Assessment of Anticipated Market Area Served & Commodities to Be Serviced and Likely Destinations

Two factors define the estimate of the market for the MWVIC, specifically the relevant geography and universe of goods. These are then used to develop a quantification of both exports and domestic shipments out of the Mid-Willamette Valley that inform the demand estimation in the next section.

Figure 6: Area within a 5-hour drive of Millersburg and the Port of Seattle

Source: ECONorthwest

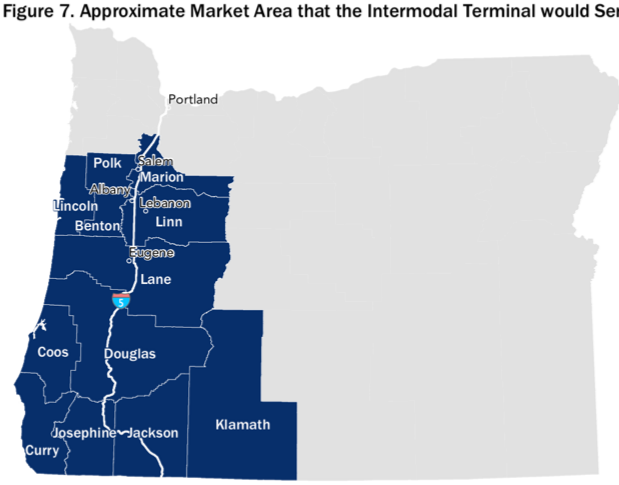
Geography

The literature review and stakeholder interviews indicate that the economic advantage to transferring products from truck to rail are a function of the relative cost of each mode. Furthermore, it is strongly evident that the ability to move products to their final destination within a single "turn" (i.e. local trucking shipment) is a factor in shipping mode. The distance that a truck can travel within a day is used to inform the likely geography of the users of the MWVIC.

Existing regulations require truckers to follow four driving limits at all times:

- Drivers may not work more than 60 hours within 7 days, or 70 hours within 8 days.
- Each workday is limited to a 14-hour "driving window" regardless of what the driver is doing (resting, waiting at a port, etc.)
- Each workday "driving window" limits actual drive time to 11 hours.
- Lastly, drivers must take a 30-minute rest break if 8 consecutive hours have passed since the last off-duty period of at least 30 minutes.

Figure 7. Approximate Market Area that the Intermodal Terminal would Serve



Source: ECONorthwest

These rules impose a discrete distance threshold that determines whether a shipment travels on a local truck or a long-distance truck. Taking an allowance for uncertainty, this threshold occurs at approximately the 5-hour one-way driving mark, displayed in Figure 6.

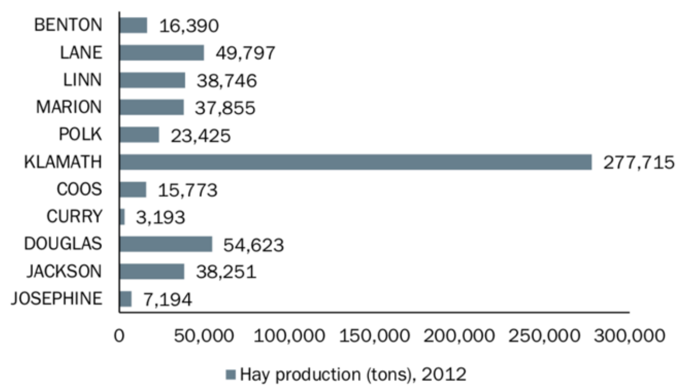
The entire shaded portions indicate the area that is within a 5-hour drive of the MWVIC, while the shaded portion at the southern end represents the subset that is more than a 5-hour drive to the Port of Seattle. Depending on the time of day and resulting congestion patterns, the area within a 5-hour drive to Seattle may be considerably smaller. Upon construction of the MWVIC, shippers in the southern portion of the state will be able to transfer their goods by truck within a single turn and will have the highest likelihood of using the intermodal center. Shippers within a 5- hour drive of Seattle have multiple transportation options and will make decisions based on the relative cost, timeliness, and reliability.

By providing a rail access point in the Mid-Willamette Valley, shippers in the region will be able to make shipping decisions based on the relative price and level of service of long-distance trucking versus short-distance trucking to rail. The increased availability of substitutes will allow shippers to respond to transportation-specific price changes and adjust their production and transportation choices accordingly. Based on this spatial definition, study area is defined as the Willamette Valley from Marion County south, the coast from Lincoln County south, and southwestern Oregon, including Klamath County to the east (see Figure 7 below). Shippers in all other areas in Oregon would likely continue to use existing container terminals in Portland or Boardman, as there does not appear be an economic incentive to divert shipments to the Willamette Valley.

Universe of Products

The Mid-Willamette Valley is considered the "grass seed capital of the world," producing almost two thirds of all U.S. cool-season grasses. Benefitting from fertile soil in the valley, mild winters and dry summers, these seeds for turf and foraging grasses are shipped around the world. In the Willamette Valley, straw is primarily a byproduct of the grass seed industry, harvested and baled after the seeds have been harvested. Most of it is sold to international markets for livestock feed. Hay is produced directly for animal feed and represents a range of varieties. While hay generally has more nutrients than straw, both hay and straw are considered forage and are valuable sources of fiber. Figure 8 shows the tons of hay produced in the study area, by county. Data on straw are not reported. Straw and hay are relatively low-value and low-margin products that are considered to be "backhaul" by the ocean carriers: it is barely more profitable for the ocean carrier to ship these products overseas than it is to ship the containers back empty.

Figure 8. Hay Production by County in Oregon, 2012



Source: ECONorthwest analysis of 2012 U.S. Census of Agriculture
Note: The U.S. Census of Agriculture reports data on hay, including alfalfa, other tame, small grain, and wild varieties, as dry tons. It does not report data on straw production. Data from the analysis of phytosanitary certificates reported by ECONorthwest in 2016 suggests that straw is exported at much higher quantities than hay from the Willamette Valley. See Literature Review for more detail.

In addition to grass seed, hay, and straw, previous research (documented in Section 2 above) and interviews conducted for this study (documented in Section 3) suggest that several other categories of products move out of the Willamette Valley by container, largely for export. A variety of vegetable seeds, including peas, clover, and radish are grown in the Mid-Valley, while pulp products are produced in the southern Valley. Some of the potatoes grown in southern Oregon are produced for export to foreign markets. Other crops produced in the Willamette Valley, such as Christmas trees and greenery, filberts, blueberries, and nursery stock, are primarily grown in the northern Valley, not produced for export, not exported by ocean carrier, or otherwise would not make up a significant portion of the potential products for export from the MWVIC.

Furthermore, analysis of commodity shipment data (described in Section 5.4 below) indicates that lower value, higher volume products are more like to move via rail. Higher value commodities or those subject to more volatile market prices have a higher time-value and are more likely to move by truck, which is generally quicker and more reliable for moving individual containers to their ultimate destinations.

When these agricultural products are shipped in and out of the region, they primarily move via intermodal containers. Broadly, these intermodal containers that flow in and out of the Willamette Valley can be grouped into four categories:

> Exports
> Intermodal containers (20-foot or 40-foot) bound for international markets. Currently, these containers leave the Valley either going north, to the Ports of Seattle and Tacoma, or going south, to ports in California, including Oakland and Long Beach. Based on the stakeholder interviews, a small number of containers bound for international export to Europe may make their way to east coast ports. These containers make their way to seaports via truck or rail where they are loaded onto container ships. Some Willamette Valley containers also make their way directly to Mexico or Canada by truck. Often, containers are hauled into the Willamette Valley empty to facilitate exports.
>
> Imports
> Intermodal containers (20-foot or 40-foot) arriving at ports in Washington and California with goods and raw materials bound for Willamette Valley customers. Currently, these containers are either trucked from their port of arrival or railed to Portland and trucked to their ultimate destination.
>
> Domestic Shipments out of the Valley
> Domestic intermodal containers (53-foot) bound for markets throughout the U.S. These containers are either trucked to their final destinations or are trucked to Portland and loaded onto long-haul trains headed south and east.
>
> Domestic Shipments into the Valley
> Domestic intermodal containers (53-foot) are trucked into the Valley from locations across the nation. They either travel the entire way by truck or arrive at an intermodal terminal via rail in Portland or Seattle where they are picked up and trucked to their ultimate destination in the Valley.

The containers used for domestic and international shipments differ in size, so from a shipping perspective these serve separate markets. However, the intermodal center is expected to handle both domestic and international shipments (lift equipment, for example, can accommodate both types of containers). If shippers are sending domestic and international containers in the same direction (i.e., north to Portland), it is possible that they could be combined on the same north- bound train and sorted out at their destination. Whether this would actually occur depends on many factors independent to the market definition, including how railroads choose to serve the intermodal center.

Quantification of the Market

Two of the above categories of containers that would likely use the MWVIC are quantified and form the basis of the demand analysis: 1) exports, and 2) domestic shipments out of the Valley. Although there are indications that other types of use are likely to occur, shipments out of the valley were highlighted as the highest priority and need during the stakeholder interviews.

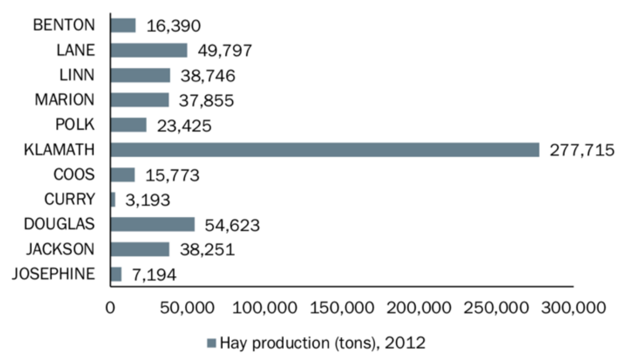
It is likely that loaded containers traveling into the Valley will use the intermodal center and help address container availability; however, these are not included in the quantification of the potential market. A number of the participants in the stakeholder interviews indicated that they pick up empty containers directly from the Ports of Seattle, Tacoma, or Portland. A previous study estimated that the volume of loaded containers entering the valley is between one-third and one-fourth of the number of loaded containers leaving. Thus, the number of containers leaving the Valley serves as the limiting factor in the feasibility of the MWVIC.

