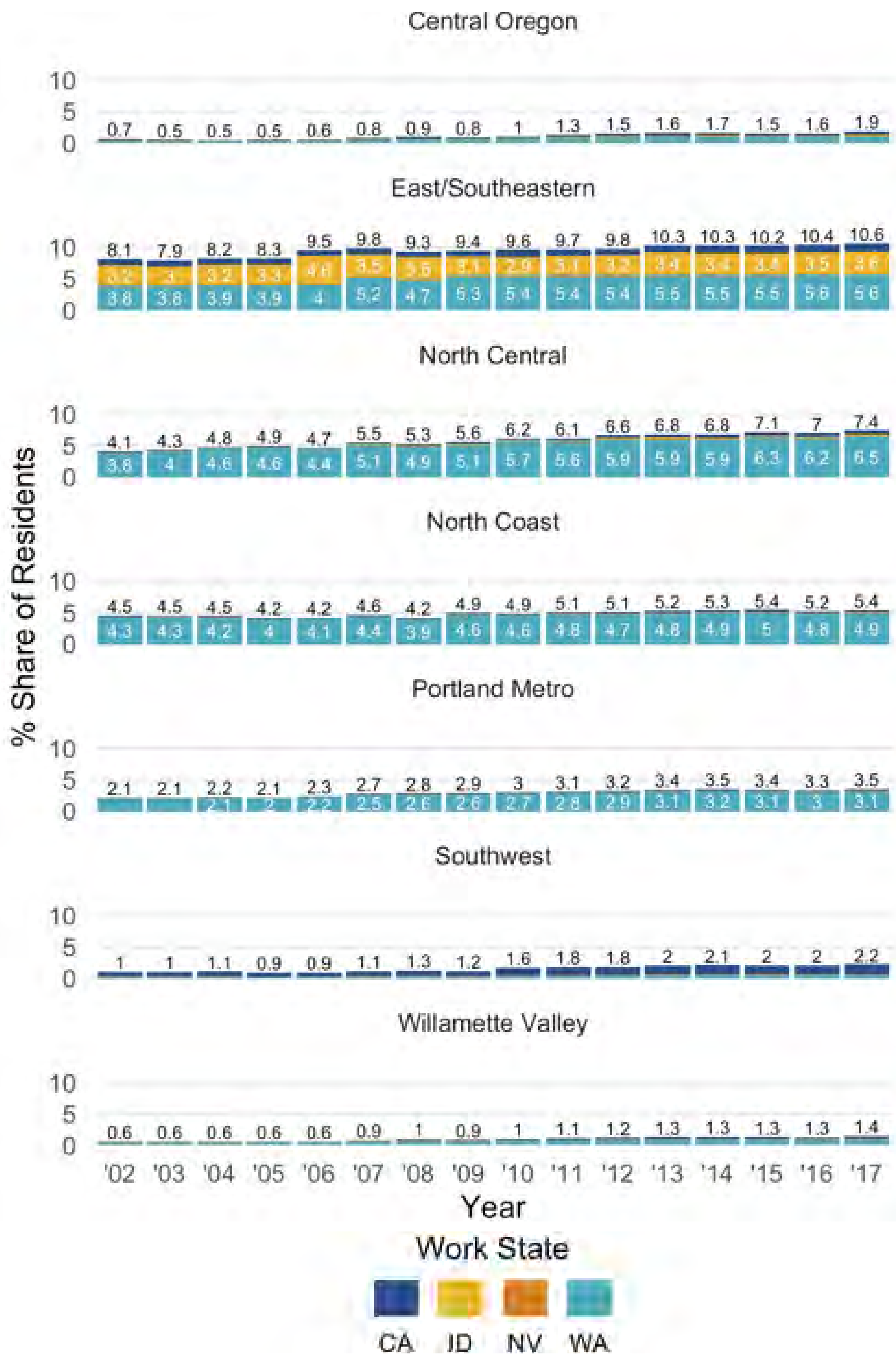


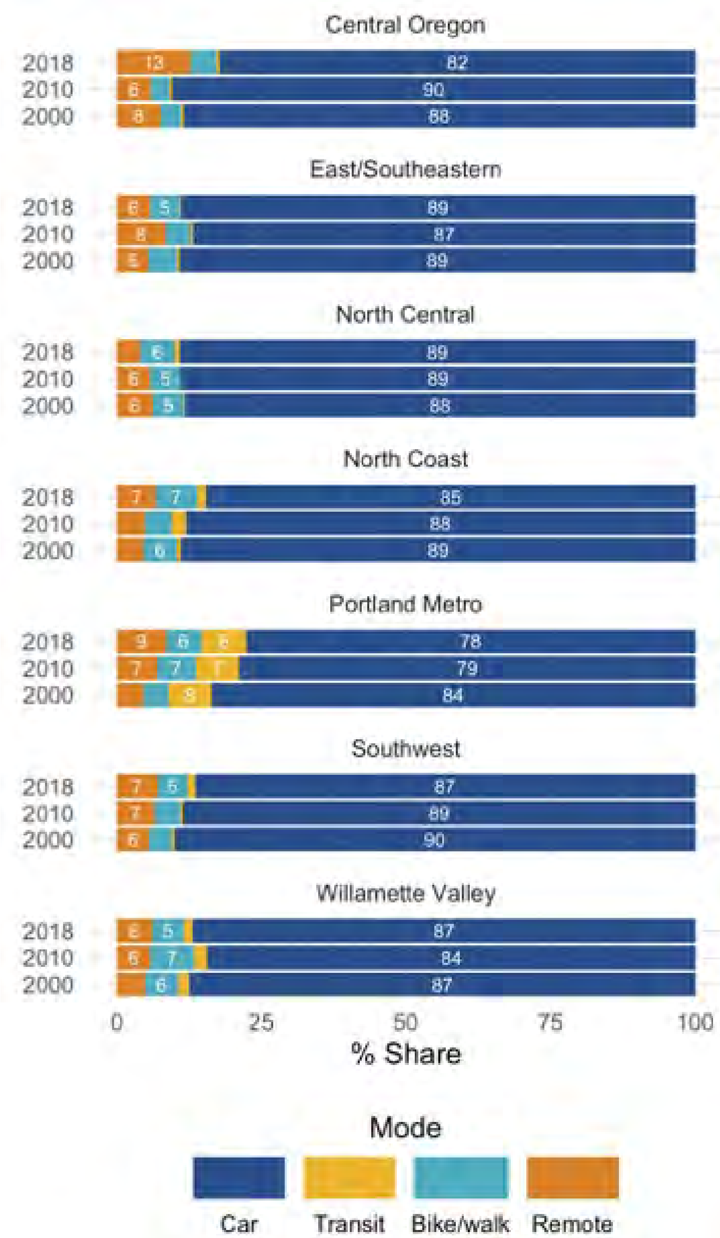
Figure 17 shows the percentage of the population living in each region that works in another state. In all regions except for Central Oregon, more workers commute inbound to the state, than residents leaving the state for employment in another state.

Figure 16. Outbound cross-border commutes for Oregon, by region, 2002 – 2017
Source: Longitudinal Employer-Household Dynamics (LODES), 2002-2017.
Note: Out-of-state commutes were limited to counties neighboring Oregon.



Over the 2000 to 2018 period, the vast majority of workers in all regions commuted to their jobs via private passenger vehicles (Figure 18). During this time, however, there has been a shift toward workers working remotely in certain regions. Of note are the share of remote workers in Central Oregon, which grew by about five percentage points, from eight percent in 2000 to 13 percent in 2018. In the Portland Metro region, the share of those working remote grew from sub-five percent to nine percent in tandem with a bike/walk transit increase of sub-five percent to six percent.

Figure 17. Mode of transportation to work by region, 2000, 2010, and 2018
Source: U.S. Census Bureau, ACS PUMS, 1-Year Estimates, 2000 2010, and 2018.
Note: Estimates represent home-based trips to place of work.

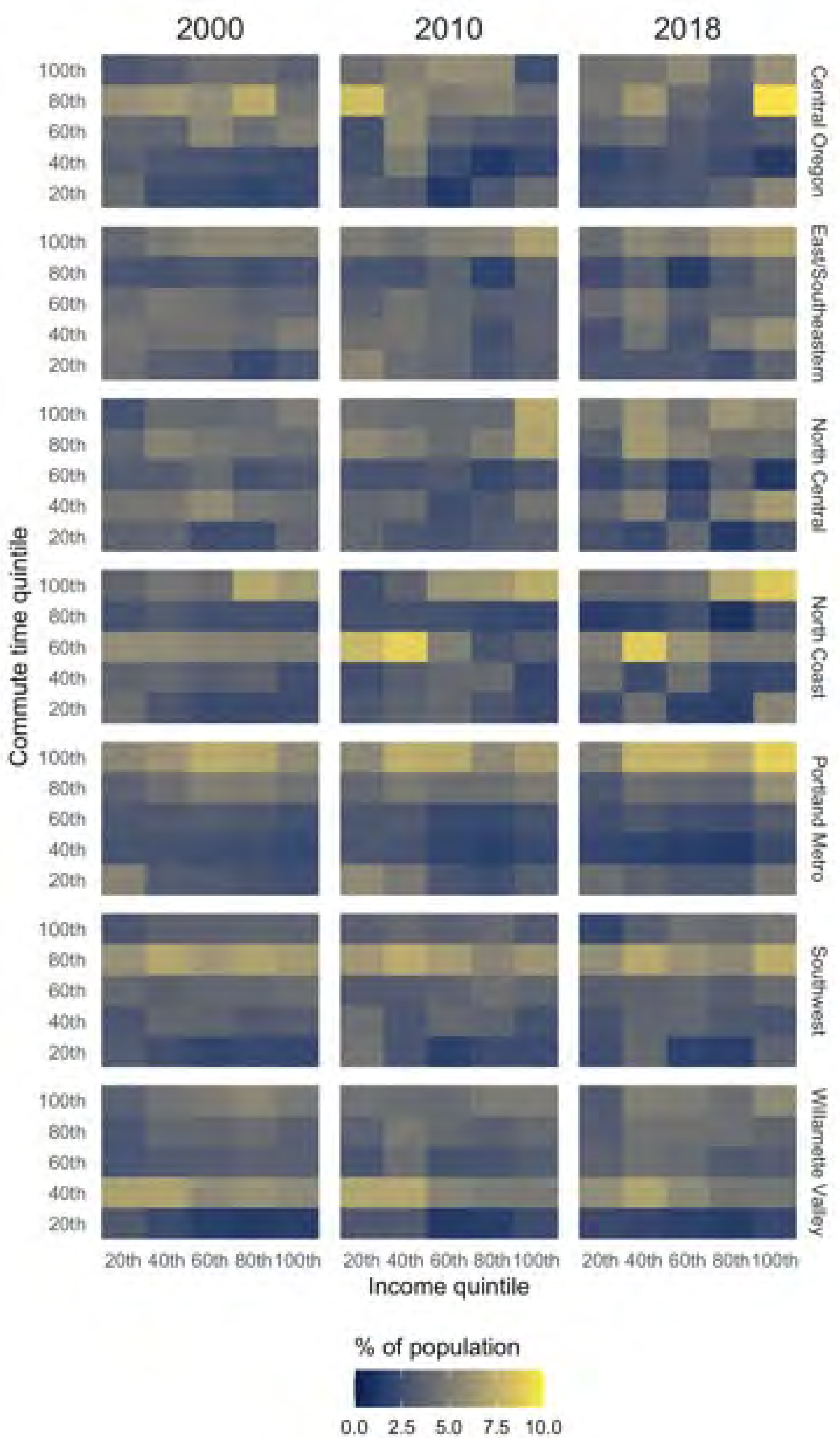


Commuting distances have increased across all regions during the 2002 to 2017 period. The East/Southeastern, Central Oregon, Southwest, and North Central regions all had an approximately 20-minute average commute time in 2002, though over the following fifteen years, these times increased in all regions (see Figure 19). The largest average commute distance increase occurred in the East/Southeastern region, growing by about 74 percent over the analysis period.

Figure 18. Weighted average commute distance by destination region, 2002 – 2017
Source: Longitudinal Employer-Household Dynamics (LODES), 2002-2017.
Note: Distances are geodesic straight-line distances between block groups, and commutes are limited to only those occurring entirely within Oregon.

Figure 19. Commute time by income and region, 2000, 2010, and 2018
Source: Longitudinal Employer-Household Dynamics (LODES), 2002-2017.

Note: Quintiles are region-specific. Income has been adjusted to 2018$

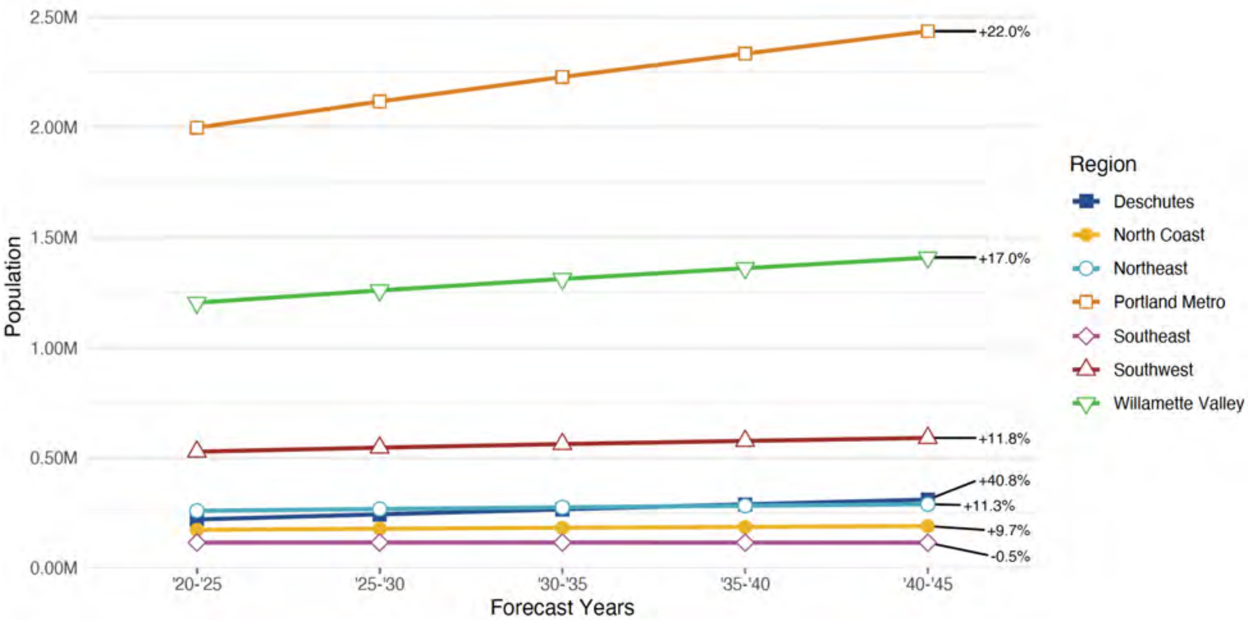


Drivers of future population and demographic trends

The population in all regions is expected to grow through 2045. Figure 21 shows the forecasted population growth in five-year intervals for each region. Central Oregon is expected to grow by 32 percent, with the Portland Metro and Willamette Valley the only other regions forecast to grow by more than 10 percent. All other regions are expected to grow by less than 0.5 percent per year through 2045.

Figure 20. Total forecasted population by region, 2020 – 2045

Source: Portland State University, Population Research Center.



Population growth is sum of births, deaths, and net migration. Figure 22 breaks down each component, for each of the regions, in 5-year increments. With the exception of the birth rate in the Southwest, the rate of growth is expected to slow for all three components of population growth in all regions through 2045. The most impactful decrease is in the projected net migration rate. Given the statewide forecast of negative natural growth (births minus deaths), the state will be entirely reliant on net migration in order to achieve any population increases.

Figure 21. Forecasted average annual population growth by region, 2025 – 2045
Source: Portland State University, Population Research Center.

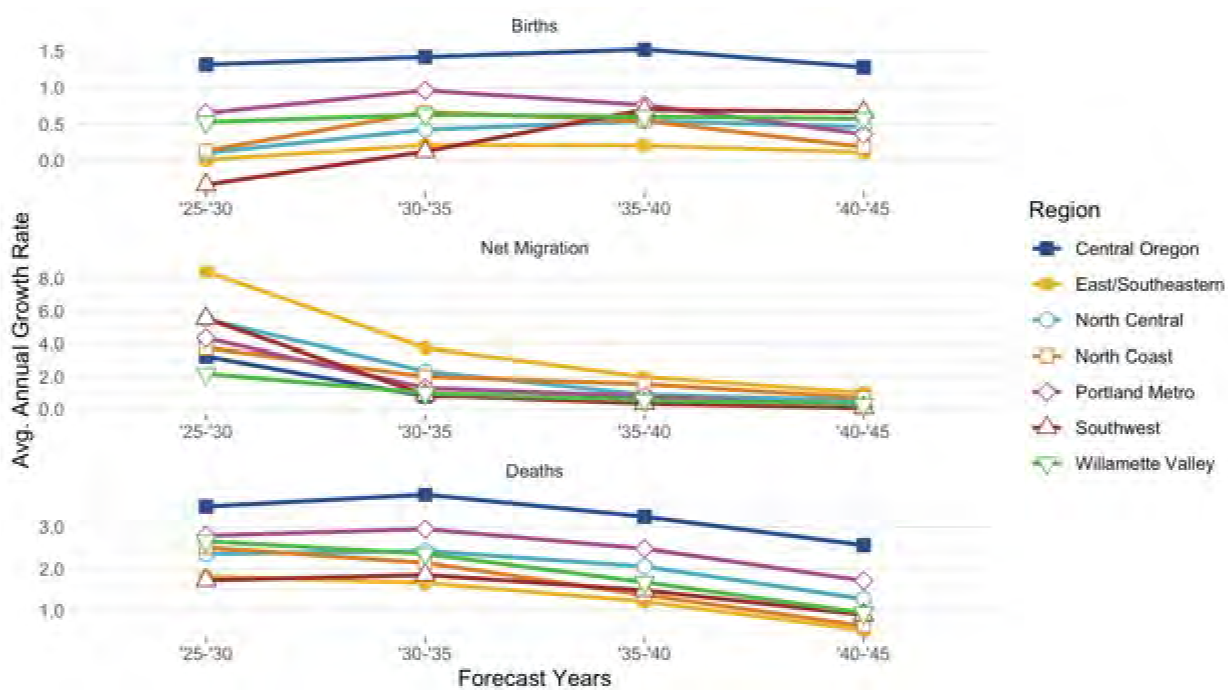


Figure 23 provides an alternative data visualization, stacking the 3 components of population change for each region, in 5-year increments. The label above each of the bars represents the average annual growth rate for each 5-year period in the region. All regions across the state are expected to have decreasing population growth rates through 2045. Central Oregon is the only region expected to observe growth rates greater than one percent in 2045.

Figure 22. Components of forecasted population change by region, 2020 – 2045
Source: Portland State University, Population Research Center.
Note: Average annual growth rate by period indicated in the label above each bar.

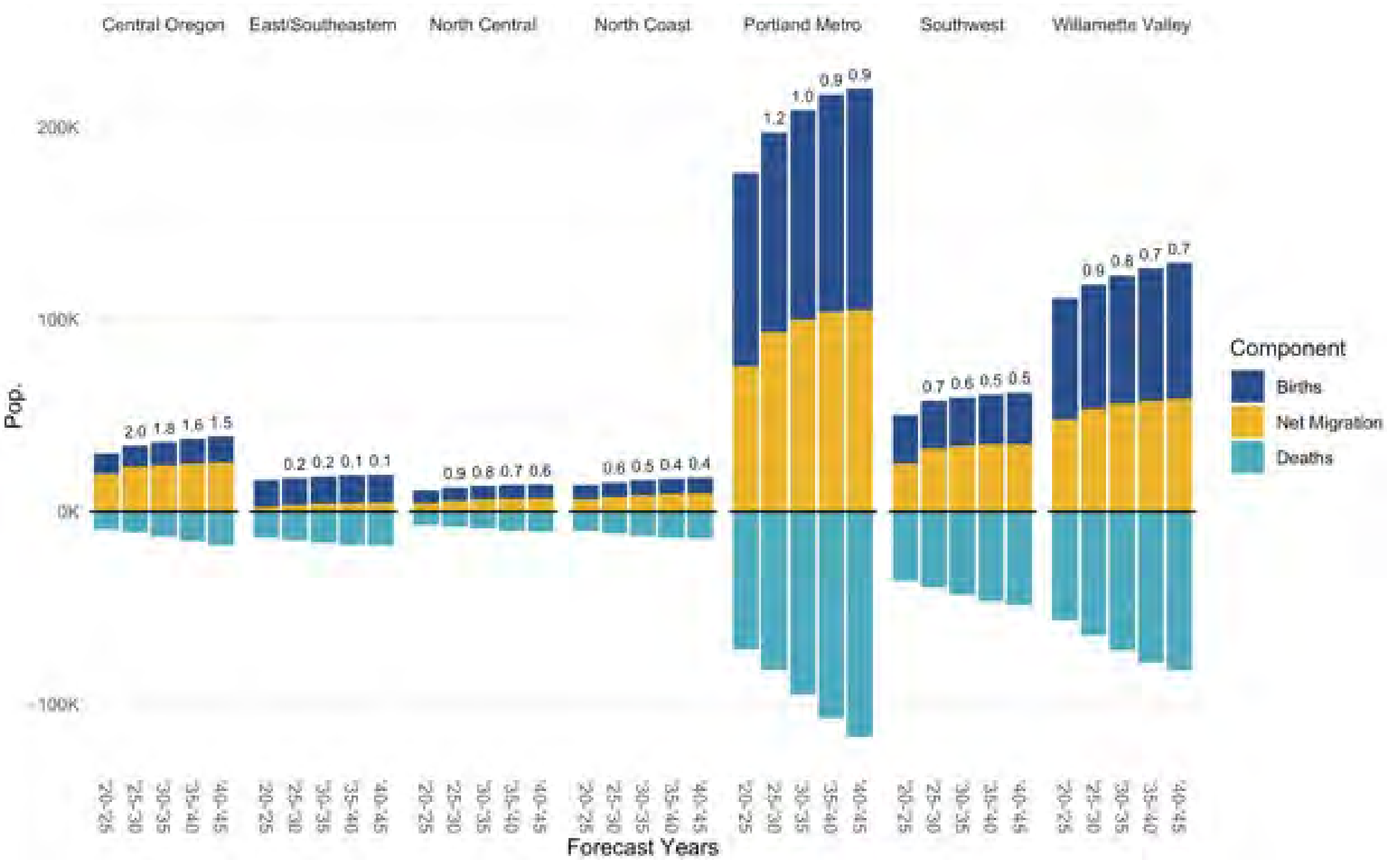
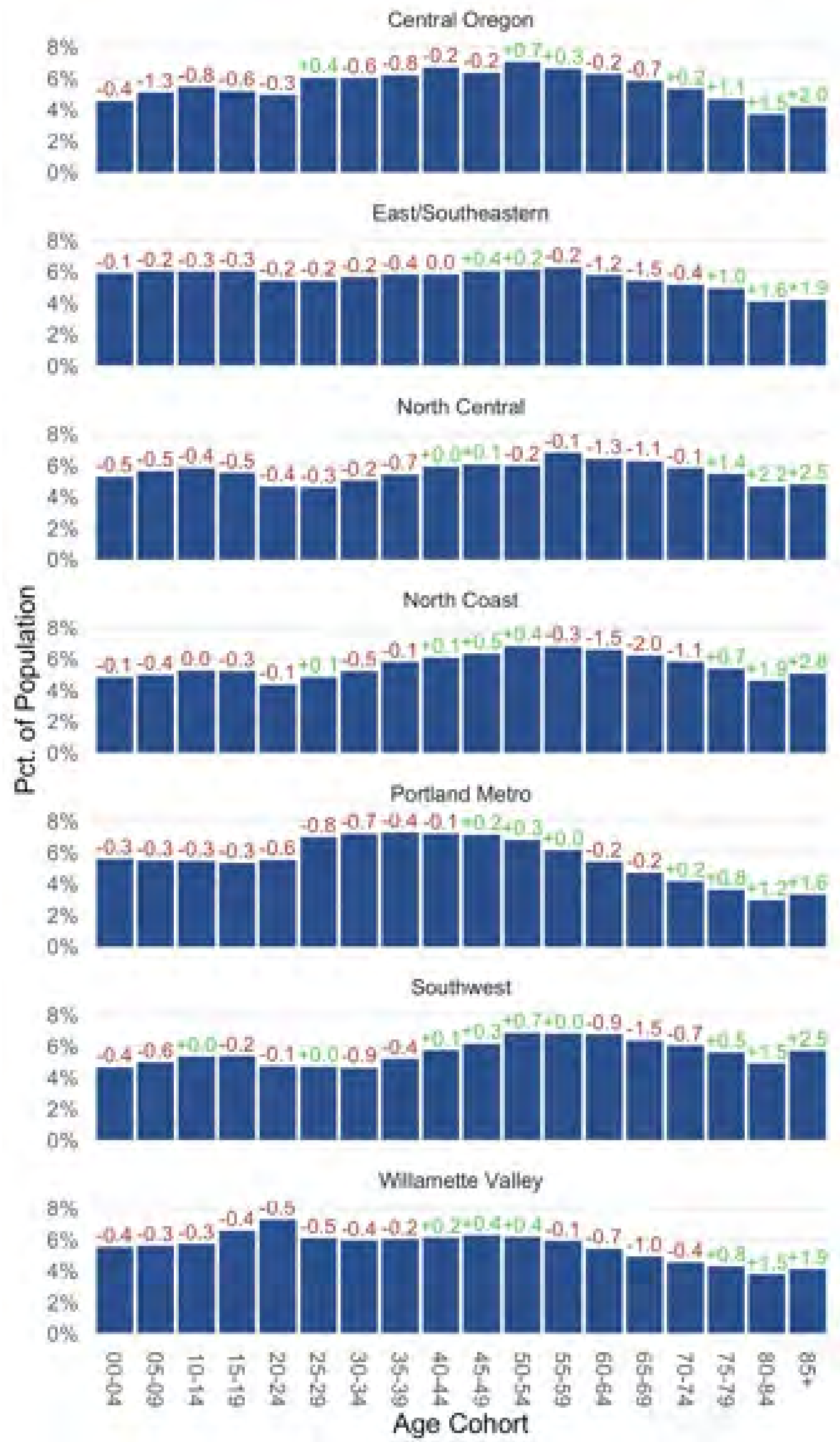


Figure 24 shows the forecasted change in each age cohorts share of the population from 2020 to 2040. In most regions, the population below 40 is expected to decrease as a share of the population. Put differently, the population is expected to age in all regions compared to the distribution in 2020.

Figure 23. Change in population (as a share) between 2020 and 2040 by age cohort

Source: Portland State University, Population Research Center.



APPENDIX C. ECONOMICS

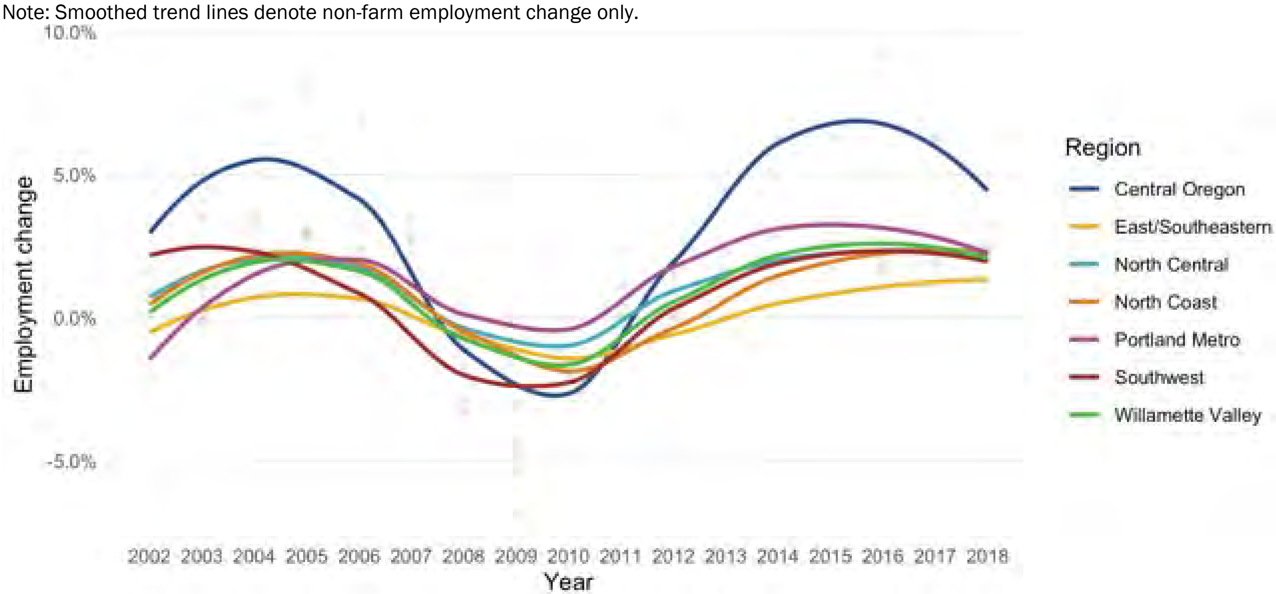
Recent economic trends in Oregon

An accepted framework for measuring a region's economic health relies on several measure of wellbeing (e.g. jobs and income) along with broader measures of quality of life (e.g., the social and natural environment). Often, data for measuring these broader measures are constrained and unavailable, and typically we rely on narrower definitions of economic activity for planning purposes. In the context of Oregon's highway and transportation system, this includes trying to incorporate demand for the transportation network for both households and businesses. The previous section focused on socioeconomic trends around that state that are correlated with household drivers of demand for the transportation network. This section focuses on outlines the directionality of labor and industry activities across the study regions, which can be used to support transportation planning.

Labor force and employment characteristics

Employment levels across all regions have increased during the 2001 to 2018 period, however, the rate of employment growth has slowed to about one-to-three percent in recent years for all regions.

Figure 24. Annual change in total employment by region, 2001 – 2018
Source: Bureau of Economic Analysis.
Note: Smoothed trend lines denote non-farm employment change only.



The employment-to-population ratio is a macroeconomic indicator that describes the proportion of a region's working population relative to its overall population. Over the 2000 to 2018 analysis period, this ratio fluctuated for all regions. During the Great Recession, this ratio declined quite severely for the Central Oregon, Southwest, and North Coast regions, and less severely for the others; however, since recovering from the economic downturn, most regions have not reached their respective pre-recession peaks. Figure 26 shows the change in employment-to-population ratio for all regions.

Figure 25. Employment-to-population ratio by region, 2000 – 2018
Source: Portland State University, Population Research Center; Bureau of Labor Statistics.

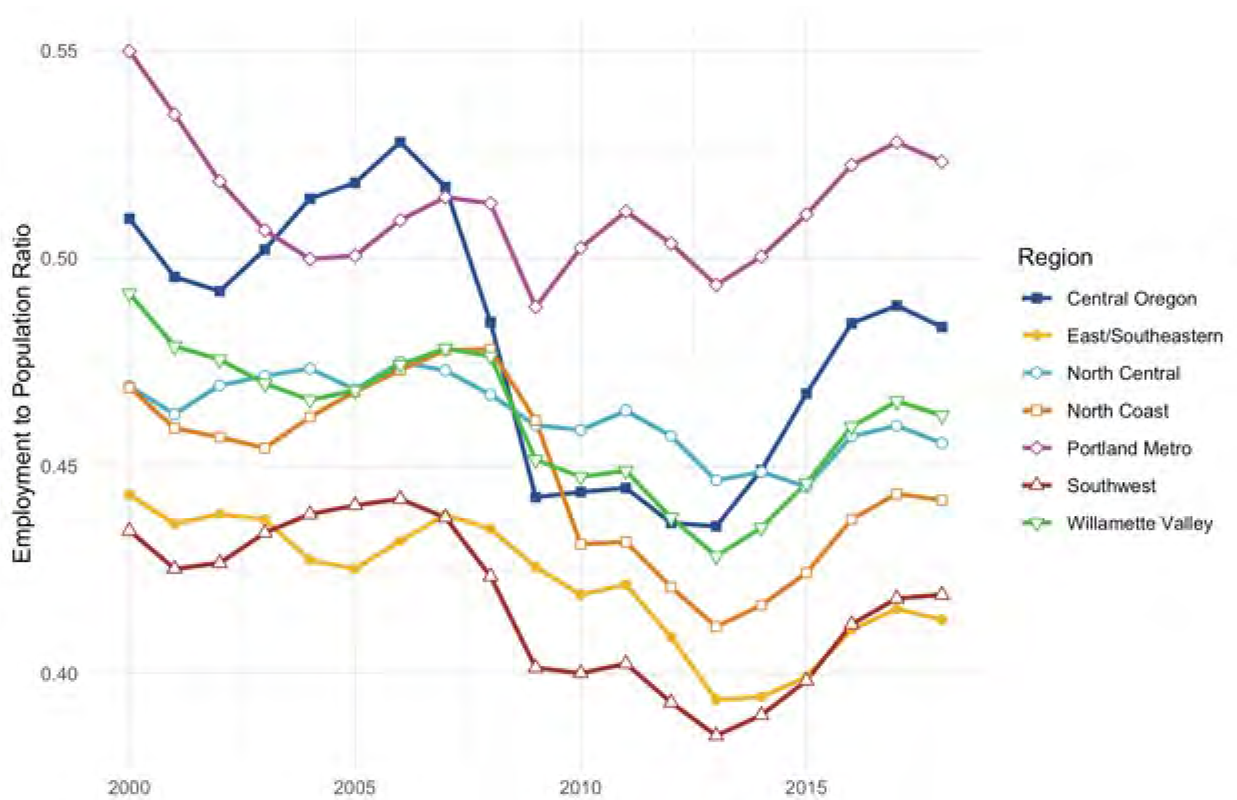


Figure 28 through Figure 34 show the industry concentration and average annual growth rate by North American Industry Classification System[1] (NAICS) sector for each respective region. Figure 27 provides a high-level description of each NAICS sector, its color coding in the region-specific charts to follow, and an example firm within each sector. The x-axis shows the average annual growth rate over the 2001 to 2018 period, and the y-axis shows the location quotient for each sector. Location quotient is a way to measure the specialization of a sector in a region relative to the statewide economy.

A value of 1.0 indicates that a region's sector is equally specialized in comparison to the state. A quotient exceeding 1.0 indicates that a region's labor force is more concentrated relative to other areas of the state. Each NAICS sector is denoted by a bubble and its size represents its employment in 2018. For each regional figure, the three NAICS sectors with the highest location quotients are labelled as are the two sectors with the highest average annual growth rates and the two with the lowest growth rates.

[1] The North American Industry Classification System (NAICS) is used by the United States, Canada, and Mexico to classify businesses by their primary industry.

Figure 26. NAICS industry descriptions and example firms

Source: ECONorthwest.

Color Code	NAICS Sector Code	NAICS Sector Title	NAICS Sector Description	Example Firm
	11	Agriculture, Forestry, Fishing and Hunting	Establishments primarily engaged in growing crops, raising animals, harvesting timber, and harvesting fish and other animals from a farm, ranch, or their natural habitats.	Lochmead Dairy Farms
	21	Mining, Quarrying, and Oil and Gas Extraction	Establishments that extract naturally occurring mineral solids, such as coal and ores; liquid minerals, such as crude petroleum; and gases, such as natural gas.	Portland Sand & Gravel Co.
	22	Utilities	Establishments engaged in the provision of the following utility services: electric power, natural gas, steam supply, water supply, and sewage removal.	Northwest Natural Gas Co.
	23	Construction	Establishments primarily engaged in the construction of buildings or engineering projects (e.g., highways and utility systems).	OEG Inc.
	31-33	Manufacturing	Establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products.	Precision Castparts Corp.
	42	Wholesale Trade	Establishments engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise.	Adidas Intl. Inc.
	44-45	Retail Trade	Establishments engaged in retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise.	Winco Foods
	48-49	Transportation & Warehousing	Establishments providing transportation of passengers and cargo, warehousing and storage for goods, scenic and sightseeing transportation, and support activities related to modes of transportation.	Alaskan Airlines
	51	Information	Establishments engaged in the following processes: (a) producing and distributing information and cultural products, (b) providing the means to transmit or distribute these products as well as data or communications, and (c) processing data.	Oregon Public Broadcasting
	52	Finance and Insurance	Establishments primarily engaged in financial transactions (transactions involving the creation, liquidation, or change in ownership of financial assets) and/or in facilitating financial transactions.	Blue Cross & Blue Shield of Oregon
	53	Real Estate and Rental and Leasing	Establishments primarily engaged in renting, leasing, or otherwise allowing the use of tangible or intangible assets, and establishments providing related services.	Vacasa Inc.
	54	Professional, Scientific, and Technical Services	Establishments that specialize in performing professional, scientific, and technical activities for others.	ECONorthwest
	55	Management of Companies and Enterprises	Establishments that hold the securities of (or other equity interests in) companies and enterprises for the purpose of owning a controlling interest or influencing management decisions or establishments (except government establishments) that administer, oversee, and	Adidas America Inc.
	56	Administrative and Support and Waste Management and	Establishments performing routine support activities for the day-to-day operations of other organizations.	Securitas Security Services Inc.
	61	Educational Services	Establishments that provide instruction and training in a wide variety of subjects.	Reed College
	62	Health Care and Social Assistance	Establishments providing health care and social assistance for individuals.	Kaiser Foundation Hospitals
	71	Arts, Entertainment, and Recreation	Establishments that operate facilities or provide services to meet varied cultural, entertainment, and recreational interests of their patrons.	Trail Blazers Inc.
	72	Accommodation and Food Service	Establishments providing customers with lodging and/or preparing meals, snacks, and beverages for immediate consumption.	Hilton Portland & Executive Tower
	81	Other Services (except Public Administration)	Establishments engaged in providing services not specifically provided for elsewhere in the classification system.	Mannahouse Church
	92	Public Administration	Establishments of federal, state, and local government agencies that administer, oversee, and manage public programs and have executive, legislative, or judicial authority over other institutions within a given area.	Multnomah County

In Central Oregon, the management of companies and enterprises sector had the highest annual average growth rate (6 percent) during the 2001 to 2018 period; however, it's one of the smallest industries by employment count in the region (0.8 percent of total employment). The largest industry is government and government enterprises, which totaled almost 17,000 employees, or 13 percent, of the Central Oregon's total workforce in 2018. Construction and real estate and rental and leasing had the highest location quotients region-wide at 1.4 and 1.3, respectively. (See Figure 28).

Figure 27. Industry concentration and growth in Central Oregon, 2001 – 2018
Source: Bureau of Economic Analysis.

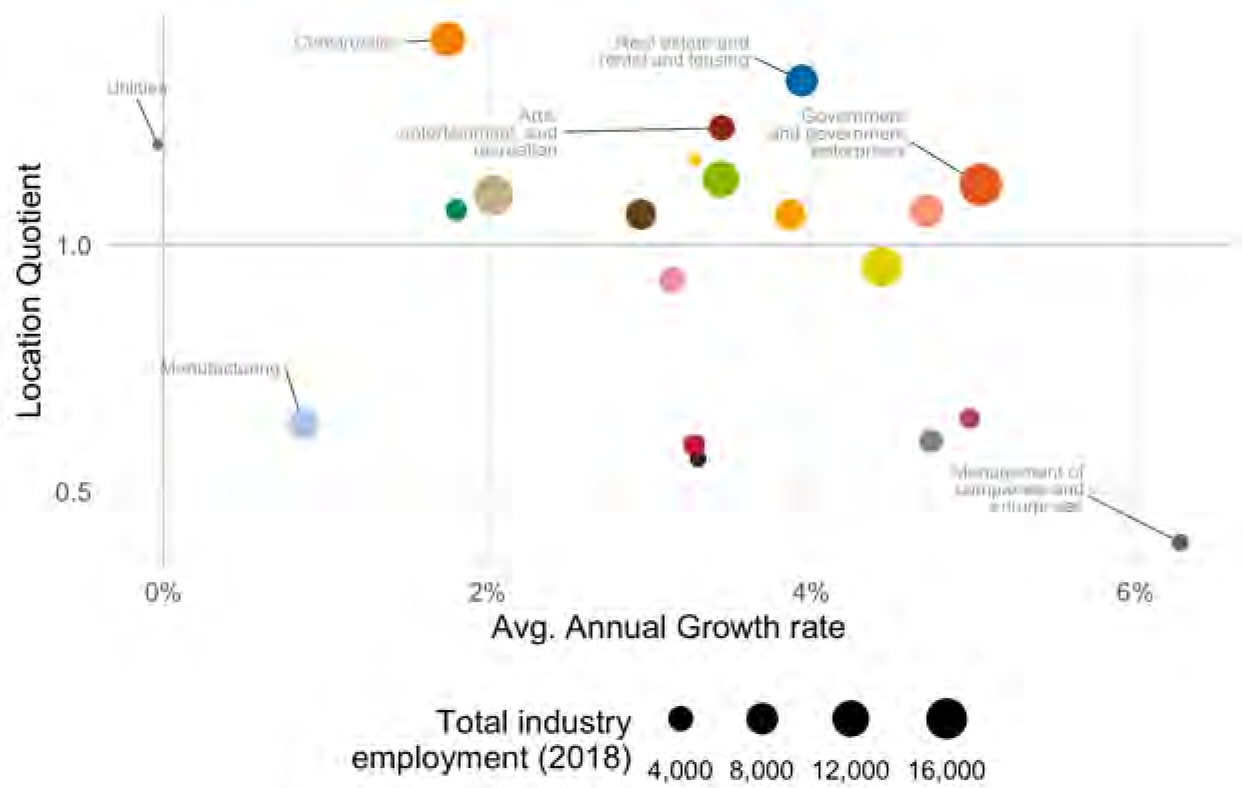
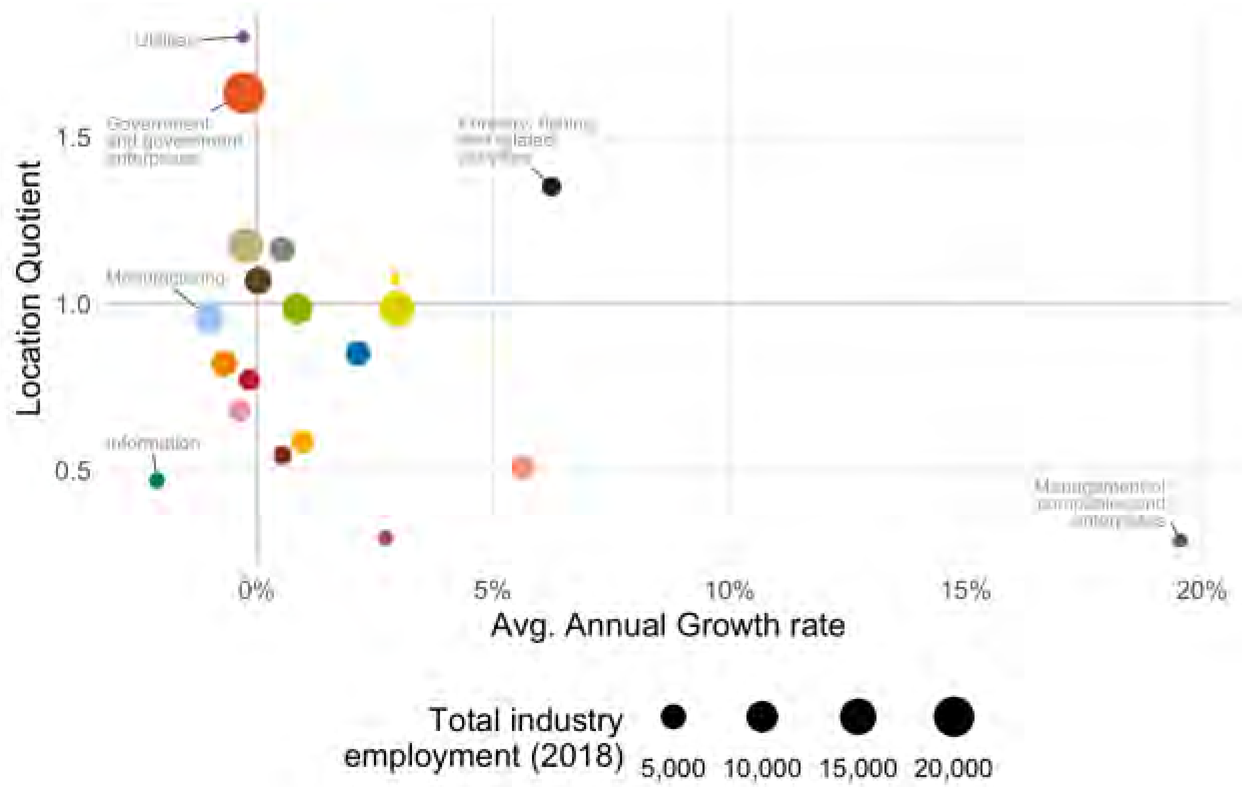


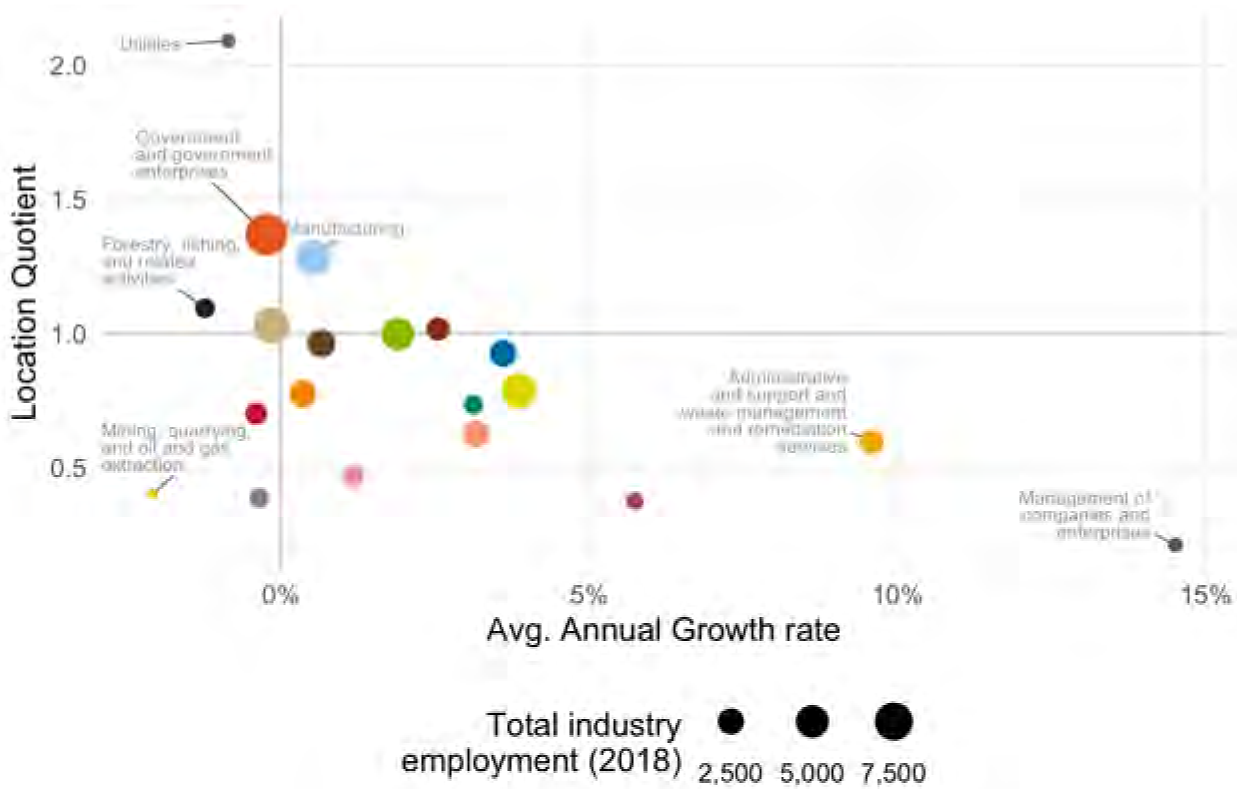
Figure 28 reveals many industries in Oregon's East/Southeastern region shrank during the 2001 to 2018 period. The largest contractions occurred in the information (2.1 percent average annual decrease) and manufacturing (1.0 percent average annual decrease) sectors. At the same time, the management of companies and enterprises grew by nearly 20 percent per year, but like the Central Oregon region, this sector's share of overall employment is small, making up only 0.6 percent of the East/Southeastern regional employment in 2018. Forestry, fishing, and other related activities had one of the largest growth rates in the region, increasing by approximately six percent per year, however, its total employment is only 1.8 percent of the regional total. The region's largest employment by volume, government and government enterprises (19 percent of total employment) decreased in size by about 0.3 percent annually.

Figure 28. Industry concentration and growth in East/Southeastern Oregon, 2001 – 2018
Source: Bureau of Economic Analysis.



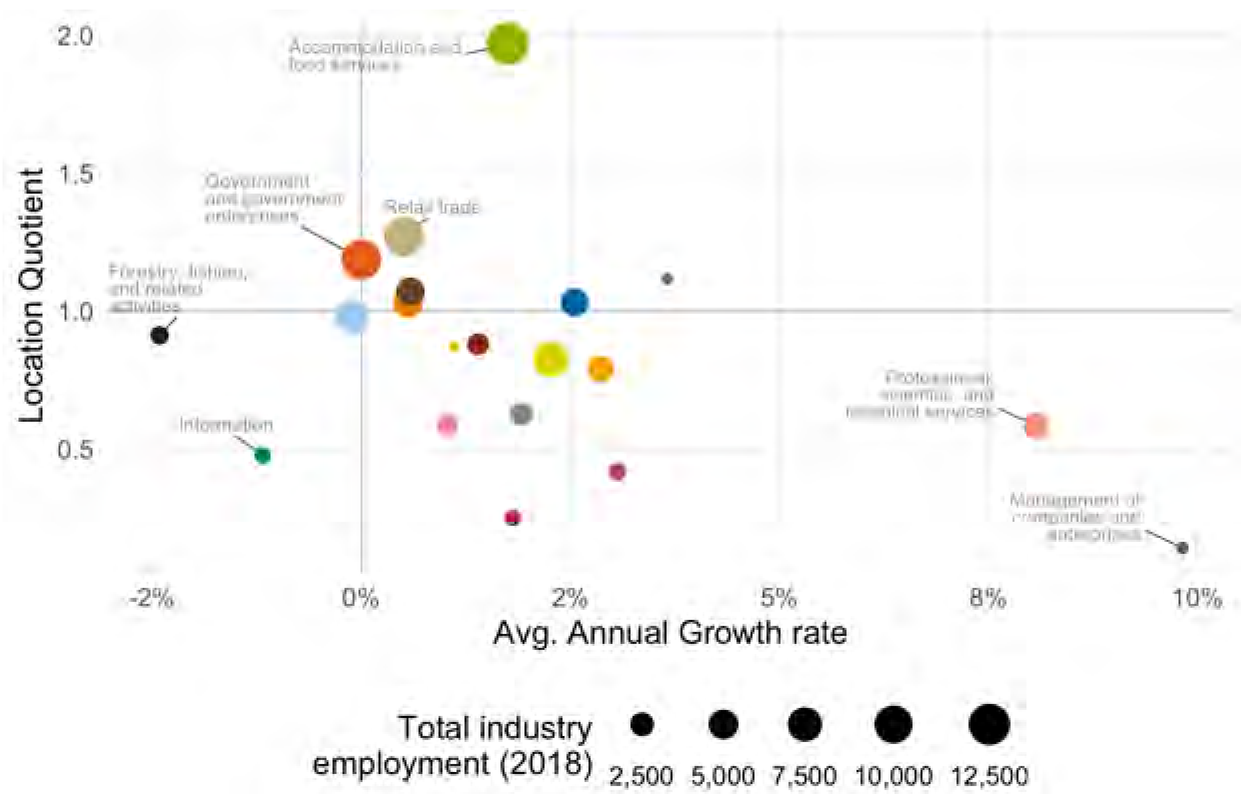
The majority of employment sectors in the North Central region falls below that of the statewide average, as indicated by the location quotient values that are less than 1.0. Administrative, waste, and remediation services, along with management of companies experienced the largest average growth between 2001 and 2018, however both remain a smaller share of overall employment in the region (3.2 percent and 0.4 percent of total employment, respectively). Like other areas of the region, employment concentrated in production activities remains high in certain industries, but experienced limited growth. (See Figure 30).

Figure 29. Industry concentration and growth in North Central Oregon, 2001 – 2018
Source: Bureau of Economic Analysis.



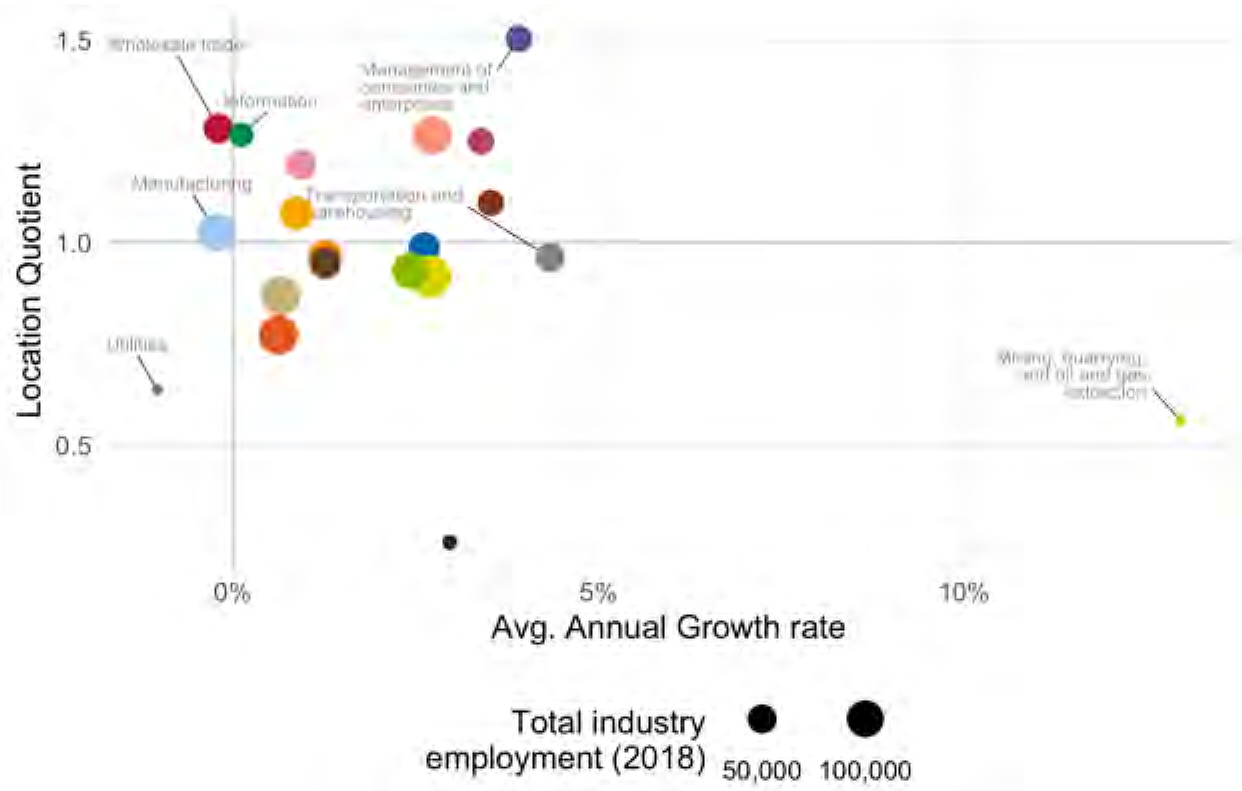
The majority of industries in the North Coast region are not specialized relative to statewide trends. However, the accommodation and food services sector has the highest location quotient in the region, meaning the sector's output more than meets local demand for its residents (see Figure 31). Additionally, this sector has the highest level of employment in the region, making up approximately 16 percent of its 2018 total employment. Other large employment sectors include government and government enterprises (14 percent of total employment in 2018) and retail trade (13 percent of total employment). The professional, scientific, and technical services sector had one of the highest average annual growth rates across the region, which increased by about eight percent per year.

Figure 30. Industry concentration and growth in North Coast Oregon, 2001 – 2018
Source: Bureau of Economic Analysis.



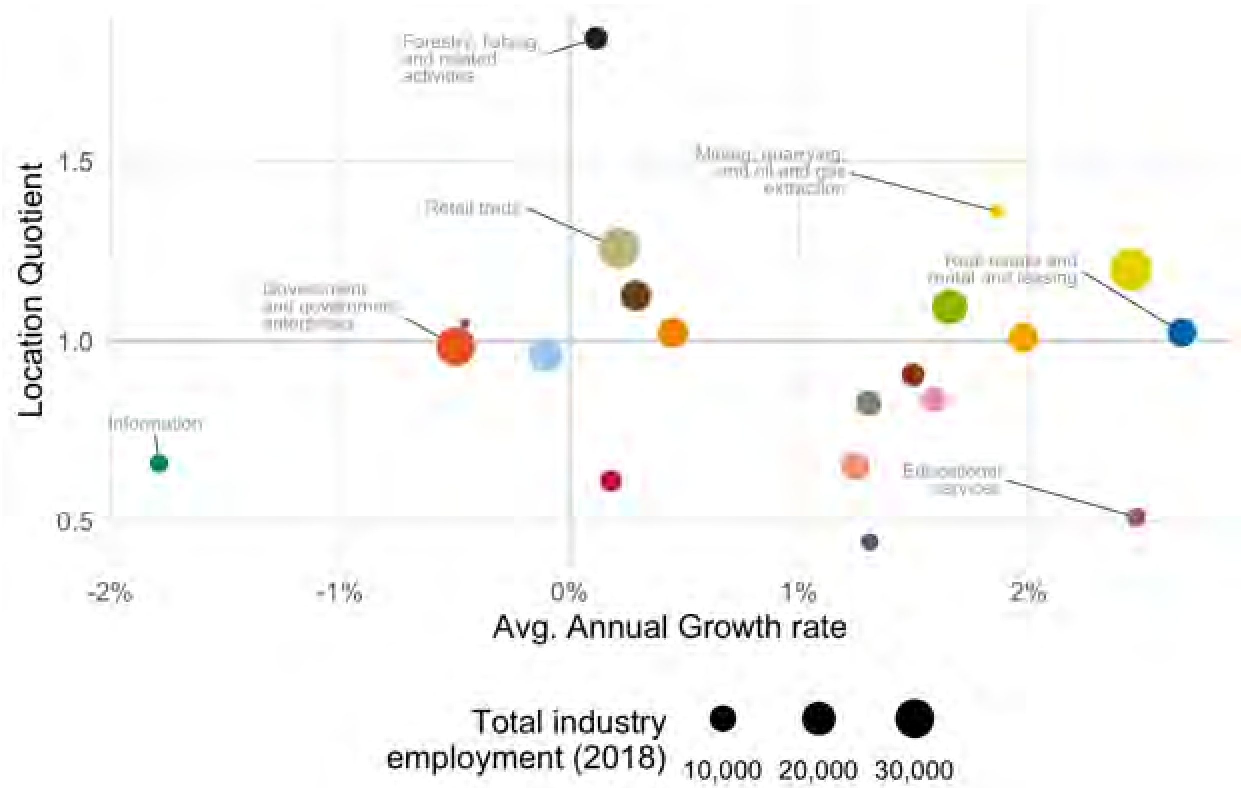
In 2018, the Portland Metro area made up approximately 51 percent of the state's total employment. The mining, quarrying, and oil and gas extraction industry grew the most on an annual average basis (13 percent per year) relative to all other industries in the area, however, it is one of the smallest employment sectors. Management of companies and enterprises had the largest location quotient in the region, and it grew approximately 3.9 percent per year, growing by nearly 18,700 jobs from 2001 to 2018. Of particular note is the average annual average growth of the transportation and warehousing sector (4.3 percent). During the 2001 to 2018 period, its share of employment relative to total employment grew from 2.4 percent to 3.9 percent, or an increase of 1.5 percentage points. (See Figure 32).

Figure 31. Industry concentration and growth in Portland Metro, 2001 – 2018
Source: Bureau of Economic Analysis.



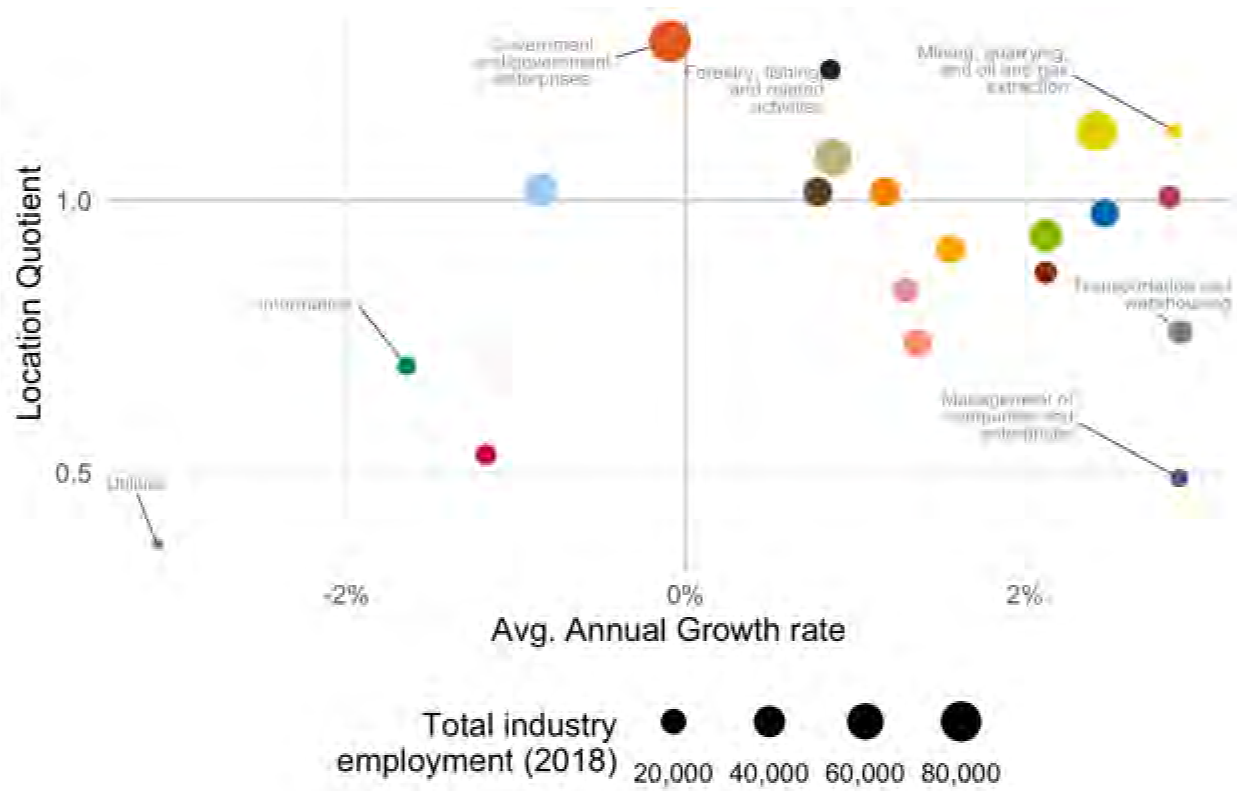
Retail trade and health care and social assistance make up the largest share of total employment in the Southwest region at 14 percent and 13 percent, respectively. Forestry, fishing, and related activities had the highest location quotient in the region, though it only grew by 0.1 percent per year during the 2001 to 2018 period. The real estate and rental and leasing sector had the highest average annual growth rate in the region, increasing by about 2.7 percent per year. During this period, the real estate sector's employment as a share of regionwide employment grew by 1.2 percentage points, from 3.7 percent in 2001 to 4.9 percent in 2018. (See Figure 33).

Figure 32. Industry concentration and growth in Southwest Oregon, 2001 – 2018
Source: Bureau of Economic Analysis.



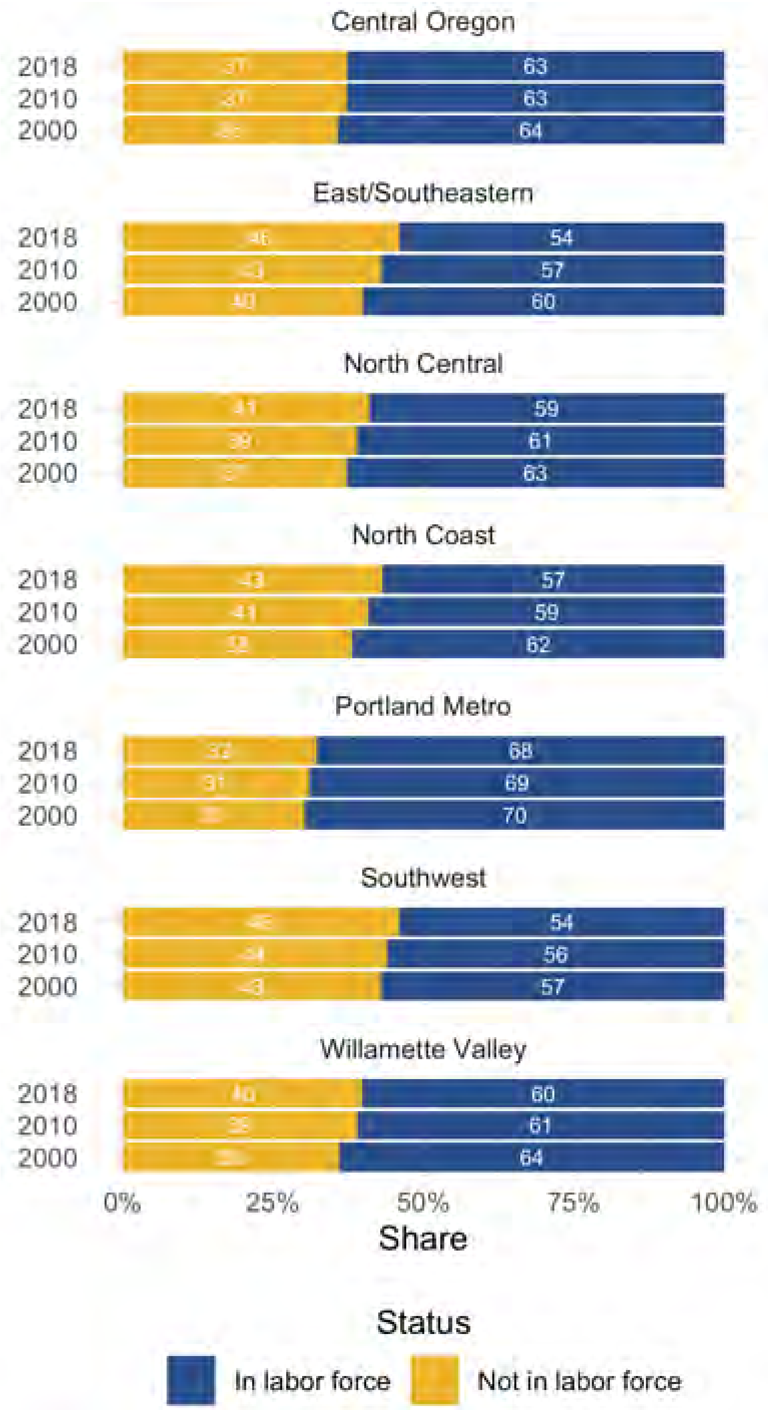
In the Willamette Valley region, government and government enterprises was the largest employment sector, making up about 15 percent of region-wide employment in 2018.; however, this sector shrank by approximately 0.1 percent per year on average. Retail trade is the second largest employment sector as it makes up about 11 percent of total employment, though it only grew by approximately 0.9 percent per year. Transportation and warehousing had the largest annual average growth rate, increasing by 2.9 percent per year. During the 2001 to 2018 period, this sector's share of total employment increased by 0.4 percentage points, from 2.7 percent in 2001 to 3.1 percent in 2018. (See Figure 34).

Figure 33. Industry concentration and growth in Willamette Valley, 2001 – 2018
Source: Bureau of Economic Analysis.



The labor force participation rate describes the share of the working age population (those 16 years of age and older) that are currently employed or are actively seeking employment in the labor market. Across all regions for the 2000 to 2018 period, the participation rate has declined. The largest decreases occurred in the East/Southeastern (six percentage points), North Central (five percentage points), and Willamette Valley (four percentage points) regions. (See Figure 35).

Figure 34. Labor force participation rate for the population 16 and older, 2000 – 2018
Source: U.S. Census Bureau, ACS PUMS, 1-Year Estimates, 2000, 2010, and 2018.

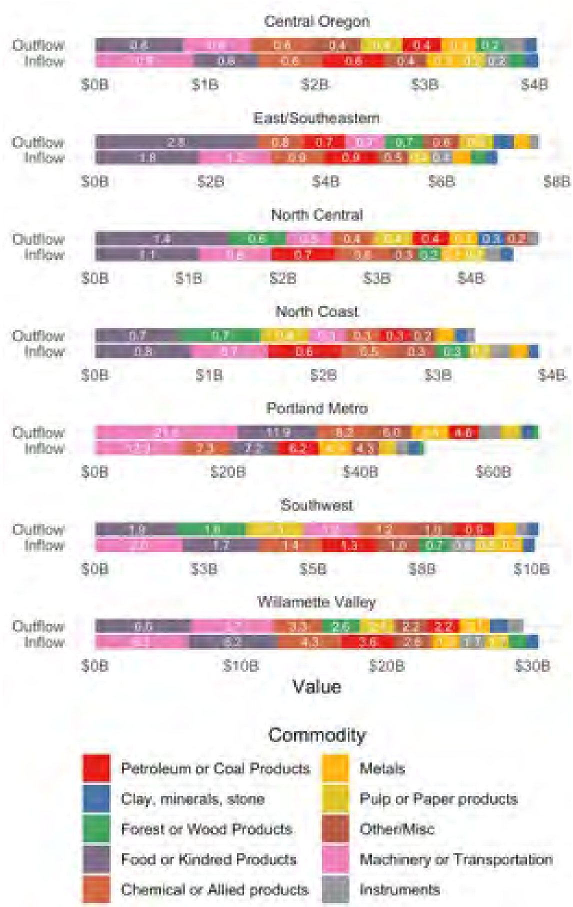


Regional industry activity

Demand for the transportation network is not just driven by household demand for commuting and non-labor use of the road. Freight transportation helps increase economic value by moving goods and services to markets where they can be used for consumption or production of other goods and services. This helps support a broad range of economic activity from traditional commodities used in manufacturing to more novel forms of service delivery for e-commerce. Although an important component of the economy, freight transportation increases demand for the transportation network and can increase maintenance costs due to the heavy trucks and equipment needed to move these goods and services to market.

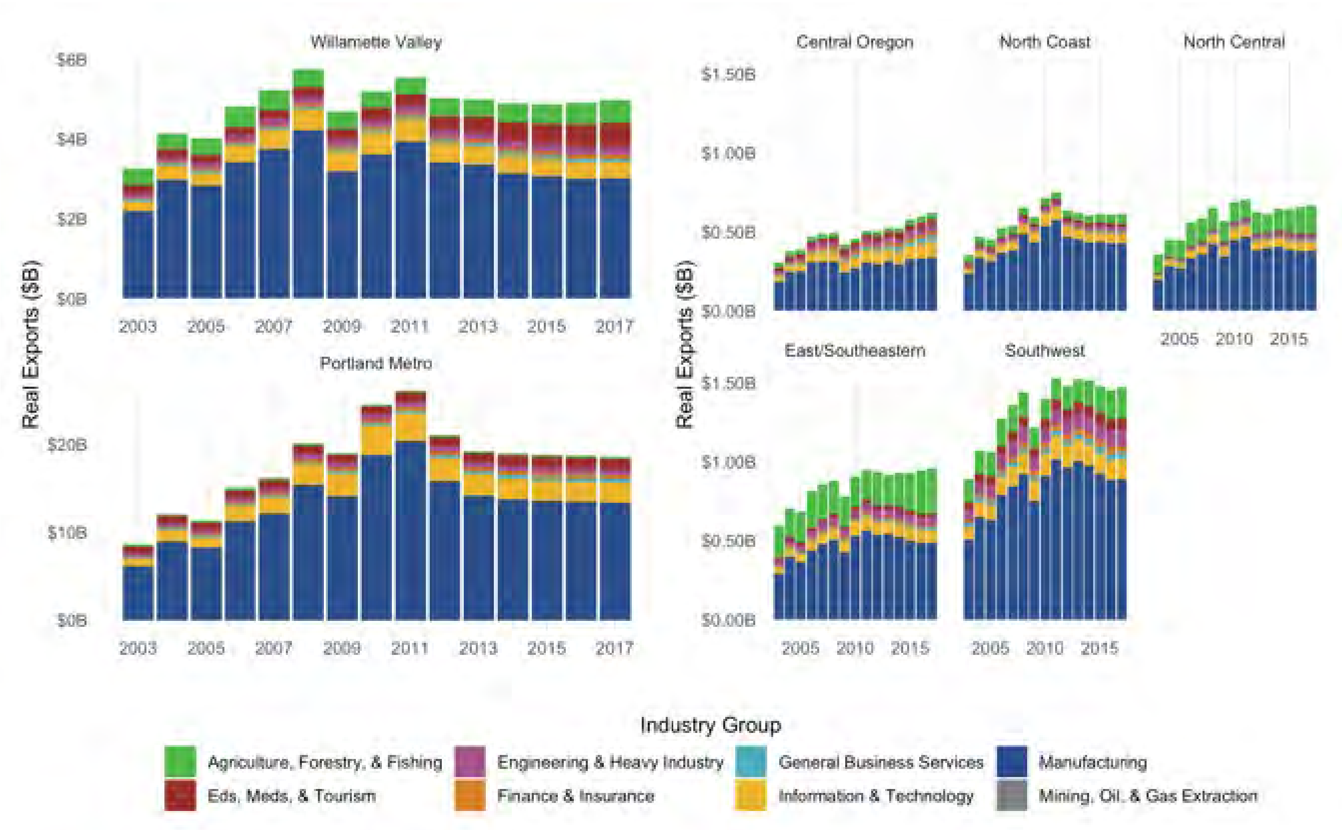
One way to understand how freight can affect our study regions is to look at how commodities are moved and utilized across the state. This is helpful context for understanding which commodities are being exported to areas outside the region, and which are being used as intermediate inputs for local production. Figure 36 displays the inflow and outflow of commodities by region for 2019. Machinery and Transportation, along with Food represent a large segment of inflows and outflows for most regions around the state. This broadly aligns with Oregon's large traded sector industries in semiconductors, e-commerce/distribution, and food processing.

Figure 35. Value of commodity flows by region, 2019
Source: Oakridge National Laboratory, Freight Analysis Framework



The Portland Metro region, by value, exported[2] the most goods compared to any other Oregon region, followed by the Willamette Valley and then Southwest Oregon. Exports are goods produced in a local economy that are then sold and transported to domestic (e.g., other counties in Oregon) and international firms not located within a commodity's place of origin. In 2017, approximately $28 billion in goods were exported from Oregon. Portland accounted for 67 percent of the value of all 2017 exports. The Willamette Valley region exported approximately 18 percent of Oregon's total export value and the Southwest region exported about five percent. The remaining regions exported less than five percent of total exports apiece, with three percent coming from the East/Southeastern region and two percent coming from each of the North Central, North Coast, and Central Oregon regions.

Figure 36. Real exports by region, 2003 – 2017
Source: Brookings Institute Export Monitor



The majority of exports for every Oregon region come from the manufacturing sector. Though this fluctuates year-over-year, every region exported at least 50 percent of all their exports in this sector. The Portland Metro region had the highest share of manufacturing exports compared to all other regions at 72 percent of its 2017 total. Other industries that made up sizable shares of exports include information and

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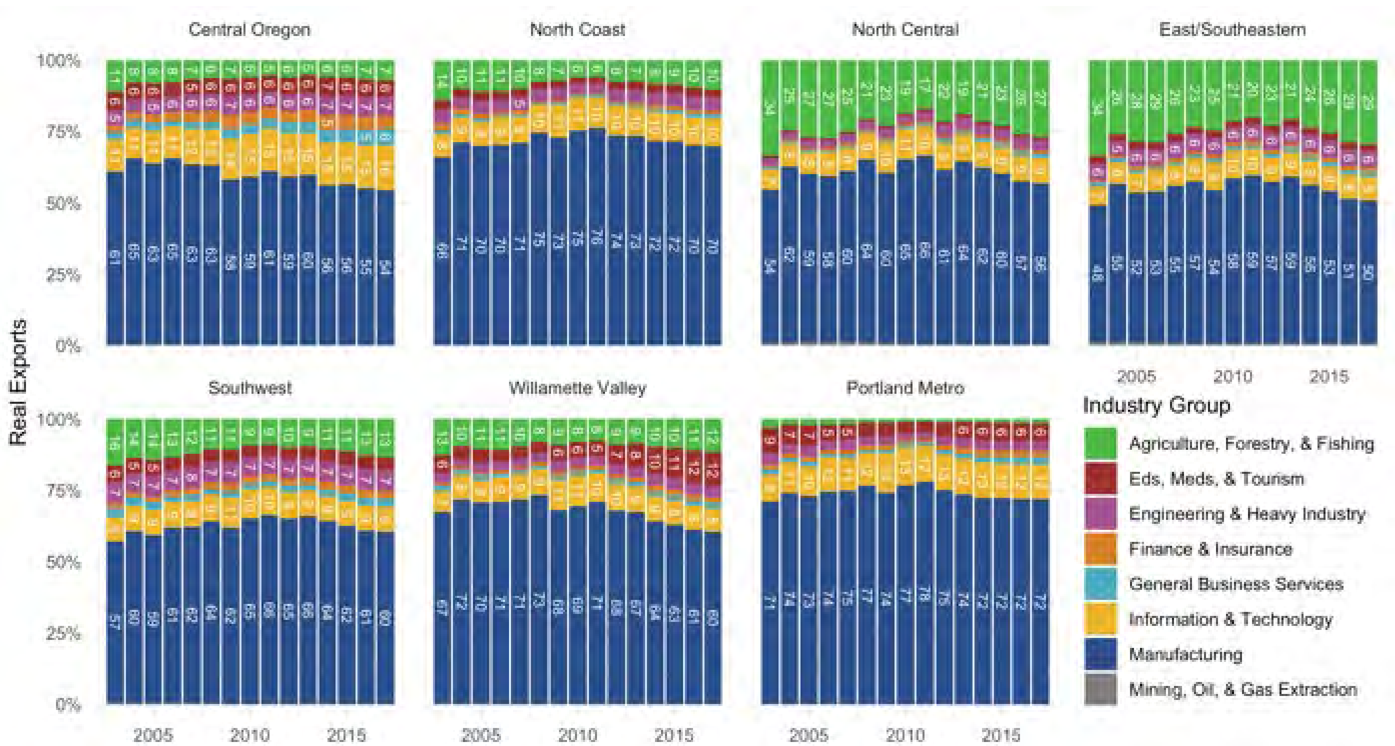
[2] Export sectors are defined as those that bring revenue into a region from another market. For this analysis, we include both domestic and international exports.

technology and agriculture, forestry, and fishing. The East/Southeastern region had the highest share of agricultural exports at 29 percent of its export total, followed by 27 percent of North Central's export total. Information and technology made up a sizable share of Central Oregon's exports with 16 percent of its total in 2017.

Figure 37. Share of real exports by region, 2003 – 2017
Source: Brookings Institute Export Monitor.

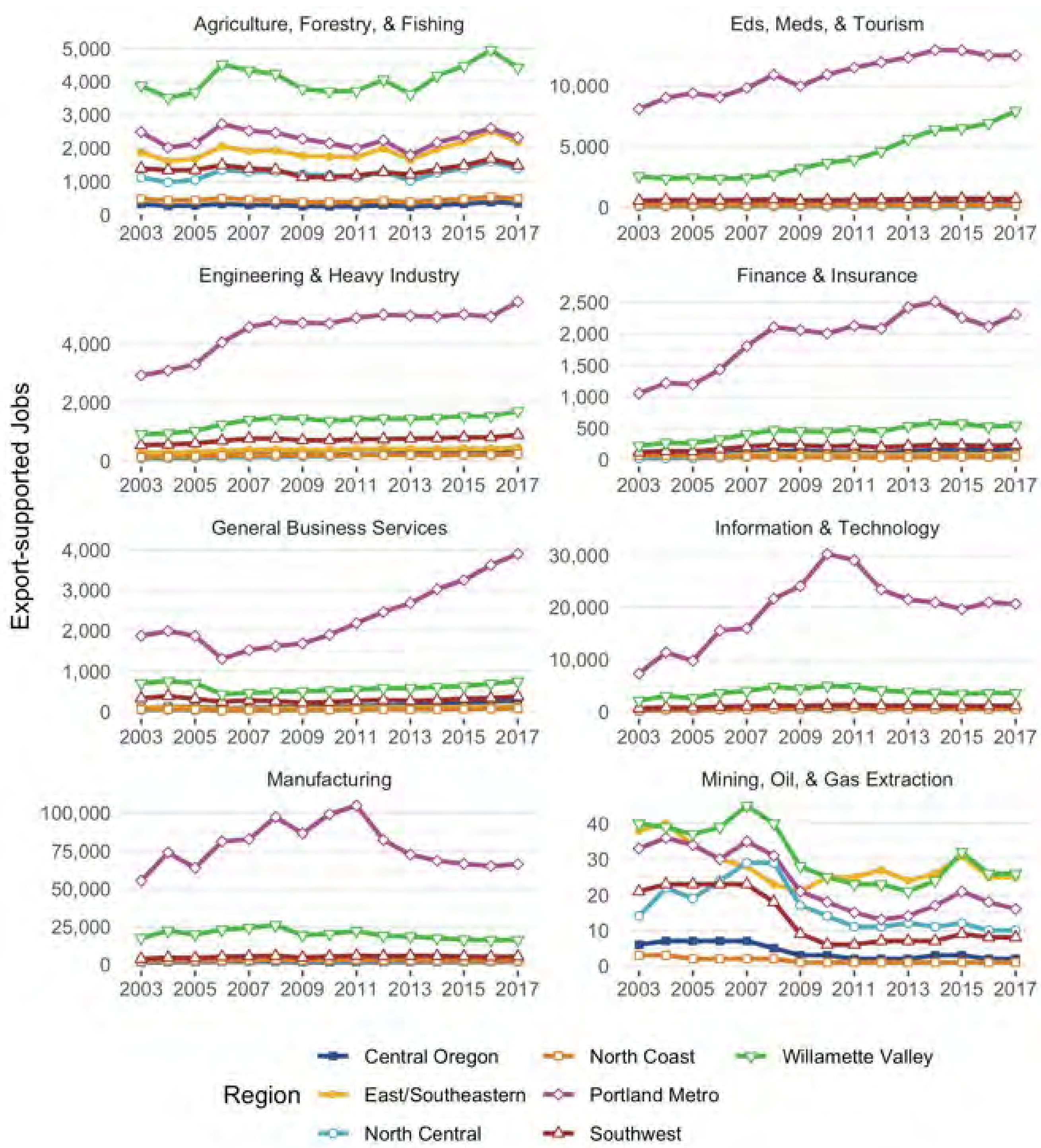


In addition to the total value of goods exported from Oregon's economy, the export market supports well over 100,000 total jobs across the state. These jobs include direct export jobs, which are jobs directly supported in an industry, plus jobs supported by the export market in an industry's supply chain.[3] In 2017, approximately 177,130 total jobs were supported by the export market in Oregon, a 39 percent increase from the 127,700 total export jobs supported in 2003. Across all regions, manufacturing supported the most jobs in 2017, making up 54 percent of total export jobs (about 96,340 jobs), followed by information and technology with 16 percent of the total (about 28,000 jobs), and then eds, meds, and tourism with 12 percent (about 21,800 jobs). Figure 39 describes the change in total export-supported jobs by NAICS sector for each region. Unsurprisingly, the Portland Metro region had the highest share of export-supported jobs

[3] As noted by the Brookings Institute, "• Direct export jobs are jobs supported by exports in that particular industry. Total export-supported jobs include direct export jobs as well as jobs supported by exports in the exporting industries supply chain. The value is based on the national multiplier for that industry and does not reflect an exact count of workers involved in the physical production of exports, but rather the number of jobs that a given amount of export sales can support."

in Oregon for 2017 (64 percent), followed by the Willamette Valley (20 percent) and Southwest (20 percent) regions.

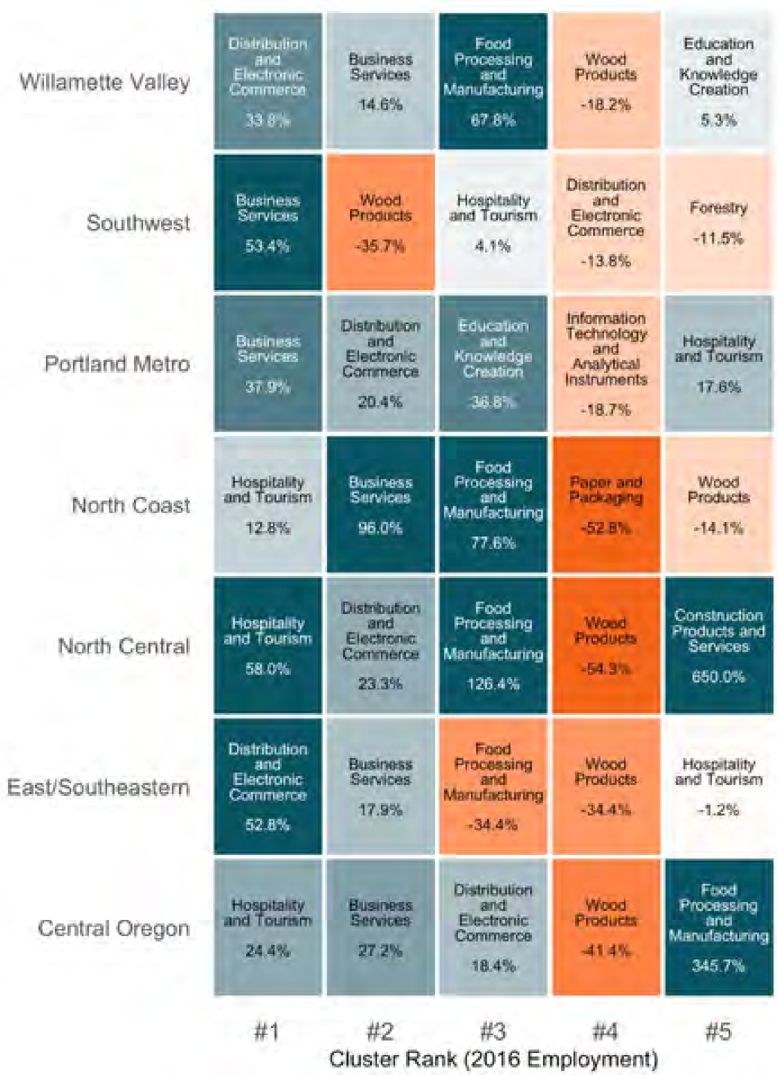
Figure 38. Total export-supported jobs by NAICS sector, 2003 – 2017
Source: Brookings Institute Export Monitor.



A traded cluster is an industry that serves markets outside of its local region through both sales and/or investment and they also indicate a region's competitive advantages. In general, traded sectors tend to have high value-added jobs and they bring in outside dollars from surrounding local regions and beyond, which makes them desirable investments as they continue to bolster a region's competitive advantages. Figure 40 shows the top five traded economic clusters by employment in each region in 2016. In this analysis, we analyzed the employment levels of each top traded cluster in 2016 and compared the change to their respective 2000 employment levels. Notable increases include the growth in the food processing and manufacturing sectors for the Willamette Valley (68 percent), North Coast (78 percent), North Central (126 percent), and Central Oregon (346 percent) regions. Distribution and electronic commerce also grew by sizable percentages in the Willamette Valley (34 percent), Portland Metro (20 percent), North Central (23 percent), East/Southeast (53 percent), and Central Oregon (18 percent) regions.

Figure 39. Change in major traded economic clusters by region, 2000 – 2016 (top five clusters)

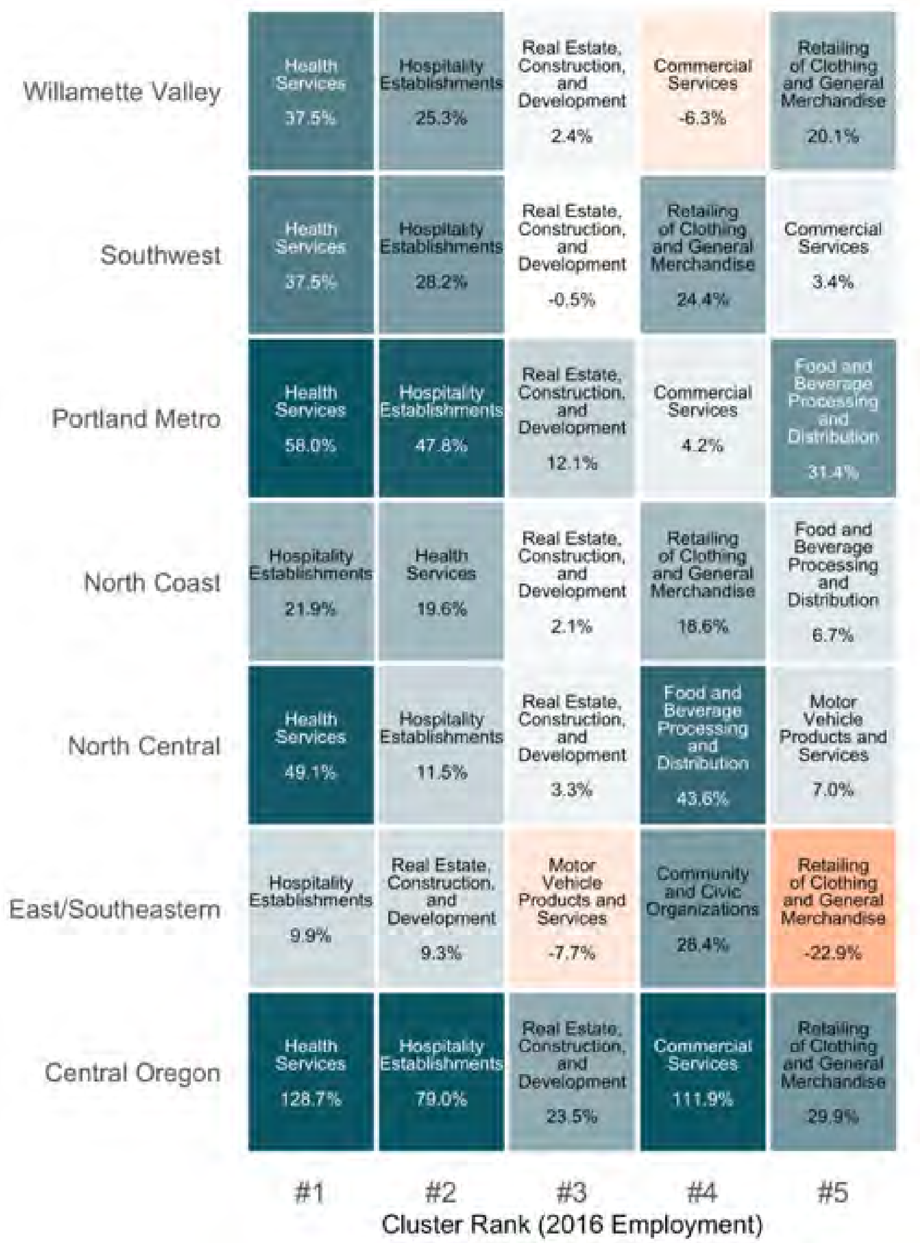
Source: Harvard Business School and the U.S. Economic Development Administration



A local cluster is the analogous counterpart to a traded cluster insofar that it describes industries that are important to local economies. We took the identical analytical approach we performed with traded clusters for local clusters. Health services was among one of the most important clusters for almost every region, being the top cluster in 2016 for five out of the seven regions. It grew in the Willamette Valley (38 percent), Southwest (38 percent), Portland Metro (58 percent), North Coast (20 percent), North Central (49 percent), and Central Oregon (129 percent) areas. Hospitality establishments was generally the second-most important local cluster, followed by real estate, construction, and development. (See Figure 41).

