Appendix M

Risk Assessment Technical Report

WESTWAY AND IMPERIUM EXPANSION PROJECTS RISK ASSESSMENT TECHNICAL REPORT

PREPARED FOR:

City of Hoquiam, Washington
609 8th Street
Hoquiam, WA 98550
Contact: Brian Shay
(360) 538-3983

Washington State Department of Ecology
300 Desmond Drive SE
Lacey, WA 98503
Contact: Sally Toteff
(360) 407-0271

PREPARED BY:

ICF International
317 SW Alder Street, Suite 200
Portland, Oregon 97205
Contact: Kim Marcotte
(503) 525-6196

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Acronyms and Abbreviations

AAR	American Association of Railroads
BNSF	BNSF Railway Company
Ecology	Washington State Department of Ecology
Imperium	Imperium Terminal Services
FRA	Federal Railroad Administration
mph	miles per hour
PS&P	Puget Sound & Pacific Railroad
RPI	Railway Progress Institute
USDOT	U.S. Department of Transportation
Westway	Westway Terminal Company LLC

Chapter 1
Introduction

Risk management involves the systematic identification, evaluation, and control of potential losses that may arise from uncertain future events—such as spills, fires, explosions, or natural disasters. This includes recognition of possible hazards, evaluation of the frequency of adverse events and the magnitude of their potential impacts, and a determination of appropriate measures for prevention or reduction of these risks considering cost/benefit tradeoffs.

This report addresses the first part of the risk management process. It provides information and evaluates the potential for the Westway Terminal Company LLC (Westway) and Imperium Terminal Services (Imperium) Expansion Projects (proposed actions) to result in increased risks of releasing crude oil (or the other proposed bulk liquids) into the environment. More information about the proposed actions can be found in Chapter 2, *Proposed Action and Alternatives*, of each Draft Environmental Impact Statement. Chapter 2, *Methods*, describes the general approach and assumptions used for completing the risk assessment. Chapter 3, *Terminal (Onsite) Evaluation*, Chapter 4, *Rail Transport Evaluation*, and Chapter 5, *Vessel Transport Evaluation*, presents the methods for and estimates of increased risks of releasing crude oil or other bulk liquids into the environment related to the proposed actions for onsite activities, rail transport, and vessel transport, respectively. The primary mechanisms by which increased risks could occur include onsite handling and storage (e.g., rail unloading, storage tank use, and vessel loading at each facility). Operation of the proposed actions would also result in increased rail and vessel traffic related to the transport of crude oil or the other proposed bulk liquids to and from the site. Chapter 6, *Risk of Fire or Explosion*, addresses the likelihood of fire or explosion resulting from a spill related to the risk scenarios addressed in Chapters 3, 4, and 5. Chapter 7, *Existing Risks (No-Action Alternative)*, characterizes the current baseline for risks in the study area associated with current operations.

Chapter 2
Methods

2.1 General Approach

Risk assessment is the part of risk management that identifies hazards or undesirable events and determines both the likelihood of occurrence (the frequency) and the potential impacts of these undesirable events, including spills of materials such as crude oil or other bulk liquids as may occur related to the proposed actions. Risk assessment results allow decision makers to consider both the potential severity of such an event and its likelihood of occurrence, not just the upper bound of potential impacts. A semiquantitative risk assessment was conducted for the proposed actions to develop representative frequencies and potential impacts associated with a set of potential release scenarios in the study area.

In general, this risk assessment considers the implementation of the proposed actions over a 20-year analysis period from 2017 (anticipated start of operations) to 2037. This analysis assumes that the proposed actions would be built and would achieve 100% throughput (i.e., would handle and store the maximum permitted volume of bulk liquids) beginning in 2017. In reality, a slower ramp-up to 100% throughput is more likely.

Because the baseline risks do not currently include the handling, storage, or transport of large amounts of crude oil, the risk assessment evaluates the additional risks that would result from implementation of the proposed actions beyond existing risks. In general, baseline risks represent the no-action alternative; however, where the factor of time influences the outcome of the analysis (i.e., the existing condition would change over the 20-year analysis period), a distinction is made.

Additionally, Imperium is proposing to handle and store additional bulk liquids. Because it is assumed crude oil would be handled, stored, and transported in the largest volumes, this risk assessment focuses primarily on crude oil; however, differences in the consequences are noted as appropriate.

The risk assessment considers the following parameters in the analysis of the proposed actions.

- Terminal (onsite) operational activities (e.g., rail unloading, bulk liquids storage, and vessel loading) under the proposed actions and the baseline activities that would continue that could result in the risk of crude oil or other hazardous materials releases.
- The identified routes and transportation movements of concern within the study area (e.g., the Puget Sound & Pacific Railroad [PS&P] rail line and Grays Harbor Navigation Channel) related to offsite rail and vessel transport.
- The appropriate accident or failure rates for onsite handling and storage and offsite rail and vessel transport (based on historical accident data and previous analyses).
- The potential for ignition (related to the operational activity and chemical properties of the spilled material).

Using information for the parameters discussed above, the risk assessment determines the frequency of various release sizes given the occurrence of an accident for each operational activity (e.g., onsite handling and storage and offsite rail or vessel transport).

The risk assessment considers the combination of all of these data to develop approximate estimates of different release scenarios compared to baseline risk levels (the no-action alternative). The resulting estimates are most meaningful when compared to each other, as opposed to considering them as predicting absolute frequencies or potential impacts.

2.2 Development of Risk Scenarios

Because of the numerous factors that can affect the environmental outcomes (e.g., extent of a spill, potential for ignition, persistence of released materials in the environment over time), the risk assessment focuses on a specific set of scenarios to frame the discussion of the relative changes in frequencies of occurrence and the potential outcome of each event. The release volumes are based on a combination of regulatory-based response planning cases and the maximum volumes that either are currently or would be handled or stored by Westway or Imperium or transported by rail and vessel operators related to the proposed actions. The scenarios are further informed by the past occurrence of accidents in the study area and across the United States and represent a mix of events that are statistically more probable with those that are theoretically possible but extremely unlikely to occur in the study area. The approach, particularly the data, used to determine the frequencies of various scenarios for the proposed actions and current operations varied by the nature of the activity evaluated. These are first summarized below and then explained in detail in Chapters 3, 4, and 5, as appropriate.

- **Terminal (onsite).** Operational information, including the number of rail car unloadings, vessel loadings, and storage tanks in use, was combined with historical information on failure rates to predict order-of-magnitude frequencies for a limited number of scenarios, particularly those with the potential to release material off site.
- **Rail**. Information on the number of rail transits was combined with Federal Railroad Administration (FRA) data on accidents on the PS&P rail line and across the country, coupled with numerous peer-reviewed analyses of the number of rail cars derailing and failing in accidents. Notably, only half of these events would involve loaded rail cars.
- **Vessel**. Information on the number of vessel transits was combined with available data and analyses on accident rates for vessels maneuvering and in transit. Half of these accidents would involve loaded vessels and half unloaded vessels

In all cases, the purpose of the risk assessment is to demonstrate the relative likelihoods of different releases and to estimate possible impacts, not to make precise estimates of the chance of various impacts occurring in specific locations.

Chapter 3
Terminal (Onsite) Evaluation

3.1 Basis of Analysis

Westway currently has four storage tanks on the northern portion of the project site. Each tank has the capacity to hold approximately 33.6 million gallons (80,000 barrels). Under the proposed action, up to five 8.4-million-gallon (200,000-barrel) tanks would be added to store crude oil. Imperium currently has eight primary tanks, each with a capacity of up to almost 2.0 million gallons (48,000 barrels). Six smaller tanks are used for storing materials such as methanol, sulfuric acid, and sodium methylate. Under the proposed action, up to nine 3.6-million-gallon (80,000-barrel) tanks would be added to store crude oil but could also eventually be used to store other bulk liquids.

While the proposed tanks would be located in containment areas to collect any releases—up to the loss of a full tank plus an additional volume related to storm overflow—that containment could fail, particularly in a catastrophic event that would also affect the containment structure or as a result of a massive tank failure. Smaller failures and piping leaks would remain in the containment and would be collected for disposal.