It is possible that the MWVIC will serve as a consolidation point for empty containers in the Mid- Valley. A number of consumer product distribution centers are located in the Mid-Valley, including Amazon and Frito Lay near Salem, Lowe's and Target near Albany, and True-Value near Eugene. The MWVIC presents an opportunity to match these importers with agricultural exporters in the region. Any loaded containers entering the valley can potentially reduce overall costs for shippers, however they do not influence the total number of containers passing through the intermodal center.

Estimate of Export Volume

Following the methodology used in the 2016 Feasibility Study, de-identified copies of all phytosanitary certificates issued in Oregon in 2016, 2017, and part of 2018 were obtained from the U.S. Department of Agriculture. These phytosanitary certificates are issued to all agricultural products leaving the U.S. These data were processed using the following steps to identify a subset of records that represents the universe of agricultural products bound for export from the study area.

Figure 8. Hay Production by County in Oregon, 2012



Source: ECONorthwest analysis of 2012 U.S. Census of Agriculture
Note: The U.S. Census of Agriculture reports data on hay, including alfalfa, other tame, small grain, and wild varieties, as dry tons. It does not report data on straw production. Data from the analysis of phytosanitary certificates reported by ECONorthwest in 2016 suggests that straw is exported at much higher quantities than hay from the Willamette Valley. See Literature Review for more detail.

- Records where the mode of transport was ocean vessel were identified, and all other modes of transportation were excluded.
- Records where both the number of containers and other units (e.g., pounds, metric tons, cubic meters, thousand board feet, etc.) were specified on the certificate were used to develop units per container for each commodity type.
- Those units per container were used to estimate the number of containers for records where that number wasn't specified.
- Records associated with the Hood River, Hermiston, and Ontario duty stations were dropped, given that those products were likely outside the geographic study area. Phytosanitary certificates are issued from a number of duty stations in Oregon, and the location of the duty station serves as a reasonable proxy for the location of production and shipment origination. Records from the

Portland duty station were included because it is the location of a specialized grass seed testing lab that handles most of the grass seed certifications for the Willamette Valley.

Based on this analysis, an average of 47,992 export containers left the study area per year. Figure 9 shows the average quarterly shipments for 2016, 2017, and for the first two quarters of 2018.

Estimate of Domestic Shipments out of the Valley

The U. S. Department of Agriculture's National Agricultural Statistics Service (NASS) conducts the Census of Agriculture every five years to generate uniform, comprehensive agricultural data. As of the writing of this report, the most recent Census of Agriculture was conducted in 2017. However, results will not be publicly available until February 2019. Thus, for the purposes of this analysis, the 2012 data is used.

NASS reports a number of measures of agricultural production by county and crop. To estimate the universe of grass seeds that may use the MWVIC, publicly available Census of Agriculture data was limited to grass seed production, by pound, in the study area. These include fescue, orchardgrass, ryegrass, and bentgrass seeds, and a total of approximately 520 million pounds of grass seed produced in the study area. This estimate is broken out by county in Figure 10 below. Using a standard grass seed density58 and 53-foot container volume, this amounts to approximately 12,000 domestic containers per year.

Figure 10: Pounds of Grass Seed Produced, by County

County	Fescue	Orchardgrass	Ryegrass	Bentgrass
Benton	26,538,414	2,088,050	31,767,525	-
Lane	10,052,288	4,021,950	48,963,633	-
Linn	40,018,990	2,474,905	176,186,612	171,740
Marion	42,131,834	-	65,334,230	1,339,138
Polk	31,442,982	658,025	35,439,746	-
Douglas	-	-	1,291,500	-
Jackson	2,600	-	-	-

Source: ECONorthwest analysis of 2012 U.S. Census of Agriculture

Assessment of Market Share in Area to Utilize Facility

Conceptual Model

A number of different data sources are used to estimate the demand for the services provided by the proposed intermodal center. Currently, shippers have two primary alternatives for moving their products from the mid-Willamette Valley to international customers via the ports of Seattle and Tacoma, 1) trucking the product to Portland, after which it makes the remaining journey to a seaport via train, or 2) trucking the product the entire distance to the seaport. The mode-choice decision is determined by many factors including cost, timeliness, and reliability.

Although the MWVIC will produce an additional shipping alternative, it is unlikely to change the existing preference structure for transportation services. That is, preferences for cost, timeliness, and reliability will still be significant factors that determine how shippers choose between the two existing modes and the new intermodal center. The MWVIC will compete directly with existing modes and allow shippers to choose the alternative that provides the best level of service and price. Furthermore, due to the containerization of products, substitution between modes is relatively easy. Since shippers will maintain their underlying preference structure, existing data can be used to project the number of containers likely to pass through the proposed intermodal center.

A sequential process utilizing multiple data sources is outlined in Figure 11 below. Shipping costs by both truck and rail are calculated using observed prices from The Drayage Directory and Surface

Transportation Board Carload Waybill Sample, respectively. These observed costs are used to predict shipping cost for all containers exported from the region in the U.S. Census' Commodity Flow Survey. These inputs are then combined in an econometric model that predicts the mode and site-choice decision for all container shipments in the region. The results of this model are then applied to a scenario representing the new intermodal center to predict the share of containers traveling by rail. This result is then applied to an estimate of the number of containers leaving the region to predict the number of containers using the intermodal center.

Figure 11: Conceptual Model Process

Each step utilizes the best available information to construct an estimate of the projected demand for the proposed intermodal center. Although the spatial resolution at each step is broader than the Mid-Willamette Valley in most cases, the underlying information is transferable to the region. In particular, estimation of latent demand for the proposed intermodal center (where none currently exists) necessitates the use of data from outside of the region. Each element is further described in the following sections.

Costs

The cost to transport loaded containers from the Mid-Willamette Valley to the ports of Seattle and Tacoma are subject to fluctuating market conditions. Various factor inputs affect the absolute and relative prices of both truck and rail including the availability of equipment, labor costs, fuel costs, local congestion, state and federal regulations, etc. A competitive market generally provides trucking services with many players and relatively low barriers to entry. Economic theory suggests that the market price for trucking services will approximately equal the marginal cost of providing those services. Rail services, on the other hand, are provided by two major players (and their subsidiaries), providing the opportunity for price-taking behavior, as well as strategically induced artificial scarcity.

Truck and rail services operate as substitutes for transporting goods between the Mid-Valley and the ports. Thus, the prices of both services are expected to be roughly equivalent, with all other factors (e.g., timeliness and reliability) being equal. Rail, however, gains a structural competitive advantage when transporting large volumes over long distances. Rail service providers operate in a market where they seek to allocate their resources across both short and long-distance transportation optimally. These market forces are apparent when evaluating predicted marginal per-mile container transportation prices.

Figure 12: Drayage Rates Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
Miles	213	54	175	465
Rate	$1,149	$351	$195	$3,850
Rate/Mile	$5.40	$1.10	$1.0	$15

Source: ECONorthwest analysis of The Drayage Directory, May 2014 through June 2018

A cost structure for trucking was generated from a sample of 683 drayage rates from Oregon to Seattle/Tacoma ports obtained from The Drayage Directory61 from May 2014 to June 2018. Prices ranged from $1 to $15 per mile, with an average of $5.4 per mile. Summary statistics are displayed in Figure 12.

A cost structure for rail was generated from the most recent complete version (2016) of the Surface Transportation Board Carload Waybill Sample. This dataset is a "stratified sample of carload waybills for all U.S. rail traffic submitted by those rail carriers terminating 4,500 or more revenue carloads annually."62 The unrestricted public-use version of this dataset partially obscures geographic information to make it impossible to trace individual observations back to shippers. To best represent the market prices faced by shippers in the region, observations were restricted to container rail cars (STB car type "46") with origins and destinations in the western United States (STB "Mountain-Pacific" Freight Rate Territory). This resulted in 95,798 observations, each with an individual sampling weight. Average prices per mile are notably lower than those for trucks, ranging from $0.05 to $27.23 per mile, with an average of $0.71 per mile. Summary statistics are presented in Figure 13.

Figure 13: Carload Waybill Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
Miles	2,064	306	10	3,370
Tons	14.3	7.2	1	31.0
Rail Charge	$1,440	$479	$101	$13,260
Rate/Mile	$0.71	$0.29	$0.05	$27.23

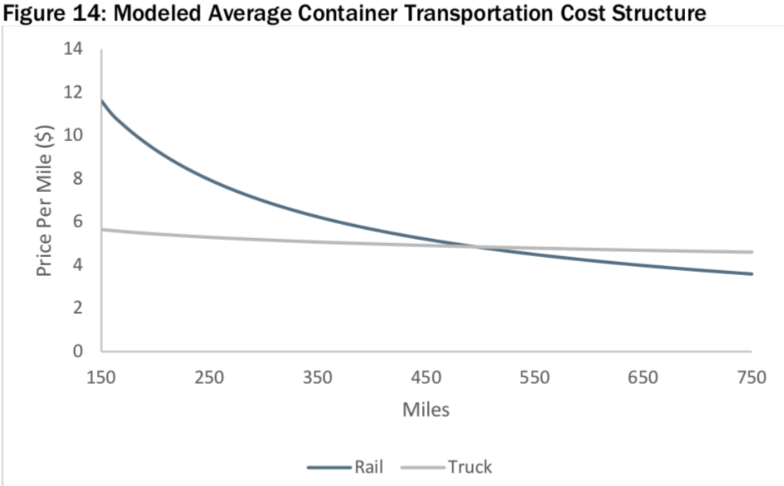
Source: ECONorthwest analysis of STB Public Waybill Sample

To predict the set of truck and rail prices faced for each origin-destination pair in the region, a truncated linear regression model is applied. The general specification is

$$E[Rate_{Mode}|Rate_{Mode} > 0] = (\ln(Miles)\,, \ln(Tons)\,, Quarter)'\beta_i + \varepsilon,$$

where C is distributed normally. The average per-mile price to ship a container by either mode is displayed in Figure 14 below.