Figure 40. Change in major local economic clusters by region, 2000 – 2016 (top five clusters)

Source: Harvard Business School and the U.S. Economic Development Administration



OREGON DEPARTMENT OF TRANSPORTATION

KITTELSON & ASSOCIATES

ECONorthwest

ECONOMICS · FINANCE · PLANNING

KEY FINDINGS BRIEF

OREGON ECONOMIC & DEMOGRAPHIC REGIONS WHITE PAPER

OREGON DEPARTMENT OF TRANSPORTATION | JULY 2020

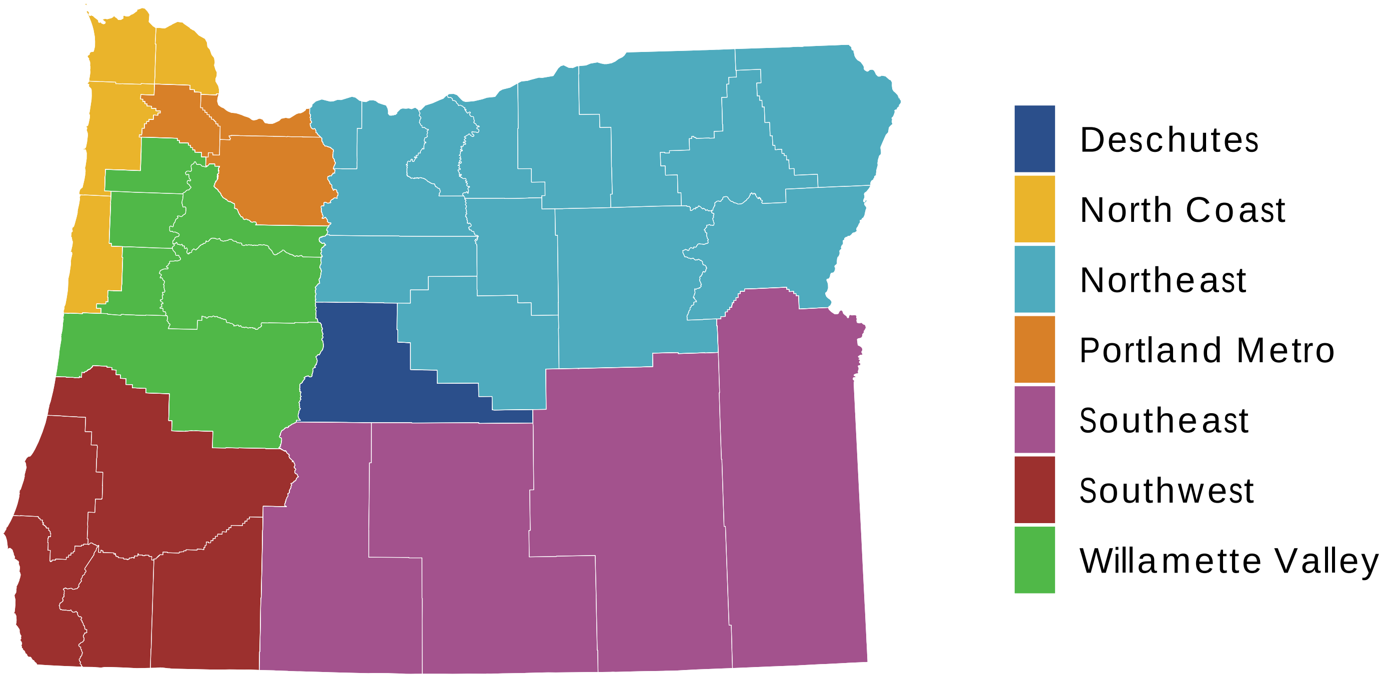
1 | BRINGING A REGIONAL PERSPECTIVE TO OREGON'S TRANSPORTATION PLANNING

- How do demographics and economic regions influence transportation system use and needs in Oregon?
- What has influenced transportation demand in the past? What will influence it in the future?

Oregon is revising its Transportation and Highway plans (OTP/OHP), which are intended to guide the state's future transportation investments. The findings of this white paper are intended to answer the following questions:

1. Informing how statewide transportation plans, policies, and strategies may reflect or impact regional economic/demographic contexts.
2. Recommending potential study regions for specific policy consideration.
3. Identifying potential themes and scenarios to consider during the updates to the 2006 OTP and 1999 OHP.

Recommended Study Regions
Source: EcoNorthwest



2 | EMPHASIZING REGIONAL INDICATORS OF TRANSPORTATION DEMAND IN OREGON

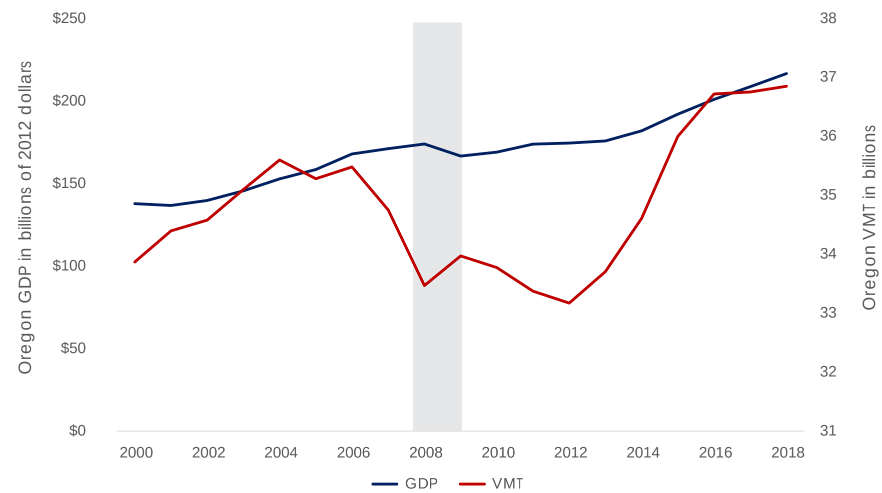
Structural drivers

- It is critical for the OTP/OHP process to identify the relationship between transportation demand and economic growth

Transportation demand is related to the growth of a region's economy, but the relationship is complex. Investments in transportation infrastructure inform understanding of economic productivity.

Our recommendation is that the appropriate framework for the OTP/OHP is to assume transportation demand (i.e., vehicles miles traveled) and economic growth are interrelated. Policy objectives can be nuanced: for example attempting to reduce transportation demand while benefiting a region's economy.

Oregon VMT and GDP growth, 2000 to 2018
Source: Federal Highway Administration, Bureau of Economic Analysis



Shaded area represents Recession from Dec 2007 to June 2009

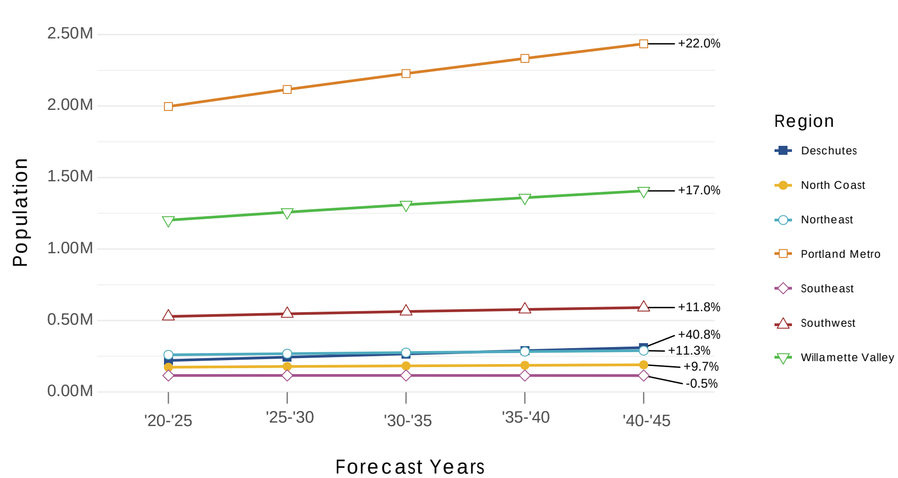
Population and labor force changes

- Population growth, an aging population, and urbanization are important factors relevant to OTP/OHP planning and scenario development.

Several key findings are relevant to the upcoming OTP/OHP process:

1. The population has grown by 24%ince 2000. ~8% additional growth is expected by 2030.
2. The population statewide is aging. This is particularly important in rural communities as they become more reliant on an efficient transportation network to access lifeline services.
3. As congestion rises with urbanization and the increasing remoteness of affordable housing, network reliability suffers.

Forecasted population growth by region 2020 to 2045
Source: Portland State University, Population Research Center.



Changes in Oregon’s industrial composition

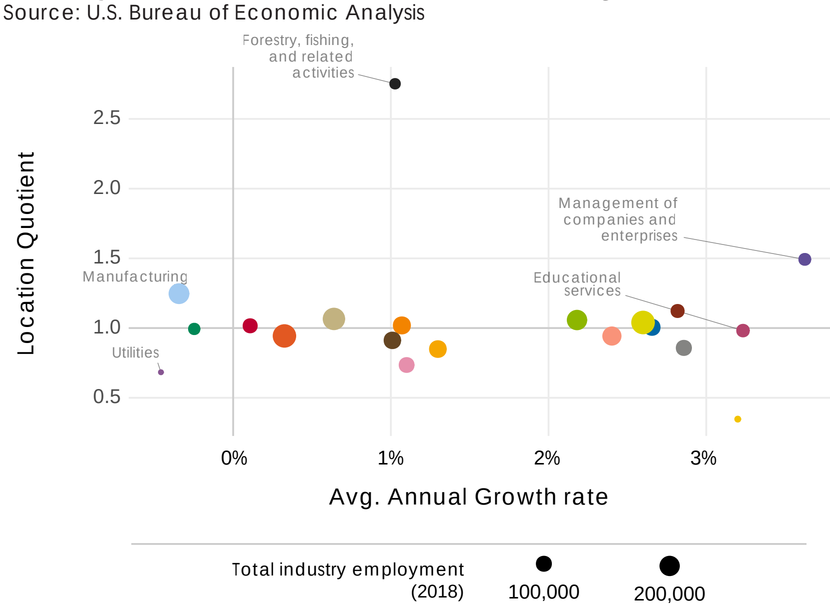
- Industrial composition affects how a region’s economy responds to negative shocks or downward swings in the business cycle
- Industry mix impacts regional transportation demand

Several trends in industrial mix are relevant for the OTP/OHP:

1. Oregon’s economy is becoming more diversified, growing more rapidly in services and technology.
2. Rural regions face challenges with changing economic conditions while diversifying economies in the Portland Metro and Central Oregon regions helps them withstand economic shocks.
3. The economic shock from COVID-19 reveals growing disparities in our regional economies. Oregon’s economy is volatile, outperfoming in periods of growth, but suffering more in periods of contraction.

Industry Concentration and Growth in Oregon, 2010–2018

Source: U.S. Bureau of Economic Analysis



Note: Location Quotient indicates how concentrated an industry is in Oregon compared to the national average. LQ’s over 1 indicate more concentration in that industry than the national average.

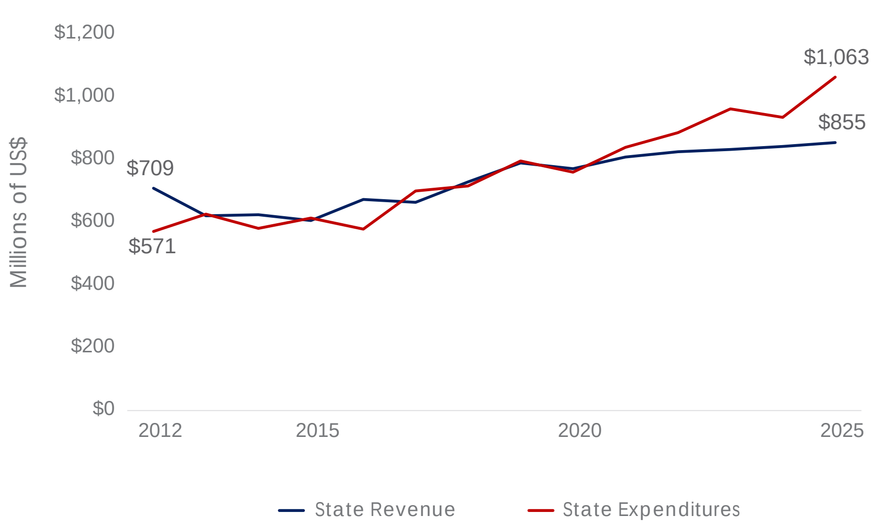
Aligning changing demand with transportation financing

- Oregon should consider new approaches to evaluate statewide and regional transportation demand while balancing costs and revenues to maintain existing public assets

1. Increasingly, existing tax revenue instruments will be inadequate for financing Oregon’s transportation infrastructure.
2. We recommend that Oregon consider new approaches for evaluating statewide and regional transportation demand to prioritize investments.
3. Alternative financing mechanisms that serve multiple goals of efficiently raising revenues while moderating demand should be an important consideration for sustainability.

Forecast of State Highway Fund Balance (May 2020)

Source: Oregon Department of Transportation



Important themes to consider in scenario planning

External factors affect the drivers of transportation demand and supply. The following themes can be used to guide the process of exploring choices.

Land use and density. Changes in land use affect where people live and how they travel.

Changing nature of freight. Changes in purchasing modes and innovations in distribution systems are driving new services that rely heavily on the transportation network.

Structural economic changes. Changes in Oregon's industrial composition will impact the types of investments that will need to be made to support future economic growth.

Economic Resilience. Investing in resilient infrastructure will help the state's economy recover more rapidly after a major event, such as a Cascadia Subduction Zone earthquake.

3 | IMPLICATIONS FOR OTP/OHP

Transportation planning through a regional perspective

- Demographic and economic factors vary by region, resulting in different policy implications for long-term transportation planning.
- The State of Oregon should consider including a data-driven approach to incorporate regional analysis in the OTP/OHP process.
- Our recommendation is to use combined Public Use Microdata regions as a guide to aggregate regions to ensure reproducibility and harmony across all metrics used in the OTP/OHP process.

Drivers of transportation demand in Oregon

- Understanding the distribution of population growth is key to identifying the demographic changes that lead to effective regional policies and infrastructure investment.
- All regions in Oregon are facing diverse transportation challenges. The increasing demands on urban infrastructure, along with health and safety concerns for rural residents should be considered as part of the OTP/OHP process.
- The changing mix of industries around the state will also affect the type of transportation investment that will be needed. The OTP/OHP should account for these regional changes to understand how to build scenarios that can help prioritize investments.

Economic factors impacting the supply side

- Total lane miles have remained flat for the state's facilities, while population growth and environmental changes have placed increasing stresses on the state's aging roads and bridges.
- Changing system user needs will impact the efficacy of existing revenue instruments and will not be to be enough to maintain enough investment in the state's transportation infrastructure in the future.
- With declining revenues and increasing demand, increasing costs, and aging infrastructure, the OTP/OHP process should emphasize strategies that guide prioritization of transportation investments and demonstrate which investments result in the largest public benefits.

Oregon Department of Transportation

Social Equity White Paper

Oregon, USA

HDR

MultiCultural Collaborative

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September 2021

Oregon Department of Transportation

Social Equity White Paper

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Oregon Department of Transportation

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Contents

Purpose of the Social Equity White Paper

This white paper serves as a primer on the topic of Social Equity in transportation policymaking and as a tool to inform the development of the Oregon Transportation Plan (OTP) and Oregon Highway Plan (OHP), which are in progress and continuing to be developed through 2023. It provides a definition of Social Equity and identifies Social Equity best practices. The definition and best practices are based on evaluations of ODOT's most recent equity-focused efforts, all of which are ongoing, and case studies of efforts made by other transportation agencies to prioritize Social Equity within transportation planning.

Those involved in the OTP and OHP updates, the Oregon Transportation Commission (OTC), project-specific Policy Coordination Committee, Planning Coordination Team, Project Management Team and subject matter expert Work Groups will seek ways to actively address historic inequities through the transportation policies developed within the OTP and OHP update process. We approach this work with humility, empathy and seek to understand the experiences of historically excluded and underserved communities by validating and amplifying their voices. We cannot assume we understand one another's lived experiences accessing our transportation systems. Social Equity underscores the importance of having diverse voices involved in the process and amongst decision-makers. Collectively, as a society, we are continuing to understand how our systems, including our transportation system, uphold inequities and can be used to redress them.

When reviewing best practices, consider how they may affect your personal approach to involvement in the OTP and OHP development, such as recommendations for who participates and how, and specific vision, goals, future scenarios, policies, and performance metrics.

See Appendix A for a summary of methodology used to develop the Social Equity White Paper.

What is Social Equity? Why is it important?

While the concept of **Equality** strives to give everyone the same access to resources and opportunities to succeed, **Social Equity** asks what type of support may be needed by different people in order to achieve the same level of success and is rooted in outcomes. Both aim to promote fairness and justice, but equality is only effective if all people start from the same place and have the same needs. However, all people do not have the same histories, conditions or the same needs because they were not allowed the same access to opportunities and resources.

Systematically racist transportation and housing policies, urban planning, discriminatory housing practices, and operation of public services such as housing and transportation have led to disparities for Black, Indigenous, and People of Color (BIPOC). For example, homes, businesses, and churches in communities of colors were displaced when the interstate system was built in the 1950s, locally and nationally. Until passage of the Fair Housing Act (1968) and the Community Reinvestment Act (1977), mortgage lenders redlined neighborhoods of color as areas they did not want to make a loan and denied creditworthy applicants of color a loan for housing (Federal Reserve, 2016). These actions resulted in racist and harmful outcomes, including disinvestment in these communities that effectively prevented the building of generational wealth. Historically, the State of Oregon, more specifically the Oregon Highway Department until 1961 and later Oregon Department of Transportation (ODOT) continued investments in the highway system as a segregation tool. These public investments enabled and resulted in affluent people living further away from existing cities centers and concentrated poverty in specific areas. Simultaneously, governments discontinued investment in public transit and multimodal transportation infrastructure. This resulted in prioritizing a system based on private vehicle use and ownership. The result was an additional burden for low-income households reducing their social mobility and access to resources. For people experiencing low-income or BIPOC in rural areas, their isolation is greater, because they have greater distances to travel and have fewer transportation choices, affecting their access to jobs, education and services.

Oregon State agency, Oregon Health Authorities (OHA), has defined health equity and has begun to documented health inequities.

Oregon Health Authority (OHA) states, “one primary goal of the definition is to get at the root cause of inequities including racism, discrimination and bias, and understand that health inequities are differences in health that are not only unnecessary and avoidable but, in addition, are unfair and unjust. Health inequities are rooted in social injustices that make some population groups more vulnerable to poor health than other groups. An example they provide is that babies born to Black Americans are more likely to die in their first year of life than babies born to White Americans. This remains true even when controlling for education and wealth. This is a health inequity because the difference between the populations is unfair, avoidable, and rooted in social injustice.

OHA has developed a framework (pictured below) that emphasizes the importance of moving upstream from health inequities to the understanding that racism, discrimination and bias impact health outcomes of people who have been historically excluded. (OHA, Health Equity Definition, 2019)

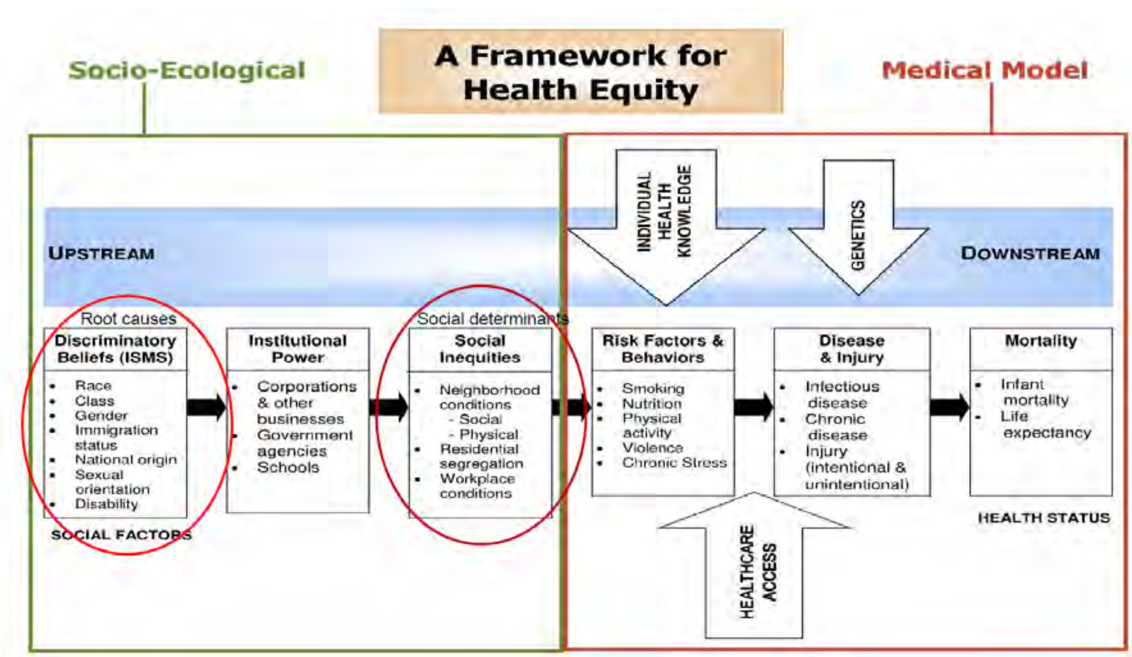

Figure 1. “A Framework for Health Equity.” Oregon Health Authority

Social Equity in transportation recognizes the role that transportation plays in affecting people's overall health and quality of life, and the unique history of barriers that historically excluded and underserved communities face. It also aims to ensure access to transportation solutions to get all people where they need to go to enable their quality of life. Since people use transportation infrastructure to access work, school, entertainment, food, commerce, healthcare, and other needs, Social Equity in transportation creates overarching goals for all transportation users and simultaneously develops transportation polices, programs, and solutions that consider the unique situations and barriers faced by specific people.

The image on the next page illustrates the different terminologies Social Equity encompasses. In the first frame, "Inequality" shows how not everyone faces the same path ahead or has the same resources. "Equality" shows that even when given the same tools, in this case a bicycle, the obstacles each person faces are still different. "Social Equity" recognizes inequalities, in this case a more obstructed path, and creates custom solutions—in this case, a bicycle with different tread designed to handle the terrain—but still the obstacles are present. "Social Equity" is on the path to "Justice," which is the final goal of Social Equity, taking away the inequalities, and creates the same outcomes for all.

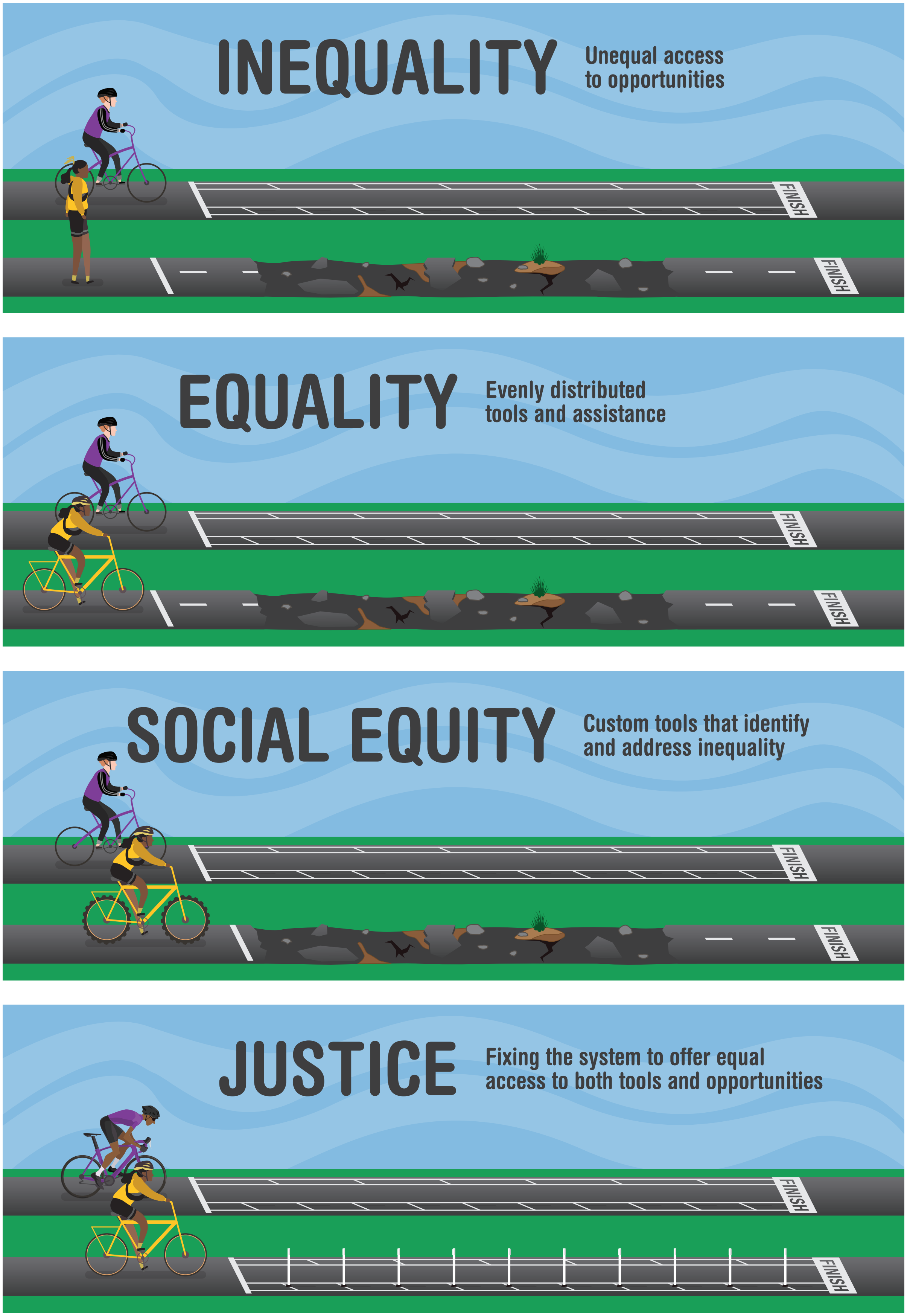

Figure 2. Social Equity — From Inequality to Justice

Why is Equity a Priority Now?

At the state level, ODOT and the Oregon Transportation Commission (OTC) jointly developed the 2021-23 Strategic Action Plan (SAP), which names Social Equity as one of three strategic priorities for ODOT (SAP, 2021).

In addition, the OTP and OHP will prioritize Social Equity implementation.

The federal government is also driving change toward more equitable transportation systems. In January of 2021, President Biden issued the Executive Order 13985: Advancing Racial Equity and Support for Underserved Communities Through the Federal Government. The order sets forth the policy that: **"The federal government should pursue a comprehensive approach to advancing equity for all, including people of color and others who have been historically underserved, marginalized, and adversely affected by persistent poverty and inequality." (The White House, 2021)**

Some provisions of the Executive Order pertinent to OTP and OHP development are:

- Sec. 5. Conducting an Equity Assessment in Federal Agencies. The head of each agency, or designee, shall, in consultation with the Director of the Office of Management and Budget, select certain of the agency's programs and policies for a review that will assess whether underserved communities and their members face systemic barriers in accessing benefits and opportunities available pursuant to those policies and programs.
- Sec. 6. Allocating Federal Resources to Advance Fairness and Opportunity. The Federal Government should, consistent with applicable law, allocate resources to address the historic failure to invest sufficiently, justly, and equally in underserved communities, as well as individuals from those communities.
- Sec. 8. Engagement with Members of Underserved Communities. In carrying out this order, agencies shall consult with members of communities that have been historically underrepresented in the Federal Government and underserved by, or subject to discrimination in, Federal policies and programs.[1]

"Equity — Prioritize diversity, equity and inclusion by identifying and addressing systemic barriers to ensure all Oregonians benefit from transportation services and investments."

2021-2023 Strategic Action Plan (2021)

In March of 2021, The U.S. Department of Transportation issued an Equity and Access Policy Statement, which states, **"The U.S. Department of Transportation is committed to advancing equity, civil rights, racial justice, environmental justice, and equal opportunity. The simple yet powerful mandate of equity and access in transportation will shape and drive all departmental programs and activities.... It is the Department's policy, as reflected in the Department's Environmental Justice (EJ) Strategy, to incorporate EJ and equity principles into all transportation planning and decision-making processes and project development and to promote these goals through public outreach efforts conducted by the Department and its funding recipients."**

At the same time as these policy changes, uprisings against structural racism in the pursuit of justice for communities that have been victimized by collective government policies have taken place across the country, including within Oregon communities. These protests were sparked by longstanding injustices and the continued loss of Black lives to police violence nationally. The result has been a social movement focused on dismantling racism.

[1] **Executive Order Advancing Racial Equity and Support for Underserved Communities Through Federal Government. January 20, 2021.**

ODOT must not only, at a minimum, comply with both the Executive Order 13985 and the Equity and Access Policy Statement as a recipient of Federal funding, but prioritizing Social Equity will make ODOT more competitive for funding. ODOT has a history of innovation at the DOT level and being highly competitive for federal funding. Prioritizing Social Equity can do the same for Oregonians. Moreover, aside from the federal mandate, addressing Social Equity is a moral imperative.

Social Equity Defined

In 2020, ODOT created an Office of Social Equity (OSE), which has worked to define equity agency wide. ODOT's Social Equity definition is from the State of Oregon Equity Framework in COVID-19 Response and Recovery, and in the I-5 and I-205 Toll Project Equity Framework (2020).

It reads:

"Equity acknowledges that not all people, or all communities, are starting from the same place due to historic and current systems of oppression. Equity is the effort to provide different levels of support based on an individual's or group's needs in order to achieve fairness in outcomes.

Equity actionably empowers communities most impacted by systemic oppression and requires the redistribution of resources, power, and opportunity to those communities."

This white paper further defines historically excluded and underserved people, as:

- **People experiencing low income or economic disadvantage**
- **Black, Indigenous, and People of Color (BIPOC)**
- **Older adults (65+) and children**
- **People with limited English proficiency (LEP)**
- **People living with a disability**

Addressing Social Equity has two dimensions, both for the Agency planning process and outcomes.

1. **Process equity** means that the planning process actively and successfully creates opportunities for historically excluded or underserved communities to engage in and co-create plan outcomes.
2. **Outcome equity** means that the OTP and OHP planning processes will acknowledge existing inequities and strive to prioritize and prevent historically excluded and underserved communities from further bearing the burden of negative effects related to transportation decisions. The process will further seek to create more equitable outcomes by improving community health and overall transportation accessibility, options, and affordability.

Neither process equity nor outcome equity can replace the other—both are necessary to prioritize and work toward for Social Equity.

How is Social Equity the Same or Different from Environmental Justice?

Environmental justice (EJ) identifies and addresses the disproportionately high and adverse effects of an agency's programs, policies, and activities on minority (as defined by the census) and low-income populations to achieve an equitable distribution of benefits and burdens, and it includes the full and fair participation by all potentially affected communities in the decision-making process.

Both equity and EJ call for meaningful public engagement, but in practice, EJ focuses on not furthering harm or burdens to already burdened communities (disproportionately high impacts to minority and low-income populations). It is also procedural and often applied during project impact assessment under the National Environmental Policy Act (NEPA), occurring further downstream in the process, during project impact analysis, and not during long-range planning or project development.

By contrast equity, seeks to uplift historically excluded and underserved communities through programmatic and policy changes to improve their outcomes. It acknowledges past harm, that not all groups start at the same place, and sets baselines, goals, and measures progress toward those both process and outcomes goals.

More information on Environmental Justice.

Best Practices

This white paper identifies best practices based on ODOT's latest efforts and other agencies' experiences to operationalize equitable processes and outcomes. Identifying best practices allows all those involved in the OTP and OHP updates, from staff, various committee or work group members, and the OTC, to consider these best practices as we work to develop the OTP and OHP. The intent is to provide ODOT with an actionable, structural overview of how to operationalize Social Equity within the OTP and OHP updates.

These best practices have been organized into the following categories:

- Overarching Social Equity Practices,
- Process Social Equity,
- Social Equity Tools,
- Operationalizing Equitable Outcomes

While reviewing the Social Equity best practices, some key considerations to keep in mind during the development of the OTP and OHP, in sequence of early in the planning process towards implementation and monitoring, are:

- Define Social Equity
- Focus on people, not assets or geographies
- Be clear on the causes of inequities, including race
- Identify distinct barriers historically excluded or underserved people face and develop corresponding, distinct solutions
- Develop a relationship-building mentality and seek to co-create with communities
- Make use of ODOT's Social Equity Index, social equity frameworks and other tools

- Be inclusive, transparent, and clear about how equity tools change decisions
- Increase access to transportation options and opportunities, such as walking, bicycling, and using public transit, and make the transportation system more affordable overall
- Measure Social Equity, evaluate, monitor, and reinvest to implement policies and hold ODOT and the OTP and OHP to account.

These key best practices, amongst others, are described further throughout the best practices section.

Overarching Social Equity Practices

1. **Define Social Equity:** Defining Social Equity, so all involved know what it means and what it does not, is foundational to achieving equitable processes and outcomes. Projects or agencies that did not define Social Equity have struggled to find focus and identify equity as a gap to address. Defining Social Equity precisely, including naming specific people experiencing inequities, provides clarity and focus. Too broad of a definition can dilute the impact of efforts and maintain existing power structures.

   ODOT has used the language "social equity," in the Office of Social Equity to make the focus on people, and the City of San Antonio has defined "racial equity" to center their focus on addressing racial disparities.

   Please see the City of San Antonio's [Racial Equity Indicator Report].

2. **Focus on people, not assets or geographies:** Equity does not seek the equal distribution of resources between asset types, geographies, or political boundaries, but instead addresses disparities among people.

   DOTs have traditionally identified needs based on transportation assets to drive investments, such as whether roadways meet standards, because of their responsibility to build and maintain transportation systems. ODOT's Social Equity Index (see page 13) is an example of focusing on historically excluded and underserved people.

3. **Be bold:** MnDOT's equity efforts have been driven at the staff level, and they recommend being bold in equity work and messaging to better affect necessary change. While equity can be controversial, not taking a clear stand can contribute to maintaining existing power structures and the status quo.

   The image below was co-created with a BIPOC community member, Noah Lawrence-Holder, as part of the Minnesota Department of Transportation (MnDOT) Statewide Multimodal Transportation Plan update process, and contains a clear, simple, factual statement. This image was part of a public survey with a strong educational component. Appendix B has the full public survey.

Figure 3. From MnDOT Statewide Multimodal Transportation Plan Public Survey (2020), Artist: Noah Lawrence-Holder

4. **Be clear about the causes of inequity, including race:** Inequity is the result of cumulative historical and present-day decisions that result in the marginalization of groups of people. Agencies must be willing to understand and own their contributions to this history and gain trust among groups that have been historically excluded and underserved to better enable more equitable outcomes—safe, affordable and convenient access to daily needs. An early step toward Social Equity and justice is to acknowledge, not justify, and apologize for past harms.

ODOT has recently embarked on an oral history project entitled, "A path forward: ODOT's Movement Toward Equity," that researches the impacts of historical transportation projects to help ODOT understand how past practices contributed to barriers in achieving Social Equity.

5. **Identify distinct barriers historically excluded or underserved people face and develop corresponding, distinct solutions:** Barriers faced by different people differ and need to be acknowledged distinctly. One group, such as displaced Black communities in urban and suburban areas, may face different and distinct barriers from those in tribal communities. Those individuals face different barriers compared to people living with disabilities in urban versus rural areas. Additionally, BIPOC individuals living in rural areas likely face different barriers than those in urban areas. Thus, transportation solutions should be developed to respond to the unique barriers and needs historically excluded or underserved people face.

6. **Increase data collection and disaggregate data as much as possible:** Understanding the unique barriers and needs of people by race, ethnicity, income, disability, and age requires collecting data that includes those demographics. Similarly breaking down data as small as geographically possible allows us to understand where historically excluded and underserved populations exist.

   To achieve equitable outcomes, ODOT must not only collect data with race, but also disaggregate data as much as possible to understand the presence of historically excluded and underserved communities, particularly in rural areas. MnDOT quickly realized aggregated data at the census tract level, diluted and masked the presence of the most vulnerable communities in their state, which were BIPOC and low-income communities in rural areas. They have disaggregated all data by race, ethnicity, income, disability, and age (Turner, 2021).

   Understanding how to achieve Social Equity and the unique needs of people may require developing specific studies to test hypothesis and develop additional findings. The Portland State University transportation study Racial Bias in Drivers' Yielding Behavior at Crosswalks: Understanding the Effect[2] explored the hypothesis that "drivers will exhibit racial bias when making decisions about whether or not to stop for pedestrians waiting to cross the street at a crosswalk, which may reflect conscious or non-conscious bias." Based on a Centers for Disease Control Study examining crash history, racial minorities are disproportionately represented in pedestrian fatalities (2013). Looking at driver yielding behavior at marked crosswalks, the study found that Black male pedestrians were passed by twice as many cars, and waited 32 percent longer, compared to white male pedestrians. Regardless of race and gender, drivers were less likely to stop for Black and male pedestrians, and when they did stop, drivers were more likely to stop closer to Black male and Black female pedestrians compared to white male or white female pedestrians. These negative

[2] Kahn, Kimberly, Jean McMahon, Tara Goddard and Arlie Adkins. 2017. *Racial Bias in Drivers' Yielding Behavior at Crosswalks: Understanding the Effect*. NITC-RR-869. Portland, OR: Transportation Research and Education Center (TREC).

Social Equity Index

ODOT has developed a statewide Social Equity Index, which will be foundational to the OTP and OHP development. The Office of Social Equity's description of the Social Equity Index,

"This map allows us to make data driven decisions with understanding of where home is for Oregon's most vulnerable populations, vulnerable because the impact of our investments are felt deeply, consistently, and often faster in high index spaces than others who may experience the burdens of our projects, programs, policies.

We know that age, ability, income, language, and race/ethnicity are predictors in the United States for those that are less likely to be resilience in the face of disaster or health, transportation, education, housing, and economic systems. Additionally, they are more likely to experience disparity with little to no input around how they experience it or what would be most helpful in solution making. So, we have used the most recent block group data form the American Community Survey to share the degree to which Oregonians may be experiencing less than excellence in service, access, investments, and maybe even quality of life. We are using this map to inform how we look at active transportation, safety, air quality, and connectivity through our planning, design, construction, maintenance, finance, compliance, an DMV services to increase the probability of equal outcomes regardless of social demographic or identity."

The Social Equity Index is comprised of people based on low-income, race/ethnicity, age (65+), limited English proficiency, and disability.

experiences lead to increased stress, harms, and fatalities for Black pedestrians. Currently, crash data does not exist by race.

Recently, the State Legislature passed House Bill 3159 the Data Justice Act that requires healthcare providers to collect and report to OHA data on their patient's race, ethnicity, preferred spoken and written languages, disability status, sexual orientation and gender identity. In addition to mandating data collection by providers, the Data Justice Act directs OHA to develop a database for storing and analyzing patient demographic data. The area of health has been at the forefront of considering Social Equity outcomes. Social Equity mandates, innovations, and practices from the arena of health can be instructive for transportation.

7. **Understanding people's lived experiences are as valuable as quantified data:** Current policies and performance measures tend to value things that can be measured over those things that cannot, and lack of quantifiable data can lead to inaction. Input from those who have been historically excluded and underserved about their lived experiences must balance readily available data, which often do not include demographics. Listening is key, which requires more open-ended questions and conversations during engagement.

   For example, MnDOT conducted transportation equity labs. In so doing, they gained qualitative data that spoke to lived experiences that may differ from staff who often do not share those lived experiences. They discovered that some people were paying 25 percent interest on car loans for car access, which made car ownership financially difficult. This was not the experience of staff or those who have traditionally participated in transportation planning processes.

   The PedPDX plan is one local example of how equity considerations can drive changes to the transportation system. During the development of PedPDX, the City of Portland studied the experiences of Black pedestrians in PedPDX: Walking While Black (2019), which concluded that while the experience of being a pedestrian in Portland depends significantly on where you live or work, it also depends on who you are. In sum, the plan encourages transportation planners and engineers to not just think about safety in terms of traffic safety (i.e. preventing injuries and crashes), but to also pay attention to community members' sense of personal safety and security in the public realm,[3] which can be gained through qualitative data collected through engagement.

8. **Social Equity is cross-cutting and cannot be isolated:** Understanding how to make our systems more equitable is the responsibility of everyone involved in plan, policy, and project development. When the topic of Social Equity exists in isolation or is tacked on at the end of a project or process as an impact assessment, agencies will struggle to operationalize it. Integrating Social Equity means actively seeking out ways to incorporate Social Equity more deeply into ODOT's processes from the beginning, such as OTP policies, implementing programs, and through agreements between leadership and internal departments to commit to delivering more equitable outcomes (Metrolink, 2021).

9. **Incorporate a trauma-informed perspective in our current context (tolling):** The I-205 and I-5 Toll Projects' Equity Framework (2020) was co-created with the Equity and Mobility Advisory Committee, made up of Social Equity and/or BIPOC community leaders specifically convened for the tolling project. The Equity Framework calls to, "Incorporate a trauma-informed perspective in our current context by recognizing the trauma associated with multiple historic and current events, including the ongoing killings of African Americans by police, the COVID-19 pandemic, the economic ramification from these events, as well as the impacts of past transportation and land use investments… Embracing this trauma-informed perspective in policy making can begin to address past harms, minimize burdens, and maximize benefits for historically underserved community members." The graphic (Figure 4) developed for I-205 and I-5 Toll Projects' Equity Framework (2020) illustrates a trauma-informed perspective. A trauma-informed perspective recognizes signs of community trauma, such as health disparities and economic instability. The notion of trauma-informed perspectives is derived from mental health fields and has been adapted to a community trauma-informed approach for the tolling projects.

Process Social Equity

1. **Shift power to historically excluded or underserved groups and celebrate their inclusion:** Shifting power dynamics requires careful examination of who participates at all levels. Consideration includes participating staff, committee makeups, and decision-making bodies to reflect historically excluded or underserved populations. The Oregon Toll program aims to elevate the needs and priorities of historically marginalized communities. To do this, the I-205 and I-5 Toll Projects' Equity Framework (2020) requires that each of the projects recognize, understand, and shift existing power dynamics within ODOT, other government agencies, groups, the community, and the projects' teams.

   During the development of the OTP/OHP a Social Equity Framework will be used to evaluate both the planning process and plan outcomes to better prioritize Social Equity. The OTP/OHP planning process will also conduct a Power Analysis of stakeholder participants to evaluate whether the most impacted are centered in their influence or have the least amount of influence.

   Historically excluded, underserved people and BIPOC communities have rich cultures and have demonstrated enormous resiliency and strength, due to the often multiple types of discriminating, exclusion, and marginalization they have endured. During interviews with ODOT leadership, some expressed concern that BIPOC were too routinely portrayed as victims who need saviors. We can strive to further co-create with historically excluded and underserved people, while recognizing their resiliency and strength.

[3] **Portland Bureau of Transportation. 2019. "PedPDX: Walking While Black." Accessed July 13, 2021.**

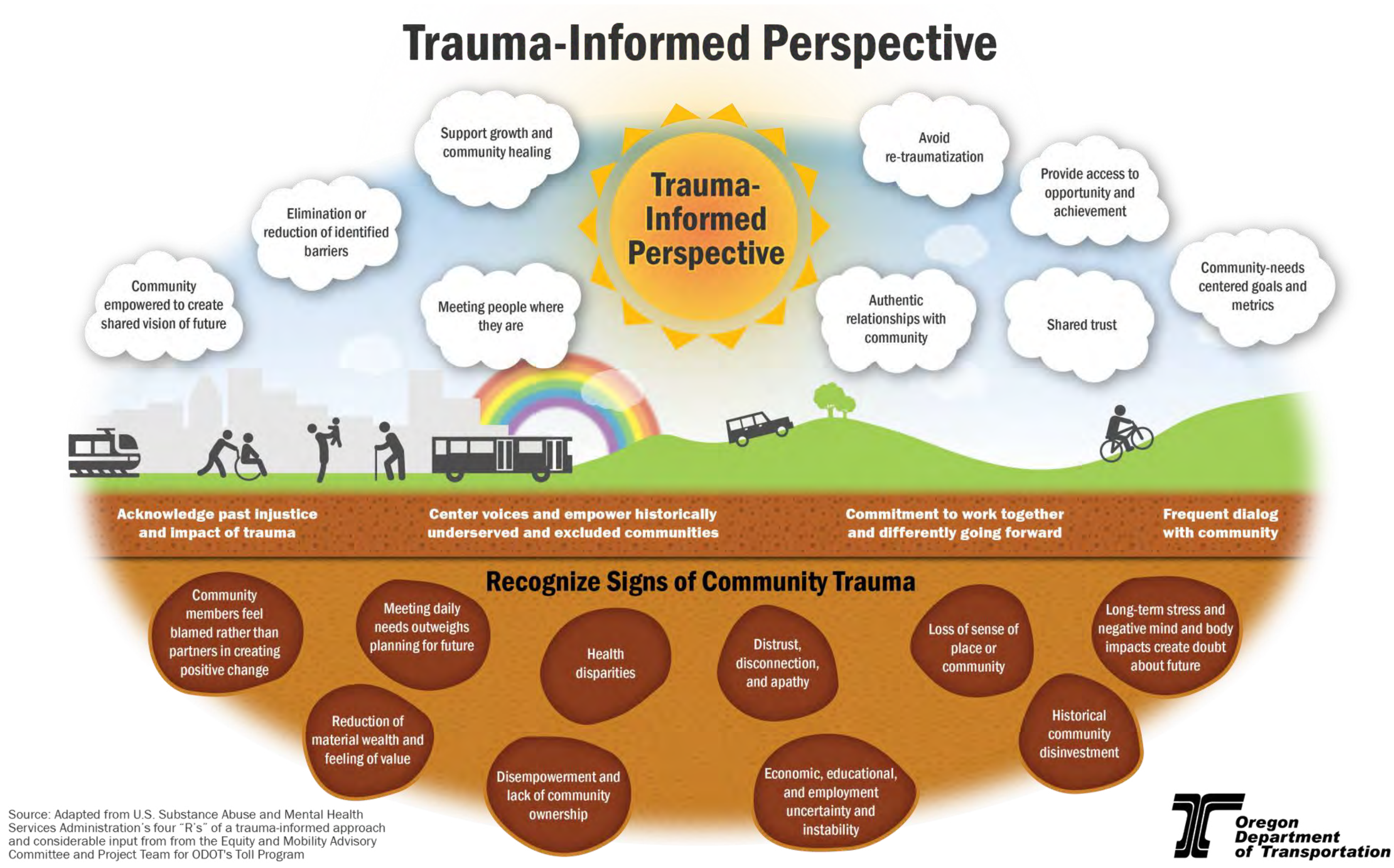

Figure 4. Trauma-Informed Perspective used in the I 205 and I-5 Toll Projects' Equity Framework (2020). Artist: Geoff Gibson (WSP) and Emily Benoit (WSP)

Use inclusive framing with language and approaches. Typically, the framing of BIPOC communities is othered by using language such as “non-white” or “minority,” which is a white framing that uses a white perspective. Similarly, our framing of transportation needs and options can be more inclusive. For instance, referring to bicycling and walking as active transportation instead of “alternative modes,” implying alternative to a personal vehicle. The recommendation encourages shifting power to make the perspectives and needs of BIPOC and other historically excluded and underserved people central to the framing and execution of the planning process.

2. **Root out paternalism:** Often, decision-making and ways to participate and influence are clear to those with power and unclear to those without it. In fact, this knowledge itself is power. Those with existing power and influence think they know best and are capable of making decisions for and in the interest of those without power. Yet, those with power often don’t think it is important or necessary to understand the experiences of those for whom they are making decisions. In contrast, those without power often do not know how decisions get made and how to gain influence; however, they often bear the burdens of these decisions.[4]

   Elevating technical expertise over the lived experiences of users of the transportation system can be one way the use of paternalism manifests. Another is use of relational or political power and leveraging connections to advantage certain outcomes. These are ways in which paternalism can influence planning processes. Putting into place several of the Social Equity Process best practices in this section, such as affinity groups for historically excluded and underserved people and demonstrating how input from those affinity groups is acted upon are ways to counter paternalism.

3. **Develop and formalize a relationship-building mentality and seek to co-create with communities:** ODOT leadership expressed the understanding that the agency typically engages communities project by project, and that greater ongoing relationship building must take place to address existing trust deficits among communities that have been historically excluded or underserved. Agencies that have led with equity as a priority have found it is useful to think about their ongoing relationships with historically excluded or underserved communities.

   For example, the City of Seattle has established an “Equitable Development Initiative” with an ongoing, standing advisory board. The City of Seattle co-created with historically excluded and underserved people who make up the committee by taking the time to explain the Department of Transportation’s Role, asking, listening and learning so communication was more than one-way. They listened to BIPOC by empathizing, understanding and building relationships that enabled the committee to co-create a definition of equitable development. The City of Seattle defines equitable development as, “public and private investments, programs, and policies in neighborhoods that take into account past history and current conditions to meet the needs of marginalized populations and to reduce disparities so that the quality of life outcomes such as access to quality education, living wage employment, healthy environment, affordable housing and transportation, are equitably distributed for the people currently living and working here, as well as for new people moving in.”

   Agencies are likely used to engagement for discrete projects. However, strengthening relationships that outlive individual projects can help agencies deliver more equitable projects by ensuring communities are getting involved early with knowledge of how to participate. When agencies work with community organizations to learn what communities need, they can avoid costly public opposition and increase the appreciation and effectiveness of their work.

[4] Jones, Kenneth and Tema Okun. White Supremacy Culture: From Dismantling Racism, A Workbook for Social Change Groups. Minnesota Historical Society. ChangeWork. 2001.

4. **Conduct public engagement where people live, play, and work:** Historically excluded or underserved communities frequently face barriers just to engage in traditional agency outreach methods. A given location may be difficult to access, schedules may conflict, language may be a barrier, and people may lack awareness that meetings are being held or for what purpose, and they may believe that agencies will not listen to or act upon their feedback (Metrolink, 2020).

   MnDOT developed an ongoing series of community engagements for the purpose of relationship-building and called them Community Conversations. The Community Conversations are a series of in-person conversations between MnDOT staff and individuals who work with and represent underserved communities in Minnesota. Through these conversations, MnDOT has learned, and will continue to learn, directly from underserved people, their unique experiences and struggles with transportation. Since MnDOT did not have a definition of equity when the project began, conversations focused on connecting with communities that are:

   - Currently underrepresented in transportation decision-making processes
   - Experiencing known inequities in transportation access or outcomes
   - Facing unique transportation needs that are not addressed well by current approaches

   In the future, a definition of equity will guide future Community Conversation work. The structure of the Community Conversations project is based around MnDOT's eight districts. This structure was set-up to allowing for district-specific conversations and relationship building between local staff and community-based equity partners.

   An additional consideration is to engage people who may have been displaced from a neighborhood or place, and their identities and cultural ties are still to that neighborhood or place. Special care must be taken to identify and engage displaced people.

5. **Focus on cultural agility:** Cultural agility encompasses far more than translating information into other languages. Agencies must develop their capacity to compose messages that speak to the cultural values of the communities they serve, particularly those that are historically excluded or underserved. A literal translation into another language is likely going to be perceived differently than intended because cultural context is not considered. Cultural agility goes beyond linguistic considerations and includes cultural variations across racial, ethnic, and religious lines. Cultural agility requires agencies to be culturally specific, which means adopting new ways of doing things. Greater diversity amongst staff at all levels and stakeholders participating in the development of the OTP that reflects the diversity of the state is one way to achieve greater cultural agility. Another is to engage community-based organizations and community leaders that represent people of specific cultural backgrounds and compensating them for their expertise.

   Oregon is becoming more diverse, and our planning process must reflect cultural agility to be responsive to more diverse needs. Based on the 2020 Census, Oregon grew more diverse in the last decade and is now the 29th most diverse state. Growth occurred in the following race/ethnicity categories, from greatest to least: Hispanic or Latino, Asian, White (non-Hispanic), Black, American Indian or Native Alaskan, and Native Hawaiian. However, the greatest growth was amongst those who identify as multiracial, tripling over the decade (Oregonian, 2021). Cultural agility is critical to serving the needs of Oregonians.

6. **Use affinity groups to draw-out and uplift historically excluded or underserved voices:** Affinity groups are groups made up of people who have shared identity, such as people living with disabilities or BIPOC, and can be at the staff or stakeholder engagement level. For people experiencing low income, older adults, children, people with LEP, and people living with disabilities, participating in mixed groups can feel exposing. Based on feedback from affinity focus groups, people stated that they felt more comfortable sharing their experience amongst others of a similar background. This is intensified for BIPOC who have almost universally experienced racial bias. A history of being excluded has led to legitimate mistrust amongst underserved people and providing them a separate space and way to engage can help engender trust. Likewise, allies who want to enable equity can come together in separate spaces to talk about how they can advocate and enable.

7. **Maintain a learning orientation and operate with empathy:** The prioritization of Social Equity is a new for ODOT and staff and stakeholders involved are learning how to create more equitable outcomes. Centering and honoring the lived experiences of historically excluded and underserved groups requires active listening, a willingness to learn, and entering conversations with empathy.

8. **Slow down and build trust, but make progress:** Operating with a sense of urgency can stymie innovative approaches and has the potential to reinforce the status quo. Further, relationship building and overcoming trust deficits takes time.

   The City of Seattle has had a commitment to race and equity for 10 years, and the co-creation of an equity definition and equity drivers has taken place over 3 years, including taking time to educate stakeholders about processes so they could fully participate.

Social Equity Tools

1. **Make use of equity indices, frameworks and other tools:** Equity tools can assist with intentional and objective analysis and are often the most visible product of an equity analysis. One recent tool the ODOT Office of Social Equity has produced is a Social Equity Index (see description on page 11), which identifies low to high social equity areas and can be used as a tool to understand the distribution of populations and as a means to help set priorities.

   The City of Seattle has recommended an approach to racial equity (Figure 5). Their Racial Equity Toolkit lays out a process and a set of questions to guide the development, implementation, and evaluation of policies, initiatives, programs, and budget issues to address the impacts on racial equity.

   The California Office of Environmental Health Hazard Assessment has developed CalEnviro Screen, which is a mapping tool that helps identify California communities that are most affected by many sources of pollution, and where people are often especially vulnerable to pollutions effects. Amar Cid, Program Manager for Office of Race and Equity at Caltrans says that CalEnviro Screen is fundamental to the way that policy is made in California and relying on communities that are most harmed by pollution is the way they are centering Social Equity. State level health policies that relate to quality food accessibility has also been helpful in shaping transportation policies to focus on Social Equity.

   The OTP process will develop an equity framework as a tool to help prioritize equity during the planning process.

2. **Make tools accessible and interactive:** Interactive, map-based equity tools, created by cities like San Antonio, provide a way for an agency to clearly communicate equity data that it has collected. These map-based tools, such as the Social Equity Index being developed by ODOT, can be integrated into decision-making processes both within the agency and

Figure 5. Seattle Race and Social Justice Initiative's Racial Equity Tool Kit to Assess Policies, Initiatives, Programs, and Budget Issues (City of Seattle, 2012)

beyond. Early use of these equity map-based tools can inform policy, program, and project development.

The City of San Antonio's Equity Atlas provides census-tract level data based on several regional inequality indicators. These include race, income, education, language, and historic redlining data. The atlas is publicly accessible and allows users to click on tracts to see how the City's scoring system assesses needs and access barriers in detail.

3. **Be inclusive, transparent, and clear about how equity tools change decisions:** The purpose of equity tools is to push agencies toward innovation and more equitable outcomes and to think critically about the ways in which they serve communities. Agencies must be able to point to how these tools have affected concrete and meaningful change in policies, programs, and projects, or how and why they have not. Being clear with the public about how a given equity tool has changed agency decisions garners trust among stakeholders and provides an opportunity for the public to weigh-in on the effectiveness of the tool, which ultimately leads to better relationship building and different outcomes (Metrolink, 2020).

Operationalizing Equitable Outcomes

1. **Measure Social Equity, evaluate, monitor, and reinvest—measuring, evaluating, and monitoring Social Equity is an act of an agency holding itself to account.** Measuring Social Equity is important, especially to elevate Social Equity to the same level as other performance-based frameworks used within the Agency. Both MnDOT and Washington State Department of Transportation (WSDOT) have recognized the need for and continue to research and develop equity focused performance metrics. For the 2024-27 STIP process, which sets funding priorities by category, ODOT introduced Social Equity criteria and used active transportation investment as a means by which to measure the prioritization of Social Equity, recognizing that underserved communities are in need of greater transportation options and multimodal access.

   Following the implementation of a policy, program, or project, monitoring and evaluating the actual outcomes against stated goals should be completed to assess whether anticipated benefits and burdens are realized and whether any unforeseen issues may require mitigation. These metrics can be coordinated with health equity metrics and outcomes. Baseline and post-implementation evaluations, through data collection or surveys, can be used to confirm whether target outcomes have been achieved. Within health equity, this process is called "Continuous Improvement." Evaluations provide another opportunity for public transparency and have the potential to build trust among historically excluded or underserved communities, especially if the monitoring and evaluation results in further investment and clarification of ways to meet Social Equity goals.

   Within Social Equity, accessibility measures with measurable objectives include accessibility to jobs, education, services, and other essential needs. However, ODOT must balance performance-based measurement with qualitative assessments because overreliance on what can be quantified can limit full understanding of historically excluded or underserved communities.

In 2020, the Washington State Legislature directed the WSDOT to study the feasibility of performance-based evaluation of transportation projects. **WSDOT studied how to compare transportation projects to determine which investments will best help the transportation system meet the policy goals set by the Legislature. The study included:**

- **Looking at how WSDOT has used the transportation policy goals to make decisions.**
- **Reviewing WSDOT's current tools and procedures for evaluating performance.**
- **Asking for feedback from stakeholders, including traditionally underserved and historically disadvantaged populations, to help inform how WSDOT and the Legislature could evaluate transportation investments.**
- **Analyzing how WSDOT engages and communicates with stakeholders, including people who have been historically underrepresented, about project evaluation.**

WSDOT learned through public engagement that the way projects are currently selected is not widely understood, particularly for people without deep experience in transportation policy. The study produced a performance-based project evaluation developmental model that responds to the assessment results and stakeholder input. The model incorporates a sorting layer to take advantage of internal subject matter expertise, a criteria-based scoring layer, and a more detailed evaluation of environmental, health and equity values through a screening layer. The steps of the layered evaluation process contribute to a project's composite score. Next steps include taking the findings of the study, including the performance-based project evaluation developmental model back to the State legislature to further gauge their interest in implementation.

2. **Increase access to transportation options and opportunities:** Increasing transit, bicycle, and pedestrian access greatly benefits low-income households for whom car affordability may be difficult. These individuals are disproportionately BIPOC and/or disabled. Increasing transportation options—transit, bicycle, and pedestrian opportunities, while making them safe, convenient, and affordable—generally provides benefits for all people and has greater potential for reducing greenhouse gas emissions. People experiencing low-income benefit the most from increased transit access because transit riders are disproportionately lower income.

   ODOT's 2024-27 STIP allocation process uses multimodal investment, meaning investment in transit, bicycle, and pedestrian access, as a way to approximate greater equitable investments. All efforts the agency investigated identified greater investment in transportation options as a way to make the transportation system more equitable for historically excluded and underserved people. Making these investments in a way that anticipates and responds to the potential of gentrification and displacement is also important. Stabilizing the housing market and keeping it affordable before transportation investments are made, including multimodal investments, helps lead to greater Social Equity. To better understand the dynamics between transportation investments and housing, including identifying anti-displacement tools, ODOT is conducting a Transit and Housing Study, which is currently in progress and expected to be completed in the spring of 2022.

3. **Increase the affordability of the transportation system:** The need to make the transportation system more affordable is directly related to the need to increase transportation options. The connection between land use and transportation is key to overall affordability. Typically, next to housing, transportation makes up the second greatest expense in a household budget.

   When evaluating new approaches, such as tolling, or emerging technologies, such as

   electric vehicles and charging infrastructure, e-bikes and e-scooters, and highly-automated shuttles to augment public transit, decision-makers need to strive to make the transportation system increasingly affordable, and thus more accessible to all. We need to consider the private household investment required to participate in the transportation systems we create.

4. **Contribute to healthier communities, particularly for those who have been historically excluded and underserved:** Transportation access is a social determinant of health outcomes. Transportation choices are connected and can affect a household's physical environment, health outcomes, economic mobility, educational and cultural opportunities, and numerous other factors that influence quality of life. As with any public works project, transportation infrastructure projects carry potential health and safety impacts such as air quality, noise, and traffic safety. Moreover, people experiencing low-income are more likely to live near highways and are therefore exposed to more traffic noise and air pollution than affluent populations. Highway pollution can disproportionally burden low-income populations who are less likely to drive.[5]

   Contrasted with impact analysis, such as Environmental Justice processes, contributing to healthy communities calls for more than mitigating negative effects of a project

[5] Manville, M. and Goldman, E., Would Congestion Pricing Harm the Poor? Do Free Roads Help the Poor? Journal of Planning Education and Research, (2018).

ODOT's recently adopted 2021-2026 Climate Action Plan (2021) lists 5-Year Climate Actions, including a Climate Justice Approach. The list of actions represents the work ODOT is committed to conduct between 2021 and 2026 to reduce emissions from transportation, address equity and climate justice, and make the transportation system more resilient to extreme weather events.

The Climate Action Plan states, "Climate Justice requires acknowledgment that past and current policies, practices, and investments may exacerbate differing social, economic, public health and other adverse effects on communities throughout the state and seeks to eradicate or mitigate these adverse effects on marginalized and underserved communities as much as possible. Modernizing the transportation system in Oregon offers important opportunities to address climate justice while improving outcomes for all Oregonians. ODOT Climate Office will lead development of a data-driven approach to integrate climate justice into agency policies, decision-making processes, and investments to ensure ODOT's work extends beyond improving the transportation system, and results in an environmentally friendly transportation system that advances the protection of marginalized and underserved communities from climate hazards. The climate justice approach will be developed in conjunction with ODOT's existing work to prioritize equity with an emphasis on designing fair, transparent, and inclusive decision-making processes, accessible to all Oregonians, (Climate Action Plan, 2021)."

after decisions about it have been made. Contributing to healthier communities and people, particularly those who have been historically excluded and underserved, requires upstream action from policy making and program development to implementation and evaluation. Contributing to healthier communities is rooted in creating equitable outcomes, and can be coordinated with education, health, and economic data to understand people's conditions and disparities and to evaluate the distribution of outcomes.

5. **Prioritize equitable investments:** Within WSDOT's Performance-based Project Evaluation Feasibility Report, health and equity factors, such as air pollution and access to employment and education, were evaluated based on screening questions and deemed important to consider during the decision-making process.

   The process used the health and equity screening questions below, which are answered "yes" or "no" and could include a brief explanatory statement. The highest screening score came from projects with positive outcomes for environmental, health, and equity value benefits.

   For example, with respect to air pollution…

   a. Does the project produce a best outcome?
   b. Does the project have a net positive impact?
   c. Does the project have a negative impact?
   d. Can the project be modified to decrease or avoid impact?
   e. Can the negative impact be mitigated?

   Additional screening questions could relate to community support.

6. **Establish universal goals with targeted strategies:** Planning for the City of Seattle Pedestrian Plan focused on walkable communities with accessible sidewalks, which was a universal, citywide goal. There was an understanding that there would not be an even, or equal, investment across the city. Rather, investments were prioritized based on need recognizing that some neighborhoods had sidewalks in greater disrepair. Those areas of the city received a higher priority and were the recipient of a greater share of funds. Therefore, while the goal was universal, the planning process developed targeted strategies to address inequities (or equity).

7. **Seek transformative, not transactional changes:** The Othering and Belonging Institute differentiates transactional and transformational change and recommends striving for transformational change.[6] Transactional changes reform or eliminate a single barrier within a structure to enable more people to achieve a universal goal, and these are necessary changes. Transformative changes are changes in the structures and systems that shape group outcomes. These are more durable and may be sufficient changes.

   An example of transformative change, and progressing toward it, could be moving away from traditional roadway investments and moving increasingly toward emerging technologies and transportation options.

8. **Assign ownership and hold staff to account:** To better operationalize equity policies, MNDOT staff recommend the agency assign ownership of activities and provide sufficient staff level resources to support and advance the activities. Sufficient staff levels would enable focused and substantial work towards achieving Social Equity.

Conclusion

Collectively, transportation agencies at the state and local levels are making equity a priority and are developing policies, programs, and strategies to better achieve equity through their processes and with their outcomes. Having a clear and common definition for equity is a critical grounding step. While all agencies have not taken this step, all staff at agencies interviewed recognize it is necessary. We have much to learn from other current ODOT Social Equity efforts and the work of other agencies. The OTP and OHP, with a planning time horizons of 20 years and beyond, are opportunities to create transformational change toward a more equitable and just transportation system for all.

[6] Targeted Universalism, Policy and Practice, May 2019.

Resources

Agencies' Work Related to Social Equity

Minnesota Department of Transportation Statewide Multimodal Transportation Plan

City of Seattle Pedestrian Master Plan and Progress Reports

Oregon Department of Transportation Climate Action Plan

Washington Department of Transportation Performance Based Evaluation Report

City of San Antonio Equity Atlas

City of Seattle Racial Equity Toolkit

CalEnviroScreen 3.0

I-5 and I-205 Toll Project's Equity Framework

City of Portland Bureau of Planning and Sustainability's History of Racist Planning in Portland

Oregon Health Authority's Health Equity Strategy—Case Study by Princeton University

On Racism, Transportation as a Social Determinant of Health, and Cultural Agility

A Hidden History: The stories and struggles of Oregon's African American Communities (from Oregon Humanities, by Walidah Imarisha)

The Racist History of Portland, the Whitest City in America (Atlantic Magazine, by Alana Semuels)

White Supremacy Culture: From Dismantling Racism, A Workbook for Social Change Groups (Minnesota Historical Society)

Divorcing White Supremacy Culture (Tema Okun))

Cultural Agility (Top Talent Solutions)

Social Determinants of Health Series: Transportation (American Hospital Association)

Oregon Health Authority Transportation Research Brief

Legislation Related to Equity

Oregon House Bill 3129: The Data Justice Act (pertains to Health Care Providers and Oregon Health Authorities)

Currently in House Committee House Bill on declaring Racism is a Public Health Crisis; Oregon Public Health Association Info Fact Sheet in Support

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Appendix A

Methodology

The Social Equity white paper was developed using: a workshop with select ODOT staff who have experience implementing Social Equity efforts; interviews with ODOT leadership on the topic of Social Equity; an examination of the latest ODOT Social Equity-focused efforts; and case studies of other state and local transportation agencies regarding their approaches to Social Equity. This evaluation prioritized other state Departments of Transportation (DOT), as well as two cities that have innovative approaches to Social Equity.

ODOT Leadership Interviewed:

- Kris Strickler, Director
- Travis Brouwer, Assistant Director of Revenue, Finance, and Compliance
- Nikotris Perkins, Assistant Director of Social Equity
- Amanda Pietz, Policy, Data, Analysis Division Administrator (and former Climate Office Director)
- Lucinda Broussard, Tolling Program Manager (ODOT Region 1)

ODOT Equity-Focused Efforts:

- 2021-2023 Strategic Action Plan
- I-5 and I-205 Toll Projects Equity Framework
- 2024-2027 Statewide Transportation Improvement Program (STIP)

Other Transportation Agencies and Interviewees:

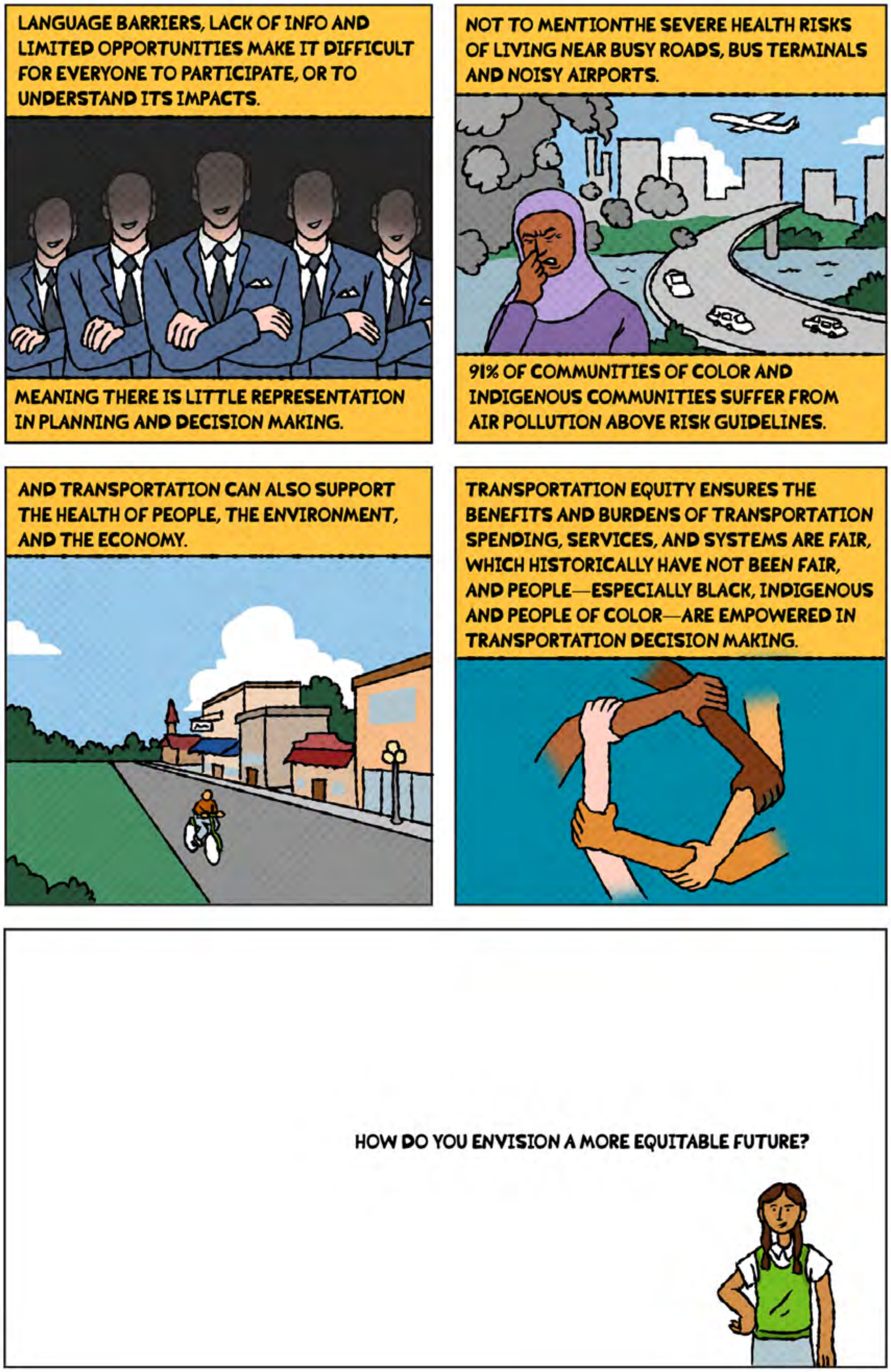
- Caltrans (California), Amar Cid, Program Manager for Office of Race and Equity
- Minnesota Department of Transportation (MnDOT), Hally Turner, Policy Planning Director; Abdullahi Abdulle, Transportation Equity Planning Coordinator; Ashley Zidon, Multimodal Program Coordinator
- Washington Department of Transportation (WSDOT), Karena Houser, Statewide Planning
- City of San Antonio, Zan Gibbs, Chief Equity Officer
- City of Seattle Department of Transportation, Annya Pintak, Transportation Equity Program Manager, Office of Equity and Economic Inclusion (OEEI)

Appendix B

Minnesota Department of Transportation (MnDOT) Statewide Multimodal Transportation Plan (SMTP) Public Survey Related to Equity

The survey provided information as well as sought feedback from the public. MnDOT staff specifically asked open-ended questions instead of multiple choice questions, which requires more time to evaluate, because they wanted to do their best to listen openly to answers without preconceived notions about what answers may be.


EQUITY
WHAT DOES IT MEAN?
POLICY, DESIGN AND OPERATIONS IN THINGS LIKE HOUSING AND TRANSPORTATION HAVE LED TO INEQUITIES FOR INDIGENOUS PEOPLE AND PEOPLE OF COLOR
FOR EXAMPLE, CONSTRUCTION OF INTERSTATES IN THE 1950'S DISPLACED HOMES, BUSINESSES AND CHURCHES
AND REDUCED HOUSING IN THESE AREAS.
THIS MOSTLY TOOK PLACE IN COMMUNITIES WHERE LOANS WERE DENIED OR HOUSING WAS RESTRICTED BY DEED, LEADING TO MUCH LOWER PROPERTY VALUES.
LOAN
DENIED
THIS DISPROPORTIONATELY AFFECTED POC.
FAVORING HIGHWAY DEVELOPMENT OVER PUBLIC TRANSPORT LASTED FOR YEARS.
THIS ENCOURAGED HOUSING DEVELOPMENT FURTHER FROM KEY DESTINATIONS, FOSTERING SEGREGATION AND INCOME INEQUALITY.


LANGUAGE BARRIERS, LACK OF INFO AND LIMITED OPPORTUNITIES MAKE IT DIFFICULT FOR EVERYONE TO PARTICIPATE, OR TO UNDERSTAND ITS IMPACTS.
MEANING THERE IS LITTLE REPRESENTATION IN PLANNING AND DECISION MAKING.
NOT TO MENTIONTHE SEVERE HEALTH RISKS OF LIVING NEAR BUSY ROADS, BUS TERMINALS AND NOISY AIRPORTS.
91% OF COMMUNITIES OF COLOR AND INDIGENOUS COMMUNITIES SUFFER FROM AIR POLLUTION ABOVE RISK GUIDELINES.
AND TRANSPORTATION CAN ALSO SUPPORT THE HEALTH OF PEOPLE, THE ENVIRONMENT, AND THE ECONOMY.
TRANSPORTATION EQUITY ENSURES THE BENEFITS AND BURDENS OF TRANSPORTATION SPENDING, SERVICES, AND SYSTEMS ARE FAIR, WHICH HISTORICALLY HAVE NOT BEEN FAIR, AND PEOPLE—ESPECIALLY BLACK, INDIGENOUS AND PEOPLE OF COLOR—ARE EMPOWERED IN TRANSPORTATION DECISION MAKING.
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MOBILITY AS A SERVICE (MAAS) IN OREGON

Implications for the Oregon Department of Transportation

Prepared for ODOT by Trillium Solutions

May 2020

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Introduction

Innovations in transportation technology are reshaping the way Oregonians travel, particularly by expanding options beyond driving alone. Recognizing this, the Oregon Department of Transportation (ODOT) has identified the emerging concept of Mobility as a Service, or MaaS, as an area of opportunity for the agency to play a significant role.

ODOT hired Trillium Solutions to explore the agency's potential approach to MaaS, given Trillium's experience in the transportation technology field. Trillium conducted extensive research to this end, including stakeholder engagement within and outside of ODOT. This document is the final product of that work.

The document is organized into four sections:

1. **Mobility as a Service: Defining the concept**, which provides an operational definition of MaaS for ODOT. Interviewees for this portion of the project primarily came from experts at agencies within Oregon, while research included a broader set of informational resources.
2. **Summary of current and planned practices related to MaaS**, which summarizes a review of several public, private, and non-profit sector programs, projects, and products in the MaaS realm. The focus is on practices most relevant to the Oregon context.
3. **Assessing ODOT's readiness for MaaS**, which examines the agency's organizational and technical capacity to play a role in MaaS implementation in the state. This review included engaging ODOT's Transportation Technology Advisory Group and interviews with several other ODOT staff.
4. **Role recommendations and implications for policy in planning**, which is the culmination of the prior three sections. It includes actionable next steps for ODOT to consider taking, including creation of a MaaS-focused advisory group and a MaaS policy evaluation framework.

A major purpose of this work is to inform two forthcoming efforts: updates to the Oregon Transportation Plan (OTP) and Oregon Highway Plan (OHP). Note that this document does not serve as the agency's comprehensive MaaS policy document; rather, it provides a foundation from which ODOT can determine how MaaS will impact the future of the transportation system in Oregon, and how the agency may shape those impacts.

1. Mobility as a Service: Defining the concept

Section Overview

In order to identify the appropriate roles that the agency should play with respect to MaaS, ODOT must first establish an operational definition of the concept. This section provides this definition, formulated from a review of the latest practices and understandings of stakeholders from the public and private sectors.

Context: Why MaaS? Why now?

In March 2019, ODOT released an Emerging Technologies Impact Assessment (ETIA) report that frames policy implications for the agency to consider for an uncertain future due to advancements in computing power and miniaturization, communications and networking, and the increased volume of and access to data. This changing landscape calls for transportation planning that acknowledges how different Oregon's transportation system is likely to look over the next few decades compared to the present. Specifically, updates to the Oregon Highway Plan (OHP) and Oregon Transportation Plan (OTP) must aim to align the state's transportation vision and policies with both current and projected future circumstances.

ODOT recognizes that MaaS will be a key component of this future. Various MaaS initiatives are being implemented around the world, with implications for private and public transportation providers, policymakers, regulatory agencies, and – most importantly – transportation system users. At the same time, the concept is arguably still in its nascent stages, especially in the U.S. This presents an opportunity for ODOT to define its role within the MaaS ecosystem in a way that supports agency goals. The first step towards this is to develop a shared understanding of what we mean when we talk about MaaS.

Defining Mobility as a Service

Based on a review of public agency, non-profit, and private business stakeholders in the MaaS realm (further described in the Summary of Findings later in this section), we provide this working definition of MaaS:

In its visionary form, MaaS is an open marketplace that maximizes personal mobility in a way that reduces one's need to rely on a privately-owned vehicle. Successful MaaS implementation integrates the suite of available transportation options into a single platform that enables on-demand trip planning, real-time information, and payment for seamless end-to-end journeys.

Within this definition are terms that call for further description:

Open marketplace

A marketplace is a venue for the sale and purchase of goods and services. The MaaS marketplace must be accessible ("open") for providers and users to sell and buy transportation services, enabled by open data architecture, which is discussed in more detail in Section 4 of this document. Not only will this help foster a more robust menu of current services, but it leaves room to add services in the future that do not exist currently. "Open marketplace" should *not* be interpreted as one that operates free of any policy or regulatory structures. On the contrary, public policy interventions will likely be necessary to create the most open, accessible, and competitive arena for MaaS.

Suite of available transportation options

The transportation options that users have to make trips differ from place to place and from person to person. In this sense, the "suite" we are referring to is highly contextual. For example, micro-mobility services such as bikeshare or e-scooters exist in relatively few communities; even where available, not everyone has the ability to use them. Additionally, some transportation providers may not wish to participate in MaaS, rendering those services unavailable, and therefore not part of the suite in the context of MaaS.

One platform

While some definitions of MaaS include a specific type of platform for implementation (e.g. mobile application), this definition avoids prescribing to that degree. A MaaS platform is meant to be a “one stop shop,” so to speak, and this definition embraces the “one stop” concept without asserting what the “shops” should look like. It also allows for the likelihood that multiple MaaS providers will compete to offer their one platform to meet customers’ transportation needs.

Seamless end-to-end journeys
Piecing together multimodal journeys from multiple information sources and paying for services separately causes friction for travelers. MaaS must reduce or eliminate this friction by enabling complete trips as conveniently as possible, in order to compete with the experience of getting from door to door by driving a personal vehicle.

The intent here is not to create a set of categorical standards for MaaS. Rather, MaaS can be considered on a spectrum, where the farther along that spectrum a particular application of MaaS lies, the closer it gets to maximizing personal mobility without the need to own a car. It should also be noted that implicit in this definition is that the quality of service options on the ground – especially public transit – can support the type of trip-making facilitated by a MaaS platform. Without adequate infrastructure and service provision, MaaS will not be useful to travelers, appealing to private investors, or worthy of public sector resources.

Summary of Findings

This working definition was informed by a review of the thinking and practice of major local, national, and international MaaS stakeholders. Through research and interviews, several themes emerged that informed this definition.

Theme 1: Integration
“A single mobility service provided through an app is not MaaS.” --project interviewee

At its most basic level, MaaS is about integrating transportation options that have varying operators, payment systems, and information access points. Without this integration (e.g. in the case of operator-specific applications), trip planning begins by selecting a mode like ride-hailing or bike share or public transit, and then proceeding to navigation and payment. This model puts the onus on the traveler to determine their best option with incomplete information, which in turn reinforces habits that may not most effectively meet traveler needs in terms of travel time or cost. The result is a significant barrier to the multimodal mobility that policymakers aim to encourage. Having all of one’s choices presented in a single location, with itineraries to complete entire journeys using the traveler's best modal options to do so, is essential to MaaS.

Theme 2: User-centric, seamless experience
"The goal of MaaS is seamless, frictionless city movement." --project interviewee

MaaS is about personal mobility. Successful implementation requires an experience that end users find useful, convenient, affordable, and perhaps even enjoyable. Consumers must be able to fulfill their transportation needs primarily using public transit and shared mobility options. Reliable real-time information is key, as it allows users to plan journeys on the fly and make adjustments as plans or conditions on the ground change.

Without these characteristics, MaaS will not be an effective alternative to the use of private vehicles.

Theme 3: Reduce reliance on private vehicle use and ownership
"MaaS creates an environment where people don't have to own their means of transportation." --project interviewee

Stakeholders tend to assert that MaaS is meant to be a viable option to meet *all* of one's transportation needs. In many areas this would not be possible if driving were eliminated; services like Whim include rental car options in their packages, so users can drive, if needed, without needing to own a vehicle. Still, reducing negative externalities stemming from driving – traffic congestion, greenhouse gas emissions, pollution, injuries and fatalities, land use impacts – is very much behind the push for MaaS.

Theme 4: Data challenges and opportunities
"In our business we run into issues with data ownership, since each entity needs to approve of its use." --project interviewee

Behind any MaaS implementation is a wealth of data. As a result, discussions about data occurred in most interviews:

- User privacy and the protection of personal data is a top priority.
- Travel and payment data generated could be very useful for transportation planning purposes.

- Determining data ownership & standardization requirements will impact the degree to which the MaaS marketplace is an open one.

Given oftentimes competing objectives between the private, public, and non-profit sectors, data integration and policy may be the greatest challenge for MaaS. The Finnish Government's Act on Transport Services[1], which established open data requirements for all transportation providers, is one example of a data policy intervention that could provide useful lessons, albeit in a different governmental and societal context.

Theme 5: Geographic context
"MaaS is not going to be one size fits all." --project interviewee

To this point, MaaS has generally been conceptualized as applicable to large cities and regions with a plethora of transportation options. Still, MaaS solutions have the potential to benefit smaller communities as well, so long as solutions are designed with those communities in mind. The focus in such areas may be geared more towards options such as carshare services, public transit, or mobility management to address the needs of transportation disadvantaged populations. These approaches imply a significant role for the public sector to support innovative MaaS or MaaS-like strategies.

Theme 6: Interoperable payment systems
"Solving fare payment integration may be the most difficult part of MaaS." --project interviewee

An important foundation for MaaS is integration of payment for services, and the task of integrating is complicated. Service providers understand the value of open standardized fare payment, but concerns exist about fair distribution of revenues. In the public transit realm, regional (and even national) smartcard-based fare systems have made riding transit on different operators simpler for users. Behind the front-end simplicity are backend fare reciprocity agreements and complex technical implementations. Accepting payment via bank-issued payment cards, especially contactless, delivers convenience for some travelers, but this approach involves agreements with the banking sector and may create disparities for unbanked and underbanked populations. Some mobility apps integrate trip planning and fare payment through private commercial partnerships. Questions about how pricing can be used as a tool to encourage certain transportation choices add to this complexity.

[1] https://www.lvm.fi/en/-/act-on-transport-services-955864

Additionally, quality auditable data is needed for jurisdictions or public agencies that are receiving funds as part of MaaS facilitation.

Interviewees

To allow for candid responses during the interviews, interviewees were assured that their specific comments would not be attributed to them or their organizations. We are providing a list of interviewees here to highlight the range of experience of those who contributed to this portion of the project.

Kevin Chambers, Founder and Principal, Full Path LLC
Jeremy Dalton, Method City Planning and Technical Project Manager for the California Integrated Travel Project (Cal-ITP)
Clinton Fulcher, Director, Business Rental Sales, Commute with Enterprise
Linda Gehrke, Region 10 Administrator, Federal Transit Administration
Robert Johnson, Transit Fleet & Safety Manager, Kayak Public Transit
Susan Johnson, Public Transit Manager, Kayak Public Transit
Melissa Lowry, Associate Planner, Rogue Valley Transportation District
Dwight Mengel, Chief Transportation Planner, Tompkins County, New York Department of Social Services
Roger Millar, Secretary of Transportation, Washington Department of Transportation
Miller Nuttle, Bike & Pedestrian Policy, Lyft
Chris Pangilinan, Head of Global Policy for Public Transportation, Uber
Lilly Shoup, Senior Director, Policy & Partnerships, Lyft

Related Resources

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MaaS Alliance: https://maas-alliance.eu/
MaaS Global/Whim: https://whimapp.com/about-us/
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Schweiger, Carol, *Mobility as a Service White Paper,* National Aging and Disability Transportation Center, January 2017
Goodall et al., *The rise of mobility as a service: Reshaping how urbanites get around*, Deloitte Review Issue 20, 2017
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2. Summary of Current and Planned Practices Related to MaaS

Section Overview

This section provides a sampling of public, private, and non-profit sector practices that connect to MaaS. These practices take several forms including projects, programs, and products, both current and planned. While this is not meant to be an exhaustive resource of all things MaaS, it is a curated list meant to inform ODOT as it determines its role with respect to MaaS. It therefore focuses on practices most relevant to the Oregon context.

Matrix Primer

The Oregon Department of Transportation's (ODOT's) working definition of MaaS is as follows:

In its visionary form, MaaS is an open marketplace that maximizes personal mobility in a way that reduces one's need to rely on a privately-owned vehicle. Successful MaaS implementation integrates the suite of available transportation options into a single platform that enables on-demand trip planning, real-time information, and payment for seamless end-to-end journeys.

The information in the matrix below is organized into three sub-categories that support movement towards this vision:

1. **Open data and trip-planning technology development**. Several efforts are underway to develop and implement data specifications and tools to aid transportation system users, particularly to more easily use modes besides driving alone.
2. **Supply-side multimodal connectivity projects.** These initiatives are focused on services, infrastructure, and modal integration in order to improve transportation options.

3. **Demand-side programs to reduce single occupancy vehicle trips.** By incorporating information resources and incentives, these programs aim to shape traveler behavior, encouraging use of public transit and other non-single-occupancy vehicle modes.

The summary of each practice includes: a brief description, the leading agency or organization, the timeline/status and applicable geography for implementation, and the transportation context (i.e. the types of trips it intends to enable or support)

Table 2.1: Matrix of Current and Planned MaaS Practice

Program/Project	Agency/ Organization	Timeline/ Status	Geographies	Supported Trips
Open data & trip planning technology development				
GTFS-Flex[2] Project to build GTFS (General Transit Feed Specification)-flex datasets for all public transit agencies in Oregon, describing dial-a-ride, deviations, and flag stopping, in combination with fixed route data. Surveys for this data have also collected information about service capabilities and eligibility.	ODOT	Active	State of Oregon	Small urban, rural
GTFS-capabilities & GTFS-eligibilities ODOT has invested in the development of the early drafts of GTFS-capabilities and GTFS-eligibilities - these extensions of the GTFS allow for better representation of a traveler's full range of transit options. GTFS-capabilities will allow transit operators to share vehicle capabilities related to passengers, mobility devices, and more. GTFS-eligibilities will allow transit operators to share what factors determine eligibility for service - for example age, income, or veteran status. ODOT submitted an Integrated Mobility Innovation (IMI) grant proposal as well as a Mobility for All proposal to continue the development of these data specifications and to create these data sets for transit operators in Oregon.	ODOT	2020 (pending grant approval)	State of Oregon (complete datasets); International (data specifications)	Small urban, rural, urban, intercity

[2] https://content.govdelivery.com/accounts/ORDOT/bulletins/248330d

Program/Project	Agency/ Organization	Timeline/ Status	Geographies	Supported Trips
Open Trip Planner improvements[3] Open Trip Planner (OTP), used for the back end of trip planners such as TriMet's trip planner and ODOT's Get There trip planner, needs to be updated to support flexible transit services. ODOT, soon to have a complete GTFS-flex dataset for transit options throughout the state, has proposed updated OTP development in the FTA Innovative Mobility Integration (IMI) grant.	ODOT	2020 (pending grant approval)	State of Oregon (representing flexible services); International (potential use once data is created)	Small urban, rural, urban, intercity
Open Street Map improvements[4] ODOT's proposed IMI project includes improvements to Open Street Map (OSM). Get There's OTP instance uses OSM for routing options.	ODOT	2020 (pending grant approval)	State of Oregon	Small urban, rural, urban
TriMet Next Generation Trip Planner[5] Navigation tool that includes transit, bicycling, bike share, e-scooters, park and ride, and Uber. User selects between transit only or transit + the option of their choice to plan trips.	TriMet	Beta version 2019	Portland Metro	Large urban, medium urban, intercity
Get There[6] Trip planning tool to help connect travelers to transportation options including carpool, vanpool, transit, and bike share.	ODOT	Active	State of Oregon	Large urban, medium urban, small urban, rural, intercity

[3] https://www.opentripplanner.org/

[4] https://www.openstreetmap.org/
[5] https://trimet.org/newplanner/index.htm
[6] https://getthereoregon.org/

Program/Project	Agency/ Organization	Timeline/ Status	Geographies	Supported Trips
Biketown[7] - General Bikeshare Feed Specification (GBFS) GBFS is the open data standard for bikeshare. Biketown in Portland publishes GBFS, allowing third-party apps to make Biketown bikes discoverable to travelers. TriMet includes Biketown availability in its new trip planner. Biketown is the only Oregon bikeshare system with a publicly available GBFS dataset, according to the GBFS GitHub repository[8].	Portland Bureau of Transportation/ TriMet	Active	Portland, OR	Large urban
Portland eScooter pilot[9] - Mobility Data Specification (MDS)[10] MDS is a set of Application Programming Interfaces (APIs) focused on dockless e-scooters, bicycles, and carshare. Currently, shared scooter operators in Portland and Milwaukee create MDS data. Portland manages the data for both Portland Milwaukee. MDS data is directly shared with third-party software vendors, but the City only stores aggregated data on City cloud servers.	Portland Bureau of Transportation/ Bureau of Planning and Sustainability (Smart City PDX)	Active	Portland, OR; Milwaukee, OR	Large urban, medium urban
Supply-side multimodal connectivity projects				
LTD Mobility on Demand Pilot[11] 13-month Statewide Transportation Improvement Fund (STIF)-funded project to better serve outlying areas of the LTD service district. Includes a pilot in Cottage Grove (the Connector) and downtown Eugene (EmGo), which uses 5-passenger electric vehicles. Includes the development of mobility management plan focused on emerging technologies and innovative service models.	Lane Transit District	January 2019 – August 2020	Eugene/ Springfield, OR metro area	Small urban, rural

[7] https://www.portlandoregon.gov/transportation/57983

[8] https://github.com/NABSA/gbfs

[9] https://www.portlandoregon.gov/transportation/77294

[10] https://github.com/openmobilityfoundation/mobility-data-specification

[11] https://www.ltd.org/system-map/route_MOD/

Program/Project	Agency/ Organization	Timeline/ Status	Geographies	Supported Trips
Clean Rural Shared Electric Mobility Project (CRuSE)[12] Electric vehicle car share pilot in Hood River. To include tiered pricing and alternative payment methods on a digital platform.	Forth	2019 - 2022	Hood River, OR	Small urban, rural, intercity
Oregon State University Cascades Mobility Lab[13] Stated purpose is to educate the community, inform policy, and test transportation technologies to encourage implementation of those that can safely and efficiently move people and goods. Collaborative effort led by OSU-Cascades, with support from the City of Bend, the Bend Metropolitan Planning Organization, Bend 2030's Move Bend Coalition, and St. Charles Health System. Programs include Ride Bend micro-transit pilot, Zagster Bike Share, potential e-scooter pilot, as well as data analysis and community outreach.	OSU-Cascades + partners	Active	Central Oregon	Medium urban
Rogue Bike Share[14] Partnership between Rogue Valley Council of Governments (RVCOG), Rogue Valley Transportation District (RVTD), ODOT, City of Ashland, and Southern Oregon University, with stations throughout Ashland, including one at RVTD's Front Street Station.	RVCOG/RVTD	Active	Jackson County, OR	Small urban

[12] https://forthmobility.org/news/forth-to-receive-doe-funding-for-clean-rural-shared-electric-mobility-cruse-project

[13] https://osucascades.edu/mobility-lab

[14] http://bike.zagster.com/jacksoncounty/

Program/Project	Agency/ Organization	Timeline/ Status	Geographies	Supported Trips
Ashland Connector[15] Funded by STIF, Rogue Valley Transportation District (RVTD) launched this 18-month micro-transit pilot in December 2019. RVTD purchased two hybrid vans; riders can use an app to call on demand for rides from home to one of 24 stops in the city.	RVTD	2019-2021	Ashland, OR	Small urban
First and Last Mile Project[16] Project to recommend first and last mile strategies, including: Infrastructure investments to provide safer, faster, and more comfortable access to transit; and Opportunities to support and integrate innovative mobility options that are coordinated, flexible, and responsive to the land use and transportation context.	Washington County Long Range Planning section	2019-2020	Washington County, OR	Medium urban, small urban, rural
Gresham Emerging Transportation Technologies Project[17] Project looking to explore near-term impacts and opportunities in Gresham related to transportation technology. In November 2019, City launched an online survey to gather community input on micromobility.	City of Gresham	2019	Gresham, OR	Medium urban

[15] https://www.ashlandconnector.org/

[16] https://www.co.washington.or.us/LUT/Divisions/LongRangePlanning/PlanningPrograms/TransportationPlanning/first-and-last-mile.cfm

[17] https://greshamoregon.gov/Planning-Projects/

Program/Project	Agency/ Organization	Timeline/ Status	Geographies	Supported Trips
Demand-side programs to reduce single-occupancy-vehicle trips				
Commuter Benefits/Transportation Demand Management software services Akin to MaaS, but geared specifically towards reducing driving alone to work, these platforms integrate mobility options and use incentives (e.g., earned rewards) to influence commuter behavior. Examples include RideAmigos, Luum, Metropia, and Velocia.	Multiple private companies	N/A	Multiple	Large urban, intercity
Portland Transportation Wallet[18] Program available to residents in targeted areas that offers a package of transportation options. Currently costs $99 and includes $150 in stored value loaded onto a TriMet Hop card, an annual Portland Streetcar pass, and an annual Biketown membership. The City has issued an RFP for the development of a digital platform to administer this program.	PBOT	Active Work on digital platform expected to begin July 2020.	City of Portland	Large urban
LTD Point2Point Program[19] Partnership between LTD and multiple jurisdictions/agencies providing information about transportation options in order to reduce driving and encourage use of transit, biking, walking, carshare, carpooling, and telecommuting.	Lane Transit District	Active	Eugene/ Springfield, OR	Medium urban, small urban, rural

[18] https://www.portlandoregon.gov/transportation/78470

[19] https://www.ltd.org/point2point/

Program/Project	Agency/ Organization	Timeline/ Status	Geographies	Supported Trips
Humboldt County Mobility on Demand Strategic Plan[20] Purpose is to assist the HCAOG in determining the best courses of action to increase multimodal mobility and accessibility in Humboldt County, especially for public transportation, bicycling, walking, rideshare, and other modes separate from single-occupancy automobile.	Humboldt County Association of Governments (HCAOG)	Draft complete Oct 2019; Final expected June 2020	Humboldt County, CA	Suburban, rural

[20] http://www.hcaog.net/documents/mobility-demand-strategic-development-plan

3. Assessing ODOT's Readiness for MaaS

Section Overview

The extent to which ODOT can play a role in the implementation of Mobility as a Service (MaaS) depends on the agency's capacity to do so. This section provides an assessment of ODOT's current organizational and technical capacity to support MaaS in Oregon as a prelude to recommending what that role should entail (discussed in the next section).