Onsite operations under the proposed actions would consist of unloading rail cars and loading vessels with crude oil or the other proposed bulk liquids. The vessel loading activities (up to approximately 119 loadings for Westway and 173 to 200 for Imperium, annually) could cause releases directly to the water depending on the extent of the release. Most loading activities involving releases would be shut down very quickly, but there is a chance that the resulting spill would not be fully contained. The rail unloading activities (27,594 cars for Westway and 43,800 cars for Imperium, annually on average) would involve the greatest number of active transfers of oil or other materials given the number of rail cars that must be unloaded on a daily basis. Thus, there is a greater potential for releases because of unloading hose or connection failures during rail unloading compared to the vessel loading, because it takes many more rail cars to fill just one tanker or tank barge.

3.2 Approach and Data

No spillage of oil or hazardous materials into the water has been reported from facility operations since Westway and Imperium began activities in Grays Harbor. One explosion at Imperium was reported on December 2, 2009, when a 10,000-gallon tank containing heated glycerin exploded because of over pressurization (U.S. Environmental Protection Agency 2009; Butorac pers.comm.). The tank was roughly half-full of neutralized glycerin and spread black glycerin compound and metal tank shards over the ground, in and around parts of the tank farm. An adjoining 5,000-gallon tank containing sulfuric acid was also damaged by the explosion, and sulfuric acid spilled into a secondary containment and perimeter walkway around the tank, releasing vapor as it reacted with rainwater and debris within the containment area. No one was injured and no sulfuric acid or glycerin reached the water because of the accident. Air monitoring results were all negative for any sulfuric acid in the air directly over the spill area and in the adjoining neighborhood and businesses.

Predicted release rates for the identified scenarios were based on a number of past studies that analyzed historical data along with guidance published by the United Kingdom's Health and Safety Executive for use in risk assessments (2012; Atherton and Ash 2014). This source is based on a definitive compilation and analysis of numerous databases and past studies. To determine accident frequencies for rail unloading, a combination of historical data and previous analyses, as captured by the Health and Safety Executive, were used to determine the likelihood of a larger release. The failure data for the larger release during vessel loading (10,000 gallons) were based on Health and Safety Executive data as well; smaller loading releases (e.g., 2,100 gallons) were based on the *Vessel Traffic and Risk Assessment Study* for the Gateway Pacific Terminal (Glosten Associates 2014).

The failure rate data applied for each scenario are given in Table 1. These rates are not multiplied by the number of tanks or the number of loadings or unloadings that are anticipated to occur each year related to the proposed actions—that occurs in the next step of the assessment. They are based on historical data and not detailed evaluations of each tank's specific design and safety features.

Table 1. Failure Rate Assumptions for Terminal (Onsite) Operations

Failure Event and Associated Releases	Rate of Occurrence	Notes
Rail unloading release (2,100 gallons [50 barrels])	0.000004 per unloading	Assumes one connection; based on road tanker hoses at average facilities[a] and comparison with other detailed risk assessments
Vessel loading release (2,100 gallons [50 barrels])	0.001 per loading	Per Gateway study (Glosten Associates 2014)
Major vessel loading release (10,000 gallons [238 barrels])	0.000062 per loading	Assumes three loading arms[a]
Pipeline or storage tank release (50,400 gallons [1,200 barrels])	0.0001 per year per tank	Based on large tanks[a]
Catastrophic storage tank failure (3.4 million gallons [80,000 barrels] for Westway) and (2 million gallons [48,000 barrels] for Imperium)	0.000005 per year per tank	Based on large tanks[a]

[a] Health and Safety Executive 2012

The number of storage tanks associated with each proposed action was then multiplied by the failure rate to obtain an estimate of the frequency of a catastrophic failure on site. Because the hazards of seismic and tsunami-related events have been taken into account in the design of the tanks, both existing and proposed, the historical failure rates were not adjusted for these specific hazards. Similarly, the number of tanks was multiplied by the rate for smaller failures to determine the overall estimate of a release each year, and the number of unloadings and loadings were multiplied by the appropriate failure rates to determine the chance of a release from those scenarios.

3.3 Results

Table 2 summarizes the predicted number of releases per year generated for each scenario for the additional number of tanks and loading/unloading activities associated with the proposed actions. Risks attributable to existing operations are not included in these estimates; they may be found in Chapter 7, *Existing Risks*. In other words, these risks are only associated with the proposed actions and are in additional to baseline risks associated with operations at the existing facilities.

Table 2. Predicted Increases in Releases for Proposed Actions—Terminal (Onsite) Operations

Failure Event	Potential Associated Release	Predicted Increases in Frequency of Release (events/year)		
		Westway	Imperium	Cumulative[a]
Rail unloading release due to equipment failure or human error	2,100 gallons (50 barrels)	0.11	0.18	0.38
Vessel loading release due to adverse weather, human error, or equipment failure that affects pipelines or loading arm connections	2,100 gallons (50 barrels)	0.12	0.2	0.38
Major vessel loading release from loading arm failure(s)	10,000 gallons (238 barrels)	0.0074	0.012	0.023
Pipeline or storage tank release due to seismic event with moderate damage or equipment failures and human errors	50,400 gallons (1,200 barrels)	0.0005	0.0009	0.0022
Catastrophic failure of storage tank due to seismic event, tsunami, or construction or material failure	8,400,000 gallons (200,000 barrels) for Westway 3,360,000 gallons (80,000 barrels) for Imperium	0.000025	0.000045	0.00011

[a] Cumulative projects include the proposed Westway, Imperium, and Grays Harbor Rail Terminal projects.

As shown in Table 2, the potential for a catastrophic event substantial enough to result in the release equivalent to the volume of an entire new tank would only very slightly increase by 0.000025 events per year for Westway and 0.000045 events per year for Imperium. The potential for any event that might lead to smaller volume releases (e.g., 50,400 gallons [1,200 barrels]) would also only increase very slightly by 0.0005 (Westway) or 0.0009 (Imperium) events per year. As noted above, the increase in frequency is primarily due to the increased number of tanks on the project site. These estimates assume the tanks are always full. In actual operations, the tanks would slowly be filled from the rail cars and then would be used to fill vessels for delivery off site. Thus, the actual amount of time a tank is completely full would be less than 100% of the time.

As presented in Table 2, implementation of the proposed actions would mean that an event resulting in a 2,100-gallon (50-barrel) release during rail transfers could occur 0.11 (Westway) or 0.18 (Imperium) times per year. Events resulting in a similarly sized release during vessel transfers could occur 0.12 (Westway) and 0.17 (Imperium) times per year. Events resulting in major vessel transfer release (10,000 gallons [238 barrels]) could occur 0.0074 (Westway) and 0.012 (Imperium) times per year.

An alternate way of expressing this is given below. As mentioned previously, the likelihood these events could occur is additional to baseline risks associated with current operations.

- A rail transfer release would be expected to occur once in 9 (Westway) or 6 (Imperium) years but would be expected to remain on site.
- A vessel transfer release[1] cwould be expected to occur once in 8 (Westway) or 5 (Imperium) years. A major vessel transfer release would be expected to occur once in 136 (Westway) or 83 (Imperium) years.
- A 50,400-gallon (1,200-barrel) pipeline or storage tank release into the containment areas (not including very minor leaks) would be expected to occur once in 2,000 (Westway) or 1,100 (Imperium) years.
- Catastrophic failure of a storage tank is quite unlikely, with a release predicted once in 40,000 or 22,000 years, for Westway and Imperium, respectively.

These estimates are based on generic historical data, not detailed examinations of the specific equipment and protective features on site, and are likely to overestimate the chance of release for the equipment mentioned. As noted earlier, they are not inclusive of all the equipment on site, just the largest storage and active transfer (loading and unloading) points.

Cumulative risks from the Imperium, Westway, and Grays Harbor Rail Terminal proposals (referred to as the *cumulative projects*) are listed in the third column of Table 2. These risk reflect implementation of all three projects.

- A rail transfer release would be more likely than a vessel transfer release, once every 3 years but would be expected to remain on site.
- A smaller vessel transfer release could be expected every 3 years, and a major release every 43 years. As noted earlier, most small spills are actually 200 gallons or fewer.
- A 50,400-gallon (1,200-barrel) pipeline or storage tank release would be expected to occur once in 460 years.
- Catastrophic failure of the storage tanks is quite unlikely, with a release predicted every 9,000 years for all three projects combined.

[1] While this smaller release could be up to 2,100 gallons, recent data show that most such spills are actually 200 gallons or fewer.