Figure 14: Modeled Average Container Transportation Cost Structure



Source: ECONorthwest

Notably, the model predicts that transportation rates via rail are higher than truck for distances under 500 miles. Values in this range are below the minimum distance observed in the waybill sample, making this an out-of-of sample prediction which should not be considered a representation of actual rail prices observed. Rates for transporting containers over this short distance are likely to be competitive with the truck drayage rates, with all other factors being equal (i.e. timeliness, reliability, and availability of service). Although the model may have limited reliability in predicting actual rail prices charged at the intermodal center, this model is a critical input for understanding the mode choice decision for shippers across the full range of available distances in the region. The ultimate estimate of container utilization is predicted via a marginal change in mode price.

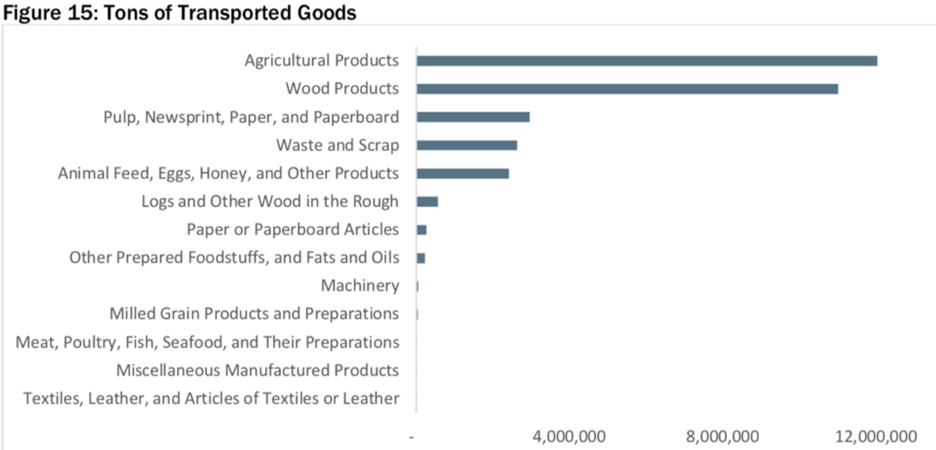
Shipments

The U.S. Census conducts the Commodity Flow Survey63 every five years to measure how products move through, in, and out of the U.S. and can be used to represent the mode and destination choice decision for shippers in the Willamette Valley. It is a broad dataset with a large number of regions, products, and shipping modes. A number of steps are taken to filter the observations down to a set of goods that most closely mirrors those being shipped in the study area. These parameters were chosen to be inclusive of all potential users of the intermodal center in the Mid-Valley, as well as all regional producers that may compete for an equivalent set of container shipping services.

The universe of goods in the 2012 survey were restricted to represent two types of users of the intermodal center: 1) exporters shipping goods via container to west coast ports, and 2) domestic producers of grass seed. The former includes non-hazmat agricultural goods labeled for export to countries other than Canada or Mexico, shipped to port locations on the west coast, and originating in Oregon or Washington. The latter category includes all non-hazmat agricultural goods not labeled for export, shipped anywhere in the United States, and originating in rural areas of Oregon or Washington.

This results in 5,418 observations of a wide diversity of products, summarized in Figure 15 below.

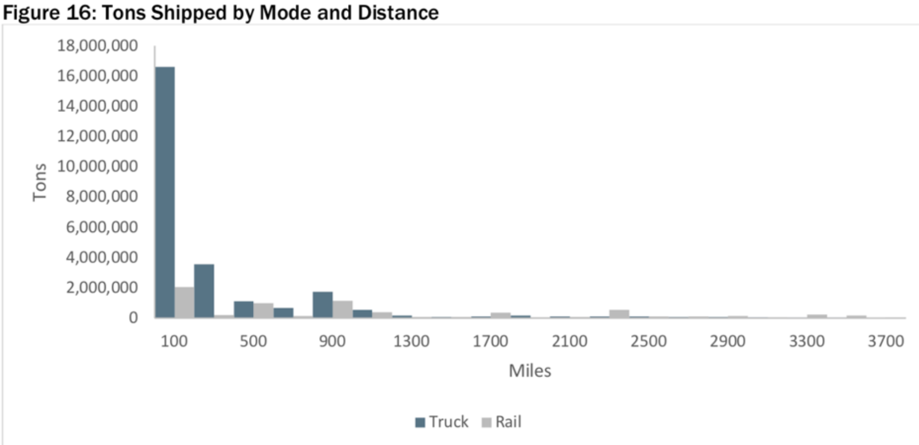
Figure 15: Tons of Transported Goods



Source: ECONorthwest analysis of Commodity Flow Survey

These products were shipped by a mix of rail and truck across a wide distance band. However, over 90 percent of goods travel by truck. The distribution of tons shipped by mode and distance is summarized in Figure 16 below.

Figure 16: Tons Shipped by Mode and Distance



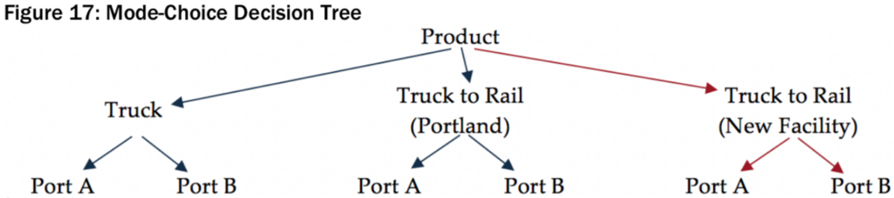
Source: ECONorthwest analysis of Commodity Flow Survey

Econometric Model

The literature review and stakeholder interviews both revealed numerous factors that determine the mode selected to ship goods with price, reliability, and timeliness indicated most frequently. Evaluation of shipping prices found that rates are widely variable, particularly concerning mode, weight, and distance. Due to this wide variety of factors along with an additional likely set of unobservable effects, a simple minimum-cost financial model is not sufficient to predict demand for the services provided by the proposed intermodal center. Instead, a full representation of the choice structure is necessary.

A nested logit model is used to jointly evaluate a shipper's mode and site-choice decision. This approach incorporates the set of decisions outlined in Figure 17 below. Black arrows on the left represent the current mode and destination alternatives, and the new intermodal center is represented by the set of red arrows on the right. A shipper jointly selects the mode (i.e., Truck or Truck to Rail) and the destination (i.e., Port A or Port B). A set of independent variables can be incorporated at each nesting level to describe the factors motivating both mode and site choice. This entire choice structure can then be applied to the new intermodal center to predict the share of products that will get shipped by rail. This type of discrete choice model uses attributes of the decision process to predict the probabilities of each of the limited number of available choices made. In this context, these choice probabilities can be interpreted as mode shares.

Figure 17: Mode-Choice Decision Tree



Source: ECONorthwest

The nested logit model is particularly attractive for this application because it allows for a rich set of possible substitution patterns. Assuming that a given shipper, i, receives economic profit p from shipping their product to a given destination, j, via mode Bk, profit takes the following functional form:

$$\pi_{ij} = V_{ij} + \varepsilon_{ij},$$

where F is a set of observable variables while C is unobservable and assumed to have the following cumulative distribution:

$$exp\left(-\sum_{k=1}^{K}\left(\sum_{j\in B_k} e^{-\varepsilon_{ij}/\lambda_k}\right)^{\lambda_k}\right).$$

The parameter \X is a measure of the degree of independence among the variables within a nest. The probability of shipper i choosing destination j via mode k can now be calculated as:

$$P_{ij} = \frac{e^{V_{ij}/\lambda_k}\left(\sum_{j\in B_k} e^{V_{ij}/\lambda_k}\right)^{\lambda_k - 1}}{\sum_{k=1}^{K}\left(\sum_{j\in B_k} e^{V_{ij}/\lambda_k}\right)^{\lambda_k}}.$$

This model is applied to CFS data, and the quarterly rail and trucking price functions developed earlier. Given that the transportation markets (and functionality of the proposed intermodal center) are distinct for both exports and domestic shipments, separate models are estimated for each.

In both models, distance and the value per ton exhibit characteristics of a log-normal distribution, with a cluster of values at the relatively low end of the spectrum and a small number of very large values at the high end. These variables are logged in the specification, and state fixed effects are used to represent unobservable variation in shipping characteristics between Washington and Oregon. Results for both export and domestic models are displayed in Figure 18.

Figure 18: Nested Logit Model Results

	Exports Coefficient	Std. Err.	Domestic Coefficient	Std. Err.
Site Choice Nest				
Price	-0.0017	0.0000	-0.0016	-0.0000
Mode Choice Nest				
Truck (base)				
Rail				
Ln Distance	0.43	0.01	1.79	0.01
Ln Value Per Ton	-0.16	0.01	-0.92	0.01
State Fixed Effects				
Washington	-0.56	0.03	0.49	-0.02
Oregon (base)	-	-	-	-
Dissimilarity Parameters[67]				
/truck_tau	0.19	0.01	3.70	0.02
/rail_tau	2.80	0.05	1.05	0.01
Log likelihood	-469,350		-2,881,277	
Wald chi2(4)	3,049		76,044	

Source: ECONorthwest

All coefficients are statistically significant, with the coefficient on price taking an expected negative sign (indicating that destinations that are more expensive to ship to are selected less often). At the mode-choice nest, the log of distance has a positive coefficient indicating that products that are shipped further are more likely to move by rail. Additionally, the log of value per ton has a negative coefficient, indicating that lower-value products (such as straw and hay) are more likely to move by rail while higher-value products (such as vegetables, fruits, and consumer goods) are more likely to move by truck.