Organizational Capacity

To assess ODOT's organizational capacity to play a role in MaaS, we aimed to answer three key questions:

1. What MaaS-related work is currently underway at ODOT?
2. What MaaS-supportive structures are already in place?
3. Where are the major gaps or barriers (organizationally) that need to be addressed in order for ODOT to play a role in MaaS?

The project team led a roundtable discussion with ODOT's Transportation Technology Advisory Group (TTAG) and interviewed internal stakeholders to inform answers to these questions.

1. What MaaS-related work is currently underway at ODOT?

The Public Transportation Division (PTD) has discretionary funds that are allocated through two programs – the Statewide Transportation Improvement Fund (STIF) and the Statewide Transit Network Program (STN) – in part to support "technological innovations that improve efficiencies and support a seamless, easy-to-use Statewide Transit Network." Distributed via grants to public transportation providers in Oregon, this funding presents an opportunity to enable projects that move communities and the transit agencies that serve them further along the MaaS spectrum.

ODOT is also engaged in the realm of data standards and specifications. This includes a statewide General Transit Feed Specification (GTFS) program to build and maintain transit providers' GTFS data feeds, as well as work to expand upon GTFS with extensions such as GTFS-flex (describes dial-a-ride, deviations, and flag stopping); GTFS-ride (describes ridership information); GTFS-capabilities[21] (describes vehicle capabilities related to passengers, mobility devices, and more); and GTFS-eligibilities (describes what factors determine eligibility for service - for example age, income, or veteran status). These efforts lay the groundwork for integration of a variety of transit services into a MaaS platform.

Another ODOT initiative relevant to MaaS is OReGO, the state's road usage charge program. Launched in 2015, the program relies on personal accounts through which participants pay for their miles driven. It is statutorily required that OReGO adopt standards for open system technology and have an open architecture that integrates "information systems currently in use or planned for future use."[22] This could establish a foundation for the integration and payment of many transportation services (see Figure 3.1).

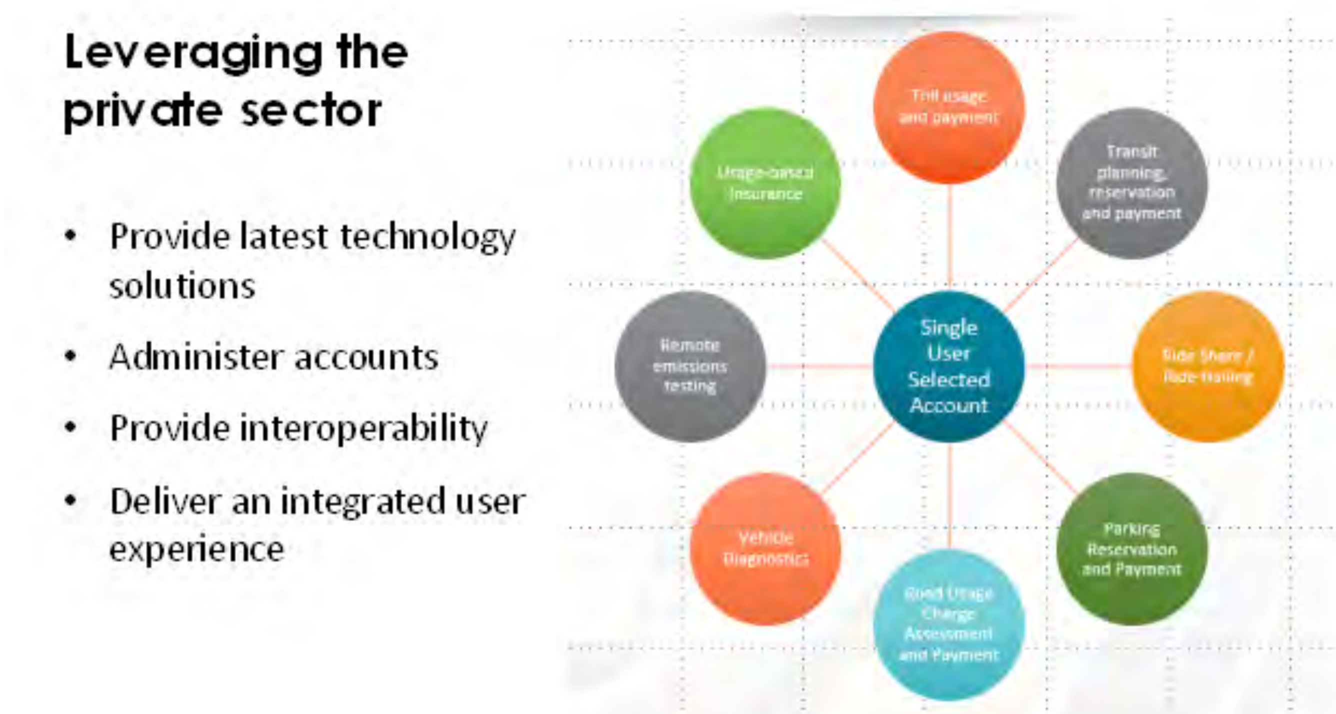

Figure 3.1: ODOT Office of Innovation's schema of potential use cases for personal transportation accounts.

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[21] Other options for the name of this specification are being considered as of this writing.

[22] Enrolled Senate Bill 810 (SB 810-B), Oregon State Legislature. (2013) https://olis.leg.state.or.us/liz/2013R1/Measures/Overview/SB0810

2. What MaaS-supportive structures are already in place?

MaaS has the potential to touch many business areas within ODOT. PTD is likely to play a major role, and many staff members who participated in the TTAG roundtable indicated interest and capacity to support MaaS. PTD's role may include: helping shape policy, funding MaaS-relevant projects through STIF and STN, coordinating and convening transit providers around the state, MaaS marketing, and providing analytic support/customer service. ODOT's policy and planning efforts establish a foundation from which to support MaaS implementation. The Oregon Transportation Plan (OTP), Oregon Public Transportation Plan (OPTP), and Oregon Highway Plan (OHP) all present opportunities to connect MaaS to long term goals.

In the shorter term, initiatives like implementation of the Statewide Transportation Strategy (STS) and the Oregon Innovative Partnerships Program (OIPP) also have logical connections to MaaS. The purpose of the OIPP, for example, is to develop public-private partnerships and streamline a variety of projects. It helps ODOT overcome some of the barriers discussed in the next section, in that it enables private companies to work with ODOT in earlier stages of projects; in some cases, direct negotiations between private firms and ODOT are possible.

One exemplary project under the OIPP umbrella is the Road Usage Charge program (OReGO), which is based on an open data architecture, demonstrating how a user transportation account could function. The system lends itself to expansion, which could include things like tolling, congestion pricing, and other transportation services.

The Public Transportation Advisory Committee (PTAC) is another body that could play a role in supporting MaaS. PTAC's stated role is to "...[provide] a forward thinking, strategic view of public transportation for the state of Oregon. PTAC focuses on the dual roles of addressing the realities of the current state transportation paradigm as well as providing direction on the future of public transportation." Specifically, the committee advises PTD and the Oregon Transportation Commission on matters of policy and funding, and its 2019-2021 work plan includes convening a first mile/last mile summit. This summit presents an opportunity to further explore ODOT's role with respect to MaaS.

3. Where are the major gaps or barriers (organizationally) that need to be addressed in order for ODOT to play a role in MaaS?

As with any large organization, inter-divisional coordination does not always occur naturally at ODOT. The relevance of MaaS to multiple ODOT business units means that communicative partnerships are crucial; interviewees identified this as a potential challenge to ODOT's ability to support MaaS.

Similarly, slow internal processes (such as procurement) limit the nimbleness of ODOT. Because transportation technology is changing at a rapid pace, having an impact requires swift adaptation; ODOT's ability in this area is deficient, according to several staff interviewed. The Office of Innovation was established in part to address this and is therefore likely to be an important MaaS partner.

Technical Capacity

To assess ODOT's technical capacity to play a role in MaaS, we aimed to answer three key questions:

1. What knowledge and skills exist at ODOT to foster MaaS implementation?
2. What technologies and tools does ODOT have at its disposal to support MaaS?
3. Where are the major technical gaps or barriers that need to be addressed in order for ODOT to play a role in MaaS?

Answers to these questions were also informed by the TTAG roundtable and interviews with internal stakeholders.

1. What knowledge and skills exist at ODOT to foster MaaS implementation?

A major reason for ODOT's interest in MaaS is the policy implications: how will MaaS impact the transportation system and its users? How can MaaS play a role in furthering established goals? TTAG participants pointed to policy development as a strength of the agency, with experienced staff and ample precedent from which to draw.

ODOT often plays the role of convener and leader of strategic partnerships. Relationships established throughout the state are an asset to the agency and will be necessary for successful MaaS deployment in Oregon. Regional Transit Coordinators (RTCs) are likely to be instrumental in this sense, as they engage a variety of transit stakeholders across the state.

The agency also has experience deploying technology to support Oregon transportation providers and users. These technologies are discussed next.

2. What technologies and tools does ODOT have at its disposal to support MaaS?
ODOT has made a concerted effort to develop and utilize technology for transportation planning, analysis, and system user information[23]. Table 3.1 provides a summary of MaaS-related technological tools, projects, and resources available to ODOT.

Table 3.1: Summary of ODOT's MaaS-related technology resources

Tool/Project/ Resource	Description	Connection to MaaS
Statewide General Transit Feed Specification (GTFS) data	Since 2011, ODOT's Public Transportation Division has supported and maintained GTFS datasets for public transit providers in the state. GTFS-flex – an extension of the specification that describes dial-a-ride, deviations, and flag stopping, in combination with fixed route data – datasets are currently being built for Oregon transit providers.	GTFS is an open data specification that is used by third-party software applications for a variety of transit-related purposes. MaaS applications will rely on GTFS for fixed route transit information and GTFS-flex for the various services it describes.
Transit Network Explorer Tool (TNExT)	Open source tool developed by OSU and ODOT that tracks a variety of transit performance measures (for example, agency connectivity and access to employment via transit) for the statewide transit network.	ODOT intends to evaluate how MaaS impacts travel in the state, and MaaS is likely to enable analysis that builds upon what TNExT currently offers.

[23] Note that ODOT has extensive interest in technologies such as Intelligent Transportation Systems (ITS) and Vehicle to Infrastructure (V2I), which this paper does not address as they are outside its scope.

Tool/Project/ Resource	Description	Connection to MaaS
TransData Portal	Online portal that links to a variety of data resources, including maps and GIS, safety/crash data, traffic counts, and others.	The TransData Portal establishes a centralized location for tools that can aid in MaaS-related analysis.
Get There	Online tool supported by ODOT that helps travelers connect to transportation options including carpool match, joining or starting a vanpool, finding transit options, locating bike share stations, and more.	Get There is a MaaS-like application that aggregates several different modes besides driving alone in one place.
Open Trip Planner	Tool that provides itineraries combining transit, pedestrian, bicycle, and car segments through networks built from widely available, open standard OpenStreetMap (OSM) and GTFS data. An OTP instance is part of Get There. It currently uses a proprietary mapping system rather than OSM.	Open Trip Planner is one tool likely to be used by MaaS applications.
Transit Technical Resource Center	Site designed to help Oregon's transportation agencies find resources for training, transportation planning, and information technology tools.	The Resource Center's purposes include: • Provide educational opportunities to transit agencies on existing and emerging transit technology. • Identify and pursue opportunities for shared solutions among transit agencies.

Tool/Project/ Resource	Description	Connection to MaaS
Remix	Software tool to aid in transportation planning and analysis. ODOT subscribes to Remix, providing access to transit providers across the state.	Remix has the capacity to track shared mobility metrics that ODOT could use in analyzing the impacts of MaaS on the state's transportation system.
TripCheck	ODOT's real-time road traveler tool to help drivers access traffic congestion, road conditions, and weather information.	The information provided through TripCheck is relevant to trip-planning components of a MaaS platform.

3. Where are the major technical gaps or barriers that need to be addressed in order for ODOT to play a role in MaaS?
Lack of a shared understanding of MaaS itself across relevant sections of ODOT is a fundamental barrier to MaaS-supportive initiatives at the agency. This project aims to address this barrier, but its importance should be reiterated.

Seamless payment for transportation services is a feature envisioned for advanced MaaS platforms. A common theme that arose through this project was ODOT's limited experience with payment systems, indicating that the agency does not have the technical capacity to shape such systems in a significant way. However, through OReGO, ODOT has formed public-private partnerships wherein third-party service providers handle account management and banking transactions for the agency.

Conclusions

ODOT has some valuable structures, resources, and experience to lend to MaaS in the state. This may entail leveraging existing programs to include an explicit MaaS focus, expanding the roles of PTD staff whose roles intersect with MaaS, utilizing the various technological tools at the agency's disposal, and expanding upon these tools as new software developments occur.

While there are several potential organizational and technical limitations that preclude ODOT from being the sole implementer of MaaS, the agency has a history of partnering with stakeholders to accomplish statewide goals. Additionally, programs like OReGO demonstrate capacity to innovate in order to address organizational barriers and respond to emerging technological challenges and opportunities.

4. Role Recommendations and Implications for Policy & Planning

Section Overview

In this section, we first present options for roles along with potential pros and cons, followed by recommendations to put roles into action. ODOT should consider the interrelatedness of these roles in order to identify which ones to assume, given the context of the agency's recent leadership changes, reorganization, and to-be-developed updates to long range plans.

Roles and recommendations are categorized under four umbrella roles that ODOT plays currently:

1. ODOT as partner and convener,
2. ODOT as policymaker,
3. ODOT as investor, and
4. ODOT as technical resource and data steward.

These categories are meant both to organize the information and to help inform which ODOT divisions and staff are most appropriate to assume related tasks. Following role recommendations, we discuss policy and planning implications for ODOT to consider as part of MaaS implementation.

Note that these recommendations are based solely upon the consultant team's perspective given the scope of this document. Unless specific citations to existing ODOT policy and/or programs are given, the recommendations have not been approved or endorsed in any way by ODOT.

1. ODOT as Partner and Convener

ODOT has a large and diverse array of stakeholders. Forming partnerships - with public, private, and nonprofit entities - is essential to the management of the state's transportation system. Even in areas where ODOT does not serve as a direct provider of transportation service (e.g., nearly all public transportation in Oregon), the agency has a vested interest in working with partners to achieve transportation outcomes vis-à-vis the goals established in the Oregon Transportation Plan and its eight modal plans.

It is therefore not surprising that many internal and external stakeholders engaged for this project suggested the agency play a convening role in MaaS implementation. ODOT has extensive experience bringing partners to the table and working towards mutually beneficial solutions. **The agency should develop a new MaaS-oriented task force that will engage with existing advisory committees, such as the Area Commissions on Transportation (ACTs) and Public Transportation Advisory Committee (PTAC)**.

Public-private partnerships (PPPs) in particular will be important for ODOT to influence Oregon's MaaS ecosystem, and PPPs are called out in the Oregon Transportation Plan (OTP) as a strategy under Goal 6 - Funding the Transportation System as well as the Oregon Public Transportation Plan under multiple goal areas. OReGO, the state's road usage charge pilot program, provides valuable lessons and a model for ODOT's MaaS efforts. OReGO demonstrated ODOT's ability to implement an innovative program that relies on user accounts and open data architecture. ODOT served as program administrator while contracting with private companies to handle account management, data collection, and payment processing. Previous experience developing the business and technical requirements for the program, as well as the specifications for the various functions, provides ODOT with a framework that could be applied to implementation of MaaS-related projects.

Key to this program was state-level legislation, which amended ORS 367.804[24] to establish the Oregon Innovative Partnerships Program (OIPP), enabling ODOT to expedite project delivery and overcome statutory limitations, especially with regard to standard procurement processes. Through OIPP, ODOT is able to work more directly with private companies, select projects based on overall value rather than lowest bid, and "...consider any financing mechanisms, including but not limited to the imposition and collection of franchise fees or user fees and the development or use of other revenue sources."

Support from leaders within ODOT will be essential to supporting MaaS. **At an early stage, internal champions who will liaise with existing advisory bodies and represent ODOT with respect to MaaS should be identified.** These champions should be adequately charged to ensure that adopted policies related to MaaS services (e.g. in the updated Oregon

[24] https://www.oregonlaws.org/ors/367.804

Transportation Plan, Oregon Public Transportation Plan, and Oregon Highway Plan) translate to practice. Champions could include representatives from the Policy, Data and Analysis Division, Public Transportation Division (PTD), Office of Innovation, the Office of Urban Mobility and Mega Project Delivery, and the newly-established Climate Office.

Pros to assuming this role in the MaaS ecosystem

- ODOT is familiar with the role of partner and convener. The agency often coordinates multi-stakeholder programs and initiatives. As a proactive convener, ODOT will assume a guiding role in MaaS implementation and may be able to avoid or mitigate solutions that do not meet ODOT's goals.
- Working together with partners plays to the strengths that each party brings to the table and leverages existing resources. This reduces the risk of ODOT (or others) taking on roles that they have little-to-no expertise in carrying out.

Cons to assuming this role in the MaaS ecosystem

- Likely overlap between individual stakeholders on existing advisory bodies, and demand for their participation on a potential new MaaS-specific advisory group, could constrain some people's capacity to participate.
- Successful partnership necessarily depends on the level of investment of participating entities. If crucial MaaS stakeholders do not join and fully engage, ODOT may not have sufficient leverage to compel participation. This may result in less robust MaaS solutions and strategies.

Recommended Next Steps

Putting the above partnership/convener-related recommendations into action may include the following elements:

Establish a MaaS-oriented task force

- Identify needed skills and department representation for the group.
- Survey existing advisory groups to see to what degree they already meet the purpose and needs identified.
- Form a new group if currently existing groups do not meet these needs.

Develop public-private partnerships

- Develop the business case to present to the Oregon Transportation Commission, so this effort is enrolled as a transportation project.

- Conduct further analysis of lessons learned from OReGO and how they apply to MaaS implementation.
- Identify potential roles of private sector entities and candidates to engage based on these roles.
- Work with existing mobility on demand providers to expand services and incorporate MaaS concepts.

Cultivate internal MaaS champions

- Identify potential champions, based on relevant business areas within ODOT, and including those with decision-making authority (i.e. director level) and staff tasked with core implementation roles.
- Develop educational materials that help build the technical capacity of these champions.
- Determine ODOT staff capacity and potential future needs in regard to identifying and addressing local MaaS implementations and coordinating with the new advisory group.

2. ODOT as Policymaker

In February 2019, Washington State DOT (WSDOT) released a memorandum summarizing interviews exploring government's role in Mobility on Demand (MoD), a concept closely related to MaaS[25]. Interviewees included: staff from WSDOT, transit agencies in Washington, Federal Highway Administration (FHWA), transportation researchers, representatives of shared mobility providers (e.g. Lime, Lyft, Reach Now), consultants, and others. The memo's recommendations included the establishment of a set of values with respect to MoD that WSDOT should consider. Table 4.1 evaluates the alignment of these values with the goals and supportive policies established in the OTP.

[25] According to the US Department of Transportation, Mobility on Demand is "an innovative, user-focused approach which leverages emerging mobility services, integrated transit networks and operations, real-time data, connected travelers, and cooperative Intelligent Transportation Systems (ITS) to allow for a more traveler-centric, transportation system-of-systems approach, providing improved mobility options to all travelers and users of the system in an efficient and safe manner." MaaS can be thought of as an implementation of Mobility on Demand.

Table 4.1: Alignment of WSDOT's values for Mobility on Demand with the Oregon Transportation Plan goals

Washington DOT Mobility on Demand Values	Relevant Oregon Transportation Plan Goal	Relevant Policies
Accessibility	OTP Goal 1 - Mobility and Accessibility	Policy 1.2 - Equity, Efficiency and Travel Choices
Safety	OTP Goal 5 - Safety and Security	Policy 5.1 - Safety
Equity	OTP Goal 1 - Mobility and Accessibility	Policy 1.2 - Equity, Efficiency and Travel Choices
Affordability	OTP Goal 1 - Mobility and Accessibility	Policy 1.2 - Equity, Efficiency and Travel Choices
Reduced congestion	OTP Goal 2 - Management of the System	Policy 2.1 - Capacity and Operational Efficiency
	OTP Goal 3 - Economic Vitality	Policy 3.2 – Moving People to Support Economic Vitality
Decreased trip time	OTP Goal 1 - Mobility and Accessibility	Policy 1.2 – Equity, Efficiency and Travel Choices (note: focus on intercity transit)
Carbon reductions	OTP Goal 4 - Sustainability	Policy 4.2 - Environmentally Responsible Transportation System
Reduced vehicle ownership	OTP Goal 4 - Sustainability	Policy 1.2 - Equity, Efficiency and Travel Choices Policy 4.2 – Environmentally Responsible Transportation System

The WSDOT values largely align with the OTP goals and supportive policies. While "reduced vehicle ownership" is not currently an *explicitly* stated ODOT goal, the agency is initiating research efforts to understand how reduced vehicle ownership could stimulate increased demand for longer distance travel via public transportation, particularly for trips where air travel is less of a viable option. Additionally, several of these values (e.g. reduced congestion, decreased trip time, carbon reductions, and reduced vehicle ownership) are consistent with the vision and strategies outlined in the ODOT Statewide Transportation Strategy.

Implicit in many of these values, and explicit in ODOT's working definition of MaaS, is the value of an open, competitive marketplace. However, this will not occur without supportive regulation. Private companies whose business models call for maximizing market share (e.g. acting as a sole gateway for mobility options) have little-to-no incentive to offer access to all available transportation services or to support open data environments. While these companies may support the types of transportation goals ODOT adopts, their primary motive is profitability, which may conflict with some of ODOT's adopted goals.

Finally, ODOT has a policy role to play regarding MaaS cybersecurity and data privacy. Integrating multiple systems and payment platforms presents inherent risks that call for the implementation of security standards. But these standards alone will not be enough to ensure user privacy. Geolocation data is increasingly being identified as personally-identifiable information (PII), indicating the sensitivity of the matter. ODOT has direct experience with this through OReGO and the Open Architecture for Transportation Services, as the American Civil Liberties Union pushed for stronger PII protections than had been included in the initial draft of the foundational legislation.[26] With implementation of Hop Fastpass, the state legislature passed HB4086, granting a public records exemption in order to protect individuals' personal and travel behavior information associated with electronic fare accounts. While acknowledging the current backlog of public records exemption reviews that the Oregon Sunshine Commission has – and a desire by some members to halt passage of exemptions for the time being[27] – **ODOT should consider if further state legislation is needed in anticipation of cybersecurity and privacy[28] concerns, for both users and service providers.**

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[26] https://www.oregon.gov/ODOT/Programs/RUF/IP-Road%20Usage%20Evaluation%20Book%20WEB_4-26.pdf, pg. 25

[27] https://www.statesmanjournal.com/story/news/2019/10/01/public-records-exemptions-expanded-oregon-legislature-panel-seeks-limit/2419751001/

[28] ODOT's policy ADM 08-01 guides the agency's collection and use of passive electronic data in a way that is transparent and ensures protection of the privacy and sensitive information of the public, including collected personal information (PI). This policy can inform potential legislation that expands protections beyond the data collected by ODOT.

Pros to assuming this role in the MaaS ecosystem

- Staff whose roles connect to MaaS (e.g. members of the Transit Technology Advisory Group and the Office of Innovation) have experience in the policy arena.
- ODOT can shape regulations such that they best support statewide goals and values.
- Equity considerations are necessary to build and protect affordability and access for low-income Oregonians and communities of color. Stakeholders commonly identify potential negative impacts of MaaS on these communities. ODOT also has an important role to play in addressing the impacts that the growth of TNCs - growth that MaaS has potential to further - may have on vehicle accessibility for people with disabilities.
- State-level legislation and guidance, and private sector partnerships, can take some onus off individual jurisdictions to navigate data-related issues.
- Leadership on MaaS policy better enables ODOT to connect MaaS to other issues such as shaping roadway capacity utilization, determining modal equity targets, and improving system operations.

Cons to assuming this role in the MaaS ecosystem

- If policies are developed that put too high a regulatory and/or financial burden on mobility providers, they may refuse to participate. This could increase the risk of diminishing service, which would most significantly affect communities with limited alternative transportation options.
- Local jurisdictions may prefer to maintain the ability to set different standards with MaaS operators and vendors.

Recommended Next Steps

Putting the above policy-related recommendations into action may include the following elements:

Establish values and goals for MaaS

- As part of statewide policy development, establish policy language with respect to MaaS implementation that should act as a lens in evaluating MaaS-supportive policies and investments. A recommended approach for such a lens is described in the Policy and Planning Implications section of this document.
- Provide a statewide view and vision for mobility and mobility related services, defining and prioritizing strategic corridors, hubs, gaps, and connection opportunities for MaaS implementation.

- Utilize informational resources of the MaaS Alliance, which ODOT recently joined. The MaaS Alliance is a public-private partnership creating the foundations for a common approach to MaaS, unlocking the economies of scale needed for successful implementation and take-up of MaaS.

Support an open, competitive marketplace

- Provide technical assistance to regional and local jurisdictions in Oregon that are looking to regulate private mobility providers.
- Support emerging open data standards and their adoption within cities, which could include a pilot in partnership with a jurisdiction to build MaaS-related datasets (e.g. using SharedStreets' CurbLR data standard[29] for curb data). This pilot should include assistance with crafting policies consistent with MaaS objectives and the jurisdiction's long-range Regional Transportation Plan or Transportation System Plan.
- Create a MaaS and related shared mobility/mobility on-demand toolkit with guidance for jurisdictions on working with and regulating private mobility providers. The toolkit should include recommended strategies to assess potential equity impacts on low-income households, communities of color, and people with disabilities, with a menu of interventions to work towards equitable outcomes.
- Advise the Oregon Transportation Commission (OTC) and the Oregon State Legislature on the importance of standardized, open data and its value as a tool to support statewide policy objectives.

Provide guidance on cybersecurity and data privacy

- Research cybersecurity and data privacy best practices, including related legislation passed at city, regional, and/or state levels.
- Advise the OTC and the Oregon State Legislature on implementable strategies.

3. ODOT as Investor

MaaS implementation in Oregon calls for strategic investment. A clear role that ODOT already plays, and should continue in support of MaaS, is funding public transit services and transportation system planning efforts. A MaaS platform will have little use if it does not connect users to quality transportation options.

[29] As a demonstration project, SharedStreets created a CurbLR feed and interactive map for a small area of downtown Portland: https://medium.com/sharedstreets/interactive-curb-map-curblr-feed-for-portland-or-c638dbdf1b45

In addition to investments in public transit service, ODOT funds many transportation projects and programs across the state. **The agency should tie funding opportunities to data comprehensiveness and quality, perhaps by including grant application questions and tailoring scoring criteria to that end.** For example, currently the STIF Discretionary Evaluation Criteria Framework includes the following criterion, established by OAR 732-044-0030(1)(c)(B): “Implements technological innovations that improve efficiencies and supports a seamless, easy-to-use Statewide Transit Network.” If MaaS-related data work would meet this criterion, then this should be emphasized to applicants. If not, ODOT should consider updating the OAR so that it would.

Similarly, several objectives of the Transportation Growth Management Program (TGM)[30] align with MaaS, i.e. providing transportation choices, accommodating future transportation needs within the existing or improved system, and promoting environmental stewardship. **ODOT should update guidance for eligible uses under Category 1 (Transportation System Planning) to include MaaS-related planning initiatives.**

Existing funding should not be the only focus area, however. **ODOT should dedicate funds specifically to support data creation, collection, storage, integration, and analysis[31].** This would not only help lay the groundwork for MaaS but would signal the priority ODOT is placing on transportation data and technology. The statewide GTFS program managed by PTD – including current work to create GTFS-flex datasets for providers and the development of GTFS-ride – are examples of this and should be replicated where doing so will support interoperability of data in the state.

Finally, even if not providing direct funding, ODOT should aim to influence investments around the state to support MaaS. The agency should work with the Department of Administrative Services to develop **statewide shared procurement tools and price agreements for MaaS-related investments,** including: low and zero-emission vehicle infrastructure, transit vehicles, operations technology, and software. This may dovetail with an action in the OPTP Implementation Work Program to provide procurement, service, marketing, and other tools for public transportation providers to leverage resources and create consistent solutions.

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[30] https://www.oregon.gov/lcd/TGM/Documents/TGM-Application-Packet.pdf

[31] Note that advancing data-sharing opportunities, tools, and standards is an action in the OPTP Implementation Work Program and Goal 10: Communication Collaboration and Coordination.

Pros to assuming this role in the MaaS ecosystem

- Service available to users is the most important, foundational component of MaaS.
- Many of the resources and structures are already in place.
- Fosters partner buy-in of MaaS implementation by incentivizing participation.
- Budgeting for MaaS demonstrates ODOT's leadership in the arena.

Cons to assuming this role in the MaaS ecosystem

- For the STIF criteria example, updating OARs is a time-consuming and political process.
- The relevance of MaaS (and therefore any associated funding opportunities) will likely vary by constituent. Some may see this as an inequitable distribution of state resources.

Recommended Next Steps

Putting the above investment-related recommendations into action may include the following elements:

Analyze Oregon's existing transit network[32]

- Identify connectivity gaps (both in terms of coverage and service levels) in the statewide transit network.
- Determine needs to address gaps identified, working towards coordinated and seamless transit connections throughout the state.

Tie funding opportunities to data comprehensiveness and quality

- Research and publish the benefits of a seamless user experience for MaaS services – for example related to cost, operations, and customer experience – provided by complete and accurate data to encourage partners across the state to seek funding for MaaS-related planning, thereby helping to build a foundation for MaaS implementation.
- Update PTD funding (including STIF) and TGM guidance documents[33] and criteria to encourage applicants to make MaaS-related investments.

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[32] The forthcoming Transit Network Report, Key Transit Hubs report, and planned follow-up activities should address the steps noted here.

[33] For example: https://www.oregon.gov/ODOT/RPTD/RPTD%20Committee%20Meeting%20Documents/STIF-Substantially-Compliant-Considerations.pdf and https://www.oregon.gov/ODOT/RPTD/RPTD%20Committee%20Meeting%20Documents/Updated-Formula-Fund-Guidance-Application-Instructions-Dec2019.pdf

- Continue to identify other potential funding streams (beyond STIF and TGM) that could include data creation, collection, storage, integration, and analysis as eligible uses.

4. ODOT as Technical Resource and Data Steward

From conversations with stakeholders (especially in smaller urban or more rural areas), it is clear that there is limited understanding of MaaS concepts. For example, some transit providers are unsure how it applies to their core mission of delivering traditional fixed route and/or demand response transit service, and capacity is limited to expand the scope of services provided. **ODOT should educate partners throughout the state about MaaS concepts, while determining where extra resources are needed**.

Along these same lines, **ODOT should work to understand and plan for the risks associated with MaaS implementation**, especially considering potential impacts on small and rural transit providers. For example, some transit agencies throughout the U.S. are forming partnerships with TNCs to provide paratransit and non-emergency medical transportation. These partnerships may initially reduce capital and operating costs while improving service levels for customers. To date, TNCs are generally unprofitable and have relied on venture capital to subsidize operations; their migration to publicly-traded companies makes profitability the primary objective. As a result, communities where operations do not turn a profit could see TNCs leave altogether, with significant impacts on those who have relied on them to meet their transportation needs.

The data standards that PTD is working to develop for the state's transportation providers should prioritize data quality, interoperability, and the use of open data architecture. The agency will need to demonstrate to providers the value of data interoperability, not only to the statewide transportation network and MaaS implementation, but for their own operations and user experience. ODOT manages troves of transportation data that MaaS platforms, including the back ends to TripCheck and Get There, will need to consume. Ensuring the ongoing accuracy and quality of ODOT's own data is crucial.

Part of the seamless user experience envisioned with MaaS entails integrated fare payment. ODOT itself has an opportunity to expand fare integration through the POINT, Columbia Gorge, and Cascades services that the agency manages directly. Beyond that, **ODOT should**

build upon work[34] examining the expansion of electronic fares, providing transit agencies throughout the state with the information and assistance they need to implement e-fare systems that other agencies in Oregon have adopted (i.e. Hop Fastpass Touch Pass). This not only includes the technological and financial components of fare systems, but guidance on policies such as revenue sharing and fare reciprocity; a common concern for providers regarding payment integration is that it will result in an unfair distribution of revenue.

A promising opportunity with MaaS is the potential to help ODOT and Oregon's transit operators access a wealth of travel behavior data. While sensitive in nature due to aforementioned data privacy concerns, MaaS is likely to enable more in-depth analyses than currently possible, informing planning and operational decision-making. Again, the ability and capacity to perform such analyses will vary by provider or jurisdiction, calling for ODOT to assist some more than others.

Pros to assuming this role in the MaaS ecosystem

- Educating stakeholders throughout the state with consistent information about MaaS enables a more cohesive statewide strategy.
- Many resources and structures are already in place.
- Technical assistance (as opposed to regulation) allows jurisdictions and providers more autonomy, which acknowledges that solutions are not one-size-fits-all.
- Analyses performed could be used to help influence traveler behavior in ways that support agency goals (e.g. by informing incentive-based programs deployed within a MaaS platform).

Cons to assuming this role in the MaaS ecosystem

- Constituents' use of ODOT as a technical resource will depend on the relative importance placed on MaaS. Utilization may be inconsistent across the state.

Recommended Next Steps

Putting the above recommendations into action may include the following elements:

[34] Included in this work is a completed eFare Expansion Gap Analysis (https://www.oregon.gov/ODOT/RPTD/RPTD%20Document%20Library/eFare-Expansion-Gap-Analysis.pdf) and a forthcoming eFare white paper being completed as part of the OPTP implementation process.

Educate partners about MaaS

- Identify opportunities to educate staff, jurisdictions, transit providers, and other stakeholders on MaaS concepts. This may include iLearn curriculum, webinars, and sessions at the annual Oregon Public Transportation Conference.

Identify and mitigate MaaS risks

- Conduct a statewide MaaS risk assessment that evaluates the potential impacts on communities' transportation systems and users, given reliance on MaaS and subsequent losses or reductions of service.

Support quality, open data

- Create a framework for the development or adoption of statewide data standards that sets the foundation for use of open data. This framework may include a set of guiding principles, identification of the universe of potential use cases (i.e. desired outcomes with respect to interoperability), and key stakeholders to include in the process.
- Assess current Standard Operating Procedures (SOPs) with respect to ongoing maintenance of the data that ODOT manages.
- Update SOPs to address gaps that may lead to data quality issues.
- Invest in software tools to manage, analyze, leverage, and share data.

Explore fare integration[35]

- Build upon the eFare White Paper (forthcoming as part of OPTP implementation) by conducting a feasibility study for statewide (and beyond) electronic fare integration.
- Explore smaller scale opportunities (e.g. pilot programs) to test payment integration between transit providers and other mobility services, perhaps using existing platforms.

Plan for new travel behavior data

- Survey jurisdictions' existing use of travel behavior data to inform transportation planning and operations, and capacity for future analysis. Include questions to gather feedback on desired analyses that MaaS may support.

[35] Work is underway at ODOT in this topic area, as well as smaller regional projects being implemented using STIF funding.

Policy and Planning Implications

ODOT should consider the recommendations provided within the context of ODOT's past, current, and future planning efforts. While several plans and policies reference potential impacts of technological innovation on the transportation system generally, these plans were developed prior to the emergence of MaaS. This section discusses where MaaS has relevance to existing plans, and where ODOT has opportunities to codify its roles with respect to MaaS into future plans.

Existing Plans

The Oregon Transportation Plan and three modal/topic plans in particular – the Oregon Public Transportation Plan, Oregon Highway Plan, and Oregon Transportation Options Plan – should guide ODOT's efforts supporting MaaS implementation. MaaS presents many opportunities to work towards the goals established in these plans as currently written. These opportunities are outlined in this section in order to demonstrate the policy basis for MaaS and its connection to long-range planning.

The Emerging Technologies Impact Assessment (ETIA) – which discusses the importance of MaaS for Oregon's transportation future and the need to define ODOT's role in MaaS implementation – identified eight foundational goals and desired outcomes for Oregon's transportation system outlined in the OTP and recent modal and topic plans:

- Safety
- Efficient freight movement
- Equity
- Mobility
- Transportation options
- Fuel efficiency and reducing carbon dioxide (CO_2) emissions
- Transportation funding sufficiency
- Land use management

Table 4.2 builds upon this framework to home in on connections to MaaS under each goal area.

Table 4.2: OTP and modal plan goals identified in the ETIA and their connections to MaaS

Goal Area	Connection to MaaS
Safety & Security	Ensuring cybersecurity and data privacy are inherent and crucial challenges for MaaS. At the core of these issues are concerns about personal safety.

Goal Area	Connection to MaaS
	Travel behavior data generated by MaaS could be used to analyze the impacts of MaaS in relation to safety performance targets.
	Public and private transportation service providers vary in terms of driver training, background check requirements, and insurance, implying the need to consider how MaaS-related mode shifts may impact user safety.
Efficient freight movement	MaaS data foundations could increase open curb space for loading and unloading, use pricing to incentivize travel on certain routes and at certain times of day by non-freight modes, and improve information about road closures and roadwork (e.g. the Work Zone Data Exchange (WZDx) specification[36]).
Equity	MaaS has potential to improve mobility and accessibility for transportation disadvantaged persons. This is less likely to occur, however, without targeted policy interventions that address issues like cost barriers, impacts on paratransit services, and geographic areas served.
	Certain communities, e.g. immigrant and refugee populations, may be particularly concerned about privacy issues due to distrust of governmental institutions. This should be considered in the context of creating data privacy policies.
Mobility	Enabling seamless end-to-end journeys is a defining objective for MaaS.
Transportation options	MaaS promises to improve information about and access to available transportation options. It will not, however, increase transportation options on its own.
Fuel efficiency and reducing CO2 emissions	A MaaS ecosystem that makes non-SOV and non-TNC[37] options attractive and competitive – with public transit as its backbone – should result in reduced CO2 emissions from driving.
	The relationship between fuel efficiency and MaaS is unclear.

[36] https://www.transportation.gov/av/data/wzdx

[37] Note recent findings of increased emissions related to ride-hailing as currently utilized in the U.S.: https://www.ucsusa.org/resources/ride-hailing-problem-climate

Goal Area	Connection to MaaS
Transportation funding sufficiency	MaaS solutions may reduce costs of providing certain transportation services, especially through public-private partnerships, potentially enabling reallocation of those resources. However, TNCs in particular may create a temporary illusion of reduced costs, given high subsidization by investors.
	Pricing incentives can be used to encourage modal shifts, impacting utilization of certain transportation facilities and, therefore, maintenance costs and expansion needs.
	The provision of MaaS services could present the potential of a new revenue stream and positively impact the Highway Fund.
Land use management	MaaS could support communities' land use strategies, for example if tied to TGM strategies.

Future Planning Efforts

If ODOT is to play a leading role in MaaS, its plan updates and program implementations should reflect this. We have provided recommended strategies to incorporate and encourage MaaS within current programs (i.e. PTD funds and TGM funds), and now we turn to a discussion of higher level, longer range planning opportunities.

The timing of this work is meant to help determine how to include MaaS in two plan updates underway: the OTP and OHP. While many considerations covering a variety of topics will inform these processes, MaaS will likely have significant direct and indirect impacts on how to achieve the adopted goals and policy objectives. In this sense, ODOT should not consider MaaS implementation as its own goal; rather, the agency should focus on how MaaS (as a tool) can support – and/or hinder – desired outcomes.

One strategy ODOT may employ is the creation of a **MaaS-focused policy evaluation tool**. Applying such a lens to goal-setting and policy making would make ODOT better prepared for goal/policy implementation in an era of emerging transportation technologies. Questions the tool may include are:

- How might MaaS implementation support achievement of the stated goal/policy, and vice-versa?
- Are there inherent conflicts between MaaS implementation and this goal/policy?

- Who within the MaaS ecosystem might be affected (positively, negatively, or otherwise) as ODOT implements this goal/policy?
- What are the equity implications of this goal/policy, and what interventions might address potential inequitable outcomes?
- What partnerships would ODOT need to rely on (and/or form) in order to effectively connect this goal/policy to MaaS?
- What are the costs associated with each option, and how are these costs addressed?

ODOT will have the opportunity to develop analysis methods that utilize data generated through MaaS platforms (presuming the agency has access to this data, reinforcing the need for open data policies and standards). **As the transportation landscape continues to evolve, transportation modeling needs to adapt.** A recent project conducted by the National Institute for Transportation and Communities (NITC)[38] provided a new approach to modeling that accounts for reductions in private vehicle ownership, non-motorized mode choice, and intrazonal travel – all of which are likely to be impacted by MaaS adoption, and which MaaS data could support. While ODOT has a sophisticated model (last updated in 2017), its next iteration could benefit from MaaS, potentially by reducing costs of data gathering and better predicting travel behavior.

Another area that MaaS should inform is the **development of agency performance measures.** Current mobility key performance measures[39] are separated by mode (e.g. number of rail service passengers). However, MaaS platforms will ideally integrate modes in a way that prioritizes seamless and efficient travel. While defining performance measures by mode is an effective way to understand how various ODOT business areas and modal operations are functioning, the approach does not take a holistic view towards the transportation system's impact on individuals' mobility.

Crucial to all of these strategies is **continued engagement of MaaS stakeholders** – especially Oregon's transportation providers and the community members they serve. Because much about the future of transportation and related technologies is unpredictable, so are the potential impacts on these stakeholders. In the same vein, ongoing engagement will help ODOT stay abreast of innovation in this sector, which it will need to do in order to plan and implement related strategies. We have seen TNCs organize to influence legislation at the state level, and they will continue to do so as they strive for profitability. This is not to say that the

[38] https://ppms.trec.pdx.edu/media/project_files/NITC-RR-1086_Key_Enhancements_to_the_WFRCMAG_Four-Step_Travel_Demand_Model_ir92NOW.pdf

[39] https://www.oregon.gov/ODOT/PerformMang/Pages/index.aspx

actions and goals of private MaaS entities will necessarily conflict with those of ODOT; rather that ODOT should be aware of these efforts and identify where interests align.

Emerging Technology Impact Assessment Final Report

March 2019

Prepared for

Oregon Department of Transportation

Oregon Department of Transportation

By

JACOBS

Executive Summary

Advancements in computing power and miniaturization, communications and networking, and the increased volume of and access to data have enabled the development of transportation technologies with the potential to transform the transportation system and the way that Oregonians travel. These technologies – termed ***emerging technologies*** – could provide benefits to Oregon's transportation system, but there are also societal costs associated with technological advancements. The extent of possible impacts to the transportation system in the next three to four decades remains uncertain.

Examples of emerging technologies include connected vehicles and infrastructure that can sense the environment and driving conditions and communicate with each other in real time; on-demand mobility options (for example, carshare and bikeshare services); electric vehicles; and the collection and analysis of massive amounts of data.

These technological developments could improve the safety, reliability, accessibility, and environmental impacts of the transportation system. However, these same technologies have the potential to adversely impact travel demand and mobility, land use patterns, and the environment. While the extent of possible impacts to the transportation system in the coming decades remains uncertain, state and local agencies, including the Oregon Department of Transportation (ODOT), are beginning to consider and grapple with an uncertain future. ODOT is conducting strategic and scenario planning to consider the uncertainties associated with emerging technologies. ODOT's Emerging Technology Impact Assessment (ETIA) identifies and describes the potential impacts of these advancements on Oregon's transportation system. The ETIA outlines key trends in emerging transportation technology, assesses potential impacts to Oregon's transportation system, and identifies a suite of tools Oregon could consider shaping future transportation outcomes.

Defining "Emerging Technologies"

The Emerging Technology Impact Assessment (ETIA) project team assessed three categories of technological advancements that have the potential to dramatically improve the safety, reliability, and accessibility of Oregon's transportation system. However, industry experts disagree on the impacts these technologies may have on travel demand and behavior, land use patterns, and investment needs.

Vehicle technology*, including connected vehicles (CVs), automated vehicles (AVs), and electric vehicles (EVs).*

Mobility options, *including active transportation options, shared mobility services, and ride-hailing services. made available to users using various models that operate within the concept of the integration of transportation services into a single trip-planning and payment platform is known as Mobility-as-a-Service (MaaS).*

Freight logistics and local delivery applications, *including freight vehicle platooning, efficiencies in distribution networks, and on-demand delivery services.*

ODOT's ETIA project team developed a framework – depicted on Figure ES-1 – that considered how modal and topic plans, regional and local planning, data, and funding would interact with emerging technology trends to identify impacts to Oregon's transportation system. The project team conducted research, a literature review, interviews with industry experts, and engaged the Oregon Transportation Commission (OTC) to address how technological advancements in vehicle technology, mobility options, freight applications, and system management could impact statewide planning, policy-making, and investment decisions.

This report summarizes work conducted during Phase 1 of the ETIA project. The outcomes from Phase 1 will inform the analysis framework to be developed during Phase 2 of the project. Phase 2 will focus on the development of alternative future scenarios that explore a broader range of trends and considerations in preparation for updates to ODOT's Oregon Transportation Plan (OTP) and Oregon Highway Plan (OHP).

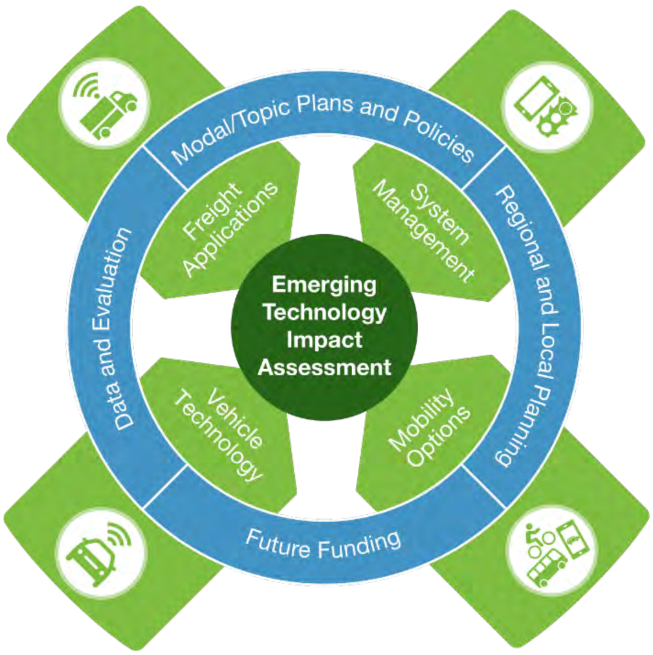


Figure ES-1. ETIA Analysis Framework

Understanding Potential Impacts

The OTP and recent modal and topic plans provide a set of goals and desired outcomes for Oregon's transportation system. The ETIA used these goals and desired outcomes to frame how emerging transportation technologies are likely to affect the transportation system. The project team identified eight foundational goal areas, as shown on the left-hand column of Table ES-1. The table summarizes the likely impacts of emerging technologies on each of the following goal areas:

- Safety
- Efficient freight movement
- Equity
- Mobility
- Transportation options
- Fuel efficiency/reducing carbon dioxide (CO_2) emissions
- Transportation funding sufficiency
- Land use management

Table ES-1. Summary of Likely Impacts to ODOT Foundational Goals

Goal Area	Likely Impacts
Safety	Safety is expected to improve significantly even with a limited adoption of CVs and AVs.
Efficient freight movement	Truck platooning, automated freight vehicles, and advanced logistics are likely to improve the safety and reliability of freight movement.
Equity	More transportation choices are likely to be available to many people who are unable to drive today. However, the benefits may not extend to all transportation-disadvantaged populations.

Table ES-1. Summary of Likely Impacts to ODOT Foundational Goals

Goal Area	Likely Impacts
	Shared automated trips, including public transit vehicles and transportation network company (TNC) trips, are likely to cost less per mile than trips taken by private auto or public transit today.
	Automated technology is likely to allow some people to commute farther and access new career and educational opportunities.
Mobility	Travel time reliability is likely to improve even with moderate adoption of CV and AV technologies.
	Impacts to congestion are uncertain and depend on the uses of AVs. Non-recurrent congestion should decrease under any scenario.
	It is difficult to predict impacts to vehicle miles traveled (VMT); the degree of impact will depend on whether AVs will be used predominantly as private or shared vehicles.
Transportation Options	Residents of urban communities are likely to experience increased access to more transportation options, potentially resulting in improved access to jobs, education, and services.
	Access to transportation options could moderately improve in rural areas with limited public transit services, but this outcome is dependent on market support for expansion in rural areas.
	Increased access to shared mobility options could enable greater use of active transportation options for short trips, addressing first-and-last mile issues. However, if motorized trips become more affordable, active transportation trips could decrease.
Fuel Efficiency / Reducing CO_2 Emissions	Some fleet electrification is likely and could generate environmental benefits. The prevailing usage of EVs could eliminate VMT as a factor in emissions.
Transportation Funding Sufficiency	Integrated vehicle technology enables some degree of expansion for a “user-pays” funding system, and some mechanisms are identified to ensure that all vehicles are paying some share for their use of the roadway. However, funding continues to be constrained, and increases in revenue are not fully sufficient to cover existing and future infrastructure needs.
Land Use Management	It is difficult to predict impacts to land use patterns. However, any impact will be somewhat tempered by Oregon’s Statewide Planning Goals.

Figure ES-2 depicts the range of potential impacts emerging technologies could have on the eight foundational goals summarized in Table ES-1. ODOT outlined the range of potential impacts emerging technologies could have on transportation system performance related to each foundational goal. The horizontal axis indicates whether impacts are anticipated to be positive or negative, while the vertical axis displays the certainty or uncertainty of the predicted outcome. A range of potential outcomes is depicted—including best case, worst case, and most likely scenarios— that Oregon could see by 2040 assuming the continuation of current policies without significant new policy interventions.

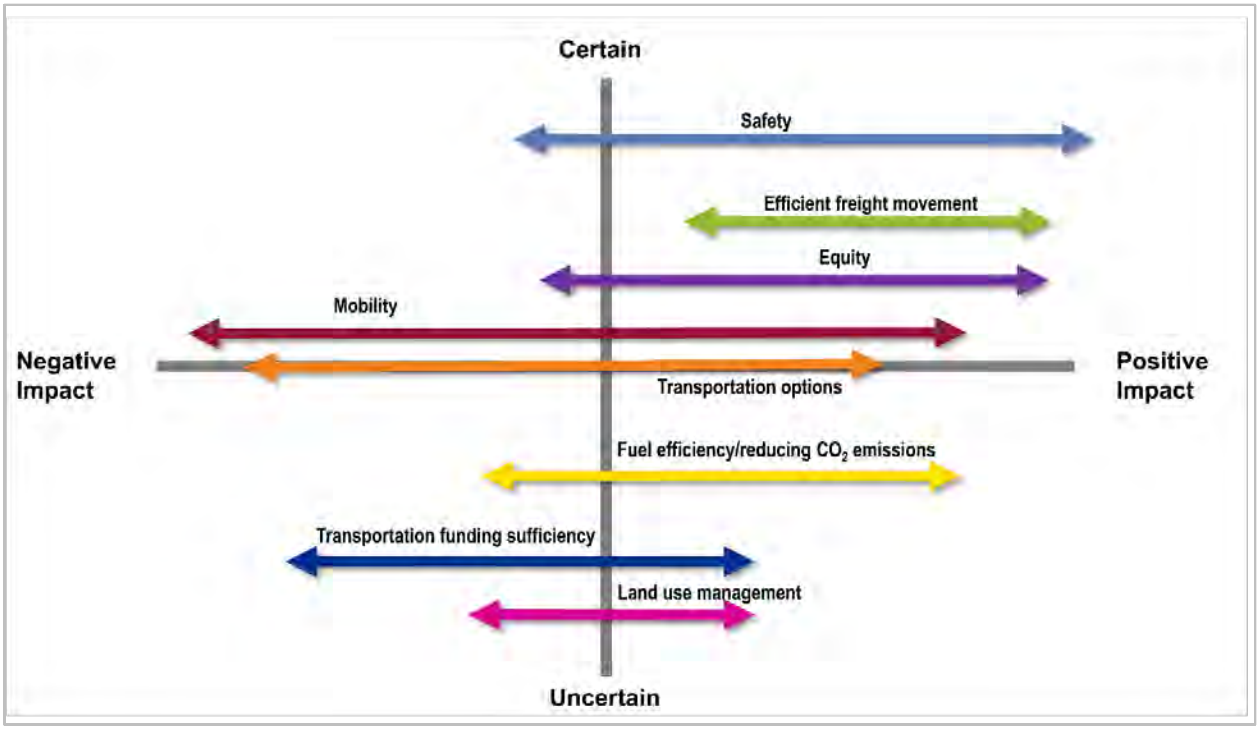


Figure ES-2. Range of Impacts of Emerging Technology on ODOT's Foundational Goals

The State of Oregon plays an integral role in identifying, developing, and implementing policies to address the range of potential impacts from emerging transportation technologies. Impacts to Oregon's transportation system are likely to affect many geographies, jurisdictions, and agencies. This assessment considers emerging technologies within a statewide, jurisdictionally neutral framework to more comprehensively identify the range of potential impacts to the transportation system.

While ODOT considered impacts to Oregon's transportation system, considering other local, regional, and state agencies, staff focused on identifying policy interventions that are exclusively within the authority of the OTC and the agency. Policy interventions include a variety of actions, including updating statewide modal and topic plans and guidance documents and standards, deploying infrastructure and initiating pilot projects, regulating how certain emerging technologies are used on Oregon's roadways, and updating funding programs and strategic investment decision making processes.

ODOT could consider a variety of interventions to influence potential impacts of emerging technology on Oregon's transportation system. Some policy interventions cross-cut multiple goal areas while others are specific to a single goal area. Potential policy interventions are organized according to each of ODOT's eight foundational goals. The policy interventions with the greatest potential to influence impacts of emerging technology are summarized below. A complete list of potential ODOT policy interventions is provided in the final report.

Safety

- Deploy vehicle-to-infrastructure and vehicle-to-vehicle technology
- Regulate level 3 automated vehicles
- Update roadway design standards
- Update All Roads Transportation Safety program requirements

Efficient Freight Movement

- Deploy vehicle-to-infrastructure and vehicle-to-vehicle technology for freight
- Initiate automated, platooning, or other connected freight pilot projects
- Digitize freight route planning

Equity

- Ensure investments benefit transportation-disadvantaged and underserved groups
- Update equity criteria
- Update Statewide Transportation Improvement Fund program requirements

Mobility

- Deploy vehicle-to-vehicle and vehicle-to-infrastructure technology
- Update roadway standards
- Explore pricing strategies and priority for high-occupancy vehicles
- Update development review tools

Transportation Options

- Support investments in statewide Mobility-as-a-Service (MaaS) applications and payment systems, including integrated fare payment
- Support investments in mobility hubs
- Update funding program requirements to support public transit and active transportation

Fuel Efficiency/Reducing CO_2 Emissions

- Develop or adjust taxes and fees
- Participate in multistate initiatives
- Plan for alternative fuels infrastructure

Transportation Funding Sufficiency

- Implement statewide road usage charge
- Consider pricing of roadway infrastructure
- Develop Driver and Motor Vehicle Services fees and policies

Land Use Management

- Develop system planning and overlay standards and guidance
- Update mobility targets on state facilities
- Update development review requirements

Conclusion

Traditionally, planners have used past travel behavior to inform the development of transportation plans and policies to shape the transportation system. The rapid emergence and development of emerging transportation technologies is quickly changing travel patterns, making it difficult for planners to consider travel patterns developed prior to emerging technologies to inform decision making. Planners and transportation professionals are now using scenario planning to identify and define potential futures. These scenarios guide the development of plans and policies and inform investment decisions.

ODOT initiated the ETIA project to identify and define implications, including benefits and impacts, for Oregon's transportation system from emerging transportation technology. The project will be conducted in two phases. Phase 1 outlines the key trends in emerging transportation technology, assesses potential impacts to Oregon's transportation system, and identifies a suite of interventions ODOT could consider when addressing potential impacts to Oregon's transportation system. ETIA Phase 1 will inform the analysis framework that will be developed during Phase 2 of the project.

Phase 2 will focus on development of three to five alternative future scenarios to explore a broader range of trends and considerations that will inform future updates to ODOT's modal and topic plans, including the OTP and OHP. Phase 2 will develop a framework to conduct scenario planning, which will be incorporated during the OTP and OHP plan update process. The development of the scenarios and framework will be informed through internal and external engagement with ODOT staff and local, regional, and state stakeholders, including local agencies, Area Commissions on Transportation, and other state agencies.

Understanding how and when emerging technologies are likely to affect Oregon's transportation system will help ODOT develop effective policies that can influence potential transportation outcomes. There are opportunities for further study in addition to the work conducted as part of the ETIA project. ODOT could conduct targeted studies of MaaS, Transportation System Management and Operations, and demographic trends to inform scenario development as part of ETIA Phase 2.

Contents

Figures

Table

Acronyms and Abbreviations

ARTS	All Roads Transportation Safety
AV	automated vehicle
CAV	connected and automated vehicle
CO_2	carbon dioxide
CV	connected vehicle
C-V2X	cellular vehicle-to-everything
DLCD	Department of Land Conservation and Development
DMV	Driver and Motor Vehicle Services
DSRC	Dedicated Short Range Communications
ETIA	Emerging Technology Impact Assessment
EV	electric vehicle
GHz	gigahertz
GPS	Global Positioning System
HOV	high-occupancy vehicle
MaaS	Mobility-as-a-Service
NHTSA	National Highway Traffic Safety Administration
ODOT	Oregon Department of Transportation
OHA	Oregon Health Authority
OHP	Oregon Highway Plan
OTC	Oregon Transportation Commission
OTP	Oregon Transportation Plan
PPP	public-private partnership
RUC	road usage charge
STIF	Statewide Transportation Improvement Fund
TNC	transportation network company
U.S. DOT	U.S. Department of Transportation
V2I	vehicle-to-infrastructure
V2V	vehicle-to-vehicle
V2X	vehicle-to-everything
VMT	vehicle miles traveled
ZEV	zero emission vehicle

Glossary of Terms

Automated Vehicle (AV)
An automated vehicle uses sensors and computer systems to drive itself. Often called "self-driving" cars, AVs partially or entirely remove the need for a driver to control the vehicle.

Connected Vehicle (CV)
Connected vehicle sends and receives messages to other vehicles, wireless devices, and infrastructure such as traffic signals and road side units.

Connected and Automated Vehicle (CAV)
Connected and automated vehicles enable both AV and CV technology to be used in a single vehicle simultaneously.

Dedicated Short Range Communications (DSRC)
Dedicated short range communications service involves vehicle-to-vehicle and vehicle-to-infrastructure communications, helping to protect the safety of the traveling public.

Mobility-as-a-Service (MaaS)
Mobility-as-a-Service is the integration of various forms of transportation services into a single, on-demand mobility service, such as public transportation, rideshare, carshare, bikeshare, and taxi.

Electric Vehicle (EV)
Electric vehicles, also known as plug-in electric vehicles, receive power from the electricity grid.

High-Occupancy Vehicle (HOV)
High-occupancy vehicles are motor vehicles that carry more than a specified number of occupants.

Public-Private Partnership (PPP)
Public-private partnerships, also known as P3s, are agreements between a public agency and a private entity that often implement public infrastructure projects.

Transportation Network Company (TNC)
Transportation network companies such as Uber and Lyft use mobile online platforms to enable people to secure individual and carpooling rides on demand, from drivers using their personal vehicles.

Road Usage Charge (RUC)
A road usage charge is a fee that is applied to every mile a driver drives.

Vehicle-to-Vehicle (V2V)
Vehicle-to-vehicle is technology that allows vehicles to communicate with other vehicles, often using a Global Positioning System (GPS) receiver, computer, and antenna.

Vehicle-to-Infrastructure (V2I)
Vehicle-to-infrastructure is technology that allows vehicles to communicate directly with their physical surroundings, such as traffic signals or other roadway infrastructure.

Vehicle-to-Everything (V2X)
Vehicle-to-everything is technology that allows communication from a vehicle to any entity that may affect the vehicle, and vice versa, such as a person, a traffic signal, or another vehicle.

Introduction

Technological advancements could provide safety, mobility, and environmental benefits to users of Oregon's transportation system. These technological advancements – termed emerging transportation technologies – encompass a broad range of applications. Examples of emerging transportation technologies include automated vehicles (AVs) that can sense the environment and driving conditions, connected vehicles (CVs) that can communicate with each other and infrastructure in real-time, on-demand mobility options (such as carshare and bikeshare services), and electric vehicles (EVs). In addition, improved data collection and analysis could inform investment decisions, help agencies better manage the transportation system, and improve traveler experience. Benefits could include improve safety, reliability and accessibility, and reduced environmental impacts. Conversely, there are potentially adverse impacts associated with these technological advancements. Adverse impacts could include increased congestion and travel demand, increased travel costs for users, threats to cybersecurity and privacy, and the erosion of transportation funding sources, all of which present challenges for public agencies to address.

The ETIA Final Report is organized into the following sections:

- **Introduction** – describes the project purpose, background and development
- **Emerging Transportation Technology Trends** – provides an overview of the technological trends likely to impact Oregon's transportation system
- **Policy Implications** – outlines potential interventions ODOT could consider to address impacts of emerging transportation technology to Oregon's transportation system
- **Conclusion** – summarizes key takeaways from ETIA assessment

Purpose

While the extent of possible impacts to Oregon's transportation system in the coming decades remains uncertain, state and local transportation agencies, including the Oregon Department of Transportation (ODOT), are beginning to consider and grapple with an uncertain future. ODOT initiated the Emerging Technology Impact Assessment (ETIA) project to identify and define implications, including benefits and impacts, for Oregon's transportation system. This report outlines the key trends in emerging transportation technology, assesses potential impacts to Oregon's transportation system, and identifies a suite of interventions ODOT could consider when addressing potential impacts to Oregon's transportation system. The assessment will inform future ODOT planning, programming, and investment decisions.

Background and Development

ODOT is one of the many agencies leading studies and planning efforts to understand how emerging technology will impact the transportation system and identify strategies to address an uncertain future. ETIA builds on current and ongoing initiatives led by and supported by ODOT, including emerging technology research, planning efforts, and leveraging of staff expertise, such as the following:

- **Connected Vehicle and Automated Vehicle Steering Team**. Coordinates across the agency's various functions and is responsible for tracking developments in CVs and AVs and briefing the agency on critical CV and AV investment decisions.
- **Task Force on Autonomous Vehicles**. Created by House Bill 4063, which directed ODOT to staff and convene a task force to make recommendations to the legislature for potential statutory changes

related to automated vehicles. The task force submitted recommendations to the legislature in September 2018. For more information visit: https://www.oregon.gov/ODOT/Get-Involved/Pages/Task-Force-on-Autonomous-Vehicles.aspx

- **The Drive Toward Change: Use Cases for Automated Vehicles**. Report produced by ODOT to help the State of Oregon and other stakeholders prepare for the deployment of AVs. For more information visit: https://www.oregon.gov/ODOT/Programs/CAV%20documents/AV-ODOT-Use-Cases-for-Automated-Vehicles.pdf

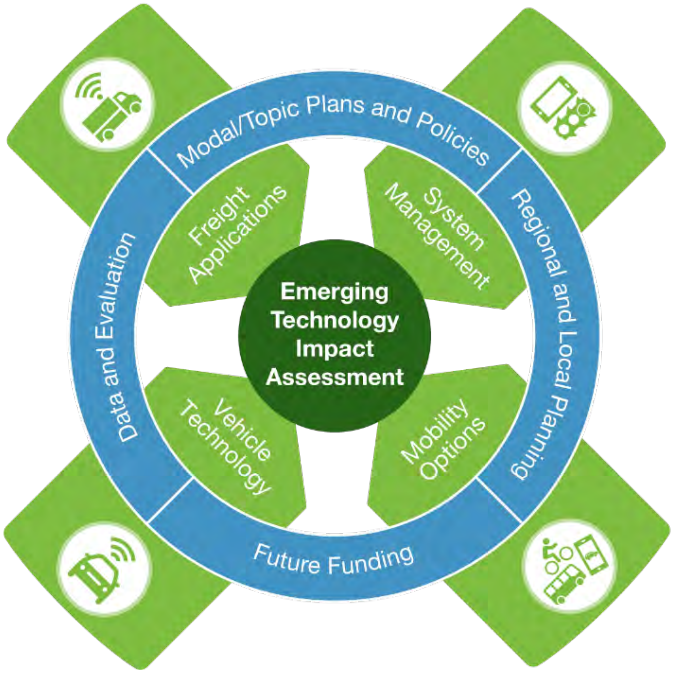


Figure 1. ETIA Analysis Framework

Building on this foundation, ODOT developed the ETIA to assess how advancements in vehicle technology, mobility options, freight applications, and system management could affect statewide planning and investment decisions.

ODOT's ETIA project team developed a framework – depicted on Figure 1 – that considered how modal and topic plans, regional and local planning, data, and funding would interact with emerging technology trends to identify impacts to Oregon's transportation system.

The project team conducted research, a literature review, interviews with industry experts, and engaged the Oregon Transportation Commission (OTC) to address how technological advancements in vehicle technology, mobility options, freight applications, and system management could impact statewide planning, policy-making, and investment decisions.

ODOT formed an Expanded Project Management Team, comprising internal agency staff, to guide the project. The project team led a workshop with the OTC to identify and prioritize key questions to address. This report is the culmination of ETIA Phase 1. Figure 2 illustrates how ETIA Phase 1 will inform the second phase of the project. ETIA Phase 2 work will focus on the development of planning scenarios to explore a broader range of considerations in preparation of updates to the Oregon Transportation Plan (OTP) and Oregon Highway Plan (OHP).

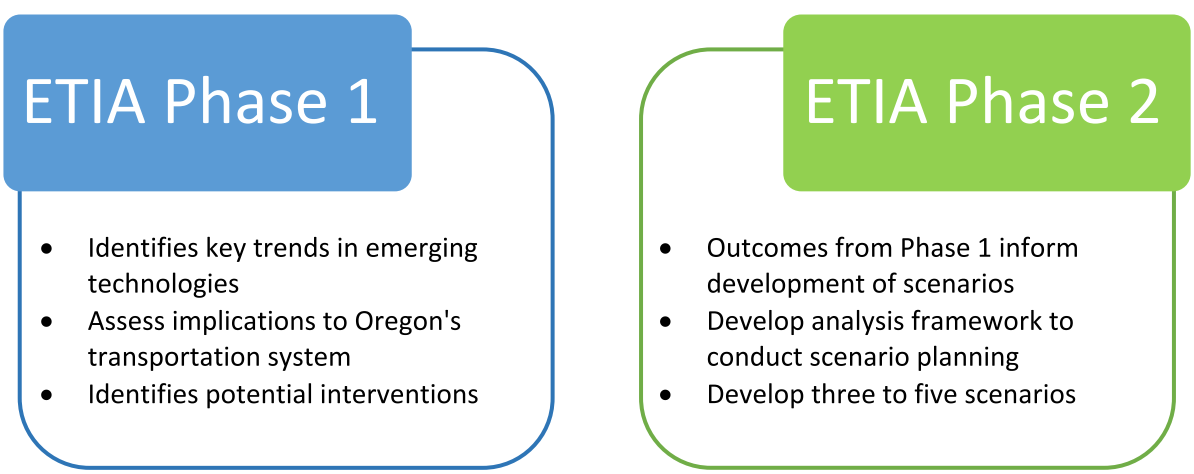


Figure 2. ETIA Project Phases

Emerging Transportation Technology Trends

New transportation technologies are advancing rapidly and could revolutionize how people get around, how goods are delivered, and how vehicles are operated in the coming decades. Advancements can be grouped into three categories:

- ***Vehicle technology***, including CVs, AVs, and EVs.
- ***Mobility services***, including active transportation options, shared mobility services, and ride-hailing services. The integration of transportation services into a single trip-planning and payment platform is known as Mobility-as-a-Service (MaaS).
- ***Freight logistics and local delivery applications***, including freight vehicle platooning, efficiencies in distribution networks, and on-demand delivery services.

Overarching trends enabling transportation advancements

Three interconnected technological advancements are significantly shaping the transportation system:

Improvements in computing power and miniaturization
The ongoing miniaturization of integrated circuits has delivered continually greater amounts of computing power in smaller form factors.

Communications and networking
Communications improvements have also enabled previously unimaginable connectivity capabilities. The newest generation of cellular communications, 5G, could allow lower-latency exchange of data at much higher bandwidths than the current 4G LTE cellular system.

Increase of available data
Computing power, communications, and networking improvements are collectively increasing in the amount of data that can be consumed. This increase in data can be used to identify patterns that inform real-time decisions in complex systems.

Vehicle Technology

Connected vehicles (CVs). CV technology enables vehicles to communicate with each other, roadside infrastructure, smartphones and other devices. CV applications are organized into three general categories that describe different types of connectivity: vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-everything (V2X). Vehicle-to-everything is technology that allows communication from a vehicle to any entity that may affect the vehicle, and vice versa, such as a person, a traffic signal, or another vehicle.

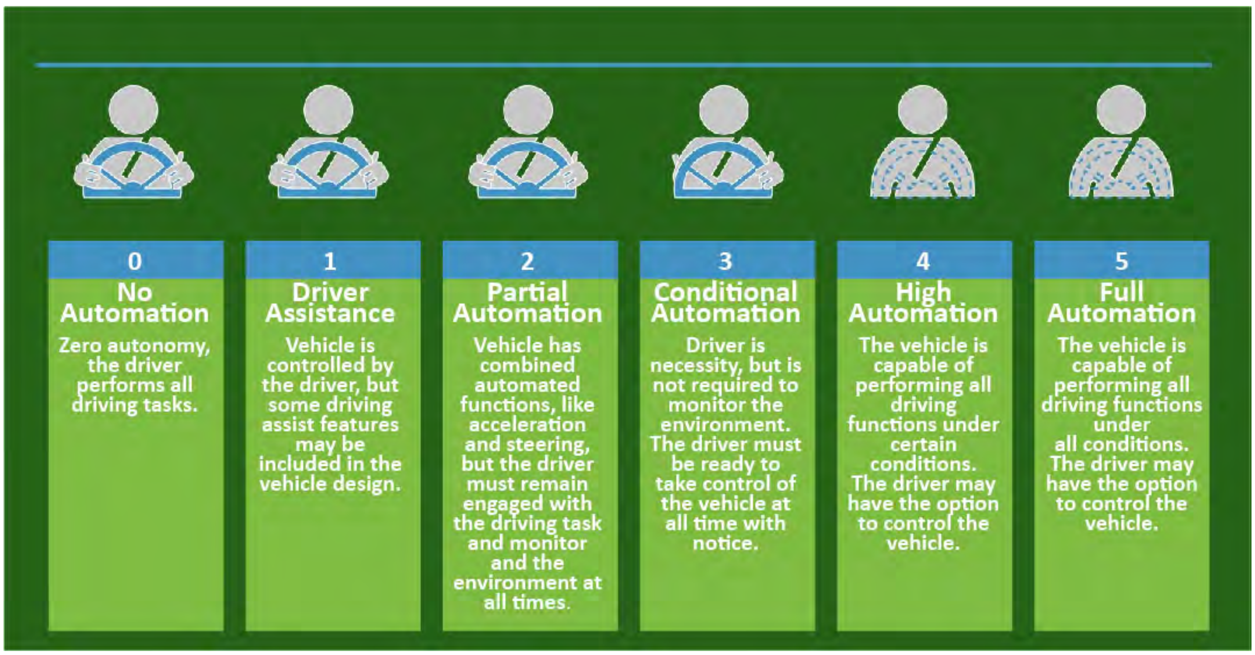
Connected vehicles principally rely on two communication technologies: cellular technology and Dedicated Short Range Communications (DSRC). The Federal Communications Commission allocated a range of wireless spectrum, referred to as the 5.9-gigahertz (GHz) band, for Intelligent Transportation System services. DSRC utilizes the 5.9-GHz band and is a WiFi-derivative technology developed to support secure, low-latency communications.

Cellular and DSRC technology have enabled navigation systems to alert drivers of real-time traffic, roadway incidents, and weather conditions. However, cellular technology is now the most widely used form of communication technology inside vehicles. The newest generation of cellular technology, 5G or cellular vehicle-to-everything (C-V2X), could potentially compete with DSRC as a communication platform for CVs because it transmits low latency communication and enables peer-to-peer communication.[1]

The National Highway Traffic Safety Administration (NHTSA) and U.S. Department of Transportation (U.S. DOT) initiated the federal rulemaking process to mandate use of V2V radios in all-new light vehicles by 2023, but the current administration has delayed this process and has taken a technology-neutral approach to regulation. Furthermore, some automotive manufactures have committed to DSRC while others focus on 5G cellular technology.

Regardless of which communication platform succeeds in the long term, CV deployments have had documented safety, mobility, and operational benefits. Results from CV pilots conducted by the U.S. DOT indicate that short-range communication technology could prevent 80 to 90 percent of incidents in which the driver is not impaired. However, the ongoing debate between 5G and DSRC advocates and the lack of federal rulemaking complicates investment decisions for state, regional, and local agencies.

Automated vehicles (AVs). Technologies enabling AVs, including those that improve sensing, mapping, and control, have advanced rapidly over the past 5 years. The Society of Automotive Engineers established six levels of automation to describe different levels of vehicle autonomy and driver responsibility (see Figure 3). The six levels are organized along a spectrum from no automation (level 0) to full automation (level 5). The AV system can monitor the driving environment at levels 3 and above.



Source: NHTSA, 2019[2]

Figure 3. Society of Automotive Engineers Levels of Automation

AVs will affect the transportation system; however, experts are not certain exactly how, in large part because the deployment model for AVs remains uncertain. While AVs have the potential to create public benefits, such as reducing the occurrence and severity of collisions and improving mobility, AVs could also have societal and environmental costs. The advantages and disadvantages of three potential operating models are outlined as follows:

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[1] A detailed discussion of the differences between cellular and DSRC communication platforms can be found in the Key Trends Memorandum conducted as part of Phase 1 of the ETIA project.

[2] National Highway Transportation Safety Administration (NHTSA). 2019. Automated Vehicles for Safety. Accessed January 6, 2019. https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety.

- **Personal automated vehicles:** Includes motorists who own or lease their own self-driving vehicles. This operational model is highly convenient and allows for immediate and on-demand usage. Disadvantages include high costs and inflexibility to choose different modes for different trips.
- **Shared automated vehicles:** Includes self-driving taxis to transport individuals or groups to destinations. This operational model allows users to choose the vehicles and services that best meet their needs, including door-to-door service. However, users must wait for vehicles and service could be limited at times.
- **Shared automated rides:** Includes self-driving vans that take passengers to or near destinations. This operational model is associated with lower costs and is typically operated on a fixed route and schedule. This model is least comfortable, convenient, and expedient.

AV and CV technology could be combined to maximize the safety and efficiency benefits of AVs. However, in the near term, it is likely that connected vehicle technology will not be a precondition to the deployment of automated vehicles.

AVs will likely be adopted incrementally over the next several decades and may look substantially different in Oregon’s large- and medium-sized cities than in the rest of the state. AVs could have major impacts on transportation demand by making travel more convenient and accessible and providing transportation options for people who previously could not drive, including the elderly, disabled, and those without a driver’s license. However, the introduction of AVs will likely affect urban, suburban, and rural communities differently because of differing demographics, population density, and travel patterns.

Electric vehicles (EVs). EVs have the potential to significantly reduce transportation-related emissions EVs have become more prevalent because improvements in battery technology have increased the operating ranges, shortened recharging periods, and lowered costs. These advancements make EVs more practical for more households, supporting broader adoption of EVs.

Many experts believe that CVs and AVs will be electric due to the advancements in battery technology. However, adequate charging infrastructure for these vehicles continues to limit widespread adoption, both nationally and at the state and regional level. Oregon supports the West Coast Electric Highway, a network of EV direct current fast-charging stations located along Interstate 5, Highway 99, and other major roads that span British Columbia, Washington, Oregon, and California. Oregon is also a member of the Multi-State Zero Emission Vehicle (ZEV) Task Force, a group of nine states that have committed to putting a combined 3.3 million ZEVs on their roads by 2025.

Mobility Services

Mobility services are advancing rapidly as the number of transportation modes in the last decade have expanded beyond the realm of personal vehicles, carpools, vanpools, taxis, public transportation, bicycling, and walking. Advancements in mobility services include ride-hailing services (for example Uber or Lyft and are sometimes referred to as transportation network companies or TNCs), carshare, bikeshare, microtransit, and Maas. In addition to these services, companies also offer dockless or electric shared mobility options such as scootershare and electric bikeshare services and programs.

Figure 4 displays the five different types of shared mobility service models: (1) membership-based self-service, (2) peer-to-peer self-service, (3) non-membership self-service, (4) for-hire service, and (5) mass transit systems. Several mobility services are represented in more than one category of shared mobility service models. For example, bikesharing and carsharing can be organized according to three of the shared mobility service models, including membership-based self-service, peer-to-peer self-service, and non-membership self-service models. MaaS platforms could allow customers to plan and pay for trips across multiple mobility options through a single application.

Membership - Based Self-Service Models	Peer-to-Peer Self-Service Models	Non-Membership Self-Service Models	For-Hire Service Models	Mass Transit Systems
• Bikesharing • Carsharing • Carpooling • On-demand Ridesharing • Scooter-sharing • Vanpooling	• Bikesharing • Carsharing	• Bikesharing • Car Rental • Casual Carpooling	• Courier Network Services • Liveries/ Limousines/ Pedicabs • Ridesourcing/ TNCs • Taxis/E-Hail	• Public Transportation • Micro and Alternative Transit Services (including Microtransit, Paratransit, and Shuttles)

Source: Federal Highway Administration, 2016[3]

Figure 4. Shared Mobility Service Models

Without public sector intervention, benefits from mobility options are likely to be disproportionately concentrated in wealthier urban communities. Because most shared mobility providers are private, for-profit entities, they do not have an incentive to provide services in less profitable rural markets without specific subsidies or mandates. Access to shared mobility services can also be more difficult in unbanked communities, or for people who lack a smartphone with a data plan.

Freight Logistics and Local Delivery Applications

The freight industry is undergoing significant changes and advancements in logistics management enabled by automated technologies affecting both long-distance freight movements as well as distribution networks. In addition, consumer expectations and new e-commerce services have influenced the local delivery providers to develop more demand-responsive delivery services. This includes individual delivery services (for example, UberEATS), an increased emphasis on car and bike deliveries, and fleets of smaller trucks.

The trucking industry could gain safety, environmental, and operational benefits from CVs, AVs, and EVs. For example, CAV technology is being used in pilot studies that enable trucks to engage in cooperative adaptive cruise control, or “platooning” and advancements in propulsion technologies have enabled battery-electric and fuel-cell options for long-haul freight vehicles. The current shortage of truck drivers across the country has increased interest in these technologies.

Overarching Implications

Adoption timelines for emerging transportation technologies, including vehicle technology, mobility options, and freight logistics, will vary. The most significant impacts are likely to occur in the long term (30 to 40 years) and will require the convergence of multiple technological advancements. In the near to medium term (20 years), Oregon likely will have a mixed fleet of connected vehicles, automated vehicles, and vehicles that are not connected and have low levels of automation operating on the

[3] Federal Highway Administration. 2016. *Shared Mobility: Current Practices and Guiding Principles.* Accessed February 18, 2019. https://ops.fhwa.dot.gov/publications/fhwahop16022/fhwahop16022.pdf.

transportation system. While safety benefits can be realized, the combination of vehicle types will present challenges to realizing these benefits.

As emerging technologies are deployed on Oregon's transportation system, ODOT and other local, regional, and state agencies will have access to significantly more data. Increased access to data can improve agency decision making as it could allow for ODOT to better understand traveler patterns, behavior, and demand. However, much of the data are likely to be proprietary and will require agencies to purchase access to traveler data or the development of public-private and public-public partnerships to leverage data use. In addition, increasing volumes of data will require agencies to dedicate more resources to the analysis and interpretation of data in support of informed decision making. These trends will impact ODOT planning, policy, and investment decisions.

Policy Implications

The State of Oregon has an integral role in identifying, developing, and implementing policies to address the range of potential impacts from emerging transportation technologies. This report considers emerging technologies within a statewide, jurisdictionally neutral framework to more comprehensively identify the range of potential impacts to the transportation system. While ODOT considered impacts to Oregon's transportation system as a whole, taking into account other local, regional, and state agencies, staff focused on identifying policy interventions that are exclusively within the authority of the agency and the OTC.

The OTP and recent modal and topic plans provide a set of overarching goals and desired outcomes for Oregon's transportation system. The ETIA used these goals and desired outcomes to frame how emerging transportation technologies are likely to affect the transportation system. The project team identified the following eight foundational goals:

- Safety
- Efficient freight movement
- Equity
- Mobility
- Transportation options
- Fuel efficiency and reducing carbon dioxide (CO_2) emissions
- Transportation funding sufficiency
- Land use management

These goals provide a framework to examine how emerging technology could affect important transportation outcomes.

ODOT outlined the range of potential impacts emerging technologies could have on transportation system performance related to each foundational goal. Figure 5 illustrates the potential transportation system impacts based on degree of impact and certainty. The horizontal axis shows whether impacts are anticipated to be positive or negative, while the vertical axis displays the certainty or uncertainty of the predicted outcome. Figure 5 depicts a range of potential outcomes—including best case, worst case, and most likely scenarios—that Oregon could see by 2040 assuming the continuation of current policies without significant new policy intervention.

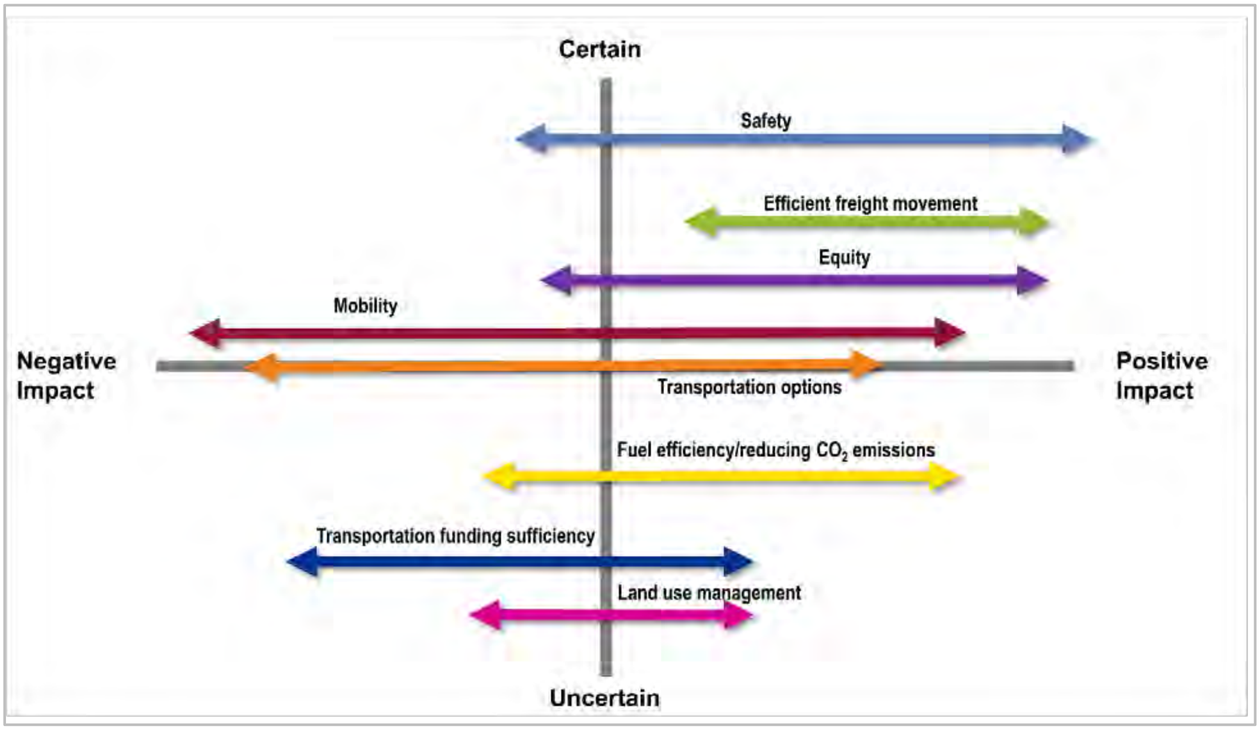

Figure 5. Impacts of Emerging Technology on ODOT's Foundational Goals

The range of impacts without new policy intervention identifies where influences or changes may need to be applied to create a more positive or certain outcome. Observing the range of impacts shown on Figure 5, ODOT identified areas where potential policy interventions may influence how impacts to the transportation system could unfold. The analysis of policy implications for each foundational goal covers the following elements:

- Summary of potential impacts from emerging technologies to Oregon's transportation system
- Level of influence for partner government agencies (including federal, state, regional, and local) and private industry on each outcome area
- Suite of tools that ODOT could employ to address potential impacts to the transportation system given the uncertainty of future impacts

The following sections describe the relative level of influence ODOT, partner government agencies (including the federal government, other state agencies, local and regional agencies), and private industry could have to effect how emerging technologies impact Oregon. The level of public acceptance regarding emerging transportation technologies will influence both private sector technological developments and how public agencies implement policies.

Each entity's influence is indicated by either a partially or fully filled-in circle in the graphic accompanying the description. Entities with the greatest influence are indicated by a fully filled-in circle, while those with least influence are indicated by an empty circle. Specific interventions identified to address impacts to the transportation system are specific to the OTC and ODOT.

Safety

Safety is one of the most positive and certain outcomes of changing technology. Even with as little as 15 to 30 percent market penetration, CV and AV technology could improve safety outcomes on Oregon's roadways for all users, including drivers of legacy vehicles and people walking and biking.[4] CV and AV technology could reduce human error and driver distraction, which contributes to crashes. CVs could communicate with each other, infrastructure, and other devices in real-time about vehicle position, traffic and infrastructure condition, inclement weather, work zones, and other safety-related elements. CVs and AVs could also improve information available to drivers and road operators about conditions, enabling more active system management.

Although CVs and AVs are expected to provide significant transportation safety benefits, technology could develop more slowly than predicted or fail to provide anticipated reductions in crashes. Additionally, different communication platforms that enable V2X communications are competing for market dominance, potentially resulting in incompatible communication systems and lengthening the time to achieve critical mass to support safety benefits.

Particular risk exists with level 3 AVs, those that have many automated features but still require driver input, because drivers may be distracted and unready to assume control of the vehicle when needed. Furthermore, all CVs and AVs have varying levels of security that protect them from rogue control or system corruption. These cybersecurity systems may have vulnerabilities that could result in vehicle safety systems failures or in-operation. This is of greatest concern when individuals or companies fail to update software to adequately protect against unauthorized access to automated driving technology.

Entity	Level of Influence
Federal Government	●
ODOT	◕
Other State Agencies	◑
Local and Regional Agencies	◕
Private Sector	●

Figure 6. Agency and Private Sector Level of Influence for Safety

Influence. Private industry and the federal government have the most influence over safety outcomes from new technology because they will dictate how fast technology comes to the market and because the federal government is responsible for setting safety standards for vehicles. However, ODOT can have significant influence on how, where, and when safety benefits accrue. Oregon State Police can also influence safety outcomes through enforcement. Figure 6 illustrates the level of influence that the federal government, ODOT, other state agencies, local and regional agencies, and the private sector possess to shape safety-related outcomes.

Potential Areas of ODOT Policy Intervention:

- **V2I and V2V** – V2V communication is a private industry endeavor. A pending federal rule would mandate use of V2V communications and define system requirements. To best capitalize on V2I, ODOT can include policies designed to encourage local and regional agencies to deploy V2I that use the same communications and system framework as V2V in modal and topic plans.
- **Traveler information and incident response** – Policies designed to improve traveler information and incident response could be included or updated in topic and modal plans. Policies could encourage the deployment of technology that provides real-time data on roadway and weather conditions, evacuation routes, and road closures. Implementing roadside infrastructure to enable V2I communications would provide access to useful data from equipped CVs. To garner these data, ODOT may want to consider developing operational strategies to support the deployment of CV technologies on facilities and corridors.

[4] Tientrakook, Patcharinee, Ya-Chi Ho, and Nicholas Maxemchuck. 2011. *Highway Capacity Benefits from Using Vehicle-to-Vehicle Communication and Sensors for Collision Avoidance*. IEEE Vehicular Technology Conference.

- **Regulation of level 3 automation** – ODOT's Driver and Motor Vehicle Services division (DMV) could implement policies for special driver license endorsements or certifications enabling the operation of vehicles with Level 3 automation.
- **Cybersecurity protections** – As the transportation system becomes increasingly connected, its exposure to cybersecurity threats increases, which could pose serious risks to safety and privacy. The federal government has a significant role in leading the regulation of cybersecurity for vehicles. ODOT has a role in developing operational plans, policies, and guidelines for the deployment of V2I technology that could protect ODOT facilities from potential cybersecurity attacks.
- **Public-private partnerships (PPPs) to leverage data** – There is the potential for CVs and AVs to produce a lot of data that can support greater understanding of the use and status of the transportation system. CVs provide an opportunity to make use of anonymized data[5]. There is also an opportunity for both ODOT and private industry to benefit through partnerships that support sharing of proprietary anonymized data between them. Agencies possess, real-time data that can help make automated driving safer, such as detailed information about work zones, crashes, closures, and other system disruptions. Other types of data that are normally not publicly available such as road weather information from fleet vehicles or signal, phase, and timing from traffic signals could form the basis of PPPs. Safety and traveler behavior data can be used to inform investment and operational decision making and exchanging real-time agency data to support safer operation of AVs on Oregon's roadways. Policies that reduce barriers to establishing partnerships could further support development of partnerships.
- **Update roadway design standards** – ODOT could monitor and update roadway design standards in the Highway Design Manual to improve the operation of AVs on roadways (for example, striping and signing standards and lane widths).
- **All Roads Transportation Safety (ARTS) program** – ODOT manages and facilitates disbursement of ARTS program funding through a jurisdictionally blind process. Both local and regional agencies and ODOT are eligible for program funding. ODOT could consider updating evaluation criteria to encourage V2I deployment on state and local facilities.
- **Coordination with Oregon State Police** – ODOT could coordinate with and develop partnerships or initiatives to support Oregon State Police efforts to enforce current and future laws that may be affected by emerging transportation technologies.