Chapter 4
Rail Transport Evaluation

4.1 Basis of Analysis

As noted previously, operation of the proposed actions would result in increased rail traffic to and from the project sites. An increase in rail traffic (1.25 trips per day for Westway and 2.0 for Imperium on average) would occur related to the proposed actions and could increase the potential for accidental releases during transit along the PS&P rail line in the study area. Accidents could also occur during switching; however, the speeds are typically so low that the chance of a puncture and release are much lower than during transport. If a release were to occur during switching, it would most likely be a relatively slow release from one rail car. Therefore, release scenarios during switching activities are not considered further in this analysis, except as otherwise built into the accident rates.

The PS&P rail line in the study area covers 59 miles of Track Class 2 lines. All traffic in the study area moves at 25 miles per hour (mph) or less, as per Track Class 2 standards. Several key bridges and areas have lower speed limits: 10 mph over Devonshire Bridge (Wynoochee River) because of bridge condition and 5 mph over the moveable bridges over the Wishkah and Hoquiam Rivers. For conservatism and to match the official designation, this analysis is based on PS&P historical data as well as data for other Class 2 track operations nationwide.

To analyze the potential increase in accidents related to the proposed actions, Table 3 provides the predicted increases in unit trains for Westway and Imperium related to the proposed actions. Table 3 also lists the baseline train traffic levels (i.e., no-action alternative), which include a combination of freight and unit trains. Table 3 also considers the cumulative projects.

Table 3. Existing and Anticipated Rail Traffic Volumes in the Study Area—Cumulative Projects

Facility	Current Number of Trains/Day[a]	Current Number of Cars/Train, (Not Including Locomotives)	Proposed Oil Trains/Day 50% Are Loaded	Proposed Number of Oil Cars/Train (On Average, Not Including Locomotives)
Baseline	3.0–3.1	69.4–69.47[b]	--	--
Westway	Part of existing traffic	Part of existing traffic (approximately 10 cars/day)	1.25	120
Imperium	Part of existing traffic	Part of existing traffic (approximately 12 cars/day)	2.0	120
Westway, Imperium, and Grays Harbor Rail Terminal (cumulative projects)	--	--	4.2	120

[a] There is a minor reduction in the number of trains in the baseline contributions close to the project sites because a few of the baseline trains go to other facilities and do not travel the last few segments to the project sites. This is the reason for the range presented.

Crude oil has typically been transported in DOT-111 rail cars, which are nonpressure tank cars designed to carry a wide range of products, including both hazardous and nonhazardous materials. A somewhat enhanced car, the CPC-1232, is also in service today.

The U.S. Department of Transportation (USDOT) issued a final rule for new tank car design (DOT-117) standards in May 2015, which addressed thickening the walls of the tank car and adding jackets to minimize the chance of side penetrations, the provision of 0.5-inch-thick, full-height head shields to minimize the chance of end penetrations, thermal protection, better relief valves, and better bottom outlet valves. A replacement or retrofit schedule was also provided for the DOT-111 and CPC-1232 cars currently in service. This schedule has been considered when looking at the mix of cars likely to be used for the proposed actions in 2017 versus 2037.

The risk assessment assumed a mix of 50% current jacketed CPC-1232 rail cars (no upgraded CPC-1232s yet, but also no DOT-111s) and 50% new DOT-117s for 2017 conditions, and all DOT-117s under 2037 conditions.

4.2 Approach and Data

Estimating the chance of a release from a rail accident is a two-part process. The first part is to estimate the chance that a train will be involved in an accident, particularly derailments and collisions. The second (nonsequential) part is to estimate the chance of a release given the occurrence of the accident, including both the probability that one or more tank cars will be damaged or derailed and that those cars will release some or all of their cargo. The number of cars derailing and releasing product determines the ultimate spill size.

4.2.1 Spill Sizes and Release Probabilities

In the past, rail accidents involving crude oil or other harmful materials typically resulted in small releases. For example the average petroleum release size of 738 gallons (17.6 barrels), from 2001 to 2012, is based on nationwide spills as reported by in the *Rail Transportation Impact Analysis for Imperium* (WorleyParsons 2014:146) using Association of American Railroads data. However, recent accidents in Lac-Mégantic, Québec; Casselton, North Dakota; Aliceville, Alabama; and Lynchburg, Virginia (Table 4) have been more significant and generated additional attention on crude by rail transportation. A number of additional accidents from late 2014-2015 that resulted in fires or explosions are described in each EIS.

Table 4. Recent and Significant Crude Oil Rail Accidents

Event/Source	Description
Lac-Mégantic, Québec (http://www.tsb.gc.ca/eng/rapports-reports/rail/2013/r13d0054/r13d0054-r-es.pdf)	July 6, 2013: After hand and air brakes on a parked train failed, train rolled downhill reaching a speed of 65 mph before derailing. Almost all of the 63 derailed tank cars were damaged in some way; many had large failures. Roughly 1.6 million gallons (38,000 barrels) of oil were released. Fires and explosions caused 47 fatalities and massive property damage. All cars were DOT-111s.
Casselton, North Dakota (http://www.ntsb.gov/investigations/AccidentReports/Reports/Casselton_ND_Preliminary.pdf)	December 30, 2013: Crude oil train collided with a previously derailed grain car on an adjacent mainline track at roughly 42 mph. Twenty tank cars derailed and 18 were punctured, releasing more than 420,000 gallons (10,000 barrels) of crude oil. No injuries were reported.
Aliceville, Alabama (http://www.ntsb.gov/news/events/Documents/Panel%204_B_Magdy%20El-Sibaie.pdf and http://www.ntsb.gov/safety/safety-recs/RecLetters/R-14-001-003.pdf)	November 7, 2013: Derailment at 38 mph, with 26 cars derailed, Loss of 630,000 gallons (15,000 barrels) with some wetlands contamination.
Lynchburg, Virginia (http://www.politico.com/story/2014/05/oil-train-safety-department-of-transportation-106460.html and Final_EO_on_Transport_of_Bakken_Crude_Oi_05_07_2014.pdf)	April 30, 2014: Derailment of 17 cars, with one car failing, which led to a fire. Three of the derailed crude oil cars ended up in the James River, spilling up to 30,000 gallons (714 barrels) of crude into the river. Later clarification noted that the fire involved a CPC-1232 rail car.

mph = miles per hour

A detailed hazardous materials rail transportation model develop by Arthur D. Little, Inc. for the American Association of Railroads (AAR), the Railway Progress Institute (RPI), and the then Chemical Manufacturers Association considered a range of release sizes to try and bracket the potential range of consequences and allow for the frequencies of different size releases to be determined (Arthur D. Little 1996). That model used data from the RPI-AAR Railroad Tank Car Safety Research and Test Project on the relative frequencies of various release sizes from individual cars as a function of the number of cars derailed in an incident. It then considered the possible combination of releases from multiple cars in order to select representative spill sizes for the model.

In particular, the following spill sizes were used—eliminating the very small releases, as they do not contribute much to overall risk.

- 30 gallons per minute for 10 minutes (300 gallons)
- 300 gallons per minute for 10 minutes (3,000 gallons)
- Single rail car volume spilled instantaneously
- Three rail cars spilled instantaneously
- Five rail cars spilled instantaneously

Given the uncertainty over the likely spill size, this analysis considers a range of potential release sizes and their associated chance of occurrence using the same ranges of spill sizes listed above; however, the first two categories were combined into one spill size of 1,000 gallons (23.8 barrels). Additionally, an extreme case of 450,000 to 900,000 gallons (10,714 to 21,429 barrels) was added, to put such extreme spills in perspective, even though most recent extreme spills occurred at much higher speeds than would be experienced on the PS&P rail line.

In terms of the number of cars derailed, the *Marine & Rail Oil Transportation Study* (Washington State Department of Ecology 2015) found that the number of derailed tank cars per major crude oil accident in 2013 and 2014 ranged from 6 to 30 in the United States and 4 to 63 in Canada. The number of cars that spilled their contents was 1 to 20 in the United States and 0 to 5 in Canada. When looking at derailments, a larger set of accidents can be examined to understand the outcomes because the specific cargo type does not generally affect the chance of a train accident. Also, in general, slower speeds result in fewer cars derailed (Liu et al. 2014).

In addition, the number of cars derailed is not the same as the number of cars releasing, as not all derailed cars will fail, and some will only lose a portion of their cargo. The chance of a release is dependent on the type of rail car, which is more closely related to the cargo (although DOT-111 cars are also used for other liquid cargoes besides crude oil). Thus, detailed risk assessments tend to look at spills in terms of an equivalent number of cars releasing. This was the approach taken in the previously mentioned study and this risk assessment.

