Economic Development RESEARCH GROUP

December 20, 2012

Jay Lyman
Columbia River Crossing
700 Washington Street, Suite 300
Vancouver, WA 98660

Dear Mr. Lyman,

After our final submission to CRC Economic Benefits Analysis, we (EDR Group) identified a couple of errors where numbers were not correctly updated in our report. This letter identifies those errors and the corrections to be made.

While all numbers are correct in the tables, there was a failure to update two numbers in the text of the first paragraph on page 5-7 (and again in the executive summary). Here is the paragraph as it currently stands:

> The discounted NPV of the greater net gross regional product (GRP) for the Portland region plus the rest of the West Coast with the LPA versus the No Build is highly positive, indicating that the LPA is a very desirable investment. The net present value of benefits of the LPA are $7 B and the costs of the LPA are $3 B through 2050 if a discount rate of five percent is used to value future benefits year benefits and costs. The net present value of benefits of the LPA are $9 B and the costs of the LPA are $3 B through 2050 if a discount rate of three percent is used to value future benefits year benefits and costs. Therefore, the net-added GRP to 2050 would be more than $4 billion if a five-percent discount rate is used, and more than $6 billion if a three-percent discount rate is used. In terms of a benefit-to-cost ratio for the project, this added GRP from the LPA is equivalent to more than 2 to 1 (7/3) to 3 to 1 (9/3) ratio of benefits to costs. The LPA is thus a highly justified investment in terms of its economic results.

The errors are the $7 B and $9 B figures, which derive from Table 5-2 (far right column). These should be $5.4 B and $7.9 B, respectively. We have double-checked the values in the tables, and these are all correct as of the last iteration of our analysis; only the text needs to be changed. The same numbers need to be updated in the executive summary on page 1-1 (bottom paragraph).

Additionally, Mr. Replinger noted that the discussion of traveler benefits in Section 5.3 is confusing, since the focus of 5.3 is Economic Impacts. We see his point, and would therefore like to move the first half of the paragraph (with corrected numbers) to Section 5.2, with additional clarification in the executive summary.

The attached draft contains all of these revisions in "track changes" mode. Please let us know if there's anything else we can do to resolve the matter.

Sincerely,
Brian Alstadt, Economist
Economic Development Research Group

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CRC Economic Benefits Analysis

Final Report

December 21, 2012

Columbia River CROSSING

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ACRONYMS

AAA American Automobile Association

BFI Buffer Time Index

BIA bridge influence area

BNSF BNSF Railway Company

CBD central business district

CRC Columbia River Crossing

CS Cambridge Systematics

EDRG Economic Development Research Group

EIS Environmental Impact Statement

FAA Federal Aviation Administration

FAF freight analysis framework

FEIS Final Environmental Impact Statement

GRP gross regional product

LPA Locally Preferred Alternative

LRT light-rail transit

MPO metropolitan planning organization

NAICS North American Industry Classification System

NEPA National Environmental Policy Act

NPV net present value

ODOT Oregon Department of Transportation

SIC Standard Industry Classification

TREDIS Transportation Economic Development Impact System

UP, UPRR Union Pacific Railroad

VHT vehicle hours of travel

VMT vehicle miles of travel

VSL value of a statistical life

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1. Summary, Introduction, and Purpose and Need

1.1 Summary of Findings

The selection of the Columbia River Crossing **(**CRC) locally preferred alternative (LPA) is the result of extensive analyses that have considered positive and negative impacts to transportation system users and to the built and natural environments. The LPA is a carefully crafted proposal to address the Purpose and Need of the project, while balancing the often competing needs of various user groups. In considering those tradeoffs between users, it is important to also consider the very significant economic benefits of the project to the region, the West Coast, and the United States. Those benefits derive from reduced congestion and decreased travel times, improved safety for motorists, and improved safety and efficiency for marine navigation, those direct benefits to transportation system users in turn will result in economic benefits to the region by improving access to job opportunities throughout the region, reducing business costs, and improving access to goods and services both domestically and internationally.

1.1.1 Methodology

The economic benefits of the CRC project have been estimated by utilizing the Transportation Economic Development Impact System (TREDIS) model to provide the overall economic benefits of the LPA versus the No Build. The TREDIS model has been widely and successfully used in many previous Portland regional, Oregon state, and national studies. Inputs to the model were derived from information in the CRC Final Environmental Impact Statement (FEIS) documents. The TREDIS model estimates traveler benefits and any added benefits from the impacts of investments on improved market access and improved connectivity. It has been used to compare what happens to the future economies of the region, the rest of Washington, the rest of Oregon, and California under the LPA versus the No Build.

1.1.2 Summary of Project Economic Benefits

Project-related economic benefits are a summary of landside traveler savings, marine navigation savings, and the economic effects of improved market access and connectivity. The net present value (NPV) to the economy of the LPA versus the No Build is estimated in the TREDIS model by comparing the time streams of costs and benefits for each option, using a discount rate for future years.

Combining all traveler benefits categories over the 2018 to 2050 time horizon results in a present value of $5.37 billion using a five-percent discount rate, and $7.87 billion PV using a three-percent discount rate. These compare favorably to the present value of LPA costs, which is roughly $3 B using both 5% and 3% discount rates. The project's discounted net present value is therefore highly positive and its benefit cost ratio is much greater than 1, indicating that the LPA is a desirable investment (versus the no-build scenario).

The discounted present value of the additional gross regional product (GRP) for the Portland region plus the rest of the West Coast with the LPA versus the No Build is also highly positive, indicating that the LPA is a very desirable investment. Using a 5% discount rate, the present value of additional GRP through 2050 would be more than $4 billion; with a 3% rate, the present value is more than $6 billion. In terms of an impact-to-cost ratio for the project, this added GRP from the LPA is in excess of costs, indicating ratio greater than 1. The LPA is thus a highly justified investment in terms of its economic impacts.

TREDIS also produces additional economic measures for future years. The combined net economic impacts of the traveler savings and the market access and connectivity impacts of the LPA will also result in additions of 4,200 jobs and $231 million in additional wages in 2030 under the LPA compared to the No Build, which are the annual jobs and wages associated with the added annual GRP added in 2030.

Traveler savings and market access impacts are described in more detail in the following paragraphs. In addition, the benefits derived from reducing a risk of catastrophic loss of a bridge are also discussed.

1.1.3 Landside Traveler Savings

By 2030, the estimated annual traveler savings due to the LPA versus the No Build will exceed $435 million per year, according to the TREDIS results. These savings accrue to highway, transit, and marine users.

Landside transportation benefits include substantial savings in highway travel times and transit travel times. There will be about 6.8 million hours per year in auto and truck delay savings on just the facility itself for automobile and truck users for the LPA versus the No Build. This savings comes both from less congestion delay during peak periods and due to fewer bridge closures during off-peak periods. There is also less congestion on other facilities, as estimated from regional data. The diversion of travelers to transit with the much better transit service under the LPA also provides substantial portions of these savings.

Landside transportation benefits also include the savings in accident costs, which will be achieved by the LPA compared with the No Build, with 510 to 540 fewer crashes per year, with resulting dollar savings in accident costs. The lower accident rates for the LPA are not modeled in the TREDIS model (which does not include highway design parameters), and so the likely accident cost savings will be around $18 million higher with the LPA than shown in the TREDIS results. Landside transportation benefits also include lower vehicle miles traveled (VMT) and lower vehicle operating costs per mile for autos and trucks, which are included in the TREDIS results.

1.1.4 Marine Navigation Savings

Transportation benefits to the marine industry also accrue because elimination of bridge closures will provide greater flexibility for marine traffic to achieve future efficiencies due to the removal of constraints on daytime travel. Although bridge openings are not allowed during peak periods, marine productivity savings could be achieved by eliminating the need to schedule movements at night. Savings are estimated very conservatively at about $137,000 per year.

1.1.5 Economic Benefits Due to Improved Market Access

In addition to the direct transportation benefits, there are further significant benefits resulting from the impacts of the LPA on freight and personal travel access and connectivity.

Trucks operating during periods of congestion will drop by 60 percent or more under the LPA, preserving and enhancing the key freight industries, such as lumber and wood, food and farm products, distribution, transportation and equipment, and high-tech products. These industries are highly dependent on the level of service on the CRC.

Person throughput during peak periods across the CRC will be enhanced by 33 percent during the AM peak and by 40 percent during the PM peak, due largely to the greater multimodal person capacity. This enhanced throughput will also increase the economic competitiveness of the region and states by enhancing market access and connectivity.

The LPA improves labor and business market access and improves connections, stimulating additional economic activity. Matching employees and their unique skills to employer needs, enhancing supplier connections, supply chain coordination, and overall knowledge sharing are the results of improved market access and connectivity. These market access and connectivity benefits under the LPA generate 1,700 (out of 4,200) additional jobs and $111 million (out of the total $231 million) in added wages in 2030, with the Portland Metro area receiving the majority of these benefits.

1.1.6 Eliminating the Risk of Catastrophic Loss of the Existing Bridges

An equally important potential economic benefit of the LPA is that its implementation will avoid the risk of an economic catastrophe. The current structures are nearly 100 years old and nearly 60 years old, respectively, and are not designed to meet current seismic standards. In a major earthquake, one or both structures could be rendered inoperable. The failure of one or both I-5 structures would have disastrous economic consequences until replacement facilities could be built on an emergency basis. Other regions have chosen not to take these risks.

The economic analysis of the No Build includes the probability that the project would have to be implemented on an emergency basis at some time. The No Build thus includes the risk of a very major economic disaster lasting at least several years until emergency construction can be completed, followed by a similar but later future with the LPA finally being implemented.

1.2 Introduction

This chapter provides the introduction to the CRC economic benefits analysis, and describes how it relates to the Purpose and Need for the CRC project. It relates the CRC project to the overall economic context of the region, the states, and the nation; and also provides the data to meet the U.S. Coast Guard mission:

> *In considering a permit application, the Coast Guard must promote and expedite projects that facilitate national and international commerce and provide for the reasonable needs of present and prospective land and marine transportation.*[1]

Economic benefit analysis in U.S. surface transportation is usually done for overall system investment scenarios because each individual project or link does not function fully on its own without an overall system that enables trips to be made. Some extremely critical projects, such as the CRC improvements, are however so important in themselves that they can be subjected to economic benefit analysis, keeping in mind that the other needed connections to the rest of the transportation system must continue to be in place.

The CRC project represents a very important element of the future transportation system for the Portland-Vancouver region, the Pacific Northwest, and the nation as a whole. The FEIS for the project documents all of the impacts of the LPA. This analysis summarizes the economic benefits of this project to the region, the states, and the nation; and it relates the information contained in the FEIS to the conclusions from other related economic studies. This study is a synthesis of the information in the FEIS along with the findings of the other analyses. It provides additional specific information on the transportation benefits and other economic benefits of the proposed multimodal improvements to the corridor.

Investments in improved multimodal transportation can have very positive economic benefits. In the Portland region, a study of alternative levels of regional investment was completed by EDRG Group in 2005, "The Cost of Congestion to the Economy of the Portland Region." This study provided a comprehensive analysis of transportation investment costs and benefits for alternative levels of investment, and found that the higher level of investment that was examined returned twice as many economic benefits to the region as the incremental costs of the investments. The EDRG study thus identified a set of investments that made the entire transportation system and the economy function better in the future, and provided documentation of the substantial net benefits of investment.

The EDRG study also identified that an expected 84 percent of freight by value would be on the highways; 8 percent on rail; and 8 percent split between marine and aviation in 2030. This highlights the substantial economic importance of highway freight.

1.2.1 The National Context of the Need for Improved River Crossings

Other areas have already made investments in major river crossings to preserve the future of the economic performance of their regions and of the nation, including the outdated Woodrow Wilson Bridge on I-95 in the Washington, D.C. region; and the outdated and seismically deficient portions of the San Francisco-Oakland Bay Bridge on I-80. Both the Louisville region, which is acting to replace Interstate bridges over the Ohio River, and the New York metropolitan region, which is acting to replace the Tappan Zee Bridge over the Hudson River, are organized to address very similar needs as the CRC for replacing crossings that are either contemporaneous with or younger than the existing CRC facilities.

[1] Source: U.S. Coast Guard Bridge Administration Manual, p. 1-2.

These other regions were motivated by both the need for modernization and by the realization that past major infrastructure investments will not function forever. These facilities are subject to limits on their ultimate lifetime of functionality, or have other limitations due to greater knowledge of the consequences of seismic events and how to design the most critical infrastructure links to survive potential seismic events.

The CRC I-5 crossings, which were built in 1917 and 1958, represent similar problems of aging and outdated facilities as these other regional examples. Those other regions' updated facilities that were also designed and constructed prior to current understanding about design for potential seismic events, or for ensuring longer terms of life of structures and pavements. Modern and new facilities will not only provide better functionality and great economic benefits for the overall transportation system, but will protect against the economic consequences of the potential loss of CRC.

Table 1-1 compares the number of highway and rail crossings serving the Portland-Vancouver area with the number of crossings serving other similar river crossing areas. With the limited bridge capacity on I-5 and I-205 and growing travel demand, the Portland-Vancouver crossings have become major traffic bottlenecks, and will become more of an economic constraint in the future.

The existing crossings of the Columbia River in the Portland-Vancouver region represent the fewest river crossings of a major river for any of the top U.S. urban areas. The corridor and the region are particularly susceptible to capacity and level of service constraints at the river crossings for both highway and rail. These few crossings are critical to integrated functioning of the region, the two states, the West Coast, and the nation.

Table 1-1. Number of River Crossings in Selected U.S. Metropolitan Areas of Similar Size

Metro Area	Population[a]	Body of Water	Highway Crossings	Rail Crossings
Norfolk	1.57 million	Hampton Roads/ Chesapeake Bay	4	0
Cincinnati	1.65 million	Ohio River	7	2
Kansas City	1.78 million	Missouri River	10	3
Portland-Vancouver	**1.95 million**	**Columbia River**	**2**	**1**
Pittsburgh	2.36 million	Three Rivers	>30	3
St. Louis	2.60 million	Mississippi River	8	2

[a] *Oregon Department of Transportation, 2003 Regional Economic Effects of the I-5 Corridor/Columbia River Crossing Transportation Choke Points.*

The future health and performance of the proposed CRC facilities have important consequences for increasing or decreasing production costs, shrinking or growing labor pools, and reducing or increasing access to business inputs and markets. Continuing to function as subregions would be highly inefficient and would substantially detract from the future economic potential for both sides of the Columbia River, including the region and both states. This beneficial aspect also is extremely important to the region.

Beyond the region itself, I-5 and the CRC are critical links in the overall West Coast and national transportation systems. Previous studies and research have documented the importance of the CRC and the I-5 corridor to the national and West Coast multimodal transportation system.

1.3 Purpose and Need for the I-5 Columbia River Crossing Project

One of the first and most important steps of any major project is to define why the project has been initiated and what problem(s) it seeks to address. The purpose and need statement provides this definition for projects complying with the National Environmental Policy Act (NEPA), and serves as the basis for how project alternatives will be developed and evaluated. A reasonable alternative must address the needs specified in the purpose and need statement for the alternative to be considered in an EIS. The purpose and need statement, developed by the lead agencies, project sponsors, and CRC Task Force, is provided below.

1.3.1 Project Purpose

The purpose of the proposed action is to improve I-5 corridor mobility by addressing present and future travel demand and mobility needs in the CRC Bridge Influence Area (BIA). The BIA extends from approximately Columbia Boulevard in the south to SR 500 in the north. Relative to the No-Build Alternative, the proposed action is intended to achieve the following objectives: 1) improve travel safety and traffic operations on the I-5 crossing's bridges and associated interchanges; 2) improve connectivity, reliability, travel times, and operations of public transportation modal alternatives in the BIA; 3) improve highway freight mobility and address interstate travel and commerce needs in the BIA; and 4) improve the I-5 river crossing's structural integrity (seismic stability).

1.3.2 Project Need

The specific needs to be addressed by the proposed action include:

- **Growing travel demand and congestion –** Existing travel demand exceeds capacity in the I-5 Columbia River Crossing and associated interchanges. This corridor experiences heavy congestion and delay lasting four to six hours daily during the morning and afternoon peak travel periods and when traffic accidents, vehicle breakdowns, or bridge lifts occur. Due to excess travel demand and congestion in the I-5 bridge corridor, many trips take the longer, alternative I-205 route across the river. Spillover traffic from I-5 onto parallel arterials, such as Martin Luther King Jr. Boulevard and Interstate Avenue, increases local congestion. In 2005, the two crossings carried 280,000 vehicle trips across the Columbia River daily. Daily traffic demand over the I-5 crossing is projected to increase by more than 35 percent during the next 20 years, with stop-and-go conditions increasing to approximately 15 hours daily if no improvements are made.

- **Impaired freight movement –** I-5 is part of the National Truck Network and the most important freight highway on the West Coast, linking international, national, and regional markets in Canada, Mexico, and the Pacific Rim with destinations throughout the western United States. In the center of the project area, I-5 intersects with the Columbia River's deepwater shipping and barging, as well as two river-level, transcontinental rail lines. The I-5 crossing provides direct and important highway connections to the Port of Vancouver and Port of Portland facilities located on the Columbia River, as well as the majority of the area's freight consolidation facilities and distribution terminals. Freight volumes moved by truck to and from the area are projected to more than double over the next 25 years. Vehicle-hours of delay on truck routes in the Portland-Vancouver area are projected to increase by more than 90 percent over the next 20 years. Growing demand and congestion will result in increasing delay, costs, and uncertainty for all businesses that rely on this corridor for freight movement.

