Washington State
2014 Marine and Rail Oil Transportation Study

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Cover photo: Mt. Rainer, oil train, Columbia River, and oil tanker.

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Contents

List of Tables

List of Figures

Abstract

Significant changes in the transportation of crude oil are occurring in Washington State. In particular, transportation methods and oil types have been changing. Historically, 90% of crude oil bound for refineries was delivered by tank ship. In 2014, pipeline and rail delivery made up more than 30% of the oil imports, while vessel delivery was reduced to less than 70%. The properties of some of the oils being transported also raise planning and response concerns.

This report contains the results of the Marine and Rail Oil Transportation Study authorized by the Legislature in April 2014. The objective of the study was to analyze the risks to public health and safety and to the environment associated with the transport of oil in Washington.

In the study, the Washington State Emergency Management Division, surveyed local and tribal planning and fire districts on the readiness of local jurisdictions to respond to an oil-by-rail incident. The Washington State Utilities and Transportation Commission reviewed safety records of almost 350 rail crossings. The Washington State Department of Ecology reviewed oil spill prevention and readiness measures in place at the federal and state levels. The January 2015 Salish Sea workshop was conducted, focusing on oil spill risk in the geographic region of the Salish Sea. Comments from hundreds of people were collected through information-gathering workshops, government-to-government meetings with tribes and tribal organizations, and meetings with communities across the state.

This report contains 43 findings and recommendations for legislative, regulatory, or voluntary actions. The recommendations propose ways to maximize public safety and protect the environment, tribal treaty rights, and the state's natural and economic resources. The report also identifies gaps in information which future studies should address. Seven of the appendices in the report contain detailed information on oil transport by rail, facilities and vessels, spill planning and response, properties of oil, and the fate of oil when spilled.

Acknowledgments

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- Washington Military Department, Emergency Management Division
- Washington State Utilities and Transportation Commission
- Washington State Department of Transportation
- Tribal governments and commissions
- Other federal and state agencies
- Other public and private organizations

Executive Summary

Over the last decade, especially in the past three years, significant changes have occurred in how crude oil is transported through the state. Historically, 90% of crude oil bound for Washington's refineries was delivered here by tank ship from Alaska or from other international sources of oil. Today pipeline and rail delivery of crude oil make up more than 30% of our imports, while vessel delivery is reduced to less than 70%. Crude oil transportation is rapidly shifting to delivery by rail and pipeline, including oil that passes by rail through our rail corridors bound for other coastal states.

Some pipeline and rail oil is delivered directly to the refineries. Some oil is delivered to the refineries in several steps – first by rail to a facility for short-term storage, then loaded onto tank ships for the refineries, or exported out of Washington. If the federal ban on oil exports is lifted on U.S.-produced oil, then crude oil could move through our state to offshore markets. Each added transfer in the delivery chain increases the potential for oil spills.

We estimate that 12.7 billion gallons of crude oil was moved in the United States by rail in 2013. It is difficult to be certain how much crude oil is now moved by rail without required, full disclosure from the rail operators. In 2014, the railroads reported 19 unit trains of Bakken oil moving through Washington each week. Each unit train is made up of as many as 100 cars carrying a total of 3 million gallons of oil. By 2020, this number could increase from 19 to 137 trains a week, if the full build-out of proposed facilities is permitted and the export of oil through our state continues.

The properties of the oils produced today present concerns. Canadian bitumen crude oil in various forms raises spill response challenges. It may sink or submerge in water if spilled, making recovery of the oil difficult. Bakken crude oil has variable and often higher volatility than other forms of crude oil, putting public safety at risk. These hazards came to light in a tragic rail incident in Quebec when 47 people died as an oil train derailed and burned.

The Study Process

This study and the report were authorized by the Washington State Legislature in April 2014.

> *The Washington State 2014 Supplement Budget provided one-time funding for Ecology to conduct a Marine and Rail Oil Transportation Study. The objective of the study is to analyze the risks to public health and safety, and the environmental impacts associated with the transportation of oil in Washington State:*
>
> *$300,000 of the state toxics control account — state appropriation is provided solely for the department to conduct a study of oil shipment through the state. The purpose of the study is to assess public health and safety as well as environmental impacts associated with oil transportation. The study must provide data and analysis of statewide risks, gaps, and options for increasing public safety and improving spill prevention and response readiness.*

The department shall conduct the study in consultation with the department of transportation, the emergency management division of the military department, the utilities and transportation commission, tribes, appropriate local, state, and federal agencies, impacted industry groups, and stakeholders. The department must provide an update to the governor and the legislature by December 1, 2014, and a final report by March 1, 2015.

In June 2014, Governor Inslee issued an Oil Transport Directive to Ecology to act more swiftly in assessing the safety of oil transportation and to provide recommendations sooner.[1]

The Pacific Northwest is experiencing rapid changes in how crude oil is moving through rail corridors and over Washington waters, creating new safety and environmental risks. As petroleum shipments from Alaska decline, transportation of crude oil from the Bakken region via rail is increasing. At the same time, shipments of Canadian crude oil into British Columbia ports are increasing. These shipments also travel through Washington waters. The changing sources and transportation of crude oil bring new risks to our communities along rail lines and to the Columbia River, Grays Harbor, and Puget Sound waters. Since 2008, rail traffic hauling crude oil has increased more than 40-fold nationwide and major accidents have occurred over the past year in both the United States and Canada.

Public interest in this issue is growing, and an increasing number of Washington State communities are calling for improved safety measures. Public safety is of paramount concern to our residents, citizens, and local governments. While the State will do all it can within its authority to ensure that safety, the Federal government must also exercise its authority to improve the safety of oil transported by rail. In addition, both governments must work to enhance our collective ability to prevent and respond to spills that can harm our natural resources.

This directive outlines key components to be addressed by State agencies in their charge to assess the safety of oil transportation in Washington. With respect to the transportation of oil by rail within Washington State, the Department of Ecology, in consultation with the Department of Transportation, Utilities and Transportation Commission, Washington Military Department's Emergency Management Division, the Federal Railroad Administration, and Tribal governments, will:

- *Characterize risk of accidents along rail lines.*
- *Review State and Federal laws and rules with respect to rail safety and identify regulatory gaps.*
- *Assess the relative risk of Bakken crude with respect to other forms of crude oil.*
- *Identify data and information gaps that hinder improvements in public safety and spill prevention and response.*

[1] http://www.governor.wa.gov/sites/default/files/directive/dir_14-06.pdf.

- *Begin development of spill response plans for impacted counties.*
- *Identify potential actions that can be coordinated with neighboring States and British Columbia.*
- *Identify, prioritize, and estimate costs for State actions that will improve public safety and spill prevention and response*

In advance of its update to the Legislature, the Department of Ecology will prepare a draft report with initial findings and recommendations by October 1, 2014, that addresses these and any other issues necessary to ensure public safety and environmental protection with respect to the transportation of oil in Washington State. The Department of Ecology will also propose a strategy for consideration in the Governor's 2015-17 Budget to meet funding needs that would increase the safety and spill response and prevention capacity related to transportation of oil by rail.

The concerns of Washington citizens with respect to the safe transportation of oil through our State must be re-examined in light of the rapid changes taking place. This directive will help ensure that we respond to these changes to protect our communities and environment.

The Military Department Emergency Management Division (EMD) conducted a survey of Washington fire districts for this study. EMD reports that 59% of districts believe that they are not sufficiently trained and lack the resources to respond to a train derailment accompanied by a fire. The Utilities and Transportation Commission (UTC) reviewed records of almost 350 rail crossings for this study. UTC finds that in general most crossings are protected at appropriate levels, but they found a number of crossings at higher risk of derailment. The Department of Ecology (Ecology) looked at oil spill readiness and made recommendations to reduce damages as the risk of oil spills shifts.

The study team used existing information to reach recommendations for legislative, regulatory, or voluntary actions that maximize public safety and the protection of the environment, tribal treaty rights, and the state's natural and economic resources. The team also identified gaps in information.

The Study Results

A list of 43 findings and recommendations is discussed in detail later in this report. A shorter list of key legislative or budget recommendations that can be acted on quickly are highlighted in the Executive Summary. The recommendations are prioritized based on additional protection they provide, their technological achievability, and their cost. Where possible, we note which actions can be accomplished within current resources and which will require additional funding (with an estimated cost or range of costs).[2]

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[2] Numbers are rounded to the thousands per biennium. FTEs are biennialized. These are the agency's best estimates at this time. These numbers will be refined as we move through the budget process.

The Executive Summary also highlights a prioritized list of recommendations to the federal government. For both marine and rail oil movement, the ability for a state to set operational or safety standards is limited or pre-empted by the jurisdiction of the federal government. In this report, we encourage the federal government to be an active partner in making these recommended changes.

Key Recommendations to the Washington State Legislature for the 2015-17 Biennium

1. Consider funding options to adequately fund Washington's Spill Prevention, Preparedness, and Response Program.
2. Modify the railroad regulatory fee structure. It should allow the UTC to fund additional inspector positions, including the Federal Railroad Administration (FRA)-certified inspectors with increased pay that is competitive with comparable private sector and federal inspectors. As part of this, the certified inspectors would increase inspections in the areas of track, hazardous materials, operating practices, motive power and equipment, and crossing signals. (8 FTEs, $2.5 million)
3. Amend statutory authority to allow UTC inspectors to enter a private shipper's property to conduct hazardous material inspections related to rail operations. This would require no additional resources.
4. Ensure permanent ongoing funding for three Ecology planners. This would allow Ecology to develop new, and maintain existing, geographic response plans for inland and marine areas at risk from oil spills. (3.5 FTEs, $777,000)
5. Ensure permanent funding for assessing oil transportation risks. This would keep agencies informed on the changing energy picture and its potential effect on public health and safety and environment. Additional funding is needed to support the expansion of Vessel Traffic Risk Assessment (VTRA) to Grays Harbor, the Columbia River, the outer coast, changes in Puget Sound, and the development of a Rail Traffic Risk Assessment (RTRA) model to analyze changes to the rail transportation system. (2.3 FTEs for risk assessments, $577,000, and $500,000 for the VTRA and RTRA)
6. Enhance and provide for a continuous supply of oil spill response equipment and local first responder firefighting equipment. Direct Ecology to develop a grant program for firefighting equipment and working with local responders to develop rules for the administration of the program. Provide ongoing funding and staffing to administer the program, maintain existing equipment, and provide periodic training to first responders. (4.6 FTEs, $4.6 million)
7. Require the State Emergency Response Commission (SERC) to modify regulatory authority requiring Local Emergency Planning Committees (LEPC) to submit hazardous materials plans and updates on a five-year cycle basis for compliance reviews. Plan updates should address new hazards not discussed in previous plans. (10 FTEs, $2.5 million)

8. Amend statutory authority to allow designated "first-class cities" to join the UTC's railroad crossing inspection and enforcement program. Grant the UTC jurisdiction to require that first class cities inform the UTC when crossings are opened or closed. (0.75 of the eight FTEs described in Recommendation 2, funded by the increase in regulatory fees)
9. Provide funding for the UTC to conduct railroad and road authority diagnostic reviews of high-risk crossings. Create new statutory authority to give UTC jurisdiction over private road crossings on the primary railroad routes, including those over which crude oil is transported. This would allow the UTC to establish minimum safety standards, including appropriate safety signage. (1.25 of the eight FTEs described in Recommendation Number 2, funded by the increase in regulatory fees)
10. Modify the definition of "facility" in statute to include moving trains carrying oil as cargo. Direct Ecology to develop regulations that require rail oil spill contingency plans and participation in drills. (2.5 FTEs, $608,000) Other related legislative amendments to include are: (1) modifying the statute to require operators of railroads and pipelines to submit advance notice to the state, identifying the volume and characteristics of oil being transferred at facilities (1.6 FTE, $348,000), (2) extending the concept of Best Achievable Protection (BAP) as a regulatory standard to all facilities handling oil, and (3) modifying the definition of oil to include all types of oil. These last two amendments would be performed with current resources.
11. Modify statutory authority to extend financial responsibility requirements to rail and mobile facilities and enable Ecology to modify the regulations on financial responsibility requirements. By requiring Certificates of Financial Responsibility[3], Ecology can ensure that companies transporting oil through the state can pay for cleanup costs and damages from oil spills. (8.2 FTEs, $1.8 million).

12. The Washington Pilotage Commission should undertake an analysis with the Harbor Safety Committees, U.S. Coast Guard, Ecology and the state of Oregon, and consider rulemaking on expanding requirements for escort tugs and/or other safety measures for tank vessels including articulated tug and barges (1.2 FTE, $379,000).

13. Direct Ecology and the fire marshal's office to analyze the need for hazardous materials response teams. This analysis should consider team composition, equipment and training, locations, funding mechanisms, and statewide coordination. Part of this analysis should include development of a startup and recurring cost estimates for such teams. (0.3 FTE, $321,000).

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[3] A program created to ensure that tankers, barges, and other vessels used to transport oil and chemical-based products on U.S. should bear any ensuing cleanup costs from spills or leaks; this is based on the Oil Pollution Act of 1990 (OPA90) and other environmental statutes.

Key Recommendations for the Federal Government

1. Following full implementation of the Bakken Crude Oil Conditioning Standard on April 1, 2015, the Northwest Area Committee should conduct sampling of Bakken crude oil transported through Washington and perform analysis to characterize the hazards presented to first responders. The results and potential health/environmental threats should be communicated to Washington response organizations.
2. The FRA and the Pipeline Hazardous Materials Safety Administration (PHMSA)[4] should establish tank car standards with the most stringent requirements, and older model tank cars should be phased out for use in transporting Class 3 flammable liquids within two years.
3. The FRA and PHMSA should require that the threshold for comprehensive oil spill plans for rail be set at 3,500 gallons, equivalent to the current requirement for basic oil spill plans.
4. The United States Coast Guard (USCG) should establish a long-term waterways management plan to accommodate increased vessel traffic and an appropriate vessel traffic service for the waterways of Grays Harbor, Columbia River, the Salish Sea and the outer coast.
5. The USCG and Harbor Safety Committees[5] should analyze and evaluate prospect of limiting or moving bunkering activities to locations at which enhanced prevention and preparedness capabilities exist or could be established.
6. Congress should work with the Internal Revenue Service and clarify that the revenues for the Oil Spill Liability Trust Fund include oil sands oils.

Changes to the report since the December 2014 draft publication

Some changes in this final report since the publication of the draft report in December include an update on the occurrences of rail derailments in North America, including the February oil train derailment, fire and spill in West Virginia. There is also new information on five incidents of leaking rail cars reported in Washington, the details of which are under investigation at the time of this report. There is additional information on the changes made in North Dakota to remove lighter, volatile hydrocarbons to make Bakken oil safer to transport by railroad. And a new appendix to the report has been added with the results of the Salish Sea Workshop conducted in January 2015. The appendix includes the Salish Sea handbook which was prepared to connect findings, and recommendations from previous Salish Sea studies and for developing actionable

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[4] An agency within the US Department of Transportation that is responsible for establishing and enforcing requirements, including the design of railroad tank cars carrying crude oil, for the safe transport of hazardous materials by all modes of transportation. PHMSA was created in 2004 to provide US Department of Transportation a more focused research organization and establishing an operating administration for the inspection and enforcement of requirements for pipeline safety and hazardous materials transportation.

[5] Harbor Safety Committee: a proactive forum for identifying, assessing, planning, communicating, and implementing those operational and environmental measures, beyond that which is in laws or regulations, that promote safe, secure, and efficient use of relevant waterways, harbors, or ports. The committee is generally made up of delegates appointed by broadly based organizations representing a span of interests with various governmental agencies formally supporting its work in advisory capacities.

recommendations to enhance public safety and environmental protection. The workshop had a goal of connecting findings, and recommendations from previous Salish Sea studies and developing actionable recommendations to enhance public safety and environmental protection.

Ecology and the study team received comments from over a thousand people through workshops, tribal meetings, and meetings with communities across the state. Concerns were voiced over increased oil production and movement, in particular shale crude oils from the Bakken region in North Dakota and Montana, and bitumen oil from Canada. The team also heard concerns about notification to the public and response agencies from railroads of their disaster preparedness plans and the volumes of oil they move through the state. A summary of the most frequently heard comments and the study team's response to those comments will be published and made available March 2015. Copies of the comments received during development of this report are available upon request to Ecology.

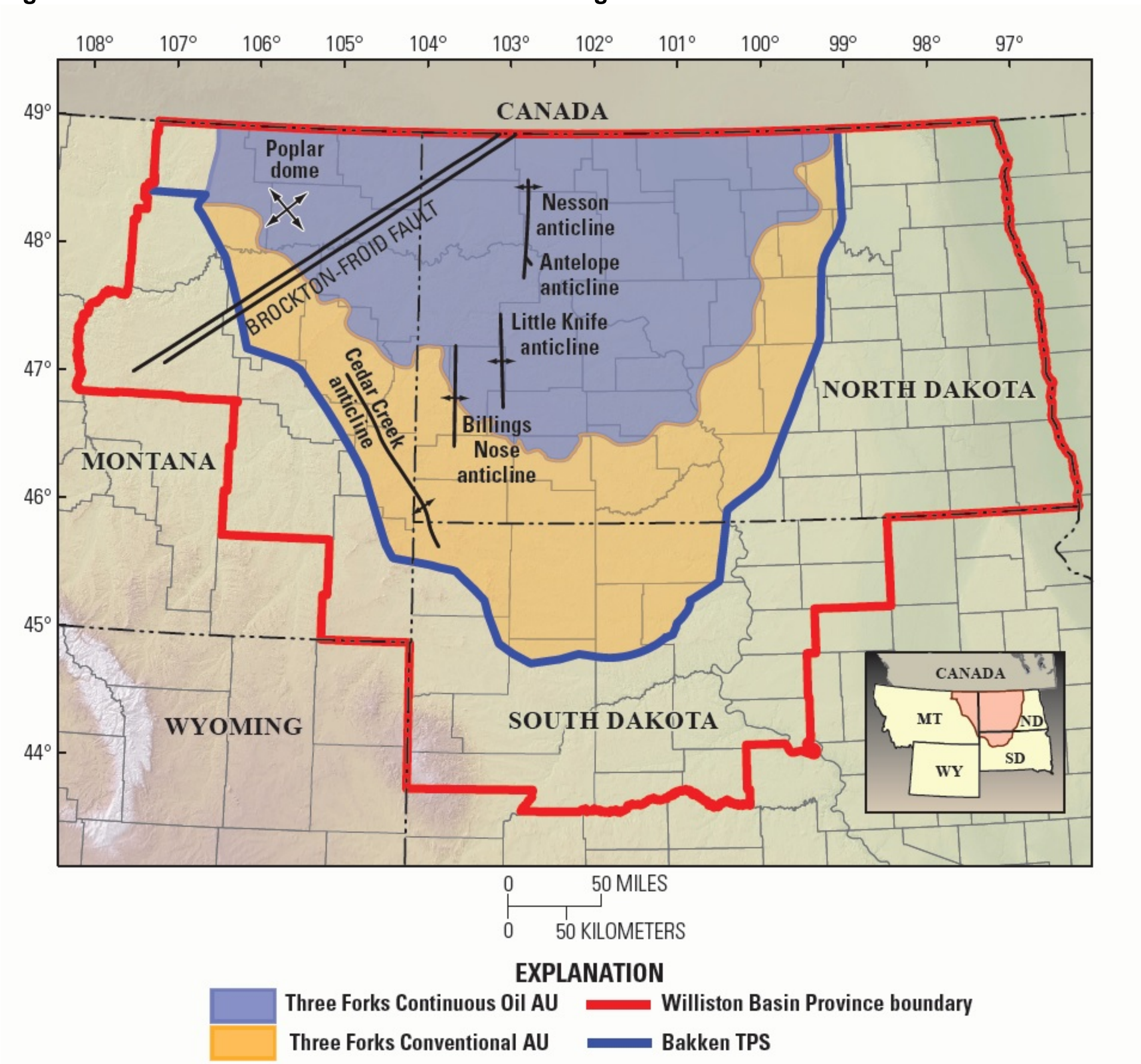
Updates on future actions associated with study recommendations can be found on the Ecology website at www.ecy.wa.gov/programs/spills/OilMovement/2014MRstudy.html.

The Changing Oil Transportation Picture

National Changes in Oil Production and Transport

The changing landscape of crude oil exploration and drilling, together with economic considerations and availability of various types of crude oil, have made Bakken crude oil the largest growing segment of crude oil entering the state. Bakken crude oil comes from the Bakken Formation in the Williston Basin, which is one of the largest contiguous deposits of oil and natural gas in the United States. It is located in northwestern North Dakota, northeastern Montana, southern Saskatchewan, and southwestern Manitoba (Figure 1).

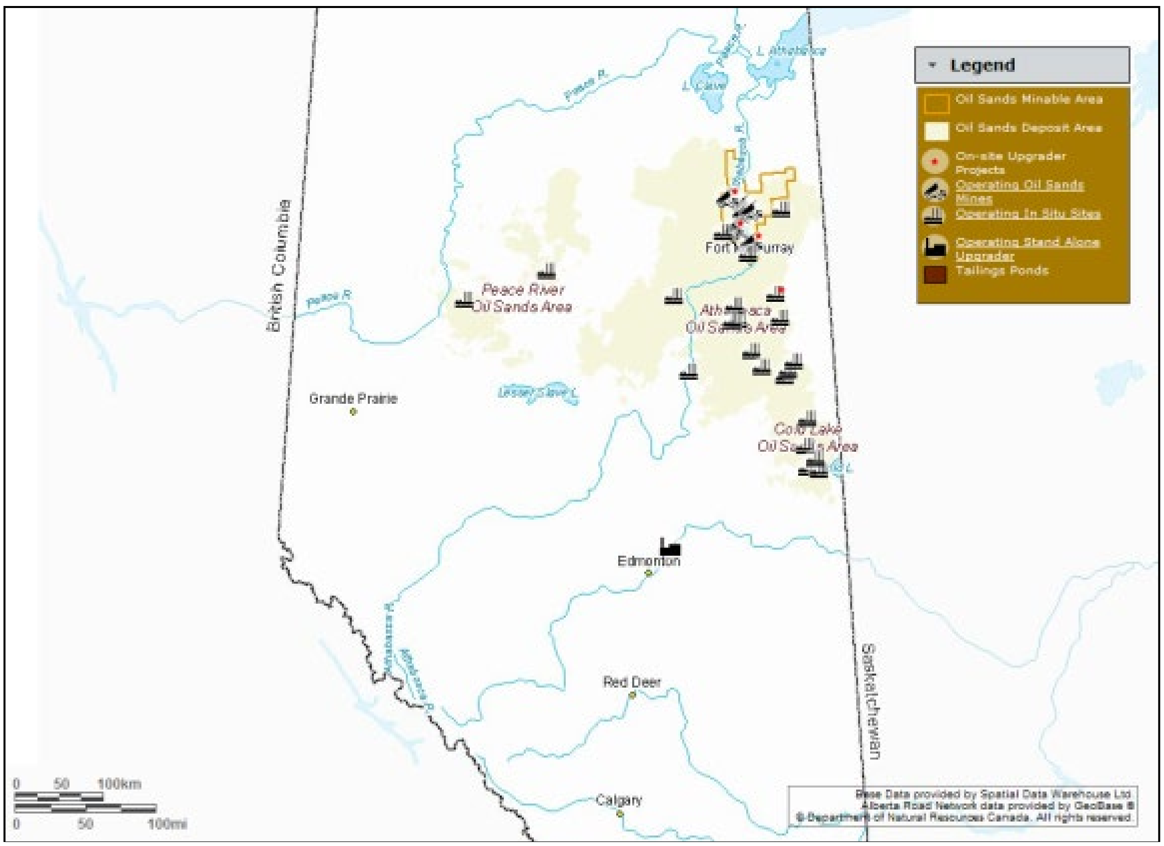
Figure 1: Bakken Formation in Williston Basin. Image source: USGS



The U.S. Geological Survey Assessment for the Bakken Formation estimates undiscovered volumes of 3.65 billion barrels of oil and 148 million barrels of natural gas liquids in the U.S. portion alone.[6] The Canadian portion of the Bakken Formation contains additional resources and is one of the largest oil fields in Canada. North Dakota crude extraction increased more than 11 times between 2003 and 2013 – from 3.4 million gallons to 37.8 million gallons per day.[7] There are more than 10,000 active wells in the Bakken Formation[8] with an estimated potential increase to 35,000 or 70,000 wells in the next ten years.

During this same time period, production of Canadian oil sands oil, which is converted to diluted bitumen (sometimes referred to as “dilbit”) has increased 2.5 times, from 36.2 million gallons to 73.5 million gallons per day (Figure 2).[9]

Figure 2: Oil Sands Mines in Alberta, Canada[10]. Image source:



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[6] National Assessment of Oil and Gas Fact Sheet, Assessment of Undiscovered Oil Resources in the Bakken and Three Forks Formations, Williston Basin Province, Montana, North Dakota, and South Dakota, 2013.
[7] US Energy Information Administration http://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbbl_a.htm
[8] http://bakkenshale.com/drilling-rig-count/bakken-rig-count-175-production-approaching-1-million/
[9] Statistical Handbook for Canada’s Upstream Petroleum Industry, Canadian Association of Petroleum Producers, http://www.capp.ca/GetDoc.aspx?DocId=241200&DT=NTV.
[10] Department of Natural Resources Canada.

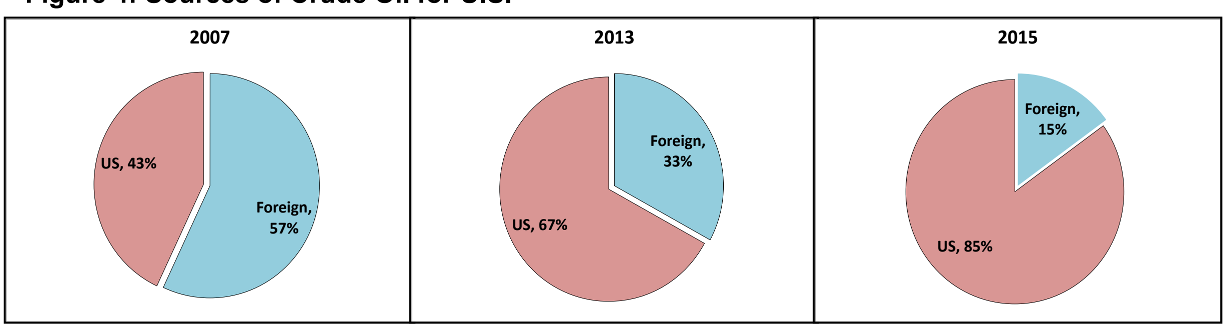
With new technologies for extracting shale oil, additional crude oil production is occurring or being planned or evaluated in Utah, Colorado, Wyoming, Arizona, New Mexico, Pennsylvania, and New York (Figure 3).

The increase in U.S. petroleum production has shifted so dramatically in the last six years that the nation now produces most of its own oil and has decreased dependence on oil imports (Figure 4). In 2011, the U.S. produced 5.5 million barrels (231 billion gallons) of oil per day. By 2015, that amount is expected to increase 1.7 times, to about 382 billion gallons per day.

Figure 3: North American Shale Plays. Image source: U.S. EIA (May 2011)[11]

Source: U.S. Energy Information Administration based on data from various published studies. Canada and Mexico plays from ARI.
Updated: May 9, 2011

Figure 4: Sources of Crude Oil for U.S.[12]

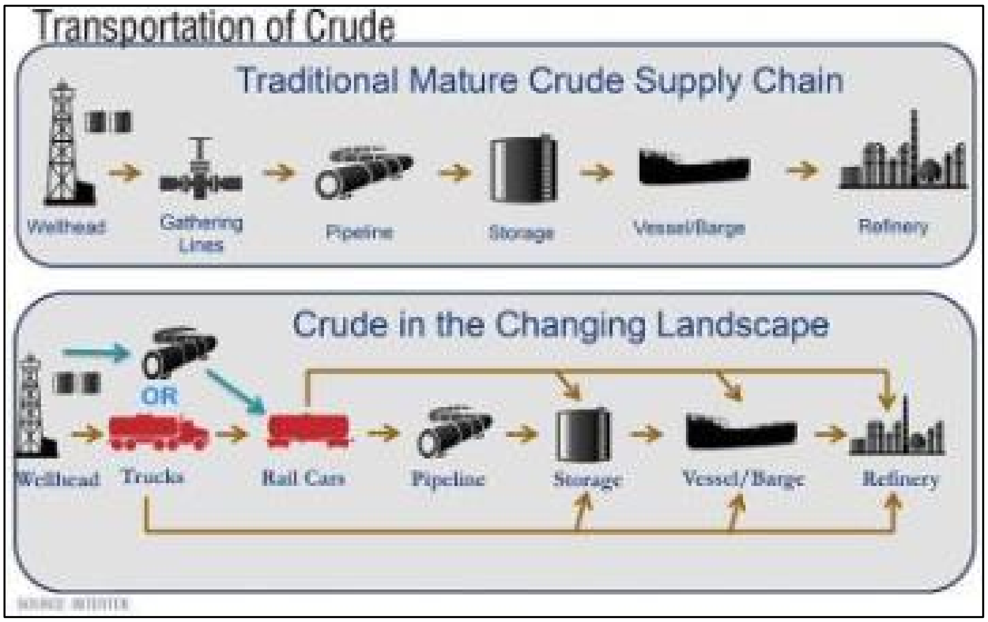


[11] Source: US Energy Information Administration. "Shale plays" are geographic areas that have been targeted for oil and gas exploration and production due to favorable geoseismic survey results or other data.
[12] US Energy Information Administration.

Limited numbers of pipelines serve the Bakken Formation to transport crude oil to other parts of the U.S. or within Canada. While some of this crude oil is moved by pipeline, much is transported by rail tank cars in freight trains containing exclusively oil tank cars (called *unit trains*).[13] The increase in U.S. crude oil production has strained the capacity of existing oil pipeline infrastructure and caused a sudden shift in the supply chain[14] to transport by rail. The change in the supply chain is depicted in Figure 5.

In 2013, an estimated 11.8 billion to 12.7 billion gallons of oil were shipped by railroad through the U.S.[15] This represents a 42-fold increase in national oil transportation by rail since 2008.

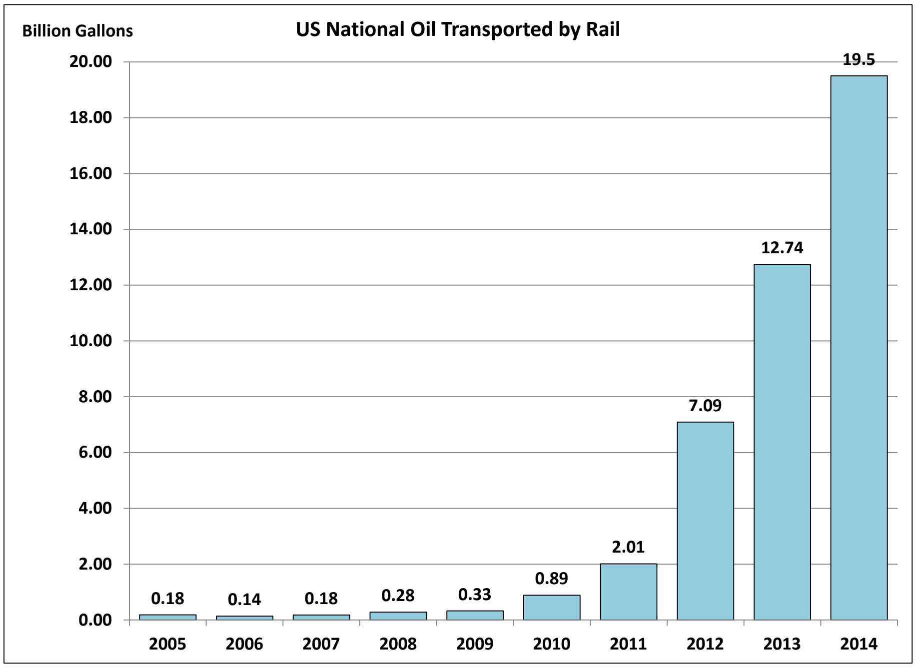
Figure 5: Changing Modes of Transporting Crude Oil



By the end of 2014, 650,000 carloads are expected to carry 19.5 billion gallons of crude oil through the U.S.[16] This means that the number of crude oil-containing rail tank cars would have increased over 108 times in the last seven years.[17] The changes in U.S. oil transport by rail from 2005 to 2014 are shown in Figure 6.

[13] A train in which all cars carry the same commodity and are shipped from the same origin to the same destination, without being split up or stored en route (also called "block train"). The term "unit trains" can also be used for other single-commodity freight trains.
[14] A system of organizations, people, activities, information, and resources involved in moving a product or service from supplier to customer; supply chain activities transform natural resources, raw materials, and components into a finished product that is delivered to the end customer.
[15] Fritelli et al. 2014
[16] Hamberger and Black 2013.
[17] Source: Association of American Railroads.

Figure 6: Increase in U.S. Oil Transport by Rail 2005 – 2014



Crude Oil Types Transported by Rail

Bakken oil and diluted bitumen from "oil sands" are examples of two common, but fundamentally different, crude oils being transported by rail. Their basic properties are summarized in Table 1.

Table 1: Basic Properties of Example Types of Crude Oil Transported by Rail[18]

Property	Diluted Bitumen	Bakken Crude
Origin	Alberta, Canada ("oil sands").	North Dakota, Montana; and Saskatchewan, Manitoba, Canada.
Density	Some portions heavy.[19]	Light to medium.[20]
Flammability/Volatility	Higher; dependent on diluents.[21]	Higher than other crudes.
Persistence	Relatively higher than other crude.	Lower than other crudes.
Toxicity	Variable, depending on diluent.	High for a crude oil.
Behavior if Spilled in Water	May break down and submerge or sink, especially in contact with sediment in turbulent waters.	Dissolves, evaporates.

For Bakken crude, the greatest concerns are the potential volatility or flammability of the oil and the higher potential for groundwater intrusion due to its solubility. These properties create the potential for public safety, environmental and health risk. A recent report from the

[18] Properties relative to other types of crude oil, such as West Texas Intermediate crude which is used as a standard.
[19] Compared with West Texas Intermediate. Diluted bitumen has specific gravity of 0.925 (API° 21.5).
[20] Compared with West Texas Intermediate. Bakken crude has specific gravity of 0.845 – 0.806 (API° 36 – 44).
[21] Diluting or thinning agent; the commonly-used diluent, condensate, has a higher volatility.

Transportation Safety Board of Canada[22] shows that Bakken oil produces flammable vapors at temperatures as low as minus 31°F, which is similar to gasoline.

For diluted bitumen, the greatest concern is the heavier portions of bitumen that may not be lighter than water, causing it to either be neutrally buoyant or sink when spilled. Diluted bitumen has been transported in Washington State for decades, mainly via pipeline. Transport by rail is relatively new. Diluted bitumen is created from oil sands, which is similar to asphalt. The bitumen product is mixed with diluents, to reduce viscosity for ease of transportation. Various formulations of diluents are used at different times of year, depending on temperature and availability, though one common diluent is natural gas condensate. Although much less frequent, heated bitumen[23] without diluent can be transported by rail tank car.

The risk of sinking oil is especially high if sediment and turbulence in the water are high, as in a fast-moving stream. This sinking behavior was observed during the response to the July 2010 Enbridge Pipeline Kalamazoo River.

Changes in Oil Transport in Washington State

The capacity of Washington's refineries has not substantially changed over the last decade. Annual crude oil imports remained steady in volume at about 8.5 billion gallons. The mode of transportation has shifted away from tank vessel[24] to increases in pipeline and rail tank car. Washington State crude oil imports over the last decade by mode, are in Table 2 and Figure 7.

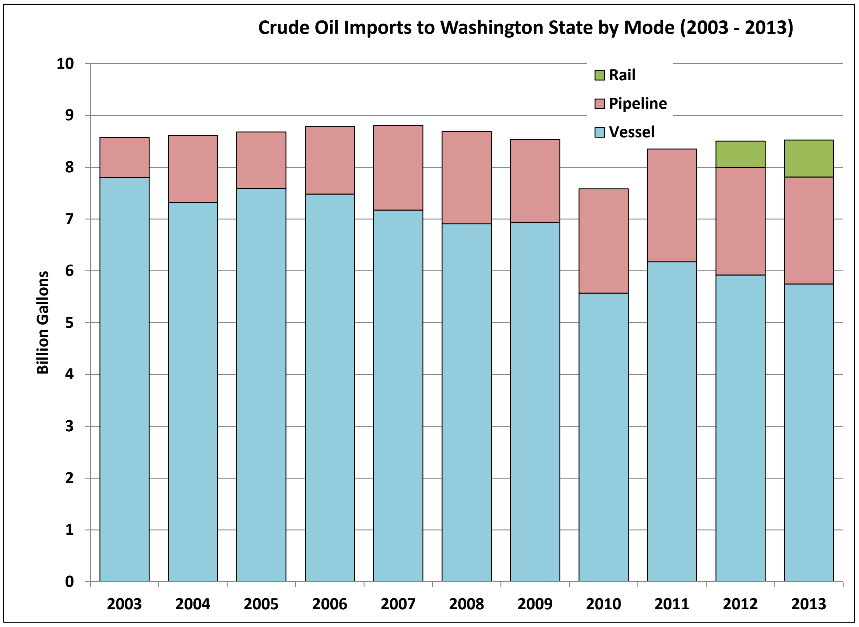
Table 2: Estimated Annual Oil Imports by Mode of Transportation into Washington State[25]

Year	Billion Gallons				% Total		
	Vessel	Pipeline	Rail	Total	Vessel	Pipeline	Rail
2003	7.8030	0.7753	0.0000	8.5783	91.0%	9.0%	0.0%
2004	7.3171	1.2929	0.0000	8.6100	85.0%	15.0%	0.0%
2005	7.5884	1.0919	0.0000	8.6803	87.4%	12.6%	0.0%
2006	7.4826	1.3079	0.0000	8.7905	85.1%	14.9%	0.0%
2007	7.1744	1.6338	0.0000	8.8083	81.5%	18.5%	0.0%
2008	6.9090	1.7784	0.0000	8.6875	79.5%	20.5%	0.0%
2009	6.9398	1.5992	0.0000	8.5390	81.3%	18.7%	0.0%
2010	5.5713	2.0129	0.0000	7.5842	73.5%	26.5%	0.0%
2011	6.1756	2.1769	0.0000	8.3525	73.9%	26.1%	0.0%
2012	5.9210	2.0756	0.5092	8.5057	69.6%	24.4%	6.0%

[22] Transportation Safety Board of Canada. 2014. *Runaway and Main-Track Derailment: Montreal, Maine & Atlantic Railway Freight Train MMA-002 Mile 0.23, Sherbrooke Subdivision, Lac-Mégantic, Quebec, 6 July 2013*. Transportation Safety Board of Canada Railway Investigation Report R13D0054. 191 p.
[23] Bitumen needs to be heated so that it can flow during transfers into and out of the rail tank cars and at facilities.
[24] In 2013, 70% of the crude imported into Washington by tank vessel was from Alaska, 20% from foreign sources (not Canada), 3% from Canada, and 6% tank barge and ATB carrying Bakken crude.
[25] Ecology data; based on shipping data from Washington State Petroleum Association for 2003-2007, and Advanced Notice of Transfer (ANT) data for 2008-2013. Pipeline data from Washington State Department of Commerce, as reported by TransMountain Pipeline. Rail data estimated based on refinery throughput data, ANT data, pipeline throughput for refineries, predicted volume transported by rail reported by refineries, and estimated increases in total crude transported through the state.

Year	Billion Gallons				% Total		
	Vessel	Pipeline	Rail	Total	Vessel	Pipeline	Rail
2013	5.7480	2.0652	0.7128	8.5260	67.4%	24.2%	8.4%
Total	74.6302	17.8100	1.2220	93.6621	79.7%	19.0%	1.3%

Figure 7: Crude Oil Imports into Washington State by Mode 2003 – 2013



As shown in Figures 8 and 9, there has been a shift in the transport mode away from vessels to pipelines and rail. These data do not include the transport of refined petroleum products. A more detailed breakdown of types of crude oil being imported into the state for the last three years is in Figure 10.

Figure 8: Comparison between Oil Transport Modes in Washington 2003 and 2013

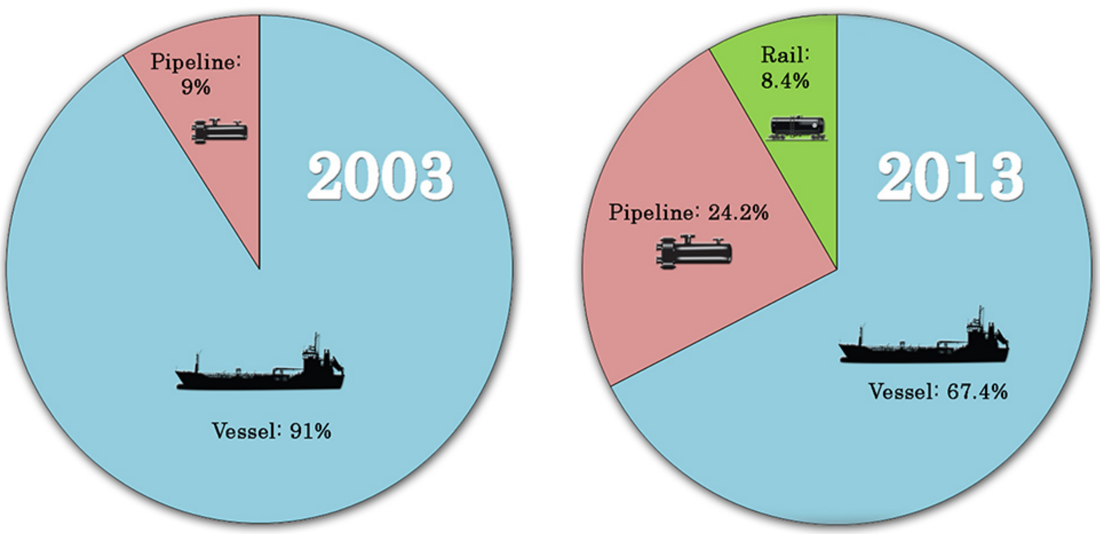


Figure 9: Changes in Crude Oil Import Transport Mode in Washington State 2003 – 2013

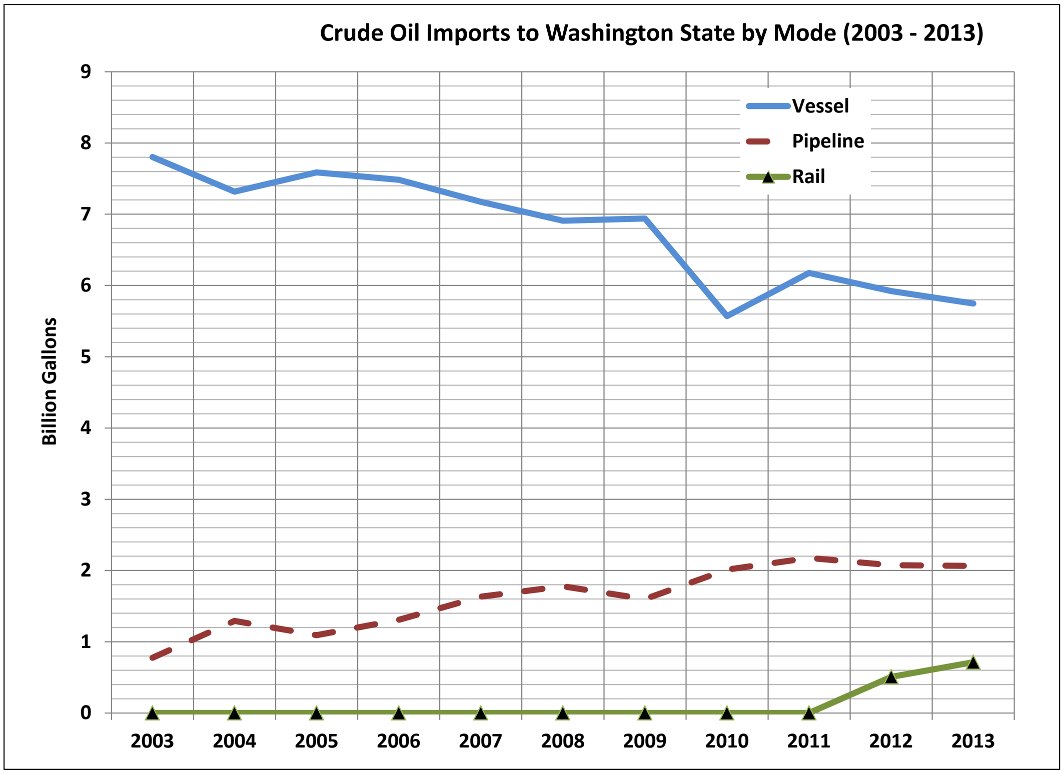
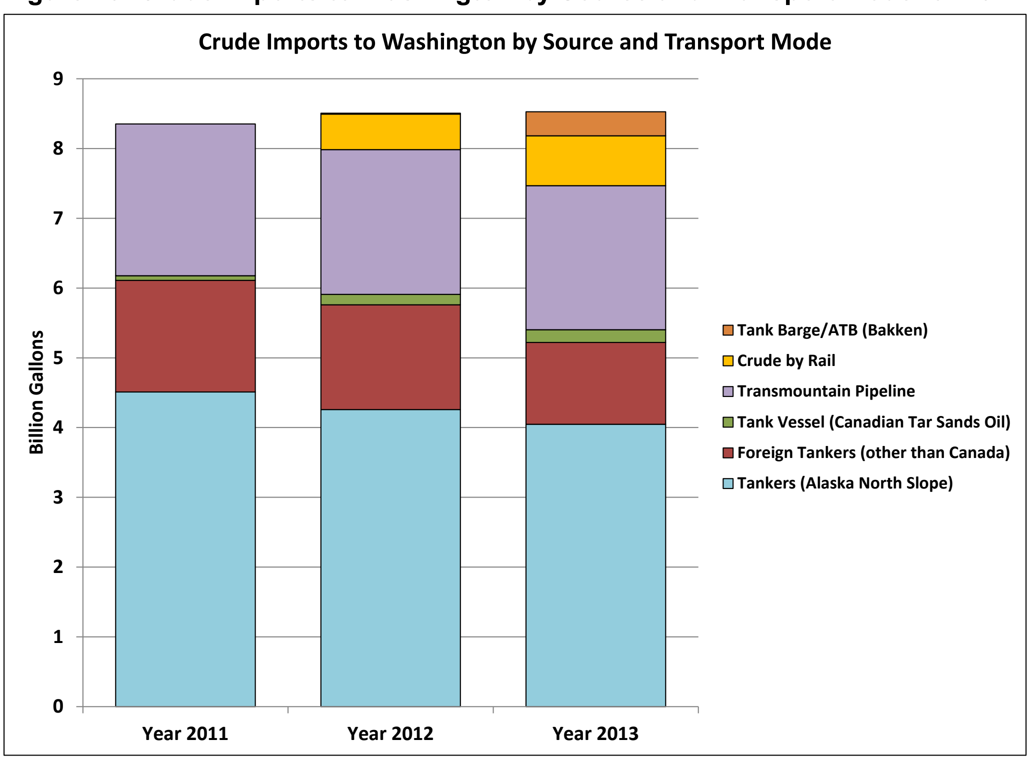


Figure 10: Crude Imports to Washington by Source and Transport Mode for 2011 – 2013



Import of Alaska North Slope (ANS) crude oil has steadily declined. In 2011, 1.6 billion gallons (20.6%) of crude oil imports came into Washington refineries from overseas sources, with the balance coming from Alaska by tanker, also by tanker and pipeline from Canada (Table 3 and Figure 11).[26] In 2013, the overseas crude shipments decreased to less than 1.2 billion gallons.

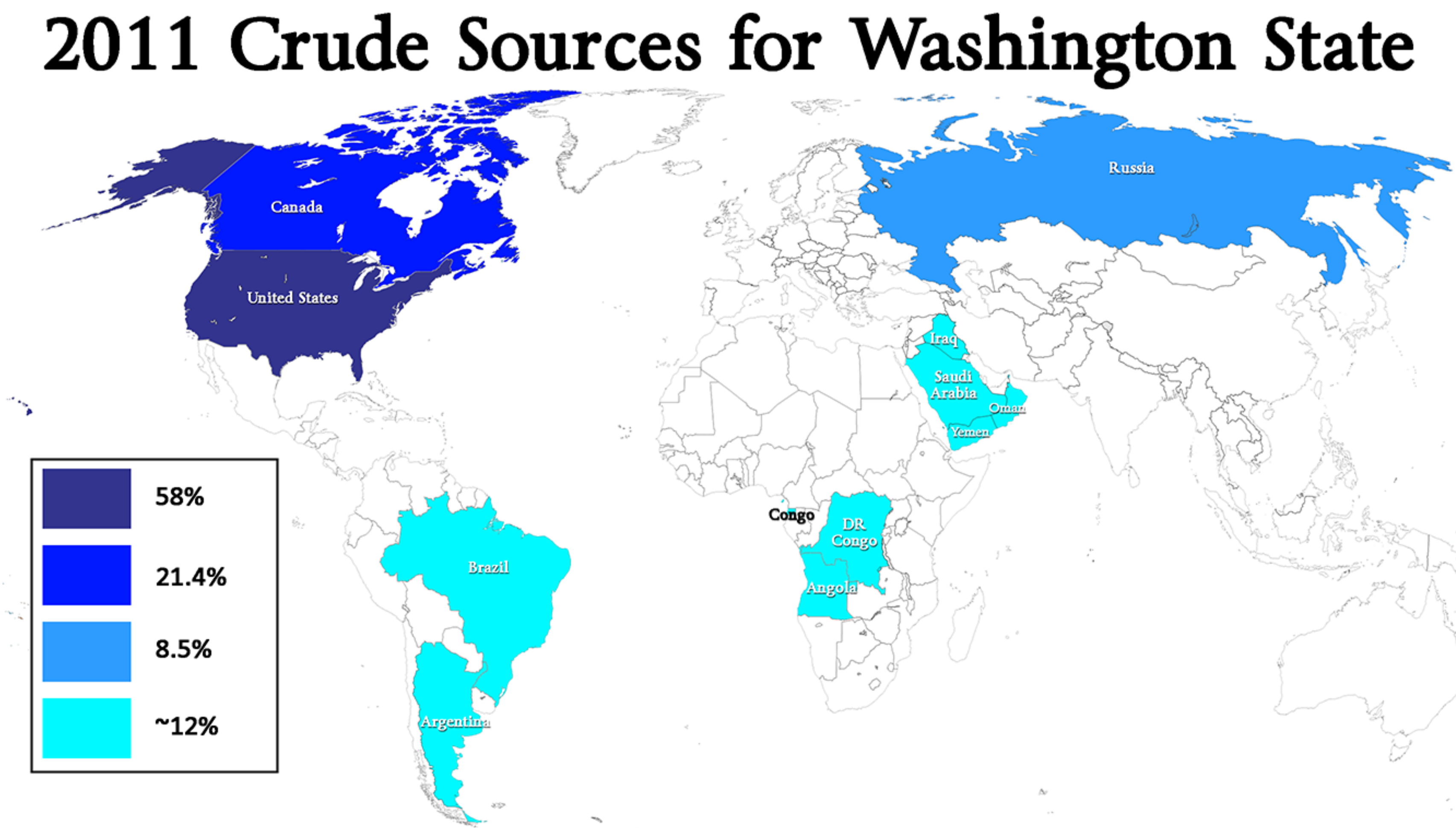
Table 3: Source of Crude Oil Imports to Washington State 2011

Source	Type of Crude	Gallons	% Total
Alaska	Alaska North Slope, Cook Inlet	4,510,082,346	58.0%
Canada[27]	Oil sands, some conventional	1,668,015,678	21.4%
Brazil/Argentina	Escalante, Lula, Marlim, Canadon, Seco	207,018,714	2.7%
Russia	ESPO, some Vityaz	657,261,276	8.5%
Middle East	Arabian, Omani, Masila, Upper Zakum, Basra	293,651,778	3.8%
Angola	Nemba, Plutino	58,460,850	0.8%
Mixed Origin	-	53,766,342	0.7%
Unknown Foreign	-	307,613,124	4.0%
Not Known	-	20,496,000	0.3%
Total		7,776,366,108	100.0%

[26] Ecology. 2014. *Analysis from Ecology's Advance Notice of Transfer (ANT) System - 2011 Washington State Petroleum Imports and Exports.* (ANT is Ecology's oil transfer rules to prevent spills when oil is transferred over water. Delivering facilities (fixed or mobile) or vessels that are transferring over 100 gallons of bulk oil to a non-recreational vessel or facility must submit an ANT to Ecology.)

[27] Includes TransMountain Pipeline.

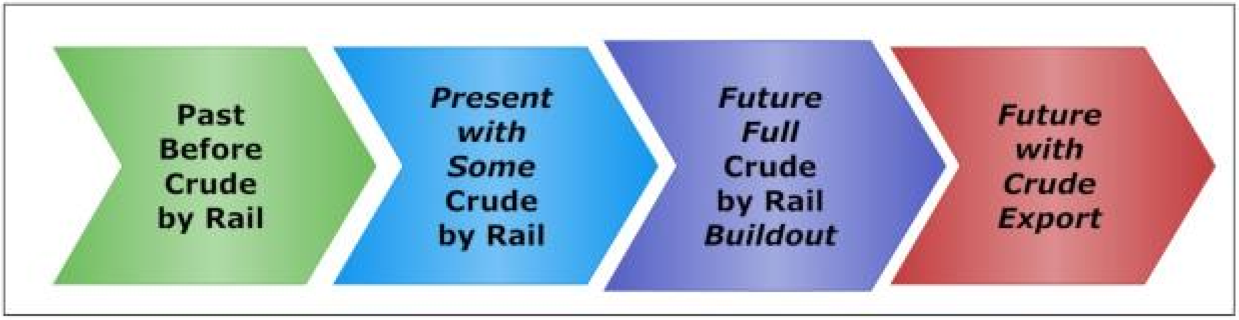
Figure 11: Washington State Crude Sources by Country of Origin 2011



The Oil Transport Model for Washington State

Four situations were considered in a comparative analysis of risks and impacts to public health and safety, tribal treaty rights, environment, and the economic resources of Washington State (Figure 12).

Figure 12: Four Crude-by-Rail Situations for Comparative Risk Analysis in Washington State



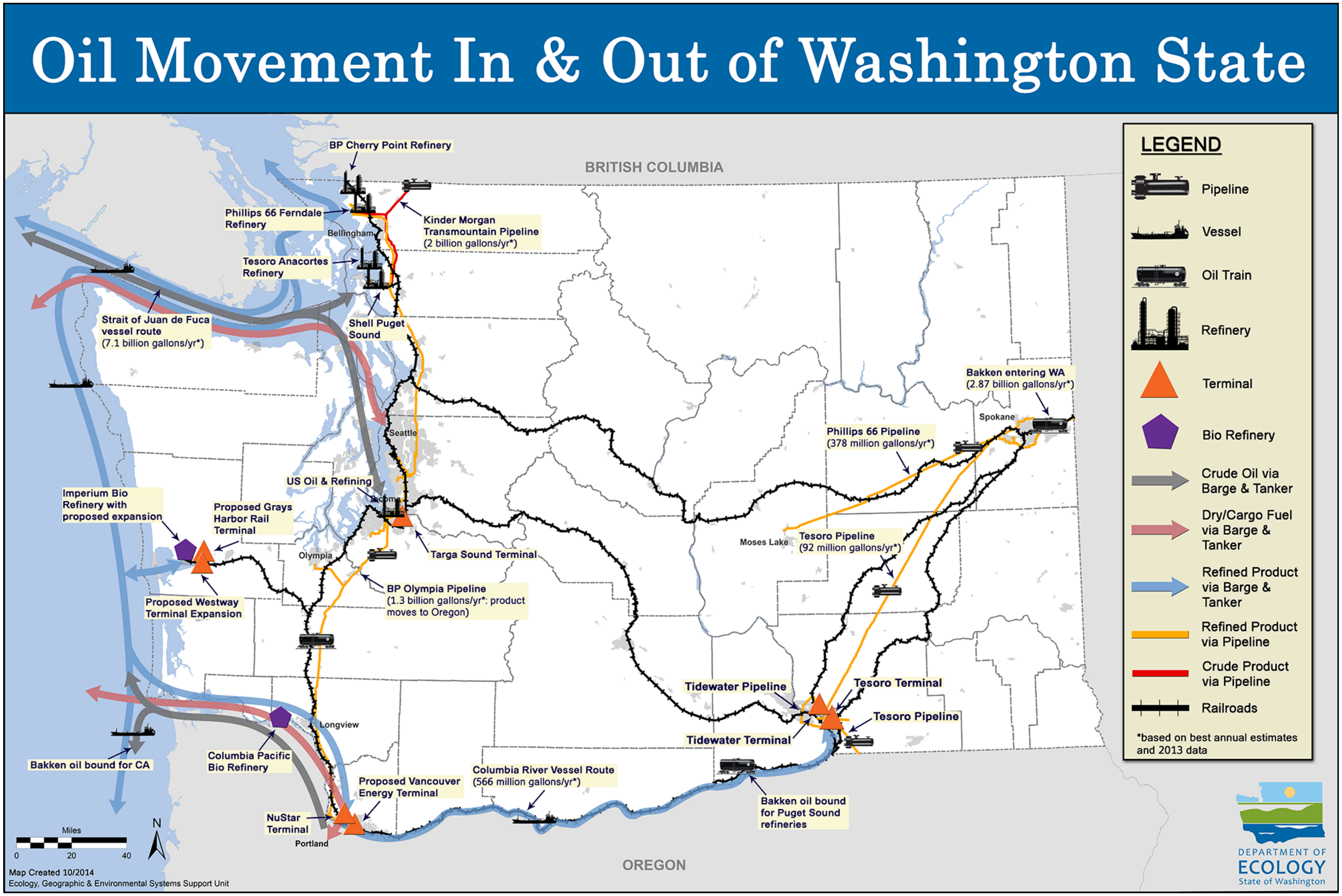
The overall analysis is based on the conceptual model of oil movement into and out of Washington State, as shown in Figure 13. This conceptual model includes current and potential future transport should the full build-out and expansion of proposed facilities in Puget Sound, Grays Harbor, and the Lower Columbia River occur.

In the model, diluted bitumen from Canada continues to move by pipeline and rail from Canada (to refineries in northern Puget Sound), but volumes are increasing due to changes on the Canadian side. Bitumen is also moved by rail; however, the volumes, the properties of the oil, and the rail routes are still not fully understood. As of mid-December 2014, Union Pacific Railroad has begun transporting bitumen from Alberta into Tacoma. Today, Bakken oil transported by rail comes through Spokane to facilities on the Columbia River and Puget Sound. The bulk of crude-by-rail traffic is currently going through the Columbia River Gorge, but in the future it could transit over other rail routes. Facilities on the west side of the state receive the oil by rail, store it, and then export the oil by tanker and tank barge to Puget Sound and California.

Today a federal ban on crude oil export in the United States prohibits these oils from being transported out of the country. However, bitumen and refined oils from Canada may be exported from Columbia River, Grays Harbor, or Puget Sound facilities to international markets since it would be non-U.S. crude oil.[28] The possibility of exporting to international markets pre-treated Bakken crude oil, which has been partially refined to remove the most volatile components at the well sites, has also been raised.

[28] The primary laws prohibiting crude exports are the Mineral Leasing Act of 1920, the Energy Policy and Conservation Act of 1975, and the Export Administration Act of 1979.

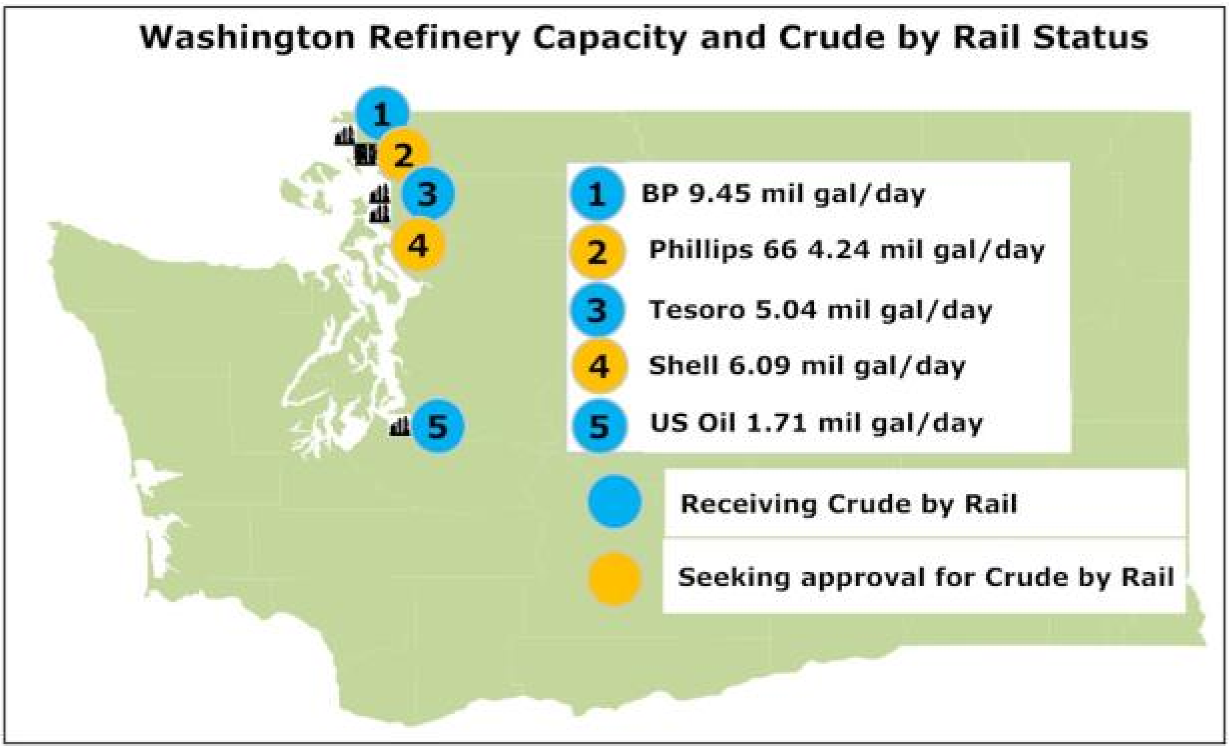
Figure 13: Oil Movement into and out of Washington State



There is only one crude oil pipeline in the state; the other pipelines carry refined oil products. Pipeline transport of crude oil has increased by 2.7 times since 2003, with a leveling-off in the last three years.[29] If proposed changes are approved in Canada, the volume of crude oil moved through this pipeline may increase again. No additional pipelines are being proposed for construction in Washington.

Puget Sound refineries continue to transfer their refined products to the Olympic Pipeline, tankers, articulated tug-barges (ATBs)[30], and trucks for export. Washington refineries and their operating status are shown in Figure 14. The refineries have a combined throughput capacity[31] of 26.5 million gallons per day but process, on average, about 24.3 million gallons daily. Three receive crude-by-rail and refine it. Another refinery may begin to receive crude-by-rail in late 2014. At present, there are no plans to build new refineries in Washington or Oregon.

Figure 14: Refineries in Washington State with Throughput Capacity and Crude-by-Rail Status



[29] Pipeline transport is not addressed in this study, but it potentially impacts the larger picture of oil movement and risk.
[30] An articulated tug barge is a tug-barge combination system capable of operation on the high seas, coast, and further inland. It combines a normal barge, with a bow resembling that of a ship, but having a deep indent at the stern to accommodate the bow of a tug. The fit is such that the resulting combination behaves almost like a single vessel at sea as well as while maneuvering.
[31] A refinery's throughput capacity is the maximum amount of crude oil designed to flow into the distillation units; in other words, this is the amount of crude oil that a refinery can process on a daily basis. Actual throughput may be less than this and may vary from day to day.

The status of proposed and operating crude-by-rail facilities, including refineries and terminals, in Washington is summarized in Figure 15 and Table 4.

Figure 15: Proposed and Operating Crude-by-Rail Facilities in Washington

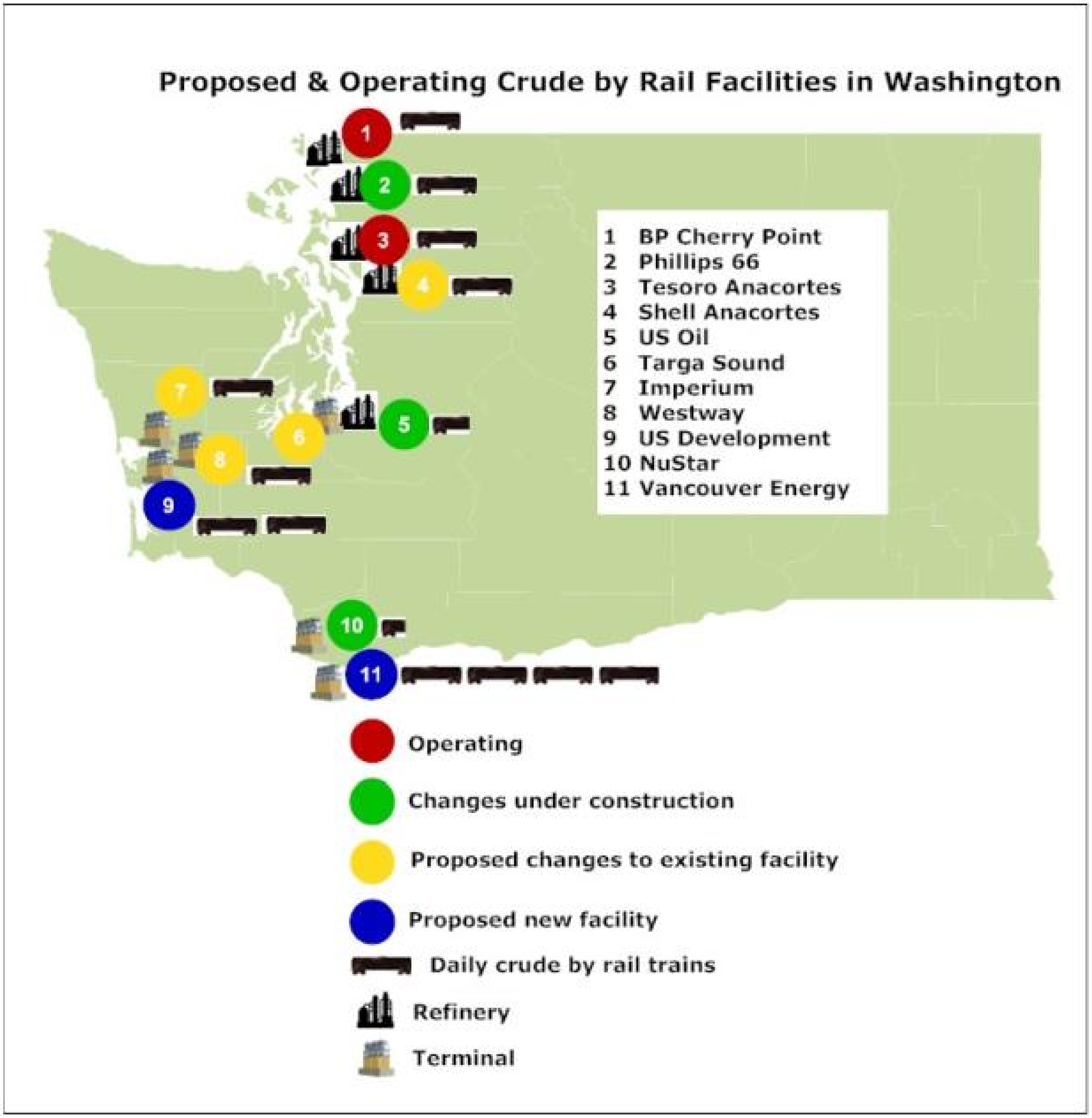


Table 4: Crude-by-Rail In-Operation at Facilities and Proposals (Status as of November 2014)

Owner or Proponent/ Location	Facility Specifications				Status	Daily Trains	
	Offload System Type[32]	Offload Stations	Throughput	New Storage		Off-load	In/ Out
BP Refinery/ Cherry Point	Loop	52	146,000 barrels/day	None	Receiving oil by rail as of 2013. Whatcom Co. issued MDNS[33] for rail expansion.	1	2
Imperium Terminal/ Grays Harbor	Ladder	Offload stations: 64 existing, propose adding 41	82,192 barrels/day	Up to 9 new tanks	Existing biodiesel facility proposed to add crude-by-rail capability and additional liquid storage. Ecology and the City of Hoquiam are SEPA leads. In the EIS process.[34]	1	2
NuStar Terminal/ Vancouver	Single-track	12	41,000 barrels/day	Convert existing tank	Proposal to convert 120,000-bbl methanol tank for crude oil; add rail offload capability. Southwest Clean Air Agency issued Determination of Non Significance in January 2014.	0.3	0.6
Phillips66 Refinery/ Ferndale	Ladder	54	75,000 barrels/day	None	In construction with completion anticipated 2014. Whatcom Co. issued MDNS for rail expansion.	0.5	1

[32] Ladder track - a ladder track, sometimes called the "lead track", is a track off which switches to yard tracks that are normally parallel to each other are contained. The switches provide access to the yard tracks from the ladder or lead track. Train/car movements arrive to or depart from yard tracks by utilizing the ladder track to access the specific switch that allows movements to/from a particular yard track. The ladder or lead track is also often used as the "switching lead" when cars are pulled from a yard track and separated to other yard tracks for the purpose of combining cars with similar destinations together on one track.

Loop track - a loop track is a continuous track within a facility, normally of sufficient length to allow a unit train to remain intact while loading or unloading a commodity. An example of loop tracks that allow unit train unloading while the train remains intact is the EGT export grain facility at Port of Longview. Many of the origin locations for unit grain and coal trains feature loop tracks that allow loading of a train without breaking it apart. If a loop track is not available at a loading or unloading facility, cars are spotted in smaller numbers, then reassembled after the loading or unloading activity is completed to create the unit train.

Single track - single track is a location, either on the mainline or within a facility, that features only one track on which trains can operate at any given time. For example, an unloading facility that features a loop track operation may only have one loop track for unloading. Consequently, only one train can be in the facility at any given time, unless the loop track has sufficient length to allow a train to be on either side of the unloading location at the same time. The second train can arrive short of the unloading location as the first train is completing its unloading. If the facility only features sufficient track length for one train to be on-site at any given time, following trains waiting to access the facility when the first train departs must be staged on other tracks off the facility site, normally either in a yard or in mainline meet/pass sidings.

[33] Mitigated Determination of Non-Significance (SEPA). Mitigated Determination of Non-Significance (MDNS): a mitigated determination of non-significance is issued under WAC 197-11-350(2) or 350(3), or a DNS issued after a determination of significance is withdrawn [WAC 197-11-360(4)].

[34] Environmental Impact Statement (EIS): under U.S. environmental law, a document required by the National Environmental Policy Act (NEPA) for certain actions "significantly affecting the quality of the human environment"; an EIS is a tool for decision making. It describes the positive and negative environmental effects of a proposed action, and it usually also lists one or more alternative actions that may be chosen instead of the action described in the EIS.