[5] Data anonymization seeks to protect private or sensitive data by deleting or encrypting personally identifiable information from a database. Its purpose is to protect an individual's or company's private activities while maintaining the integrity of the date gathered and shared.

Efficient Freight Movement

Connected and automated vehicle technology is likely to improve freight efficiency and safety.

Truck platooning, automated freight vehicles, and advanced logistics are likely to improve the safety and reliability of freight movement in Oregon.

Advances in vehicle technology, logistics, and other technologies will likely enable more efficient freight movement. Connected freight vehicles will provide information on travel time and road and weather conditions, contributing to the safety and efficiency of freight movement. Platooning,[6] automated freight vehicles, and advanced logistics could result in reduced shipping costs and more reliable delivery times. Data sharing between system operators and freight vehicles can improve information about the system and guide investment and operational decisions. Even if CV or AV technologies mature more slowly than predicted, limited deployments could still improve the safety, reliability, and efficiency of freight movement.

Entity	Level of Influence
Federal Government	●
ODOT	◕
Other State Agencies	◑
Local and Regional Agencies	◕
Private Sector	●

Figure 7. Agency and Private Sector Level of Influence for Freight

Influence. Private industry has been a key driver of advances in freight movement and logistics and will continue to influence which emerging transportation technologies are widely deployed (that is, whether connected, automated, or connected *and* automated freight vehicles prevail). The federal government has the authority to establish standards for commercial vehicles and regulate interstate commerce. Local and regional governments hold some degree of influence over the deployment of short-haul freight and local delivery vehicles. Figure 7 illustrates the level of influence that the federal government, ODOT, other state agencies, local and regional agencies, and the private sector possess to shape freight-related outcomes.

Potential Areas of ODOT Policy Intervention:

- **V2I and V2V for freight** – ODOT could develop operational policies to support the deployment of V2I targeted at freight vehicles on state facilities. Polices included in modal and topic plans would encourage deployment on local and regional facilities.
- **Automated, platooning, or other connected freight pilot projects** – ODOT could develop pilot projects involving automated or connected freight projects on select facilities. Pilot projects would likely require ODOT to establish PPPs with freight vehicle manufacturers, among others in the private sector.
- **Update roadway design standards** – Any updates will be informed by research conducted by the U.S. DOT, National Cooperative Highway Research Program, and Federal Motor Carrier Safety Administration to understand safety considerations and identify which design changes may be necessary as AV and CV technology is more fully deployed on the transportation system. ODOT could update roadway design standards to address identified safety considerations related to the

[6] Truck platooning is the linking of two or more trucks in convoy, using connected vehicle or automated vehicle technology. These vehicles automatically maintain a set, close distance between each other when they are connected while traveling on roadways. Platooning has the potential to improve safety, mobility, and fuel efficiency.

operation of connected and automated freight vehicles on state-owned and -operated facilities, paving the way for pilot projects.

- **Leverage new data** – ODOT could develop operational policies, plans, and programs to gather data about the freight system in support of investment and operational decision making. To fully maximize available data, ODOT may consider developing PPPs with application developers and others in the private sector.
- **Digitize freight route planning** – ODOT could digitize freight routes and characteristics to support development of an integrated, real-time freight route planning system or an application or system by the private sector. Digitization of freight routes and characteristics would require significant staff time and resources.

Equity

Emerging technologies are likely to provide benefits for many populations. However, the benefits are not likely to extend to all populations or be evenly distributed. For example, new mobility services could be concentrated in more affluent and urban areas. Additional observations include the following:

- **Mobility for the transportation-disadvantaged** is likely to improve with increased access to affordable and efficient transportation options for those who are unable to drive. Expanded public and private transportation services could increase access to jobs, education, social activities, and essential services. However, new mobility services may not be available to some people who need some assistance or an attendant during travel. In addition, public transit services may decrease in some areas due to competition between private automated transportation services and public transit. These two trends could result in diminished transit services and travel options for those that need the most assistance during travel.

Emerging transportation technologies are likely to generate benefits, but those benefits may not extend to all Oregonians.

More transportation choices are likely to be available to many people who are unable to drive today. However, the benefits may not extend to all transportation-disadvantaged populations. Shared automated trips, including public transit vehicles and TNC trips, are likely to cost less per mile than trips taken by private auto or public transit today and AV technology is likely to allow some people to commute farther and access new career and educational opportunities.

- **Mobility for the transportation-underserved** could be negatively impacted for groups that are traditionally underserved. A recent study, *Predictive Inequity in Object Identification*, suggests that the equity implications of AVs are not limited to class, disability, and geography. People of color could bear a disproportionate burden of pedestrian crash injuries and fatalities because the systems designed to help automated cares recognize pedestrians may have trouble recognizing people with darker skin tones.[7]
- **Transportation costs per mile** are likely to decrease for ride-hailing services (for example, example app-based, on-demand ride services such as Uber and Lyft) and public transit trips as AV technology matures. This is due to decreased overhead from removing drivers. Reductions in travel costs could allow people to make more trips, including those at lower income levels. However, if public

[7] Wilson, Benjamin, Judy Hoffman, and Jamie Morgenstern. 2019. "Predictive Inequity in Object Identification." arXiv e-print archive, Cornell University. February 21. https://arxiv.org/pdf/1902.11097.pdf.

transportation services decrease and travel costs increase, people at lower income levels could experience constraints on the number of trips they can make.

- **Access to jobs and educational opportunities** is likely to increase as AVs are deployed. Commute times could be dedicated to other activities, resulting in a willingness to commute longer distances. How AVs are used – shared versus personal/private – will impact how benefits are distributed. For example, personally owned AVs would primarily benefit those who are more affluent.

Entity	Level of Influence
Federal Government	◔
ODOT	◕
Other State Agencies	◑
Local and Regional Agencies	◔
Private Sector	●

Figure 8. Agency and Private Sector Level of Influence for Equity

Influence. The private sector significantly affects issues related to equity. Access to affordable and efficient transportation options, jobs, and educational opportunities for the transportation-disadvantaged could be limited if driven primarily by the private sector. The federal government can influence equity-related outcomes through policy and regulations such as through Title VI and Environmental Justice requirements[8]. ODOT, other state agencies, and local and regional agencies can impact the equitable implementation of emerging transportation technologies through policies that support increased access to new transportation and mobility options for all Oregonians, especially transportation-disadvantaged groups. Figure 8 illustrates the level of influence that the federal government, ODOT, other state agencies, local and regional agencies, and the private sector possess to shape equity-related outcomes.

Potential Areas of ODOT Policy Intervention:

- **Statewide Transportation Improvement Fund (STIF) requirements** – ODOT could evaluate and revise STIF program funding requirements to ensure public transportation will be available for transportation-disadvantaged groups.
- **Ensure investments benefit transportation-disadvantaged groups** – Policies that evaluate equity impacts of CV and AV infrastructure investments and projects could ensure that rural areas and areas with concentrations of traditionally underserved populations experience benefits from emerging transportation technologies.
- **Consider equity criteria** – ODOT could include equity criteria to ensure that transportation-disadvantaged and underserved populations have access to affordable and efficient transportation options through funding, pilot, and grant programs.
- **Leverage increased access to data** – ODOT could use data about travel patterns and behavior to better understand the travel needs of underserved groups and inform investment decisions.
- **Oregon Health Authority (OHA) partnership** – ODOT and OHA have established a Memorandum of Understanding to guide collaboration between the two agencies and identify, develop, and promote connections between public health and transportation, including climate change. Building from this Memorandum of Understanding, ODOT could identify strategies that leverage emerging transportation technology to increase access to health services and to mitigate health-related impacts from climate change for transportation-disadvantaged and underrepresented groups.

[8] Executive Order No. 12898. 1994. "Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations." *Federal Register*. Vol. 59, No. 32. February 16.

Mobility

Impacts to mobility are difficult to predict with a high level of certainty. The predominant operational model and resultant changes in vehicle miles traveled (VMT), and the timeline under which CVs and AVs are deployed, will significantly influence mobility. For example:

- **Travel time reliability** is likely to improve even with moderate deployment of CV and AV technology. Safety benefits related to CVs and AVs will contribute to traffic "smoothing" through reductions in crashes and incidents. Travel time may increase but would become more reliable as access to real-time traveler information improves.
- **VMT** impacts are difficult to predict with a high degree of certainty and depend on the AV operational model that is adopted. A shared-ownership model could decrease reliance on single-occupancy trips and potentially limit or slightly decrease VMT. If a private ownership model prevails, or if reduced travel costs induce additional demand, VMT per capita could increase.

Impacts to mobility are uncertain and will depend on the operational model adopted with AVs.

Increased availability of and access to real-time traveler information combined with traffic smoothing related to safety improvements are expected to improve travel time reliability.

- **Congestion** is difficult to predict. It is likely that the conveniences of AVs, such as being able to work while driving, will lead to additional vehicle travel and increase congestion. Consequently, either AV operational model, shared or personal/private, could contribute to increased congestion. If ridesharing and other forms of shared mobility are common, congestion could worsen as AVs make zero-occupancy trips. If personal/private AVs are common, congestion could increase as people make more trips. However, non-recurrent congestion should decrease under any scenario as safety benefits are realized.

Entity	Level of Influence
Federal Government	○
ODOT	◕
Other State Agencies	◔
Local and Regional Agencies	◑
Private Sector	●

Figure 9. Agency and Private Sector Level of Influence for Mobility

Influence. ODOT and the private sector wields the greatest influence over mobility. The private sector will drive operational model for AVs, though state and local agencies can put policies in place to influence private sector choices. Local and regional governments can influence mobility through land use policies and policies that regulate TNCs and other transportation options such as bikeshare services. Figure 9 illustrates the level of influence that the federal government, ODOT, other state agencies, local and regional agencies, and the private sector possess to shape mobility-related outcomes.

Potential Areas of ODOT Policy Intervention:

- **Real-time traveler information** – Development of operational and long-range planning policies to increase access to real-time traveler information could address impacts to mobility. This will likely necessitate the development of PPPs to access available data because private application developers own much of the data that could provide ODOT with real-time traveler information in the near term. There is still an opportunity for mutually beneficial partnerships that facilitate data sharing between ODOT and the private sector in the medium to long term because ODOT will continue to be an authoritative source of data about closures, chain and tire requirements, and construction activity.

- **Pricing strategies** – Implementation of pricing strategies could address mobility issues on state facilities related to potential increases in VMT and congestion. Strategies that address equity concerns should be considered.
- **V2X infrastructure** – Development of ODOT operational strategies to deploy V2X infrastructure could increase access to real-time traveler information and support the integration of transportation information, mobility hubs, and MaaS.
- **Roadway design standards** – ODOT could evaluate the Highway Design Manual and consider updates to roadway design standards that improve operations of AVs. Standards could address striping, roadway widths, and signage, among other elements.
- **Incident response** – ODOT could develop operational policies that encourage the deployment of CV applications to optimize incident response, minimizing clearance times and providing travelers with real-time information to support route planning.
- **Priority for high-occupancy vehicles (HOVs)** – Policies designed to prioritize HOVs on ODOT facilities could mitigate congestion and increased VMT related to the deployment of AVs.
- **Development review tools** – Policies that address the development review process could improve system capacity in urbanized areas by rethinking trip generation. Curb space access needs will likely change; with the deployment of AVs, and other emerging transportation technologies, it is expected that there will be a significant increase in demand for curb space to pick up and drop off passengers and delivery goods. This will warrant important discussions regarding any changes to development review policies.
- **PPPs** – ODOT could consider policies that reduce barriers to PPPs and leverage data to inform investment and operational decision making.

Transportation Options

Impacts to transportation options are uncertain and the distribution of benefits is likely to vary according to geography and income. Public transit services could erode as the public opts to take more trips using shared mobility options or private vehicles. However, it is possible that an increased use of first-and-last-mile AV transit could increase the use of public transit. For example:

> Access to transportation options is likely to increase.
>
> Urban communities are likely to experience the greatest increase in transportation options with limited benefits accruing in rural communities.

- **Urban transportation options** are likely to improve as people experience increasing travel options, including TNCs, microtransit, carshare, bikeshare, and e-scooters. These emerging options improve access to jobs, education, and essential services. However, these increased options are likely to be concentrated in affluent communities and could contribute to the erosion of fixed route transit service in some areas.
- **Rural transportation options** could expand due to AV technology and provide increased access for people in areas with limited public transit services. However, new transportation choices in rural areas may not be economically viable for the private sector.
- **Active transportation choices** are expanding, with many new active transportation services coming online today. Increased access to shared mobility options, including bike and e-scooter share, enables people to use active transportation options for short trips, increasing access to public transit

and addressing first-and-last mile issues. However, as motorized shared mobility options become accessible and affordable, active transportation trips could decrease.

Entity	Level of Influence
Federal Government	○
ODOT	●
Other State Agencies	○
Local and Regional Agencies	●
Private Sector	●

Figure 10. Agency and Private Sector Level of Influence for Transportation Options

Influence. Private industry, local agencies, and ODOT have the greatest influence on access to transportation options in Oregon. The private sector is likely to deliver mobility services to affluent, urban, and suburban communities first. Local and regional agencies can guide public transit investments and regulate how TNCs, microtransit, bikeshare, and e-scooters operate within their jurisdictions. Figure 10 illustrates the level of influence that the federal government, ODOT, other state agencies, local and regional agencies, and the private sector possess to shape outcomes related to transportation options.

Potential Areas of ODOT Policy Intervention:

- **Public transit support** – ODOT could consider policies to ensure public transit is provided in urban and rural areas. STIF program requirements and evaluation criteria could be updated to ensure and maintain access to public transit, especially for transportation-disadvantaged populations
- **Active transportation support** – ODOT could have a role in coordinating various providers and jurisdictions to encourage development of active transportation options, including bikeshare and scootershare.
- **Integrated fare payment** – ODOT could consider including policies in modal and topic plans to encourage coordination between different public transportation providers and jurisdictions to integrate fare payment systems for customers. PPPs may be necessary to facilitate integrated fare payment systems. ODOT could update STIF program requirements and evaluation criteria to further support deployment of integrated fare payment systems.
- **Statewide MaaS applications and payment systems** – Policies that facilitate and support implementation of universal payment systems and MaaS applications, including integrated trip planning and first-mile/last-mile connections to transit, could be considered for inclusion in ODOT modal and topic plans. PPPs may be necessary to facilitate early applications and payment systems. ODOT could consider updating STIF program requirements to encourage statewide MaaS applications.
- **Support for mobility hubs** – STIF funding program requirements that encourage implementation of mobility hubs, support the integration of traveler information, and encourage connections to other transportation options, including transit, carshare, bikeshare, and other services, could increase access to transportation options. In addition, ODOT could coordinate with transportation providers and jurisdictions to encourage the development of mobility hubs across the state.

Fuel Efficiency and Reducing CO_2 Emissions

Increased levels of fleet electrification are likely and may produce fuel efficiencies.

Some fleet electrification is likely and could generate some environmental benefits. The prevailing use of EVs will obviate VMT as a factor in emissions.

The impacts of emerging technologies on emissions are uncertain and depend on the public's adoption of EVs and deployment of the supporting charging infrastructure. Fleet electrification could range from moderate penetration to widespread adoption of EVs, generating some reductions in CO_2 emissions. The prevailing operational model of EVs, whether it is shared or private, could also influence emissions. It is likely that shared AVs, which are expected to be mostly electric, will emerge as a transportation option in some urban environments. Connected vehicles and automated vehicles are likely to improve system reliability and reduce non-recurrent congestion, which may provide fuel efficiency benefits regardless of VMT. However, if AVs are not electric and if people use AVs for more frequent and longer trips, CO_2 emissions could increase.

Entity	Level of Influence
Federal Government	◕
ODOT	◕
Other State Agencies	◕
Local and Regional Agencies	◔
Private Sector	●

Figure 11. Agency and Private Sector Level of Influence for Fuel Efficiency and Reducing CO_2 Emissions

Influence. State departments of transportation, the federal government, and the private sector have the greatest role in driving fuel efficiency and reductions in CO_2 emissions. The federal government is a strong driver of fuel economy increases through the Corporate Average Fuel Economy standards, which mandate fuel economy standards for vehicle manufacturers. However, the private sector also tends to be a leader in technological innovations that could support improved fuel efficiency and reductions in CO_2 emissions if there is adequate consumer demand to drive these innovations.

ODOT and other state agencies, including the Oregon Department of Energy, Oregon Department of Environmental Quality, Oregon Public Utility Commission, and Oregon Department of Administrative Services, are collaborating to support the expansion of EV adoption and infrastructure in Oregon. Figure 11 illustrates the level of influence that the federal government, ODOT, other state agencies, local and regional agencies, and the private sector possess to shape outcomes related to fuel efficiency and reducing CO_2 emissions.

Potential Areas of ODOT Policy Intervention:

- **Taxes and fees** – To support expansion of EV adoption and infrastructure, ODOT could consider developing incentive programs for the electrification of transit, freight, or personal vehicles. Taxes or fees, including a user-pays system, could be used to support any future incentive programs.
- **Planning for alternative fuels infrastructure** – ODOT could convene stakeholders to determine fueling infrastructure needs, identify gaps in coverage, and develop investment plans to support expansion of alternative fuels infrastructure in the region.
- **Participation in multistate initiatives** – Continued participation in multistate initiatives, such as the Multi-State ZEV Task Force, Pacific Coast Collaborative, and International ZEV Alliance, could support EV adoption and expansion of charging infrastructure.

- **Coordination with other state agency efforts** – ODOT's continued participation in the ZEV Interagency Working Group could support planning for charging infrastructure and EV adoption in Oregon.

Transportation Funding Sufficiency

Increased fuel economy and fleet electrification will continue to reduce gas tax revenue, but the rate of decrease is uncertain. One option for addressing the future funding shortfall is to implement a user-pays system. The state legislature will determine whether a mandatory road usage charge (RUC) program or another system is implemented.

Integrated vehicle technology will enable an expansion of a user-pays funding system.

Emerging technologies can help ensure that all vehicles are paying some share for their use of Oregon's roadways. However, transportation funding is likely to continue to be constrained.

Entity	Level of Influence
Federal Government	●
ODOT	◕
Other State Agencies	◔
Local and Regional Agencies	◑
Private Sector	○

Figure 12. Agency and Private Sector Level of Influence for Transportation Funding Sufficiency

Influence. The federal government and ODOT have the most influence over policies that will support sufficient transportation funding. The federal government allocates significant transportation funding to state departments of transportation, but typically agencies must supplement this funding with other sources.

ODOT can impact funding levels through various policy levers, including pricing, fees, and taxes, among others. However, the Oregon State Legislature would have to direct ODOT to implement pricing, fees, and taxes, because ODOT does not have authority to initiate new taxes. Figure 12 illustrates the level of influence that the federal government, ODOT, other state agencies, local and regional agencies, and the private sector possess to shape transportation funding sufficiency outcomes.

Potential Areas of ODOT Policy Intervention:

- **Road usage charge (RUC)** – ODOT is a leader in operating a RUC system based on miles driven, and the implementation of an expanded statewide, mandatory RUC could supplement or replace decreasing revenues from the gas tax.
- **Pricing of roadway infrastructure** – Pricing strategies to capture costs associated with increased VMT or delay on the state highway system could supplement transportation revenue.
- **DMV fees and policies** – ODOT could consider DMV policies that require issuance of a special driver's license, and an associated fee, for people operating vehicles with Level 3 automation. This registration process could also be used to monitor not only the penetration of these types of vehicles into the population, but to generate analyses of crashes or changes in driver behavior.
- **Western State RUC Consortium** – ODOT's ongoing participation in RUC West could continue to build broad support and technical capacity to implement a statewide or multistate RUC.

Land Use Management

It is difficult to predict the impacts of emerging technologies on land use patterns. The operational model that emerges for AVs will influence land use patterns, and what model is most likely to emerge is uncertain. It is possible that a combination of operational models (i.e. personal automated vehicles, shared automated vehicles, and shared automated rides) could be deployed, with shared mobility options prevalent in urban areas and private ownership models prevalent in rural areas. Shared mobility operational models are anticipated to support denser development patterns, while private ownership models are expected to contribute to longer commute distances and more diffuse land use patterns. However, any impact will be somewhat tempered by Oregon's Statewide Planning Goals.

Impacts to land use patterns are difficult to predict.

However, any impact will be somewhat tempered by Oregon's Statewide Planning Goals.

Entity	**Level of Influence**
Federal Government	○
ODOT	◐
Other State Agencies	◐
Local and Regional Agencies	●
Private Sector	◔

Figure 13. Agency and Private Sector Level of Influence for Land Use

Influence. Local and regional agencies, state agencies, and private sector actors and market economies drive local development patterns. The Department of Land Conservation and Development (DLCD) manages the statewide land use program, which lays out goals and policies that influence land use and development patterns in Oregon. Local jurisdictions implement land use goals and policies, guiding development patterns through zoning and regulations.

ODOT supports and complements the implementation of DLCD goals and policies through mobility policies and the development review process. Figure 13 illustrates the level of influence that the federal government, ODOT, other state agencies, local and regional agencies, and the private sector possess to shape land use outcomes.

Potential Areas of ODOT Policy Intervention:

- **System planning and overlay standards and guidance** – ODOT could update standards, guidance documents, and processes for Interchange Area Management Plans, policies, and land use overlay standards, to consider impacts to capacity resulting from increased deployment of AVs and CVs.
- **Mobility policies and targets on state facilities** – Mobility policies and targets may need to be updated to address potential capacity issues stemming from a mixed fleet of AVs, CVs, and legacy vehicles. These policies would be included in any future updates to the OTP or OHP. The OTC would play an integral role in supporting and adopting any updates to mobility policies.
- **Development review** – ODOT could update guidance to support consideration of AVs, CVs, and emerging active transportation modes (for example, bikeshare, scootershare, and paratransit) in the development review process. Development review requirements may need to consider changes in trip generation associated with new transportation technologies. Both DLCD and local agencies may need to consider changes to development review processes and requirements within their respective purviews.

Conclusion

Emerging technologies are rapidly changing the ways Oregonians move around the state, how goods are transported, and how Oregon's roadways are used. ODOT has traditionally used past behavior to help anticipate and model future travel needs. As technology changes occur more rapidly, it becomes harder to rely on the trends of the past to forecast future outcomes.

As ODOT considers the investment needs and policies to guide its decisions over the next 20 years, understanding and accepting uncertainty by preparing for a range of futures is the most reliable course of action. ODOT's next generation of statewide plans – particularly the OTP and OHP – must be flexible.

Over the next 20 years, the transportation system will increasingly incorporate new transportation technologies, which will exist alongside legacy vehicles and systems. Knowing exactly how fast different technological changes may occur, how those technological changes will interact, and what the outcomes of technology changes will be may be impossible. However, understanding the likelihood of possible outcomes can help ODOT both adopt policy now to support desired outcomes and be prepared to react as the future unfolds.

This first phase of the ETIA was designed to introduce the emerging technology trends that are impacting transportation, to begin to examine how these trends may affect how ODOT delivers transportation services in the state, and to identify policy implications and interventions to maximize positive outcomes and minimize negative outcomes.

The second phase will be an opportunity for ODOT to develop several possible futures that include different combinations of technological change and adoption, demographics, and other variables. Assessing key outcomes under each of these futures will lay the groundwork for updating ODOT policy documents in a way that allows the agency to anticipate and proactively address future challenges in a changing world.

Oregon Futures
Emerging Technologies Impact Assessment Project

Results Report

February 24, 2020

Oregon Department of Transportation

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Acronyms and Abbreviations

AV	automated vehicle
CAVST	Connected and Automated Vehicle Steering Team
CO_2	carbon dioxide
CV	connected vehicle
ETIA	Emerging Technology Impact Assessment
EV	electric vehicle
FTA	Federal Transit Administration
HOV	high-occupancy vehicle
Jacobs	Jacobs Engineering Group Inc.
MaaS	Mobility-as-a-Service
MnDOT	Minnesota Department of Transportation
MPO	metropolitan Planning Organization
ODOT	Oregon Department of Transportation
OHP	Oregon Highway Plan
OTC	Oregon Transportation Commission
OTP	Oregon Transportation Plan
Peer Exchange	Oregon Futures State Agency Peer Exchange
RUC	road-usage charge
SOV	single-occupancy vehicle
SWIM	Statewide Integrated Model
TNC	transportation network company
TPAU	Transportation Planning Analysis Unit
V2I	vehicle-to-infrastructure
V2V	vehicle-to-vehicle
V2X	vehicle-to-everything
VMT	vehicle miles traveled

1. Project Background

Emerging technologies such as connected, electric vehicles and infrastructure, on-demand mobility options, and the collection and analysis of large amounts of data have led to rapid changes in Oregon's transportation system and mobility choices. To better prepare for an increasingly uncertain future, the Oregon Department of Transportation (ODOT) initiated the Emerging Technology Impact Assessment (ETIA) Project through a contract with CH2M HILL, Inc. (now Jacobs Engineering Group Inc. [Jacobs]) to identify and consider implications, including benefits and impacts, from emerging transportation technologies for Oregon's transportation system.

In 2015, ODOT established the Connected and Automated Vehicle Steering Team (CAVST), an internal group charged with leading the agency in implementing ODOT's transportation vision—as it relates to connected and autonomous vehicles—and coordinating across ODOT's various functions to manage resource investment. The CAVST first identified the need for the ETIA project when developing its work plan for 2018. The CAVST determined that the results of the assessment would inform next steps the agency takes on connected and automated vehicle policy and conferred responsibility for the scoping and completion of this task to ODOT's Transportation Development Division (now renamed as Policy, Data, and Analysis Division). They expanded the scope of this task to explore a range of additional emerging transportation technologies, such as micro-mobility (e-bikes and e-scooters) and e-commerce, in order to consider broader multimodal policy implications in preparation of updates to the Oregon Transportation Plan (OTP) and the Oregon Highway Plan (OHP).

The ODOT/Jacobs project team conducted the ETIA project in two phases. Phase 1 outlined the key trends in emerging transportation technologies, assessed potential policy implications and effects upon Oregon's transportation system, and identified a suite of potential interventions for ODOT to consider. ETIA Phase 2 built on the assumptions developed in Phase 1 to identify and prioritize analysis tools and methods to be used in the development of scenarios to inform ODOT's long-range strategic planning.

2. Scenario Planning in Context

Scenario planning for transportation occurs at multiple levels of government in accordance with federal planning principles. According to the Federal Transit Administration (FTA), scenario planning is a process that evaluates the effects of alternative policies, plans, and/or programs on the future of a community or region (FTA 2019). Scenario planning is a long-term approach used to explore and debate alternatives and trade-offs by looking at a range of future possibilities.

Designating specific outcomes before a scenario planning effort is referred to as a **normative** scenario planning approach. An **exploratory** approach examines a broad range of variables that go beyond land use and transportation. This approach broadens the scope of traditional scenario planning to generate more integrated planning and policy efforts that include more factors such as housing affordability, water conservation, fiscal sustainability, and public health (FTA 2019). Results under exploratory planning are not specific outcomes or prescriptive paths, but rather roadmaps to test and explore different influencers, drivers, and options that might be developed. The exploratory approach makes scenario planning suitable for both small and large applications.

Advantages of Scenario Planning (FTA 2019):

- Accommodates uncertainty and ambiguity.
- Helps communities prepare for a range of plausible futures rather than a single forecast.
- Results in decisions that are more robust in a variety of futures.
- Provides a forum for engaging a diverse set of stakeholders to identify critical factors.
- Facilitates testing out possible decisions and their effects on multiple future scenarios.

Scenario planning is common at a regional level through local metropolitan planning organization (MPOs) or regional governments. MPOs and regional governments are well suited to implement scenario planning because they operate within a smaller geographical area when compared to a statewide agency, they have easy access to necessary data, and are able to more quickly conduct stakeholder outreach to understand underlying issues and trends. Though the ETIA project focused on statewide scenario planning applications, the project team identified and evaluated various assessment tools that could be used to measure, track, and influence regional objectives as well.

3. ETIA Phase 1 Overview and Outcomes

The project team designed the first phase of the ETIA project to identify and describe the emerging technology trends that affect transportation in Oregon. During Phase 1, the project team evaluated how these trends and drivers of change might affect how ODOT manages their transportation programs and systems and how they deliver transportation services in the state. This process also identified policy implications and suggested interventions to maximize positive outcomes and minimize negative outcomes.

The State of Oregon plays an integral role in identifying, developing, and implementing policies to address a future with emerging transportation technologies. To identify and understand potential impacts, the team used goals from the OTP and relevant modal plans that are elements of the OTP as a guide. ODOT then determined whether these impacts were positive or negative towards meeting project goals and indicated the level of certainty of each predicted impact. For example, how might the increased use of ride-hailing over personal vehicle ownership impact roadway usage? How might the transition to more connected, electric vehicles impact roadway safety and transportation infrastructure needs? Are these changes more likely to have positive or negative impacts on our goals and what policy interventions are possible to influence those outcomes?

The work in ETIA Phase 1 culminated in the development of potential policy interventions that could influence how emerging technologies could affect Oregon's transportation system. Some policy interventions cross-cut multiple goal areas, while others are linked to a single goal area. The project team then organized potential policy interventions according to each of ODOT's eight foundational goal areas and identified those most likely to influence outcomes. The following policy interventions (listed by ODOT foundational goal area) exemplify potential actions to incorporate in the development of future scenarios, trends, and considerations for the OTP and OHP Updates:

Safety

- Deploy vehicle-to-infrastructure and vehicle-to-vehicle technology
- Regulate level 3 and higher automated vehicles (automated driving functions)
- Update roadway design standards
- Update All Roads Transportation Safety program requirements

Efficient Freight Movement

- Deploy vehicle-to-infrastructure and vehicle-to-vehicle technology for freight
- Initiate automated, platooning, or other connected freight pilot projects
- Digitize freight route planning

Equity

- Ensure investments benefit transportation-disadvantaged and underserved groups
- Update equity criteria
- Update Statewide Transportation Improvement Fund program requirements

Mobility

- Deploy vehicle-to-vehicle and vehicle-to-infrastructure technology
- Update roadway standards
- Explore pricing strategies and priority for high-occupancy vehicles
- Update development review tools

Transportation Options

- Support investments in statewide Mobility-as-a-Service (MaaS) applications and payment systems, including integrated fare payment
- Support investments in mobility hubs
- Update funding program requirements to support public transit and active transportation

Fuel Efficiency/Reducing Carbon Dioxide (CO_2) Emissions

- Develop or adjust taxes and fees
- Participate in multistate initiatives
- Plan for alternative fuels infrastructure

Transportation Funding Sufficiency

- Implement statewide road usage charge
- Consider pricing of roadway infrastructure
- Develop Driver and Motor Vehicle Services fees and policies

Land Use Management

- Develop system planning and overlay standards and guidance
- Update mobility targets on state facilities
- Update development review requirements

4. ETIA Phase 2 Overview

Phase 2 builds on the work of Phase 1, informing how Oregon can prepare for and address emerging technologies in ODOT's strategic long-range planning approach through exploratory scenario planning. The project team evaluated the tools, metrics, and inputs for a range of alternative future scenarios. Each scenario could incorporate different combinations of technological change and adoption, demographics, economics, and other variables. Assessing key outcomes under each of these futures was a critical aspect of Phase 2 and laid the groundwork for updating key ODOT policy documents: the OTP and the OHP.

To develop and understand potential scenarios, the ETIA project team convened stakeholder consultation sessions and meetings that consisted of a state agency peer exchange, an ODOT scenarios development workshop, and an ODOT tools assessment workshop. These efforts strengthened the project team's understanding of state priorities and issues to consider in defining a potential range of alternative future scenarios.

Statewide scenario planning efforts are becoming more common, but the size is challenging because of the number of state agencies and stakeholders within a state government. The State Agency Peer Exchange worked to remove barriers to cross-agency planning efforts and identify shared priorities for future planning.

4.1 Oregon Futures State Agency Peer Exchange

The Oregon Futures State Agency Peer Exchange (Peer Exchange), held in July 2019, was a single, half-day, in-person workshop in Salem, with 16 statewide and local/regional partner agencies and Portland State University in attendance. Its purpose was to inform partners of ODOT's work to plan for the transportation system's future, learn from peer agencies on how they are planning for the future, and establish a network for information sharing. It was convened as a response to the Oregon Transportation Commission's (OTC) assessment of Phase 1. OTC members reviewed Phase 1 findings and directed ODOT to learn of other agency's approach to emerging technology. The Peer Exchange helped ODOT develop future scenario questions around 11 key themes:

- Equity
- Climate change
- Planning horizons
- Workforce preparedness
- Resiliency
- Urban–rural disparities
- Housing costs and supply
- Demographic and cohort changes
- Nexus of housing access and educational success
- Homelessness
- Health impacts

Examples of Statewide Scenario Planning

In winter 2018/2019, the *Minnesota Department of Transportation* (MnDOT) used scenario planning as part of an innovative approach to determine how plans and programs will address connected and automated vehicle technologies in their *CAV Scenario Planning Report*. The effort also helped educate local partners and stakeholders while giving MnDOT staff new perspectives on the promises and potential problems with different scenarios.

MnDOT developed four scenarios that each describe a possible future Minnesota in the year 2040. Each scenario assumed varied levels of automation, connectivity, electrification, and sharing. The scenarios ranged from describing a future with incremental change from today's technology to a future with a fleet of fully automated vehicles operating as part of a robust multimodal system. The implications of each scenario were distinct to allow for unique group discussion at the workshops based on scenario-specific challenges and opportunities.

The Peer Exchange also identified long-term trends, impacts, approaches to planning, priority trends, and opportunities to collaborate (sharing info, communication channels, and other collaborative efforts). Full notes from the Peer Exchange can be found in **Appendix A.**

4.2 ODOT Scenario Development Workshop

The Scenario Development Workshop was the second key stakeholder engagement effort. It included 30 participants who represent different ODOT programs and divisions. The workshop's purpose was to share Phase 1 outcomes, review and discuss emerging trends and drivers of change that could affect Oregon in the future, and brainstorm potential future outcomes and implications. Before the workshop, ODOT sent an online survey to participants to help identify key goal areas to emphasize. Survey respondents indicated that safety, mobility, and reducing CO_2 emissions were their highest priorities. Key emerging trends and drivers of change were identified and discussed during the workshop under the themes of environmental, demographics, economic/financial, emerging technologies, and freight logistics and local delivery applications.

This workshop encouraged participants to brainstorm positive and negative impacts in relation to ODOT's eight foundational goals applied to the ETIA project. The brainstorming activity provided direction for the project team to prioritize inputs, assessment tools, and metrics for scenario development. Key takeaways and notes from the workshop can be found in **Appendix B.**

4.3 Assessment Tools Workshop

The Assessment Tools Workshop included representatives of ODOT's Transportation Planning Analysis Unit division, who provided insight into various in-house modeling and long-range planning tools that could be used to test potential future scenarios. Tools are generally categorized into three buckets under the Strategic Tactical Operational STORM Analysis framework—ODOT'S process for determining the right tool for a particular scenario planning effort—to better determine how they can be used.

Key Tools reviewed included the following:

- **VisionEval –** a strategic modeling tool designed to evaluate several alternative futures when there are many unknowns.
- **The Statewide Integrated Model (SWIM)** – a model created to test policies statewide by adjusting inputs depending on a variety of changes that can be economized.
- **Place Types –** a geospatial, data-driven application to define and visualize the many aspects of land use–transportation interactions embodied in land use plans. It is context sensitive, so it compares existing built environment characteristics with what is expected to occur in the future.

Scenario Planning at the Regional Level

Some scenario planning tools have been effectively used at the regional level to plan for and evaluate alternative transportation futures.

In September 2009, the Memphis Urban Area MPO began the *Imagine 2040 Midsouth Transportation & Land Use Plan*, a regional visioning and scenario planning process. Scenario planning was used as a tool throughout the process to identify regional goals and values and explore alternatives for growth, development, and transportation investment. Scenario planning helped the public and stakeholders visualize the interaction of new development, economic vitality, and the surrounding transportation system.

In 2017, Metrolinx (Toronto and Hamilton road and public transport agency) used a scenario planning approach for its *Regional Transportation Plan* that presented alternative futures covering wide-ranging trends in order to understand what might change in the future.

Metrolinx created a total of six alternative future scenarios that were built off previously established key questions and then shaped by a variety of driving forces stemming from different categories, including demographics, the economy, technology, and the environment.

5. Phase 2 Outcomes to Guide Scenario Planning

5.1 Exploratory Scenario Planning

ODOT will use an exploratory approach for future scenario planning in association with its long-range plan updates. This approach will allow the state to take a holistic and objective perspective in exploring, testing, and planning for different scenarios. ETIA Phases 1 and 2 prepared ODOT for this approach by developing potential policy interventions to address emerging trends and drivers of change, as well as understanding some applicable tools to be used to analyze and measure different scenarios.

5.2 Assumptions and Trends

A key outcome in Phase 2 was identifying underlying assumptions and trends for scenario development, which were informed through stakeholder engagement discussions. The following assumptions and trends were critical in establishing ETIA's scenario development framework:

- The State of Oregon acknowledges the international scientific consensus on climate change and associated implications.
- Resiliency (including seismic readiness and natural disaster preparedness) underlies all ODOT goal areas.
- Statewide sustainability policy initiatives to protect environmental resources and habitats, and to mitigate and reverse the effects of fossil fuel usage will continue to be in effect.
- Transportation revenue will continue to change because of declining fuel tax revenues and other factors.
- Statewide land use planning framework and Transportation Planning Rule will remain consistent to enable balanced land use development in coordination with transportation planning.
- Emerging vehicle and infrastructure technologies create workforce and supply chain impacts across many goal areas, with new workforce needed to plan, maintain, engineer, and construct a changing transportation system.

The listed assumptions and trends were summarized into three broad categories (the drivers of change around emerging technologies) that were used to inform a framework for exploring scenarios that will include an expanded list of assumptions and trends as ODOT begins the OTP and OHP Updates. The three categories helped organize future trends and outcomes developed by ODOT.

Mobility Options, including active transportation options, shared mobility services, and ride-hailing services that operate within the concept of the integration of transportation services into a single trip-planning and payment platform is known as Mobility-as-a-Service (MaaS).

Vehicle Technologies, including connected vehicles (CVs), automated vehicles (AVs), and electric vehicles (EVs).

Freight Logistics, including freight vehicle platooning, efficiencies in distribution networks, and on-demand delivery services.

5.3 Assessment Tools

Following the Assessment Tools Workshop and after receiving feedback from ODOT staff, the project team identified a variety of assessment tools for future scenario development for both the state and regional level. Modeling tools include SWIM, VisionEval, Travel Demand Models, and the Highway Economic Requirements System – State Version.

SWIM is intended to be used in response to large, statewide or regional project and policy questions but not for local issues around land use changes or small road segment realignments. Unlike travel demand models where land use is the major factor, SWIM uses the economy first and then models land use and transportation impact.

VisionEval is a strategic modeling tool designed to evaluate several alternative futures when there are numerous unknowns. It considers how a wide range of emerging modes and trends and policies on land use and transportation may affect future goals, such as sustainability, health, and mobility at state, regional, and local levels.

Travel Demand Models are intended to represent travel decisions that are consistent with actual travel trends and patterns. They can test the impacts of "what if" questions and can be used to predict future travel patterns and demands based on changes in transportation, land use, and demographics.

HERS-ST model identifies roadway deficiencies over a period of time and can provide a report of performance measures like speed, delay, and travel time. It can forecast future conditions and calculate cost-benefit ratios to evaluate a potential improvement to determine the best solution to a problem.

RSPM is a performance-based planning tool that models household travel, fuel and power consumption, and greenhouse gas emissions calculations. It is intended to be used when testing ideas where there are many unknown policy implementation details. The RSPM model can be used at both the statewide and regional level.

Mosaic is a tool that enables the benefits and costs of transportation options and investments to be weighed on a common scale. Mosaic compares groups of transportation investments (bundles) with one another but does not work at a fine enough resolution to evaluate individual projects.

5.4 Scenario Planning Matrix

In coordination with ODOT, Jacobs developed a draft scenarios development framework matrix that organizes the outcomes of ETIA Phase 2 and provides a reference document that ODOT can carry into its strategic planning efforts.

The matrix in **Appendix C** is organized by the drivers of change. Under each driver of change category is a set of trends that were developed through outreach to various state agencies and coordination between ODOT and Jacobs. The trends identified through research in Phase 1 and stakeholder engagement in Phase 2 inform the outcomes and are potential results of these futures, both positive and negative. The matrix also includes applicable goal areas to better understand how trends and outcomes relate to ODOT foundational goal areas.

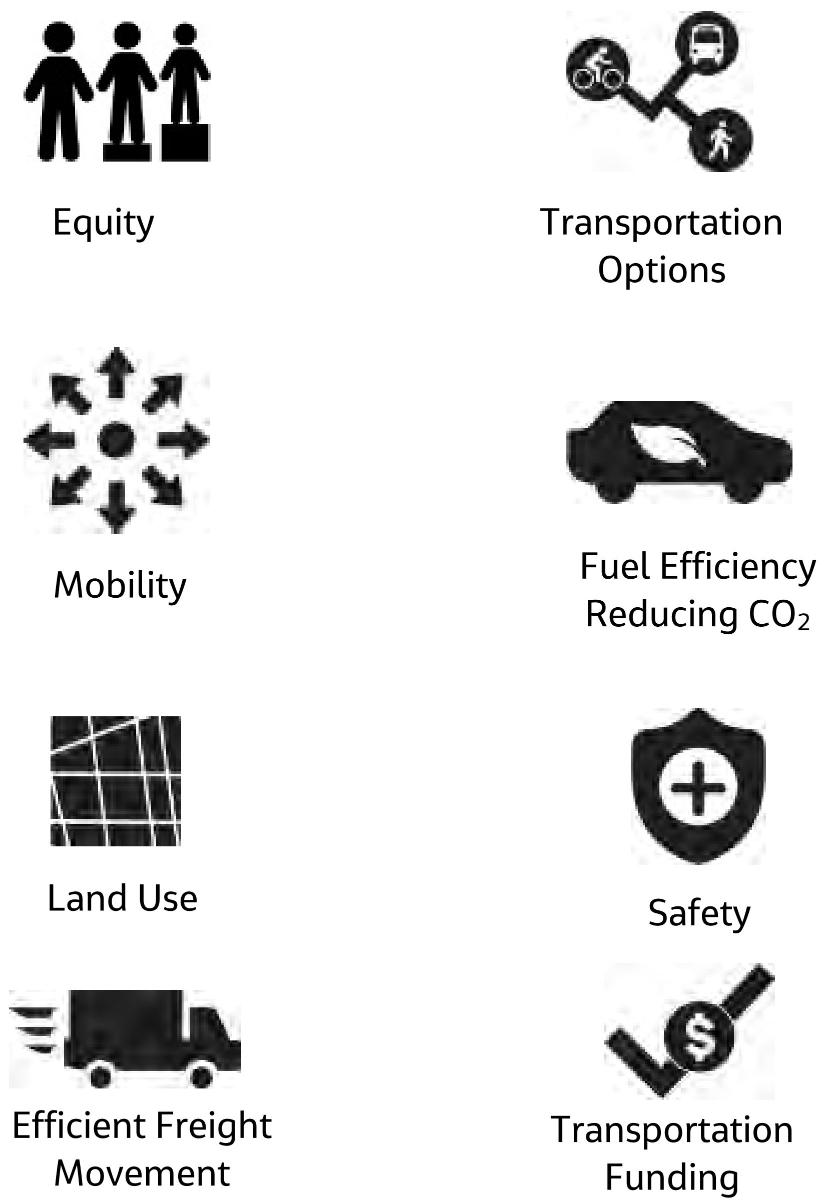

Figure 1. Goal Areas and Their Icons

5.5 Guiding Questions for Next Phase of Planning

The ETIA project management team, consisting of ODOT and Jacobs staff, developed a draft set of focal questions early in the ETIA Phase 2 to initiate the scenario planning process for the OTP and OHP Updates. While ODOT did not incorporate these questions into the ETIA process, the agency could consider their application moving forward in their long-range transportation planning. The focal questions to consider include:

- What are the key drivers of change that we need to understand and that affect how we manage the transportation system?
- What are the transportation-related goals that ODOT wants to influence for the state, and what policy levers does ODOT have or could have to impact those goals?
- How do goals and objectives that are known and foreseeable, such as the Statewide Transportation Strategy, inform the state's perspective and impact decision making?
- What are the measures ODOT can use to determine how well the agency is achieving the set goals?
- What uncertainties can we imagine that might impact our goals outside of our control?
- Of the key drivers of change, uncertainties, and anticipated impacts to Oregon's transportation system, which ones should ODOT prioritize?
- What is most critical for Oregonians and the state to prioritize to account for changes to, and use of, the systems that are associated with the deployment of emerging technologies?
- How can ODOT manage change to effectively mitigate negative impacts and leverage positive opportunities to the transportation system?
- What are reasonable funding levels to assume for the future and do they meet needs for maintaining the statewide transportation system?

6. Next Steps and Recommendations

Moving forward, ODOT can lead or influence implementing opportunities identified in this report to reach shared goals and achieve success in future planning efforts.

The following are recommendations for future planning:

- Use focal questions developed for internal discussion to guide the future planning process within the agency. These questions are included in Section 5.5.
- Market ETIA findings broadly across ODOT's multiple divisions.
- Create outreach and communications materials to inform the public of drivers of change and trends that are an instrumental component of messaging for the OTP and OHP Updates.
- Build on peer exchange for cross-collaboration with other agencies and consortiums (for example, share findings and host a discussion of Emerging Technologies with RUC West).
- Collaborate with MPOs on their efforts in this area (for example, Metro Emerging Technologies project) and present findings at regional events and roundtables because some outcomes are best modeled and influenced at an urban/urbanizing regional scale.
- Use the policy experts on the ETIA project team to inform legislative discussions so that foundational goal areas are being influenced in the right direction (for example, regulating AVs, requiring equitable distribution of new technologies in low-income areas by private companies.)
- Use the information about drivers of change to recruit needed staff expertise and develop training programs.
- Create pilot initiatives that analyze or study possible future scenarios. Use the findings to further inform assumptions on possible future impacts, planning process, and policy.
- Continue to update the Oregon Intelligent Transportation Systems Architecture with content from the most current service packages using the latest USDOT National ITS Reference Architecture. The new architecture addresses future considerations like connected and automated vehicles. ODOT could also expand the current planning horizon for the statewide architecture from 2011–2021 to 2021–2031.
- Conduct a follow-up session with internal ODOT team on assessment tools to make final decisions on scenario modeling.

To effectively prepare for and support emerging technologies in transportation that align with State of Oregon policies, communication, and coordination about priorities, goals, and future planning efforts will be essential. ODOT cannot effectively accomplish this alone and will rely on strong partnerships with other jurisdictions and agencies across the state. Even though realities of how emerging technologies are disrupting existing transportation systems are rapidly changing and largely uncertain, the drivers of change and policy influencers considered through this project provide valuable elements for ODOT and other stakeholders to create a plan for addressing these impacts and advancing shared goals.

7. References

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Appendix A. Peer Exchange Summary

Oregon Futures State Agency Peer Exchange

Peer Exchange Summary

July 16, 2019; 8:00 am – 12:00 pm

Attendees

Peer Exchange Participants	
Name	**Agency**
Linda Beuckens	Department of Motor Vehicle
Cara Biddlecom	Oregon Health Authority
Maureen Bock	ODOT
Jerri Bohard	ODOT
Megan Bolton	Oregon Housing and Community Services
Alan DeLaTorre	Portland State University
Kirstin Greene	Department of Land Conservation and Development
Cole Grisham	ODOT
Kim Herb	Business Oregon
Terra Hernandez	Oregon Department Education
Gail Krumenauer	Oregon Employment Department
Josh Lehner	Oregon Department of Administrative Services
Brian Reeder	Oregon Department of Education
Jessica Reichers	Oregon Department of Energy
Michael Rock	ODOT
Cory-Ann Wind	Oregon Department of Environmental Quality
Heather Peck	Oregon Department of Aviation
Amanda Pietz	ODOT

Project Team	
Name	**Agency**
Scott Richman	Jacobs
Brooke Jordan	Jacobs

Welcome and Meeting Overview

Jerri Bohard, ODOT Transportation Development Division (TDD) Administrator opened the Peer Exchange and welcomed the attendees to the meeting. Jerri provided an overview of the workshop objectives and purpose and facilitated self-introductions.

Overview of Oregon Trends

Josh Lehner, Oregon Office of Economic Analysis Senior Economist, provided an overview of current trends in Oregon based on population growth, migrant patterns, and labor force and industry outlook. Below is a list of key points that Josh made.

- Oregon's strength is its ability to attract and retain working age households. This strength is not just associated with cities in the Willamette Valley, but across the entire state.
- Attracting workers drives the State's long-term population forecast, which impacts and under pins all other economic measures and forecasts – economy, housing affordability, etc.
- Overall, deaths outpace births in the state and overall population would drop absent in-migration from other states. The large proportion of baby boomers in the state's total population contributes to a low growth rate forecast over the next 15 years. Moreover, Oregon has one of the lowest birthrates in the country and it continues to decrease.
- When it comes to Oregon's labor force, Josh highlighted that the Willamette Valley is the only area of the state that will see increases in workers – everywhere else will likely experience decreases.
- Oregon's industrial structure is diverse and has a good mix of industries, but it's still somewhat lower than the national average. Economic diversity helps protect the state from changes and recessions in individual industries. Industries in Oregon that have been strong historically will not continue to be leading industries in the next 10 years. Timber and hardware jobs will continue to decline, while collar jobs will continue to grow.
- Between 2020-2030, Oregon expects over 8% growth in urban areas and up to 8% nearby.

Discussion

- **Question:** Is population growth always good?
    - **Answer:** Managing growth declines is more challenging than managing growth. Shrinking communities, demolishing infrastructure, etc., quickly becomes problematic. Maintaining the status quo is difficult and there is no good model to do that. If Oregon isn't accommodating growth, communities will experience increased displacement.

- **Question:** What states does Oregon attract residents from?
    - **Answer:** About 30-40% of Oregon's in migration comes from California, with consistent out migration from Oregon to Washington. Flow of migration typically flows northward from California to Oregon to Washington.

Oregon Transportation Plan Update

Adam Argo, ODOT Senior Transportation Planner, updated the group about the upcoming major updates to the Oregon Transportation Plan (OTP) and the Oregon Highway Plan (OHP). Along with plan updates, Adam provided an overview of emerging transportation technologies and trends, work to-date on the Emerging Technology Impact Assessment (ETIA) Project, and the next steps for the ETIA Project.

Current Timeline
In preparation for the OTP and OHP updates ODOT will complete the following tasks:

- Emerging Technologies Impact Assessment: July 2018 – October/November 2019
- Stakeholder Interviews: August – November 2019
- Whitepapers/Background Research: Late Summer/Fall 2019

- Scope New Contract: RFP Fall 2019, kickoff by early 2020

ETIA Overview
ETIA is comprised of two phases of work:

- **Phase 1:** Identify key trends in emerging transportation technologies and analyze impacts of trends on Oregon's transportation system
- **Phase 2:** Develop planning scenarios on a broader range of considerations to inform the OTP/OHP updates

Overview of Technologies and Trends

Technologies
Report groups emerging technologies into three categories:

- Vehicle technology (automated, connected, and electric vehicles)
- Mobility options (bike and e-scooter share, ride-hailing services)
- Freight logistics (and local delivery applications)

Trends
Report organizes technological trends into three categories:

- Improvements in computing power
- Communications and networking
- Increase of available data ("big data")

OTC Emerging Technologies Workshop Concerns

An Oregon Transportation Commission (OTC) Workshop was held on October 18, 2018 to share information about emerging transportation technologies and outline potential impacts to Oregon's transportation system. OTC commissioners identified the following issues to inform the ETIA process.

- Understanding funding impacts
- Understanding resettlement patterns
- Aligning ODOT's efforts with other state/local agencies
- Developing new needed skills and experiences within ODOT's workforce to address impacts from emerging trends

Future Work and Next Steps

Next steps for the rest of 2019 and into 2020 will be to complete ETIA Phase 2 and prepare to evaluate scenarios and updates to the OTP and OHP. The following list provides a high-level work plan to conduct this work.

- Oregon Futures Peer Exchange: July 16, 2019
- Oregon Futures Scenario Planning Workshop: July 31, 2019
- Conduct Stakeholder Interviews: August – November 2019
    - Seek advice of transportation experts on topics and areas of focus for OTP and OHP updates
- Kick off OTP process: Early 2020
    - Initiate Public Involvement process

- Form advisory groups
- Evaluation of scenarios and research: Early 2020

Roundtable Discussion

Scott Richman and Brooke Jordan, Jacobs, facilitated a round table discussion with the group. Meeting participants were asked to share the long-term trends that their agency has identified, as well as key anticipated impacts, and their approach to planning (their planning horizons and their agency's structure for planning). The long-term trends were often identified in question format. These topics then led to a discussion among agencies in which they prioritized trends to highlight which issues are most important to their work.

Long-Term Trends

- **ODA:** Drones, pilot shortage, disaster preparedness
- **Business Oregon:** Aging infrastructure, climate change (impacts planning for the future – water and sewer), and financing
- **OED:** How do automated vehicles(AVs) effect jobs/workforce? Some occupations may come from Emerging Technology. How will that affect existing workers?
- **DLCD:** Where do people desire to live?
    - How does income affect location choices?
    - How does this impact housing access and affordability?
    - What geographic disparities exist in broadband access? E.g., limited access in most rural areas of OR.
    - Employment: Declining population in many counties means lower tax revenue and associated impacts on public investment capability
- **ODE:** 2/3 of Oregon schools are losing enrollment
    - Impacts school location decisions
- **DEQ:** Growth, congestion, and climate change is outpacing DEQ planning
    - Concerned with more than just greenhouse gas--also particulate matter
    - Portland has met air quality standards, but trends have flattened or are starting to increase due to wildfire
- **OHA:** Climate change, diversification of population, and lack of federal support on key issues
- **PSU:** Age 85+ population share is growing and with it comes an increase in adults with disabilities.
    - Mobility is core issue for aging adults and access to transit and door-to-door service is limited, even with some aging adults continuing to drive
    - Focused on how to maintain and build community connection within elderly communities
- **OHCS:** Loss of naturally occurring affordable housing (not subsidized necessarily, but perhaps small and cost-effective housing)
    - Increase in homelessness
    - Service provision for housing stability
    - Coordination with other agencies to meet service needs
- **ODE:** Getting kids to school and appointments

- Mitigating push-out (instead of "drop-out") factors
    - Schools need social services on-site; off-site services lead to attendance conflicts
    - Highest rate of truancy is among homeless students
    - Lack of childcare after school and related transportation limits attendance in extracurricular activities too
    - 'Most kids say they can finish high-school in 2-years… why then make them stay for 4 years?'

Impacts

- **DLCD:** Helping jurisdictions decide where to invest based on climate change
- **OHA:** Stresses resources
  - Greater frequency of emergencies and water crises
  - Can lead to positive changes with how OHA conducts work, including
    - Engagement
    - Outreach
    - Program management and access
- **OHCS:** More funding for housing due to increased visibility of housing challenges
  - Helps with housing siting
  - Working with DLCD on local housing strategies
  - High rate of child homelessness; leads to coordination with DHS
- **ODE:**
  - Focus on childcare provision
  - Transportation for elderly and young - those not participating in the workforce tend to be those caring for family members including young children and aging adults
  - Consider workforce training options for new occupations
- **PSU:** Eligibility for paratransit
  - More people are eligible, but costs are increasing
  - Recognition that elderly can still work and contribute to society
  - Vision Zero continues to be important especially for aging adults
- **DEQ:** Tend to do well as an agency at regulating air quality, but struggles with transportation emissions in particular
- **ODE:** The longer people spend working/commuting, the less time they spend with their kids, which leads to decreased education success
  - Some experiments gave money to parents to allow them to be home
  - Outcomes include increased school attendance and academic achievement
- **ODE:** "Wrap-around services" for communities contribute to educational success
- **ODE:** Greater focus on mental illness and trauma
  - Education is starting to recognize disadvantages in more population groups and how to provide targeted services to those communities. For example, there is a higher risk of suicide in black and LGTBQ communities. How does ODE provide services here?
- **Business Oregon:** Increased costs to businesses from climate change

- o Impacts overall competitiveness. 'How does Business Oregon support emerging companies in light of climate change?'
  - o Concerned with businesses ability to pay/retain workers due to climate change impacts
- **ODOE:** Concerned with transportation energy burden on households
  - o Cost of transportation energy is 20% in urban areas, and close to 50% in rural areas. See: 10-Year Plan: Reducing Energy Burden report.
  - o Primary reliance on SOVs in rural areas - 'ride sharing started in rural areas'
  - o Climate change impacts: energy burden increasing in summer, because typically, Oregon is a winter peak energy state, but that is shifting to a double peak due to air conditioning use in summer

Approach to Planning (Horizon and Structure)

- o **ODE:** ODE primarily supports local school districts. It was formerly a compliance agency, but now more of an assistance agency. Long range planning is not a current focus, as they are more focused on current research and improving support. ODE looks at population and enrollment forecasts and how that may inform investments (which is more of a local decision, with agency assistance). ODE's planning horizon is not a year in the future necessarily, but is more by class cohorts. Long range planning is more the domain of local school districts. Resources and investment decisions are made over the course of a student's 13-year school horizon.
  - ▪ '$2 Billion Student Success funding passed, which will lead to new priorities and efforts.'
- o **OHA:** 5-year State Health Assessments followed by State Health Improvement Plan. 5 framework priorities identified:[1]
  1. Social Determinants of Heath
  2. Environmental Health
  3. Prevention and Health Promotion
  4. Access to Clinical Preventive Services
  5. Communicable Disease Control
- o **ODOE:** ODOE does not have long range plans as an agency. The planning and Innovation division does, but it is called a framework rather than a plan. ODOE does look out to the far future (50-100 years) but actually only uses a 5-year strategic plan, but has recently procured contractor for long range strategic planning.
- o **OHCS:** OHCS just completed a 5-year plan that resulted in lots of data and outreach efforts. This was the first time for this type of plan.
  - ▪ Also recommends all state agency staff look at "Government Alliance for Racial Equity" (GARE) training for government professionals.
- o **ODA:** ODA is in the middle of their strategic planning process. This process also includes the Aviation modal plan (7-10 year updates, plus ~5-year studies). Oregon has 97 public airports, 28 of which are

[1] The list item were heard in the Peer Exchange by the note taker but not written. The five priorities listed were added when editing the notes a few days later based on the SHIP document mentioned, and may not be what was exactly said in the meeting.

owned/operated by Aviation, with only 15 FTE employees. Current strategic planning responds to ODA's Board priorities in coordination with partner state and local agencies. No horizon for modal plan—updated continuously/periodically.

- **Business Oregon:** 5-Year Strategic Plan. Their 5-year strategic plan is used to develop implementation and work plans, which they are beginning to use to inform investment decisions.
- **OED:** OED is in the middle of a strategic planning process.[2] There is no known planning horizon, but the current process is looking at 5-6 years out. OED's work is counter-cyclical—a good economy equals less department work and staff while a bad economy equals more work and staff. Tracking key indicators and how they change to position the agency for a changing economy is an important aspect of their planning process. OED was assigned paid FMLA in last legislative session, which is new for the agency, as FMLA work allows Employment to go from a federally funded to partially federal, partially state funded agency.
- **DAS:** DAS operates on a 10-year forecast updated quarterly and annually[3]
  - Mission: Articulate risk associated with forecasts and changes
  - Tries to keep 8-10 year numbers stable, since near-term fluctuation does not often lead to dramatic long-term change
- **PSU:** Planning approach for PSU is different because it is not a state agency, but a plan on aging will be developed in response to Governor's age friendly initiative.
- **DEQ:** DEQ is in the middle of their planning process. The average planning horizon is 10 years - 10-year plans for DEQ, plus coordination with Metropolitan Planning Organization (MPO) Regional Transportation Plans (RTPs). Three-year blocks of data are used for MPO coordination.
- **DLCD:** DLCD typically operates on a 20-year horizon, but this is changing over time due to climate and other challenges (see Tsunami Preparedness Guide).

- **Question**
  - **Michael Rock: Anything these agencies should think about from DAS Economic Analysis?**
    - Two horizons appear: Short-term business cycle and Long-term drivers
    - Learn to separate short-term, fluctuating business planning from more stable long-term trends.
    - Consider trends you can and cannot change. For example, demographics cannot be changed, since they occur generationally.

Priority Trends

- **PSU:** Aging in community (accessible homes, weatherization, and services) instead of just aging in place (past focus)
- **OHA:** Climate change and equity leading to new opportunities
- **DLCD**: Housing, climate change, resiliency, and rural development

[2] Employment Department's most recent completed Strategic Plan can be found here: https://www.oregon.gov/EMPLOY/Agency/Documents/OED_Strategic_Plan_2014-2019.pdf

[3] Most recent DAS Economic Analysis Report can be found here: https://www.oregon.gov/das/OEA/Documents/forecast0519.pdf

- **DEQ:** GHG reduction (either directly or co-benefit)
- **ODE:** Income and wealth inequality and impacts on student success. Non-attendance gap analysis (currently in south coast, due to highest absenteeism concentration), including Memorandum of Understanding with OHA and prospective MOU with ODOT.
- **OED:** Labor force engagement (All who want to join the workforce can). Everyone who wants to be employed is adequately prepared (education and training).
    - Ensuring we have infrastructure and managing/encouraging innovation and new companies
    - Focus on job creation in rural areas and engaging under represented communities
    - Support business to be competitive in face of climate change
- **Business Oregon:** Supporting infrastructure and managing innovation pipeline (mostly small and mid-sized business). Special focus on small and rural communities and wealth generation. Climate change impacts on business competitiveness (cap and trade, emissions cap).
    - Opportunity for Oregon businesses to be at the fore of climate change
    - How to ensure that communities across Oregon are not disproportionately affected by changing energy sector in relation to climate change
    - What will energy source changes mean for rural Oregon and those struggling to meet energy needs? Equitable access to new energy infrastructure (i.e. – electric vehicles)
    - South coast area and lack of access to jobs and schools – conducting a gap analysis and developing advocates to connect people to resources.
- **OHCS:** Oregon's Statewide Housing Plan (5-Year), released February 2019.
    - Priorities:
        - Equity and racial justice
        - Homelessness
        - Permanent Supportive Housing
        - Homeownership
        - Affordable Rental Housing
        - Rural Communities
    - DLCD: 'Look at Housing's data work on population'
- **ODOE:** Offsetting impacts of shifting energy consumption on rural and low-income communities
    - Possibly shifting from internal state energy market to broad, western states market
    - Preparing for changing personal (such as home charging stations) and systemic infrastructure for new energy
- **DAS:** Always focused on skills, employment, and other indicators leading to money in the pocket of Oregonians
- **ODA:** Emerging technology, rural economic stability, disaster preparedness for all airports

Synthesis and Cross-Agency Connections

Scott Richman and Brooke Jordan, Jacobs, synthesized the key themes that were identified by the group. The opportunities for collaboration were identified through a discussion of areas of overlap and opportunities for agency collaboration and coordination. Eleven common themes emerged from the discussion:

1. Equity
2. Climate Change
3. Planning horizons (diverging perspectives). All are doing it, but few do longer than 5-year business cycle planning.
4. Workforce preparedness
5. Resiliency
6. Urban-rural disparities
7. Housing costs and supply
8. Demographic and cohort changes
9. Nexus of housing access and education success
10. Homelessness
11. Health impacts

Opportunities for Collaboration

- Many state agencies are participating in similar meetings with common themes: equity, climate change, and resiliency and a driving force of wanting the State to thrive are priorities that cross-cut across all state agencies
- Participants at this peer exchange meeting expressed interest in continuing to meeting or otherwise coordinating share information, either monthly or quarterly, but would need to secure executive level support for committing staff time for coordination purposes
    - Use an email or list serve to check in with/others informally
- Sharing data and outcomes from public engagement is very important to improve storytelling broadly. Developing a standardized process for cross agency work and data sharing is important, either through a common MOU or other process
- **ODE**: There are often numerous coordination meetings that occur, but how do we increase information sharing with boots-on-the ground staff? It is interesting to see the common goals and language across agencies.
- **ODOE:** Working with OHA on climate issues and sharing information with DEQ are opportunities for collaboration that ODOE identified.
- **DAS:** A regular communication channel between agencies would be nice. DAS Economic Analysis uses a list-serve with other states to discuss topics, and a similar list-serve may be useful for this group.
- **Business Oregon:** Lots of strategic work happening, and Business Oregon would love to see overlap and divergence. Working on Innovation Plan and would like to see more collaboration.
- **OHA:** Lots of venues to address identified topics, except equity. OHA would like to see data sharing and leveraging research between agencies, while also comparing strategic planning work for mutual benefit and service alignment.

- **ODOE:** ODOE highlighted that data used between agencies often differs, and there is a need to explain to the public why they differ, when that's the right answer, and when to leverage each other's work when appropriate.
- **ODE:** This Peer Exchange is missing Agriculture's perspective – Agriculture provides key partnership and data for Education
- **DEQ**: Agriculture has important fuel and emission information that DEQ needs
- **OHCS:** Interested in greater coordination with ODOT and DLCD on housing siting and tax incentives
- **Question from group:**
    - We want to use one another's data, and work on process together, but how do we defer to one another's interpretation and conclusions?

Appendix B. Oregon Futures Scenario Workshop Summary

Oregon Futures Scenario Workshop

Summary

July 31, 2019; 8:30 am – 12:30 pm

Oregon Department of Transportation (ODOT) Workshop Participants

ODOT Workshop Participants		
Name	Agency	Position
Tara Weidner	Transportation Planning & Analysis Unit	Professional Engineer
Hal Gard	Rail & Public Transit Division	Administrator
Becky Knudson	Transportation Planning & Analysis Unit	Principal Economist
Brian Hurley	Transportation Planning Unit	Senior Transportation Planner
Brian Dunn	Transportation Planning & Analysis Unit	Manager
Teresa Penninger	ODOT Region 5	Planning Manager
Denise Whitney Dahlke	Transportation Development Division	Strategic Data Program Manager
Gary Farnsworth	ODOT Region 4	Manager
Nikki Nowack	Asset Management	Program Manager
Michael Bufalino	Research Section	Manager
Joel McCarroll	ODOT Region 4	Traffic Manager
Galen McGill	System Operations & Intelligent Transportation Systems	Manager
Troy Costales	Transportation Safety Division	Administrator
Darlene Weaver	Environmental Engineering & Policy Unit	Environmental Policy and Program Advisor
Rod Thompson	Environmental Engineering & Policy Unit	Manager
Jerri Bohard	Transportation Development Division	Administrator
Amanda Pietz	Program Implementation & Analysis Unit	Manager
Sonny Chickering	ODOT Region 2	Manager
Glen Bolen	ODOT Region 1	Principal
Tom McClennan	Division of Motor Vehicles	Administrator

Project Team Attendees		
Name	Agency	Position
Cole Grisham	ODOT	Transportation Development Division
Michael Rock	ODOT	Transportation Development Division
Adam Argo	ODOT	Transportation Development Division
Scott Richman	Jacobs	Consultant
Tara O'Brien	Jacobs	Consultant
Brian Burkhard	Jacobs	Consultant
Brooke Jordan	Jacobs	Consultant

Welcome and Meeting Overview

Michael Rock and Scott Richman opened the Scenario Planning workshop and welcomed the attendees to the meeting. Michael provided an overview of the workshop objectives and purpose and facilitated self-introductions.

ETIA Project Background; Scenario Workshop purpose and objectives

Adam Argo reviewed the project purpose and objectives and discussed the goals of the workshop. Below is a list of key points that Adam made.

Adam reviewed work to-date on the Emerging Technology Impact Assessment (ETIA) Project.

ETIA is comprised of two phases of work:

- **Phase 1:** Identify key trends in emerging transportation technologies and analyze impacts of trends on Oregon's transportation system
- **Phase 2:** Develop planning scenarios on a broader range of considerations to inform the Oregon Transportation Plan (OTP) and Oregon Highway Plan (OHP) updates
    - Focusing on how to frame uncertainties within ODOT goal areas
    - Look to a vision for the transportation system in 2050
    - Share outcomes for Phase 1

ETIA Themes from OTC Workshop

In an OTC Emerging Technologies ½ day workshop last fall – some common themes and top concerns emerged to help frame the project:

- What does sustainable funding of the system look like moving forward?
- Understanding resettlement patterns: where people will want to go/goods and services delivery based on changing technologies
- Aligning ODOT's work with other state and local agencies
- Developing the skills and experience within ODOT to address emerging technologies impacts.

ETIA Project Schedule, Future Work and Next Steps

Next steps for the rest of 2019 and into 2020 will be to complete ETIA Phase 2 and prepare to evaluate scenarios and updates to the OTP and OHP. The following list provides a high-level work plan to conduct this work.

- Oregon Futures Peer Exchange: July 16, 2019
- Oregon Futures Scenario Planning Workshop: July 31, 2019
- Assessment Tools Workshop – September 2019
- White Papers and additional background research
- Conduct Stakeholder Interviews: August – November 2019
    - Seek advice of transportation experts on topics and areas of focus for OTP and OHP updates
- Kick off OTP process: Early 2020
    - Initiate Public Involvement process

- Form advisory groups
- Evaluation of scenarios and research: Early 2020

Scenario Workshop purpose and objectives

Adam Argo reviewed the objectives of the workshop:

- To share the ETIA Phase 1 outcomes and develop a shared understanding of the approach
- To review emerging disruptors and drivers of change that could impact Oregon in the future
- To brainstorm potential outcomes and impacts to Oregon related to these emerging trends – which will build the framework for the scenarios analysis

Emerging Disruptors and Drivers of Change

Cole Grisham and Brian Burkhard provided an overview of technologies, trends and emerging disruptors.

Overview of Technologies and Trends

- Emerging disruptors and drivers of change (Cole Grisham)
  - Demographics: Birth rates fuel projections
  - Potential labor force change – new people and new types of jobs: growth in the Willamette Valley, Portland Metro and Central Oregon over the next 10 years but declines in eastern Oregon
  - Environmental disruptors:
    - Various plans and studies within ODOT help identify how projected environmental changes will impact our systems.
- Emerging technologies (Brian Burkhard).
  - Miniaturization of technologies
  - Wireless communications – talking to your electronic devices, 5G wireless capabilities
    - Even with fiber optic capabilities, still have to go through data farms
  - Massive amounts of data impacting our systems
  - Relationship with technology is changing and being adopted more quickly in all generations – influencing behaviors and ability to access more travel modes more easily
  - Mobility services changing quickly
    - TNCs (Transportation Network Companies) are seen as a stepping stone toward Autonomous Vehicles (AVs). The share of Americans who have used TNCs has more than doubled since 2015.
    - 37% increase in TNCs in Oregon – now surpassing bus usage
    - Microtransit and AV transit growing in communities around the country (including a 3D printed vehicle)
    - Car share companies are continuing to grow in usage – some jurisdictions have mandated their usage data to be shared
    - Bike and scooter share: also growing quickly. Usage data is usually shared with municipalities or in partnership, making it easier to track trips than with TNCs.

- GTFS (General Transit Feed Specification) and MaaS (Mobility as a Service) to promote multimodal trip planning. Still in development phase but many agencies and companies interested in how this tool will transform commuting.
  - Example: new ODOT ride matching tool: Get there - to make connections integrating transit, carpooling, biking, walking options.
- Connected vehicles:
  - Vehicle to vehicle and vehicle to phone communication with a focus on improved safe driving behavior and protecting vulnerable road users
  - New generations of phones have peer to peer communications, being used for vehicle to vehicle communications
  - Pilots in Wyoming, Florida, New York
- AV
  - Conditional Automation (Level 3 AV) is in most new vehicles already
  - Progression from High Automation (level 4) to Full Automation (level 5) is most anticipated type of AV technology development
  - CVs and AVs deployed together and all being designed as electric vehicles – so this deployment is highly dependent on a successful expansion of EV infrastructure
- Freight:
  - App-based demand and responsive delivery is changing the freight delivery paradigm quickly.
  - Connected and electric vehicles, platooning trucks – technologies being developed quickly and Daimler is a major player here in Oregon.
- Data lakes: new data science that is emerging to more quickly analyze large segments of data.
- Takeaway: Adoption timelines faster for these emerging technologies than any other technological change in modern history

Framing Potential Outcomes

Scott Richman and Brooke Jordan, Jacobs, set the stage for a round table brainstorm the group.

- A pre-workshop survey was distributed prior to the workshop to evaluate which ODOT goal areas attendees anticipated would be most impacted by emerging technologies.
  - Top 3 goal areas from survey: safety, mobility, reducing CO_2 emissions
      - Surprising to the group that there was less focus on resiliency
      - Shared economy – could see future growth in shared vehicle based on who is investing in CAVs – less likely to see private ownership of AVs as at high of a rate as existing vehicle ownership.
  - Brainstorm on ODOT's foundational goal areas in small groups, identifying possible positive and negative impacts to the transportation system as a result of the emerging technologies discussed today.

  - Safety
  - Efficient freight movement
  - Equity
  - Mobility
  - Transportation options
  - Fuel efficiency and reducing CO_2 emissions
  - Transportation funding sufficiency
  - Land use management
- In each of these goal areas, participants will consider:
  - Impacts of emerging technology on active transportation modes
  - Uncertainty regarding the integration of new technologies
  - Shifting roles of agencies and private industry
  - Concerns around housing affordability and access
  - Climate change impacts to transportation infrastructure
  - Changing demographics and workforce needs
  - Economic impacts to housing costs, jobs
  - Overall operations of the transportation system in the face of change

Review of Brainstorming Exercise on outcomes for ODOT goal areas

Scott Richman and Brooke Jordan, Jacobs, synthesized the key themes that were identified by the group.

- Discussion of how workshop participants anticipated that emerging technologies are likely to affect the transportation system organized according to the 8 foundational goals

Notes on positive and negative outcomes that could occur for each goal area:

- Safety
  - Positive –
    - In the long term, there should be improvements in safety for vulnerable road users with improved technology when potential for human error is removed.
    - Mix of speeds in new micro-mobility options (scooters, slower bikes, faster e-bikes) can be a safety concern in urban environments
    - More people biking and walking brings safety and numbers
    - More cameras and sensors could increase safety (but decrease privacy and cause data protection issues)

        - Removes bad drivers (or distracted or impaired drivers) from the road
    - Negative
        - Poor pavement conditions – creates safety issues for all modes: e-scooter and bikes and vehicles must shift from their "lanes" to avoid poor road conditions
        - Ability of AVs to recognize pedestrians is a challenge in the short term.
        - Concerns about privacy/security of data, hacking risk, tracking of transportation movements by companies and the government
        - Drivers and passengers absolve themselves of responsibility of vulnerable road users
        - Safety features of AVs are slower to get rolled out – so it won't necessarily improve as quickly as we'd think.
        - Complexity: there are many factors that impact potential safety of the improved technologies of vehicles – weather, unanticipated crossings etc.
- Efficient freight movement – possibly change title of this goal area to "movement of goods and services"
    - Positive
        - Opportunity for ODOT to lead in driving the standards for freight mobility (and other categories) needs for the state
        - With more efficient freight mobility, cost of consumer goods could not rise as quickly.
        - Drone delivery of small items could reduce congestion in urban areas
    - Neutral
        - Change in long haul vs. rail vs. short haul vs. drones for efficient freight mobility.
        - 3D printing could reduce need for delivery of items across long distances = less congestion, more local delivery focus
    - Negative
        - Electrification of trucking will drive a need for changing the locations and nature of truck charging depots.
        - Public policy is slow to adapt to regulate changing freight mobility trends such as platooning and connected and autonomous trucks
        - Oregon could be bypassed by major freight providers
- Equity
    - Positive:

        - Improved accessibility of multiple transportation modes as well as with trip planning could help give people who are car or transit dependent more options
        - New fees can help invest in low income communities: we can price by Census Tract if needed.
    - Neutral:
        - Lack of supply of operators (transit drivers, truckers) already, though it is one of the most common job in most states
        - Insurance coverage will have to change for shared vehicle economy
    - Negative:
        - Ensuring needs of all users met in light of increased TNC and private companies
        - Affordability and accessibility: with private sector driving the trends of adoption of new technologies, less of a focus on providing improved transportation options for those who can't afford it. Need to prevent excluding of low-income populations from benefitting from new technologies.
        - Automation replaces jobs and could widen the wealth gap
        - AI – there is a known bias of these technologies not recognizing people of color
- Mobility
    - Positive:
        - Rural areas don't have a transit network now but increased use of shared vehicles and micro-mobility could make it more viable in areas where developing a transit system was not feasible in the past.
        - Increased capacity on roadways with increased shared vehicles
        - Possible streamlining for signage/striping/signals standards nationally for AV integration
        - Increased mobility for seniors or those who can't drive
        - Improved efficiency of commute and ability to work in AVs
    - Neutral:
        - Changing role for ODOT: need to consider how to manage congestion of low-level air space
        - Capacity on roadways could be higher or lower
        - Opportunity for re-evaluation of peak hour congestion to shift demand to other times of day for choice trips
    - Negative

- Possible increased congestion due to platooning or increased size of fleet of AVs (and potential for more zero occupancy vehicles)
- Need for improving multimodal system around state – speed differential for a mix of more modes of travel using the same roadways.
- Longer high congestion times if people can work in vehicles

- Transportation options
  - Positive
    - Opportunities for improved connectivity and accessibility
    - More AV buses could provide service to more people
  - Negative
    - A challenge to maintain transit ridership with increased TNC and AV availability
    - Increased VMT with increased prevalence of shared vehicles and TNCs
    - Inter community transit remains a rural challenge
- Fuel efficiency and reducing CO_2 emissions
  - Positive
    - Shift to electric vehicles will improve GHG impacts, but will impact where our energy comes from to power electric, which needs to be better coordinated.
    - Powering electric grid and charging infrastructure is a separate challenge
- Transportation funding sufficiency
  - Positive:
    - Rethinking public ROW: leverage for funding opportunities
    - Opportunities to capture revenue from trip fees to manage congestion, support low-income users
    - OreGo sets us up to capture new revenue as we move to electrification of the fleet
  - Neutral
    - Do funding programs line up with future needs? New funding mechanisms needed for smart vehicle infrastructure
  - Negative:
    - Possible reduced revenue from vehicle registration and title fees with more shared vehicles
    - Staff reductions with changing nature of transportation needs

- Land use management
  - Positive:
    - Much less demand for parking
    - ODOT owns lots of real estate that could be used for charging facilities or vehicle storage
  - Neutral:
    - Need to maintain our strong land use framework in Oregon to preserve UGBs.
  - Negative:
    - People with higher incomes have more options of where to move with being able to use commutes more productively.
    - AVs could lead people to move farther out – will need to accommodate different commute schedules since people will be able to work during their commute, if they need to commute at all.
- Other impacts discussed
  - Health impacts with longer vehicle commutes – if people are living further away and commuting longer in AVs, how does that impact health?
  - Opportunity for changing ODOT's own fleet for more CAVs – cost savings and safety benefits
  - Resiliency should be an overarching framework for all these changes: Preparing for resiliency in light of earthquake and other natural disasters
  - Increasing role of private sector in providing transportation services is a risk and liability – concerns over big data implications
  - Need for ODOT to become more agile to respond to these technology trends – and both lead AND fill the gaps the private sector will not.
  - Need for ODOT to adapt in hiring, training and position descriptions to better reflect changes in urban and rural transportation needs
  - Need for ODOT to become more intersectional between health, equity and transportation goals
  - Need for ODOT maintenance and construction to adapt to changes in road maintenance needs with changes in vehicle technology (EVs, AVs, different sized vehicles) and changes in construction equipment
  - Changing role of government in regulating these changes: ensure that ODOT is prepared for this transition.
  - Environmental Stewardship
    - Strong expectation for ODOT to protect environment – need to be proactive as an agency in preparing for these technological changes and how they could impact environmental resources

- Wildlife passage
- Stormwater mitigation
- Improve resiliency of assets to prepare for climate change, earthquake, wildfire risk
- Roadside development: improve planting for noise concerns, visual aesthetics and pollinator habitat protection

Next steps

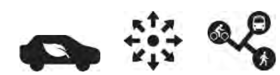
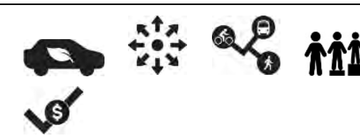
Adam Argo reported back to the group on next steps before closing the workshop.

- Assessment Tools workshop in September to determine quantitative and qualitative tools for assessing scenarios
- Scenario framework memo this fall to discuss scenario concepts and approach to evaluating them
- Report to OTC on scenarios and next steps for the OTP and OHP Updates.

Appendix C. Tools Assessment Workshop Summary

The Scenario Planning Matrix was developed to present potential policy interventions (not recommendations) for future scenario planning efforts, tying to the Phase 1 Final Report. The table was developed using key trends within ETIA's organizational structure and through engagement outside of the ETIA structure. Discussions from the Peer Exchange and Scenario Planning Workshop identified trends, themes, and outcomes that will need to be addressed in the OTP and OHP Updates.

Mobility Options

Trend	**Outcome** (ODOT's ability to influence outcome – high, moderate, low)	Goals
Transition towards purchasing trips (from transportation network companies [TNCs] and other modes) over purchasing personal vehicles	**Increased use of shared-use vehicles and multimodal trips over personal single-occupancy vehicle (SOV) trips should reduce emissions and congestion.** Moderate – Oregon Department of Transportation (ODOT) could prioritize high-occupancy vehicles (HOVs) on ODOT facilities to mitigate congestion and increased vehicle miles traveled (VMT) per capita.	
	Replace short motorized vehicle trips with shared bike and scooters (approximately 3 miles or less) High – ODOT could regulate TNCs, bikeshare, or scooter-share service or fees.	
	Could negatively affect future transportation funding with fewer vehicle registrations Moderate – ODOT could levy fees or taxes on personal vehicles, parking, or other areas.	
	Could lead to increased VMT and congestion with increased growth of TNCs instead of transit Low – Optimize service (frequency and reliability) and improve/promote inter-agency transfers, which could include a single-fare payment system.	

Positive Outcome | Negative Outcome | Unclear Outcome

Mobility Options

Trend	**Outcome** (ODOT's ability to influence outcome – high, moderate, low)	Goals
Increasing number of mobility choices (bikeshare, scooters, micro-mobility, shared vehicles) become available to more segments of population	**Modal shift – could lead to reduced VMT, reduced need for parking, change in curb management or use, reduced car ownership, increased transit ridership and opportunities for smaller scale freight distribution** High – ODOT could work with communities to support the development of mobility hubs.	
	Replacing SOV trips will affect congestion and transit ridership Moderate – ODOT could consider policies that provide adequate transit in urban and rural areas.	
	Increased number of mobility options could lead to increased conflict on roadways with increased demand for roadway and curb space High – ODOT could prioritize HOVs on ODOT facilities to mitigate congestion and increased VMT per capita related to increased mobility options.	
Electrification of micro-mobility options	**The electrification of public and privately available bike, scooter, and other micro-mobility options expands the availability of these transportation choices to more people and (likely) creates more environmentally friendly options to SOV trips** Moderate – ODOT could support active transportation options such as bikeshare and scooter-share.	
	Increased pressure on electric grid may cause load challenges Low – ODOT could work with energy providers (PG&E and Pacific Power, for example) to plan for future power needs.	

Positive Outcome   Negative Outcome   Unclear Outcome

Mobility Options

Trend	Outcome (ODOT's ability to influence outcome – high, moderate, low)	Goals
Increasing availability of mobility data.	**More articulated information on the use of transportation systems can be used for more informed decision making, targeting marketing towards mobility needs and service planning** High – ODOT will continue to be an authoritative source of data about closures, chain and tire requirements, and construction activities. ODOT also has an important role in ensuring that transportation disadvantaged and underserved have access to options, programs, and information. ODOT's ability to influence could grow larger if future legislative action requires ODOT to regulate mobility data as well.	
	Challenges to ODOT's trip planning guidance Moderate – ODOT could use data about travel patterns and behavior to better understand the travel needs of underserved groups and inform investment decisions.	
	Increased need for cyber-security brings vulnerability of system to hacking Moderate – ODOT has a role in developing operational plans, policies, and guidelines for the deployment of vehicle-to-infrastructure (V2I) technology that could protect ODOT facilities from potential cybersecurity attacks.	

Positive Outcome   Negative Outcome   Unclear Outcome

Vehicle Technologies

Trend	**Outcome** (ODOT's ability to influence outcome – high, moderate, low)	Goals
Vehicle fleet electrification	**The prevailing usage of EVs could eliminate congestion as a factor in emissions** High – ODOT is a leader in operating a road-usage charge (RUC) system based on miles driven, and the implementation of an expanded statewide, mandatory RUC could supplement or replace decreasing revenues from the gas tax.	
	Revenue impacts of fewer vehicles paying into fuels tax without transition to RUC. Lower household costs could increase VMT per capita Moderate – ODOT could use data about travel patterns and behavior to plan.	
	Demand for charging infrastructure may exceed capacity to deliver it High – ODOT can develop infrastructure along ODOT facilities.	
Expansion of electric vehicle charging infrastructure statewide (enabler of change)	**Improvements in air quality, opportunities for co-location of charging infrastructure with other services** High - ODOT could convene stakeholders (multistate) to determine fueling infrastructure needs, identify gaps in coverage, and develop investment plans.	
	Transition to, and deployment of, electric vehicles will require significant investment in new public and private charging infrastructure statewide High – ODOT's continued participation in the Zero Emission Vehicle Interagency Working Group could support planning for charging infrastructure and electric vehicle (EV) adoption in Oregon.	

Positive Outcome | Negative Outcome | Unclear Outcome

Vehicle Technologies

Trend	Outcome (ODOT's ability to influence outcome – high, moderate, low)	Goals
Prevalence of vehicle-to-vehicle (V2V) and vehicle-to-everything (V2X) technology in more vehicles	**More connected vehicles and communication will lead to improved safety, environment, and mobility** High – Development of ODOT operational strategies to deploy V2X infrastructure could increase access to real-time traveler information and support the integration of transportation information, mobility hubs, and Mobility-as-a-Service (MaaS).	
	As the transportation system becomes increasingly connected, its exposure to cybersecurity threats increases, which could pose serious risks to safety and privacy Moderate – ODOT has a role in developing operational plans, policies, and guidelines for the deployment of V2I technology that could protect ODOT facilities from potential cybersecurity attacks.	
Prevalence and availability of autonomous vehicle technology	**Safety improvements in vehicles will reduce user error from primary cause of crashes** High – ODOT could evaluate the Highway Design Manual and consider updates to roadway design standards that improve operations of automated vehicles (AVs), as well as ensure emerging tech investments benefit transportation-disadvantaged groups.	
	Increase VMT or congestion if more zero-occupancy vehicles appear on roadways if unregulated High – ODOT could prioritize HOVs on ODOT facilities, which could mitigate congestion and increased VMT related to the deployment of AVs.	

Positive Outcome | Negative Outcome | Unclear Outcome

Vehicle Technologies

Trend	**Outcome** (ODOT's ability to influence outcome – high, moderate, low)	Goals
	Longer willingness to commute could affect land use patterns Moderate – ODOT could update guidance to support consideration of AVs, CVs, and emerging active transportation modes on trip generation in development review process.	
	Increased reliance on technology for crash prevention could lead to more distracted driving Moderate – ODOT could develop operational policies that encourage the deployment of AV applications to improve safety.	
Growth and prevalence of 5G technology statewide (enabler of change)	**Expanded network brings benefits of V2I technology to more places** Moderate – ODOT could support efforts of V2I to enable positive acceptance of this new communication type.	
	Challenges around widespread adoption Low – ODOT could consider policies that reduce barriers to public-private partnerships and leverage to inform investment and operational decision making.	

Positive Outcome | Negative Outcome | Unclear Outcome

Freight Technologies

Trend	**Outcome** (ODOT's ability to influence outcome – high, moderate, low)	Goals
Increased expectation of on-demand delivery of goods and services	**Increased economic activity with availability of on-demand delivery**	
	Possibilities for increased and decreased efficiencies with changing retail patterns Low – Local delivery hubs, rather than door-to-door service.	
	Increased VMT per capita and congestion Moderate – ODOT could coordinate with jurisdictions on time-of-day and type-of-vehicle regulations to reduce impacts to peak-hour congestion.	
Increased use of V2V, V2I, and AV technologies in long-haul trucking	**Likely to improve delivery efficiency, reduce VMT per capita, and improve air quality** Moderate – Development of ODOT operational strategies to deploy V2X infrastructure.	
	Likely economic impacts to truck stop infrastructure based on changing schedules and ability to platoon vehicles without required rest stops Moderate – ODOT could develop pilot projects involving automated or connected freight projects on select facilities and digitize freight route planning to support real-time freight route planning.	
	Likely fewer truck operating job opportunities in an industry of need Moderate – ODOT could leverage new data to develop policies, plans, and programs for decision making.	

Positive Outcome | Negative Outcome | Unclear Outcome

Freight Technologies

Trend	**Outcome** (ODOT's ability to influence outcome – high, moderate, low)	Goals
Increased use of drones or robotic technologies for delivery	Could reduce congestion or move smaller items more efficiently – fewer unnecessary vehicles on roadways	
	Concerns about regulation and safety of these technologies	
	Impacts to employment, likely to eliminate some jobs while creating new jobs – net impacts are unclear	
Growth of 3D printing	Could reduce need to transport goods across long distances and increase availability of goods in more places	

Positive Outcome | Negative Outcome | Unclear Outcome

Assessment Tools Workshop

Summary

September 4, 2019; 10:30 am – 12:00 pm

Oregon Department of Transportation (ODOT) Workshop Participants

ODOT Workshop Participants		
Name	Agency	Position
Tara Weidner	Transportation Planning & Analysis Unit	Professional Engineer
Hal Gard	Rail & Public Transit Division	Administrator
Becky Knudson	Transportation Planning & Analysis Unit	Principal Economist
Brian Hurley	Transportation Planning Unit	Senior Transportation Planner
Brian Dunn	Transportation Planning & Analysis Unit	Manager

Project Team Attendees		
Name	Agency	Position
Cole Grisham	ODOT	Transportation Development Division
Michael Rock	ODOT	Transportation Development Division
Adam Argo	ODOT	Transportation Development Division
Scott Richman	Jacobs	Consultant
Stuart Campbell	Jacobs	Consultant

Welcome and Meeting Overview

Adam Argo opened the Assessment Tools workshop and welcomed the attendees to the meeting. Adam provided an overview of the workshop objectives and purpose and facilitated self-introductions.

ETIA Project Background; Scenario Workshop purpose and objectives

Adam Argo reviewed the project purpose and objectives and discussed the goals of the workshop. Below is a list of key points that Adam made.

Workshop Purpose and Objectives:

- Engage small group of ODOT technical staff to determine how key outcomes of each of the scenarios should be assessed
- Ensure that available assessment tools reflect measurable outcomes and potential policy interventions
- Identify and document assessment tools to align with potential alternative future scenarios related to emerging trends

Adam reviewed work to-date on the Emerging Technology Impact Assessment (ETIA) Project. ETIA is comprised of two phases of work:

- **Phase 1:** Identify key trends in emerging transportation technologies and analyze impacts of trends on Oregon's transportation system
- **Phase 2:** Develop planning scenarios on a broader range of considerations to inform the Oregon Transportation Plan (OTP) and Oregon Highway Plan (OHP) updates
    - Focusing on how to frame uncertainties within ODOT goal areas
    - Look to a vision for the transportation system in 2050
    - Share outcomes for Phase 1

Drivers of Change and Scenario Framework

Scott Richman introduced the Drivers of Change and Assumptions, which included a handout. The handouts provided a table that provided a framework for how trends within the Drivers of Change might impact future outcomes. Trends are identified under the Drivers of Change, which are assessed for their future impact/influence on outcomes.

The Drivers of Change are categorized into 3 categories:

- **Mobility Options**: including active transportation options, shared mobility services, and ride-hailing services made available to users using various models that operate within the concept of the integration of transportation services into a single trip-planning and payment platform is known as Mobility-as-a-Service (MaaS).
- **Vehicle Technologies:** including connected vehicles (CVs), automated vehicles (AVs), and electric vehicles (EVs).
- **Freight Logistics:** including freight vehicle platooning, efficiencies in distribution networks, and on-demand delivery services.

The Drivers of Change were developed based on 7 underlying assumptions:

- Climate change impacts will have cascading effects across many goal areas.
- Resiliency (including seismic readiness and natural disaster preparedness) underlies all ODOT goal areas.
- There will always be sustainability initiatives to protect environmental resources and habitat and to work to curb and reverse the effects of fossil fuel usage to decrease greenhouse gas emissions and improve air quality.
- Demographic changes such as the movement of the working age population towards more urbanized counties and rural areas losing population will frame the statewide needs of the transportation system for decades to come.
- Transportation revenue will continue to change due to declining fuel tax revenues and other factors.
- The statewide land use planning framework and Transportation Planning Rule will remain consistent to ensuring balanced land use development in coordination with transportation planning.
- Emerging vehicle and infrastructure technologies create workforce and supply chain impacts across many goal areas, with new workforce needed to plan, maintain, engineer and construct and changing transportation system.