- **Limited public transportation operation, connectivity, and reliability –** Due to limited public transportation options, a number of transportation markets are not well served. The key transit markets include trips between the Portland Central City and the City of Vancouver and Clark County, trips between north/northeast Portland and the City of Vancouver and Clark County, and trips connecting the City of Vancouver and Clark County with the regional transit system in Oregon. Current congestion in the corridor adversely impacts public transportation service reliability and travel speed. Southbound bus travel times across the bridge currently are up to three times longer during parts of the a.m. peak compared to off-peak. Travel times for public transit using general purpose lanes on I-5 in the BIA are expected to increase substantially by 2030.

- **Safety and vulnerability to incidents –** I-5 river crossings and approach sections experience crash rates more than two times higher than statewide averages for comparable facilities. Incident evaluations generally attribute these crashes to traffic congestion and weaving movements associated with closely spaced interchanges and short merge distances. Without breakdown lanes or shoulders, even minor traffic accidents or stalls cause severe delay or more serious accidents.

- **Substandard bicycle and pedestrian facilities –** The bike/pedestrian lanes on the I-5 Columbia River bridges are about 3.5 to 4 feet wide, narrower than the 10-foot standard, and are located extremely close to traffic lanes, thus impacting safety for pedestrians and bicyclists. Direct pedestrian and bicycle connectivity is poor in the BIA.

- **Seismic vulnerability –** The existing I-5 bridges are located in a seismically active zone. They do not meet current seismic standards and are vulnerable to failure in an earthquake.

This report identifies how the economic benefits analysis relates to each of the key points. A summary of the economic benefits related to the purpose and need includes:

- **Improving travel safety and traffic operations on the I-5 corridor bridges and associated interchanges** – The LPA provides for vastly improved safety and traffic flow throughout the corridor. The FEIS forecasts that collisions will be reduced substantially with the LPA from 210 to 240 per year, compared to an expected 750 per year with the No Build. Hours of congestion per day are substantially reduced, leading to much lower travel time costs due to delay; and vehicle operating costs are reduced due to fewer vehicles operating under congestion and due to lower VMT. In economic terms, this improvement in operations reduces accident costs, vehicle operating costs, and travel time costs.

- **Improving connectivity, reliability, travel times, and operations of public transportation modal alternatives in the bridge influence area –** The LPA improves public transportation and substantially increases the total peak-period throughput of people across the river by nearly one-third in the morning peak from 28,000 to 37,000, and by 40 percent in the evening peak from 29,000 to 41,000, enabling the economy of the region to function more efficiently as a region by vastly increasing the opportunities for businesses and labor regionwide, and by providing much improved multimodal accessibility. Reliability and person throughput for public transportation users are vastly improved by having light-rail service on dedicated rights-of-way for the LPA, compared to buses operating in mixed traffic for the No Build. Because connectivity is so important to the potential for achieving the economic benefits to the economy from agglomeration, this also is a key driver of the economic benefits of the CRC project.

- **Improving highway freight mobility and address interstate travel and commerce needs in the bridge influence area –** According to the FEIS, the LPA reduces the future daily river crossing truck trips operating during congested periods from 5,300 to 2,000, vastly enhancing freight productivity for the region and for the nation. The level of congestion for trucks also is less under the LPA, since both those trucks operating during congested periods and those trucks operating in uncongested travel faster under the LPA than under the No Build. Those trucks shown as operating during a "zero to two hours" so-called congested period in the northbound PM peak with the LPA will actually not experience much delay since overall speeds are very high. The actual reduction of trucks operating in congestion is much greater than 3,300 per day.

- **Improving the crossings' structural integrity (seismic stability) –** The LPA will provide protection against any potentially adverse future seismic events, which could close the current facilities at substantial economic cost, as well as assure a longer life for the river crossing facilities.

2. Economic Role and Context of the CRC

2.1 Introduction

Chapter 2 provides the findings of the previous studies of the economic importance of the strategic I-5 corridor. The information presented here is drawn from the FEIS and from the 2003 report for the Oregon Department of Transportation (ODOT) by Cambridge Systematics, Inc. and David Evans and Associates, Inc., which is titled, *Regional Economic Effects of the I-5 Corridor/Columbia River Crossing Transportation Choke Points*. This report fully documented the economic importance of the corridor and the crossings, and its conclusions remain valid today. Information from other relevant reports is also summarized in this chapter.

The I-5 corridor across the Columbia River connects Portland, Oregon and Vancouver, Washington, along with the remainder of Oregon and Washington. The corridor is also served by the BNSF Railway Company (BNSF) and Union Pacific Railroad (UPRR), the Portland International Airport, Pearson Airfield, and marine terminals. The crossings are of strategic importance to freight transportation and to personal travel in the Portland-Vancouver area, as well as the Pacific Northwest and the nation. However, the ability of the corridor to effectively support freight and people movement to contribute to the regional and national economy is threatened by growing congestion.

The Columbia River highway and rail crossings connect Portland and Vancouver for work, recreation, shopping, and entertainment. They provide critical freight connections to the area's two major ports for deepwater shipping and upriver barges, link its two transcontinental rail lines, and connect much of the region's industrial land.

The crossings are transportation choke points because the Portland-Vancouver area has only two highway bridges and one rail bridge over the Columbia River. Figure 2-1 shows the location of the I-5 and I-205 Columbia River highway bridges and the BNSF rail bridge crossing the Columbia River. Figure 2-2 is an aerial photograph of the I-5/Columbia River highway bridges.

FIGURE 2-1. MAP OF COLUMBIA RIVER CROSSINGS

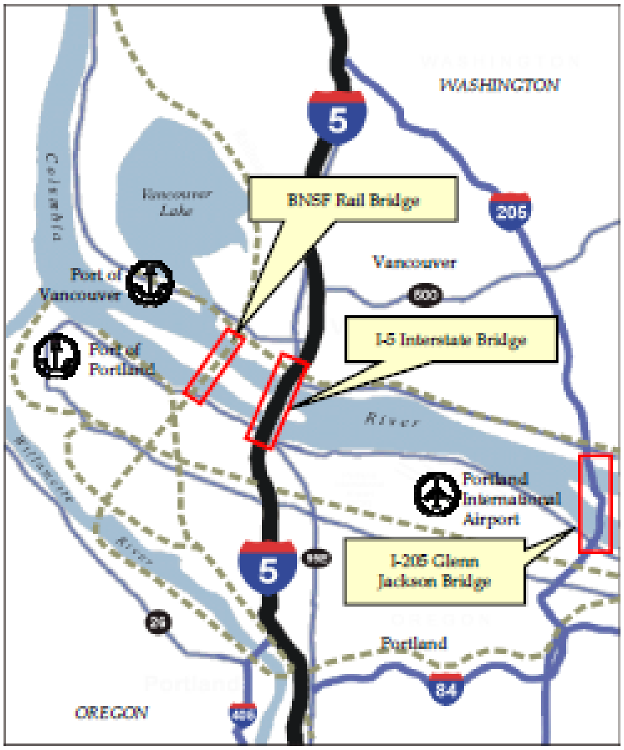
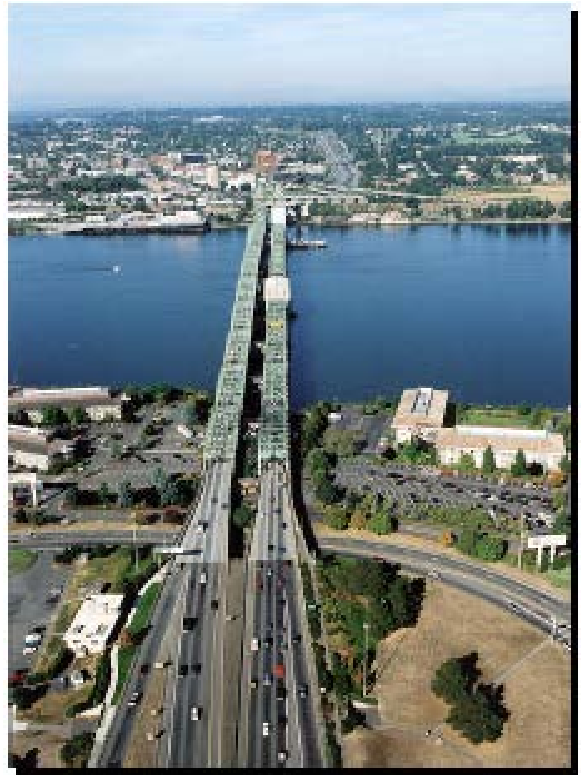


FIGURE 2-2. I-5 BRIDGES



The congestion is caused by limited vehicle throughput capacity on the bridge itself and by the complex traffic patterns on the Oregon and Washington sides of the river:

- The six traffic lanes on the I-5/Columbia River bridges are inadequate for the volume of traffic crossing the river during peak-travel periods.
- Close interchange spacing north and south of the bridge does not allow for adequate merging and weaving sections, effectively reducing the capacity available for through traffic.
- Short entrance and exit ramps force trucks to accelerate and decelerate on the freeway, further slowing traffic.
- The bridge's low-level lift span, one of the last remaining on the national Interstate Highway System, opens for 10 minutes for barge traffic 20 to 30 times per month during daily off-peak periods, closing the highway and bringing traffic to a halt for periods of 30 minutes.

Congestion on I-5 causes diversion of traffic to other roadways in the area, which causes congestion on those facilities. Some drivers heading to the I-5/Columbia River bridges use the arterial roadways paralleling I-5; and during the peak-travel periods, this diverted traffic fills the local north-south streets and jams the interchanges near the bridge, blocking the east-west arterial streets as well.

The Portland-Vancouver rail network and the Columbia River rail crossing are also severely congested. The two-track BNSF rail bridge, adjacent to the I-5/Columbia River bridges, is the only rail crossing connecting Portland and Vancouver. The rail bridge carries 63 freight trains and 10 Amtrak passenger trains across the river each day. The next major rail crossing of the Columbia River is 92 miles upstream near The Dalles, Oregon.

The primary cause of congestion in the rail system is inadequate capacity within the overall Portland-Vancouver terminal and junction “triangle.” On each side of the Columbia River, trains crossing the bridge compete for track space with local and long-distance trains going to rail yards and terminals. Single tracks connect most junctions, and yard capacity is inadequate for the volume of rail traffic traveling to and from rail yards and port terminals in Portland and Vancouver. Local operations – the movement of locomotives and cars between yards and the movement of trains into and out of port and railroad terminals – must share track time and space with long-distance, through trains, including intermodal trains traveling from Seattle and Tacoma to the Midwest and California through the Portland-Vancouver area.

These rail delays affect freight service across the Pacific Northwest; limit opportunities for growth at the Ports of Portland, Vancouver, Kalama, Longview, and other Columbia River ports; and make it difficult to expand intercity passenger service along the Seattle-Portland-Eugene corridor. Access to rail facilities will be enhanced by the LPA for the CRC, but no direct investments are made in freight rail facilities.

Increasing congestion affects not only the Portland-Vancouver crossings, but also affects businesses and communities across the entire Pacific Northwest region, leading to impacts nationally. Businesses realize these costs as increased shipping and production costs; shrinking and more expensive access to labor; and reduced competitiveness in regional, national, and global markets. This creates long-term costs to the region’s competitiveness and economic viability. Trade and freight traffic, upon which the economies of the Pacific Northwest and the nation are dependent, funnels through the Portland-Vancouver crossings.

Within the transportation-intensive sectors, five specific freight-intensive industries are especially sensitive to the Portland-Vancouver highway and rail choke points. These industries are:

- Lumber, wood, and paper products;
- Transportation equipment manufacturing and steel;
- Farm and food products;
- High technology (electronics and scientific instruments); and
- Distribution and wholesale trade.

These freight-intensive industries account for approximately one-quarter of the Oregon-Washington GRP and 20 percent of the states’ employment. Table 2-1 provides a breakout of contribution of these industries to the GRP, and Table 2-2 provides a breakout of employment by industry.

Table 2-1. Contribution to Oregon and Washington GRP of Five Freight-Intensive Industries (in Millions of Current Dollars)

GRP	Oregon	Washington	Total GRP (2009)
Lumber/wood/paper			**5,376**
Forestry, fishing, and related activities	1,336	1,618	2,954
Paper manufacturing	832	1,590	2,422
Farm and food products			**7,979**
Crop and animal production (farms)	1,727	2,576	4,303
Food and beverage and tobacco product manufacturing	1,311	2,365	3,676
Transportation equipment/steel			**11,248**
Motor vehicle, body, trailer, and parts manufacturing	521	308	829
Other transportation equipment manufacturing	331	10,088	10,419
High technology			**26,120**
Computer and electronic product manufacturing	7,867	1,496	9,363
Electrical equipment, appliance, and component manufacturing	194	251	445
Information	2,828	13,484	16,312
Distribution and warehousing			**8,690**
Transportation and warehousing	3,032	5,658	8,690
Water transportation[a]	35	451	486
Totals	**19,979**	**39,434**	
Total as percent of Oregon and Washington GRP	**12%**	**12%**	

[a] *Included in transportation and warehousing industry, extracted to provide specific industry detail.*

Table 2-2. Employment in Five Freight-Intensive Industries

Employment	Oregon	Washington	Total Employment (2009)
Lumber/wood/paper			**83,064**
Forestry and logging	8,650	6,480	15,130
Paper manufacturing	5,566	9,785	15,351
Printing and related support activities	7,072	8,354	15,426
Wood product manufacturing	22,321	14,836	37,157
Farm and food products			**119,033**
Agriculture and forestry support activities	15,846	23,498	39,344
Food manufacturing	24,415	35,522	59,937
Beverage and tobacco product manufacturing	4,062	5,312	9,374
Fishing, hunting, and trapping	3,319	7,059	10,378
Transportation equipment/steel			**10,297**
Motor vehicles, bodies and trailers, and parts manufacturing	4,868	(D)	4,868
Other transportation equipment manufacturing	5,429	(D)	5,429
High technology			**216,712**
Computer and electronic product manufacturing	35,687	20,625	56,312
Electrical equipment and appliance manufacturing	2,384	3,909	6,293
Information	40,046	114,061	154,107
Distribution and warehousing			**173,387**
Transportation and warehousing	62,913	110,474	173,387
Water transportation[a]	503	3,693	4,196
Totals	**242,578**	**359,915**	
Total as a percent of Oregon and Washington employment	**11%**	**9%**	

(D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the total.
[a] *Included in transportation and warehousing industry, extracted to provide specific industry detail.*

These state total employment and GRP numbers, Tables 2-1 and 2-2, are updated to reflect new mapping of industry sectors to the North American Industry Classification Code (NAICS), as well as to provide more recent employment and GRP numbers published by the U.S. Bureau of Economic Analysis. There are slight differences in the cross-mapping from the Standard Industry Classification (SIC) to NAICS, so lower-level detailed industries are used to comprise the five freight-intensive industry sectors. Water transportation, although included in the general transportation and warehousing industry sector, is called out specifically in Tables 2-1 and 2-2 to provide further detailed information as to the contribution of the waterways in the Portland-Vancouver region to overall employment and GRP.

These five industries account for approximately 70 percent of the commodity tonnage crossing the I-5 and I-205/Columbia River bridges by large truck[2]; and about 60 percent of the commodity tonnage moving through the Portland-Vancouver rail triangle, as shown in Figures 2-3 and 2-4.

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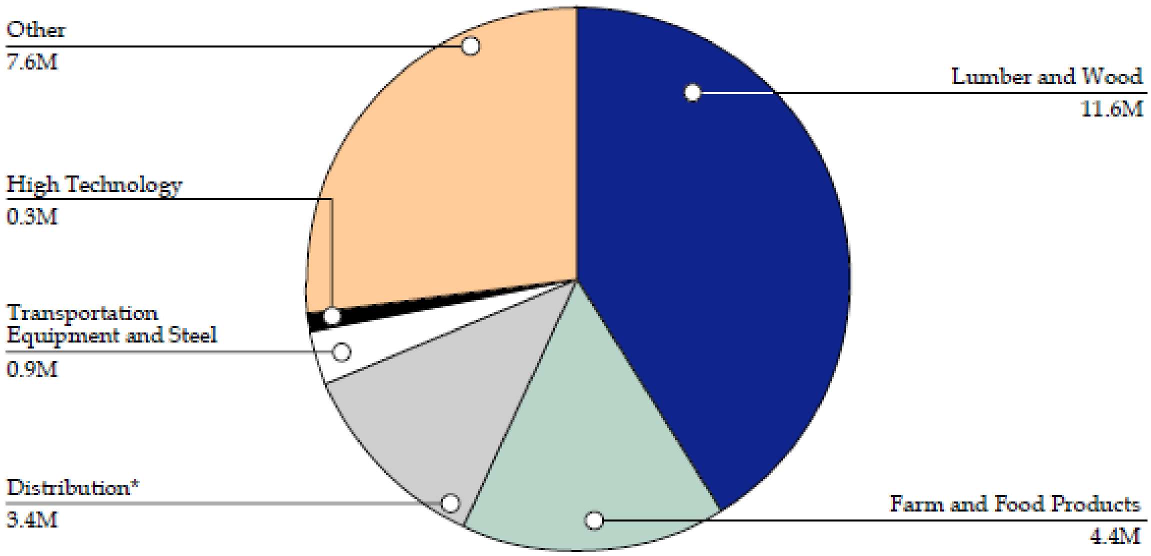
2 The statistics capture primary and long-haul freight moves (e.g., supplier-to-manufacturer, manufacturer-to-distribution center, and most intermodal moves), but do not capture local distribution-to-retail moves and farm-to-processor moves. The long-haul freight moves are typically made in large, over-the-road trucks (e.g., 18-wheel, tractor-semi-trailer trucks or heavy-duty three-axle trucks). The statistics do not capture moves made by smaller trucks and service vehicles. The total of all freight movement by truck will be higher than reported in the figures, but reliable data accounting for all truck moves are not readily available.