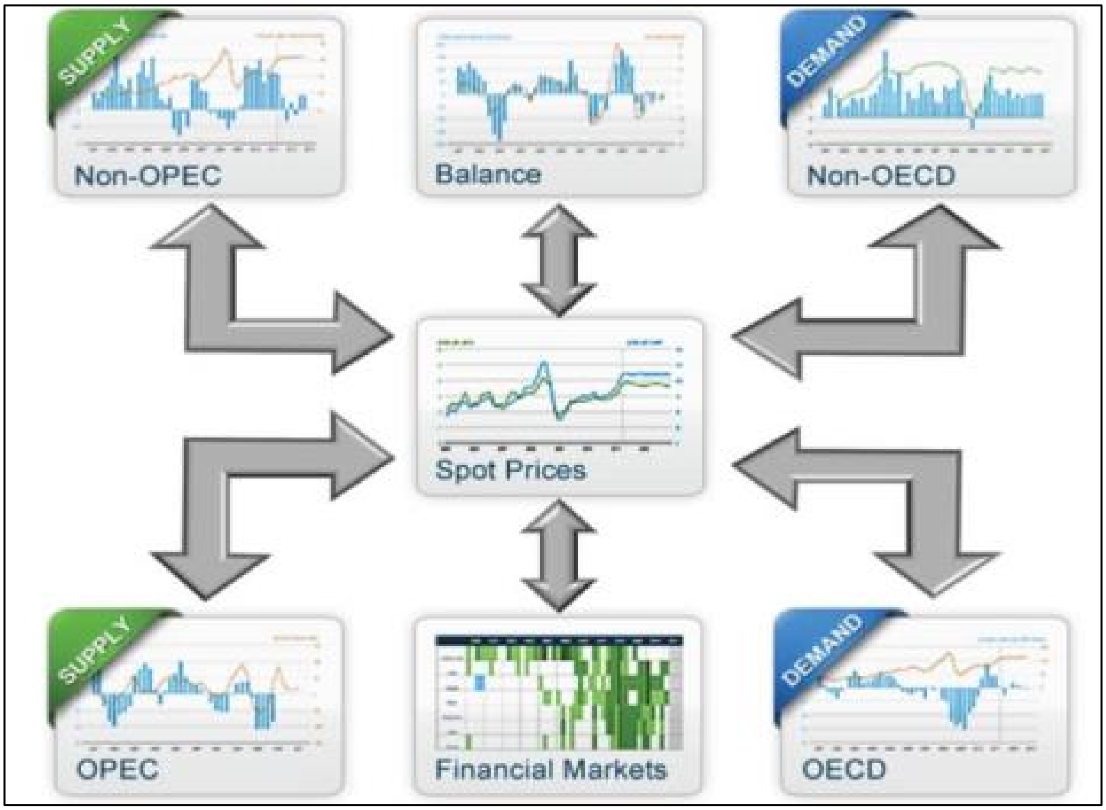
Table 4: Crude-by-Rail In-Operation at Facilities and Proposals (Status as of November 2014)

Owner or Proponent/ Location	Facility Specifications				Status	Daily Trains	
	Offload System Type[32]	Offload Stations	Throughput	New Storage		Off-load	In/ Out
Shell Refinery/ Anacortes	Ladder	Unknown	75,000 barrels/day	Unknown	Expansion proposed. SEPA process underway.	1	2
Targa Sound Terminal/ Tacoma	Ladder	12 existing 36 planned	75,000 barrels/day	2 new tanks, modify 2 existing tanks	DNS[35] issued 12/2013 for rail expansion by City of Tacoma. Still completing permitting.	1	2
Tesoro Refinery/ Anacortes	Ladder	100	75,000 barrels/day	None	Receiving Bakken oil since 9/2012. Skagit Co. issued MDNS 10/2011 for rail.	1	2
Grays Harbor Rail Terminal[36]/ Grays Harbor	Ladder	120 planned	45,000 barrels/day	Up to 8 new tanks	Ecology and the City of Hoquiam are SEPA leads. In EIS process.	1	2
U.S. Oil Refinery/ Tacoma	Ladder	64 existing; Adding 48 stations	48,000 barrels/day	None	Receiving oil by rail at 60 stations. Permitting underway for project to increase the size of the rail facility. Construction expected in late 2014.	0.5	1
Vancouver Energy Terminal [37] / Vancouver	Loop	90	292,000 barrels/day	6 new tanks	Proposed new site. EFSEC[38] is SEPA lead. In EIS process.	4	8
Westway Terminal/ Grays Harbor	Ladder	18 existing; adding 62 stations	48,918 barrels/day	5 new tanks	Existing methanol terminal proposed to add crude-by-rail capability. Ecology and the City of Hoquiam are SEPA leads. In EIS process.	0.6	1.25
TOTAL Daily	State of Washington					11.9	23.8
TOTAL Weekly	State of Washington					83	166
TOTAL Annually	State of Washington					4,332	8,664

[35] Determination of non-significance documents the responsible official's decision that a proposal is not likely to have significant adverse environmental impacts.
[36] Formerly U.S. Development.
[37] Formerly called Tesoro-Savage.
[38] Energy Facility Site Evaluation Council (EFSEC): provides a "one-stop" siting process for major energy facilities in Washington. EFSEC coordinates all evaluation and licensing steps for siting certain energy facilities in Washington. EFSEC specifies the conditions of construction and operation. If approved, a Site Certification Agreement is issued in lieu of any other individual state or local agency permits. EFSEC also manages an environmental and safety oversight program of facility and site operations.

It is hard to predict how long these trends will continue. Seven factors that influence the crude oil markets are outlined in Figure 16. Crude-by-rail must compete on a price basis with oil from other sources, and transportation costs of crude-by-rail are relatively high. Potential Alaskan oil expansion in the Outer Continental Shelf (OCS) and exploitation of North Slope shale gas fields may reduce the demand for crude-by-rail in the long term as prices compete. Potential export of crude or lightly refined products could change the model through increased export from the United States.

Figure 16: Factors that Influence Crude Oil Markets[39]. Image source: US EIA

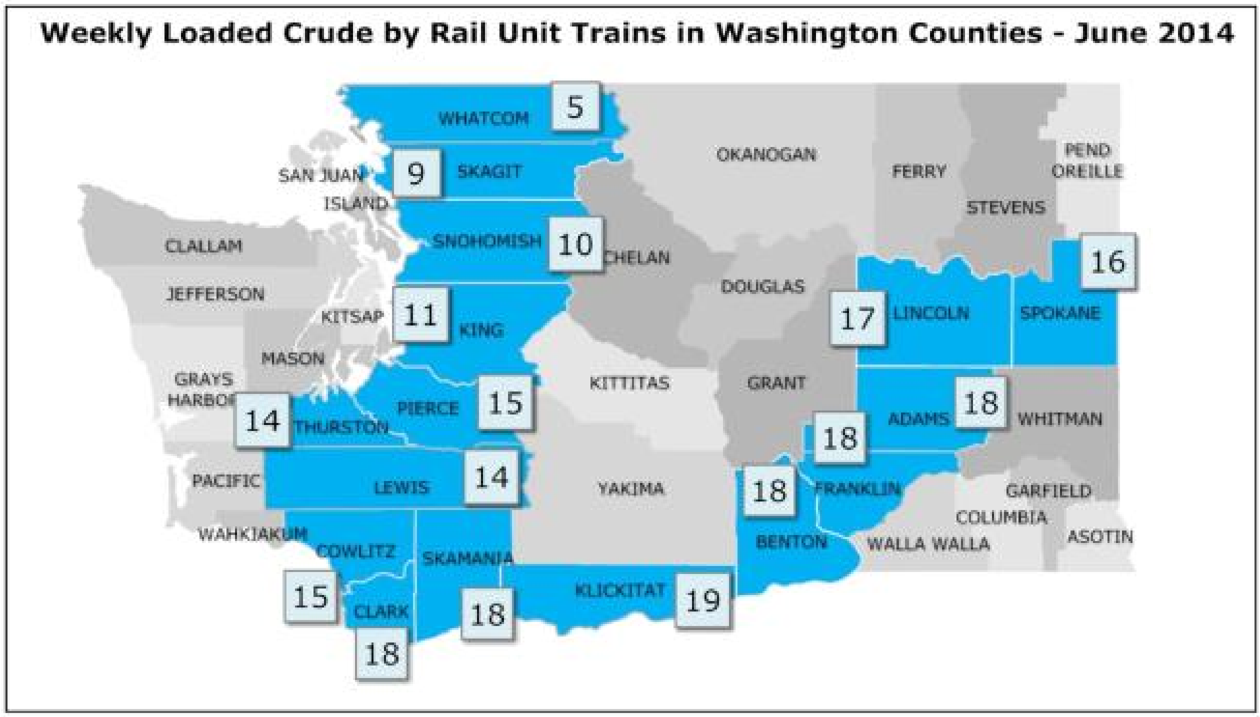


[39] http://www.eia.gov/finance/markets/ Spot prices are for commodities (like crude oil) that are sold with physical delivery in a month or less; OPEC = Organization of Petroleum Exporting Countries; OECD = Organization for Economic Cooperation and Development, a forum in which governments can work together to share experiences and seek solutions to common problems. OECD works with governments to understand what drives economic, social, and environmental change, and it measures productivity and global flows of trade and investment.

Crude-by-Rail Traffic

A total of 19 loaded unit trains with Bakken oil pass through the state weekly. These numbers are based on surveys conducted the week of June 25, 2014. Some trains go south to Oregon and California in Clark County without stopping to transfer oil in Washington. Others deliver oil to Washington facilities. Weekly Bakken crude-by-rail unit trains are shown by county in Figure 17 and Table 5.

Figure 17: Weekly Loaded Crude-by-Rail Unit Train Traffic in Washington Counties in 2014[40]



[40] June 25, 2014 data from US DOT Emergency Order WA Reports from Portland & Western Railroad, Union Pacific, BNSF, and Tacoma Rail. http://mil.wa.gov/static/123/state-emergency-response-commission-serc. For planning purposes, state and federal authorities might consider adding non-unit train shipments to the Emergency DOT reporting requirements. When unit train information from the DOT Emergency Order becomes available for Oregon and Idaho, this information can help to develop a complete risk picture for the Columbia River and can clarify the regional oil movement picture.

Table 5: Total Unit Trains Transiting Washington State Weekly[41]

County	BNSF	Tacoma Rail	PNWR[42]	Union Pacific[43]	Total
Clark	18	0	3	0	21
Klickitat	19	0	0	0	19
Pierce	15	3	0	0	18
Adams	18	0	0	0	18
Franklin	18	0	0	0	18
Benton	18	0	0	0	18
Skamania	18	0	0	0	18
Lincoln	17	0	0	0	17
Spokane	16	0	0	0	16
Cowlitz	15	0	0	0	15
Thurston	14	0	0	0	14
Lewis	14	0	0	0	14
King	11	0	0	0	11
Snohomish	10	0	0	0	10
Skagit	9	0	0	0	9
Whatcom	5	0	0	0	5

For each loaded train coming into the state, an unloaded train returns primarily through Stevens and Stampede Passes. Washington counties that are affected or would potentially be affected in the future by loaded and/or unloaded trains are shown in Figure 18.

Future crude-by-rail traffic may increase to three times this volume by 2020, and six times this volume, or 17 billion gallons, by 2035. This is dependent partially on permit decisions made on the proposed facilities in Washington State and on export volumes to Oregon and California. This would mean about 113 trains weekly or 16.6 trains daily by 2035. Past, present, and potential future crude-by-rail transport levels in Washington State are summarized in Figure 19.

[41] Data for June 25,2014 from: Portland and Western Railroad USDOT Emergency Order WA Report, UP USDOT Emergency Order WA Report , BNSF USDOT Emergency Order WA Report, Tacoma Rail USDOT Emergency Order WA Report. http://mil.wa.gov/static/123/state-emergency-response-commission-serc

[42] Note: the PNWR numbers for Clark County are in the BNSF numbers, since they interchange in Vancouver.

[43] As of mid-December 2014, Union Pacific Railroad began to transport bitumen from Alberta to Tacoma via rail. We do not have definitive data on numbers of trains.

Figure 18: Counties Currently or Potentially Affected by Loaded/Unloaded Crude-by-Rail Trains

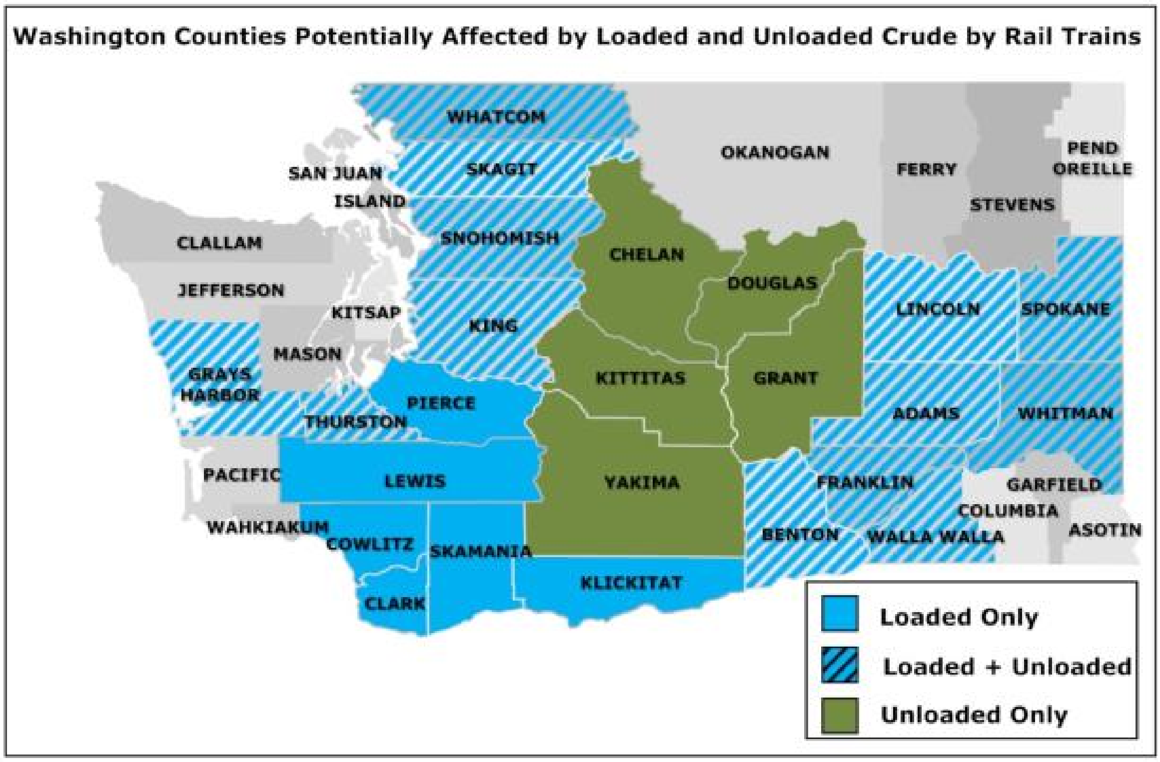
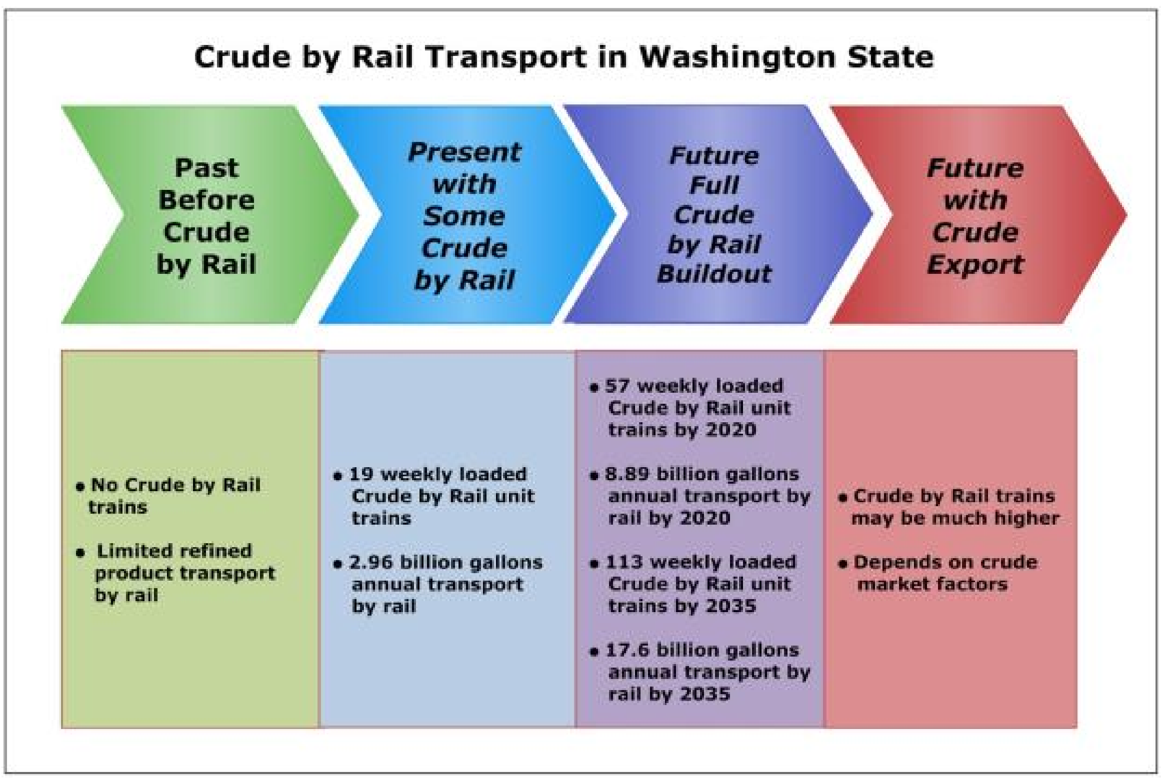


Figure 19: Crude-by-Rail Transport in Washington State – Past, Present, and Potential Future



Tank Vessel Transport of Crude-by-Rail Oil

Crude oil is delivered to refineries in Puget Sound for purposes of refining oil into various products that are then transported via pipeline and/or by tanker and ATB. Washington oil refineries exported about 2.6 billion gallons of refined products in 2011, an increase of 17% from 2008 (Table 6). In addition, 487.2 million gallons of bunker fuel was loaded onto deep draft ships[44] and exported from Puget Sound in 2011.

Table 6: Exports of Refined Petroleum Products from Washington State

Export to	2008		2011	
	Gallons	% Total	Gallons	% Total
Foreign (Not Canada)	283,275,342	12.6%	654,108,462	25.1%
Canada	469,878,864	21.0%	498,697,500	19.1%
Interstate (U.S.)	1,488,612,300	66.4%	1,454,406,240	55.8%
Total	2,241,766,506	100.0%	2,607,212,202	100.0%

The destinations of refined products exported overseas to countries other than Canada are listed in Table 7.

Table 7: Annual Washington Refinery Cargo Exports Overseas (Other than Canada)

Product	Gallons	% Total	Most Common Destination[45]
Heavier Products[46]	162,944,250	25.4%	Mostly Far East
Diesel Fuel	196,665,000	30.7%	Mostly to South America, Mexico
Gasoline	224,910,000	35.1%	Mostly to Mexico
Kerosene/Jet Fuel	42,672,000	6.7%	Various Overseas
Other (Nonene,[47] Biodiesel)	13,981,212	2.2%	Various Overseas
Total	641,172,462	100.0%	

At their planned full operating capacity, the refineries' rail projects represent the equivalent annual import volume of over 120 fully laden 125,000 deadweight tonnage (DWT) tankers. This would not result in any net changes with regard to existing crude or refined tanker traffic unless one of the following occurs:

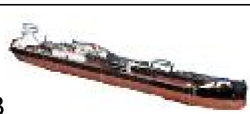
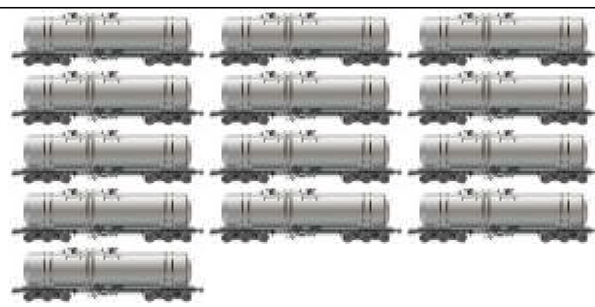
- The rate of refining in Washington increases substantially.
- The U.S. federal ban on international export of crude oil is lifted.
- The Bakken crude that goes through "stabilizing micro-refineries" and the micro-refined product is transported through the state for export.

[44] A ship with a draft of over 40 feet (a very deep draft ship has a laden draft of 45 feet or more).
[45] The destinations are for the vessel but perhaps not for the product. It is very common for tankers to travel the length of the West Coast, picking up parcels of product as they go. A foreign tanker that calls here may go next to Richmond, then Long Beach, before travelling on to multiple overseas destinations before the final disport of the oil. The Jones Act prohibits foreign flagged vessels from moving cargo between US ports so that all product loaded is for foreign export.
[46] Includes bunker fuel, heavy fuel oil (HFO), and decant oil.
[47] An alkene with the molecular formula C_9H_{18}. Industrially, the most important nonenes are trimers of propene, which are used in the alkylation of phenol to produce nonylphenol, a precursor to detergents.

There are ATBs carrying crude-by-rail oil from a terminal near Clatskanie, Oregon, out of the Columbia River north to Puget Sound via the outer coast, or south to California.[48] Crude-by-rail is also being carried by barge traffic within Puget Sound. Diluted bitumen is moved by both barge and tanker in northern Puget Sound. The proposed crude-by-rail terminals could change the traffic patterns by increasing movement of crude-by-rail from lower Columbia River ports and creating crude-by-rail movement in Grays Harbor. The Columbia River and Grays Harbor projects could be used to export oil to California and Puget Sound, and internationally. Refined products may also be exported from Grays Harbor facilities. This shift in traffic patterns would result in additional tanker and ATB traffic in the Columbia River and Grays Harbor, as well as along the outer coast.

Each crude-by-rail unit train of 100 cars[49] holds about 3 million gallons.[50] This translates to two to three trainloads per ATB or about 12 to 13 trainloads per Aframax tanker (Table 8).[51]

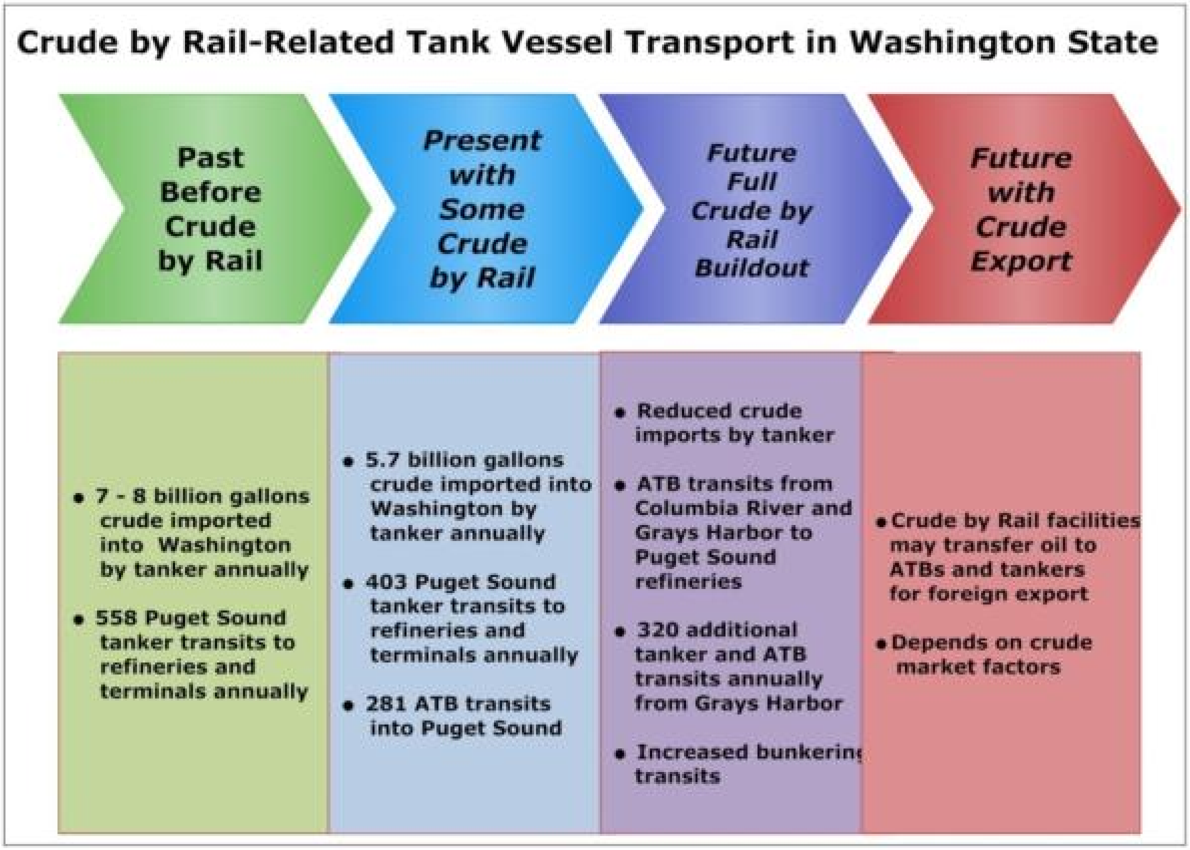
Table 8: Crude-by-Rail Transit Mode Volume Equivalencies

Transport Mode	Capacity	Crude-by-Rail Unit Train Equivalents (100-Car Trains)
Crude-by-Rail Unit Train 	3 million gallons	
 ATB	9 million gallons	
Aframax Tanker[52] 	33 million gallons	

[48] Kirby and Harley (OTB) traditional tow-wire barges are currently moving oil out of Clatskanie (Port Westward), bound for BP Cherry Point and Phillips 66.
[49] Note that unit trains can include more than 100 cars, but this is the typical arrangement.
[50] Each of the 100 tank cars in a CBR unit train holds about 30,000 gallons, regardless of the tank type.
[51] A tanker smaller than 120,000 deadweight tonnage.
[52] An Aframax is a tank vessel that is 830.1 feet in length, has a draft of 38 feet, and has a deadweight tonnage (DWT) of between 80,000 and 120,000.

If the transported volume increases to 59 trains weekly, as estimated for 2020, there may be 28 ATBs or five tankers per week. With 113 trains weekly, as estimated for 2035, this would double again. Based on the data available at this time, changes in Washington's oil tank vessel transport system are compared in Figure 20.

Figure 20: Crude-by-Rail-Related Tank Vessel Transport in Washington State – Past, Present, and Potential Future

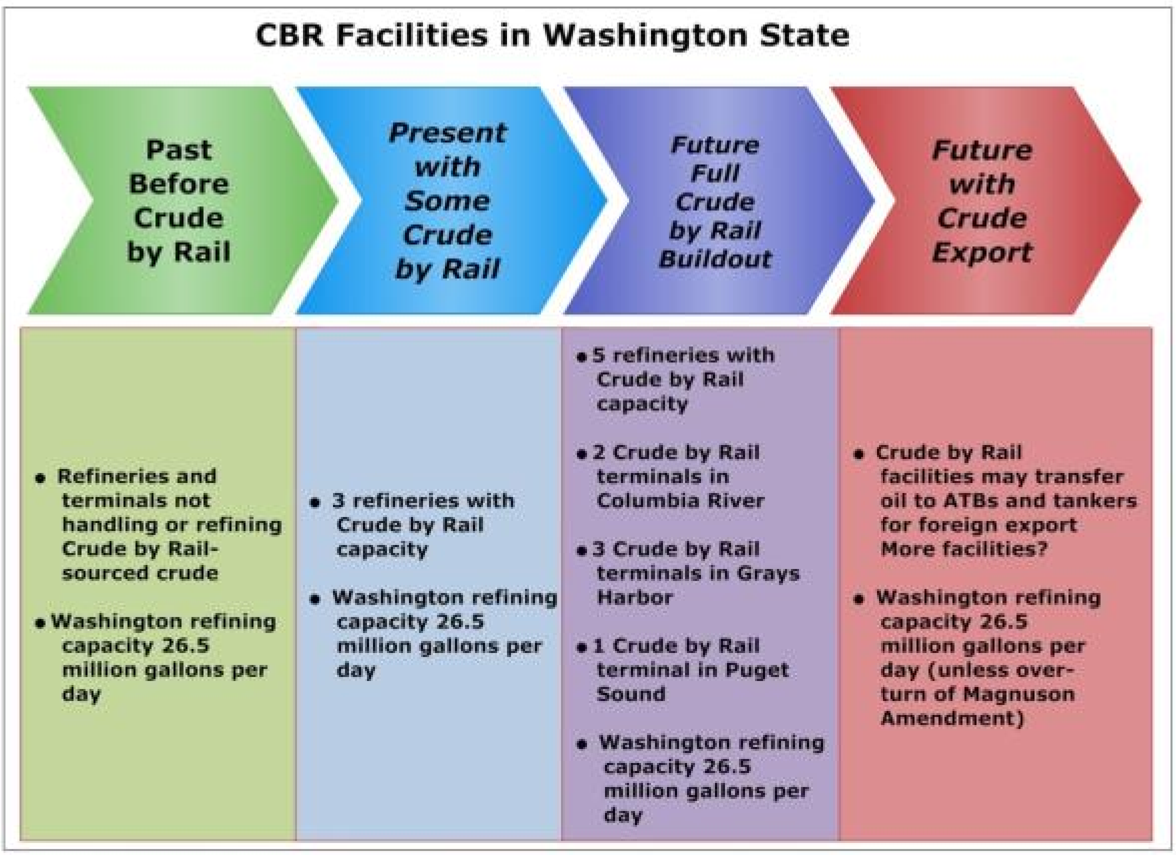


Crude-by-Rail-Related Facilities

There are two types of facilities that are handling crude-by-rail-sourced crude oil: refineries that process oil and terminals that receive the crude oil from trains, temporarily store, and then transfer the oil to tank vessels (tankers, ATBs, and tank barges) for transport. Refineries can receive oil via pipeline, tanker, or directly from crude-by-rail trains.

Changes in Washington's oil facilities, relating to crude-by-rail, are compared in Figure 21. The figure assumes the approval of proposed changes currently being evaluated.

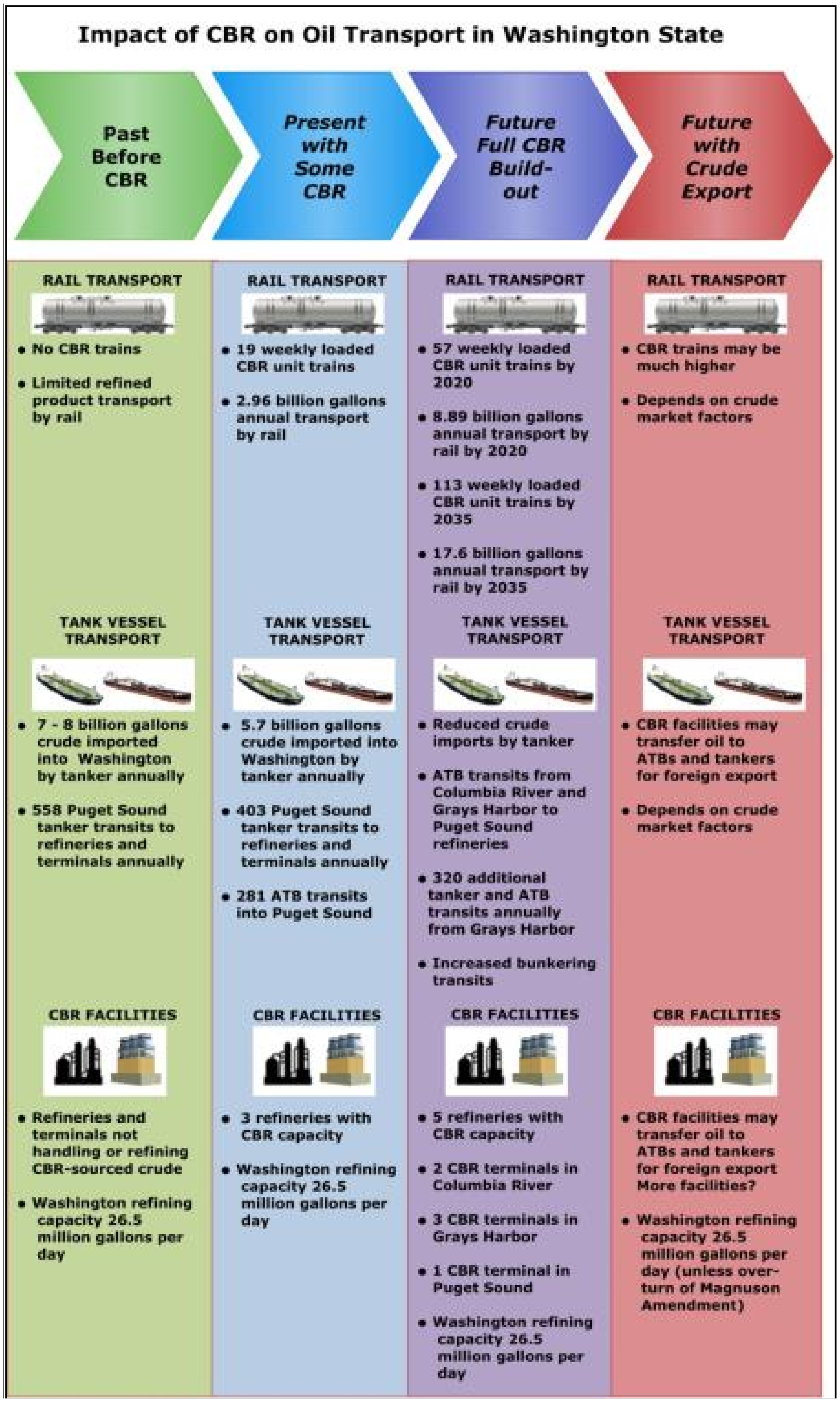
Figure 21: Crude-by-Rail Facilities in Washington State – Past, Present, and Potential Future



Summarizing Major Changes with Crude-by-Rail Transport

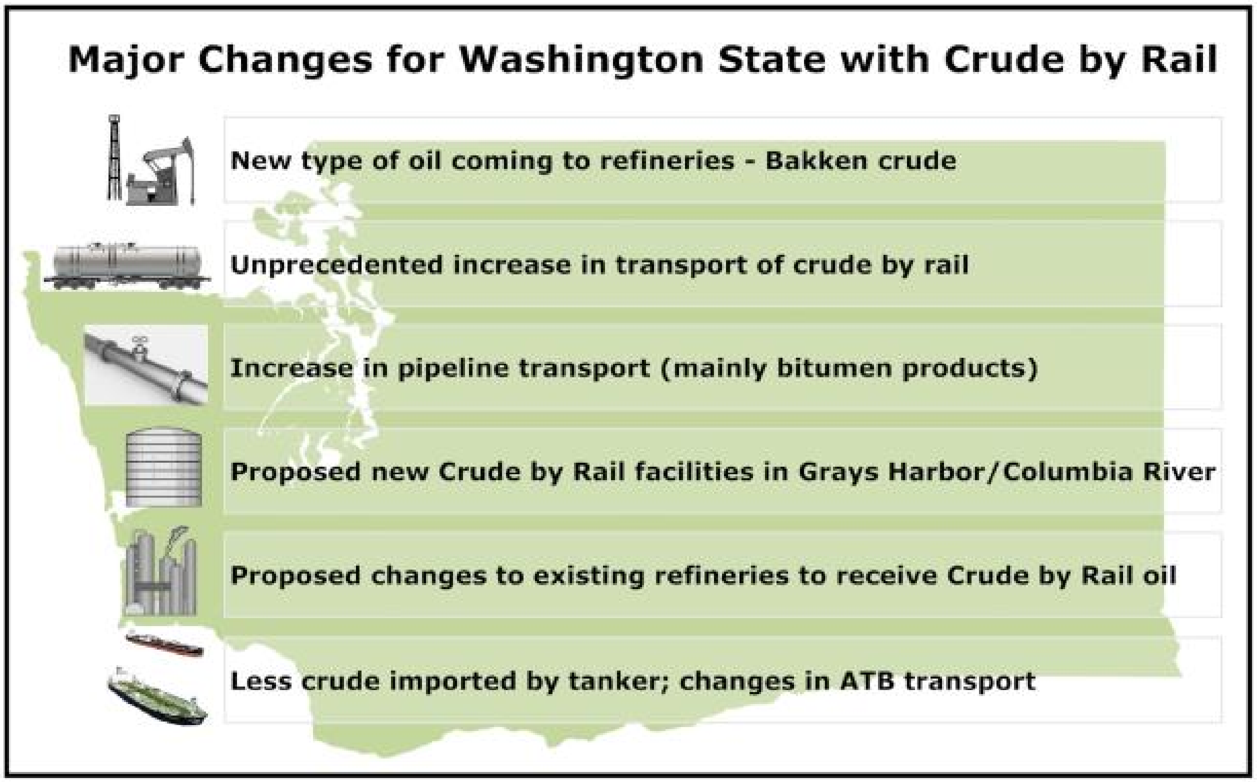
In the last decade, and particularly in the last three years, there have been significant changes in crude oil transport in Washington, which mirror changes occurring across the nation. The changes in Washington's oil transport system are summarized in Figures 22 and 23.

Figure 22: Crude-by-Rail Oil Transport in Washington – Past, Present, and Potential Future[53]



[53] CBR = crude-by-rail

Figure 23: Major Changes for Washington State with Addition of Crude-by-Rail



Crude-by-Rail and Marine Transport Risk Concerns

The following includes risks that have been identified by first responders and stakeholders as concerns during the outreach for this report and have been identified in scoping meetings held for proposed facilities currently in an Environmental Impact Statement process.

Public Safety Risks: Fires and Explosions

There are public safety risks from fires and explosions related to spills with the rail transport of Bakken crude oil due to its potentially higher volatility. The issue of the safety of Bakken crude oil transport came to light with the July 6, 2013 accident in Lac-Mégantic, Quebec, Canada, in which a crude-by-rail train derailed near a town center, causing an explosion that resulted in 47 fatalities (Figure 24). In this incident, 63 tank cars from an unattended train rolled down a descending grade into the town's center, derailed, and spilled oil that then ignited.

Figure 24: Railcars Burning in Lac-Mégantic, Quebec[54]. Image source: AP Photo.

[54] Source: AP Photo/The Canadian Press, Paul Chiasson.

According to Transportation Safety Board Canada, the incident occurred as follows:[55]

> At about 22:45 Eastern Daylight Time (EDT) on 05 July 2013, Montreal Maine & Atlantic (MMA) freight train MMA 2 (the train) was proceeding eastward on the MMA Sherbrooke Subdivision, en route from Montréal, Quebec, towards Saint John, New Brunswick. The train was about 4700 feet long and weighed approximately 10,300 tons. It was comprised of five head-end locomotives, a VB car (a special-purpose caboose), and one loaded box car followed by 72 Class 111 non-pressure tank cars[56] loaded with petroleum crude oil. The waybill information described the product in each tank car as Petroleum Crude Oil,[57] UN 1267, Class 3,[58] Packing Group (PG) III**.**[59]
>
> At approximately 23:00, the train was secured at the designated MMA crew change point at Mile 7.40 near Nantes, Quebec, on mainline track with a descending grade of 1.2%. Shortly before 01:00 on 06 July 2013, the train started to move and gathered speed as it rolled uncontrolled down the descending grade towards the town of Lac-Mégantic, Quebec, and derailed near the centre of the town. The derailed equipment included the boxcar and 63 tank cars.
>
> Several derailed tank cars released product, which ignited almost immediately, resulting in a large pool fire that burned for several days. There were 42 victims and five persons still missing, the town center sustained extensive damage, and about 2000 people were initially evacuated from the surrounding area. At the time of the accident, ambient temperature was recorded as 22ºC [71.6ºF] (TSB Occurrence No. R13D0054). The petroleum crude oil had originated from New Town, North Dakota, and was destined to an oil refinery in Saint John, New Brunswick. The tank cars were picked up at New Town by Canadian Pacific Railway (CP) and transported to Montréal. The train, with the same waybill information, was then interchanged to MMA.

In addition to this tragic incident, there were ten other notable crude oil train derailment incidents in North America in 2013 and 2014. Only the Lac-Mégantic incident involved human casualties – fatalities or injuries. Seven of the incidents involved fires and/or explosions as shown in Figure 25 and Table 9.

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[55] http://www.bst-tsb.gc.ca/eng/medias-media/sur-safe/letter/rail/2013/r13d0054/r13d0054-617-13-13.asp

[56] The Canadian term "Class 111" non-pressure tank car is the equivalent of the DOT-111 tank car, as shown in Figure 61. This type of tank car is also sometimes called the CTC-111A.

[57] This notation refers to the fact that the tank car contained crude oil rather than refined product.

[58] UN 1267, class 3 refers to the international (United Nations) classification of a flammable liquid.

[59] Packing Group III refers to the fact that the crude oil contained in the tank cars had an initial boiling point higher than 95°F, and a flash point over 73.4°F, such as is the case for diesel and kerosene. Packing Groups are discussed further in the In-Depth section on Rail.

Figure 25: Recent Crude-by-Rail Train Accidents Involving Fires in the U.S. and Canada

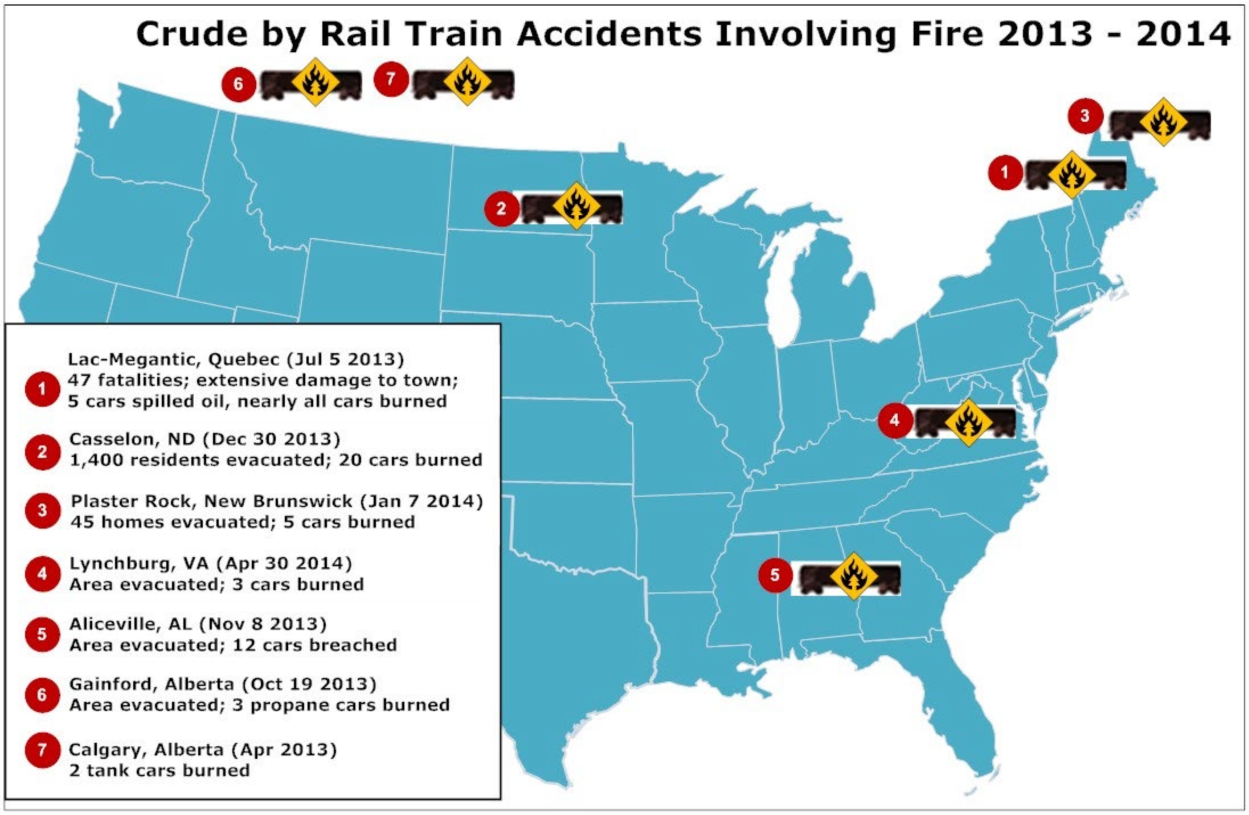


Table 9: Recent Accidents Involving Crude-by-Rail Trains

Location/Date Incident Type	Railroad	Fire	Spill (Gallons)	Details of Incident
LaSalle, CO[60] May 9, 2014 Derailment	Union Pacific	No	6,500	6 cars of a 100-car crude oil train derailed, causing leakage from one car. Leakage was at rate of 20-50 gallons/minute. Spill contained in ditch. No injuries.
Lynchburg, VA[61] April 30, 2014 Derailment	CSX	Yes	<50,000	15 cars in crude oil train derailed in downtown area of city. 3 cars caught fire, and some cars derailed into river along tracks. Immediate area surrounding derailment evacuated. No injuries were reported.
Vandergrift, PA[62] Feb 13, 2014 Derailment	Norfolk Southern	No	4,550	21 tank cars of 120-car train derailed outside Pittsburgh. 19 derailed cars carrying crude oil from western Canada; 4 released product. No fire or injuries.
Philadelphia, PA January 20, 2014 Derailment	CSX	No	None	7 cars of 101-car CSX train, including 6 carrying crude oil, derailed on bridge over Schuylkill River. No injuries and no leakage were reported, but 2 cars, one tanker, leaning over river.
Wisconsin/ Minnesota[63] Feb 3, 2014 Leak	Canadian Pacific	No	12,000	Valve or cap mishap caused spill of 12,000 gallons from one tank car while en route between Winona and Red Wing. Train traveling at low speed.
Plaster Rock, New Brunswick, Canada[64] Jan 7, 2014 Derailment	Canadian National	Yes	Unknown	17 cars of mixed train hauling crude oil, propane, and other goods derailed likely due to sudden wheel/axle failure. 5 tank cars carrying crude oil caught fire and exploded. Train delivering crude from Manitoba and Alberta to Irving Oil refinery in St. John, New Brunswick. 45 homes evacuated; no injuries reported.
Casselton, ND[65] Dec 30, 2013 Derailment	BNSF	Yes	>400,000	Eastbound train hauling 106 tank cars of crude oil struck westbound train carrying grain that shortly before had derailed onto eastbound track. Some 34 cars from both trains derailed, including 20 cars carrying crude that exploded and burned for over 24 hours. About 1,400 residents of Casselton were evacuated, but no injuries were reported. Cause of derailments and subsequent fire under investigation.

[60] http://www.greeleytribune.com/news/11353788-113/crude-car-cars-davis.
[61] http://www.latimes.com/nation/nationnow/la-na-nn-lynchburg-virginia-train-derailment-20140430-story.html
[62] http://triblive.com/neighborhoods/yourallekiskivalley/yourallekiskivalleymore/5596923-74/railroad-oil-norfolk#axzz37qQHJGGf.
[63] http://www.winonadailynews.com/news/local/gallons-of-crude-oil-spilled-between-winona-and-red-wing/article_850d10d2-a702-5fc8-b97e-f822d0c5c30b.html.
[64] http://dot111.info/category/recent-derailments/.
[65] http://www.ntsb.gov/investigations/AccidentReports/Reports/Casselton_ND_Preliminary.pdf.

Table 9: Recent Accidents Involving Crude-by-Rail Trains

Location/Date Incident Type	Railroad	Fire	Spill (Gallons)	Details of Incident
Aliceville, AL[66] Nov 8, 2013 Derailment	Genesee & Wyoming	Yes	<748,400	Train hauling 90 cars of crude oil from North Dakota to refinery near Mobile, AL, derailed on section of track through wetland near Aliceville, AL. 30 tank cars derailed and some dozen burned. No one was injured or killed. The derailment occurred on a short line railroad's track that had been inspected a few days earlier. Cause of derailment under investigation. 30 cars derailed, 12 breached.
Gainford, Alberta, Canada[67] Oct 19, 2013 Derailment	Canadian National	Yes	Unknown	9 tank cars of propane and four tank cars of crude oil from Canada derailed.About 100 residents evacuated. 3 propane cars burned, but tank cars carrying oil were pushed away and did not burn. No one injured or killed. Derailment cause under investigation. 9 propane, 4 crude; 3 propane cars burned.
Lac-Mégantic, Quebec, Canada[68] July 5, 2013 Derailment	Montreal, Main & Atlantic	Yes	>26,500	Train with 72 loaded tank cars of crude oil from North Dakota moving from Montreal, Quebec, to St. John, New Brunswick, stopped at Nantes, Quebec, at 11:00 pm. Operator and sole railroad employee aboard train secured it and departed, leaving train on short line track with descending grade of 1.2%. At about 1:00 am, train began rolling down descending grade toward own of Lac-Mégantic, about 30 miles from U.S. border. Near center of town, 63 tank cars derailed, resulting in multiple explosions and subsequent fires. 47 fatalities and extensive damage to town. 2,000 people evacuated. .
White River, Calgary, Alberta[69]	Canadian Pacific	Yes	26,866	A broken wheel and emergency brake application caused a derailment. Two of seven cars carrying crude oil spilled. There was a fire that was put out by local firefighters.
Parkers Prairie, MN[70] Mar 27, 2013 Derailment	Canadian Pacific	No	30,000	14 cars on 94-car crude oil train derailed; up to 3 cars ruptured.
Lynchburg, VA May 2014	CSX Transportation	Yes	Unknown	17 car derailment and fire
Ontario, Canada Feb 2015	Canadian National	Yes	Unknown	35 cars derailed and 7 caught fire
Southwestern Alberta Feb 2015	Canadian Pacific	No	None	12 crude oil cars derailed.

66 http://dot111.info/category/disasters/aliceville-al/.
67 http://www.edmontonsun.com/2013/10/23/evacuation-lifted-after-train-derailment-in-gainford-alberta.
68 http://priceofoil.org/content/uploads/2014/05/OCI_Runaway_Train_Single_reduce.pdf.
69 http://www.saultstar.com/2014/12/15/wheel-caused-white-river-derailment
70 http://usnews.nbcnews.com/_news/2013/03/28/17501526-train-hauling-oil-derails-spilling-30000-gallons-of-crude-in-minnesota.

Table 9: Recent Accidents Involving Crude-by-Rail Trains

Location/Date Incident Type	Railroad	Fire	Spill (Gallons)	Details of Incident
West Virginia Feb 2015	CSX Transportation	Yes	Under investigation	Train derailment involving 27 cars. spilled oil into the Kanawha River, a source of drinking water in Kanawha and Fayette counties. 19 cars were involved in the fire.

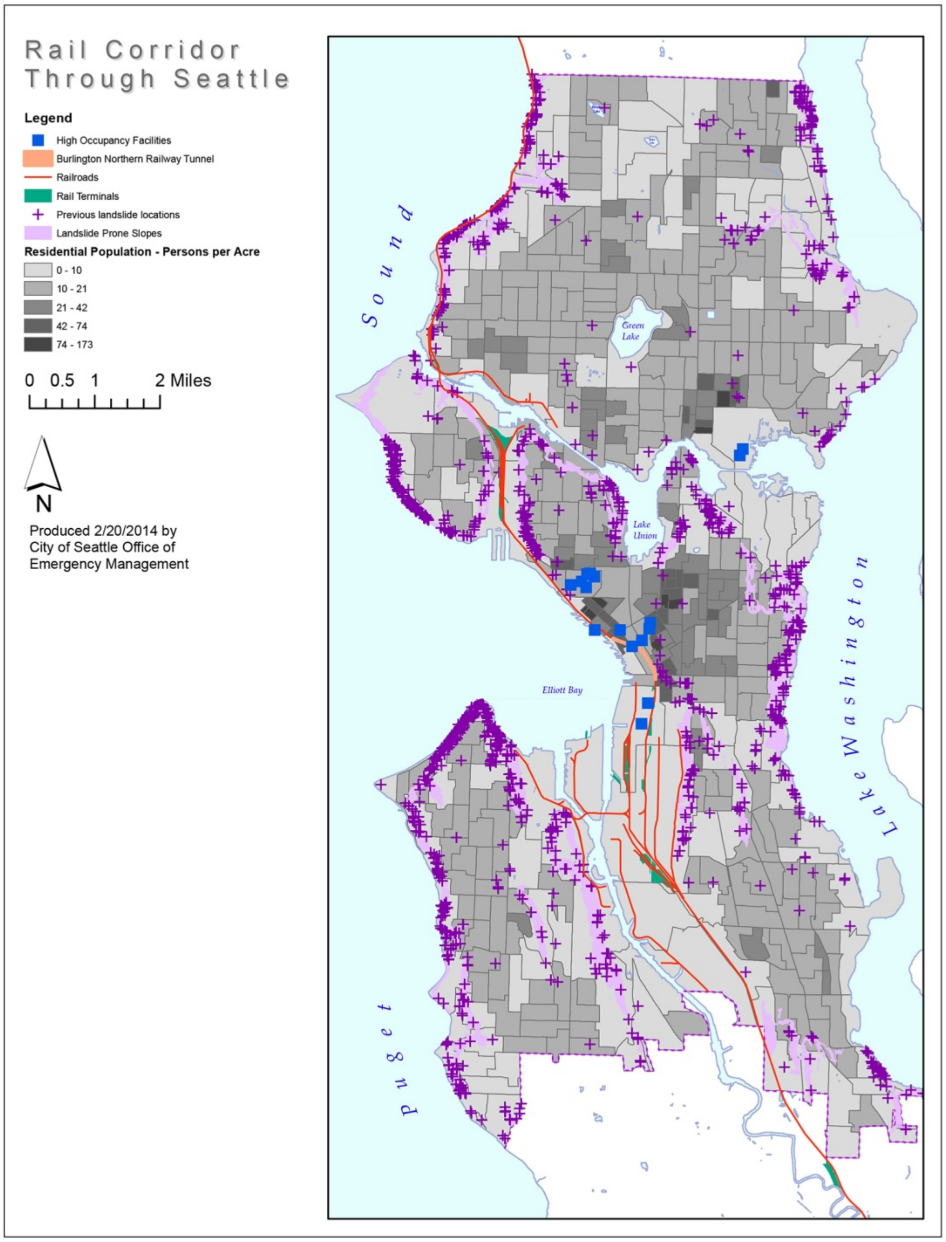
The risk to public safety and health is greatest in locations where crude-by-rail lines run through heavily populated areas, such as the City of Seattle with over 7,000 people per square mile in the vicinity of crude-by-rail lines (Figure 26).

According to a report to the Seattle City Council from the Office of Emergency Management and the Seattle Fire Department:

> In Seattle, railroad tracks run north and south through the City. From the Port of Seattle north, the tracks travel by Safeco Field and CenturyLink Field, as well as the City's Emergency Operations Center and Fire Station 10, which housed Hazard Materials Unit. The tracks then travel through a tunnel under downtown Seattle and along Puget Sound through residential neighborhoods and parks. This route is particularly prone to winter landslides and storms coming off the Puget Sound. To the south, the tracks travel through the Duwamish Waterway and head inland until they pass Tacoma where they run along the Puget Sound. There are a number of major street arterial/rail crossings in the SODO district and Belltown areas.[71]

[71] Graff and Vickery 2014.

Figure 26: Rail Corridor through Seattle[72]. Image source: City of Seattle, Office Emergency Management



In Seattle on July 24, 2014, a train laden with Bakken crude oil derailed near the Magnolia Bridge. While there was no release of oil or hazardous materials in this incident, the proximity of the incident to the densely-populated city of Seattle and nearby waterways caused concern (Figure 27).

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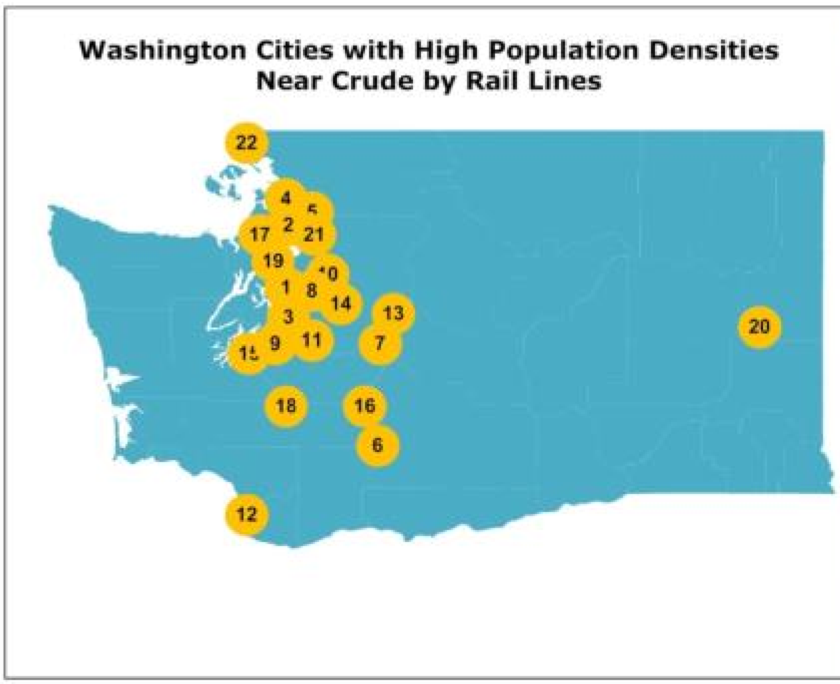
72 Source: City of Seattle Office of Emergency Management (from Graff and Vickery 2014). http://www.seattle.gov/council/attachments/oiltrainsreport.pdf

Figure 27: Loaded Crude-by-Rail Train Derailment in Seattle July 24, 2014

The 38 heavily-populated cities and towns (over 3,000 persons per square mile) that are adjacent to crude-by-rail lines are shown in Figure 28. There are also at least a dozen other cities and towns with population densities of 2,500 to 3,000 per square mile at potential risk.

Figure 28: Densely-Populated Washington Cities near Crude-by-Rail Train Routes



Rank	City	Density (per square mile)
1	Seattle	7,782
2	Kirkland	4,738
3	Des Moines	4,723
4	Shoreline	4,695
5	Edmonds	4,576
6	Toppenish	4,273
7	Wenatchee	4,160
8	Renton	4,151
9	Tacoma	4,091
10	Bellevue	4,002
11	Kent	3,686
12	Vancouver	3,579
13	E. Wenatchee	3,547
14	Redmond	3,493
15	Lakewood	3,440
16	Yakima	3,375
17	Mukilteo	3,290
18	Covington	3,241
19	Everett	3,182
20	Spokane	3,066
21	Marysville	3,058
22	Bellingham	3,052

Historically, cities and towns were established along railroad lines and rivers for economic and practical purposes. It is not surprising that railroad tracks run through some heavily-populated areas. More than three million Washington residents live in 93 cities and towns on or near crude-by-rail train routes. A detailed listing is shown in Table 10.

Table 10: Washington Cities and Towns On or Near Crude-by-Rail Routes

Route	Railroad	City/Town[73]	Population (2012)
Main Route North Dakota–Spokane	BNSF	Millwood	1,770
		Spokane	209,525
		Spokane Valley	91,113
West Route Spokane–Everett	BNSF	Harrington	413
		Odessa	887
		Ephrata	7,916
		Quincy	7,013
		Wenatchee	32,562
		Cashmere	3,145
		Leavenworth	1,989
		Index	184
		Gold Bar	2,089
		Sultan	4,715
		Monroe	17,503
		Snohomish	9,275
		Everett	104,655
Southwest Route Spokane–Tri-Cities	BNSF	Cheney	11,018
		Sprague	435
		Ritzville	1,678
		Lind	572
		Hatton	102
		Connell	5,421
		Mesa	501
		Pasco	65,600
		Kennewick	75,971
Northwest Route Tri-Cities–Auburn	BNSF	Benton City	3,142
		Prosser	5,799
		Mabton	2,323
		Toppenish	9,017
		Wapato	5,065
		Union Gap	6,060
		Yakima	93,101
		Selah	7,333
		Ellensburg	18,348
		Cle Elum	1,890
		Maple Valley	24,171
		Covington	18,298
		Auburn	73,505
Western Route Tri-Cities–Vancouver, WA	BNSF	Lyle	530
		White Salmon	2,259
		Stevenson	1,482
		North Bonneville	961
		Washougal	14,584
		Camas	20,490
		Vancouver	165,489
North Route	BNSF	Ridgefield	5,260

[73] List does not include: (1.) Small towns/cities without established form of government such as elected mayor and city council; (2.) Small towns/cities without official government website or affiliated public website.

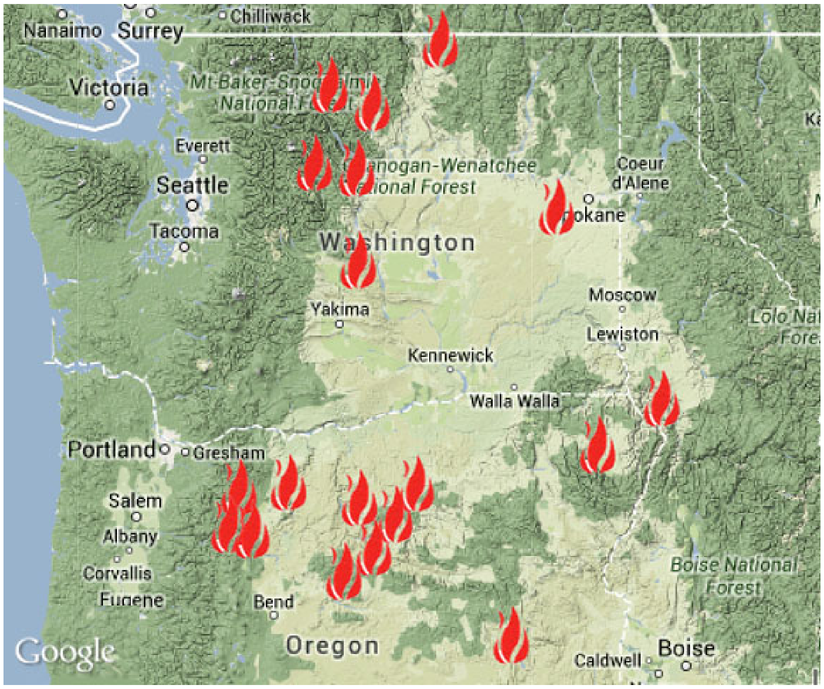
Table 10: Washington Cities and Towns On or Near Crude-by-Rail Routes

Route	Railroad	City/Town[73]	Population (2012)
Vancouver–Centralia		Woodland	5,540
		Kalama	2,323
		Kelso	11,832
		Longview	36,548
		Castle Rock	1,984
		Vader	619
		Winlock	1,329
		Napavine	1,766
		Chehalis	7,298
		Centralia	16,505
West Sub-Route Centralia–Hoquiam	Puget Sound & Pacific (Genesee & Wyoming)	Rochester	1,829
		Oakville	676
		Elma	3,052
		Montesano	3,905
		Aberdeen	16,529
		Hoquiam	8,535
North Route Centralia–Seattle	BNSF	Bucoda	562
		Tenino	1,699
		Lacey	43,860
		DuPont	8,808
		Steilacoom	6,070
		Lakewood	31,562
		Tacoma	202,010
		Fife	9,333
		Puyallup	38,147
		Edgewood	9,501
		Sumner	9,541
		Pacific	6,838
		Algona	3,101
		Auburn	73,505
		Kent	122,999
		Tukwila	19,611
		Renton	95,448
		Seattle	634,535
North Route Seattle–Vancouver, BC	BNSF	Shoreline	54,352
		Woodway	1,322
		Edmonds	40,400
		Lynnwood	36,275
		Mukilteo	20,605
		Everett	104,655
		Marysville	62,402
		Stanwood	6,422
		Mt. Vernon	32,287
		Burlington	8,470
		Anacortes	15,928
		Bellingham	82,234
		Ferndale	11,998
		Blaine	4,831
		Total	3,054,740

Public Safety Risks: Wildfires

Fire risk extends not only to populated areas where casualties and property destruction may occur, but also to rural areas where wildfire risks exist during certain times of year (Figure 29). Even a relatively small fire associated with a rail incident could spark a much larger wildfire, creating safety risks to residents, business owners, and first responders.

Figure 29: Wildfire Status in Pacific Northwest July 2014[74]. Image source: Northwest Interagency Coordination Center



Public Safety Risks: Crossing Accidents

The passage of freight and passenger trains through populated areas and road crossings creates a risk of crossing accidents. With an increase in the number of trains passing through these areas, the likelihood of fatalities and serious injuries increases. Each week, 19 loaded unit trains carrying Bakken oil pass through different parts of the state. Each of these railcars then returns unloaded. This means there are as many as 38 new trains weekly, or five additional trains passing through daily.

Many locations lack over- or under-passes, and trains intersect roads at grade or level crossings. This is particularly true in lesser-populated areas. Accidents in these areas may also occur when tribal members access Tribal Usual and Accustomed (U&A) Fishing Areas.

[74] Northwest Interagency Coordination Center (http://nwpr.org/post/governor-inslee-feds-will-help-restore-power-fire-zone)

There are 347 public-grade crossings[75] along the routes used by BNSF and Union Pacific (UP) to transport crude-by-rail unit trains through Washington. Overall, including other rail lines, there are 468 crossings in eight first-class cities (i.e., cities with populations of 10,000 or more) in Washington (Table 11).

Table 11: Railroad Crossings along Crude-by-Rail Routes in First-Class Washington Cities

City	Population	Number of Crossings
Aberdeen	16,529	15
Bellingham	82,234	24
Everett	104,655	25
Seattle	634,535	161
Spokane	209,525	82
Tacoma	202,010	132
Vancouver	165,489	29
Total	1,414,977	468

A majority of these crossings are protected at appropriate levels. However, a UTC Rail Crossing Study identifies many crossings in the state as having a heightened risk of incident. There is the potential for human fatalities and injuries at some of these crossings. Train collisions with vehicles, especially large trucks, increase the possibility of train derailment. There is also a risk for human casualties at crossings that lack appropriate safety measures or areas of increased train traffic. Private crossings,[76] due to lack of safety standards, also present a risk for pedestrians and vehicles.

Many citizens have expressed concern about people being tempted to make dangerous crossings at unprotected crossings to avoid the inconvenience of long waits for 100-car crude-by-rail trains to pass. These trains can be 1.5 miles long. This would also be true of any longer freight train. At 30 mph, a crude-by-rail train would take three minutes to pass; at a higher speed of 50 mph, the train would pass in less than two minutes. But with increasing numbers of trains, citizens could feel frustrated with delays of this duration, as traffic backs up.

Blocked access, from transiting trains or after a serious accident, is a major concern for emergency services. Many communities have emergency service resources (firefighters and equipment, hospitals and other medical services, police) on either or both sides of railroad tracks that run through cities and towns.

[75] Public grade crossings are roadways that are under the jurisdiction of, and maintained by, a public authority. Private grade crossings are on privately owned roadways, such as on a farm or industrial area, and are intended for use by the owner or by the owner's licensees and invitees.

[76] Crossing between railroad tracks and privately owned roadways, such as on a farm or industrial area, that is intended for use by the owner or by the owner's licensees and invitees. A private crossing is not intended for public use and is not maintained by a public highway authority. (FRA, US Department of Transportation)

Health Risks

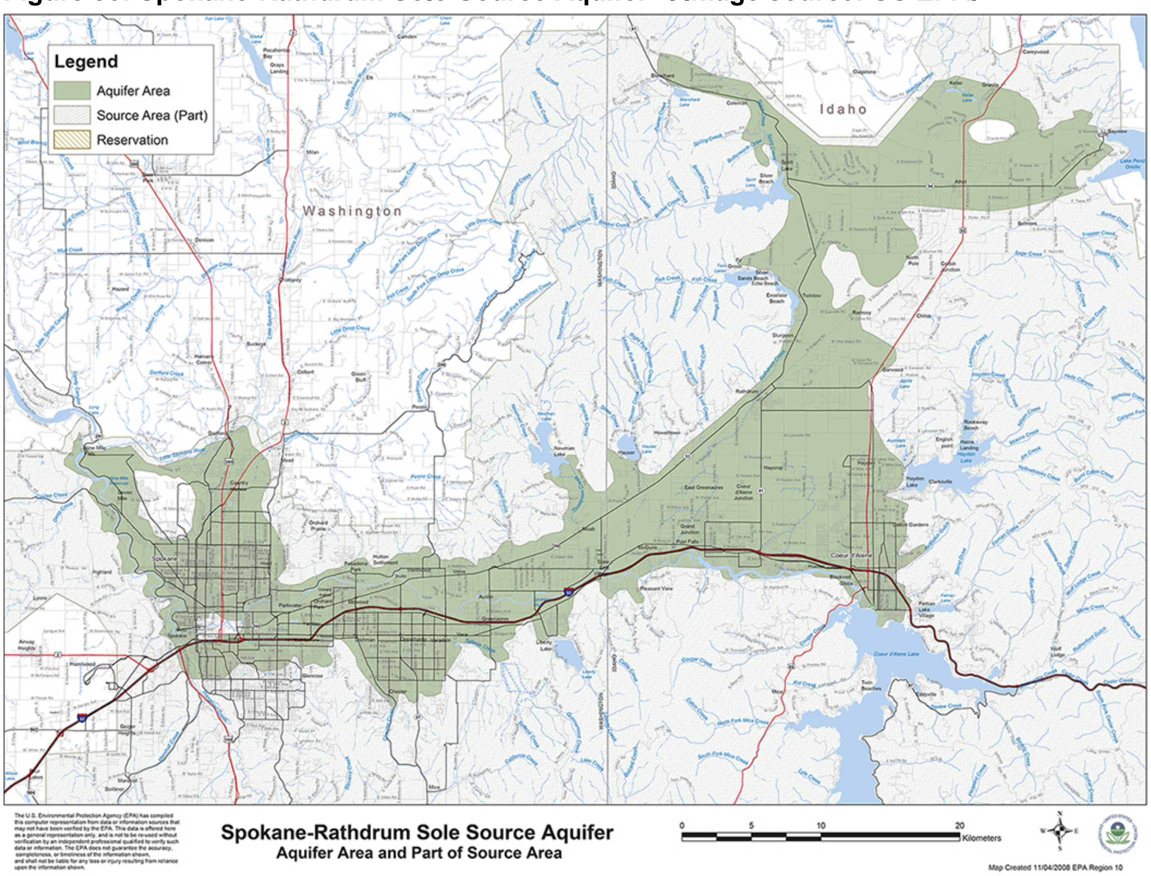
Health risks are associated with spills of Bakken crude and diluted bitumen, as there are for any type of oil spill. Health risks from spills have existed in all areas of the state. However, there are changes in risk associated with crude-by-rail marine and rail transport, and associated facilities may contribute to and/or change the health risks.

Drinking Water Contamination

Drinking water intakes along the Columbia River for Kennewick, Longview, Pasco, and Richland, as well as innumerable wells and intakes at aquifers in inland areas are at risk from spills. There is a sole-source aquifer in the Spokane region (Figure 30).

The U.S. Environmental Protection Agency (EPA) defines a sole or principal source aquifer as an aquifer that supplies at least 50% of the drinking water consumed in the area overlying the aquifer. These areas may have no alternative drinking water source(s) that could physically, legally, and economically supply drinking water to all those who depend on the aquifer.

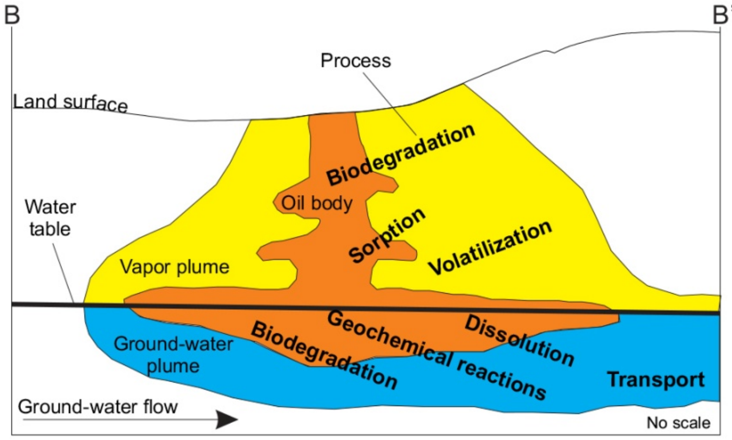
Figure 30: Spokane-Rathdrum Sole-Source Aquifer[77]. Image source: US EPA.



[77] Source: US EPA. http://www.epa.gov/region10/pdf/water/ssa/maps/ssa_spokane2_2008.pdf

Groundwater can be contaminated when any type of oil or refined petroleum product spills. The processes by which this occurs are shown in Figure 31.