Questions from the group:

- How was the degree of certainty determined?
    - Internal conversation within consultant team and Adam Argo's ODOT team.

Suggestions from group:

- How are the trends impacting choices or the transportation system? And what are the measures or leavers its related to?
    - It was suggested that another field in the table would be beneficial to indicate 'why it matters' or 'why we care' about each trend.

Present and Discuss Potential Assessment Tools and Assumptions

Brian Dunn and Tara Weidner, ODOT TPAU, introduced a series of assessment tools that might be beneficial as the ETIA program moves forward. The two tools presented included:

- STORM Analysis Toolkit
    - VisionEval
    - Oregon Statewide Integrated Model (SWIM)

STORM Analysis Toolkit

The STORM Analysis Toolkit helps to determine what tool is to use for a project and is generally categorized into 3 buckets – Strategic, Tactical, and Operational Models. Different tools are used for different reasons, including level of spatial detail (statewide, regional, local, etc), policies, investments, strategies, and response to other factors. ODOT TPAU groups modelling tools into 3 general buckets:

- Strategic Models are used for long range visioning, policy testing, uncertainty analysis, and high-level planning analysis, guide to where we want to go.
- Tactical Models are used to develop implementation plans, relies on fixed assumptions regarding land use, economic conditions & population.
- Operational Models are used for current and short-term implementation actions, such as signal timing and ramp metering.

VisionEval

VisionEval is a strategic high level analysis tool within the STORM toolkit. At its core, VisionEval is an exploratory tool for assessing risk/uncertainty in scenario planning visioning. Below is a list of broad inputs and outcomes that the tool is well equipped to address.

Broad Inputs

- Context Variables:
    - Demographics
    - Income Growth
    - Fuel Price
- Vehicles and Fuels
    - Vehicle and Fuel Economy
    - Fuels

- Commercial Fleets
- Systems and Operations
  - Intelligent Transportation Systems
  - Driving Efficiency Programs
  - TDM (home & work-based, ridesharing)
  - Parking Fees
  - Car Sharing
- Pricing
  - Pay as you drive insurance
  - Gas taxes, Road user fee, VMT fee
  - Congestion fee, Social costs/Carbon tax
- Transportation Options
  - Transit service
  - Biking and walking
  - Road growth
- Land Use
  - Future Housing (Single- & Multi-family)
  - Land Use density

Broad Outcomes

- VisionEval can inform several policy issues, such as:
  - Household travel costs
  - Transportation and energy costs
  - Air quality
  - Mixed-use development
  - Health impacts
  - Vehicle miles traveled
  - Travel delay
  - Fuel consumed
  - Walk trips and bike miles
  - GHG emissions
  - Equity

SWIM

The SWIM model is set up to test policies statewide by adjusting inputs depending on a variety of changes – if pricing for transportation is changed, population in certain areas will shift within the model. The SWIM model:

- Based on state economic forecast
- Simulates population demographic characteristics
- Simulates the dynamic activity of people and business,
- Simulates industry activity: labor, inputs, final products
- Simulates land use for residential housing and businesses,
- Simulates movement of people and commodities
- Peer reviewed

Brian and Tara provided a short list of how the SWIM model operates.

- SWIM is unique nationally – it can evaluate:
  - **Economics** – imports, exports, market factors
  - **Freight** – commodity by mode
  - **Land Use** – SWIM responds and takes into account current market conditions
  - **Transportation cost impacts** – Impacts to transportation network can impact land uses and SWIM can simulate these possibilities
  - **Prioritize investment programs** – SWIM can help prioritize corridors or other transportation infrastructure to strategically determine where there would be less of an economic impact
  - **Reveals synergies/unintended consequences** – SWIM does fewer model runs, but it can be combined with other models to get most out of the analysis

Land Use Place Types

Tara briefly provided an overview of ODOT's Land Use Place Types model. Place Types are data-driven ways to define and visualize the many aspects of land use-transportation interactions embodied in land use plans. It is context sensitive, as it compares existing built environment characteristics to what is expected to occur in the future, then analyzing how changes to the built environment can affect travel.

Discuss Priorities and Next Steps

Due to a condensed meeting there was little time for wrap-up discussion. The group reached a consensus on provided written comment and feedback on the Drivers of Change handout. The feedback will then be incorporated into a revised version by the consultant project team.

Oregon Transportation Related Greenhouse Gas Analysis

White Paper: Foundational Information

This document is intended for internal OMSC use. It may be made available externally for information only.

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Oregon Modeling Steering Committee

Greenhouse Gas Subcommittee

UPDATED: DECEMBER 23, 2020

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1 INTRODUCTION

1.1 Oregon's Commitment to Greenhouse Gas (GHG) Reduction

The State of Oregon has been working to reduce the production and impacts of greenhouse gas (GHG) for most of the 21st century. More recently, several notable GHG policy actions have occurred at the state level:

- In 2009, the Oregon Jobs and Transportation Act (HB 2001)[1] included several key measures related to transportation related GHG, setting the stage for significant metropolitan scenario planning and policy work to follow.
- Also in 2009, the Oregon Legislature enacted House Bill 2186, which authorized the Oregon Environmental Quality Commission to adopt a low carbon fuel standards program for Oregon, with considerable emphasis on medium-duty and heavy-duty trucks. This bill also created a Metropolitan Planning Organization Greenhouse Gas Emissions Task Force.[2]
- In 2010, the Legislature enacted Senate Bill 1059[3], establishing the Oregon Sustainability Transportation Initiative (OSTI), and providing a collaborative framework for state agencies to work together to identify ways to reduce GHG emissions from transportation sources.
- The launch of the OSTI and Oregon's leadership on the national level prompted development of the Statewide Transportation Strategy (STS), a two-year stakeholder effort to identify a vision and strategies for reaching statewide GHG goals. Additional rules were adopted and administered by the Oregon Department of Land Conservation and Development that set, with the exception of the Portland region, largely voluntary GHG reduction targets for household travel in Oregon's metropolitan areas to meet the statewide goals.
- In 2020, Governor Kate Brown elevated the state's GHG reduction responsibilities through an executive order[4] that requires development of specific actions, strategies, and analysis methodologies across multiple state agencies, and associated guidance. In response to the executive order, the Oregon Departments of Transportation (ODOT), Energy (ODOE), Environmental Quality (DEQ), and Land Conservation and Development (DLCD) worked together to develop an STS Multi-Agency Implementation Work Plan for 2020-2022 known as "Every Mile Counts" to make progress toward the

[1] Oregon State Legislature, 2009 Regular Session, HB 2001. Effective date September 28, 2009. Retrieved from https://olis.leg.state.or.us/liz/2009R1/Measures/Overview/HB2001
[2] Oregon State Legislature, 2009 Regular Session, HB 2186. Effective date July 22, 2009. Retrieved from https://olis.leg.state.or.us/liz/2009R1/Measures/Overview/HB2186
[3] Oregon State Legislature, 2010 Special Session, SB 1059. Effective date March 18, 2010. Retrieved from https://olis.oregonlegislature.gov/liz/2010S1/Measures/Overview/SB1059
[4] Executive Order 20-04, March 10, 2020, https://www.oregon.gov/gov/Documents/executive_orders/eo_20-04.pdf

STS vision.[5] The plan focuses on objectives and priority actions that can benefit from collaborative relationships and programs already established among the agencies.

1.2 The OMSC's Role

The Oregon Modeling Steering Committee (OMSC)[6] was formed in 1996 to improve the state of the practice and promote state-of-the-art land use and transportation modeling in Oregon. OMSC members include managerial and technical staff from multiple state agencies, metropolitan planning organizations across Oregon and southwestern Washington, and Oregon universities. The group's mission is to ensure Oregon continues to have the right data, tools, skills, and expertise needed to answer important questions about our transportation systems, land use patterns and economy.

In 2018, the OMSC's Technical Tools Subcommittee updated Oregon's GHG Tools Overview report[7], which outlines the capabilities and uses of current models and tools for GHG analysis. Then in 2020, an OMSC GHG Subcommittee was formed, to continue interagency coordination on GHG analysis needs. The GHG subcommittee is helping to identify the potential roles of various agencies related to transportation GHG data and analysis, and to provide recommendations for developing and maintaining consistent tools and data that can support efforts to reach state, regional and local GHG reduction goals.

The terms "mitigation" and "adaptation" are often used to frame GHG discussions. Mitigation involves reducing the magnitude of GHG in the earth's atmosphere. For example, mitigation may reduce GHG by changing travel behavior to reduce vehicular modes and trip lengths, promoting low-carbon vehicles operating at optimum fuel efficiency, and encouraging low-carbon methods and materials in constructing and maintaining infrastructure. Adaptation involves limiting human and transportation system vulnerability to the effects of GHG. For transportation, this typically means considering how infrastructure can be made more resilient to the effects of extreme weather associated with climate change. For the OMSC's purposes, we are primarily focused on *mitigation*. That is, our aim is to make sure that Oregon has adequate tools for analyzing various strategies and actions that can be implemented by government at state, regional and local levels *to reduce GHG*.

1.3 Intended Audience and Purpose of this Paper

This paper has been prepared to provide a common understanding of terms, requirements, issues, and challenges for transportation related GHG analysis in Oregon. The document's audience includes OMSC GHG subcommittee members, as well as other staff from state agencies, metropolitan planning organizations, cities and counties who may not be serving on the GHG subcommittee but may have GHG planning or analysis responsibilities for their organizations.

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[5] Oregon Departments of Transportation, Environmental Quality, Energy, and Land Conservation and Development, *Every Mile Counts: STS Multi-Agency Implementation Work Plan (2020-2022)*, retrieved from https://www.oregon.gov/odot/Programs/Pages/Every-Mile-Counts.aspx

[6] OMSC information is available on ODOT's website at https://www.oregon.gov/ODOT/Planning/Pages/OMIP.aspx

[7] Bettinardi, A. and Weidner, T, (2018) *Oregon Greenhouse Gas Modeling and Analysis Tools*, retrieved from: https://www.oregon.gov/odot/Planning/Documents/GHG_Tools_Overview.pdf

The primary purposes of the paper are to:

- Explain the GHG analysis spectrum.
- Explain current laws, rules and statewide policies affecting transportation related GHG in Oregon.
- Explain how transportation related GHG measures are currently defined in the policy nexus, including known issues with different definitions.
- Explain what Oregon has already learned about GHG production from the transportation sector and government's ability to influence them ("what actions move the needle")
- Provide additional references that may help the audience build knowledge.

2 ANALYSIS SPECTRUM

Governmental agencies have transportation GHG analysis needs that range from very broad to very focused. The Oregon Department of Transportation (ODOT) uses the "STORM" acronym, to generally describe typical transportation analysis levels, including *strategic*, *tactical,* and *operational* analyses, plus *reporting* and *monitoring* (Figure 1).

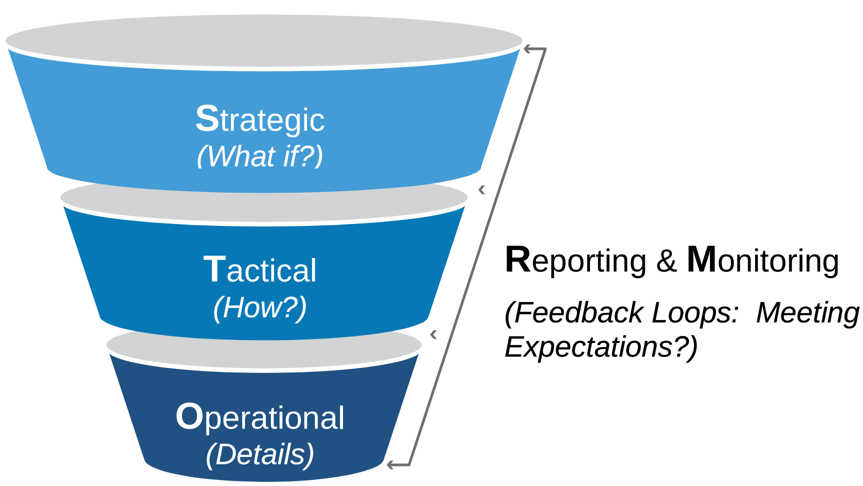
Strategic analysis explores the potential effects of major paradigm shifts and broad policy and investment decisions by evaluating many possible futures. At the strategic level, decision-makers can look at "what if" scenarios to help with long-term visioning, policymaking, or resilience planning to address uncertainty.

Tactical analysis helps to assess the impact of potential statewide or regional investment programs. Analysis at the tactical level helps decision-makers work out how best to implement funding under a limited set of future scenarios. For example, a single or limited set of assumptions for land use, economic conditions, fuel prices, etc. is typical of tactical-level analysis.

Operational analysis helps with short-term decisions in more narrowly focused geographic areas; for example, assessing the effects of localized traffic control strategies, safety improvements, or ITS/system management strategies.

Reporting and monitoring involve measuring the impact of decisions made at each level and confirming that expectations are met or determining if adjustments are needed to improve progress toward goals. Feedback loops, ideally fed by observed rather than modeled data, can inform future strategies, tactics, operational plans, and associated planning tools.

Figure 1. "STORM" Analysis Levels



ODOT, MPOs and local agencies have analysis needs that may fall within multiple STORM categories. Table 1 illustrates how typical planning and project-level activities may correlate with the broad STORM analysis levels. Please note that Table 1 is merely intended to help illuminate common terms for use in GHG analysis discussions. Not every plan or project is the same, and some activities may not fit neatly into a single STORM category.

Table 1. Planning and Project Phases and Typical STORM Analysis Levels

TRANSPORTATION PLANNING AND PROJECT DEVELOPMENT ACTIVITIES	TYPICAL HORIZON TIMELINE	TYPICAL ANALYSIS LEVEL(S)			
		Strategic	Tactical	Operational	Reporting/ Monitoring
PLANNING					
Long Range Scenario Planning	20 to 50 years	✓			
System Planning • ODOT Mode and Topic Plans • MPO Regional Transportation Plans • Regional, City and County Transportation System Plans	Typically 20 years		✓		
Corridor or Sub-Area Planning	10 to 20 years		✓	✓	
PROGRAMMING					
Determining short-term project priorities and funding commitments • Statewide Transportation Improvement Program (STIP) • MPO Transportation Improvement Programs (TIPs) • City and County Capital Improvement Programs (CIPs)	Typically 20 years*		✓	✓	
PROJECT DEVELOPMENT					
NEPA / Environmental Studies	25+ years**			✓	
Project Design	3 to 75 years***			✓	
PROJECT IMPLEMENTATION					
Construction	Immediate			✓	
Maintenance and Operations	Retrospective, typically looking back 1 to 5 years			✓	✓

***** While programming is typically done every 2-6 years, analysis of projects within a given program would likely have a 20-year horizon.

**NEPA studies typically look 20 years beyond the opening date of the project. Project environmental studies can begin several years before the project opening date.

TRANSPORTATION PLANNING AND PROJECT DEVELOPMENT ACTIVITIES	TYPICAL HORIZON TIMELINE	TYPICAL ANALYSIS LEVEL(S)			
		Strategic	Tactical	Operational	Reporting/ Monitoring
***Project design horizons can range widely depending on the purpose. For example, a simple operational improvement such as a new traffic signal may use a 3-year design horizon; a roadway improvement project may assume a 20-year design life; a new bridge design may need to consider future conditions 50-75 years out.					

3 CURRENT GHG ANALYSIS REQUIREMENTS

Oregon has several policies, laws and rules that are foundational to understanding current transportation GHG analysis monitoring and reporting requirements (Table 2). There are no federal requirements for GHG analysis in transportation plans and projects at this time, although GHG analysis concepts are being considered at the federal level.[8]

Table 2. Summary of Oregon's Transportation-Related GHG Policies, Laws, Rules and Regulations

Oregon GHG Policy Nexus	
Policy, Law, Rule or Regulation	**Description**
National Environmental Policy Act (NEPA)	Draft guidance has been prepared by the national Council on Environmental Quality on how NEPA analysis and documentation should address GHG emissions.[9] Broadly, the guidance states that, "Agencies should attempt to quantify a proposed action's projected direct and reasonably foreseeable indirect GHG emissions when the amount of those emissions is substantial enough to warrant quantification, and when it is practicable to quantify them using available data and GHG quantification tools."

[8] The draft Fixing America's Surface Transportation (FAST) Act included a GHG reporting metric which was dropped from consideration in July 2018: The proposed metric was percent CO2 reduction relative to 2017, due to on-road mobile sources on the National Highway System. (82 FR 5970, 1/18/17)
[9] Federal Register, June 26, 2019. *Draft National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions: A Notice by the Council on Environmental Quality.* Retrieved from https://www.federalregister.gov/documents/2019/06/26/2019-13576/draft-national-environmental-policy-act-guidance-on-consideration-of-greenhouse-gas-emissions

<table>
<tr><th colspan="2">Oregon GHG Policy Nexus</th></tr>
<tr><th>Policy, Law, Rule or Regulation</th><th>Description</th></tr>
<tr><td>ORS 468A.205

Legislative Policy</td><td>Declares Oregon’s policy to reduce GHG from all sources:
▪ By 2020, arrest the growth of Oregon’s GHG emissions and begin to reduce them
▪ By 2020, achieve GHG levels that are 10% below 1990 levels
▪ By 2050, achieve GHG levels that are at least 75% below 1990 levels
(Note: The Governor’s March 2020 Executive Order 20-4 set slightly more stringent targets. See details below.)</td></tr>
<tr><td>2009 Legislative Session, House Bill 2001</td><td>This bill laid the foundation for GHG scenario planning processes in Oregon.
• Required DEQ and ODOE to work with ODOT to estimate the historic and forecast light-duty GHG emissions for each MPO region, considering improvements in vehicle technologies.
• Created requirements for scenario planning in the Portland Metro and Eugene/Springfield metropolitan areas, per GHG targets identified by the Land Conservation and Development Commission (LCDC):
o Required Metro and the local governments in the Portland metropolitan area to prepare, cooperatively select, adopt, and implement (through comprehensive plans and land use regulations) a land use and transportation scenario that meets the GHG target
o Required the Central Lane Metropolitan Planning Organization (CLMPO) that serves the Eugene-Springfield area to identify, and local governments to cooperatively select (not adopt or implement), a scenario that meets the GHG target.
• Specified that DLCD and ODOT provide technical and financial support to the scenario planning efforts.</td></tr>
<tr><td>2010 Legislative Session, Senate Bill 1059</td><td>Required the Oregon Transportation Commission (OTC) to develop a Statewide Transportation Strategy (STS) on GHG emissions, identifying state and local actions needed to make progress toward the emission reduction goals in ORS 468A.205.
Required ODOT and DLCD to work collaboratively to:
▪ Develop guidelines for scenario planning (developing and evaluating alternative land use and transportation scenarios) that may reduce GHG emissions.</td></tr>
</table>

Oregon GHG Policy Nexus	
Policy, Law, Rule or Regulation	**Description**
	▪ Provide analysis tools and case studies to help local and regional decision-makers understand the effectiveness of their actions and programs for reducing GHG. Required LDCD to adopt and periodically review rules setting GHG reduction targets for metropolitan areas, reflecting locally led actions.
Statewide Transportation Strategy (STS)	Completed in 2012 and incorporated into the Oregon Transportation Plan (the state's overarching transportation policy document) on August 16, 2018. Successful implementation of the STS requires actions at the national, state, local and personal level across industry and government. Included a 2-year stakeholder process to agree on a 2050 vision for transportation GHG emission reduction. Covers ground transportation, freight, and air travel and considers a mix of actions that state agencies, with support of local agencies, can do to help meet the state's GHG emission goals. Strategies span actions related to vehicle and fuel technologies, pricing, transportation options, and land use patterns. The STS and on-going monitoring reports are used to inform statewide multi-agency plans. The STS near term implementation plan calls for ODOT and DLCD to support scenario planning in metropolitan areas.
OAR 660.012 **LCDC Transportation Planning Rule (TPR)**	Intended to support Oregon Statewide Planning Goal 12 which includes "avoiding principal reliance on any one mode of transportation" by providing "variety of transportation choices for moving people". Does not currently have specific GHG analysis requirements. Rather, long range transportation system plans are required to reduce VMT per capita, with a focus on short trips served by non-auto modes. Prescribes a 5% internal VMT per capita reduction target over a 20-year planning period for city, county, and regional transportation system plans in metropolitan areas. Scope is limited to trips that start and end in the metro area. If the 5% target cannot be met, allows regions to propose alternative standards with supporting performance measures that must be tracked. Local cities and counties are principally charged with meeting the requirements of the Transportation Planning Rule in metropolitan areas. Revisions to this rule may be coming in the near term. See Governor's Executive Order No. 20-04 below.

Oregon GHG Policy Nexus	
Policy, Law, Rule or Regulation	**Description**
OAR 660.044 **LCDC** **Metropolitan GHG Reduction Targets Rule**	Establishes GHG reduction targets for Oregon's metropolitan areas, with a focus on local policies. Local cities and county jurisdictions within metropolitan areas are principally charged with the reduction of GHG, not MPOs directly. However, local jurisdictions may elect to work cooperatively with the MPO to set targets. Targets under this rule are defined as reductions from 2005 emission levels of per capita GHG emissions from household-based travel and supporting commercial services. The focus is on household-based emissions, both personal travel and local delivery. Requires scenario planning activities for the Portland Metro region. This region must adopt a preferred land use and transportation scenario that supports the region's GHG target. The Portland Metro region is further required to implement their preferred scenario and monitor progress. Scenario planning and implementation is voluntary for other metropolitan regions. Provides light duty vehicle emission rates to be used for scenario planning analyses, by year, in grams of carbon dioxide equivalent per vehicle mile. Prescribes methods and processes to be used for calculating a region's progress relative to the GHG reduction target including state-led policies that can be assumed. Guidelines have been developed to support the scenario planning process and how to calculate the GHG Target Metric for this rule.[10]
OAR 340.215 **DEQ** **Oregon GHG Reporting Program**	Requires owners or operators of emission sources to obtain operating permits or air contaminant discharge permits from DEQ. Transportation-related industries subject to these rules include fuel suppliers (gas, diesel, aircraft dealers, natural gas, propane, and electricity).
ORS 468A.250 **Oregon Global Warming Commission**	The Oregon Global Warming Commission mandate includes tracking and evaluating progress toward the state's GHG reduction goals (ORS 468A.205). In response, DEQ produces annual inventories of GHG emitted by various sectors of the state economy, including but not limited to industrial, transportation and utility sectors. DOE staff support the Commission's work.

[10] Further guidance on tools and assumptions for GHG Target Rule can be found in Oregon's Scenario Planning Guidelines Technical Appendix (pp. 110-124). Retrieved from https://www.oregon.gov/ODOT/Planning/Documents/Oregon-Scenario-Planning-Guidelines-Tech-Appendix.pdf

<table>
<tr><th colspan="2">Oregon GHG Policy Nexus</th></tr>
<tr><th>Policy, Law, Rule or Regulation</th><th>Description</th></tr>
<tr><td>Governor’s Executive Order No. 20-04

Directing State Agencies to Take Actions to Reduce and Regulate GHG Emissions</td><td>Establishes new GHG reduction goals for the state:[11]
▪ 45% below 1990 levels by 2035
▪ 80% below 1990 levels by 2050
These goals represent reductions 5% greater than currently prescribed in legislative policy (ORS 468A.205).
(At this time, however, legislative policy goals under ORS 468A.205 are still used to develop Metropolitan Greenhouse Gas Reduction Targets.)
Directs state agencies to use any and all authorities to help reach the goals, prioritize work to accelerate GHG reductions, and integrate climate impacts and reductions into policy decisions.
On Transportation Specifically:
Directs ODOT, DLCD, ODOE and DEQ to establish GHG reduction performance metrics.
Directs DLCD to change the Transportation Planning Rule to require transportation plan amendments in metropolitan areas to meet GHG goals.
Directs ODOT to develop and apply a process for evaluating GHG impacts of transportation projects as part of regular capital improvement programming processes.
Additional general and individual agency directives.</td></tr>
</table>

[11] The goal change reflects changes in Intergovernmental Panel on Climate Change (IPCC) guidance for limiting global warming to 2 degrees Celsius by 2050.

4 HOW DO WE MEASURE GHG?

As the policy nexus outlined in Section 3 indicates, transportation related GHG in Oregon is expressed differently for different purposes.

4.1 GHG Accounting Methods

The following quantification concepts have been used to tell the GHG story from different analysis perspectives.

Sector-based. GHG emissions can be described for broad economic sectors, either in combination or individually. A transportation sector based GHG estimate would tally GHG emissions from all forms of transportation: ground passenger and light duty commercial vehicles, plus multi-modal freight, and air passenger transport.

Vehicle-based. GHG emissions may be tallied for all transportation vehicles, or may be quantified for a specific category, such as light duty vehicles alone.

Household-based. GHG emissions can be quantified based on household activity. By default, household-based quantification is typically focused on light duty vehicles. When a spatial analysis is done using a household-based emissions quantification method, all GHG due to household travel is assigned to a household's geographic location, regardless of where travel-related emissions actually occur, including inter-city travel.

Roadway-based. GHG emissions can be estimated for a given stretch of road, based on the number and types of vehicles that use the road over a specified time period. This can be extended to cover emissions generated by vehicles on all roadways within a certain geographic boundary.

Carbon dioxide equivalent (CO2e). GHG emissions are typically measured in carbon dioxide equivalents, reflecting the calculations of combining various man-made GHGs with different heat retention capabilities created with the combustion of fossil fuels. The quantity of man-made GHG emissions is typically represented in terms of the weight of CO2e emitted (often in metric tons).

Emissions beyond vehicles and fuels. Vehicle and fuel policies are largely set by federal and state legislative regulations (such as federal CAFÉ standards, Zero Emission Vehicle mandates, clean fuels programs). Because vehicle and fuel policies are mostly outside the control of regional and local governments, the Metropolitan GHG Reduction Target Rules focus on regional and local policies over and above any benefits achieved through state-led vehicle and fuel initiatives. Examples of "emissions beyond vehicles and fuels" strategies are VMT reduction strategies, encouraging alternative modes, and some pricing policies.

Well to wheels (lifecycle) emissions. Like a "cradle to grave" approach, a "well to wheels" method accounts for the GHG contribution of fossil fuels from the point of extraction from the ground to discharge into the air in the form of vehicle emissions.

Tank to wheels (tailpipe) emissions. A “tank to wheels” method accounts for the GHG contribution of fossil fuels only as vehicle emissions. That is, the amount of GHG generated from a given volume of fuel after it is placed in the fuel tank.

Project life or specific project period. Life-of-project and project opening year information are used for federal air quality conformity analyses (a process that regulates criteria air pollutants, not GHG). Air quality criteria pollutant standards established by the Environmental Protection Agency (EPA) are used to protect human health and the environment from exposure to pollutants that may dissipate with weather patterns that may vary hourly, daily, or seasonally. Both emission and dispersion modeling plus existing background concentrations are used to assess this impact in both the project opening year and design year. In contrast, a GHG is not an exposure threat; rather it has a cumulative impact. As such, a life of project GHG quantification requires summing the emissions from all hours, all days across the life of a project. (This is rarely done.)

Consumption-based. A consumption-based approach assigns GHG production based on consumption of goods, rather than by vehicle group. A consumption-based perspective assumes each item or service used by a household has GHG emissions associated with its production, movement, and ultimate disposal.

Total vs. per capita emissions. For a given geographic area, GHG can be presented as total emissions contributed by all activity, or as a per person value. GHG estimates that are developed using many of the accounting methods listed above can also be presented as total or per capita values (or similarly, on a per mile basis).

Other GHG accounting considerations. GHG quantification methods are often selected based on the geographic scope of the study in question, and the specific reporting requirement or question that the study is intended to address. For example, different quantification methods are used for DEQ’s GHG inventory than for metropolitan area target setting, or regional or local transportation system planning. Some data is not available or useful at all scales. For example, fuel sales information is typically not available at sub-state levels, and there is less confidence in data at smaller scales because people may buy fuel in one geography and burn it in another.

Similarly, analysis periods may also differ due to different purposes, depending on the perspective required. For example, Oregon’s Metropolitan Greenhouse Gas Reduction Target rules require a comparison of future annual GHG emissions to 2005 levels, whereas the state’s Transportation Planning Rule requires VMT analysis using a rolling 20-year planning horizon.

Quantification results can also be significantly influenced by the presence or lack of financial constraint. For example, Oregon’s Metropolitan Greenhouse Gas Reduction Targets rule and Transportation Planning Rule require plans to reflect “reasonably likely” financial plans, whereas the STS and scenario planning processes allow broader “what if” analyses.

Table 3 summarizes various GHG definitions currently used for different purposes in Oregon.

Table 3. Example GHG Definitions and Quantification Methods for Transportation Related Analysis

Quantifying GHG	
Analysis Purpose	**GHG Estimation Approach**
Metropolitan Greenhouse Gas Reduction Targets and the Statewide Transportation Strategy	For Metropolitan Greenhouse Gas Reduction Targets, OAR 660.044 defines GHG reductions as the change in per-capita emissions from travel activities using light vehicles relative to the fixed year of 2005, covering the metropolitan region. Targets are defined as "emissions beyond vehicles and fuels" (GHG reductions that can be made over and above reductions anticipated through advances in vehicles and fuel technologies). ODOT's VisionEval[12] tools were used for setting and tracking targets in several metropolitan areas. These tools are set up to account for annual metric tons of lifecycle household-based carbon-dioxide equivalent (CO2E) GHG per capita.
Transportation System Plans (TSPs) **and** **Regional Transportation System Plans (RTSPs)**	Oregon's Transportation Planning Rule (OAR 660.012) does not require transportation system plans to forecast or estimate GHG emissions. Rather, transportation plans must demonstrate regional reductions in average weekday vehicle miles travelled (VMT) per capita. We include a description of how VMT reductions are quantified for Transportation Planning Rule compliance here, since VMT is sometimes perceived as a proxy for GHG (see further discussion in Section 4.2.2.). With application of emission rates, VMT might be used to track GHG in general or potentially to the GHG Target Rule if definitions are aligned. In the Transportation Planning Rule, VMT is defined as miles of travel for "automobiles", which are further defined as "automobiles, light trucks, and other similar vehicles used for movement of people." [13] The definition does not include buses, heavy trucks and trips that involve commercial movement of goods.[14] Also, VMT calculations for this purpose include only trips with an origin and a destination within the metropolitan planning boundary. Pass through trips (trips with a beginning and end point

[12] VisionEval is a national initiative to develop an open source programming framework for disaggregate strategic planning models. This work is supported by a multi-agency partnership that includes ODOT. For more information, see https://github.com/visioneval/visioneval.
[13] Transportation Planning Rule, OAR 660-012-0005.
[14] Although only automobile trips are included in VMT calculations used for Regional Transportation System Plans, only some regional travel demand models in Oregon can differentiate between auto, transit, commercial and freight trips.

Quantifying GHG	
Analysis Purpose	**GHG Estimation Approach**
	outside of the boundary) and external trips (trips with either a beginning or an end point outside of the boundary) are excluded. While only a portion of a region's VMT is considered for Transportation Planning Rule compliance, travel demand models used for local and regional planning can typically forecast travel of all vehicle types on the roadway network within a given geographic boundary for a 20-year rolling horizon. Travel demand models typically do not include weekends, and do not account for non-recurring incidents as well as other GHG reducing policies (i.e. TDM, Eco Driving, ITS/Operations policies), however. The EPA MOVES model has been used as a post-processor to estimate GHG and other pollutants from the VMT estimated by a travel demand model. MOVES emission rates are tank-to-wheels and vary by vehicle speed, drive cycle and meteorological conditions. However, MOVES models are currently available only in areas under federal air quality conformity regulations. Emissions are reported for the federally recognized air quality maintenance boundary for metropolitan areas designated as attainment or maintenance. Emissions reported are for vehicle travel occurring within the federally designated metropolitan planning area boundary, regardless of where trips begin or end.
Sector-Based Inventory	A sector approach accounts for GHG emissions associated with activities occurring within a geography of interest by multiple economic sectors. For example, DEQ estimates tank-to-wheels (except for the electricity sector) GHG emissions based on data collected through their GHG Reporting Program from certain facilities, fuel importers, electricity and natural gas suppliers and landfills[15], and modeled emissions estimates from EPA's State Inventory Tool (SIT)[16] Statewide GHG contributions are summarized from broad economic sectors including transportation, electricity use, natural gas, residential and commercial, industrial, and agricultural. Results are expressed in total annual metric tons of carbon dioxide equivalent.

[15] Oregon Department of Environmental Quality, Oregon Greenhouse Gas Sector-Based Inventory Data, https://www.oregon.gov/deq/aq/programs/Pages/GHG-Inventory.aspx.

[16] United States Environmental Protection Agency, Energy Resources for State and Local Governments, State Inventory and Projection Tool, retrieved from https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool#:~:text=EPA's%20State%20Inventory%20Tool%20(SIT,or%20complete%20a%20new%20inventory.

Quantifying GHG	
Analysis Purpose	**GHG Estimation Approach**
	Local Climate Action Plans also are multi-sector. Some local inventories have used the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions[17] and Greenhouse Gas Protocol[18] methods that comply with international commitments associated with membership in the C40 cities.
Consumption-Based Inventory	A consumption-based approach accounts for life cycle (i.e. production to disposal) GHG emissions associated with the consumption of goods and services by residents and businesses within a geography of interest. DEQ produces a statewide consumption-based inventory[19] every five years that measures GHG emissions produced locally, nationally and internationally due to the state's consumption of goods and services like cars, food, fuels, appliances, and clothing, many of which are produced in other states or overseas. While DEQ's sector-based inventory is a tank-to-wheels approach, their consumption-based approach is well-to wheels. It considers the purchase of a final good or service by an Oregon consumer as the act that determines whether a commodity's life-cycle emissions should be in or out of the inventory, regardless of where the consumption or emissions actually occur. Like other inventories, GHG is expressed as annual lifecycle metric tons of carbon dioxide equivalent. In 2010, Metro developed a systems-based approach to estimate GHG emissions within their jurisdictional boundary. This inventory, blended sector- and consumption-based approaches to establish a carbon footprint of the region to focus planning efforts on achieving long-term GHG emissions reductions from all sectors. The inventory estimated the annual lifecycle GHG contribution of locally consumed materials (i.e., goods and food), energy and transportation from all domestic and international source where possible. Relying on evolving EPA data and analysis methods, this hybrid inventory was considered provisional and experimental because it did not reflect a fully vetted protocol for

[17] ICLEI USA, Local Governments for Sustainability, US Community Protocol is available online at https://icleiusa.org/publications/us-community-protocol/
[18] Greenhouse Gas Protocol, GHG Protocol for Cities: An Accounting and Reporting Standard for Cities, retrieved from https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities
[19] Oregon Department of Environmental Quality, Consumption-based Greenhouse Gas Emissions Inventory for Oregon, retrieved from https://www.oregon.gov/deq/mm/Pages/Consumption-based-GHG.aspx

Quantifying GHG	
Analysis Purpose	**GHG Estimation Approach**
	GHG accounting at the regional level. There are no plans to update this inventory in its current form.[20]

4.2 Issues with Current GHG Estimation Approaches and Measures

It is important to understand that each approach described above in Table 3 serves a different policy purpose. Different assumptions, tools and calculation methods pertain to each approach.

4.2.1 Comparability of Results from Different Stages of the Planning Spectrum

Quantification of GHG using one approach may not be comparable with GHG estimation findings using another approach. This is a challenge for transportation analysts and planners who may desire to compare estimated GHG outcomes of transportation system plans and air quality conformity analyses against metropolitan GHG reduction targets. These numbers are not directly comparable. For example, significant methodological differences in how VisionEval and RTP-level tools estimate on-road vehicle emissions do not currently allow for direct comparison of forecasted on-road vehicle emissions results, for sub-state areas. These differences have been documented by Metro in Appendix J to Metro's 2018 RTP[21]

Analysis for local and regional transportation plans is focused on the transportation system performance and related needs and improvements by location and type (all modes). These planning processes use travel demand models that were developed to plan for average-weekday future infrastructure needs counting all vehicles. Travel demand models use a *roadway network* accounting method limited to travel within the region's boundary.

Conversely, Oregon's Metropolitan Greenhouse Gas Reduction Targets look at a variety of policy issues beyond those typically accounted for in regional travel demand models used in the RTP process. Within the target setting process, GHG is defined as all days, *household-based*, light duty vehicle GHG regardless of where the travel occurs (inside or outside the planning area). This is done to capture cumulative impacts attributed to GHG-producing activity where reduction policies can be effectively implemented. Further the Metropolitan Greenhouse Gas Reduction Targets focus on emissions reductions *beyond vehicles and fuels* and allow regions to account for ambitious *state-led policies* that are not typically included in local and regional transportation plans (e.g., pricing, accelerated vehicle electrification).

The issue is further complicated when looking at the per capita VMT reduction that must be addressed in transportation system plans to comply with Oregon's Transportation Planning

[20] Oregon Metro (2018), *2015 Consumption-Based Greenhouse Gas Emissions for the Metro Wasteshed*.
[21] Metro, 2018 Regional Transportation Plan Appendix J: Climate Smart Strategy implementation and monitoring, https://www.oregonmetro.gov/sites/default/files/2019/04/02/RTP-Appendix_J_Climate_Smart_Strategy_Monitoring181206.pdf

Rules. The purpose of the VMT reduction requirement in Oregon's Transportation Planning Rule is to reduce reliance on the automobile, so a more restrictive *internal* VMT definition is used that only counts trips that both start and end within the city or region boundary.

Because of these differences, GHG outcomes calculated based on VMT information from local and regional transportation plans cannot be easily extended for comparison with the region's Metropolitan Greenhouse Gas Reduction Targets.

Similarly, in the monitoring stage, there is a need for consistency in methods and accounting approaches for GHG inventories, so they are comparable across the state and best align with policy actions (e.g., by vehicle group). As important tools to track progress, DEQ's statewide Sector- and Consumption Based inventories are valuable templates for local inventories.

More work is needed to understand the differences in definitions, assumptions, and quantification methods, and to create guidance for aligning GHG estimates generated at different stages of the planning spectrum. A key discussion question for the OMSC's GHG subcommittee is whether strict comparability of results from two or more planning levels is essential, or if we primarily need tools to assure that the magnitude of GHG reductions from investment decisions are adequately moving Oregon toward the ultimate GHG goals.

4.2.2 VMT as a Proxy for GHG

Caution is prudent in the use of any of the various VMT definitions as a proxy for GHG because the relationship between VMT and GHG changes over time as vehicle powertrain technology and fuel efficiency ratings change.

For example, the GHG produced by an electric vehicle travelling a certain number of miles is different than the GHG produced by a gasoline vehicle that gets 9 mpg travelling the same distance.[22] Odometer data that would allow tracking of VMT by powertrain type and help to inform policy or pricing choices is not widely collected in Oregon. Also, emission rates are sensitive to both vehicle speed and future vehicle mix assumptions.

4.2.3 Converting VMT to GHG: Defining Emission Rates

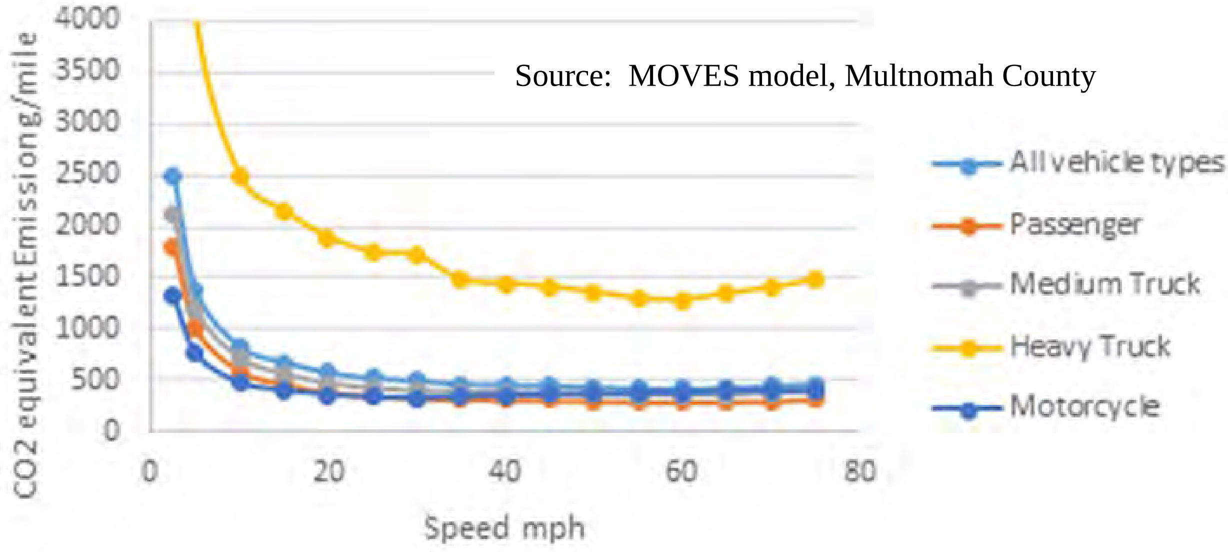
Most transportation planning efforts in Oregon do not currently report on GHG. In large part this is due to a lack of universally used assumptions and standard calculation methods for GHG emission rates. If emission rates were developed for use statewide, they could potentially be applied to existing study outputs of VMT to estimate GHG.

Vehicle speed considerations. Figure 2 shows how GHG is sensitive to speed using an example from Multnomah County in the Portland Metro region. Fuel efficiency varies with speed (more so for combustion engines), so simply looking at VMT discounts the emission reduction of more optimal speeds. Thus, GHG analysis methods should account for VMT by speed, with sensitivity to eco-driving or speed smoothing of advanced vehicles and ITS/Operational policy actions, including congestion due to incidents. Obtaining accurate forecasted speed information

[22] This website compares EV fuel efficiency to other vehicles: https://evtool.ucsusa.org/

for urban areas is a challenge since most travel demand models are not validated to vehicle speed.

Figure 2. GHG Emissions by Vehicle Speed: Example from Multnomah County



Future vehicle mix considerations. GHG emissions per mile travelled also vary by vehicle type and model year. An old car or even a newer SUV emits considerably different (higher) amounts of CO2 per mile travelled than newer passenger cars.

There are questions about the level of refinement needed when representing future vehicle mix to meet various analysis purposes. Less refinement is needed when simply comparing between alternative scenarios, more accuracy is needed when absolute values of total emissions are used. Conservative estimates that meet a target, are sufficient without further refinement, but may not be the most accurate or current in reporting for other purposes. For example, a conservative assumption that assumes little change from today's higher emitting vehicle mix may be sufficient for confirming that regional air pollutants are below an established threshold, but further refinement may be needed to meet tighter GHG targets.

Further complicating matters, the Metropolitan Greenhouse Gas Reduction Target Rule allows local agencies to assume future vehicle and fuel actions outlined in the STS Vision will occur. These actions reflect more ambitious vehicle electrification than the current trend policies assumed in the MOVES model.

For the most accuracy, emission rates would reflect local vehicle mix data (i.e., from DMV records) and vary by year, given the anticipated fleet electrification over time. In more detailed project-level efforts, since travel models are not validated to speed, speed outputs should come from microsimulation models, or be adjusted using real-time speed data to be more realistic. Assumptions may need to be made about the proportion and type of heavy-duty vehicles.

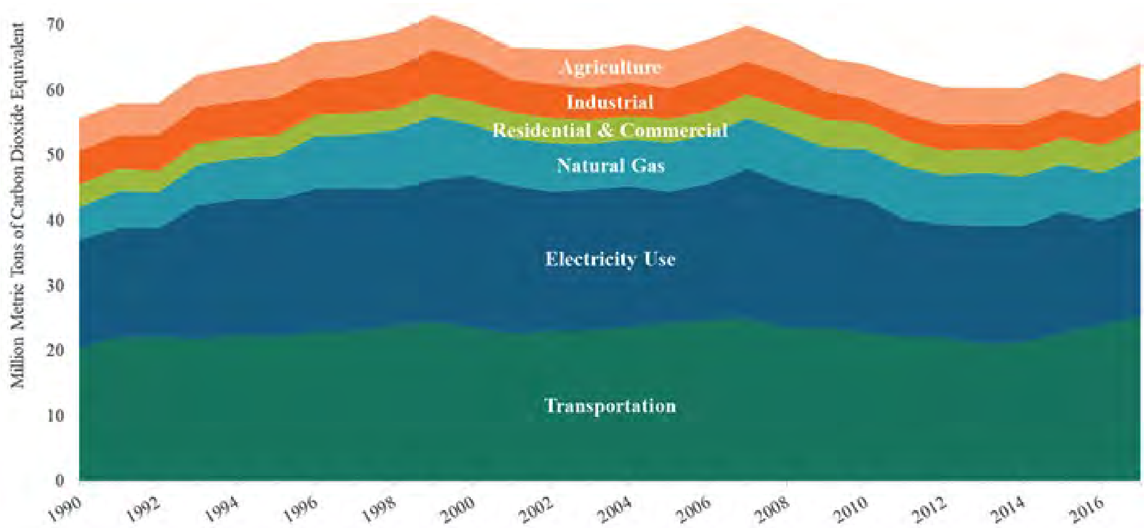
5 WHAT HAVE WE ALREADY LEARNED?

5.1 GHG Contributions from the Transportation Sector

5.1.1 Transportation's Historic Contribution to GHG

DEQ's GHG inventory indicates that the transportation sector overall in Oregon has comprised up to 40% of the state's annually reported GHG emissions over the last two decades (Figure 3).

Figure 3. Oregon GHG Emissions by Broad Economic Sector, 1990-2017[23]



However, ground transportation concerns (those dealing with passenger vehicles and light/medium duty commercial delivery trucks) dominate transportation system planning and decision making at the state, regional and local level. Historically, according to the STS 2018 Monitoring Report, these modes have comprised roughly half of the transportation sector's total GHG (Figure 4). This is an important point in understanding the amount of influence that local governmental agencies can realistically have on reducing future GHG. Meaningful strategies to reduce GHG from ground passenger vehicles and light trucks will be helpful; however, significant GHG reduction strategies for modes that have been less actively pursued by governmental agencies, such as air, rail, water transport, and long-haul heavy truck freight, will also be required.

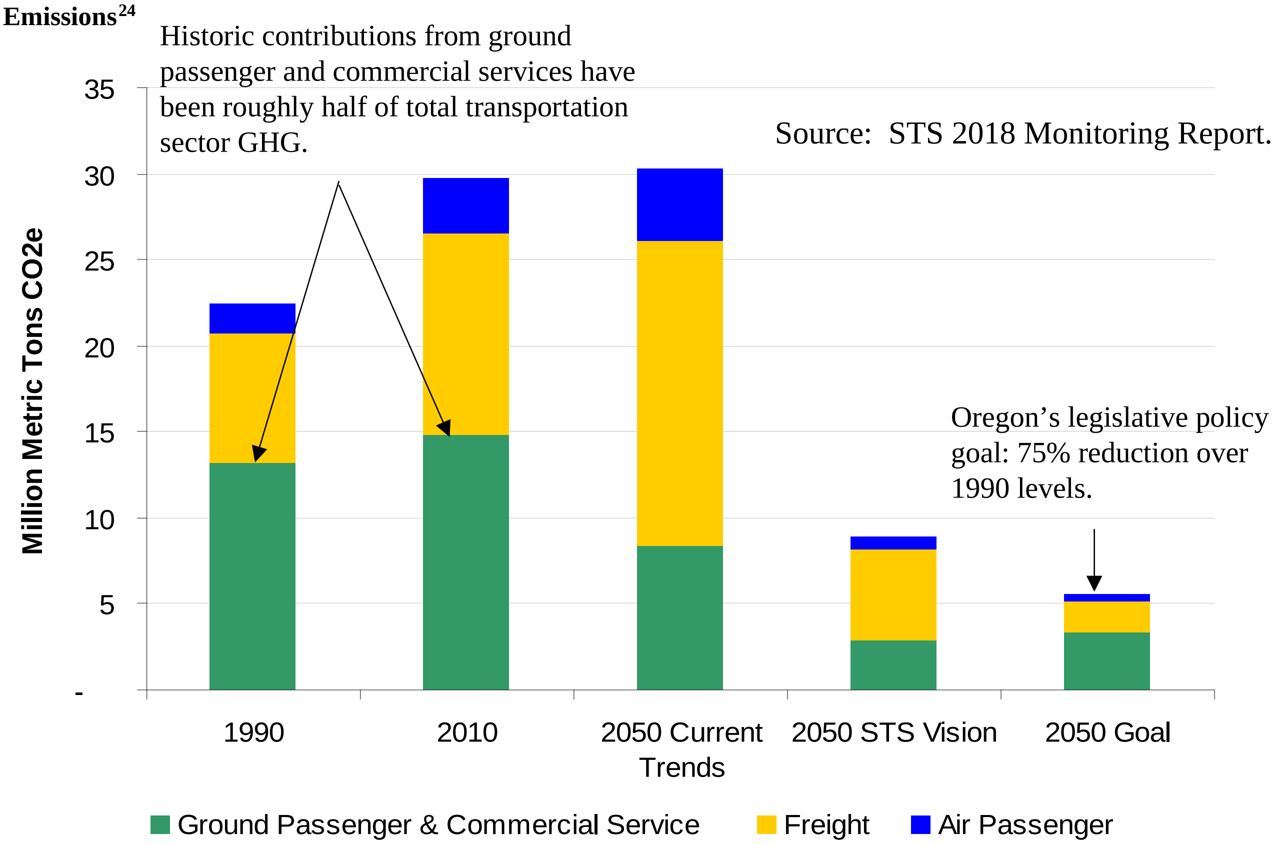
As Figure 4 implies, significant action will be required to meet or approach Oregon's legislative policy goal of reducing GHG production to 75% of 1990 levels by the year 2050. Since the STS was launched in 2010, we have learned much about how best to influence GHG in the planning and project development process, and the actions that have the greatest benefit.

Notably, Figure 4 indicates that while GHG from ground passenger and commercial service is expected to decline under current trends, GHG from freight activities is expected to grow

[23] Oregon Department of Environmental Quality, Oregon Greenhouse Gas Sector-Based Inventory Data, https://www.oregon.gov/deq/aq/programs/Pages/GHG-Inventory.aspx

significantly. This is chiefly because electric vehicle rollout for passenger vehicles is expected to outpace fuel technology innovations for other modes. Also, state, regional, and local governments have less ability to affect freight and air modes than light duty vehicles.

Figure 4. Estimated (1990 and 2010) and Projected (2050) Statewide Transportation Sector GHG Emissions[24]



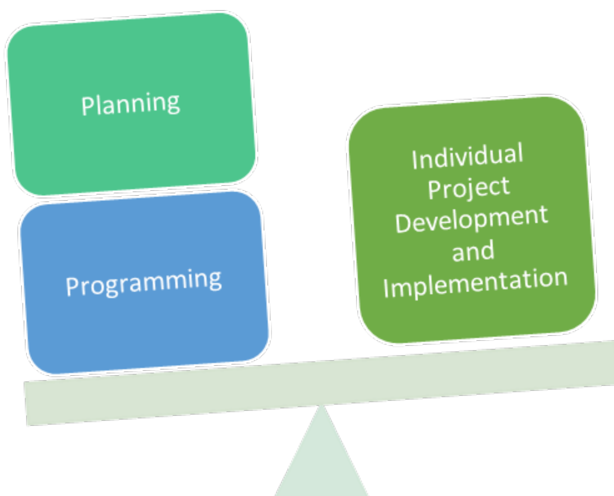
The general public may incorrectly perceive that ground passenger transport contributes a majority of the state's GHG emissions. However statewide inventories indicate passenger vehicles are less than half of all transportation sector emissions. These findings provide a reality check on the amount influence that strategies focused solely on light duty vehicles can be expected to have. This highlights the need for action on multiple transportation fronts, and other consumption behaviors outside of the OMSC's purview (e.g., food waste, goods consumption, and energy efficiency of residential, commercial, and industrial buildings).

[24] Oregon Department of Transportation (2018), *Oregon Statewide Transportation Strategy 2018 Monitoring Report*. Retrieved from ODOT website at: https://www.oregon.gov/odot/Planning/Documents/STS-2018-Monitoring-Report.pdf

5.1.2 When Do Agencies Have the Greatest Ability to Influence GHG?

Reducing GHG requires investment decisions that make progress toward Oregon's long term GHG reduction goals. At the planning stage, broader, policy-level decisions can create large-scale changes in how investments are prioritized and how transportation projects and strategies are developed and implemented. Thus decisions made during planning (for example identifying long-range strategies for a system-wide plan) and programming (for example selecting a package of near-term capital investments for funding and implementation) have a greater ability to impact future GHG levels than decisions made later as individual projects are developed and implemented (Figure 5). This is not to say that planning and programming matter more than following through with implementation, since we cannot move the needle if plans are not ultimately implemented.

Figure 5. Influencing GHG in Planning and Project Processes



For this reason, tools designed specifically for transportation GHG evaluation so far (such as ODOT's VisionEval tools) have focused on supporting statewide and regional scenario planning, to help decision makers understand the broad scale benefits and impacts of future potential actions. ODOT is currently working on GHG analysis methods and processes, (mandated in Executive Order 20-04), that can be used during programming, when capital investments are selected for near-term funding.

5.2 Governmental Interventions to Reduce Transportation Related GHG

5.2.1 What Moves the Needle Statewide?

State, regional, and local agencies have varying processes and tools at their disposal for reducing transportation related GHG. The STS looked at how GHG emissions may be reduced through vehicle and fuel technology, pricing, system and operations strategies, transportation options, and land use. Figure 6 shows the relative magnitude of broad categories of strategies from a statewide perspective.

Figure 6. STS 2018 Monitoring Report: What Moves the GHG Needle?

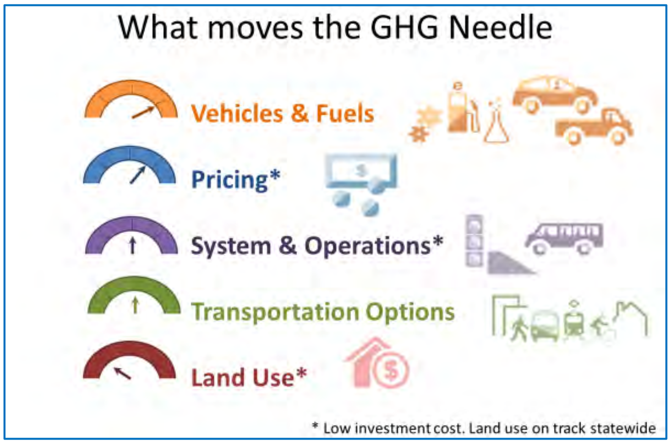


Table 4 shows the state's progress in achieving the policy actions called for in the STS based on adopted state and regional transportation plans. Government policies can encourage GHG reduction, but the choices made by individuals and businesses will largely determine whether GHGs are ultimately reduced. The recovery from the 2008 recession and low gas prices, for instance, are powerful headwinds that increased the challenge in reaching GHG reduction goals according to the 2018 STS-Monitoring Report.

Table 4. Potential of Ground Transportation Strategies to Move Toward Oregon's GHG Goals[25]

Effects of Governmental Strategies on Transportation Related GHG[26]

● On track with or exceeding the STS Vision
◖ Moving in the direction of the STS Vision
○ Little to no progress toward the STS Vision
⊗ Moving away from the STS vision / trending in a negative direction

	STS Strategy	Short Term	Long Term
VEHICLES & FUELS	Vehicle Mix	◖	○
	Fuel Efficiency (MPG)	◖	○
	Battery Range	●	●
	SUV/Light Truck Share	⊗	⊗
	Vehicle Age	⊗	⊗
	Fuel Carbon Intensity	◖	○
	Electric Carbon Intensity	●	◖
	Bus Fuels	⊗	◖

[25] ODOT Presentation to State Agency Directors, "*Statewide Transportation Strategy 2018 Monitoring Report Findings, Key Messages and Progress Relative to STS Vision*",(previously unpublished work from April 2018)
[26] STS strategies presented in this table are for ground passenger vehicles and commercial services rather than freight or air modes.

Effects of Governmental Strategies on Transportation Related GHG[26]

● On track with or exceeding the STS Vision

◖ Moving in the direction of the STS Vision

○ Little to no progress toward the STS Vision

⊗ Moving away from the STS vision / trending in a negative direction

	STS Strategy	Short Term	Long Term
PRICING	More Sustainable Funding Source (e.g. OReGo)	◖	○
	Congestion Fee (Portland Area)	◖	◖
	Pay-As-You Drive Insurance	◖	○
	True Cost Pricing (e.g. Carbon Fee)	⊗	⊗
SYSTEMS AND OPERATIONS	Intelligent Transportation Systems	◖	◖
	Managed Road Growth	●	●
	Parking Fee Coverage	●	●
	Parking Price	⊗	⊗
	Fuel Efficient Driving	⊗	⊗
TRANSPORTATION OPTIONS	Public Transportation Service	◖	○
	Biking and Walking	◖	◖
	Carshare	●	◖
	Demand Management Programs	●	◖
LAND USE[27]	Urban Growth Boundary Expansion	●	●
	Mixed Use Areas	●	●

5.2.2 Metropolitan Area Considerations

Scenario planning activities to date in Portland-Metro, Eugene-Springfield, Corvallis, and Rogue Valley, indicate that regional GHG strategies are relatively consistent with those recommended in the STS. That is, strategies developed for these metropolitan areas typically include full support for state-led transition to cleaner vehicles and fuels, funding of local modal options (projects often already on the books for transit, walking, and biking), associated marketing programs, options to ease congestion, and land use laws to restrain the footprint of urban growth.

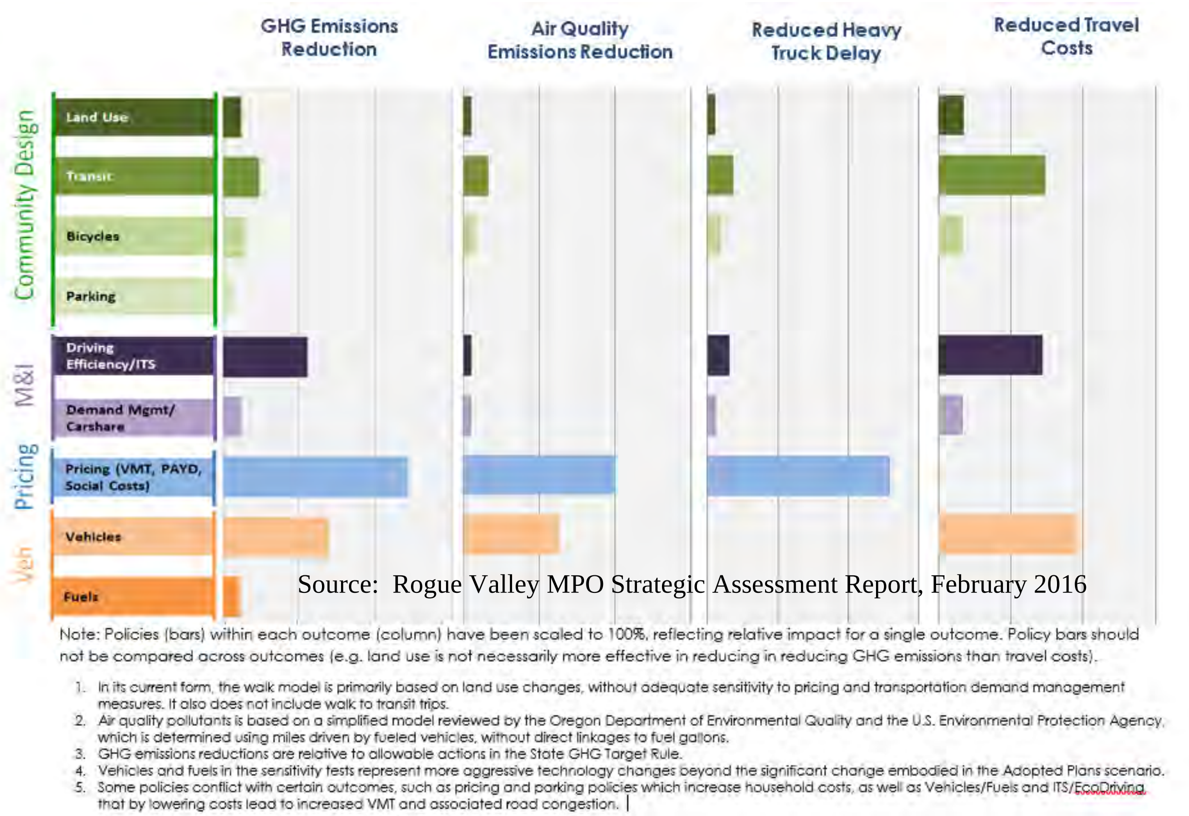
Multi-modal options are important elements of MPO planning for many reasons, such as considering the needs of protected population and addressing congestion issues. While modal strategies alone may not have a significant effect on GHG, modal strategies can provide

[27] Land use can be a significant aid to GHG and other multi-modal policy benefits. This table summarizes progress relative to the mix of policies identified in the two-year stakeholder process that developed the STS Vision. The agreed-to mix of policies balanced meeting GHG reduction goals with other impacts. STS stakeholders chose to assume that Oregon's historical land use growth restrictions would continue through 2050. From a statewide view, land use metrics of UGB growth and population living in urban mixed-use areas remain on track per the STS Vision, albeit the bulk of the progress comes from land use trends in the Bend and Portland metropolitan areas. Given its key role on GHG goals, it is essential to keep land use on-track with the STS Vision.

significant value when combined with other GHG reduction strategies. For example, pricing policies were embraced with more trepidation by policymakers in metropolitan areas. The role of modal options was seen as critical for GHG reduction – not only to reduce VMT, but perhaps more importantly to buffer the equity impacts of rigorous pricing strategies needed to reach GHG and congestion reduction goals.

Sub-areas of the state may be more or less sensitive to specific policy actions than the state as a whole, and each metropolitan area has placed a slightly different emphasis on the package of policies and strategies to be implemented for GHG mitigation. Figure 7 provides the relative impacts of potential policy adjustments that were discussed in the Rogue Valley metropolitan area (Medford region).

Figure 7. Relative Impacts of Policies by Outcome Measures for the Rogue Valley MPO



Source: Rogue Valley MPO Strategic Assessment Report, February 2016

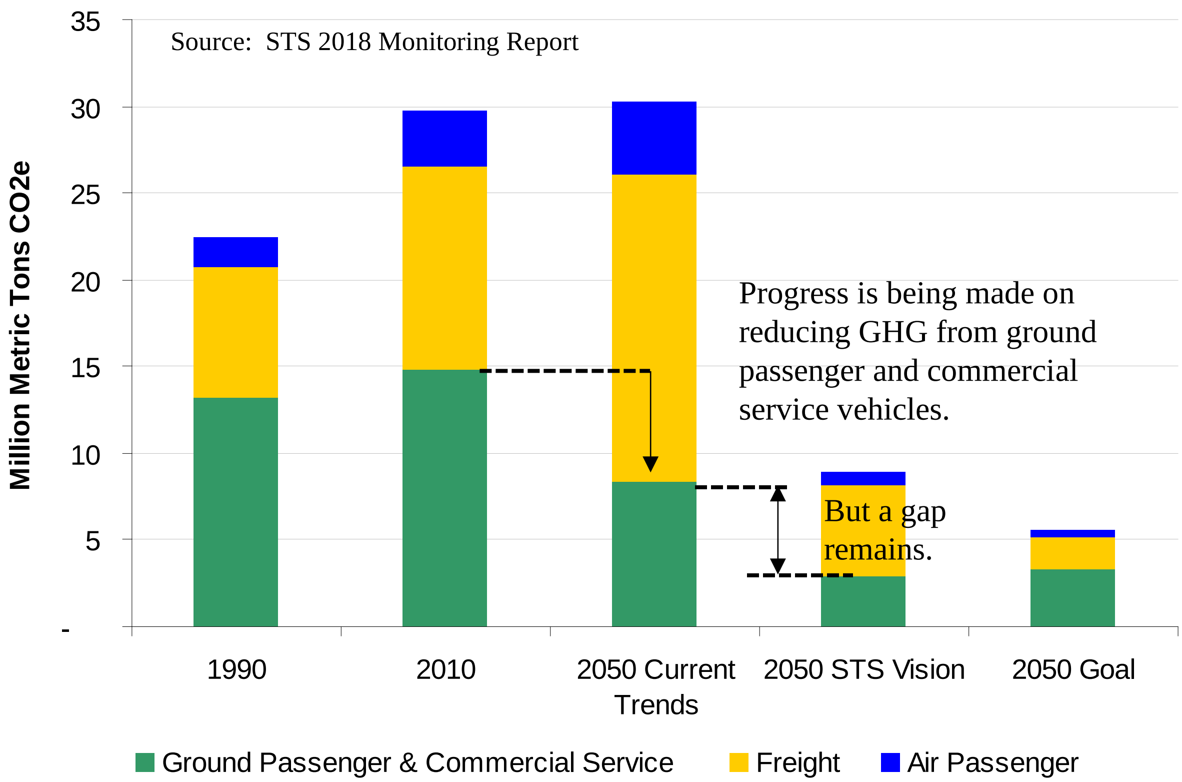
6 LOOKING AHEAD

6.1.1 Addressing the Gap Between Current Plans and Oregon's GHG Goals

Oregon as a state will need to reduce overall annual transportation related GHG emissions by roughly 22 to 25 million metric tons of carbon dioxide equivalent to achieve the state's goals by the year 2050.

Regional and local governments have more influence on strategies associated with ground passenger vehicles and light duty delivery trucks than on heavy freight and air transportation. An STS analysis of current trends (Figure 8) indicates that significant strides toward GHG reduction goals for ground passenger vehicles and light duty trucks are anticipated by 2050. This is chiefly because electric vehicle rollout for passenger vehicles is expected to outpace fuel technology innovations for other modes. Nonetheless, a gap remains, and further strategies across many authorities will need to be implemented to meet the state's vision for 2050.

Figure 8. Progress Toward Oregon's GHG Vision



For light-duty ground transportation modes, addressing the gap between the STS Vision and Plans & Trends, as reported in the STS-Monitoring report, will require a mix of statewide policies related to vehicles and fuel, system operations, transportation options and pricing. (Figure 9 and Figure 10).

Figure 9. Gap Between STS Vision and Current Trends

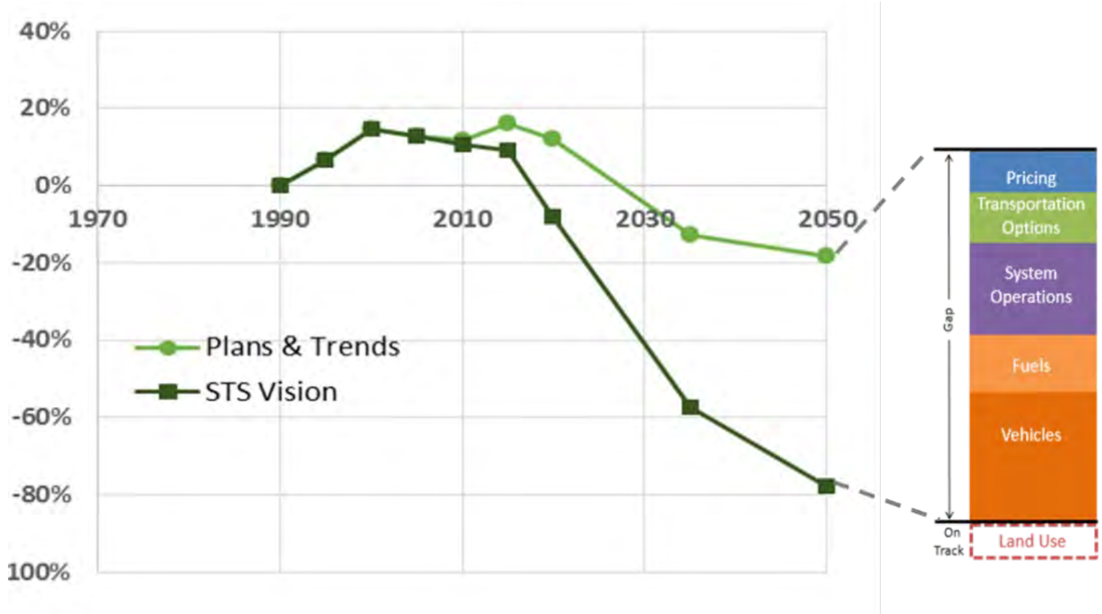
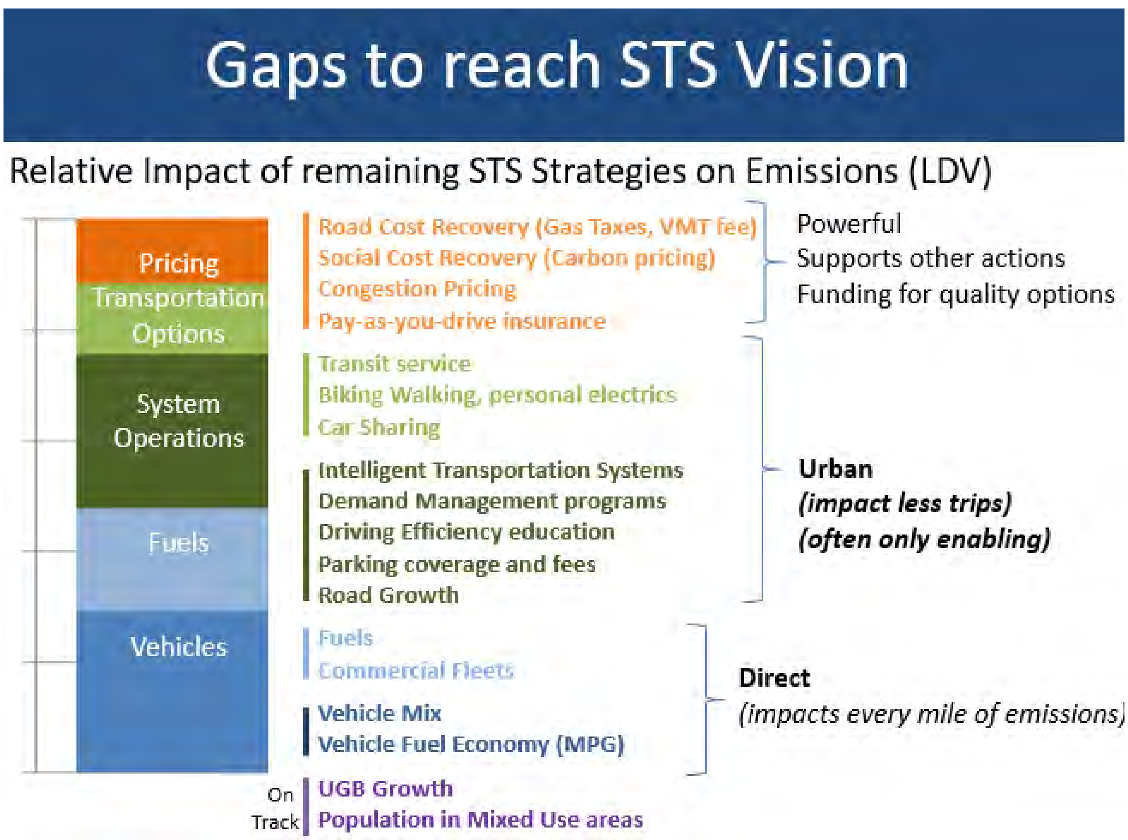


Figure 10. Addressing the Gap to Meet the STS Vision



6.1.2 Inter-Relationships Affecting GHG Reduction Planning

Government agencies at different levels each have a role to play in achieving the STS vision. And, while governments can enable behavioral choices through investments in infrastructure and policies that provide incentives and disincentives, ultimately consumers and businesses determine GHG levels through their choice of home and work locations, vehicle purchase decisions, mode choice, and travel distances.

6.1.3 Shared Responsibilities

While we have gathered some understanding of roles and responsibilities in GHG production, further analysis is needed to support concepts for sharing the GHG mitigation burden among various economic sectors, geographies, authorities, and project contexts. Given future uncertainties, roles and responsibilities may not be static. Rather, flexibility will likely be needed with opportunities to revisit and adjust roles and responsibilities as we learn more over times. Some initial concepts for data to support these burden sharing concepts are outlined here.

<u>Sector burden</u>. The STS lays out a clear roadmap for reducing state GHG in the transportation sector, and comparable roadmaps for other sectors do not exist to date. However, from financial or political standpoints, GHG reductions may be easier to achieve in one economic sector than another. For example, non-transportation sectors may be able to take on a disproportionately larger share of mitigation responsibility, allowing a lower mitigation burden for the transportation sector.

Policy makers may also need information to help deal with uncertainties in policy effectiveness. For example, within the transportation sector, Oregon's Metropolitan Greenhouse Gas Reduction Targets allow metropolitan regions to include credit for ambitious state-led actions such as vehicle and fuel technology shifts that lead to less GHG reduction per mile driven. If legislation necessary for that broad paradigm shift on vehicles and fuel or pricing is hindered, or federal fuel efficiency standards are rolled-back, the importance of collective action by state, regional, and local governments, and potentially other sectors across Oregon will increase. Conversely, if more GHG reduction can be accomplished through vehicle and fuel related strategies, less action may be needed from state, regional, county and city governments.

<u>Varied burden by transportation mode</u>. Looking at ground transportation, heavy duty freight vehicles are anticipated to lag light duty vehicles in the implementation of electric vehicle and alternate fuel technology. So, a disproportionate share of the mitigation burden may fall on the light duty fleet, at least in the near term.

Strategies and ongoing actions aimed to reduce freight emissions as well as commercial delivery and transit vehicles, could be shared and communicated in local plans. (Transit vehicles are increasingly moving to cleaner technologies but drive fewer miles than other vehicle groups.) More analysis is needed to forecast GHG by <u>all</u> modes over time.

<u>Varied burden for state, regional and local transportation agencies.</u> Authorities for implementing the STS Vision are split across state, regional, and local actions. The Governor's Executive Order 20-04 outlines a mix of authorities for transportation related GHG actions, such

as clean fuels strategies led by DEQ and electric vehicles adoption led by ODOE. Other actions recommended in the STS, such as cap and trade concepts or fuel taxation, require legislative action.

Collaboration is required as no one level of government alone can mitigate GHG to target levels. However, within the range of governmental entities with transportation jurisdiction, some agencies may be in position to have a larger influence over GHG emissions than others.

Regional and local governments are best positioned to implement other strategies such as land use planning, multi-modal options (transit, bike, walk, car sharing), congestion management (ITS, road growth), and urban pricing policies (congestion pricing, parking fees, local gas taxes and registration fees). Many of these have less direct impact on GHG on their own but are important to enable implementation of other policies with greater impacts. For example, providing multi-modal options in urban areas may or may not change how a person chooses to travel depending on the cost and quality of other mode options. But multi-modal options have significant value in helping to address equity issues that may surface with implementation of pricing policies.

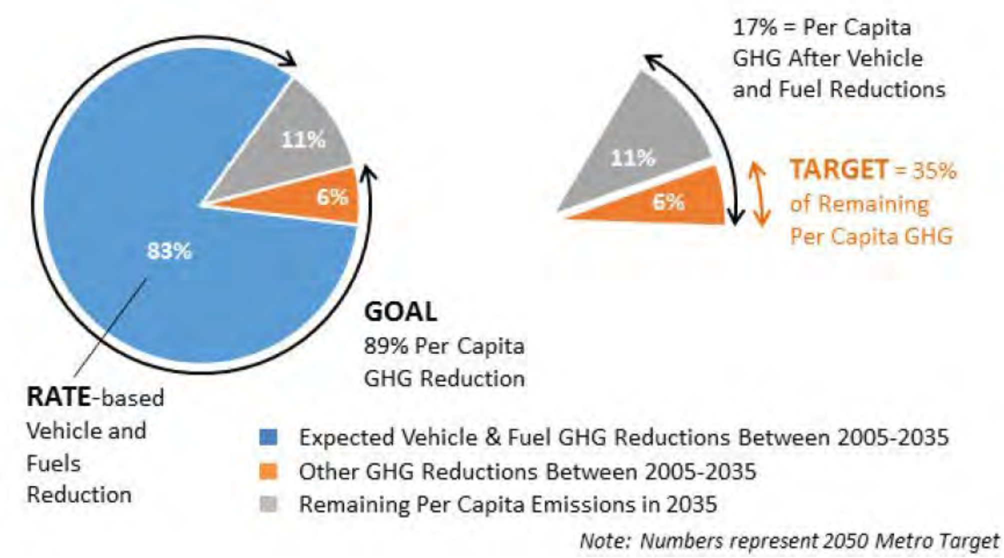
Analysis is starting to help us understand authorities for the light duty household-based vehicle emissions. For example, the STS found that vehicle and fuel policies, and many pricing policies, are important for <u>all</u> areas to meet GHG goals. Federal and state governments have the greatest influence in these policy areas. Because vehicle and fuel technologies are largely outside the policy purview of MPOs, benefits from these strategies are excluded in the GHG targets set for metropolitan areas (Figure 11). The remaining local actions primarily result from VMT reduction through pricing policies, shorter trips, and robust multi-modal transportation options.

More analysis will likely be needed to understand the role of emerging modes on GHG, both micro-mobility and connected/automated vehicles, as well as incentives and disincentives for pricing to achieve public goods, e.g., limit vehicle miles travelled, and maximize use of low-carbon vehicles. Resource limitations may require analysis to better focus investments, e.g., EV subsidies for non-urban households with fewer multi-modal options and longer trip lengths.

<u>Geographic context</u>. Strategies for mitigating GHG are context sensitive. Due to geography and supportive conditions, some locations or agencies may have greater success with a given mitigation strategy than others. In the past, governmental resources (and thus responsibilities) are often distributed between state, regional and local government according to population. However, draft Oregon Cap and Trade legislation debated in 2019 suggested GHG reduction take a different approach, implementing regulation on large urban areas first, suggesting a sliding scale of responsibility according to the amount of impact that can be made by each level of government. Policy leaders may ask for further analysis to assess the impact of such policy approaches.

Similarly, Oregon's GHG planning and target setting processes are focused on metropolitan areas, and no equivalent processes currently exist for small urban and rural areas. Metropolitan areas contain roughly 60% of the state's population and 70% of employment, justifying a focus on these areas.

Figure 11. Calculating Metropolitan Area Target from the Goal[28]



Source: Scenario Planning Guidelines Appendix

[28] Figure 12 shows how a GHG reduction *target* is calculated from the per capital emissions reduction *goal* and the forecast for reduction in the light vehicle emissions *rate*. This example is for the Portland Metro region.

The circle represents total metropolitan area per capita emissions from light duty vehicles in 2005. The overall goal is to reduce per capita emissions by 89% from 2005 to 2050.

The blue slice indicates the reduction in per capita emissions due to advances in vehicle and fuel technology. In Metro's case, the forecasted change in the emission rate would reduce total per capita emissions by 83%. 17% of the original total (100% - 83%) would remain if no further action were taken.

An additional 6 percentage point reduction is thus necessary to meet the overall 89% reduction goal (89% – 83%). This 6 percent of total emissions represents ***35%*** of the remaining emissions (6% ÷ 17%) after reductions due to vehicle and fuel advancements are excluded. Thus, 35% is the 2050 Metropolitan *target* for Portland Metro: the percentage reduction in emissions "beyond vehicles and fuels".

7 NEXT STEPS FOR THE OMSC

7.1 Executive Order 20-04 and the OMSC

In the near term, state agencies represented on the OMSC will be working under swift timelines to address the requirements of Governor Brown's Executive Order 20-04. The OMSC's GHG subcommittee and other OMSC forums may serve as sounding boards for agencies as they develop analysis methods and guidance to support near-term processes aimed at GHG reduction.

Specific topics in the Executive Order for which interaction between the OMSC and responsible state agencies may be particularly helpful, including:

- Work by ODOT to develop and apply a process for evaluating the GHG emissions implications of transportation projects as part of its regular Statewide Transportation Improvement Program processes.
- Work by ODOT, DEQ, DLCD and ODOE to establish GHG emissions reduction performance metrics.
- Work by DLCD and ODOT to implement local planning guidelines for GHG emission reductions.
- Work by DEQ to amend low carbon fuel standards and implementation schedule and actions to cap and reduce GHG emissions from transportation fuels (this information may be helpful in establishing future assumptions to be used in transportation related GHG analysis tools).

The near-term work currently underway by state agencies should provide a good foundation for the GHG Subcommittee to make longer-term recommendations for the OMSC. The subcommittee can make the most of these near-term efforts by:

- <u>Understanding background, definitions, and context setting</u>. Subcommittee members can help promote a common understanding of terms and GHG analysis issues, by educating themselves and others on the concepts outlined in this white paper.
- <u>Participating in a GHG peer exchange</u>. The Oregon Modeling Users Group (OMUG), which serves as the OMSC's outreach arm, is planning a forum for sharing useful case studies of how others have incorporated a GHG lens into planning decisions. Subcommittee members can attend this forum to help build professional knowledge and identify needs and potential best practices for GHG analysis.
- <u>Providing feedback on state agency work related GHG analysis tools and data</u>. Much of the work of state agencies in response to the Executive Order on investment planning parallels OMSC objectives. The GHG subcommittee could assist with:
    - Developing, maintaining, and implementing consistent GHG emission rates to be used in various planning efforts across different regions.

- Developing tools guidance for GHG policy actions that currently lack GHG calculation methods (e.g., actions not covered in traditional tools, construction emissions, projects outside modeled areas).
- Identifying roles & responsibilities for developing, maintaining, and implementing vehicles and fuels pathways that can be used in STS performance tracking (for example, electric vehicle adoption targets) and roll-up into emission forecasts for use in planning.
- Identifying data analysis/needs and next steps, for tackling significant gaps in transportation GHG emissions analysis. This could include heavy duty vehicles, air travel, etc.

7.2 Next Steps for the GHG Subcommittee

7.2.1 Subcommittee Work Plan

Figure 12 briefly summarizes the work outlined in the GHG Subcommittee's Charter, showing next steps.

Following the publication of this white paper, the subcommittee's next deliverable will be an assessment of transportation related GHG analysis needs and gaps.

7.2.2 Developing Subcommittee Recommendations

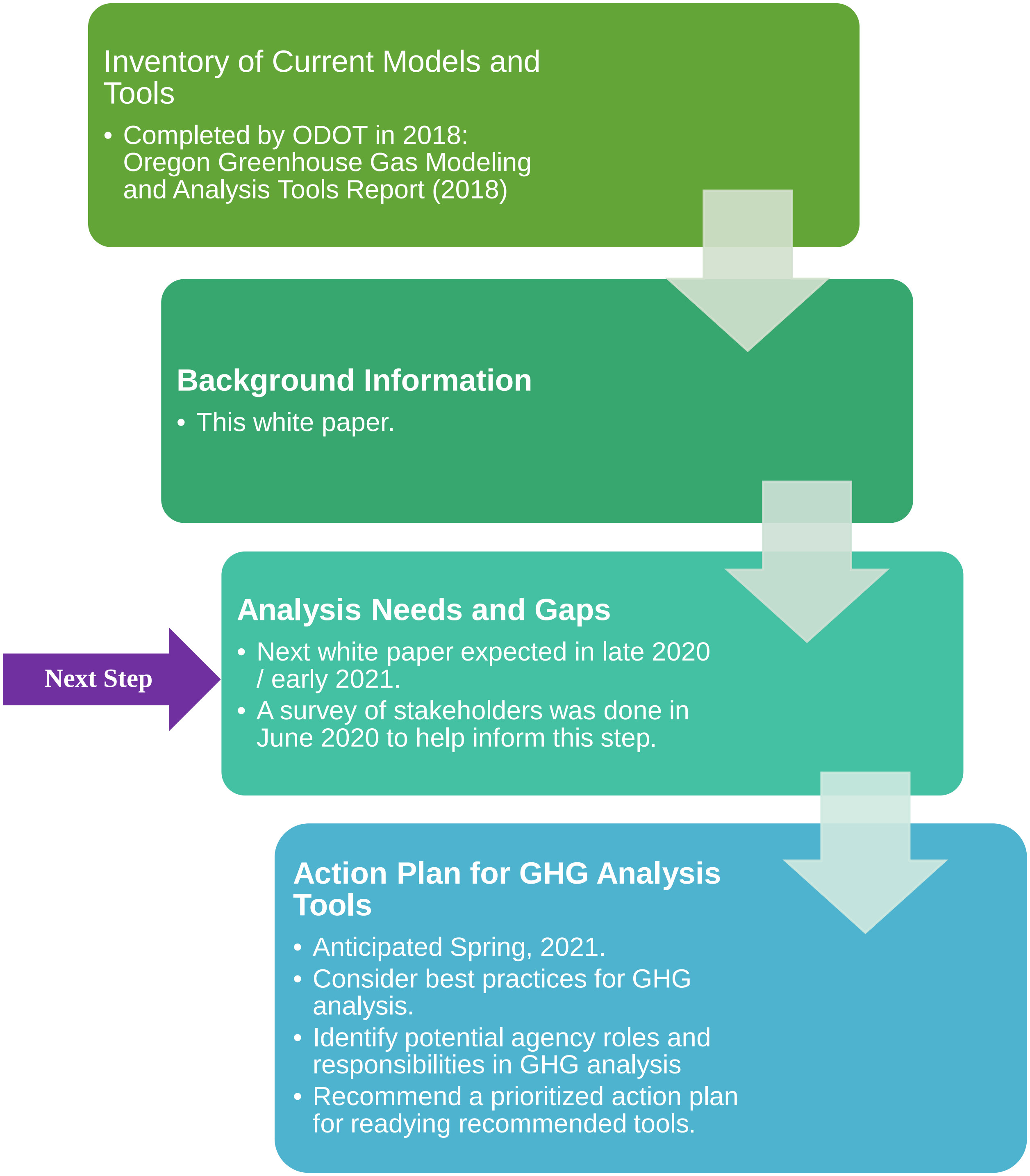
The subcommittee's ultimate deliverable is a prioritized action plan, to be approved by the OMSC's Executive Committee, with recommendations for getting GHG analysis tools ready for implementation. In working to prepare these recommendations, the OMSC's GHG Subcommittee can address key questions such as:

- What are the best tools and processes for forecasting and reporting GHG emissions?
- What common data and inventories will state and local agencies need?
- What potential policies may need analytic support and what best practices in transportation and GHG modeling could support those policy decisions?

7.2.3 Implementing GHG Subcommittee Recommendations

Depending on the technical expertise needed to implement the GHG Subcommittee's recommendations, work to prepare specific analysis tools may be assigned to the OMSC's Technical Tools Subcommittee or farmed out to individual OMSC member agencies. GHG Subcommittee members may be asked to continue to serve as a sounding board during the implementation process.

Figure 12. OMSC GHG Subcommittee Work Plan Overview



8 FURTHER GUIDANCE

The OMSC GHG Subcommittee is tracking relevant resources that may be of interest to the reader. This includes information on national tools, experiences of other states, and Oregon-specific guidance documents and reports. Some highlights are provided below.

8.1 Oregon-Specific Guidance

The Oregon Sustainable Transportation Initiative (OSTI) Greenhous Gas Emissions Reduction Toolkit, available on ODOT's website[29], details individual actions that local and regional governments could consider for reducing transportation related GHG emissions. Several case studies that highlight specific actions taken by cities and transit agencies are also provided.

In addition, Table 5 lists a number of recent planning efforts that may be of interest to those looking for information on processes used to identify strategies and actions for mitigating GHG.

Table 5. Recent Planning Examples with Transportation Related GHG Components

Planning Study	Description
Oregon Statewide Transportation Strategy Monitoring Report, 2018	A recommended short-term implementation plan for the STS was first published in 2014. In 2018, a monitoring report looked back at progress made, and described additional reduction efforts by ODOT.
Metro Climate Smart Strategy, 2014	Adopted in 2014, this strategy fulfilled a mandate by the Oregon Legislature requiring the Portland region to develop and implement a strategy to reduce the region's per capita GHG emissions from cars and light trucks to at least 20 percent by 2035. The strategy included a set of performance measures and monitoring targets for tracking implementation actions and whether the strategy is achieving expected outcomes. Metro's analysis, confirmed in its 2018 RTP, [21] determined they can exceed this target if the region continues to work together to fully invest in plans that Metro and local communities have adopted.
Central Lane Scenario Planning, 2015	The Central Lane MPO (Eugene/Springfield region) examined multiple combinations of land use and transportation strategies to reduce GHG and improve community livability. The process considered planned investments, fleet and fuels, transit, pricing, parking, and roadway infrastructure, and investing beyond existing plans in areas of active transportation, education, and marketing.

[29] Oregon Department of Transportation, Planning and Technical Guidance, Greenhouse Gas Emissions Reduction Toolkit, retrieved from https://www.oregon.gov/ODOT/Planning/Pages/GHG-Toolkit.aspx, April 23, 2020.

Planning Study	Description
Rogue Valley MPO Strategic Assessment of Transportation and Land Use Plan, 2016	This study was a voluntary assessment of adopted local and regional land use and transportation plans, to estimate the likely outcomes of these plans on several community and livability factors, including GHG. It assessed how close the region's existing plans come to meeting the state's GHG emissions reduction target.
Corvallis Area MPO Scenario Analysis Report, 2016	The Corvallis metropolitan area underwent a two-phase scenario analysis process, beginning with a strategic assessment to determine the trajectory of current plans. This was followed by scenario planning exercises that looked at the effects of different potential policy changes, both in isolation and in combination with other potential policies.
Bend Community Climate Action Plan, 2019	This planning process addressed multi-sector GHG reductions from buildings, fuels, waste disposal and local industrial processes. Transportation related elements included reducing fossil fuel consumption for travel by supporting a transition to electric vehicles; increasing non-motorized travel, transit trips and car sharing; and conversion of public agency vehicle fleets to electric and alternative fuel technologies.
Additional Climate Action Plan Examples	Several other local agencies in Oregon have developed climate action plans with transportation components. Examples include the cities of Portland (2015), Corvallis (2016), Ashland (2017), Milwaukie (2018), and Eugene (2020).

8.2 National and International Guidance

The National Cooperative Highway Research Program (NCHRP) is developing a guidebook for state DOTs, outlining methods for reducing GHG emissions from the transportation sector.[30] This guidebook, scheduled for publication in Fall 2020, is anticipated to provide processes and strategies that can be implemented at appropriate points throughout the cycle of policy making, planning, programming, project development and project implementation.

At the international level, the need for global consistency in GHG quantification methods is being promoted by an international group led by the World Resources Institute, known as the GHG Protocol.[31] The GHG Protocol emphasizes six core principles, listed in Table 6, that should underpin all aspects of GHG accounting, quantification and reporting. The OMSC could

[30] National Cooperative Highway Research Program Report 25-56 [Active], *Methods for State DOTs to Reduce Greenhouse Gas Emissions from the Transportation Sector*. Abstract information retrieved from https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4384, April 27, 2020.
[31] Greenhouse Gas Protocol, https://ghgprotocol.org/

consider embracing these principles when recommending approaches for GHG analysis in Oregon.

Table 6. The GHG Protocol: GHG Accounting Principles

The GHG Protocol GHG Accounting Principles	
Relevance	**Use data, methods, criteria, and assumptions that are appropriate for the intended use of reported information.** The quantification and reporting of GHG reductions should include only information that users—both internal and external -- need for their decision-making.
Completeness	**Consider all relevant information that may affect the accounting and quantification of GHG reductions and complete all requirements.** That is, all GHG effects of a proposed action should be considered.
Consistency	**Use data, methods, criteria, and assumptions that allow meaningful and valid comparison.** The credible quantification of GHG reductions requires that methods and procedures used to assess a given action are always applied in the same manner, and that data collected and reported will be compatible enough to allow meaningful comparisons over time.
Transparency	**Provide clear and sufficient information for reviewers to assess the credibility and reliability of GHG reduction claims.** Transparency is critical for credibility. Information should be compiled, analyzed, and documented clearly and coherently. Specific exclusions or inclusions should be clearly identified, assumptions explained, and references provided for all data and assumptions used.
Accuracy	**Reduce uncertainties as much as is practical.** Acceptable levels of uncertainty will depend on the objectives of a given action and the intended use of quantified GHG reductions. Greater accuracy will generally ensure greater credibility. Where accuracy is sacrificed, data and estimates used to quantify GHG reductions should be conservative.
Conservativeness	**Use conservative assumptions, values, and procedures when uncertainty is high.** GHG reductions should not be overestimated. Where data and assumptions are uncertain and where the cost of measures to reduce uncertainty is not worth the increase in accuracy, conservative values and assumptions should be used. Conservative values and assumptions are those that are more likely to underestimate GHG reductions.
Source: Adapted from World Resources Institute and World Business Council for Sustainable Development, *The GHG Protocol for Project Accounting.* **https://ghgprotocol.org/sites/default/files/standards/ghg_project_accounting.pdf**	

2020 STATEWIDE CONGESTION OVERVIEW

September 10, 2020
Revised May 2022

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This report was originally published September 10, 2020. Errors were discovered in the VMT time series data and corrected within this revised addition.