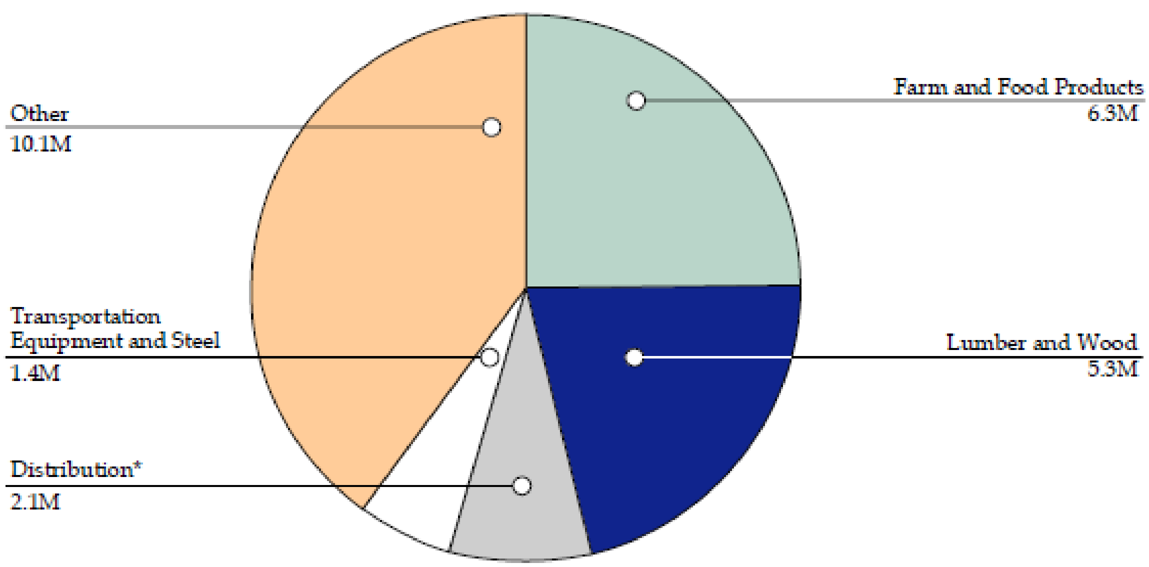
FIGURE 2-3. ANNUAL DISTRIBUTION OF FREIGHT TONNAGE CROSSING THE I-5 AND I-205/ COLUMBIA RIVER BRIDGES BY INDUSTRY



* Distribution (or "Miscellaneous Shipments") includes most intermodal shipments.

Source: 2003 CS report.

FIGURE 2-4. ANNUAL DISTRIBUTION OF FREIGHT TONNAGE USING THE PORTLAND-VANCOUVER RAIL TRIANGLE BY INDUSTRY



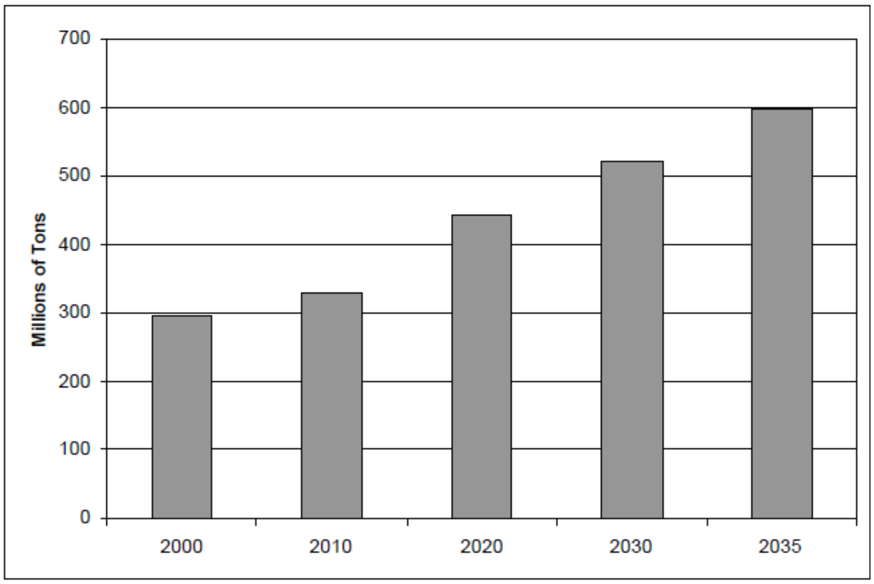
* Distribution (or "Miscellaneous Shipments") includes most intermodal shipments.

Source: 2003 CS report.

2.2 The Future Local and Regional Economic Context

Total annual tonnage moving through the Ports of Portland and Vancouver will double from approximately 300 million tons in 2000 to almost 600 million tons in 2035, as shown in Figure 2-5. This growth has implications for the transportation network as products move to and from the regional marketplace.

FIGURE 2-5. PORTS OF PORTLAND-VANCOUVER PROJECTED COMMODITY GROWTH (IN MILLIONS OF TONS)

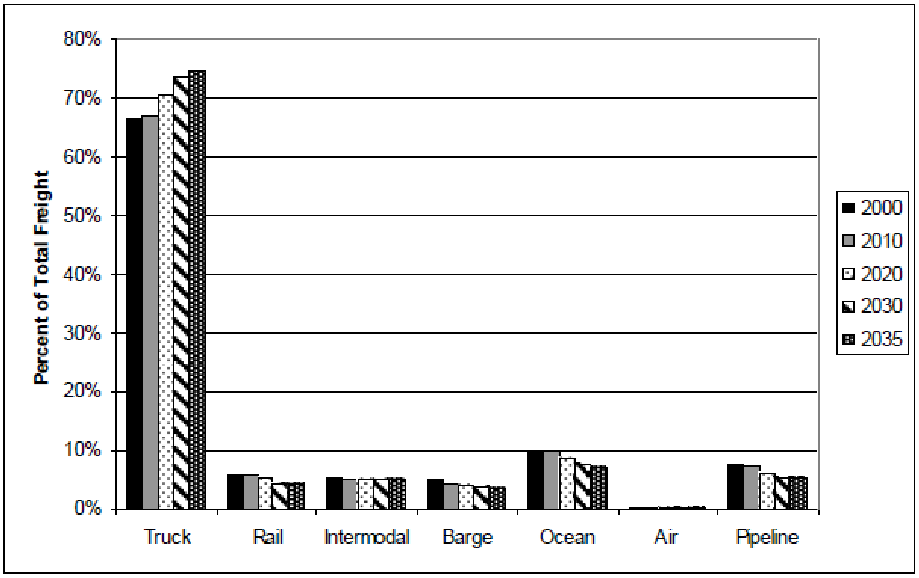


Source: FEIS economics technical report.

To remain competitive with other West Coast ports, efficient and cost-effective multimodal transportation systems must be available. The ability to reduce freight travel times by investing in transportation infrastructure to improve access and reduce congestion can help maintain the region's competitiveness.

Commercial trucks have been and are expected to be the principal mode of moving commodities through the region. Figure 2-6 illustrates the historic and predicted volumes by mode. The projected growth in trucking specifically has implications for the road network, as efficient and safe movements of products to and from the ports are needed to maintain the ports' competitiveness. As such, the increase in truck traffic will compete for highway capacity with an expected increase in passenger travel.

FIGURE 2-6. PORTS OF PORTLAND-VANCOUVER COMMODITY FLOW FORECAST BY MODE



Source: FEIS economics technical report.

2.3 The Future Pacific Northwest and National Economic Context

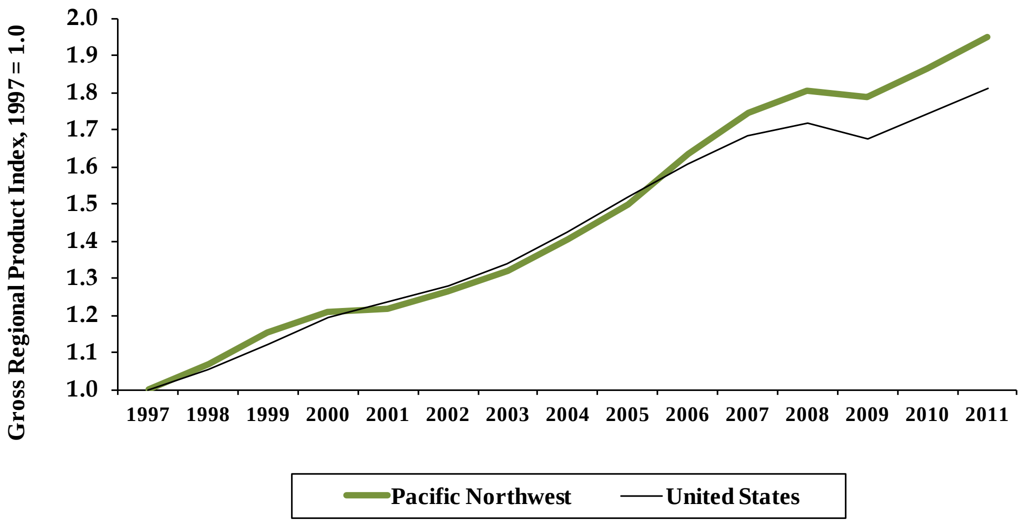
Based on the Cambridge Systematics 2003 Regional Economic Effects of the I-5 Corridor/ Columbia River Crossing Transportation Choke Points report, the Pacific Northwest region has significant potential for economic expansion. Regional economic growth has averaged 3.4 percent per year over the last 20 years, outpacing the United States average in the last decade. Figure 2-7 compares the growth of the Oregon-Washington economy to the United States average. Regional employment also has grown faster than the national average. Despite a recent slowdown in the economy, the economy of the Pacific Northwest is forecast to match or exceed the national average over the next 20 years.

The physical geography of the Pacific Northwest defines the regional transportation system and makes the crossings at Portland-Vancouver strategic regional choke points. Mountain ranges across the region have constrained development of most of the region's highways, rail lines, and large population centers to a narrow corridor running from Vancouver, British Columbia through the Portland-Vancouver area to Eugene, Oregon. Highways and rail lines, which connect the region to the other major North American trade blocs to the east and south, run through difficult mountain passes and the Columbia River Gorge.

The Pacific Northwest is very reliant on international trade. With exports worth $83 billion (2011 value) per year, Oregon and Washington are more dependent on international trade than the United States as a whole.[3]

[3] Census U.S. Exports by Origin State (Origin of Movement Series).

FIGURE 2-7. GROWTH IN OREGON-WASHINGTON GRP AND U.S. GROSS DOMESTIC PRODUCT (GDP)



Source: United States Bureau of Economic Analysis.

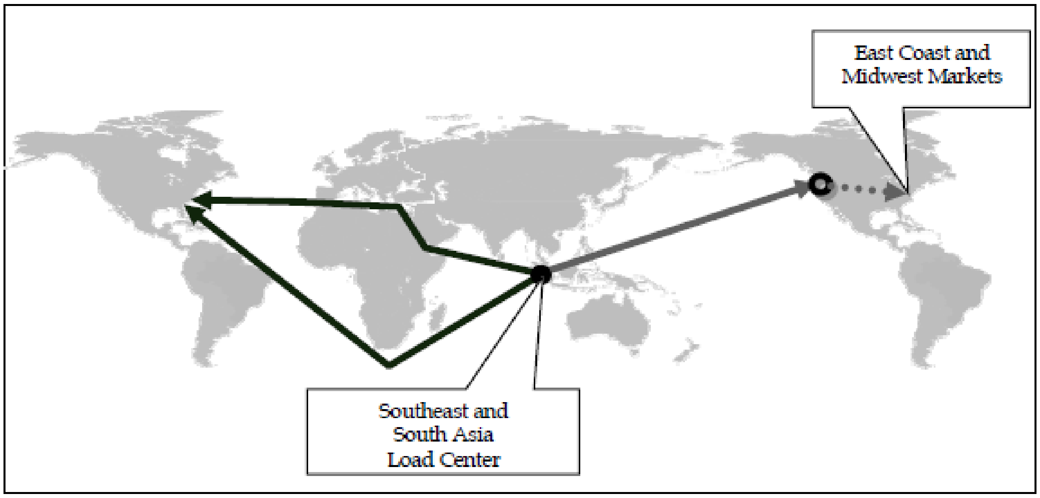
The Portland-Vancouver area's preeminent position as an export region is being undermined by global competition and rising transportation costs. Over one-half of the Pacific Northwest's export trade today is with Pacific Rim countries; much of it is trade in grain that moves through Portland-Vancouver and other Columbia River ports. Grain export sales are particularly sensitive to cost. Differences of a few cents a ton affect buyers' choices among global suppliers.

Highway and rail congestion at the Portland-Vancouver crossings increases the cost and decreases the reliability of export shipments, weakening the competitive position of businesses selling to overseas markets using Pacific Northwest ports. The Ports of Seattle and Tacoma have been major transshipment centers for imported merchandise moving from the Pacific Rim to Midwest and East Coast markets. The Ports of Seattle and Tacoma are important to the I-5 corridor because about one-half of rail shipments originating from Seattle-Tacoma travel south through Portland-Vancouver, and then eastward along one of the Columbia River Gorge rail lines. As the Portland-Vancouver crossings become more congested, the ability of the Ports of Seattle and Tacoma to transship will be restricted, thereby, affecting the ability of the region to compete with other ports for business from the Pacific Rim.

Especially with the anticipated expansion of the Panama Canal, the Pacific Northwest is no longer on the shortest, most cost-effective route from the growing, global load centers of South and Southeast Asia to the major United States Midwest and East Coast markets. Much of the freight traffic upon which the regional economy depends on funnels through the Portland-Vancouver crossings. Thus, congestion at the Columbia River highway and rail crossings affects the entire region. As illustrated in the schematic diagram in Figure 2-8, when the cost of transporting goods by land across the United States is considered, shipping routes via the Cape of Good Hope or the Suez Canal and the Atlantic Ocean are now competitive with Pacific routes. The Pacific Northwest ports will be competing more and more with the ports in New York, New Jersey, and the Southeast United States, as well as the Ports of Los Angeles and Long Beach.

For Oregon and Washington ports to maintain or increase their share of the global merchandise trade, access to and from its ports must be as reliable and as cost effective as possible.

FIGURE 2-8. SHIPPING ROUTES FROM SOUTHEAST AND SOUTH ASIA LOAD CENTERS TO EAST COAST AND MIDWEST MARKETS IN U.S.



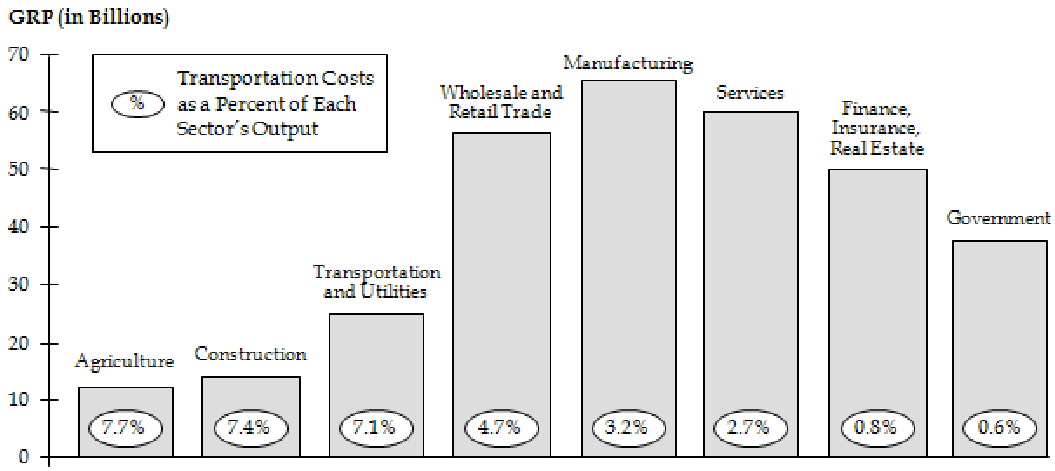
Source: 2003 report.

2.4 Summary of the Economic Context and Conclusions

Transportation underpins the $550 billion (2011 value) of the Oregon and Washington economies and the region's five million jobs.[4] In a trade capacity analysis (Global Insight et al., 2006), the forecasts show an increase in commodities to be transported by truck in the Portland-Vancouver region from 197.2 million tons in 2000 to 390.0 million tons in 2030; nearly doubling in 30 years. Figure 2-9 shows the contribution of each major sector to the GRP of the Oregon-Washington economy.

[4] U.S. Bureau of Economic Analysis.

FIGURE 2-9. OREGON AND WASHINGTON GRP BY INDUSTRY SECTOR



Source: 2003 report

These five freight-intensive industries generate significant economic value, as shown in Table 2-3; and place significant demands on the transportation system. These industries are particularly vulnerable to the delays and decreased travel time reliability resulting from roadway and rail congestion in Portland and Vancouver.

Table 2-3. Five Freight-Intensive Industry Employment in Oregon and Washington

Employment	Total Oregon and Washington Employment (2009)
Lumber/wood/paper	83,064
Farm and food products	119,033
Transportation equipment/steel	10,297
High technology	216,712
Distribution and warehousing	173,387

Source: U.S. Bureau of Economic Analysis.

2.5 Other Transportation Impacts

Delays at the crossings will impact a wide range of transportation users, including employees commuting to work, customers traveling to stores and business meetings, local and long-distance shippers, local trucks picking up and delivering goods, and trains moving freight to and from ports and intermodal terminals. The costs of delay are passed on to businesses by:

- **Increasing Production Costs –** Congestion leads to higher transportation costs for businesses due to delay, unreliable travel times, and increased logistics and inventory costs. Freight carriers must adjust schedules and routes, hire more drivers, and purchase additional vehicles to serve the same customers. Firms must accommodate larger inventories of parts, supplies, and products; causing inventory and operating costs to increase, unless they can find savings elsewhere.