To ensure an appropriate representation of the mode-choice decision, a number of specifications were tested; ultimately a parsimonious model was used to avoid researcher-induced variable selection bias.

Scenario Analysis

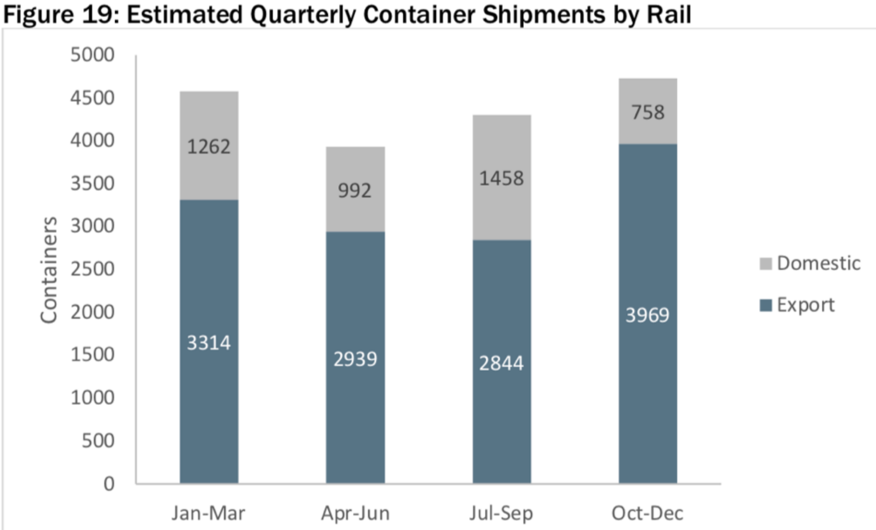
The econometric model serves as a representation of the existing origin-mode-destination decision structure for shippers competing in the same market as those in the mid-Willamette Valley. Construction of the new intermodal center will introduce a new mode alternative with an equivalent set of unobservable attributes (e.g., timeliness and reliability) as the existing Truck-to-Rail (Portland) alternative, albeit with a different overall cost function.

Thus, to predict the amount of goods shipped by rail from the new intermodal center, the cost function in the existing model is modified to represent the new intermodal center. In particular, the price of rail is reduced by the marginal cost to ship goods 65 miles by truck from Millersburg to the intermodal center in Portland and increased by the marginal cost to ship goods by rail over that equivalent distance. When applied to the CFS data used in the nested logit model, shippers observe an average price decrease of $326 (30 percent decline) for all rail- mode origin-destination pairs. This results in the econometric model predicting that approximately a quarter of goods will travel by rail, with significant seasonal variation.

Projection

The econometric model represents the set of preferences for transportation services in the region. This model is then applied to an estimate of the number of containers that originate in the study area and could use the intermodal center. For exports, this is calculated using USDA phytosanitary certificates. Domestic shipments are calculated using the U.S. Agricultural Census.

Figure 19: Estimated Quarterly Container Shipments by Rail



Source: ECONorthwest

Figure 20: Estimated Quarterly Container Shipments

Quarter	Export	Domestic	Total
Jan-Mar	3,314	1,262	4,576
Apr-Jun	2,939	992	3,931
Jul-Sep	2,844	1,458	4,302
Oct-Dec	3,969	758	4,727

Source: ECONorthwest

When applied to the estimated number of containers, the econometric model predicts that between 66 percent and 84 percent of the shipments moving through the intermodal center will be exports traveling to ports in Seattle or Tacoma, with the remainder consisting of domestic shipments traveling to other locations in the U.S. Combined, an estimated 17,537 loaded containers will pass through the intermodal center per year, with significant seasonal variation as illustrated in Figure 19 and Figure 20 below. This estimate is predicated on the assumption that the intermodal center operates efficiently, is priced at market rates, and provides a level of service equivalent to that currently available throughout the region.

Exogenous Factors that May Affect Demand

The validity of these projections is conditional on the intermodal center operating in a manner that provides a level of service equivalent to existing rail services in the region. Aside from this operating assumption, there are a number of exogenous factors that may affect these projections. Changes in commodity value, trucking prices, and production volumes may influence shipper mode choice, and ultimately, the number of containers passing through the intermodal center.

Commodity Value Fluctuations

The relative value of commodities affects the relative likelihood of a shipper choosing rail or truck to move their products. Agricultural commodities are subject to cross-year price variation. Figure 21 below lists the three-year average price of various row crop seeds, along with their three-year price variation from 2012 - 2016.

As seen in the nested logit model results in Figure 18 on page 41 above, lower value products are more likely to move by rail. Goods that have a higher time value are more likely to move by truck. As the relative value of shipped commodities increases or decreases, respective mode choice may change as well. Contributing factors to changes in value include changes in international tariffs, quotas, or duties that affect the availability of substitute goods in international markets.

Figure 21. Average Prices of Seeds, 2012-16

Product	Average Price Per CWT 2012-16	Range (+/-) 2012-16
Grass seed, Kentucky Bluegrass	230	6%
Grass seed, Tall Fescue	148	3%
Grass seed, Orchardgrass	194	6%
Grass seed, Ryegrass	99	6%
Alfalfa Seed	317	6%
Red Clover Seed	225	6%
Flaxseed	33	11%
Sorghum Seed	207	4%
Peanut Seed	83	25%
Potato Seed	15	7%
Soybean Seed	95	6%
Barley Seed	28	6%
Oat Seed	33	4%
Rice Seed	60	29%

Source: ECONorthwest analysis of USDA National Agricultural Statistics Service data

Trucking Price Changes

The stakeholder interviews indicated that the price of the intermodal center must be competitive with other transportation options for it to be utilized. This price of available substitute services provided by the intermodal center has a strong likelihood of either increasing or decreasing utilization. As described in section 2.1 on page 5, there are a number of factors contributing to changing trucking prices, including restrictions on hours of service, a decrease in the number of available truck drivers, and parking shortages. Other factors, such as changes in fuel costs may also influence the relative price of trucking.

Production Volumes

Agricultural production is highly variable and is a function of both pre-season crop acreage allocations as well as environmental conditions including temperature, rainfall, and solar intensity. Shifts in acreage from products that might not use the intermodal center, increased rainfall during the summer, or a longer growing season may increase crop yields and resulting demand for the MWVIC.

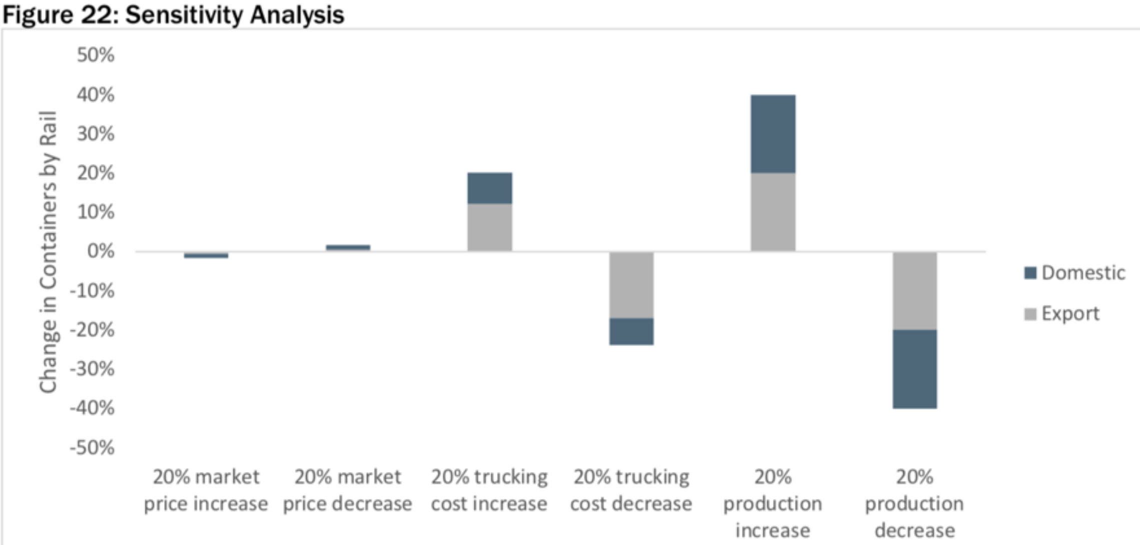
Sensitivity Analysis

While explicit quantification of these exogenous factors is difficult to perform with certainty, it is possible to evaluate the magnitude that each of these changes may have on the number of containers passing through the proposed intermodal center. Each of the above listed effects may operate independently or jointly and of a currently unknown magnitude. In order to test the implications of a number of different changes in macroeconomic conditions, a generic set of value, price, and production changes are analyzed. Six potential stylized scenarios are evaluated to test the sensitivity of the econometric model to exogenous effects. Each is listed below, along with an example of a potential cause of such a change:

1. A 20 percent increase in the market price of shipped commodities (example: change in international tariffs, quotas, or duties restricting available substitutes)
2. A 20 percent decrease in the market price of shipped commodities (example: increased availability of substitute goods produced in Australia)
3. A 20 percent increase in truck transportation costs (example: decrease in the number of available truck drivers)
4. A 20 percent decrease in truck transportation costs (example: decrease in fuel costs)
5. A 20 percent increase in production in the Mid-Valley (example: shift in acreage from other uses)
6. A 20 percent decrease in production in the Mid-Valley (example: drought)

Each scenario is designed to capture the net effect of many different exogenous factors and is evaluated independently. The results are displayed in Figure 22 below.