Figure 31: Processes of Fate and Transport in the Subsurface at Oil Spill Sites on Land[78]. Image source: USGS



Pollution of Subsistence and Tribal Fishing Resources

Many communities rely on fish and shellfish from inland rivers, streams, the Columbia River, and the marine waters of Washington. These communities would be severely affected by temporary or long-term impacts to fisheries. Impacts would include toxicity-related mortality to existing fish and shellfish stocks (adults, juveniles, and eggs), decreased fish and shellfish fecundity (reproductive capacity) in future years, and reduced important food sources. Even if marine species mortality rates were relatively low, there is a risk of contamination of marine species food sources, which may lead to a fishery closure. Communities that rely on subsistence fishing and/or for whom locally caught marine species are an important part of traditional practices could be significantly affected. Moreover, many Washington residents rely on local fish for an important part of their diet.

Many of Washington's waterways still contain Chinook salmon runs. Chinook salmon tend to spawn in larger rivers and streams. Their spring runs normally travel longer distances inland from the ocean. The largest populations can be found in the Columbia and Snake River basins. Fall runs are found in higher concentrations in the Puget Sound area but also include populations that travel inland to spawn.[79]

Chum salmon populations are found relatively close to seawater. Since they are dependent on salt water for most of their lives, most of these populations do not spawn east of the Cascades.

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[78] US Geological Service 1998. http://mn.water.usgs.gov/projects/bemidji/results/fact-sheet.pdf
[79] http://www.pacificbio.org/initiatives/ESIN/Fish/ChinookSalmon/chinooksalmonpg.html

Currently, limited chum populations do cross over the Cascades as they spawn up the Columbia River.[80]

Sockeye salmon populations are considered to be in severe decline throughout Washington. The species is distributed throughout the state, with runs traveling as far as Idaho along the Snake River.[81]

Of all the salmon populations within Washington, steelhead salmon spend the greatest amount of their lives within the inland boundaries of the state. This species is found much of the year throughout most of the waterways in Washington. Winter runs are normally in the Puget Sound region, with only a few populations traveling east of the Cascades via the Columbia River. In contrast, the summer runs travel much farther, throughout all the major river systems.[82]

Air Quality Issues with Emissions from Locomotives and Vapor Release

Citizens have expressed concern over air pollution associated with increased rail traffic and associated locomotive diesel exhaust and its particulate matter content, especially for persons with asthma. In addition, concerns about health impacts from potential vapor release from tank cars containing the more volatile Bakken crude have been raised. Complaints about odors and irritation from volatile organic compound emissions at crude-by-rail transfer facilities have also been reported from at least one facility in Canada, particularly with diluted bitumen shipments.[83] Some groups have expressed concern about vapors from Bakken crude oil affecting people who reside, work, or attend school near railroad lines with crude-by-rail traffic, particularly highly urbanized areas such as the Spokane corridor and Seattle.[84]

Tribal Treaty Risks

There are also potential risks to tribal culture, tribal community subsistence harvest, and tribal treaty rights. With spills and potential fires associated with crude-by-rail transport, there are potential impacts to tribes on lands used for cultural and traditional practices, and lands associated with treaty resources, including U&A,[85] tribal ceded areas,[86] and tribal fisheries habitat areas (Figure 32).

[80] http://www.pacificbio.org/initiatives/ESIN/Fish/ChumSalmon/chumsalmonpg.html

[81] http://www.pacificbio.org/initiatives/ESIN/Fish/SockeyeSalmon/sockeysalmonpg.html

[82] http://www.pacificbio.org/initiatives/ESIN/Fish/SteelheadTrout/steelheadpg.html

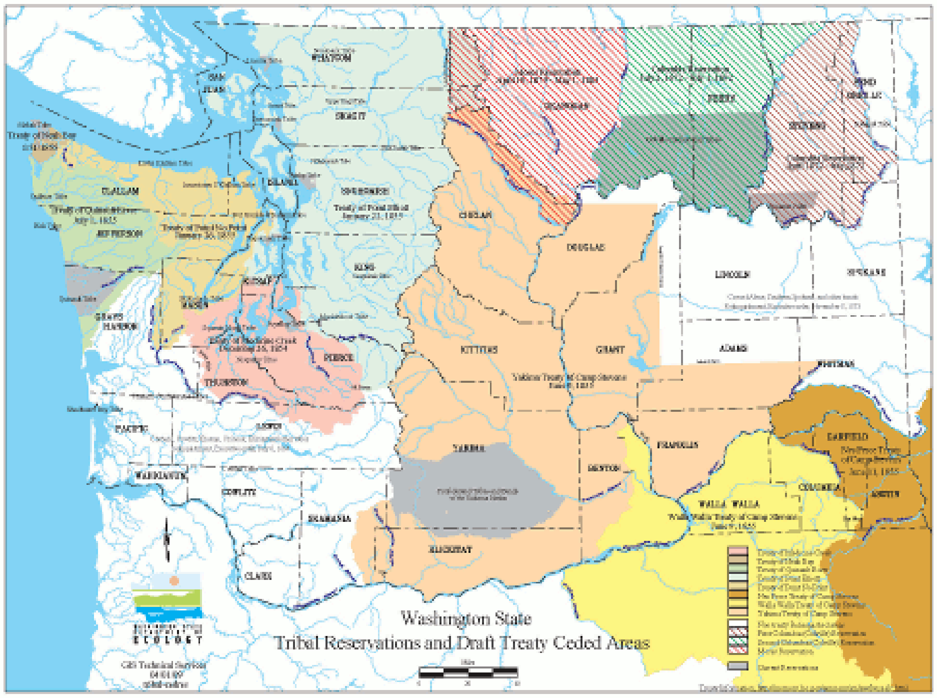
[83] http://www.reuters.com/article/2014/08/28/us-oil-railway-irving-idUSKBN0GS29620140828.

[84] University Legal Assistance and Gonzaga University Environmental Law Clinic, in an October 27, 2014 letter to Ecology expressed concern that a Conoco Phillips Safety Data Sheet on Bakken crude oil reports that "H304-May be fatal if swallowed and enters airways; H319 – Causes serious eye irritation; H336 – May cause drowsiness or dizziness; H373 – May cause damage to organs through prolonged or repeated exposure; H351 – Suspected of causing cancer."

[85] U&A is a Treaty term from the 1854–1855 Stevens' Treaties used extensively in US v. Washington, referring to an area where a particular Tribe traditionally fished and over which the Tribe has a territorial use claim under the provisions of the Treaty. Treaty Tribes retained their right to take fish in their "usual and accustomed" areas. These treaties are legally-binding contracts and are the supreme law of the land under the US Constitution.

[86] Areas over which tribes by treaty relinquished control to the federal government in return for compensation in the form of livestock, merchandise, and annuities.

Figure 32: Washington State Tribal Reservations and Draft Treaty Ceded Areas



Risks to tribal areas from spills already exist in all areas of the state. Changes associated with increased marine and rail transport of crude and associated facilities may increase and/or change the types of risks.

Pollution of Fishing Rights Areas

In addition to the potential health impacts of oil contamination of fish and shellfish, damages to fisheries affect cultural, traditional, and economic uses of fish for many tribes. Nearly all of the 29 tribes of Washington and several bordering tribes have traditional use areas, ceded lands, or treaty U&As. These tribes could be impacted by either rail and/or marine incidents associated with the crude-by-rail marine and rail transport and associated facilities.

Destruction of Reservations, Ceded Lands, and Traditional Use Areas

Fires associated with rail accidents in inland areas could have short- and long-term impacts on U&A fishing, hunting, and culturally important tribal lands. Oil spill damages to these lands could also have short-term or long-term impacts for tribes.

Reduction of Access to Reservations, Tribal Ceded Lands, and Traditional Use Areas

Prolonged spill responses, safety evacuations, fires, and the aftermath of an event could reduce access to U&A fishing, hunting, and culturally important tribal lands.

Environmental Risks from Spills Related to Crude-by-Rail

The first refinery operations in the state began in the 1950s. Washington's inland, coastal, marine, and estuarine areas have been at risk for oil spill impacts since petroleum products first were transported, handled, and used in the state.

The environmental impacts of an oil spill are dependent on a large number of factors, but most particularly:

- Type of oil (chemical and physical properties, toxicity, adherence, persistence).
- Spill location (habitat types, species present).
- Time of year (nesting season, reproductive cycles, migration patterns).

These three factors influence the type of impact that might be expected from an oil spill.

A 2009 study conducted for the Washington Joint Legislative Audit and Review Committee (JLARC) and Ecology[87] indicated that the impact risk was highest for the heavy fuels, followed by crude oil, and lower for light oils and gasoline. This trend is related to the higher persistence of heavier oils and the greater likelihood that these oils would coat and threaten organism health. This means that these types of oils, which include diluted bitumen, have more risk to birds, mammals, habitats, and recreation than the less persistent oils, like gasoline.

The natural resources are at added risk from spills associated with crude-by-rail transport in inland areas, crude handling and transfer at marine facilities, and crude transport by tank vessels. Spills are already an environmental risk in all areas of the state, but environmental risks for Washington's unique, sensitive, and highly-treasured natural resources may increase or change with increased transport of crude-by-rail.

Spill and fire incidents would trigger spill and emergency response operations that may also affect the environment. Crude oils being transported by rail may have varying effects, due to their individual properties. Many important changes in spills could occur with crude-by-rail transport that may affect the type and magnitude of environmental risk.

Spills of New Types of Crude Oil

Bakken crude may spill into waterways and inland areas, and impact aquifers, as it is handled and transported by rail in marine areas. The toxicity and other properties of this oil may cause environmental impacts different from other types of oils that have spilled. With respect to potential environmental impacts, Bakken crude and other shale oils can most closely be compared with light oils like diesel.

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[87] State of Washington JLARC 2009; Etkin et al. 2009; French-McCay et al. 2009.

Spills of Diluted Bitumen into Waters of the State

Diluted bitumen transported by tankers, articulated tank barges, and railcars that run parallel to waterways like the Columbia River present a higher risk for spills directly to waterways. Bitumen alone can have heavy properties that, depending on its formulation and the density[88] of the water, may lead to a greater possibility of submerging in water, particularly if there is a great deal of sediment and turbulence. This is likely to be more of a concern in rivers because of the increased volume of sediment, shallower depths, and because fresh water is less dense than salt water, which may have an influence on if an oil will sink or float, high turbulence in rivers that more easily stir up sediments. Any hydrocarbons that become submerged in rivers and streams could cause particular impacts in salmon spawning areas. Bakken crude and other shale oils can most closely be compared with heavy oils. It is also possible for some sedimentation-related submergence of diluted bitumen to occur in marine waters. The issue of sinking or submergence of diluted bitumen and its relationship to the degree of sedimentation and water salinity is discussed in greater detail in Appendix F.

Potentially More and Larger Inland Spills than Previously Experienced

Historically, the largest spills in most inland areas were from overturned tanker trucks, and pipelines. Occasional rail spills have come mainly from leaks from locomotives on freight or passenger trains. The volume of oil in these cases pales in comparison to the nearly three million gallons of crude oil as carried by a single crude-by-rail unit train.[89]

A 2009 study[90] conducted for the JLARC[91] analyzed spills occurring in all areas of Washington from 1995 through 2007. This time period represents the pre-crude-by-rail baseline. There were a total of 1,080 spills of at least 50 gallons, or about 83 spills annually, in inland areas[92] (Olympic Peninsula, Cascades, West of Cascades, and East of Cascades). A total of 589,000 gallons spilled in these areas. Facilities, railroads, and tanker trucks were the sources of 67% of these spills (Table 12).

Table 12: Pre-Crude-by-Rail Oil Spills in Inland Areas of Washington 1995 - 2007[93]

Source Class	Number	Number %	Gallons	Volume %	Average Gallons

[88] Mass or weight per unit volume.
[89] Note that there have been freight trains containing hazardous cargo (e.g., chlorine gas) in tank cars passing through Washington for decades, but the quantities have been much lower.
[90] State of Washington JLARC 2009; Etkin et al. 2009; French-McCay et al. 2009.
[91] The Joint Legislative Audit and Review Committee (JLARC) works to make state government operations more effective, efficient, and accountable. The Committee is composed of an equal number of House and Senate members, Democrats, and Republicans. JLARC pursues its mission by conducting performance audits, program evaluations, sunset reviews, and other analyses. Assignments to conduct studies are made by the Legislature and the Committee itself. Based on these assignments, JLARC's non-partisan staff auditors, under the direction of the Legislative Auditor, independently seek answers to audit questions and issue recommendations to improve performance. Work by JLARC staff is conducted using Generally Accepted Government Auditing Standards. These standards ensure audit conclusions are independent, objective, and accurate. JLARC's authority is established in Chapter 44.28 Revised Code of Washington.
[92] Includes waters in these regions.
[93] Etkin et al. 2009.

Source Class	Number	Number %	Gallons	Volume %	Average Gallons
Facility-Other	336	31.1%	171,658	29.1%	511
Railroad	55	5.1%	150,435	25.5%	2,735
Tanker Truck	55	5.1%	73,475	12.5%	1,336
Vehicle-Other	394	36.5%	43,331	7.4%	110
Oil Terminal	18	1.7%	34,255	5.8%	1,903
Military	50	4.6%	31,275	5.3%	626
Power Utility	32	3.0%	28,205	4.8%	881
Gas Station	47	4.4%	16,892	2.9%	359
Residential	41	3.8%	15,338	2.6%	374
Facility-Milling	24	2.2%	13,370	2.3%	557
Pipeline	3	0.3%	6,938	1.2%	2,313
Airport	4	0.4%	1,650	0.3%	413
Pleasure Craft	8	0.7%	1,325	0.2%	166
Aircraft	6	0.6%	470	0.1%	78
Fishing Vessel	4	0.4%	270	0.0%	68
Non-Tank Vessel[94]	1	0.1%	100	0.0%	100
Passenger Vessel	1	0.1%	75	0.0%	75
Towboat/Tugboat	1	0.1%	50	0.0%	50
Total	1,080	100.0%	589,112	100.0%	545

Railroad spills accounted for over 150,000 gallons of oil spilled, with an average volume of 2,700 gallons per incident. The Upper Columbia and Snake Rivers had 163 incidents, or 13 incidents annually. The majority of these incidents involved facilities. There were 15 railroad incidents for a total of 8,625 gallons spilled (Table 13). Spills from several crude-by-rail tank cars (with 30,000 gallons each) in a single incident would be larger than all previous inland spills. Inland resources, including streams and rivers, as well as farmland, forests, wetlands, and other uniquely sensitive areas will be at increased risk from spills of Bakken crude and/or diluted bitumen.

Table 13: Pre-Crude-by-Rail Oil Spills in Upper Columbia/Snake Rivers 1995 - 2007[95]

Source Class	Number	Number %	Gallons	Volume %	Average Gallons
Oil Terminal	5	3.7%	75,710	35.4%	15,142
Facility-Other	62	37.8%	44,931	21.0%	725
Pipeline	3	1.8%	43,588	20.4%	14,529
Tanker Truck	9	5.5%	28,650	13.4%	3,183
Railroad	15	9.1%	8,625	4.0%	575
Vehicle-Other	49	29.9%	4,471	2.1%	91
Gas Station	5	3.0%	3,785	1.8%	757
Power Utility	9	5.5%	2,675	1.3%	297
Passenger Vessel	1	0.6%	580	0.3%	580
Tank Barge	1	0.6%	308	0.1%	308
Pleasure Craft	2	1.2%	250	0.1%	125
Facility-Milling	1	0.6%	250	0.1%	250
Residential	1	0.6%	150	0.1%	150

[94] A ship that does not carry oil as cargo, such as a container ship or a bulk carrier.
[95] Etkin et al. 2009.

Source Class	Number	Number %	Gallons	Volume %	Average Gallons
Total	163	100.0%	213,973	100.0%	1,313

Reports of Oil Stained Rail Cars in Washington
On January 21, 2015, Ecology became aware of a Bakken crude oil rail shipment transported through Washington which had leaked during transport. This incident had not previously been reported to the federal National Response Center, the Washington Division of Emergency Management nor to Ecology. The incident was reported to the Federal Rail Administration within the required timeline (within 30 days after the end of month in which the incident occurred). During the investigation into this incident, two other similar incidents were reported to Ecology that had occurred within the previous two weeks. Following these three incidents, two additional leaking rail car incidents were reported to Ecology immediately upon their discovery. A summary of these five incidents includes:

- One Bakken crude oil railcar arrived at the Blaine terminal on November 5, 2014 with oil staining on the leaking car, and oil stains a few of the trailing cars, with oil stains to their wheels. The loading/arrival volume discrepancy was 1,611 gallons.
- Seven Bakken crude oil railcars were observed with oil stains while in Vancouver on January 12, 2015. It was estimated that each of the seven cars had lost 5 gallons of crude oil each.
- Six Bakken crude oil railcars were observed with oil stains while in Auburn on January 13, 2015. It was estimated that each of the six cars had lost 1 gallon of crude oil
- One Bakken crude oil rail car was observed leaking in a Seattle rail yard on February 12, 2015. An estimated 2 gallons of Bakken crude oil leaked out of a top fitting on the car.
- One rail car was observed by a Federal Railroad Administration inspector to have oil residue around the top fittings of the rail car while in Fife on February 23, 2015. This was a shipment of Canadian crude oil. No estimate of the volume was provided.

At the time of this publication, these incidents were under investigation and the cause(s) were not determined. Additionally, it is not know where these rail cars may have leaked between their point of loading crude oil and the location where crude oil staining was first observed in Washington.

Proposed Crude-by-Rail Facilities and Changes to Potential Marine Spill Frequency

With the full build-out of proposed crude-by-rail facilities in Washington (Figure 13), there is a potential for oil spills from facility storage tanks and transfer operations, as well as from tankers and ATBs that receive the crude oil for transport.

Grays Harbor

The JLARC study[96] showed that Grays Harbor experienced 60 spills from 1995 through 2007, averaging less that 5 spills annually, and a total of 27,000 gallons. Tanker truck incidents accounted for the majority of the 27,000 gallons spilled. Fishing vessels were the most frequent spill source. Average spill volume was 453 gallons. One oil terminal spilled 3,000 gallons (Table 14).

Spills of Bakken crude and/or diluted bitumen and other forms of bitumen present a risk of environmental damage to the sensitive marine and coastal environment of Grays Harbor. Marine wetlands such as those in Grays Harbor are a particularly vulnerable habitat, because they are often tidally influenced, environmentally sensitive, and difficult to clean without further harming the habitat.

Table 14: Pre-Crude-by-Rail Oil Spillage in Grays Harbor 1995 - 2007[97]

Source Class	Number	Number %	Gallons	Volume %	Average Gallons
Tanker Truck	7	11.7%	11,900	43.8%	1,700
Fishing Vessel	13	21.7%	4,584	16.9%	353
Facility-Other	9	15.0%	3,855	14.2%	428
Oil Terminal	1	1.7%	3,000	11.0%	3,000
Vehicle-Other	10	16.7%	1,290	4.7%	129
Facility-Milling	8	13.3%	1,005	3.7%	126
Residential	4	6.7%	495	1.8%	124
Passenger Vessel	2	3.3%	372	1.4%	186
Non-Tank Vessel	2	3.3%	216	0.8%	108
Towboat/Tugboat	1	1.7%	200	0.7%	200
Gas Station	1	1.7%	100	0.4%	100
Pleasure Craft	1	1.7%	100	0.4%	100
Power Utility	1	1.7%	60	0.2%	60
Total	60	100.0%	27,177	100.0%	453

Outer Coast of Washington

Spills along the outer coast affect Willapa Bay and other environmentally-sensitive areas, as well as Tribal U&A areas.

The JLARC study[98] showed that there were 108 spills along the outer coast, about 8 spills annually from 1995 through 2007. The majority of these incidents involved fishing vessels that spilled diesel fuel Table 15). In the Willapa Bay area, there were 17 spills, or 1.3 annually, for a total of less than 8,000 gallons spilled. The largest incident occurred from a tanker truck that spilled 2,900 gallons of diesel fuel (Table 16).

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[96] State of Washington JLARC 2009; Etkin et al. 2009; French-McCay et al. 2009.
[97] Etkin et al. 2009.
[98] State of Washington JLARC 2009; Etkin et al. 2009; French-McCay et al. 2009.

Table 15: Pre-Crude-by-Rail Oil Spills on Outer Coast 1995 - 2007[99]

Source Class	Number	Number %	Gallons	Volume %	Average Gallons
Tanker Truck	8	7.4%	14,800	34.0%	1,850
Fishing Vessel	31	28.7%	11,069	25.5%	357
Oil Terminal	5	4.6%	4,350	10.0%	870
Facility-Other	13	12.0%	4,310	9.9%	332
Facility-Milling	13	12.0%	2,827	6.5%	217
Vehicle-Other	14	13.0%	1,620	3.7%	116
Gas Station	2	1.9%	1,200	2.8%	600
Towboat/Tugboat	2	1.9%	900	2.1%	450
Non-Tank Vessel	9	8.3%	889	2.0%	99
Residential	4	3.7%	495	1.1%	124
Passenger Vessel	2	1.9%	372	0.9%	186
Pleasure Craft	2	1.9%	300	0.7%	150
Unknown	1	0.9%	250	0.6%	250
Power Utility	1	0.9%	60	0.1%	60
Total	108	100.0%	43,492	100.0%	403

Table 16: Pre-Crude-by-Rail Oil Spillage in Willapa Bay 1995 - 2007[100]

Source Class	Number	Number %	Gallons	Volume %	Average Gallons
Tanker Truck	1	5.9%	2,900	36.8%	2,900
Facility-Milling	5	29.4%	1,822	23.1%	364
Oil Terminal	2	11.8%	1,150	14.6%	575
Gas Station	1	5.9%	1,100	14.0%	1,100
Facility-Other	2	11.8%	310	3.9%	155
Pleasure Craft	1	5.9%	200	2.5%	200
Fishing Vessel	2	11.8%	185	2.4%	93
Vehicle-Other	2	11.8%	155	2.0%	78
Non-Tank Vessel	1	5.9%	50	0.6%	50
Total	17	100.0%	7,872	100.0%	463

Columbia River

The expected volume and frequency of spills in the Lower Columbia will increase from what this area has experienced in the past. Wetlands are particularly vulnerable.

The JLARC study[101] showed that spills in the Lower Columbia River amounted to 197 incidents or about 15 incidents annually, with a total of less than 151,000 gallons of spillage. The greatest volume came from gas stations and facilities. Vessel spills amounted to 24 incidents involving less than 13,000 gallons of spills (Table 17).

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[99] Etkin et al. 2009.
[100] Etkin et al. 2009.
[101] State of Washington JLARC 2009; Etkin et al. 2009; French-McCay et al. 2009.

Table 17: Pre-Crude-by-Rail Oil Spills in Lower Columbia River 1995 - 2007[102]

Source Class	Number	Number %	Gallons	Volume %	Average Gallons
Gas Station	7	3.6%	43,025	28.5%	6,146
Facility-Other	50	25.4%	35,629	23.6%	713
Power Utility	4	2.0%	29,720	19.7%	7,430
Fishing Vessel	1	0.5%	8,000	5.3%	8,000
Vehicle-Other	73	37.1%	6,721	4.5%	92
Railroad	10	5.1%	6,000	4.0%	600
Pipeline	4	2.0%	4,851	3.2%	1,213
Residential	7	3.6%	3,870	2.6%	553
Non-Tank Vessel	15	7.6%	3,333	2.2%	222
Facility-Milling	7	3.6%	2,840	1.9%	406
Refinery	1	0.5%	2,600	1.7%	2,600
Tanker Truck	6	3.0%	2,543	1.7%	424
Tank Ship	1	0.5%	519	0.3%	519
Oil Terminal	3	1.5%	300	0.2%	100
Towboat/Tugboat	2	1.0%	255	0.2%	128
Pleasure Craft	2	1.0%	230	0.2%	115
Passenger Vessel	2	1.0%	155	0.1%	78
Unknown	1	0.5%	100	0.1%	100
Tank Barge	1	0.5%	53	0.0%	53
Total	197	100.0%	150,744	100.0%	765

Puget Sound

Puget Sound could be affected by shifts in the patterns of vessel traffic related to the proposed Gateway Pacific Terminal, Roberts Bank Terminal 2 (in Vancouver, British Columbia), Kinder Morgan Terminal (also in Vancouver), and other factors unrelated to crude-by-rail. There are documented decreases in tanker traffic bringing oil from Alaska and foreign sources, and this pattern of reduced crude imports is likely to continue as crude-by-rail operations continue. [Vessel traffic in Puget Sound is discussed in greater detail in Appendix B.] The vessel traffic associated with crude-by-rail (refined product carriers, ATBs, and oil barges) will be superimposed on this uncertain future background and may further strain the waterway system as bunkering/fueling operations increase and anchorages get more congested.

If the export of crude oil is adopted, then the potential for additional vessel traffic exists. Foreign-flag tankers must meet international marine standards and applicable federal and state domestic standards. Though these standards serve the safety and spill prevention regime well internationally, they are lower than the voluntarily adopted levels of design redundancy in powering and steerage on the current Jones Act[103] fleet of tankers transporting ANS crude oil

[102] Etkin et al. 2009.
[103] The Merchant Marine Act of 1920 (also known as the Jones Act) is a US Federal statute that provides for the promotion and maintenance of the American merchant marine. Among other requirements, it stipulates that goods transported between US ports be carried on US-flag ships, constructed in the US, owned by US citizens, and crewed by US citizens and permanent residents. This affects all oil transportation in tank vessels between US ports.

into Washington. Canadian-sourced, diluted bitumen could be exported through crude-by-rail as well as by pipeline expansions.

Climate Risks

The Washington Environment Council and individual groups of citizens have expressed concern about the effect to climate from oil extraction occurring in North Dakota, Alberta, and other locations, from burning of crude-by-rail-sourced oil as a fossil fuel, and from fuel used during the transport of the oil by rail and eventually by tank vessel:

> "Carbon emissions are released into the atmosphere in the process of using and extracting oil, and greenhouse gas concentrations vary based on the type of oil. This includes use of oil in the transportation of crude oil, as well as the use of refined product. Key issues to consider include impacts and risks to the environment, public health, and economy related to climate change."[104]

The extent to which the burning of fossil fuels affects climate is well understood by Ecology. This issue is not within the scope of this study, which does not lessen the importance of the concerns.

Socio-Economic Risks

The socio-economic risks from oil spills already exists in all areas of the state. However, changes associated with crude-by-rail transport add to this background and may increase or change the types of environmental risks for Washington's unique, sensitive, and highly-treasured natural resources. Damages to economic resources because of spillage and/or fires associated with crude-by-rail incidents could have direct effects on local and regional economies. Prolonged response operations and evacuations could also have significant impacts.

Increasing the weekly number of loaded crude-by-rail trains from19 to, potentially, 83 to 137[105] with the full build-out of Washington facilities and export to Oregon and California could have far-reaching rippling effects on the region's economic infrastructure. Additional facilities and changes in vessel traffic associated with crude-by-rail could have complex effects on other port activities and economic resources.[106] Potential economic impacts of crude-by-rail have been identified by various stakeholders and are discussed in the following sections.

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[104] From Washington Environment Council Puget Sound Policy Specialist Rebecca Ponzio letter to Department of Ecology, August 15, 2014. 3 p.

[105] Estimates of 83 trains weekly are based analyses for 2020 with expected build-out of proposed facilities (see Table 4); 137 trains weekly are based on estimates for 2035 with full build-out of proposed facilities and export of oil to California and Oregon.

[106] There are potential economic benefits from CBR that are not addressed in this preliminary study.

Crude-by-Rail Train Traffic Blocking or Slowing Other Freight Train Traffic

Adding crude-by-rail trains to the rails in Washington and to parts of the Northern Corridor[107] has caused concerns about slowdowns or temporary blockages of other freight trains carrying grains and other perishable food commodities. Slowdowns and blockages are mainly due to a lack of locomotives, freight cars, congestion on the rails, and other factors. BNSF and UP have stated that the increase in crude-by-rail trains will not impact other freight train traffic; however, stakeholders are nevertheless concerned that this is not proving true. Decisions on the use of locomotives and railroad lines are based on commercial market factors. Train capacity affecting transport of various commodities is an on-going concern. At certain times of year, anhydrous ammonia[108] shipments (for fertilizer used in spring planting) are given priority, for example.

Increased Vessel Traffic in Grays Harbor and Columbia River

Increased vessel traffic with the full build-out of proposed crude-by-rail facilities in Grays Harbor and the lower Columbia River may require additional vessel management. This could have economic impacts on existing industries in the area.

Social and Economic Disruptions due to Evacuations

If residents must be evacuated due to a rail accident with actual or potential fire or explosions that threaten public safety, there may be associated social and economic impacts for affected residents, businesses, and communities as a whole.

Property Damage from Fires or Spills

The potential for damage to private and public property as a result of spills or fires directly or indirectly associated with crude-by-rail transport is of enormous concern to many residents, business owners, and first responders. In addition, there is concern that there may not be adequate compensation for damages.

Effects on Property Values with Proximity to Tracks

The potential for property damage from fires and spills along inland railroad lines may have an effect on property values due to perceptions of added risk.

Vehicular Traffic Interruptions at Rail Crossings

In the outreach for this Study, many citizens have expressed frustration and concern about vehicular traffic disruptions by the several-minute waits experienced as trains pass in locations with no vehicular overpasses. Some groups have mentioned concerns regarding people choosing to drive rather than take commuter trains due to fears about potential service and emergency response disruptions due to crude-by-rail trains.

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[107] The "Northern Corridor", sometimes called the "Great Northern Corridor", spans the northern US between the Pacific Northwest and Chicago and reaches key southern points in Canada.
[108] A colorless, highly irritating gas or liquid commonly used to make fertilizers. It has a sharp, suffocating odor.

Vehicular Access Interruptions Due to Accidents and Fires

Citizens have expressed concern about traffic disruptions in the aftermath of accidents due to fires and/or cleanup operations. This may block access to different parts of communities, which may have economic and social implications.

Potential Inadequate Compensation for Damages from Fires and Spills along Rail Lines

Various community groups have expressed concern about who would pay for cleanup response and compensate affected third parties in the event of a major spill and fire accident. The liability and financial responsibility of vessel and facility owners is well understood by most groups, but there is a concern that railroads would not pay for response and damages.

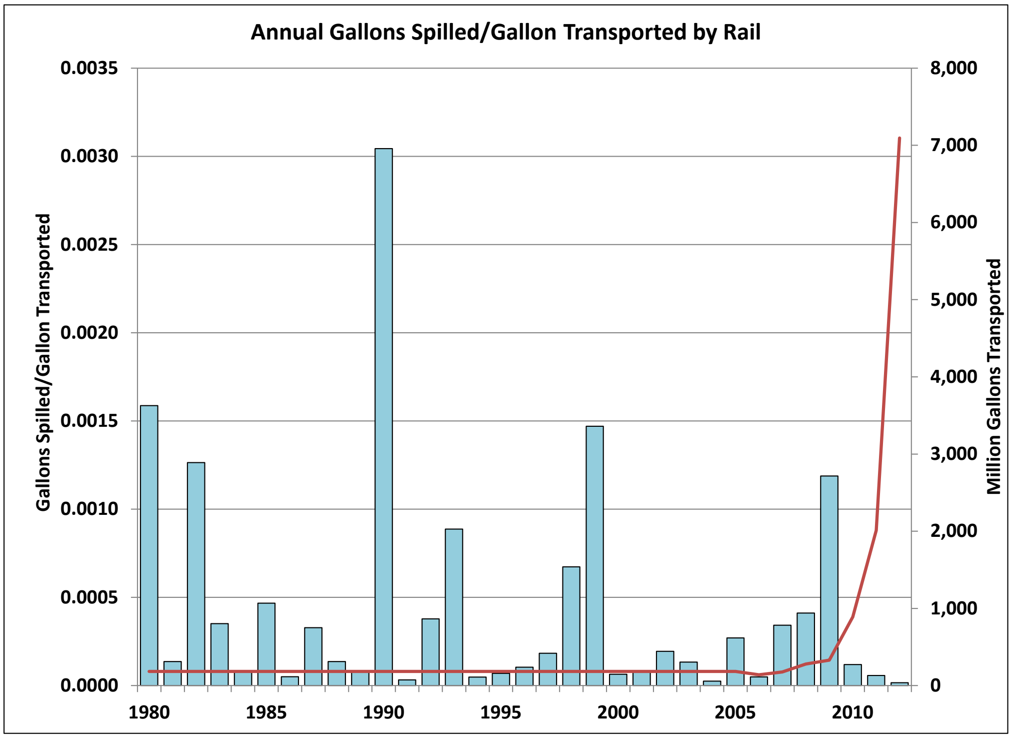
Probability of Oil Spills from Trains

During the last decade (2003–2012), throughout the U.S., an average of 96,600 gallons of oil spilled annually from trains, or about 0.000086 gallon spilled for every gallon transported. This means that, on average, one gallon of oil spilled for every 11,628 gallons transported by rail. The rate of spills per barrel of transport has varied from year to year (Figure 33), but reached an all-time low in 2012 with a spill rate of 0.000016 gallons spilled per gallon transported. In 2012, nearly 7.1 billion gallons of oil were transported by rail and 110,250 gallons spilled – or one gallon spilled for every 62,500 gallons transported.[109]

Another researcher has estimated the spill incident rate specifically for crude-by-rail unit trains as 0.81 – 2.08 incidents per billion ton-miles, which is contrasted with the rate of 0.56 – 0.58 incidents per billion ton-miles of pipeline transport. The magnitude of spills for the crude-by-rail spills is 690 to 2,800 gallons per incident. For pipelines, the spill volume is 11,100 to 11,300 gallons.[110] This is based on a limited data set.

[109] Data from ERC spill databases.
[110] Carlson 2014.

Figure 33: Annual U.S. Oil Spill Rate per Oil Transport by Rail 1980 – 2012



With the dramatic increase in oil transport in the last several years, however, the average annual spillage by rail has increased by 42% (Figure 34). While the rate of spills per gallon of oil transported has gone down over the decades, with 44 times more oil being transported, more oil is now being spilled by trains than was in the past 30 years. Since the 1980s, the rate of spillage per amount transported has decreased by 91%, and since the last decade, it has decreased by 77% (Figure 35). This means that rail transport of crude, and rail transport is generally safer than in past decades.

The potential for spills is higher than in previous years, though not as high as it would be if practices in the 1980s and 1990s continued. The nature of potential rail incidents with possible fires, impacts to tribal treaty U&A areas, and impacts to sensitive environmental and economic resources, coupled with possible increases in spill underlines the heightened risk to Washington.

The potential numbers of incidents and volume of spills in Washington depend on the amount of oil transported and the likelihood of incidents by cause, e.g., derailment. Currently, we lack data on specific conditions in Washington to derive estimates of the number of future incidents. Nationally, one gallon of oil is spilled for every 11,628 gallons transported by rail.

Figure 34: Average U.S. Oil Spill Rate per Oil Transported by Rail (Decade Comparison)

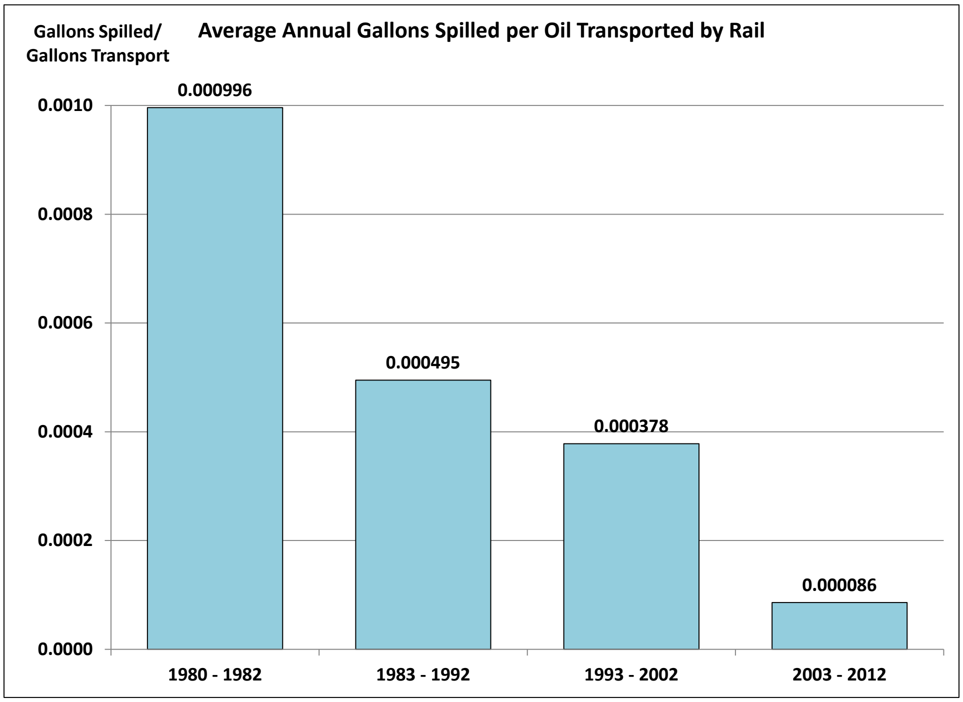
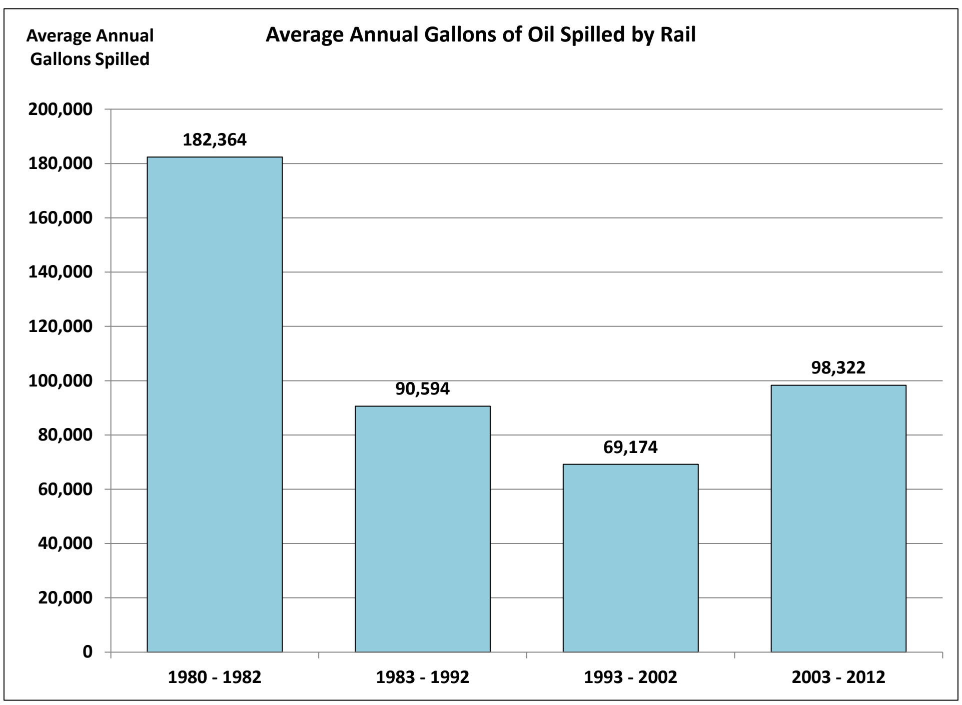


Figure 35: Average Annual Oil Spills by Rail in the U.S.



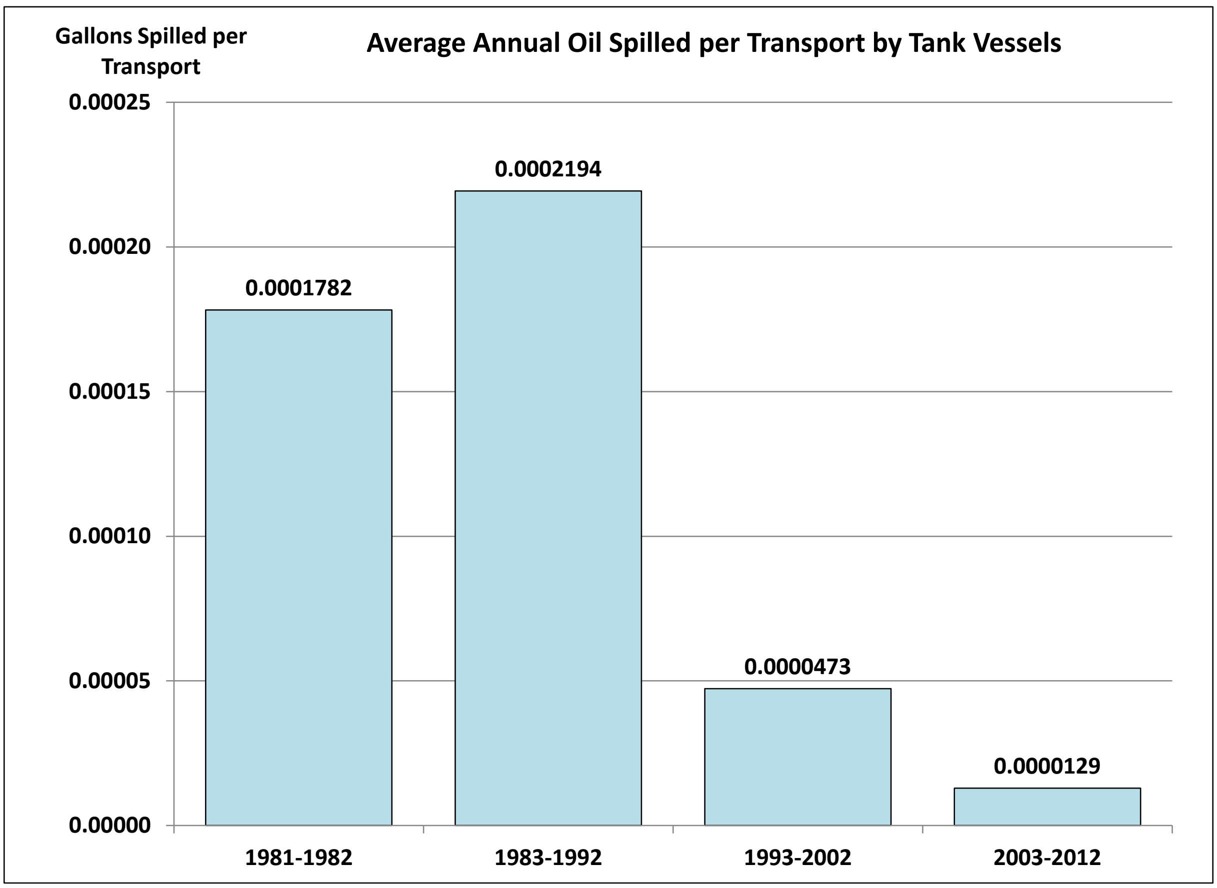
Crude-by-Rail Marine Transport Oil Spill Probability

On a national basis, the rate of spills from tank vessels (tankers or tank ships and tank barges) decreased over the last decades (Figure 36). In the last decade, for each gallon of oil transported by tank vessel, 0.0000129 gallons spilled, or one gallon spilled for every 77,519 gallons transported. This is a 73% decrease since the 1990s and a 94% decrease in the 1980s. Transport of oil by tank vessel has become safer.

A previous study showed that vessel spill rates in Washington were lower than in other comparable port areas and the U.S. as a whole due to spill prevention measures in place.[111]

In the JLARC Study[112] between 1995 and 2007, tank barges made up 0.9% of the number of spills and nearly 56% of the spill volume from all sources. Tankers made up 0.3% of the incidents and 2.8% of the total volume of spillage.

Figure 36: Average Annual Oil Spills per Transport by Tank Vessel



[111] Etkin and Neel 2001.
[112] Etkin et al. 2009.

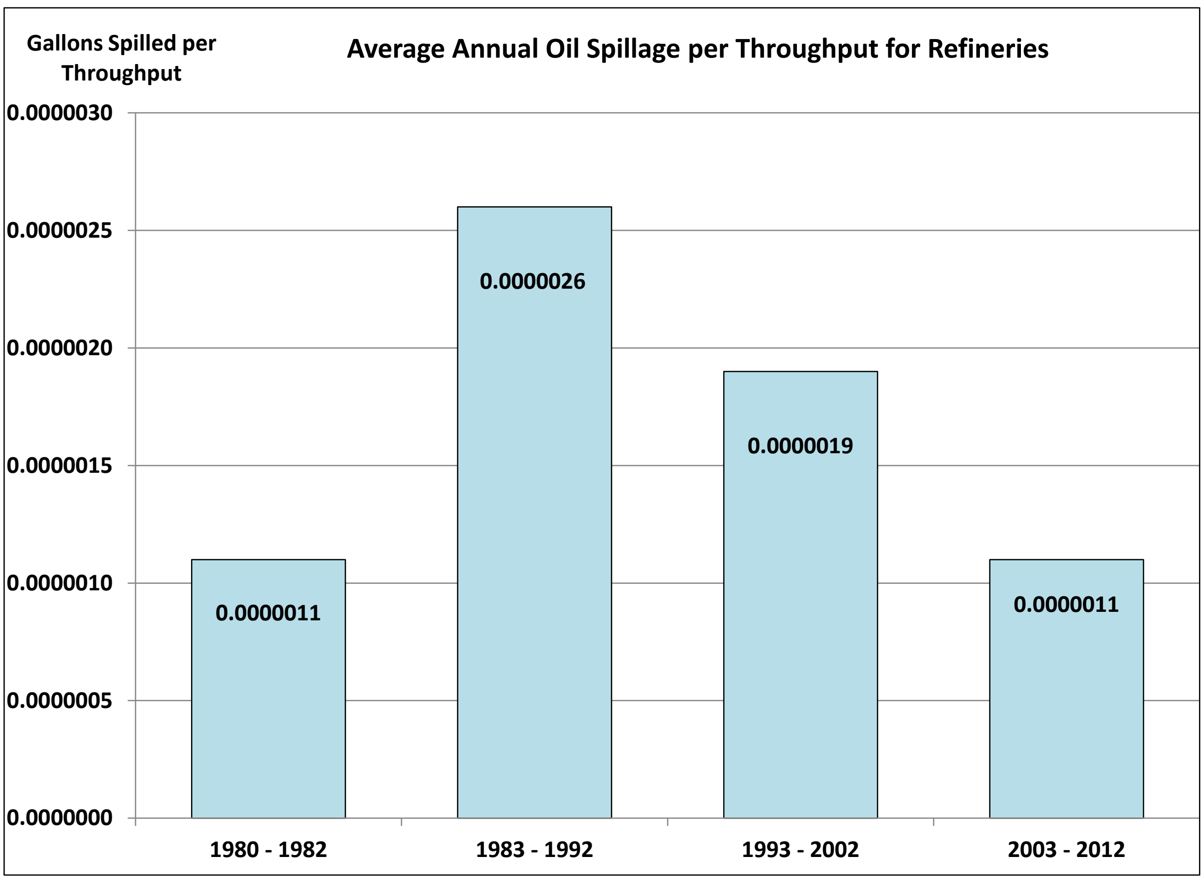
Crude-by-Rail Facility Oil Spill Probability

Between 1995 and 2007, oil terminals and refineries that now handle crude-by-rail shipments in Washington accounted for 2.2% and 1.7%, respectively, of the total number of incidents reported in Washington.[113] Each facility type accounted for 2.6% of the total spill volume during this time period, for a total of 5.2% combined.

Nationally, rates of spills from oil refineries per throughput have decreased by 58% since the 1980s and 42% since the 1990s. During 2003–2012, one gallon of oil spilled for every 909,000 gallons of throughput (Figure 37).

The amount spilled from facilities has also decreased on a national basis. (These data are not available on a per-amount handled basis.) The annual volume of spillage has decreased by 84% since the last decade and 98% since the 1970s (Figure 38).

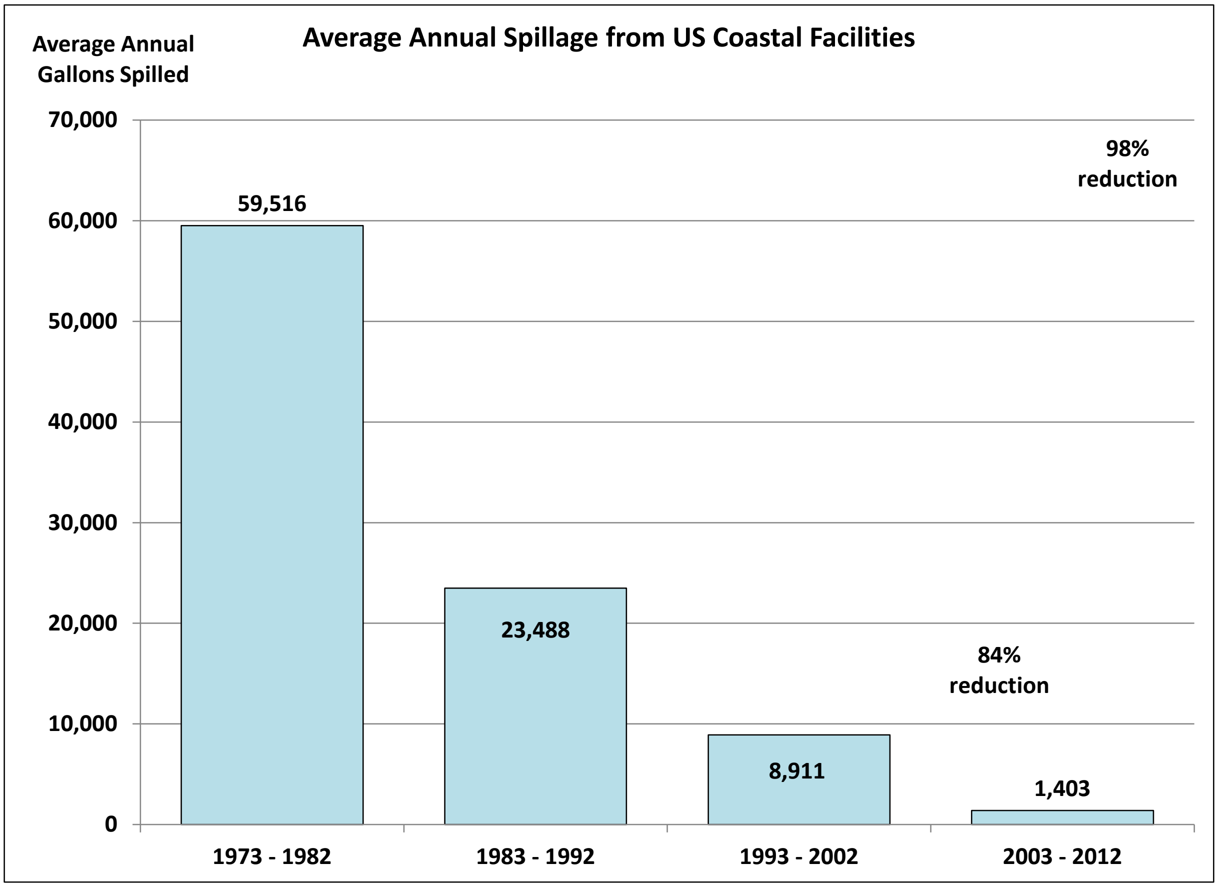
Figure 37: U.S. Average Annual Oil Spilled per Throughput[114] for Refineries



[113] Etkin et al. 2009.

[114] Refinery throughput is the actual volume of petroleum products "processed" or produced at a refinery, or essentially, the refinery capacity multiplied by the refinery utilization.

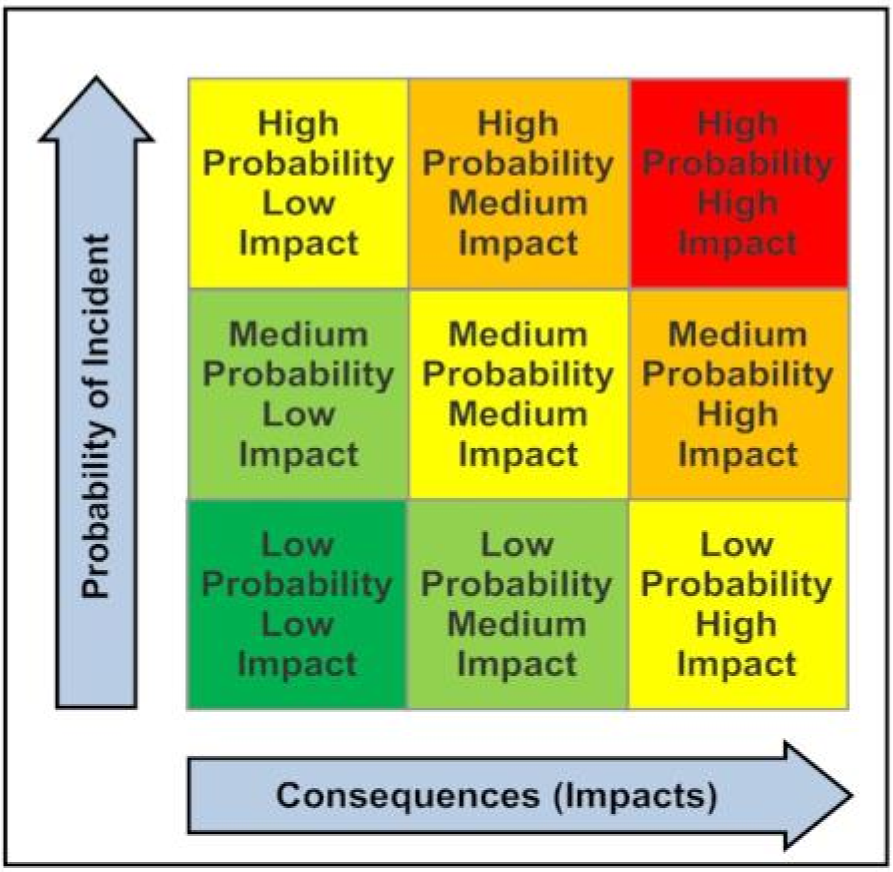
Figure 38: U.S. Average Annual Oil Spillage from Coastal Facilities



Mitigating Risk

Risk encompasses both the likelihood, or probability, of an event occurring and the consequences or impacts of that event. The "event" in the case of rail and marine crude oil transport is an incident or accident that causes the release of oil. Spilled oil may cause impacts to valued environmental, cultural, and economic resources – and the oil may ignite causing human safety and health impacts, including fatalities. The consequences of the incident depend on the type and amount of oil released, whether it ignites, and the timing and location of the incident relative to humans and sensitive resources. The incidents with the highest risk are those with the highest probability and the highest consequences (Figure 39).

Figure 39: Basic Risk Matrix

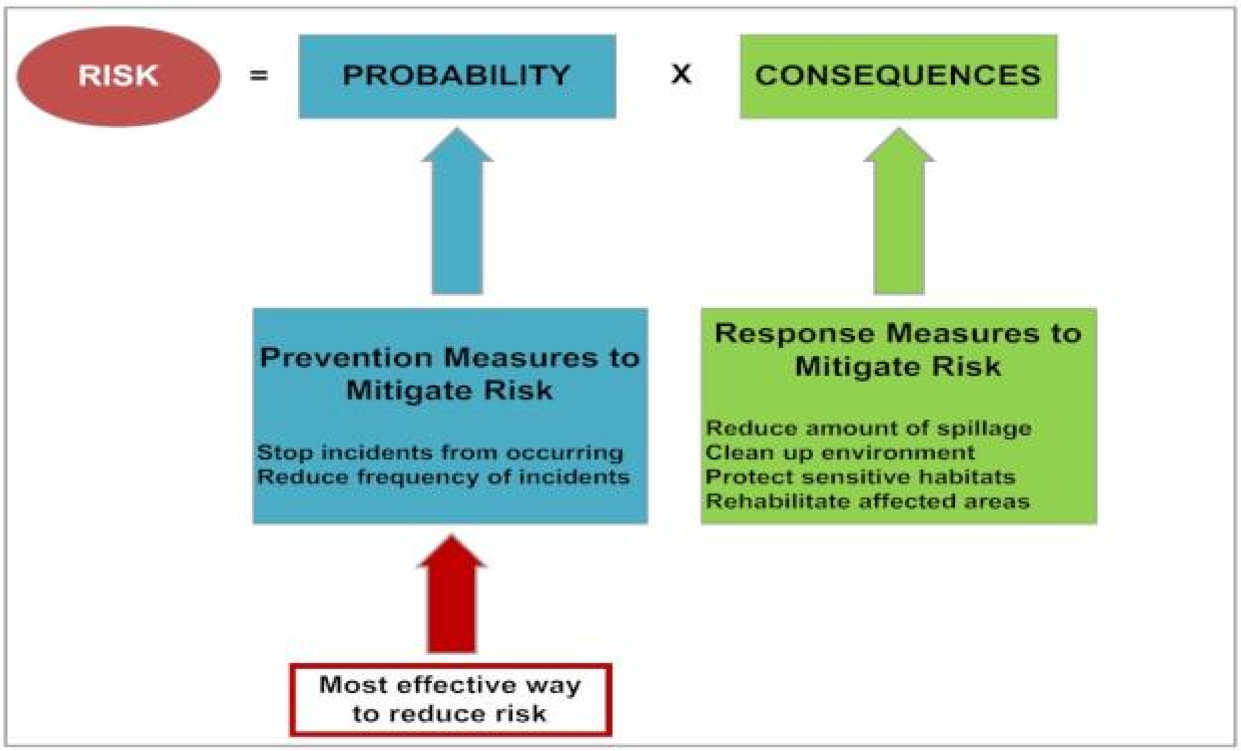


The incidents with the highest probability may often have the lowest impacts (e.g., small operational spills in industrial areas). Incidents with the highest impact (e.g., a major spill or catastrophic incident involving a fire) are more rare events with low probability. In the risk matrix, the situation types shown in yellow, orange, and red present the greatest challenge.

Risk can be mitigated or reduced in two principle ways – by reducing the probability, and by reducing the consequences (Figure 40). Incident probability is reduced through prevention measures, i.e., stopping the incidents from happening in the first place, or at least reducing their frequency. Prevention is the most effective means to reduce risk.

Addressing the consequences for oil spills means being prepared to respond to an emergency and reducing the degree to which humans and sensitive resources are impacted. This includes, first and foremost, preventing fatalities and injuries from fires and/or explosions and minimizing exposure of humans and environment to spilled substances, either through direct contact or through contact with contaminated groundwater. An effective spill response protects people, minimizes the spread of oil, protects natural resources, and removes oil from the environment, to the extent possible. If damage occurs, later phases of response operations include rehabilitation of the affected environmental, cultural, and economic resources.

Figure 40: Risk Mitigation Approaches Addressing Probability and Consequences



Mitigating Crude-by-Rail Risks by Prevention

Preventing accidents is the most important way of minimizing impacts of crude-by-rail incidents on human safety and health, tribal lands, sensitive environmental resources, and the state's economy. Washington's ability to directly address rail incident prevention is dictated largely by current federal regulations, but the state can take actions that protect the safety of its citizens.

UTC Railroad Safety Program

The UTC's railroad safety program is designed to protect the public and railroad employees by ensuring that railroad companies meet established state and federal safety standards and by educating the public about the dangers of traveling on or near railroad tracks. The UTC was created in 1905 by the Washington State Legislature as a three-member Railroad Commission, with regulatory authority to inspect and evaluate railroad company accounts, set rates, approve time schedules, monitor safety issues, and enforce violations. However, in 1970 and again in 1980, the U.S. Congress passed legislation preempting states in all areas pertaining to economic regulation of railroads and limited the scope of state jurisdiction in regards to safety.[115]

The UTC's jurisdiction over railroad safety and the mission of the agency's railroad safety program is focused in a few key areas that are not preempted by federal law. Those areas include opening, closing, and reconfiguring railroad-highway crossings, public crossing safety, railroad employee safety, the grade crossing protective fund, educating the public and promoting awareness, responding to citizens' complaints, and providing technical assistance.

In the area of public crossing safety, the UTC works with the railroads and road authorities, under RCW 81.53, on petitions filed with the UTC requesting the construction of new public crossings, and modifications and closures of crossings. In 2013, the UTC received 15 petitions to open, close, or modify crossings and 11 petitions to fund safety improvements from the grade crossing protective fund. The UTC also regularly inspects public crossing to ensure that required state and federal standards are met and responds to citizen complaints regarding crossings. The UTC inspects each public crossing in the state at least once every three years. In 2013, the UTC inspected 1,134 crossings and responded to 29 complaints. Complaints are generally focused on blocked crossings, crossing conditions, train noise, and signal malfunctions.

The UTC railroad safety program also supports and assists the FRA by performing inspections and issuing notices and violations for non-compliance with federal railroad safety regulations. While ensuring compliance with FRA safety regulations is a federal responsibility, Washington and 29 other states participate in the FRA's State Rail Safety Participation Program to augment the scarce number of federal regional inspectors. This program is discussed further below in this Section. In this capacity, the UTC may identify defects or violations in the areas of hazardous

[115] The Federal Railroad Safety and Hazardous Materials Transportation Control Act of 1970, the Interstate Commerce Commission Termination Act (ICCTA) and the Staggers Rail Act of 1980.

materials, signal and train control, and track and operating practices. The UTC submits notice of these defects and violations to the FRA. The FRA works with the UTC and agencies in other states to authorize delegation of its enforcement authority as though state staff were FRA employees. The UTC maintains a state crossing database and updates FRA's national database for Washington.

In the area of crossing safety, the UTC inspects railroad crossings to determine compliance with FRA rules governing signals and circuitry at crossings, federal rules concerning the configuration and condition of roadways and signage at crossings, and state rules.

In the course of ensuring railroad employee safety, UTC staff inspect walkways within railroad yards. The UTC also responds to requests for exemptions to overhead and side clearance rules and responds to complaints of sanitation of railroad facilities. In 2013, the UTC conducted 15 walkway inspections and granted four exemptions for overhead or side clearance rules.

The grade crossing protective fund is dedicated to safety upgrades at public crossings and along railroad rights-of-way and other projects related to railroad safety. During the 2011-2013 biennium, the UTC issued 35 grants totaling $433,000 to local jurisdictions and railroads to upgrade public safety at crossings.

The UTC, in its efforts to educate the public and promote public awareness of railroad safety, is actively engaged in Operation Lifesaver. Washington Operation Lifesaver (WAOL) is a free public service education program dedicated to preventing and reducing fatalities and injuries at highway-railroad grade crossings and along railroad rights-of-way. Through its participation in the WAOL, the UTC coordinates presentations to the public on grade crossing safety and provides vital information about the dangers people encounter when they are on railroad property.

The UTC is also involved with engineering projects to improve public safety and works with the law enforcement community to reduce grade crossing and trespass incidents. WAOL is part of a national program known as Operation Lifesaver, Inc. (OLI). Both WAOL and OLI are non-profit organizations. WAOL is sponsored by BNSF, UP, UTC, Washington State Patrol, WSDOT, Amtrak, Sound Transit, Office of the Superintendent of Public Instruction, FRA, Washington Traffic Safety Commission, Brotherhood of Locomotive Engineers, and the United Transportation Union. The UTC staff's public outreach for 2013 consisted of 442 presentations to 36,159 attendees, four technical classes to 87 attendees, and 62 special events to 68,201 attendees.

Federal Partnerships

The FRA is an agency within the USDOT and has jurisdiction over railroad safety at the federal level. There are approximately 400 federal inspectors throughout the country. This number includes state inspectors with both federal and state powers. FRA was created by the

Department of Transportation Act of 1966 and was charged with the uniform administration of the Federal Railroad Safety Act. Under the FRA region designation, Washington is located in FRA Region 8, along with Alaska, Idaho, Montana, North Dakota, Oregon, South Dakota, and Wyoming. FRA employs 43 inspectors in Region 8. All eight regions focus their regulatory activity in five key areas:

- Safety of track.
- Signal and train control.
- Motive power and equipment.
- Operating practices.
- Movement of hazardous materials.

Traditionally, and because of limited resources, FRA has used past incident data to determine the target areas for inspection activity. However, with the increase in Bakken crude oil movements and recent rail accidents, FRA has adopted a new policy incorporating "pockets of risk."[116]

The PHMSA is an agency within the USDOT and is responsible for establishing and enforcing requirements for the safe transport of hazardous materials by all modes of transportation. This includes the design of railroad tank cars carrying crude oil.[117] PHMSA was created in 2004 to provide USDOT with a more focused research organization and establish an operating administration for the inspection and enforcement of requirements for pipeline safety and hazardous materials transportation.

The Surface Transportation Board (STB) was created by the ICC Termination Act of 1995 and is the successor agency to the Interstate Commerce Commission. STB has jurisdiction over railroad rate and service issues and rail restructuring, such as mergers, sales, and the construction and abandonment of rail lines. STB is an independent adjudicatory and economic regulatory agency, but administratively is part of USDOT.

Accidents involving railroads are investigated, in part, by the NTSB. The NTSB is an independent federal agency that makes recommendations for preventing future accidents based on its findings, but has no regulatory authority. Unlike the FRA, the NTSB is not required to factor costs, input from stakeholders, or impacts on industry when making recommendations or issuing safety advisories.

Regulatory and Statutory Framework Governing Rail Industry

Regulation of railroads is largely under exclusive federal jurisdiction. Federal statute limits state authority, even with regard to safety measures under the Federal Railroad Safety Act,[118]

[116] FRA Administrator Szabo, Opening Remarks to Railroad Safety Advisory Committee (RSAC) Meeting, October 31, 2013.
[117] 49 CFR § 179.200, 179.201-1.
[118] 49 US Code §20109.

controlling, restricting, or prohibiting the transport of goods, including hazardous materials, through the state based upon common carrier obligations. Common carrier obligations only apply to operations and economic regulation, not safety regulation.

Railroads have a common carrier obligation to transport all goods offered for transportation, including hazardous materials. This obligation is a common law doctrine, codified in the Interstate Commerce Act and recognized by the U.S. Supreme Court in the early 1900s.[119] The Interstate Commerce Commission Termination Act of 1995 (ICCTA) maintains the common carrier obligations of railroads and requires railroads to "provide the transportation or service on reasonable request."[120] This obligation ensures that railroads do not unreasonably discriminate between shippers. Thus, railroads may not refuse shipment on the basis of inconvenience or lack of profitability.[121] The Surface Transportation Board (STB), which succeeded the Interstate Commerce Commission, has exclusive jurisdiction over the transportation of goods by rail within the U.S., as well as intrastate operations along an interstate rail network, preempting state and local authority.[122]

Washington's first railroad regulatory laws were enacted in the early 1900s. For decades after the creation of the Washington Railroad Commission in 1905, Washington was involved in regulating railroad companies in four critical areas: economics (rates, routes, and services), public safety, railroad employee health and safety, and consumer protection.

Since 1970, a number of changes in federal law further limit the ability of states to regulate railroad companies. For example, states can no longer have a role in determining the rates and routes of railroad companies or in protecting consumers. These responsibilities rest with the STB.

Regulation of railroad employee health and safety is shared by both federal and state agencies. States have limited authority for health and safety matters. In Washington, this authority is shared by the UTC and the Department of Labor and Industries. Federal responsibilities for employee health and safety are shared by the FRA and the Occupational Safety and Health Administration.

The federal laws that limit the ability of states to regulate railroads for public safety issues are the 1970 Federal Railroad Safety Act (FRSA)[123] and the ICCTA. In particular, the FRSA preempts states from passing laws or adopting rules in safety areas where the federal government has adopted its own laws or rules. The FRA is the federal agency with jurisdiction to administer FRSA and adopt railroad safety regulations. The FRSA provides that:

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[119] *Pa. R.R. Co v. Puritan Coal Mining Co*., 237 US 121, 133 (1914).
[120] Pub. L. No. 104-88, 109 Stat. 803 (Dec. 29, 1994); 49 USC. § 11101(a).
[121] *G.S. Roofing Prods. Co. v. Surface Transp. Bd.*, 143 F.3d 387, 391 (8th Cir. 1998).
[122] See 49 USC. § 10501.
[123] A Congressional act of 1970 that promotes the safety in all areas of railroad operations to reduce railroad-related accidents, and to reduce deaths and injuries to persons, and to reduce damage to property caused by accidents involving any carrier of hazardous materials (49 U.S.C §20109). (http://www.gpo.gov/fdsys/pkg/STATUTE-84/pdf/STATUTE-84-Pg971.pdf).

- Laws, regulations, and orders related to railroad safety must be nationally uniform to the extent practicable.
- A state may adopt regulations related to railroad safety only if the federal government does not already have a law or rule on the same topic. It is this provision that allows Washington to adopt laws and rules for changing the configuration of public railroad crossings.[124]
- A state may adopt additional or more stringent regulations than those at the federal level if the regulations are necessary to "eliminate or reduce an essentially local safety hazard". Note that case law since 1970 defines an "essentially local safety hazard" as one that is unique on a nationwide basis. In other words, the same or similar safety hazard cannot exist anywhere else in the country.[125] While the statutory language appears to provide states the flexibility to deal with local safety issues, the courts have interpreted the statute to permit state action only when the federal government has not addressed the safety issue – essentially preempting the field of railroad safety.
- Finally, a state may adopt additional or more stringent regulations than those at the federal level if the regulations are not incompatible with a law, regulation, or order of the United States Government and if the regulations do not unreasonably burden interstate commerce.

Under the ICCTA, the courts have held that most state and local regulation of railroads is preempted. However, state and local regulation is not preempted in two distinct circumstances: (1) when the state or local government is implementing a federal law through a federally approved state plan, such as under the Clean Water Act, the Clean Air Act, or the Coastal Zone Management Act and (2) when the state or local regulation is intended to protect the health, safety and welfare of the community, it is non-discriminatory, and it does not unduly restrict railroad operations. Thus, for example, the Ninth Circuit has stated:

[T]his system preserves a role for state and local agencies in the environmental regulation of railroads in at least two ways. First, to the extent that state and local agencies promulgate EPA-approved statewide plans under federal environmental laws (such as "statewide implementation plans" under the Clean Air Act), ICCTA generally does not preempt those regulations because it is possible to harmonize ICCTA with those federally recognized regulations. . . . Second, to the extent that state and local agencies enforce their generally applicable regulations in a way that does not unreasonably burden railroad activity, ICCTA does not preempt such regulation, despite the fact that the regulation does not have the force and effect of federal law,

Association of American Railroads v. South Coast Air Quality Management Dist., 622 F. 3d 1094, 1097 – 1098 (9th Cir. 2010) (citation omitted); see also Florida East Coast Ry. Co. v. City

[124] While the UTC has jurisdiction and authority under Chapter 81.53 RCW to determine whether a public crossing should be opened, closed or modified, the Legislature provided that the UTC does not have authority over the configuration of crossings in first class cities in the state. See RCW 81.53.240.
[125] The courts have set a very high bar for states attempting to impose more stringent railroad safety regulations. Essentially, the courts have interpreted the statute to allow additional state regulation only where it can be demonstrated that the safety issue is unique to the area and does not exist anywhere else in the country.

of West Palm Beach, 266 F. 3d 1324, 1330 – 1332 (11th Cir. 2001); Southern Pacific Transportation Co. v. California Coastal Commission, 520 F. Supp. 800, 804 – 805 (D.C.N.D. Cal. 1981).

The STB has given some examples of the types of state and local regulations that are not preempted under the second exception:

[W]e agree . . . that there are areas with respect to railroad activity that are reasonably within the local authorities' jurisdiction under the Constitution. For example, even in cases where we approve a construction or abandonment project, a local law prohibiting the railroad from dumping excavated earth into local waterways would appear to be a reasonable exercise of local police power. Similarly, . . . a state or local government could issue citations or seek damages if harmful substances were discharged during a railroad construction or upgrading project. A railroad that violated a local ordinance involving the dumping of waste could be fined or penalized for dumping by the state or local entity. The railroad also could be required to bear the cost of disposing of the waste from the construction in a way that did not harm the health or well-being of the community. We know of no court or agency ruling that such a requirement would constitute an unreasonable burden on, or interfere with, interstate commerce. Therefore, such requirements are not preempted.