- **Shrinking Labor Pools –** Congestion effectively reduces the geographical area in which potential employees can afford to work (or are willing to work) by increasing the time and cost of commuting. As a region's quality of life deteriorates and the cost of living increases, the area also becomes less attractive to new workers. Business productivity declines as the number of workers with specialized skills decreases.

- **Reducing Access to Business Inputs and Markets –** Congestion shrinks business market areas and reduces the economies of scale that can be realized by operating in large urban areas near concentrations of similar firms or concentrations of competing suppliers.

Each of these implications of delays is reduced substantially by the LPA in comparison to the No Build; and each is addressed in Chapter 5 of this report.

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3. Economic Costs of Congestion and the CRC

3.1 Congestion's Direct Economic Costs

The previous chapter described the CRC's significance to the local, regional, and national economies. This chapter explains those linkages in further detail, focusing on the specific ways that congestion in the I-5 corridor affects the growth potential of local and regional businesses. This section draws on information from the 2005 Report for the Portland Business Alliance by EDRG, which is titled *The Cost of Congestion to the Economy of the Portland Region*.

Congestion affects the economy in two ways: by increasing transportation costs and by shrinking markets. The rest of this section highlights the specific ways these effects are felt by the households and businesses that are dependent on I-5 and the CRC.

Chapters 1 and 2 described the pervasive congestion on the I-5 corridor and CRC. Through additional delay, vehicle costs, and travel time variability, congestion ultimately has the effect of increasing transportation costs to regional households and businesses, as well as to the more distant shippers and receivers of freight movement that rely on the corridor.

3.1.1 Households

Congestion's short-term costs to households are straightforward, adding time and out-of-pocket expenses to personal and commute trips. These expenses translate directly into lost consumer spending in the local service and retail economies. Further, the perceived problem of congestion affects local and regional competitiveness by diminishing quality of life – a factor in attracting a mobile workforce.

3.1.2 Industries

Congestion's cost to businesses varies depending on the type of industry. Although direct expenses such as vehicle operating costs increase production costs in all cases, the 2005 *Cost of Congestion* study highlighted a number of specific ways that businesses endure additional costs when adjusting to delay and travel time variability.

- **Natural Resources and Agriculture –** Chapter 2 identified lumber and farm products as important regional commodities moving on the I-5 corridor. In addition to increasing delivered prices of these commodities, corridor congestion indirectly affects mode choice (truck vs. rail).

- **Transportation and Warehousing, and Distribution –** I-5 congestion affects warehousing and distribution activity in a number of ways. In the short term, delay means more trucks are necessary to achieve delivery schedules; and there is less flexibility in delivery times, reduced route efficiency, and less efficient warehouse operations. Unreliable travel conditions also require greater inventory holdings – not just for the warehouses and distributers, but also for wholesalers and retailers. All of these factors reduce the productive capacity of workers and increase business costs per delivery. Over time, these costs affect the locations of warehouses and distribution hubs – both with respect to regional customers and foreign gateways.

- **Manufacturers** – Although manufacturers represent a broad set of operational types – from paper manufacturing to just-in-time electronics – I-5 congestion translates to increased business costs in some common ways. Peak-period congestion can affect when production shifts start and end, and when deliveries can be made reliably. This extends to shipments coming through the Port of Portland and Portland International Airport. Congestion also increases costs by requiring greater inventories of raw materials and finished products. As with transportation and warehousing, over time these costs affect where firms can locate and expand in relation to intermodal facilities, customers, and suppliers.

- **Services –** In contrast to the business groups listed above, services typically do not transport physical goods. However, they do bear the costs of I-5 congestion because services rely heavily on commuting trips. Independent of labor market access effects (discussed below), additional commuter costs affect worker productivity in ways similar to the manufacturing sector – by forcing workers to arrive at work at non-optimal times (or work from home) to avoid transportation costs. In addition, a number of service sectors rely on on-the-clock travel throughout the day. Health care, information services, education, and business services are all frequent transportation users for business operations. Moreover, this type of travel extends beyond the Portland Metro area, as a number of services – professional, scientific, and technical services in particular – rely on same-day business trips between Portland and Seattle.

3.2 Congestion's Impacts on Market Access and Connectivity

Independent of the traveler costs described above, congestion has the perverse effect of shrinking markets. A host of recent research shows that broader access to production inputs and customers has the effect of increasing productivity and growth.[5]

Market Access refers to the ability of transportation facilities and services to provide households and businesses with access to opportunities that they desire. In the economic development literature, businesses desire access to three basic kinds of markets:

- **Labor Market –** The workforce with required skills that a business can draw from to obtain its employees.

- **Input Material Market –** The sources of specialized materials that a business can acquire (or specialized services that it can use) to produce its output.

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[5] See "The Relationship of Transportation Access and Connectivity to Local Economic Outcomes: A Statistical Analysis" (http://www.edrgroup.com/pdf/Alstadt-Weisbrod-Market%20Access-TRB-2012.pdf). The paper reviews relevant research and summarizes the empirical approach behind the TREDIS Market Access Module. The current discussion draws from this paper.

- **Customer Market –** The buyers whose specific needs can be reasonably and competitively served by a business. (This can include shoppers, tourists, or freight delivery recipients.)

From the viewpoint of households (rather than businesses), transportation can alternatively be viewed as providing workers access to employment and shopping opportunities that match to their skills and needs. Transportation investments can potentially expand any of these forms of market access; and conversely, severe congestion can shrink them.

Connectivity refers to the ease, time, or cost of traveling between different transportation route systems or modal systems. In a strict language sense, "connectivity" represents a form of "access" that is between two systems. However, in practice, it is useful to distinguish market access and connectivity. "Market access" refers to a surrounding area or region comprising the market, and connectivity commonly refers to characteristics of the link to terminals or interchanges.

Congestion in the I-5 corridor and at the CRC affects regional accessibility in three important ways. First, it shrinks the local labor and customer markets for both Portland and Vancouver. Second, the crossing is a critical link in the complicated supply chain between Portland and Seattle. Finally, the link acts as a barrier to greater freight connectivity through Portland International Airport and the Port of Portland.

3.2.1 Local Labor and Customer Market

The CRC is a critical bottleneck that prevents greater integration of the Portland and Vancouver economies. There are two primary markets affected by this bottleneck: the labor market and the local consumer market (retail and services). Both markets tend to operate at scales less than 40-minute drives. Reduced congestion at the crossing would, therefore, have the effect of providing a larger pool of workers for businesses on both sides of the bridge, as well as providing retailers and services larger pools of customers.

Greater scale in these markets allows for greater specialization and matching of workers to businesses, and customers to products and services, which ultimately increases productivity and competitiveness. In addition, greater access between the cities facilitates knowledge spillovers and learning – critical elements of "creative economies."

3.2.2 Regional Supplier Market

Despite the approximately three hours separating them, Portland and Seattle are highly integrated economies. In contrast to the local markets describe above, the integration of the Portland-Seattle economies is via manufacturing and distribution supply chains. Research and business interviews have indicated that fluid supply chains rely on accessibility levels of less than three hours drive time. This is the approximate time that a truck can make a same-day delivery.

Expanding access to suppliers means manufacturers can enjoy better quality or lower-cost suppliers, and input producers enjoy greater market scale. Both these effects translate to more efficient production and greater productivity. With existing congestion levels on the I-5 corridor, many parts of this region lie just beyond the critical market threshold.

3.2.3 Freight Connectivity

Finally, I-5 serves as a feeder facility to a number of key domestic and international gateways. Most relevant to the CRC are the Ports of Portland and Vancouver and Portland International Airport.

Chapter 2 summarized the importance of the marine ports to the Portland economy in terms of commodity throughput. Issues of congestion, as it relates to port access, were also identified by businesses interviewed for the 2005 *Cost of Congestion* study. Shippers cited an increase in container movements through Portland to areas north as an alternative to the Port of Tacoma. However, I-5 congestion was a limiting factor to additional Port of Portland growth. Reduced congestion at all times of day will benefit the Port, and will also benefit the producers and consumers to the north. These producers will have access to larger pools of customers and suppliers through better international connections.

These connectivity benefits also extend to freight movements through Portland International Airport to and from points north. However, in contrast to marine ports, which primarily serve foreign markets, greater connectivity to Portland International Airport opens domestic markets as well. As with marine ports, reduced I-5 congestion will provide businesses better access to input and consumer markets

3.3 Implications for Economic Growth

The costs of congestion – both in terms of greater traveler expense and shrinking markets – have the ultimate effect of reducing Portland competitiveness and opportunities for growth. Higher costs translate to a relative disadvantage for business expansion and location, and less capital for investment. Ultimately, transportation costs percolate through supply chains to higher product prices, reducing the price competitiveness of goods – from California to Portland to Seattle – in domestic and world markets.

4. Transportation Costs and Benefits of the CRC

4.1 Introduction

Chapter 4 provides a description of the transportation costs and benefits of CRC alternatives using tables and graphs. The information available in the FEIS, appendices, and referenced documents are assembled in the context of differences between the regional data associated with the LPA versus the No Build.

Information on a regional multimodal basis are compiled for modal and total travel, total volumes, system performance, modal and total user benefits, modal and total travel times, and modal and total travel costs. Costs, benefits, and performance measures are assembled by mode and for future years, interpolating and extrapolating where necessary, for both the LPA and the No Build. The FEIS includes comprehensive information on costs, benefits, and performance for highway and transit modes. The alternatives have a much smaller impact on the rail system, except for changes in intermodal access. For the marine system, both benefits and costs are expressed in terms of impacts on movements and operations. An overall multimodal summary is compiled for each alternative in this chapter.

The intent of assembling this information is to enable a modal and multimodal travel cost and overall economic benefit analysis with comparison of the differences between the LPA and the No Build. For the No Build, the possibility that one or more of the spans may go out of service during the analysis period also is to be considered qualitatively. Full information similar to the FEIS are not developed on the transportation and economic consequences of a potential loss of one or both of the current spans prior to when replacement facilities are in place. If one or more of the current spans fail, replacement facilities would be implemented on an emergency basis, as was recently done for I-35 in Minnesota.

From the synthesis of the information from the FEIS and related studies, a regional economic impact and modal transportation benefit-cost picture are developed for the LPA and for the No Build.

4.1.1 Locally Preferred Alternative (LPA)

The following are the primary transportation improvements included in the LPA:

- The new river crossing over the Columbia River and the I-5 highway improvements, including improvements to seven interchanges, north and south of the river, as well as related enhancements to the local street network;
- Extension of light rail from the Expo Center in Portland to Clark College in Vancouver and associated transit improvements, including transit stations, park and

rides, bus route changes, and expansion of a light-rail transit (LRT) maintenance facility;

- Bicycle and pedestrian improvements throughout the project corridor;
- A toll on motorists using the river crossing; and
- Transportation demand and system management measures to be implemented with the project.

4.1.2 No Build Alternative

The No Build illustrates how transportation and environmental conditions would likely change by the year 2030, if the CRC project is not built. This alternative makes the same assumptions as the Build alternatives regarding population and employment growth through 2030, and also assumes that the same transportation and land use projects in the region would occur as planned. The No Build also includes several major land use changes that are planned within the project area, such as the Riverwest development just south of Evergreen Boulevard and west of I-5; the Columbia West Renaissance project along the western waterfront in downtown Vancouver; and redevelopment of the Jantzen Beach shopping center on Hayden Island.

All traffic and transit projects within or near the CRC project area that are anticipated to be built by 2030 separately from this project are included in the LPA and No Build. In addition, the No Build assumes bridge repair and continuing maintenance costs to the existing bridge, which are not anticipated with the replacement bridge option.

The table below highlights the comparison of the LPA and No Build for each component.

Table 4-1. Comparison of the No Build and LPA

Components	No Build	LPA
Multimodal River Crossing and Highway	Existing	Replacement
Transit Mode[a]	None	Light Rail
Transit Terminus	N/A	Clark College
TDM/TSM Measures[b]	Current Programs	Expanded TDM/TSM programs
I-5 Bridges Toll	None	Standard Rate
Transit Operations	Existing	Efficient (refined)

[a] *Transit mode dictated the location of a maintenance expansion. Bus rapid transit would have entailed expanding a bus maintenance facility in eastern Vancouver. LRT would entail expanding the Ruby Junction Maintenance Facility in Gresham. See Section 2.2.2 of the CRC FEIS Chapter 2.*

[b] *See Section 2.2.5 of the CRC FEIS Chapter 2 for a description of the TSM/TDM measures.*

4.2 Methodology

4.2.1 Highway Methodology and Sources of Data for Average Hours of Delay, Annual Cost of Delay, Total Hours of Congestion, Accident Costs (and Other Information), and VMT Cost Savings

The FEIS provides information on traffic and congestion for the LPA and the No Build. This information was used to identify and estimate the differences in all economic cost measures between the options. Other regional forecasts were used to provide a regional basis and total basis for estimating the impacts of the project options on the net relative changes in regional and total parameters, which are utilized in the TREDIS model.

4.2.1.1 Delay Costs and Hours

Delay costs for the LPA and the No Build were estimated by using the CRC definition of travel under congested conditions (less than 30 mph) to estimate the delay hours that would accrue under each option. For each option, travel over the entire 24-hour weekday period was estimated, with congested hours identified for each direction; and VMT under congestion periods was calculated for each direction. Overall, hours of delay were estimated using delay values per mile for speed reductions from 55 mph to 30 mph. Hours of congestion delay on the corridor were estimated for the LPA and the No Build. The results are estimated at more than 6.2 million fewer hours of weekday delay for the LPA versus the No Build. Delay due to bridge closures also was estimated. This delay results from infrequent bridge closures, but about 500,000 fewer hours per year of bridge closure delay costs will occur with the LPA versus the No Build.

4.2.1.2 Accident Costs

Accident costs were estimated using information both from the FEIS supplemented by TREDIS and the updated 2011 Cambridge Systematics (CS) *Crashes vs. Congestion* report for the American Automobile Association (AAA).

Table 4-2. TREDIS Current Estimates for Accident Costs for Cars and Trucks

Property Damage Only	$3,160
Personal Injury	$83,520
Fatality	$6,000,000

These TREDIS values of accident costs are derived from the following sources: total fatality cost, including both money costs and social value of lost life (lifetime earnings) from *Treatment of the Economic Value of a Statistical Life in Departmental Analysis – 2009 Annual Revision*, U.S. DOT, Memorandum to Modal Administrators, March 18, 2009. The detailed values for injury and property damage are drawn from Blincoe, L., et al., 2002, "*The Economic Cost of Motor Vehicle Crashes, 2000"* (Table 2); and then updated from 2000 dollars to 2008 dollars by the consumer price index (CPI) change, which was 25 percent.

The 2011 CS AAA study "Crashes vs. Congestion" report estimates accident costs as shown in Table 4-3, along with the total estimated regional accident costs in the Portland-Vancouver region.

Table 4-3. 2011 Cambridge Systematics AAA "Crashes vs. Congestion" Report

General Averages	
Fatality (2009 dollars)	$6,000,000
Cost of Injury (2009 dollars)	$126,000
Portland-Vancouver	
Cost of Fatalities (millions)	$720
Cost of Injuries (millions)	$2,015
Total Cost of Crashes (millions)	$2,735

The CS AAA 2011 report did not include property damage-only costs in their estimates as data were inconsistent. However, the property damage resulting from accidents was included in the *Treatment of the Economic Value of a Statistical Life in Departmental Analyses* memoranda by the U.S. DOT in 2008 and 2009, which were used as a basis to determine the Value of Statistical Life (VSL) from motor vehicle traffic crashes. The memorandum indicates:

> *… potential damage associated with accidents includes both the personal disutility of death or injury and a variety of purely economic losses (to both the victims and others), including property damage, traffic delay, lost productivity, and the costs of police, investigation, medical, legal, and insurance services. In general, the benefit of preventing economic losses to society, apart from victims and their families, should also be accounted for in analyses.*

In addition, property damage costs were included as 1 of the 11 cost components estimating the cost of crashes. Since TREDIS is used to estimate the economic impacts of the CRC, the TREDIS accident cost data are used to estimate the cost of accidents, as well as the cost savings from reduced accidents from the LPA as compared to the No Build.

4.2.1.3 VMT and Operating Costs

Using the numbers for the nine-hour VMT from the FEIS, a daily VMT was calculated to provide 2030 daily estimates for the LPA and No Build. First, the nine-hour VMT values are assumed to be during peak hours, and thus assigned to specific AM and PM peak hours to estimate the amount of average daily trips that take place for a given hour of the day. Then the proportion of the peak-hour travel is then applied to get the remaining 15 hours of daily traffic. In other words, the nine-hour peak represents a percentage of travel during the day; in this case, approximately 56 percent, which leaves the remaining percentage of 44 percent to represent the traffic during the rest of the day. There are savings in VMT with the LPA compared to the No Build, which reduces operating costs. Detailed calculations of congestion impacts were done for each hour of the day for the No Build and the LPA. Delay was estimated for each hour of the day for the facility itself. Since the definition of congestion used in the FEIS is when traffic slows to 30 mph or less, this method somewhat underestimated the delay savings from the LPA, since speeds will be better with the LPA during more than the 9-hour period.

In addition, operating costs per mile for autos and trucks are higher under congested conditions than under uncongested conditions, and estimates for these differences are computed for use in TREDIS. These increased costs in congested conditions stem from the additional fuel used during stop-and-go traffic conditions and idling, as well as additional wear and tear on vehicles as more time is spent using them.

The reduction in VMT is used in conjunction with the reduced VMT cost per mile for peak and rest of day (or free-flow) to provide the total cost savings (dollars per mile) provided by the LPA compared to the No Build. The appendix shows the values TREDIS uses in calculating all of these parameters.