Data from the RPI-AAR Railroad Tank Car Safety Research and Test Project also provided information on the probabilities of release for rail cars of different designs and the detailed analysis to determine the chance of different numbers of cars derailing and releasing different quantities of the product carried. Liu et al. (2014) provides a recent description of this approach and gives some representative results. For Class I railroads, 24% of derailments involved one car, 50% involved five or fewer cars, and the overall average was about nine cars. As a group, the Class I railroads operate largely on Class 4 or 5 track, with the associated higher speeds. The same article provided an example of an analysis of DOT-111 rail cars versus the enhanced CPC-1232 design. For the scenario that was modeled (a specific configuration and track class, with a mixed cargo train involving 10 cars of concern) the average conditional probability of release from a DOT-111 car was 0.266, while for a CPC-1232 the same probability was 0.064. The change in chance of release per car also changes the number of cars releasing and therefore the relative likelihood of the spills of different sizes.

This analysis used a combination of these and other data to determine representative distributions of release sizes for the two types of rail cars addressed in the assessment of the proposed actions, given that a derailment or collision has occurred on the PS&P rail line. Table 5 presents these data, which are applicable to both proposed actions. Data are also provided for the existing conditions/no-action alternative, which uses DOT-111 cars and has many fewer cars of interest per train. This limits the potential for the events with many cars derailed and releasing.

Table 5. Representative Probabilities of Different Release Sizes during Rail Transport

Failure Event and Potential Associated Release	No-Action Alternative[a]	2017 Operations[b]	2037 Operations[c]
Minor spill from collision/derailment (1,000 gallons or 23.8 barrels)	0.02	0.08	0.07
Collision/derailment with release equivalent to contents of one rail car (30,000 gallons or 714 barrels)	0.035	0.21	0.17
Collision/derailment with release equivalent to three rail cars (90,000 gallons or 2,143 barrels—equivalent to three rail cars)	0.00054	0.03	0.02
Collision/derailment with release equivalent to five rail cars[d]	Not evaluated	0.0015	0.00066
Extreme collision/derailment leads to release equivalent to 15–30 rail cars[d]	Not applicable	0.0001	0.00005

[a] The release probabilities associated with the no-action alternative assume fewer rail cars of interest per train.
[b] 2017 Operations assumes a mix of 50% current jacketed CPC-1232 rail cars (no upgraded CPC-1232s yet, but also no DOT-111s) and 50% new DOT-117s.
[c] 2037 Operations assume use of all DOT-117 rail cars.
[d] For the proposed operations in 2017 and 2037, the associated release volumes for a five-car release is 150,000 gallons (3,571 barrels) and for the extreme release is 450,000 to 900,000 gallons (10,710 to 21,420 barrels).

4.2.2 Accident Rates

The determination of the chance of a derailment or collision is based on accident rates derived from FRA data finalized through October 2014 (Federal Railroad Administration 2015). Train accident rates were collected for all operations on Class 2 track nationwide, both for mainline operations and for all track including main lines, industry tracks, yards, and sidings. The same data were collected specific to the PS&P rail line.

The PS&P rail line had four derailments in April and May 2014.

- On April 29, two cars derailed at 5 mph at South Washington Street in Aberdeen due to wide gage (track separation).
- On May 9, seven cars derailed at 6 mph at Heron Street in Aberdeen due to wide gage.
- On May 15, 10 cars derailed at 10 mph near Montesano due to thermal track misalignment.
- On May 21, 11 cars derailed at 5 mph at Blakeslee Junction due to a combination of train make-up and track geometry design.

These recent accidents led to an increase in the accident rate on the PS&P rail line in 2014, and for the 4-year average, as shown in Table 6.

Table 6. Accident Rates (per million train miles) for Track Class 2

Subset of Accident Database	2011	2012	2013	2014 (through October 2014)	4-Year Average
PS&P main line only			14.64	49.16	15.95
PS&P total (main, industry, yard, siding)	16.73		13.26	59.31	**22.325**
All mainline Class 2 track nationwide	0.98	0.78	0.86	0.77	0.8475
All Class 2 track nationwide total	2.82	2.4	2.43	2.25	**2.475**

Source: Federal Railroad Administration 2015
PS&P = Puget Sound & Pacific Railroad

Because sidings and industry track on site would be involved, the total rates were of greatest interest. The overall historical accident rates for PS&P are roughly ten times the national average, at 2.2E-5 per train mile. With the changes made by PS&P since the accidents in April and May 2014, and assuming the improvements that PS&P has planned prior to implementation of the proposed actions, a long-term rate of 1E-5 per train mile was applied in this analysis. This is still higher than the national average.

4.3 Results

Applying the distribution of release probabilities, the annual anticipated number of loaded train trips for each project (half of the overall number of trips), the length of the PS&P rail line (59 miles), and the accident rate of 1E-5 per train mile, the anticipated frequency of accidents resulting in the various release scenarios are presented in Table 7.

Related to the proposed action, the likelihood that an accident resulting in a relatively minor release of crude oil or bulk liquids (e.g., 1,000 gallons) would occur is 0.010 (Westway) or 0.016 (Imperium) times per year. Larger events, equivalent to release volumes of one, two, or three rail cars, have the potential to occur 0.028 (Westway) or 0.044 (Imperium), 0.0041 (Westway) or 0.0065 (Imperium), and 0.00021 (Westway) or 0.00033 (Imperium), times per year respectively. The likelihood that an extreme catastrophic events could occur is 0.000014 (Westway) or 0.000022 (Imperium) times per year. The frequency of occurrence would be lower for all scenarios with full implementation of the newer rail cars (shown in the 2037 columns).

Under the proposed actions, the chance of an accident resulting in the various release scenarios ranges from once every 98 (Westway) or 62 (Imperium) years for the smallest release (1,000 gallons) to once every 4,800 (Westway) or 3,000 (Imperium) years for the larger releases (e.g., 150,000 gallons). With the improvements in rail cars, these chances drop to roughly once every 105 (Westway) or 66 (Imperium) years and once every 11,000 (Westway) or 7,000 (Imperium) years, respectively. In addition, a case representative of the most extreme of the recent accidents was modeled. This showed that such an accident might occur within the study area once every 73,000 (Westway) or 46,000 (Imperium) years with the current rail cars, dropping to every 150,000 (Westway) or 93,000 (Imperium) years with the newer rail cars. These are very rough (i.e., higher uncertainty) estimates for the largest spills given the limited data available.

Table 7. Predicted Rail Transport Releases—Proposed Actions and Cumulative Projects

		Predicted Increase in Releases per Year					
		Westway		Imperium		Cumulative[a]	
Failure Event	Potential Associated Release	2017	2037	2017	2037	2017	2037
Minor collision/derailment	1,000 gallons (24 barrels) spill	0.010	0.0095	0.016	0.015	0.034	0.032
Collision/derailment with release equivalent to one rail car	30,000 gallons (714 barrels)	0.028	0.023	0.044	0.037	0.094	0.078
Collision/derailment with release equivalent to three rail cars	90,000 gallons (2,143 barrels)	0.0041	0.0027	0.0065	0.0043	0.014	0.0091
Collision/derailment with release equivalent to five rail cars	150,000 gallons (3,571 barrels)	0.00021	0.00009	0.00033	0.00014	0.0007	0.0003
Extreme collision/derailment with release equivalent to 15–30 rail cars	450,000 to 900,000 gallons (10,710 to 21,420 barrels)	0.000014	0.000007	0.000022	0.000011	0.000046	0.000023

[a] Cumulative projects include the proposed Westway, Imperium, and Grays Harbor Terminal projects.

For the cumulative projects, the chances of an event that would result in the following release scenarios would increase as follows.

- The chance of a minor collision/derailment resulting in the loss of 1,000 gallons (24 barrels) is once in 29 years, with a slight reduction to once in 31 years for 2037 with the full implementation of the more robust cars.
- The chance of a collision/derailment resulting in the loss of 30,000 gallons (714 barrels) is once in 11 years, dropping to once in 13 years.
- The chance of a collision/derailment resulting in the loss of 90,000 gallons (2,143 barrels) is lower, at once in 73 years for 2017 and once in 110 years for 2037.
- The chance of a collision/derailment resulting in the loss of 150,000 gallons (3,571 barrels) is lower, at once in 1,400 years for 2017 and once in 3,300 years for 2037.
- The chance of an extreme event involving a release from a large number of rail cars is predicted as once in 22,000 years for 2017 and once in 44,000 years for 2037.