Cities of Auburn & Kent, STB No. 33200, 1997 WL 362017 at *6 (July 1, 1997)

The following is a summary of state and local permitting requirements preempted by the ICCTA, or case law under the ICCTA:

- State statutes regulating railroad operations,[126] including state and local regulations on blocked crossings.[127]
- Environmental and land use permitting, subject to the exceptions outlined above.[128]
- State negligence and nuisance claims.[129]
- The demolition permitting process.[130]
- The requirement that a railroad obtain state approval before discontinuing station agents, abandoning rail lines or removing side tracks or spurs.[131]
- Preconstruction permitting of a transload facility.[132]
- State statutes regulating contracts between rail carriers.[133]

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126 *Friberg v. Kansas City S. Ry Co*., 267 F.3d 439 (5th Cir. 2001).
127 RR Ventures, Inc. v. Surface Transportation Board, 299 F.3d 523 (6th Cir. 2002).
128 *Auburn v. United States*, 154 F.3d 1025 (9th Cir. 1998).
129 *Friberg*, 267 F.3d 439 (5th Cir. 2001).
130 *Soo Line RR Co v. City of Minneapolis*, 38 F. Supp. 2d 1096 (D. Minn. 1998).
131 Burlington Northern Santa Fe Corp v. Anderson, 959 F. Supp. 1288 (D. Mont. 1997).
132 *Green Mountain RR Corp v. Vermont*, 404 F.3d 638 (2nd Cir. 2005).
133 San Luis Cent RR Co. v. Springfield Terminal Ry Co., 369 F. Supp. 2d 172 (D. Mass. 2005).

- Attempts to condemn railroad tracks.[134]

The FRA's stated purpose, as it pertains to the implementation of the FRSA, is to develop and implement a national railroad safety program to reduce deaths, injuries, and damage to property resulting from railroad accidents. The program consists of mandatory safety requirements and inspections to ensure compliance with these requirements. The FRA has adopted rules covering five safety disciplines: track, signal and train control, motive power and equipment (locomotives, freight cars, and other equipment), operating practices, and hazardous materials transportation. These five areas of railroad safety represent the majority of subject matter over which the FRA has exclusive jurisdiction.

Even though the FRA has exclusive authority over railroad safety for these five areas, the states have a role in inspections and enforcement if they so choose. FRSA provides for establishment of a state rail safety participation program whereby states may conduct inspections related to federal railroad safety laws and regulations. The intent of the program is to provide enhanced inspection, investigative, and surveillance capability.

The program was initiated by the Railroad Safety Act of 1970, and by 1975, regulations were adopted to enable states to enforce track and freight car safety standards. In 1980, Congress broadened state involvement to include the Safety Appliance, Locomotive Inspection, Signal Inspection, and Hours of Service Acts. The State Safety Participation regulations (49 CFR, Part 212) were revised in 1992 to permit states to perform rail hazardous materials inspections, allowing them to participate in all five safety disciplines. In 1995, the Grade Crossing Signal System Safety regulations (49 CFR, Part 234) were revised to authorize both federal and state signal inspectors to assure that railroads were properly testing, inspecting, and maintaining automated warning devices at grade crossings.[135]

When FRA began the program, the federal government provided partial federal funding (60%) as an incentive for states to participate. That funding ended in the 1980s and states must now participate at their own expense. The FRA provides extensive training to state-employed inspectors and pays for associated travel for maintaining certification.

The FRA will train and then certify state inspectors to conduct federal inspections and investigations in the five safety disciplines over which the FRA has adopted rules.

Findings on Crude-by-Rail Prevention-Based Risk Mitigation Measures

The following are findings related to rail operations, rail equipment, and rules and regulations.

[134] Lincoln v. Surface Transportation Board, 414 F.3d 858 (8th Cir. 2005).
[135] The Rail Safety State Participation Program, Association of State Rail Managers.

Multi-Agency Comments on Federal Rulemaking

There is a Notice of Proposed Rulemaking (NPRM)[136] at the federal level by FRA, the PHMSA, and the USDOT that addresses many of the safety concerns regarding rail transportation. (See Appendix H.)

On September 30, 2014, Washington provided multi-agency comments to the FRA, PHMSA, and USDOT in response to its NPRM on enhanced tank car standards, operational controls, and other matters involving the transportation of Bakken oil and other highly flammable liquids by rail. A copy is provided in Appendix I.

Derailment Prevention is Key to Public Safety, Health, and Environmental Protection

Preventing derailments is the key to protecting the public and the environment in regards to rail operations. Actions by the state rail safety program may be limited by federal pre-emption.

Decision-makers in Washington should explore actions they can take that are not pre-empted. This includes (1) improving rail infrastructure, (2) reviewing the impacts on rail safety regarding speed and working with the railroads and the federal government to make appropriate changes, and (3) monitoring, through the state's inspection programs, the human factors relating to railroad track operational management.

The pending federal decision on the operating requirements and restrictions of HHFT/Key Trains, along with BNSF's willingness to accept a 45 mph maximum speed for such trains, is an identified study gap.

BNSF restricts the maximum speed of loaded unit bulk trains (i.e., grain and coal) to 45 mph for safe operating purposes. Empty unit bulk trains are allowed to operate at maximum track speed. Operating HHFT/Key Trains at the same maximum speed as other loaded unit bulk trains would likely have a minimal impact on unit train cycle times and not negatively impact overall route capacity, as most loaded bulk trains move east to west within the state.

Regulation and Oversight Issue: Insufficiency of Trained Personnel

State funding mechanism levels are insufficient to support an adequate number of state rail inspectors.

The UTC receives revenue to fund its rail safety program from fees the railroads operating in Washington pay to the UTC. These fees are set in statute based on a percentage of railroad revenue from intrastate rail traffic only. The fee structure limits the number of railroad

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[136] Notice of Proposed Rulemaking (NPRM): a public notice issued by law when one of the independent agencies of the United States government wishes to add, remove, or change a rule or regulation as part of the rulemaking process. It is an important part of United States administrative law which facilitates government by typically creating a process of taking of public comment.

inspectors the UTC can hire. Other states use other funding sources that provide a broader base of revenue. Oregon, for example, uses a methodology that generates revenue from the railroads based on intrastate, interstate, and mileage. Given that railroads operate in interstate commerce, the state should develop a funding structure that would not be overly burdensome to the railroads and their interstate operations. California is reportedly also investigating the creation of a railroad-generated funding source to meet similar needs.

In addition to the current budget limitations, the UTC railroad safety program also faces the issue that UTC FRA-certified inspectors are classified in such a way that Washington's salary levels are lower than those currently offered by FRA, other states, and railroads. As a result, the UTC has had difficulty attracting and retaining qualified FRA-certified inspectors.

Regulation and Oversight Issue: Authority for UTC Rails Inspections on Private Property

UTC regulatory authority to conduct hazardous material inspections on private shipper's property is limited, complicating the ability of UTC inspectors to perform vital safety inspections.

The UTC FRA-certified inspectors must be accompanied by an FRA representative to enter private shipper's property for the purpose of conducting hazardous material inspections relating to railroad operations. These inspections are already occurring, but the need for FRA to attend complicates and sometimes delays the ability of inspectors to perform their work.

Regulation and Oversight Issue: At-Risk Crossings

The UTC has identified a number of at-grade crossings[137] over which crude-by-rail trains operate, that represent a higher risk of train accidents/incidents due to characteristics at the crossing.

Regulation and Oversight Issue: Oversight of At-Grade Crossings

There is a gap in Washington law concerning oversight of at-grade crossings between those in first-class cities and other crossings within the state.

The UTC does not have jurisdiction for at-grade crossings in first-class cities. Each city so designated is free to open, close, or modify at-grade crossings without UTC involvement.

Regulation and Oversight Issue: Private Crossings

There is insufficient regulatory authority to monitor safety at private crossings in the state. Federal and state regulations for safety standards and inspection authority do not apply to private crossings.

[137] A railroad crossing with a roadway where the two transport axes intersect at the same level.

Regulation and Oversight Issue: Placarding Standards for Railcars

Current tank car placarding standards for the transportation of hazardous materials are insufficient in providing First Responders timely and important information in the case of a derailment, spill, or undesired release.

The current placarding standard for railcars transporting hazardous flammable materials is insufficient for non-railroad personnel. While railroad personnel often have specific information regarding the specific commodity(s) involved in an incident/derailment, that information is often not available to First Responders in a timely manner, and the current placarding criteria does not provide meaningful assistance.

Regulation and Oversight Issue: Improvement of FRA/UTC Rail Incident Databases

Existing FRA and state rail incident databases are difficult to use, not always current, and not quickly or easily accessible. Additionally, rail accidents investigated by the FRA and/or state have a preliminary short form (FRA 6180), with information filled out and placed online up to one month after the accident to aid in data collection and dissemination.

The FRA and UTC rail incident databases are inadequate for use in a timely and effective manner to research and investigate various rail incidents within a state or in a localized area. The FRA database of rail incidents is massive and difficult to navigate to find specific and meaningful data in a timely manner. The UTC information files may not correspond with FRA data files for a specific incident or type of incident.

Cooperation and Communication: Establishment of Railroad Safety Committee Based on Harbor Safety Committee Model

There is not existing infrastructure for cooperative communications between the railroad industry, regulatory agencies, and other interested stakeholders to foster safety on the rail systems.

The Harbor Safety Committee process has been successful in Puget Sound, Grays Harbor, and the Columbia River; it fosters communication and cooperative approaches to reducing accidents and promoting safe practices in the state's waterways. An analogous entity may help to promote safety on the railroads running through the state. Since the Harbor Safety Committees are generally overseen by the USCG, the railroad committee may best be administered by the FRA.

Mitigating Potential Risks from Marine Transport through Prevention

Crude-by-rail impacts on marine vessel traffic could occur over all regions of Washington's waterways and all segments of the marine transportation industry. In large part, due to the federal government's pre-emption of a state's ability to regulate in this area, states rely on the USCG to set strong standards for prevention and waterways management.

Current Marine Traffic Carrying Crude-by-Rail Cargoes[138]

- **Columbia River:** BP Cherry Point Refinery in Puget Sound is receiving Bakken crude oil deliveries via Crowley Maritime ATBs from the Columbia River. Harley and Kirby are also moving crude oil from Clatskanie by tank barge (without inert gas systems) for delivery to BP Cherry Point, Phillips 66 Ferndale, and California. These transshipments originate from unit train deliveries (in 2013, 110 oil trains[139]) to the Columbia Pacific Bio-Refinery storage facility in Clatskanie, Oregon. BP has indicated these transshipments may cease upon completion of Crude Oil Rail Facility on-site at the Cherry Point refinery complex.
- **Columbia River and Puget Sound:** Portland oil terminals, McCall Oil, Willbridge, Famm Oil, Tesoro, and NuStar load tankers with Utah crude-by-rail for shipment to California refineries.[140]
- **Puget Sound:** The Targa Sound oil terminal (ex-Sound Refining) in Tacoma previously received unit trainloads of Bakken crude oil for transshipment by barge to Washington's northern refineries.

Potential Future Marine Traffic Carrying Crude-by-Rail Cargoes

- **Grays Harbor:** Three proposed projects (Westway, Imperium, and Grays Harbor Rail Terminal (formerly U.S. Development)) to receive crude-by-rail in the Port of Grays Harbor could add up to an estimated high end of 379 laden tankers and tank barge transits[141] a year.[142] Three facilities to receive crude-by-rail are in the environmental review phase with a potential of up to 2.7 billion gallons of oil per year.[143]

- **Columbia River:** Arc Terminals in Portland (the old Paramount Facility) takes Utah crude-by-rail to load onto Chevron tankers at the Portland Chevron oil dock to go to California.

[138] WSDOE. 2013. Changing Oil Movement in the Northwest, July 2013.
[139] WSDOE. 2014. Marine Transportation Lower Columbia River Waterway Use.
[140] WSDOE. 2014. Changes to the Marine Transportation Lower Columbia River Waterway Use.
[141] Westway: 99 – 119; Imperium: 300; and Grays Harbor Rail Terminal: 60 transits.
[142] WSDOE. 2013. Changing Oil Movement in the Northwest, July 2013.
[143] Westway = 749,910,000 gal; Imperium = 1,260,000,000 gal; Grays Harbor Rail Terminal = 689,850,000 gal based on 45,000 bbl/day

This operation began in May 2014 and current or future capacities have not yet been determined.[144] In Vancouver, NuStar Energy LP (2.1 million gallons a day) is in construction to handle crude-by-rail. One facility is in the environmental review process: Vancouver Energy (7.56 million gallons a day).

- **Puget Sound:** As noted above, Bakken crude was being brought in by rail to Targa Sound (ex-Sound Refining) to supply Phillips 66 Ferndale by barge, and now these operations are occurring from Clatskanie. Plans are to start the rail back up and eventually take one unit train per day at the Targa facility.

Impact of Crude-by-Rail on Future Vessel Traffic

Incorporating crude-by-rail-related tankers and ATBs into the ever-changing vessel traffic in Washington waters could increase risks of spills from all vessels. Although difficult to quantify, the most likely source of a major oil spill from a marine vessel in Washington is the rupture of a non-tank vessel's fuel oil tanks from a collision or grounding event. The non-tank vessel scenario is more likely due to the relative number of non-tank ships to tank ships. Probable spill sizes reach to a few thousand tons (several hundred thousand gallons). Increased traffic from all sources increases these risks. Crude-by-rail leading to increased exports of petroleum products contributes to this increased risk. The effects of this change have not been included in existing publicly-released vessel traffic studies. Potential impacts to Grays Harbor vessel traffic from crude-by-rail proposals will be included in the environmental impact statements (EIS).[145]

Adding crude-by-rail-related tank vessels to the existing and future traffic will also change the patterns of bunkering activities. Many of the tank vessels that transit north from Grays Harbor, for example, are expected to transit to Puget Sound for bunkering, adding to the existing bunkering activities in those waters. Increases in bunkering in the Lower Columbia River with the increases of tank vessel traffic in those ports are expected. A decrease in tank vessel traffic from Alaska to Puget Sound and California is expected.

A number of factors will determine future vessel traffic patterns into which the crude-by-rail traffic would be incorporated:

- If crude prices continue as projected, incoming crude tanker traffic from Alaska will continue to decrease in Puget Sound; however, crude-by-rail-related ATB and tanker traffic from Lower Columbia River and Grays Harbor ports may supplant this to some degree. Tankers will continue to export refined products, and the amount of refined product exported is predicted to stay the same or slightly increase.

- Due to economy of scale, cargo ship sizes (container ships, bulk carriers) are increasing, which may lead to fewer ship transits, but the larger ships have more mass and windage and might experience more difficulty in maneuvering in congested areas. In Washington, tanker

[144] Ecology. 2014. Changes to the Marine Transportation Lower Columbia River Waterway Use.
[145] This may also be done for Columbia River under the EFSEC EIS.

sizes are limited to 125,000 DWT by regulation. Ship size is also limited by navigational restrictions in BC, Grays Harbor, and Columbia River.[146] This risk is partially offset by improved navigational equipment onboard these new vessels, as well as fuel tanks independent from the hull.

- During peak traffic events, anchorages in Washington in Puget Sound and the Columbia River are near capacity. Any increase in the number of vessels requiring anchorage increases the likelihood of vessel "bunching" and exceeding the designate anchorage capacity. In addition, crude oil tankers servicing refineries often make multiple trips to/from anchorages.

- The proposed Canadian TransMountain Pipeline Expansion Project in Canada represents the largest potential, single introduction of new oil (diluted bitumen and other forms of bitumen) to be transported in Washington waters.

- Additional exports of petroleum products could lead to more spills of hazardous cargoes (refined products and chemicals) other than crude oil. In 2011, for example, 83 million barrels of refined products were exported from the state.

Safety Concerns with Crude-by-Rail Vessel Traffic

The current and potentially expanding crude-by-rail vessel traffic in Puget Sound, Grays Harbor, and the Lower Columbia River present a number of specific vessel safety concerns, including:

- ATBs, which hold up to 7.5 million gallons of oil,[147] are not required to meet the Rosario Strait one way/vessel meeting traffic rules."[148]

- Inerting of tanks is not required on tank vessels under 20,000 deadweight tons. This includes most towed oil barges transiting Washington waters. Although not required, ATBs do have Inert Gas Systems onboard. The inability to inert tanks greatly increases the likelihood of a fire or explosion when transporting more flammable/volatile cargoes of Bakken crude, though ATBs are most likely to be used for crude oil.

- "Pre-booming" of tank vessels during transfer operations at refineries and terminals may not be possible with cargoes of highly volatile Bakken crude for safety reasons; this may increase the spread of oil in the event of a spill.

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[146] The Lower Columbia River Harbor Safety Plan States in its Navigation Practices Section: "The federally maintained channel is depicted on the NOAA charts by dashed black lines. The US Army Corps of Engineers is authorized to maintain a 600-foot wide channel in the Lower Columbia River designed for deep draft ship traffic by dredging restrictive shoaling to provide an authorized depth of 43 feet below CRD or MLLW. On the Mouth of the Columbia River (MCR) the US Army Corps of Engineers is authorized to maintain a channel 2,640-foot wide to depths of 55 and 48 feet below MLLW." [This allows most tankers trading the West Coast, but not the really big ones (VLCC and ULCC) as they can have significantly deeper drafts. San Francisco and LA have similar draft limits.] In Vancouver, BC, the channel through the Second Narrows to the Westridge terminal (Kinder Morgan) places draft limitations on the ships essentially limiting the size to Aframax tankers. The GH Harbor Safety Plan States: "Maximum Draft and Length - Limitations: Maximum draft for vessels west of Chehalis River Bridge in Aberdeen is 40 feet and 35 feet if transiting east of the bridge. Vessels passing through the bridge are restricted to a length of 600 feet."

[147] Some ATBs hold up to 13 million gallons, but these are not currently transiting Washington waters.

[148] 33 CFR 161.55 Vessel Traffic Service Puget Sound and the Cooperative Vessel Traffic Service for the Juan de Fuca Region.

Findings on Crude-by-Rail Marine Prevention-Based Risk Mitigation Measures

The following are findings related to marine transport of oil.

Build on Previous Spill Prevention Successes

There has been a great degree of success with vessel spill and accident prevention measures in Washington waters. Existing training and management practices in the state represent high standards of care, including:

- Sixty years of experience with marine transportation of oil.
- Active Harbor Safety Committees in Puget Sound, the Lower Columbia River, and Grays Harbor.
- Vessel inspections at federal and state levels, as well as classification societies and industry audits.
- Managed vessel traffic in Columbia River, Puget Sound and Southern Salish Sea including vessel traffic services (VTS),[149] the Cooperative VTS (CTVS) between the U.S. and Canada, and the Canadian Marine Communications and Traffic Services (MCTS).
- Tanker escort practices.
- Pilotage of large vessels in most areas, with:
    - Extensive training procedures (with federal- and state-issued licenses).
    - More than one pilot for long voyages to reduce fatigue.
    - Two pilots required onboard in some areas (e.g., BC requirements in Boundary Pass) to reduce the risk of pilot distraction.
    - High levels of redundancy in powering and steering systems[150] for current U.S. flagged crude oil tankers and ATBs.

Current regulatory, inspection, and operational procedures have been effective at prevention. The 2014 VTRA 2010 report[151] findings show that there have been no spills from deep draft vessels in transit and none greater than 10,000 gallons from oil barges in transit in the past 20 years.

[149] A marine traffic monitoring system established by harbor or port authorities, similar to air traffic control for aircraft. Typical VTS systems use radar, closed-circuit television (CCTV), VHF radiotelephony and automatic identification system to keep track of vessel movements and provide navigational safety in a limited geographical area.
[150] Both the ATC and Polar tankers are twin-screw, twin-rudder designs. This is not typical of foreign flag tankers. The Crowley ATBs have redundant steering systems.
[151] vanDorp and Merrick. 2014.

Reduce Human Error and Increase Situational Awareness

Risk mitigation options that address human error and improve situational awareness are the most effective. A number of these measures would increase safety of crude-by-rail and other transport in Washington waters.

As much as 80% of maritime accidents are attributed to human error,[152] many with fatigue as a root cause. Evidence of this can be found in a recent NTSB action and subsequent Safety Recommendation implanted by the Columbia River Bar Pilots (CRBP) and Columbia River Pilots (COLRIP).[153] Risk control options that improve situational awareness (e.g., navigational tools, traffic management systems, management practices) and reduce mariner fatigue (e.g., manning/work hour requirements) have been evaluated to be most effective.[154] Looking at this issue from a situational awareness perspective, which encompasses manning levels on all classes of vessels including commercial fishing and towing vessels, is appropriate for follow-on work related to this study

Long voyages lead to mariner (pilot and crew) fatigue and to more accidents; this has been verified by a Pacific Pilotage Authority study.[155] Increased numbers of ships, driven in part by increased exports of petroleum products using crude-by-rail as a source, will lead to more vessel encounters requiring heightened situational awareness.

Approaches to reducing human error and increasing situational awareness that have proven successful in other locations include:

- Restriction of working hours in command positions on small passenger vessels, tug boats, and fishing boats.
- Increased manning on covered fishing vessels and tugs towing oil barges.
- Automated track control system for pilots.
- Requirement for pilots in high-risk areas.

Reduce Spill Probability with Protected Fuel Tanks on Ships

The implementation of International Maritime Organization (IMO)**[156]** requirements for protective location of fuel oil tanks[157] for ships constructed in 2010 and later reduces the risk of a fuel oil spill in collisions, allusions, and groundings. The shipping industry is voluntarily implementing this requirement ahead of schedule.

[152] Approximately 50% of maritime accidents are initiated by human error, while another 30% occur due to failures of humans to avoid an accident (Baker and Seah 2004).
[153] NTSB, 2014. Safety Recommendation M-11-20
[154] Based on various IMO Formal Safety Assessments.
[155] Pacific Pilotage Authority, Canada, personal communication.
[156] The United Nations' specialized agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships.
[157] International Maritime Organization (IMO). 2010. Regulation 12A to MARPOL Annex I. 2010.

This regulation eliminates the placement of fuel oil tanks adjacent to the hull skin for all vessels subject to the regulation: all vessel types, including tankers for which the double hull requirements of OPA90[158] only applies to cargo tanks. This requirement reduces the probability of oil spills in accidents similar to the Cosco Busan spill (in San Francisco) and spills due to tug and bunker barge impacts. Research[159] in support of the IMO regulation indicated that fuel tank spill probabilities are reduced by 80% in the examined bulk carriers and by 50% in the examined container ships.

If newly-permitted facilities required, or encouraged through a voluntary "best practices" program, the new fuel tank construction,this would effectively put an age restriction on vessels but might be implemented as a performance standard. It would be difficult to require this of vessels visiting existing facilities; however, other countries, such as Japan, have a maximum age requirement for tankers. Commitments to using best practices would encourage adoption of this approach for all facilities. Costs to implement these procedures are indirect in that they reduce the available pool of vessels that can call. However, because new ships are generally safer than old ships, costs associated with non-environmental risks should decrease. Costs could also decrease with time as fewer ships built before 2010 transit the region.

Railroads as Part of Harbor Safety, Area Maritime Security, and NW Area Committees, SERCs, Tribal Emergency Response Commissions (TERCs), and LEPCs

Railroad representation has been notably absent in Harbor Safety and Area Maritime Security Committees, the Northwest Area Committee, SERCs,[160] TERCs, and Local Area Planning Committees (LEPCs)[161] at a time when there are changes to the crude-by-rail facility and maritime interface.

Harbor Safety and Area Maritime Security Committees, the Northwest Area Committee, and as LEPCs, are important entities that effectively foster spill and accident prevention and improve maritime safety and security through cooperation and communication between regulatory agencies, industry, and other stakeholder groups.

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[158] Oil Pollution Act of 1990 (OPA90): an act of Congress designed to mitigate and prevent civil liability from oil spills off the coast of the U.S., including provisions for spill contingency plans, liability limits and specifications for responsible parties, spill prevention measures (e.g., double hulls on tankers), and other measures.

[159] Michel and Winslow 2000.

[160] State Emergency Response Commission (SERC): A commission appointed by the Governor that is responsible for implementing Emergency Planning and Community Right-to-Know Act (EPCRA) provisions within the state.

[161] Local Emergency Planning Committee (LEPC): under the Emergency Planning and Community Right-to-Know Act (EPCRA), Local Emergency Planning Committees (LEPCs) must develop an emergency response plan, review the plan at least annually, and provide information about chemicals in the community to citizens; plans are developed by LEPCs with stakeholder participation. the LEPC membership must include (at a minimum): elected state and local officials; police, fire, civil defense, and public health professionals; environment, transportation, and hospital officials; facility representatives; and representatives from community groups and the media.

Expansion of Tug Escort Requirement for Oil Tankers to Grays Harbor and Columbia River

Tug escorts are required for tank vessels in Puget Sound but not in Grays Harbor or the Columbia River. Tug escorts provide one of the strongest prevention measures for vessel incidents.

The regulation for tanker tug escorts applies only to Puget Sound. Tug escorts are a critical prevention measure for reducing risks from vessel incidents such as loss of propulsion, loss of steering, or adverse weather. Pilots in Grays Harbor and the Columbia River determine if tug escorts are needed and some facilities, such as Imperium, have voluntarily enacted tug escort procedures for laden tankers. This standard practice could be expanded to include Grays Harbor and the Columbia River with the new levels of tanker traffic anticipated in these waterbodies.

Evaluation of the Effectiveness of Additional Emergency Tow/Rescue Tugs

Emergency Tow/Rescue Tugs can be effective to assist disabled vessels. Effectiveness is site-specific, and experience in one location does not necessarily transfer to other locations. Therefore, analysis is needed to ascertain the potential gains and cost of additional tow/rescue tugs.

Other countries refer to these tugs as emergency towing vessels (ETVs). Experience in countries where government-funded ETVs are stationed[162], shows that ETVs are particularly successful at stopping drifting vessels from grounding on leeward shores and providing passive escort to high-risk ships in transit. Often ETVs are tasked to stand-by disabled ships being repaired. They provide assurance that should conditions change, or repairs prove ineffective, a capable tug is immediately available to take the vessel under tow. An example of such is the Emergency Response Towing Vessel (ERTV) stationed at Neah Bay. A characteristic of these applications is relatively wide passages with long drift times.

[162] Middleton, R. 2009. Emergency Towing Arrangements in the Mediterranean Sea, SAFEMED Project: MED.2005/109-573

It is important to note the capabilities of ERTVs and ETVs. The towing vessels can assist a disabled vessel (or tug and barge) and could prevent it from drifting ashore. To accomplish this, the tug must meet all the following criteria:

- Be able to operate in severe weather.
- Reach the vessel before it grounds.
- Be able to attach a towline in the prevailing weather conditions.
- Have sufficient power to prevent the drift ashore.

ERTVs and ETVs may also be able to escort high-risk vessels if appropriately sized and equipped and to assist in other emergency situations (e.g., fires, persons overboard, and medical emergencies). But an ERTV or ETV cannot prevent a collision or prevent a powered grounding.[163]

Turn Point is recognized as a Special Operating Area by the USCG[164], applying procedures to minimize meetings of large vessels. Use of the rescue tug as a passive escort for vessels, especially high-risk vessels, has been proposed. In the VTRA 2010 study (published in 2014) an attempt to model this approach was made. In that study, the model applied an escort to all "focus vessels" through Haro Strait and Boundary Pass. Clearly, this is beyond the capabilities of a single tug. Further, the effectiveness of an untethered escort in a narrow passage is questionable. Laden tankers travelling this area must have tethered escort in narrow passages such as Rosario Strait. At this time there is insufficient information to assess the effectiveness of such an operation.

The function of an ERTV positioned near the entrance to Grays Harbor and mouth of the Columbia River would be similar to that of the Neah Bay rescue tug or ERTV. Consideration should be given to maintaining it on station outside the harbor or river entrance during periods of heavy weather to avoid bar closures preventing potential rescue actions. Closures are rare; however, requiring a tug to wait outside the bar during closures would increase costs and risks. At this time there is insufficient information to assess the effectiveness of such an operation.

[163] A powered grounding occurs when a ship proceeds down an unsafe track, even though it is able to follow safe track, due to errors related to human or technical failure. This is opposed to a "drift grounding" in which the vessel is unable to follow a safe track due to mechanical failure, adverse environmental conditions, anchor failure, or assistance failure (DNV Formal Safety Assessment of Cruise Navigation DNV Report 2003-0277. Det Norske Veritas, Høvik, Norway. 2005.
[164] USCG, 2014. Turn Point: Special Operating Area, http://www.uscg.mil/d13/cvts/turn.asp Accessed July 25, 2014.

The safety of ERTVs crossing bars during inclement weather must be considered. The deep draft navigation channel in the Columbia River is 100 miles long and 600 feet wide — geographically different from Puget Sound. A typical escort tug[165] tethered on a long line will not work in many areas. The tug's safety could be jeopardized by having to leave the channel to effectively steer a disabled vessel or, in much of the Columbia River, response time could be too great.

Reconsideration of the Definition of High-Risk Vessels

High-risk vessels may better be identified by reviewing and adjusting the criteria. Some of the criteria currently used are based on incorrect data that should be re-examined. For example, the 2014 VTRA 2010 study states that "no Capesize[166] bulker vessels travel through the VTRA study area". In 2010, 120 bulkers over 100,000 tons DWT berthed at the Canadian Westshore Terminals at the Roberts Bank terminal complex. Of these, over 100 were greater than 150,000 DWT tons and 15 over 200,000 DWT tons. Thus, the CVTS and MCTS, pilots and ship masters of ships traveling in Haro Strait and Boundary Pass, do, in fact, have experience with Capesize bulk carriers. This suggests a risk mitigation measure to consider these "high-risk" vessels and require the potential Gateway Pacific Terminal Capesize traffic to be escorted. At least initially, this mitigation measure is probably not cost-effective.[167]

Enhancement of VTS Capability in Grays Harbor, Lower Columbia River, and Outer Coast

Currently, a formal vessel traffic system is lacking in Grays Harbor and on the outer coast. Also, the current system on the Columbia River may not be adequate in the long term. Current VTS systems are at risk of under-funding, reduction in watchstanders, and reductions in situational awareness, due to employed technology systems.

A USCG-sponsored VTS covering Grays Harbor, Columbia River, and the outer coast will reduce shipping accidents such as collisions and groundings. However, if traffic increases, more monitoring will be appropriate. Given the level of traffic, this could be a tiered or localized system, but the risks are high enough to warrant this level of effort.

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[165] An escort tug is a tugboat that meets the following characteristics: the hull is designed to provide adequate hydrodynamic lift and drag forces when in indirect towing mode (due attention shall be paid to the balance between hydrodynamic forces, towline pull and propulsion forces); the towing winch has a load-reducing system in order to prevent overload caused by dynamic oscillation in the towing line; the propulsors are able to provide ample thrust for maneuvering at higher speeds for tug being in any oblique angular position; the vessel is designed such that forces are in equilibrium with a minimum use of propulsive force except for providing forward thrust and balancing transverse forces during escorting service; and in case of loss of propulsion, the remaining forces are balanced so that the resulting turning moment will turn [yaw] the escort tug to a safer position with reduced heel.

[166] A Capesize bulker (bulk carrier) is over 150,000 deadweight tonnage (DWT).

[167] Not all the experience is good. A capesize bulker allided with the coal terminal in late 2012; however, an escort would not have prevented it.

Restrictions on Vessel Bunkering Activities to Reduce Incidents

Bunkering operations may be increased in Puget Sound with crude-by-rail vessel traffic coming from Grays Harbor and Columbia River ports, since there are limited bunkering facilities in those ports. This increase in bunkering may lead to additional spillage in Puget Sound.

Bunkering restrictions can protect sensitive areas from related spills. These restrictions can shift risk, but this can be controlled by having enhanced prevention and preparedness in areas where bunkering occurs.

Reduction of Speed for Container Ships

Speed restrictions on container ships may reduce the likelihood of collisions with other vessels, including crude-by-rail-related traffic. The 2014 VTRA 2010 study indicated that speed of container ships in congested areas may be a factor that increases the potential for collisions.

Minimization of Multiple Trips from Berth to Anchorage by Tankers

Foreign-flag tankers used to import crude oil make multiple trips from anchorage to berth and back during the off-loading process.

Automatic Identification System (AIS)[168] data show that this is a behavior pattern that increases risk, due to added maneuvers and effective storage of crude oil in vessels in the anchorages.

[168] An automatic tracking system used on ships and by vessel traffic services (VTS) for identifying and locating vessels by electronically exchanging data with other nearby ships, AIS base stations, and satellites.

Mitigating Risks at Terminals – Prevention

The terminals embody the interface between transport of oil by rail, and either end use of the oil for refining or the next phase of transport, tank vessels.

Findings on Crude-by-Rail Terminal Risk Mitigation

The following are findings related to oil handling facilities.

Building on 20 years of Spill Prevention at Oil Handling Facilities

Washington's spill prevention programs at facilities are some of the most effective in the nation. They include:

- State-approved plans for spill prevention, operations manuals, training and certification of operations staff, minimum design standards for technology and operations practices, and inspections for compliance.
- Spill investigation with the intent of applying and sharing lessons learned to all facilities.
- Consensus standards for minimum performance-based technology and practices for oil handling with a focus on preventing spills over water and land.
- Inspection of oil transfers between onshore facilities and vessels to encourage spill-free operations.

Chapter 173-180 WAC has not been updated for facility spill prevention standards since 1994. Transporting crude-by-rail was not a common practice at that time, and no design standards exist to cover this area of oil handling. Other areas of the minimum standards are outdated or are missing new technologies and practices that have developed over the intervening years.

Application of Best Achievable Protection (BAP) Standard to Facilities

The concept of BAP exists for tank vessels and has not been extended to facilities handling oil. BAP sets a standard to continuously reach the highest level of protection in preventing and preparing for oil spills. BAP focuses on best technology, staffing levels, training procedures, and operational methods that provide the greatest degree of protection available. The Legislature established this standard for covered vessels to keep the state's program rigorous.

Shared Standards of Spill Prevention on the Columbia River

The lower Columbia River is a shared waterway between Washington and Oregon, and both states have an interest in protecting it from pollution. The state of Washington, among other states, has adopted regulations that address over-water oil transfers from oil handling facilities. A highlight of the Washington regulation (WAC 173-180) is the requirement to place containment boom around receiving marine vessels ("pre-booms"), unless it is deemed unsafe and ineffective to do so. When oil spills into water at applicable facilities, the oil has an initial level of containment already in place. Successful oil spill prevention programs have been developed in Washington, California, and Alaska, among other states.

Oregon lacks similar regulations regarding the prevention of oil spills from oil handling facilities and tank ships; in particular, it lacks a requirement to pre-boom oil transfers when safe and effective to do so.

With the beginning of crude-by-rail operations at the Columbia Pacific Bio-Refinery facility near Clatskanie, Oregon, in 2012, the state of Oregon accepted the increase in risk associated with crude-by-rail transportation on land, as well as via marine transportation on the lower Columbia River and outer coast. Oregon does not have regulations regarding the storage of oil in the proximity of waters of the state, nor for transferring the oil from tank farm facilities to forms of freight transportation. The Columbia Pacific Bio-Refinery facility pre-booms voluntarily, but there is no authority for Oregon to require it there or at any of the refined product terminals in the state.

Mitigating Risks through Preparedness and Response

The most effective ways to mitigate or reduce risk are by preventing spills and accidents from occurring in the first place, through effective prevention measures. The next tier of risk mitigation comes from effective response to incidents, to minimize damage. For crude-by-rail-related train incidents, and for crude-by-rail-related vessel and facility incidents, the possibility of fire and/or explosion means that emergency preparedness must focus, first and foremost, on public safety.

Protecting the environment is also a high priority, in reducing adverse effects. Spills from crude oil trains, tank vessels, or facilities require appropriate responses to limit the volume of oil released, reduce the spread of oil, protect the most sensitive habitats as prioritized by geographic response plans and other means, and clean up oil that is released to the environment.

Spill response planning has been repeatedly shown to be instrumental in assuring rapid and effective mitigation of spill incidents, regardless of the source of spillage or location. Washington has developed a comprehensive program to prepare for and respond to spills through the Department of Ecology Spill Prevention, Preparedness, and Response Program. This program needs to be able to prepare and plan for the changing types of incidents that may occur on rail lines, at facilities, and from vessels with crude-by-rail.

Findings on Oil Spill Planning and Emergency Response for Crude-by-Rail

The following are findings and recommendations related to oil spill preparedness and response.

Support of Multi-Agency Comments on Federal Rulemaking on Oil Spill Response Plans for High-Hazard Flammable Trains

There is an Advanced Notice of Proposed Rulemaking (ANPRM)[169] at the federal level by FRA, the PHMSA, and USDOT that proposes revisions to federal requirements for oil spill plans for trains.

Federal regulations only require comprehensive response plans for spills from carriers of individual rail tank cars with individual capacities of more than 42,000 gallons. This means that trains with blocks of cars of 30 or more or unit trains consisting of 100+ rail tank cars are only required to have basic spill response plans under federal authority. Crude-by-rail tank cars (both

[169] An ANPRM is a document that an agency may chooses to issue before it is ready to issue an NPRM, used as a vehicle for public participation in the formulation of the regulatory change before the agency has done significant research or investigation on its own.

DOT-111[170] and the newer CPC-1232 cars) typically contain 30,000 to 30,110 gallons. This means that none of the current crude-by-rail trains are subject to requirements for comprehensive response plans. Washington provided multi-agency comments to the FRA, PHMSA, and USDOT in support of potential revisions to federal regulations that would expand the applicability of comprehensive oil spill response plans (OSRPs) to high-hazard flammable trains. (See Appendix J.)

Modification of Washington's Statutory Definition of "Facility" to Include Moving Trains (as well as Stationary Trains Conducting Oil Transfers) in Oil Spill Contingency Plans

Railroad spills are not covered by state-approved oil spill contingency plans. This represents a gap in an otherwise rapid, aggressive and well-coordinated response. State laws do not have the same limiting thresholds as federal rules. If the definition of "facility" included moving trains and stationary trains conducting oil transfers, rail oil spill plans would include unit trains as well as single cars carrying oil as cargo (crude and refined oil products). Washington has not enforced its laws and regulations requiring oil spill contingency plans for railcars carrying oil as cargo because this has not been a widespread practice in the past..

Current state laws do not define railroads as facilities while moving. RCW 90.56.010 excludes rail as a facility "while transporting oil over the … rail lines of this state." This means that the responsible party has a gap in planning for a potential major spill, fire and toxic emission release incidents while the train is underway.

Certify the Financial Responsibility of Vessel and Facility Operators: Paying for Damages from Oil Spills

Washington State has not yet established a level of financial responsibility for oil handling facilities, including rail. This is another situation which represents a gap in response planning.

The United States has established a spill response framework based on the premise that the "polluter pays" for oil spills.[171] Both the federal government and Washington have laws and rules that require certain oil handlers to demonstrate evidence of their financial ability to pay for the removal of oil spills, for natural resource damages, and for other expenses related to spill responses. "Financial responsibility" refers to the proof or demonstration that a responsible party is able to pay for the costs and damages of a spill, up to a specified amount. Typically, financial responsibility is evidenced by an insurance policy or Protection and Indemnity (P&I) club

[170] The general characteristics of a DOT-111 tank car under existing regulations are as follows: DOT-111 cars are roughly 60 feet long, 11 feet wide and 16 feet high; the cars weigh approximately 80,000 pounds empty and 286,000 pounds when full; the cars can hold about 30,000 gallons or 715 barrels of oil depending on oil density; the tank is made of steel plate with a thickness of 7/16 of an inch; and the tank has a life span of approximately 50 years, with a 30 – 40 year economic lifespan.

[171] National Contingency Plan (NCP) as found in 40 CFR Part 300. The polluter pays principle as set forth in Principle 16 of the International Rio Declaration on Environment and Development, which is reflected in the national laws of each Participant that require that the polluter or responsible party is, generally, responsible for the costs associated with pollution.

documents, but it also may involve surety bonds, guarantees, letters of credit, or qualification for self-insurance.

The federal government has an established limit to the potential liability for the spiller; Washington has an unlimited potential liability for the spiller. For vessels operating in Washington, financial responsibility is based on the type of vessel and the total capacity for storage of product. However, Washington does not currently have a certification program and relies on the USCG, California and Alaska to certify vessels for financial responsibility. Washington has not established financial responsibility levels for facilities which include fixed, mobile facilities, and rail while train is stopped and transferring oil.

Definition of Oil to Include All Forms of Crude Oil

The current state regulatory definition of oil may not include certain heavy oils, diluted bitumen, synthetic crudes, and other crude oils produced in Canada and transported within Washington. Additionally, the current definition of oil has a technical drafting error, which may add confusion to the applicability to certain oils.

Reporting of Volume and Characteristics of Oil Transferred by Rail and Pipeline Facilities

State and local agencies are charged with preparation for and response to rail spills and incidents that threaten spills. However, they do not have access to essential data on product type or oil volumes by rail and pipeline in order to properly plan for response strategies. Further, there is no federal or state requirement for railroads to submit oil product type and volume data at the point of transfer to state and local agencies.

The state does not have means to gather information on the type or volume of oil being shipped through Washington. There are no federal requirements in place to provide the information, with the exception of a recent USDOT Bakken oil emergency order. But even this does not provide thorough enough information for complete risk-based emergency and spill response planning. For example, the USDOT emergency order was specific to only Bakken crude oil. Railroads are not required to report on shipments of Bakken crude smaller than one million gallons.

Reduction of Volatility of Bakken Oil Before Transport

Dissolved gas should be removed from Bakken crude prior to shipment in order to reduce its volatility. In recent comments on the proposed federal regulations on improved tank car standards, New York State again urged the USDOT to require such pre-treatment. Because this is a common practice in other oil producing areas, New York State believes it is not only prudent for health and safety purposes but also economically feasible. Importantly, the rail transportation industry strongly supports safer tank car standards and removal of dissolved gas prior to shipment.

Improvement of Equipment Capability by Designating Columbia River a High Volume Port Area (HVPA)

In HVPAs, defined in 33 CFR 155.1020, the risk of a cargo spill is considered higher than normal because of a higher volume of shipping activity. Under federal law and regulation, tank ships are required to have a vessel response plan (VRP). The VRP must demonstrate the tanker's ability to deploy specific response resources (equipment and people) within one of three different timeframes (Tiers 1 through 3). See 33 CFR 155.1020. Those response resources typically include the services of response vessels under a contract between the tanker's owner or operator and an oil spill response organization that owns the response vessel. To offset the increased risk in an HVPA, tank ships are required to have faster response times for each potential tier.

Ensurance of Sufficient Funding of Federal Oil Spill Liability Trust Fund by Extension to Oil Sands Oils

The Oil Spill Liability Trust Fund (OSLTF or Fund) is a billion-dollar fund established as a funding source to pay removal costs and damages resulting from oil spills or substantial threats of oil spills to navigable waters of the U.S. In a January 2011 memorandum, the Internal Revenue Service (IRS) determined that to generate revenues for the oil spill trust fund, Congress intended to tax only conventional crude and not oil sands or other unconventional oils. The Trust Fund is liable for oil sands oil spill cleanups without collecting revenue from oil sands transport.

Findings on Local, County, and State Emergency Preparedness Response Capabilities

Local, county, and state emergency responders need to be able to respond effectively to any incident occurring with crude-by-rail. This means that First Responders may need additional training, equipment, and resources to respond to a train derailment with an associated spill, fire/explosion and toxic fume emissions. The following are findings related to local response capability.

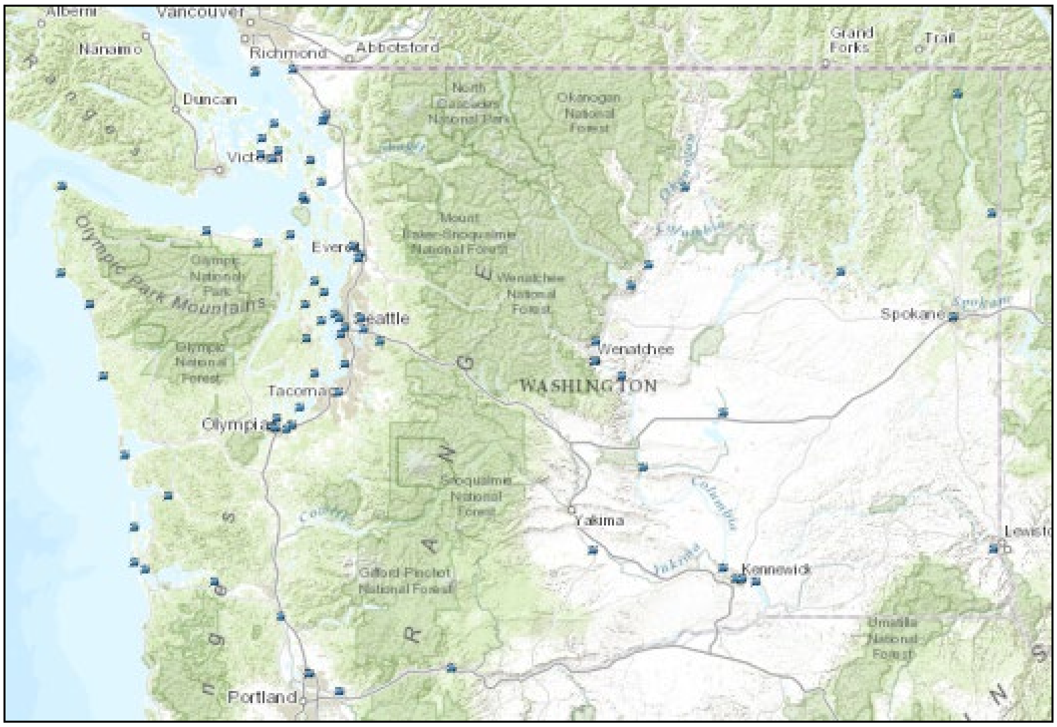
Enhancement of Emergency Response Capabilities

Equipment necessary for oil spill containment, responder health and safety monitoring and fire suppression during a crude oil emergency response are insufficient across much of Washington.

A survey was conducted by EMD of Washington’s 278 local fire districts, through which crude-by-rail transport occurs or is likely to occur. Study results showed that 59% believe that their departments are insufficiently trained or lack the resources to respond to a train derailment accompanied by fire. Local fire departments and fire protection districts across the rail transportation corridor do not have adequate funding necessary to plan, train, and equip their communities for a crude oil incident. These incidents need specialized resources such as fire suppressant foam and support equipment, the ability to monitor for potential human health exposures related to Bakken and other crude oil spills, and the ability to contain spilled oil with specialized oil spill response equipment.

In 2006, Ecology administered an oil spill response equipment grant program that provided specialized oil spill response equipment and training to local first responders and tribes across Washington. The $1.45 million grant project provided 99 oil spill response equipment caches across the state and trained over 1,000 first responders on how to safely and effectively deploy the equipment (Figure 41).

Figure 41: Existing Response Equipment Caches



The equipment has been used a number of times since the equipment was deployed, and has effectively limited the spreading and environmental damage of spills and has reduced the time and costs associated with oils spill cleanup. For example, in the August 2005 Harborview Marina Fire in Gig Harbor, response costs may have been reduced by an estimated $1.5 million, due to the immediate containment of the fire debris and spilled oil.[172] The potential benefits of a timely response were also analyzed in a 2005 study conducted for Ecology. This study demonstrated that responding to a spill in a shorter amount of time may reduce environmental and socioeconomic impacts and reduce cleanup costs.[173] In the implementation of the grant program, its effectiveness was demonstrated when local first responders deployed the equipment

[172] On August 31, 2005, a fire at the Harborview Marina in Gig Harbor destroyed about 50 small boats. Diesel fuel and gasoline spilled from the boats, though much of it burned. The cleanup cost reduction estimate is based on informal analyses conducted by Jim Riedel of NRC Environmental Services, Inc., who was under contract to the US Coast Guard at the time of the response operations.

[173] Etkin et al. 2005; French-McCay et al. 2005.

in a much more timely manner than would have been the case if they waited for state or federal response resources to help.

Although this grant program has been effective, it was limited to locating equipment based on risks as they were understood in 2006, prior to the development of Bakken crude rail shipment in Washington. Additionally, the grant program was only a one-time funding, and to be most effective, on-going training, maintenance, and periodic equipment replacement is necessary. Also, the existing equipment cache program was limited in the scope of equipment that was provided to local and tribal first responders. Furthermore, the program did not fulfill the entire equipment and training needs of first responders who now face the additional risk of highly flammable crudes being shipped by rail.

Local Responder Knowledge of Response Equipment and Plans Related to Crude-by-Rail

Local responders have state that they lack knowledge of available equipment and response resources to effectively handle crude-by-rail incidents. Further, there is a communication gap between railroads and local responders on railroad plans and strategies for crude-by-rail incidents.

As discovered in the survey developed and disseminated to all fire chiefs and LEPCs within the state, many first responders do not feel adequately prepared to contain, defend, and suppress a crude-by-rail incident. An overwhelming majority of those surveyed are not aware of the response strategies or resources in place by the railroads should an incident take place. There is also a general lack of communication between the railroads and the local response community.

Expansion of Current Centralized Hazardous Material Resources and Training

The majority of local emergency response agencies in the state lack the resources to provide adequate response training for their personnel or to conduct emergency planning.

According to the state fire marshal, current funding for federal grants is variable. Homeland Security grants are being reduced while the SAFER and AFG grants are stable at the moment. Some hazardous materials response equipment has been provided by federal grants and private industry; however, ongoing training for using this equipment is not provided. Additionally, there is not a comprehensive inventory of the equipment locations that would aid in locating and sharing equipment when it is needed. There should be a concerted effort to identify this equipment on a statewide basis. Training for First Responders in Washington is insufficient and is not uniformly coordinated, and currently available training may be reduced, due to reduced federal grants.

Update of Study on Hazardous Response Teams and Response Structure

There is a need for regional hazardous materials response teams to adequately respond to spills of Bakken crude oil and other hazardous materials.

Previous studies led by Ecology and other stakeholders in 1993 and 2005 were conducted to evaluate gaps in the current hazardous materials response capability in Washington and make recommendations to fill identified gaps. Both of these studies found substantial gaps in hazardous materials response capability in Washington, and both made recommendations to develop state-supported regional hazardous material response teams. In January 2006, the Washington State Emergency Management Council unanimously endorsed pursuing the development of regional hazmat teams. Ecology administered an additional study, which was completed in October 2006, and provided a detailed description and recommendations of the program description, candidate funding mechanisms, and draft legislation. Details were provided on the location, team types, number of technicians, and required training, based on a recent review of the history of hazardous material call types and exposure factors using a risk-based model. Legislation to create the program was introduced; however, no action by the legislature was taken.[174]

Findings on Geographic Response Plans (GRPs)

Each oil spill contingency plan is required by law to include information on resources at risk from oil spills, to plan for spills response. For many years in Washington this information and the response strategies (GRPs) have been developed collectively as a community and published by the state, rather than being developed individually, to have a more accurate and more widely available plan for oil spills. GRPs are developed as part of the Region 10 Response Team (RRT)[175] and Northwest Area Committee (NWAC).

GRPs are geographic-specific response plans for oil spills to water. They include response strategies tailored to a specific beach, shore, or waterway and are meant to minimize impacts to sensitive areas threatened by the spill. GRPs are an important part of Washington's oil spill programs. Each GRP has two main priorities:

- To identify natural, cultural, and economic resources near vessel traffic routes, pipeline and rail corridors, highways, facilities, and other potential pathways of spills to water.
- To describe and prioritize response strategies in an effort to minimize injury from oil spills.

[174] South Seattle Community College District, B. Zetlen, and J. Bernhardt. February 1993. Hazardous Material Response Study Report. Prepared for the Washington State Department of Ecology. DMJM technology. November 2005. Establishing Sustainable Regional crude-by-rail NE/Hazmat Response Capability in Washington State, Final Report. Prepared for Washington State Department of Ecology.; Patriot Technical Consultants, Inc. October 2006. Statewide Crude by Rail NE Response Program Final Report. Prepared for the Washington State Emergency Response Commission.

[175] The entities that work together to protect public health and safety and the environment by ensuring coordinated, efficient, and effective support of the federal, state, tribal, local, and international responses to significant oil and hazardous substance incidents within the Pacific Northwest Region as mandated by the National Contingency Plan (NCP).

Review of Geographic Response Plans for Adequacy

GRPs have not been developed for most of the rail corridors through which crude-by-rail trains are transiting or are projected to transit. There are also gaps in GRPs for marine areas. Capacity does not exist in the state to update and field test GRPs on a regular basis.

A preliminary analysis conducted by the NWAC Oil by Rail Task Force GRP Gap Analysis Work Group (2014) indicated that GRPs have not been developed for most rail corridors. However, there is some overlap in marine areas where trains travel along the Puget Sound (South Puget Sound, Central Puget Sound, North Central Puget Sound, and Columbia River). Also, there is some overlap with pipeline companies who have developed company-specific response strategies.

In addition to gaps in plans for certain inland regions, there are also gaps in marine areas. While the goal is to maintain and update GRPs every five years, Ecology has not been able to do this on a regular basis. There have not been sufficient resources to make progress in testing GRP strategies through response equipment deployment.

The GRPs also do not address responses for submerged or sinking oils. This is a concern for diluted bitumen spills under some conditions, particularly for spills into waters that have high sediment content and are turbulent. The increased handling of oils that are known to sink or may weather and sink (designated by the federal regulations as Group V oils) requires updates to oil spill response procedures in the Northwest. Traditionally, response and contingency planning has focused on containing and recovering surface floating oil through the use of booms and surface skimmers. There are limitations on the ability to model, track, locate, and recover submerged oil. Regulations do not take into consideration submerged oil response planning for oils that may weather and sink, other than those classed as Group V oils.[176]

Findings on Oil Spill Response Resources: Rail and Vessels

Allocating appropriate spill response resources requires an assessment of the locations and types of incidents likely to occur.

Sustainable Funding to Maintain Highest Levels of Prevention, Preparedness, and Response Programs in Washington

With the shift of crude oil imports away from tankers to rail and pipeline, a vital funding source supporting the Spill Prevention, Preparedness, and Response Program (Spills Program) at Ecology and other state entities has decreased. The additional state costs needed to manage Prevention, Preparedness, and Response activities as the energy picture and transportation modes change, e.g., rail and pipelines, is not sustainable with current funding mechanisms.

[176] Group V oils are those that have a density equal to or greater than that of water; these oils may sink when spilled in water.

Evaluation of Risk for Spills Related to Crude-by-Rail by Location and Incident Nature

Changing oil characteristics and changing transportation modes and routes necessitate the re-evaluation of the sufficiency of oil spill response resources. These resources include evaluating response planning standards, response resource availability and response tactics.

As stated in the NWAC Emerging Risks Task Force Report:[177]

> Where the Northwest Area Contingency Plan (NWACP) has traditionally focused on response to spills of oil to marine waters, recent changes and future trends in modes of crude oil transportation in the Northwest Area reflect a geographic shift to inland areas with a focus on rail transportation. This will result in a change in response strategy and response resource utilization and may warrant a review of the distribution of response resources. Federal and state on-scene coordinators will need to re-focus preparedness and response resources from traditional marine-based scenarios to a broader range of scenarios and work with Plan-holders to ensure that transfer of custody issues – and associated response expectations – are clearly articulated within Contingency Plans.

Locations considered at higher risk of spills due to vessel collisions/allisions and train derailments and locations associated with high spill consequences (e.g., high population density or environmentally- sensitive areas) should be thoroughly evaluated. This evaluation could be used to study commodity flows through those locations, analyze the probability of defined incident scenarios in those locations, and planning for the type and amount of response resources that might be needed. This will help in determining the situations with greatest risk (high probability of incident and high consequences).

To meet the state's planning standards, it is critical to know the state can capably respond to oils that tend to sink or submerge in inland and marine spill situations. Because the nature of various oil types is not sufficiently understood or communicated, NWAC should specifically conduct a study to review the current response resources attributed to submerged oil response in Washington. NWAC should also develop a definitive status of specific submerged oil response tools and tactics. For inland areas, information on fast-water response tactic is also needed.

[177] Northwest Area Committee. 2014. *Emerging Risks Task Force Project Overview* 2013. 61 p.

Analysis and Enhancement of Equipment Planning Standards for Grays Harbor, Columbia River, and Puget Sound to Incorporate Crude-by-Rail Facilities

The current regulatory response planning for Grays Harbor will require enhancements if all three proposed crude-by-rail facilities are permitted. Current response equipment would likely be insufficient for spills from both the facilities and the associated tank vessel traffic. Changes on the Columbia River and in Puget Sound also necessitate an analysis to determine whether current standards still remain adequate.

Mitigating Future Risk through Understanding Oil Transport Changes

The landscape of energy extraction and transport of extracted crude oil in the U.S. has changed in the last few years and continues to change nearly weekly. Unpredictable market changes, technological developments, federal regulatory developments, and other factors make it nearly impossible to predict what will occur in Washington with respect to crude-by-rail transport over the next few years, let alone decades. There are weekly and sometimes daily changes with regard to federal regulations, new findings on the nature of Bakken crude and diluted bitumen, forecasts of future oil production, speculations on changes to the federal ban on exporting crude oil, and technologies to boost crude production in the Bakken oil fields. Many other factors also directly affect levels of risk to citizens of Washington by the transport of crude oil by rail, by vessel, and by pipeline. In addition to this, other changes may soon occur in vessel and rail transport patterns related to other economic developments in the state.

Findings on Risk Mitigation Through Understanding of Oil Transport Changes

Long-Term Commitment to the Vessel Traffic and Rail Traffic Risk Assessment Analysis

To provide the greatest degree of public safety and to properly protect and honor tribal treaty rights, environmental resources, and the economic resources of the state, the changing energy picture and oil transport needs to be evaluated as an ongoing, long-term process.

To provide the citizens of Washington the best means to foster public safety and health, to honor and respect the tribal treaty rights, and to protect the precious natural and economic resources of the state, the Vessel Traffic and Rail Traffic Risk Assessment Analysis needs to be considered a program that will be an ongoing process.

This assessment work is critical in keeping our knowledge current, as new factors and information such as these come into play:

- Changes in federal regulations related to railroads.
- Changes in the oil volumes transported by different modes, including vessels, rail, pipelines, trucks, and even air, depending on national and international markets, and patterns of transport.
- Potential exports of crude oil if the federal ban on crude exports is lifted.
- Potential imports of additional new types of crude oil from other parts of North America.
- Further shifts in oil movements with potential permitting of various crude-by-rail facilities.

- Changes in vessel and rail traffic related to proposed and potential future projects, such as the Gateway Pacific Terminal.
- Greater understanding of the efficacy and cost-effectiveness of risk mitigation measures.
- Greater understanding of the causes and frequencies of crude-by-rail-related incidents.
- Greater understanding of the nature of impacts and behavior of Bakken crude, diluted bitumen, and, potentially, other crude oils, as well as refined products.
- Greater understanding of the impacts of fires and spills of crude oil transported by rail – particularly Bakken crude and diluted bitumen – in the highly sensitive areas.
- Updates to the identification and mapping of sensitive and high-consequence areas in the vicinity of rail lines (e.g., densely-populated areas, tribal lands, aquifers, highly-sensitive ecological habitats), as well as marine areas affected by crude-by-rail vessel traffic and other changes in vessel traffic.
- Greater assistance to first responders and LEPCs developing hazardous materials response plans.

The Vessel Traffic Risk Assessment (VTRA) model developed by George Washington University (GWU) for the greater Puget Sound/Salish Sea area[178] provides a powerful reusable tool to predict locations and frequencies of collisions, allisions, and groundings of modeled vessels. The model also predicts subsequent potential releases of oil (fuel or cargo including petroleum products) and other hazardous materials. This tool can assist in evaluating preventative measures such as the placement of rescue tugs, implementation of vessel traffic restrictions, and other measures to reduce risk of oil spills.

However, its value is dependent upon the use of current and accurate vessel population types and numbers. For example, the 2014 VTRA 2010 study provides a VTRA based on vessel population models that pre-date the recent increase in crude-by-rail and uses incomplete information on Canadian-sourced vessel traffic. The baseline year for the study is 2010. There were no crude-by-rail imports into Washington in 2010.[179] As such, the 2014 VTRA 2010 study does not include the current or future impacts of crude-by-rail on marine traffic in Northern Puget Sound. The VTRA included an analysis of the impact of three significant potential projects: the Gateway bulk carrier terminal, the Trans-Mountain pipeline expansion, and the combination of proposed changes at Roberts Bank Terminal 2. The last project as modeled actually represents a combination of several projects in Port Metro Vancouver, beyond just expansions, at Roberts Bank terminals that include Westshore Terminals (coal) and Deltaport (containers). However, it does not include the largest project: the proposed container terminal expansion at Roberts Bank Terminal 2. The model was based on planned expansion and

[178] vanDorp and Merrick 2014.
[179] Department of Ecology data. 2014.

construction projects that were in advanced stages of a permitting process at the initiation of the VTRA.

The VTRA 2010 also does not address vessel traffic in Grays Harbor or the Columbia River; both are waterways now affected by the changes brought about by crude-by-rail transport and handling and likely to be further affected. Additional VTRA studies should evaluate such factors as one-way traffic, more call-in points, large vessel no-meeting requirements, speed restrictions, high-risk tug escort requirements, and tug escort requirements for ATBs. Assessments should include the effects of traffic congestion on risk.

There are few, if any, studies that analyze the risk of accidents and spills from crude-by-rail trains. Since crude-by-rail transport, in particular, is new to Washington and the rest of North America (U.S. and Canada) as a whole, there are few studies to help in analyzing risk to Washington. Quantifying risks of crude-by-rail is challenging, because of the uncertainty of changes to federal regulations for railroads and the changing energy picture for Washington, and North America as a whole.

A Rail Transport Risk Assessment (RTRA) model (reusable risk model) that can be updated and adapted to the changing energy picture is critical in keeping our knowledge current, as new factors and information come into play. The RTRA model should incorporate all of the following:

- Crude-by-rail traffic patterns as part of the larger rail traffic system in Washington (train types, routes, frequency of transits – loaded and unloaded, cargo types, tank car types).
- Analysis of the increasing infrastructure of rail components (e.g., track, ballast, ties, bearings) and its relationship to prevention of derailments and collisions.
- Frequency analysis of incidents that might lead to spillage and/or fires (e.g., derailments, collisions).
- Geographic analysis of track systems and locations where incidents are more likely, due to track condition, inspection frequency, operating conditions, train congestion, and other factors.
- Analysis of the types of incidents that occur with respect to numbers of cars involved (e.g., in a derailment).
- Incident rates for spills and spill volume involved.
- Analyses of the degree to which prevention measures may reduce the likelihood of major incidents.

Crude-by-Rail Transport System Impacts to Cultural and Economic Resources

There is great concern among the public and various stakeholder groups about the wide-reaching effects of the crude-by-rail marine and rail transport and associated facilities. Public concerns are not limited to the effects of potential accidents (spills and/or fires). Concern is also for the ways in which the crude-by-rail system and the increase in port activities with new facilities could affect the tribal treaty rights, the environment and climate change, and the regional economy.

Study Recommendations

Rail-Based Risk Mitigation Measures

1. Act on the Multi-Agency Comments to the Federal Government on Safe Rail Transport

Recommendations: The joint state agency comments included the following recommendations:

- FRA and PHMSA should ensure that the standards, operational controls, routing, and speed restrictions for railcars transporting crude oil provide the highest level of protection for the state's citizens and environment.
- FRA and PHMSA should define a high-hazard flammable train (HHFT) to include a single train carrying 20 or more carloads of a Class 3 flammable liquid or a single train carrying one carload of a Packing Group I, Class 3 flammable liquid.
- FRA and PHMSA should establish tank car standards with the most stringent requirements, and older model tank cars should be phased out for use in transporting Class 3 flammable liquids within two years.

2. Derailment Prevention is Key to Public Safety, Health, and Environmental Protection

Recommendation: Modify the state's railroad regulatory fee structure. It should allow the UTC to fund additional inspector positions, including FRA-certified inspectors, and to increase state inspections in the areas of track, hazardous materials, operating practices, motive power and equipment, and crossing signals.

3. Derailment Prevention is Key to Public Safety, Health, and Environmental Protection

Recommendation: Work with BNSF, UP, and other railroads operating in Washington to establish voluntary agreement(s), to operate loaded HHFT/Key Trains at a maximum speed of no more than 45 mph.

4. Regulation and Oversight Issue: Insufficiency of Trained Personnel

Recommendation: Modify the railroad regulatory fee structure. It should allow the UTC to fund additional inspector positions, including FRA-certified inspectors with increased pay that is competitive with comparable private-sector and federal inspectors.

5. Regulation and Oversight Issue: Authority for UTC Rails Inspections on Private Property

Recommendation: Amend statutory authority to allow UTC inspectors to enter a private shipper's property to conduct hazardous material inspections related to rail operations.

6. Regulation and Oversight Issue: At-Risk Crossings

Recommendation: Provide authority and funding for UTC to conduct Railroad and Road Authority Diagnostic reviews of the road crossings most at risk, to determine whether each crossing has sufficient protective devices.

7. Regulation and Oversight Issue: Oversight of At-Grade Crossings

Recommendation: Amend Chapter 81.53 RCW to allow designated "first-class cities"[180] to opt-in to the UTC's railroad crossing inspection and enforcement program. Give the UTC jurisdiction to require first class cities to inform the UTC when crossings are opened or closed.

8. Regulation and Oversight Issue: Private Crossings

Recommendation: Amend Chapter 81.53 RCW to give UTC jurisdiction over private road crossings on the primary routes for the transportation of crude oil and to establish and enforce minimum safety standards, including appropriate safety signage.

9. Regulation and Oversight Issue: Placarding Standards for Railcars

Recommendation: DOT should change the hazardous material identification on trains to be easy for all First Responders to understand. The United Nations is responsible for assigning unique and internationally consistent hazardous materials identifiers. The current identification system does not meet the needs of First Responders and community leaders who must respond to train derailments or releases of hazardous flammable liquids.

10. Regulation and Oversight Issue: Enhancement of FRA/UTC Rail Incident Databases

Recommendation: FRA, in conjunction with state and local governments, should review and improve usability of existing databases to include the ability to sort data by state and incident type. This would save time and improve the ability to search and retrieve accident and incident information.

[180] Cities with 10,000 or more population.

11. Cooperation and Communication: Establish Railroad Safety Committee Based on Harbor Safety Committee Model

Recommendation: PHMSA, FRA and UTC should form and co-lead Railroad Safety Committees analogous to maritime-oriented Harbor Safety Committee(s) for Class I railroads[181] and for short-line railroads. This would foster communication and cooperative approaches to promote safe practices on Washington railroads. These committees may be expansions of the already existing monthly safety programs operating at the railroad and union levels.

Marine-Based Risk Mitigation Measures

12. Build on Previous Spill Prevention Successes

Recommendation: Ecology, the Washington Pilotage Commission, and the Oregon Board of Maritime Pilots should continue to support the extensive maritime safety programs in place at the international, federal, state, and industry levels, and they should be a catalyst for continued training, drills, and vigilance at all levels of spills prevention programs.

13. Reduce Human Error and Increase Situational Awareness

Recommendation: Ecology should continue to develop marine safety, industry oversight, and inspection criteria to reduce human error and increase situational awareness by:

- Advocating the implementation and monitoring of the proposed USCG rulemaking on barge inspections and crew working hours.[182]
- Directing the implementation of an automated track control system into mobile navigational systems used by state pilots.
- Advocating analysis of a situational awareness, to include staffing levels on all classes of vessels including commercial fishing and towing vessels.

14. Reduce Spill Probability with Protected Fuel Tanks on Ships

Recommendation: Require, through a process such as the project permitting process, that newly constructed and expanded facilities implement ship vetting procedures or contractual agreements with shippers calling at their docks. This would meet the IMO Convention for Prevention of Marine Pollution (MARPOL) Annex 1, Regulation 12A, Oil Fuel Tank Protection requirements

[181] As per the Surface Transportation Board, a railroad “having annual carrier operating revenues of $250 million or more" after adjusting for inflation using the Railroad Freight Price Index developed by the Bureau of Labor Statistics.

[182] In the US Coast Guard and Maritime Transportation Act of 2004 (P,L. 108-293, §415), Congress directed the USCG to establish a barge safety inspection and certification regime similar to that for ships. This regime includes structural standards and crew standards. The inspection regime is more significant for tank barges used on rivers than for sea-going barges, because sea-going barges carrying oil or hazardous materials are already inspected under 46 USC Subchapter I. River tows (tow boats and their attached barges) are subject to other regulations in CFR Titles 33 and 46. On August 11, 2011, the USCG issued a notice of proposed rulemaking on barge inspections and work hours (76 *Federal Register* 49976-50050). This notice provides for six hours of work followed by six hours of rest to alleviate issues related to sleep debt and crew member fatigue (76 *Federal Register* 49991-49997, August 11, 2011. The USCG has not yet issued final regulations. (Reviewed in Fritelli 2014.)

for independent from the hull fuel tank construction standards required for new vessel builds after 2010. An additional possible strategy for implementation is through the Army Corps of Engineers facility permitting process.

15. Railroads Join Harbor Safety, Area Maritime Security, and NW Area Committees, SERCs, Tribal Emergency Response Commissions (TERCs), and LEPCs

Recommendation: Engage the applicable railroads to actively participate in the three harbor safety committees, two Area Maritime Security Committees, the Northwest Area Committee, SERCs, TERCs, and LEPCs. The USCG and Ecology should support the harbor safety committees through increased funding.

16. Expand Tug Escort Requirements for Oil Tankers: Puget Sound, Grays Harbor, and Columbia River

Recommendation: The Washington Pilotage Commission should undertake an analysis with the Harbor Safety Committees, U.S. Coast Guard, Ecology and the state of Oregon, and consider rulemaking on expanding requirements for escort tugs and/or other safety measures for tank vessels including articulated tug and barges.

17. Evaluate the Effectiveness of Additional Emergency Tow/Rescue Tugs

Recommendation: Ecology should lead an analysis with the USCG and Harbor Safety Committees on the potential effectiveness of a pre-positioned ERTV(s), stationed in the vicinity of Turn Point at the junction of Haro Strait and Boundary Pass, near the entrance to Grays Harbor and the mouth of the Columbia River.

18. Reconsider the Definition of High-Risk Vessels

Recommendation: Ecology should lead an analysis with the USCG and Harbor Safety Committees to define and develop tug escort requirements and standards for "high risk" vessels, based on the probability of human error or mechanical failure. For more cost-effective reduction of incidents, "high risk" vessels could be defined based on their probability of human error or mechanical failure , such as"tramp ships",[183] which may have less experience in the region. High-risk vessels, as defined by large numbers of inspection deficiencies, are already subject to increased vigilance.

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[183] A ship engaged in the tramp trade is one that does not have a fixed schedule or published ports of call. As opposed to freight liners, tramp ships trade on the spot market with no fixed schedule or itinerary/ports-of-call(s).

19. Enhance VTS Capability in Grays Harbor, Lower Columbia River, and Outer Coast

Recommendation: USCG should establish a long-term waterways management plan to accommodate increased vessel traffic and an appropriate vessel traffic service for the waterways of Grays Harbor, Columbia River, and the outer coast.

20. Restrictions on Vessel Bunkering Activities to Reduce Incidents

Recommendation: Ecology should lead an analysis with the USCG and Harbor Safety Committees to evaluate limiting or moving bunkering activities to locations where enhanced prevention and preparedness capabilities exist or could be established.

21. Reduction of Speed for Container Ships

Recommendation: Ecology should lead an analysis with the USCG and Harbor Safety Committees on restricting speed for container ships (and other large vessels), to reduce the likelihood of collisions in congested areas of ports or shipping channels in Puget Sound.

22. Minimize Multiple Trips from Berth to Anchorage by Tankers

Recommendation: Advocate with the USCG to eliminate industry's current practice of multiple berthing/partial discharging/anchoring of tankers carrying foreign crude oil. This practice could be eliminated through regulation or through voluntary action adopted as harbor safety standards of care. Exceptions should be allowed on a case-by-case basis, such as when facility operations require floating storage or partial discharges or and when sailing offshore would increase risk of a spill.