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2020 STATEWIDE CONGESTION OVERVIEW

CONTENTS

Executive Summary

Supporting the daily activity of Oregon businesses and residents is key to the mission of the Oregon Department of Transportation (ODOT). Policy-makers must make strategic choices about how and where resources are spent. Effective solutions require an understanding of how travel affects people's lives and the economy. As Oregon grows, congestion in urban centers rises, which impacts mobility. When making transportation choices, businesses and people consider cost, time, safety, and reliability. It is important to understand the economic motivations behind travel, mobility and congestion in order to develop effective policies and strategic investment plans. For the purpose of this report, mobility means having quality transportation options that enable businesses and people to safely fulfill needs within budgets for time and money. Mobility directly impacts the quality of life for Oregonians every day. ODOT must understand factors underlying mobility in order to develop effective means to optimize system performance and support a sustainable economy, while serving the needs of a diverse set of individual users.

The purpose of this report is 3-fold:

- Identify factors affecting transportation demand in a manner that informs policy development,
- Quantify system use, measure how much the system is used, provide context with respect to system capacity and condition,
- Measure the quality of system performance, identify how well the system functions and report congestion issues.

Mobility directly impacts the quality of life for Oregonians every day.

The Economy

A well-functioning transportation system is foundational to a robust economy. Oregon has experienced significant economic growth over the last 20 years. **Figure S1** illustrates change in population, employment and vehicle miles traveled between 2000 and 2018:

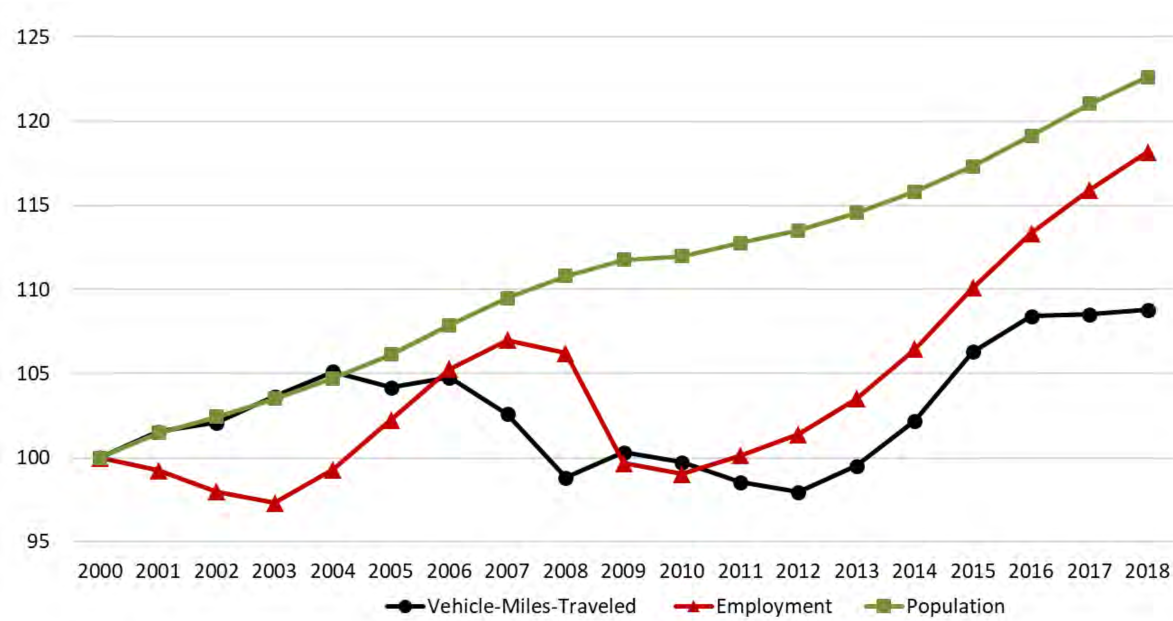
- Oregon population increased 23 percent, from 3.4 million people to 4.2 million.
- Oregon employment increased 18 percent, from 1.6 million to 1.9 million.
- Vehicle-miles-traveled (VMT) in Oregon has increased 8.8 percent.

Over this 19 year period there were two recessions, one in 2001 (8 months) and the Great Recession of 2007-2009 (18 months). During these recessions employment declined, unemployment rose, population continued to grow, but at slower rates. VMT rose 5% between 2000 and 2004, followed by a decline during the Great Recession. VMT remained at or below year 2000 levels until 2014, rising to statewide VMT 8.8% higher than year 2000 By 2012 the Oregon economy was in full recovery: population began to grow faster and employment began rising faster than population. The fact that

Economic conditions affect population and employment, which impacts travel.

VMT is rising slower than population indicates household travel choices may be changing, trips are conserved, trip distances may be shorter and non-auto modes are utilized more than in the past. The change in patterns may be in response to rising congestion levels, or indicate a change in choices and attitudes.

FIGURE S1. OREGON POPULATION, EMPLOYMENT AND VMT OVER TIME: 2000-2018

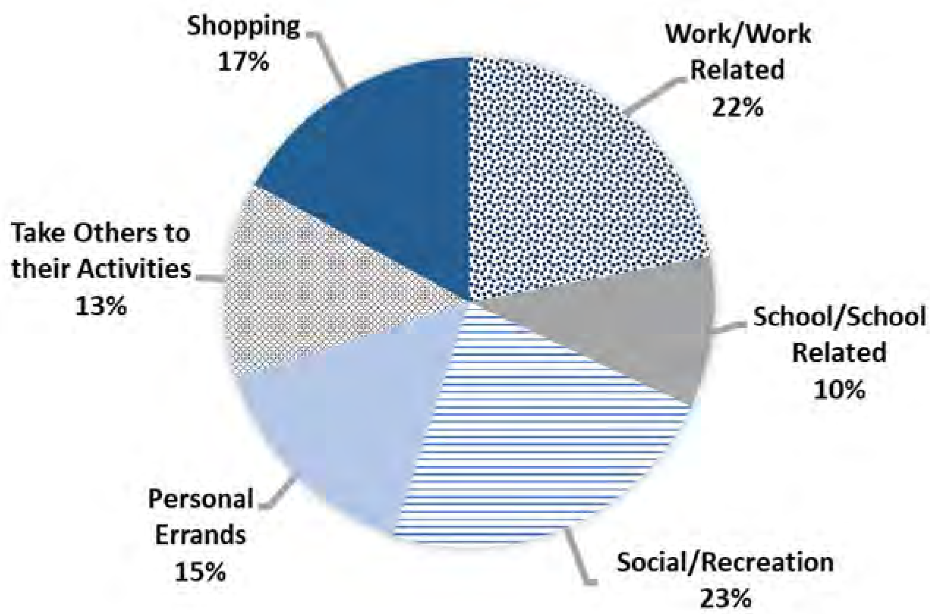


Household Economic Activity

Individual household activity varies depending on characteristics such as household size, age, income, number of workers, and presence of children. Travel occurs for a variety of reasons, presented in **Figure S2**. According to the most recent Oregon statewide household activity survey, about 55 percent of trips are for social/recreational activity, shopping and personal errands. Twenty-two percent are for work or work-related, while 23 percent are for school, school-related, or escorting others for their activity (e.g., children, elderly).

Each household has different mobility needs that rely on transportation.

FIGURE S2. HOUSEHOLD TRAVEL TRIP PURPOSE – STATEWIDE AVERAGE WEEKDAYS



Commercial Economic Activity

Individual businesses have diverse transportation needs which vary across the industry within which they operate. However, they all need access to workers, materials and services to support production activity, and markets where their goods and services are sold.

One aspect of commercial activity involves freight movement in heavy trucks, consisting of a large variety of commodities used in different ways across industries. Oregon freight moves predominantly by heavy truck, 70 percent of freight moves by truck, while other freight modes such as rail, air and marine depend on trucks for the first and last mile. Freight movement supports Oregon trade, our top trading partners include Washington, California, Idaho, Minnesota and Texas, which rely on trucks.

Another aspect of commercial activity involves medium trucks, used for commercial activity, trade services such as plumbing, electricians, roofing, painting and other construction; as well as local deliveries for e-commerce, groceries and nursery goods.

Each business has different mobility needs that rely on transportation.

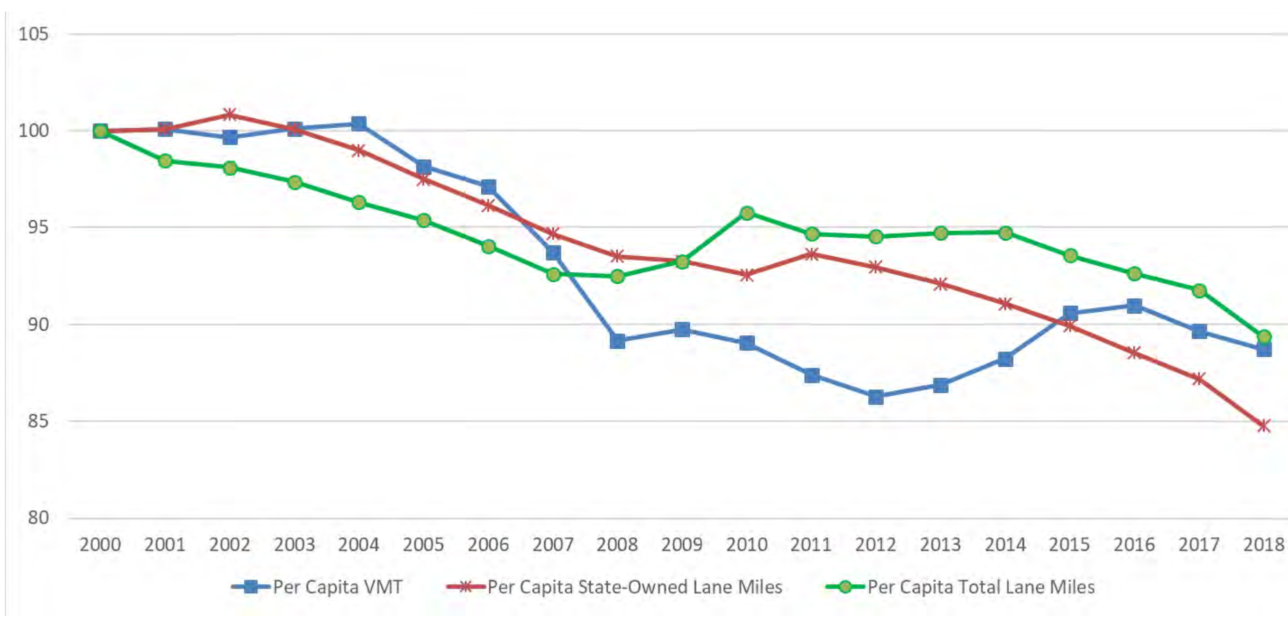
QUANTIFYING USE

Transportation roadway use can be quantified using metrics such as VMT and VMT per capita. Since year 2000, total statewide VMT has risen steadily, while per capita VMT has declined over time. This means the reduction in average VMT per person has not been enough to compensate for overall growth in population and employment, which has led to an overall increase in statewide VMT over the last 19 years. At the same time, the number of system lane miles has not kept pace with increasing use. Since 2000, total state owned lane miles have remained the same, while city and county lane miles increased by 9.5 percent.

Figure S3 illustrates growth in lane miles relative to growth in system per capita VMT, per capita state-owned lane miles, and per capita total lane miles. State-owned highway lane miles make up 18 percent of statewide lane miles and accommodated 59 percent of VMT in 2018, but per capita state-owned lane miles have decreased 15% since 2000. Per capita statewide VMT decreased 15 percent since 2000, while total statewide per capita lane miles decreased 11%. During this time congestion levels have been rising in urban areas where the majority of growth occurs.

Highway system capacity has not kept pace with demand.

FIGURE S3. CHANGE IN PER CAPITA VMT AND PER CAPITA LANE MILES: 2000-2018 (INDEXED TO YEAR 2000)



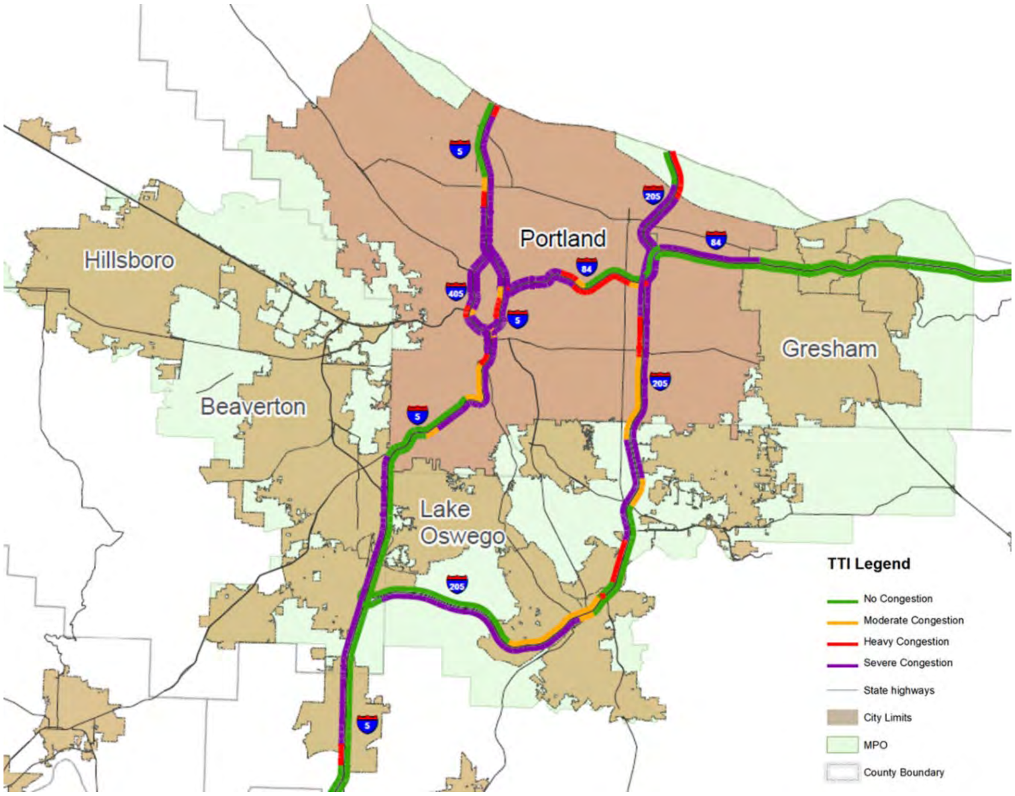
MEASURING QUALITY

As congestion levels rise, the quality of system use is impacted. There are performance measures revealing how well the system operates, the focus of this report is on freeway congestion and reliability. In the future, non-freeway and non-motorized modal information may be added to reporting metrics. Congestion falls into two distinct categories: recurring and non-recurring congestion. According to federal data, recurring congestion relates to bottlenecks and capacity issues which account for 40% of total congestion. Non-recurring congestion relates to less predictable causes, such as traffic incidents, weather, construction work zones and special events.

Effective solutions require a clear understanding of the root cause of congestion, which relies heavily on timely observed data. Measuring quality includes metrics looking at peak period travel times, using the Travel Time Index (TTI) and the Planning Time Index (PTI) to measure congestion and reliability. **Figure S4** illustrates afternoon peak period congestion for the Portland region using the TTI. The most severe congestion occurs in the Portland metropolitan area, which experiences multiple hours of congested conditions on a daily basis. As the state grows, congestion is expected to become more severe and spread beyond typical peak periods in many areas of the state.

Congestion is an urban issue, predominantly in the Portland Metro region, but rising in other urban areas.

FIGURE S4. PORTLAND REGION, TRAVEL TIME INDEX 2017, PM PEAK PERIOD 4 PM - 6 PM



CONCLUSION

As Oregon continues to experience economic growth, there will be increased demand for people and goods to move around using the transportation system. Most of the severe congestion occurs in the Portland Metropolitan area today. However, despite the downward trend in per capita VMT, continued statewide growth will likely lead to rising congestion in Portland and other urban regions of the state spreading beyond the typical peak periods.

Managing the Oregon transportation system effectively is complex, especially given the varied needs of diverse users while ensuring travel is as safe as possible. Making data-driven decisions will better reveal root causes and lead to developing effective solutions.

INTRODUCTION

1.1 Travel Mobility

Supporting the daily lives of Oregon businesses and residents is key to the mission of the Oregon Department of Transportation (ODOT). Policy-makers must make strategic choices about how and where resources are spent. Effective solutions require an understanding of how travel affects people's lives and the economy. It is important to understand the economic motivations behind travel, mobility and congestion in order to develop effective policies and strategic investment plans. As Oregon grows, congestion in urban centers rises, which impacts mobility.

Answering the question "what is mobility" is not as simple as it initially appears, mobility is not synonymous with transportation. The Mobility Lab[1] describes having mobility is having access to the places needed to fulfill a rich and satisfying life, such as a job, schools, medical services, shopping, parks, and personal amenities such as seeing your kid's game after work. In this sense, mobility means having quality transportation options enabling businesses and people to safely fulfill needs within budgets for time and money. Mobility directly impacts the quality of life for all Oregonians every day.

Roadways are preserved and maintained by multiple agencies, ODOT, counties and cities, covering more than 74 thousand lane miles.[2] Oregon has over 4.1 million registered vehicles: about 80 percent are passenger vehicles and 20 percent commercial[3]; 3.1 million licensed drivers, which is about 70 percent of the state population. The ability for businesses, freight and people to move throughout the state depends on having robust transportation infrastructure.

Mobility means having quality transportation options that enable businesses and people to safely fulfill needs within budgets for time and money

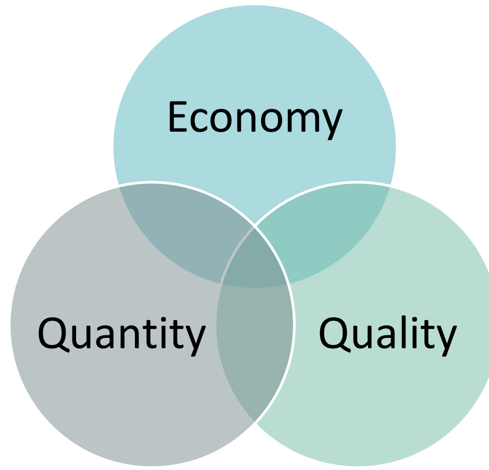
When making transportation choices, businesses and people consider cost, time, safety, and reliability. In order to support Oregon's quality of life, ODOT must understand factors underlying mobility in order to manage safety, develop effective means to optimize system performance, support a sustainable economy, while serving the needs of a diverse set of individual users.

[1] https://mobilitylab.org/2018/07/26/what-is-mobility/
[2] 2018 Oregon Annual Mileage Report: https://www.oregon.gov/odot/data/pages/road-assets-mileage.aspx#OMR
[3] DMV Key Facts online

1.2 How Do We Evaluate Roadway Mobility?

The "ease" of moving on Oregon's highway system can be examined from several different vantage points:

- **Economy:** Economic activity generates demand for transportation systems. What factors impact travel demand? Why is a well-functioning transportation system important to the Oregon economy?
- **Quantity:** How many people use the freeway system? How much freight is transported on our freeways? Are businesses able to access customers? Are customers able to access businesses?
- **Quality:** How well are people and goods being transported on the system? What is user perception of freeway operation? How reliable is the system - where is congestion associated with incidents, such as crashes, weather, and other activity?



Looking at mobility from multiple perspectives provides a more holistic view of system performance.

Section 2 of this report highlights the fundamental role played by the Oregon economy, revealing different market forces related to day-to-day decisions impacting the overall use of the transportation system. Section 3 presents performance measures on the quantity and quality of system use and performance.

1.3 Purpose of this Report

Managing the transportation system effectively is challenging and complex. Information on system performance will position ODOT to gain a deeper understanding of statewide mobility issues. Fact-based, data-driven reporting provides information supporting transportation policy development and long range planning. The purpose of this report is to support data-driven development of transportation policy and investment, with a focus on three areas:

- Economic context, identify factors affecting transportation demand in a manner that informs policy development,
- Quantify system use, measure how much the system is used, provide context with respect to system capacity and condition,
- Measure the quality of system performance, identify how well the system functions and report congestion issues.

Data sources, technical methods and procedures have been developed and vetted for reporting on freeways, which is the focus of this report. This approach is designed for high-level statewide monitoring with the intent to inform long range planning efforts, such as the Oregon Transportation Plan[4] and Oregon Highway Plan[5]. This report can also support regional planning and analysis, such as the information prepared for the ODOT "Portland Region Traffic Performance Report"[6], which evaluates corridor performance. This type of reporting requires development of performance measures, high-quality observed data and technical methods to produce statistically valid results. This report presents information based on currently available data and reporting methods.

The purpose of this report is to support data-driven development of transportation policy and investment.

2 The Role of the Economy in Mobility

Is freeway mobility changing because Oregonians are making different business, lifestyle and travel choices, or are business, lifestyle and travel choices changing in response to congestion and delays on our freeways? It is likely both are occurring simultaneously. Complex economic relationships between freeway mobility and travel behavior are continually in flux and have long created challenges for transportation analysts. Land use characteristics such as density, accessibility, and travel mode connectivity influence where businesses and households choose to locate.

This section takes a look at several high-level indicators related to the movement of people, goods and services in Oregon. Economists refer to transportation as a "derived demand" because demand for transportation is mostly derived from demand to access goods and services. **Figure 1** illustrates how economic activity of households and businesses generates demand for transportation. Thus, the economy plays a very large role in the demands on the transportation system, while ODOT has very limited influence on transportation users' choice and economic behavior.

[4] https://www.oregon.gov/odot/planning/pages/plans.aspx
[5] https://www.oregon.gov/odot/planning/pages/plans.aspx#OHP
[6] 2018 report is available here: https://www.oregon.gov/ODOT/Projects/Project%20Documents/2018TrafficPerformanceReport.pdf

Figure 1. Transportation as a Derived Demand

ECONOMIC ACTIVITY			
Household Production/Activity		**Business Production/Activity**	
Workers - Earn Income	Attend School	Hire Workers	Produce Goods
Consume Goods	Consume Services	Provide Services	Capital Investment

DERIVED DEMAND	
Household Demand for Trips:	**Business Demand for Trips**
Household trips by purpose:	Worker trips destined to job site
Work and work related	Service trips to customers
School and school related	Freight trips coming in and going out:
Social/Recreation	Within Oregon, outbound, inbound
Personal business	Freight by different modes
Shopping	Light, Medium & Heavy Vehicles
Escorting others to their activities (kids, elderly)	Rail, Air, Marine, & Pipeline

2.1 The Economy

Since 2001, the Oregon economy has been expanding faster than the national average[7], attracting more people, jobs and freight movement as it grows. **Table 1** reports vehicle-miles-traveled (VMT) by highway ownership and vehicle weight group. This information was compiled from the Oregon Highway Cost Allocation study, which defines light vehicles as weighing less than 10,000 pounds and heavy vehicles weighing more than 10,000 pounds. In 2018 fifty-nine percent of total VMT occurred on state-owned highways[8], which account for 18 percent of lane miles. City and county roads carried 41 percent of total VMT in 2018, while accounting for 82 percent of Oregon lane miles. The majority of heavy vehicle VMT occurs on the state system (78 percent), while city and county roads carry the remaining 22 percent. About 8 percent of overall statewide VMT is from heavy vehicles, where 10 percent of state-owned highway VMT is from heavy vehicles and 4 percent of non-state highway VMT is from heavy vehicles.

[7] Oregon Center for Public Policy: https://www.ocpp.org/2019/04/18/SWO-strong-economic-growth/ accessed 02/14/2020.

[8] This pattern has been consistent over time. Further detail can be found in Exhibit 4-4 of the 2011 Highway Cost Allocation Study Report available here: https://www.oregon.gov/das/OEA/Documents/2011report.pdf

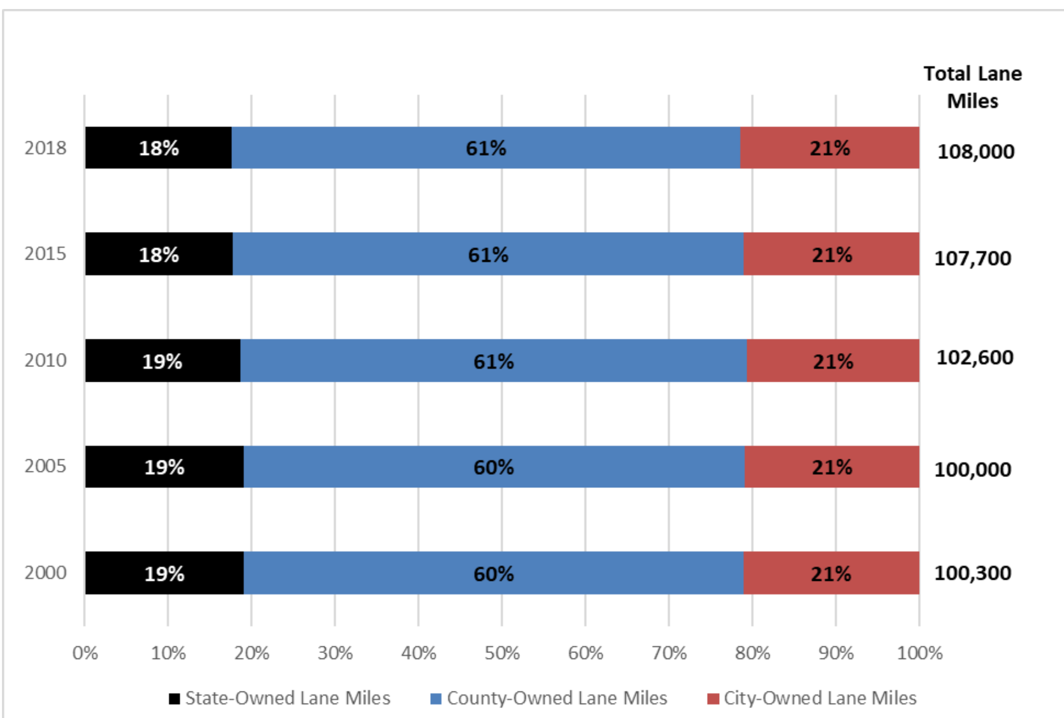
TABLE 1. 2018 VEHICLE-MILES-TRAVELED BY HIGHWAY JURISDICTIONAL OWNERSHIP AND WEIGHT GROUP

	Total VMT, in millions	Percent of Total	Share of Lane Miles	Light Vehicles		Heavy Vehicles	
State Roads	**22,739**	**59%**	**18%**	20,378	57%	2,361	78%
Interstate	10,050	26%					
Non-Interstate	12,688	33%					
Local Roads	**15,796**	**41%**	**82%**	15,118	43%	678	22%
County Roads	8,424	22%	61%				
City Streets	7,372	19%	21%				
TOTAL All Roads	**38,535**	**100%**		**35,496**	**92%**	**3,039**	**8%**

Source: VMT - Highway Cost Allocation Study: 2017-2019 Biennium, Oregon Department of Administrative Services, Office of Economic Analysis; Lane Miles - Highway Performance Monitoring System, ODOT

Major expansion of the national highway system ended with the completion of the Interstate system in 1992[9]. Since this time, Oregon infrastructure investment has focused on relatively small enhancement projects designed to optimize system performance – especially in the areas of safety and reliability, but not adding a large amount of capacity. **Figure 2** reports lane miles by jurisdictional ownership between years 2000 and 2018. Total lane miles increased 7.7 percent over the last eighteen years, most of the change occurred on the local system to accommodate new housing and businesses.[10]

FIGURE 2. OREGON LANE MILES BY OWNERSHIP 2000-2018



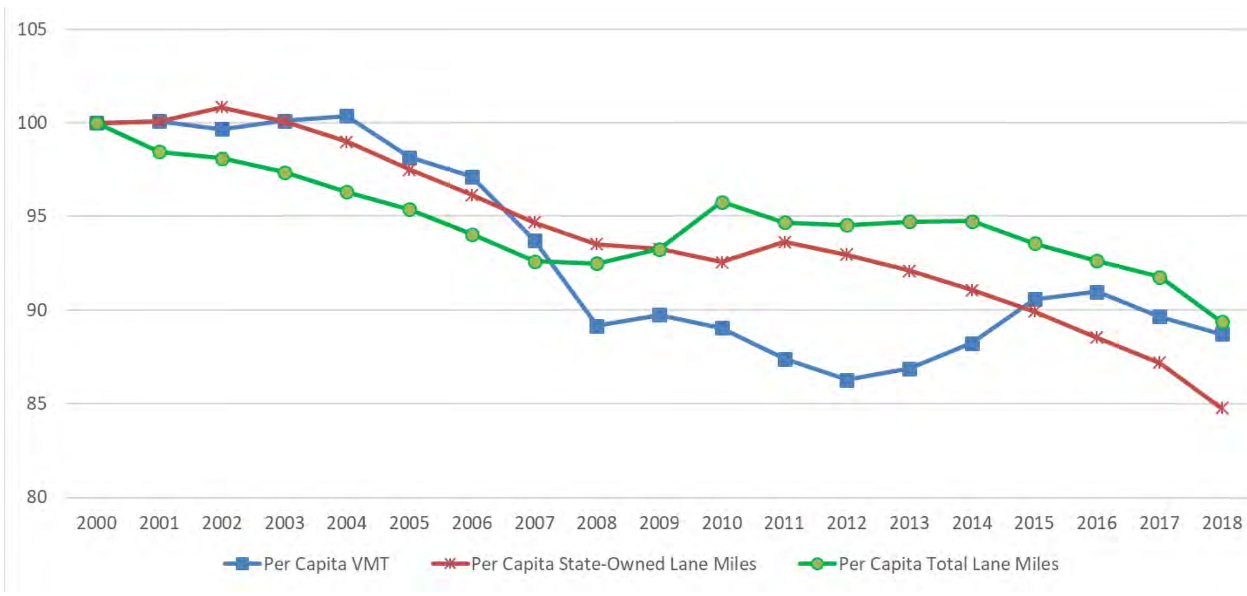
[9] https://en.wikipedia.org/wiki/Interstate_Highway_System accessed 02/14/2020.

[10] State-owned lane miles have remained effectively flat over time, through a combination of jurisdictional transfers, changes in highway configuration and limited construction of new lane miles.

Figure 3 illustrates the change in lane miles and VMT over time relative to changes in population, reported as per capita VMT. These figures are indexed to year 2000 as a reference to illustrate relative change over time. Since 2000, the overall trend in per capita VMT is downward. The Great Recession contributed to lower per capita VMT, but there was some rebound once the economy fully recovered from the recession. By 2018, per capita VMT was 11% lower than year 2000.

Between years 2000 and 2008, population grew 11 percent. New infrastructure is necessary to accommodate this growth, resulting in additional lane miles for city streets and county roads. While, overall population and statewide lane miles have increased, state-owned highway lane miles have remained very close to the same level over time. State highway lane mile capacity accommodates about 60 percent of statewide VMT each year.

FIGURE 3. CHANGE IN PER CAPITA VMT AND PER CAPITA LANE MILES: 2000-2018 (INDEXED TO YEAR 2000)



2.2 Population and Employment

As the Oregon economy grows, greater demands are placed on state highways to accommodate rising levels of freight and people movement, while lane miles increase very little. For this reason, the need to understand and optimize use of highways is key to supporting the Oregon economy.

Historically Oregon has been growing faster than the national average. **Figure 4** illustrates change in population, employment and VMT for years 2000 through 2018. During this time state population increased 23 percent[11], from 3.4 million to 4.2 million. The number of jobs in Oregon rose 18 percent[12], from 1.6 million to 1.9 million. Oregon's economy relies on the transportation system to get goods and

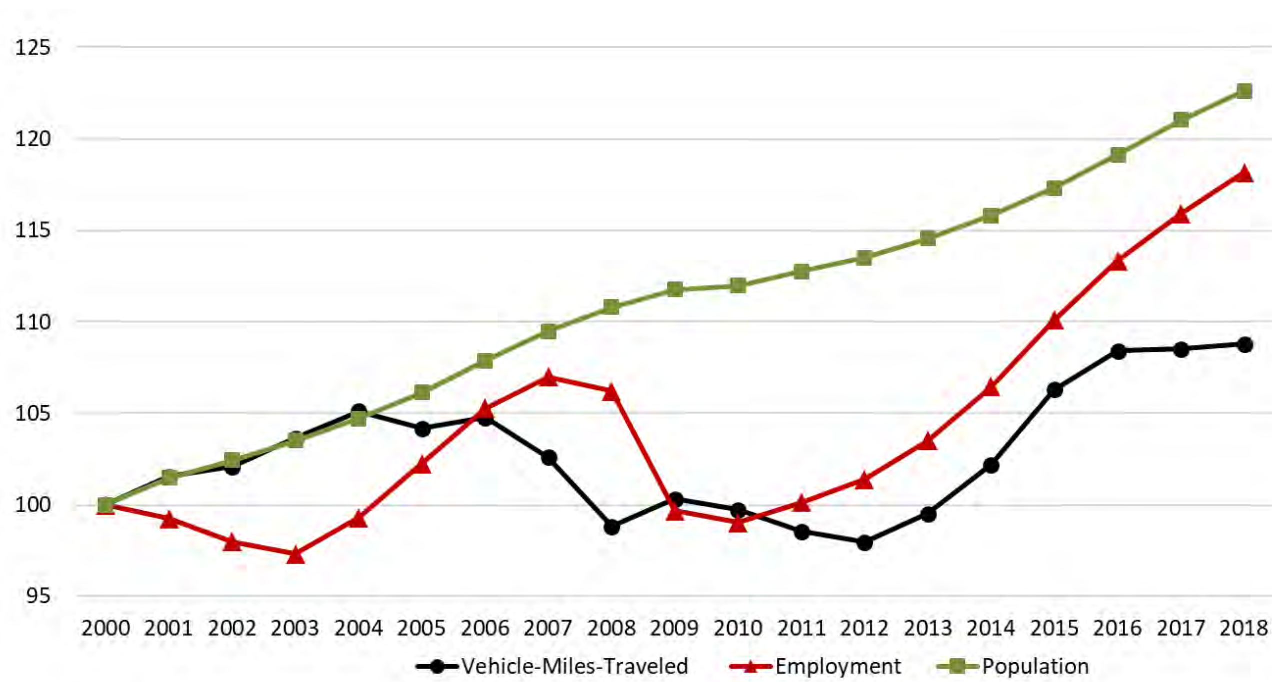
[11] PSU Population Research Center Current Population Estimates data series

[12] Oregon Employment Department, Current Employment Statistics data series.

services to markets, workers to their jobs and consumers to marketplaces. This resulted in total statewide VMT increasing 8.8%[13].

Over this 19 year period there were two recessions, one in 2001 (8 months) and the Great Recession of 2007-2009 (18 months). During these recessions employment declined and population continued to grow, but at slower rates VMT rose 5% between 2000 and 2004, followed by a decline during the Great Recession. VMT remained at or below year 2000 levels until 2014, rising to statewide VMT 8.8% higher than year 2000 By 2012 the Oregon economy was in full recovery: population began to grow faster and employment began rising faster than population. The fact that VMT is rising slower than population indicates household travel choices may be changing, trips are conserved, trip distances may be shorter and non-auto modes are utilized more than in the past. The change in patterns may be in response to rising congestion levels, or indicate a change in choices and attitudes.

FIGURE 4. OREGON POPULATION, EMPLOYMENT AND VMT OVER TIME: 2000-2018



While population growth has occurred in both rural and urban areas of Oregon, the majority of increased population has been in metropolitan areas. **Table 2** reports Oregon population by Metropolitan Planning Organization (MPO) for years 2010 and 2018. Bend MPO has been growing the fastest, increasing nearly 20 percent in population over the last 8 years. Albany MPO and Portland Metro grew 12 percent, while the remaining MPOs grew between 6 and 9 percent, resulting in an overall average increase of 11 percent for Oregon MPOs. Smaller cities and rural areas of Oregon have

[13] FHWA Highway Statistics, Table VM-2; statistics for year 2018 are not currently published

risen steadily over time, 7 percent since 2010. Overall, Oregon's state population has increased 10 percent over the last 8 years.

TABLE 2. OREGON POPULATION 2010 AND 2018, STATEWIDE, MPO, OTHER CITIES AND RURAL AREAS

Geographic Area	Census 2010 Population	July 1, 2018 Estimate	Population Change	Percent Change
Albany MPO	57,714	64,802	7,088	12%
Bend Area MPO, Deschutes Co.	85,305	101,658	16,353	19%
Corvallis MPO, Benton Co.	65,311	71,113	5,802	9%
Eugene-Springfield MPO, Lane Co.	249,800	266,921	17,121	7%
Grants Pass/Middle Rogue MPO	56,560	59,952	3,392	6%
Medford/Rogue River MPO, Jackson Co.	167,895	180,678	12,783	8%
Portland Metro MPO	1,502,867	1,680,169	177,302	12%
Salem-Keizer MPO	243,500	265,121	21,621	9%
Total All Metropolitan Areas	**2,428,952**	**2,690,415**	**261,463**	**11%**
Other Cities and Rural Areas	**1,402,122**	**1,504,885**	**102,763**	**7%**
Oregon Statewide	**3,831,074**	**4,195,300**	**364,226**	**10%**

Sources: Census 2010 - US Census Bureau; 2018 Population Estimates - Population Research Center, Portland State University

2.3 Human Behavior: Moving People and Goods

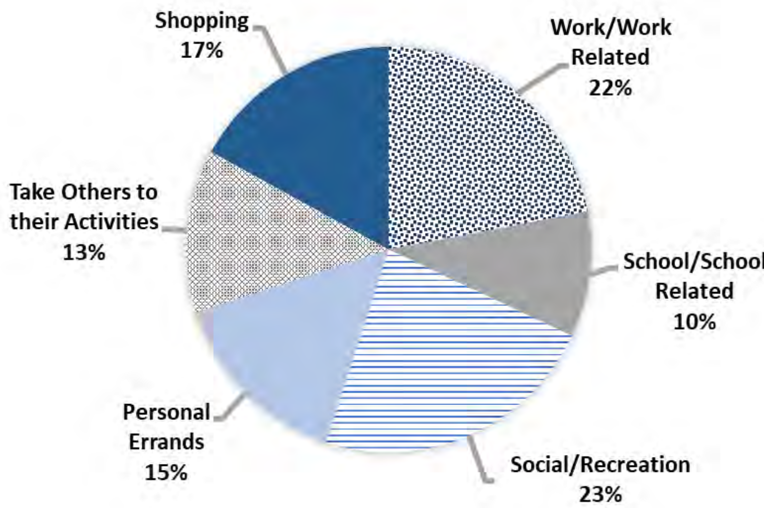
A growing population places additional demands on the highway system as people partake in household activity, such as commuting to work, shopping, household errands, escorting children to school and activities, and recreational travel. A growing economy also places additional demands on the system as businesses hire more workers, demand for services rise, and more freight is moved between businesses and to final markets. Most of Oregon's MPOs are located along the I-5 corridor, with the exception of Bend. For this reason, it is no surprise to see congestion rising on the urban sections of the interstate freeway system.

2.3.1 Household Travel

On an average weekday, households make about 9 trips per day[14]. The number of trips varies by household characteristics, such as age of household members, household size, household income, number of workers, presence of children, and availability of vehicles. The specific purpose varies as well, where some trips are mandatory and others more flexible in terms of time-of-day or day-of-week. **Figure 5** illustrates the average proportion of household trips by purpose statewide.

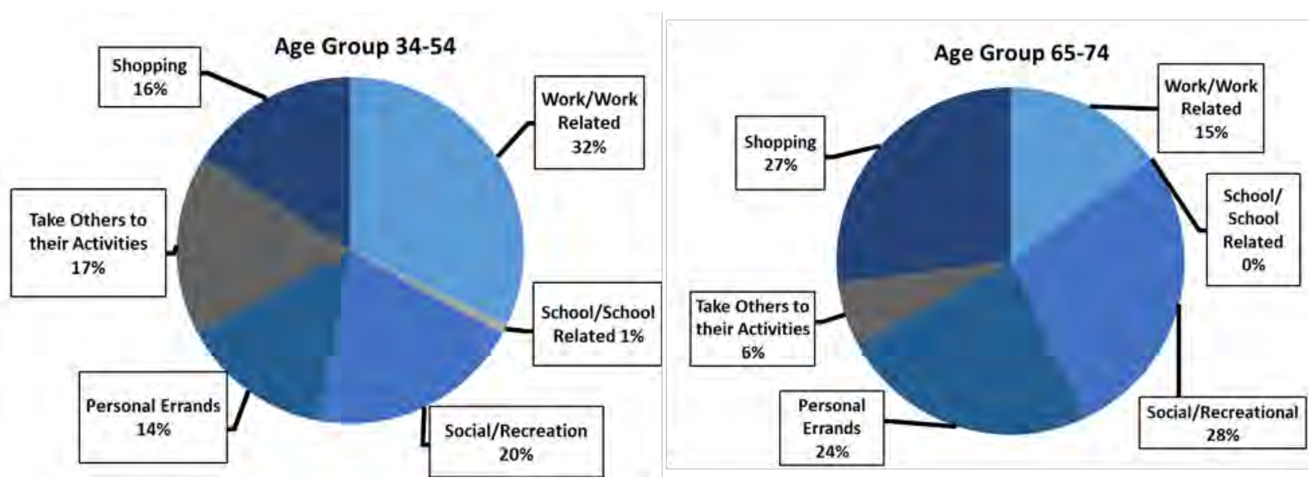
[14] Stacey Bricka (2019), *Personal Travel in Oregon: A Snapshot of Daily Household Travel Patterns*. Accessible on Oregon Department of Transportation website: https://www.oregon.gov/ODOT/Planning/Documents/OHAS-Daily-Travel-In-Oregon-Report.pdf.

FIGURE 5. HOUSEHOLD TRAVEL TRIP PURPOSE – STATEWIDE AVERAGE WEEKDAYS



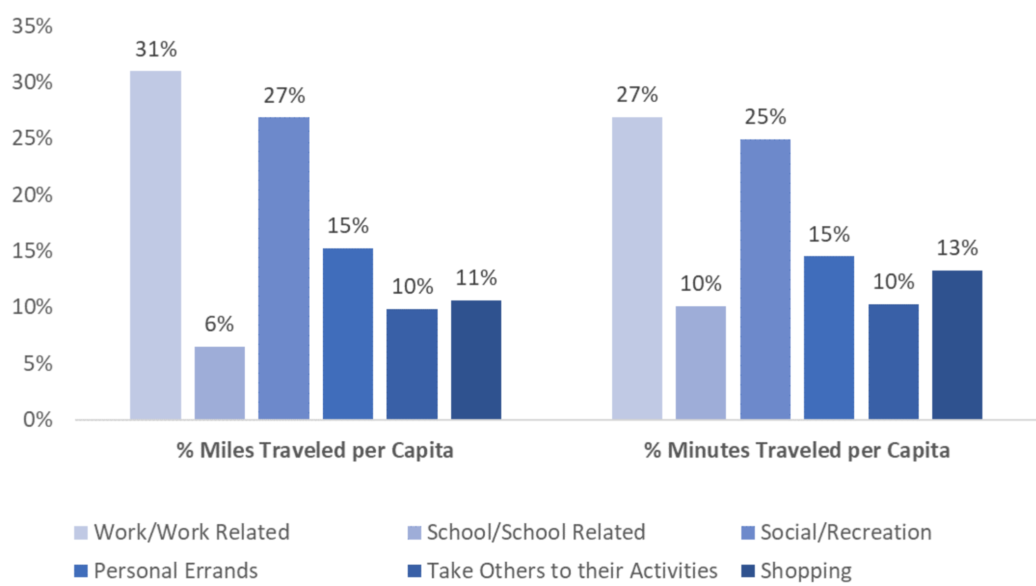
As Oregon's population ages, the overall statewide patterns may change. **Figure 6** illustrates how age impacts travel by comparing two age groups: ages 34-54 and ages 65-74. People in the age group 34-54 have a large share of trips related to work and taking others to their activities, making up nearly half of all trips. People in the age group of 65-74 have a large share of trips related to social/recreation and shopping, making up 55 percent of all trips. Thus, travel patterns vary by household characteristics and these differences are important to understand when developing transportation policy. Travel patterns are continuously changing as new modes become available, such as ride-services (Uber, Lyft), e-bikes, and e-scooters. Utilization of existing options are also likely to change as the system matures, such as bicycling, walking, transit and rising use of online shopping.

FIGURE 6. SHARE OF TRIPS BY PURPOSE FOR AGE GROUPS 34-54 AND 65-74



Household trips vary in terms of distance and time. **Figure 7** illustrates the variation in patterns by distance and travel time for average weekday travel. Work-related travel is typically longer in terms of time and distance, social/recreational trips follow a similar pattern. School-related trips are generally the shortest in terms of distance, since households are typically located fairly close to schools. Trips involving personal errands, shopping and taking others to activities as a group make up nearly 40 percent of travel in terms of time and distance combined, but each trip has different needs related to reliability and ability to avoid congested time periods This reveals the complexity associated with managing the highway system and developing public policy to meet the diverse needs of personal travel.

FIGURE 7. TRAVEL TIME AND DISTANCE BY TRIP PURPOSE

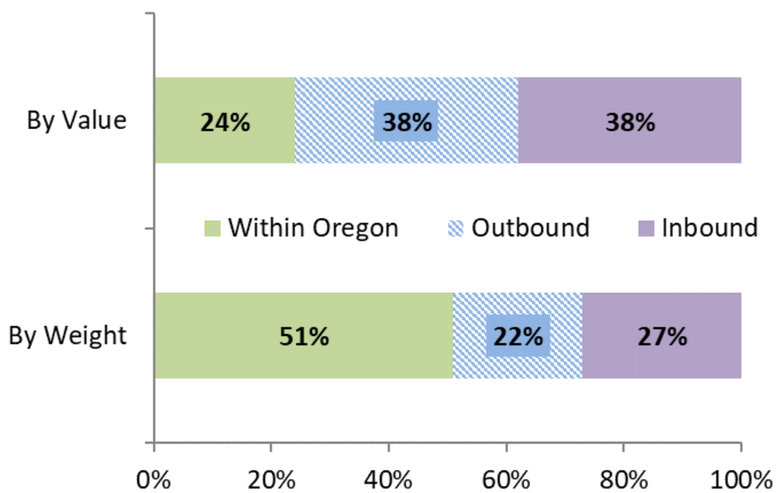


2.3.2 Freight and Commercial Travel

Commercial travel is the other distinct group of highway users. The majority of this travel is to move freight and provide business services. As an export-dependent economy, freight movement plays a major role in Oregon. Firms follow logistic management techniques designed to operate supply chains effectively and efficiently. Companies strive to get their goods to market in the most cost-effective manner by minimizing overhead, inventory and cost-per-order processing. These firms follow logistic strategies with the ultimate goal of meeting the desires of customers at the lowest feasible cost. Logistic strategies vary by industry, commodity and individual firms. Information regarding freight logistics is difficult to come by, firms operate in competitive markets and keep operational details private. Thus, analytical capabilities are less for commercial activity relative to household travel.

In 2017, 240 million tons of freight valued at $280 billion moved within, to and from Oregon via truck, rail, air, marine, pipeline, and combinations of these modes.[15] **Figure 8** illustrates the proportion of freight commodity flows by direction, including domestic, import and export flows. By weight, about half of total commodity flows start and end within the state, while 22 percent leaves the state heading to domestic and foreign destinations and 27 percent enters the state originating from external locations. By value, 24 percent of total commodity flows starts and ends within Oregon, while 38 percent leaves the state for other destinations and 38 percent enters the state originating from external locations.

FIGURE 8. OREGON COMMODITY FLOWS BY DIRECTION, 2017



Many different commodities move from, to and within Oregon. **Table 3** reports the top ten freight commodities of Oregon for 2017 in terms of value by direction.[16] Sixty-three percent of commodities originating and destined within Oregon falls under the top ten categories, dominated by the top five categories of mixed freight, electronics, wood products, other foodstuffs, and motorized vehicles. Seventy-four percent of commodities from Oregon destined for locations in other states and countries fall within ten categories, with the top four categories making up nearly half of the total outbound flows. Seventy-two percent of commodities originating outside of Oregon, both domestic and foreign, fall within the top ten categories, with the top five making up half of the total flows.

[15] Commodity flow data obtained from the Freight Analysis Framework 4.5 Summary Statistics for Oregon: https://faf.ornl.gov/faf4/FUT.aspx

[16] Commodity flow data obtained from the Freight Analysis Framework 4.5 Summary Statistics for Oregon: https://faf.ornl.gov/faf4/FUT.aspx Commodities are classified into 41 different categories.

TABLE 3. OREGON'S TOP TEN COMMODITY FLOWS BY VALUE, 2017

Within Oregon	Share of total	Outbound	Share of total	Inbound	Share of total
Mixed freight	13%	Motorized vehicles	17%	Electronics	19%
Electronics	11%	Electronics	14%	Motorized vehicles	10%
Wood prods.	8%	Mixed freight	12%	Mixed freight	8%
Other foodstuffs	7%	Machinery	7%	Machinery	6%
Motorized vehicles	6%	Wood prods.	6%	Misc. mfg. prods.	6%
Other ag prods.	4%	Other foodstuffs	5%	Coal, n.e.c.*	6%
Machinery	4%	Textiles/leather	4%	Pharmaceuticals	5%
Furniture	4%	Coal, n.e.c.*	3%	Other foodstuffs	4%
Plastics/rubber	3%	Precision instruments	3%	Precision instruments	4%
Paper articles	3%	Misc. mfg. prods.	3%	Plastics/rubber	3%
Top 10 total share	63%	**Top 10 total share**	74%	**Top 10 total share**	72%

* n.e.c. = not elsewhere classified

Efficient freight movement relies on an integrated transportation system designed to utilize efficiencies provided by different modes. Freight mode choice for each commodity depends on cost, reliability, time sensitivity, fragility, and other factors. **Table 4** reports the share of freight movement by transportation mode for 2017. Whether looking at freight in terms of weight or value, trucks currently move about 70 percent of Oregon freight. Pipeline and Rail tend move heavy commodities of lower value, while commodities shipped by multiple modes are lighter in weight and higher in value. Constraints on movement for one mode or facility can create additional pressures on the other parts of the system. The Oregon Freight Plan[17] explores issues affecting all modes of freight transportation and identified strategies to optimize system performance.

[17] Oregon Freight Plan, adopted 2011, amended 2017; https://www.oregon.gov/ODOT/Planning/Documents/OFP-2017-Amended.pdf

TABLE 4. OREGON SHARE OF FREIGHT FLOWS BY TRANSPORT MODE, 2017

	By Weight	By Value
Truck	71%	70%
Pipeline	14%	3%
Rail	9%	5%
Multiple Modes & Mail	4%	17%
Marine	2%	< 1%
Air (includes truck-air)	< 1%	4%
Other/Unknown	< 1%	< 1%
Total	100%	100%
Source: FHWA Freight Analysis Framework 4.5		

Oregon is a trade-dependent state. **Table 5**[18] presents Oregon's top five trade partners. Thirty-seven percent of commodities by value move internally between Oregon businesses and manufacturers. Washington is Oregon's largest trade partner, buying 24 percent of commodities by value. California is the second largest trade partner, buying 15 percent of Oregon commodities by value. Altogether, the top five trade partners, including Oregon businesses, represent 80 percent of traded commodities measured by value.

Looking at traded commodities by weight, 70 percent are traded internally to Oregon. California has the largest share of Oregon commodities by weight, 14 percent. Washington is next in line, purchasing 10 percent of Oregon commodities by weight. Altogether, the top five trade partners, including Oregon businesses, represent 95 percent of traded commodities measured by weight.

TABLE 5. OREGON'S TOP 5 TRADING PARTNERS – BY VALUE AND WEIGHT, 2017

Commodities From Oregon To:	By Value	Commodities From Oregon To:	By Weight
Oregon (internal trade)	37%	**Oregon (internal trade)**	70%
Washington	24%	**California**	14%
California	15%	**Washington**	10%
Idaho	2%	**Idaho**	1%
Minnesota	2%	**Texas**	1%
Top Ten Share of Total	80%	**Top Ten Share of Total**	95%
Source: FHWA Freight Analysis Framework 4.5			

Medium-sized commercial vehicles are another distinct sector of transportation users. These vehicles are owned and operated by firms conducting day-to-day business using vehicles weighing less than 26,000 pounds.[19] Some commercial travel occurs using passenger vehicles, but there is virtually no

[18] Table 5 excludes flows for imported goods, which are included in Figure 8.

[19] DMV defines this category of medium sized trucks as used for carrying loads other than passengers. Full detailed description is available online: https://www.oregon.gov/ODOT/DMV/docs/Oregon_Vehicle_Reg_Stat_Reports.pdf

available data revealing light-vehicle commercial travel separate from household travel. Other commercial travel is conducted using medium trucks. Examples of businesses using medium trucks include services for plumbing, electricians, roofing, other trade services, local deliveries for daily business production (e.g. fresh produce for grocery stores and restaurants), other construction-related, mail and small package delivery. **Figure 9** presents medium truck registrations since 2001, including the percent change from the previous year. Registration levels for commercial trucks are strongly correlated with economic conditions. The early 2000's Oregon was recovering from a recession, following this event medium truck registrations peaked in year 2006. The Great Recession began the very end of year 2007, where the number of medium truck registrations begin to decline and hit a minimum number in 2010. As Oregon came out of the recession the number of medium registrations began to rise to the levels we see today, which are about 9 percent below the peak levels of 2006.

FIGURE 9. MEDIUM TRUCK REGISTRATION COUNT AND ANNUAL CHANGE, 2001-2018

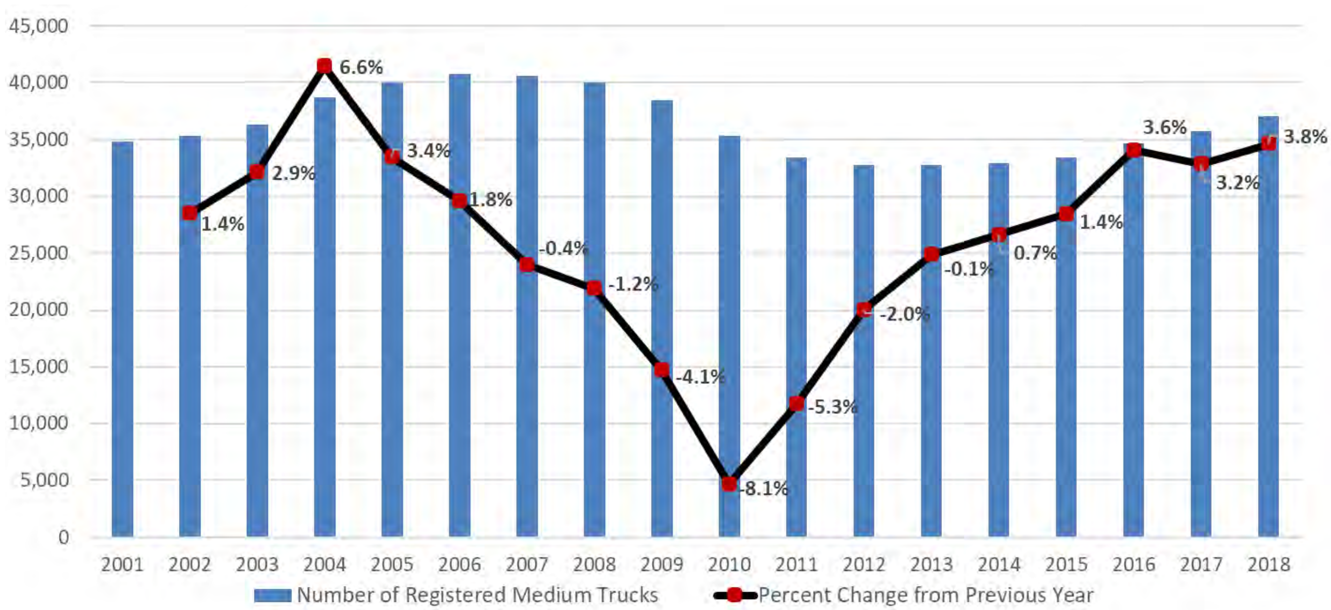


Table 6 presents a summary of annual truck VMT on all Oregon highways for years 2007 to 2018. The most notable change over time is in the share of medium truck VMT. The share of total VMT for this group changed from 646 million miles in 2007 to 869 million miles, rising from 1.8 percent of total VMT to 2.3 percent.

Table 6. Annual Truck Vehicle Miles Traveled 2007-2018, miles in millions

	2007	2009	2011	2013	2015	2018
Medium Trucks	646	559	625	780	805	869
Share of Total VMT	1.8%	1.6%	1.7%	2.3%	2.2%	2.3%
Heavy Trucks	2,145	1,740	1,843	1,955	2,044	2,184
Share of Total VMT	5.7%	4.8%	5.1%	5.8%	5.7%	5.6%
Total	2,791	2,299	2,468	2,735	2,849	3,053
Share of Total VMT	7.5%	6.4%	6.8%	8.1%	7.9%	7.9%

Source: Oregon Highway Cost Allocation Studies, Exhibit 4-1

The transportation system is the economy in motion. People travel to access jobs, services and goods. Businesses travel to access customers and depend on the transportation system to access employees and the goods and services needed to conduct their business activity. Each person, business, commodity, and industry has different needs and expectations from the transportation system. Accommodating a variety of needs while maintaining safety within a constrained budget requires strategic decision making and acknowledgement of required trade-offs. All economic "agents" must balance trade-offs, whether it is done by households, businesses or public agencies. Developing a good understanding of the underlying economic motivations and decision criteria utilized by transportation system users supports informed investment decisions.

3 Performance Measures

3.1 Quantity: How much is Moving?

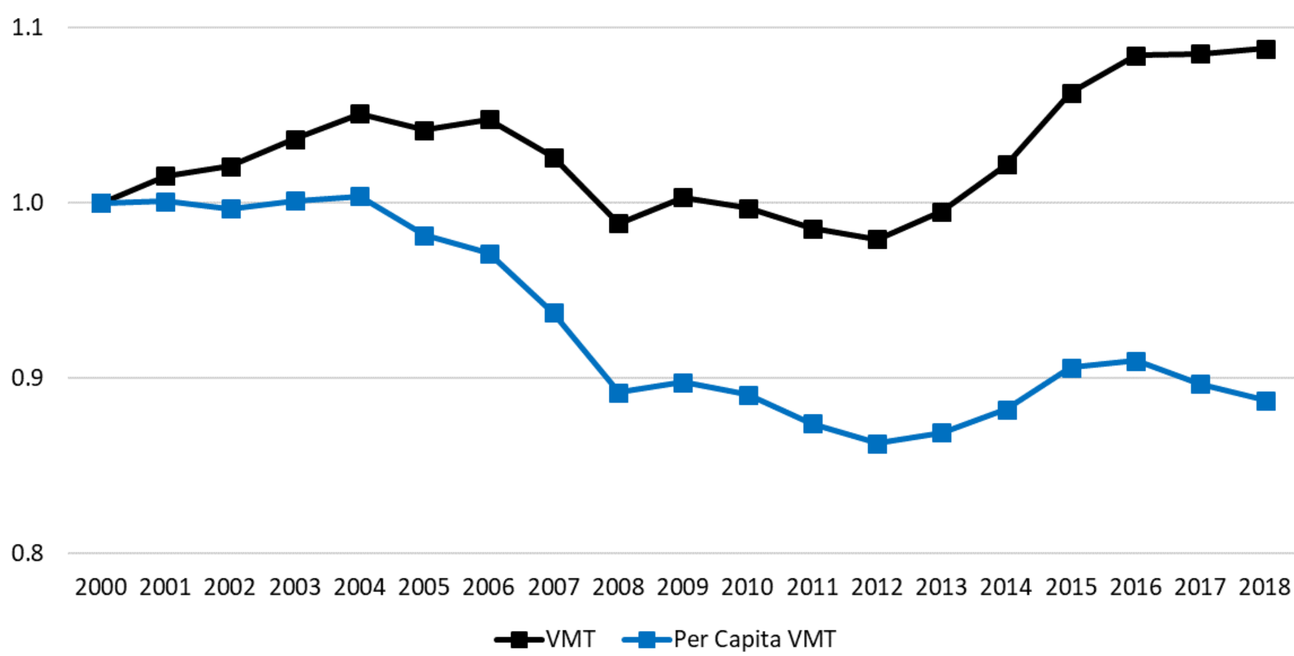
Measures of "**quantity**" report the overall use of the highway system. These measures include:

- Annual Vehicle Miles Travelled (VMT) – the annual number of miles travelled by all vehicles.
- VMT Per Capita –the annual number of miles travelled by all vehicles divided by the population. This broad measure reveals the amount of travel occurring relative to population, providing information on whether people are travelling more or less on average or whether there is more travel overall due to a growing population.
- Annual Truck VMT– annual number of miles travelled by trucks.
- Truck VMT Per Capita – the annual number of heavy truck miles travelled divided by the population. This broad measure reveals the amount of commercial travel occurring relative to population, providing information on whether the amount of freight moving is rising more or less relative to the population overall.

3.1.1 Annual Vehicle Miles Travelled

Figure 10 presents statewide annual VMT and VMT per capita side-by-side to illustrate how overall VMT is following a rising trend due to the expanding Oregon economy: rising population and employment along with increasing medium and heavy truck movement across the highway system. Per capita VMT is declining over time indicating households, businesses and trucks are reducing the number of trips and/or distances traveled on average. However, the reduction is not large enough to completely account for increased activity of higher population and employment. There are a variety of factors that could be contributing to this emerging pattern, such as rising congestion levels, concentration of growth in urban areas with closer access to goods and services, an aging population, more efficient freight logistics, and online access to business services.

FIGURE 10. STATEWIDE VMT AND PER CAPITA VMT OVER TIME: 2000-2018 INDEXED TO YEAR 2000



3.1.2 Truck VMT

As an economy grows with population and employment rising, more freight movement occurs. The Oregon Highway Cost Allocation Study[20] conducted every two years reports VMT by vehicle weight categories. **Figure 11** illustrates truck VMT since 2007 for heavy and medium trucks. The values are indexed to 2007 to compare current levels to pre-recession levels. 2009 truck VMT declined 18 percent from 2007 levels due to the recession, illustrating the strong link between freight and economic conditions. Between years 2013 and 2015 truck VMT recovered to prerecession levels. 2018 truck VMT level is about 9% above the 2007 values. Most of the increase is due to VMT from medium trucks, which is 35 percent higher than 2007 levels, while heavy truck VMT is only 2 percent higher than the 2007 level.

[20] https://www.oregon.gov/das/OEA/Pages/hcas.aspx , accessed December 2019, Table 4-1

FIGURE 11. CHANGE IN TRUCK VMT 2007-2018, INDEXED TO 2007

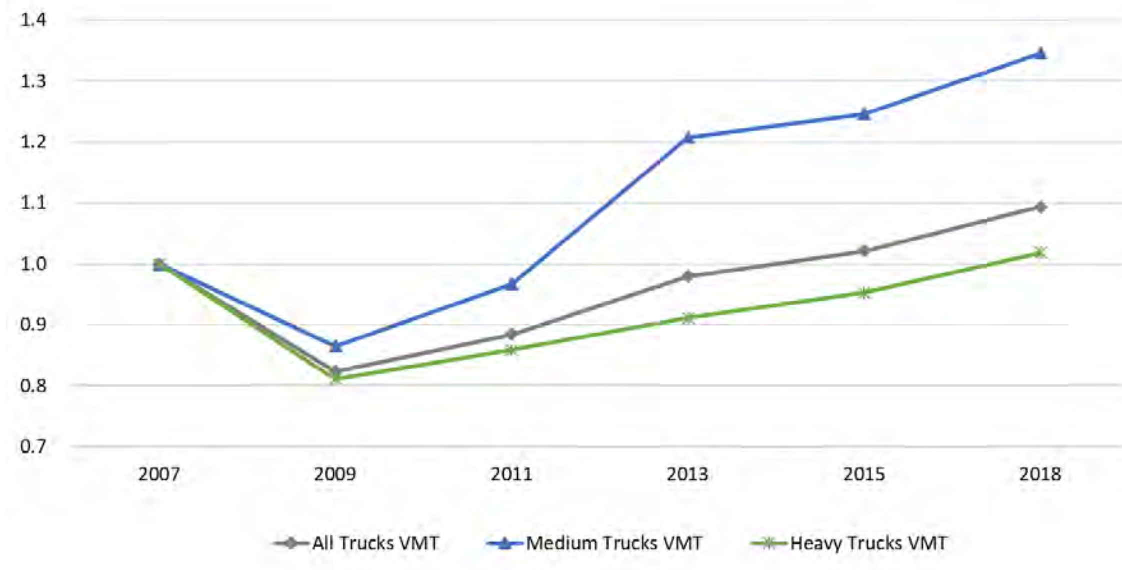
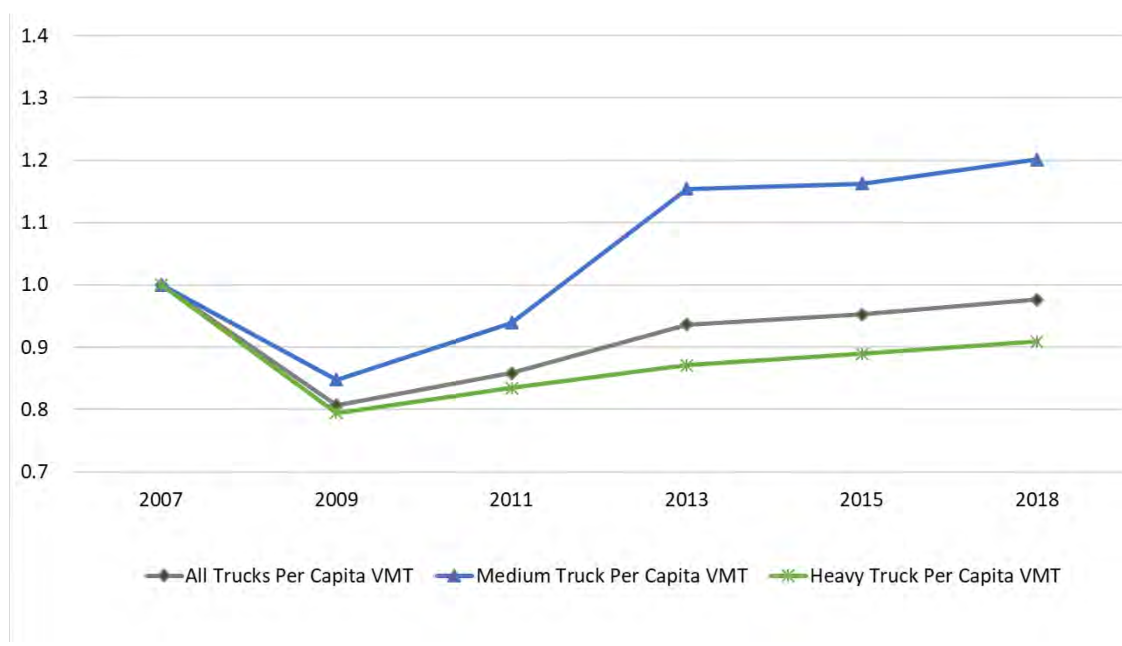


Figure 12 presents per capita truck VMT to account for the increase in population versus a change in the average per person levels. This reveals overall truck per capita VMT is 2 percent above 2007 levels. Heavy truck per capita VMT is 9 percent lower than 2007 levels, while medium truck per capita VMT is 20 percent above 2007 levels. Thus, the overall average rise in per capita VMT is due to the rise in medium truck per capita VMT. This may be due in part from the rise in e-commerce deliveries and growing demand for trade services, but understanding the complete details behind such change is limited due to lack of detailed data over time.

FIGURE 12. CHANGE IN PER CAPITA TRUCK VMT 2007-2018, INDEXED TO 2007



In addition to these observed trends are emerging trends with very little data available for analysis. For example, car sharing and ride-share services, such as Uber and Lyft, are expected to impact household vehicle ownership and use. It will be important to monitor this over time. Continued growth in e-commerce is expected to impact the number of trucks on the road. Obtaining observed data for medium trucks is key to determining the net impacts of e-commerce on statewide VMT. There is currently debate as to whether e-commerce reduces VMT by eliminating household shopping trips or increases VMT by generating more delivery trips. The impacts may vary by region.

3.2 Quality: What conditions are experienced by road users?

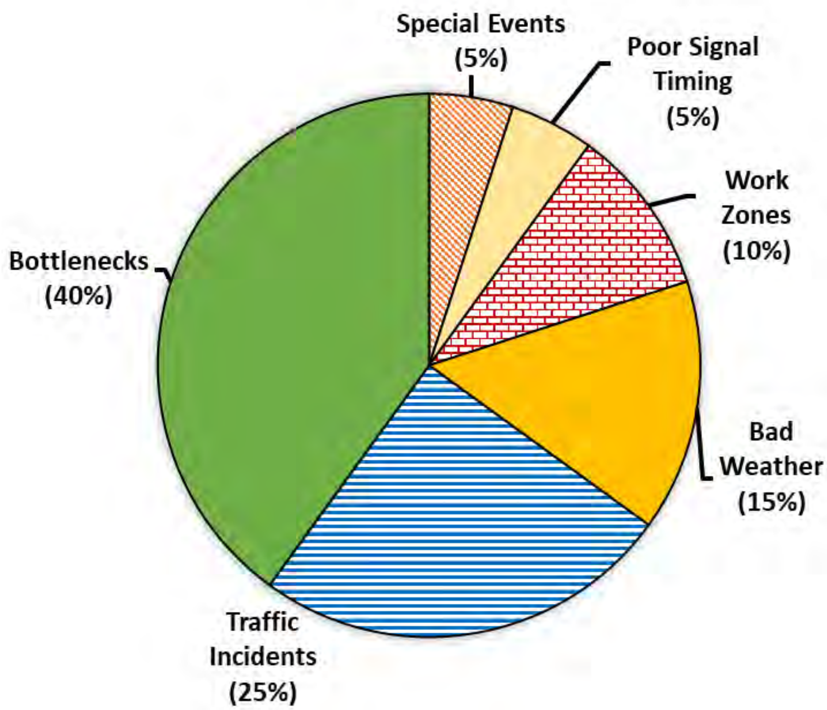
Measures of **"quality"** relate to the travel experience, primarily focused on traffic congestion and system reliability. Various factors influence congestion, which can be broadly classified into two types. The first type of congestion is the general everyday congestion typically occurring due to capacity constraints in the morning and afternoon peak periods. This is referred to as *recurring congestion*. Sections of highway where vehicles must merge onto or diverge off of the roadway, locations where the volume is greater than the capacity, or in weaving sections where traffic is both trying to enter or exit from the highway are examples of recurring congestion. Locations with these patterns may be referred to as bottlenecks.

The second type is *non-recurring congestion*. This type of congestion is due to temporary, unexpected events, such as crashes, vehicle breakdowns, inclement weather, work zones, signal timing, and special events causing delay and stop-n-go traffic conditions. This type of congestion impacts system reliability, which is a key component of system quality. Predictable delay can be adapted to by users, while unpredictable delay impacts activity requiring timeliness, such as on-time delivery, on-time services and arriving at work or appointments on time.

Figure 13 illustrates a breakdown of delay causes nationally[21]. Recurring congestion due to bottlenecks (capacity constraints and high demand) make up 40 percent of total congestion. The remaining 60 percent is caused by non-recurring events, such as incidents, weather, construction work zones, special events and poor signal timing. The distinction between the two types of congestion is important when developing effective solutions.

[21] https://ops.fhwa.dot.gov/congestion_report/executive_summary.htm#figES_2

FIGURE 13. BREAKDOWN OF THE CAUSES OF CONGESTION



ODOT uses several different approaches to optimize system performance in order to maintain and enhance mobility:

- Safety improvements – safety projects reduce crashes and incidents, which reduces fatalities, personal injuries and property damage; fewer crashes and incidents translate into reduced congestion and improved reliability.
- Optimize use of infrastructure – investments directed towards maximizing current infrastructure performance, such as locations with traffic weaving and merging;
- Manage the traffic network efficiently - use of infrastructure is optimized by leveraging new technology and traffic operations to improve system performance[22], maximizing throughput and reliability; traffic control centers employ technology to provide timely information to highway users and help them choose alternative modes and routes to avoid congestion.
- Support multi-modal transportation options - Oregon ranks among the top states for numbers of walk, bike, ride-transit, telecommute and shared-rides; multimodal transportation options reduce reliance on single-occupancy vehicles, while improving the health of Oregonians through active modes and promoting environmental benefits.

[22] http://www.oregon.gov/ODOT/MCT/Documents/MobilityProcedureManual.pdf

Developing solutions to resolve traffic congestion is complex. No single solution will eliminate congestion, but there are methods to manage it. Implementing effective solutions necessitates developing multiple performance measures, when combined they create multidimensional information that can be used to develop effective solutions to manage and optimize system performance.

As Oregon grows, more people and freight are squeezed onto a transportation system that cannot expand at the same pace. As long as the Oregon economy continues to grow, traffic congestion will be a transportation issue and developing an approach to monitor conditions is needed.

This report relies on the following metrics to measure congestion and reliability:

- **Average Annual Daily Traffic/Capacity (AADT/C)** – average annual daily traffic (AADT) divided by peak hour capacity (C) identifies where large-scale congestion occurs and enables ODOT to monitor locations over time for spreading beyond a typical two-hour peak period. This measure was develop as a Key Performance Measure[23] for mobility reported by ODOT annually. AADT/C is measured using observed traffic volumes and applying FHWA methods required for the Highway Performance Monitoring System annual submittal. This measure reports conditions for highways on the National Highway System (NHS).
- **Travel Time Index (TTI) –** this congestion measure compares the 80th percentile travel time of a trip on each highway segment at a peak hour compared to an off-peak uncongested hour. The higher the TTI, the longer the travel times and higher the congestion. For example, a TTI of 2.0 indicates that a trip that takes ten minutes in light traffic will take 20 minutes in congested conditions. The Travel Time Index is calculated using proprietary speed data available for purchase from private vendors. For this study ODOT used HERE data[24]. For this initial report, this measure reports conditions for the interstate highways only.
- **Planning Time Index (PTI) –** this reliability measure represents the total travel time users should account for in order to be on time 95 percent of the time relative to free flow speeds. Free flow speed is defined as the posted regulatory speed limit. The lower the PTI, the more reliable the travel time will be. For example, a PTI of 3.0 indicates that a trip taking ten minutes in light traffic should plan for 30 minutes to ensure arriving on time with 95 percent confidence. The Planning Time Index is calculated using proprietary speed data available for purchase from private vendors. ODOT used HERE data for this initial study, reporting conditions for the interstate highways only.

3.2.1 Peak Period Congestion: AADT/C

ODOT recently implemented a new way to measure mobility statewide, designed to link state policy to highway performance and monitor progress towards meeting mobility goals for highways on the

[23] More information is available online: https://www.oregon.gov/odot/performmang/pages/index.aspx

[24] The ODOT contract for this data source expires soon. Once a new data contract is established, methods of accessing, processing and reporting vehicle-probe data can be developed and automated in a manner that supports consistent reporting. Ability to report by region, MPO or corridor will be part of the development process.

National Highway System (NHS)[25]. The traditional approach using traffic volume to highway capacity ratios (V/C) does not reveal the extent or duration of congested periods, nor does it capture impacts of non-recurring delay caused by traffic incidents, weather or other unique events. AADT/C measures average daily congestion beyond the peak period, capturing the duration and "intensity" of congestion[26] and providing insight into the number of hours on an average day experiencing congestion.

As the AADT/C value increases, it reflects rising congestion levels, indicating peak-period congestion is spreading to adjacent hours. The measure applies to lane miles, not centerline miles, accounting for system capacity relative to demand. The data used to calculate this measure comes from the annual Highway Performance Monitoring System data submittal to FHWA[27], which includes information for all highways on the national highway system.

Six levels of congestion are used to evaluate AADT/C. These levels are based on categorizations developed for the Oregon Congestion Management System[28] and presented in **Table 7**. The table color coding is helpful when evaluating congestion levels on the entire state roadway system. The color green indicates free flow conditions. The color yellow identifies low levels of congestion, a transitional period where traffic flow is moving, but capacity is impacted by minor disruptions such as traffic incidents or weather. The color orange represents congested conditions occurring on a regular basis and reliability declining. The next three levels of congestion represented using colors red, purple and brown indicated increasingly higher levels of congestion occurring over more hours of the day.

TABLE 7. AADT/C SCALE OF VALUES FOR MEASURING CONGESTION

Color	Interpretation	AADT/C
Green	Uncongested traffic flow	Less than 7
Yellow	Moderate congestion	7 – 8.99
Orange	Congested conditions	9 – 9.99
Red	Congested and transitioning to very congested	10 – 13.99
Purple	Very congested and transitioning to extremely congested	14+

[25] The National Highway System is a network of strategic highways within the United States, including the interstate highway system and other roads and highways serving major airports, ports, rail or truck terminals, railway stations, pipeline terminals and other strategic transportation facilities. Highways were assigned this designation through the National Highway System Designation Act of 1995.

[26] https://ops.fhwa.dot.gov/congestion_report/chapter2.htm-

[27] The HPMS was developed to measure the scope, condition, performance, use and operating characteristics of the Nation's highways. This data is also used to determine the apportionment of Federal-aid Highway Program funds to states as well as serves as the primary data source for the biennial "Conditions and Performance Report" to U.S. Congress, which supports the development and evaluation of the FHWA's legislative, program and budget planning activities.

[28] Between the years 2001 and 2014, the Congestion Management System (CMS) was the primary management system tool used to identify and monitor congestion across the Oregon State Highway System network. The CMS process calculated roadway capacities and output different performance measures in a useful manner that enabled decision-makers to evaluate highway system needs and improvements. One of the primary elements of CMS was the AADT/C metric.

Figures 14 and 15 provide colorized maps of congestion levels represented by AADT/C color coding for year 2017. The maps quickly reveal state highway congestion occurs in the larger metropolitan areas, where Portland has the highest congestion levels, Salem/Keizer and Eugene/Springfield have congested conditions as well. **Figure 14** provides a closer look at congestion in the three largest MPOs of Oregon: Portland, Salem/Keizer and Eugene/Springfield for highways on the NHS.

Nearly half of the Portland Metro region NHS highways are classified as congested using this measure. Medium-sized urban areas of Salem/Keizer and Eugene/Springfield are experiencing increasing congested lane miles. Smaller MPOs such as Albany, Bend, Corvallis, Grants Pass and Rogue Valley (Medford area) have segments of the system transitioning from minor congestion to congested conditions.

Table 8 reports information presented in **Figures 14 and 15** to illustrate the level of congestion by region of the state. Statewide, 4.6 percent of NHS lane miles are classified as congested using AADT/C, but the extent of congestion varies by region. About 43 percent of NHS lane miles in the Portland region are congested, about 10 percent in Salem/Keizer and 7 percent in Eugene/Springfield. Congested lane miles in the smaller MPOs range between zero and 2 percent. Other small urban areas as a group have less than 1 percent of lane miles congested, while the rural NHS highways have about one tenth of one percent of their lane miles congested.

TABLE 8. CONGESTED NATIONAL HIGHWAY SYSTEM LANE MILES BY REGION, 2017

Region	Total Lane Miles	Congested Lane Miles	Proportion of NHS Lane Miles Congested
Albany	93	2.0	2.2%
Bend	76	0.0	0.0%
Corvallis	59	0.0	0.0%
Eugene	218	15.8	7.2%
Grants Pass	169	0.3	0.2%
Medford	252	0.0	0.0%
Metro	1,061	457.0	43.1%
Salem	190	19.1	10.1%
Other Urbanized	1,125	8.4	0.7%
Rural	7,886	4.1	0.1%
Total Oregon National Highway System (NHS)	11,129	507	4.6%

Monitoring this performance measure will reveal whether peak period congestion is spreading to other time periods, as well as increasing in severity over time. However, this measure alone tells an incomplete story. Other measures are needed to understand and monitor congestion over time.

FIGURE 14. CONGESTED LANE-MILES PER AADT/C – STATEWIDE, 2017

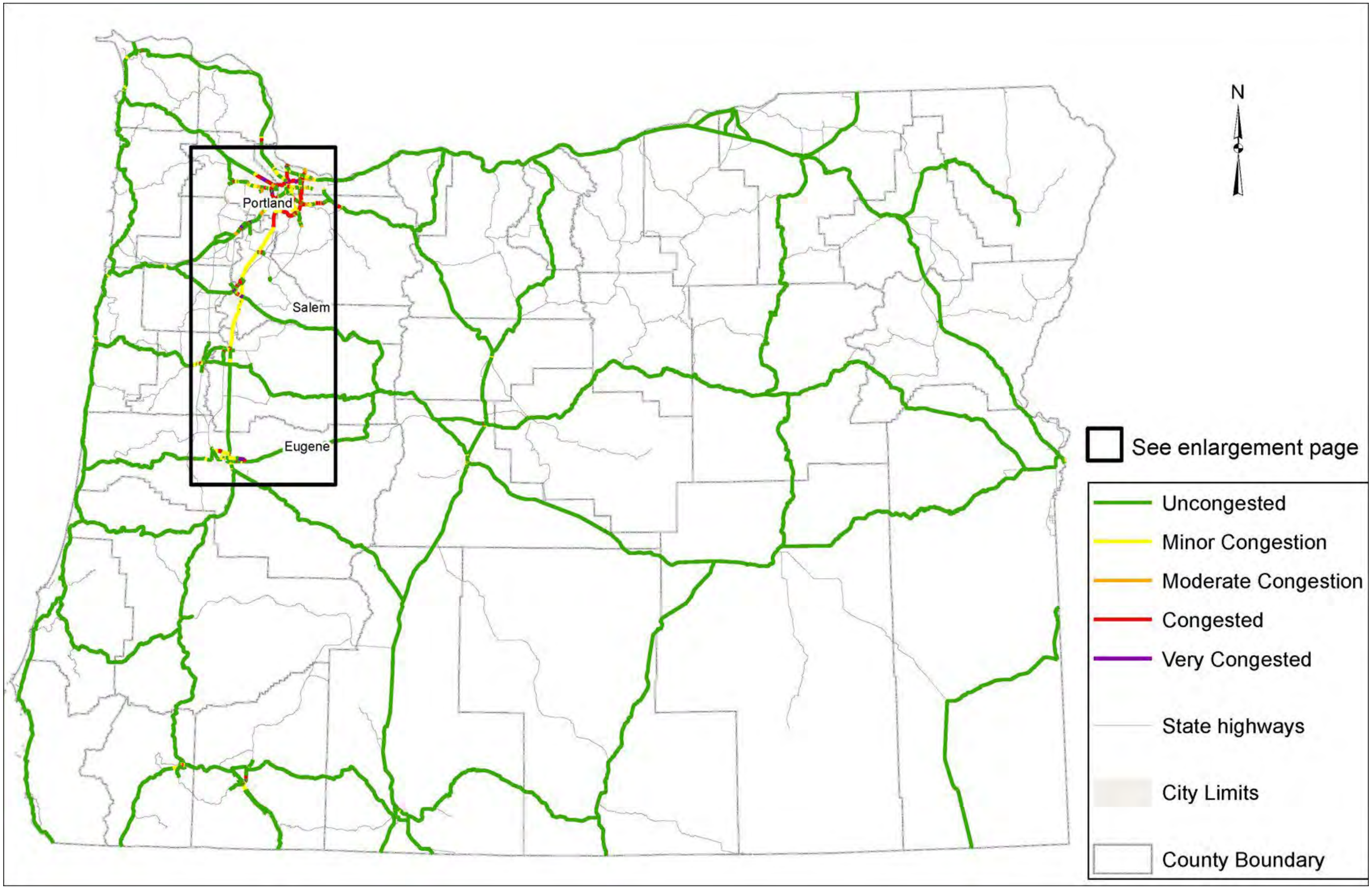
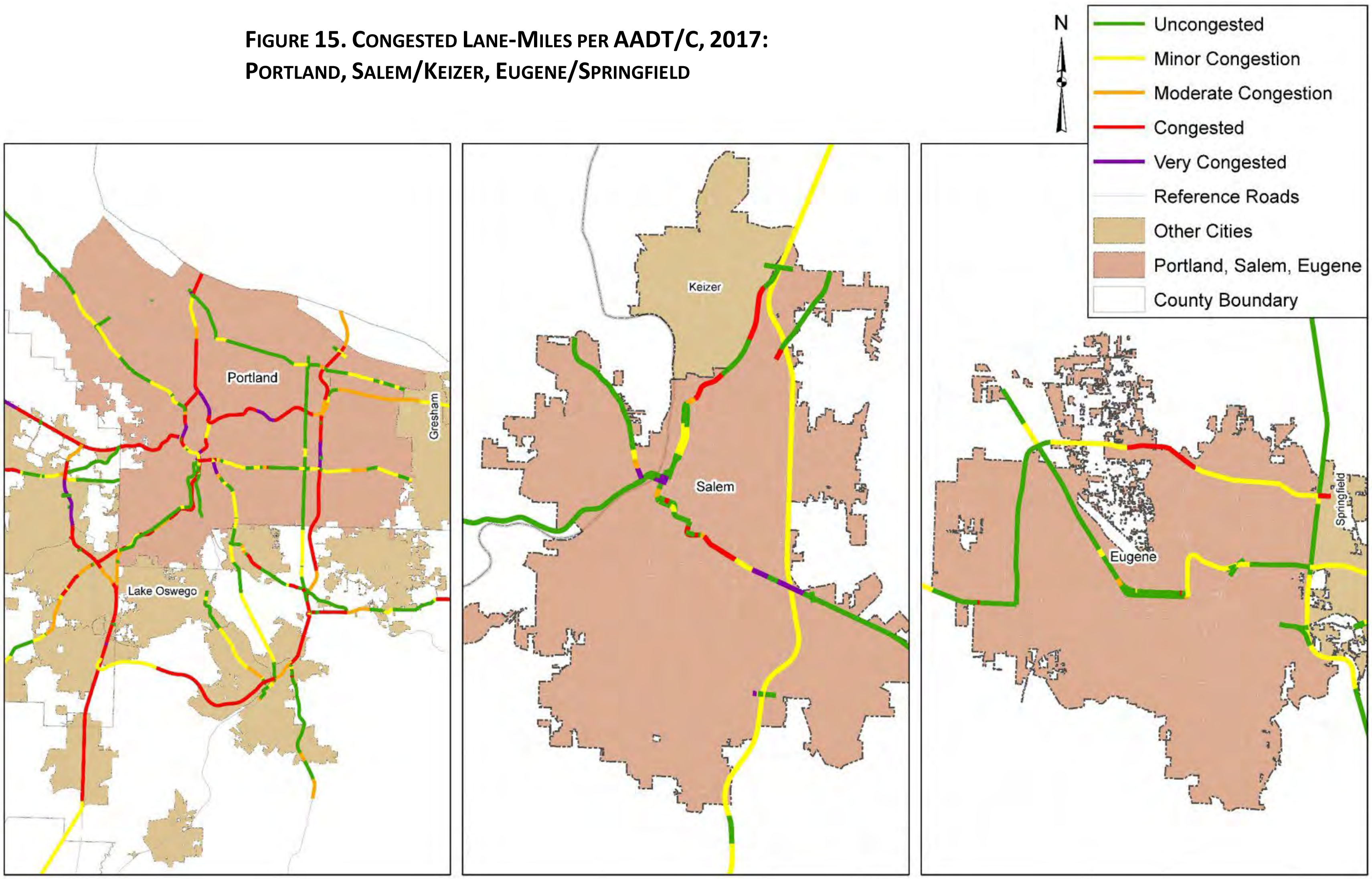


FIGURE 15. CONGESTED LANE-MILES PER AADT/C, 2017: PORTLAND, SALEM/KEIZER, EUGENE/SPRINGFIELD



3.2.2 Congestion: Travel Time Index

Availability of vehicle probe-based travel time data supports use of travel time indices to measure congestion levels. A common index used nationally by state and federal agencies to measure congestion is the Travel Time Index (TTI). The TTI compares the 80th percentile travel time of a trip on a freeway segment for a specific period to the travel time of a trip during an off-peak/uncongested period. The higher the TTI value, the longer the average travel times and greater the congestion. This measure accounts for reoccurring delay – delay that is predictable and expected due to high demand, such as peak periods. For this report, HERE traffic data is used to calculate the TTI for the interstate system. In future reports the goal is to expand TTI reporting to non-interstate highways. TTI values are calculated for each segment of the interstate highway system by direction, then categorized to a level of congestion following the ranges listed in **Table 9**.

TABLE 9. TRAVEL TIME INDEX CONGESTION CLASSIFICATION CATEGORIES: FREEWAYS

Congestion Level	Travel Time Index Value	Interpretation
No Congestion	Less than 1.2	Average travel speed is no less than ten percent below posted speed
Moderate Congestion	1.2 ≤ TTI < 1.5	Average travel speed is between 10 to 30 percent below posted speed
Heavy Congestion	1.5≤ TTI <2.0	Average travel speed is between 30 and 50 percent below posted speed
Severe Congestion	Greater than or equal to 2.0	Average travel speed is below half the posted speed limit

The TTI provides insight into highway congestion during the average weekday peak period. TTI was calculated for the interstate highways for the PM peak period of 4 pm to 6 pm. **Figure 16** illustrates PM peak period congestion for the entire interstate system. The majority of congestion occurs in the Portland region. Eugene-Springfield has congestion as well, but the remaining MPOs on the interstate system do not have measurable congestion using this index.

FIGURE 16. STATEWIDE TRAVEL TIME INDEX 2017, PM PEAK PERIOD 4 PM - 6 PM

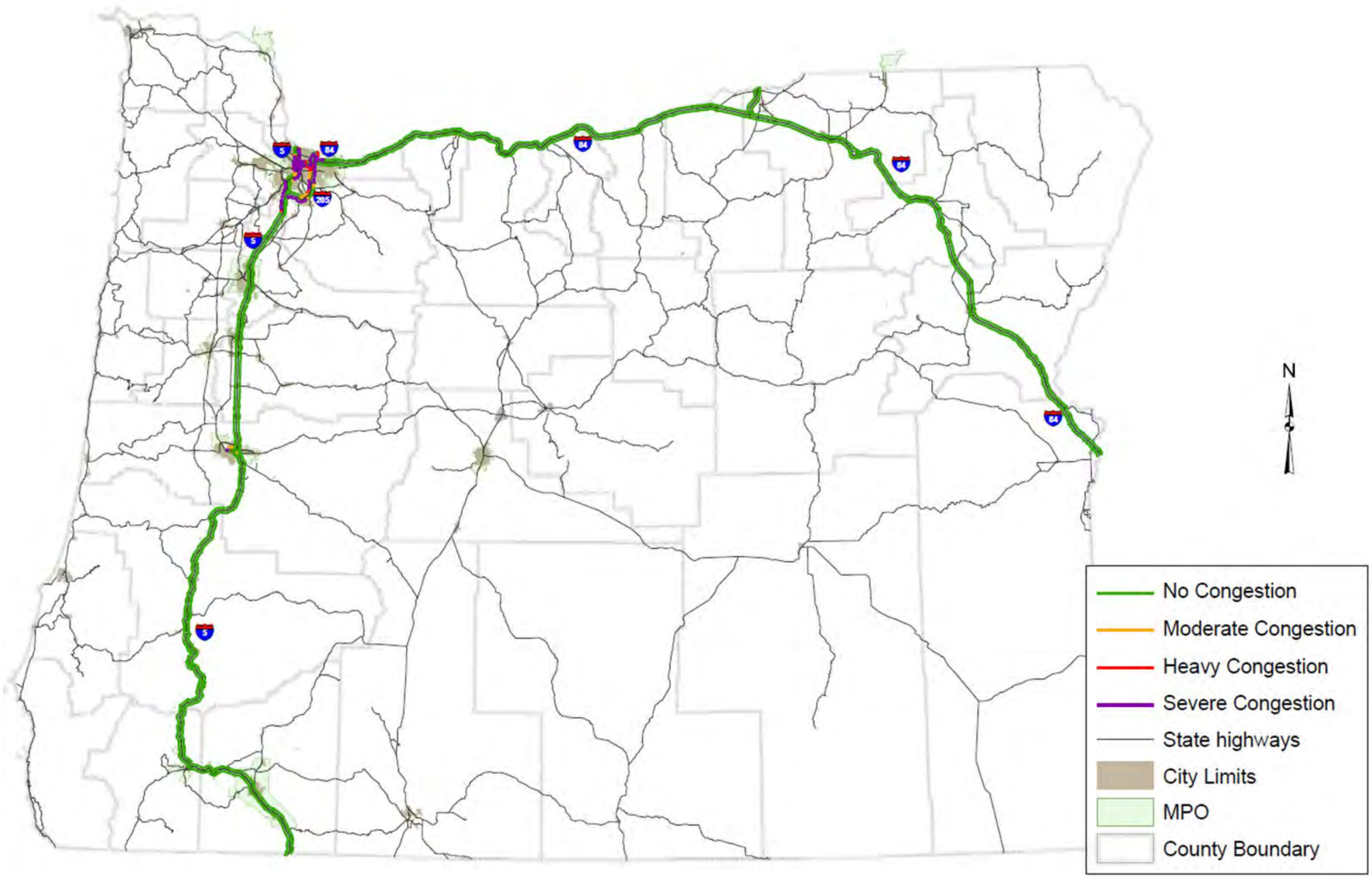


Figure 17 illustrates PM peak period congestion for the Portland region interstate highways. The Travel Time Index reveals the Portland region experiences a concentration of congested conditions during the afternoon peak period. In the vicinity of central Portland congestion is severe in both directions on I-5, I-84 and I-405. Northbound traffic on I-5 leaving Portland experiences heavy to severe congestion. Southbound traffic leaving Portland has moderate to no congestion until reaching the Beaverton area until Wilsonville. I-84 between I-5 and I-205 is heavy to severely congested for eastbound traffic, westbound traffic become congested midway between the two freeways. I-84 is severely congested westbound on the edge of Gresham entering Portland. I-205 heavy to severe congestion varies by direction with sections of moderate to no congestion. The intersection of I-205 with I-84 is severely congested in both directions.