Within the study area, a number of sensitive areas and habitats are identified. Table 8 lists some of these areas and gives an approximate number of miles for each, where an accident and release could affect the sensitive area. The percentage of the total route represented by each area is also given. This percentage can be applied to the estimated chances of a release size to determine the possibility that a specific release might occur in a particular area. This does not include any further consideration for the extent of the spread of the release, just the expected frequency that an event could occur in the area. For example, the chance of a release equal to one rail car (30,000 gallons) occurring anywhere along the line is once in 36 years for Westway or once in 23 years for Imperium. The likelihood of this occurring near the marbled murrelet critical habitat would be 5% of the total chance or once in 720 (Westway) or 450 (Imperium) years.

Another measure of interest is the increase in the total number of train collisions or derailments—with or without releases. This counts both the loaded and unloaded trains. For Westway there would be an increase of 0.27 accidents per year, and for Imperium there would be an increase of 0.43 accidents per year.

Table 8. Fraction of Route with Sensitive Habitats or Environments

Area of Concern	Approximate Length of Exposure	Percent of Total Route
Three marbled murrelet critical habitat areas	3 miles	5%
Three crossings of bull trout streams that are designated as critical habitat areas	2 miles (approximate exposure considering track leading to and from crossings)	3%
Chehalis River Surge Plain Natural Area	6 miles	10%
• Stretch of Chehalis River that is very close to the rail line and is designated as critical habitat for bull trout • Critical Habitat for the Oregon spotted frog along Black River • Locations adjacent to rail line of two sensitive plant species (multiple locations, but generally between US Route 12 and the Black River crossing area)	10 miles (includes all three areas)	17%

Chapter 5
Vessel Transport Evaluation

5.1 Basis of Analysis

Operation of the proposed actions would result in increased vessel traffic through Grays Harbor. Implementation of the proposed actions could result in up to 238 (Westway) or 346 to 400 (Imperium) additional one-way vessel trips per year, depending on the type of vessel used. This increase in vessel traffic could result in increased potential for accidental releases of oil and hazardous substances, pollutants, and contaminants during offsite transport.

A tank barge or tanker can suffer structural damage and a cargo as the result of a collision with another vessel (assuming the other vessel is sufficiently large); an allision with a fixed structure such as a seawall, jetty, pier, or bridge; or a grounding on a hard or rocky bottom. The evaluation of vessel transport risks considers all three events.

It is anticipated the vessels for the proposed actions would consistent primarily of tank barges but could also include the use of some tankers. For the purpose of the risk assessment, Table 9 gives the number of port calls and vessel transits that could be associated with the proposed actions.

Table 9. Anticipated Vessel Traffic Volumes in the Study Area—Cumulative Projects

Vessel Type	Design Draft (feet)	Vessel Calls to Transport Throughput	Vessel Transits (50% are loaded)
Westway—tank barges	27.5[a]–35	54–**119**[a]	108–**238**[a]
Imperium—tank barges	27.5[a] –35	91–**200**[a]	182–**400**[a]
Grays Harbor Rail Terminal (for cumulative)—Panamax crude oil tanker	39.5	60	120

* Based on operator's proposed vessel size.

The upward bounds of the predicted traffic volumes (bolded values) were used in this risk assessment; however, the lower draft of the smaller vessels would also help to minimize the grounding risk in the navigation channel. For Imperium, a mix of 35 tankers and 138 tank barges was also analyzed. The real concern is for grounding outside of the navigation channel where the damage potential is greater because of the rocky seabed. Thus, the estimated frequencies derived in the results section are considered conservative because there would likely be fewer trips if some of the trips were made by a tanker rather than a tank barge.

5.2 Approach and Data

Estimating the chance of a release from a vessel accident is a two-part process. The first part is to estimate the chance that the accident occurs; the second (nonsequential) part is to estimate the chance of a release given the occurrence of the accident. There are two ways in which vessel accidents have been estimated in the past—the chance of a given vessel experiencing an accident per year, which is useful for large-scale trend analyses, and the chance of an accident for each port call or port/harbor transit or per vessel day. The latter approach was used in this evaluation to understand the increases in release frequencies attributable to the number of vessel calls.

5.2.1 Spill Sizes and Release Probabilities

The evaluation of spill sizes and release probabilities started with a review of local and regional data to understand the spill and accident history that might be applicable to the proposed actions. Table 10 shows a list of the commercial tank vessel incidents in Grays Harbor reported to the U.S. Coast Guard and the state and includes incidents during transfer and transit.

Table 10. Vessel Incidents near Terminal 1 Since 2008

Vessel Name	Year	Incident Type	Comments
T/V *Kohzan Maru II*	2011	200-gallon methanol spill during transfer	Spill went into containment and some spilled onto dock. Incident was reported to the U.S. Coast Guard. No methanol went into water.
T/V *Kokuka Glorius*	2011	Generator failed requiring tug escort to dock, but no release	Methanol tanker had equipment failure on its way into the harbor. Generator failed. The U.S. Coast Guard ordered two tug escort and transit into Grays Harbor in daylight. No material released.
T/V *Steam Voyager*	2008	Grounding without any release	Fully loaded biodiesel tanker grounded in Grays Harbor while turning in navigation channel (near Buoy 11). Vessel lost propulsion while at low speed. Vessel proceeded to anchorage for hull survey, and no damage was found. The vessel was double-hulled.

Reported oil spills reviewed for this analysis were typically from fueling operations associated with small pleasure craft or commercial fishing vessels or hydraulic oil from ruptured hoses. Sheens are also reported to the National Response Corporation, but the amount of oil associated with reported sheens on the water is difficult to estimate and not quantifiable. Overall, oil spills into the waters of Grays Harbor have been infrequent and of small amounts. National Response Corporation data from 2007 to 2014 reflect that the average annual amount of oil reported spilled in the harbor during that time has been approximately 112 gallons (U.S. Coast Guard 2014) (Table 11).

Table 11. Estimated Quantity of Oil Reported Spilled in Grays Harbor

Year	Amount of Oil Reported in Water (gallons)[a]
2007	4
2008	408
2009	20
2010	107
2011	0
2012	325
2013	30
2014	1
Average: 2007–2014	112

Source: U.S. Coast Guard 2014.
[a] Other than sheens

Oil spills from all types and sizes of commercial vessels transiting in the vicinity can pose a risk to Grays Harbor as well as provide an indication of the potential size of major releases. Since 1988, three significant incidents have caused oil contamination along shorelines and impacts on Pacific Northwest wildlife, including one near Grays Harbor. Table 12 summarizes the releases—all of which occurred more than 15 years ago, before double hulls were mandated for tank vessels.

Table 12. Incidents in the Pacific Northwest that Resulted in Major Oil Spills

Year	Vessel Name	Location	Estimated Amount Released into Environment
1988	*Barge Nestucca*	Grays Harbor, Washington	231,000 gallons (5,500 barrels) of bunker C fuel oil
1991	*Tenyo Maru*	Neah Bay, Washington	100,000 gallons (2,381 barrels)—a combination of heavy and light oils
1999	*New Carissa*	Off Oregon coast	70,000 gallons (1,667 barrels) of bunker C fuel oil

The report, *Oil Spill Risk in Industry Sectors Regulated by Washington State Department of Ecology Spills Program for Oil Spill Prevention and Preparedness* (Washington State Department of Ecology 2009), found 14 oil spills from tankers from 1995 to 2008, with a total of 13,709 gallons (326 barrels) of oil spilled. The report also found 14 oils spills from tank barges for a total of 7,002 gallons (167 barrels). Both of these data points indicate that most spills are far less than a full discharge of contents. To represent the distribution of potential spill sizes, only a fraction of the estimated releases were assumed the modeled greatest possible releases; the rest would be expected to be smaller.

The local and regional historical record did not provide the full set of representative spill sizes desired for the study. Working with the Washington State Department of Ecology (Ecology), it was determined that three scenarios and two release sizes would be considered.

- Collision with another vessel during transport causing a spill of 105,000 gallons (2,500 barrels).
- Allision with a fixed object causing a spill of up to 15.1 million gallons (360,000 barrels).
- Grounding with a release of up to 1.2 million gallons (29,000 barrels).

A collision severe enough to result in a release of 105,000 gallons (2,500 barrels) was considered most likely to occur at the Hoquiam Reach or North Channel Reach of the navigation channel based on the layout of the harbor and the nature of the navigation channel. Related to this scenario, it was assumed that only one tank in the vessel would be punctured, releasing some of the contents, but the entire vessel's cargo would not be released. Based on the study area, allisions would be most likely to occur at the jetty entrance and would be more likely to involve the release of the entire vessel over time.