Facility-Based Risk Mitigation Recommendations

23. Build on 20 years of Spill Prevention at Oil Handling Facilities

Recommendation: Ecology should modernize the Prevention Design Standards for facilities (WAC 173-180-300 to 340) to address all modes of oil handling into and out of facilities.

24. Application of BAP Standard to Facilities

Recommendation: Modify RCW 90.56 to apply BAP Planning Standards to all facilities handling oil.

25. Shared Standards of Spill Prevention on the Columbia River

Recommendation: Encourage the state of Oregon to adopt facility oil handling regulations that include a pre-boom requirement to mitigate risk of and enhance protection from oil spills.

Oil Spill Planning and Response Recommendations

26. Support the Multi-Agency Comments on Federal Rulemaking on Oil Spill Response Plans for High-Hazard Flammable Trains

Recommendations: The joint state agency comments included the following recommendations:

- FRA and PHMSA should require that the threshold for comprehensive OSRPs[184] be set at 3,500 gallons, equivalent to the current requirement for basic OSRPs.
- FRA and PHMSA should require that all federal rail response plans be provided to SERCs, Tribal Emergency Response Commissions, and LEPCs and state agencies be designated authority as state on-scene coordinators.
- FRA and PHMSA should both review and approve OSRPs using clear, specific criteria for plan review and approval, including submittal and review timeframes.
- FRA and PHMSA should require that rail operators participate in a drill and exercise program, including announced and unannounced exercises following national guidelines.
- FRA and PHMSA should require a minimum amount of demonstrated financial resources to pay for response, cleanup, remediation, natural damage assessment, and restoration costs, based on the reasonable worst-case spill volume of a train carrying oil as cargo.
- FRA and PHMSA should require the use of the incident command system to respond together to both risks of spills and actual spills, with the federal, state, tribal and local governments under a Unified Command.[185]

27. Modify Washington's Statutory Definition of "Facility" to Include Moving Trains (as well as Stationary Trains Conducting Oil Transfers) into Oil Spill Contingency Plans

Recommendation: Direct Ecology to write rules requiring oil spill contingency plans from train operators to include defining a worst-case spill planning volume and participation in drills. Modify the definition of "facility" (RCW 90.56) to include moving oil cargo trains into the planning requirements.

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[184] Washington Administration Code (WAC) Chapter 173-182 requires larger oil handling facilities, pipelines, and commercial vessels to have state-approved oil spill contingency plans that describe their ability to respond to oil spills. A contingency plan is like a "game plan" that outlines what is necessary to ensure a rapid, aggressive, and well coordinated response to an oil spill. Critical elements of these plans include: notification and call out procedures to ensure response teams and resources are activated immediately; identification of spill management teams necessary to manage a spill or incident response; analysis of the planning standards and worst-case spill volume to assess the necessary response needs; appropriate response equipment and personnel to respond to a worst-case spill; identification of oil types and properties; contracts with primary response contractors to provide response equipment and personnel necessary to respond; and commitment for drills to test the plan.

[185] An authority structure in which the role of incident commander is shared by two or more individuals, each already having authority in a different responding agency: Unified Command is one way to carry out command in which responding agencies and/or jurisdictions with responsibility for the incident share incident management; Unified Command may be needed for incidents involving multiple jurisdictions or agencies.

28. Certify the Financial Responsibility of Vessel and Facility Operators: Paying for Damages from Oil Spills

Recommendation: Modify RCW 88.40 and direct Ecology to extend financial responsibility requirements to rail and mobile facilities, and enable Ecology to modify the regulations on financial responsibility requirements (Chapter 317-50 WAC). Issuing Certificates of Financial Responsibility ensure that those transporting oil can pay for cleanup costs and damages resulting from oil spills.

29. Define Oil to Include All Forms of Crude Oil

Recommendation: The Washington State Legislature should amend definitions of oil at Chapters 88.40, 88.46, 90.46 and 90.56 RCW to read as follows:

> "Oil" or "oils" means oil of any kind that is liquid at 25°C and one atmosphere of pressure, and any fractionation thereof, including, but not limited to, crude oil, bitumen, synthetic crude oil, natural gas well condensate, petroleum, gasoline, fuel oil, diesel oil, biological oils and blends, oil sludge, oil refuse, and oil mixed with wastes other than dredged spoil. Oil does not include any substance listed as of March 1, 2003, in Table 302.4 of 40 CFR Part 302 adopted under section 102(a) of the Federal Comprehensive Environmental Response, Compensation, and Liability Act of 1990, as amended by PL 99-499.

30. Modify Reporting Requirements of Volume and Characteristics of Oil Transferred by Rail and Pipeline Facilities

Recommendation: Modify RCW 90.56 to require railroads to submit advance notice to the state on the volume and characteristics of oil being transferred. Modify RCW 90.56 to define reporting requirements for oil pipelines.

31. Conduct Sampling and Analysis on Volatility of Bakken Oil Before Transport

Recommendation: Following full implementation of the Bakken Crude Oil Conditioning Standard on April 1, 2015, the Northwest Area Committee should conduct sampling of Bakken crude oil transported through Washington and perform analysis to characterize the hazards presented to first responders. The results and potential health/environmental threats should be communicated to Washington response organizations.

32. Improve Equipment Capability by Designating Columbia River and Grays Harbor as High Volume Port Areas (HVPA)

Recommendation: The USCG should consider whether designating the Columbia River and Grays Harbor as HVPA would effectively offset increased spill risk from increases in tanker traffic in these areas.

33. Ensure Sufficient and Fair Funding of Federal Oil Spill Liability Trust Fund into Future by Extension to Include Revenue from Oil Sands Oils

Recommendation: U.S. Congress should clarify that the revenues for the trust fund include oil sands oils.

Local, County, and State Response Recommendations

34. Enhance Emergency Response Capabilities

Recommendation: Fund enhanced and continuous oil spill response equipment and a local first responder firefighting equipment grant program. Ecology should work with local responders to develop rules for the administration of the grant program. Ecology should work with representatives from the local first response community to scope out additional equipment and training needs, such as fire foam and exposure monitoring equipment. Ongoing funding and staffing should be provided to administer the program, maintain existing equipment, and provide periodic training to first responders.

35. Provide for Emergency Management Planning of Response Equipment and Plans Related to Crude-by-Rail

Recommendation: Fund ten emergency management planners to assist local jurisdictions' LEPC hazardous materials response planning. These planners would be assigned to Washington Emergency Management Division. One of the planners would focus on state level planning and coordination and provide support to the SERC. The other nine planners would focus on providing outreach to LEPC through the nine Homeland Security Regions to assist in developing Emergency Planning and Community Right-to-Know Act (EPCRA) compliant Hazardous Materials Response Plans. Ecology, UTC, and EMD should work directly with PHMSA and FRA to establish a strategy for railroads to work with local responders in the state to identify railroad response strategies, equipment and available resources, as well as establish a direct line of communication to activate resources.

36. Expand Current Centralized Hazardous Material Resources and Training

Recommendation: The Washington Office of Financial Management and the state fire marshal should develop state funding options for the legislature to provide statewide coordinated training. The state fire marshal should also work with the railroad companies for expansion of the current centralized system for hazardous material training to address the unique hazards presented by crude-by-rail. The state fire marshal should review rail tank car training needs for first responders, develop a specific training program with mandatory requirements, and implement a coordinated training program for first responders.

37. Update Study on Hazardous Response Teams and Response Structure

Recommendation: Direct Ecology and the fire marshal's office to analyze the continued need for hazardous materials response teams, their composition, how they should be equipped and trained, where they should be located, funding mechanisms, and how they will mutually assist statewide. This analysis should include development of a startup and estimates of recurring cost for such teams.

Geographic Response Plan (GRP) Recommendations

38. Fund GRP Work and Continue Reviews for Adequacy

Recommendation: Ecology should continue to develop new, and maintain existing, geographic response plans for inland and marine areas at risk from oil spills. This includes full coverage, use of best technology, adequate testing of strategies, and updating after lessons are learned. This would allow responders to minimize damages to the environment and economy from spills. Ensure permanent ongoing funding for these important response tools.

Oil Spill Response Resources: Rail and Vessel Recommendations

39. Develop Sustainable Funding to Maintain Highest Levels of Prevention, Preparedness, and Response Programs in the State of Washington

Recommendation: Consider funding options to adequately fund Washington's Spill Prevention, Preparedness, and Response Program.

40. Evaluate Risk for Spills Related to Crude-by-Rail by Location and Incident Nature

Recommendation: Permitting agencies should require crude-by-rail facility permit applicants to conduct a thorough evaluation of specific locations of risk for train and/or vessel incidents related to the proposal. This should include inland and coastal areas, as determined by the lead agency.

Recommendation: The NWAC should support a task force to analyze the type and volume of Group V oils moved into the region and focus planning efforts on improving response to sinking oil.

41. Analyze and Enhance Equipment Planning Standards for Grays Harbor, Columbia River, and Puget Sound to Incorporate Crude-by-Rail Facilities

Recommendation: Ecology should review statewide regulatory planning standards (WAC 173-182) to determine whether the equipment standards are adequate for the potential increase in crude-by-rail facilities and associated tank vessel traffic, particularly in Grays Harbor and on the Columbia River.

Mitigating Future Risk Recommendations

42. Make Long-Term Commitment to the Vessel Traffic and Rail Traffic Risk Assessment Analysis

Recommendation: Ensure permanent ongoing funding for Ecology transportation risk experts. This would allow Ecology to keep informed on public health and safety, environmental protection, and other impacts of the changing energy sources and systems. Additional funding should be directed to Ecology to support the expansion of vessel traffic risk assessments to Grays Harbor, the Columbia River, the outer coast, and changes in Puget Sound. Further funding should direct the development of a rail traffic risk assessment model to analyze changes to the rail transportation system.

43. Outreach on Crude-by-Rail Transport System Impacts to Cultural and Economic Resources

Recommendation: Continue outreach efforts on the changing energy picture to potentially affected tribes, communities, and stakeholders to further refine the issues of concern for corrective assessment work to enhance public health and safety and environmental protection action. Throughout, respect for tribal people and their treaty rights must be a high priority.

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[187] On February 25, 2014, the Secretary of Transportation issued an Emergency Restriction/Prohibition Order (Original Order) to all persons who offer for transportation, or transport, in tank cars by rail in commerce to, from and within the US, a bulk quantity of petroleum crude oil (Petroleum Crude Oil Offerors and Rail Carriers.

[188] This Order is issued to all railroad carriers that transport in a single train in commerce within the US, 1,000,000 gallons or more of UN 1267, Petroleum crude oil, Class 3,1 sourced from the Bakken shale formation in the Williston Basin (Bakken crude oil).

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Glossary, Acronyms, and Abbreviations

Glossary

Acoustic bearing detector (TADS-ABD): A type of wayside detector that uses acoustic signatures to evaluate the sound of internal bearings and identify those likely to fail in the near term.

Acute toxicity: The adverse affects of a substance that result from a single exposure or over the course of a relatively short period of time (usually less than 24 hours).

Adhesiveness: The degree to which an oil sticks to surfaces.

Advance Notice of Proposed Rulemaking (ANPRM): A document that an agency may chooses to issue before it is ready to issue an NPRM, used as a vehicle for public participation in the formulation of the regulatory change before the agency has done significant research or investigation on its own.

Advanced Notice of Transfer (ANT): Ecology's oil transfer rules to prevent spills when oil is transferred over water that require submission of an Advance Notice of Oil Transfer (ANT) by the delivering facility (fixed or mobile) or vessel which is transferring over 100 gallons of bulk oil to a non-recreational vessel or facility; the ANT must be submitted 24 hours prior to the transfer for facilities, and as required by local USCG Captain of the Port requirements for vessels; smaller fueling stations that deliver oil to non-recreational vessels with an oil capacity of less than 10,500 gallons are not required to submit the ANT form; instead they must submit bi-annual reports detailing cumulative types and amounts of oil. (See WAC chapters 173-184-100, 173-180-215, and 173-180-210 for details.)

Aframax tanker: A tank vessel that is 830.1 feet in length, has a draft of 38 feet, and has a deadweight tonnage (DWT) of between 80,000 and 120,000; "Aframax" does not refer to the West African trades, but rather, started out as a fiscal descriptor, first used by U.S. oil majors to denote a class of tankers that gave certain advantages in a specific range of trades; those trades did involved tax authorities, and a means of dealing with them known as the "average freight rate assessment" scheme, or "afra".

Alaska North Slope (ANS): The region of northern Alaska that includes Prudhoe Bay; ANS crude oil produced in this area is pumped down the Trans-Alaska Pipeline System (TAPS) to Valdez Terminal for transport by tankers.

Alberta Innovates Energy and Environment Solutions (AI-EES): The lead agency for advancing energy and environmental technology innovation in Alberta, Canada. AI-EES serves as a catalyst for the development of innovative, integrated ways to convert Alberta's natural resources into market-ready, environmentally responsible energy and the sustainable management of Alberta's water resources.

Alberta Innovates Technology Futures (AITF): Provides innovation, research and commercialization services delivering economic and social benefits to Alberta, Canada.

Alkane: A simple saturated hydrocarbon contained in petroleum, the simplest of which is methane.

All-Hazard Incident Management Team (AHIMT): A multi-agency/multi-jurisdictional team for extended incidents formed and managed at the local, state or tribal level; it is a designated team of trained personnel from different departments, organizations, agencies and jurisdictions. AHIMTs are deployed as a team representing multiple disciplines who manage major and/or complex incidents requiring a large number of local, state or tribal resources.

American Association of Railroads (AAR): Representing North America's freight railroads and Amtrak, it strives to help make the rail industry increasingly safe, efficient and productive.

American Fuel and Petrochemical Manufacturers (AFPM): A trade association representing high-tech American manufacturers of virtually the entire U.S. supply of gasoline, diesel, jet fuel, other fuels and home heating oil, as well as the petrochemicals used as building blocks for thousands of vital products in daily life.

American Petroleum Institute (API): The largest U.S trade association for the oil and natural gas industry, representing about 400 corporations involved in production, refinement, distribution, and many other aspects of the petroleum industry.

American Waterways Operators (AWO): The national advocate for the U.S. tugboat, towboat and barge industry, which serves the nation as the safest, most environmentally friendly, and most economical mode of freight transportation. AWO members operate on the rivers, coasts, Great Lakes, and harbors of the United States, moving vital commodities safely, reducing air emissions, water pollution, and highway congestion, and protecting homeland security.

Anhydrous ammonia: A colorless, highly irritating gas or liquid with a sharp, suffocating odor commonly used to make fertilizers.

API gravity (°API): An alternative measure of density; the higher the °API, the lighter the oil.

Aqueous film forming foams (AFFF): Fire-fighting foam is a foam used for fire suppression. Its role is to cool the fire and to coat the fuel, preventing its contact with oxygen, resulting in suppression of the combustion. Low-expansion foams such as AFFF are low-viscosity, mobile, and able to quickly cover large areas.

Aquifer: An underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, or silt) from which groundwater can be extracted using a water well.

Aromatic: A more complex hydrocarbon that is composed of rings of benzene

Articulated tank barge (ATB): Articulated tug barge (tug-barge combination system capable of operation on the high seas, coastwise and further inland. It combines a normal barge, with a bow resembling that of a ship, but having a deep indent at the stern to accommodate the bow of a tug. The fit is such that the resulting combination behaves almost like a single vessel at sea as well as while maneuvering.)

Association of American Railroads (AAR): An industry trade group representing primarily the major freight railroads of North America (Canada, Mexico and the United States); Amtrak and some regional commuter railroads are also members.

At-grade crossing: A railroad crossing with a roadway where the two transport axes intersect at the same level.

Automatic Block System (ABS): A form of rail operation in which fixed block signals are controlled by a system in which signals work automatically, including clear track detection (device that detects the occupation and clearance of a track section).

Automatic Identification System (AIS): An automatic tracking system used on ships and by vessel traffic services (VTS) for identifying and locating vessels by electronically exchanging data with other nearby ships, AIS base stations, and satellites.

Average Annual Daily Traffic (AADT): A useful and simple measurement of how busy a road is.

Bakken crude oil: A form of light crude oil that originates from the Bakken Region or Formation in the Williston Basin located in northwestern North Dakota, northeastern Montana, southern Saskatchewan and southwestern Manitoba.

Biodegradation: The chemical dissolution of materials by bacteria or other biological means.

Biodiesel: A vegetable oil - or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, ethyl, or propyl) esters; biodiesel is typically made by chemically reacting lipids (e.g., vegetable oil, animal fat (tallow) with an alcohol producing fatty acid esters; biodiesel is meant to be used in standard diesel engines and is thus distinct from the vegetable and waste oils used to fuel converted diesel engines; biodiesel can be used alone, or blended with petrodiesel in any proportions.

Bitumen: A heavy asphalt-like form of petroleum.

Black oil: An industry term that refers to refined petroleum products that have an °API of 15 to 45, and thus are moderately heavy, between volatile oils and heavy oils and tars.

BNSF: The name for the entity formerly referred to as "Burlington Northern Santa Fe Railroad". The acronym is the official name. BNSF is no longer spelled out as "Burlington Northern Santa Fe Railroad."

Brackish water: Water that has 0.05–3% dissolved salts compared with <0.05% for freshwater and 3–5% for seawater.

British thermal unit (BTU): The amount of energy needed to cool or heat one pound of water by one degree Fahrenheit.

Bunkering: The practice of taking on ship's fuel oil.

Bureau of Safety and Environmental Enforcement (BSEE): Exercises the safety and environmental enforcement functions formerly under the Minerals Management Service, including the authority to inspect, investigate, summon witnesses and produce evidence, levy penalties, cancel or suspend activities, and oversee safety, response, and removal preparedness.

Canadian Association of Petroleum Producers (CAPP): An influential lobby group that represents the upstream Canadian oil and natural gas industry.

Canadian National Railway (CN): A Canadian Class I railway headquartered in Montreal, Quebec that serves Canada and the Midwestern and Southern United States.

Canadian Pacific Railway (CPR or CP): The Canadian Pacific Railway (CPR), formerly also known as CP Rail (reporting mark CP) between 1968 and 1996, is a historic Canadian Class I rail carrier founded in 1881 and now operated by Canadian Pacific Railway Limited (TSX: CP, NYSE: CP), which began operations as legal owner in a corporate restructuring in 2001. Headquartered in Calgary, Alberta, it owns approximately 14,000 miles (22,500 km) of track all across Canada and into the United States, stretching from Montreal to Vancouver, and as far north as Edmonton. Its rail network also serves major cities in the United States, such as Minneapolis, Milwaukee, Detroit, Chicago, and New York City.

Capesize: The largest cargo ships; ships which are too large to transit the Suez Canal (Suezmax limits) or Panama Canal (Panamax limits), and so have to pass either the Cape of Good Hope or Cape Horn to transverse between oceans; typically above 150,000 long tons deadweight (DWT), and ships in this class include bulk carriers transporting coal, ore, and other commodity raw materials; the term is most commonly used to describe bulk carriers rather than tankers. A standard capesize bulker is around 175,000 DWT, although larger ships (normally dedicated to ore transportation) have been built, up to 400,000 DWT; capesize bulker (bulk carrier) is over 150,000 deadweight tonnage (DWT).

Capital Expenditure Plan (CEP): Identifies the amount of cash a company will invest in projects and long-term assets.

Carbon dioxide (CO_2): A naturally occurring chemical compound composed of two oxygen atoms each covalently double bonded to a single carbon atom.

Centralized Traffic Control (CTC): A control system in which the local interlockings are remote-controlled by a dispatcher and the trains are governed by signal indication.

Certificate of Financial Responsibility (COFR): A program created to ensure that tankers, barges, and other vessels used to transport oil and chemical-based products on U.S. should bear any ensuing cleanup costs from spills or leaks; this is based on the Oil Pollution Act of 1990 (OPA90) and other environmental statutes.

China Shipping Container Lines (CSCL): A containerized marine shipping company, based in Shanghai, China.

Class I railroad: As per the Surface Transportation Board a railroad “having annual carrier operating revenues of $250 million or more" after adjusting for inflation using the Railroad Freight Price Index developed by the Bureau of Labor Statistics.

Class II railroad: A railroad that hauls freight and is mid-sized in terms of operating revenue (as of 2011, a railroad with revenues greater than $37.4 million but less than $433.2 million for at least three consecutive years); switching and terminal railroads are excluded from Class II status. Railroads considered by the Association of American Railroads as "Regional Railroads" are typically Class II.

Class III railroad: Also called a shortline railroad, which has an annual operating revenue of less than $20 million (1991 dollars); typically local shortline railroads serving a small number of towns and industries or hauling cars for one or more larger railroads.

Class-111 tank car: The Canadian term “Class 111” non-pressure tank car is the equivalent of the DOT-111 tank car; this type of tank car is also sometimes called the CTC-111A.

Classification bowl: A section of a rail classification yard that contains tracks in which the various cars are assembled into trains bound for various destinations

Clean product: Liquid products refined from crude oil, whose color is less than or equal to 2.5 on the National Petroleum Association scale, including naphtha, jet fuel, gasoline, and diesel/gas oil.

Closed-circuit television (CCTV): A TV system in which signals are not publicly distributed but are monitored, primarily for surveillance and security purposes.

Code of Federal Regulations (CFR): An annual codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the Federal Government.

Columbia River Bar: A system of bars and shoals at the mouth of the Columbia River spanning the U.S. states of Oregon and Washington; the bar is about 3 miles wide and 6 miles; the bar is where the river's current dissipates into the Pacific Ocean, often as large standing waves; the waves are partially caused by the deposition of sediment as the river slows, as well as mixing with ocean waves; the waves, wind, and current are hazardous for vessels of all sizes.

Commodity Owner: The shipper, consignee or a beneficial owner.

Commodity: A marketable item; a generic term for vessel cargo.

Common Carrier Obligations: The obligation of railroads to transport all goods offered for transportation, including hazardous materials. This obligation is a common law doctrine, codified in the Interstate Commerce Act and recognized by the U.S. Supreme Court in the early 1900s. The Interstate Commerce Commission Termination Act of 1995 (ICCTA) maintains the common carrier obligations of railroads and requires railroads to "provide the transportation or service on reasonable request." This obligation ensures that railroads do not unreasonably discriminate between shippers. Thus, railroads may not refuse shipment on the basis of inconvenience or lack of profitability.

Computer Aided Dispatch (CAD): A method of dispatching taxicabs, couriers, field service technicians, mass transit vehicles or emergency services assisted by computer

Consignee: The company receiving the shipment at the destination.

Corrosivity: The degree to which an oil will corrode pipelines, tanks, or tank cars.

Crude: Crude oil.

Deadweight tonnage (DWT): The carrying capacity of a vessel in tons; the difference between the light and loaded displacement (weight of the ship itself vs. ship plus cargo, fuel, stores and water).

Deep draft ship: A ship with a draft of over 40 feet (a very deep draft ship has a laden draft of 45 feet or more).

Density: Mass or weight per unit volume; e.g., one pound of lead is much more dense than one pound of feathers.

Department of Homeland Security (DHS): Charged with the primary responsibilities of protecting the United States and its territories (including protectorates) from and responding to terrorist attacks, man-made accidents, and natural disasters.

Department of the Interior (DOI): Protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

Determination of Non-Significance (DNS): Documents the responsible official's decision that a proposal is not likely to have significant adverse environmental impacts.

Dilbit: Another name for certain types of diluted bitumen.

Diluent: A diluting or thinning agent.

Diluted bitumen: A petroleum product produced by mixing bitumen (a highly viscous or solid asphaltic material) with light petroleum compounds (e.g., gas condensate or gas range oil), which are the diluent; typically, the ratio of bitumen to diluent is 70:30 or 30% diluent; there is a heavier form of diluted bitumen called "railbit", which has only 15% diluent in the mixture.

Dirty product: Synonymous with fuel oil or residual fuel.

Dispersant: A chemical substance used to enhance the breakup of oil into tiny droplets to allow for natural biodegradation and metabolism by microorganisms.

Dispersion: The breakup of oil into tiny droplets and subsequent spreading.

Dissolution: Dissolving

Distributive Power Units (DPU): Locomotives that operate in the middle and/or end of trains rather than only having all locomotives at the front end.

DOT-111 tank car: The general characteristics of a DOT-111 tank car under existing regulations are as follows: DOT-111 cars are roughly 60 feet long, 11 feet wide and 16 feet high; the cars weigh approximately 80,000 pounds empty and 286,000 pounds when full; the cars can hold about 30,000 gallons or 715 barrels of oil depending on oil density; the tank is made of steel plate with a thickness of 7/16 of an inch; and the tank has a life span of approximately 50 years, with a 30 – 40 year economic lifespan.

Draft [ship]: A measure of the depth to which a ship sits below the water surface; the vertical distance between a ship's waterline and the bottom of the hull (keel)

Dragging equipment detector (DED): A device that detects dragging equipment on a railroad, which can damage the track and grade crossings.

Eastern Daylight Time (EDT): The Eastern Time Zone of the United States of America and Canada.

Eastward direction (EWD): Situated or directed towards the east.

Ecology (ECY): Washington State Department of Ecology.

EIA: Environmental impact assessment or US Energy Information Administration

Emergency Management Division (EMD): Minimize the impact of emergencies and disasters on the people, property, environment, and economy.

Emergency Response Assistance Plan (ERAP): A plan that describes what is to be done in the event of a transportation accident involving certain higher risk dangerous goods. The ERAP is required by the Transportation of Dangerous Goods Regulations (TDGR) for dangerous goods that require special expertise and response equipment to respond to an incident. The plan is intended to assist local emergency responders by providing them with technical experts and specially trained and equipped emergency response personnel at the scene of an incident.

Emission Control Area (ECA): Sea areas in which stricter controls were established to minimize airborne emissions (SOx, NOx, ODS, VOC) from ships as defined by Annex VI of the 1997 MARPOL Protocol which came into effect in May 2005.

Emulsion: Small droplets of oil suspended in water with a resultant frothy "mousse" appearance.

Energy Facility Site Evaluation Council (EFSEC): Provides a "one-stop" siting process for major energy facilities in the State of Washington. EFSEC coordinates all evaluation and licensing steps for siting certain energy facilities in Washington. EFSEC specifies the conditions of construction and operation. If approved, a Site Certification Agreement is issued in lieu of any other individual state or local agency permits. EFSEC also manages an environmental and safety oversight program of facility and site operations.

Entrainment: The process of oil going into the water column (below the water surface) due to winds or currents, including the process of oil going under a floating boom.

Environmental Impact Statement (EIS): Under U.S. environmental law, a document required by the National Environmental Policy Act (NEPA) for certain actions "significantly affecting the quality of the human environment"; an EIS is a tool for decision making. It describes the positive and negative environmental effects of a proposed action, and it usually also lists one or more alternative actions that may be chosen instead of the action described in the EIS.

Environmental Report Tracking System (ERTS): An agency-wide Department of Ecology database that serves three functions: (1) tracks what happens to reports of incidents; (2) stores data which can be used by programs to supplement other databases; and (3) provides the Spills program with a database which documents the follow-up to reports of spills and drug lab related incidents.

Environmentally Acceptable Lubes (EAL): Lubricants that are "biodegradable" and "minimally-toxic," and are "not bioaccumulative" as defined in Appendix A of the 2013 Vessel General Permit.

Escort tug: A tugboat that meets the following characteristics - the hull is designed to provide adequate hydrodynamic lift and drag forces when in indirect towing mode (due attention shall be paid to the balance between hydrodynamic forces, towline pull and propulsion forces); the towing winch has a load reducing system in order to prevent overload caused by dynamic oscillation in the towing line; the propulsors are able to provide ample thrust for maneuvering at higher speeds for tug being in any oblique angular position; the vessel is designed such that forces are in equilibrium with a minimum use of propulsive force except for providing forward thrust and balancing transverse forces during escorting service; and in case of loss of propulsion, the remaining forces are balanced so that the resulting turning moment will turn [yaw] the escort tug to a safer position with reduced heel.

Exceptional Compliance Program (ECOPRO): This program decreases risk through engineering and management guidelines that exceed regulatory requirements for tank ships and tank barges.

Exclusive Economic Zone (EEZ): A sea zone prescribed by the United Nations Convention on the Law of the Sea over which a state has special rights regarding the exploration and use of marine resources, including energy production from water and wind; it stretches from the baseline out to 200 nautical miles from its coast. In colloquial usage, the term may include the continental shelf.

Facility response plan (FRP): A document that demonstrates a facility's preparedness to respond to a worst case oil discharge; under the Clean Water Act, as amended by the Oil Pollution Act of 1990 (OPA90), certain facilities that store and use oil are required to prepare and submit these plans.

Fecundity: Reproductive capacity.

Federal Emergency Management Agency (FEMA): An agency of the United States Department of Homeland Security, with the primary purpose to coordinate the response to a disaster that has occurred in the United States and that overwhelms the resources of local and state authorities. The governor of the state in which the disaster occurs must declare a state of emergency and formally request from the president that FEMA and the federal government respond to the disaster.

Federal Energy Regulatory Commission (FERC): The United States federal agency with jurisdiction over interstate electricity sales, wholesale electric rates, hydroelectric licensing, natural gas pricing, and oil pipeline.

Federal Railroad Administration (FRA): An agency within the US Department of Transportation that has jurisdiction over railroad safety at the federal level.

Federal Railroad Safety Act (FRSA): A Congressional act of 1970 that promotes the safety in all areas of railroad operations to reduce railroad-related accidents, and to reduce deaths and injuries to persons, and to reduce damage to property caused by accidents involving any carrier of hazardous materials (49 U.S.C §20109).

First Responder: A general term for all trained emergency service personnel (as a firefighter, police officer, paramedic, etc.) who are expected to respond to emergencies or large-scale disasters.

First-class city: A city with 10,000 or more population.

Fish barrier: Screens installed to protect endangered species of fishes that would otherwise be harmed or killed when passing through industrial facilities such as steam electric power plants, hydroelectric generators, petroleum refineries, chemical plants, farm irrigation water and municipal drinking water treatment plants.

Flash point: The lowest temperature at which it can vaporize to form an ignitable mixture in air; Measuring a flash point requires an ignition source; at the flash point, the vapor may cease to burn when the source of ignition is removed; the flash point is not to be confused with the autoignition temperature, which does not require an ignition source, or the fire point, the temperature at which the vapor continues to burn after being ignited; neither the flash point nor the fire point is dependent on the temperature of the ignition source, which is much higher.

FRA Class 1 Track: Track classified by FRA with respect to maximum speed for track condition as 10 mph for freight, 15 mph for passenger. Much yard, branch line, short line, and industrial spur trackage falls into category.

FRA Class 2 Track: Track classified by FRA with respect to maximum speed for track condition as 25 mph for freight, 30 mph for passenger; Branch lines, secondary main lines, many regional railroads, and some tourist operations frequently fall into this class.

FRA Class 3 Track: Track classified by FRA with respect to maximum speed for track condition as 40 mph for freight, 60 mph for passenger. This commonly includes regional railroads and Class 1 secondary main lines.

FRA Class 4 Track: Track classified by FRA with respect to maximum speed for track condition as 60 mph for freight, 80 mph for passenger. This is the dominant class for main-line track used in passenger and long-haul freight service.

FRA Class 5 Track: Track classified by FRA with respect to maximum speed for track condition as 80 mph for freight, 90 mph for passenger. This is the standard for most high-speed track in the U.S.

FRA Class 6 Track: Track classified by FRA with respect to maximum speed for track condition as 110 mph for freight, 110 mph for passenger. This is found in the U.S. exclusively on Amtrak's Northeast Corridor between New York and Washington, DC.

Full-time equivalent (FTE): A unit that indicates the workload of an employed person; an FTE of 1.0 means that the person is equivalent to a full-time worker, while an FTE of 0.5 signals that the worker is only half-time; two half-time workers will equal 1.0 FTE.

Gallons per minute (gpm): A unit of volumetric flow rate.

Gateway Pacific Terminal (GPT): Will be a multi-commodity, dry bulk cargo-handling facility on nearly 1,500 acres in Whatcom County, WA, with development occurring on about one-quarter of the site. The shipping, stevedoring, and warehousing facility – to be the largest on the West Coast of the U.S. – is the latest innovation of SSA Marine, a Northwest company that is a global leader in maritime services.

General Code of Operating Rules (GCOR): A set of operating rules intended to enhance railroad safety for railroads in the United States. The GCOR is used by Class I railroads west of the Mississippi River, most of the Class II railroads, and many Short-line railroads.

Geographic Response Plan (GRP): A geographic-specific response plan for oil spills to water that includes response strategies tailored to a specific beach, shore, or waterway and meant to minimize impact on sensitive resources threatened by the spill. GRPs are an important part of Washington State's oil spill programs. Each GRP has two main priorities: to identify natural, cultural and economic resources near vessel traffic routes, pipeline and rail corridors, highways, facilities or other potential pathways of spills to water; and to describe and prioritize response strategies in an effort to minimize injury from oil spills.

Gross Registered Tonnage (GRT): The internal cubic capacity of the ship expressed in tons on the basis of 100 cubic feet per ton; this differs from DWT because it measures the area versus the weight.

Group I oils: See “volatile distillates”

Group II oils: See “light oils”

Group III oils: See “medium oils

Group IV oils: See heavy oils”

Group V oils: Oils that have a specific gravity over 1.0 [API° ≤ 10.0] and are thus heavier than fresh water; see “LAPIO”

GWU: George Washington University, located in Washington, D.C.

Harbor Safety Committee: A proactive forum for identifying, assessing, planning, communicating, and implementing those operational and environmental measures, beyond that which is in laws or regulations, that promote safe, secure, and efficient use of relevant waterways, harbors, or ports. The committee is generally made up of delegates appointed by broadly based organizations representing a span of interests with various governmental agencies formally supporting its work in advisory capacities.

Heavy oils: Crude oil and petroleum products that are persistent, though less toxic. This group includes heavy fuel oil, Bunker C, No. 5 or No. 6 fuel, most intermediate fuel oils, and heavy crude oils. This category would also include bitumen blends; in the U.S., these oils are classified as Group IV, having a specific gravity between 0.95 to and including 1.0 [API° ≤17.5 and >10.0]. In general, these heavy oils exhibit the following behavior: heavy oils with little or no evaporation or dissolution; heavy contamination likely; severe impacts to waterfowl and fur-bearing mammals through coating and ingestion; long-term contamination of sediments possible; weather slowly; and shoreline and substrate cleanup is difficult under all conditions.

High Level Radioactive Waste (HLRW): Waste generated in core fuel of a nuclear reactor, found at nuclear reactors or by nuclear fuel reprocessing.

High Threat Urban Areas (HTUA): An area comprising one or more cities and surrounding areas including a 10-mile buffer zone.

High Volume Port Area (HVPA): Means the following areas, including any water area within 50 nautical miles seaward of the entrance(s) to the specified port: (1) Boston, MA, (2) New York, NY, (3) Delaware Bay and River to Philadelphia, PA, (4) St. Croix, VI, (5) Pascagoula, MS, and (6) Mississippi River from Southwest Pass, LA to Baton Rouge, LA.

High/Wide/Shifted Load Detector (SLD): A device that detects significant shifts in cargo that may cause instability in a train.

Hot box and dragging equipment detector: The most commonly used types of wayside detector; a hot box detector is a heat-sensitive device used to measure the temperature of journal bearings on passing rail cars; a dragging equipment detector detects loose components and dragging under freight cars.

Hump yard: A rail yard in which the vehicles run down an artificial hill (“hump”) into a classification bowl, i.e., an area in which the various cars are assembled into trains bound for various destinations.

Incident Command Post (ICP): The field location at which the primary tactical-level, on-scene incident command functions are performed.

Innocent passage: A concept in law of the sea, which allows for a vessel to pass through the territorial waters of another state subject to certain restrictions. The UN Convention on the Law of the Sea defines innocent passage as: passage is innocent so long as it is not prejudicial to the peace, good order or security of the coastal State; such passage shall take place in conformity with this Convention and with other rules of international law.

Interfacial tension: A measure of the surface forces that exist between the interfaces of the oil and water and the oil and air; interfacial tension affects the rate and type of spreading on the water surface as well as sheen

International Maritime Organization (IMO): The United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships.

International Regulations for Preventing Collisions at Sea (COLREGS): Published by the International Maritime Organization (IMO) and set out, among other things, the "rules of the road" or navigation rules to be followed by ships and other vessels at sea to prevent collisions between two or more vessels. COLREGs can also refer to the specific political line that divides inland waterways, which are subject to their own navigation rules, and coastal waterways, which are subject to international navigation rules.

Interstate Commerce Commission Termination Act of 1995 (ICCTA): An act of Congress that maintains the common carrier obligations of railroads and requires railroads to “provide the transportation or service on reasonable request.” (49 USC. § 11101(a)) This obligation ensures that railroads do not unreasonably discriminate between shippers. Thus, railroads may not refuse shipment on the basis of inconvenience or lack of profitability.

Island Tug and Barge (ITB): The West Coast’s largest bulk transporter of refined petroleum products. Services include bulk fuel transportation, specialty towing, marine fuel sales and marketing, and marine logistics.

Joint Legislative Audit and Review Committee (JLARC): The Joint Legislative Audit and Review Committee (JLARC) works to make state government operations more effective, efficient, and accountable. The Committee is comprised of an equal number of House and Senate members, Democrats and Republicans. JLARC pursues its mission by conducting performance audits, program evaluations, sunset reviews, and other analyses. Assignments to conduct studies are made by the Legislature and the Committee itself. Based on these assignments, JLARC’s non-partisan staff auditors, under the direction of the Legislative Auditor, independently seek answers to audit questions and issue recommendations to improve performance. Work by JLARC staff is conducted using Generally Accepted Government Auditing Standards. These standards ensure audit conclusions are independent, objective, and accurate. JLARC’s authority is established in Chapter 44.28 Revised Code of Washington.

Jones Act: The Merchant Marine Act of 1920 (also known as the Jones Act) is a US Federal statute that provides for the promotion and maintenance of the American merchant marine. Among other requirements, it stipulates that goods transported between US ports be carried on US-flag ships, constructed in the US, owned by US citizens, and crewed by US citizens and permanent residents. This affects all oil transportation in tank vessels between US ports.

Key train: Any train with 20 carloads or intermodal portable tank loads of any combination of hazardous materials.

King Street Station (KSS): A train station located in Seattle, Washington.

Ladder track: Sometimes called the "lead track", is a track off which switches to yard tracks that are normally parallel to each other are contained, The switches provide access to the yard tracks from the ladder or lead track. Train/car movements arrive or depart from yard tracks by utilizing the ladder track to access the specific switch that allows movements to/from a particular yard track. The ladder or lead track is also often used as the "switching lead" when cars are pulled from a yard track and separated to other yard tracks for the purpose of combining cars with similar destinations together on one track.

LAPIOs: "Low °API Oils", oils that have specific gravities over 1.0 [°API ≤ 10.0]; In the U.S. these oils are classified as Group V; these oils are unique in that they can sink or remain submerged in the water column when spilled without needing aggregation with any sediment to otherwise increase their mass.

Large Diameter Hose (LDH): A hose for firefighting

Lateral to Vertical (L/V): L = Actual lateral load applied (pounds); V = Actual vertical load (applied (pounds).

LC_{50}: The concentration of a contaminant at which 50% of a particular species will experience mortality; the lower the LC_{50} of a species, the more sensitive the species; the higher the LC_{50} of a compound, the lower its toxicity, because it takes a higher concentration of the contaminant to cause mortality.

Light oils: Crude oils and refined petroleum products that are quite toxic but also contain some persistent components. These oils do not evaporate as readily as volatile distillates. The category includes: No. 2 fuel, diesel fuel, light crude oil, gas oil, hydraulic oil, and catalytic feedstock. In the U.S., this category is called "Group II Oil", including crude oil and products that have a specific gravity less than 0.85 [API° >35.0]. In general, light fuels are: moderately toxic; will leave a residue of up to one-third of the spill amount after a few days; contain moderate concentrations of toxic soluble compounds; capable of oiling surface and subsurface resources with long-term contamination potential; and generally possible to clean up with effective response tools.

Local Emergency Planning Committee (LEPC): Under the Emergency Planning and Community Right-to-Know Act (EPCRA), Local Emergency Planning Committees (LEPCs) must develop an emergency response plan, review the plan at least annually, and provide information about chemicals in the community to citizens; plans are developed by LEPCs with stakeholder participation. the LEPC membership must include (at a minimum): elected state and local officials; police, fire, civil defense, and public health professionals; environment, transportation, and hospital officials; facility representatives; and representatives from community groups and the media.

Loop Track: A continuous track within a facility normally of sufficient length to allow a unit train to remain intact while loading or unloading a commodity. An example of loop tracks that allow unit train unloading while the train remains intact is the EGT export grain facility at Port of Longview. Many of the origin locations for unit grain and coal trains feature loop tracks that allow loading of a train without breaking it apart. If a loop track is not available at a loading or unloading facility, cars are spotted in smaller numbers then reassembled after the loading or unloading activity is completed to create the unit train.

Lower explosive limit (LEL): The lowest concentration (percentage) of a gas or a vapor in air capable of producing a flash of fire in presence of an ignition source (arc, flame, heat).

Low-sulfur fuel oil (LSFO): Diesel fuel with substantially lowered sulfur content.

Mainline: A track that is used for through trains or is the principal artery of the system from which branch lines, yards, sidings, and spurs are connected. It generally refers to a route between towns, as opposed to a route providing suburban or metro services.

Manifest train: A freight train contains cars with various types of cargo. They may include rail tank cars that carry chemicals, refined oil products, and even crude oil. In some cases, manifest trains contain a "block" of as many as 20 crude oil tank cars.

Manual on Uniform Track Control Devices (MUTCD): Defines the standards used by road managers nationwide to install and maintain traffic control devices on all public streets, highways, bikeways, and private roads open to public traffic.

Marine: In this report, "marine" refers to commerce on the sea (e.g., tankers carrying oil).

Maritime Fire and Safety Association (MFSA): The leading provider and advocate of safe, environmentally responsible, and cost effective response services to commercial vessels in the Columbia Willamette River Marine Transportation System.

MARPOL: IMO Convention for Prevention of Marine Pollution

Mechanical injury: An injury caused by coating, fowling or clogging of organisms and their appendages and apertures, such that movements and behaviors are mechanically inhibited; e.g., oiled birds suffer from mechanical injury.

Medium oils: Crude oils and refined petroleum products that are moderately toxic and moderately persistent, such as most crude oils, and lube oil. This category would also include synthetic crudes; in the U.S., these oils are considered "Group III Oils", having a specific gravity between 0.85 and less than 0.95 [API° ≤35.0 and >17.5]. In general, these medium oils exhibit the following behavior: about one-third will evaporate within 24 hours; oil contamination of can be severe and long-term; oil impacts to waterfowl and fur-bearing mammals can be severe; and cleanup is most effective if conducted quickly.

Mitigated Determination of Non-Significance (MDNS): A mitigated determination of non-significance is issued under WAC 197-11-350(2) or 350(3), or a DNS issued after a determination of significance is withdrawn [WAC 197-11-360(4)]

Montana Rail Link (MRL): A privately held Class II railroad in the United States.

National Contingency Plan (NCP): As found in 40 CFR Part 300 is the Federal government's strategy for responding to both oil spills and hazardous substance releases.

National Environmental Policy Act (NEPA): A United States environmental law that established a U.S. national policy promoting the enhancement of the environment. The law was enacted on January 1, 1970.

National Incident Management System (NIMS): A systematic, proactive approach to guide departments and agencies at all levels of government, nongovernmental organizations, and the private sector to work together seamlessly and manage incidents involving all threats and hazards—regardless of cause, size, location, or complexity—in order to reduce loss of life, property and harm to the environment.

National Oceanic and Atmospheric Administration (NOAA): A scientific agency within the U.S. Department of Commerce focused on the conditions of the oceans and atmosphere. NOAA warns of dangerous weather, charts seas and skies, guides the use and protection of ocean and coastal resources, and conducts research to improve understanding and stewardship of the environment.

National Response Center (NRC): The sole federal point of contact for reporting all hazardous substances releases and oil spills.

National Transportation Safety Board (NTSB): An independent federal agency that makes recommendations towards preventing future accidents based on its findings, but does not have any regulatory authority. Unlike the FRA, the NTSB is not required to factor costs, input from stakeholders or impacts on industry when making recommendations or issuing safety advisories.

New York State Department of Environmental Conservation (NYDEC or NYSDEC): New York State's environmental protection and regulatory agency.

Nippon Yusen Kaisha (NYK): A leading shipping company. It is the largest marine transporter in Japan.

Nonene: An alkene with the molecular formula C_9H_{18}. industrially, the most important nonenes are trimers of propene, which are used in the alkylation of phenol to produce nonylphenol, a precursor to detergents.

Non-persistent oil: Volatile oils that evaporate relatively rapidly, such as jet fuel, kerosene, and gasoline.

Non-tank vessel: A ship that does not carry oil as cargo, such as a container ship or a bulk carrier.

Nonylphenol ethoxylates (NPE): Widely used members of the larger alkylphenol and alkylphenol ethoxylate family of non-ionic surfactants. They are produced in large volumes, with uses that lead to widespread release to the aquatic environment.

Normalized impact risk score: A normalized score is derived by taking the lowest score and making that equal to 1.0, then comparing the other scores to that.

Northern Corridor: Sometimes called the “Great Northern Corridor”, are the railroad lines that span the northern US between the Pacific Northwest and Chicago, as well as reaching key southern points in Canada.

Northward direction (NWD): Situated or directed towards the north.

Northwest Area Contingency Plan (NWACP): A planning tool that provides for rapid, aggressive, and well-coordinated responses to reports of oil or hazardous substance spills.

Notice of Proposed Rulemaking (NPRM): A public notice issued by law when one of the independent agencies of the United States government wishes to add, remove, or change a rule or regulation as part of the rulemaking process. It is an important part of United States administrative law, which facilitates government by typically creating a process of taking of public comment.

Novacool: Fire suppression foam that is a mixture of anionic, nonionic and amphoteric surfactants; it is biodegradable and does not contain any nonylphenolethoxylates (NPE’s), flourosurfactants, or glycol ethers.

Oil Pollution Act of 1990 (OPA90): An act of Congress designed to mitigate and prevent civil liability from oil spills off the coast of the U.S., including provisions for spill contingency plans, liability limits and specifications for responsible parties, spill prevention measures (e.g., double hulls on tankers), and other measures.

Oil pour point: The lowest temperature at which the oil will still flow. Below this temperature, the oil begins to develop an internal yield stress and, in essence, solidifies. If the ambient temperature is above the pour point of the oil, it will behave as a liquid. If the ambient temperature is below the pour point, the oil will behave as a semi-solid.

Oil sands oil: Also called “tar sands oil”; oil extracted from bituminous (tar) sands.

Oil Spill Liability Trust Fund (OSLTF or Fund): A billion-dollar fund established as a funding source to pay removal costs and damages resulting from oil spills or substantial threats of oil spills to navigable waters of the U.S; the OSLTF is used for costs not directly paid by the polluter, referred to as the responsible party (RP).

Oil spill response plan (OSRP): Washington Administration Code (WAC) Chapter 173-182 requires larger oil handling facilities, pipelines and commercial vessels to have state approved oil spill contingency plans that describe their ability to respond to oil spills. A contingency plan is like a “game plan,” that outlines what is necessary to ensure a rapid, aggressive and well coordinated response to an oil spill. Critical elements of these plans include: notification and call out procedures to ensure response teams and resources are activated immediately; identification of spill management teams necessary to manage a spill or incident response; analysis of the planning standards and worst case spill volume to assess the necessary response needs; appropriate response equipment and personnel to respond to a worst case spill; identification of oil types and properties; contracts with primary response contractors to provide response equipment and personnel necessary to respond; and commitment for drills to test the plan.

Oil-mineral aggregate (OMA): A combination of oil mixed with sediment particles (e.g., sand in the surf zone of a beach); OMA may become heavier than water to cause sinking.

Olympic Tug and Barge (OTB): Based in Seattle, WA, it provides marine transportation of cargo and freight.

Orient Overseas Container Line (OOCL): A Hong Kong-based container shipping and logistics service company. It is one of the world's largest integrated international container transportation, logistics, and terminal companies.

Outer Continental Shelf (OCS): Is a peculiarity of the political geography of the U.S.; the OCS is the part of the internationally recognized continental shelf of the United States that does not fall under the jurisdictions of the individual states; the OCS is governed by Title 43, Chapter 29 "Submerged Lands", Subchapter III "Outer Continental Shelf Lands", of the U.S. Code; the term "Outer Continental Shelf" refers to all submerged lands, its subsoil, and seabed that belong to the U.S. and are lying seaward and outside of the states' jurisdiction, the latter defined as the "lands beneath navigable waters" in Title 43, Chapter 29, Subchapter I, Section 1301.

Packing Group (PG): The classification of cargoes with respect to flammability and other hazards

Packing Group I: The highest level of packing group (i.e., the most dangerous cargo); includes toxic substances and preparations presenting a very severe risk for flammability, with an initial boiling point of less than 95°F.

Packing Group II: Substances with a flash point of less than 73.4°F, and an initial boiling point of more than 95°F.

Packing Group III: Substances with a flash point of between 73.4°F and 141.8°F, and an initial boiling point of more than 95°F.

Panamax tanker: A tank vessel with a length of 750 feet, a draft of 41 feet, and a deadweight tonnage (DWT) of 60,000 to 80,000; the size limits are based on ships traveling through the Panama Canal.

Persistence: The degree to which heavier components of an oil linger in the environment before biodegrading.

Persistent oil: An oil for which at least some components tend to remain in the environment for an extended period of time after initial evaporation.

Petroleum Administration Defense Districts (PADD): The U.S. is divided into five Petroleum Administration for Defense Districts, or PADDs, as created during World War II under the Petroleum Administration for War to help organize the allocation of fuels derived from petroleum products, including gasoline and diesel (or "distillate") fuel; today, these regions are still used for data collection purposes; PADD 5 includes: Alaska, Arizona, California, Hawaii, Nevada, Oregon, and Washington.

Pierce County Terminal (PCT): A water transportation terminal on the Blair Waterway in Pierce County, WA.

Pipeline and Hazardous Material Safety Administration (PHMSA): An agency within the US Department of Transportation that is responsible for establishing and enforcing requirements for the safe transport of hazardous materials by all modes of transportation, including the design of railroad tank cars carrying crude oil. PHMSA was created in 2004 with the purpose of providing US Department of Transportation a more focused research organization and establishing an operating administration for the inspection and enforcement of requirements for pipeline safety and hazardous materials transportation.

Polluter pays principle: Principle 16 of the International Rio Declaration on Environment and Development, which is reflected in the national laws of each Participant that require that the polluter or responsible party is, generally, responsible for the costs associated with pollution.

Polycyclic aromatic hydrocarbon (PAH): Also called “polynuclear aromatic hydrocarbons” (naphthalenes, phenanthrenes, fluorenes, dibenzothiophenes).

Positive train control (PTC): An advanced automatic train protection system that enforces movement authorities, speed restrictions (signal and civil), and protection of roadway workers.

Powder River Basin (PRB): A geologic structural basin in southeast Montana and northeast Wyoming, about 120 miles east to west and 200 miles north to south, known for its coal deposits.

Pre-treated Bakken crude: Bakken crude oil that has been partially refined to remove the most volatile portions.

Private grade crossing (private crossing): Crossing between railroad tracks and privately owned roadways, such as on a farm or industrial area, and is intended for use by the owner or by the owner's licensees and invitees. A private crossing is not intended for public use and is not maintained by a public highway authority.

Protection and Indemnity (P&I): Liability insurance for practically all maritime liability risks associated with the operation of a vessel, other than that covered under a workers compensation policy and under the collision clause in a hull policy.

Public grade crossings: Crossings between railroads and roadways that are under the jurisdiction of, and maintained by, a public authority.

Puget Sound Refinery (PSR): A major receiving point for Alaskan North Slope and Canadian Crude Oil.

Puget Sound Vessel Traffic Service (PSVTS): Provides active monitoring and navigational advice for vessels in particularly confined and busy waterways.

Rail Accident Mitigation Project (RAMP): Federal officials conduct more hazardous material safety inspections and facilitate safety training seminars with shippers, consignees, contractors, and subcontractors.

Rail capacity: The maximum traffic flow a piece of infrastructure (in this case, railroad lines) can handle under specified operating conditions.

Rail crossing: An intersection of two railroad tracks or a railroad track and a highway or road.

Rail Safety Improvement Act (RSIA): In response to several fatal rail accidents between 2002 and 2008, Congress passed the Rail Safety Improvement Act of 2008, the first authorization of FRA safety programs since 1994. RSIA directs the FRA to, among other things, promulgate new safety regulations. These new regulations govern different areas related to railroad safety, such as hours of service requirements for railroad workers, positive train control implementation, standards for track inspections, certification of locomotive conductors, and safety at highway-rail grade crossings.

Rail Transportation and Engineering Center (RailTEC): Building on its leading academic and research programs in rail engineering and transport, the University of Illinois has established RailTEC which is committed to further growth and development of its teaching and research activities in support of the nation's need for talented young minds and new technologies in the rail industry.

RailBAM™: Railway bearing detector

Railroad Safety Advisory Committee (RSAC): Develops new regulatory standards, through a collaborative process, with all segments of the rail community working together to fashion mutually satisfactory solutions on safety regulatory issues.

RailTEC: Rail Transportation and Engineering Center

Railway bearing detector (RailBAM™): A type of wayside detector that detects faulty wheel bearings as trains pass by.

Refined petroleum product: A material derived from crude oil (petroleum) as it is processed in oil refineries, such as fuel oils.

Refinery throughput capacity (or refinery capacity): The maximum amount of crude oil designed to flow into the distillation units, in other words, this is the amount of crude oil that a refinery can process on a daily basis; actual throughput may be less than this and may vary from day to day.

Regional Response Team (RRT): The entities that work together to protect public health and safety and the environment by ensuring coordinated, efficient, and effective support of the federal, state, tribal, local, and international responses to significant oil and hazardous substance incidents within the Pacific Northwest Region as mandated by the National Contingency Plan (NCP).

Research and Special Programs Administration (RSPA): This subagency of the Department of Transportation focused on improving hazardous materials and pipeline safety; coordinates and advances transportation research, technology and education activities to promote innovative transportation solutions; and manages the Department's transportation-related emergency response and recovery responsibilities. RSPA was abolished by act of Nov. 30, 2004 (118 Stat. 2424-2426) and certain duties and powers were transferred to both the Pipeline Hazardous Materials Safety Administration and the Administrator of the Research and Innovative Technology Administration, Department of Transportation.

Responsible party (RP): The entity that has the legal liability for an oil spill (the "spiller").

Revised Code of Washington (RCW): The compilation of all permanent laws now in force.

Riparian: Pertaining to a river bank

Risk mitigation: Reduction of risk by reducing the likelihood of an incident through prevention, or reducing the impacts of an incident by an effective response.

Risk: A term that encompasses both the likelihood, or probability, of an event occurring *and* the consequences or impacts of that event.

Roberts Bank Terminal 2 (RBT2): A proposed new three-berth container terminal at Roberts Bank in Delta, British Columbia, that would provide 2.4 million TEUs (twenty-foot equivalent unit containers) of container capacity.

Ro-ro: "Roll-on/roll-off" vessels that are designed to carry wheeled cargo, such as automobiles, trucks, and railroad cars that are driven onto the vessel using their own wheels or using a platform vehicle to tow the vehicles. The vessels have built-in ramps to allow the cargo to be rolled on and rolled off.

Salish Sea: The intricate network of coastal waterways located between the southwestern tip of the Canadian province of British Columbia and the northwestern tip of the U.S. state of Washington. Its major bodies of water are the Strait of Georgia, the Strait of Juan de Fuca, and Puget Sound. The Salish Sea reaches from Desolation Sound at the north end of the Strait of Georgia to Oakland Bay at the head of Hammersley Inlet at the south end of Puget Sound. The inland waterways of the Salish Sea are partially separated from the open Pacific Ocean by Vancouver Island and the Olympic Peninsula, and are thus partially shielded from Pacific Ocean storms.

SCBA: Self-contained breathing apparatus

Seattle International Gateway (SIG): A rail yard located next to Pier 28 in Seattle, WA.

Seismic: pertaining to earthquakes

Self-contained Breathing Apparatus (SCBA): A device worn by rescue workers, firefighters, and others to provide breathable air in an "Immediately Dangerous to Life or Health" atmosphere.

Shale: A fine-grained, clastic sedimentary rock composed of mud that is a mix of flakes of clay minerals and tiny fragments (silt-sized particles) of other minerals, especially quartz and calcite.

Shale oil: An unconventional oil produced from oil shale rock fragments by pyrolysis, hydrogenation, or thermal dissolution. These processes convert the organic matter within the rock (kerogen) into synthetic oil and gas.

Shale play: Geographic areas that have been targeted for oil and gas exploration and production due to favorable geoseismic survey results or other data.

Sheen: A very thin layer of oil on the water surface. Rainbow-colored sheens are generally 0.0003 mm thick. Silver sheens are usually about 0.0001 mm thick.

Shipper: The party that certifies and offers the hazardous material package for transportation.

Shoreline Hearings Board (SHB): The Shoreline Management Act (SMA), Chapter 90.58 RCW, provides for the management of development along the state shorelines. Local government has the primary responsibility for initiating the planning required by the SMA and administering the regulatory program consistent with the policy and provisions of the Act. The Department of Ecology acts primarily in a supportive and review capacity with an emphasis on providing assistance to local government and on insuring compliance with the policy and provisions of the SMA. Local government administers and issues shoreline substantial development, conditional use, and variance permits. Approvals by local government of shoreline conditional use and variance permits must be reviewed by the Ecology, which then issues the final decision. Local government and Ecology can also issue fines under the SMA. The Shorelines Hearings Board hears appeals from these permit decisions, and from those shoreline penalties jointly issued by local government and Ecology, or issued by Ecology alone. The Board is not affiliated with any other unit of government.

Shoreline Management Act (SMA): Provides a statewide framework for managing, accessing, and protecting the Washington's significant shorelines including rivers, lakes, and coastal waters.

Siding: Another term for a loop track.

Single Track: A location, either on the mainline or within a facility that features only one track on which train operations can occur at any given time. For example, an unloading facility that features a loop track operation may only have one loop track for unloading. Consequently, only one train can be in the facility at any given time, unless the loop track has sufficient length to allow a train to be on either side of the unloading location at the same time. The second train can arrive short of the unloading location as the first train is completing its unloading. If the facility only features sufficient track length for one train to be on-site at any given time, following trains waiting to access the facility when the first train departs have to be staged on other tracks off the facility site, normally either in a yard or in mainline meet/pass sidings.

SMART: International Association of Sheet Metal, Air, Rail, and Transportation Workers

Sole-source aquifer: An aquifer that supplies at least 50% of the drinking water consumed in the area overlying the aquifer. These areas may have no alternative drinking water source(s) that could physically, legally and economically supply all those who depend on the aquifer for drinking water.

Sorbent: Material used in a spill response to soak up oil.

Southward direction (SWD): Situated or directed towards the south.

Specific gravity: A measure of density based on grams per cubic centimeter; fresh water has a specific gravity of 1.0.

Spent Nuclear Fuel (SNF): Irradiated fuel or targets containing uranium, plutonium, or thorium that is permanently withdrawn from a nuclear reactor or other neutron irradiation facility following irradiation, the constituent elements of which have not been separated by reprocessing.

Spill Prevention, Preparedness, and Response Program (Spills Program) (SPPR): Focuses on preventing oil spills to Washington’s waters and land, as well as planning for and delivering a rapid, aggressive, and well coordinated response to oil and hazardous substance spills wherever they occur. A program of the Washington State Department of Ecology.

Spokane, Portland, Seattle Railway (SP&S): Was a railroad incorporated in 1905. It was a joint venture by the Great Northern Railway and the Northern Pacific Railway to build a railroad along the north bank of the Columbia River. Remnants of the line are currently operated by BNSF Railway.

Spot prices: The current price at which a particular security can be bought or sold at a specified time and place. A security's spot price is regarded as the explicit value of the security at any given time in the marketplace. In contrast, a securities futures price is the expected value of the security, in relation to its current spot price and time frame in question.

State Emergency Response Commission (SERC): A commission appointed by the Governor that is responsible for implementing Emergency Planning and Community Right-to-Know Act (EPCRA) provisions within the state.

State Environmental Policy Act (SEPA): Provides a way to identify possible environmental impacts that may result from governmental decisions. These decisions may be related to issuing permits for private projects, constructing public facilities, or adopting regulations, policies, or plans. Information provided during the SEPA review process helps agency decision-makers, applicants, and the public understand how a proposal will affect the environment; this information can be used to change a proposal to reduce likely impacts, or to condition or deny a proposal when adverse environmental impacts are identified; it also gives agencies the ability to condition or deny a proposal due to identified likely significant adverse impacts; in Washington, the Act is implemented through the SEPA Rules, Chapter 197-11 WAC.

Supply chain: A system of organizations, people, activities, information, and resources involved in moving a product or service from supplier to customer; supply chain activities transform natural resources, raw materials, and components into a finished product that is delivered to the end customer.

Surface Transportation Board (STB): An agency created by the ICC Termination Act of 1995 as the successor agency to the Interstate Commerce Commission. STB has jurisdiction over railroad rate and service issues and rail restructuring, such as mergers, sales and the construction and abandonment of rail lines. STB is an independent adjudicatory and economic regulatory agency, but administratively a part of US Department of Transportation.

Sweet oil: Oil that has a low sulfur content

Synthetic crude: The output from a bitumen/extra heavy oil upgrader facility used in connection with oil sand production. It may also refer to shale oil, an output from an oil shale pyrolysis.

Tank Car Owner: The rail car owner, who often lease the cars to the shipper for use, is responsible for keeping the tank car in compliance with the Hazardous Materials Regulations (inspections/repairs, etc.).

Tank vessel: A generic category that includes tank ships (tankers), tank barges, and ATBs.

Tanker Exclusion Zone (TEZ): An area off Canada's West coast where a disabled tanker would likely drift ashore prior to the arrival of salvage tugs in unfavourable weather conditions. The purpose of the TEZ is to ensure marine tanker traffic travels far enough offshore that should the vessel become disabled, support vessels would have the ability to limit a spill. The ultimate purpose of the TEZ is to protect the windward shoreline and coastal waters from the potential risk of pollution.

Tar sands oil: See "oil sands oil"

Terminal 18 (T-18): At the Port of Seattle, nine steamship lines call on Terminal 18. Features include seven container cranes and an on-dock intermodal rail yard. The intermodal yard allows the Port and its customers to expedite shipping across the country via railroad.

Terminal 5 (T-5): At the Port of Seattle teems with activity: container ships arriving and departing, loading and unloading containers and double-stack railcars.

Ton-mile: A unit of measure the combines the tonnage of cargo or freight and the distance traveled; a single ton-mile is a ton of cargo being transported one mile.

Track Warning Device (TWD): A device that inspects passing trains for defects or monitors for unusual trackside conditions that could adversely affect the safe and efficient movement of trains.

Track Warrant Control (TWC): A verbal authorization system defined by the General Code of Operation Rules (GCOR), used to authorize trains to occupy Main Tracks.

Track Warrant: A written form for authorization of train movements used in areas that are non-signaled.

Trackage Agreement: One of a variety of agreements that allow carriers to operate on lines owned by other companies; where trackage rights do not exist the shipment continues to destination after transferring the material at an "Interchange Point". At this "Interchange Point" the responsibility shifts to the new line owner.

Traditional use area: Lands that have been used historically for tribal fishing, hunting, and cultural activities.

Traffic Separation Scheme (TSS): An area in the sea where navigation of ships is highly regulated. It is meant to create lanes in the water to ships in a specific lane are all going in (roughly) the same direction. A TSS is created in locations with dense shipping where ships can go in different directions and where there is a high risk of collisions.

Trans Mountain Expansion Project (TMEP): Trans Mountain is proposing an expansion of its current 1,150-kilometre pipeline between Strathcona County (near Edmonton), Alberta, and

Burnaby, British Columbia. The proposed expansion, if approved, would create a twinned pipeline that would increase the nominal capacity of the system from 300,000 barrels per day, to 890,000 barrels per day.

Transit: One movement (or trip) of a vessel through a waterway.

Transmix: A mixture of refined petroleum products that forms when transported in pipelines; the mixture is typically a combination of gasoline, diesel, and jet fuel, though heavier oils may also be included.

Transporter (carrier): The entity that by federal law is required to transport from origin to destination hazardous materials that meet the USDOT requirements and as certified by the "shipper"; carriers are responsible for materials that are in transport on their system, and usually operate on their own lines but often have trackage agreements in areas they don't own the lines.

Tribal ceded area: Area over which tribes by treaty relinquished control to the federal government in return for compensation in the form of livestock, merchandise, and annuities.

Truck bogie optical geometry inspection (TBOGI): A type of wayside detector that is a laser-based monitoring system to measure performance of a rail car's axle and wheel suspension (commonly known as the "truck").

Truck performance detector (TPD): A type of wayside detector that assesses the performance of rail car suspension systems or trucks on curved track by measuring the wheel's lateral forces at major segments of track containing four to six degrees of curvature.

TÜV Rail Sciences: TÜV Rheinland Mobility Rail Sciences Division

TÜV Rheinland Mobility Rail Sciences Division (TÜV Rail Sciences): Provides analytical consulting services to the rail industry.

Twenty-Foot Equivalent Unit (TEU): An inexact unit of cargo capacity often used to describe the capacity of container ships and container terminals; it is based on the volume of a 20-foot-long (6.1 m) intermodal container, a standard-sized metal box which can be easily transferred between different modes of transportation, such as ships, trains and trucks.

U&A: Usual and Accustomed (This is a Treaty term from the Stevens' Treaties used extensively in US v. Washington, referring to an area where a particular Tribe traditionally fished and over which the Tribe has a territorial use claim under the provisions of the Treaty . Treaty Tribes retained their right to take fish in their "usual and accustomed" areas.)

Ultra-large crude carrier (ULCC): The largest category of oil tanker with a DWT of 320,000 to 550,000 DWT.

Ultra-low sulfur diesel (ULSD): Diesel fuel with substantially lowered sulfur content.

Unified Command (UC): An authority structure in which the role of incident commander is shared by two or more individuals, each already having authority in a different responding agency: Unified Command is one way to carry out command in which responding agencies and/or jurisdictions with responsibility for the incident share incident management; Unified Command may be needed for incidents involving multiple jurisdictions or agencies.

Unit train: A train in which all cars carry the same commodity and are shipped from the same origin to the same destination, without being split up or stored en route (also called "block train").

United States Code (USC): A consolidation and codification by subject matter of the general and permanent laws of the United States.

United States Department of Transportation (USDOT): Oversees federal highway, air, railroad, and maritime and other transportation administration functions.

Universal Extinguishing Foam (UEF): A wetting agent with superior cooling properties that is effective on Class A, Class B, Class D as well as pressurized and 3 dimensional fires involving both hydro carbon based fuels and polar solvents such as alcohol and ethanol.

Urban Area Security Initiative (UASI): Enhances regional preparedness in major metropolitan areas throughout the United States.

US Energy Information Administration (EIA): A principal agency of the U.S. Federal Statistical System responsible for collecting, analyzing, and disseminating energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment; EIA programs cover data on coal, petroleum, natural gas, electric, renewable and nuclear energy; EIA is part of the U.S. Department of Energy.

Usual and Accustomed (U&A): A Tribal Treaty term from the 1854–1855 Stevens' Treaties used extensively in U.S. v. Washington, referring to an area where a particular Tribe traditionally fished and over which the Tribe has a territorial use claim under the provisions of the Treaty. Treaty Tribes retained their right to take fish in their "usual and accustomed" areas. These treaties are legally-binding contracts and are the supreme law of the land under the U.S. Constitution.

Utilities and Transportation Commission (UTC): Created in 1905 by the Washington State Legislature as a three-member Railroad Commission, with regulatory authority to inspect and evaluate railroad company accounts, set rates, approve time schedules, monitor safety issues and enforce violations. However, in 1970 and again in 1980, the U.S. Congress passed legislation preempting states in all areas pertaining to economic regulation of railroads and limited the scope of state jurisdiction in regards to safety.[189]

Very large crude carrier (VLCC): An oil tanker that is 1,080 feet in length, has a draft of 66 feet, and is 200,000 to 315,000 DWT.

Vessel response plan (VRP): A document that demonstrates a vessel's preparedness to respond to a worst case oil discharge.

Vessel traffic service (VTS): A marine traffic monitoring system established by harbor or port authorities, similar to air traffic control for aircraft. Typical VTS systems use radar, closed-circuit television (CCTV), VHF radiotelephony and automatic identification system to keep track of vessel movements and provide navigational safety in a limited geographical area.

Virgin gas oil (VGO): A very light petroleum product, also called straight run, gas oil, cutter stock, light coker gas oil.

Viscosity: A measure of the resistance of oil to flowing once in motion; liquids that flow very slowly, such as peanut butter or molasses have high viscosities.

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[189] The Federal Railroad Safety and Hazardous Materials Transportation Control Act of 1970, the Interstate Commerce Commission Termination Act (ICCTA) and the Staggers Rail Act of 1980.

Volatile distillates: Refined petroleum products that are highly toxic but evaporate relatively rapidly, such as gasoline, jet fuel, kerosene, crude condensate, and No. 1 fuel oil. In the U.S., this category is called "Group I Oil" that consists of hydrocarbon fractions at least 50% of which, by volume, distill at a temperature of 645ºF; and at least 95% of which, by volume, distill at a temperature of 700ºF. In general, volatile distillates exhibit the following behavior: highly volatile (evaporate completely within one to two days); contain high concentrations of toxic soluble compounds; capable of causing localized, severe impacts to surface and subsurface resources, and contaminating drinking water; and generally, because they evaporate so quickly, they are nearly impossible to clean up with conventional response tools.

Volatile organic compound (VOC): An organic chemical that has a high vapor pressure at ordinary room temperature; its high vapor pressure results from a low boiling point, which causes large numbers of molecules to evaporate or sublimate from the liquid or solid form of the compound and enter the surrounding air.

Volatilization: The process of turning from a liquid into a gas.

Voluntary Best Achievable Protection (VBAP): A unique non-regulatory environmental protection program managed by the Washington State Department of Ecology for tank vessels to protect Washington's irreplaceable natural resources from the damage caused by an oil spill.

VTRA 2010: The study "van Dorp, J.R., and J. Merrick. 2014. *2014 VTRA 2010 Final Report: Preventing Oil Spills from Large Ships and Barges in Northern Puget Sound & Strait of Juan de Fuca.* Prepared for Washington State Puget Sound Partnership. 163 p."

Washington Administrative Code (WAC): Codifies the regulations, a source of primary law, and arranges them by subject or agency.

Washington Operation Lifesaver (WAOL): A free public service education program dedicated to preventing and reducing fatalities and injuries at highway-railroad grade crossings and along railroad rights-of-way.

Washington Department of Fish and Wildlife (WDFW): A governmental agency dedicated to preserving, protecting and perpetuating the Washington state's fish and wildlife resources.

Washington State Department of Transportation (WSDOT): A governmental agency that constructs, maintains, and regulates the use of the state's transportation infrastructure. WSDOT is responsible for more than 20,000 lane-miles of roadway, nearly 3,000 vehicular bridges and 524 other structures. This infrastructure includes rail lines, state highways, state ferries (considered part of the highway system) and state airports.

Washington United Terminals (WUT): Located in the Port of Tacoma on the Blair Waterway, WUT offers the shortest gateway from Asia and the best protected harbor in Puget Sound.

Wayside detector: A technology that allows railroads to prevent damage and accidents before they could happen. Positioned along 140,000 miles of railroad in the nation, seven kinds of wayside detectors monitor the wheels of passing trains and alert rail car owners to potential defects enabling them to schedule appropriate maintenance in a safe, timely, and cost-effective manner.

Weathering: The complex physical and chemical changes that occur after oil spills onto water or onto a substrate on land. Depending on the specific type of oil and its chemical makeup, and the environmental conditions (especially temperature) into which the oil spills, the various processes occur at different rates, including spreading on the water surface, evaporation, emulsification, oxidation, dissolution, dispersion, sedimentation, and biodegradation. Weathering affects the nature of the oil, including toxicity, and its behavior.