Figure 22: Sensitivity Analysis



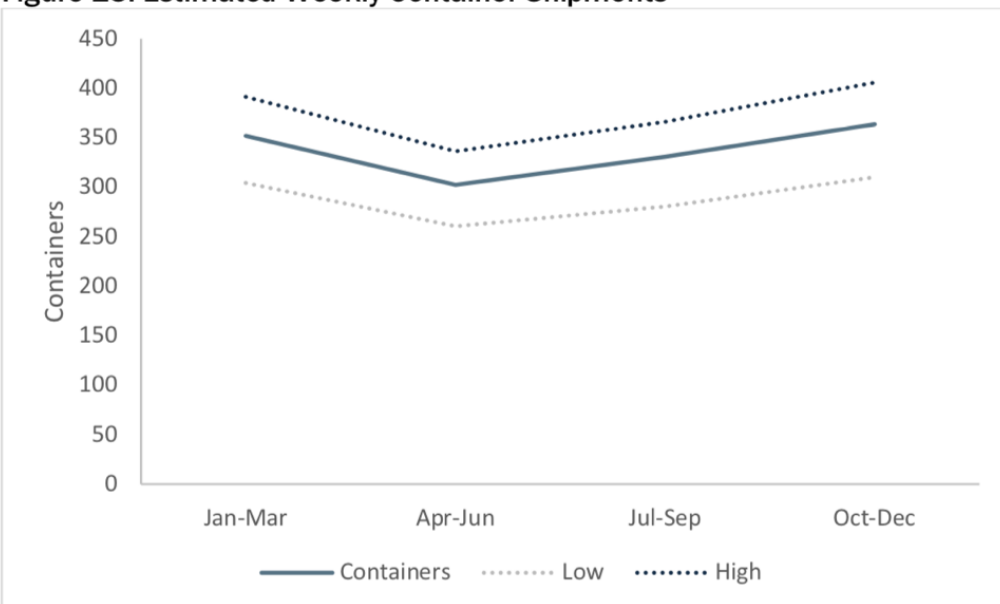
Source: ECONorthwest

The first two scenarios evaluating a change in the market price of goods indicate that both exports and domestic shipments are relatively price-inelastic with little change in volume from a 20% change in market price.

The second two scenarios evaluating a change in trucking prices have a dramatic positive effect on the use of the intermodal center. A 20 percent increase in trucking costs will lead to an 11 percent increase in the number of containers traveling by rail, while a 20 percent decrease in trucking costs will lead to a 14 percent decrease.

The final two scenarios have a direct 1:1 effect on the number of containers traveling through the intermodal center. Assuming that a change in production does not affect market prices or trucking costs, the allocation of containers between truck and rail will not change. The change in the number of containers using the intermodal center will mirror the change in production.

Figure 23. Estimated Weekly Container Shipments



Source: ECONorthwest

Each of these scenarios impact the quarterly projections of the econometric model. Figure 23 above shows the estimated weekly number of containers, with the highest and lowest scenarios plotted alongside. This projection estimates a wide range of potential use of the intermodal center depending on seasonal and exogenous effects, with 310-405 containers passing through the intermodal center per week in the peak season, and 260-336 containers passing through per week in the low season.

Assessment of Anticipated Transportation Cost Savings Generated by Use of the Facility

Construction of the proposed intermodal center has the potential to generate cost savings, both to private users of the intermodal center as well as to the general public. The following sections use inputs from sections 5 and 6, along with information from federal regulatory impacts analyses to estimate the anticipated savings to Oregon's transportation network. All calculated values are estimates that demonstrate appropriate scale and are rounded to the nearest thousandth to implying undue precision.

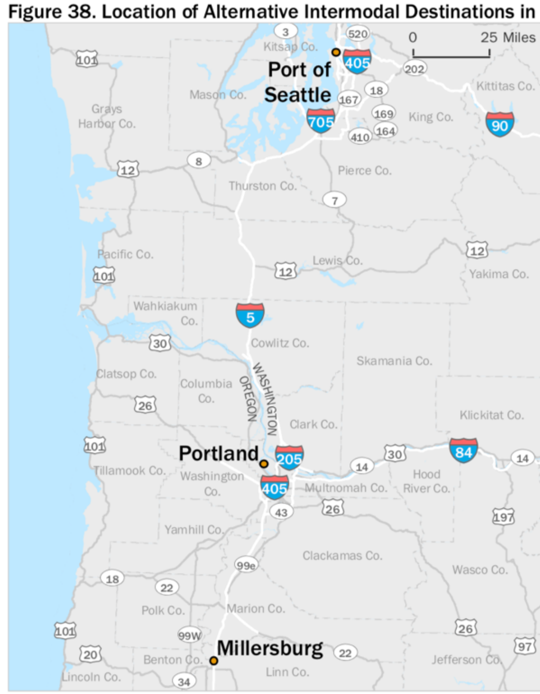
Private Benefits

Private transportation cost savings may accrue to users of the intermodal center who face lower transportation costs than current alternatives. These benefits only accrue if user fees are lower than alternative shipping modes that provide the same level of service. Although, generally, rail per-mile transportation costs are lower than truck for large volumes over long distances, these lower costs may not always be observed at the proposed intermodal center. There are many underlying economic reasons this might not occur, including scarcity induced by the capacity of the intermodal center and availability of substitutes. Since the intermodal center is being constructed at a scale that is incapable of handling the total volume of products shipped in the region, competition for available capacity will occur, resulting in pricing that most efficiently allocates that capacity. Furthermore, the current mix of shipping alternatives will continue to exist, allowing growers and shippers to choose the alternative that provides the best level of service, reliability, and timeliness necessary. Calculation of the scale of anticipated private benefits, however, can be calculated using expected trucking costs and a basic set of assumptions on markets served.

Framework

Section 5 above calculates the estimated demand for the intermodal center. The volume of exported containers will replace one of two existing transit options 1) trucking loaded containers all the way to ports in Seattle and Tacoma, and 2) trucking loaded containers to an intermodal rail facility in Portland. The volume of domestic containers is expected to completely replace truck shipments to facilities in Portland. These locations are identified in Figure 38.

Figure 38. Location of Alternative Intermodal Destinations in Relation to Millersburg



Source: ECONorthwest

There may be cost savings incurred by transporting containers by rail from Millersburg to the Seattle/Tacoma area as opposed to trucking the entire way. However, in order to generate conservative estimates of benefits, this section assumes that truck transportation cost savings accrue only for forgone trucking costs for the 65 miles from Millersburg to Portland. These benefits are mitigated by the additional rail transit costs to ship the approximately 236 miles from Millersburg to Seattle/Tacoma (as opposed to the approximately 171 miles from Portland to Seattle). Both elements are calculated using the truck and round-trip marginal rail cost structures estimated in section 5.2 on page 35. Intermodal center charges are likely to be roughly equivalent at both facilities and are excluded from the estimate of private transportation cost savings. The resulting calculation is as follows:

<u>Potential value of private transportation cost savings:</u>

- Private Transportation Cost Savings = (Cost to ship to Portland by Truck – Marginal cost to ship the added distance to Millersburg by Rail) * (Distance) * (Containers)
- Private Transportation Cost Savings = ($5.65 per mile – $3.79 per mile) * (65 miles) * (17,537 containers)
- Private Transportation Cost Savings = $2,120,000 per year

When evaluated over a twenty-year timeframe—from 2020 to 2040—at a 3 percent and 7 percent discount rate, these savings amount to between $21,032,000 and $30,682,000. These transportation cost savings are likely to be captured in the private market by either growers, shippers, the intermodal center operator, or the rail operator.

Public Benefits
This section calculates the monetary value of the public benefits derived from the proposed intermodal center, particularly by shifting container transportation from Oregon highways to rail. Public benefits accrue when goods that are non-rival and non-excludable are improved. Although the values can often be inferred from private market transactions, public goods are not regularly bought and sold. This analysis draws information from published economic literature and relevant federal guidance to calculate a range of benefits accruing to Oregon residents from the construction of the proposed intermodal center.

The existing baseline scenario involves empty container trucks departing from the Seattle/Tacoma area and traveling down the Willamette Valley toward Millersburg, Oregon. Once they reach their loading destination, empty containers and chassis are exchanged for full containers destined for international customers. These same trucks then transport these containers back up to ports in Seattle and Tacoma. Although the full suite of public benefits is broad, this analysis only focuses on the benefits of removing eighteen wheelers from highways inside the State of Oregon. As described earlier, the proposed intermodal center is expected to remove approximately 17,537 northbound containers per year.

Intermodal container transportation produces public benefits, which are often used to justify public investment in intermodal infrastructure. The transportation industry has adopted intermodal containers, in part, because they can take advantage of efficiencies associated with each form of transportation. These efficiencies produce private cost benefits, as well as benefits that accrue to the public, including reduced pollution, congestion, highway wear and tear, and fewer accidents. The subsections that follow discuss the benefits of removing eighteen wheelers from urban interstates. They are as follows:

- Highway Safety
- Air Pollution and Greenhouse Gas Reduction
- Congestion Reduction
- Reduced Highway Maintenance Costs

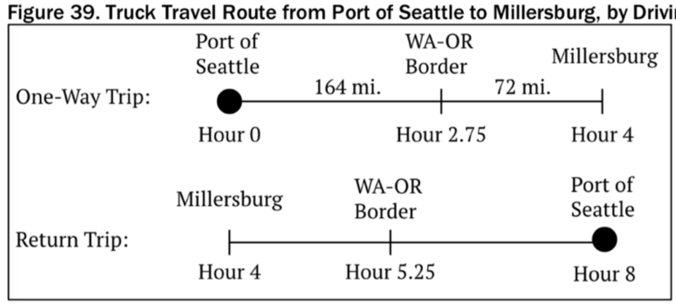
Framework
Figure 39 depicts the conceptual basis for estimating benefits for removing trucks from highways in the State of Oregon. Since the marginal effect of many of the public benefits varies across time and distance, it also details the distance traveled on I-5 and the relative driving hour for when drivers cross the Washington-Oregon border into Oregon. While this conceptual example does not precisely mirror the full set of transportation actions being made, it is roughly representative and serves as a basis for estimating the scale of public benefits.