4.2.2 Transit Methodology and Sources of Data for Annual Transit Users and Annual Transit Travel Times and Benefits per Passenger

The transit analysis utilizes data from the FEIS transit technical report, as well as default values from the TREDIS model documentation. The key components in measuring the transit improvement differences between the two alternatives were the number of additional transit passengers and the time savings resulting from the transit improvements. Transit trip production in the CRC Transit Corridor would increase 150 percent compared to existing conditions, and 15 percent compared to the 2030 No Build.

Total systemwide transit trips would more than double from existing conditions. As such, the impact of those additional passengers would generate new additional benefits to the region. In order to calculate these newly added benefits, the default values from TREDIS of $21.20 per hour for commute passenger time cost were used to compute the estimated time savings into monetary terms. Given that the average time savings for each passenger differ, a range of possible time savings of three to 28 minutes, depending on originating and destination points, were used to provide an estimate of the benefits attributed to new transit passengers between the two alternatives. The dollar per minute total benefit was calculated based on the minutes saved multiplied by the per minute passenger time cost, and then multiplied by the total number of additional transit passengers for the range of potential benefits of the improved CRC transit corridor. This methodology provides a range from low to high of those annual benefits received by new passengers between the two alternatives.

4.2.3 Marine Methodology and Sources of Data for Marine Cost Savings

The marine industry will benefit from the LPA versus the No Build because of two changes. First, without an “S” curve currently required to navigate the existing I-5 highway bridge and existing downstream railroad bridge, marine travel will be more direct in the vicinity of the I-5 Columbia River Crossings. Second, there will be no bridge closures or rules on bridge closures that limit the times of operations for the vast majority of marine traffic. These benefits assume that all vessels will be able to clear the bridge height. If the bridge is not able to accommodate all vessels, then there are other restrictions other than the times of operations limitations. This topic is being addressed in detail by other CRC analysis.

The elimination of “S” movements is primarily a safety concern rather than an impact on marine operations costs. It is the exceptionally strong skills of Columbia River pilots that determines the safety of marine operations on the entire Columbia River, and the need for those skills remains the same whether or not the “S’ curve is still needed. There will be an operating benefit from not having an “S” curve, but the potential cost savings are not considered significant enough to place a dollar value on.

There will be some potential marine productivity cost savings with the LPA versus the No Build due to the elimination of constraints on when marine vessels can pass through the I-5 crossings. The marine industry has had about 100 years to adapt their business models to closure rules, so it is unlikely that savings would be very large. However, flexibility can lead to some potential savings. Currently, three-fourths of closures occur at night hours versus day hours. If there are no time restrictions, it is assumed that there may be some productivity savings from the ability to traverse the crossings at any time, and therefore that perhaps one-half of the movements

(0.44 movements per 24-hour weekday) would find some savings from switching from the night hours to the day hours. At an estimated in port operating cost of $399 per hour, and with a potential savings of an average of 3 hours for marine vessels able to switch to day from night, the total potential cost savings could be around $137,000 per year (0.44 shifts to day hours times $399 per hour times 3 hours average hours saved by a shift times 260 weekdays).

4.3 Transportation Benefits Documented in the FEIS

4.3.1 Highway

This section presents highway and local transportation performance data, and compares the data among the various alternatives. Highway performance data address I-5 and I-205 and compares travel demands, effects of congestion, traffic service volumes, travel times, and served versus unserved on-ramp volumes for each alternative. Local street performance data address travel demands across major roadways and intersection service levels for each alternative.

4.3.1.1 Daily Traffic Levels

Average weekday traffic across the I-5 crossing in 2030 is expected to be 178,500 vehicles under the LPA scenario, which is lower than the 184,000 daily vehicle trips expected under No Build conditions. Lower traffic would be due to vehicle-trip reductions with the provision of high-capacity transit and because of tolling. I-205 traffic volumes would increase from 210,000 vehicles per day under the No Build conditions to 214,500 vehicles with the LPA. The daily traffic levels under the LPA with highway phasing are expected to be similar to the LPA scenario. The economic analysis focuses on the long term, under which the phasing options result in the same eventual outcomes. Thus, the economic analysis has not dealt with minor phasing differences between the LPA and sub-options of the LPA.

4.3.1.2 Traffic Demand

Vehicles

The growth rates in the Vancouver study area were reviewed with, and agreed upon by, the City of Vancouver staff and were consistent with the adopted Vancouver Central City Vision (VCCV) plan. The agreed-upon growth rates were applied to existing traffic volumes to forecast 2030 background traffic volumes. This resulted in traffic growth of approximately 50 percent in the morning and afternoon/evening peak periods over the 25-year period.

Demands on I-5

Traffic demand forecasts of the No Build and LPA scenarios are similar throughout the corridor. In some sections of I-5, the No Build has higher demands, while in others the LPA scenario has higher demands.

- **Southbound I-5 AM Peak (2030) –** North of the Interstate Bridge, the LPA would result in increased southbound vehicle demand relative to the No Build during the four-hour morning peak. In the vicinity of the SR 500 interchange, the LPA is forecast to have a four-hour volume of 6,000 vehicles (24 percent) higher than the No Build. Much of the travel demand volume increase can be attributed to the additional capacity of I-5 in this location; the additional capacity results in lesser traffic diversion to Main Street and other local streets in Vancouver. At the Interstate Bridge, the LPA traffic demand is only about 900 vehicles (3 percent) higher than the No Build traffic demand. South of the Interstate Bridge, traffic demand volumes between the LPA and No Build are nearly the same. For example, south of the Victory Boulevard interchange, the traffic demand for the LPA is about 800 vehicles (6 percent) higher than the No Build. South of the Going Street interchange, the traffic demand for the LPA is about 300 vehicles (1 percent) higher than the No Build.

- **Northbound I-5 AM Peak (2030) –** Throughout the project corridor, northbound I-5 traffic demand is forecast to decrease during the morning peak compared with the No Build. Crossing the Interstate Bridge, northbound traffic demand for the LPA is forecast to be lower by 1,800 vehicles (10 percent) than the No Build during the four-hour morning peak. These decreases relative to the No Build can be attributed to the increased transit use in the corridor and the imposition of tolls with the LPA scenario.

- **Southbound I-5 PM Peak (2030) –** In the vicinity of SR 500, for example, the forecast for the LPA is about 800 vehicles (4 percent) higher than the No Build. Southbound traffic demands across the I-5 bridge during the four-hour afternoon/ evening peak are forecast to be 2,000 vehicles lower (10 percent) for the LPA than the No Build. This can be attributed to higher transit usage and tolls with the LPA.

- **Northbound I-5 PM Peak (2030) –** Through much of north Portland, northbound traffic demand is slightly higher with the LPA than the No Build. At the Interstate Bridge, the traffic demand for the LPA is forecast to be about 2,600 vehicles (nine percent) higher than the No Build. Through much of Vancouver, the traffic demand for the LPA is higher than for the No Build.

Demand on I-205

- **Southbound I-205 AM Peak (2030) –** At most locations along the corridor, the traffic demand for the LPA is about 1,000 vehicles (five percent) lower than the No Build. This reduction can be attributed to the provision of high-capacity transit and tolling on I-5 that are forecast to reduce overall southbound volumes for both I-205 and I-5 during the two-hour morning peak.

- **Northbound I-205 AM Peak (2030) –** The traffic demand for the LPA is higher than the No Build. The traffic demand for the LPA is about 700 vehicles (five percent) higher than the No-Build Alternative in the vicinity of I-84; and about 1,400 vehicles (20 percent) higher than the No Build crossing the Columbia River. The increased volume with the LPA can be attributed to diversion from I-5 to I-205 due to the tolling of I-5, as well as the relatively free-flowing conditions forecast for northbound I-205 during the morning peak.

- **Southbound I-205 PM Peak (2030) –** The southbound afternoon/evening traffic demand for the LPA is generally higher than the No Build. Across the Columbia River, the traffic demand for the LPA is about 1,100 vehicles (10 percent) higher than the No Build. This can be attributed to the free-flowing conditions on southbound I-205 during the afternoon/evening off-peak period and the tolling of I-5.

- **Northbound I-205 PM Peak (2030) –** The traffic demand for the LPA is slightly lower than for the No Build. Along much of the corridor, the LPA is forecast to have volumes of 800 fewer vehicles (about 5 to 10 percent less) than the No Build. Capacity improvements identified under the LPA for I-5, combined with the forecast congestion along I-205, account for the forecast vehicle demand reduction along I-205.

Local Street Performance

Local street congestion is most intense near the I-5 ramps, and is influenced by the travel direction and length of time that I-5 is congested each day.

- **Vancouver –** The west side of I-5 experiences larger volumes than the east side of the highway. The largest northbound and southbound traffic volumes cross Fourth Plain Boulevard and Mill Plain Boulevard/15th Street, two of the major east-west thoroughfares in Vancouver. During the morning peak, volumes are highest southbound as motorists travel to the Vancouver central business district (CBD). Some commuters exit I-5 near Main Street and travel southbound along Vancouver arterials to avoid congestion on I-5. This diverted traffic, combined with local traffic destined for the Vancouver CBD, can overload certain north/south arterials. In general, given the trip attraction rate of the Vancouver CBD, traffic volumes are higher closer to downtown.

  Traffic volumes are highest for eastbound movements near I-5 as vehicles leave downtown during the afternoon/evening. The majority of vehicles exiting I-5 at Mill Plain Boulevard and Fourth Plain Boulevard contribute to the higher eastbound volumes split. I-5 is generally not congested during the northbound afternoon/ evening peak. Free-flow conditions attract motorists from the Vancouver CBD, who access I-5 from Mill Plain Boulevard and Fourth Plain Boulevard, instead of using the north/south Vancouver arterials as in the morning peak. This contributes to a more even distribution of north and southbound volumes along Vancouver arterials during the afternoon/evening peak. Traffic volumes are highest in the heart of downtown, and decrease further north as vehicles turn off arterials to access neighborhoods via local streets.

- **Portland –** Volumes are highest throughout the study area for westbound movements, especially east of I-5. In particular, traffic volumes across Martin Luther King Jr. Boulevard show a strong trend towards westbound movements, as commuters are traveling from eastern parts of the City towards the downtown area. Southbound travel is heavier than northbound and the north/south split widens closer to downtown Portland.

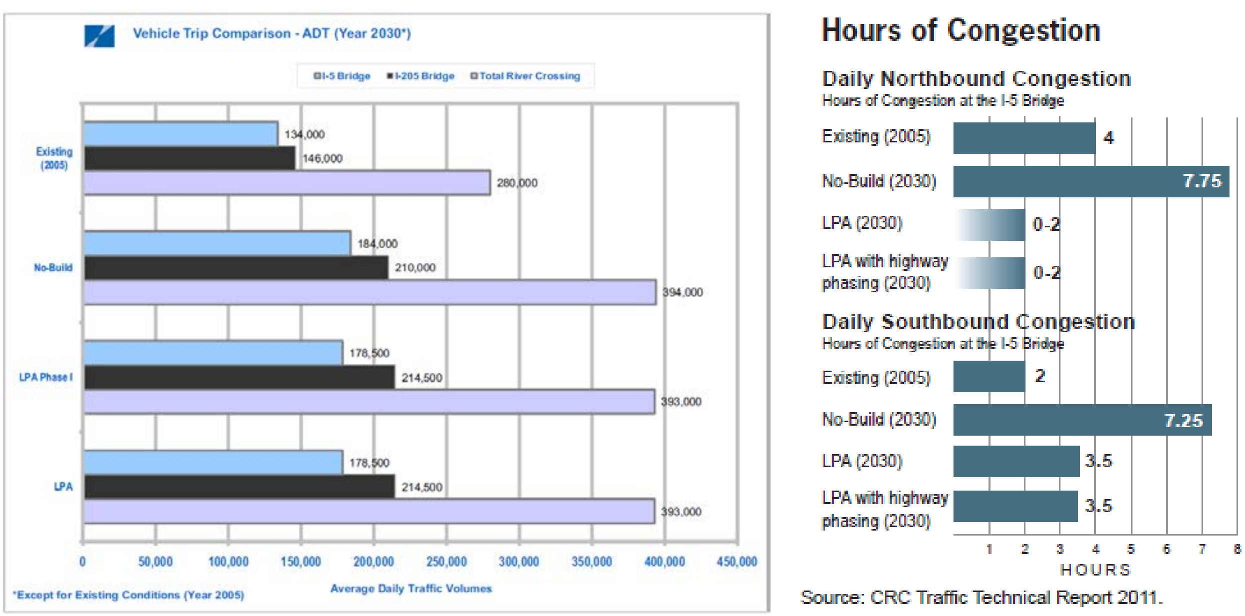
  The widest disparity between eastbound and westbound movements exists across the Interstate Avenue and Martin Luther King Jr. Boulevard screenlines. Northbound traffic is heavier than southbound. Similar to the morning peak, the disparity between northbound and southbound traffic is highest near Alberta Street, and the gap narrows farther north. As motorists leave the arterial network to access neighborhood streets, northbound volumes drop, leading to an almost even split of arterial traffic near the Columbia Slough.

Freight

The replacement river crossing greatly improves freight movement compared to the supplemental river crossing and No Build. The I-5 corridor is the backbone of a network of roads that provide access to the greater Vancouver and Portland region. Trade capacity studies conclude that, while all modes are important, the roadway system links all of the other modes and links land uses critical to business.

The LPA would result in higher volumes of trucks during midday operations compared to the No Build. The reduction in congestion and truck travel occurring throughout the day would mean more flexibility in truck scheduling and improved reliability of truck shipments. The rate of growth for truck traffic over the Interstate Bridge is predicted to be higher than the rate of growth for general purpose traffic (77 percent growth for trucks compared to 32 percent for general purpose traffic), which would result in an increase in the proportion of trucks in the overall traffic stream. Due to their size and maneuverability, large trucks, on average, operate equivalent to 2.5 passenger cars on highways, such as I-5 within the bridge influence area. Therefore, the proportion of highway capacity used by trucks will be greater than it is today.

FIGURE 4-1. VEHICLE TRIP COMPARISON AND HOURS OF CONGESTION (YEAR 2030)



Source: FEIS Traffic Technical Report.

4.3.1.3 Effects of Congestion[6]

Southbound

The LPA would reduce *southbound* congestion on the Interstate Bridge from 7.25 hours under No Build conditions to 3.5 hours. The traffic congestion remaining at the bridge would result because of an existing downstream bottleneck on I-5 just north of the I-405 split. The LPA would not exacerbate or worsen this existing bottleneck, although the CRC improvements would enable an increase in vehicular throughput of about six percent along I-5 just north of the I-405 split. The LPA would reduce *southbound* congestion near the I-405 split from 11 hours under No Build conditions to 8.25 hours. Similarly, the effects of the *southbound* bottleneck located near the I-5 lane drop in the Rose Quarter would remain, with approximately 3.75 hours of congestion.

Northbound

The LPA would eliminate the *northbound* I-5 crossing bottleneck. Northbound traffic queues would no longer extend to I-405 for multiple hours each day. The LPA would reduce the duration of congestion at the I-5 crossing from 7.75 hours to less than 2 hours each. The duration of congestion on northbound I-5 would be similar for the LPA and the LPA with highway phasing options at the Interstate Bridge, near the I-405/Rose Quarter weaving area, and near the Marquam Bridge.

Travel Time

Along I-5

Morning peak travel times are calculated for the *southbound* direction; afternoon/evening peak travel times are calculated for the *northbound* direction. Relative to the No Build, the LPA would result in a one minute (5 percent) decrease in *southbound* I-5 travel time from SR 500 to Columbia Boulevard. For the longer segment from 179th Street to I-84, the LPA is calculated to produce a time savings of eight minutes (17 percent) relative to the No Build.

The bottleneck north of the I-405 split would occur under both the LPA and No Build during the two-hour morning peak, affecting travel times in the corridor. Notwithstanding the downstream bottleneck, the geometric and operational highway improvements in the LPA allow traffic headed *southbound* from Vancouver to Portland to flow more freely. As such, the travel time improvements are much more pronounced in the *northbound* direction during the afternoon/ evening peak period than in the *southbound* direction during the morning peak period, because *northbound* traffic is unaffected by a downstream bottleneck. Relative to the No Build, travel times for the LPA are predicted to improve by 8 minutes (57 percent) from Columbia Boulevard to SR 500 and by 20 minutes (45 percent) from I-84 to 179th Street.

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[6] The numbers of hours during which speeds are less than 30 mph have been summarized for each alternative between 5:00 a.m. and 9:00 p.m.

Along I-205

For the entire 10.2-mile corridor, *southbound* I-205 travel times during the two-hour morning peak are forecast to decrease by two minutes (six percent) from SR 500 to I-84 for the LPA compared to the No Build. The reduction in travel time is attributed to decreased demands along I-205, resulting from a shift of traffic to I-5 due to reduced congestion in that corridor. *Northbound* I-205 travel times from I-84 to SR 500 would remain similar under both the 2030 LPA and 2030 No Build during the two-hour afternoon/evening peak.

The *northbound* and *southbound* travel times along I-5 and I-205 would be similar for the LPA and the LPA with highway phasing options.

4.3.1.4 Service Volumes

Service volumes refer to the total number of vehicles that are actually able to travel through a transportation facility.

Vehicle Throughput (Served Volume) on Southbound I-5

Vehicle throughput near the SR 500 interchange during the four-hour morning peak would increase by almost 7,700 vehicles (35 percent) for the LPA. Although the LPA would serve more traffic volume, it would not serve the entire forecast demand due to a downstream bottleneck located north of the I-405 split. However, the percentage served would be higher than the No Build.