Western States Petroleum Association (WSPA): Non-profit trade association that represents companies that account for the bulk of petroleum exploration, production, refining, transportation and marketing in the six western states of Arizona, California, Hawaii, Nevada, Oregon and Washington. Members of the WSPA include Aera Energy LLC, Alaska Tanker Company, Berry Petroleum, BP, Big West of California LLC, Chevron Corporation, ConocoPhillips, ExxonMobil, Lloyd Properties, Navajo Refining Co., Noble Energy, Olympic Pipeline Company, Occidental Petroleum, Pacific Operators Offshore, Plains All American, SeaRiver Maritime, Seneca Resources Corp., Shell, Tesoro, U.S. Oil and Refining, Valero Energy Corporation, Venoco, and Western Refining.

Westward direction (WWD): Situated or directed towards the west.

Wheel impact load detector (WILD): A type of wayside detector that identifies rail wheels worn or damaged into an out-of-round shape before they can damage track.

Wheel profile measurement systems (WPMS): A type of wayside detector that evaluates the complete rail profile by capturing laser images and detecting worn wheel treads or flanges.

WTI: West Texas Intermediate crude oil, a grade of crude oil used as a benchmark in oil pricing; this grade is described as light because of its relatively low density, and sweet because of its low sulfur content.

Acronyms and Abbreviations

AADT	Average annual daily traffic
AAR	Association of American Railroads
ABS	Automatic Block System
AFFF	Aqueous film forming foams
AFPM	American Fuel and Petrochemical Manufacturers
AHIMT	All-Hazard Incident Management Team
AI-EES	Alberta Innovates Energy and Environment Solutions
AIS	Automatic Identification System
AITF	Alberta Innovates Technology Futures
ANPRM	Advanced Notice of Proposed Rulemaking
ANS	Alaska North Slope crude oil
ANSI	American National Standards Institute
ANT	Advanced notice of transfer
API	American Petroleum Institute
ATB	Articulated tug barge
ATC	Alaska Tanker Company
AWO	American Waterways Operators
BAP	Best Achievable Protection
bbl	Barrels (equivalent of 42 gallons)
BC	British Columbia, Canada
BSEE	Bureau of Safety and Environmental Enforcement
BTEX	Benzene, toluene, ethylbenzene, and xylene

BTU	British thermal unit
Bunker	Fuel oil for ships
CAD	Computer Aided Dispatch
CAPP	Canadian Association of Petroleum Producers
CCTV	Closed-circuit television
CEMP	Comprehensive Emergency Management Plan
CEP	Capital Expenditure Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CN	Canadian National Railway
CO_2	Carbon dioxide
COFR	Certificate of Financial Responsibility
COLREGS	International Regulations for Preventing Collisions at Sea
COLRIP	Columbia River Pilots
CP	Canadian Pacific Railway
C&P vessels	Cargo and passenger vessels
CPG	Comprehensive Planning Guide
CPR	Canadian Pacific Railway
CRBP	Columbia River Bar Pilots
CSCL	China Shipping Container Lines
CSX	CSX Transportation Class I railroad (east coast)
CTC	Centralized Traffic Control
CVTS	Cooperative Vessel Traffic Services
DED	Dragging Equipment Detector
DHS	Department of Homeland Security
DNS	Determination of Non-Significance
DOI	Department of the Interior
DOT	Department of Transportation
DPU	Distributive Power Units
DWT	Deadweight tonnage
EAL	Environmentally Acceptable Lubes
ECA	Emission Control Area
ECDIS	Electronic Chart Display and Information Systems
Ecology	Washington State Department of Ecology
ECOPRO	Exceptional Compliance Program
ECP	Electronically Controlled Pneumatic (brake)
ECY	Washington State Department of Ecology
EDT	Eastern Daylight Time
EEZ	Exclusive Economic Zone
EFSEC	Energy Facility Site Evaluation Council
EGT	Export Grain Terminal
EHMP	Enhanced Hazard Mitigation Plan
EIS	Environmental impact statement
EMD	Emergency Management Division
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right to Know

ERAP	Emergency Response Assistance Plan
ERG	Emergency Response Guidebook
ERTS	Environmental Report Tracking System
ERTV	Emergency rescue towing vessel
ESF	Emergency Support Function
ESPO	East Siberian Pacific Ocean
ETV	Emergency towing vessel
EWD	Eastward direction
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FRP	Facility response plan
FRSA	Federal Railroad Safety Act
FTE	Full-time equivalent
FY	Fiscal year
GCOR	General Code of Operating Rules
GPAC	General Policy Advisory Council
gpm	Gallons per minute
GPT	Gateway Pacific Terminal
GRP	Geographic response plan
GRT	Gross registered tonnage
HazMat	Hazardous material
HFO	Heavy fuel oil
HHFT	High-hazard flammable trains
HLRW	High Level Radioactive Waste
HMRT	Hazardous Material Response Team
HRT	Hazardous response team
HTUA	High Threat urban Areas
HVPA	High Volume Port Area
I-5	Interstate 5
IAP	Incident Action Plan
ICC	The Interstate Commerce Commission
ICCTA	The Interstate Commerce Commission Termination Act of 1995
ICP	Incident Command Post
IFO	Intermediate fuel oil
IMO	International Maritime Organization (UN)
JLARC	Joint Legislative Audit and Review Committee
L/V	Lateral to Vertical
LEL	Lower explosive limit
LEPC	Local Emergency Planning Committee
LTQ	Loading Target Quantity
MCTS	Canadian Marine Communications and Traffic Services
MDNS	Mitigated Determination of Non-Significance
MFSA	Maritime Fire and Safety Association
MMA	Montreal Maine & Atlantic Railroad
MPH	Miles per hour

MP	Milepost (on railroad line)
MRL	Montana Rail Link
MUTCD	Manual on Uniform Track Control Devices
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NIMS	National Incident Management System
NFPA	National Fire Protection Agency
NOAA	National Oceanic and Atmospheric Administration
NORM	Naturally-occurring radioactive materials
NPE	Nonylphenol ethoxylates
NPRM	Notice of Proposed Rulemaking
NRC	National Response Center
NRF	National Response Framework
NTSB	National Transportation Safety Board
NWAC	Northwest Area Committee
NWACP	Northwest Area Contingency Plan
NWD	Northward direction
NYDEC or **NYSDEC**	New York State Department of Environmental Conservation
NYK	Nippon Yusen Kaisha Line
OCS	Outer Continental Shelf
OECD	Organization for Economic Cooperation and Development
OLI	Operation Lifesaver, Inc.
OMA	Oil-mineral aggregate
OOCL	Orient Overseas Container Line
OPA90	Oil Pollution Act of 1990
OPEC	Organization of Petroleum Exporting Countries
OPSA	Oil Spill Prevention Account
OR-DEQ	Oregon Department of Environmental Quality
OSG	Overseas Group
OSRA	Oil Spill Response Account
OSRP	Oil Spill Response Plan
OSTLF	Oil Spill Liability Trust Fund
OTB	Olympic Tug and Barge
P&I	Protection and Indemnity
PADD	Petroleum Administration for Defense Districts
PAH	Poly-nuclear aromatic hydrocarbons or polycyclic aromatic hydrocarbons
PCT	Pierce County Terminal
PG	Packing Group
PHMSA	Pipeline and Hazardous Material Safety Administration
PNWR	Portland and Western Railroad
POSI	Pipeline oil similarity index
PPE	Personal protective equipment
psi	Per square inch
PSR	Puget Sound Refinery
PSVTS	Puget Sound Vessel Traffic Service
PTC	Positive train control
Q&A	Question and answer

QTR	Quarter (of year)
RAMP	Rail Accident Mitigation Project
RBT2	Roberts Bank Terminal 2
RCW	Revised Code of Washington
RP	Responsible party
RRT	Regional Response Team
RSAC	Railroad Safety Advisory Committee
RSIA	Rail Safety Improvement Act
RSPA	Research and Special Programs Administration
RTRA	Railroad traffic risk assessment
SARA	Superfund and Reauthorization Act
SEPA	State Environmental Policy Act
SERC	State Emergency Response Commission
SFD	Seattle Fire Department
SFPC	Structural firefighting protective clothing
SHB	Shorelines Hearings Board
SIG	Seattle International Gateway
SLD	High/Wide/Shifted Load Detector
SMA	Shoreline Management Act
SNF	Spent Nuclear Fuel
SODO	Neighborhood in Seattle, south of CenturyLink Field (formerly the Kingdome)
SPPR	Spill Prevention, Preparedness, and Response Program
SP&S	Spokane, Portland, Seattle Railway
STB	Surface Transportation Board
STCW	Standards of Training, Certification, and Watchkeeping
SWCAA	Southwest Clean Air Agency
SWD	Southward direction
T-18	Terminal 18
T-5	Terminal 5
TAPS	Trans-Alaska Pipeline System
TBOGI	Truck bogie optical geometry inspection
TERC	Tribal Emergency Response Commission
TEU	Twenty-foot equivalent unit
TEZ	Tanker Exclusion Zone
TFEMC	Tesoro Far East Maritime Charter
TMEP	Trans Mountain Expansion Project
TPD	Truck performance detector
TSB	Transportation Safety Board (Canada)
TSS	Traffic Separation Scheme
TWC	Track Warrant Control
TWD	Track Warning Device
UASI	Urban Area Security Initiative
UC	Unified Command
UEF	Universal Extinguishing Foam
ULCC	Ultra-large crude carrier
ULSD	Ultra-low sulfur diesel

UN	United Nations
UP	Union Pacific Railroad
US	United States
USC	United States Code
USCG	US Coast Guard
USDOT	US Department of Transportation
VBAP	Voluntary Best Achievable Protection
VEAT	Vessel Entries and Transits of Washington Waters
VGO	Virgin gas oil
VLCC	Very large crude carrier
VOC	Volatile organic compound
VRP	Vessel response plan
VTRA	Vessel traffic risk assessment
VTS	Vessel traffic services
WAOL	Washington Operation Lifesaver
WDCFA	Washington Dungeness Crab Fishermen's Associations
WDFW	Washington Department of Fish and Wildlife
WEMD	Washington Emergency Management Division
WFC	Washington Fire Chiefs
WILD	Wheel impact load detector
WPMS	Wheel profile measurement systems
WPPA	Washington Public Ports Association
WRIA	Water Resource Inventory Area
WSDOT	Washington State Department of Transportation
WSPA	Western States Petroleum Association
WUT	Washington United Terminals
WWD	Westward direction

Appendix A: In Depth: Crude-by-Rail Transport

Overview of the Rail Network in Washington[190]

Washington has a total land area of 66,544 square miles and is the 20th largest state in the nation.[191] Washington is home to 3,157 miles of railroad track, ranking it 22nd in the nation. There are 28 railroads operating in the state, and these railroads operate trains that travel more than 10 million miles of track a year. The two primary railroads operating in the state are Class I railroads: BNSF and UP.[192] These railroads operate 2,165 miles of track in the state.[193] A Class I railroad has an operating revenue of at least $433.2 million annually.[194] There are more than 2,800 public railroad crossings and approximately 3,000 private crossings[195] in the state.

Crude oil is transported in Washington along the routes shown in Figure 42: BNSF delivers crude oil to Washington and Oregon facilities through the following routes: [196, 197]

- Sandpoint, ID to Spokane, WA: 78.3-mile segment known as the "Funnel" or the Kootenai River Subdivision. It is the second busiest rail corridor in Washington.
- Spokane, WA to Pasco, WA: The Lakeside Subdivision.
- Pasco, WA to Vancouver, WA: The Fallbridge Subdivision, along the north side of the Columbia River Gorge.
- Vancouver, WA to Seattle, WA: The Seattle Subdivision. It is the busiest rail corridor in Washington.
- Seattle, WA to Everett, WA: The Scenic Subdivision. This route is adjacent to Puget Sound most of the way.
- Everett, WA to the Canadian Border: The Bellingham Subdivision.
- North of Ferndale, WA to Northern Refineries: The Cherry Point Subdivision.
- Burlington, WA to March Point Refineries: Trains travel along a BNSF spur line.

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190 Much of the information contained in this section was developed through multiple operations and capacity studies performed by MainLine Management since 1999 (Sound Transit Commuter Rail Operations and Capacity Planning, Seattle – Tacoma). Since 2004, MainLine Management has performed numerous operations and capacity studies within the state, all of which involved detailed analysis of Class I operations and infrastructure, including mainline operations (MainLine Management 2004, 2005a, 2005b, 2005c, 2007, 2008, 2009, 2011, 2013a, 2013b). In addition to the aforementioned studies, the Department of Ecology has retained MainLine Management to perform the statewide operations and capacity analysis for the proposed Gateway Pacific Terminal EIS. That study, which is not yet completed, is analyzing BNSF's mainline network within the state for current, mid-term, and long-term capacity demand and operational capability.

191 http://www.Statemaster.com/graph/geo_lan_are-geography-land-area.

192 Surface Transportation Board under section 1201.1–1 of title 49, Code of Federal Regulations.

193 Association of American Railroads, Freight Railroads in Washington.

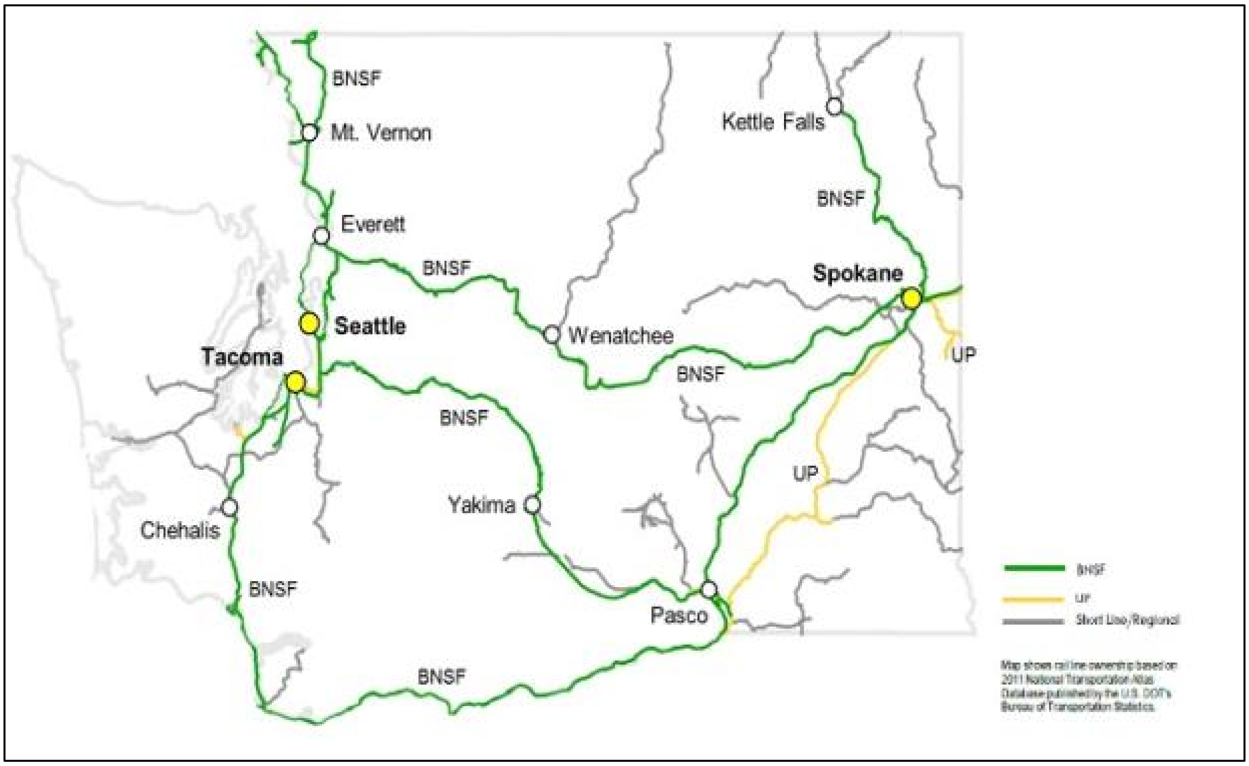
194 Surface Transportation Board under section 1201.1–1 of title 49, Code of Federal Regulations.

195 FRA National Crossing Database.

196 Northwest Area Committee(NWAC) 2013 Emerging Risks Task Force Report, http://www.rrt10nwac.com/Files/FactSheets/131217071637.pdf

197 BNSF Subdivision Map http://www.bnsf.com/customers/pdf/maps/subdivisions-map.pdf

Figure 42: Map of Primary Route of Rail Transport of Crude Oil in Washington State



BNSF Mainline Rail Network in Washington

BNSF's rail transportation network in Washington links Pacific Northwest cities with most of the U.S. Two mainline rail corridors provide access to Washington and subsequently to British Columbia. BNSF's primary mainline corridor, stretching from Washington to Chicago and points east, south, and southeast, is its Northern Corridor. The second mainline corridor connects Washington to BNSF service areas in the South and Southeast via a connection to the Montana Rail Link (MRL) at Sand Point, Idaho. Additionally, BNSF has a secondary mainline corridor that connects Washington with Northern and Southern California via a connection at Wishram, Washington. This connection extends south, accessing the BNSF north/south mainline between Northern and Southern California.

BNSF's mainline corridors host a variety of train and commodity types, with certain mainline routes focusing on specific train and traffic flows. Commodities handled by BNSF's operations within and through Washington include international container trains, domestic intermodal trains, manifest[198] (mixed cargo) trains, and bulk unit trains of coal, grain, and crude oil. With the rapid development of crude-by-rail trains carrying shale oil originating in the Bakken formation of North Dakota and Montana and destined for Pacific Northwest refineries and oil transfer facilities (current and proposed), coupled with proposals to develop large coal export

[198] Manifest train contain freight cars with various types of cargo. They may include rail tank cars that carry chemicals, refined oil products, and even crude oil. In some cases manifest trains contain a "block" of as many as 20 crude oil tank cars.

facilities within the state, BNSF mainline corridor capacity and operating protocols are continually being challenged, This is likely to continue into the future.

As a consequence, BNSF introduced in 2012 a train operations protocol change to enhance use of existing capacity by a directional running agreement using Stampede Pass for eastbound empty bulk trains, and BNSF is aggressively pursuing infrastructure expansion projects along the entire Northern Corridor.

BNSF Operations in the Pacific Northwest and British Columbia

BNSF has five primary mainline corridors in Washington: four run east/west between Puget Sound, the lower Columbia, and Spokane, and one runs north/south paralleling Interstate 5 (I-5) and Highway 99 between Portland and Vancouver, British Columbia. Each of the mainline corridors is critical in allowing BNSF to provide service levels that meet customer expectations for all commodities it handles in the Pacific Northwest.

Four of the mainline corridors are classified as "Class 4" under FRA criteria. The exception is the Stampede Pass corridor which maintained to Class 4 condition but operated at a maximum freight train speed of 49 mph. An FRA Class 4 designation allows a maximum passenger train speed of 79 mph and maximum freight train speed of 60 mph. An FRA Class 3 designation allows a maximum passenger train speed of 60 mph and a maximum freight train speed of 40 mph.

BNSF's primary mainline corridors within Washington are (Figure 43):

- Sand Point, ID to Spokane (the "Funnel").
- Spokane to Vancouver, WA via Pasco.
- Spokane to Everett via Stevens Pass.
- Vancouver, WA to Blaine and Vancouver, BC via Seattle and Everett (the I-5 Corridor).
- Auburn to Pasco via Stampede Pass.

Four of these five corridors feature tunnels on their routes. Only two of the routes, however, have restricted car heights due to tunnel clearances: the Stampede Pass route and the Everett to Blaine segment. Tunnels on the Stevens Pass route, the Spokane to Vancouver, Washington route, and the Vancouver to Everett segment of the I-5 route are cleared for double-stacked 9-foot, 6-inch containers.

Figure 43: BNSF System in Washington by Route Corridor[199]

Inland Connection to Spokane

Sand Point to Spokane: Infrastructure

The BNSF mainline segment between Sand Point and Spokane is the primary mainline between the Pacific Northwest and BNSF's inland rail network. The Northern Corridor and the MRL converge at Sand Point. The line between Sand Point and Spokane is primarily double-track with three single-track segments remaining. The single-track segments include meet/pass sidings to accommodate trains of up to 10,000 feet in length. Constructing double-track over the remaining single-track sections is possible but, as would be expected, they represent the most costly and difficult locations for additional infrastructure. Construction of a 3rd main track at critical locations on the double-track sections is also possible and will likely be constructed as traffic demand warrants.

For one of the remaining single-track segments – the single-track bridge over Lake Pend Oreille, located just west of Sand Point – BNSF has developed plans to double-track the bridge over the lake and has suggested that it could be completed as early as 2020.[200]

199 Source: MainLine Management, Inc. 2014.

Maximum track speeds over this segment are consistent with the FRA Class 4 track for passenger and freight. Loaded unit bulk trains operate at lower maximum track speeds (maximum 45 mph) due to safe stopping distances given the signal distance configuration. The segment is predominantly under Centralized Traffic Control (CTC) train movement authority. Train movements on CTC tracks are controlled by signals in both directions, and switches are normally remotely controlled by a train dispatcher. The dispatcher authorizes train movements in CTC territory by controlling signal indications at CTC control locations, such as crossovers and entering or leaving a meet/pass siding.

A component of the infrastructure on this segment is the mainline fueling facility located at Hauser, Idaho, approximately 20 miles east of Spokane. Virtually all eastbound freight trains use this facility for fueling.

Sand Point to Spokane: Commodities

As the primary conduit for BNSF train operations into and out of the Pacific Northwest, this segment hosts every train type, including international container trains to/from the ports of Seattle, Tacoma and Portland, domestic intermodal trains to/from South Seattle and Portland; manifest trains[201] between Pasco/Spokane and inland car processing facilities; auto trains to/from Portland/Vancouver, WA; and unit grain, coal, and crude-by-rail trains to/from all destinations in the Pacific Northwest, California, and British Columbia.

Finally, this segment also hosts two Amtrak trains per day, one in each direction. The Amtrak train (Empire Builder) is split/consolidated at Spokane with a westbound portion operating between Spokane and Seattle via Stevens Pass and Everett and the other portion operating between Spokane and Portland via Pasco/Vancouver, WA.

Sand Point to Spokane: Capacity

Infrastructure on this segment is predominantly double-track with fairly short single-track segments that feature sidings to minimize the distance between points where meet/pass operations could occur. The single-track segments could be eliminated through connecting the sidings and the ends of double-track sections, though the remaining areas to be double-tracked are geographically more challenging and costly, including the single-track bridge over Lake Pend Oreille at Sand Point. Double-tracking those segments, however, could be accomplished. In addition, the general geography of this segment would permit BNSF to construct segments of triple track where appropriate and to expand the mainline Fast Fueling facility at Hauser as traffic growth requires.

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[200] *Railway Age*, Bruce Kelly, August 27, 2014.
[201] Manifest trains are those that contain a number of different commodities, compared to a unit train, which is a train composed all of one commodity, such as crude oil.

Columbia River Gorge Route

Spokane to Pasco: Infrastructure

Between Spokane and Pasco, all sidings are 8,000 feet in length or longer with some sections of double-track. BNSF is constructing some additional double-track sections under its 2014 Capital Expenditure Plan (CEP).[202] Capacity exists to operate several more trains in each direction on the segment, and that will be enhanced by the 2014 CEP. The segment is predominantly CTC with segments of multiple main tracks Automatic Block System (ABS)[203] on both sides and through Pasco Terminal. Train movements in ABS territory are authorized verbally by a train dispatcher issuing a Track Warrant[204]. ABS systems often are signalized but only in the direction of traffic; flow and switches are often manual and not remotely controlled.

A critical potential capacity constraint location on this segment is the single-track bridge over the Columbia River at SP&S Junction, just south of Pasco. Recent analyses have shown that projected growth on this segment will begin to cause congestion issues over the bridge and within Pasco Terminal.

Spokane to Pasco: Commodities

The full range of BNSF commodity trains in the Pacific Northwest operate over the segment. Intermodal trains are at a minimum, however, as normally only Portland domestic intermodal trains operate over the Vancouver, WA to Spokane corridor (along with Portland origin/destination auto trains). Due to Pasco Yard being BNSF's primary car processing facility in the Pacific Northwest, virtually all manifest traffic between the Pacific Northwest and the east is handled on this corridor. In addition, due to the grade issues on BNSF routes, all loaded unit trains (coal, grain, and oil) operate from Spokane to Pasco. Empty unit trains returning from Vancouver and the Stampede Pass route also use this corridor to return to Sand Point for furtherance east. This corridor is also the Amtrak service route for the Spokane to Portland section of the Empire Builder passenger train.

Spokane to Pasco: Capacity

Capacity increases on this segment could be achieved by a continuing program of constructing double-track segments by connecting existing sidings. That capacity expansion program is continuing with BNSF's 2014 CEP.

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[202] http://www.bnsf.com/media/pdf/2014capitalplanmap.pdf

[203] ABS is a form of rail operation in which fixed block signals are controlled by a system in which signals work automatically, including clear track detection (device that detects the occupation and clearance of a track section).

[204] A written form for authorization of train movements.

Pasco to Vancouver, WA: Infrastructure

The segment is predominantly single-track, CTC, with a short stretch of double-track at Wishram and double-track on the westernmost five miles between McLoughlin and Vancouver, WA. Sidings between Pasco and Wishram are between 6,850 and 9,000 feet in length. Between Wishram and McLoughlin, all sidings are now at least 8,000 feet in length. BNSF's ability to construct double-track segments between Wishram and McLoughlin is inhibited by the route's location adjacent to the Columbia River.

More important to the capacity of the Pasco to Vancouver corridor is BNSF's introduction of the "directional running" routing strategy within Washington. Generally speaking, the strategy of directional running is to route all westbound loaded unit trains (coal, grain, oil) from Pasco to Vancouver via the Columbia River Gorge. Empty unit bulk trains generated from north of Vancouver (Kalama, Longview, Centralia, Tacoma, Seattle, and north) are destined to return to Pasco and to points east via the Stampede Pass at Auburn (between Seattle and Tacoma). Under this routing concept, train operations over Stampede Pass will be almost exclusively eastbound empty bulk trains. A small number of empty bulk trains from Everett north are routed over Stevens Pass when a "slot" is available, but BNSF does not believe that intermodal growth will allow that to occur over the long run.

Pasco to Vancouver, WA: Commodities

As with the Spokane to Pasco segment, this part of the Columbia River Gorge corridor hosts all the train types BNSF operates within the state of Washington. Loaded unit bulk trains operate westbound to Vancouver, WA due to the minimal grades. Portland intermodal and auto trains operate in both directions. Most westbound and eastbound manifest trains originated at or destined to Pasco also operate over the segment. Unit oil trains from North Dakota's Bakken formation and manifest traffic destined to California operate between Pasco and Wishram, at which point they depart the corridor, crossing the Columbia River and operating through Oregon and Northern California via the "Inside Gateway". Eastbound manifest trains destined to California via the Inside Gateway, not requiring processing at Pasco Hump Yard, and originated in the I-5 Corridor (BC, Everett, Seattle, Longview, and Vancouver) also operate over the corridor for connection to the Inside Gateway at Wishram.

With the introduction and expansion of the directional running strategy via Stampede Pass, empty bulk trains generated north of Vancouver, WA are more and more being focused through Auburn to Pasco, creating eastbound slots on the segment and allowing for more "fleeting"[205] of westbound trains from Pasco to Vancouver. The segment also hosts the Spokane/Portland segment of Amtrak's Empire Builder.

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[205] Fleeting is a scheduling principle in which trains of equal speed or direction are assembled into fleets or groups that travel together.

Pasco to Vancouver, WA: Capacity

Capacity on the Pasco to Wishram and Wishram to Vancouver segments is under increasing demand. BNSF's operating strategies and capital investments have been and continue to be focused on ensuring that mainline capacity is adequate into the foreseeable future. Analysis performed by MainLine Management in late 2011[206] indicated that capacity may become critical within the next 15 years, but that assessment did not take into account evolving enhanced changes in train operating profiles through improved locomotive power and maximization of the use of Stampede Pass under the directional running concept.

Interstate-5 (I-5) Corridor Route

Vancouver, WA to Kalama and Longview: Infrastructure

As with all of BNSF passenger corridors in the state, this segment is maintained to FRA Class 4 standards, with maximum passenger train speeds of 79 mph and maximum freight train speeds of 60 mph. The mainline structure on this segment is two main track CTC. The corridor between Vancouver and Tacoma is segmented at Kalama/Longview due to the heavy terminal operations at Vancouver, the local work involving the mainline at Kalama and Longview Junction, and the access/egress activities that take place along the segment. At Vancouver, the Columbia River Gorge Route to/from Pasco intersects the I-5 Corridor extending from Portland to Seattle and beyond. BNSF has a major yard operation at Vancouver and access to the Port of Vancouver, WA facilities, which lie on the opposite side of the mainlines from BNSF's Vancouver Yard, that requires crossing the mainlines at-grade. Amtrak Cascade trains, the Empire Builder, and the Amtrak Coast Starlight also make station stops at Vancouver just north of the Columbia River drawbridge, in the wye at the intersection of the Columbia River Gorge route (BNSF's Fallbridge Subdivision) and the north/south mainline between Portland and Seattle (BNSF's Seattle Subdivision).

CTC-controlled universal power crossovers are located at strategic locations to facilitate the movement of trains between the main tracks and the yard facilities at Vancouver and port operations at Kalama and Longview.

Vancouver, WA to Kalama and Longview: Commodities

As with the Columbia River Gorge route, the I-5 Corridor hosts all train types BNSF operates in the state. While there are fewer BNSF intermodal trains on the corridor, it is UP's route for intermodal and auto traffic between Portland and Seattle/Tacoma and for UP manifest and bulk train traffic. Considerable bulk grain train operations occur by both BNSF and UP to serve export elevators at Portland, Vancouver, Kalama, Longview, Grays Harbor (via the connection at Centralia to the Puget Sound and Pacific Railroad), Tacoma, and Seattle. The corridor is also BNSF's route for loaded unit coal trains destined for Centralia and Westshore Terminals at Roberts Bank and for unit oil trains destined for Tacoma, Fidalgo, and Cherry Point. BNSF

[206] BST Associates et al 2011.

manifest traffic to/from the Pasco Hump Yard uses the route to connect to the Columbia River Gorge route at Vancouver, as does manifest traffic destined directly to California via Wishram.

Located at Kalama and Longview are major bulk export facilities (primarily grain), which are located on the Columbia River (or west) side of the mainlines. That requires loaded northbound unit trains destined to either port to cross over both mainlines to access the port facilities. Both ports, particularly Longview, also have considerable non-bulk manifest traffic which requires manifest trains to stop to set out and pick up traffic, particularly at Longview Junction.

Vancouver, WA to Kalama and Longview: Capacity

There may be mainline capacity available on this segment as additional capacity is being constructed in conjunction with the state's expansion of intercity passenger service.[207] Primary expansion is occurring at Vancouver to streamline the movement of trains between the Fallbridge Subdivision (Columbia River Gorge Route) and the Seattle Subdivision by construction of an additional connecting track at the south end of the terminal and a "bypass" main track belting the east side of the terminal complex. In addition, the Port of Vancouver, WA is constructing a new access route to port facilities from BNSF's Fallbridge Subdivision that will cross under the north/south Seattle Subdivision mainlines. At Kalama, a new long siding/staging track is being constructed (essentially a third main track) to facilitate train movements between the mainlines and Port of Kalama facilities and between the mainlines and Port of Longview facilities and the joint BNSF/UP yard at Longview Junction. All improvements are to be completed by 2017 to facilitate the addition of two Amtrak Cascade round trips per day between Seattle and Portland.

Kalama and Longview to Tacoma: Infrastructure

As with the segment between Vancouver and Kalama/Longview, the route is two main track CTC with universal crossovers at key locations and maintained to FRA Class 4 standards. Access/egress connections are located at Centralia (Puget Sound and Pacific Railroad and the Centralia power plant), Olympia, and Tacoma. Intercity passenger station stops are located at Kelso (Longview), Centralia, Olympia, and Tacoma.

Two tunnels near Tacoma (Nelson-Bennett Tunnel, which is double-track, and Ruston Tunnel, which is single-track) are the primary capacity constraints between Longview/Kalama and Tacoma. However, the Point Defiance Bypass, which is planned to be completed by 2017 as part of the improvements required to add the two additional Amtrak Cascade round trips between Seattle and Portland, will alleviate mainline capacity constraints by shifting passenger trains from the existing mainlines to an alternate route between Nisqually and TR Junction in Tacoma. Nisqually is located between Olympia and Tacoma, and the line extends through Lakewood (the current southern terminus of the Sound Transit commuter service) to Freight House Square in

[207] http://www.wsdot.wa.gov/NR/rdonlyres/F67D73E5-2F2D-40F2-9795-736131D98106/0/StateRailPlanFinal201403.pdf (WSDOT Rail Division 2014); BST Associates et al. 2004, 2009, and 2011.

Tacoma, a current Sound Transit station stop which will become the new Amtrak/Cascade station in Tacoma. TR Junction is located near Reservation Interlocking, just north of where BNSF's main yard facilities are in Tacoma and where UP departs BNSF tracks for their own track to Seattle.

Kalama and Longview to Tacoma: Commodities

Freight train mix is fairly consistent with the segment between Vancouver and Kalama/ Longview, although there are fewer loaded unit grain trains north of Longview. BNSF serves the Centralia power plant with Powder River Basin coal trains, but that facility is planned to discontinue burning coal by 2025. Loaded coal trains to terminals in BC also traverse the segment, as do crude-by-rail trains for Tacoma, Fidalgo, and Cherry Point. UP intermodal and auto trains to/from Tacoma/Seattle use the segment, as does BNSF and UP manifest traffic between Puget Sound and Vancouver/Portland.

With the introduction of the directional routing protocol, empty unit trains generated from Kalama north are occasionally using the route to access the Stampede Pass connection at Auburn. That routing strategy is likely to increase with growth of westbound traffic on the Columbia River Gorge route between Pasco and Vancouver.

Kalama and Longview to Tacoma: Capacity

The primary capacity improvement on this segment will be the completion of the Point Defiance Bypass for the routing of intercity passenger trains between Nisqually and the TR Junction in Tacoma, scheduled to be completed in 2017. Removing passenger operations through the two tunnels at Tacoma will provide considerable capacity relief for BNSF and UP freight movements. Previous sensitivity analyses for the 2009 and 2011 WPPA/WSDOT Cargo Forecast Update and Rail Capacity Studies[208] indicated that without the Point Defiance Bypass, mainline capacity would become critically strained by the early 2020s.

Tacoma to King Street Station: Infrastructure

As with the balance of the I-5 Corridor between Vancouver and Tacoma, this corridor is predominantly a two main track CTC with three main tracks in operation between Black River Interlocking in Tukwila and Argo Interlocking (two main tracks BNSF and one main track UP). The segment is maintained to FRA Class 4 standards. UP operates its own mainline between Reservation Interlocking in Tacoma and Black River Interlocking. Multiple powered crossovers are located along the BNSF route to facilitate train movements, passenger station stops, and accessing off-mainline terminal facilities. Most access/egress switches are powered.

BNSF has terminal operating complexes in Tacoma, Auburn, South Seattle, and the Seattle International Gateway international container facility. BNSF's primary domestic intermodal facility is located in South Seattle. The Port of Tacoma also generates international container

[208] MainLine Management et al. 2004, 2009.

trains for BNSF which normally operate northward through Seattle to Everett for access to Stevens Pass. Auburn Yard, adjacent to the access to Stampede Pass, serves as a staging location for loaded unit trains destined for locations north of Everett and for empty unit trains destined to operate eastbound over Stampede Pass.

Improvements at King Street Station in Seattle have increased the efficiency of freight and passenger operations in the Seattle area. In addition, BNSF is constructing a third main track approximately five miles in length between Kent and Auburn. Approximately half of this track is on either side of the wye that accesses the Stampede Pass line. Given the plan to route empty bulk trains over Stampede Pass (the directional running concept), this additional track will be needed to minimize the impact to current and projected commuter and intercity passenger trains and also other mainline freight operations by freight trains exiting the main tracks to operate eastbound.

Tacoma to King Street Station: Commodities

Virtually all train types BNSF operates in Washington traverse this segment due to its location serving BNSF's major freight operations. The Seattle and Tacoma areas are more heavily focused on international and domestic intermodal operations, although Balmer Yard at Interbay in North Seattle and Main Yard in Tacoma also process large amounts of manifest traffic for the local areas. Unit grain trains serve the Temco export elevator in Tacoma and Terminal 86 at the Port of Seattle. Crude-by-rail oil trains terminate at Port of Tacoma and traverse the segment to serve Fidalgo and Cherry Point. Unit coal trains destined for Westshore Terminals at Roberts Bank in BC also operate over this segment.

Tacoma to King Street Station: Capacity

MainLine Management has previously analyzed capacity for this segment in two parts: Tacoma to Auburn and Auburn to King Street Station. The primary reason for splitting the segment in this manner is that the traffic mix is likely to be different on each part as BNSF continues to implement the routing of empty bulk trains over Stampede Pass. The mix of loaded and empty bulk trains between Tacoma and Auburn would be slightly different than the mix north of Auburn.

Recent MainLine Management studies have indicated there are no capacity constraints under high-growth or moderate-growth scenarios on this segment. BNSF would likely need to add the capacity necessary to meet its obligations under passenger rail agreements with Sound Transit, Amtrak, and WSDOT.

King Street Station (KSS) to Everett: Infrastructure

The segment between KSS and Everett, which is the location of the access to Stevens Pass and the mainline route to British Columbia, is also maintained to FRA Class 4 standards. The segment is primarily two main track CTC with three short stretches of single-track CTC in the

Mukilteo, Edmunds, and Interbay areas. The only tunnel is that which is under the City of Seattle leaving KSS northward, which is double-track but restricted to 25 mph maximum speed for freight.

The Port of Seattle's Terminal 86 grain export terminal is located between the Seattle Tunnel and BNSF's Balmer Yard at Interbay, but has sufficient staging yard capacity to minimize conflicts with mainline operations. At Balmer Yard, BNSF operates a car processing and distribution yard and a major locomotive and car servicing and repair facility (Interbay). Just north of Interbay is the Ballard drawbridge, which is double-track but opens for waterway traffic moving between Puget Sound and Lake Union. An additional feature of the segment is two ferry terminal access points at Edmunds and Mukilteo which intersect the mainline.

The segment has been historically prone to service interruptions due to mud slides[209] as the route for a considerable distance bounds Puget Sound on one side of the right of way and towering bluffs on the inland side. BNSF, the state of Washington, and Amtrak have embarked on a multiyear program to stabilize the most slide-prone areas to reduce service outages.

This route also hosts intercity passenger and Sound Transit commuter services. In addition to the Empire Builder (the Seattle section between Spokane and Seattle), Amtrak Cascades operates two round trips per day between Seattle and Vancouver, BC, and Sound Transit operates four weekday round trips with station stops at Edmonds and Mukilteo, with origin/termination in Everett. Amtrak Cascade trains only make a station stop at Everett.

King Street Station to Everett: Commodities

Primary freight movement on this segment is related to intermodal operations to and from Stevens Pass. There is a considerable amount of manifest traffic on the segment, however. Delta Yard in Everett and Balmer Yard at Interbay both process manifest cars for local distribution and for furtherance to Longview and Vancouver, WA. At Vancouver, manifest traffic is either routed for distribution within the Portland/Vancouver terminal complex or to the Fallbridge Subdivision for furtherance to Pasco Hump Yard or to Wishram for movement south to Oregon and California.

BNSF manifest trains to and from British Columbia normally traverse the segment after initial processing at Delta Yard in Everett (local traffic set out and pick up). Unit coal trains serving terminals in British Columbia and crude-by-rail oil trains serving Fidalgo and Cherry Point also traverse the route.[210] (Note: the only coal BNSF delivers to BC is to Westshore Terminal at Roberts Bank. Fraser Surrey Docks has recently received a permit to construct an export coal

[209] Mudslides in this area also increase the likelihood of a derailment incident.

[210] The only coal BNSF delivers to BC is to Westshore Terminal at Roberts Bank. Fraser Surrey Docks has recently received a permit to construct an export coal facility at Brownsville for the export BNSF PRB coal but that facility will likely not be in operation until at least 2016 and more likely 2017.

facility at Brownsville for the export BNSF PRB coal, but that facility will likely not be in operation until at least 2016 and more likely 2017.)

King Street Station to Everett: Capacity

Different from the capacity improvement agreement BNSF negotiated with Sound Transit for the Seattle to Tacoma commuter operations, BNSF's agreement with Sound Transit for the Seattle to Everett operations involved the purchase of "slots" for commuter operations. Under that agreement BNSF is required to construct whatever capacity is required (at its discretion) to ensure that passenger operations could maintain expected levels of service at the agreed volumes.

To date, BNSF has not been required to construct much additional capacity (most of that construction facilitates mainline movements through the Balmer Yard area). Consequently, it is expected that additional BNSF capacity improvements will be tied to freight demand rather than passenger, most likely constructing double-track on the remaining single-track segments. With the current "flatness" in international container operations to/from the Ports of Seattle and Tacoma and only moderate domestic intermodal growth, BNSF could likely delay additional capacity expansion for quite some time, unless capacity demand from other commodities, such as coal destined for Cherry Point and/or Fraser Surrey Docks, creates a congestion issue.

Everett to Blaine and Vancouver, BC: Infrastructure

The mainline segment between Everett (Delta Junction) and the border crossing at Blaine is single-track with two meet/pass sidings that are 10,000 feet or greater in length. There are three additional sidings that range in length between 8,000 and 9,000 feet, for a total of five meet/pass sidings that are 8,000 feet or longer. The greatest distance between meet/pass sidings of that length is 26.6 miles, between Ferndale and Bow, which is the area through Bellingham and the Chuckanut. A siding exists at South Bellingham between those points, but it is of insufficient length for most meet/pass operations. This line segment is single-track with sidings generally spaced 10 to 15 miles apart and is largely controlled by CTC with ABS/OCS segments at Blaine, Bellingham, and Everett. The line is maintained to FRA Class 4 with maximum speed for passenger trains of 79 mph and freight of 60 mph, with the exception of loaded coal at 40 mph and unit oil trains at a maximum speed of 45 mph over the entire segment. The line is fairly flat, with the predominant grade at slightly more than 1% northbound at Bellingham.

BNSF's rolling five-year capital plans for the Everett to Vancouver, BC mainline segment have been largely driven to date by passenger service and have included the following capacity improvement projects, which are being designed or have been constructed:

- Siding upgrade and extension at Stanwood (completed).
- Siding upgrade and extension at English (completed).
- Siding upgrade and extension at Mount Vernon.
- Construction of a new siding at the Swift Customs Facility.

- Extension of double-track from Custer to Swift.
- New 10,000 foot siding at English.

The siding extensions along with other upgrades at Stanwood, English, and Mount Vernon will allow more efficient meet/pass operations involving freight and passenger trains but will not reduce the distance between 8,000+ foot sidings between Ferndale and Bow. BNSF plans to potentially extend the siding at South Bellingham (6,347 feet in length), which if extended to 8,000 feet or more, would cut the gap between Ferndale and Bow in half for meet/pass locations of 8,000 feet or more.[211] The new siding at Swift (Blaine) will allow additional capacity for freight train customs inspections while keeping the mainline open for other train operations, including passenger. The siding extension at South Bellingham is, however, problematical due to significant geographical constraints. Another potential approach is that BNSF will look to increase capacity in the Bellingham area by constructing small segments of double-track from North Bellingham northward towards Ferndale.

There are 11.2 miles between the border crossing at Blaine and Colebrook, BC (the location where BNSF's mainline intersects BC Rail's Port Subdivision to Roberts Bank) and an additional 15.5 miles from Colebrook to Roberts Bank on the Port Subdivision. There are no meet/pass sidings on the BNSF mainline between the border and Colebrook, and the maximum speed is 50 mph for passenger trains (for short stretches) and 35 mph for freight trains. The route traverses the waterfront through White Rock and across mud flats that feature trestle bridge structures. Constructing additional capacity through this segment has been reviewed in the past, particularly across the mud flat section, but has to date been deemed too costly and environmentally challenging.

In 2012, BNSF constructed the 10,000-foot Oliver Siding just north of Colebrook. Colebrook is also the location from which BNSF's mainline extends to New Westminster (Brownsville) and is approximately half way between Swift and Brownsville. Prior to constructing the new Oliver Siding, BNSF had no meet/pass locations on its single-track between the border and Brownsville, a distance of over 20 miles.

There are three relatively short tunnels on the route between Mt. Vernon and Bellingham, through the Chuckanut area. None of the tunnels "clears" a double-stack train containing 9'-6" containers. *BNSF's 2009 Timetable and Special Instructions* restricts containers to single level loading with one exception: "Rabanco containers 48 feet long and nine feet high…may be double-stacked".[212] That exception indicates that "clearing" the existing tunnels for 9'-6" containers double stacked would likely be achievable without construction costs, probably through undercutting the existing roadbed, notching the tunnels, or a combination of both.

[211] MainLine Management 2011.
[212] *BNSF Railway Timetable No. 4*, 2009.

Everett to Blaine and Vancouver, BC: Commodities

Primary train types on this route are unit bulk and manifest trains. Unit bulk includes crude-by-rail oil trains to/from Fidalgo and Cherry Point. Unit coal trains operate over the route between Everett and terminals in British Columbia. BNSF operates three to four manifest trains daily each way, one of which directly serves Brownsville and BNSF's New Westminster operations, both located in British Columbia. The balance of BNSF manifest trains operate to/from Canadian National's Thornton Yard. Canadian National Railway provides switching and interchange services for BNSF, marshaling inbound BNSF trains at Thornton and assembling southbound trains for Everett.

Amtrak operates two round trips daily between Seattle and Vancouver, BC. Longer term Amtrak expansion plans over this route anticipate up to four round trips daily.[213]

Everett to Blaine and Vancouver, BC: Capacity

The entire segment, with the current infrastructure, has a relatively common maximum sustainable capacity for a typical single-track, FRA Class 4 mainline, with meet/pass sidings. The maximum capacity is limited somewhat by speed restrictions due to curvature, municipalities, and other geographic constraints (e.g., the mud flat segment between White Rock and Colebrook). Previous studies have generally estimated maximum capacity at approximately 24 bi-directional trains per day, which through "fleeting" could increase that capacity.[214] Fleeting of trains provides for a series of trains moving in the same direction to operate sequentially before movements in an opposing direction occur, again likely with some fleeting in the opposite direction of the original train movements.

Should an increase in train volumes occur, however, BNSF will face the increasing need to find ways to expand capacity as there are certain areas where geographic and environmental restrictions will make capacity expansion quite difficult, such as past the Chuckanut area south of Bellingham and across the mud flats between White Rock and Colebrook. Potential train volume increases include the development of the Gateway Pacific Terminal at Cherry Point and other lower-potential growth in bulk trains, such as coal to Fraser Surrey Docks in BC, Crude-by-Rail and grain. The Gateway Pacific Terminal, if constructed to planned full build out, could see an average of 18 coal trains per day (nine loaded, nine empty).[215]

Stevens Pass Route

Spokane to Everett via Stevens Pass: Infrastructure

The BNSF mainline between Spokane and Everett over Stevens Pass and connecting with the I-5 Corridor at Everett is primarily a single-track railroad with sufficient siding spacing with a few

[213] WSDOT (Rail Division) 2014.
[214] MainLine Management 2004, 2009, 2011b.
[215] MainLine Management 2011b.

sidings up to 10,000 feet in length and many sidings exceeding 8,000 feet in length. It is predominantly a CTC controlled railroad rated at FRA Class 4 for maximum freight train speeds.

The predominant feature of this route is the eight mile long Cascade Tunnel under Stevens Pass between Wenatchee and Everett. The single-track tunnel and the 2.2% ascending grade on both approaches to the tunnel represent the constricting capacity factor on this segment due to running times between sidings. The restriction is exacerbated by the requirement to "flush" the tunnel with clean air for the locomotives behind train movements. In addition to flushing, the tunnel has a maximum speed of 25 mph. The eastbound movement through the tunnel continues on an ascending grade of approximately 1.7% for most of the tunnel's length, and eastbound trains on this route are normally heavier than westbound trains. Consequently, eastbound trains traverse and clear the tunnel more slowly than westbound trains, which are moving predominantly downhill through the tunnel. The average eastbound tunnel flush time between trains is approximately 30 minutes, while tunnel flush times behind westbound trains average approximately 20 minutes.

Spokane to Everett via Stevens Pass: Commodities

The Stevens Pass route is BNSF's primary international container and domestic intermodal route between Puget Sound and points east. BNSF has indicated on numerous occasions that the capacity of Stevens Pass will be primarily reserved for intermodal/auto trains and Amtrak. BNSF operates intermodal trains up to 8,000 feet in length on the segment, so long as they do not exceed 5,000 trailing tons. If a train has distributive power units (DPU – remotely controlled locomotives placed in the middle or at the end of a train), tonnage could be increased to 7,000 tons, with increased train lengths, resulting in fewer trains being required for the movement of a certain volume of tonnage.

The Stevens Pass route, in addition to the focus on intermodal, also hosts one Amtrak train per day in each direction between Spokane and Seattle (the Empire Builder split/consolidation at Spokane). In addition, since capacity is available on a day-by-day basis, BNSF will sometimes route empty unit bulk trains (a returning empty coal train from Westshore, for example) over Stevens Pass when a "slot" is available and not being filled by a higher-priority train. Finally, there is a daily manifest train that operates in both directions between Spokane and Everett.

Spokane to Everett via Stevens Pass: Capacity

Multiple studies performed by various entities[216] have consistently identified the maximum sustainable capacity over Stevens Pass at 28 bi-directional trains per day, a capacity BNSF has consistently agreed with. On occasion, BNSF has "surged" up to 32 trains per day through the tunnel, but that volume has not proved to be sustainable. It is estimated that BNSF is operating 18 to 23 trains per day on the Stevens Pass route, which creates the available "slots" that are filled on occasion with non-intermodal traffic such as empty eastbound coal trains from Roberts

[216] Including: MainLine Management 2004, 2009, 2001b.

Bank or empty crude-by-rail trains generated at Cherry Point or Fidalgo. Increasing the maximum throughput of the Stevens Pass route is problematic without the tremendous expense of constructing a second tunnel, which in previous analyses was estimated to require a tunnel approximately 12 miles in length to reduce the approach grades.

Stampede Pass Route

Auburn to Pasco via Stampede Pass: Infrastructure

The Stampede Pass route between Auburn and Pasco is a single-track, maintained to FRA Class 4, secondary mainline with a Timetable maximum freight train speed of 49 mph. The line is an ABS signaled corridor predominantly controlled by Track Warrant Control (TWC), but with islands of CTC at meet/pass siding locations. Track Warrant Control is dispatcher issued authority for train movements between two defined locations, either in ABS signaled territory or in "dark territory", which does not have signals.

The predominant feature of the segment is the Stampede Pass Tunnel between Auburn and Ellensburg. The tunnel does not clear double stacks or tri-level auto racks. Consequently, the route does not allow the operation of double-stack intermodal trains or auto trains. BNSF has explored the possibility of "clearing" the tunnel for double-stack operations, but it would be a multi-million dollar project and BNSF has not seen the need to do so. Additionally, the balance of the route would likely need to be upgraded to FRA Class 4, full CTC controlled railroad, adding significant cost.

Additionally, the eastbound and westbound grades approaching the tunnel are nearly 2%, creating an operating issue for heavy tonnage trains. The westbound grade profile between Ellensburg and the Stampede Tunnel averages 2.2% approaching the tunnel. The eastbound grade profile between Auburn and the tunnel also averages 2.2% approaching the tunnel.

Auburn to Pasco via Stampede Pass: Commodities

There is little freight traffic on the line, primarily local traffic between Yakima and Pasco. With the introduction of the directional running routing protocol, a growing number of empty bulk trains are moving eastbound between Auburn and Pasco, with current total train volumes (including locals) estimated at approximately six to 10 trains per day. No passenger trains operate over the corridor.

Auburn to Pasco via Stampede Pass: Capacity

BNSF has begun to use Stampede Pass as a directional route for empty bulk trains generated along the I-5 Corridor north of Vancouver, WA. While the corridor is destined to become an eastbound route for empty BNSF bulk trains, it is also possible that BNSF will use the route for some eastbound merchandise trains that originate from Everett, Seattle, and Tacoma and are destined for the Pasco processing yard.

As a single-track line segment with meet/pass sidings, bi-directional capacity is approximately 24 trains per day. If BNSF continues to develop the Iron Triangle routing protocol, using the Stampede Pass route for fleeting empty bulk train movements between the I-5 Corridor and Pasco, capacity on the route would be enhanced so long as westbound through train movements were not introduced on the route, creating a growing requirement for meet/pass operations to occur.

UP Mainline Rail Network in Washington

Up until December 2014, Union Pacific (UP) was not moving oil in Washington via unit train.[217] They had, however, been moving oil along the Columbia River on the Oregon side via manifest trains heading west towards the Portland area. UP owns a stretch of rail between Tacoma and Seattle, a stretch of rail between Spokane and Wallula, with a connection to Pasco, and has trackage rights on BNSF's Seattle Subdivision. UP was moving crude oil by rail in Washington, but only in manifest trains, which were not reportable via the USDOT order.[218] In mid-December 2014, UTC reported that UP began to move unit trains into Tacoma. The train origin was reported to be Bruderheim or Rosyth, Alberta, meaning that the oil type on the trains would be diluted bitumen.

UP's primary mainline operations in the state involve trackage rights movements over the BNSF I-5 rail corridor between Portland and Tacoma. Between Reservation Interlocking in Tacoma and Black River Interlocking near Tukwila, UP operates its own mainline. At Black River UP rejoins BNSF, jointly operating parallel multiple main tracks to Argo Interlocking in South Seattle. UP's intermodal and yard facilities are located adjacent to Argo Interlocking, with its freight yard located east of the main tracks and its Argo Intermodal Facility west of the main tracks. Argo Interlocking is also UP's access to Port of Seattle International Container Facilities on Harbor Island and Southwest Harbor. UP does not have operating rights on BNSF north of the Argo Interlocking except for rights to serve the Port of Seattle's T-86 export grain facility, with BNSF performing the operating movements between Argo and T-86 on UP's behalf.

UP also operates a secondary mainline between Eastport, ID, and Hinkle, OR, via Spokane and Wallula WA. This line connects to the Canadian Pacific Railway (CPR) at Eastport, which is UP's only direct connection to Canadian rail operations in the Western U.S. Consequently, it is the only UP route that would allow direct access to CPR origin Bakken crude-by-rail trains or oil sand trains. From UP reporting to date, limited volumes, if any, Bakken or oil sands car movements are operating over this route.

[217] Union Pacific USDOT Emergency Order WA Report http://mil.wa.gov/static/123/state-emergency-response-commission-serc
[218] NWAC Rail Lines and Crude Oil Off-Loading Facilities in WA, OR, and ID Map 2014 http://waecy.maps.arcgis.com/home/webmap/viewer.html?webmap=c60daf2b074544b1a9d337c03a0576bd

UP Reservation Interlocking to Argo Interlocking: Infrastructure

UP track infrastructure between Reservation Interlocking in Tacoma and Argo Interlocking near South Seattle is single-track, CTC-controlled, with minimal meet/pass sidings. The track is maintained to FRA Class 4, but there are no passenger operations on the segment, and operating speeds are limited by track curvature and on-line industrial switching/support yard locations.

UP Reservation Interlocking to Argo Interlocking: Commodities

UP serves numerous industrial facilities along the route, particularly its auto facility near Kent, with the necessary local switching yards and support tracks. Its primary switching yards are located at Fife (just north of Reservation Interlocking) and at Argo. UP's domestic intermodal and international container operations are located at its Argo Intermodal facility, although it also serves both domestic intermodal and international container cars through operations at the Port of Tacoma. Tacoma Rail handles the transfer of railcars between UP's Fife Yard and operations on the Tidal Flats, intermodal and manifest.

UP Reservation Interlocking to Argo Interlocking: Capacity

While specific capacity issues are unknown for this segment, there have been no indications that UP is experiencing any capacity issues. With the yard facility at Fife, and the on-line industrial services, mainline occupancy of the segment is considerable for local services, but has not seemed to negatively impact UP throughput. With no passenger trains operating on the line, UP is not likely to install Positive Train Control (PTC) on this segment unless the traffic mix should change dramatically.

A number of years ago, there were suggestions that perhaps overall capacity between Tacoma and Black River would be enhanced if BNSF and UP were to agree to a joint mainline operation, using BNSF's two main tracks and UP's single mainline between those locations. The proposed concept envisioned UP and BNSF thru trains between Portland/Vancouver and Seattle operating on the BNSF mainlines between Reservation Interlocking and Black River. Conversely, BNSF international container trains to/from Port of Tacoma facilities were envisioned to operate over UP's mainline between Bullfrog Junction on the Tidal Flats and Black River, eliminating the BNSF requirement to have Port of Tacoma trains enter its Main Yard in Tacoma and be reversed to access the Tidal Flats. The concept did not progress, as reportedly both railroads were unable to identify sufficient benefit for their respective operations to pursue the initiative.

Hinkle, OR to Eastgate, ID: Infrastructure

Much of this segment consists of a single-track, non-signalized railroad between Hinkle, OR and Eastgate, ID operated by Track Warrant Control, with a maximum speed to 49 mph. The distance between meet/pass sidings limits capacity, but current available capacity is sufficient to meet projected traffic volumes under both a high and moderate growth scenario. UP does operate over a segment of BNSF mainlines through Spokane on this corridor.

Hinkle, OR to Eastgate, ID: Commodities

The route primarily handles manifest traffic, with some movement of bulk, non-hazardous commodities in less that unit train volumes.

It should be noted, however, that Eastport is UP's only direct access to CPR for interchange of U.S./Canadian traffic. As such, this route has the potential to eventually host crude-by-rail unit trains generated from CPR's Canadian operations in the Bakken formation and from the Northern Alberta oil sands. While there is apparently little or no oil traffic operating today on the route (UP has yet to report any weekly movements in Washington meeting the reporting threshold of 1,000,000 gallons of crude oil), UP direct access to Oregon, California, and western Washington locations between Vancouver and Tacoma could eventually result in crude-by-rail trains being interchanged at Eastport between CPR and UP. If that should occur, those trains would operate not only the UP route, but through Spokane on BNSF.

Hinkle, OR to Eastgate, ID: Capacity

Typical of non-signalized single-track mainline segments with interspaced meet/pass sidings, throughput between Eastport and Hinkle is somewhat limited but more than sufficient for the volume of trains that operate on the route. UP could likely increase capacity by constructing additional meet/pass sidings if warranted by growth in cargo traffic and installing a combination of ABS and CTC signal systems (similar to BNSF's Stampede Pass route). There is no indication that UP intends to install PTC on this route.

Other Rail Carriers

Tacoma Rail delivers crude oil to the U.S. Oil and Refining facility in Tacoma from the BNSF Seattle Subdivision Line.

Portland and Western Railroad operates on BNSF from Portland to the interchange at Vancouver, WA, as this railroad delivers crude oil from the Vancouver /Portland area to the Global Partners terminal in Clatskanie, OR. This line runs along the Columbia River. Portland and Western Railroad is a Genesee and Wyoming Company.[219]

Puget Sound and Pacific Railroad operates from Centralia to the Port of Grays Harbor and north along Hood Canal. This line would be used for crude-by-rail if the proposals in Grays Harbor are permitted. Puget Sound and Pacific Railroad is a Genesee and Wyoming Company.

[219] Oregon DOT Crude by Rail Map; Portland and Western Railroad USDOT Emergency Order WA Report http://mil.wa.gov/static/123/state-emergency-response-commission-serc

Presence and Characteristics of Railroad Facilities

As a result of its extensive, complex, and high-volume rail activities in Washington, BNSF Railway has numerous terminal operations within the state, providing a variety of rail operating services for its operations and it customers.

Primary Manifest[220] Car Handling Facilities

Primary manifest car handling facilities in Washington are located at:

- Spokane
- Pasco
- Vancouver
- Longview Junction
- Tacoma Main Yard
- Seattle Balmer Yard (Interbay)
- Everett

BNSF's primary car processing facility in the Pacific Northwest is its automated "hump yard"[221] in Pasco. Eastbound manifest traffic is gathered at Pasco and marshaled and forwarded in dedicated trains for such eastern destinations as Northtown Yard in Minneapolis, MN, Galesburg, IL, Hump Yard, Cicero, IL, and Kansas City, KS. Westbound manifest traffic forwarded by multiple origins on BNSF's system is marshaled at Pasco for distribution to BNSF service areas between Portland, Oregon; California; and Vancouver, BC. There are also manifest movements between Pacific Northwest locations, such as Everett, Longview, Vancouver/ Portland, and Spokane. These movements are also processed at the yards listed above.

Primary International Container Facilities

Primary international container facilities in the Pacific Northwest are located at:

- Port of Portland North Rivergate[222]
- Port of Tacoma (multiple)
- Port of Seattle (multiple, including Seattle International Gateway/SIG)

BNSF serves North Rivergate at Portland directly, as does UP. All rail service on the Port of Tacoma's Tidal Flats is provided by Tacoma Rail, which is owned by the City of Tacoma. The Port of Seattle has on-dock intermodal rail yards at Terminal 5 (T-5) in Southwest Harbor and Terminal 18 (T-18) on Harbor Island, both of which are directly served by BNSF, although a

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[220] Manifest train: a freight train contains cars with various types of cargo. They may include rail tank cars that carry chemicals, refined oil products, and even crude oil. In some cases manifest trains contain a "block" of as many as 20 crude oil tank cars.
[221] A hump yard is a rail yard in which the vehicles run down an artificial hill ("hump") into a classification bowl, i.e., an area in which the various cars are assembled into trains bound for various destinations.
[222] MainLine Management 2005.

considerable number of BNSF containers generated at T-18 are transported to Seattle International Gateway (SIG). In addition to the Port's on-dock container operations, BNSF operates its own international container terminal at the SIG, with two facility operations – North SIG and South SIG. The SIG facilities provide loading/unloading services for all Port of Seattle international container operations, including container operations on the Seattle waterfront adjacent to SIG as well as T-5 and T-18.

Primary Domestic Intermodal Facilities

Primary domestic intermodal facilities are located at:

- South Seattle
- Lakeyard Portland
- Spokane

Virtually all domestic intermodal traffic generated or terminated in the I-5 Corridor (by far the largest domestic intermodal market BNSF has in the Pacific Northwest) is transported to/from either South Seattle or Lakeyard. Domestic intermodal also originates and terminates from local sources in Spokane. In addition to the general domestic intermodal traffic handled by those two facilities, BNSF operates double-stack intermodal trains of municipal waste to an inland landfill at Roosevelt, WA, which is located east of Vancouver, WA, on the Columbia River Gorge route between Vancouver and Pasco. The waste containers handled by these trains are generated at Everett, Seattle, and Tacoma and combined for transit to/from Roosevelt. Incremental volumes of waste container traffic also move in manifest trains. The lift stations that handle these containers are operated by non-rail contractors.

Bulk Train – Grain Facilities

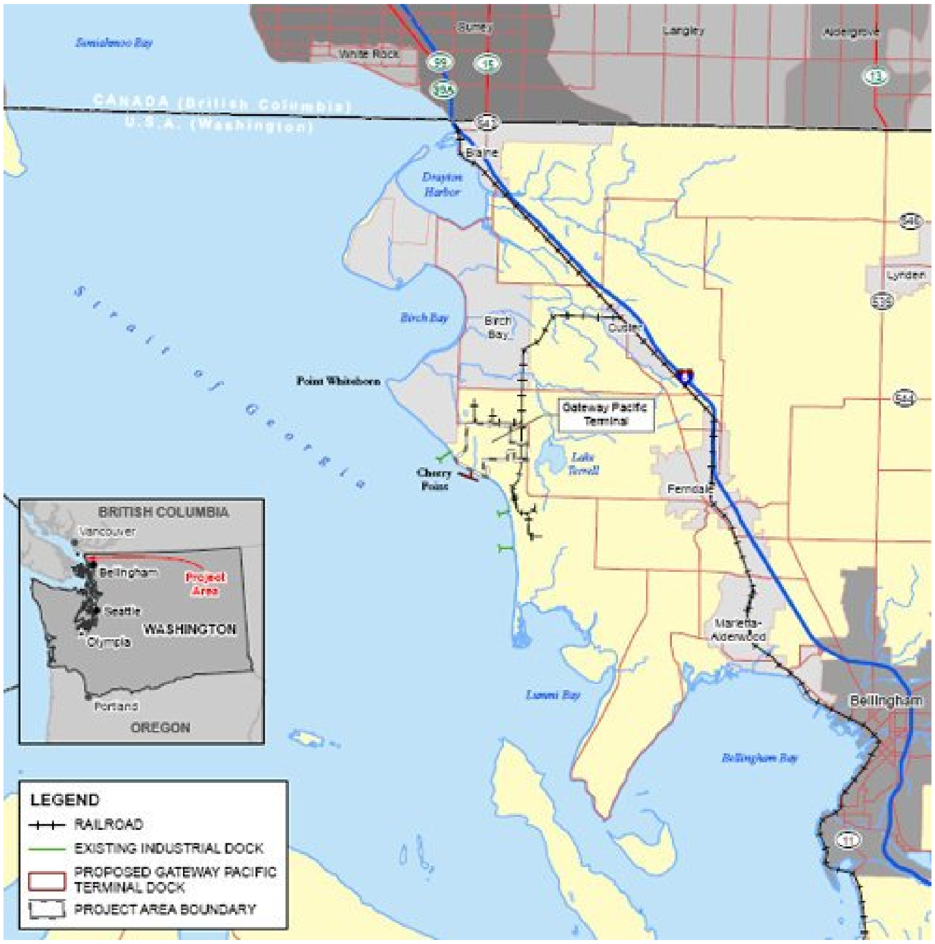
Bulk train grain facilities are located at:

- Portland, OR
- Vancouver, WA
- Kalama
- Longview
- Grays Harbor
- Tacoma
- Seattle
- Gateway Pacific Terminal, Cherry Point (proposed) (Figure 44)

All of the above export grain unloading sites are unit train (BNSF 110-car shuttle trains) capable. Expansion or improvement projects are being planned or under construction at Vancouver and Kalama to increase throughput capabilities. Potential growth in current facilities and/or new facilities for the handling of export grain is possible for Port of Grays Harbor (Puget Sound and

Pacific Railroad connection at Centralia) and the proposed Gateway Pacific Terminal project at Cherry Point.

Figure 44: Location of Proposed Gateway Pacific Terminal[223]



Bulk Train – Coal Facilities

Facilities that handle unit trains of coal are located at:

- Centralia, WA.
- Westshore Terminals (Roberts Bank, British Columbia).
- Boardman, OR.
- Gateway Pacific Terminal, Cherry Point, WA (proposed).
- Millennium Bulk Terminals, Longview, WA (proposed).
- Fraser Surrey Docks, Brownsville, BC (proposed).

223 Source: NOAA 2013.

Coal-fired steam electricity generation at Centralia will be eliminated by 2025. The first coal-fired boiler is planned to be shut down by 2020, with the second boiler shut down by 2025.

Several coal export facilities are proposed in Washington, Oregon, and British Columbia. These include:

- Westshore Terminals. This is likely to experience moderate growth until Westshore reaches capacity. Westshore will likely receive on average three trains per day from BNSF of Powder River Basin (PRB) steam coal, or six trains bi-directionally each day, when facility capacity is reached.
- The Gateway Pacific Terminal at Cherry Point. This terminal could handle as many as nine loaded BNSF coal trains per day plus the nine resultant empty trains.
- The Millennium Bulk Terminals facility near Longview. This terminal could handle as many as eight loaded coal trains per day plus eight empty trains.
- A coal export facility at Fraser Surrey Docks that could generate up to three loaded and three empty coal trains per day. Port of Metro Vancouver recently approved the permit for Fraser Surrey Docks to proceed with constructing a coal export facility.

Finally, BNSF is handling one or two loaded coal trains per day destined to Boardman, Oregon, which is on UP's mainline between Hinkle and Portland, OR. BNSF interchanges the trains to/from UP at Spokane, from which they operate on UP tracks to Hinkle and Boardman. The trains do operate over BNSF's mainline corridor between Sand Point and Spokane, which is the primary access into BNSF's Washington rail network. The Boardman facility, however, is scheduled to close by 2020. A new export coal facility, Coyote Island Terminal, is proposed for Boardman. The proposal has recently been denied a permit by the State of Oregon and is going through the appeal process.

Bulk Train – Crude Oil Facilities

Crude-by-rail facilities are located at:

- Tacoma, WA
- Fidalgo, WA
- Cherry Point, WA
- Port Westward, OR
- Vancouver, WA (proposed)
- Port of Grays Harbor, WA (proposed)
- California (existing and proposed)

The rapid expansion of shale oil extraction in the Bakken formation of North Dakota and Montana, with destinations to the Pacific Northwest, planned oil transfer facility development in Washington would result in growth over the next five to 10 years. Oil trains operate through the state to serve existing facilities in Tacoma (U.S. Oil), Fidalgo (Tesoro), Cherry Point (British Petroleum) and Point Westward (Global Partners). In addition, CPR shale operations in Saskatchewan may contribute to growth in the number of unit oil trains operating within and through the state of Washington.

A major development proposed for the handling of crude-by-rail unit oil trains is the Vancouver Energy oil transfer facility at Vancouver, WA. That facility would handle up to four loaded unit trains per day (plus the resultant empty return trains) via Sand Point, Spokane, Pasco and Vancouver. Other potential expansion of current or proposed facilities for handling unit oil trains have been revealed for Phillips at Cherry Point, Shell at Anacortes, U.S. Oil in Tacoma, Targa in Tacoma, Westway Terminal, Imperium Terminal and Grays Harbor Rail Terminal in Grays Harbor, and various sites in California via Wishram. The oil train movement to Point Westward in Oregon is expected to remain relatively consistent at one loaded train per day via the Northern Corridor, Spokane, and Vancouver, WA.

The above described facilities, and the trains that originate and terminate at these facilities, require locomotive and railcar mechanical facilities that are strategically located for rail equipment inspection and repair requirements. Within Washington, BNSF maintains locomotive car and inspection facilities at the following locations: [224]

- Sand Point ID-Spokane (Kootenai/Spokane Subdivision), 68.5 miles
    - Hauser ID – locomotive mainline fueling, inspection, and light repairs for locomotives
    - Spokane, Yardley Yard – locomotive and car inspection/repair (light)
- Spokane-Pasco (Lakeside Subdivision), 146.4 miles
    - Pasco Yard – locomotive and car inspection/repair
- Pasco-Vancouver (Fallbridge Subdivision), 219.8 miles
    - Vancouver Yard – locomotive and car inspection/repair (moderate to light)
- Vancouver-King Street Station (Seattle Subdivision), 136.47 miles
    - Vancouver Yard – locomotive and car inspection/repair (moderate to light)
    - Tacoma Main Yard – locomotive and car inspection/repair (light)
- King Street Station-Everett (Scenic Subdivision), 32.2 miles
    - Interbay, Seattle – locomotive and car inspection/repair
    - Everett/Delta Yard – locomotive and car inspection/repair (light)

[224] *BNSF Railway Timetable No. 4*, 2009.