Much of the historical data on release probabilities is not reflective of the required change to double hulls, which are designed to reduce the chance of a release given that an accident (collision, allusion, or grounding) occurs. A number of new studies have tried to estimate the long-term impact of double hulls, including *A Review of Double Hull Tanker Oil Spill Prevention Considerations*, Report to Prince William Sound RCAC (Nuka Research & Planning Group, LLC 2009). This study reviewed the tanker incident database maintained by Ecology for trends associated with the use of double hulls. The observations included a trend toward fewer oil spills, but the authors had difficulty quantifying the benefit of double hulls due to a limited data set. Yip et al. (2011) found that the expected average spill sizes for double-hull tank barges and tankers were 2,933 and 1,218 gallons (70 and 29 barrels), respectively, based on 2001 to 2008 data and their model. They concluded that a double-hull design reduces the size of oil spills in accidents by 62% for tankers and 20% for tank barges.

Glosten Associates (2014) developed release probabilities given the type of accident, as shown in Table 13. The data show that 13 to 22% of the incidents actually resulted in a spill. In the remaining 77 to 88% of the cases, there was no loss of cargo resulting from the accident.

Table 13. Spill Probabilities Given an Incident

	Type of Vessel	
Type of Accident	**Tankers**	**Barges**
Collisions	0.19	0.13
Allisions	0.19	0.13
Groundings	0.2	0.22
Glosten Associates 2014		

A spill probability of 0.2 was used for all types of vessels and accidents. However, as noted, most releases are much smaller than the release scenarios addressed in this analysis. Therefore, the chance of a major release (consistent with release scenarios addressed in this report) was considered to be 20% of the overall release rate presented in Table 13, or 0.04 per accident.

5.2.2 Accident Rates

Accident rate data were reviewed from a number of sources, including the U.S. Coast Guard, various ports, shipping companies, and data gathered for other studies, along with analyses of those data. For example, the Transportation Safety Board of Canada's *Statistical Summary, Marine Occurrences 2013* captured data on marine activity for Canadian commercial nonfishing vessels of more than 15 gross tons, excluding passenger vessels and cruise ships. This data yielded an accident rate of 3.3 accidents per 1,000 movements, down from the 5-year average of 3.9 per 1000. This rate is useful in calibrating U.S. analyses and rates, although it includes all types of accidents, not just those that could potentially lead to an oil spill. No information on spills was provided (Government of Canada 2014).

The International Maritime Organization (2012) found a loss rate of 1.7 per 1,000 ships. As noted, this is more useful for looking at national and international trends. . The study also looked at the ratio of the annual quantity of oil released to the annual amount shipped, and noted significant year-to-year variations.

Glosten Associates' (2014) *Vessel Traffic and Risk Assessment Study* for Puget Sound determined both historical and adjusted accident rates (to account for instances with no historical data). The accident rates were expressed per vessel day and were determined for a number of geographic areas, but not Grays Harbor specifically. The rates for the grouping, including Cherry Point, were applied in this analysis and in the corresponding environmental impact statement after a comparison with other data sources for general consistency. Table 14 presents the rates from the *Vessel Traffic and Risk Assessment Study*. To apply the data, it was assumed that the vessels in Grays Harbor spent one day each way in transit and half of a day maneuvering, which is expected to be quite conservative compared to actual transit and maneuvering times.

Table 14. Failure Rates Assumptions per Vessel Day

Type of Vessel	Tankers	Barges	Tankers	Barges
Type of Accident	*Underway*		*Maneuvering*	
Collisions	1.50E-05	5.40E-04	4.30E-04	2.30E-03
Allisions	1.50E-05	4.10E-05	8.40E-04	1.10E-03
Groundings	6.50E-04	4.10E-05	4.30E-04	8.20E-04

Source: Glosten Associates 2014

5.3 Results

Table 15 presents the estimated increases in the frequencies of a release, using the data presented above for number of vessels per year, accident rates, and release probabilities. No differences between 2017 and 2037 assumptions would affect the results. As mentioned previously, the risk assessment evaluates the risks associated with the additional project-related traffic beyond existing risks.

Table 15. Predicted Vessel Releases—Proposed Actions and Cumulative Projects

Failure Event	Potential Associated Release[a]	Predicted Increases in Releases (Events/Year)		
		Westway	Imperium	Cumulative[b]
Collision with another vessel during transport	105,000 gallons (2,500 barrels) spill with some potential for ignition from collision	0.008	0.014	0.022
Allision with fixed object	Up to 15.1 million gallons (360,000 barrels)	0.0028	0.0047	0.0086
Grounding	Up to 1.2 million gallons (29,000 barrels)	0.0021	0.0036	0.0078

[a] Bakken crude oil, bitumen, ethanol, naphtha, gasoline, vacuum gas oil, jet fuel, No. 2 fuel oil, No. 6 fuel oil, kerosene, renewable jet fuel, renewable diesel, used cooking oil, and animal fat.
[b] Cumulative projects include the proposed Westway, Imperium, and Grays Harbor Rail Terminal projects.

As presented in Table 15, the predicted frequency that a collision resulting in a more substantial release of crude oil or bulk liquids during vessel transit (e.g., 105,000 gallons [2,500 barrels]) could occur is 0.008 for Westway 0.014 for Imperium per year. A more catastrophic event that could, in theory, lead to the release of the entire contents of a vessel plus the fuel (up to 15.1 million gallons [360,000 barrels]) could occur is 0.0028 for Westway or 0.0047 for Imperium per year. Vessel groundings have the potential to result in much smaller releases over time as the material seeps out of a tank and could occur 0.0021 times per year for Westway or 0.0036 times per year for Imperium.

Under the proposed actions, the chance of a collision with a very significant release is roughly once in 120 or 74 years for Westway and Imperium, respectively. The chance of an allision with a full loss of cargo is roughly once in 360 or 210 years for Westway and Imperium, respectively. A significant release from grounding might be approximately once in 470 or 280 years for Westway and Imperium, respectively.

Based on these results, significant releases of oil are not expected to be commonplace but are likely enough to be considered in the spill prevention and response planning. Accidents without a release are much more likely, as they could occur from either a loaded or unloaded vessel in an accident—and because most accidents involving a loaded vessel will not experience a release. The overall additional chance of an accident from the proposed actions (not necessarily involving a release) is estimated as 0.65 accidents per year for Westway and 0.9 to 1.1 for Imperium.

Looking at the predicted cumulative impact, the chance of a release each year increases as follows.

- Once in 45 years for a collision
- Once in 116 years for an allision
- Once in 128 years for a grounding

Chapter 6
Potential Risk of Fire or Explosion

Operation of the proposed actions would generally result in the potential for more frequent releases of bulk liquids relative to existing conditions (although the risk of very large releases remains relatively low). As indicated in the analysis, the likelihood of different release scenarios occurring can differ greatly depending on the specific circumstances of the event (onsite tank failure versus train derailment versus vessel collision).The likelihood of fires or explosions resulting from a spill also differ based on the scenario.

6.1 Terminal (Onsite)

Many of the materials to be handled under the proposed actions are flammable, but they are generally in a liquid and not gaseous form, so they will pool on the ground with only limited vapor generation—particularly compared to other common materials like propane.. The facilities are required to be designed to minimize the chance of fires or explosions of such flammable liquids if a release does occur. Numerous containment areas control or limit where the release can spread; these also minimize the chance of an ignited release impinging on other equipment or getting offsite, via land or water. Shutoffs help to limit the quantity of material that is released. In addition, ignition and possible explosions are limited through a broad range of physical and procedural precautions, as follows.

- Floating roofs to limit vapor generation in confined areas
- Elimination of ignition sources to limit ignition
- Use of nonsparking tools and explosion-proof equipment
- Appropriate separation distances between tanks
- Grounded equipment

Should a release occur, emergency response would address the roles, responsibilities, and actions to take, depending on how much was spilled and where, as well as whether or not ignition has already occurred and there is a fire or explosions to address. Fire suppression and firefighting equipment is located on site.

6.2 Rail

If an accident and release occurs along the PS&P rail line, possible outcomes include an unignited spill that may or may not enter a waterway, a fire that remains contained, or a fire that spreads to other cars and causes a larger fire or explosion or more extensive damage in the surrounding area. In general, the greater the potential for damage, the lower the likelihood such an event would occur.