Vehicle Throughput (Served Volume) on Northbound I-5

During the four-hour afternoon/evening peak, *northbound* I-5 vehicle throughput north of I-405 would increase by more than 4,700 vehicles (30 percent) compared to the No Build. Although the vehicle demand would be similar for the two alternatives, the LPA would remove the bottleneck at Interstate Bridge, resulting in improved service volumes for *northbound* I-5. Similarly *northbound* I-5 vehicle throughputs on the Interstate Bridge and near SR 500 would increase substantially over the No Build. The volume served during the four-hour afternoon/ evening peak would increase by 9,100 vehicles (45 percent) and 12,400 vehicles (51 percent), respectively.

4.3.1.5 Person Throughput

Southbound

Under the LPA, in year 2030 about 29,200 persons in southbound vehicles would be expected to use the I-5 crossing during the four-hour morning peak, an increase of 18 percent over No-Build conditions. With the provision of high-capacity transit, up to 7,550 persons under the LPA option are forecast to be using transit during the four-hour morning peak.

Northbound

In year 2030, about 35,300 persons in vehicles would be expected to use the I-5 crossing under the LPA during the four-hour afternoon/evening peak, an increase of 33 percent over the No

Build. With the provision of high-capacity transit, up to 6,100 persons under the LPA are forecast to be using transit during the four-hour afternoon/evening peak.

4.3.1.6 Summary of findings from Analysis and FEIS

The following major direct benefits will accrue from the LPA versus the No Build:

- Savings in auto delays and truck delays;
- Savings in lower accident costs;
- Savings in lower highway vehicle operating costs;
- Savings of 5.75 to 7.75 hours per weekday of northbound corridor congestion;
- Savings of 3.75 hours per weekday of southbound corridor congestion;
- Savings of at least 60 percent for trucks in operating in congestion; and
- Increased peak-period person throughput on the I-5 crossings of about one-third for the southbound AM peak and 40 percent for the northbound PM peak.

4.3.2 Transit

The 2030 No Build is consistent with the service characteristics of the financially constrained transit networks associated with the *2004 Regional Transportation Plan* (Metro) and the *2007 Metropolitan Transportation Plan* (Southwest Washington Regional Transportation Council) *with July 2008 amendments*. The CRC transit corridor includes part of the larger south/north transit corridor serving the Portland metropolitan area, comprising the urban portion of Clark County in Washington;, and Multnomah, Clackamas, and Washington Counties in Oregon.

The LPA would more than double the number of transit passenger trips over the I-5 crossing, compared to the 2030 No Build. For weekdays, there would be approximately 20,600 bridge crossings on transit, compared to approximately 10,200 trips under the 2030 No Build. Of the transit passengers crossing the Columbia River under the LPA, about 18,700 would be on LRT (91 percent) and about 1,900 would be on buses (nine percent).

4.3.2.1 Service Growth

Service growth under the 2030 No Build would be constrained by available revenue sources, consistent with the financially constrained transit network in Oregon Metro's 2004 Regional Transportation Plan. With the 2030 No Build, weekday corridor transit VMT and vehicle hours of travel (VHT) would increase compared to existing levels by 25 and 28 percent, respectively. The greater percentage increase in VHT compared to VMT reflects that trips are anticipated to take longer in the out years due to more background congestion on roadways. The transit place miles (transit capacity in the system) are 2 percent greater with the LPA, as compared to the 2030 No Build, with most of the increase attributed to light-rail vehicles' greater capacity; even though VMT decreases by almost 20 percent.

The LPA includes an approximately 2.9-mile light-rail extension between Expo Center Station in Portland and the Clark College park and ride in Vancouver. In peak periods in 2030, two-car trains would operate every 7.5 minutes in the peak direction. The C-TRAN bus network would provide convenient bus connections to the light-rail line in downtown Vancouver with 15 C-TRAN bus routes serving downtown Vancouver. In addition, express bus service would continue from the suburban park-and-ride lots in Clark County to downtown Portland. The local service buses that connect downtown Vancouver to the Delta Park/Vanport Station in North Portland would be truncated in downtown Vancouver because they would duplicate the new light-rail extension service. The C-TRAN 105 route also would be truncated in downtown Vancouver. Three new park-and-ride lots would be constructed adjacent to the LRT stations in Vancouver.

4.3.2.2 Travel Time

Bus

Travel times were derived using travel demand forecasting model results and field-based data. Travel times for bus routes were derived from the Metro regional travel demand forecasting model (utilizing the software package for auto and transit assignments) for all bus routing not on I-5 and outside of downtown Portland and downtown Vancouver. In downtown Vancouver, bus speeds were projected to be approximately eight miles per hour, based on a VISSIM microsimulation analysis.[7] In downtown Portland, bus speeds were projected to be approximately six miles per hour, based on observed travel speeds.[8] Where buses traveled on I-5, speeds were derived from the VISSIM microsimulation model.

Rail

Transit travel times would be more competitive with automobile travel times with the LPA, despite numerous highway improvements. In many cases, the travel times for transit are shorter than travel times for automobiles. Transit reliability between major origins and destinations is higher due to the availability of LRT that travels in an exclusive guideway.

4.3.2.3 Reliability

In the TriMet system, existing light-rail lines, which generally use reserved or separated right-of-way, exhibit greater percentages of on-time arrivals than buses operating in mixed traffic. For fiscal year (FY) 2007, on-time performance for the TriMet light-rail system was 90 percent, while bus on-time performance was 78 percent.

The 2030 No Build would not provide any LRT passenger miles north of Expo Center Station. The CRC Project would add 2.9 additional miles of LRT right-of-way, which would result in up to 160,000 additional average weekday passenger miles on LRT compared to the 2030 No-Build alternative. Of the average weekday passenger miles within the corridor in 2030, approximately 79 percent (approximately 206,000) would be on light rail with the LPA.

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[7] CRC VISSIM Analysis 2007.

[8] In February 2007, the CRC project staff conducted a travel time survey of buses in downtown Portland. The average downtown Portland travel time was 5.4 miles per hour on the C-TRAN #105 and #134 lines based on 1,137 observations.

4.3.2.4 Summary of Findings from Analysis and FEIS

The data collected provided the annual transit passengers, time savings, and annual new passengers between the two alternatives in forming an estimated benefits ranging between $4 million and $38 million in cost savings as a result of improved transit in the region. The range is dependent upon the varied time savings incurred by transit passengers.

Table 4-4. Transit Findings

	No-Build	LPA
Annual Transit Passengers	3,723,000	7,519,000
	Difference between LPA vs. No-Build	
Annual Time Savings	3-28 minutes	
Annual New Transit Passengers	3,796,000	
Estimated Benefits	$4,099,680-$38,263,680	

4.3.3 Rail

The CRC provides critical freight connections to the area’s two major ports for deepwater shipping and upriver barges, linking two transcontinental rail lines; and connects much of the region’s industrial land. As mentioned previously, the corridor is served by the BNSF and UPRR, and the crossing is critical for freight transportation as goods move from truck and barges onto rail. Since the LPA and No Build do not include improvements to the freight rail, there are benefits as access to the yards become less congested; however, the benefits are minimal.

In addition, the demand for commodity transportation in the Portland/Vancouver region is influenced by several other factors that are exacerbated by the congestion and will affect the region, such as:

- Portland/Vancouver’s unique position on the West Coast, an export dominated port, will continue to shape the outlook for international cargo in the region. Ocean carriers can fill otherwise empty containers back to Asia across the Pacific by serving the exporters shipping through Portland.

- A greater share of domestic production will be sold for domestic consumption in the Pacific Northwest, which will reduce the available production capacity for exports.

- The region’s traditional ties to North Asia, especially Japan, has reduced potential trade growth as those economies have lost out to Southeast Asia and Southern China in share of trans-Pacific trade with the U.S.

The value of commodities shipped to, from, through, and within the Portland/Vancouver region will triple between 1997 and 2030, increasing from $352 billion in 1997 to $824 billion per year in 2030. This increase reflects the increase in demand for commodities, as well as forecast inflation and commodity price changes over 33 years. The value of commodity demand shipped by air will increase most rapidly over the forecast at a compound average annual rate of 4 percent. However, most of total commodity value is transported by truck. The value of trucked commodities demanded will grow at a compound average annual rate of 2.8 percent, increasing the truck share of total commodity value from 79 percent in 1997 to 84 percent by 2030.

Table 4-5 provides rough estimates of the number of trains operated by the Class I railroads and Amtrak on five of the major rail corridors today, and forecasts of the number of trains likely to be operated in 2010 and 2020. The forecasts are based on an extrapolation of train frequency data from I-5 Transportation and Trade Partnership studies.[9]

Table 4-5. Average Trains per Day (Approximation)

Corridor	2001				2010 Estimated Trains	2020 Estimated Trains
	UPRR Trains	BNSF Trains	Amtrak Trains	Total		
Portland-Seattle	38	~35	10	~83	~115	~165
Portland-Willamette Valley	21	~1	8	~30	~45	~65
Columbia Gorge	23	25-30	2	~55	~75	~105
Bend (BNSF)	8	6	0	~14	~20	~25
Klamath Gateway	26	6	2	~34	~45	~65

Source: Cambridge Systematics, Inc., Freight Rail and the Oregon Economy, 2004.

The CRC mainly focuses on improving the I-5 highway and transit facilities, directly alleviating existing and future congestion. However, the ability of the corridor to effectively support freight in order to contribute to the regional and national economy is threatened by the growing congestion on the highway.

4.3.4 Marine

The I-5 bridges extend across Hayden Island crossing two channels that are designated as Federally Navigable Waterways: the main channel of the Columbia River and North Portland Harbor, and the channel on the south side of Hayden Island. The height and alignment of the existing crossings create difficulties for vessels navigating the waterway that require vertical clearance in excess of 40 feet.

[9] I-5 Transportation and Trade Partnership, I-5 Rail Capacity Study data, 2003, as reported in the Portland Regional Rail Infrastructure Reconfiguration Analysis, prepared by DKS and TranSystems Corporation, September 12, 2003. The extrapolations assume a 3.16-percent average annual growth in the number of freight trains, and a 5.71 percent average annual growth rate in the number of Amtrak passenger trains. Numbers for 2010 and 2020 were rounded to the nearest five trains. These are preliminary estimates not based on detailed demand forecasts or analysis of railroad operating plans.

FIGURE 4-1. MARINE AREA OF POTENTIAL IMPACT

Vessels navigating this stretch of the main channel of the Columbia River currently must pass three bridges: the *northbound* and *southbound* structures of the Interstate Bridges and the BNSF Railroad Bridge. The channel routes through the Interstate Bridges that accommodate vessels requiring vertical clearance in excess of 40 feet without opening the lifts do not line up with the BNSF Bridge's swing spans. For vessels requiring a vertical clearance in excess of 40 feet, this route is subject to lift span restriction time periods, which can cause vessel travel delays. The Federal Code of Regulations stipulates that the span need not be raised, Monday through Friday, from 6:30 a.m. to 9:00 a.m. and from 2:30 p.m. to 6:00 p.m.

4.3.4.1 No Build Alternative

North Portland Harbor

The existing North Portland Harbor Bridge has been in service for nearly 23 years and spans over the harbor, carrying I-5. No functional or operational deficiencies have been identified for this bridge. The No Build would involve continued maintenance for this bridge, and would not change the existing navigational clearance envelope or any limitations experienced by vessel traffic today. Under normal conditions, there are no apparent adverse impacts to navigation from the No Build within the harbor.

Catastrophic Event Considerations **–** A catastrophic event could create an adverse impact to navigation. A seismic evaluation has not been performed on the existing North Portland Harbor Bridge. Due to the close proximity of this structure with the Interstate Bridges, it is possible that this structure is also founded on highly liquefiable soils. If this were the case, a major seismic event could liquefy the soils and collapse a span into the navigation channel, disrupting river navigation for an unspecified amount of time.

Columbia River Bridge

The No Build involves continued maintenance and normal operation of the existing I-5 Interstate Bridges. The alternative does not change the navigational restrictions, nor does it adversely affect the current navigational path through the Interstate Bridges and the BNSF Railroad Bridge. Although it does not adversely affect navigational safety, it does not improve the situation either. Travel delays from lift span restriction periods are avoided by vessel pilots choosing to use the barge channel or the alternate barge channel under the Interstate Bridges. These routes require traversing an “S” curve between the Interstate Bridges and the downstream BNSF Railroad Bridge’s swing span. Although there is not a significant accident history for these “S” curve routes, navigation safety is somewhat compromised. The lack of significant accident history is possibly attributed more to the experience of barge pilots than the ease of traversing the route.

Catastrophic Event Considerations **–** Key components of the existing bridges are considered vulnerable to severe damage and/or collapse in a major seismic event. In August 2006, the CRC Project Team convened a panel of seismic bridge design experts to qualitatively assess the vulnerability of the existing Interstate Bridges in a major seismic event. A critical issue discussed was the determination (through geotechnical testing) that the bridges are founded on soil that could liquefy in a major seismic event. This situation would render the existing foundations ineffective in resisting seismic forces.

The No Build, coupled with a major seismic event, could result in the bridges sustaining severe damage (including collapse). If a seismic event were to cause spans to collapse, they could collapse in one or several of the navigation channels and disrupt river navigation for an unspecified amount of time.

4.3.4.2 LPA

The LPA includes a navigation clearance envelope of 300 feet wide by 95 feet high (from the Columbia River datum). This proposed navigational clearance was identified in 2006 by CRC based on a previous survey of river users and airport navigation limits, and it will provide passage for nearly all vessels traveling under the Interstate Bridges during most portions of the year without the use of a lift span. Some river users have stated they require greater clearances. The air traffic clearance limits of Pearson Airfield and Portland International Airport could influence the height of features above the deck of the new bridge.

North Portland Harbor

The existing North Portland Harbor Bridge is proposed to be supplemented by four new bridges: three accommodating ramps connecting with mainline I-5; and a combined, local street, transit, and pedestrian bridge.

The proposed North Portland Harbor navigation vertical clearance envelope will meet or exceed the existing clearance envelope. There are no apparent adverse long-term effects to vertical clearance. Proposed bridge piers are spaced 275 feet apart over the navigation channel and exceeding the current navigation horizontal clearance of 215 feet. For the four proposed bridges, the length in which vessels must navigate through clearance envelopes, under bridges, is a longer distance than the current situation. Considering the predominant vessel type (recreational vessels) and the slow speeds (no wake zone due to nearby floating homes), there are no apparent adverse impacts to navigation from this longer trip through the clearance envelopes. The navigation channel and associated clearances will be improved over the existing condition. There will be no long-term adverse effect to navigation resulting from the I-5 CRC project.

Columbia River Bridge

The potential impact that the bridge soffit elevation has on three vessel groups was evaluated. These groups include tugs and tows (require 60 feet vertical by 300 feet horizontal clearance envelope); high mast sailboats (require 88 feet vertical by 50 feet horizontal clearance envelope); and marine contractors (require 110 feet vertical by 100 feet horizontal clearance envelope).

A new replacement bridge, with a minimum proposed navigation clearance envelope of 300 feet wide by 95 feet high (from 0.00 CRD), provides passage for nearly all vessels traveling under the Interstate Bridges, during most portions of the year. Only marine contractors, which travel this portion of the river infrequently, may have vertical height requirements greater than the available clearance. Interviews with some marine contractors suggest there is a possibility they can disassemble their equipment, at a cost; such that they are able to meet the available vertical clearance. Other marine contractors have said that they cannot dismantle their loads.

Features of the replacement bridge improve navigation safety by:

- **Reducing the number of piers in the water –** The alternative reduces the number of piers (obstacles) in the water from nine to a maximum of six.
- **Simplifying the decision-making process for vessel pilots –** Today, vessel operators have three possible routes under the Interstate Bridges (primary, barge, and alternate barge channels). The proposed fixed span bridge offers one primary navigation channel, which (as stated above) meets the clearance envelope needs of nearly all vessels. Navigation safety will be improved by making the vessel pilot's decision on which path to traverse less dependent on the river elevation at the time.
- **Eliminating the lift span –** Navigation safety is improved by eliminating the dependency on lift span operations and the navigational constraint of lift span restriction periods.
- **Realigning the navigation channel –** Navigation safety is further enhanced by locating the primary navigation channel in better alignment with the downstream BNSF Railroad Bridge swing span than the barge and alternate barge channel routes. Relocating the primary navigation channel to reduce the "S" curve path will improve navigation safety.

4.3.4.3 Summary of Findings from Analysis and FEIS

Based on analysis and data available, barge costs could be reduced by approximately $137,000 per year due to productivity savings from improved bridge alignment. This estimate assumes port delay costs are applied to outbound traffic that is waiting at the port for a window to transit under the bridge. Inbound traffic, however, has to idle in the water if arriving at the wrong time, which could present higher costs as cost estimates for per hour waiting time is higher at sea versus at port. These costs for inbound traffic were not included in the estimate for the marine benefits.

Marine cost savings are estimated based on vessel operating costs for a 50,000-deadweight tonnage vessel published in the National Economic Development Manual for Deep Water Draft Navigation by the U.S. Army Corps of Engineers and the Institute for Water Resources.

4.4 Key Findings

Provide high-level benefits to include differences between LPA and No Build for highway, transit, and marine.

4.4.1 Total Highway Cost Differences

The total highway cost differences include the VMT cost savings, accident cost savings, and delay cost savings between the LPA and the No Build. Not all of these are financial savings, since people do not pay actual dollars for their travel time, but these costs do accrue to travelers. These are shown below in Chapter 5.

4.4.2 Total Transit Benefits

The total benefits from transit improvements to range between $4,099,680 and $38,263,680. The wide range of benefits is due to the large range in minutes saved by transit users based on various originating and destination points.