In the analysis to follow, it is important to note the calculations monetizing these public benefits rely heavily on assumptions. These calculations do not account for specific trade-offs when trucks are removed from Oregon interstates. For example, when calculating the benefit of reduced congestion, the potential scenario of private passenger vehicles or light trucks replacing the space created on highways as a result of the eighteen wheelers removed is not considered. Additionally, assumptions are made on the given weight for each eighteen-wheeler, a specific driving route, and an amount of time taken to drive this route. Any deviation from these assumptions will result in public benefits being reduced (e.g., private passenger vehicles replacing eighteen wheelers, trucks taking a longer driving route, trucks being only partially loaded) or increased (e.g., highway congestion worsens). For this reason, all values are produced as a range and are intended to demonstrate the potential scale of public benefits.

Driving Distance Assumptions

The distance from the Port of Seattle down to Millersburg is approximately 3 hours and 55 minutes, or about 236 miles. From the Port of Seattle to the Washington-Oregon state border, it is about 164 miles or 2 hours and 42 minutes. Truck drivers travel on Oregon interstates for approximately 72 miles in one direction or about 144 miles over their entire trip. Thus, drivers spend about 2.5 hours of their driving route on Oregon interstates. For simplicity, it is assumed truck drivers occupy Oregon interstates for their full third and fourth hours of driving. Their fifth hour, while partial, is also in Oregon.

Figure 39. Truck Travel Route from Port of Seattle to Millersburg, by Driving Hour



Source: ECONorthwest.

Truck Weight Assumptions

Two assumptions are made regarding the weight of eighteen wheelers. These will be restated when employed in calculations to follow.

- The typical weight of a Class 8 truck tractor is approximately 17,000 pounds or 8.5 tons.[78,79]
- A standard empty container and chassis has an approximate tare weight (empty) of 15,000 pounds (7.5 tons) and can hold up to a maximum of 44,000 pounds (inclusive of its tare weight).

Combining the weight of the truck tractor with an empty container and chassis, the typical tare weight of an eighteen-wheeler is about 16 tons. It is important to note, however, that this tonnage can vary widely based on the type of truck tractor and the trailer attached to it. Using publicly available measures for the density of pressed straw, a full container is estimated to carry a load of 21 tons.

An eighteen-wheeler with a full load of pressed straw weighs about 37 tons on its return trip. However, on its drive from the Washington-Oregon border toward Millersburg, it weighs about 16 tons. Thus, when performing calculations in the following sections where weight is a key factor, both legs are incorporated.

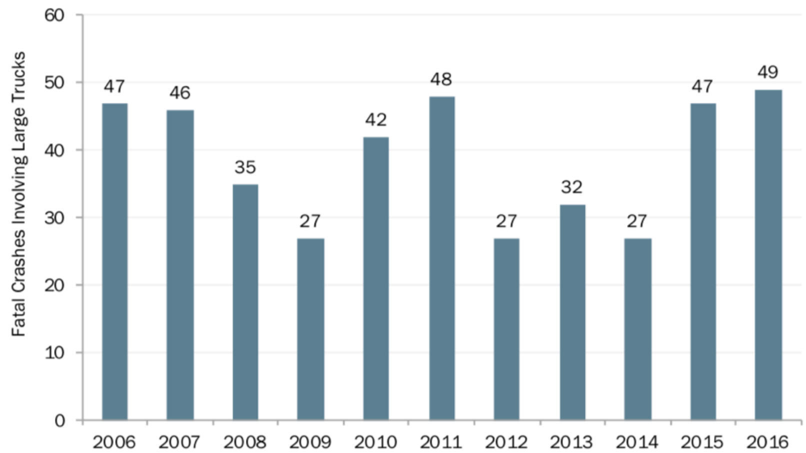
Marginal Costs

Marginal costs are essential for understanding travel impacts as they illustrate the incremental cost per extra mile driven on interstates. These costs, though not regularly considered by road users, are imposed on drivers (travel time, costs of vehicle operation), public agencies (road maintenance), and they externally affect other highway users by congestion and, more broadly, communities by pollution. It should be noted that while these marginal costs illuminate the incremental cost per extra mile, their value can vary based on time of day. For example, the marginal cost of congestion during peak travel periods through Portland will be higher than during non-peak travel periods.

Highway Safety

Large trucks have been involved in fatal crashes on Oregon roadways. To contextualize the number of fatal crashes and fatalities, Figure 40 and Figure 41 provide trend analyses of these statistics over the last eleven years, respectively. It is important to note that not all of these fatal crashes and fatalities necessarily occurred on interstate freeways; more generally, these statistics describe the number of fatal truck crashes on public roadways. Over the 2006 to 2016 timeframe in Oregon, the largest number of fatal crashes occurred in 2016 at 49 with an overall average of 43 fatal truck crashes occurred per year.

Figure 40. Fatal Crashes Involving Large Trucks, 2006-2016



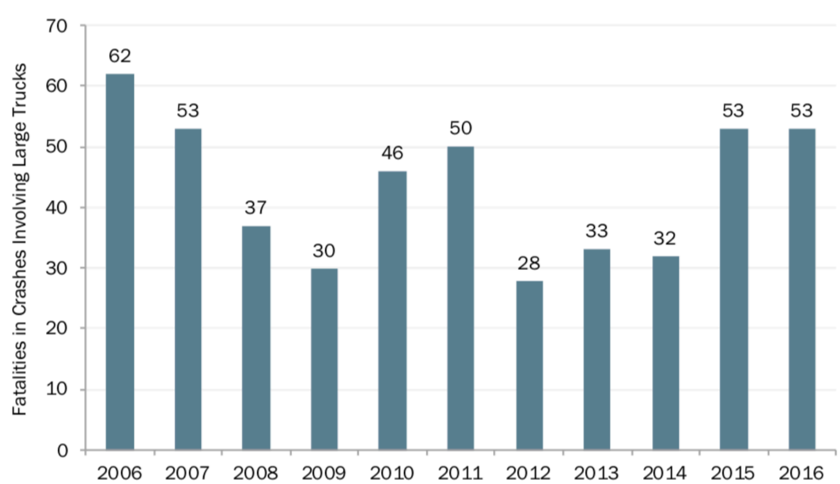
Source: U.S. Department of Transportation, Large Truck and Bus Crash Facts 2016.

The number of fatalities from crashes involving large trucks has fluctuated over the last eleven years. During the 2006 to 2016 timeframe, the largest number of fatalities occurred in 2006 at 62. Over these eleven years, the lowest number of fatalities was 28 in 2012. In 2015 and 2016, however, the number of fatalities rose to 53 in each year. On average, 39 fatalities from crashes involving large trucks occurred each year in Oregon over the past eleven years.

There are additional estimates of the rate of large truck-at-fault crashes reported by the Oregon Department of Transportation. From 2013 through 2017, there was an average of 0.43 large truck crashes involving a fatality, injury, or disabling damage per million vehicle miles traveled. Additionally, there were 1.32 deaths per 100 million vehicle miles traveled on Oregon roads in 2016.

Two ranges are used to approximate the monetary value of increased highway safety via the removal of trucks from Oregon interstates. One range uses the Value of a Statistical Life (VSL) to approximate the monetary value of fatalities prevented. The other range is based more broadly on accidents, specifically how removing trucks from highways would decrease this negative externality experienced by other users of interstates.

Figure 41. Fatalities in Crashes Involving Large Trucks, 2006-2016



Source: U.S. Department of Transportation, Large Truck and Bus Crash Facts 2016.

First, the range for potential fatalities prevented as a result of removing trucks from Oregon interstates is calculated. The U.S. Department of Transportation (DOT) reported a VSL of $9.6 million for 2016 in its revised VSL Guidance memorandum. Using the Consumer Price Index published by the Bureau of Labor Statistics, the 2016 VSL value is adjusted to 2018 dollars.84 This inflation adjustment raises the VSL to $9.91 million.

<u>Potential value of fatalities prevented, U.S. DOT VSL:</u>

- Potential value of fatalities prevented = (U.S. DOT VSL) * (Fatality rate, per mile) * (Truck trips removed from interstates per year) * (Miles per truck trip)
- Potential value of fatalities prevented = ($9.91 mill.) * (1.32 / 100 mill) * (17,537 trucks) * (144 miles)
- Potential value of fatalities prevented = $330,000 per year

Aside from reducing fatalities on roadways, there are additional benefits from the reduction in general accidents. In a technical report from Blanco, et al. (2011), they estimate the rate of Safety Critical Events (SCE) as a function of driving hour. An SCE is any crash, near-crash, crash-relevant conflict, or unintentional lane deviation. These rates help estimate the potential number of crashes that could occur from eighteen-wheelers while driving through Oregon. Using Blanco, et al.'s estimates provided in Figure 42, the average rate of SCE occurrence for driving hours 3, 4, and 5 is 0.154.

Figure 42. Rate of SCE Occurrence by Driving Hour

Driving Hour	SCEs Per Driving Hour	Total Opportunities Per Driving Hour	Rate of SCE Occurrence
1	218	1,864.60	0.117
2	230	1,826.97	0.126
3	235	1,786.90	0.132
4	285	1,715.56	0.166
5	263	1,612.94	0.163
6	265	1,477.66	0.179
7	248	1,261.41	0.197
8	154	1,021.06	0.151
9	125	808.78	0.155
10	98	553.16	0.177
11	76	321.48	0.236

Source: Blanco, *et al.* (2011). Table 11, page 29.

It is expected that there will be a reduction in approximately 6,752 safety SCEs per year (0.154 SCE rate * 17,537 trucks * 2.5 hours driving per truck) from removing trucks from the roads.

While there is no precise monetary estimate for a reduction in SCEs, a range of values of general accidents prevented by removing trucks from Oregon interstates is available from evaluations of several federal highway regulations. According to the EPA's final rulemaking regarding greenhouse gas emissions standards and fuel efficiency standards for heavy-duty trucks, the marginal cost per freeway mile driven of an accident range from a low estimate of $0.01 to a high of $0.08. To generate an approximate value, the 'Middle' estimate, or $0.03, is used to approximate the value of accidents avoided.