- Everett-Blaine/Vancouver BC (Bellingham Subdivision), 119.3 miles to Blaine
    - Everett/Delta Yard – locomotive and car inspection/repair (light)
    - New Westminster Yard, Vancouver – locomotive and car inspection/repair (light)
- Everett-Wenatchee (Scenic Subdivision), 134.5 miles
    - Everett/Delta Yard – locomotive and car inspection/repair (light)
    - Wenatchee – locomotive and car inspection/repair (light)
- Wenatchee-Spokane (Columbia River Subdivision), 168.6 miles
    - Wenatchee – locomotive and car inspection/repair (light)
    - Spokane, Yardley Yard – locomotive and car inspection/repair (light to moderate)
- Pasco-Ellensburg (Yakima Valley Subdivision), 125.10 miles
    - Pasco Yard – locomotive and car inspection/repair
- Ellensburg-Stampede Wye, Auburn (Stampede Subdivision), 102.6 miles
    - Pasco Yard – locomotive and car inspection/repair
    - Interbay, Seattle – locomotive and car inspection/repair
    - Tacoma Main Yard – locomotive and car inspections/repair (light)

BNSF's primary heavy car repair facilities in the state are at Pasco and Interbay. All car repair facilities, however, have the ability to repair most common bad order defects, including the changing out of wheels. Normally, it is significant structural damage to a car body that requires a car be repaired sufficiently at another location for safe transport to a larger shop for final repairs, such as at Pasco.

In addition to the car inspection/repair facilities above, BNSF, as does all large railways, has car repair personnel and equipment that go to the site where a bad order car has been "set out" on line. Similar to the light repair facilities, those personnel normally have the ability to make light to moderate repairs, including wheel changes when necessary, and could also repair a car sufficiently for safe transport to a larger repair facility.

Presence or Absence of Wayside Hazard Detectors

The nationwide wayside detector system is a technology that allows railroads to prevent damage and accidents before they could happen. Positioned along 140,000 miles of railroad in the nation, seven kinds of wayside detectors monitor the wheels of passing trains and alert railcar operators to potential defects enabling them to schedule appropriate maintenance in a safe, timely, and cost-effective manner. According to the Association of American Railroads, since the system was developed in 2004, the broken wheel and accident rate has dropped over 20%.[225]

There are seven types of wayside detectors in operation:

- Acoustic bearing detectors (TADS-ABD) use acoustic signatures to evaluate the sound of internal bearings and identify those likely to fail in the near term.
- Railway bearing detectors (RailBAM™) detect faulty wheel bearings as trains pass by.[226]
- Truck bogie optical geometry inspection (TBOGI) is a laser-based monitoring system that measures performance of a railcar's axle and wheel suspension (commonly known as the "truck").[227]
- Truck performance detectors (TPD) assess the performance of railcar suspension systems or trucks on curved track by measuring the wheel's lateral forces at major segments of track containing four to six degrees of curvature. [228]
- Wheel impact load detectors (WILD) identify rail wheels worn or damaged into an out-of-round shape before they can damage track.
- Wheel profile measurement systems (WPMS) evaluate the complete rail profile by capturing laser images and detecting worn wheel treads or flanges. [229]
- Hot box and dragging equipment detectors are the most commonly used types of wayside detectors. A hot box detector is a heat-sensitive device used to measure the temperature of journal bearings on passing railcars.[230] Dragging equipment detectors detect loose components and dragging under freight cars.[231]

The Association of American Railroads (AAR)[232] defines in *Circular OT-55-N* a "Key Route" (or HHFT route) as "Any track with a combination of 10,000 car loads or intermodal portable tank loads of hazardous material, or a combination of 4,000 car loadings of PIH or TIH (Hazard zone A, B, C, or D), anhydrous ammonia, flammable gas, Class 1.1 or 1.2 explosives, environmentally sensitive chemicals, Spent Nuclear Fuel (SNF),[233] and High Level Radioactive Waste (HLRW)[234] over a period of one year".[235]

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225 http://freightrailworks.org/wp-content/uploads/safety2.pdf
226 Not currently present in Washington State.
227 Not currently present in Washington State.
228 Not currently present in Washington State.
229 Not currently present in Washington State.
230 There are more than 6,000 hot box detectors on 140,000 miles of track in North America.
231 More than 1,000 dragging equipment detectors are installed on the North American freight rail network.
232 AAR is an industry trade group representing primarily the major freight railroads of North America (Canada, Mexico, and the United States); Amtrak and some regional commuter railroads are also members.
233 Irradiated fuel or targets containing uranium, plutonium, or thorium that is permanently withdrawn from a nuclear reactor or other neutron irradiation facility following irradiation, the constituent elements of which have not been separated by reprocessing.
234 Waste generated in core fuel of a nuclear reactor, found at nuclear reactors or by nuclear fuel reprocessing.

Contained within *Circular OT-55-N* are the Wayside Detector requirements for Key Routes. Those requirements are:

- Wayside defective bearing detectors shall be placed at a maximum of 40 miles apart on "Key Routes", or equivalent level of protection may be installed based on improved technology.
- Main Track on "Key Routes" is inspected by rail defect detection and track geometry inspection cars or any equivalent level of inspection no less than two times each year. Sidings are similarly inspected no less than one time each year. Main tracks and sidings will have periodic track inspections that will identify cracks or breaks in joint bars.
- Any track used for meeting and passing "Key Trains" must be FRA Class 2[236] or higher. If a meet or pass must occur on less than FRA Class 2 track, due to an emergency, one of the trains must be stopped before the other train passes.

BNSF Railway's Northwest Division Timetable No. 4 identifies Wayside Detectors at multiple locations on its primary mainline corridors in the state of Washington. The detectors include dragging equipment detection, railcar journal integrity exception reporting, wheel impact detectors, and slide fence detectors.

By subdivision/corridor segment, the Timetable provides the following information for Wayside Detectors on BNSF's mainline rail corridors in the state, as shown in Table 18.

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[235] Association of *American Railroads Circular OT-55-N*, Effective August 5, 2013, II. *Designation of "Key Routes"*, paragraph A.
[236] Track classified by FRA with respect to maximum speed for track condition as 25 mph for freight, 30 mph for passenger; Branch lines, secondary mainlines, many regional railroads, and some tourist operations frequently fall into this class.

Table 18: Summary of Wayside Detectors on BNSF Mainline Rail Corridors in Washington[237]

Subdivision/Corridor	Mileposts (MP)	Route Miles	Number Wayside Detectors	Average Miles Between Detectors	Longest Mileage Gap
Sand Point–Spokane, Kootenai/Spokane	MP3.0–MP71.5	68.5	14	4.89	10.4 miles between MP60.1–MP70.5 (Spokane Terminal)
Spokane (Sunset Jct.)–Pasco (SP&S Jct.), Lakeside	MP1.1–MP147.5	146.4	28	5.23	8.2 miles between MP6.1–MP14.3
SP&S Jct.–Vancouver, Fallbridge	MP229.7–MP9.9	219.8	28	7.85	17.0 miles between MP207.8–MP190.8
Vancouver–King Street Station, Seattle	MP136.5–MP0.3	136.2	12	11.35	29.5 miles between MP87.4–MP57.9
King Street Station–Everett (Everett Jct.), Scenic	MP0.0–MP32.2	32.2	4	8.05	10.1 miles between MP17.1–MP27.2
Everett (PA Jct.)–Blaine, Bellingham	MP0.0–MP119.3	119.3	9	13.26	40.7 miles between MP0.0–MP40.7[238]
Everett (Everett Jct.)–Wenatchee, Scenic	MP1784.7–MP1650.2	134.5	22	6.11	23.9 miles between MP1721.2–MP1697.3
Wenatchee–Spokane (Latah Jct.), Columbia River	MP1650.2–MP1481.6	168.6	11	15.33	27.7 miles between MP1607.9–MP1580.2
SP&S Jct. (Pasco)–Ellensburg, Yakima Valley	MP1.9–MP127.0	125.1	12	10.43	30.2 miles between MP49.6–MP79.8
Ellensburg–Stampede Wye (Auburn), Stampede	MP0.0–MP102.6	102.6	18	5.7	16.4 miles between MP20.5–MP36.9

AAR Circular OT-55-N provides restrictions for the operation of HHFT/Key trains that are impacted by Wayside Detectors. Item B, paragraphs 2, 3 and 4, under Road Operating Practices, I. “Key Trains”, provides the following restrictions:

- Unless siding or auxiliary track meets FRA Class 2 standards, a Key Train will hold main track at meeting or passing points, when practicable.
- Only cars equipped with roller bearings will be allowed in a Key Train.

[237] *BNSF Railway Northwest Division Timetable No. 4*, 2009.
[238] Note: BNSF’s Delta Yard is at MP9.1 on the Bellingham Subdivision.

- If a defect in a Key Train bearing is reported by a wayside detector, but a visual inspection fails to confirm evidence of a defect, the train will not exceed 30 mph until it has passed over the next wayside detector or delivered to a terminal for a mechanical inspection. If the same car again sets off the next detector or is found to be defective, it must be set out from the train.

Trackside Warning Devices (TWD) inspect passing trains for defects or monitor for unusual trackside conditions that could adversely affect the safe and efficient movements of trains. Examples of such devices in operation in Washington include the following:

- Overheated journal bearings (HBD)
- Hot wheels
- Dragging equipment detector (DED)[239]
- High/Wide/Shifted load (SLD)
- High water detector
- Earth/Rock slide fence

Individual subdivision special instructions identify detector location and type.

A more detailed description of wayside detectors in Washington is shown in Table 19. Unless otherwise stated, protection will be hot journal and dragging equipment with bidirectional operation. Exceptions are shown as follows:

- Northward direction only (NWD)
- Southward direction only (SWD)
- Eastward direction only (EWD)
- Westward direction only (WWD)
- Dragging equipment only (DED)
- Shifted loads only (SLD)
- Detectors that project bridges, tunnels, or other structures
- Exception Report detector

A message stating, "You have a defect," will be transmitted during the train passage if a defect is detected. When this message is received from a TWD, the train crew must immediately reduce train speed to less than 30 mph, utilizing train handling methods that minimize in-train forces. After train passes the detector, a radio message will be transmitted (unless defined as "Exception Reporting" or "Failure Reporting"). This message will indicate "no defects" or will state any "alarms" or "integrity failures" that were detected during train passage. The detector message is

[239] A device that detects dragging equipment on a railroad, which can damage the track and grade crossings.

not complete until "Out" is received. Radios at Exception Reporting detectors will only transmit a message when an alarm is present.

Table 19: Details on BNSF Wayside Detectors in Washington State

Subdivision	Start	End	Mile Post Location	Type[240]
Kootenai/Spokane Subdivision 68.5 Miles in Length 14 TWDs Average distance apart: 4.89 miles Longest gap: 10.4 miles	Sand Point MP 3.0	Spokane MP 71.5	MP 2.9	Exception Reporting, Recall code 497
			MP 8.5	DED/WWD only, Recall code 498
			MP 11.7	Recall code 487
			MP 16.5	DED - Exception Reporting
	MP 60.1-70.5		MP 24.2	Recall code 488
			MP 27.1	DED - Exception Reporting
			MP 35.5	DED - Exception Reporting
			MP 36.8	DED - Exception Reporting
			MP 41.2	Recall code 497
			MP 47.0	DED - Exception Reporting
			MP 51.9	DED - Exception Reporting
			MP 56.1	DED - Exception Reporting
			MP 60.1	EWD only - Recall code 498
	Protecting bridges, tunnels & other structures:		MP 8.5	DED/WED only, Recall code 498
			MP 60.1	WWD only, Recall code 498
			MP 70.5	DED/WWD only, Recall code 438
Lakeside Subdivision 146.4 Miles in Length 28 TWDs Average distance apart: 5.23 miles Longest gap: 8.2 miles	Spokane MP 1.1	Pasco MP 147.5	MP 6.1	DED/Exception Reporting
	Sunset Jct.	SP&S Jct.	MP 14.3	DED/Exception Reporting
			MP 19.2	DED/Exception Reporting
			MP 25.7	Recall code 617
	MP 6.1-14.3		MP 31.4	DED/Exception Reporting
			MP 36.5	DED/Exception Reporting
			MP 41.3	DED/Exception Reporting
			MP 47.8	Exception code 618
			MP 52.8	DED/Exception Reporting
			MP 57.4	DED/Exception Reporting
			MP 62.5	DED/Exception Reporting
			MP 66.9	Recall code 627
			MP 72.5	DED/Exception Reporting
			MP 78.4	DED/Exception Reporting
			MP 82.3	DED/Exception Reporting
			MP 88.8	DED/Exception Reporting
			MP 94.2	Both tracks. Recall code 628
			MP 99.5	DED/Exception Reporting
			MP 104.6	DED/Exception Reporting
			MP 108.2	DED/Exception Reporting
			MP 112.4	DED/Exception Reporting
			MP 118.8	DED/Exception Reporting
			MP 122.3	Recall code 638
			MP 122.5	Wheel impact detector, no readout
			MP 126.3	DED/Exception Reporting

[240] Trackside warning device (TSD) inspect

Subdivision	Start	End	Mile Post Location	Type[240]
			MP 130.5	DED/Exception Reporting
			MP 134.6	Recall code 648, transmitted on radio
			MP 138.7	DED/Exception Reporting
				Pasco Terminal - MP 145.6
Fallbridge Subdivision 219.8 Miles in Length 28 TWDs Average distance apart: 7.85 miles Longest gap: 17.0 miles	SP&S Jct. MP 229.7	Vancouver MP 9.9	MP 207.8	Recall code 718
			MP 190.2	Recall code737
			MP 177.2	Recall code 738
			MP 152.2	Recall code 598
	(MP 207.8 – MP 190.8)		MP 147.1	DED/Exception Reporting
			MP 142.2	DED/Exception Reporting
			MP 136.7	DED/Exception Reporting
			MP 131.86	DED/Exception Reporting
			MP 128.0	Recall code 758
			MP 118.6	DED/Exception Reporting
			MP 110.1	DED/Exception Reporting
			MP 105.1	DED/Exception Reporting
			MP 100.0	Recall code768
			MP 96.1	DED/Exception Reporting
			MP 89.6	DED/Exception Reporting
			MP 81.7	Recall code 788
			MP 73.9	DED/Exception Reporting
			MP 70.7	Recall code 798
			MP 66.0	DED/Exception Reporting
			MP 61.0	Recall code 818
			MP 58.6	DED/Exception Reporting
			MP 52.5	DED/Exception Reporting
			MP 48.4	Recall code 808
			MP 43.5	DED/Exception Reporting
			MP 37.6	Recall code 238
			MP 32.2	DED/Exception Reporting
			MP 25.1	DED/Exception Reporting
			MP 19.8	Recall code 508
				Vancouver Terminal MP 9.9
Seattle Subdivision 136.47 Miles in Length 12 TWDs Average distance apart: 11.37 miles Longest gap: 29.5 miles	Vancouver MP 136.5	Seattle MP 0.3 (KSS)	MP 113.5	Recall code 298
			MP 87.4	Recall code 258
			MP 57.9	Recall code 468
			MP 30.0	Recall code 268
	MP 87.4-57.9		MP 18.5	Recall code 518, DED
			MP 35.2X	DED/Exception Reporting
			MP 31.4X	DED/Exception Reporting
			MP 26.4X	Recall code 428
			MP 20.8X	DED/Exception Reporting
			MP 15.1X	DED/Exception Reporting
			MP 5.2X	Recall code 407
	Protecting bridges, tunnels & other structures:		MP 18.5	Recall code 518, DED
			MP 10.1	Recall code 528

Subdivision	Start	End	Mile Post Location	Type[240]
Scenic Subdivision 32.2 Miles in Length 4 TWDs Average distance apart: 8.05 miles Longest gap: 10.1 miles	King Street Station MP 0.0	Everett Jct. MP 32.2	MP 10.4	DED/EWD Recall code 548
			MP 17.1	Recall code 368
			MP 27.2	Recall code 358
	MP 17.1-27.2)			
	Protecting bridges, tunnels & other structures:		MP 6.0	DED/EWD - Main 2
			MP 10.4	DED/EWD Recall code 548
Bellingham Subdivision 119.3 Miles in Length 9 TWDs Average distance apart: 13.26 miles Longest Gap: 40.7 Miles	PA Jct. (Everett) MP 0.0	Blaine MP 119.3	MP 40.7	DED - Recall code 378, Exception Reporting
			MP 46.2	DED/SWD - Recall code 408
			MP 55.2	DED/NWD - Recall code 387
			MP 58.9	Recall code 388
	(MP 0.0 – MP 40.7)		MP 67.4	DED/SWD - Recall code 407
	(Delta Yard; MP 9.1)		MP 74.6	DED/NWD - Recall code 389
			MP 81.9	Recall code 398
			MP 95.1	Recall code 397
			MP 110.5	Recall code 418
	Protecting bridges, tunnels & other structures:		MP 46.2	DED/NWD - Recall code 408
			MP 55.2	DED/SWD - Recall code 387
			MP 67.4	DED/NWD - Recall code 407
			MP 74.6	DED/SWD - Recall code 389
Scenic Subdivision 134.5 Miles in Length 22 TWDs Average distance apart: 6.11 miles Longest Gap: 23.9 miles	Everett Jct. MP 1784.7	Wenatchee MP 1650.2	MP 1778.6	DED/EWD - Recall code 338
			MP 1776.2	Recall code 348
			MP 1771.1	DED/EWD - Recall code 329
			MP 1765.8	DED/Exception Reporting
	MP 1721.2-1697.3		MP 1762.0	Recall code 308
			MP 1756.8	DED/Exception Reporting
			MP 1745.7	DED/Exception Reporting
			MP 1735.0	Recall code 318
			MP 1730.7	DED/WWD - Recall code 738
			MP 1725.5	DED/EWD - Recall code 728
			MP 1721.1	DED/WWD - Recall code 317
			MP 1690.0	Recall code 308
			MP 1683.7	DED/Exception Reporting
			MP 1677.2	DED/Exception Reporting
			MP 1673.0	DED/Exception Reporting
			MP 1668.2	Recall code 298

Subdivision	Start	End	Mile Post Location	Type[240]
			MP 1661.6	DED/EWD - Recall code 297
			MP 1654.7	Recall Code 278
	Protecting bridges, tunnels & other structures:		MP 1778.6	DED/EWD - Recall code 338
			MP 1771.1	DED/WWD - Recall code 329
			MP 1751.9	DED - Recall code 337
			MP 1740.5	DED - Recall code 319
			MP 1730.7	DED/EWD - Recall code 738
			MP 1725.5	DED/WWD - Recall code 728
			MP 1721.2	DED/EWD - Recall code 317
			MP 1697.3	DED - Recall code 309
			MP 1695.1	DED - Recall code 307
			MP 1661.6	DED/WED - Recall code 297
Columbia River Subdivision 168.6 Miles in Length 11 TWDs Average distance apart: 15.33 miles Longest Gap: 27.7 miles	Wenatchee MP 1650.2	Latah Jct. MP 1481.6	MP 1644.6	DED/Exception Reporting
		(Spokane)	MP 1638.1	DED/EWD Only – Recall code 277
			MP 1633.6	Recall code 518
			MP 1622.2	DED/EWD Only – Recall code 277
	MP 1607.9-1580.2		MP 1607.9	Recall code 268
			MP 1580.2	Recall code 258
			MP 1555.8	Recall code 248
			MP 1543.2	Recall code 218
			MP 1519.3	Recall code 208
			MP 1495.9	Recall code 198
	Protecting bridges, tunnels & other structures:		MP 1638.1	DED/WWD Only
			MP 1624.2	DED
			MP 1622.2	DED/WWD Only
Yakima Valley Subdivision 125.10 Miles in Length 12 TWDs Average distance apart: 10.43 miles Longest Gap: 30.2 miles	SP&S Jct. MP 1.9	Ellensburg MP 127.0	MP 19.5	Recall code 588
	(Pasco)		MP 30.9	Slidefence detector MP 30.9 – MP 31.0
			MP 35.8	Slidefence detector MP 35.9 – MP 36.0
			MP 49.6	Recall code 238
	MP 49.6- 79.8		MP 79.8	Recal code 498
			MP 94.8	Recall code 478
			MP 101.2	DED/Exception Reporting
			MP 106.5	DED/Exception Reporting
			MP 106.5	Slidefence detector MP 106.5 - MP 107.3
			MP 110.2	DED/Exception Reporting
			MP 116.4	DED/Exception Reporting
			MP 124.2	EWD Only, Recall code 598

Subdivision	Start	End	Mile Post Location	Type[240]
	Protecting bridges, tunnels & other structures:		MP 124.2	WWD Only, Recall code 598
Stampede Subdivision 102.6 Miles in Length 18 TWDs Average distance apart: 5.7 miles Longest Gap: 16.4 miles	Ellensburg MP 0.0	Stampede Wye MP 102.6	MP 9.2	DED/Exception Reporting
		(Auburn)	MP 13.9	DED/Exception Reporting
			MP 20.5	Recall code 518
			MP 36.9	Recall code 617
	MP 20.5-36.9		MP 43.5	DED (EWD Only) – Recall code 618
			MP 46.0	DED/Exception Reporting
			MP 49.0	DED/Exception Reporting
			MP 52.0	DED (WWD Only) – Recall code 537
			MP 56.4	DED/Exception Reporting
			MP 59.0	DED/Exception Reporting
			MP 62.9	Recall code 538
			MP 66.8	DED/Exception Reporting
			MP 71.6	DED/Exception Reporting
			MP 77.9	DED/Exception Reporting
			MP 81.4	DED/Exception Reporting
			MP 86.0	DED/Exception Reporting
			MP 91.5	Recall code 528
			MP 100.6	WWD Only – Recall code 628
	Protecting bridges, tunnels & other structures:		MP 43.5	DED (WWD Only) – Recall code 618
			MP 52.0	DED (EWD Only) – Recall code 537
			MP 100.6	EWD Only - Recall code 628

Safety Gaps and Concerns

UTC identified the following railroad safety gaps and concerns related to matters within federal jurisdiction:

- The sufficiency of tank car standards for Bakken oil.
- Appropriate placarding of tank cars and classification of hazardous materials, including Bakken oil.
- Train speeds of unit trains carrying Bakken oil.
- Routing of trains carrying Bakken oil and other highly flammable liquids.

Tank Car Standards

The adequacy and safety of the tank cars used to transport Bakken oil and other highly flammable liquids is one of the key railroad safety gaps and concerns. Because PHMSA rules govern the construction standards for tank cars for the transportation of highly flammable liquids, and crude oil in particular, referred to as DOT-111 cars,[241] states are preempted from requiring different or more stringent standards for these cars.

The general characteristics of a DOT-111 tank car under existing regulations are as follows:

- DOT-111 cars are roughly 60 feet long, 11 feet wide, and 16 feet high.
- The cars weigh approximately 80,000 pounds empty and 286,000 pounds when full.
- The cars can hold about 30,000 gallons or 715 barrels of oil depending on oil density.
- The tank is made of steel plate with a thickness of 7/16 of an inch.
- The tank has a life span of approximately 50 years,[242] with a 30 – 40 year economic lifespan.

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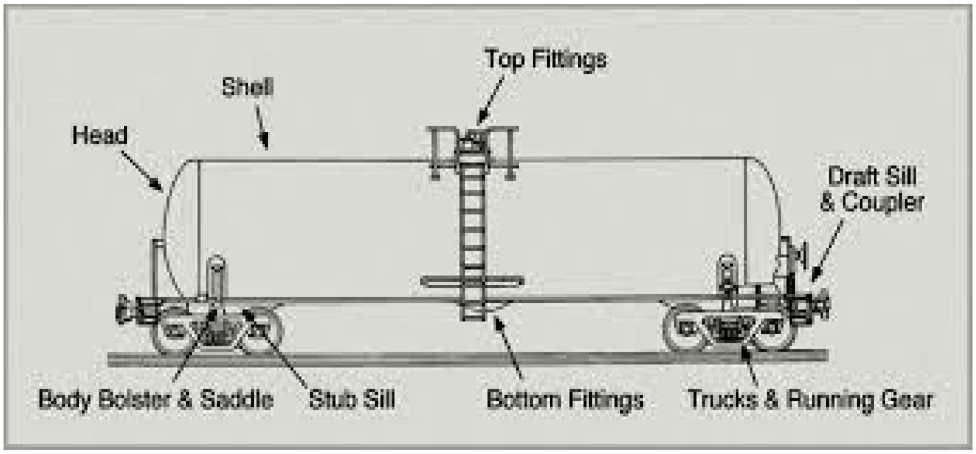
[241] 49 CFR Section 179.201.

[242] GPAC Means of Containment Working Group Recommendations, Transportation of Dangerous Goods General Policy Advisory Council.

Figure 45 shows the basic features of a DOT-111 tank car.

Figure 45: DOT-111 Basic Diagram



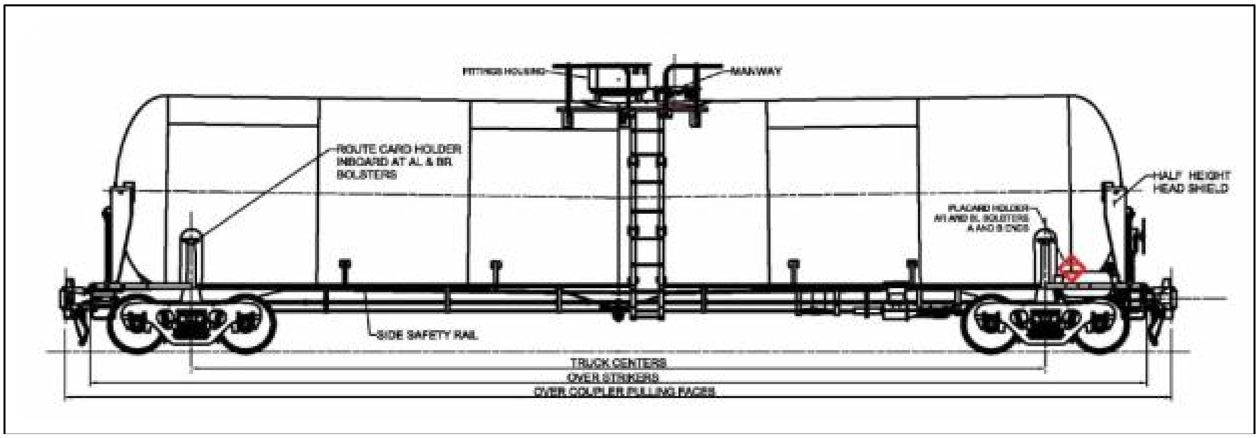
A 1991 study by NTSB found that the DOT-111 tank car is significantly more likely to release its product, suffer a failure, or experience a head or shell puncture than other tank car models (DOT-105, -112 and -114 pressurized tank cars), which have a tank shell thickness of 9/16 of an inch and thermal protection.[243] These tank cars are also used for the transportation of hazardous chemicals. The study found that tank head and shell puncture resistance systems and increased shell thickness may reduce the severity of accidents and the likelihood that hazardous materials are released or spilled. The railroad industry and the PHMSA have only recently begun to address these safety gaps.

In July 2011, the Association of American Railroads (AAR) Tank Car Committee adopted voluntary higher standards as a requirement for new tank cars transporting crude oil and ethanol. The standard, labeled CPC-1232 (Figure 46), applies to all tank cars ordered after October 1, 2011. The specifications for the CPC-1232 are as follows:

- Tank Material: TC-128 Grade B normalized steel.
- Shell of non-jacketed cars must be at least ½ inch thick.
- Shell of jacketed cars must be at least 7/16" inch thick.
- Reclosing pressure relief device.
- Head Protection: Minimum of ½ inch thick half height head shield.
- Top Fittings Protection (similar to a pressurized car).

[243] James Kolstad, National Transportation Safety Recommendation letter to Honorable Gilbert E. Carmichael, Administrator, Federal Rail Administration, July 1, 1991

Figure 46: CPC-1232-Compliant Rail Tank Car[244]



There are approximately 90,000 DOT-111 tank cars in service in the United States, although about 18,000 of those cars have been built or retrofitted to the AAR CPC-1232 standards.[245] It is estimated that approximately 60% of the national domestic fleet of tank cars will meet or exceed the CPC-1232 standard by the end of 2015. [246]

Petroleum industry representatives have informed the UTC that refineries in Washington State are voluntarily adopting a policy that only newer CPC-1232 model tank cars be used to ship Bakken oil to the state. Based on inspections by the UTC hazardous materials inspector, the UTC understands that about 80 to 85% of the tank cars servicing Washington are the newer models and that older models are being replaced as they arrive at Washington refineries.

PHMSA initiated a rulemaking in April 2012 to consider changes to the standards for railroad tank cars and released proposed rules on July 23, 2014, which propose a new DOT Specification 117 tank car for highly flammable materials. All new construction after October 1, 2015, will need to meet or exceed the DOT-117 standards. The proposed regulation requests comments on several options for possible tank car standards. The state filed comments on this rulemaking as found in Appendix I of this report.

Placarding and Classification of Hazardous Materials

With the increased shipments of Bakken oil and the recent accidents involving these shipments, there is a concern that those offering the shipments for transportation by rail are not properly classifying the hazardous materials, or ensuring appropriate placarding of these materials. PHMSA rules govern the testing, classification, and placarding of hazardous materials. If materials are not properly classified or placarded, first responders cannot effectively respond to spills, fires or explosions. Further, the necessary information is carried by the trainmen on the train but not captured visually on the tank car placards.

[244] Barkan et al. 2014.
[245] Tank Car Fact Sheet, Association of American Railroads.
[246] Industry estimate based on discussion with industry group.

Two recent studies prepared for the states of New York and California[247] have addressed the need for more standardized placarding. These studies recommend that the United Nations, which assigns unique internationally consistent hazardous materials identifiers on tank placards, should update the information for tank car placards. They suggest the updated information should contain the flash point and vapor pressure of the specific type of crude oil in each tank car. This would allow emergency responders to quickly and easily determine what resources and strategies are best deployed in the event of an accident that results in release of product or fire. Such a system would allow for a safer and more effective response strategy.

In its July 23, 2014, notice of proposed rulemaking, PHMSA proposes new standards for classification and placarding for mined gases and liquids. The state filed comments on this rulemaking as found in Appendix H to this report.

Speed Restrictions

BNSF restricts the maximum speed of loaded unit bulk trains (i.e., grain and coal) to 45 mph for safe operating purposes. Empty unit bulk trains are allowed to operate at maximum track speed. Operating HHFT/Key Trains at the same maximum speed as other loaded unit bulk trains would likely have a minimal impact on unit train cycle times and not negatively impact overall route capacity as most loaded bulk trains move east to west within the state.

BNSF restricts all trains that are over 100 tons per operative brakes (100 OB) to a maximum speed of 45 mph throughout its system.[248] Whether a train exceeds 100 OB is determined by the total weight of the train (cars and commodity without the weight of the locomotives) divided by the number of cars in the train with operable brakes. For example, a 100-car train that weighs 12,000 U.S. tons has a ratio of 120 tons per each car with operating brakes, assuming all cars within the train have operable brakes (12,000 /100 = 120).

Unit crude-by-rail trains exceed 100 tons per operative brakes so are restricted to a maximum speed of 45 mph on BNSF. Lesser volumes of crude-by-rail cars, however, can often be transported in manifest trains, which frequently do not exceed 100 OB. Manifest trains are normally comprised of loaded and empty box cars, gondolas, individual tank cars, auto cars, and the like. Trains that do not exceed 100 OB can operate at the maximum speed of the track for freight trains. Maximum speed on BNSF in Washington for freight trains on its primary routes is 60 mph, with the exception of the Auburn to Pasco corridor (Stampede Pass) which has a maximum speed of 49 mph.[249.] Empty bulk trains, including crude-by-rail, do not exceed 100 OB and can therefore operate at the maximum freight speed for the particular corridor(s) they operate on.

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[247] New York State Department of Environmental Conservation et al. 2014; State of California Interagency Rail Safety Working Group 2014.

[248] *BNSF Railway System Special Instructions – No. 3* – July 18, 2012.

[249] *BNSF Railway Northwest Division Timetable No. 4*, June 17, 2009.

Maximum speed on any line segment is determined by FRA track classifications in 49 CFR 213.9 - Classes of track: operating speed limits.[250] BNSF mainline corridors that have passenger operations on them are all designated and maintained as FRA Class 4 tracks – 60 mph maximum speed for freight trains and 79 mph maximum speed for passenger trains. The Auburn to Pasco corridor (Stampede Pass), which does not host passenger trains, is maintained to FRA Class 4 specifications, but is limited to a maximum freight train speed of 49 mph by BNSF. The maximum speed of FRA Class 3 tracks under 49 CFR 213.9 is 40 mph for freight but exceptions are provided in paragraph (b) as defined in sections 213.57(b), 213.59(a), 213.113(a), and 213.137)(b) and (c).[251] The Stampede Pass corridor is a signalized combination of Automatic Block Signal System (ABS) and Centralized Traffic Control (CTC).[252]

An ABS signal system is defined in the General Code of Operating Rules (GCOR) as "A series of consecutive blocks governed by block signals, cab signals, or both. The signals are activated by a train or by certain conditions that affect the block use".[253] Certain conditions include any event that disrupts the continuity of the signal current within the rail infrastructure, such as washouts, slides that disturb the track structure, a switch intentionally opened prior to a train's arrival, broken rail, or other items that interrupt the signal system continuity.

A CTC system is defined in the GCOR as a "Block signal system that uses block signal indications to authorize train movements".[254] Train movements within CTC signal territory are "authorized" by signal indications which are controlled remotely by a train dispatcher or control operator. The control operator has train movement authorization control through "Control Points", which are locations on the track network at which the control operator has direct remote control of the position of switches and the resulting alignment of signals. A control point is defined in the GCOR as "The location of absolute signals controlled by a control operator".[255] A control operator is defined in the GCOR as an "Employee assigned to operate a CTC or interlocking control machine or authorized grant track permits"**.** [256]

Depending on FRA's final decision in the rulemaking on the definition and authorized maximum speed of a HHFT (or Key) train, certain HHFT freight trains that do not exceed 100 OB could operate at a maximum speed of 50 mph, rather than 45 mph. Limiting all trains that are designated as HHFT or Key trains to a maximum speed of 45 mph, regardless of whether they exceed 100 OB, would be consistent with maximum operating speeds for unit bulk trains on the BNSF network and should have appreciably little impact on train performance and capacity as such trains would be operating in a consistent manner with other 100 OB trains.

[250] *Federal Register, CFR*: Title 49, Subtitle B, Chapter II, Part 213, Subpart A, Section 213.9.
[251] *General Code of Operating Rules*, Sixth Edition, Effective April 7, 2010.
[252] *General Code of Operating Rules*, Sixth Edition, Effective April 7, 2010.
[253] *General Code of Operating Rules*, Sixth Edition, Effective April 7, 2010.
[254] *General Code of Operating Rules*, Sixth Edition, Effective April 7, 2010.
[255] *General Code of Operating Rules*, Sixth Edition, Effective April 7, 2010.
[256] *General Code of Operating Rules*, Sixth Edition, Effective April 7, 2010.

BNSF agreement on restricting the maximum speed of defined HHFT trains to 45 mph on its network would apply to Union Pacific Railway (UPRR) trains operating on BNSF between Portland and Seattle. A BNSF agreement would not apply to UPRR trains operating on its line between Eastport/Kingsgate ID and Wallula, which is an FRA Class 3 rail line with a maximum freight speed of 49 mph. While it appears that minimal, if any, crude-by-rail traffic is operating on UPRR's route connecting to Canadian Pacific Railway (CPR) at Eastport, the potential for HHFT defined trains to transit the route cannot be dismissed as CPR has access to the northern Bakken Oil Field and to the Alberta Oil Sands. An agreement to restrict HHFT defined trains to 45 mph with BNSF should also be pursued with UPRR regardless of the FRA's final decision on determining the maximum speed of HHFT trains.

Maximum speed of trains, freight and passenger, is determined by FRA track classification, railway restrictions (such as for 100 OB trains on BNSF), or permanent speed restrictions at specified locations. Temporary speed restrictions are implemented at specific locations where it has been determined that track condition requires a slower speed until the condition can be repaired. Most often locations where temporary speed restrictions (also called Slow Orders) are applied are discovered by railway Track Inspectors or are reported by the operating crews of passing trains.

On the BNSF network in Washington, permanent speed restrictions are in place through many of the more heavily populated cities and communities. Examples of the locations with permanent speed restrictions are listed in Table 20.

Table 20: Examples of Permanent Speed Restrictions for BNSF Railway Northwest Division[257]

Route	Subdivision/Section	Mileposts (MP)	Train Speed (mph)	
			Freight	Passenger
Spokane	Sunset Junction	MP 71.5–MP 1481.1	25	25
	2 Main Track CTC	MP 71.5–MP 1.1	25	25
		MP 375.0–MP 374.8	25	25
	Latah Junction	MP 1481.6–MP 375.0	30	30
Pasco	Lakeside	MP 229.7–229.1	25	35
		MP 145.3–MP 146.6	25	25
	Columbia River Drawbridge	MP 146.6–MP 147.5	25	35
Vancouver	Fallbridge	MP 10.5–MP 9.8	10	10
		MP 9.8–MP 9.2	30	30
		MP 8.9–MP 8.5	30	30
	Seattle	MP 136.5–MP 136.2	35	35
Kelso	Seattle	MP 95.3–MP 97.2	40	45
Centralia	Seattle	MP 53.7–MP 54.4	40	40
Tacoma	Ruston/Seattle	MP 5.1–MP 6.5	40	40
	21st Street/ Main Track 1 & 2	MP 0.0–MP 2.8	40	40
	Clear Creek	MP 0.0–MP 37.8x	30	30
Puyallup, Auburn, Kent	Seattle	-	50[258]	-
Tukwila	Seattle	MP 10.7x–MP 10.4x	45	55
Argo	Seattle	MP 3.4x–MP 2.6x	35	50
Seattle	King Street Station (Stadium)	MP 3.4x–MP 0.0	25	30
Seattle, King Street Station	Seattle Tunnel, Scenic	MP 0.0–MP 1.9	25	30
	Through Interbay	MP 1.9–MP 5.9	35	60/49
	Ballard Bridge	MP 5.9–MP 6.6	20	30/20
Edmonds	Scenic	MP 16.7–MP 17.0	40	50
Mukilteo	Scenic	MP 26.9–MP 28.1	35	45
Everett	Scenic	MP 1782.9–MP 1780.7	40	40
Marysville	Bellingham	MP 37.0–MP 37.2	10	10
		MP 37.2–MP 38.7	20	35/20
Mt. Vernon	Bellingham	MP 67.9–MP 70.4	45	50
Bellingham	Bellingham	MP 90.5–MP 93.6	35	45
		MP 93.6–MP 96.7	30	35
		MP 66.7–MP 97.1	20	20
		MP 97.1–MP 100.2	35	45
Ferndale	Bellingham	MP 105.8–MP 106.2	40	45
Wenatchee	Scenic (Main 1)	MP 1650.2–MP 1652.9	25	25
	Scenic (Main 2)	MP 1650.2–MP 1651.1	35	35
	Scenic (Main 2)	MP 1651.1–MP 1652.9	45	50
Kennewick	Yakima Valley	MP 1.9–MP 4.3	35	-
Yakima	Yakima Valley	MP 88.0–MP 99.1	25	-
Ellensburg	Stampede	MP 127.0–MP 1.3	35	-
Stampede Pass Tunnel	Stampede	MP 39.3–MP 57.6	20	-
Auburn (Stampede	Stampede	MP 101.0–MP 101.80	25	-

[257] *BNSF Northwest Division Timetable No. 4.*

[258] Specific for HHFT/Key trains.

Route	Subdivision/Section	Mileposts (MP)	Train Speed (mph)	
			Freight	Passenger
Pass Route)		MP 101.8–MP 102.9	20	-

In addition to permanent slow orders listed in the active Timetable and System Special Instructions, and slow orders for track or operating issues temporary in nature, permanent or semi-permanent slow orders are put in place through issuance of Notices or General Orders, which are posted at locations where operating crews go on duty. Slow orders intended to become permanent are then included in the next update of the Timetable or System Special Instructions.

Train Routing

Federal rules, including those issued by FRA and the Department of Homeland Security (DHS), govern how train shipments of hazardous materials are routed across the United States. FRA routing and train speed rules are based on the nature of the materials being shipped, track condition, and other operating conditions. In 2006, DHS conducted an Urban Area Security Initiative (UASI), which studied the nation's largest urban areas. In that study, 46 areas were determined to have a combination of the highest populations with the most critical infrastructure and were designated High Threat Urban Areas (HTUA). The HTUAs were developed to mitigate casualties resulting in the release of railroad cargo classified as poisonous by inhalation, which include chlorine and anhydrous ammonia. In Washington State, Seattle is the only city on the HTUA list.

The absence of cities like Spokane, Vancouver, and Tacoma illustrate the gap that exists in the determination of how a high threat urban area should be classified. There is no mechanism for states to include cities for consideration to the HTUA.

Given the increase in crude oil transportation by rail, and the potential for catastrophic loss of life in populated urban areas, there exists an opportunity for FRA to evaluate the effectiveness of its routing and train speed rules, and for DHS to reevaluate its list of HTUA's to include cities through which railroads are moving crude oil. Examples in Washington would include, but not be limited to, Spokane and Tacoma.[259]

Availability of Practical Alternative Routes

A synopsis of the commodity types and traffic flows over each of BNSF's mainline corridors in Washington was included in the overview of the BNSF rail network (Figure 43). Those corridors are:

- Sand Point, ID, to Spokane.
- Spokane to Vancouver, WA, via Pasco and Wishram.
- Spokane to Everett via Wenatchee (Stevens Pass route).

[259] A map of densely-populated areas that may be affected by crude-by-rail trains is shown in Figure 28.

- Vancouver, WA, to Blaine via Tacoma, Seattle, Everett, and Bellingham.
- Auburn to Pasco via Ellensburg and Yakima (Stampede Pass route).

The first four corridors above are FRA Class 4 routes (maximum freight speed of 60 mph and maximum passenger speed of 79 mph). Each of the four routes is predominantly governed by Centralized Traffic Control (CTC) signals, and each hosts passenger operations.

The Stampede Pass route has a maximum freight speed of 49 mph and is predominantly governed by an Automatic Block Signal System, with "islands" of CTC control points at meet/pass sidings. There are no passenger trains operating on the Stampede Pass route.

All trains entering and exiting the state on BNSF tracks operate over the corridor between Sand Point and Spokane, with the exception of those few trains that operate to California and Oregon from Puget Sound via Vancouver and Wishram. The Sand Point to Spokane corridor is primarily double-track and includes the mainline locomotive fueling facility at Hauser, ID.

Current BNSF routing protocols for loaded unit bulk trains, including crude-by-rail, are westbound from Spokane on the Gorge Route to Wishram and Vancouver, and the I-5 Corridor from Vancouver to Tacoma, Seattle, and Everett to Anacortes and Cherry Point. Eastbound routing of empty trains to Spokane is dependent on available train slots on Stevens Pass and the Columbia River Gorge route on a daily basis with a growing number of eastbound empty unit bulk trains operating over Stampede Pass under the Iron Triangle routing concept. That concept is a long-term strategy to maximize westbound capacity between Pasco, Wishram, and Vancouver by utilizing Stampede Pass as the eastbound outlet for most of the empty bulk trains originated along the I-5 Corridor. It also protects the Stevens Pass route, with its finite capacity, to accommodate future growth of premium intermodal[260] and auto trains between Puget Sound and the Midwest, Southeast, and Southern U.S.

While it might be assumed that BNSF could route crude-by-rail trains (and/or other unit bulk trains) over all three of the east-west corridors west of Spokane (Spokane-Pasco-Vancouver, Spokane-Pasco-Stampede Pass, Spokane-Wenatchee-Everett), the routing of crude-by-rail trains via Stampede Pass or Stevens Pass would likely have negative impacts to BNSF rail operations in the state.

Spokane to Everett via Stevens Pass

The Stevens Pass route is BNSF's primary intermodal route between Puget Sound and the Midwest, Southeast, and Southern U.S. Due to the eight-mile-long Cascade Tunnel and the 2.2% ascending grade on both approaches to the tunnel, maximum sustainable capacity on the route has consistently been determined to be 28 bi-directional trains per day. BNSF would

[260] An intermodal train is one that carries containers that may also be loaded onto ships or trucks for transport.

consider three primary factors for routing loaded crude-by-rail trains destined for points north of Everett – commercial, operational, and geographic.

- **Commercial Considerations:** The route is BNSF's most competitive route between Puget Sound and the Chicago Gateway, comparing in mileage with Canadian Pacific Railway's (CPR) route between Vancouver BC and Chicago, and shorter than Canadian National Railway's (CN) route between Vancouver BC and Chicago and UP's route between Puget Sound and Chicago via Portland. If some of the available 28 train slots per day were devoted to westbound slower, heavier crude-by-rail trains, growth in international container trains from the Ports of Seattle and Tacoma, and domestic intermodal trains from South Seattle, could become constrained. Alternately routing international and domestic intermodal trains via Vancouver, WA and the Columbia River Gorge route to Spokane would add considerable miles and time from a service and cost perspective.
- **Operational Considerations:** The current routing of loaded crude-by-rail and other unit bulk trains via Pasco and Vancouver minimizes the grades loaded trains have to traverse. The prevailing westbound grade on the Lakeside Subdivision between Spokane and Pasco is 1.15% between Sunset Jct. and Marshall, just west of Spokane. The prevailing westbound grade between Pasco and Vancouver on the Fallbridge Subdivision is 0.20% between Berrian and Paterson. The prevailing westbound grade between Vancouver and Seattle is 0.9% at Napavine between Kelso and Centralia.

  With the limited westbound grades on the Lakeside, Fallbridge, and Seattle Subdivisions, BNSF is able to operate loaded unit bulk trains, including crude-by-rail trains, with four locomotives, generally two on the head end and two DPU locomotives on the rear end. If loaded unit crude-by-rail trains were operated over Stevens Pass between Spokane and Everett, it is likely that at least two additional locomotives would be required for each loaded train to surmount the approximately eight miles of 2.2% ascending grade between Merritt and the East Portal of the Cascade Tunnel. [261]
- **Geographic Considerations:** The Stevens Pass route between Wenatchee and Monroe is essentially through mountainous terrain that includes seven tunnels (including the Cascade Tunnel), curves, and snow sheds. In addition to the ascending grade issue, the descending grade westbound leaving the Cascade Tunnel is 1.66% from the west portal to Scenic and 2.2% from Scenic to near Skykomish, or approximately 30 miles of significant descending grade. Maximum freight train speed between the west portal of the tunnel and Skykomish is 25 mph with 20 mph maximum speed between MP 1721.2 and MP 1730.0. Maintaining speed control of heavily loaded unit bulk trains for a considerable distance on significant ascending grade with multiple curves is a familiar, often daily task that locomotive engineers undertake, but the chances of losing control of a heavy tonnage train in mountain terrain increase with the distance the train must traverse on mountainous ascending grades.

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[261] *BNSF Railway Timetable No. 4*, 2009.

Spokane to Puget Sound via Stampede Pass

Routing loaded crude-by-rail trains to Puget Sound and north via Stampede Pass would have some of the same issues for BNSF that routing via Stevens Pass would have. Crude-by-rail trains would still operate over the Lakeside Subdivision between Spokane and Pasco, as they do today, but Tacoma, Anacortes, and Cherry Point loaded crude-by-rail trains would be routed via Yakima, Ellensburg, and Stampede Pass to Auburn. If this route were developed in that manner, it is conceivable that the proposed Grays Harbor crude-by-rail trains might be routed via Auburn, Tacoma, and Centralia.

- **Commercial Considerations:** There would likely be minimal impact on BNSF service strategies as minimal service-sensitive traffic operates over Stampede Pass, since the tunnel is not cleared for double-stack intermodal traffic or auto cars. Westbound routing of crude-by-rail trains on the route, however, would have a definite impact on the full potential of the Stampede Pass route as the primary eastbound empty unit train route between the upper I-5 rail corridor and Pasco. Depending on the number of crude-by-rail trains that might operate daily on the route, some number of empty unit bulk trains that could utilize the route would likely be forced to routing eastbound through the Columbia River Gorge, impacting capacity on the Fallbridge Subdivision between Vancouver and Pasco.

- **Operational Considerations:** Similar to Stevens Pass, fully loaded unit crude-by-rail trains operating westbound between Pasco and Auburn would likely require at least two additional locomotives due to the terrain to be traversed. The westbound prevailing grade approaching the Stampede Pass tunnel parallels that approaching the Cascade tunnel at an average of 2.2%. While not as long as the eastbound prevailing grade on Stevens Pass, the eastbound ascending grade approaching the Stampede Pass tunnel also averages nearly 2.2%.

  Train movements on the Stampede Pass route is generally governed an Automatic Block Signal System and Track Warrant Control, with islands of CTC at meet/pass points. The maximum speed on the route is 49 mph. No passenger trains or HHFT designated trains operate on the line so it is doubtful that BNSF is planning to install PTC on the route in the foreseeable future. Should HHFT trains be routed between Pasco and Auburn via Stampede Pass, it is likely it would become necessary for BNSF to install PTC and to upgrade the entire route to full CTC, which would require an expenditure in capital.

- **Geographic Considerations:** Also similar to Stevens Pass, the Stampede Pass route traverses considerable mountainous terrain with the attendant ascending grades, descending grades, and curves. The westbound descending grade between Stampede and Lester is generally 1.95% and from 1.5% and 0.5% between Lester and Ravensdale. The west slope of the route between Stampede and the Auburn Wye is burdened with multiple curves that restrict maximum train speed. Maximum freight train speeds between Stampede (MP 49.0) and the Stampede Wye at Auburn (MP 102.6) is predominantly between 20 mph and 35 mph, with one section of 40 mph between MP 84.9 and MP 98.4.[262] There are approximately 53 miles of ascending track with multiple curves, with maximum speeds ranging between 20 mph and 40 mph.

Derailments

Prevention is the key to minimizing the impacts that a derailment would have on communities and the environment. Derailments occur for a number of reasons, such as track conditions, human error, equipment failure, and signal defects. In Washington State, there are added concerns about derailments in areas subject to mudslides or seismic activity (earthquakes).

Derailments in rail operations occur for a variety of reasons and will most likely continue to occur, although every effort should be made to reduce their frequency and severity. Since it is an unrealistic expectation that all derailments will be prevented, preparedness for emergency response will be important for minimizing the potential consequences of a derailment incident. It is important to note that not all derailments result in oil spillage or fires.

Analysis of Nationwide Rail Incident Data

During the ten-year period, 2001–2010, there were, on average, 809 derailments annually on tracks throughout the U.S. (Table 21), of which 444 occur on mainlines. There were also about 70 collisions annually (between trains), and 137 highway-rail accidents in which there were collisions between trains and motor vehicles at crossings.

With an estimated 95,514 miles of mainline track, that comes to about 0.0046 annual mainline derailments per track mile, or one derailment for every 215 miles of track. On a ton-mile[263] basis, there were, on average, 0.00000000026 derailments per ton-mile, or one mainline derailment for every 3.85 billion tons of freight moved (including but not limited to crude-by-rail cargo).[264]

A proportion of railroad derailments occur on yard tracks and auxiliary tracks. Those tracks are normally not maintained to the same level as mainline or mainline siding meet/pass tracks. They are, however, normally limited to much lower maximum speeds than are mainline and meet/pass sidings, generally with a maximum speed of 10 mph. Mainline and meet/pass siding derailments tend to create more community awareness due to the extent of damage that results and often the greater threat to involved community(s) and to the environment.

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[262] *BNSF Railway Timetable No. 4*, 2009.

[263] A ton-mile is a unit of measure the combines the tonnage of cargo or freight and the distance traveled. A single ton-mile is a ton of cargo being transported one mile.

[264] https://www.aar.org/STATISTICSANDPUBLICATIONS/Documents/AAR-Stats-2013-04-17.pdf

Table 21: Accident Number, Severity, and Car Derailment by Accident/Track Type, Class I Freight Railroads 2001 – 2010 (Nationwide)[265]

Track Type	Total Number of Incidents 2001 – 2010 by Accident Type				
	Derailment	Collision	Highway-Rail	Other	All Accident Types
Number of Freight Train Accidents					
Mainline	4,439	302	1,343	590	6,674
Yard	2,848	355	12	378	3,593
Siding[266]	436	23	4	40	503
Industry[267]	369	21	6	49	445
All	8,092	701	1,365	1,057	11,215
Average Number of Cars Derailed per Accident					
Mainline	8.4	3.3	0.5	1.0	5.9
Yard	4.7	1.5	0.8	1.4	4.0
Siding	5.7	3.7	0.0	1.2	5.2
Industry	4.3	1.0	1.3	0.5	3.7
All	6.8	2.3	0.5	1.1	5.2
Total Number of Cars Derailed					
Mainline	37,456	989	609	580	39,634
Yard	13,363	527	9	511	14,410
Siding	2,477	85	0	47	2,609
Industry	1,593	22	8	23	1,646
All	54,889	1,623	626	1,161	58,299

A key prevention component in minimizing derailments is the extent to which the subject railroad employs monitoring equipment to detect anomalies with a train's operation, its equipment, or other factors which could affect the safe passage of a train. In Washington, BNSF's extensive distribution of such equipment (i.e., Wayside Detectors) is identified elsewhere in the report.

Other components in minimizing derailments include track condition, track inspection, operating protocols, and maintenance policies. BNSF's mainline corridors in the state of Washington over which loaded crude-by-rail trains operate are FRA Class 4 tracks,[268] maintained to allow Amtrak passenger trains to operate at a maximum speed of 79 mph, and freight trains to operate at a maximum speed of 60 mph. BNSF restricts loaded unit bulk trains that exceed 100 tons per operative brakes to 45 mph, which applies to crude-by-rail trains system-wide.[269]

Derailments result from many causes, primarily track condition, equipment failures, or human error. Human error has often been cited as a primary cause for concern as a contributory component of derailments. For derailments other than on the mainline and sidings, human error has been to shown to be a frequent primary cause. A study performed for the Rail Transportation

[265] Based on Liu et al. 2012.
[266] A track that is used for passing and overtaking trains.
[267] Within loading/offloading facilities.
[268] *BNSF Northwest Division Timetable No. 4*, 2009.
[269] *BNSF System Special Instructions,* 2012.

and Engineering Center at the University of Illinois at Urbana-Champaign analyzed derailments throughout the United States between 2001 and 2010.[270]

The analysis revealed different results for mainline track than siding track. For mainline derailments, broken rails accounted for the largest percentage of derailment cause (15.3%). Train handling (excluding brakes), a human error factor, resulted in 4.6% of the derailments analyzed, the only human error factor specifically identified. The analysis of derailments on sidings indicated that broken rails or welds were the largest contributors to derailments at 16.5%. Two human factors were on the list of the 10 most prevalent causes of derailments on sidings – switching at 7.7% and train handling (excluding brakes) at 3.5%.

Crude-by-Rail Derailments

The nine crude-by-rail-related derailments that occurred on mainline track in North America over the past year involved varying numbers of cars, as shown in Table 22.

Table 22: Crude-by-Rail Derailments with Spillage - Tank Car Numbers 2013–2014

Location	Derailed Tank Cars	Tank Cars with Spillage	Total Tank Cars	Percent Derailed	Percent Spilled
LaSalle, Colorado	6	1	100	6%	1%
Vandergraft, Pennsylvania	19	1	120	16%	1%
Plaster Rock, New Brunswick	17	5	n/a	n/a	n/a
Lac-Mégantic, Quebec	63	5	72	88%	7%
Aliceville, Alabama	30	12	90	33%	13%
Casselton, North Dakota	20	20	106	19%	19%
Lynchburg, Virginia	17	3	105	16%	3%
Gainford, Alberta	4	0	n/a	n/a	n/a
Parkers Prairie, Minnesota	14	3	94	15%	8%

270 Liu et al. 2012.

Analysis of Washington State Data

To assess BNSF's derailment record on its mainlines in Washington (including meet/pass sidings), a review of its derailment record was performed for years 2003 through 2013. Data available through March 2014 were included as well.[271, 272] The data analyzed for the assessment focused on BNSF mainline corridors on which crude-by-rail oil trains operate, e.g., Sand Point-Spokane, Spokane-Vancouver via Pasco, Vancouver-Seattle, and Seattle-Cherry Point. The Stampede Pass route between Auburn and Pasco, and the Stevens Pass route between Everett and Spokane, were also included due to the movement of empty crude-by-rail trains via those corridors.

The review of the information generated from the FRA database indicates that during the years 2003 through 2013, BNSF experienced 89 mainline and meet/pass siding derailments that were reportable under FRA criteria. A graphic representation of the number of derailments by year is shown in Figure 47. BNSF experienced only three derailments per year statewide in the years 2011, 2012, and 2013, when crude-by-rail trains were operating, of those only one was attributable to human error. Of the 89 derailments during the review period, 18 were credited to human error, or about 20%. Most of the derailment causes were assigned to track or equipment.

In Washington, during 2006–2013, there have been, on average, 240 rail accidents annually, including 45 derailments (Table 23). Of the derailment incidents, 36.5% occurred on mainlines, 62.4% in yards, and 1.1% under other circumstances. The number of derailments has decreased in recent years, even with the addition of crude-by-rail trains to the system Figure 47).

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271 FRA Office of Safety and Analysis, *Section 2.03 Train Accidents by Railroad Groups.*

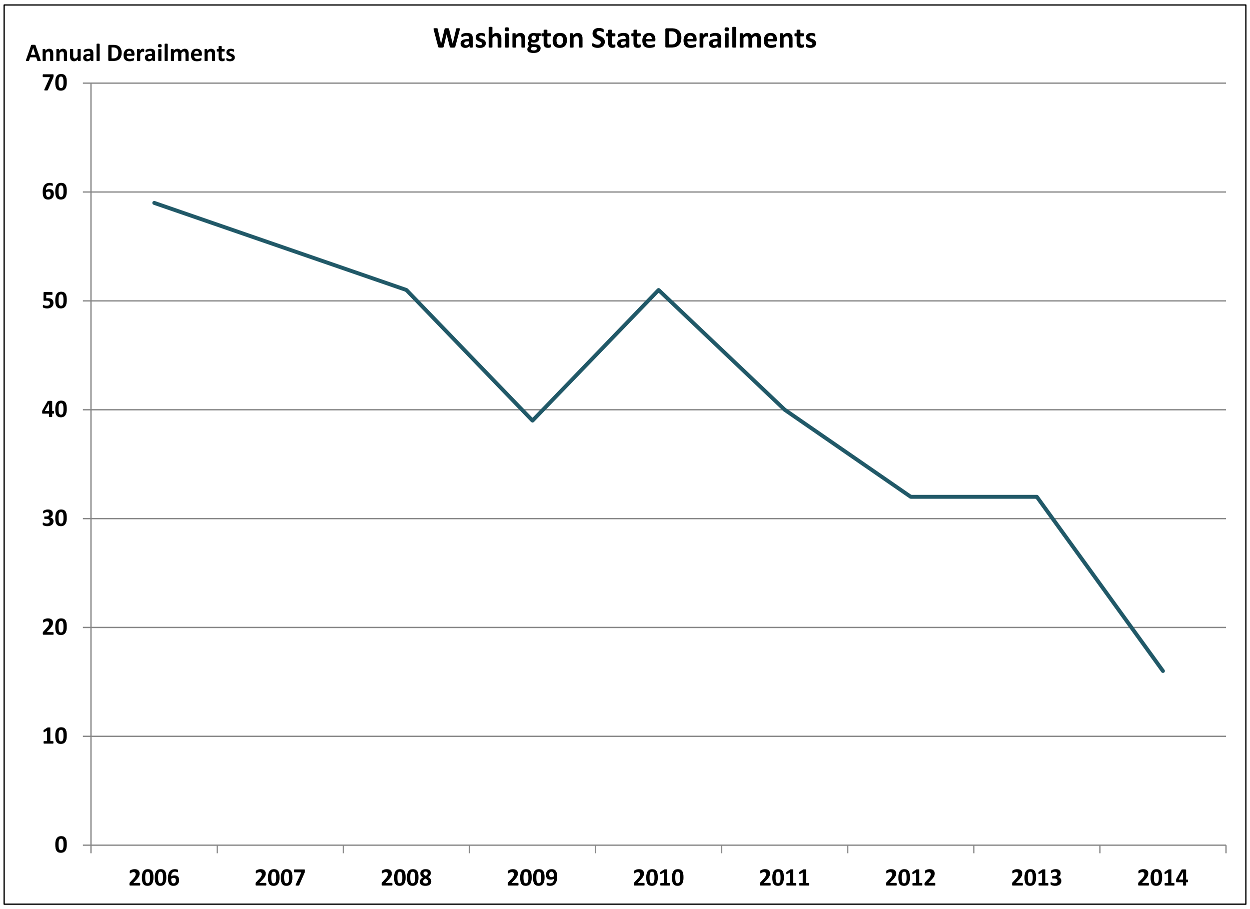
272 The FRA database can be sorted by railroad and geographically. The source of the derailment data was the Federal Railroad Administration Office of Safety and Analysis database, which maintains a record of all derailments meeting the damage criteria for reporting an accident (currently $10,500 in track, equipment and other property damages).Yard derailments and at-grade crossing accidents were not downloaded and analyzed at this time, although that information is also retrievable from the FRA database. As indicated elsewhere in this report, however, there are concerns about the adequacy and accuracy of the FRA reported information. It was noted in the review that 3 BNSF derailments incidents, one each in 2011, 2012 and 2013, did not yet have an assigned incident number or cause yet assigned. That issue can result from a railroad investigation as to a cause not yet determined or the FRA updating process not yet complete.

Table 23: Washington State Rail Accidents/Incidents 2006–2014[273]

Incident Type	Number of Incidents by Year									Total 2006-2013
	2006	2007	2008	2009	2010	2011	2012	2013	2014	
Incidents	271	280	261	254	269	207	195	183	48	1,928
Derailments	59	55	51	39	51	40	32	32	4	359
Derailment Location	Number of Incidents by Year and Derailment Location									Total
	2006	2007	2008	2009	2010	2011	2012	2013	2014	
Yard	37	31	29	26	32	29	17	23	1	224
Mainline	18	24	22	13	19	11	15	9	3	131
	% Incidents by Derailment Location in Each Year									Total
Yard	67%	56%	57%	67%	63%	73%	53%	72%	-	63%
Mainline	33%	44%	43%	33%	37%	28%	47%	28%	-	37%
Derailment Cause	Number of Incidents by Year and Derailment Cause									Total
	2006	2007	2008	2009	2010	2011	2012	2013	2014	
Human Factor	8	5	5	4	6	4	0	2	2	34
Equip. Defect	17	13	16	8	14	9	10	9	1	96
Track Condition	10	11	9	3	6	3	0	5	0	47
Miscellaneous	1	0	1	1	1	0	0	0	0	4
Signal Defect	23	26	20	23	24	24	17	16	1	173
	% Incidents by Derailment Cause in Each Year									
Human Factor	13.6%	9.1%	9.8%	10.3%	11.8%	10.0%	0.0%	6.3%	-	9.6%
Equip. Defect	28.8%	23.6%	31.4%	20.5%	27.5%	22.5%	37.0%	28.1%	-	27.1%
Track Condition	16.9%	20.0%	17.6%	7.7%	11.8%	7.5%	0.0%	15.6%	-	13.3%
Miscellaneous	1.7%	0.0%	2.0%	2.6%	2.0%	0.0%	0.0%	0.0%	-	1.1%
Signal Defect	39.0%	47.3%	39.2%	59.0%	47.1%	60.0%	63.0%	50.0%	-	48.9%
Hazardous Material Release	Number by Year									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
Car Number	0	0	0	0	2	4	1	0	0	7
Incident Number	0	0	0	0	2	3	1	0	0	6
Other Incidents	Number of Incidents by Year									Total
	2006	2007	2008	2009	2010	2011	2012	2013	2014	
Crossing	18	16	14	16	12	20	13	14	1	123
Fatalities	21	16	14	17	13	22	13	15	1	131
Other	173	193	182	182	191	122	136	122	42	1,309

[273] 2014 data through March 31, 2014. Data from Federal Railroad Administration (FRA). FRA has a $10,500 damage threshold for the reporting of derailments, except for the release of hazardous materials.

Figure 47: Washington State Derailments 2006–2014[274]



Derailment causes are summarized in Figure 48. Nearly half of the derailments in the state occurred as a result of a signal defect. Equipment defects were cited as the cause of 27% of incidents. Track condition was the next highest cited cause with 13% of incidents. Human factors were cited in 10% of cases.

Derailment and other accidents by location are in Figure 49, and further detailed in Table 24.

[274] Based on FRA Data ($10,500 damage threshold for derailment reporting, except for hazardous material releases, for which all incidents are included). 2014 data estimated based on rate reported for first three months of year.

Figure 48: Washington State Derailment Causes 2006–2013

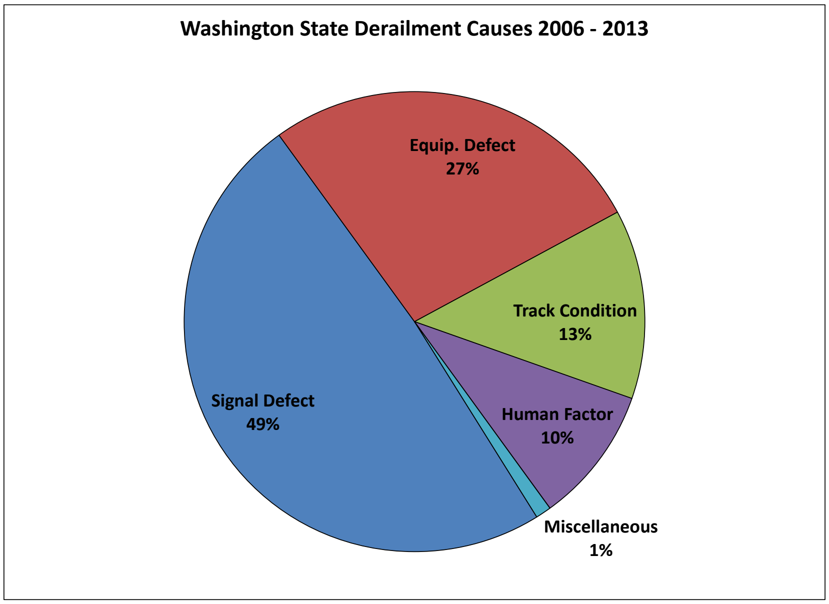
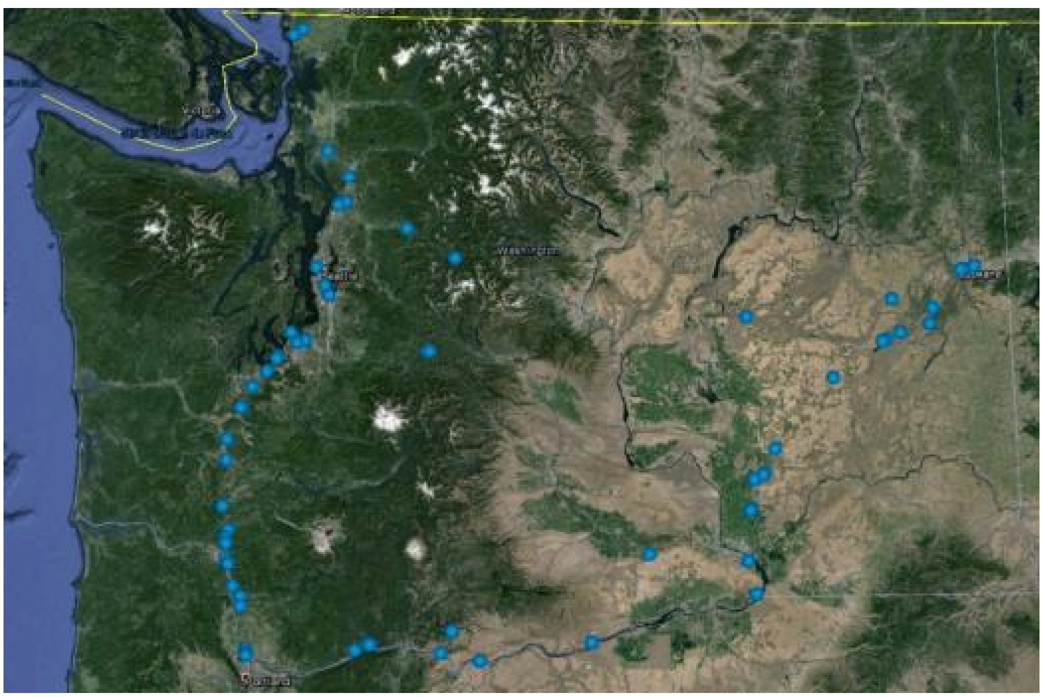


Figure 49: Derailment and Other Major Accident Locations in Washington 2003–2013[275]



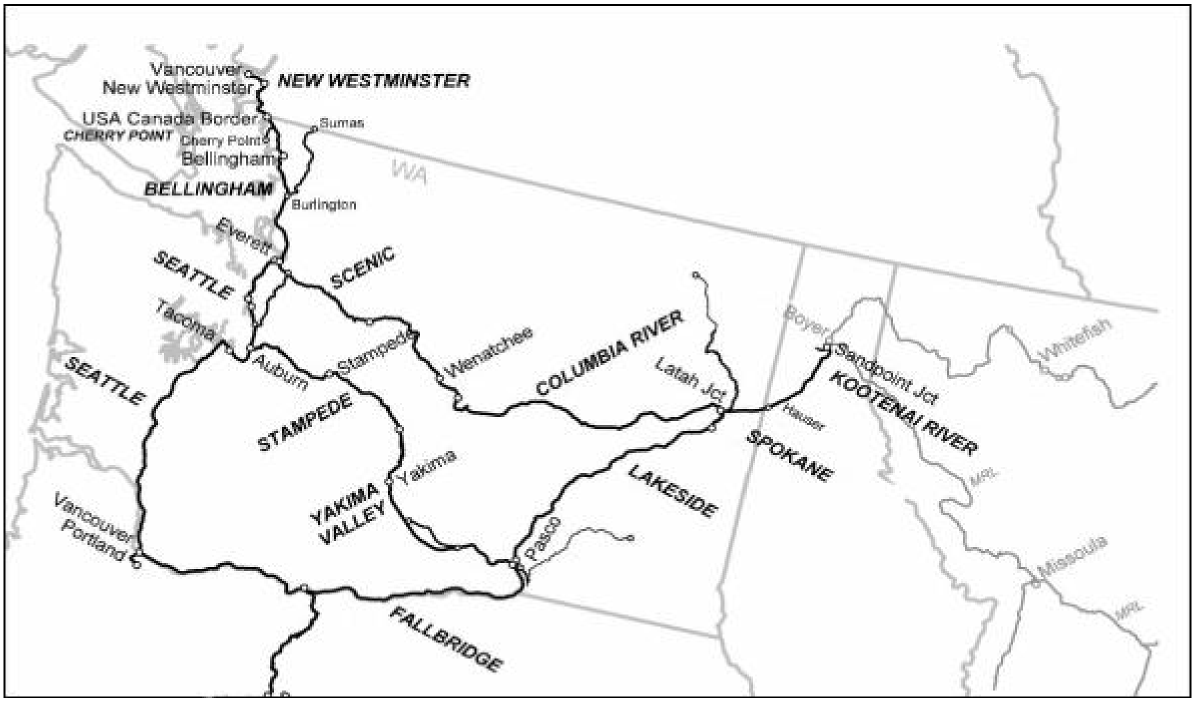
[275] Based on FRA Data.