4.4.3 Total Marine Benefits

Based on analysis and data available, marine costs could be reduced by approximately $137,000 per year due to productivity savings from eliminating the impact of closure restrictions on the flexibility of marine operations.

4.4.4 Discounted Net Traveler Benefits

The time stream of around net $435 million per year in traveler benefits from the LPA will repay all capital investments in around eight years, with net benefits continuing to enrich the region for the remainder of the probable 100-year lifetime of the LPA improvements compared to the No Build.

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5. Overall Economic Costs and Benefits of the CRC

5.1 Economic Impacts from Improved System Efficiency

The role of ground transportation, including trucks, buses, light-rail vehicles, and cars, is a natural element of economic activity; and is becoming more integrated with the vitality of the Portland Metro regional economy and the overall economies of the Pacific Northwest and the nation. A trend towards high value-added products and services has resulted in a greater reliance on trucking, which is the fastest growing mode of transportation in Oregon and Washington, as well as the United States. This dependence highlights the critical need to maintain flow on Oregon and Washington roads to prevent barriers to economic growth. Interstate 5 (and 205) is part of an important trade and transportation corridor that provides not only U.S. regional connectivity, but also links trade from the United States to Canada and Mexico. Any increased congestion along this trade route is expected to have a negative economic impact on all users of the corridor.

This chapter reviews the economic results of the CRC capital investment by comparing the benefits and economic impacts of the LPA against those of the No Build. Business operating costs, household expenses, and access for product delivery markets and labor markets were the basis for estimating these impacts. The results indicate the relative importance the CRC project plays for the development and competitiveness of the economies of Oregon, Washington, and the nation, as well as for the regional economy.

The economic impacts evaluated due to the CRC project come from primarily two sources:

1. **Traveler savings from improved system efficiency impacts –** Cost-saving categories include travel time, schedule variability, and travel distance impacts, which in turn also affect traveler fuel use, safety, cost of living, and business operating expenses. The major benefits in this category come from the vehicle operating cost savings from individuals that switch from car to transit, and from the reduction in congestion costs (due to the highway performance differences and due to modal diversion) for the cars and trucks that remain on the highway system.

2. **Market access impacts –** These effects are beyond the cost of travel that impact the nature of freight delivery markets, logistics, labor markets, and the business productivity of operating in alternative locations.

To capture these impacts, the TREDIS economic modeling tool was applied to estimate the regional and statewide multimodal alternatives. This widely-accepted tool enables analysis of the broader economic impacts of multimodal alternatives (including effects on marine, rail, road, and transit modes and their interactions); and it presents impacts in terms of jobs, income, and economic output growth. For this assignment, TREDIS was calibrated to the economic and transportation conditions of the Portland Metro area, as well as the remainder of Oregon, the remainder of Washington, and the State of California. It provides an estimate of overall impacts on the regional economy, impacts for specific industries, and wider economic benefits, as well as measures of the direct multimodal transportation benefits and costs as viewed from both state and national perspectives.

5.2 Traveler Savings from Improved System Efficiency

The primary passenger benefits are a result of reduced travel time (shown in Table 5-1). The enhanced CRC highway and transit capacity reduces traveler delays and improves travel times, and the improved connectivity of LRT provides an added incentive for commuters and individuals taking personal/recreation trips to switch from car to transit. This modal diversion further reduces the volume of cars on the highway network, allowing drivers that remain on the highway to drive faster and reduce their travel time. The car volume reduction also provides an additional benefit of reducing congestion, and consequently improves reliability for all users of the highway network. The modal diversion from car to transit also has an added benefit of reduced vehicle operating costs.

Table 5-1. Annual Traveler Benefits of the LPA, 2030 (in Millions of 2012 Dollars)

Source	Benefit Type	Portland/ Vancouver Region	Rest of Oregon	Rest of Washington	California	Total
Passenger	Travel Time	$250	No passenger benefits outside Portland-Vancouver Region			$250
	Reliability	$97				$97
	Vehicle Operating Cost	$28				$28
	Tolls & Fares	-$2				-$2
	Safety	$4				$4
	Emissions	$1				$1
Truck Freight	Travel Time	$24	$1	$11	$3	$38
	Reliability	$7	$0	$3	$1	$11
	Vehicle Operating Cost	$6	$0	$3	$1	$10
	Tolls & Fares	$0	$0	$0	$0	$0
	Safety	$0	$0	$0	$0	$0
	Emissions	$0	$0	$0	$0	$1
Total Benefits		**$415**	**$2**	**$16**	**$4**	**$437**

Trucks transporting freight also benefit from the increased performance of the CRC with the LPA; and from the reduced volume of cars on the highway network, which is reflected in the savings gained in travel time and reliability. The truck traveler benefits were allocated to the various regions based on origin and destination patterns between the Portland/Vancouver region and the rest of Oregon, rest of Washington, and the State of California, according to trips and commodity movements between these regions included in the freight analysis framework (FAF). The rest of Washington is the primary beneficiary of the CRC, because it lies north of the project and is within a short trading proximity.

Tolls and fare spending are included to represent the additional cost of crossing the bridge, as well as passenger transit costs (e.g., farebox revenue) which were due to mode switching activities. For both roadways and public transport modes, average toll rates and fares were calculated in the FEIS and remain the same between the No Build and the LPA. No tolls are collected under the No Build. However, diversions to transit from auto generate a minor change in household out-of-pocket expenditure that is accounted for in the TREDIS economic impact analysis. TREDIS shows increases as negative because it presents results as savings from the traveler's perspective.

Quality of life impacts, such as safety and emission benefits, are considered to be nonmonetary, yet are included in the concept of overall "social benefits" and are tied in TREDIS to the overall reduction in VMT.

It should be noted that because TREDIS does not have highway design parameters, the safety benefits shown in Table 5-1 are much lower than the $21 million to $22 million in annual safety benefits estimated in Chapter 4. Using the more design sensitive safety impacts of Chapter 4, these safety benefits would increase by $17 million to $28 million per year, and the total benefits would be increased by these amounts over what is shown in Table 5-1.

Combining all of the benefits categories from Table 5-1 over the 2018 to 2050 time horizon results in a present value of $5.37 billion using a five-percent discount rate, and $7.87 billion PV using a three-percent discount rate (shown inTable 5-2). These compare favorably to the present value of LPA costs, which is roughly $3 B using both 5% and 3% discount rates. The project's discounted net present value is therefore highly positive and its benefit cost ratio is much greater than 1, indicating that the LPA is a desirable investment (versus the no-build scenario).

Table 5-2. Present Value of Traveler Benefits through 2050 (in Millions of 2012 Dollars)

	Portland/ Vancouver Region	Rest of Oregon	Rest of Washington	California	Total
5% discount	$5,101	$23	$202	$50	**$5,376**
3% discount	$7,473	$34	$296	$73	**$7,876**

Traveler savings that accrue to individuals and businesses also result in additional economic activity. A reduction in transportation costs provides the opportunities for individuals to spend these savings in other ways, and businesses are able to expand their output. For all benefits that result in a monetary transaction, additional economic activity will result that is measured in terms of jobs, increases in personal income, value added, and business output. Table 5-3 provides a 2030 snapshot of the economic impact due to traveler savings to each study region, which results in a total of 2,611 jobs; $119 million in wages; and $283 million in additional business output.

Table 5-3. Traveler Savings from LPA Economic Impacts (2030)

Impact Source	Impact Measure	Portland/ Vancouver MPO	Rest of Oregon	Rest of Washington	California	Total
Traveler Savings	Jobs	2,464	16	104	27	**2,611**
	Business Output (in millions of 2012 dollars)	$260	$2	$16	$4	**$283**
	Value Added (in millions of 2012 dollars)	$155	$1	$9	$2	**$167**
	Wage Income (in millions of 2012 dollars)	$111	$1	$6	$2	**$119**

5.3 Economic Impacts from Improved Accessibility and Connectivity

In addition to traveler savings, there are other benefits associated with the CRC project, such as labor and business market access and connectivity. Overall the project provides:

- An expanded labor market on both sides of the CRC;
- An expanded supply chain market between the economic centers in Seattle and Portland; and
- Improved access to intermodal facilities (such as the marine ports of Portland and Vancouver and the Portland International Airport).

Expanded labor markets improve matching employee's skills to businesses needs and reduce commuting costs. The change in the amount of the local population that lives within a 40-minute drive time is a proxy metric for the change in labor market access. With the LPA investment, Multnomah County businesses will have access to roughly 10,000 more workers on the northern side of the river. Conversely, Vancouver businesses will gain access to more than 8,000 more workers south of the river. Together, these gains translate to greater labor force accessibility of the region by about 1.3 percent.

Expanded supply chain markets are beneficial to businesses because it allows a reduction in the number of trucks to facilitate deliveries, expands the number of accessible suppliers, and improves supply chain scheduling and coordination. The change in the amount of employed individuals within a three-hour drive time is a proxy metric for the change in supply chain regional markets. With the LPA investment, Portland's access to employment within three hours will increase by about 54,000 or two percent. Vancouver's gain is slightly larger at 72,000 or about two percent.

Finally, Vancouver and other areas to the north of the river will enjoy greater connectivity to the Port of Portland and Portland International Airport. This connectivity is measured by the average travel time to the facility. The average daily CRC time (peak and off-peak) is estimated to be reduced by about 6.2 minutes. Weighting by origin, access to these facilities from points north improves by about 2.2 percent.

The changes in labor and business market access, as well as improved connections to Portland's air and marine ports, stimulate additional economic activity. Matching employees and their unique skills to employer needs, enhancing supplier connections, supply chain coordination, and overall knowledge sharing are the benefits that result from improved access and connectivity. These benefits are reflected in Table 5-4 below, resulting in nearly 1,700 jobs; $332 million in business output; and $111 million in wages in 2030, with the Portland-Vancouver region receiving the majority of these impacts.

Table 5-4. Market Access and Connectivity LPA Economic Impacts (2030)

Impact Source	Impact Measure	Portland/ Vancouver MPO	Rest of Oregon	Rest of Washington	California	Total
Market Access	Jobs	977	0	691	0	**1,669**
	Business Output (in millions of 2012 dollars)	$148	$0	$184	$0	**$332**
	Value Added (in millions of 2012 dollars)	$84	$0	$86	$0	**$169**
	Wage Income (in millions of 2012 dollars)	$56	$0	$55	$0	**$111**

5.4 Total Economic Impacts

Combining the total economic impacts of the traveler savings and the market access impacts of the LPA results in more than 4,200 annual jobs; $614 million in annual output; and $231 million in annual wages in 2030, as shown in Table 5-5. These impacts are just for 2030 and are not cumulative meaning that these occur every year, growing over time until 2030.

Table 5-5. Total LPA Annual Economic Impacts (2030)

Impact Source	Impact Measure	Portland/ Vancouver MPO	Rest of Oregon	Rest of Washington	California	Total
Total Impacts	Jobs	3,441	16	796	27	**4,280**
	Business Output (mil. $2012)	$407	$2	$200	$4	**$614**
	Value Added (mil. $2012)	$238	$1	$94	$2	**$336**
	Wage Income (mil. $2012)	$167	$1	$61	$2	**$231**

A cross-sectional view of the economic impacts by industry group in Table 5-6 categorizes the industries into freight-intensive and trade and service industries. About 1,200 jobs or about 27 percent of the total annual employment impacts occur in freight-intensive industries with the majority of them in the distribution and warehousing industry. Trade and service industries account for around 3,000 annual jobs or 73 percent of the total impacts, with household services representing the highest employment impacts.

Table 5-6. Total Employment Impacts by Industry (2030)

Industry Type	Industry Group	Portland/ Vancouver Region	Rest of Oregon	Rest of Washington	California	Total
Freight-Intensive Industries	Lumber/Wood/Paper	40	0	32	1	73
	Farm and Food Products	57	0	25	1	82
	Transportation Equipment/Steel	72	2	30	1	105
	High-Tech Manufact./Information	98	3	10	0	112
	Distribution and Warehousing	440	2	300	11	754
	Other Freight-Intensive Industries[a]	71	0	44	1	116
	Total of Freight-Intensive Industries	779	8	440	15	1,243
Trade and Services	Retail Trade	498	1	53	2	553
	Finance/Insurance/Real Estate	269	1	50	2	322
	Business Services	754	2	93	3	852
	Household Services	1,068	3	132	4	1,207
	Government	75	1	28	1	104
	Total of Trade and Services	2,662	7	355	12	3,037
Total – All Industries		**3,441**	**16**	**796**	**27**	**4,280**

[a] *Includes Mining, Utilities, Construction, and Manufacturing sectors not elsewhere described.*

When evaluating GRP (e.g., value added) across industries, the balance significantly shifts with 44 percent of GRP coming from freight-intensive industries and 56 percent coming from trade and service industries, as shown in Table 5-7. This indicates the higher value that jobs in freight-intensive industries provide, which may also be reflected as higher wages.

Table 5-7. Total GRP Impacts by Industry, 2030 (millions $2012)

Industry Type	Industry Group	Portland/ Vancouver MPO	Rest of Oregon	Rest of Washington	California	Total
Freight-Intensive Industries	Lumber/Wood/Paper	$3	$0	$3	$0	$6
	Farm and Food Products	$3	$0	$3	$0	$6
	Transportation Equipment/Steel	$8	$0	$5	$0	$13
	High-Tech Manufact./Information	$19	$0	$3	$0	$23
	Distribution and Warehousing	$43	$0	$37	$1	$81
	Other Freight-Intensive Industries*	$9	$0	$9	$0	$19
	TOTAL of Freight-Intensive Industries	$85	$1	$60	$2	$147
Trade and Services	Retail Trade	$22	$0	$4	$0	$25
	Finance/Insurance/Real Estate	$30	$0	$9	$0	$38
	Business Services	$49	$0	$9	$0	$58
	Household Services	$48	$0	$10	$0	$58
	Government	$6	$0	$3	$0	$9
	TOTAL of Trade and Services	$154	$0	$34	$1	$189
Total – All Industries		**$238**	**$1**	**$94**	**$2**	**$336**

[a] *Includes Mining, Utilities, Construction, and Manufacturing sectors not elsewhere described.*

The discounted present value of the additional gross regional product (GRP) for the Portland region plus the rest of the West Coast with the LPA versus the No Build is highly positive, indicating that the LPA is a very desirable investment. Using a 5% discount rate, the present value of additional GRP through 2050 would be more than $4 billion; with a 3% rate, the present value is more than $6 billion. The impact-to-cost ratio is therefore well greater to 1.0, indicating that the LPA is a highly justified investment in terms of its economic impacts.

Table 5-8 shows that estimating the present value of cumulative GRP impacts over the life of the project from 2018 to 2050 results in $4.13 billion using a five-percent discount rate and $6.06 billion using a three-percent discount rate.

Table 5-8. Present Value of Gross Regional Product (Value Added, in millions) 2018-2050

	Portland/ Vancouver MPO	Rest of Oregon	Rest of Washington	California	Total
5% discount	$2,933	$14	$1,161	$31	**$4,139**
3% discount	$4,297	$20	$1,701	$45	**$6,064**

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6. Technical Appendix

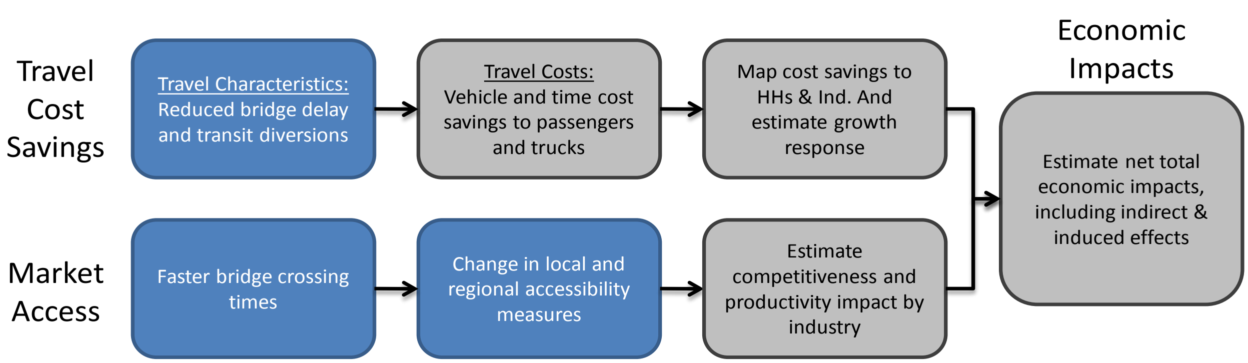
6.1 Economic Impact Methodology

The proposed Columbia River Crossing project improvements are expected to have two primary impacts on the economies of region, the West Coast, and the United States. The first is traveler time and expense savings, which arise where highway, bus, and rail investments provide transit-alternative modes of travel, alleviate congestion, and provide faster travel on the regional highway. Second, service improvements will improve regional access to markets, thereby, improving businesses' ability to find workers, consumers, suppliers, and collaborators – in turn, improving competitiveness and productivity for businesses transporting freight through the corridor.

This section provides an overview of the assumptions and methodology used to estimate the economic impacts from the two sources described above. In all cases, TREDIS was used to calculate the total economic impacts of investing in LPA. TREDIS is a web-based economic impact and benefit-cost analysis tool for transportation projects and programs. It spans all modes of passenger and freight transportation; and is highly detailed in its representation of both freight and passenger costs and benefits, including the value of improving transportation reliability, access, and system connectivity. It is widely recognized for its high level of documentation backed by published research, and its transparency that allows users to trace and follow the calculation of results.

Figure 6-1 shows an overview of how TREDIS is used to estimate the two sources of impacts described above. For each source, the first step (shown in blue) is to use information describing the LPA from Chapter 4 to estimate changes in travel characteristics and market access. These inputs are then entered into TREDIS (grey boxes) to estimate the total economic impacts to the Portland MPO, the remaining sections of Oregon and Washington, and the State of California.