FIGURE 17. PORTLAND REGION, TRAVEL TIME INDEX 2017, PM PEAK PERIOD 4 PM - 6 PM

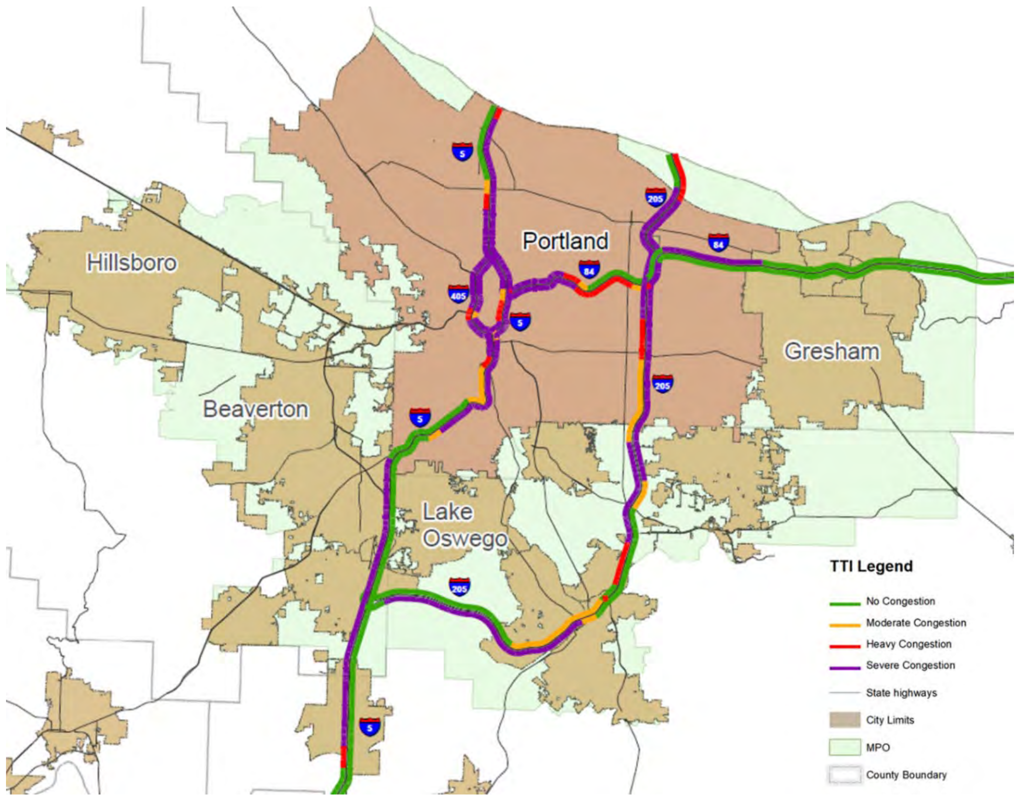
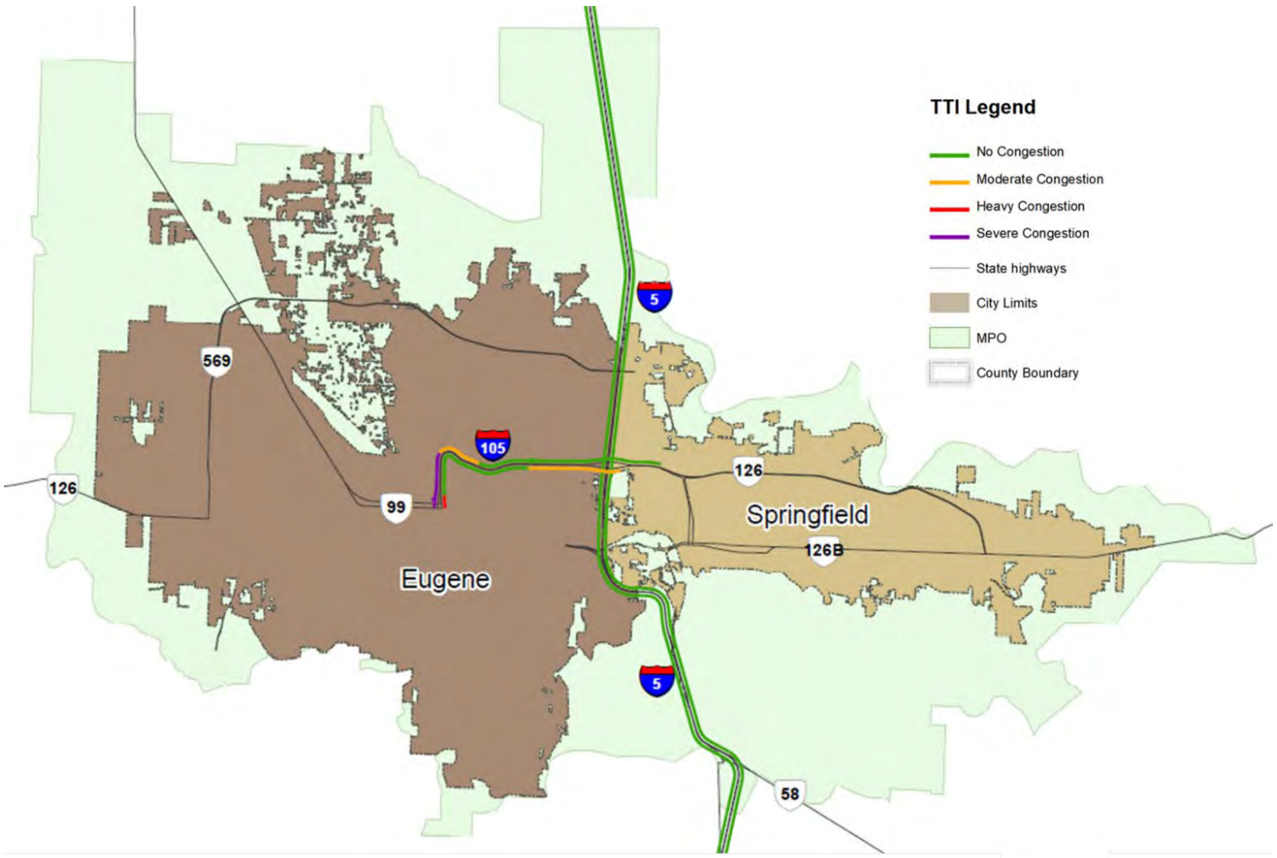


Figure 18 illustrates PM peak period interstate congestion for the Eugene-Springfield region. I-5 does not have measurable congestion using this metric. However, I-105 has severe congestion at the entry point for eastbound traffic and moderate congestion on the approach to I-5. I-105 westbound transitions from moderate congestion to severe congestion as the freeway approaches OR 99 in central Eugene.

FIGURE 18. EUGENE-SPRINGFIELD REGION, TRAVEL TIME INDEX 2017, PM PEAK PERIOD 4 PM - 6 PM



The TTI is a useful tool to identify the worst congested locations on the interstate system. It is a data-driven method to monitor changes in system performance statewide over time. This is a relatively new reporting capability dependent upon access to vehicle speed data, which is expected to provide more reporting capabilities in the future.

3.2.3 Reliability: Planning Time Index

Where the Travel Time Index measures congestion occurring repeatedly caused by high demand, the Planning Time Index (PTI) measures variation in travel time caused by unexpected events, such as crashes, vehicle breakdowns, work zones, and inclement weather causing delay and stop-n-go conditions. Variability in travel times day-to-day reflects the reliability of a transportation system, also referred to as non-recurring congestion, which is random and unpredictable. This form of congestion makes is difficult to plan trips requiring punctuality. An estimated 60 percent of traffic delay is due to non-recurring congestion.

When people travel, they plan based on the worst days, not the average day. Travelers must include extra travel time for regularly planned trips, such as commuting to work. However, trips requiring punctuality, such as catching a plane flight, making a freight delivery, attending a work meeting, or seeing your child’s game after school may require extra time to guarantee on-time arrival. The PTI is designed to measure system reliability and the extra time needed to ensure punctuality. It represents the total time travelers should allow to make sure they arrive at their destination on-time knowing there may be unexpected delay. As with the TTI, the PTI is calculated using HERE speed data for the interstate system. In future reports the expectation is to expand PTI reporting to include non-interstate highways. PTI values are calculated for each segment of the interstate highway system by direction, then categorized to a level of reliability following the ranges listed in **Table 10**.

TABLE 10. PLANNING TIME INDEX CONGESTION CLASSIFICATION CATEGORIES: FREEWAYS

Reliability Level	Planning Time Index Value	Interpretation
Reliable	Less than 1.33	Average travel speed is no less than 25 percent below posted speed
Moderately Unreliable	1.33 ≤ PTI < 2.0	Average travel speed is between 25 to 50 percent below posted speed
Highly or Extremely Unreliable	Greater than or equal to 2.0	Average travel speed is at least 50 percent below the posted speed limit

The PTI provides insight into interstate highway reliability during the average weekday peak period. PTI was calculated for the interstate highways for the PM peak period of 4 pm to 6 pm. **Figure 19** illustrates PM peak period reliability for the entire interstate highway system. The Portland region has the majority of unreliable lane miles, but there are also unreliable sections in the metropolitan regions of Salem-Keizer, Albany, and Eugene-Springfield. The remaining MPOs do not have segments meeting the criteria for being unreliable on the interstate system in 2017. Non-metropolitan sections of the interstate system do not have locations exhibiting reliability issues for the afternoon peak period.

FIGURE 19. STATEWIDE PLANNING TIME INDEX 2017, PM PEAK PERIOD 4 PM – 6 PM

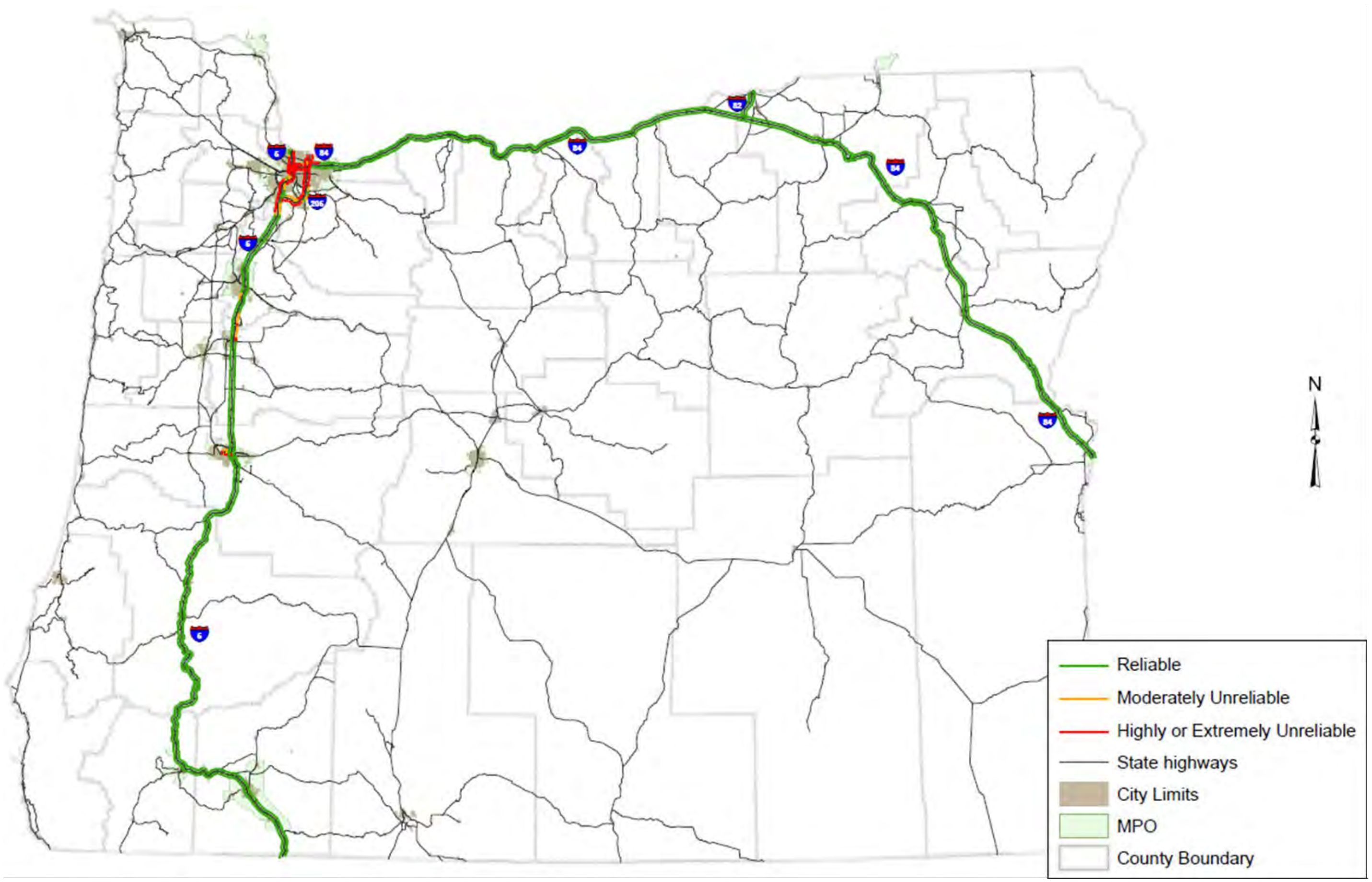


Figure 20 illustrates the PTI for the Portland region interstate highways. The PTI reveals the majority of lane miles on the interstate system in this region are unreliable. Segments defined as reliable using this metric are represented in green, but they are bounded by moderately unreliable segments transitioning to highly or extremely unreliable segments.

FIGURE 20. PORTLAND REGION PLANNING TIME INDEX 2017, PM PEAK PERIOD 4 PM – 6 PM

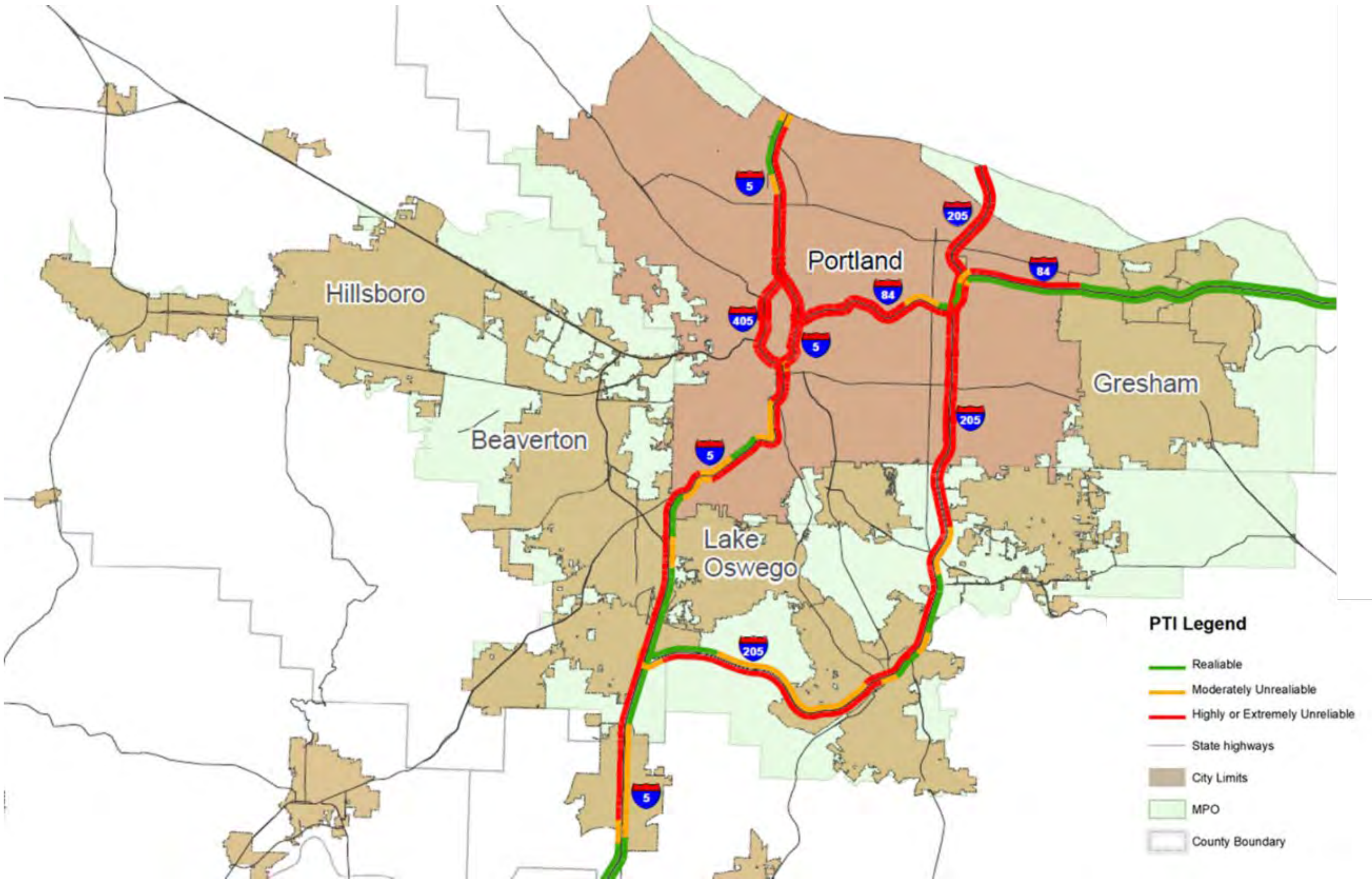


Figure 21 illustrates the PTI for Salem-Keizer and Albany interstate highways. I-5 through Salem is predominantly reliable. The southbound fringe of Salem is moderately unreliable during PM peak period. The Albany segment of I-5 northbound is moderately unreliable through Millersburg, bounded by segments of highly to extremely unreliable on both ends.

FIGURE 21. SALEM-KEIZER AND ALBANY REGION PLANNING TIME INDEX 2017, PM PEAK PERIOD 4 PM – 6 PM

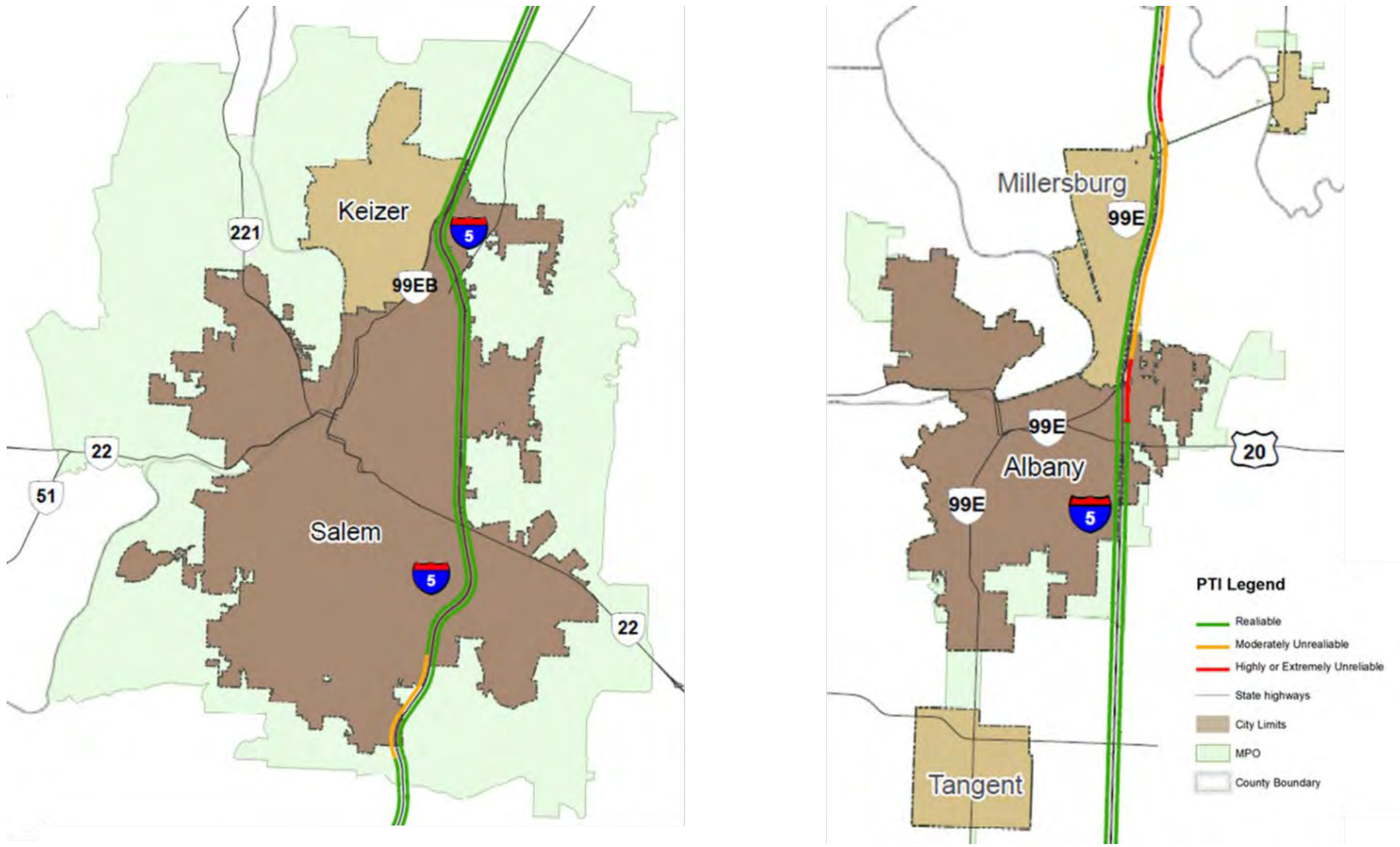
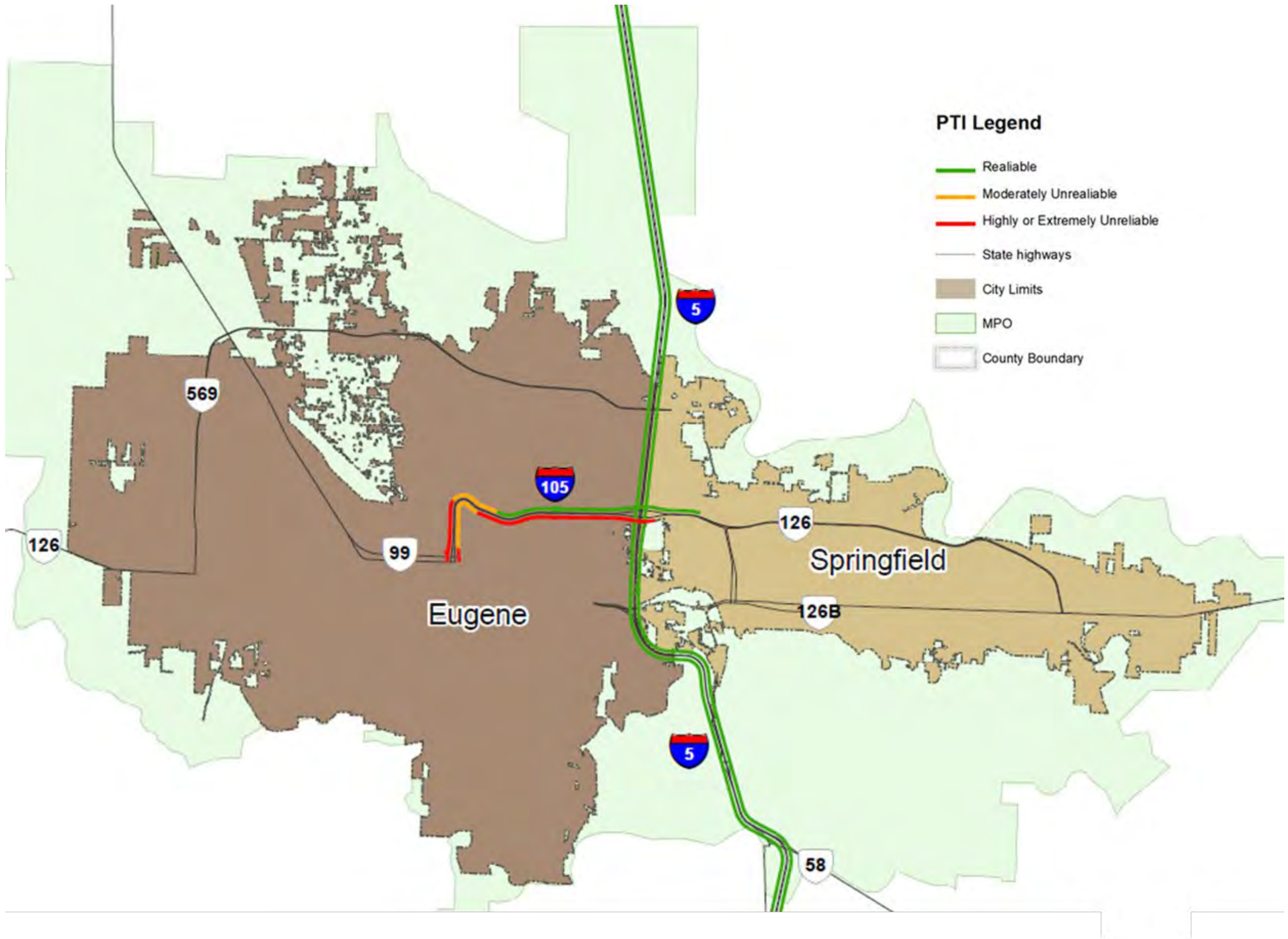


Figure 22 illustrates the PTI for Eugene-Springfield interstate highways. While the I-5 section through the region is reliable, I-105 eastbound is extremely unreliable with a portion moderately unreliable. I-105 westbound is reliable until approaching the end of the highway as it transitions to OR 99 within central Eugene.

FIGURE 22. EUGENE-SPRINGFIELD REGION PLANNING TIME INDEX 2017, PM PEAK PERIOD 4 PM – 6 PM



3.2.4 Truck Reliability

Freight movement within Oregon relies heavily on the highway system, 70 percent of freight moves by truck and 78 percent of heavy truck VMT occurs on the state highway system. Developing performance measures specifically designed to identify freight mobility is challenging at best – observed data is hard to come by, the few existing sources have limited detail due to the confidential nature of a competitive industry. Transporting freight requires reliable travel times, predictable congestion can be accounted for in delivery schedules. Unpredictable congestion causes late deliveries, firms incur penalty fees and risk losing customers. Unreliable travel times require firms to adapt by putting more trucks on the road to deliver the same quantity of goods on time, cargo typically stored in trucks on the road are stored in warehouses as the number of daily stops a truck can make declines. This drives up the cost of freight transportation, which is passed on to businesses and consumers. Rising costs erode Oregon's competitive advantage, presenting risk to our export dependent economy.

Daniel Murray, current senior vice president and past director of research for the American Transportation Research Institute (ATRI) said:

> *"From a freight perspective, the quintessential requirement for succeeding in a global, just-in-time economy is the ability to plan trips, deliveries, and transactions down to hours and minutes—rather than days and weeks. This makes reliability one of the single most important performance measures from a private sector perspective."*[29]

Trucks moving freight share the same highway system used by cars and busses moving people. Congestion and unreliable performance affects all highway users alike. Measures such as the Travel Time Index and Planning Time Index reveal the worst locations. Resolving these locations will help all highway users. There are specific freight bottleneck locations that have been identified within Oregon in the "Oregon Freight Highway Bottleneck Project Final Report"[30]. There have been national bottleneck studies as well, including the ATRI "2018 Top 100 Truck Bottlenecks"[31] where Portland is listed as number 62 worst location and the ATRI "2019 Top 100 Truck Bottleneck List"[32] where Portland moved up the list to number 28. When it comes to measuring the impacts of congestion and unreliable conditions on medium trucks and other commercial travel, very little is known due to a lack of data describing these users.

[29] Public Roads, Volume 68, Issue 3, page 56.
[30] https://www.oregon.gov/ODOT/Planning/Documents/FHBL_Final-Report.pdf
[31] https://truckingresearch.org/2018/01/25/2018-top-truck-bottleneck-list/
[32] https://truckingresearch.org/2019/02/06/atri-2019-truck-bottlenecks/

4 CONCLUSION

The transportation system is the economy in motion. People travel to access jobs, services and goods. Businesses depend on the transportation system to access employees, customers and the goods and services needed to conduct their business activity. Each person, business, commodity, and industry has different needs from the transportation system. Accommodating a variety of needs while maintaining safety within a constrained budget requires strategic decision making and acknowledgement of necessary trade-offs. All economic “agents” must balance trade-offs, whether it is done by households, businesses or public agencies. Building a good understanding of the underlying economic motivations and decision criteria utilized by transportation system users supports development of effective solutions and informed investment decisions.

Oregon’s growing economy means demands on the transportation system will continue into the future. Long range investment capabilities do not include adding significant capacity, investment will focus on utilizing current capacity more efficiently and effectively. Understanding the motivations behind transportation user choice helps inform development of public policy. Quantifying use of the transportation system provides information needed to develop the right solutions at the right time at the right locations. Access to observed data enables monitoring of system performance, revealing congested locations and overall system performance. In a time of declining revenue streams and rising system use, it is more important than ever to develop effective ways to manage the transportation system and provide safe and affordable mobility options to preserve the quality of life in Oregon now and into the future.

Oregon Transportation Commission

INVESTMENT STRATEGY

2020 UPDATE

Oregon Department of Transportation

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EXECUTIVE SUMMARY

Investments in maintaining and preserving transportation infrastructure have not kept pace with growing system needs over time. The effects of decades-long underinvestment are particularly acute across state highways and transit systems that are facing growing maintenance and modernization needs.

In 2019, the Commission requested the opportunity to update its 2017 Investment Strategy to account for the additional funding in HB 2017 and an updated assessment of need across the transportation system. Across all modes of transportation, HB 2017 met only a portion of the funding needed to maintain and enhance the transportation system. In some areas such as bridges and pavement HB 2017 means we are falling behind more slowly; in other areas like bicycle-pedestrian we will be able to slowly eat away at significant unmet need; and in transit we will see significant service expansion that will meet only a portion of the need for public transportation.

The Commission plays a key role in making investment decisions for the transportation system and the agency, primarily through the Statewide Transportation Improvement Program. In 2020 the Commission will begin work on the next STIP that will cover the 2024-2027 time period. This work will begin with allocating funding among basic program categories. The Commission also will provides direction on the specific funding programs in which projects are selected.

Revenue

- The Oregon Constitutional restriction on use of highway funds ensures that user fees are invested in roads but makes it challenging to fund non-highway modes.
- The Constitution's requirement for cost responsibility between light and heavy vehicles underlies our unique weight-mile tax and ensures trucks pay their fair share for their use and impact on the roads.
- The State Highway Fund relies on a three-legged stool of fuels tax, driver and motor vehicle fees, and motor carrier taxes and fees, a well-balanced portfolio of revenue.
- Oregon's overall highway taxes are lower than most western states, and Oregon has among the lowest vehicle fees of any state in the nation.
- The Legislature has effectively used bonding to pay for transportation projects, but debt service payments will limit the ability to fund new projects in the future.
- Inflation erodes most of our highway revenue streams.
- Increasing fuel efficiency will erode the fuels tax, the primary source of transportation revenue; per-mile road usage charges could be a solution.

- Federal funding has been flat for about a decade, and federal funding is at serious risk of being cut because the Highway Trust Fund will run short of cash in 2021.

Preservation

- Oregon is a fix-it first state. The Oregon Transportation Plan and Oregon Highway Plan focus on preserving the system; highway improvements are focused on enhancing efficiency and the capacity of existing facilities rather than building new ones.
- ODOT focuses on preserving a set of Fix-It Priority Corridors that carry high volumes of freight and connect most communities.
- Funding to preserve state highway assets is not adequate, resulting in a triage approach to preservation, rehabilitation, and repair, and maintaining status quo conditions requires more than doubling current funding.
- Due to the aging of Oregon's bridges, many are reaching the end of their service life. But funding only allows for bridge rehabilitation rather than replacement; the current bridge replacement cycle is about 900 years.
- Repaving on most state highways has stretched to a 50-year cycle. As a result, conditions will start declining in 2024. The resulting pavement deterioration will require more expensive reconstruction rather than simple repaving.
- Thousands of culverts cross Oregon highways. However, culverts face a 1,310 year replacement cycle, increasing the risk of catastrophic failures that close highways.
- Day to day highway maintenance and operations can only be funded by a portion of State Highway Fund revenue– and ODOT faces a major shortfall in these funds.
- More burden will fall on maintenance crews as the system deteriorates.
- 24% of maintenance facilities are over 50 years old and over 40% are obsolete.

Safety

- ODOT funds safety through a variety of programs, including road and rail infrastructure investments, behavioral programs, and rail/transit regulatory programs.
- The primary infrastructure program is the All Roads Transportation Safety (ARTS) program, which uses a data-driven process to find the most cost-effective ways to drive down fatalities and serious injuries for all road users regardless of jurisdiction.
- Programs focused on road user behavior are funded by a variety of state and federal sources and flow through the Transportation Safety Division (TSD). TSD selects projects within priority focus areas through a strategic investment process based on the Transportation Safety Action Plan.

Multimodal Transportation Options

- Across the non-highway programs the agency has a significant role in program development, project selection, and grant administration. These functions are all performed in partnership with stakeholders.

- In non-highway programs, the role of the agency and the OTC is to select the best projects across jurisdictions to ensure connectivity and mobility, rather than on ensuring the health of the state highway system.
- Bicycle and pedestrian projects can be funded from a wide variety of funding sources. However, these disparate funding sources often lead to opportunistic and fragmented investments rather than strategic investments.
- State Highway Fund resources can only go to bicycle and pedestrian projects within the right of way. As a result, most of the active transportation funding in HB 2017 went to Safe Routes to School projects within the road right of way and very little additional money went to off-road paths that are often preferred by walkers and bikers.
- The Statewide Transportation Improvement Fund is the first significant state investment in public transportation; previously most funding came from local and federal sources.
- Much of the need for investment in public transportation is for operations, rather than capital expenditures to preserve the bus fleet or invest in infrastructure.
- Oregon's passenger rail funding can pay for existing service, but we don't have a dedicated funding source for passenger rail that is sufficient to pay for increased service or improve infrastructure to reduce travel times and increase reliability.
- ODOT has managed to creatively scrape together match funding to secure some federal grants to improve the rail system, but a lack of state match sources make it difficult to leverage federal rail grant programs.

Multimodal Freight

- Aviation, ports and rail are highly reliant on Connect Oregon for infrastructure investments. While the new privilege tax will provide Connect Oregon a sustainable funding base, it won't be adequate to run a robust program.
- New aviation funding provided by the Legislature has provided match funds that have allowed most general aviation airports to leverage Federal Aviation Administration grants. However, funding has only met a portion of grant requests and the funding has not been able to provide significant assistance to the commercial service airports.

System Operations

- Operations investments can be a cost-effective way to improve mobility and safety while reducing GHG emissions.
- With relatively short replacement cycles, aging operations infrastructure increases maintenance expenditures and impacts mobility and safety.

Modernization

- Modernization projects have relied primarily on legislative funding in recent years.
- Tolling may be a way to pay for major highway expansion projects that don't have a funding source, but federal law limits where a state can impose tolls.

TABLE OF CONTENTS

INTRODUCTION

The 2016 Investment Strategy, adopted by the Commission in January 2017, laid out the agency's investment strategies in various program areas, compared total need to available funding, discussed the implications of long-term system performance at current funding-levels, and outlined options for additional investment. It was developed for legislative consideration during the 2017 legislative session, during development of the transportation funding package.

In response to the projected impact of deferred investment described in the 2016 Investment Strategy, the 2017 Oregon Legislature passed House Bill 2017 (HB 2017). Often referred to as Keep Oregon Moving, HB 2017 marked a historic investment in transportation, designed to promote a clean environment, strong communities with good quality of life, a vibrant economy with good jobs, and safe, healthy people.

The funding package included substantial investments in public transit, roads, and bridges, advanced congestion-pricing (tolling) and allocated funding for safe routes to school infrastructure and electric vehicle purchase incentives as well as increasing funds for roads and bridges. To provide this additional funding, the legislation increased traditional Highway Fund taxes and fees (i.e. motor-fuels tax and DMV fees) and introduced four new taxes (privilege-tax, use-tax, payroll-tax, and bicycle-tax).

The 2020 Investment Strategy update will build on the 2016 iteration by examining the gap between total system-wide needs and current funding-levels (post-HB 2017), given that revenue is projected to decline, costs are rising and needs are growing. This report consists of an updated overview of how the Department's scarce resources are being invested, the resulting performance/system conditions, and prioritization of expenditures should funding levels remain flat or are further reduced. The anticipated impacts and implications for the transportation system, economy, and traveling public in Oregon have been updated and are included to inform future decisions regarding Department priorities and strategic investments.

With future funding uncertain and significant unmet needs identified across all modes and investment areas, the Department recognizes that the need for sustainable revenue remains significant. To that end, information regarding the status of current revenue generation efforts and additional options for further exploration has also been incorporated.

BACKGROUND

Strategic Investment Decisions

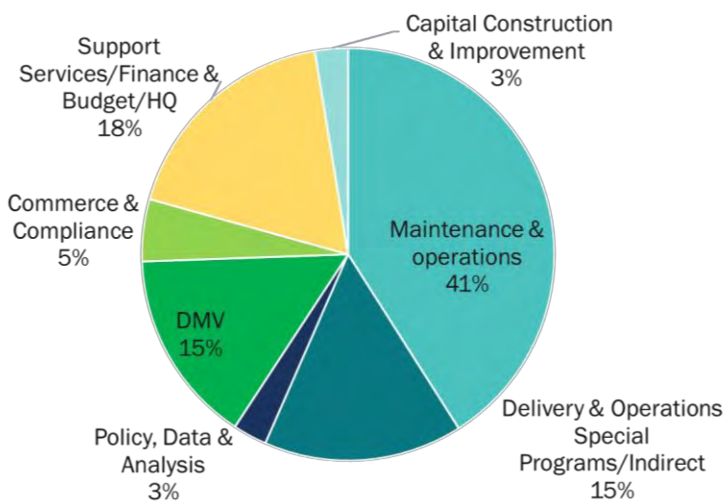
The Commission plays a key role in making investment decisions for the transportation system and the agency. Throughout 2019, the Commission held a series of Strategic Investment Workshops aimed at familiarizing the Commission with system revenue streams, budget process and program funding investments, as well as developing a shared understanding of how current statewide policy direction and past transportation plans relate to ODOT's strategic investment work under the Strategic Business Plan (SBP). This shared understanding is foundational to the policy development in the Oregon Transportation Plan (OTP) update.

The program funding levels, transportation system conditions, as well as the impact to Oregon's economy and users of the system contained in this report, are based on the best available information.

Agency Request Budget (ARB)

The Department Budget includes all of the funds that flow through the department, for both the transportation system and the agency, over a two-year period. The budget includes expenditures focused on agency service levels and capabilities, including capital expenditures on fleet, facilities, and information systems. It also includes agency operations costs for our maintenance and operations forces and ODOT's service, revenue, administrative and regulatory functions (i.e. DMV, Commerce and Compliance Division, and Support Services Division). The Commission approves the Agency Request Budget, and the Legislature ultimately approves the final budget.

Allocation of State Highway Fund Resources in ODOT's Operational Budget

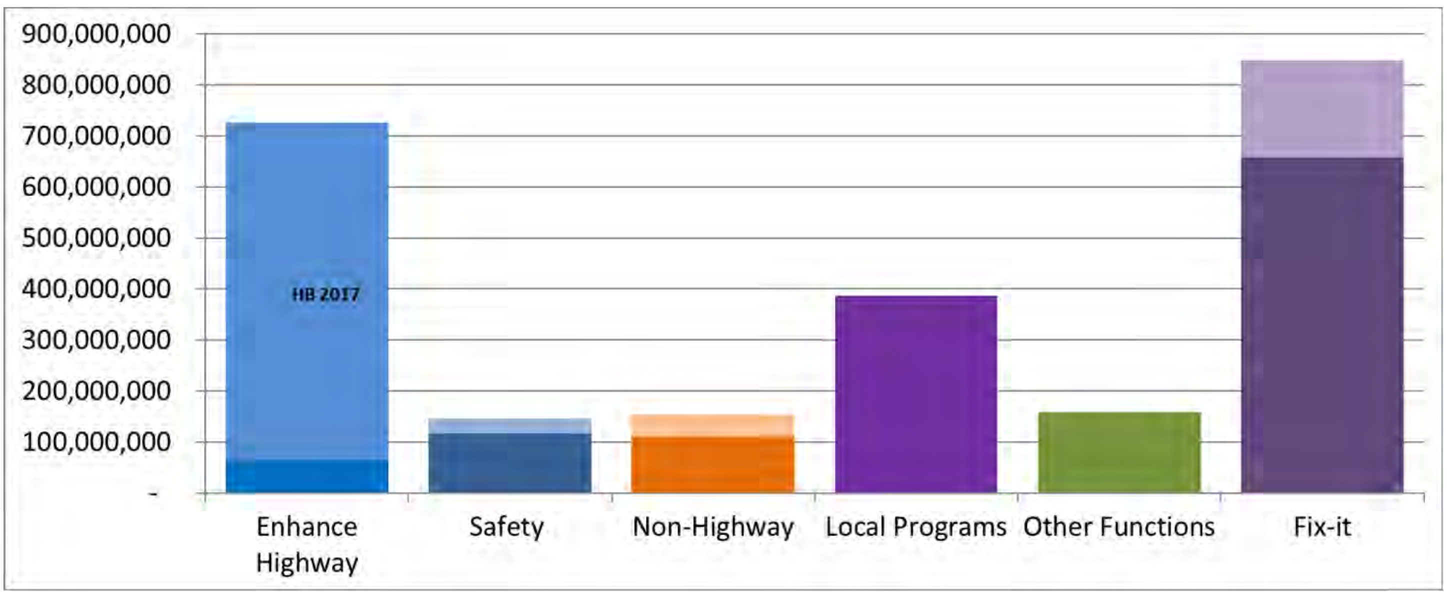


The Department relies on a large number of funding sources, and each comes with specific restrictions. Although ODOT is a multimodal agency, our funding is heavily tilted toward highways. As a result, the budget for the Delivery and Operations Division is four times larger than the Public Transportation Division.

The Statewide Transportation Improvement Program (STIP)

The STIP is a subset of the budget that focuses on capital investments in the transportation system. It is required by the Federal government and shows how we plan to use all of our federal funds, although it also includes regionally significant state-funded highway projects. The STIP is where the Commission has the most flexibility to make investment decisions by allocating available funding among programs. Investment decisions made in the STIP are then folded into the agency's biennial budget. In recent STIPs, the OTC put the vast majority of its discretionary resources into Fix-it and safety programs.

Allocation of Funding in the 2021-2024 Draft STIP



Non-highway Grant Programs

Because it focuses on programing federal funds, the STIP does not include all transportation system funding. It does not include highway maintenance or state-funded non-highway programs (i.e. Connect Oregon, Statewide Transportation Improvement Fund (STIF),Safe Routes to School (SRTS), and passenger rail operations). Funding levels for these programs are generally set by the Legislature in statute or in ODOT's budget, and the Commission makes decisions about distribution of these funds in competitive funding cycles.

TRANSPORTATION REVENUE AND FUNDING: CHALLENGES AND RISKS

Oregon Department of Transportation and Oregon's transportation system face significant long-term funding challenges. A number of trends will drive changes in the way the state invests in the transportation system, while other trends will create significant challenges for the revenue needed to invest in the system.

State Highway Fund Revenue

A key concept in highway funding is the "user pays principle." Most highway funding comes from user fees, where those who use the system and benefit from it pay for it. There are two primary sources of highway funding: State and Federal.

Constitutional and Legal Framework

Oregon's Constitution in Article IX Section 3a states that "Any tax levied on, with respect to, or measured by the storage, withdrawal, use, sale, distribution, importation or receipt of motor vehicle fuel or any other product used for the propulsion of motor vehicles" and "Any tax or excise levied on the ownership, operation or use of motor vehicles" "shall be used exclusively for the construction, reconstruction, improvement, repair, maintenance, operation and use of public highways, roads, streets and roadside rest areas in this state". This provision limits State Highway Fund spending to roads; no rail, aviation, or even bicycle and pedestrian trails outside the right of way can be funded.

A number of Oregon Supreme Court decisions have provided case law that clarifies the meaning of this provision. These include:

- Automobile Club of Oregon v. State of Oregon, in which the Court found that revenues from a fuel storage "assessment" were a "tax" on motor vehicle fuel, and also that an "emission fee" was a "tax or excise" on the ownership, operation or use of motor vehicles, and therefore both are subject to the constitutional restriction on use of highway funds.
- Rogers v. Lane County, which clarified eligible highway expenditures, noting that to be eligible expenses must "primarily and directly facilitate motorized vehicle travel".
- Oregon Telecommunications Association v. Oregon Department of Transportation, which further clarified what expenses are eligible under the Article IX Section 3a.

Based on these cases and consultation with the Oregon Department of Justice, ODOT has concluded that it most likely can fund the following transit and bicycle/pedestrian programs using constitutionally dedicated highway resources.

- Congestion management options such as dedicated lanes for transit or carpooling, shared lanes for mixed auto/light rail traffic, and queue-jumping lanes.
- Transit facilities within public highway rights-of-way such as transit stops and transit stations.
- Park and ride locations in or adjacent to the right of way that serve buses.
- Transit signal priority.
- Highway pull outs to accommodate buses.
- Bicycle and pedestrian facilities within the highway, road, or street right-of-way.

ODOT has also concluded that new sources of revenue, such as tolls and road usage charges, do constitute a tax that would be subject to the constitutional restriction.

Sources

The State Highway Fund relies on three primary sources: fuels tax, driver and motor vehicle fees, and motor carrier taxes and fees (primarily the weight-mile tax). The Department's share of the State Highway Trust Fund is expended in four primary ways: to fund highway projects, to pay debt service on bonds issued to fund projects, highway maintenance and operations by ODOT forces, and other agency operations.

Prior to HB 2017, State Highway Fund resources were essentially fully committed to highway maintenance and operations by ODOT forces, other agency operations costs, and debt service, with a very small amount going to match federal funds and a handful of small capital programs. As a result, federal funds constituted almost the entire Statewide Transportation Improvement Plan (STIP).

To pay for highway investments, HB 2017 raised the gas tax in multiple steps over a six-year period. The gas tax will increase a total of 10 cents with the final two-cent increase going into effect on January 1, 2024 – provided the Department meets the accountability requirements in HB 2017 by December 1, 2021 and 2023. Registration and title fees have also been increased, and the legislation created surcharges for electric vehicles and hybrids that pay little in gas tax to ensure they pay for their use of roads. Even with these increases, Oregon has among the lowest vehicle fees of any state in the nation.

Increases in revenue over the next several biennia can be attributed to HB 2017. The base funding—which constitutes the resources available to operate the agency – isn't really growing. Pre-COVID 19, the revenue forecast, beyond the next couple years, showed a sluggish growth rate, at best.

COVID-19 and the Economy

The onset of the COVID-19 pandemic has reduced traffic volumes significantly, which has also reduced fuels tax revenue. Oregon's three-legged stool of fuels tax, driver and motor vehicle fees, and weight-mile taxes has limited the pandemic's impact on the State Highway Fund compared to other states that are more dependent on the fuels tax. Nonetheless, ODOT economists' initial revenue forecast predicts a loss of about $125 million in State Highway Fund revenue from the beginning of the pandemic in March 2020 through June 2021—a reduction of about 6% that will reduce funding available to ODOT, cities and counties.

What's more, this revenue forecast is highly uncertain, as the pandemic's longer-term impact on the economy is unknown. The abrupt recession we find ourselves in is unprecedented and likely to double the percentage drop in employment compared to the Great Recession. The June 2020 State Economic and Revenue Forecast predicts that once the economy begins to reopen almost 40% of those jobs will return. Also, because the economy was in good shape heading into the recession our expectation is for a relatively quick recovery, reaching pre-recession employment levels within four years.

Even if the recession is modest, it will punch a hole in state and federal transportation revenue—and if the recession is worse than projected, the revenue loss could be significant. And COVID-19 could also impact traffic volumes and commuting patterns for years, changing investment needs.

Discussion in Congress has begun on potential fiscal relief legislation that could provide additional funding for infrastructure. Legislation passed by the House of Representatives would provide $15 billion for state DOTs and metropolitan areas to backfill lost revenue and stimulate the economy with transportation investment.

Fuel Efficiency and Electrification

Cars driven today are drastically different than they were even a decade ago. National fuel economy standards were 27.5 miles per gallon in 1982, 30.2 MPG in 2011, 37.7 MPG in 2019 and will go up to 49.7 MPG by 2026 for passenger vehicles and light-duty trucks, according to the final rule published by the Environmental Protection Agency and the National Highway Traffic Safety Administration in 2012. While the growing number of hybrids and electric vehicles on the road account for some of this growth, even vehicles powered by internal combustion engines are becoming much more efficient than previous models. As a result of increasing fuel efficiency, Oregon's fuels tax revenue is projected to peak in coming years and start to decline in 2022.

The Legislature attempted to address the revenue issue of higher efficiency vehicles with a surcharge on hybrid and electric vehicle title and registration fees built into HB 2017.

However, even with the tiered registration and title fees high-efficiency vehicles will pay much less than the average vehicle that gets about 20 miles per gallon.

Though the registration surcharges ensure that electric vehicles pay for their use of the roads, the surcharges introduce two inequities:

- An electric vehicle that drives a lot of miles will pay much less than a low-efficiency vehicle.
- An electric vehicle pays the same amount regardless of how many miles it drives, which does not incentivize driving less.

Federal Funding Uncertainty

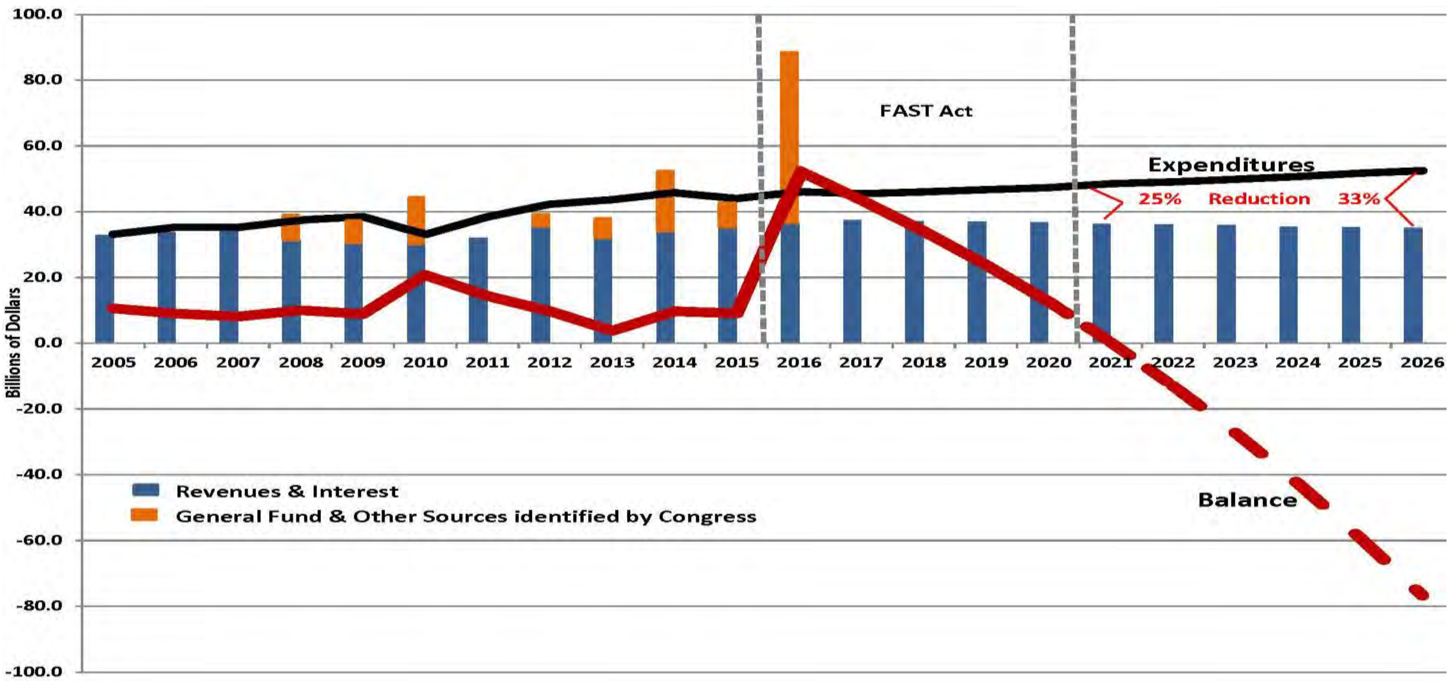
Each year the federal government sends approximately $45 billion to states for highway projects and another $10 billion to states and transit agencies for transit. Oregon receives more than $600 million annually in federal funds through a variety of formula programs tailored to specific areas of the system. Federal funding for highways, transit, and safety has been provided through September 2020 under the current surface transportation authorization act, known as the Fixing America's Surface Transportation (FAST) Act.

The federal gas tax provides virtually all of the resources flowing into the federal Highway Trust Fund. The 18.3 cent per gallon federal gas tax has not been raised since 1993, resulting in a significant gap between user fee revenue and expenditures.

In order to provide funding at current levels Congress has had to transfer over one hundred billion dollars of general fund revenue into the Trust Fund. Federal funding levels are unknown and risky because the Highway Trust Fund will exhaust its balances in 2021, and funding will be cut by more than a third if Congress does nothing; the Trump Administration has already expressed its intent to bring spending into alignment with revenue when the FAST Act expires. The imminent expiration of the FAST Act combined with the looming insolvency of the Highway Trust Fund makes long-term, strategic planning difficult for the Department and local government agencies.

The recently adopted 2021-2024 STIP assumes a 10% reduction in federal funds each year following the expiration of the FAST Act, which is consistent with past reductions of federal funding after expiration of authorization acts. If more money is available, projects can easily be added to the STIP.

Federal Highway Trust Fund: Revenues, Expenditures, and Balances



Increasing Cost of Doing Business: Inflation and Aging Infrastructure

Inflation

Most taxes generally rise along with incomes, prices, or property values. However, the gas tax, DMV fees, and weight-mile taxes are set at a flat level (rather than a percentage) and their purchasing power is constantly eroded by inflation.

State Highway Fund revenue in total is barely growing, even with HB 2017's tax increases, when accounting for inflation. The gas tax increases under HB 2017 will only get the gas tax back to the same purchasing power of 2011 after the Jobs and Transportation Act gas tax increase. The three 2 cent increases under HB 2017 only keep up with inflation.

Aging Infrastructure

Most of ODOT's transportation assets were built in the post-war Interstate construction era and are reaching the end of their original lifespans. For example, more than half of the state's bridges were built before 1970 and have reached the end of their 50 year design life.

However, funding for maintenance and repair has not kept up with the growing needs of an aging system. As a result, ODOT is managing the decline of the transportation system. Deliberate strategies and expertise by ODOT's public servants and industry partners help stretch the available funding and slow the deterioration.

The Shifting Landscape of Mobility

As the smart phone continues to change society, new mobility options enabled by mobile apps continue to roll out. Uber, Lyft and other shared transportation services continue expanding. Electric bicycles and scooters as well as bike-share systems (sometimes referred to as "micro-mobility" options) are shifting how users get from point A to point B.

These services are often referred to as "mobility on demand" and they will have broad-ranging impacts on transportation, particularly in urban areas. Commuting, public transportation and management of the right of way will all be impacted. Due to COVID-19, teleworking has risen significantly, keeping people plugged in remotely (and out of their cars). Whether this is a short-term blip or part of a longer-term shift is not yet known. As technology continues rapidly advancing, the deployment of autonomous vehicles will undoubtedly alter travel and commuting patterns. All of these trends will modify investment needs across the transportation system, in ways that are not well-understood at this time.

INVESTMENT AREAS & SUPPORTING PROGRAMS

PRESERVATION	SAFETY	MULTIMODAL TRANSPORTATION OPTIONS	SYSTEM OPERATIONS	STRATEGIC CAPACITY EXPANSION
Bridge Pavement Culverts Seismic Highway Maintenance	All Roads Transportation Safety (ARTS) Rail Crossings	Active Multimodal Freight Public Transit Passenger Rail	Optimization/ Enhancements Operations Incident Response	Modernization

PRESERVATION

Oregon has 74,000 miles of highways, streets, and roads and 8,000 bridges to preserve and maintain. The transportation system that the Oregon Department of Transportation (ODOT) operates was built primarily by past generations.

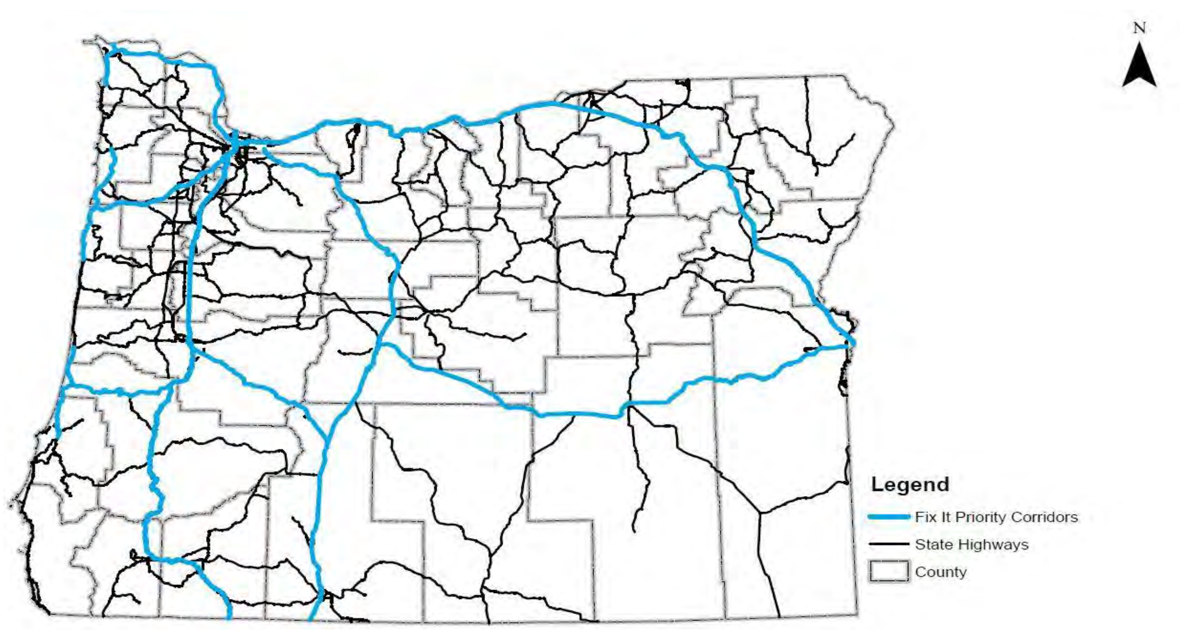
Oregon is a "fix-it first" state. In alignment with the Oregon Transportation Plan, ODOT places a top priority on maintaining assets that make up our transportation system. "Fix- It" programs within ODOT strategically invest toward stated outcomes by allocating funds to specific projects and maintenance activities. The Oregon Transportation Plan (OTP) and Oregon Highway Plan (OHP) focus on preserving the system and making it safer before adding capacity. OHP policy 1G.1outlines the following investment hierarchy:

1. Protect the existing system.
2. Improve the efficiency of facilities that already exist, by implementing intelligent transportation systems and other solutions.
3. Add capacity to the existing system.
4. Only after we've done everything else do we add new facilities.

This hierarchy and fix-it policy lean is reflected in the STIP.

One of the ways we deal with limited funding is by focusing on the most critical corridors– the ones that connect most of our communities and serve most freight. By focusing our investments we can stretch scarce bridge and pavement funding further.

ODOT Fix-It Priority Corridors



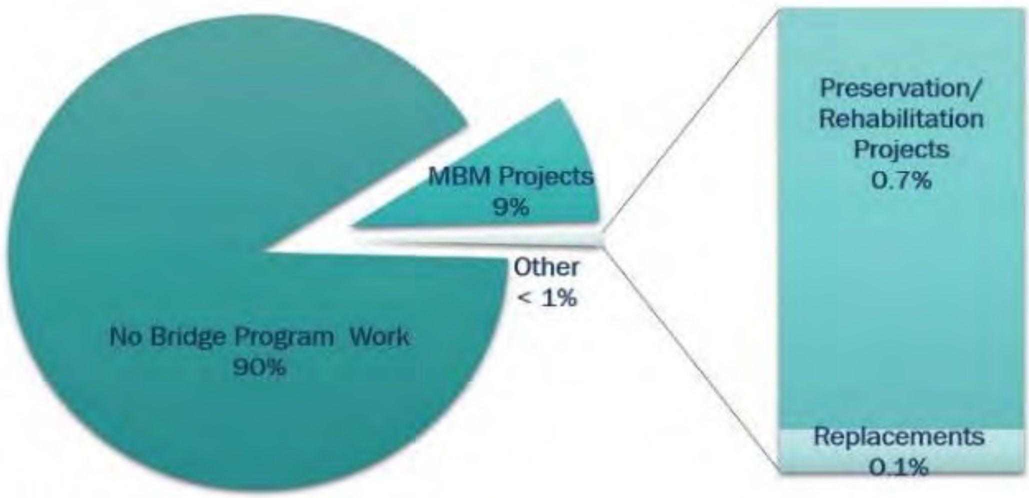
Oregon Department of Transportation

STATE BRIDGE PROGRAM

Purpose & Funding Levels

The State Bridge Program oversees Oregon's state highway bridges, inspecting conditions on a bi-annual basis and using inspection and asset data to manage the selection and funding of bridge preservation, rehabilitation, and replacement projects.

Current funding allows ODOT to touch less than 10% of state highway bridges each year. Most of the bridges addressed each year are done through the Major Bridge Maintenance program, which addresses emergency repairs and preservation treatments like deck seals. Each year less than 1% of bridges see rehabilitation (deck work, strengthening, and concrete repairs), and just 0.1% are replaced. This means that bridges are currently being replaced on an approximately 900 year cycle—far beyond their intended life of 50-100 years.

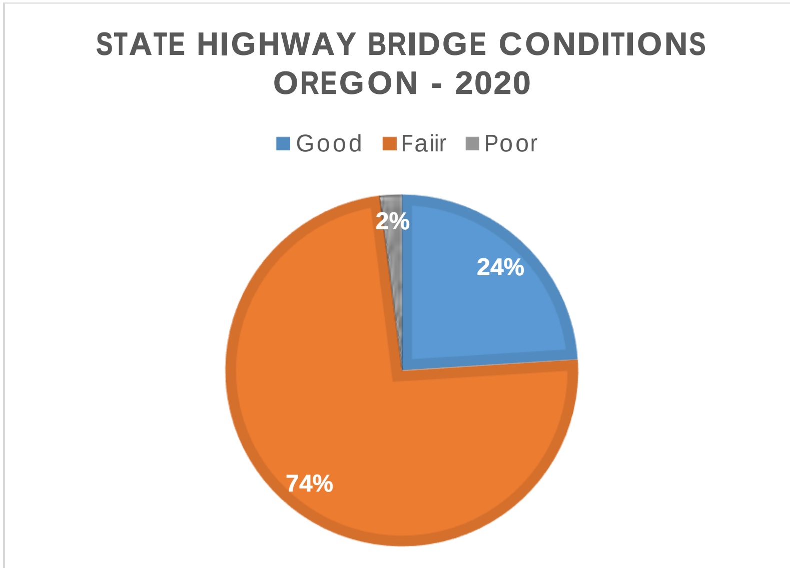


A sustainable program would increase the number of annual bridge replacements from 0.1% to 1.0%, or 28 bridges replaced each year. It would also increase the number of bridges receiving preservation/ rehabilitation projects from 0.07% to 2.0% annually. This would target a 100-year service-life and address the wave of Interstate Era bridges approaching the end of their service-lives that need to be addressed.

Investment Strategy

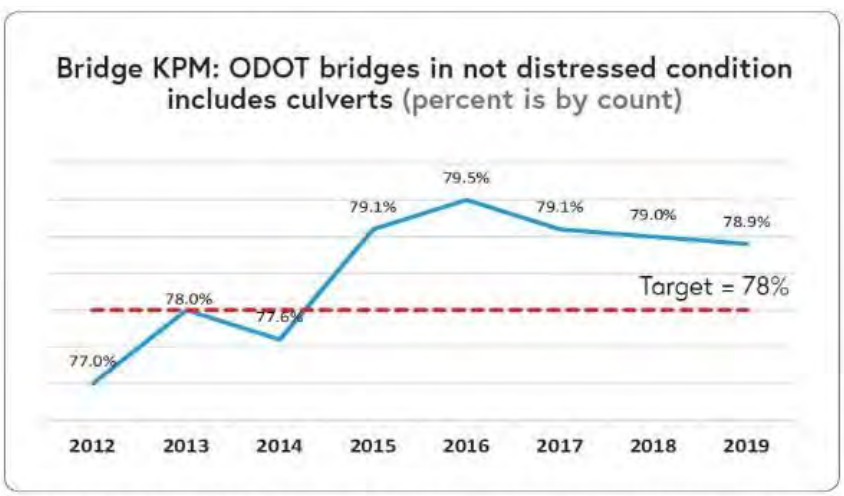
The current strategy for managing Oregon's bridges places an emphasis on maintaining the bridge system, funding bridge repairs on the highest priority freight routes (Fix-It Priority Corridors). Even the infusion of additional resources under HB 2017 leaves ODOT with resources for very few bridge replacements. Oregon's scenic beauty is enhanced by many iconic and historic high-value bridges, particularly bridges on US 101 on the Oregon Coast. Because replacement of these bridges is cost-prohibitive, preserving them is the only option to ensure safe transportation and critical services.

The bulk of state highway bridges are in fair condition, with few poor (or structurally deficient) bridges. However, a large number of these fair bridges are at the cusp of slipping into poor condition and requiring increased attention.



ODOT considers both structurally deficient and other deficiencies in determining bridge needs and selecting projects for the STIP. ODOT measures bridge conditions based on the Bridge Key Performance Measure – Percent of Bridges Not Distressed. The Key Performance Measure includes two categories of bridges:

- The percent of bridges not structurally deficient as defined by FHWA.
- The percent of bridges without other deficiencies as defined by ODOT.



ODOT bridges Not Distressed condition. Larger percentages are better.

While bridge conditions currently exceed the Key Performance Measure target, 2019 marks the third year of a measureable decline, and ODOT projects conditions will sleep below the target in the future.

Typical Life Cycle

The typical service life of a bridge is driven by deterioration caused by studded tire wear, impact loading, salt, weather, and aging materials.

- Typical service life including repairs is about 75-100 years.
- Replacement cycle at current funding level is about 900 years.

By extending the service life of a large population of bridges instead of replacing a sustainable portion each year, we are leaving the next generation with an issue that will take an extended amount of time and money to address. Based on the large number of bridges in service that were built prior-to or during the Interstate Era, a significant number of Oregon's bridges will fall below the desired state of good repair between 2025 and 2030. Even if the decision to fund bridges to maintain a state of good repair is left to the next generation, they will be paying substantially more and will not see the benefit since the number of bridges in poor condition will greatly exceed the rate at which new bridges can be built.

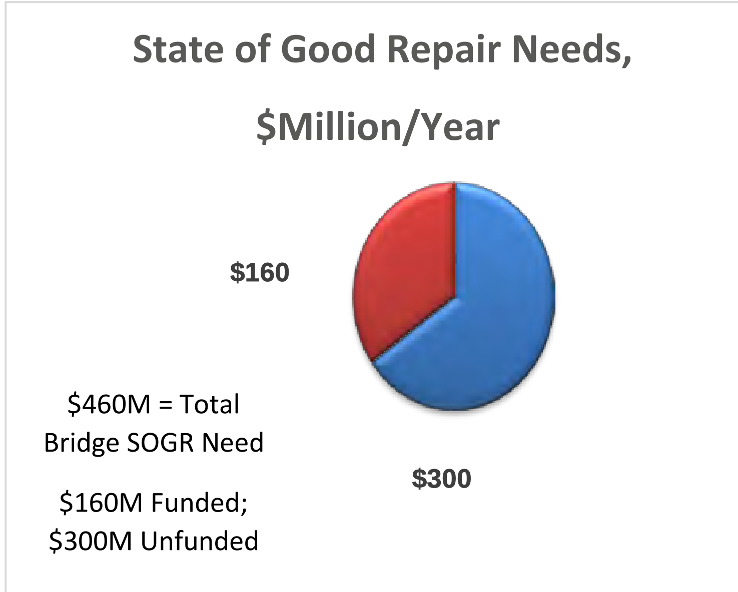
Needs

A large number of bridges with critical and near-critical conditions have had their service lives extended beyond a normal time period because of long standing inadequate funding. Those bridges demand vigilance and dedication by inspectors and maintenance personnel to maintain safe conditions. Those critical and near-critical conditions will grow at an increasing rate until a point in the near future that current resources will not be able to keep up with these serious issues.

Doubling the current annual Bridge Program Funding from $100 million to about $200 million would allow ODOT to continue to manage the system in accordance with the Bridge Strategy, with emphasis on the Fix-It Priority Corridors, the protection of high-value, historic, major river crossings, and border structures. Funds would primarily be used to address bridge needs on the highest priority freight corridors. The few additional bridges that could be replaced would be based on freight and seismic priorities.

An incremental increase in funding will slightly increase the number of good bridges, however many bridges will still remain in fair condition for a longer period of time. An incremental funding increase would result in fewer restrictions for the movement of freight. It would also decrease the chances of a major structure deteriorating to the point that the only practical choice is replacement. With a doubled bridge program, funding would primarily be directed to the Fix-It Priority Corridors and high value bridges with some bridges not part of that population still subject to postings and ultimately closures.

With the growing population of bridges in fair condition deteriorating into poor condition, a significant and prolonged investment in new bridge construction will be required to return the system to a state of good repair. Funding to maintain a state of good repair is substantial, close to $460M per year, which far exceeds the level of funding that bridges have received for several decades.

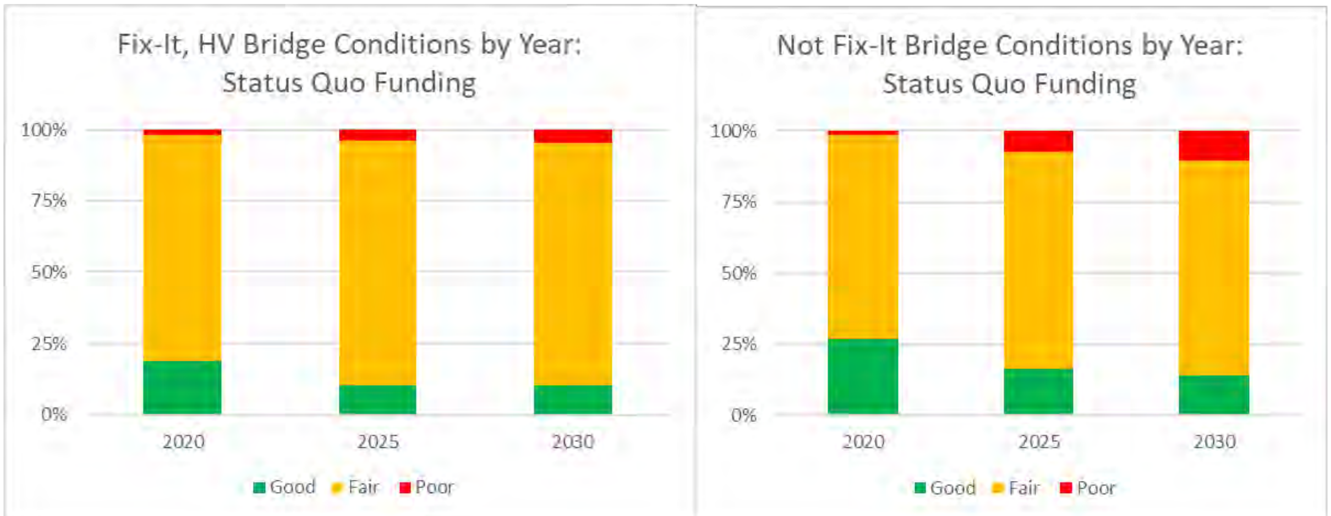


Impacts & Implications

Although every bridge is important to someone, the bridge program investment strategy focuses on maintaining bridges critical to Oregon's economy, which is not always in alignment with bridges perceived as critical to the general public.

Even with the increased funding from HB 2017, bridge conditions are expected to continue to deteriorate. The number of poor bridges will increase on the Fix-It, High Volume (HV) routes and increase even more on the non-Fix-It routes over the next ten years. Bridges on non-Fix-It routes will only be repaired as needed while rehabilitation or replacement needs will be deferred. As bridge conditions decline and rehabilitation or replacement work is deferred, bridges may be load restricted or closed to manage public safety, which will require detours that may increase delays and shipping costs. The Rough Roads Ahead 2 report published by ODOT demonstrated that bridge restrictions will create significant negative impacts to Oregon's economy.

The Major Bridge Maintenance program provides significant repairs on poor bridges to temporarily improve their condition from poor to fair. Due to limited resources, at some point, Major Bridge Maintenance efforts will not be sufficient, resulting in bridge restrictions, delays, and detours onto local roads.



Seismic Resilience

In the event of an earthquake and tsunami, a resilient transportation network is necessary for reestablishing critical connections for emergency response, medical and shelter facilities, population centers, energy and communications facilities and freight needs for response and economic recovery. The Oregon Resilience Plan assessed the seismic integrity of Oregon's multimodal transportation system and characterized the work considered necessary to restore and maintain transportation lifeline routes after a Cascadia earthquake and tsunami. The Oregon Resilience Plan emphasizes the physical infrastructure needed to support business and community continuity. The policy recommendations, if implemented over the next 50 years, will enhance infrastructure reliability, help preserve communities and protect the state economy.

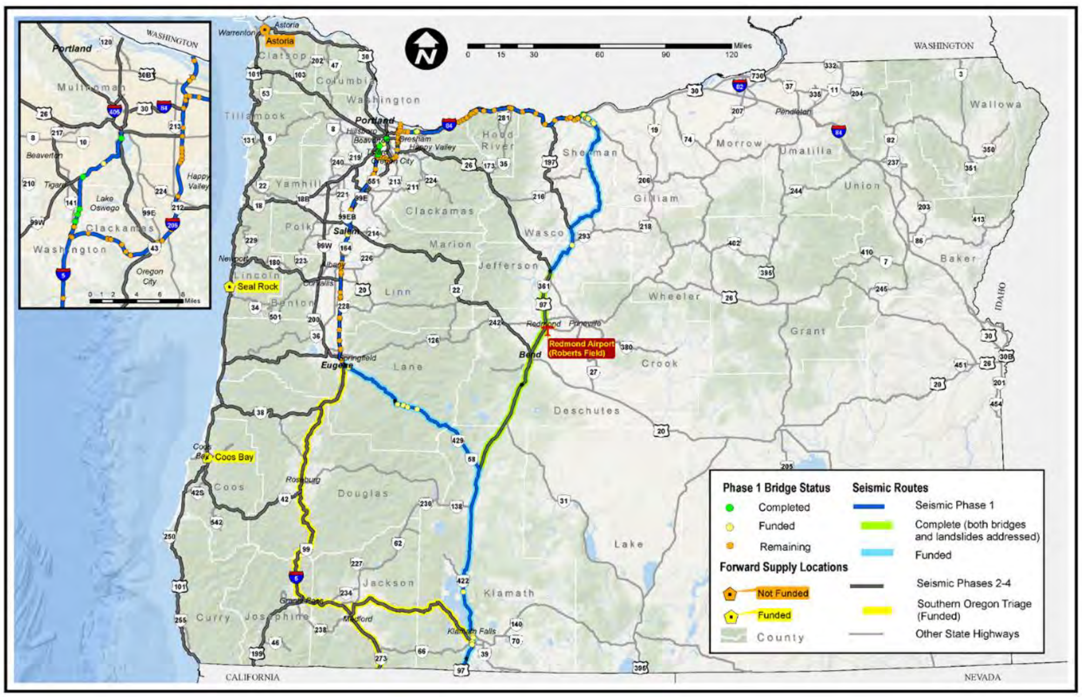
As part of this work, ODOT assessed the vulnerabilities of the highway system, considered links to critical facilities and prioritized routes for investments in improved resilience. The focus of the effort was on preparation for response and recovery from a major Cascadia Subduction Zone earthquake and related events. The result was a recommended "Backbone" system of lifeline routes. The findings were incorporated into an Oregon Highways Seismic PLUS Report that describes the types of retrofits required to address bridge, landslide and other hazards. Implementation of the Seismic PLUS program would make the state highway system resilient in the face of an earthquake, allowing more effective response and reducing economic impact.

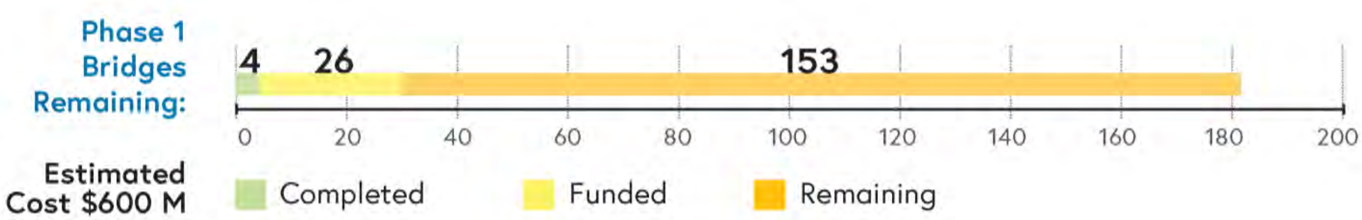
The Seismic PLUS program includes five phases that would cost an estimated $5.1 billion. This would pay to replace 138 bridges, seismically retrofit 390 bridges, rehabilitate and retrofit 190 bridges, and mitigate nearly 1200 landslides and rockfalls. Even with the infusion of resources under HB 2017, the limited number of bridge replacements ODOT can undertake limits the pace at which ODOT can implement the Seismic PLUS investments.

Given limited resources, ODOT's seismic investment strategy has a number of components.

- **Focus mitigation on Phase 1.** ODOT is retrofitting and replacing bridges to achieve a long-term full mitigation for the most important corridors in Phase 1.
- **Triage for Phases 2-4.** ODOT will identify lower cost alternative routes on the local system that could serve segments of the corridor.
- **Recovery planning for bridges in Phase 5.** Phase 5 bridges include the major coastal bridges that are cost-prohibitive to replace at current funding levels.
- **Enhance maintenance facilities**. ODOT is enhancing maintenance stations and pre-staging critical supplies in the most affected areas. This approach aims to leverage existing funding and co-location with local partnerships. The three first priority locations that have been identified are Coos Bay, the central coast, and Astoria.

ODOT Phase 1 Seismic Routes





PAVEMENT PRESERVATION PROGRAM

Purpose & Funding Levels

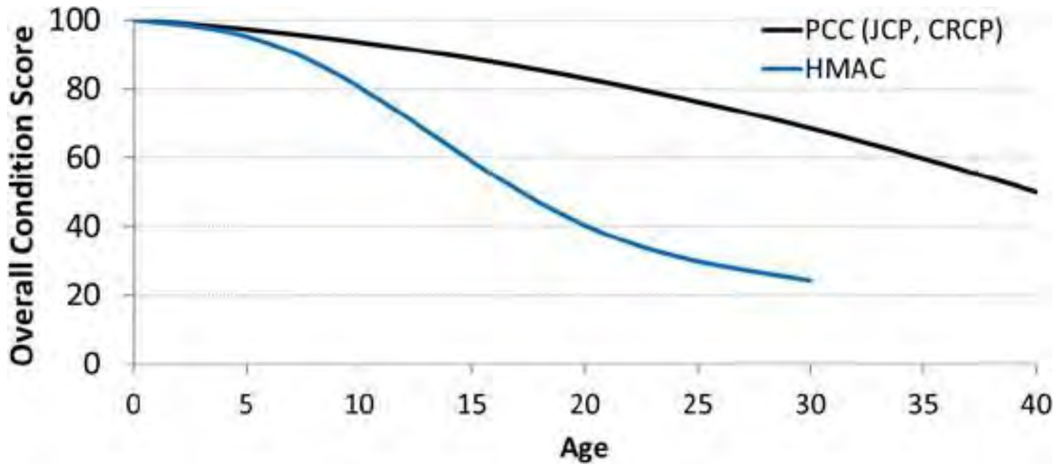
The Preservation Program maintains the pavement on roughly 7,350 centerline miles of Oregon state highways to prevent them from becoming a threat to safe travel, from costing more to rebuild, and from having a negative effect on the state's economy. The program also corrects roadside safety feature deficiencies such as obsolete guard rail, addresses curb ramp accessibility deficiencies abutting repaving projects, and applies new stripes to the surface resulting in smooth "like new" highways at a fraction of the cost to replace them. The Program's overall goal is to keep highways in the best condition possible with available funding, by taking a life-cycle cost approach to preservation and maintenance. Rather than following a "worst-first" philosophy, the Program applies a "mix of fixes" including preventive maintenance seal coats, resurfacing preservation projects, pavement rehabilitation, and reconstruction.

While federal funding allocations to the Preservation program have remained relatively flat for nearly two decades, the Preservation program has received supplemental funding through the Oregon Transportation Investment Acts (OTIA), federal Recovery Act, HB 2017, and also the Maintenance program outside the STIP. As a result, pavement spending over the last few years has averaged roughly $150 million per year. The long term average pavement project cycle time since the early 2000's has been 20 to 25 years for most of the state highway system, which isn't far from the state of good repair goals.

However, even with HB 2017, funding for the Preservation program drops to about $106 million per year after 2022. At the same time, costs for pavement projects continue to increase. Based on Preservation project mileage from projects programmed in the 2021-2024 STIP, this funding level only provides an equivalent life-cycle time of 50 years. In the future, unless additional pavement funding is provided, there will be fewer paving projects and a substantial drop in miles treated, leading to a corresponding decline in pavement conditions.

Typical Life Cycle

Pavements are load-carrying structures that degrade over time due to the cumulative effects of traffic, weather, and material aging. To keep them properly maintained and out of poor condition, they must be resurfaced or rehabilitated at periodic intervals. Typical design life for asphalt pavements are 15 to 20 years, while concrete pavements last 40 to 50 years.



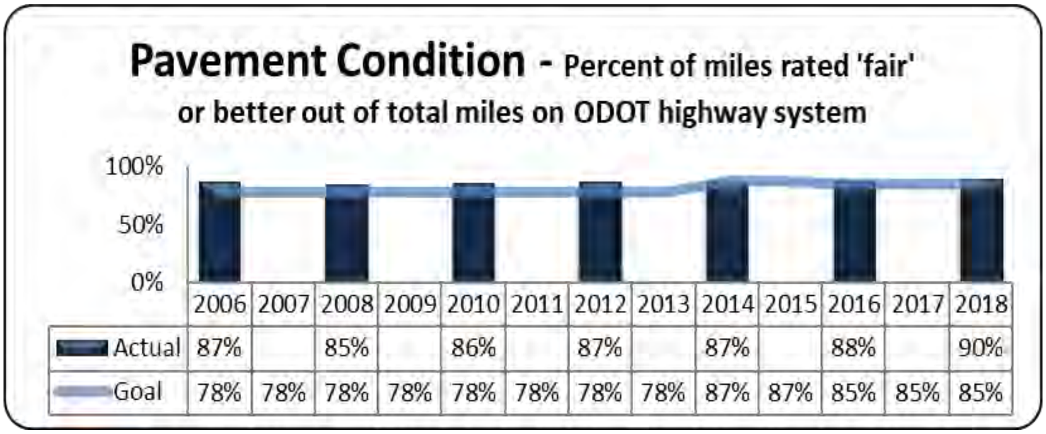
When degradation is confined to the surfacing only, and the pavement's foundation and base layers are protected, a given pavement can be resurfaced over and over again, with occasional strengthening, but without the need for a complete replacement. But when pavement is allowed to deteriorate, replacement at great cost becomes necessary.

Investment Strategy

Current funding for maintenance and repair does not keep up with all needs, so the program follows an asset management strategy to reduce the slope of declining pavement conditions across the system. ODOT has developed and implemented a pavement strategy that uses a tiered approach to prioritize highway routes and also prioritizes projects where the most cost-effective maintenance treatments can be employed. State highway pavement preservation investments prioritize pavement conditions by state highway classification into four levels:

1. Interstate Highways (highest priority, condition target, and level of investment)
2. Fix-It Priority Routes (e.g., US-97, OR-58, or US-26)
3. Remaining State Level National Highway System Routes (e.g., US-101)
4. Region and District Level Routes (e.g., OR 99E or OR214)

Pavement conditions have recently trended upward due to a focus on lower cost per mile projects, temporary increases in Federal funding, and new funding from HB 2017. The current 90 percent "fair" or better KPM is above the 85 percent legislative target.



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Actual	87%		85%		86%		87%		87%		88%		90%
Goal	78%	78%	78%	78%	78%	78%	78%	78%	87%	87%	85%	85%	85%

Needs

Although the overall statewide pavement KPM is currently 90% "fair" or better, some parts of the system, particularly state highways through urban areas and lower traffic routes, are on the decline as needs exceed available funding. If Pavement funding levels were restored to the recent average annual allocation of approximately $150 million per year, pavement conditions could be maintained at a near optimal investment level on the most important routes in the system. This funding level would ensure that the interstates and fix-it priority routes are maintained at a state of good repair and also provide for relatively slow declines on other parts of the system. Although this investment roughly doubles the number of projects off the interstate compared with current funding, it still is not sufficient to address all of the needs of the system, particularly those off the Fix-It Priority Corridors.

Previous studies, including the 2017 OTC Investment Strategy, the Rough Roads 2 report, and the Oregon Transportation Asset Management Plan (TAMP), have defined a state of good repair for Pavement as maintaining the current 90% "fair" or better KPM, while addressing pavement needs across the entire system, not just the routes with less expensive projects. ODOT estimates that the agency needs approximately $220 million per year to achieve and hold pavement at a state of good repair over the long term across the entire system.

Impacts and Implications

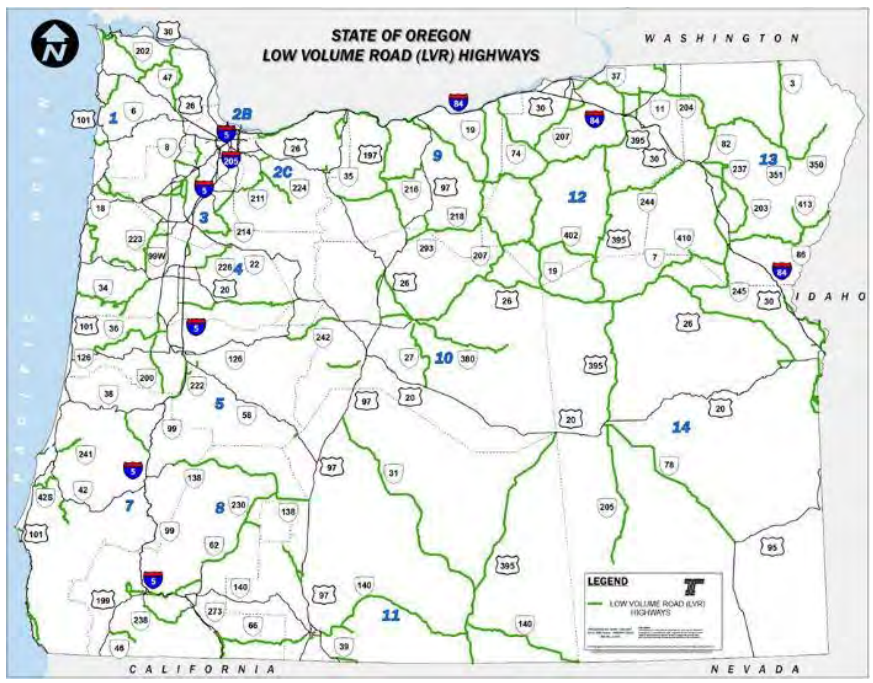
Highways in very poor condition, those that need extensive rehabilitation, and those that require costly upgrades to meet current standards, are typically cost-prohibitive. These problems are most acute on district level routes which are critical roads for our local communities. Poor pavement surfaces are often associated with potholes, excessive ruts, rough ride, low friction, and worn out striping, which decrease safety and negatively impact vehicle repair costs, freight movement, and mobility.

If resurfacing is delayed for too long, the pavement structure and underlying base materials can become excessively damaged and complete replacement (i.e. reconstruction) becomes necessary at a much higher cost. The typical cost to restore a severely damaged road is orders of magnitude higher than the cost to preserve pavement through seals and resurfacing treatments. Timely maintenance and preservation are by far the most efficient way to preserve our investment.

Reliance on Maintenance Funding outside the Fix-It Program

Pavement funding in the Maintenance program outside the STIP plays a critical role in the overall preservation of the pavement system. Approximately 46% of state highway mileage are not eligible for STIP Pavement Preservation funding program and only receive maintenance treatments through the Low Volume Road (LVR) program, funded through ODOT's maintenance program at $13.5 million per year. This amount is subject to cuts during heavy winter weather years when maintenance funds are diverted to more immediate needs.



In the future, LVR program allocations may have to be reduced in the face of flat or declining Maintenance budgets. Given that less than 15 percent of the overall Pavement budget is holding up nearly 50 percent of the system, cuts to this program would have a devastating effect on pavement conditions. Although these roads are not as high in priority as other routes, they are vital links between local communities and the rest of the state.

ADA PROGRAM

In March of 2017, ODOT and the Association of Centers for Independent Living reached a settlement agreement whereby the Department committed to bring business practices into compliance with the Americans with Disabilities Act.

As a result, the ADA Program was established to implement ODOT's responsibilities, outlined in the settlement agreement. In accordance with the agreement, the Department's focus thus far has been on program development, curb ramp projects, and pedestrian-activated signals. The Department is also responsible for the development and implementation of an ADA transition plan, required by FHWA (describing how ODOT will come into full compliance with the Americans with Disabilities Act). The funding allocated to date has been focused on establishing the ADA Program and working to meet the various requirements of the legal settlement.

Investment Strategy

Initial efforts were focused on leveraging existing projects to construct or reconstruct curb ramps to validate innovative approaches for curb-ramp-only projects. The focus now is on projects that will construct a substantial number of curb ramps – more than 2,400 curb ramps across the state each year. These curb-ramp-only projects will increase significantly in the near-term, with 16 curb-ramp-only projects scheduled to be under construction this year (2020) and more to follow in 2021.

Need

While ODOT is learning from other states and local agencies about costs for constructing a large number of curb ramps, significant uncertainty exists around the true costs of these projects. Funding levels have been and will continue to be adjusted to react to market conditions as additional cost data is obtained. Current estimates are as high as $50 million per year to meet the agreed upon mitigation requirements. One of the primary constraining factors is the capacity to program, design, and reconstruct the thousands of curb ramps.

The Commission recently approved the following increased funding for ADA curb ramps through 2023. The following table summarizes funding needs and when funds need to be made available through 2023. These estimates reflect the best available information to date on the costs for delivering curb ramps. Based on the projects that go to construction in June 2020, future estimates will be updated to reflect market conditions for this type of work in Oregon.