For comparison, Figure 44 details the marginal cost of each urban interstate mile driven for various externalities by truck weight per the Federal Highway Administration's (FHWA) 1997 Addendum to their Highway Cost Allocation Study. A number of the externalities listed will be referenced in later sections and employed in other calculations. These values, initially reported in 2000 dollars, have been adjusted to 2018 dollars using the CPI. Given the focus on eighteen wheelers, the pertinent estimates for marginal crash costs from Figure 44 are in rows '60 kip 5- axle Comb.' (empty trucks on their way to Millersburg) and '80 kip 5-axle Comb.' (loaded trucks returning to the Port of Seattle). The values for these two vehicle classes are identical for crashes, so $0.017, or approximately two cents per interstate mile driven is used to calculate the potential value of avoiding highway accidents involving large trucks.

Figure 43. Cost of Highway Externalities for Combination Tractors per Mile, in 2018 dollars

Highway Impact	High	Middle	Low
Noise	$0.06	$0.02	$0.01
Accidents	$0.08	$0.03	$0.01
Congestion	$0.37	$0.13	$0.03
Combined	$0.51	$0.18	$0.05

Source: U.S. EPA. Final Rulemaking to Establish Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles, Regulatory Impact Analysis. Table 9-10: Low-Mid-High Cost Estimates.

Figure 44. Marginal Cost of Incremental Highway Mile Driven, by Vehicle Class on Urban Interstates, in Cents per Mile, 2018 dollars

Vehicle Class on Urban Interstate	Pavement	Congestion	Crash	Air Pollution	Noise	Total
40 kip 4-axle S.U. Truck	$0.045	$0.352	$0.012	$0.065	$0.022	$0.496
60 kip 4-axle S.U. Truck	$0.261	$0.470	$0.012	$0.065	$0.024	$0.832
60 kip 5-axle Comb.	$0.151	$0.265	$0.017	$0.065	$0.040	$0.537
80 kip 5-axle Comb.	$0.589	$0.289	$0.017	$0.065	$0.044	$1.002

Source: U.S. Department of Transportation, Federal Highway Administration. Addendum to the 1997 Federal Highway Cost Allocation Study, Final Report.

<u>Potential value of highway accidents avoided, EPA accident value:</u>

- Value of accidents avoided = (EPA's marginal cost of crash) *(Truck miles driven) * (Number of trucks removed from interstates per year)
- Value of accidents avoided = ($0.03) * (144 miles) * (17,537 trucks per year)
- Value of accidents avoided = $76,000 per year

<u>Potential value of highway accidents avoided, FHWA accident value:</u>

- Value of accidents avoided = (FHWA's marginal cost of crash) * (Truck miles driven) * (Number of trucks removed from interstates per year)
- Value of accidents avoided = ($0.017) * (144 miles) * (17,537 trucks per year)
- Value of accidents avoided = $43,000 per year

Greenhouse Gas Reduction and Air Pollution

Shifting intermodal containers from trucks to rail reduces greenhouse gases (GHGs) and air pollution. The primary reason for this is that rail can transport cargo further per ton-mile of fuel consumed. According to the EPA, "the most important greenhouse gases directly emitted by humans include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and several other fluorine-containing halogenated substances." In their 2018 Inventory of U.S. Greenhouse Gas Emissions and Sinks, the EPA reports approximately 2.2 percent of the U.S.'s GHG emissions (CO2, CH4, N2O, HFCs, Other Emissions from Electric Power) in

2016 came from rail transportation. Medium- and heavy-duty trucks contributed to 22.9 percent of the total GHG emissions (CO_2, CH_4, N_2O, HFCs) in 2016. Other gases accounted for in this section include indirect greenhouse gases, which do not necessarily contribute to the global warming effect, but they indirectly impact the Earth's atmosphere "by influencing the formation and destruction of tropospheric and stratospheric ozone ...." Among these are carbon monoxide (CO), nitrogen oxides (NOx), volatile organic compounds (VOCs), sulfur dioxide (SO_2), and others. Particulate matter (PM2.5), ammonia (NH_3), nitrogen oxides, sulfur dioxide, and VOCs are gasses that affect human health and air quality.89 The human health component is monetized later in this section as it relates to the reduction of these harmful gasses from fewer trucks.

The Texas Transportation Institute (TTI) estimated railroads moved approximately one ton of cargo 478 miles per gallon of fuel in 2009. In comparison, trucks moved one ton of cargo 150 miles per gallon. Thus, railroad transportation is more fuel efficient for moving cargo relative to trucks, and as a result of consuming less fuel, railroad transportation produces fewer GHGs.

The TTI report estimates railroads produce one ton of GHG per 47,308 ton-miles while trucks produce one ton of GHG per 5,802 ton-miles. Below are the calculations for the quantity of GHG emitted by a single truck driving on Oregon interstates by the leg of the route.

From Washington-Oregon border to Millersburg (one way; first leg):

- Travels 72 miles at 16 tons (empty container) = (72 miles) * (16 tons) = 1,152 ton- miles

From Millersburg to Washington-Oregon border (round trip; second leg):

- Travels 72 miles at 37 tons (loaded container) = (72 miles) * (37 tons) = 2,664 ton- miles

Thus, for one truck driving on Oregon's interstates, it travels 3,816 ton-miles (1,152 plus 2,664) and produces 0.66 tons of GHG (3,816 divided by 5,820).

One way to estimate the impacts of taking trucks off the road in favor of intermodal rail is calculating the reduction of carbon dioxide (CO_2) emissions by using the social cost of carbon (SCC). Figure 45 shows the social costs of CO_2 per metric ton across various discount rates published by the EPA.

Figure 45. Social Cost of Carbon per Metric Ton, 2012–2050, 2018 dollars

Year	5% Avg. Discount	3% Avg. Discount	2.5% Avg. Discount	3%, 95th Percentile
2012	$6.10	$26.64	$43.36	$81.04
2015	$6.85	$28.40	$45.72	$85.53
2020	$8.10	$31.31	$49.66	$96.09
2025	$9.86	$35.16	$54.63	$107.58
2030	$11.61	$38.99	$59.59	$119.07
2035	$13.37	$42.84	$64.56	$130.56
2040	$15.12	$46.68	$69.54	$142.05
2045	$16.90	$50.07	$73.47	$152.11
2050	$18.69	$53.46	$77.40	$162.18

Source: U.S. EPA. *Final Rulemaking to Establish Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles, Regulatory Impact Analysis.*

Using the 2020 SCC value across various discount rates from Figure 45, displays a range of values for carbon removed from the atmosphere as a result of taking 17,537 eighteen wheelers off the road each year.

<u>Social cost of carbon, 5 percent discount rate:</u>

- SCC at 5 percent discount = (2020 value at 5 percent) * (Tons of GHG produced by one truck) * (Number of trucks removed from interstates per year)

- SCC at 5 percent discount = ($8.10) * (0.66 tons of GHG per truck) * (17,537 trucks per year)
- SCC at 5 percent discount = $94,000 per year

Social cost of carbon, 3 percent discount rate:

- SCC at 3 percent discount = ($31.31) * (0.66 tons of GHG per truck) * (17,537 trucks per year)
- SCC at 3 percent discount = $362,000 per year

Social cost of carbon, 2.5 percent discount rate:

- SCC at 2.5 percent discount = ($49.66) * (0.66 tons of GHG per truck) * (17,537 trucks per year)
- SCC at 2.5 percent discount = $575,000 per year

In addition to computing the social cost of carbon, an estimate of the human health impacts of air pollution is generated. These impacts manifest themselves through respiratory complications, premature mortality, cardiovascular illnesses, and other afflictions. Delucchi et al. (2010) estimated an air pollution health cost value of 1.55 cents per ton-mile (in 2006 dollars) for heavy-duty diesel vehicles using the Co-Benefits Risk Assessment Screening Model (COBRA). COBRA is a screening and mapping tool developed by the EPA that estimates "the economic value of the health benefits associated with clean energy policies and programs to compare against program costs." It estimates emissions of particulate matter, sulfur dioxide, nitrogen oxides, ammonia, and volatile organic compounds. As a result, this estimate calculated by Delucchi, et al. (2010) does not overlap with the public benefits accrual associated with carbon reduction. Using the CPI, the cost estimate is adjusted to 2018 dollars, resulting in a health cost of approximately 1.91 cents per ton-mile, or $0.019. For comparison, the human health cost associated with rail is $0.0043.

Human health benefit of reducing air pollution, heavy-duty diesel vehicles:

- Value of air pollution reduced = (Delucchi, et al.'s value of air pollution) * (Ton- miles driven per truck) * (Trucks removed from interstates per year)
- Value of air pollution reduced = ($0.019) * (3,816 ton-miles) * (17,537 trucks per year)
- Value of air pollution reduced = $1,272,000 Human health benefit of reducing air pollution, rail:
- Value of air pollution reduced = ($0.0043) * (3,816 ton-miles) * (17,537 trucks per year)
- Value of air pollution reduced = $288,000

The difference between the two values calculated above is $984,000. In other words, removing 17,537 trucks per year from Oregon interstates would yield an approximate human health benefit of $984,000 assuming no private passenger vehicles replace the space created by the absent trucks.

The FHWA similarly reports air pollution marginal cost per driving mile of $0.065 in Figure 44, though this value is more general, and it does not directly evaluate the impact on human health. It estimates the difference in air pollution concentrations between highway traffic and no highway traffic. The calculation below can be interpreted as a lower bound estimate of the public benefit of air pollution reduction as its value hinges on cents per mile and not cents per ton-mile as Delucchi, et al.'s does.