For the smaller releases (e.g., minor collision/derailment or derailment with spills equivalent to one or three rail cars), there is a chance of ignition, but a greater fraction of releases are not expected to ignite.

Of those releases that do result in a fire or explosion, the fire could engulf or affect other rail cars. As the material in these adjacent rail cars heat up, the pressure would build and may eventually cause other rail cars to fail. This is dependent on the exact configuration of the release and the fire or explosion compared to the location of the other rail cars after the derailment, any fire suppression capabilities, and the timing and nature of response actions. Thus, there is a chance of a small spill escalating into a larger spill due to a fire or explosion.

For the larger spill scenarios—five or more rail car equivalents, the likelihood of the accident having sufficient energy to yield an ignition is greater; for example, closer to 50% or more. The additional number of cars that are derailed in the accident and the additional amount of material released increase the likelihood that ignited cars would affect other rail cars and cause an explosion.

Thus, the likelihood of an outcome involving an explosion or larger fire would be less than the spill frequencies provided earlier and would depend on the number of cars derailing and releasing. The frequencies of the larger spills are lower with more robust rail cars, and the exact specifications of the rail cars would determine just how much lower.

To put recent accidents in context, the chance of an extreme derailment where a more severe fire or explosion also occurs is limited in the study area. This is because the circumstances that would lead to such an event are less likely on the PS&P rail line, primarily because the speeds on the PS&P rail line are so low. Although the rates of accidents on this line are greater than the national average, the nature of the expected incidents are relatively small in magnitude (i.e., a single-car derailment) and are not of the magnitude that would result in multiple car derailments. In general, large derailments lead to releases from multiple rail cars. The energy involved in high-speed derailments and the resulting scatter of rail cars yield the greatest chance of a fire or explosion that is able to affect other rail cars. The energy involved in these larger derailments is what ignites the releases and the subsequent escalation of the event. Furthermore, an additional factor of safety would be provided with implementation of the stronger rail cars that also have thermal protection. The risk of a single event on an annual basis is the same for any given portion of the PS&P rail line. Table 16 restates the results of this analysis on a per-mile basis. These values provide an idea of the risk that an event might occur along any 1-mile segment between Centralia and the project sites. A given community might experience a multiple of this depending on the size of the community (such as a factor of 10 if a community spans 10 miles of track)—which is still less than the total risk for the entire study area.

The overall additional chance of an accident per mile per year for 2017 conditions is once per 440 years for loaded trains and once per 217 years for the combination of loaded and unloaded trains for Westway. For Imperium, the equivalent values are 270 and 140 years.

Table 16. Predicted Rail Transport Releases on Per Mile Per Year Basis—Proposed Actions and Cumulative Projects

		Predicted Increase in Releases per Mile per Year					
		Westway		Imperium		Cumulative[a]	
Scenario	Associated Release	2017	2037	2017	2037	2017	2037
Minor collision/ derailment	1,000 gallons (24 barrels) spill	1.7E-04	1.6E-04	2.7E-04	2.6E-04	5.8E-04	5.4E-04
Collision/derailment with release equivalent to rail car	30,000 gallons (714 barrels)	4.7E-04	3.9E-04	7.5E-04	6.2E-04	1.6E-03	1.3E-03
Collision/derailment with release equivalent to three rail cars	90,000 gallons (2,143 barrels)	6.9E-05	4.6E-05	1.1E-04	7.3E-05	2.3E-04	1.5E-04
Collision/derailment with release equivalent to five rail cars	150,000 gallons (3,571 barrels)	3.5E-6	1.5E-06	5.6E-06	2.4E-06	1.2E-05	5.1E-06
Extreme collision/ derailment with release equivalent to 15–30 rail cars	450,000 to 900,000 gallons (10,710 to 21,420 barrels)	2.3E-7	1.1E-07	3.7E-07	1.8E-07	7.7E-07	3.9E-07

[a] Cumulative projects include the proposed Westway, Imperium, and Grays Harbor Terminal projects.

6.3 Vessel

The outcome of a vessel release is dependent on the circumstances of the accident, particularly the forces involved, and any generation of sparks sufficient to ignite the release. Numerous safety precautions are taken on vessels as required by federal and state law related to spill prevention and safety in general. The precautions fall between those for a facility where the potential spill locations are known and some protective measures can be built into the design and others colocated at the site, and those for rail transportation where the potential spill locations cover a broad area and may have limited accessibility. Vessel accidents can occur anywhere along the transit, but are most likely in certain locations such as near the dock where other vessels may be maneuvering or near the jetties where it is possible to allide with fixed objects.

Vessel accidents that release flammable liquids may not confine vapors to the degree required to result in an explosion, but this depends on the location of the penetration and the proximity of any fire or explosion to other compartments on the barge or tanker.

Chapter 7
Existing Risks (No-Action Alternative)

7.1 Terminal (Onsite) Operations

7.1.1 Basis of Analysis

Westway Existing Operations

The analysis of potential releases for existing operations focused on the larger volumes associated with onsite storage tanks plus the loading/unloading of rail cars and vessels for each proposed action.

Westway receives, certifies, and loads methanol for transport to the end customer. Currently, approximately 36.0 million gallons of methanol are received and 33.3 million gallons of methanol are shipped annually; this will be increasing by roughly 12 million gallons in and out over the 20-year analysis period. Four existing 80,000-barrel (2 million gallons) storage tanks are on the northern portion of the project site. Under existing conditions, these tanks are used to store methanol. In general, methanol arrives at the project site by rail or vessel, is unloaded and stored, and then loaded into tanker trucks or rail cars for transport to the customer. The 2,700 or so truck round trips per year have not been analyzed due to the smaller volumes per truck and the local use of most of the shipments. Any releases during loading are expected to be contained on site.

Typically, there are one to two switch trips on and off the project site each day to deliver and remove an average of 10 rail cars, including the methanol shipped offsite by rail. Thus, there are roughly 1,000 one-way train transits each year, each with up to 10 loaded cars of methanol, for 10,000 loadings/unloadings of rail cars each year. The expansion of the methanol operation is expected to add seven loadings of a rail car per week to the existing trains. These loadings will not add appreciably to the number of loadings/unloadings (350 compared to approximately 10,000).

Expansion of the existing Westway methanol operations under the no-action alternative would increase traffic to 16 vessel calls in 2017 and 27 in 2037, for 16 and 27 loadings and unloadings, respectively.

Imperium Existing Operations

Imperium is permitted for the production of 100 million gallons of biodiesel per year, although actual annual throughput varies due to market conditions. This requires roughly the same volume of vegetable oil feedstock. Both biodiesel and vegetable oil are transported via vessel, rail, and truck. Imperium uses eight primary tanks to store biodiesel or vegetable oil, each with a capacity of up to almost 48,000 barrels. Six smaller tanks are used for storing materials such as methanol, sulfuric acid, and sodium methylate. The methanol reacts with vegetable oil to make biodiesel (when catalyzed by sodium methylate) and the small quantities needed are generally received by truck from Westway. These and other small shipments by truck have not been analyzed.

This process typically results in one to two switch trips onto and off the project site each day, to deliver and remove an average of 12 rail cars. There are roughly 1,000 one-way train transits each year, half of them with 12 loaded rail cars of vegetable oil or sodium methylate. Thus, there are approximately 6,000 unloadings per year.

For Imperium, this analysis assumes that all the biodiesel is transported by vessel. Current projections are that there will be seven vessel loadings per year for both 2017 and 2037.

7.1.2 Approach and Data

The approach and data sources used for the proposed actions, as presented in Chapter 2, were also used for the existing operations with the specific numbers of tanks and rail and vessel transfers described above.

7.1.3 Results

Table 17 summarizes the potential for releases from the tanks and the loading/unloading operations.

Table 17. Predicted Terminal (Onsite) Releases for Existing Conditions

Failure Event	Potential Associated Release	Predicted Baseline/No Action Frequencies of Release (per year)	
		Westway	Imperium
Piping or smaller storage tank failures due to seismic event with moderate damage or equipment failures and human errors	50,400 gallons (1,200 barrels) spill	0.0004	0.0014
Catastrophic failure of storage tank due to seismic event, tsunami, or construction or material failure	80,000 barrel tanks (Westway); 48,000 barrel tanks plus smaller ones (Imperium)	0.00002	0.00007
Rail loading/unloading release due to equipment failure or human error	2,100 gallons (50 barrels) spill	0.04	0.024
Vessel transfer release due to adverse weather, human error, or equipment failure(s) that affects pipelines or loading arm connections	2,100 gallons (50 barrels) spill	2017: 0.016 2037: 0.027	0.007
Major transfer release during vessel loading/unloading	10,000 gallons (238 barrels) spill from loading arm failure(s)	2017: 0.00099 2037: 0.0017	0.00043

These results show that the most likely releases are those associated with the loading and unloading of rail cars and vessels, as was the case for the proposed actions. A release from the rail car loading and unloading for Westway could occur roughly once every 25 years, while for Imperium the corresponding value is every 42 years.