FIGURE 6-1. TREDIS METHODOLOGY OVERVIEW



6.2 Travel Cost Savings

As noted in Chapter 4, travel cost savings arise from a number of sources:

- Faster travel times from greater bridge (and ramp) capacity,
- Elimination of bridge closures, and
- Faster transit (and associated congestion relief from diversions)

This section describes the estimation of economic impacts arising from these traveler savings. As noted in Figure 6-1, the first step is to monetize the time and operating cost savings before passing these cost savings onto households and industries.

6.2.1 Travel Time Savings

Passenger travel time savings is determined based on the total number of passenger-hours saved due to the LPA investment. For transit, this is calculated from ridership estimates and average speed change. For autos, this is based on auto VHT estimates before and after the LPA combined with average vehicle occupancy rates. Truck time savings is based on truck VHT estimates combined with average freight loadings. All vehicle loading assumptions are shown in Table 6-1.

Table 6-1. Average Vehicle Loading Assumptions

Mode	Unit	Value
Auto	Avg. passengers per vehicle	1.5[a]
Truck	Avg. drivers per truck	1
	Avg. tons per truck	13.9[b]

[a] *Source: Estimate for all trip purposes based on 2009 National Household Travel Survey.*
[b] *Source: Estimate based on Freight Analysis Framework (Version 3.3).*

The next step is to monetize the passenger-hour and truck-hour savings based on the per-hour valuations shown in Table 6-2. Note that for truck travel, this is calculated as vehicle hours (VHT) times the total cost per hour of vehicle operation, including the truck driver and opportunity cost of the freight on board. In-vehicle travel times were calculated for peak and off-peak periods on an annual basis (annualized using a factor of 300). Travel growth was estimated at a 1.23-percent per annum growth rate, reflecting the expected traffic growth within the Portland MPO area.

Table 6-2. Value of In-Vehicle Travel Time Savings (2012 Dollars)

Mode	Unit	Value of Time
Passenger (auto and transit)	Cost per passenger-hour	$22.49[a]
Truck	Cost per driver-hour	$26.06[b]
	Cost per ton-hour	$1.59[3]

[a] *Source: TREDIS estimate for all trip purposes based on Bureau of Labor Statistics, U.S. DOT guidance, and National Household Travel Survey.*
[b] *Source: TREDIS based on Bureau of Labor Statistics.*
[C] *Source: TREDIS based on Research by EDR Group.*

6.2.2 Car and Truck Vehicle Operating Cost Savings

Vehicle operating cost savings were calculated by applying per mile cost factors to the changes in VMT between the Build and the LPA. To improve accuracy for peak periods, VMT was separated into two conditions: "congested" and "free-flow" based on a volume/capacity threshold of 90 percent. The value of the operating costs in free-flow and congestion conditions are shown in Table 6-3.

Table 6-3. Per-mile Vehicle Operating Cost (in 2012 Dollars)

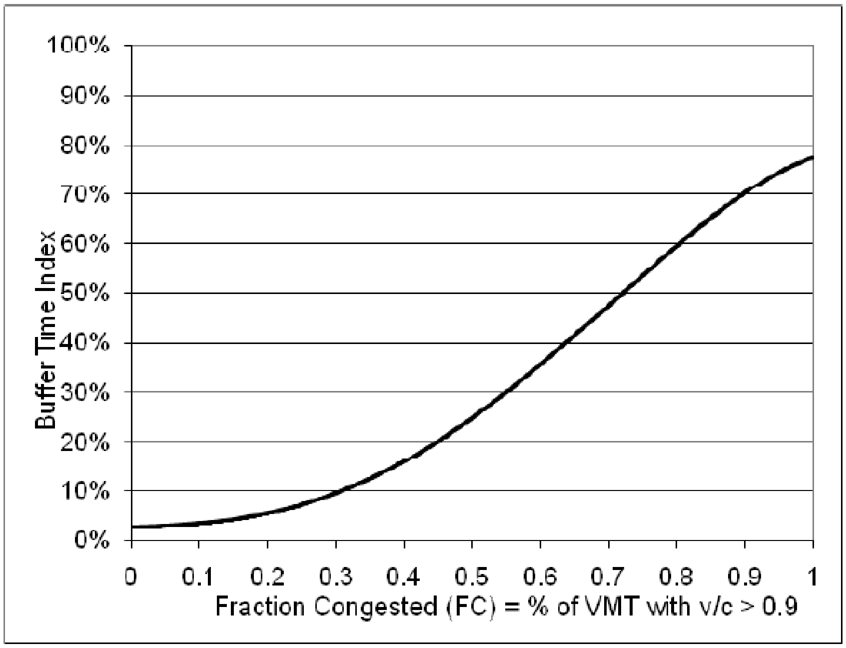
Type	Unit	Detail	Free-Flow Conditions	Congested Conditions
Vehicle Operating Cost	$/vehicle-mi	Car (All Purposes)	$0.42	$0.48
		Truck (Freight)	$1.23	$1.50

6.2.3 Travel Time Reliability

Beyond creating delay and higher vehicle operating costs, congestion has the effect of increasing the variability of travel times. Travel time variability relates to how long it takes to complete the same trip on different days. Consider a morning commute, where a driver makes the same trip roughly 20 times per month. If he or she can make the trip in about 30 minutes almost every day, then that trip is very reliable. If, on the other hand, the same trip sometimes takes 35, 45, or 60 minutes, then the travel time is highly variable, and the driver must budget extra time into his or her commute. As with in-vehicle travel time, this extra "schedule", "float", or "buffer" time has an opportunity cost because it infringes on work and leisure activities. TREDIS estimates the costs of buffer time by multiplying the total number of trips by the average buffer hours per trip and the average cost per hour of buffer time (assumed to be the same as in-vehicle costs per hour)

TREDIS estimates buffer time based on empirical relationships between buffer time and congestion. This relationship is summarized in Figure 6-2. Buffer Time Index (BTI) is defined as the "extra time (or time cushion) that travelers must add to their average travel time when planning trips to ensure on-time arrival." To generalize the concept, BTI is shown as a percent of the total trip time. So if a particular trip on average takes 20 minutes, but has a BTI of 20 percent, a traveler must budget 4 extra minutes to ensure an on-time arrival. Note that the relationship is nonlinear, so that reducing low levels of congestion has little effect on buffer time. But as congestion worsens, travel time becomes more and more unreliable, and so the incremental reduction in congestion has a more pronounced benefit in improving reliability. Estimates of the fraction of travel subject to congestion were based on projected volume/capacity ratios before and after the LPA investment.

FIGURE 6-2. RELATIONSHIP BETWEEN BUFFER TIME AND CONGESTION FOR ROAD MODES



6.2.4 Tolls and Fares

For transit, the FEIS reported an average system-wide transit fare of $0.226 per mile and new daily ridership of 19,600 per day. This results in an annualized ridership figure of 5,880,000, and an average CRC transit fare of about $1.13, based on an average trip length. Thus, increased spending on transit fares was estimate at about $8.1 million ($1.13 x 5,880,000). For the autos, assuming an estimated car occupancy of 1.5, each new transit rider would represent 2/3 of a car being removed from the road. Then, multiplying by diversions yield about 3.9 million fewer CRC crossings by car. At $1.50 per crossing, about $5.9 million is saved on the mode switch. Therefore, the figure reported by TREDIS is about a $2.2 million increase in passenger spending on tolls and fares across the switch (TREDIS shows increases as negative because it presents results as savings from the traveler's perspective).

6.2.5 Emissions

Emission costs were calculated in a way similar to vehicle operating costs, applying per-mile factors to car and truck changes in VMT between the No Build and the LPA. Cost factors are a product of average emission rates and health/environmental costs for the following emissions: nitrogen oxides (NO_x), sulfur dioxide (SO_2), particulate matter (PM), volatile organic compounds (VOC), and carbon dioxide (CO_2).

Table 6-4. Per-Mile Emission Cost Factors (2012 Dollars)

Type	Unit	Detail	Free-Flow Conditions	Congested Conditions
Vehicle Operating Cost	$/vehicle-mile	Car (all purposes)	$0.053	$0.067
		Truck (Freight)	$0.053	$0.067

6.2.6 Safety

Safety benefits were calculated in two steps. First, changes in roadway VMT were used to determine reductions in the number of crashes for three severity types. The average rates used are shown in Table 6-5.

Table 6-5. Average Crash Rates by Mode and Severity

Mode	Fatality Accidents per 100m VMT	Person Injury Accidents per 100m VMT	Property Damage Accidents per 100 m VMT
Car (all purposes)	1.3	79	195
Truck (Freight)	0.3	10.1	167
Transit (Bus and LRT)	0.01	1.02	0

Source: Bureau of Transportation Statistics.

Next, average costs (2012 dollars per crash) [10] were applied to the crash reductions to determine total benefits using the following figures:

- Fatality – $6,297,097 per crash;
- Injury – $87,655 per crash; and
- Property damage – $3,316 per crash.

6.3 Market Access

As discussed in Chapters 3 and 5, an important source of impact from the LPA is due to improved access to markets from both sides of the Columbia River. There are three components to this:

1. For Portland and Vancouver businesses, expanded access to labor markets;
2. Expanded supply chain market between the economic centers in Seattle and Portland; and
3. For Vancouver businesses, improved access to the Port of Portland and the Portland International Airport.

Market access impacts are calculated in two steps. First, changes in travel speeds across the Columbia River were used to estimate changes in access measures used by the TREDIS Market Access Module. The following four measures were used:

- **Access to total population within a 40-minute drive time –** This variable measures "local" market potential, and should capture agglomeration effects related to labor market matching, final good (consumer market) matching, sharing, knowledge spillovers, and competition.
- **Access to total employment within a three-hour drive time –** This variable measures "regional" market potential; and it should capture matching, sharing, knowledge spillover, and competition consequences of industry supplier/delivery

[10] Source: U.S. DOT guidance adjusted for inflation.

markets. The three-hour threshold was chosen because this is the outer limit within which a business can make same-day deliveries (based on industry surveys). Employment was chosen as the potential measure because it is a better proxy for industrial access than population.

- **Access to "major" airport –** This serves as a proxy for interregional and international connectivity, which is an important component of innovation networks, knowledge spillovers, and high-value supply chains.
- **Access to "major" seaport –** This variable measures the population-weighted drive time to any of the 20 most active freight seaports, measured by the tonnage of goods exported per year. It therefore captures one facet of international supply chain access.

Based on expected improvement in average crossing times of 6.2 minutes, Multnomah County businesses will have access to roughly 10,000 more workers on the northern side of the river. Conversely, Vancouver businesses will gain access to more than 8,000 more workers south of the river. Together, these gains translate to greater labor force accessibility of the region by about 1.3 percent.

Similarly, with the LPA investment, Portland's access to employment within three hours will increase by about 54,000 or two percent. Seattle's gain is slightly larger at 72,000 – also about two percent.

Finally, Vancouver and other areas to the north of the river will enjoy greater connectivity to the Port of Portland and Portland International Airport. Weighting by origin population, access to these facilities from points north improves by about 2.2 percent.

These changes in access variables were input into TREDIS, which applies a statistical model to estimate changes in employment density, productivity, and export activity for detailed NAICS industries. The following descriptions are taken from *TREDIS Methodology Technical Document: Market Access Module*.

6.3.1 Model Calibration

TREDIS uses simultaneous equations regression techniques to estimate the contribution of market access measures to economic outcomes for each TREDIS industry. TREDIS combines the four variables discussed above with control variables and other access measures to specify the following three log-linear econometric equations:

Variable	Description
I	Industry index (see Appendix A for industry list)
C	County index (for each of approx. 3,000 Continental U.S. counties)
	Employment in county *c* and industry *i*
	Total Output (sales) in county *c* and industry *i*
	International exports from county *c* in industry *i*
A	Calibration model parameter (constant or control variable)
B	Access concept model parameter (used to estimate scenario impacts)
Γ	Simultaneous equations model parameter (used to calibrate equation system)
	Worker skill level in county *c* (percent of workers with college degree)
	County *c*'s access to population within 40-minute drive[a]
	County *c*'s access to employment within 3-hour (180 minute) drive[a]
	Number of annual operations at County *c*'s closest domestic commercial airport[a]
	Drive time to County *c*'s closest domestic commercial airport[a]
	Drive time to County *c*'s closest intermodal rail terminal[a]
	Drive time to County *c*'s closest "major" marine port[a]
	Drive time to County *c*'s closest "major" international freight airport[a]
	Drive time to County *c*'s closest border to Canada or Mexico[a]

[a] See Section 3.1 for extended variable description.

Note that some of the *dependent variables* (to the left of "=") also appear as *explanatory variables* (to the right of "=") in other equations. This effectively ties the three equations into a system that is estimated "simultaneously", ensuring no double-counting among the three types of outcomes.

Furthermore, note that the market access measures are included simultaneously. Therefore, the effect of each measure is incremental in nature. When it comes to applying the result of this statistical model, we can be sure that there is no double-counting between, say the effect from population access and domestic airport access. Each measure's contribution is in the context of the county's *entire baseline accessibility landscape*.

The system described above was estimated for each TREDIS industry using two-stage least squares (2SLS) with 2007 cross-sectional county data (roughly 3,100 observations).

6.3.2 Results

Using the equations and estimated model coefficients (the α's,β's, and γ's) described above, TREDIS calculates the expected employment density, productivity, and exports for each industry based on the access measure levels for each scenario. Project impacts are estimated by differencing the expected outcomes for two scenarios.

Recall that the system of three equations is estimated for each industry. Therefore, the model's results reflect that particular industry's sensitivity to access measures. Furthermore, note that the model's estimates of employment density, productivity, and exports are dependent on the entire suite of access and control variables for the region. Therefore, even if only a single input variable is changed (say, access to population within 40 minutes), the resulting effects depend on the levels of all the other access measures in the study region, as well as the control variables Population and Worker Skill.

6.4 Economic Impacts

The economic adjustment module estimates the full economic consequences of investment, including all sources of impact: construction and operation spending, market access impacts, and traveler cost savings.

Impacts are calculated in two steps. The first step is to determine each investment's complete "direct" impact on the economy in terms of new output (sales). For market access impacts, the direct impacts are the estimated changes in productive activity resulting from the applied statistical analysis, based on the LPA's expected change in access measures. For travel cost savings, direct impacts are based on household and industry responses to travel cost savings. The second step is concerned with how the direct effects flow through the economy to trigger additional economic activity, including the inter-industry (indirect) supply-chain impacts and wage spending (induced) impacts.

6.4.1 Household and Industry Responses

In order to determine total economic impacts from transport investment, the economic adjustment module translates transport cost savings to direct changes in household consumption (spending) and businesses production. Before this can be done, the travel cost savings described above must first be allocated to each TREDIS region separately:

- Portland/Vancouver MPO
- Rest of Oregon
- Rest of Washington
- California

Passenger travel cost savings were assumed to accrue fully within the Portland/Vancouver MPO. Truck travel cost savings were assigned to the four regions based on productions and attractions of truck trips according to the Freight Analysis Framework (v3.3, 2010).

6.4.2 Households

The primary household response is to reallocate spending patterns away from transportation-related sectors to other sectors. Household demand for transportation is "derived", meaning that households do not inherently demand transportation; rather, transportation is a necessary purchase to engage in work and leisure activities. As such, any reduction in out-of-pocket transportation expenses is re-allocated by TREDIS to other industries based on the existing mix of household spending (minus transportation). The result of this process converts household savings in direct transportation expenses to changes in industry demand, which are then used to determine subsequent indirect and induced effects.

6.4.3 Industry

Industry response to travel cost saving is more complicated than households, because firms generally have a wider set of options on how to "use" the cost savings. TREDIS calculations are based on three possible behavioral responses.

First, firms can retain the savings as profit, and either hold it as cash or distribute it to shareholders. This response is more prominent in industries with large firms with some pricing power – such as banks and communication service providers. Cost savings retained as profits are assumed to generate no downstream economic impact (i.e., are treated as "leakage").

Second, firms can pass the savings on to customers in the form of reduced prices. This response is more prominent in highly competitive industries, such as personal services and construction. The economic impact of this response varies based on the trading characteristics of the industry. If the industry is traded mostly locally (such as dry cleaners), then impacts are small. However, if the industry is traded more widely (as is typical for extraction and manufacturing), then reduced prices have the effect of increasing national and global market share, therefore, generating larger impacts.

Finally, firms can use the savings for investment – to hire more workers, buy more equipment, or conduct research and development. This response has the effect of enabling greater productivity or new product offerings, and is more likely for traded industries and fast-growing industry groups, such as manufacturing, information, and professional and business services.

TREDIS estimates each industry's response to travel cost savings through empirical relationships between industry characteristics and outcomes across all three dimensions. Because each industry reflects a wide variety of firm sizes and covers a broad range of detailed commodity offerings, all three behaviors are estimated for each industry, and the resulting response depends on the combined effect. The result of this process "converts" travel cost savings to increased industry output (sales), which is used to determine follow-on indirect and induced "multiplier" impacts.

6.5 Total Economic Impacts

The final step is to calculate the total economic impacts from all sources. TREDIS uses the IMPLAN model to estimate the indirect and induced effects from each "direct" effect described above. Total economic impacts were estimated separately for the Portland/Vancouver MPO, the rest of Oregon, the Rest of Washington, and California.

- **Indirect effects are due to increased inter-industry demand –** That is, due to industries buying more goods and services (from other industries), given a general increase in business activities; and
- **Induced effects are due to spending of wages in local economies –** That is, given a general increase in business activity, increased employee wages are spent on typical household expenditures, such as retail, restaurants, and services.