Benefit of reducing air pollution, FHWA air pollution estimate:

- Value of air pollution reduced = (FHWA's marginal cost of air pollution) * (Truck miles driven) * (Trucks removed from interstates per year)
- Value of air pollution reduced = ($0.065) * (144 miles) * (17,537 trucks per year)
- Value of air pollution reduced = $164,000

Congestion Reduction

Shifting intermodal containers from highways to railways affects highway congestion by reducing the number of eighteen wheelers on the road. This benefits other highway traffic, particularly passenger vehicles, motorcycles, and light-duty trucks. Since eighteen wheelers occupy more space than other types of highway traveling vehicles, the benefit of removing them from the road can either reduce congestion or allow additional vehicles to take their place.

Sulbaran and Sarder (2013) state, "... freight trains are capable of carrying loads equivalent of 280 trucks in a single haul making space for 1,000 or more passenger automobiles." Reducing congestion produces benefits for every commuter on the road, by reducing the amount of time spent driving, allowing people to do other things. It also has the potential to make businesses more efficient, by reducing travel times for employees who drive on the job. A 2014 report on the economic impacts of congestion in Oregon found that businesses have already implemented strategies to avoid and mitigate current congestion issues, and expected increases in congestion would impose direct costs, including reduced service levels (e.g., fewer deliveries per day), which would have an increasingly negative impact on Oregon's economy.

A crucial dimension to consider in calculating the public benefit of congestion reduction is hyper-congestion, which can become acute on Portland's I-5 stretch during peak traffic flow periods. The Portland area has grown over recent years and highway congestion in the region has increased. These congestion impacts affect both shippers transiting through the region as well as local residents. As described in section 2.1 on page 5, the Portland region is considering implementing congestion tolling to alleviate these impacts. This type of tolling sets a price for limited highway resources, leading to a more efficient allocation by inducing lower-value users to substitute to other times or transportation modes. When congestion tolling revenues are spent by a public agency appropriately, congestion tolling is a net welfare maximizing policy. However, individual user welfare may increase or decrease depending on their respective profit or utility function. Regardless of the implementation of congestion tolling, the MWVIC will give shippers the opportunity to either avoid regional congestion in Portland, or the avoid the tolls. From a public benefits perspective, any reduction in trucks traveling through the area has the potential to either reduce travel times or increase the number of cars that can take the place of trucks on the roads. The calculation below estimates benefits that largely accrue to the Portland area and is a direct function of the volume of trucks removed from I-5.

Additional concerns have been raised about non-traditional truck parking in the Portland area. In an attempt to avoid hyper-congested hours in the region, some trucks have been observed arriving outside the Port of Portland before they open and parking in non-traditional areas (e.g. neighborhood streets, school parking lots, and in commercial shopping centers). The trucking parking facilities at the MWVIC are designed to alleviate these localized impacts. Due to incomplete information on the location of truck parking and no direct value of their localized impacts, this element of public benefits is only included qualitatively.

To calculate the value of potential highway congestion reduction, it is assumed that unloaded trucks departing from the Seattle area leave at a range of times early in the morning toward Millersburg, between the hours of 3:00 AM and 6:00 AM. Drivers spend about 2.75 hours on the road before broaching the

Washington-Oregon border and thus arrive in Portland sometime between approximately 5:45 AM and 8:45 AM when congestion is rather dense. Using vehicular volume estimates of 5 axle trucks on I-5 in Portland, a weighted estimate of marginal cost per mile driven for these heavy-duty vehicles is generated. This value is added to the existing marginal cost estimates in Figure 43 and Figure 44 for the miles driven through Portland to Tigard (18 miles).

Figure 46 displays the marginal cost per mile driven by eighteen wheelers for distinct segments of I-5 by direction of travel. Across Portland to Tigard, the marginal cost is approximately $25.69 per truck moving in the southbound direction using the EPA value of $0.13 per mile from Figure 43 on page 74. Using the FHWA's value of $0.265 (Figure 44) for the southbound leg of truck travel, the marginal cost is approximately $28.09, or $2.40 higher than the EPA-derived marginal cost. Once a truck moves beyond Tigard, the marginal cost of travel decreases as traffic tends to become less dense and thus imposes a smaller cost on drivers sharing the interstate. When the truck travels on its return trip from Millersburg up to Tigard, and then through Portland, the marginal cost of traveling through Portland is less as the trucks are passing through at a time preceding the rush-hour peak (between 8:15 AM and 11:15 AM).

A range of benefits earned from removing 17,537 eighteen wheelers from Oregon interstates using the marginal cost estimates is calculated in Figure 46. These amounts already encapsulate the mileage driven for each leg of the trip. Summing across each of the EPA- and FHWA-based values, the marginal cost of congestion is estimated to be $54.35 and $75.52 per truck, respectively.

Figure 45. Social Cost of Carbon per Metric Ton, 2012–2050, 2018 dollars

Year	5% Avg. Discount	3% Avg. Discount	2.5% Avg. Discount	3%, 95th Percentile
2012	$6.10	$26.64	$43.36	$81.04
2015	$6.85	$28.40	$45.72	$85.53
2020	$8.10	$31.31	$49.66	$96.09
2025	$9.86	$35.16	$54.63	$107.58
2030	$11.61	$38.99	$59.59	$119.07
2035	$13.37	$42.84	$64.56	$130.56
2040	$15.12	$46.68	$69.54	$142.05
2045	$16.90	$50.07	$73.47	$152.11
2050	$18.69	$53.46	$77.40	$162.18

Source: U.S. EPA. *Final Rulemaking to Establish Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles, Regulatory Impact Analysis.*

Marginal cost of congestion, EPA value:

- Value of congestion removed = (Marginal cost of congestion per round trip) * (Trucks removed from interstates per year)
- Value of congestion removed = ($54.35 per round trip) * (17,537 trucks per year)
- Value of congestion removed = $953,000 per year

Marginal cost of congestion, FHWA value:

- Value of congestion removed = ($75.52 per round trip) * (17,537 trucks per year)
- Value of congestion removed = $1,324,000 per year

Thus, the estimate of the public benefit of congestion reduction via removing 17,537 trucks per year from Oregon interstates is about $953,000 to $1,324,000.

Reduced Highway Maintenance Costs

Freight rail advocates argue that increased rail freight movement significantly reduces highways infrastructure maintenance and expansion costs. Trucks are substantially heavier than private passenger vehicles. A GAO report states, "Although a five-axle tractor-trailer loaded to the current 80,000-pound Federal weight limit weighs about the same as 20 automobiles, the impact of the tractor-trailer is dramatically higher ... a tractor-trailer has the same impact on an interstate highway as at least 9,600 automobiles... ." The eighteen wheelers driving on Oregon interstates do not reach the maximum Federal weight limit, though, on their return trip, they come close (37 tons). Again referencing Figure 44 on page

74, the ‘60 kip 5-axle comb.’ and ‘80 kip 5-axle comb’ values are used to derive estimates for the roadway maintenance eighteen wheelers impose on Oregon interstates.

Marginal cost of highway road maintenance, trip to Millersburg:

- Value of highway maintenance = (Marginal cost of highway road maintenance, 60 kip 5-axle combination truck) * (Truck miles driven) * (Trucks removed from interstates per year)
- Value of highway maintenance = ($0.151) * (72 miles) * (17,537 trucks per year)
- Value of highway maintenance = $191,000 per year

Marginal cost of highway road maintenance, return trip to Port of Seattle:

- Value of highway maintenance = (Marginal cost of highway road maintenance, 80 kip 5-axle combination truck) * (Truck miles driven) * (Trucks removed from interstates per year)
- Value of highway maintenance = ($0.589) * (72 miles) * (17,537 trucks per year)
- Value of highway maintenance = $744,000 per year

Summing across each leg of the Oregon truck driver trip, the estimate of the public benefit of removing 17,537 eighteen wheelers from interstates annually is approximately $934,000. States and the Federal Government regularly conduct Highway Cost Allocation Studies to evaluate highway-related costs attributable to different vehicle classes and determine whether fees paid by different vehicles (e.g. through tolls, transit charges, or gasoline taxes) cover their highway cost responsibility99. A fully efficient fee structure where trucks are paying weight-mile fees, motor fuel excise taxes, and registration fees that properly account for their impact on the highway network would result in no external public costs. In order to accommodate the full range of potentially fee efficiency, the value above is used only in the “high” estimate, while a value of zero is used in the “low” estimate.

Summary of Public Benefits

Diverting export containers from trucks to rail would help relieve a handful of public costs exerted on the environment, human health, highway maintenance, and congestion. The most substantial benefits to highway users manifest through congestion reduction, lower levels of particulate matter emission and thus a benefit on human health, and a reduction in highway road wear and tear. While the sum of all of these public benefits is not gargantuan, the reduction of eighteen wheelers is still noteworthy. Figure 47 summarizes the low and high estimates calculated for each public benefit category in order of appearance in this public benefits section.

Figure 47. Potential Annual Benefits, 2018 dollars

Category of Public Benefit	Low Estimate	High Estimate
Potential value of fatalities prevented	$330,000	$330,000
Potential value of highway accidents avoided	$43,000	$76,000
Social Cost of Carbon	$94,000	$575,000
Human Health	$1,272,000	$1,272,000
Air Pollution Reduction	$164,000	$164,000
Congestion Reduction	$953,000	$1,324,000
Reduced Highway Road Maintenance	$0	$934,000
Total	$2,856,000	$4,675,000

Figure 48 projects and sums the public benefits in Figure 47 over a twenty-year timeframe— from 2020 through 2040—at a 3 percent and 7 percent discount rate. This analysis timeframe and the chosen discount rates are consistent with federal guidelines for preparing economic analyses. The potential present value of public benefits over the next twenty years for the 'Low Estimate' is between $28 million (7 percent discount) and $41 million (3 percent discount). For the 'High Estimate', the benefits are estimated to be between $46 million to $68 million.

Figure 48. Potential Present Value Benefits over 2020 to 2040, 2018 dollars

Discount Rate	Low Estimate	High Estimate
3 percent	$41,252,000	$67,526,000
7 percent	$28,277,000	$46,287,000