Compared with the proposed action for Imperium, there is a higher risk of an incident under current conditions because there are more tanks; however, the existing tanks are smaller and would therefore have a smaller spill quantity associated with them should a release occur.

7.2 Rail

7.2.1 Basis of Analysis

Under Westway's existing operations, approximately 60% of the incoming methanol arrives at the facility by rail as part of standard freight traffic on the PS&P rail line. Typically, there are one to two switch trips on and off the project site each day to deliver and remove an average of 10 rail cars, including the methanol shipped off site by rail. Thus, there are roughly 1,000 one-way train transits each year, each with up to 10 loaded cars of methanol. The expansion of the methanol operation is expected to add seven loadings of a rail car per week to the existing trains. Westway currently uses DOT-111 and CPC-1232 cars to ship methanol in and out of the terminal. Without implementation of the proposed action, although the number of rail cars received in the future related to the existing operations may increase slightly, they would be similar to existing conditions.

Under existing conditions for Imperium, most vegetable oil and all sodium methylate are transported to the project site by rail via the PS&P as part of the existing freight traffic using DOT-111 rail cars. Imperium typically has one to two switch trips onto and off the project site each day, to deliver and remove an average of 12 rail cars. Thus, there are roughly 1,000 one-way train transits each year, half of them with 12 loaded rail cars of vegetable oil or sodium methylate. Without implementation of the proposed action, although the number of rail cars received in the future related to the existing operations may increase slightly, it is anticipated the numbers would be similar to existing conditions.

7.2.2 Approach and Data

The approach and data sources used for the proposed actions, presented in Chapter 2, *Methods*, and detailed in Chapter 4, *Rail Transport Evaluation*, were also used to analyze the risks associated with existing rail transport and were applied to baseline PS&P rail line traffic related to each project's current operations as described above. As noted in Chapter 4, the accident rate used in this analysis was based on the historical accident rates for the PS&P rail line and considered improvements that have been most recently made to the PS&P rail line. Additionally, this analysis applies the release probabilities presented in Table 5 for the no-action alternative and considers only the relatively smaller releases (three rail cars or fewer). This is because, under existing conditions, the combination of the frequency of trains, the mix of cars per train (tanker cars versus other types of commodities), and the average number of Westway or Imperium tank cars per train (e.g., 10 to 12 cars for one site) makes the probability of greater releases extremely unlikely.

7.2.3 Results

Table 18 presents the expected frequencies of train accidents for existing conditions. It is possible (and likely) that some of the same trains could carry rail cars for both sites, which would reduce the combined chance of a train accident under existing operations; however, because the results were informed in part by the number of individual loaded cars delivered or shipped each day, the results are shown separately. The main difference is that Westway both receives and ships loaded cars, while Imperium has empty rail cars leaving the site. The results for rail transportation are not expected to vary between 2017 and 2037.

Table 18. Predicted Rail Transport Releases for Existing Conditions

		Current Risks (events per year)	
Failure Event	**Potential Associated Release[a]**	**Westway**	**Imperium**
Minor collision/ derailment	Minor collision/derailment (1,000 gallons or 24 barrels)	0.012	0.0059
Collision/derailment with release equivalent to contents of one rail car	Collision/derailment with release equivalent to contents of one rail car (30,000 gallons or 714 barrels)	0.021	0.010
Collision/ derailment with release equivalent to three rail cars	Collision/derailment with release equivalent to three rail cars 90,000 gallons or 2,143 barrels)	0.00032	0.00016

[a] Primarily methanol for Westway and vegetable oil and biodiesel for Imperium as these are the only products currently stored and transported in large volumes.

Under existing conditions, Westway's operations could result in the release of methanol along the PS&P rail line as follows. These risks are higher for Westway, which transports methanol off-site by rail while Imperium mostly transfers its bulk liquids (biodiesel) off site by vessel.

- The chance of a minor collision/derailment resulting in the loss of 1,000 gallons (24 barrels) is once in 85 years.
- The chance of a collision/derailment resulting in the loss of 30,000 gallons (714 barrels) is once in 48 years.
- The chance of a collision/derailment resulting in the loss of 90,000 gallons (2,143 barrels) is once in 3,100 years.

Imperium' current operations could result in the release of vegetable oil or other bulk liquids along the PS&P rail line as follows.

- The chance of a minor collision/derailment resulting in the loss of 1,000 gallons (24 barrels) is once in 170 years.
- The chance of a collision/derailment resulting in the loss of 30,000 gallons (714 barrels) is once in 97 years.
- The chance of a collision/derailment resulting in the loss of 90,000 gallons (2,143 barrels) is once in 6,300 years.

The overall chance of an accident with loaded or unloaded cars (not necessarily a release) is once in 1.7 years on average for both Westway and Imperium. For Westway, all of these accidents could involve loaded cars; for Imperium, the chance of an accident with loaded cars is slightly lower at once in 3.4 years.

7.3 Vessel

7.3.1 Basis of Analysis

Westway currently unloads roughly 40% of its incoming methanol from tank vessels, places it into storage, and distributes it via truck and rail. Recent operations at the project site have resulted in approximately six vessel calls per year (Doucette pers. comm.). However, existing operations vary year to year and expansion of the existing methanol operations under the no-action alternative would increase to 16 vessel calls (32 vessel transits in 2017) and 27 in 2037. These tank vessels are expected to include a mix of tankers and barges.

Imperium is permitted to load finished biodiesel onto rail cars, tanker trucks, or vessels, with the mode of transportation depending on market conditions. Given the greatest potential for offsite potential impacts, this analysis assumes that all biodiesel is transported by vessel. Current projections are for 14 vessel transits (seven vessel calls) per year, similar to the 13 experienced in 2013, for both 2017 and 2037.

7.3.2 Approach and Data

The accident rates and release probabilities discussed in Chapter 2, *Methods*, were applied here for Westway's 16 vessel calls in 2017 and 27 in 2037 and Imperium' 7 vessel calls in both periods. While there may be a mix of tankers and barges, all movements were analyzed using the barge rates, which are higher for all accident types except groundings.

7.3.3 Results

Table 19 provides the expected frequencies of release. Only the Westway results vary from 2017 to 2037. In addition to the expected frequency of a release, the total number of accidents was also estimated. These were 0.087 per year for Westway in 2017 and 0.15 in 2037, and 0.038 for Imperium for both periods. Therefore, while a vessel accident might be predicted to occur every 11 to 23 years for Westway and every 26 years for Imperium, the chance of a release in these accidents is only 10% and the chance of a large release is much smaller as shown in the table.

Table 19. Predicted Vessel Transport Releases for Existing Conditions

Failure Event	Potential Associated Release	Predicted Frequency of Release (Events/Year)		
		Westway		Imperium
		2017	2037	2017/2037
Collision with another vessel during transport	Spill of bulk liquids and potential for ignition	0.0011	0.0018	0.00047
Allision with fixed object	Spill of bulk liquids and potential for ignition	0.00038	0.00064	0.00017
Grounding of vessel	Spill of bulk liquids	0.00029	0.00049	0.00013

Under existing conditions, Westway's operations could result in the release of methanol in the harbor as follows. These risks are higher than would occur related to Imperium because Westway's operations currently have more vessel transport movements of methanol than Imperium does of its bulk liquids (biodiesel).

- The chance of a collision with another vessel resulting in a release during transport is once in 920 years.
- The chance of a vessel allision resulting in a release is once in 2,600 years.
- The chance of a vessel grounding resulting in a release is once in 3,500 years.

Imperium' current operations could result in the release of biodiesel in Grays Harbor as follows.

- The chance of a collision with another vessel resulting in a release during transport is once in 2,100 years.
- The chance of a vessel allision resulting in a release is once in 6,000 years.
- The chance of a vessel grounding resulting in a release is once in 7,900 years.

The overall chance of a vessel accident (with or without release and while loaded or not) is once in 11 years for Westway (2017 conditions) and once in 26 years for Imperium. Accidents involving loaded vessels, not necessarily with a release, occur half as often.

Chapter 8
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