CULVERT FUNDING PROGRAM

Purpose and Funding Levels

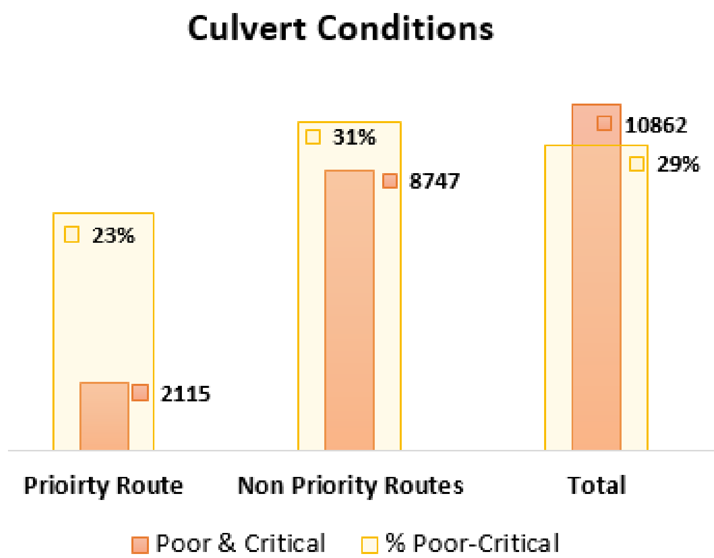
Culverts convey water across roadways to help reduce flooding, protect streams and roadways, and provide safety for the traveling public. The majority of Oregon's culverts were installed prior to 1960. These culverts were not designed to current standards, don't allow for fish passage and exhibit a higher failure rate due to their age.

In 2016 ODOT dedicated additional funding to address the growing need and urgency to replace and repair ODOT's aging culverts. The Culvert Funding Program encompasses the Culvert Fix-It Program and the Major Culvert Maintenance (MCM) Program. The Culvert Fix-It Program focuses on scheduled replacement and repair of culverts through the STIP. The MCM program is comprised of state maintenance program funding, allocated to address culverts in urgent need of repairs prior to the next STIP. Eligibility for both programs requires the culvert to be in critical or poor condition.

The current post-HB 2017 funding level for culverts of $14.1 million per year is not keeping pace with the steep deterioration rate. As culvert conditions deteriorate, low-cost renewal options become less viable and complete replacement becomes necessary at higher cost.

Investment Strategy

ODOT's culvert investments focus on improving the condition of culverts on the Fix-It Priority Corridors to fair or better. For non-priority routes, the agency focuses on addressing urgent culvert needs utilizing the MCM program funds. At post-HB 2017 funding levels, currently identified poor and critical condition culverts on priority routes are slated for repair or replacement on a 58-year cycle. Meanwhile, the percentage of culvert failures is increasing each year. These failures result in catastrophic washouts, sinkholes in the roadway, and/or major landslides, especially along coastal routes that cause environmental damage and economic hardships to Oregon's local communities.



ODOT's Culvert Conditions in 2020

Needs

The majority of the agency's culverts were designed to last between 25-50 years. In 2004 ODOT Hydraulics changed the standard practice for design life to 25-75 years. Based on a total culvert asset replacement cost of $18.5 billion, if the status quo funding levels remains stagnant, at approximately $14.1 million per year, the resulting service life needed for culverts is 1,310 years.

To replace or repair all culverts on priority routes that are currently in critical and poor condition would require funding at $20.5 million per year, for 50 years, which does not include funding to mitigate additional culvert infrastructure deterioration. To repair, replace and maintain culverts on priority routes in fair or better condition would require $96 million per year in perpetuity.

Oregon Department of Transportation

Impacts & Implications

Culverts on non-priority routes, which make up the majority of critical and poor culverts on the highway system, will continue to decline. With the limited size and scope of the MCM program, ODOT would struggle to adequately address culvert failures occurring on non- priority routes and lack of resources to be responsive to emergent issues on non-priority routes will result in increased risk to public safety and potential isolation of rural communities.

- Funding level is insufficient to address deterioration of culverts along the priority routes.
- Continuing decline of the non-priority routes which make up the majority of critical and poor culverts on the highway system.
- MCM program is limited in size and scope to address all the urgent culverts located on non- priority routes.
- Increased risk to public safety, isolating rural communities and the economy.
- Continued deferred investment reduces low-cost renewal options and results in more expensive replacements.

HIGHWAY MAINTENANCE & OPERATIONS

Purpose and Funding Levels

ODOT is responsible for operating and maintaining more than 8,000 miles of Oregon's highway system. Drivers expect to be able to drive on safe, properly-maintained and functioning state highways; they don't typically think about the cost and effort it takes to maintain them.

ODOT's maintenance and operations program provides for a safe and reliable transportation system that promotes efficient use and freight movement through routine daily activities of maintaining, preserving, repairing and restoring more than 8,000 miles of existing highways and bicycle/pedestrian facilities. The maintenance and operations program also responds to traffic incidents and major emergencies affecting the system. These activities may include replacing what is necessary to keep the system safe (such as signs, pavement markings, and traffic signals), but generally does not include road reconstruction.

ODOT's maintenance and operations program is composed of two types of general transportation maintenance functions: reactive ("fix it if it breaks") and proactive ("spend now to save later"). Reactive activities include responding to weather-caused events to clear roads, responding to crashes, cleaning ditches, and repairing guardrails, potholes and signals. Proactive activities include inspection and upkeep of bridges and pavement surfaces, and maintaining vegetation to ensure proper drainage and safety for motorists. In addition, significant effort is also given to winter operations, including snow removal, the application of salt and sanding material.

Major cost drivers for maintenance activities include the following:

Inflation: Increased materials costs that are growing faster than the consumer inflation rate are currently consuming any savings realized from efficiencies, decreasing the amount of maintenance that can be accomplished.

Aging and deteriorating infrastructure: Older infrastructure requires more maintenance, and as assets deteriorate due to inadequate preservation funding, more burden will fall on maintenance crews. This includes the hard infrastructure of roads, bridges, and culverts – and also the aging fleet of maintenance and operations equipment.

Aging and obsolete maintenance facilities: ODOT operates 100 maintenance stations across the state. Of these, 24% of maintenance facilities are over 50 years old and over 40% have become functionally obsolete. Maintenance stations should be replaced on a cycle of about 75 years. Meeting this replacement cycle would require $108 million each biennium until 2037 to catch up; in recent biennia ODOT's capital construction budget for maintenance facilities has been about $20 million.

Traffic volumes: Daytime traffic volumes are high enough that maintenance work must often take place at night, increasing worker risk and costs.

ITS/operations infrastructure: ODOT is increasingly deploying cost-effective Intelligent Transportation Systems operational solutions to mitigate congestion and improve safety on state highways, which result in added infrastructure to operate, maintain and replace as the equipment reaches the end of its relatively short useful life. Since 2003, the number of Intelligent Transportation System (ITS) devices has increased 352%.

Budget increases have not kept up with cost increases. During the last 10 years, ODOT has felt the effects of increases in reactive activities and other costs and ODOT has offset these effects by reducing personnel.

Maintenance Program Budget Trends (Average annual change since 2005)

- **Maintenance Budget** **+4%**
- **Culvert Repairs** **+24%**
- **Illegal Camping Management** **+30%**
- **Guard Rail and Barrier** **+15%**
- **Winter Maintenance** **+10%**
- **FTE** **-.027%**

Investment Strategy

ODOT continues to look for efficiencies in the maintenance program to help offset increasing costs.

Winter Maintenance

- ODOT continues to evaluate and use new types of winter maintenance equipment that makes the removal of snow more cost-effective, including new plow bits, double wing plows, and tow plows.
- The agency is expanding the use of rock salt. The use of solid deicer chemicals adds a new tool to the toolbox for conditions where liquid deicers are not viable. Deploying this new product also requires an upgrade in equipment and technology.

ODOT has winter operations staffed for areas of the state that normally expect extreme winter stroms. During extreme storms in other parts of the state that do not typically see extreme winter storms, staff are shifted to those areas when possible – but staffing levels cannot maintain a strong statewide response to an extreme winter storm.

Southern Oregon Incident Response Pilot

Dedicated Incident Response positions have become very beneficial in urban areas of the state, reducing the impact on maintenance crews and increasing the response to the users of the system. The addition of a dedicated Incident responder was evaluated on I-5 and on OR 62 and OR 140 in the Medford area. Maintenance crews responded to 40% fewer calls in the summer and 17% fewer in the winter, improving maintenance operational efficiencies. Incident clearance times were reduced between four and 16 minutes which reduced the exposure of the motoring public to secondary crashes between 14% and 56%.

Fleet Management

ODOT is now utilizing a fleet reservation system to increase utilization of specialty fleet. Plans are underway to start managing certain specialty equipment at a statewide level which would rotate the equipment around the state to optimize life-cycle costs. The equipment would move high-use equipment to crews who use specialty equipment less frequently as well as using underutilized equipment from low-use crews to those that use it more consistently.

Needs

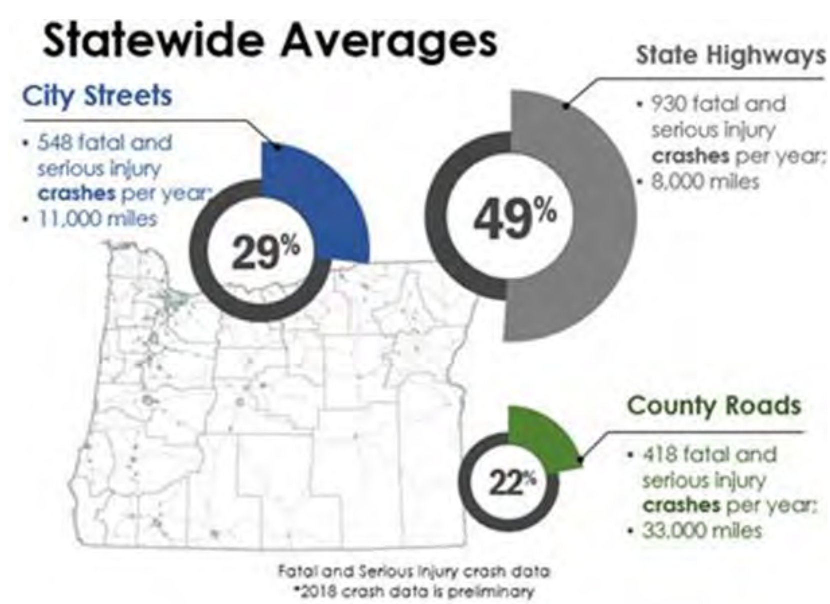
Existing resources no longer keep pace with the maintenance and operations needs of an aging system, responding to more extreme weather events, and dealing with increasing traffic volumes. The result has been multi-vehicle crashes and lengthy closures that delay people and goods. In addition, maintenance requirements for the upkeep of traffic signs, retaining walls, tunnels, variable message signs, and other infrastructure are growing. An additional investment would help address maintenance needs in freeway corridors and across key highway assets, preserving our multibillion dollar highway system and keeping our highways more reliable and safe during the winter months. With revenues not keeping up with expenditures, the level of service the traveling public expects will decrease as the staffing levels of maintenance crews are decreased to reduce costs; this will impact winter operations, repairs to the aging infrastructure, and response times to incidents and clearing those incidents.

SAFETY

ODOT's Highway Safety Program is focused on reducing the number of fatal and serious injury crashes using several system management tools that help guide and prioritize how public investments are made. Oregon's transportation safety vision is no deaths or life-changing injuries on Oregon's transportation system by 2035. That vision is laid out in the Transportation Safety Action Plan (TSAP), which serves as our statewide topic plan for safety and our federal Strategic Highway Safety Plan.

Safety investments are focused on four key areas known as the 4Es of safety: engineering, education, enforcement, and emergency medical services (EMS). Of these four, the Department and Commission are primarily responsible for engineering of roadways and education. The TSAP covers all four Es of safety and lays out a number of priorities for investment and action, including:

- Risky behaviors,
- Infrastructure,
- Vulnerable users, and
- Improved systems.



The Highway Safety Plan (HSP) is analogous to the Statewide Transportation Improvement Program (STIP). The HSP follows the strategies outlined in the TSAP, sets goals and performance measures, and lays out how we will spend all of the funding ODOT receives from the National Highway Traffic Safety Administration, or NHTSA.

While our goal is eliminating all fatalities and serious injuries, Oregon has set realistic targets to reduce fatalities and serious injuries gradually over time. Despite these goals and agency investments, fatalities and serious injuries have been increasing in Oregon. Between 2013 and 2017 an average of more 1,800 fatal and serious injury crashes occurred per year. Oregon is not the only state experiencing this trend; fatal and serious injury crashes are increasing nation- and world-wide.

ALL ROADS TRANSPORTATION SAFETY (ARTS) PROGRAM

Purpose and Funding Levels

The All Roads Transportation Safety (ARTS) program is a collaborative effort to carry out safety improvement projects on all public roads to achieve a significant reduction in traffic fatalities and serious injuries, through a data-driven, strategic approach with a focus on implementation of cost-effective and proven measures. Working jointly with local jurisdictions increases awareness of safety on roads, promotes best practices for infrastructure safety, complements behavioral safety efforts, and focuses limited resources.

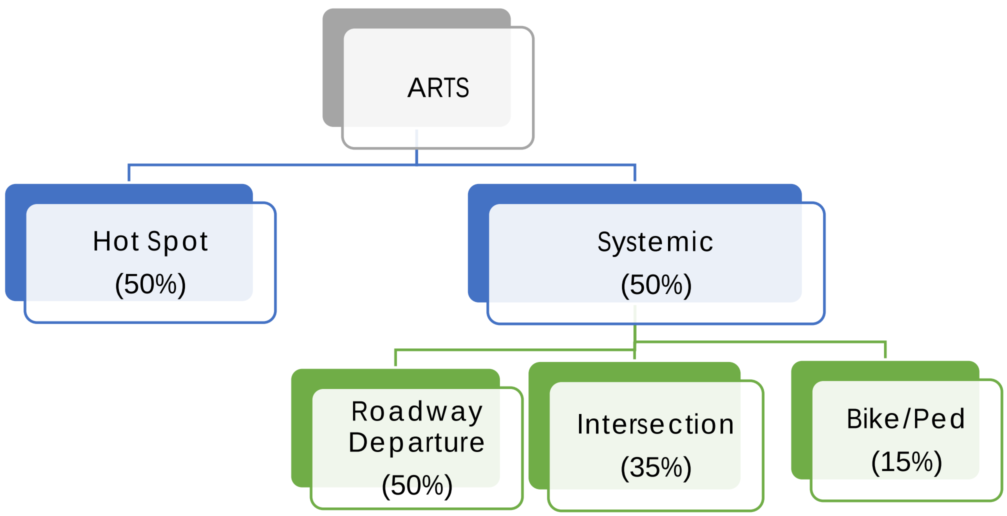
Safety projects consist of data-driven safety countermeasures, including:

- New and upgraded traffic signals
- Roundabouts
- Medians and refuge islands
- Rumble strips
- Rapid flash beacons
- Lighting
- Sign upgrades and chevrons
- Curve waring systems
- Median barriers
- Left turn lanes
- Road configurations
- Bike lanes and cycle tracks
- Widening shoulders and increase sight distance

Safety programs currently receive approximately $49 million per year, $10 million of which is new state funding established under HB 2017 for safety projects on state highways. An additional $6 million per year goes to upgrading deficient guardrails and $3 million goes to rail crossing safety improvements.

Investment Strategy

ODOT invests approximately 50% of safety funds in low-cost, widespread, systemic improvements (e.g. curve signs, rumble strips, and cable barriers). These improvements are highly effective at addressing safety risks in priority areas to prevent Pedestrian/Bicycle, Roadway Departure and Intersections crashes. The other 50% of safety funding is invested in “hot-spot measures.” These higher-cost safety improvements are deployed at “hot-spot” locations where a higher than expected number of crashes occur. The increased funds stemming from HB 2017, have allowed ODOT to strategically upgrade traffic controls, place more low-cost elements, and also address some higher-cost areas.



Safety project selection is a data-driven process that is blind to jurisdictional ownership. Projects are compared based on benefit to cost analysis, which compares the benefit a measure may bring to cost of the project. Projects with higher benefit-cost ratios receive priority for funding. Benefit-cost ratios for safety projects can vary, but typically range between average 5 and 20—meaning every dollar spent results in safety benefits 5 to 20 times the amount invested.

Needs

Despite recent increases in safety funding, a significant number of important and cost-effective safety improvements remain unfunded. For example, ODOT received All Roads Transportation Safety (ARTS) applications for $295 million for the three year, 2021-2024, STIP cycle. Only $88 million, just under 30%, of the submitted projects were funded.

Doubling current funding would save lives, reduce serious injury and advance our goal of no fatal and serious injury on Oregon roadways. While increases in overall crashes are linked to primary driver errors such as speeding, impaired driving, lack of seat belts and distracted driving, the implementation of safety countermeasures can reduce the severity of the crashes and sometimes prevent the crash. Investments in Roadway Departure systemic measures (i.e. rumble strips, curve warning, delineators) yield some of the highest returns because these are some of the lowest cost safety measures. The Roadway Departure Plan found that an expenditure of $18 million on state highways can prevent an estimated 36 fatalities and 77 serious injuries. On non-state roadways an investment of $30 million can prevent an estimated 48 fatalities and 109 serious injuries.

Impacts & Implications

At current funding levels the number of fatal and serious injury crashes are increasing or at best holding level. To make gains we will need more funding. Many of the easy fixes have been done. The remaining fixes are more expensive and inflation reduces efficiency of the funding. Although trends have been in the wrong direction, the investments in safety measures are saving lives. Any increase in investments will pay off in lives saved and reductions in serious injuries. The relatively recent introduction of systemic low-cost measures has helped.

Oregon Department of Transportation

RAIL CROSSINGS

Oregon has 1,887 public at-grade highway-railroad crossings. Approximately 48 percent have active warning devices. Between 2006 and 2017, 120 recorded incidents occurred at public railroad crossings, resulting in 20 fatalities. ODOT allocates state and federal grade crossing safety funds to improve safety at public crossings. In 2016, federal rules mandated all states to complete a State Rail Crossing Action Plan.

In 2018, ODOT began work on a plan that will assess rail crossing incidents and locations. The plan will identify, prioritize, and develop solutions to address rail crossing safety issues and provide a framework to prioritize locations for improvements. Rail inspections and crossing safety are funded in part or in full by a gross revenue fee on railroads. Additional funding for crossing safety comes from Federal Highway funds and the Grade Crossing Protection Account, a subset of the State Highway Fund.

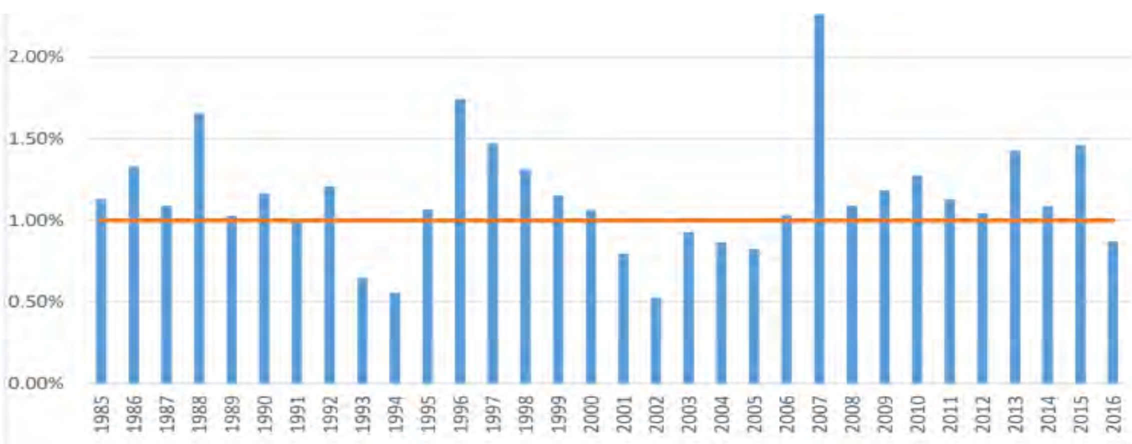
MULTI-MODAL TRANSPORTATION OPTIONS

Oregon constitutional restriction on use of highway funds ensures that user fees are invested in the highway system. However, it makes it challenging to fund non-highway modes. Oregon relies on a number of small funding sources for non-highway modes that are not adequate to meet needs. HB 2017 met only a portion of the funding need for the multimodal transportation system, including non-highway modes. In non-highway programs, the role of the agency and the commission is to select the best projects across jurisdictions to ensure connectivity and mobility, rather than ensuring the health of the state highway system.

ACTIVE TRANSPORTATION PROGRAMS

Active transportation modes such as walking, bicycling, and accessing public transit, continue to be important to Oregonians. Since 1971, Oregon's Bicycle and Pedestrian Bill (ORS 366.514) has required recipients of State Highway Funds to provide appropriate walkways and bikeways whenever a highway is "constructed, reconstructed, or relocated" and to spend a minimum of one percent of State Highway Funds on pedestrian and bicycle improvements annually.[1] Over the past 30 years, ODOT has expended an average of 1.1% of state highway funds on pedestrian and bicycle improvements.

ODOT Pedestrian & Bicycle Spending as Percent of State Highway Fund



[1] https://www.oregon.gov/odot/Programs/TDD%20Documents/Interpretation-of-ORS-366.514.pdf

PEDESTRIAN AND BICYCLE INFRASTRUCTURE PROGRAM

Purpose & Funding Levels

ODOT's Pedestrian and Bicycle Program constructs walking and bicycling infrastructure along and across state highways to improve accessibility, safety, health, and climate outcomes while advancing ODOT's mission to provide a safe and reliable multimodal transportation system that connects people and helps Oregon's communities and economies thrive.

ODOT funds pedestrian and bicycle projects through a wide variety of programs. Roadway projects across ODOT's programs often include bicycle and pedestrian features, and a number of dedicated bicycle/pedestrian programs also provide funding. ODOT's Sidewalk Improvement Program (SWIP) funds smaller-scale construction of sidewalks, crossings, bike facilities and other pedestrian and bicycle safety improvements located on or along state highways. In the 2018-2021 STIP, SWIP was funded at $4 million per year, roughly 0.5% of ODOT's estimated State Highway Fund revenues, for a total of $12 million over three years. In the 2021-24 STIP, SWIP funding was increased to a full one percent of ODOT's estimated State Highway Fund revenues, $7.4 million per year or $22.2 million over three years. Additionally, the 2021-24 STIP allocated $21 million in funds for the Active Transportation Leverage Program to add active transportation improvements to projects funded through Fix-It programs.

In addition to targeted projects along the state system, $6.3 million of All Roads Transportation Safety (ARTS) program funding is dedicated to addressing bicycle and pedestrian safety improvements through a jurisdictionally blind grant program. Bicycle and pedestrian improvements are also eligible for funding through the Small City Allotment, Congestion Mitigation and Air Quality Improvement Program, Federal Lands Access Program, and local State Highway Fund allocations; however, these improvements are primarily focused on local streets.

Shared use paths outside of the road right-of-way are not eligible for State Highway Funds, but provide critical active connections within and between communities that are more attractive to many users because they are separated from traffic. The 2021-24 STIP allocated $6 million in federal Transportation Alternatives Program funds to address this need. Additionally, the Multimodal Active Transportation (MAT) Fund was established in 2019 by the Oregon legislature to support shared use path projects. The MAT Fund is comprised of 7% of the Connect Oregon Fund and revenues from the bicycle excise tax. Both the MAT and the $6 million from the 21-24 STIP are combined together to provide the funding for the Oregon

Community Paths program. This is a competitive grant program for local agencies to build transportation focused paths in and between communities.

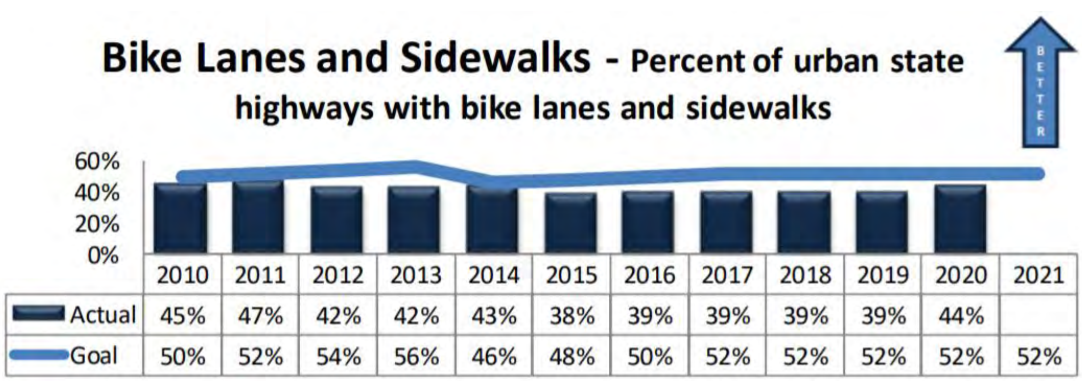
Investment Strategy

ODOT addresses pedestrian and bicycle network needs by targeting funds to reducing gaps in the walkway and bikeway network. Oregon's Bicycle and Pedestrian Plan provides a strategic investment framework for prioritizing investments in the state and local pedestrian and bicycle system:

1. Protect the existing system and address significant safety issues
2. Add critical connections and address other safety issues
3. Complete the system
4. Elaborate the system

Many ODOT projects include walking and biking facilities as is required by ORS 366.514. Utilizing existing projects to include walkways and bikeways is a critical strategy for providing accommodation but has resulted in an incomplete network for people walking and biking along or across state roadways.

The Oregon Transportation Plan includes a goal of completing sidewalk and bicycle facilities along 100 percent of ODOT's urban state highway miles by 2030. Progress towards this goal is monitored as an agency key performance measure, but due to inadequate funding ODOT has never achieved its performance targets for this measure.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Actual	45%	47%	42%	42%	43%	38%	39%	39%	39%	39%	44%	
Goal	50%	52%	54%	56%	46%	48%	50%	52%	52%	52%	52%	52%

Needs

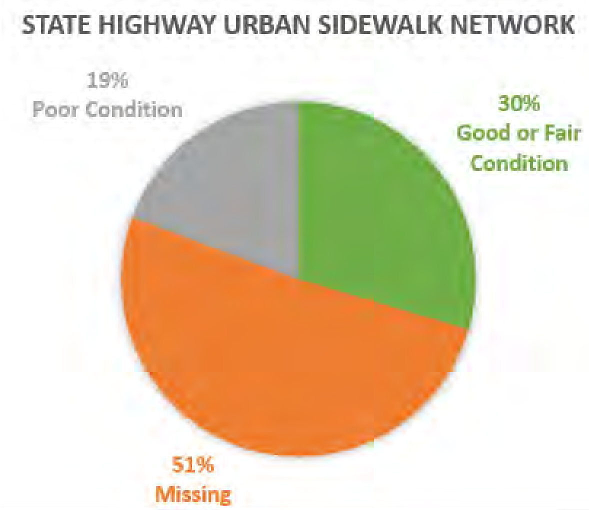
There are currently roughly 1,169 miles of sidewalk and 1,222 miles of bicycle facilities along state highways. An additional 1,222 miles of sidewalk and 805 miles of bicycle facilities are needed to complete a basic connected pedestrian and bicycle network. The ODOT urban sidewalk network is currently only 49% complete and 19% of the network with existing sidewalk is in poor condition, meaning it has cracks or other issues that make it non-compliant with the American's with Disabilities Act (ADA). Additionally, several hundred improved pedestrian crossings are needed to meet ODOT's crossing spacing guidelines and provide safe access to transit stops, schools, and other destinations.

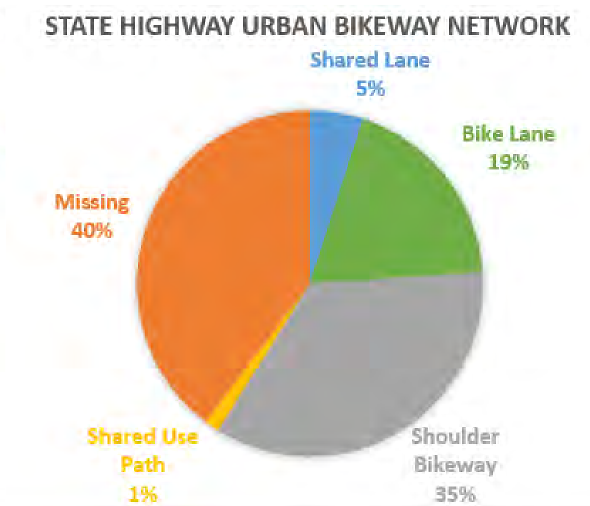
Nearly one-third of Americans are "transportation disadvantaged," meaning they are unable to drive due to age, disability, or cost to purchase a car or transportation services and must generally rely on walking and biking.[2] Businesses depend on well-connected walkways or bikeways to get workers to their jobs and consumers to their stores, and school age children often rely on these travel modes to get to class, especially where school bus service is not available. Programs that promote walking and biking and reduce VMT are critical in helping ODOT achieve its GHG targets and implementing the Statewide Transportation Strategy and Executive Order 17-20. Approximately one half of trips are under three miles and can be completed within a 15 minute bike ride. A basic network of connected facilities must be made available for Oregonians to change their travel behavior and allow people to get around safely.

[2] https://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2014/07/31/08/21/improving-health-through-transportation-and-land-use-policies



The Oregon Bicycle and Pedestrian Plan estimated the total cost of pedestrian and bicycle facility needs along state highways over the next 25 years to be over $1 billion. At current funding levels it will take over 150 years to achieve the goal of completing minimal sidewalks and bike lanes along state highways, not accounting for inflation, increasing construction costs, growing urban areas, or maintenance. A minimum annual investment of $53 million per year is needed to complete a basic walking and biking network along state highways by 2050.





Impacts & Implications

Due to the overwhelming active transportation system needs versus available funding, ODOT has developed an Active Transportation Needs Inventory (ATNI) to further prioritize investments based upon Oregon Bicycle and Pedestrian Plan goals, including safety, equity, access to essential destinations, and connections to transit. The ATNI identifies locations with the highest need for improvement. However, current funding is inadequate to pursue strategic large-scale standalone projects such as providing safe crossings and sidewalks and bicycle facilities along a corridor. Communities must often wait years until a STIP preservation project is programmed in the area for an opportunity to address sidewalk and bike lane gaps to remediate barriers and safety concerns that impede walking and biking.

A significantly higher level of investment is needed to construct the modern system of separated sidewalks and bike lanes needed to achieve the mode share increases called for in the Statewide Transportation Strategy and to maintain these facilities in fair or better condition. The quality of pedestrian and bicycle infrastructure is often lower in low-income and minority communities, contributing to higher pedestrian fatality rates, lower physical activity levels, and poorer health outcomes. Deferring investment in walking and biking facilities also results in more expensive and complex improvements in the future.

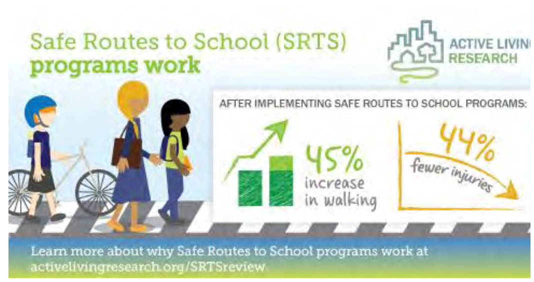
SAFE ROUTES TO SCHOOLS PROGRAM

Purpose and Funding Levels

Through ODOT's Safe Routes to School (SRTS) program, the agency aims to create a future where all students and families can safely use active and shared transportation options to and from school. SRTS addresses barriers to students walking and biking to school through both a construction program and an education program.

Construction (Infrastructure): HB 2017 dedicated $10 million annually (increasing to $15 million in 2023) of State Highway Fund revenue to address physical barriers for children biking or walking to school, including adding walkways, bikeways, safe crossings, and other features. The majority of the funds are distributed through a competitive grant process, and smaller amounts are used as a discretionary funding program for urgent projects that can address a recent injury or fatality and to help communities with limited capacity identify Safe Routes to School projects.

Education (Non-Infrastructure): The OTC dedicated an additional $3 million in the 21-24 STIP cycle for SRTS non-infrastructure programs. The focus of these funds is to help children to bike or walk to school safely through education and engagement programs. Sixty percentage of the funds are distributed in grants through a competitive process to provide local capacity and SRTS resources to students and families. Forty percent is used to provide statewide technical assistance and statewide resources and to cover ODOT staff time.

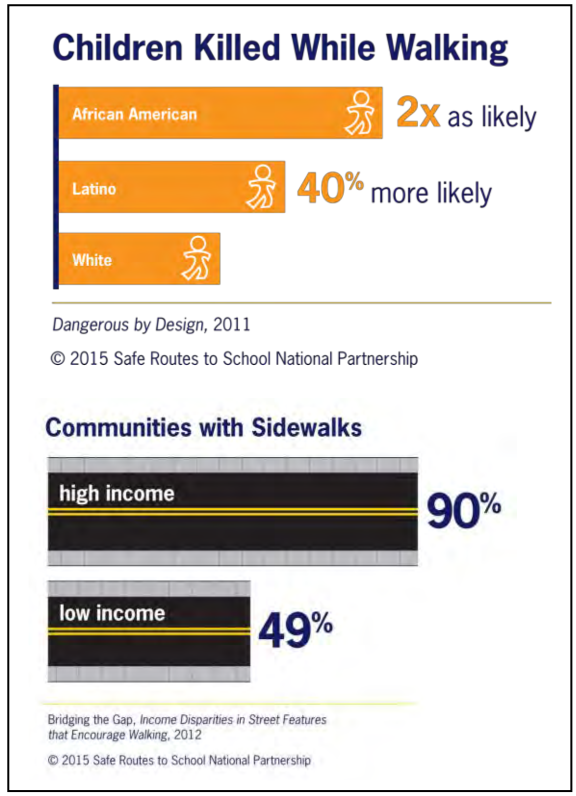


Investment Strategy

Through ODOT's SRTS Programs, the Department includes and leverages investments for safety focused construction projects and education programs to increase access for students. To achieve this vision with limited capacity, the agency aims to prioritize low-income communities and communities of color (35% of Oregon students are students of color) while facilitating high quality and effective programs implemented with transparency.

Needs

The Oregon Safe Routes to School Network, a statewide group that shares best practices and promotes walking and biking to school, estimates the need for construction projects at $1 billion and the need for education programs at $12 million annually for Safe Routes to School in Oregon. Even though ODOT is one of several agencies investing in Safe Routes to School, ODOT is often the sole opportunity for rural, low-income communities and communities of color to access funds. Studies continue to show that low-income and communities of color are at higher risk to be killed while walking. Students are more likely to walk to school without access to a sidewalk and are more likely to have poor health outcomes. Even through current investments are prioritized for communities at higher risk, ODOT can only fund projects at three percent of the low-income schools in Oregon annually.



Impacts & Implications

In the 2019-2020 school year, ODOT's Safe Routes to School Construction and Education programs supported or created local staff capacity to provide direct service to 156 schools, free resources to 250 schools, and improved infrastructure at 25 schools. ODOT grantees have educated hundreds of students in classrooms, have completed or are building numerous sidewalk and crossing enhancements, celebrated and encouraged walking and biking to school with hundreds of families and teachers, and created or are working on 43 Safe Routes to School Plans or school travel action plans.

"My son told me about the bike safety classes he has been taking with the Safe Routes program and so I thought we'd give biking a try. I was impressed with his skills I didn't even know he had. (Some other parents should take this class too) We've now been riding to school when it's sunny out. It varies two to three days a week." Juniper Elementary Parent

Safe Routes to School provides needed transportation options that increase physical

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activity and access to school-based health care, increase safety in a community by providing safe places to walk and bike, and increase the ability of students arrive at school ready to participate. The impact of Safe Routes to School also reduces morning and afternoon traffic congestion and improves air quality around schools.

On average, ODOT's Safe Routes to School programs currently reach 12.5% of Oregon schools by addressing barriers to walking and biking to school at some level. Increased investment is needed in order to provide current or improved level of investment to more low-income schools in Oregon, increasing the health, safety, and access to education of Oregon students and reducing congestion and greenhouse gas emissions. There are 1,253 schools in Oregon and of those 835 (67%) are low-income schools. In order to provide our current level of service to all 835 low income schools we would need to invest $4.5 million annually in education programs, and it would take 60 years of current construction funding to address one project at each low-income school.

TRANSPORTATION OPTIONS

Transportation Options programs enhance choices available to travelers to connect people to jobs, schools, shopping, and other destinations through transportation choices including carpool, vanpool, transit, walking, biking, and telecommuting. Implementation efforts focus on providing people with information and access, including park-and-ride facilities, ride-matching services, vanpool coordination, telecommuting, and public transportation pass programs, safety and modal education, and employer programs. Programs and strategies can help make the most of existing transportation infrastructure, help individuals save money, reduce overall GHG emissions, and improve active transportation choices.

Purpose and Funding Levels

Transportation Options programs help people identify and take advantage of their options: drive alone, carpool, vanpool, transit, bike, walk or switch out a trip for an online replacement like telework, allowing individuals to choose the right mode to meet their needs. Examples of ODOT's Transportation Option (TO) activities include:

- Administration of federal grant funds and collaboration with local transportation options partner programs. These programs are often housed within a local transit agency, city, county or Metropolitan Planning Organization.
- Support congestion mitigation for major construction projects, safety corridors, and congestion points. The TO Program supports ODOT Regional offices in providing outreach and education around specific issues or projects to reduce impacts and delays and/or promote safety.
- Management of the statewide ride matching database, Get There, to help people connect with carpools, vanpools and other travel options. The ride matching database is an essential tool for local and regional partners, and provides information on fuel savings and reductions of vehicles miles traveled.
- Management (in collaboration with local partners) of an annual event, Get There Challenge, to help the public become familiar with their transportation options and support carpooling, vanpooling, biking, walking and transit.

get there oregon

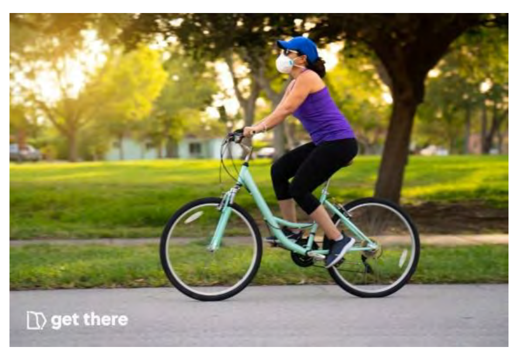
The Statewide Options program work includes communications with businesses and the general public about the TO program; management of the carpool matching and trip logging tool named Get There; management of grant recipients including provision of communications support materials and training; and, the Annual Get There Challenge. The current funding-level during the 21-24 STIP cycle is roughly $500,000 per year ($1.5 million over three years).

Funds are also distributed directly to local providers through a formula distribution. The Local TO Providers program focuses on on-the-ground outreach, working directly with businesses in their assigned region to promote reduction in single occupancy commute trips, and working with individuals to make them aware of the travel options available for all their trips and how to travel safely. During the 21-24 STIP cycle, a total of $4.5 million in funds will be distributed to providers across the state.

Congestion and Construction Mitigation is a TO program to assist the Agency in integrating alternative modes into the congestion mitigation strategy during construction and exploring no-build solutions on congested corridors. This program has already shown positive early results and will continue to build on the past pilots and support policy conversations on topics such as climate change, congestion pricing and state agency telework policies. Funding for this program is $300,000 over the 21-24 STIP cycle.

ODOT also provides Technology Innovation Research and Pilot Program grants. This competitive process is a refined evolution of previous years "Innovation Grants." In its updated form, ODOT will utilize this process to support research, white papers and pilot implementation for transportation options topics such Mobility as a Service (MaaS). Funding for this program is $500,000 over the 21-24 STIP cycle.

Impacts and Implications



Transportation options can help achieve significant reductions in personal vehicle miles traveled which in turn help reduce carbon emissions from personal transportation. Prior to the adoption of the Oregon Transportation Options Plan (OPTP) in 2015, ODOTs Transportation Options program primarily operated as a formula grant disbursement program with little state level engagement. Implementation of the OPTP has resulted in a more robust and strategic program.

One key example of a statewide implementation effort includes the launch of the statewide travel planning tool, Get There, on July 1, 2019. In the last year, 8,406,905 miles of non-drive-alone trips were voluntarily logged resulting in 2,663 tons of carbon not emitted just from the program participants. Other implementation efforts of the OPTP include the Local Transportation Options Providers' work directly with businesses setting up carpool matching networks, distributing bus passes and providing information at transportation and benefit information fairs. Investing in Transportation Options programs at the state and local level are a key strategy for ODOT to help us achieve our goals to transition to a truly multimodal system.

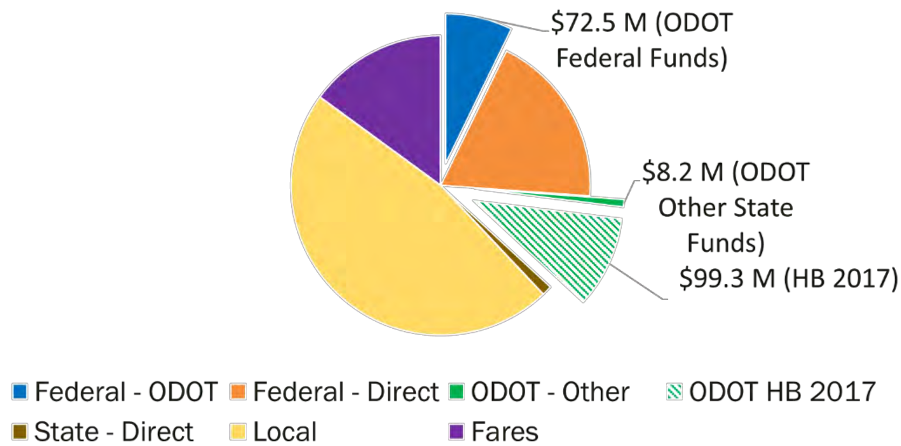
PUBLIC TRANSPORTATION PROGRAMS

Purpose & Funding Levels

The Commission has responsibility to set the statewide vision for public transportation, which is largely implemented by local transit providers in communities across the state. ODOT's Public Transportation Division administers five public transportation programs:

- The **General Public Transportation** program funds transit services benefitting the general public in every county in the state. This program provides capital funding for buses and facilities, operations, maintenance, planning, training, and administration. The Statewide Transportation Improvement Fund Program established statewide technical resource center to assist rural areas with training, planning, and information technology.
- The **Special Transportation Program** benefits seniors and people who have disabilities by funding a range of fixed route transit service as well as demand response service, which picks people up and drops them off door-to-door. More than 20 million trips on fixed route or demand response service are taken each year by seniors and individuals with disabilities.
- The **Statewide Transit Network** includes services aimed at connecting communities to each other, cities to each other, rural communities to major transportation hubs and urban centers, as well as services that connect regions. The state focuses on statewide gaps through a combination of passenger rail and bus service.
- The **Public Transportation Planning and Research** program supports coordinated planning at statewide, regional, local, and corridor levels. Activities also include research and development of enhanced trip-making information to improve customer service and to provide information for system analysis and program improvements, including funding for route planning and analysis tools for local providers.
- The **Passenger Rail program** is part of the statewide public transportation network.

Public transportation in Oregon is funded through a combination of federal, state, and local funds and fares.



Beginning in 2020, approximately $99.3 million, or 55% of the public transportation funding administered by ODOT, will come from the payroll (transit) tax established by HB 2017. Other revenues administered by ODOT for public transportation include a portion of cigarette taxes, ID card revenues, non-highway gas taxes, federal funds appropriated by the Federal Transit Administration (FTA) as well as FHWA funds the Commission transfers to FTA.

Investment Strategy

ODOT is currently focused on implementing three key initiatives to meet the reasonable unmet need within current funding constraints:

- **Public Transportation Plan Integration** focuses on promoting an effective, efficient, and seamless public transportation system, building on the need to plan for transportation together. The focus is to help agencies further integrate their planning activities.
- The **Regional and Intercity Public Transportation Initiative** centers on improving service between cities and regions as well as connecting Oregon communities to other states. Public Transit's statewide perspective can assist providers, help fill gaps, and promote a logical system that links areas throughout the state.
- The **Transportation Technology Initiative** focuses research and effectively using technology to help Oregonians meet routine needs via public transportation.

For example, continued investment in a standardized transit network, ridership data, and software tools results in improved transit information for the public, improved transit planning, and investment at the local, regional and state level.

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2019 was the first year for distribution of STIF dollars, initiating improvements in transit. Based on plans submitted by STIF funding recipients, we estimate an increase of as many as 2.7 million rides per year, but with historic levels of population growth in the state and the impact of the COIVD-19 epidemic on public transportation ridership, the state is likely to decline below 32 rides per capita in the near-term.

The cost of providing transit service is going up. Much of the increase of new funds, over time, will be invested in sustaining service levels and other improvements, potentially affecting future ridership increased by limiting the amount of funds available for transit expansion. Local government decisions may impact ridership. For example, in some communities the need for transit support infrastructure such as passenger shelters, secure bus parking, and technology could result in less investment in direct service.

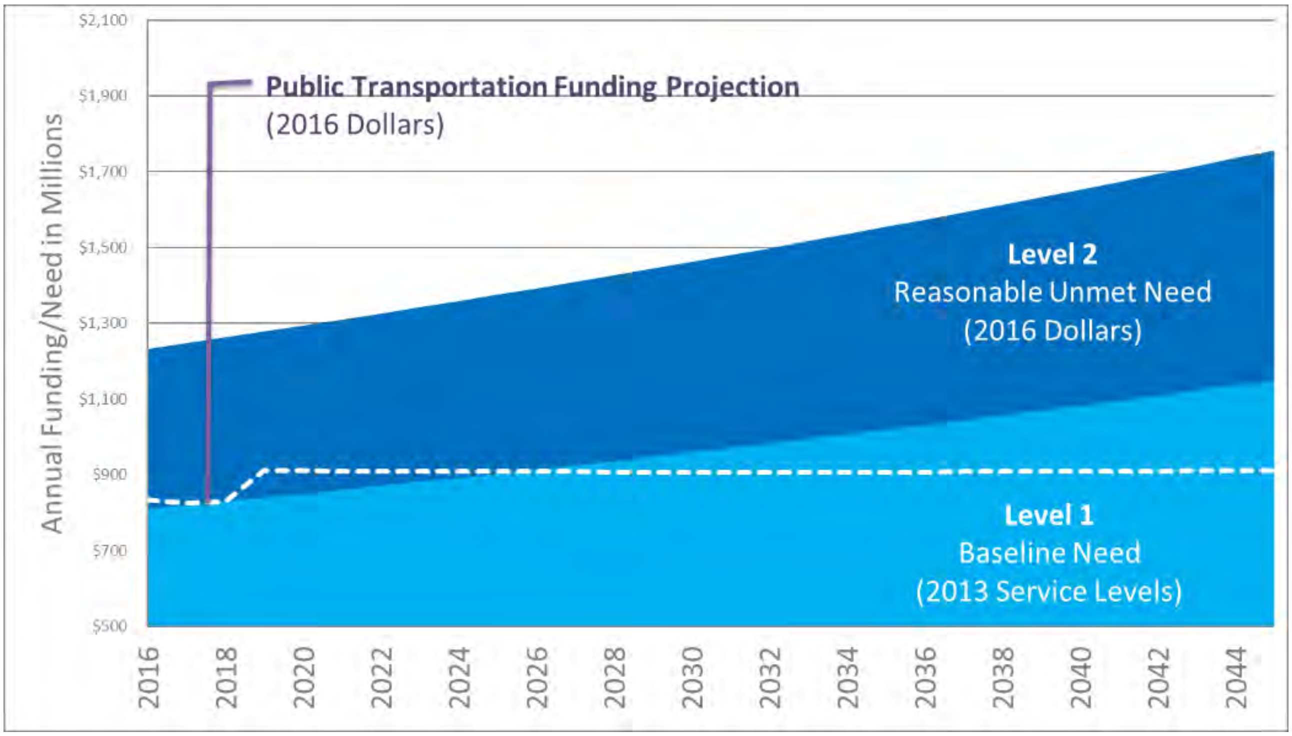
ODOT's Public Transportation Division partners with local agencies to provide buses to help communities offer safe, cost-effective public transportation. ODOT's key performance measure is to keep transit buses in a "State of Good Repair" based on federal standards for expected age, mileage and condition. ODOT's funding priority is to replace vehicles before increased maintenance costs become a poor investment. New federal requirements mandate setting a target for replacing vehicles to keep them in a continuous state of good repair. Our current target is no more than 40 percent of vehicles statewide exceeding their useful life standard.

The new Statewide Transportation Improvement Fund has provided additional capital asset funding for transit service providers to bring the fleet closer to the desired goal. To address a growing backlog of vehicle replacements resulting from vehicles purchased with Recovery Act funding in 2009, the Commission added $15 million in the 2018-2021 STIP. Additional funding will be needed to maintain this level in 2024 and beyond due to an increasing number of vehicles projected to exceed useful life by 2024.

Local governments and providers own and operate the buses that ODOT holds security interest in. Providers decide when to request vehicle replacements based upon vehicle condition and their ability to meet requirements for local match. Oregon transit providers often have difficulty raising the required local funds to maintain an optimum replacement schedule, and rely on the state Special Transportation Fund (STF) and Statewide Transportation Improvement Fund (STIF) for local match. Expanded services are causing accelerated depreciation of capital assets. These effects have yet to be forecast into future condition estimates.

Needs

Current reasonable unmet need estimates statewide based on OPTP are an estimated $400-$650 million per year (in 2016 dollars). This does not account for potential, unforeseen, reductions in funding (such as the Legislature's removal of General Fund revenues from the Special Transportation Fund), nor does it meet the level of public transportation service needed to achieve Oregon's GHG emissions reduction goals.



Significant unmet need for public transportation still exists even with expanded funding from Keep Oregon Moving. Current funding levels only sustain existing services through 2026. Transit asset condition and the need to transition to next generation technologies will continue to put pressure on funding needs.

Impacts & Implications

Any of the multiple sources of public transportation funding—including local, state, federal, funds and fare revenue-- may experience declines due to changing conditions. State funding may decline temporarily due to economic recessions that affect payroll tax receipts, for example, and cigarette tax and ID card revenues are likely to decrease in the future.

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ODOT and local providers in most cases do not have control over these risks. Inadequate funding for public transportation puts more demand on the highway and local road systems, and impacts vulnerable populations disproportionately.

Additional potential impacts from reduced funding include:

- **Reduced services.** Providers would likely strive to maintain overall service to the extent possible, but local providers would have to make some service reductions as they seek to preserve core services.
- **Limited service in rural areas.** Rural providers particularly depend on federal and state funding and operate with thin budgets. Stagnant or reduced funding would likely significantly impact rural providers, because they do not typically have substantial farebox revenues or other local revenues to support service.
- **Regional connections remain unchanged or experience service declines.** The ability of public transportation providers to supply regional services, such as connecting to the neighboring system or the next larger town, would likely decline in urban and rural areas alike.
- **Older equipment is kept in use longer.** Providers will need to keep older equipment in service longer, increasing the likelihood of equipment breakdowns, service disruptions, and increased maintenance costs. In addition, they would likely forego implementing new technologies, such as efare, or fleet technologies, like automatic passenger counters.

PASSENGER RAIL PROGRAM

The Passenger Rail program is part of the statewide public transportation network. ODOT partners with WSDOT and Amtrak to provide the Amtrak Cascades service, which provided multiple roundtrips each day between Eugene and Vancouver, British Columbia, with multiple stops in cities between. ODOT's section includes two daily round-trips between Eugene and Portland with stop in Albany, Salem, and Oregon City. These trains are supplemented by additional bus service. ODOT and WSDOT cover the operating costs of the service, net of ticket revenue.

Ridership on Oregon's portion for the service reached its highest level of more than 215,000 rides in 2013. However, ridership remained flat from 2015 through 2017 averaging fewer than 194,000 riders per year. Ridership increases result from on-time reliability, greater frequency, reduced travel time, increased range of service, connectivity with other transportation modes and optimized schedules. These conditions depend upon sufficient and dependable capital and operational investment.

On December 18, 2017, a derailment in DuPont, Washington on the Amtrak Cascades caused three fatalities, 80 injuries and destroyed a WSDOT-owned trainset. ODOT Rail has been working with WSDOT and Amtrak since the derailment to recover service levels due to loss of fleet equipment and customer confidence. Ridership is expected to increase once service is restored.

ODOT's funding for passenger rail operations and equipment comes from two sources.

- **Passenger Rail Fund (PRF)**, additional fees collected for issuance of personalized license plates.
- **Transportation Operating Fund (TOF)**, unclaimed refundable taxes paid on fuel used for off-road purposes.

Connect Oregon funds have also been used to make investments in rail systems to improve passenger rail operations. Capital grants for improving passenger rail infrastructure and planning for the future have been provided episodically by the Federal Railroad Administration (FRA), but a lack of dedicated state match sources make it difficult to leverage federal rail grant programs.

Investment Strategy

ODOT has developed an Oregon Passenger Rail Project that includes increasing train roundtrips from Portland to Eugene train from two to six by 2035 and improving reliability of passenger rail in Oregon. This will require capital improvements to the Union Pacific line that are currently unfunded as well as additional operational costs for the additional trains. However, ODOTs passenger rail operations funding is already stretched, and the agency cannot use other funding sources (such as federal and state highway funds) for the capital costs of improve service.

Needs

Oregon's passenger rail funding can pay for existing service, but the agency doesn't have a dedicated funding source for passenger rail that is sufficient to pay for increased service or improve infrastructure to reduce travel times and increase reliability. By 2035, 3.6 million people are expected to reside in the greater Willamette Valley. Intercity and regional travel demand will increase, and congested freeways will leave people looking for other options. Changing demographics and GHG reduction will disfavor automobile travel.

Impacts & Implications

With currently available resources, the Oregon Passenger Rail Project will be side-tracked. Without increased funding to leverage federal grants to add capacity on Union Pacific's line between Portland and Eugene and pay for increased service, ODOT will not be able to implement the Service Development Plan to increase passenger train service resulting in travelers having fewer modal choices.

Ultra-High Speed Ground Transportation

The Washington State Department of Transportation (WSDOT) is studying how ultra-high-speed ground transportation (UHSGT) might serve as a catalyst to transform the Pacific Northwest. A stronger, better connected Cascadia economic megaregion — stretching from greater Vancouver, British Columbia to metro Seattle, Washington to Portland, Oregon — has the potential to thrive in the global marketplace. A key component of that vision is a fast, frequent, reliable, and environmentally responsible transportation system that unites this megaregion and positions it for global competitiveness and future prosperity.

A 2019 Business Case Analysis builds on previous UHSGT studies conducted by WSDOT and provides a comprehensive and detailed picture of the wide range of benefits that would flow to the region due to UHSGT. It further confirms that an ultra-high-speed transportation system could be viable in the Pacific Northwest. The 2019 report focuses on:

- Corridor options, including possible station areas, connections to other travel modes (such as transit), and costs
- Potential ridership and revenue based on some express service trips stopping at only a few locations, interspersed with other trips that stop at more locations

- Governing structures to administer such a project across state and international borders
- Funding and finance alternatives
- Key benefits related to better travel connections, economic development, housing, environment, and safety
- Building on the Business Case Study, work for the new study is addressing:
- Development of a governance framework to result in recommendations needed to advance the development of the high-speed corridor.
- Development of a long-term funding and financing strategy for the project initiation, development, construction and program administration of the high-speed corridor. The development of this strategy is to build upon the Funding and Financing chapter of the 2019 Business Case Analysis and align with the governance framework recommendations.
- Development of recommendation for a WSDOT-led high-seed corridor engagement for policy leadership (e.g., key elected officials).

Oregon has participated in the past phases for the UHSGT Study that is working on an ultra-high speed service between Portland, Seattle and Vancouver, B.C. ODOT has contributed $200,000 for the third phase of this work and have a representative on the Steering Team and representatives on the Executive Committee from ODOT, the Oregon Transportation Commission, Metro, the City of Portland and the Governor's Office.

Construction of this project will likely cost tens of billions of dollars. However, a funding source for construction has not yet been identified, so additional work will need to be done to identify and secure new sources of funds.

MULTIMODAL FREIGHT

As a trade-dependent state, Oregon relies on multimodal freight movement to facilitate international freight movement and participate in the global economy. Investing in multimodal freight promotes expansion and diversification of Oregon's economy by providing options for shippers and businesses, reduces GHG emissions, and improves resiliency of the state transportation system by providing alternatives to highway freight movement.

Efficient freight movement relies on an integrated system designed to take advantage of the efficiencies provided by different modes. Freight mode choice depends on cost, reliability, time sensitivity, fragility, and other factors. Trucks currently move the majority of freight in Oregon. That said, a significant amount of freight is moved using multiple modes together, such as truck, rail, and marine. Constraints on movement of one mode or facility create additional pressures on the other parts of the system. The Oregon Freight Plan addresses issues affecting all modes of freight transportation and proposes strategies to maximize the efficiency of the system.

The movement of goods within Oregon will remain higher than both inbound and outbound shipments combined, indicating that transportation connections within and between cities and industries need to be maintained and potentially enhanced to meet this growth. Different modes are responsible for moving key commodities into, out of and within Oregon. For example, marine vessels are often used to carry heavy, low-value items within states or between regions. Airfreight often carries low-weight, high-value goods to markets all across the world. The Oregon Freight Plan addresses issues affecting all modes of freight transportation and proposes strategies to maximize the efficiency of the system. It will be critical to Oregon industries to make sure that the transportation system supports reliable and timely service to get these goods into the state. The amount of freight originating in Oregon is expected to exceed the amount of freight coming into Oregon by 2035. It will be critical to continue to maintain and improve connections between Oregon and the rest of the world for all modes in order to be able to support this expected increase in exports.

CONNECT OREGON

Purpose and Funding Levels

In 2005 the Oregon Legislature created the Connect Oregon program to invest in non-highway infrastructure improvements through grants and loans to non-highway transportation projects that promote economic development in Oregon. The program is critical to attracting and sustaining businesses and jobs in Oregon and ensuring the state builds strong connections to world markets.

Between 2005 and 2017, the Oregon Legislature funded seven cycles of Connect Oregon projects with lottery-backed bonds totaling $457 million invested in non-highway transportation projects statewide. In HB 2017 the Legislature provided ongoing support for the program through a vehicle dealer privilege tax.However, the net revenue provided to Connect Oregon is only about $11 million dollars annually, far less than the $35 million a year the program averaged from 2006 through 2017.

The overall investment in Connect Oregon has leveraged approximately $700 million in other funds and supports multimodal connections and better integrates transportation system components; this in turn improves the flow of commerce and promotes economic development.

Investment Strategy

Connect Oregon improves transportation connections around the state by investing in rail, ports, and aviation projects. Connect Oregon focuses on improving connections between transportation modes to better integrate and improve the efficient flow of goods and people.

Marine & Ports

Oregon's 23 ports include five deep-draft and four shallow-draft marine ports. Marine ports face a number of challenges, including maintaining adequate depths via dredging to ensure sufficient vessel accessibility. Marine/port projects (e.g. dock/wharf rebuilds, terminal expansion, supporting structures, lifting equipment, and channel dredging) have received $47 million in Connect Oregon Funds.

Airports

The aviation industry in Oregon includes over 300 aviation related companies providing a variety of employment opportunities ranging from manufacturing and repair to pilots. The Oregon Department of Aviation administers all aspects of pavement maintenance at participating airports on a three-year cycle. Maintaining good pavements can significantly extend the initial investment in the facility and saves costs by extending pavement life, and also extending the time intervals between complete airport pavement rehabilitations.

Aviation provides a significant economic boost to the state, supporting thousands of living-wage jobs. The Oregon Aviation Plan is the comprehensive transportation document for all public use airports. It identifies needed airport improvements and analyzes how aviation meets the needs of economic development, resiliency, tourism and transportation services. It provides the basis for state aviation policy and is adopted by the Oregon Aviation Board. Aviation projects (e.g. taxiway/runway rehabs, hangars and supporting buildings, equipment with long lifespan: communications, generators) have received $97 million in Connect Oregon Funds.

Railroads

There are 2,344 miles of rail track in Oregon, including 1,111 miles of interstate trunk line and 1,175 miles of secondary branches operated by short lines. Trunk lines are operated by Class I carriers such as BNSF and Union Pacific Railroad, which carry the majority of freight and passenger trains. Short line railroads, with lower traffic than trunk lines, face challenges brought on by aging infrastructure and constrained resources. To preserve efficient movement of goods and people in the future, it will be important to make rail improvements so that both freight and passenger capacity needs are met. Rail projects (e.g. track/ switch upgrades, sidings, pinch point improvements) have received $173 million in Connect Oregon Funds.

Needs

In 2016, roughly 240 million tons of freight valued at $270 billion moved within, to, and from Oregon via truck, rail, air, pipeline, and marine modes. The value of freight moved into, out of and within Oregon is expected to increase 161 percent between 2002 and 2035, substantially higher than the anticipated 88 percent increase in tonnage.

Connectivity between major highways and intermodal facilities such as airports or marine ports, between all regions of the state, and between key industries and the freight network is critical because it allows businesses and industries to move their goods throughout Oregon and beyond in a cost-effective manner.

The Oregon Freight Plan selected four major multimodal corridors whose connectivity is vital to the state economy.

- The I-5 and I-84 corridors—including nearby rail and river routes-- are the dominant corridors in terms of the tonnage and value of freight.
- The U.S. 97 and U.S. 20 corridors carry moderate freight volumes but provide critical redundancy in the freight system.

Increasing truck traffic places further demands on the system and requires substantial investment in maintenance of the existing highway and road network. The growth of truck share reflects the shift towards higher value products and greater time sensitivity in product movements. With truck traffic anticipated to rise substantially in the future, roadway congestion issues, transport reliability and road access issues will be exacerbated. Roadway issues are therefore anticipated to become an even greater focus of future freight planning in Oregon.

Impacts and Implications

The freight system connects Oregon to the rest of the global supply chain while at the same time ensuring that all regions of the state have access to quality transportation services. Anticipated growth in Oregon's population, freight volumes and resulting congestion highlight the need to plan for transportation system improvements to meet requirements of shippers, carriers and other freight system stakeholders. Effective coordination, communication, and cooperation are critical to the delivery of an efficient multimodal transportation system.

Aviation, ports and rail are highly reliant on Connect Oregon for infrastructure investments. While the new privilege tax will provide Connect Oregon a sustainable funding base, it won't be adequate to run a robust program. ODOT has managed to creatively scrape together match funding to secure some federal grants to improve the rail system, but a lack of state match sources make it difficult to leverage federal rail grant programs. New aviation funding from by the legislature provided match funds allowing most general aviation airports to leverage Federal Aviation Administration grants. However, funding has only met a portion of grant requests and the limited funding has not been able to provide significant assistance to the commercial service airports.

SYSTEM OPERATIONS

Purpose & Funding Levels

Highway system operations encompass many different activities that improve the efficiency of the transportation system and operations through technology, infrastructure investment, and operations management. Operational tools used on Oregon highways include ramp metering, traffic signal synchronization, variable speeds, the Green Light truck preclearance program, incident management programs, traveler information services, and others making the existing system safer and more efficient.

Operations solutions provide cost-effective approaches to meet the challenges presented by increased demands on the system coupled with increasing constraints on available funding. Investments in technology-based solutions not only improve mobility and safety of the system but also reduce the need for more expensive capacity expansion projects. These strategies are very effective at reducing emissions in congested areas, helping travelers to keep moving, avoiding stops and starts.

Active traffic management investments refer to technology that monitors roadway conditions and the movement of vehicles in order to keep traffic moving. Such technology can inform drivers of when to enter a freeway (ramp meters), when to slow down (advisory speed signs), how long their trip will take (traveler information signs), and more. Active traffic management systems produce measurable benefits for improved safety and reliability, travel time savings on severely congested highway and freeway segments, and increased fuel efficiency, reduced emissions. After the initial deployment of the "Real Time" active traffic management system on Oregon 217, ODOT found these technologies helped reduce crashes that cause non-recurring congestion by 21%, increased travel time reliability by 10%, and enhanced vehicle throughput by 5%.

Traffic Incident Management (TIM) focuses on clearing crashes quickly to keep traffic moving and improve safety. Doing so takes coordination across transportation departments and emergency responders. Traffic and roadway conditions are monitored; communication is made with police, fire, or others, and transportation incident response trucks sent to the scene. Such coordination and response helps get assistance to the scene quickly, helps those in need, clears crashes, and reduces resulting travel delay, congestion, and emissions.

Traffic signals are designed to keep traffic moving safely but can also keep traffic moving efficiently when they are optimized. Optimizing signals requires adding new software and hardware to older signals. When upgraded, signals can be coordinated within a corridor or area to keep traffic moving. Sequencing green lights across the system will help to reduce stops and starts, saving traveler's time, improving fuel efficiency, and reducing emissions.

The Operations Program did not receive any HB 2017 funding; however some of the seismic funding will be used to address some unstable slope problems. The program is currently funded at $27 million per year for FY 2022-2024. Key components of the program include traffic signals, signs, roadway lighting, Intelligent Transportation Systems (ITS), and landslide and rockfall mitigation.

The program has the following a number of investment areas:

- Operations Asset Replacement – replace aging operations infrastructure that is beyond its service life.
- Statewide Systems – server replacements and software modernization to keep statewide IT systems used for implementing operations strategies in reliable and supportable condition.
- Fix Identified Hazards – projects to fix identified, priority unstable slopes.
- System Optimization and Region Identified Needs – small projects to address opportunities to optimize system operations and other projects that don't fit other STIP funding categories.

The Operations Program also funds project types that don't fit the criteria for other STIP funding categories.

Typical Life Cycle

The Operations program encompasses a wide variety of assets. The following table shows a list of assets along with inventory numbers and service life. Many electronic and computer systems have a relatively short lifespan—in the range of 10 years. As more of this infrastructure is deployed, maintenance and replacement costs will grow.

Needs

Typical service life is driven primarily by asset deterioration but is also influenced by technical obsolescence. Given the wide variety of assets within the Operations Program, the assets vary in level of information available, but some current condition information is available.

- 25% of ODOT's traffic signals are in poor or very poor condition. Conditions are declining as these assets age.
- 8.8% of ODOT's ITS assets are beyond their service life. The percentage is increasing over time.

Devices	Inventory	Expected Life (years)
Signals		
Traffic Signals	1480	40
Signal detection systems	1480	10
Ramp Meters	142	30
Intersection Flashers	95	20
Hazard Beacons	2,000	15
Signs		
Major Signs	14,495	15
Minor Signs	163,832	15
Major Sign Supports	4,125	50
Minor Sign Supports	102,113	10
Lighting		
Roadway Lighting	21,000	40
Intelligent Transportation Systems		
Variable Message Sign (VMS)	321	20
VMS Support Structures	95	50
Cameras	565	10
Camera Poles	274	50
Camera Lowering Device	147	10
Weather Station	184	20
Highway Advisory Radio	22	10
Weather Warning Systems	15	10
Servers	74	5

- 1.2% (2,157 signs) of ODOT's traffic sign inventory are below minimum retro-reflectivity standards.
- Only 0.38% of ODOT's major traffic structures (e.g. sign bridges) are rated poor which has been stable over the last several years.
- There are 4,044 identified unstable slope locations on the state highway system, and the number of identified unstable slopes is continuing to increase. Of these 4,044 locations, 251 are identified as high priority and 108 are identified as immediate need meaning these sites pose significant risk to the traveling public and the system.

Impacts and Implications

Conditions will continue to decline at the current funding level. An analysis of the investment needed to keep operations assets within the design life shown in the table above is $28.7 million per year. If the entire program allocation were used for asset replacement, ignoring other program investment categories, conditions would still decline over time. The cost to repair the 4,044 known unstable slope locations is $3.3 billion in today's dollars. If the entire Operations Program allocation at the current funding level was used for this purpose it would take 122 years to repair these locations at current cost levels. The repair costs of just the 108 immediate need sites is $201 million.

Declining conditions shift costs to the maintenance program. Aging operations infrastructure impacts the reliability of equipment and increases maintenance expenditures to keep equipment functioning which also directly impacts mobility, safety and the user experience of system users. Failure to address unstable slope problems shifts costs to maintenance to respond to clean up and repair of slides and rockfall locations. Finally, the low funding level compared to the breadth of the program limits opportunities to improve the mobility and safety of the system through investment in system optimization projects. For example, rockfalls can cause crashes and close highways to vehicles.

MODERNIZATION PROGRAM

Purpose & Funding Levels

Modernization typically refers to any project that adds lanes, even if it's just an auxiliary lane or truck climbing lane, typically to address congestion and delay for freight and passenger vehicles and improve safety. As noted above, the OTP and OHP focus on making the system more efficient before adding capacity and focus on improving existing routes before adding new facilities like bypasses or new roads.

As the population and economy of the state grows, congestion increasingly afflicts the state, particularly the major urban areas. The Portland metro area faces unique transportation infrastructure challenges as it experiences population growth and increased economic activity. According to ODOT's 2018 Traffic Performance Report for the Portland metro area, hours of congestion on the region's freeways increased 13% between 2015 and 2017, while daily vehicle hours of delay increased by 20%. The region faces 123 average daily hours of congestion and more than 80,000 daily vehicle hours of delay at an economic daily cost of $2 million. Oregon's other urban areas have also seen significant increases in congestion.

Through development and subsequent implementation of HB 2017, the Legislature, OTC, and ODOT have prioritized strategies and actions to address congestion in the Portland metro area. The Commission and Department, in partnership with state, regional, and local stakeholders, have developed a comprehensive congestion relief strategy designed to enhance mobility through enhancing transportation options, deploying technology to enhance operations, tolling to manage demand and raise resources, and strategic bottleneck relief projects.

These bottleneck relief projects include:

- I-5 Rose Quarter Improvement Project
- OR-217 Oregon 10 to Oregon 99W Auxiliary Lanes
- I-205 Corridor Bottleneck & Active Traffic Management
- I-205 Widening & Seismic Improvement Project
- Interstate Bridge Replacement Program

These projects, taken together with the other elements of the comprehensive multimodal strategy, establish a path toward congestion relief in the Portland metro regional transportation system. The consequences of failure to address congestion by meeting modernization need include growing congestion and delays for freight and commerce. Past analysis, including reports on the Cost of Congestion, found that congestion imposes significant costs on Oregon's freight-dependent economy.

Investment Strategy

ODOT has traditionally focused much of its system modernization on projects that benefit both freight movement and passenger vehicles. ODOT has developed a freight bottlenecks analysis, which looked at the worst areas of truck delay across the state. Not surprisingly, most of these areas were in Portland. Virtually the entire Portland freeway network has been identified as causing significant delays for the movement of freight. I-5 in particular has been identified as critical because it provides access to ports and industrial areas and also has some of the worst truck bottlenecks in the nation.

Identifying modernization need is fundamentally a policy decision about how to effectively address travel demand and reduce congestion and delay. Rather than the universal solution for congestion, modernization projects are just one part of a comprehensive congestion management strategy. They provide a supply-side solution to addressing congestion and delay, as do adding travel capacity through transit, active transportation, and transportation options; demand-side solutions such as pricing and teleworking can also help reduce congestion and delay. As a result, it's difficult if not impossible to quantify how much modernization spending is needed to "fix" the system. However, virtually any analysis of modernization funding need would run into the billions of dollars—particularly given major projects like the Interstate Bridge replacement.

Needs

Since the Jobs and Transportation Act of 2009, major modernization projects have relied primarily on legislative earmarks. That legislation included a number of new sections of state highway—including the Newberg-Dundee Bypass Phase 1, Sunrise Corridor Phase 1, and the OR 62 Bypass—as well as improved interchanges and new lanes on state highways. HB 2017 also dedicated funding to a number of major modernization projects, including I-5 Rose Quarter and OR 217 auxiliary lanes.

With discretionary funding in the STIP primarily directed by the OTC to Fix-It programs, STIP funding for modernization has been significantly constrained. In the 2021-2024 STIP, discretionary highway modernization spending totaled just $24 million, though that was supplemented by hundreds of millions of dollars in spending on HB 2017 dedicated projects. The STIP has funded relatively small-scale modernization projects such as auxiliary lanes and truck climbing lanes, but major interchanges and new lanes typically require either a direct legislative earmark, a major funding package like OTIA III, JTA, or HB 2017, or a long-term phased approach to completing the work—or a combination of these.

Given the limited modernization funding available, ODOT has been exploring tolling as a way to both fund modernization projects and manage demand on the transportation system using congestion pricing. Going forward, tolling may be the only way to pay for modernization megaprojects—particularly the Interstate Bridge and widening of I-205—that cost hundreds of millions to billions of dollars.

CLOSING THE GAP – OPPORTUNITIES FOR ADVANCING SUSTAINABLE TRANSPORTATION REVENUE

Across the nation, transportation funding has been in a near constant state of crisis for more than a decade. State legislatures and local governments, left hanging by declining assistance from the federal government and higher costs of road construction and maintenance, have responded emphatically and creatively in their approaches to create new transportation revenue streams. Oregon has been no different, seizing on the opportunity in HB 2017 to make a substantial investment in the state's multimodal transportation system.

In addition to the traditional funding sources of the gas tax, driver and motor vehicle fees, and weight-mile tax, the Department has been exploring new approaches to fund and finance needed transportation investment, such as piloting road usage charging programs, implementing increased user-fees on electric and hybrid vehicles and establishing a tolling program to address many of Oregon's congestion challenges.

RENEWING THE FEDERAL PARTNERSHIP

Since 1956, when Congress passed the Interstate Highway program, the federal government has been a strong partner in funding the nation's surface transportation infrastructure. But since 2009, when the SAFETEA-LU authorization legislation expired, the federal contribution has been essentially flat. In fact, from 2011 through 2017 federal-aid highway funding flowing to Oregon actually fell; it wasn't until 2018 that funding reached the same level as 2010—and it was much lower in 2018 in inflation-adjusted terms.

With bipartisan support for investments in infrastructure, Congress is now considering surface transportation investments that would renew the federal government's role in highways, transit, and rail. House Transportation and Infrastructure Committee Chair Peter DeFazio's INVEST Act would significantly increase investment in state and local transportation

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programs. The Commission should continue advocating for the federal government to reclaim its role as a significant partner in infrastructure investment.

TOLLING STRATEGIES

The 2017 Legislature directed the Oregon Transportation Commission (OTC) to pursue and implement tolls on I-5 and I-205 in the Portland metro region to help manage traffic congestion and raise revenue for infrastructure improvements. HB 2017 also established a Congestion Relief Fund, which will receive any net proceeds from tolls. The fund is subject to Article IX, Section 3a of the Oregon Constitution and therefore must be spent on roadway projects, which could include construction or reconstruction of travel lanes, as well as bicycle and pedestrian facilities or transit improvements in or along the roadway.

To that end, ODOT established the Tolling Program Office in late 2019 and launched two tolling projects on I-5 and I-205 in early 2020. Revenue generated by tolling I-205 near the Abernethy Bridge could help fund the planned widening and seismic strengthening of I-205 between Stafford Road and OR 213 including the Abernethy Bridge.

Tolling may be a way to pay for major highway projects that don't have a funding source. What's more, the OTC has broad statutory authority to toll roads, making it one of the few areas where the Commission can generate additional resources. However, federal law limits where a state or local government can impose tolls. Federal law generally allows for four potential opportunities to use tolling.

Bridge Reconstruction. Federal law provides broad authority to toll when a bridge is replaced or reconstructed. This authority may allow ODOT to pay for major congestion relief projects in the Portland metro region such as widening of the I-205 Abernethy Bridge and adjacent sections of I-205 and the Interstate Bridge and perhaps other projects. In the future, this authority could allow for tolling to pay for high-cost bridge reconstruction and replacement projects elsewhere in the state where traffic volumes may be sufficient to warrant tolling.

New Roads. Federal law allows for tolling newly-constructed roads, and due to limited resources for building new roads ODOT will likely need to consider tolling for any new state highway corridors that are considered in the future. However, past feasibility analyses of tolling new facilities such as the Newberg-Dundee Bypass and the Sunrise Corridor found that much of the anticipated traffic would avoid the tolls by using parallel routes, limiting revenue generation and the traffic benefits of building a new road.

New Lanes. Federal law does not allow imposing a toll if it will reduce the number of free through lanes on the Interstate, other than when replacing or reconstructing a bridge. This makes tolling to pay for Interstate widening projects difficult, though FHWA has some ability to grant waivers to these limitations. ODOT is planning to seek a waiver from FHWA to toll I-5 through Central Portland.

High Occupancy Toll (HOT) Lanes. While federal law allows building HOT lanes or converting existing HOV lanes to HOT lanes, these opportunities in Oregon are extremely limited given the state's lack of an extensive HOV lane network. What's more, tolling a HOT is not likely to generate enough revenue to construct a new lane; HOT lanes are generally recognized as traffic management strategies rather than revenue generation tools. As a result, the value pricing feasibility analysis ODOT conducted in 2017-2018 did not find any likely opportunities for HOT lanes.

Given these federal strictures and public opinion, tolling will most likely be used primarily for congestion relief projects where the benefit to drivers makes them willing to pay a toll, as well as for to cover the costs of replacing or reconstructing major bridges that would otherwise be infeasible.

Tolling Equity and Mitigation Framework

While variable rate tolling or congestion pricing is a proven tool for funding projects and managing traffic, success for the metro region will require improved public transit or other travel options. The process to implement a toll program requires substantial analysis, public input, construction, testing and driver education before the system can be operational.

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ODOT is planning extensive public and stakeholder involvement to inform an equity framework, project development and community mobility, and equity priorities. The goals of the equity framework are:

- Gain better outcomes for traditionally disadvantaged and underserved communities;
- Be inclusive and intentional when engaging communities in solutions.

Multiple strategies are planned to ensure the Oregon Transportation Commission and ODOT staff hear a diversity of perspectives before making decisions on selected alternatives for both I-205 and I-5, equity and mobility strategies and, in the future, toll policies and rates.

ODOT is developing an equity framework to advance the community mobility and equity priorities identified during the feasibility analysis and to be the foundation for project development and delivery. The framework will serve as a navigation tool to ensure the tolling projects achieve equitable outcomes and to implement an intentional and equitable engagement process that prioritizes historically underrepresented communities. These include, for example, communities of color and people with low incomes or disabilities.

The consultant team includes TransForm, with expertise in integrating an equity focus throughout engagement, planning, development, and evaluation of pricing projects. TransForm, working with local equity experts has conducted an equity training with the project team and will lead workshops with regional partners, stakeholders and the public.

An Equity and Mobility Advisory Committee (EMAC), supported by the ODOT project team, has been convened to advise the Commission. Early engagement by the Committee will inform the equity foundation of the projects, including guidelines, strategies, processes and timelines. Committee members will provide an important link in regional public involvement and education by assisting with outreach to their constituents and communities.

MULTIMODAL REVENUE OPTIONS

Due to Oregon's constitutional restriction on the use of highway funds, modes other than roads often face funding challenges. HB 2017 addressed some of these shortfalls by providing a significant infusion of dedicated funding for public transportation provided through a statewide payroll tax of 0.1%, as well as providing dedicated permanent funding for Connect Oregon through the dealer privilege tax on new vehicles and generating additional revenue for bicycle and pedestrian trails through a bicycle excise tax.

Bicycle and pedestrian projects can be funded through a wide range of sources, including:

- Multimodal Active Transportation Fund(projects outside the road right of way)
- State Highway Fund (only projects inside the highway right of way)

- Federal highway funding (all types of bicycle/pedestrian projects)

This ability to use multiple funding sources for bicycle/pedestrian projects has allowed Oregon to make significant investments in active transportation infrastructure in recent years. However, the level of investment from these funding sources has been inadequate, indicating the need to find additional funding sources or dedicate more from these existing sources.

Rail and marine/port projects are among the most difficult projects to fund because they can only be funded through the Connect Oregon program.

While public transportation received a major increase in state funding in HB 2017, significant needs remain across the state. Increasing transit funding to meet this need could involve creating new funding sources or increasing one or more of the existing revenue sources, such as the statewide payroll tax.

ODOT proposes to develop a stakeholder-supported multimodal strategic investment framework that can be used to develop multimodal strategic investment plan. One of the plan strategies could be implementation of a consolidated multimodal funding program that would prioritize funding multimodal projects that best meet legislative and Commission investment priorities. This would vary from the current funding models that are largely focused by mode and fund source. For example, a high priority project might be one that fills in a sidewalk gap at an improved transit stop in a neighborhood that is traditionally underserved.

ROAD USAGE CHARGING

In true Oregon fashion, we're pioneering new ways to fund our roads to support our state's mobility and economy, now and for future generations. Oregon was the first state to collect a fuel tax to fund highway projects starting in 1919. Currently, Oregonians pay a fuel tax, 36 cents per gallon, to fund road preservation and improvement projects. But, as more cars and trucks run on electricity or use less gas, Oregon gets less funding to maintain roads and bridges.

With vehicles becoming more fuel efficient and increasing number of electric vehicles that pay no gas tax on the road, transportation experts have looked to migrating our current user-pays approach toward per-mile road usage charges. These charges would have the virtue of ensuring that all vehicles pay for their use of the roads while also helping square our commitments to carbon reduction with the need to fund infrastructure; we cannot shift away from fossil fuels as the motive power for automobiles while leaving taxes on fossil fuels as the primary source of state and federal transportation funding.

Oregon has been leading the nation on per-mile road usages charges for nearly two decades. In 2015 we launched OReGO, a voluntary program where people pay 1.8 cents per mile. We've had over 1,500 vehicles in the program to date and proved that it is feasible. The Legislature has taken a step toward shifting OReGO from a pilot program to a revenue generation program while retaining its voluntary nature by allowing people to opt out of the higher registration fee on electric vehicles and hybrids if they opt in to paying the road usage charge. OReGO enrollment has increased as a result.

In order to transition OReGO into a large-scale revenue program, ODOT will have to ensure both that the public accepts the concept-- particularly the privacy implications—and reduce the high administrative costs associated with a small-scale program. This will require new technologies beyond those readily available today.

The Department has received federal grants to further develop the OReGO program, including through partnerships with other states. We've teamed up with other western states, particularly California and Washington, to explore interoperability across state lines, and ODOT is also exploring local option road usage charges to provide funding solutions to local governments. Work is underway to incorporate new technologies that will lower administrative costs and eliminate the need for people to put a device in their car– which would help address privacy.

The legislatively-chartered Road User Fee Task Force is beginning the policy development process for potential legislation in 2021. In the past, RUFTF has proposed legislation that would make OReGO mandatory for high-efficiency vehicles, and the group will continue to grapple with how to advance road usage charging toward wide adoption.

THE FUTURE OF USER FEES: TRUE-COST PRICING

For economists, the Holy Grail of user fees is a system in which transportation user fees reflect both the use of and the costs drivers impose on the system and society. Going forward, Oregon could leverage its unique transportation funding system—including a weight-mile tax and the first per-mile road usage charging system—to create a "true cost pricing" approach. This could include a number of components.

Fuels taxes would charge people for emitting carbon and incentivize efficient use of fossil fuels.

Road usage charges would ensure that all vehicles pay for their actual use of the roads, regardless of whether they pay fuels tax.

Congestion charges would charge people higher prices for use of the system at peak times in order to reduce congestion and incentivize more efficient use, such as using other modes or traveling at less congested times, when prices would be lower.

Weight-based taxes would ensure that heavy trucks pay their fair share for their disproportionate wear and tear on roads; this principle of cost responsibility is enshrined in Oregon's constitution.

With the weight-mile tax and fuels taxes already in place, a nascent road usage charging system growing over time, and congestion pricing under consideration, Oregon is on the cusp of developing a truly revolutionary approach to user fees that could be replicated in other states to drive more efficient funding and use of the transportation system.

However, as Oregon moves down this path, policymakers should deliberate consider how true-cost pricing would impact people across income levels to ensure equity. Oregon's leaders also need to make the fundamental policy decision of whether to optimize user fees or transition to some other method of generating road funding.

NEXT STEPS – ALIGNING STRATEGIC PRIORITIES AND GOALS WITH NEAR-TERM INVESTMENT DECISIONS

The management review performed by McKinsey & Co. in 2017 found that ODOT and the Oregon Transportation Commission lacked clear strategic alignment on the agency's highest priorities and goals. The review found that ODOT could improve its overall coordination by defining and communicating its vision and direction more clearly, ensuring targets cascade throughout the organization, and clearly defining governance roles and responsibilities, with an eye toward simplifying strategic documents. In the past few years, the department has made significant strides to establish and simplify ODOT's mission, vision, and goals; however this work is ongoing.

Presently, ODOT remains in a period of transition, with a new OTC chair and vice chair, a new director, new executive leadership, and changing public needs and directions from the Governor and Legislature. Having expressed their collective desire to intentionally focus efforts on shared OTC/ODOT strategic priorities and long-term policy direction and plan development, the time is ripe for defining the strategic priorities and goals shared by the OTC and ODOT and developing an implementation plan to meet them. At the core of both the commission's work and the department's work is ensuring the system meets the needs of Oregonians into the future; this work is critical now more than ever as ODOT re-examines how it does its business in light of a significant operating budget shortfall and delivers on the historic investments entrusted to the agency in HB 2017. Delivering on this core responsibility for the state of Oregon requires a clear articulation of vision, priorities, and goals in order to chart a pathway forward under the current circumstances.

Upon commission approval of the priorities and goals, the department will develop and refine associated measures and outcomes and also revise existing ODOT strategic documents to ensure a clear nesting of agency activities that supports this strategic vision. ODOT anticipates socializing and discussing this work with the commission throughout the fall of 2020. Key to this strategic plan will be how ODOT addresses equity and climate change.

ODOT is taking steps to better incorporate these key priorities in decisions, including investments and project selection, across the agency's portfolio, and has begun to develop organizational structures and plans to better address these areas.

EQUITY FRAMEWORK

As part of the reorganization of the agency, the agency created a new Office of Social Equity led by a new Assistant Director position. The office's charge is to:

- Institutionalize equity, diversity, and inclusion practices in ODOT's programs, policies, performance, and priorities
- Place an equity lens on transportation decisions within communities and in funding decisions
- Develop equity and inclusion as a vital workforce skill
- Ensure that contractors, consultants and advisory structures reflect Oregon's diversity
- Ensure equitable project and service delivery for all of Oregon's communities with a specific focus on communities of color and other communities historically marginalized by government policies.

As we develop a framework of support, resource, and accountability regarding social equity for the agency an overview of plans and progress is necessary as well as an update on that which has been long withstanding and connected to social equity. Currently, the Assistant Director for Social Equity is working to understand ODOT's system based barriers to equity while providing baseline information and recruiting a team to begin the process of operationalizing equity in our planning, projects, community partnerships, and internal operations. This is happening alongside the diligent work from the Office of Civil Rights and the multiple units working on the implementation of the Americans with Disabilities Act.

Upon commission approval of the joint OTC/ODOT priorities and goals during its workshop, July 2020, we will offer a frame for social equity to the agency as well as defining and refining measures and outcomes that will allow us to move from talking about equity to pivoting our operations toward equity by the start of 2021.

CLIMATE CHANGE MITIGATION AND ADAPTATION

Flooding, landslides, and wildfires are only a few signs that Oregon's climate is changing. These events are becoming more frequent and have resulted in road closures, infrastructure damage, and hundreds of staff hours in clean-up. Impacts to the transportation system cost the state hundreds of millions each year and are far reaching to the traveling public and state economy. ODOT recognizes that concerted efforts must be placed on understanding and addressing the impacts of climate change to the transportation system.

Transportation accounts for the largest share of greenhouse gas (GHG) emissions in the state (around 40%). Increased GHG emissions will only exacerbate the impacts of climate change and efforts are needed to reduce the amount of carbon that comes from the transportation sector. ODOT is committed to implementing the Statewide Transportation Strategy for GHG reduction. In late March 2020 ODOT announced the formation of a new Climate Office. The Climate Office was created recognizing that concerted and strategic efforts are needed to understand and prepare for the impacts the climate is having on Oregon's transportation infrastructure and to reduce the carbon footprint of transportation. The Climate Office consists of three parts:

- **Climate Change Mitigation:** Implementing ODOT's Statewide Transportation Strategy: a 2050 Vision for Greenhouse Gas Reduction (STS), pursuing transportation electrification, and reducing the carbon footprint of ODOT and the transportation sector.
- **Climate Change Adaptation:** Understanding the impacts of climate change and better preparing ODOTs infrastructure and responding.
- **Sustainability:** Continuing and reporting on a limited set of sustainability actions, such as water resource management, energy use, and similar efforts.

The current focus of the Office is primarily on mitigation, complying with Executive Order 20-04 and on multi-agency STS implementation efforts (see below). In addition, staff is supporting adaptation through the creation of an Adaptation Implementation Roadmap. The Roadmap will help the Agency better understand how the climate is changing, associated impacts to transportation infrastructure, and to develop an approach for ODOT to better prepare for and respond to events such as intense rainfalls and flooding, landslides, wildfires, and sea-level rise.

Overall, the Climate Office will work across ODOT divisions to educate, develop and institutionalize mitigation and adaptation strategies in the ways the agency plans for, invests in, builds, manages, maintains, and supports the multi-modal transportation system. Staff will also work with other state agencies and local agency partners to find collaborative approaches and solutions, connect with stakeholders, and learn best practices from other states. The staff makeup and activities of the Climate Office will evolve over time as the work evolves and opportunities are identified.

Executive Order 20-04: Directing State Agencies to Take Actions to Reduce and Regulate Greenhouse Gas Emissions

On March 10, 2020, Governor Brown signed Executive Order 20-04, directing several state agencies, including ODOT, to take actions within their authority to regulate and reduce GHG emissions. The Executive Order included the following directives to ODOT:

- *Conduct a Transportation Electrification Infrastructure Needs Analysis* to identify electric charging infrastructure needs in order to support transportation electrification.
- *Evaluate the GHG Emission Impacts of Projects as Part of the STIP Planning Process* to develop and apply a process for considering GHG emissions in making STIP decisions.
- *Identify and Implement Assistance for Local Planning to Meet GHG Reduction Goals* to identify and implement technical and financial support for local planning efforts to meet GHG reduction targets.
- *Integrate Climate Change into Agency Decisions* to integrate climate change, climate change impacts, and the state's GHG emission reduction goals into policy, planning, and investment decisions.

The Climate Office is leading the agency efforts to comply with the Executive Order, working across ODOT divisions and groups. Several of these directives will require input from the OTC and staff will update the Commission regularly, and ODOT will actively collaborate with other state agencies and stakeholders.

Multi-Agency STS Implementation Work Program

ODOT is also working on a multi-agency implementation work program for the STS. The multi-agency work was directed by the Governor in a letter sent late 2019 and affirmed in Executive Order 20-04. Accordingly, ODOT has been meeting with the Department of Land Conservation and Development (DLCD), Oregon Department of Energy (DOE), and Oregon Department of Environmental Quality (DEQ) to develop a cooperative work program. This work was led at the highest levels of the agencies by the Directors and respective Commission Chairs. Staff from each agency also met and agreed on actions requiring two or more agencies to collaborate, and that are likely to have a measurable GHG reduction impact. All strategies in the STS were reviewed and the following main categories of actions have tentatively been selected:

- *Electric Vehicles:* Identify rules, regulations, and supporting actions to promote transportation electrification.
- *Cleaner Fuels:* Support DEQ's Clean Fuels program and identify state-actions to support transition to cleaner fuels for all modes of transportation.

- *Transportation Options:* Decrease drive-alone trips through parking management, pricing, and demand management techniques.
- *Local GHG Reduction Planning:* Provide technical and financial support for local GHG planning efforts and amend rules.

CONCLUSION: STRATEGIC INVESTMENTS IN THE 2024-2027 STIP AND LONG-RANGE PLANNING

2024-2027 STIP Development

The development of the 2024-2027 STIP provides the Commission the ability to make investment decisions, starting with the allocation of hundreds of millions of dollars in federal funding among categories and programs and setting program goals and requirements. Over the second half of 2020 ODOT will work with the Commission on the STIP program funding allocation process. This Investment Strategy will serve as a foundation of information for the need discussions during the STIP process. The Investment Strategy presents the current programs and strategies, allowing the Commission to make decisions about where to adjust those strategies and program allocations.

Oregon Transportation Plan and Oregon Highway Plan Updates

Beyond the next STIP period, the next several years will present the Commission the opportunity to update the key long-range policy plans that help set the basic framework for investment in Oregon's multimodal transportation system.

The Oregon Transportation Plan (OTP) OTP Update will replace a version adopted in 2006, and the Oregon Highway Plan (OHP) Update will replace a version adopted in 1999. The updates are being done in conjunction with each other. The preliminary schedule for the process to get both the OTP and OHP Updates to adoption by the Commission is 2023.

The OTP and OHP Updates will align objectives for understanding the state transportation system's multiple users and their needs to inform a framework for prioritizing investments on Oregon's transportation system. The intent of the OTP Update is to provide the long-range vision and policy framework for shaping Oregon's transportation system through the year 2050. The OHP Update then functions as a strategic element for managing the state highway system, articulating its multi-modal nature, and prioritizing investments under the guiding aspect of the OTP.

The challenges facing Oregon's transportation system are significant and growing more complex. It is critical that we effectively monitor the investment of scarce resources so we can best manage, maintain, and improve the transportation system to meet these challenges while striving to achieve the policy goals and priorities set by the Commission. Looking towards the future, ODOT will consider a range of trends, opportunities and uncertainties, as continual population growth, increasing freight volume, dramatic technological changes, and the threat of climate change impact our communities and the transportation system. The OTP-OHP Updates represent a critical opportunity to guide our strategic decision-making and shape a resilient statewide transportation system that accommodates multiple users with different needs.