Table 24: Derailment and Other Major Accident Incidents in Washington 2003–2013

Station	Number Incidents	Hazardous Cars Involved	Hazardous Cars Damaged
Avery	1	4	0
Berrian	1	0	0
Cactus	1	0	0
Castle Rock	2	12	0
Centennial	1	3	0
Centralia	1	0	0
Cheney	1	28	1
Cunningham	1	0	0
Custer	2	10	7
Edwall	1	12	0
Eltopia	2	20	0
Everett	6	22	0
Gold Bar	1	4	1
Home Valley	1	15	1
Hover	1	7	0
Kalama	1	0	0
Kelso	2	10	0
Lester	2	78	8
Longview	1	1	0
Lyle	1	0	0
Mesa	2	26	0
Napavine	1	0	0
Nisqually	2	6	2
Ostrander	2	15	0
Prosser	1	6	0
Ritzville	1	0	0
Roosevelt	1	22	3
Scribner	1	0	0
Seattle	2	11	0
Skykomish	1	2	0
Spokane	4	5	0
Sprague	4	33	0
Stanwood	1	6	0
Steilacoom	2	14	2
Stevenson	2	37	1
Tacoma	5	6	1
Tenino	2	3	0
Titlow	1	11	0
Tukwila	1	14	0
Vader	1	0	0
Vancouver	3	32	1
Wilson Creek	1	0	0
Wishram	2	8	0
Woodland	2	0	0
Total	75	483	28

Figure 50 shows the mainline rail system in Washington, and the corresponding schematic representation is shown in Figure 51. Figure 52 through Figure 66 provide details on specific derailment incidents during 2000–2014. The incident database classifies incidents as “high” if they entail more than $250,000 in reported damages, as “medium” if they result in damages of $50,000 to $250,000, and as “low” if there are less than $50,000 in damages.[276]

Figure 50: Mainline Railroad System in Washington and Neighboring States



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[276] FRA Office of Safety and Analysis, *Section 2.03 Train Accidents by Railroad Groups.*

Figure 51: Schematic Representation of Mainline System in Washington and Neighboring States

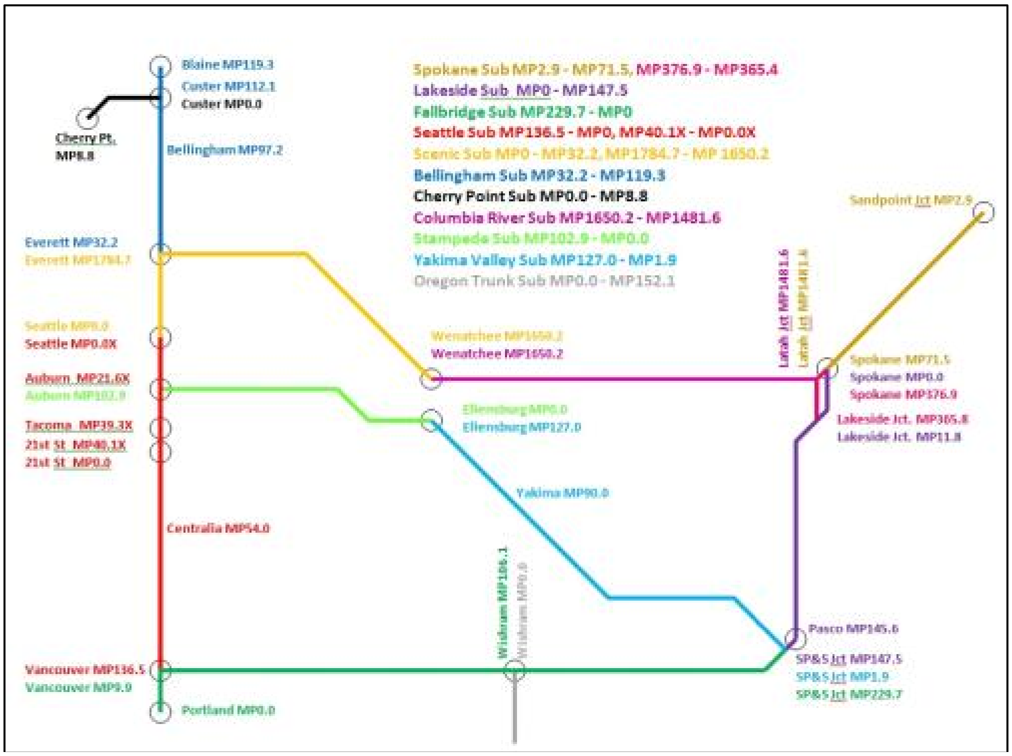


Figure 52: Derailment Incidents in Washington by Location and Severity – 2000

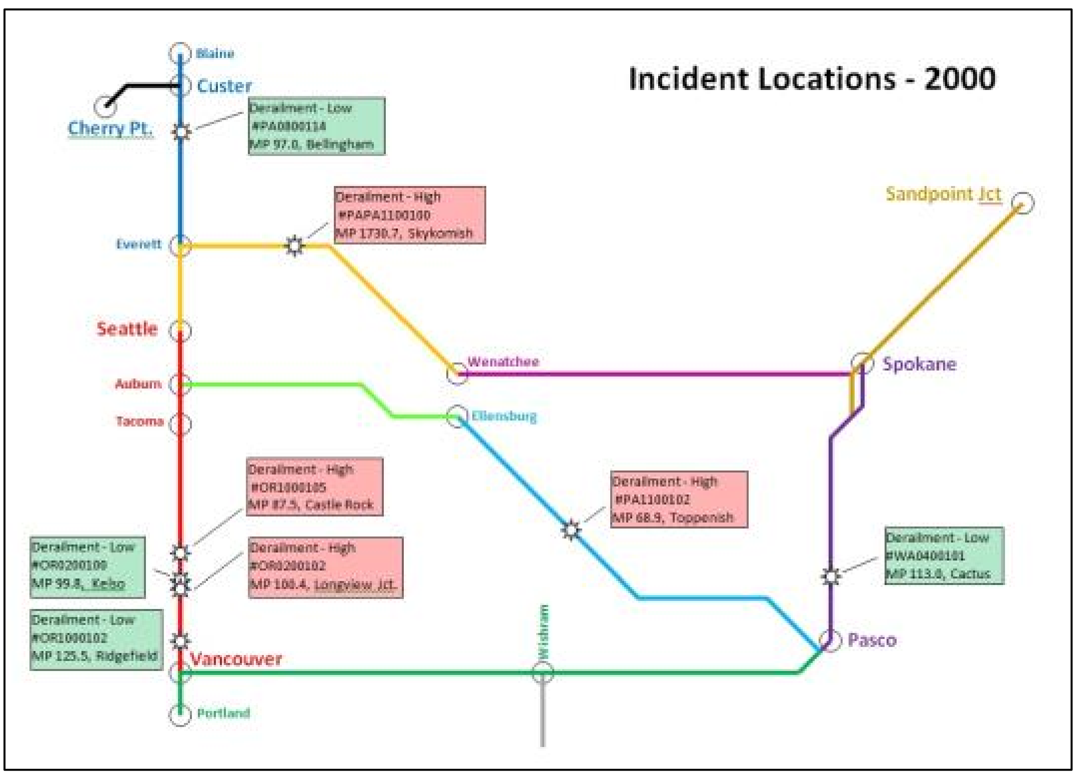


Figure 53: Derailment Incidents in Washington by Location and Severity – 2001

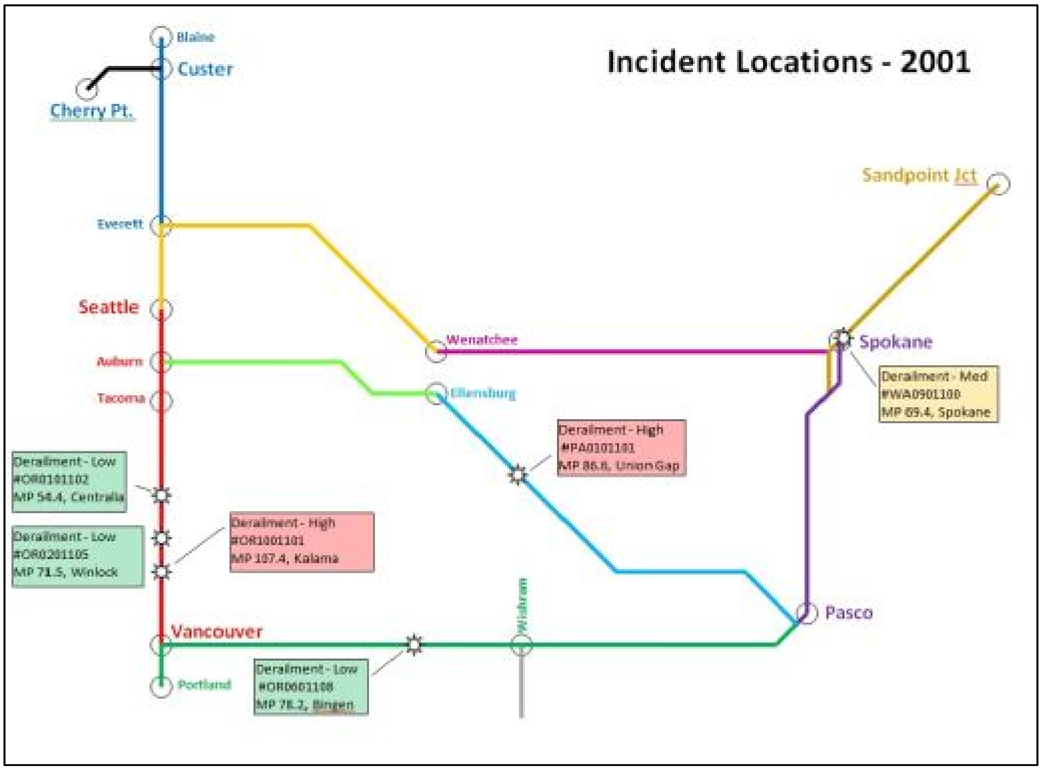


Figure 54: Derailment Incidents in Washington by Location and Severity – 2002

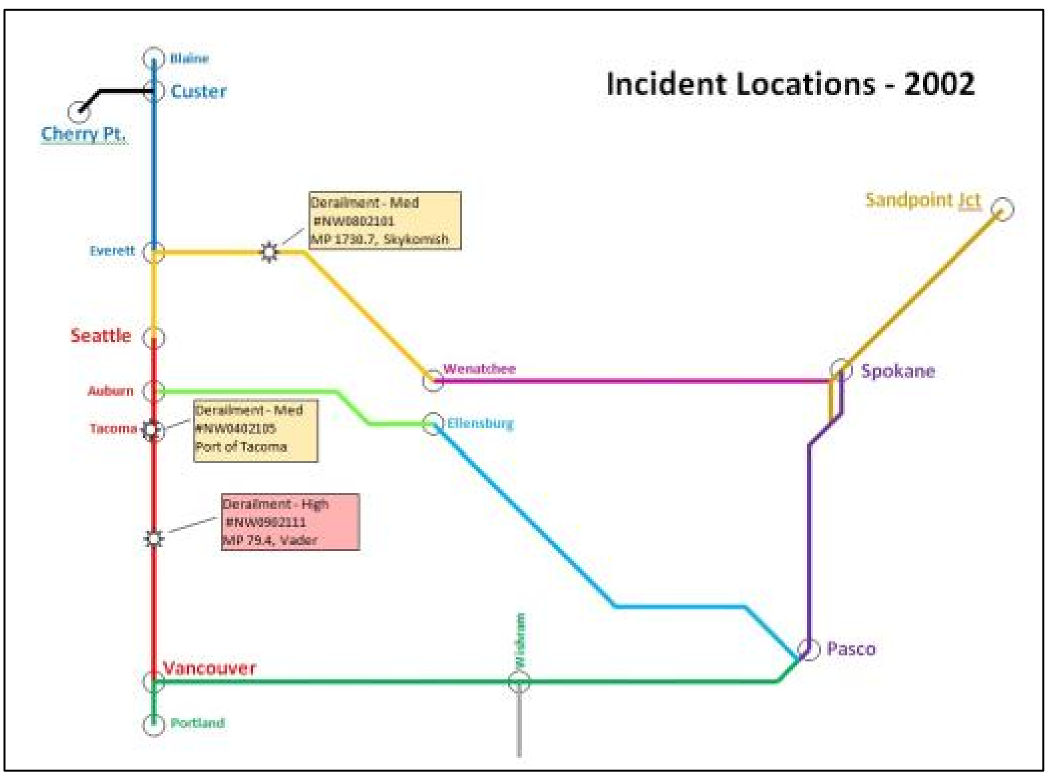


Figure 55: Derailment Incidents in Washington by Location and Severity – 2003

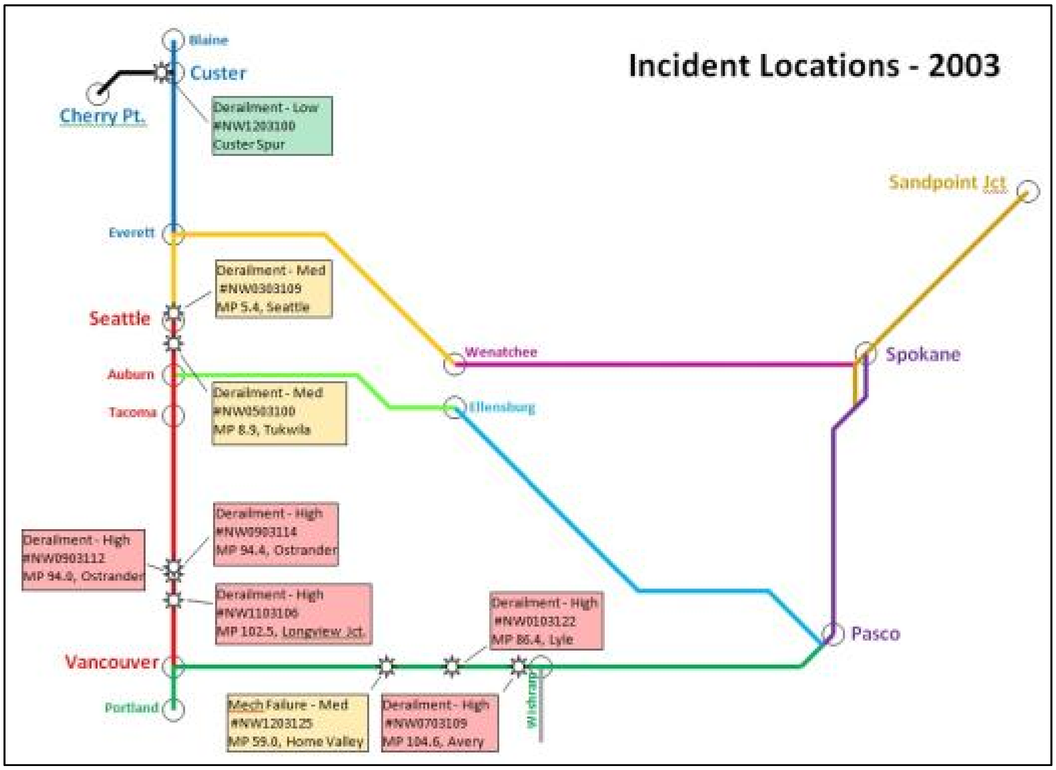


Figure 56: Derailment Incidents in Washington by Location and Severity – 2004

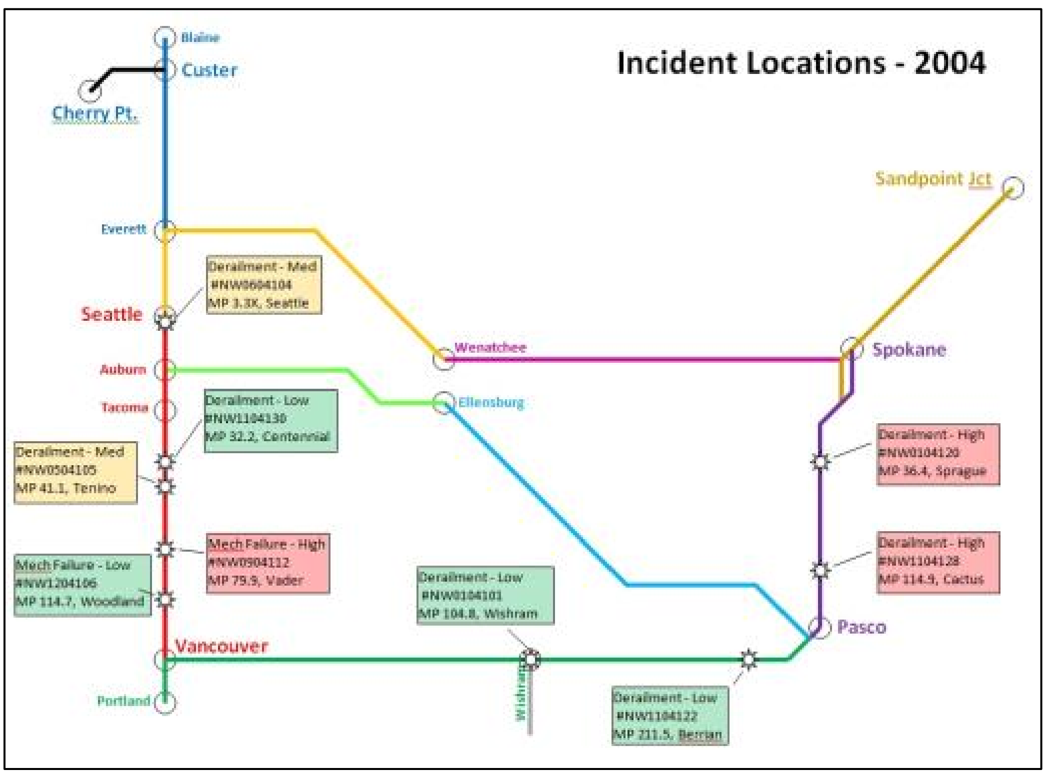


Figure 57: Derailment Incidents in Washington by Location and Severity – 2005

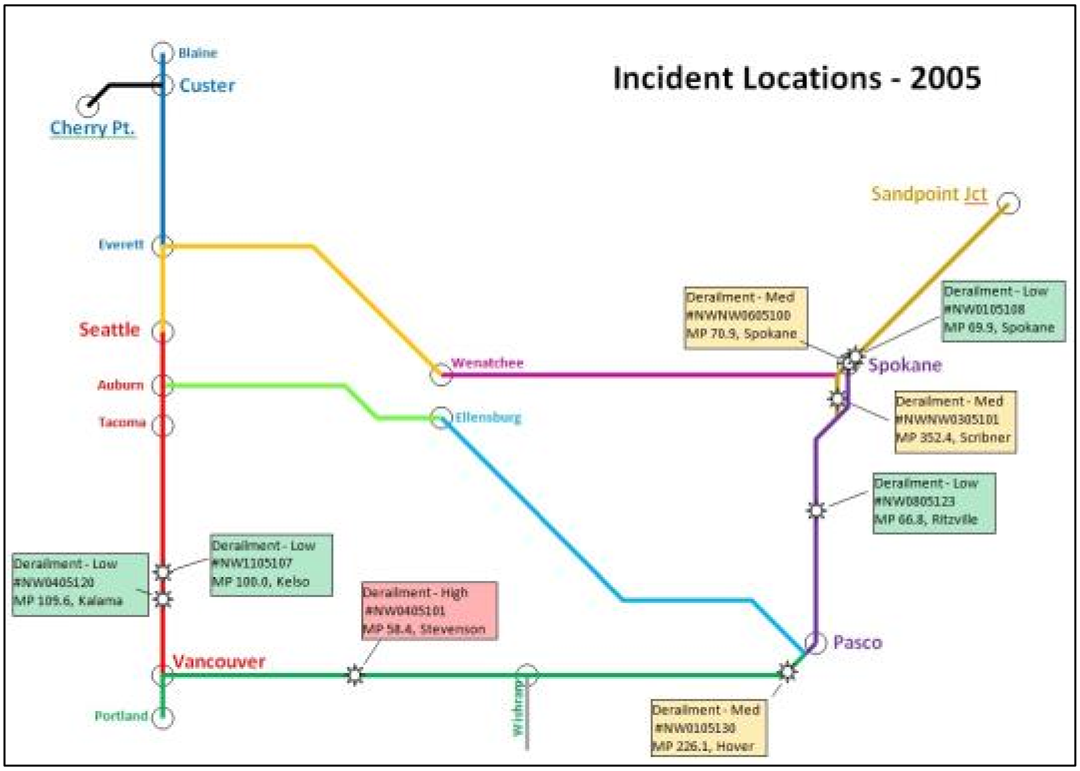


Figure 58: Derailment Incidents in Washington by Location and Severity – 2006

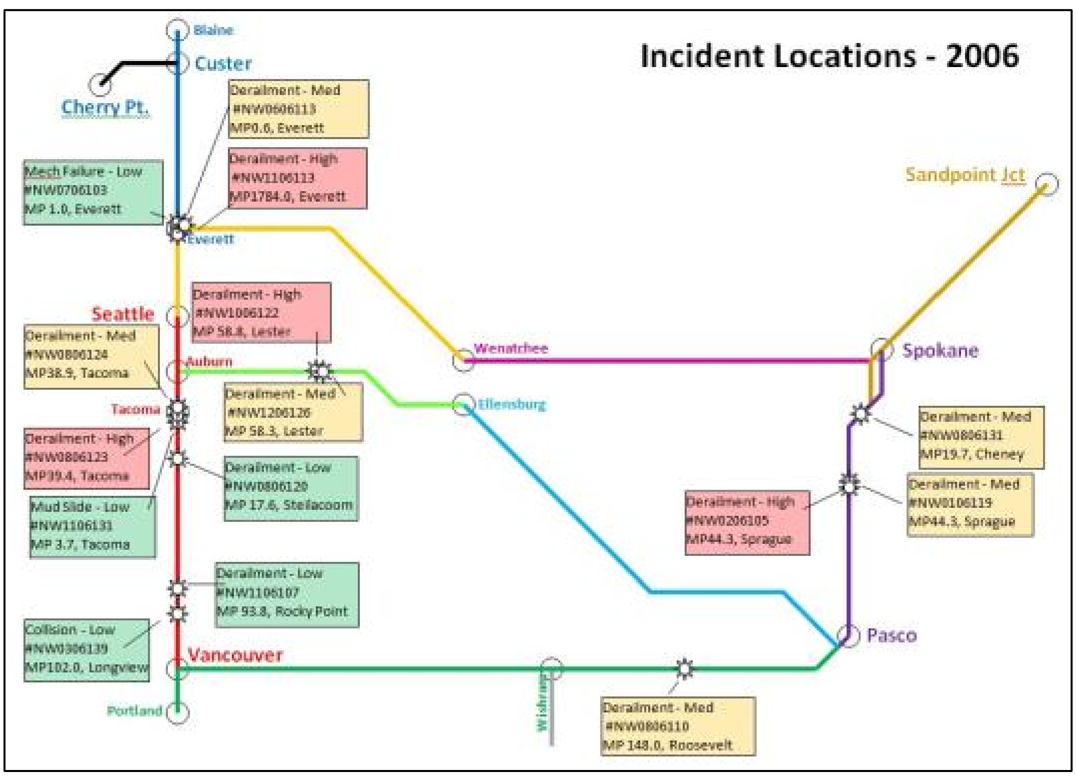


Figure 59: Derailment Incidents in Washington by Location and Severity – 2007

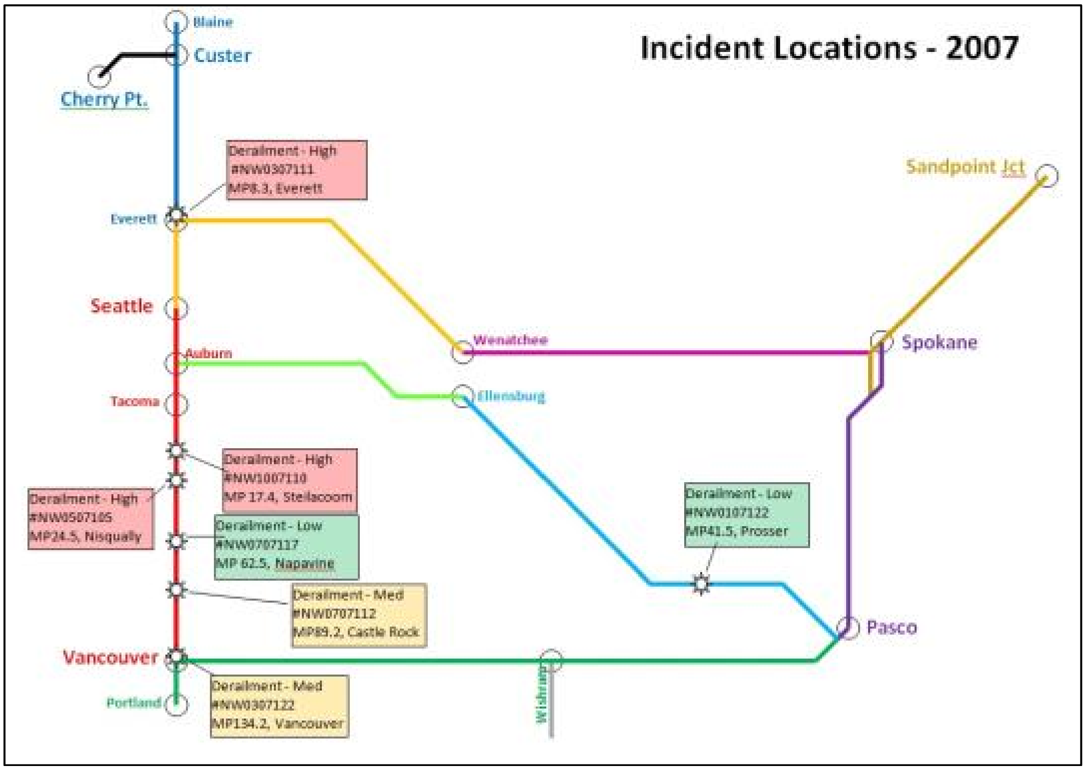


Figure 60: Derailment Incidents in Washington by Location and Severity – 2008

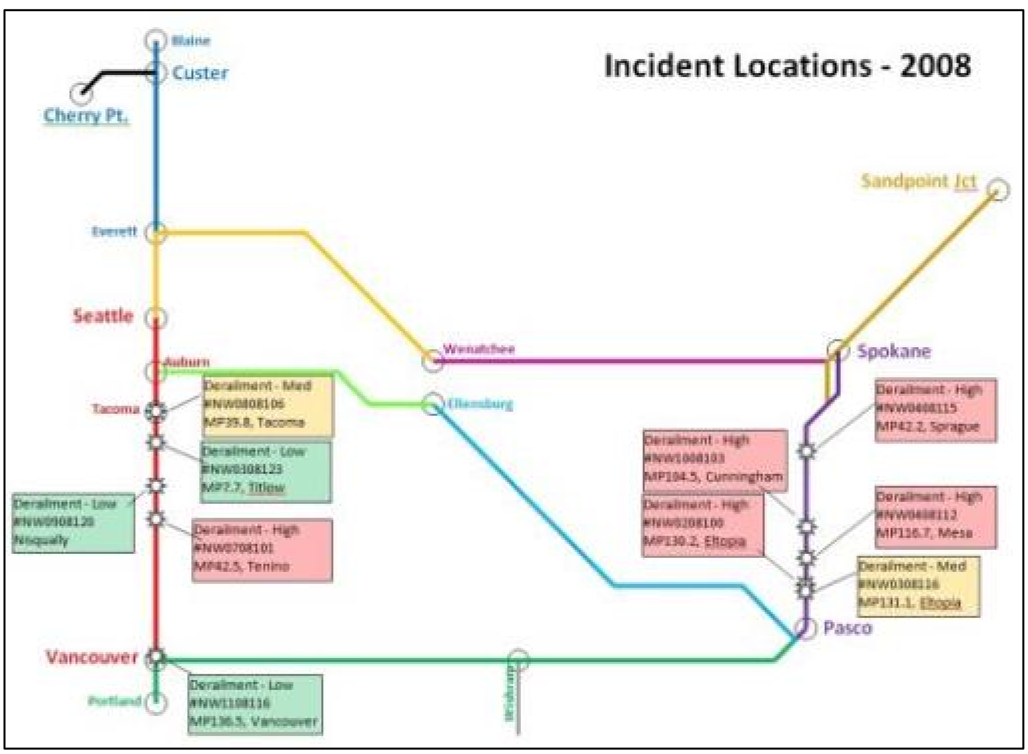


Figure 61: Derailment Incidents in Washington by Location and Severity – 2009

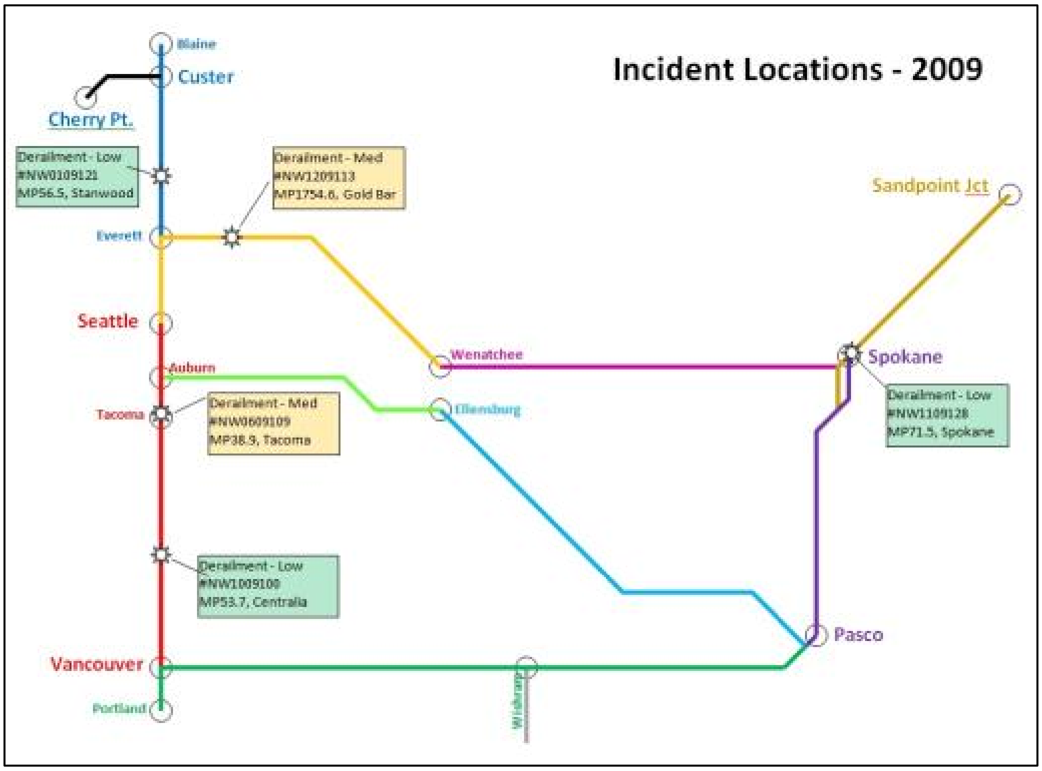


Figure 62: Derailment Incidents in Washington by Location and Severity – 2010

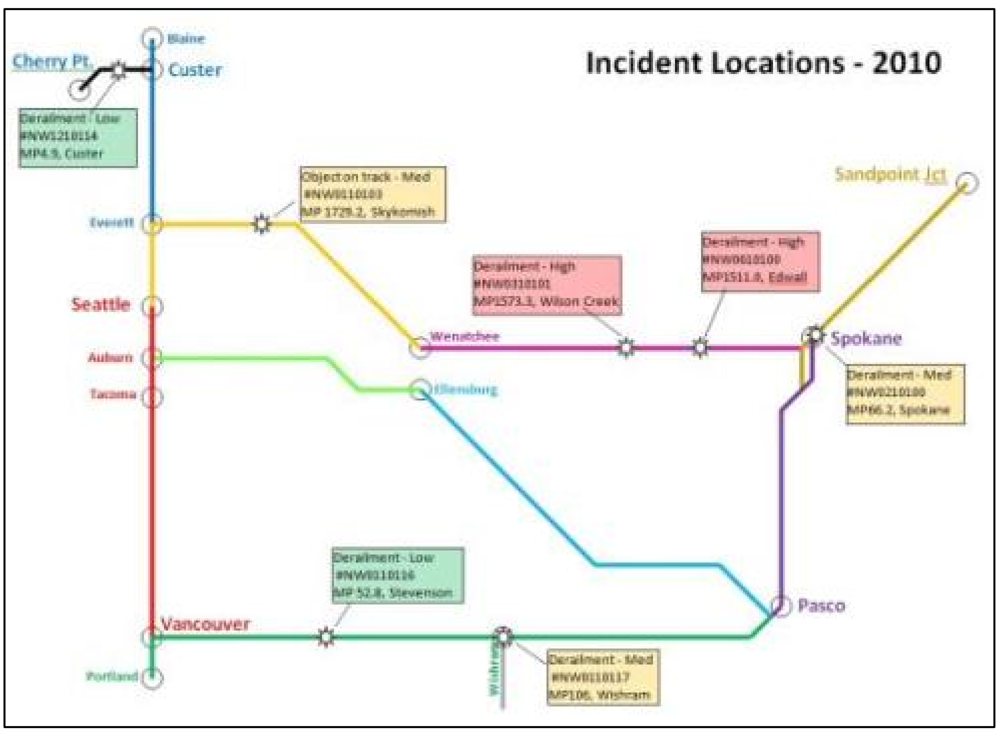


Figure 63: Derailment Incidents in Washington by Location and Severity – 2011

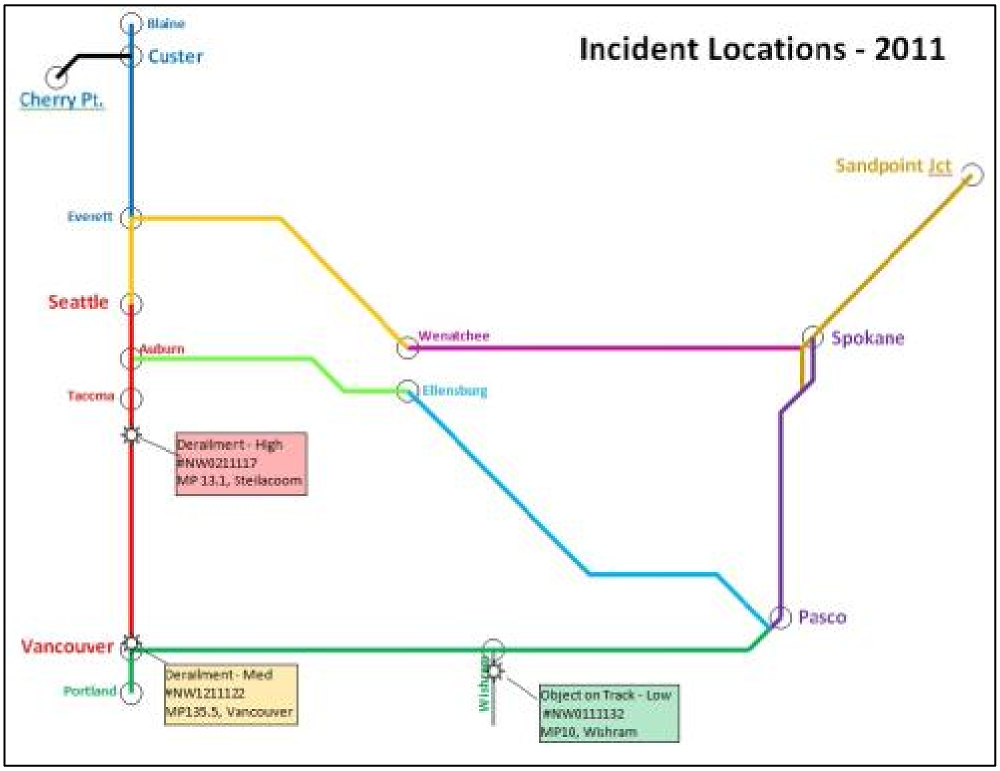


Figure 64: Derailment Incidents in Washington by Location and Severity – 2012

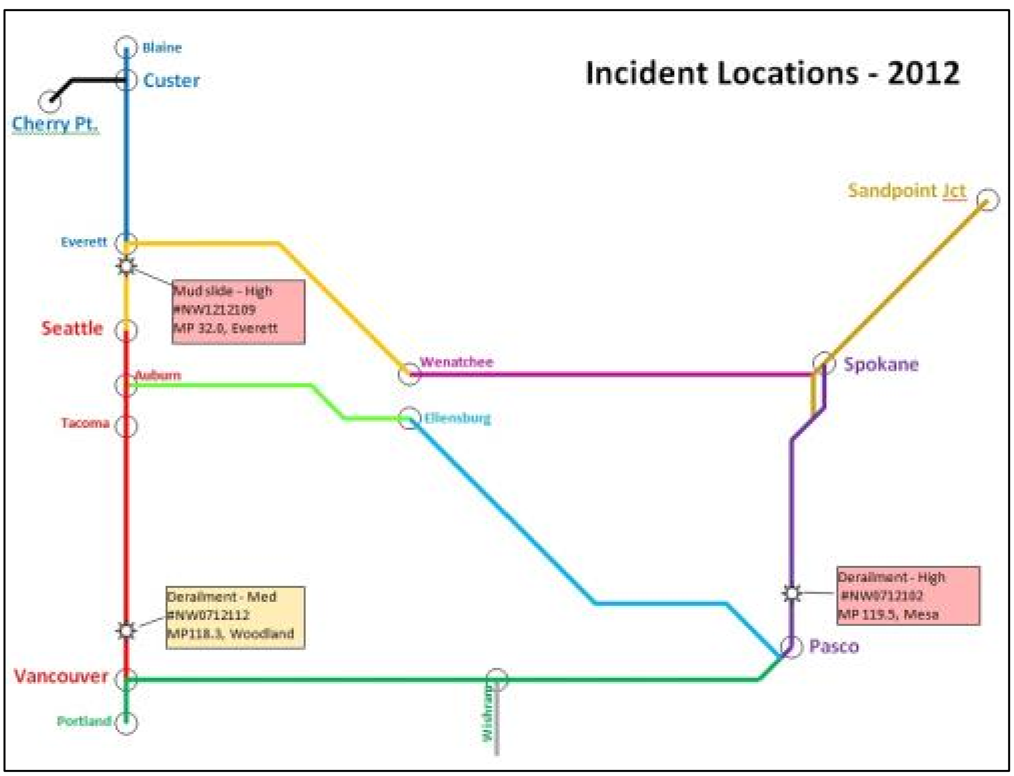


Figure 65: Derailment Incidents in Washington by Location and Severity – 2013

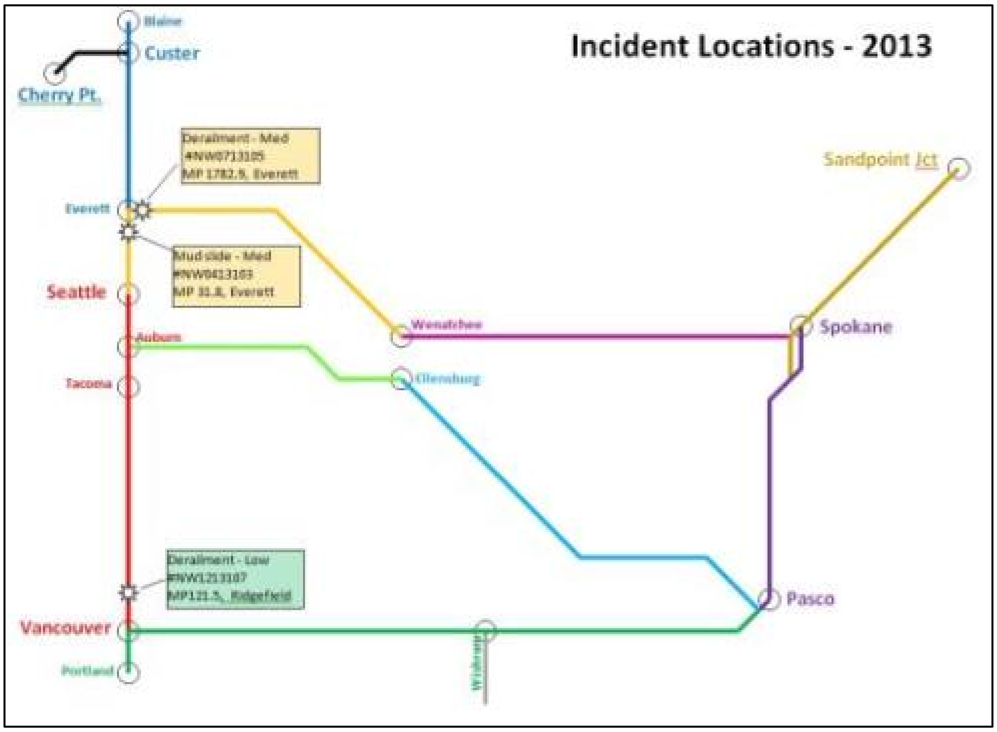
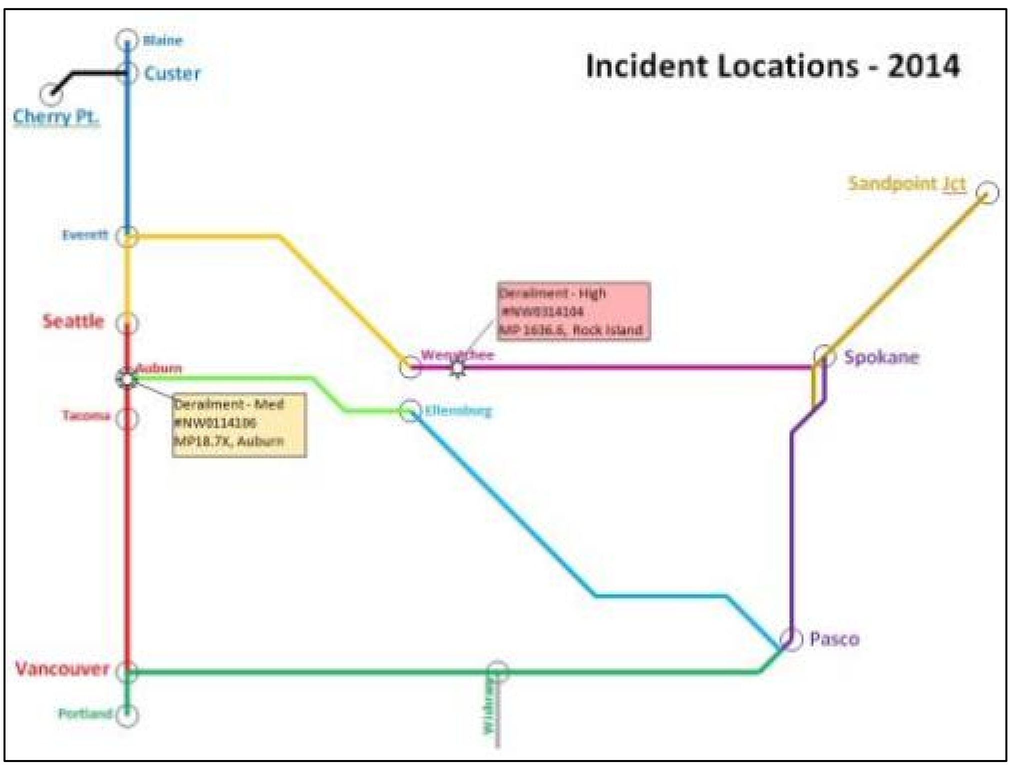
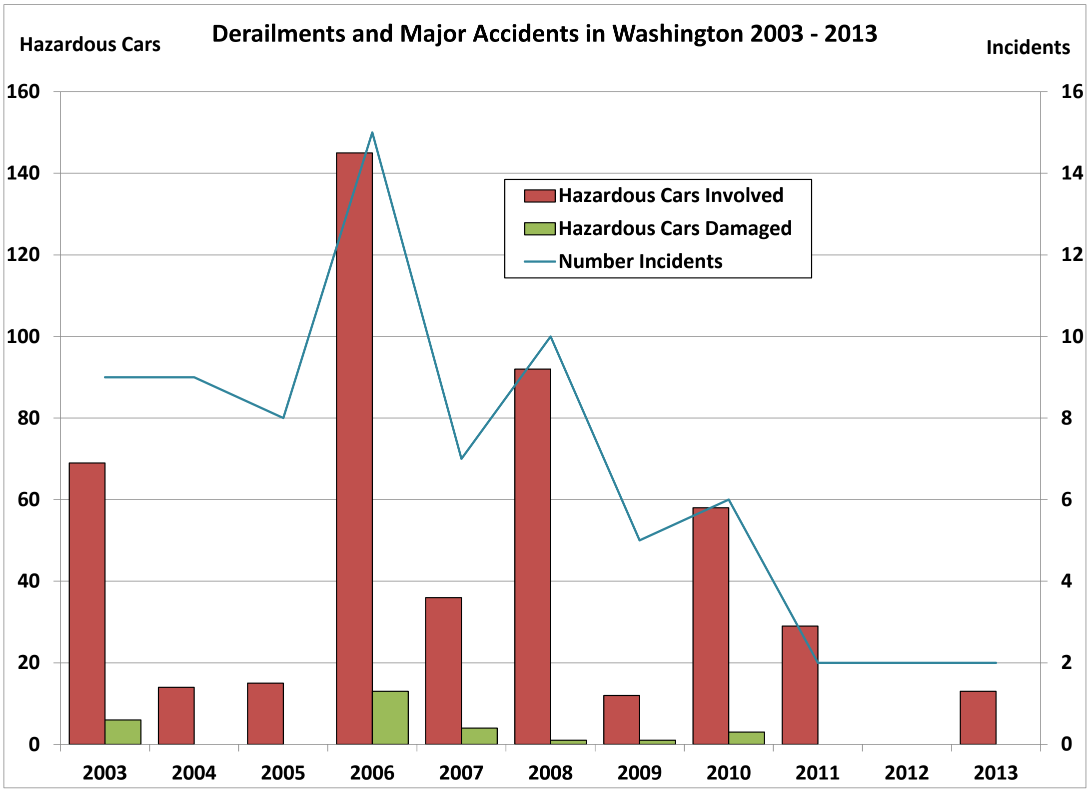


Figure 66: Derailment Incidents in Washington by Location and Severity – Through April 2014



Overall, there has been a reduction in derailments over the last decade, even with the influx of crude-by-rail trains into the system (Figure 67). From 2000–2009, there were more derailments in the western part of the state (between Vancouver and Blaine).

Figure 67: Derailments and Major Rail Accidents in Washington 2003–2013



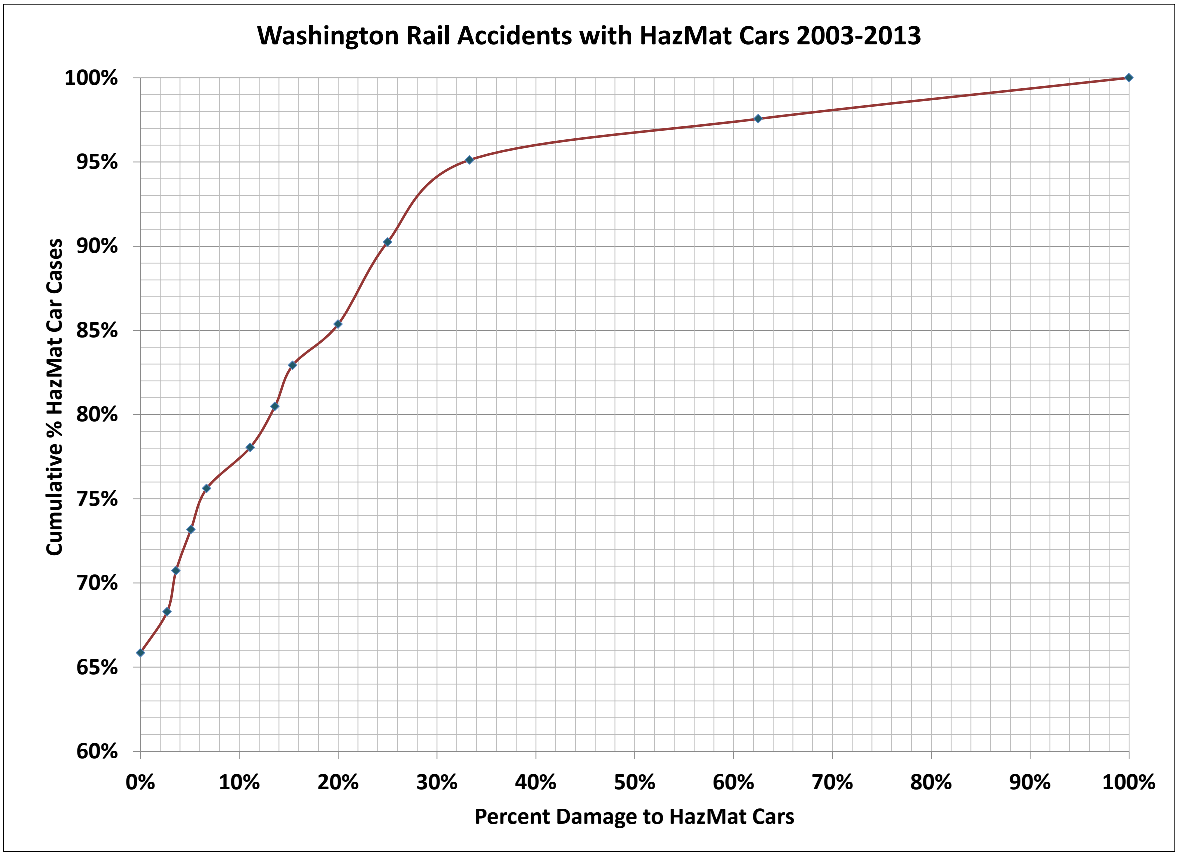
Note that in none of the accidents in Table 25 were any hazardous materials released. For those incidents in which rail tank cars containing hazardous material were involved, 66% resulted in no damage to the tank cars. In only one incident, representing 2.4% of all incidents involving hazardous material cars, there was damage to all of the cars involved in the accident, which included only two cars.

Table 25: Hazardous Material Car Damage for Washington Derailments and Other Major Accidents

% Damage	Number HazMat Car Incidents 2003–2013	% Incidents Involving HazMat Cars 2003–2013
0%	27	65.9%
2.7%	1	2.4%
3.6%	1	2.4%
5.1%	1	2.4%
6.7%	1	2.4%
11.1%	1	2.4%
13.6%	1	2.4%
15.4%	1	2.4%
20.0%	1	2.4%
25.0%	2	4.9%
33.3%	2	4.9%
62.5%	1	2.4%
100.0%	1	2.4%
Total	41	100.0%

The cumulative probability distribution of damage to the hazardous materials cars is shown in Figure 68. This graph shows the likelihood that there will be a certain percentage of damage to a railcar. For example, in 66% of cases, there was no damage. In 85% of cases, the damage to hazmat cars was 20% or less (including no damage). Only in 5% of cases was there damage to more than 35% of the hazmat cars. 95% of cases involved less than 35% damage.

Figure 68: Probability of Damage to Hazardous Material Railcars in Washington Incidents (2003–2013)



Port of Vancouver Derailment Risk Study

The Port of Vancouver requested that TÜV Rheinland Mobility Rail Sciences Division (TÜV Rail Sciences) evaluate the derailment risk of a proposed route exiting BNSF Fallbridge Subdivision at MP 10.69 into the Port of Vancouver (Figure 69).[277] As part of this, TÜV Rail Sciences analyzed the derailment probability for a 120-car crude-by-rail unit train with three locomotives at the head end and two at the rear end.

[277] TÜV Rheinland Mobility Rail Sciences Division 2014.

Figure 69: BNSF Fallbridge Subdivision Tracks into Port of Vancouver[278]

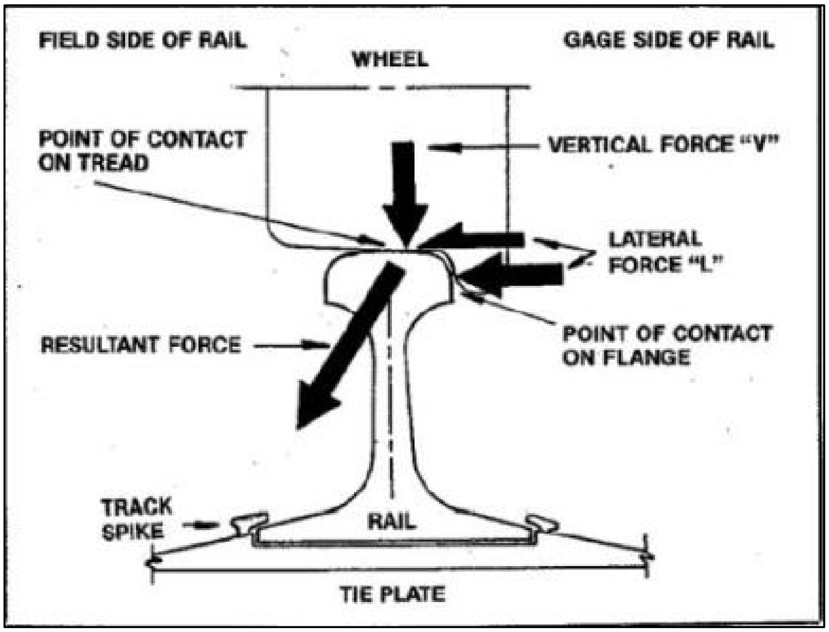
The in-train force analysis indicated that the maximum in-train longitudinal forces observed in all nominal and braking simulation scenarios are well within industry and AAR-recommended limits.

The lateral-to-vertical ratio (L/V) is the lateral (side-to-side) force pushing outward against the rail compared to the vertical force pushing downward on the top of the rail (Figure 70). The tendency for the rail to tip and/or move laterally, or for the wheel to climb the rail, increases as the L/V ratio increases:

- L/V = 1.29, wheel may climb new rail.
- L/V = 0.82, wheel lift impending.
- L/V = 0.75, wheel may climb worn rail.
- L/V = 0.64, rail overturn force starts (unrestrained rail may overturn).

278 TÜV Rheinland Mobility Rail Sciences Division 2014.

Figure 70: Lateral to Vertical Force Relationship Between Rail and Wheel[279]



The results of the analyses of the crude-by-rail unit train, as shown in Table 26, show that all individual wheel L/V ratios are well under the maximum allowable values for the industry.

Table 26: Vehicle Dynamic Results – Loaded Tanker Cars[280]

Parameter	Industry Standard	In-Train Force	As Designed Track	Class I Cross Level Dip	FRA Class 2 Cross Level Dip
Maximum Individual Wheel L/V Ratio	Maximum 0.82[281] 1.00[282]	300 Kips Buff	0.43	0.59	0.57
		300 Kips Draft	0.34	0.52	0.50
		None	0.39	0.56	0.54
Minimum % Wheel Unloading	Minimum 10.0%	300 Kips Buff	83.86	56.96	59.42
		300 Kips Draft	90.60	68.37	70.75
		None	90.87	62.09	64.75
Maximum Axle Sum L/V Ratio	Maximum 1.50	300 Kips Buff	0.76	0.91	0.89
		300 Kips Draft	0.67	0.84	0.83
		None	0.73	0.88	0/86
Maximum Truck Side L/V Ratio	Maximum 0.60	300 Kips Buff	0.32	0.39	0.38
		300 Kips Draft	0.33	0.32	0.31
		None	0.30	0.36	0.35

[279] From: TÜV Rheinland Mobility Rail Sciences Division 2014.
[280] TÜV Rheinland Mobility Rail Sciences Division 2014.
[281] Industry recommended maximum allowable L/V ratio = 0.82
[282] AAR Chapter XI Standard maximum allowable L/V ratio = 1.00.

TÜV Rail Sciences concluded that the proposed operation and track configuration is well within industry safety standards, and thus represents a low risk of derailment.

To further improve safety, the Port of Vancouver proposed all of the following enhancements:

- Maintain track to a minimum of FRA Class 2 standard to reduce levels of allowable track deviation and the associated risks of local track perturbations over time.
- Install a high guard rail frog on #15 turnout and double guard rail on the connection track between #15 turnout and the BNSF overhead bridge and through the "Trench" to further lessen the potential for damage.
- Construct the track structure with new concrete or wooden ties, premium fasteners, and continuously welded 141-pound rail to maintain a robust and less dynamically-varying track structure.
- Perform rail neutral temperature measurements during track construction to properly set track neutral temperature.
- Periodically measure track geometry to ensure safety against derailment as the track changes over time.

Federal Crude-by-Rail Train Safety Actions

Recognizing the changes affecting the nation with the introduction of crude-by-rail, the federal government took new steps on safety and environmental protection beginning in September 2012. The timetable of federal actions through the present is summarized in Table 27.

Table 27: Summary of Federal Actions on Crude-by-Rail Incident Prevention Measures

Date	Action
September 2012	PHMSA Administrator Quarterman visits North Dakota Bakken Region to observe operations at rail loading facilities and the application of USDOT regulations.
October 2012	PHMSA Bakken Field Working Group established to increase inspection focus on hazmat shipments by truck and rail from the Bakken region and increase awareness within the emergency response community.
December 2012	FRA begins Bakken Rail Accident Mitigation Project (RAMP).
July 29, 2013	In a letter to the American Petroleum Institute, FRA informed industry that it will use PHMSA's test sampling program to ensure that crude oil is being properly tested and classified.
August 2, 2013	FRA Safety Advisory 2013-06 "Preventing Unintended Movement of Freight Trains and Vehicles on Mainline[283] Track or Mainline Siding Outside of a Yard or Terminal"
August 7, 2013	FRA Emergency Order 28, "Establishing Additional Requirements for Attendance and Securement of Certain Freight Trains and Vehicles on Mainline Track or Mainline Siding Outside of a Yard or Terminal"
August 27, 2013	FRA and PHMSA public meeting with industry stakeholders.
August 29, 2013	FRA convenes emergency session of Railroad Safety Advisory Committee (RSAC). RSAC established three working groups on new rulemaking: 1) hazardous materials by rail, 2) train crew size and 3) train securement procedures. Launch of Bakken Blitz.
September 6, 2013	PHMSA issues 78 FR 54849 – ANPRM (2012-0082 HM-251), in response to railroad industry petitions and recommendations to improve the safety of railroad tank car transportation.
October 1, 2013	FRA Administrator Szabo sends a letter to railroad industry organization asking they detail actions they have taken in response to the Safety Advisory issued on August 2, 2013.
November 5, 2013	PHMSA extension of comment period of HM-251.
November 20, 2013	PHMSA and FRA issue Safety Advisory 2013-07 "Safety and Security Plans for Class 3 Hazardous Materials Transported by Rail".
December 11, 2013	FRA Safety Advisory, "Notice of safety advisory; Operational tests and inspections for compliance with maximum authorized train speeds and other speed restrictions".
January 2, 2014	PHMSA safety advisory issued stating that crude oil from the Bakken region may be more flammable than traditional crude.
January 16, 2014	Secretary Foxx meets with rail company CEOs and rail and energy association leadership as part of the USDOT's Call to Action to discuss how to maintain a safety record even as domestic crude oil production and movement has increased.

[283] Mainline: a track that is used for through trains or is the principal artery of the system from which branch lines, yards, sidings and spurs are connected. It generally refers to a route between towns, as opposed to a route providing suburban or metro services.

Date	Action
January 21, 2014	Secretary Foxx issues follow-up letter to Call to Action participants summarizing industry commitments.
February 4, 2014	PHMSA issues $93,000 in proposed civil penalties after investigation into the transportation of Bakken crude oil finds companies improperly classified shipments.
February 10, 2014	PHMSA meets with emergency response stakeholders and industry groups to discuss training and awareness related to the transport of Bakken crude. Follow-up meeting to be scheduled in late February 2014.
February 21, 2014	Secretary of Transportation sends letter to President/CEO of AAR to request members voluntarily impose: speed restrictions, braking signal propagation system, routing analysis, additional track and rail inspections, more frequent mechanical inspections, emergency response inventory, funding for emergency responder training, and more communication with communities.
February 25, 2014	USDOT Emergency Order requiring the testing and proper classification of oil being transported and does not allow crude oil to be transported at the lowest packing group.
March 6, 2014	To provide further clarity for shippers and to prevent attempts to circumvent the requirements in its recent Emergency Order concerning the safe transport of crude oil by rail, the USDOT issued an amended version that specifies which tests are required, while also prohibiting shippers from switching to an alternate classification that involves less stringent packaging.
April 9, 2014	FRA announced intention to issue a proposed rule requiring two-person train crews on crude oil trains.
May 7, 2014	Joint safety advisory issued by FRA and PHMSA strongly urging those shipping Bakken crude oil to use tank car designs with the highest level of integrity. Also recommended avoiding use of older legacy DOT 111 or CTC 111 tank cars for the shipment of Bakken crude oil.
May 7, 2014	DOT Emergency Order requiring reporting to State Emergency Response Committees (SERCs) of information on trains with more than one million gallons within 30 days of order.
July 23, 2014	USDOT releases regulations pertaining to the transportation of oil by rail and tank car standards.
September 10, 2014	FRA proposes amendments to the brake system safety standards for freight and other non-passenger trains and equipment to strengthen the requirements relating to the securement of unattended equipment. Specifically, FRA would codify many of the requirements already included in its Emergency Order 28, Establishing Additional Requirements for Attendance and Securement of Certain Freight Trains and Vehicles on Mainline Track or Mainline Siding Outside of a Yard or Terminal.

PHMSA/FRA Proposed Regulations on HHFT Movement

On July 23, 2014, the Pipeline and Hazardous Materials Safety Administration (PHMSA), along with the Federal Railroad Administration (FRA),[284] jointly through the USDOT proposed regulations for the transportation of Class 3 flammable liquids (including crude oil and ethanol) by rail. The primary regulations address 3 general areas: (1) operational requirements for Class 3 flammable liquids transported by rail, (2) enhanced tank car standards, and (3) classification and characterization of mined liquids and gasses. The proposal defines a "high-hazard flammable train" (HHFT) as a train comprised of 20 or more cars transporting Class 3 flammable liquids, regardless of packing group.

The state of Washington, through various departments including the Department of Ecology, Utilities and Transportation Commission (UTC), Military Departments Emergency Management Division (EMD), and the Department of Transportation (WSDOT), prepared a joint response to the request for comments and submitted it on September 30, 2014 (see Appendix I).

Included in the PHMSA/FRA Notice of Proposed Rule Making (NPRM) issued on July 23, 2014, were various specific items listed that the USDOT (through PHMSA and FRA) would likely consider in determining its final rule-making decision. A number of the rail-related items listed in the 27 Rail Routing Risk Assessment required of railroads transporting HHFT subject have been discussed elsewhere in this report. Those specific items include:

- Presence or absence of signals and train control systems.
- Single versus double-track.
- Track type class and maintenance.
- Presence of passenger trains along route(s).
- Speed of train operations.

There are items to which the PHMSA/FRA notice of July 23, 2014 requests response that are clearly the responsibility of the involved railroads, as these are generally internal information that is not generally in the public domain. Those items include:

- Volume of hazardous materials.
- Environmentally sensitive areas (railroad perspective vs. external perspective).
- Emergency response along route(s).
- Rail traffic density.
- Frequency and location of track turnouts.
- Population density.[285]
- Areas of high consequence (from the railroad perspective).

[284] An agency within the US Department of Transportation that has jurisdiction over railroad safety at the federal level.
[285] Identified and discussed elsewhere in this report.

- Trip length of route (dependent on destination and routing corridor).
- Track grade and curvature.[286]
- Number and type of grade crossings.[287]
- Proximity of iconic targets (from the railroad perspective).
- Venues along the route (railroad definition vs. external perspective).
- Measures in place to address safety and security risks (internal railroad policies).
- Overall times in transit (railroad internally maintains cycle and transit times for commodity movements).
- Proximity to en-route storage or repair facilities (dependent on location that generates need and routing protocol).
- Training and skill level of crews.
- Known threats.
- Past incidents (incidents undefined).

There are other items on the list of 27 factors that can be assessed through general available information and knowledge, namely:

- Impact on rail network traffic and congestion (capacity demand).
- Presence and characteristics of railroad facilities.
- Availability of practical alternative routes.
- Presence or absence of wayside hazard detectors.

[286] Prevailing grades discussed elsewhere in this report for key current and potential routes.
[287] UTC assessment included in this report.

Rail Network Traffic and Congestion – Capacity Demand

BNSF is expending $1.1 billion in capacity expansion in all states along the Northern Corridor in 2014, unprecedented by any railway standard. The numbers cited in Table 28 include capital maintenance for each state, i.e., rail and tie replacement, surface correction, and undercutting. It also includes the continuing investment in introducing Positive Train Control (PTC) over the entire Northern Corridor, as required by U.S. federal mandate, on routes that host passenger train operations and/or the movement of hazardous materials.

Table 28: Summary of Capital Expansion and Maintenance Projects for Railroads[288]

State	Cost	Expansion Projects	Maintenance Projects		
			Surfacing/ Undercutting (track miles)	Replacement (rail miles)	Replacement (ties)
Washington	$230 million	• Construction of 2nd main track in various locations between Cheney and Mesa (connection of existing sidings) • New siding at Missile Base on Lakeside Subdivision • Construction of two new staging tracks at Everett • Installation of power switch at Burlington for movements to Fidalgo/Anacortes • Sidings at Camas and Mt. Pleasant on Fallbridge Subdivision	1,200	60	1,300
Montana	$160 million	• Constructing a new siding between Marsh and Terry • Extending siding lengths at Beaver Hill, Blatchford, Hodges, Hysham, and Rosebud • Extending track lengths at train yards in Glendive and Forsyth • Upgrading to CTC and extending train siding at Terry	900	60	145,000

North Dakota	$400 million	• Complete construction of 2nd main track between Minot, ND and Glasgow, MT
		• Construct new sidings between:
		  ○ Fargo and Grand Forks
		  ○ Fargo and Minot
		  ○ Bismarck and Glendive, MT
		  ○ Minot and Grand Forks
			930	110	330,000

Minnesota	$120 million	• Parking expansions at St. Paul Intermodal Facility • Track extensions at Gunn • Construction of new siding and interchange tracks near St. Vincent	600	72	340,000
Illinois	$150	• Constructing parking expansions	1,500	36	185,000

[288] *BNSF Railway News Release*, May 1, 2014.

State	Cost	Expansion Projects	Maintenance Projects		
			Surfacing/ Undercutting (track miles)	Replacement (rail miles)	Replacement (ties)
	million	at Willow Springs Intermodal and Logistics Park Chicago Automotive facilities • Construct new siding between Barstow and Hillsdale			

It should also be noted that rail capacity[289] is composed of a number of different components, not just physical infrastructure. For example, the capital maintenance investments cited above are critical to maintaining capacity and fluidity on existing infrastructure. Class I railways, with BNSF being no exception, normally invest between 45% and 55% of their annual capital investment budgets on maintenance and upgrade of existing track, for obvious reasons. Track structure that experiences deterioration without being addressed in a timely manner results in "slow orders", which slow down the velocity of trains and consume more capacity per track mile. By investing in as much physical infrastructure expansion on the Northern Corridor in 2014, BNSF is also assuming a longer term, continuing liability for maintaining that expanded track. In its $5 billion 2014 Capital Expenditure Plan, BNSF's largest component of expenditure is $2.3 billion for maintaining its existing track infrastructure, or 46% of its total Capital Plan.[290]

Other components of "capacity" include locomotive availability (under-powered trains consume additional capacity, similar to slow orders), crew availability,[291] equipment availability to balance peak demand with car type fleet size, the differential between maximum speed of the highest priority trains and the lowest priority trains,[292] signal systems, and rail terminal size and capabilities.

In addition to the infrastructure expansion and capital maintenance projects in its 2014 Capital Plan, BNSF is pursuing enhancements to other components of capacity. Through mid-year, BNSF has added all of the following:

- $419 million in capacity expansion projects.
- 326 new locomotives.
- 4,463 new employees.
- 2,133 new railcars.[293]

[289] The maximum traffic flow a piece of infrastructure (in this case, railroad lines) can handle under specified operating conditions.
[290] *BNSF Railway Service Overview*, August 29, 2014.
[291] BNSF reports that it "aggressively hiring new train operating personnel".
[292] The differential results in "overtakes", requiring the slower train to exit the main track on which the faster train is operating.
[293] *BNSF Railway Service Overview*, August 29, 2014.

Positive Train Control (PTC)

A federal government mandate for all U.S. railroads and passenger agencies to install positive train control (PTC)[294] by the end of 2015 may also enhance existing and planned infrastructure capacity, although there are divergent views on the capacity impact PTC will make. As a result of a catastrophic accident in Southern California involving a commuter train and a UP freight train, any line segment that handles passenger operations is required to install PTC. PTC is designed to remotely monitor train movements and cause a train to be stopped if it appears it is dangerously close to overtaking or colliding with another train. There have been projections that PTC will allow trains, in conjunction with existing signal systems, to be able to operate at faster speeds at closer distances apart than existing signal systems alone will allow.[295]

PTC was mandated to be implemented by the Rail Safety Improvement Act (RSIA), signed into law on October 16, 2008.[296] The FRA published the final rule addressing PTC requirements on January 15, 2010, and published final rule amendments on September 27 and May 14, 2010.[297]

As it relates to the Northern Corridor and the Pacific Northwest, BNSF is being required to install PTC over the entire Northern Corridor between Chicago and the state of Washington due to operation of Amtrak's Empire Builder over the corridor. Within Washington, four of BNSF's five mainline corridors require installation of PTC: Sand Point to Spokane, Spokane to Everett (Stevens Pass, the primary intermodal corridor), Spokane to Vancouver/Portland via Pasco (Columbia River Gorge route), and Vancouver/Portland to Blaine via Tacoma, Seattle, Everett, and Bellingham. All of these corridors host Amtrak passenger operations and/or commuter operations between Everett and Tacoma. The only mainline corridor not immediately requiring PTC installation is the Stampede Pass route between Auburn and Pasco, which is projected to be freight only (the eastbound empty bulk train route as part of the directional running strategy).

A final federally mandated PTC installation requirement also applies to freight routes that handle hazardous material shipments that carry dangerous-by-inhalation placarding, for example tank car shipments of chlorine. The Stampede Pass segment could potentially require PTC installation if BNSF were to begin routing manifest trains to Pasco via that route involving movement of loaded hazardous cars, although BNSF would likely keep such traffic out of Auburn to Pasco manifest trains by making sure those cars were in manifest trains operated via Vancouver, WA, and the Columbia River Gorge, which will have PTC due to the passenger requirements.

[294] PTC is an advanced automatic train protection system that enforces movement authorities, speed restrictions (signal and civil), and protection of roadway workers.
[295] Reviewed in: Sweeney 2014.
[296] RSIA, Public Law 110-432.
[297] Title 49, *Code of Federal Regulations*, Part 236, Subpart 1.

Risks at Railroad Grade Crossings from Crude-by-Rail Shipments

From the mid-1970s to 2000, the UTC made a comprehensive, focused effort to improve safety at railroad crossings in Washington. Hundreds of crossings were upgraded, including the installation of automatic traffic control devices such as lights and gates. Each upgrade required substantial staff involvement but ultimately led to improvements and a measurable reduction in the number of accidents. In 1980, there were 184 collisions at public highway-railroad grade crossings in Washington. In 2013, there were 17. The dramatic reduction in crossing accidents was a combined effort by local, state, and federal governments, and the railroads. The use of advanced technology and implementation of other efficiency measures are common among state agencies, but the reduction in crossing collisions is something of which the UTC is particularly proud. The effort continues, but at a reduced level, because most hazards have been addressed.

While Washington has experienced a decrease in crossing accidents, there remains work to be done. FRA has identified in its FY2013–FY2017 Research and Development Strategic Plan the following causal factors for railroad accidents, including derailments:

- 51% occur at grade crossings.
- 17% are caused by human factors (i.e., railroad staff errors).
- 17% are caused by defective track.
- 6% are caused by faulty railroad equipment.
- 1% are caused by malfunctioning signals.
- 8% are caused by other factors.

These numbers represent a leading indicator for potential risks associated with an increase in crude oil transportation. The numbers also illustrate the need for adequate staff to inspect grade crossings and to conduct inspections of railroad operating practices, track, equipment, and signals under the state-federal participation program.

UTC Railroad Crossing Study

The UTC conducted a review of its records of all public railroad-highway grade crossings located on the known primary routes of unit trains carrying crude oil in Washington. A railroad-highway grade crossing includes any location where a railroad track and a public road intersect. The UTC's analysis examined the potential for collisions between crude oil unit trains and motor vehicles at a crossing, identifying specific crossings that have the potential for elevated safety risks.

Generally, a collision at a crossing between a motor vehicle and a train causes far more damage to the vehicle than the train. In a collision, injuries, death, and property damage are more likely to occur to a motor vehicle or the person(s) inside rather than to the train. However, when the collision is with a substantial vehicle, such as a tractor-trailer or semi-truck, there is a risk that the train will derail. When a train is carrying crude oil, derailment could result in a breach of the crude oil tank car, creating a spill or an explosion.

UTC Study Assumptions

In this review, the UTC made several assumptions about the impact of collisions on train operations:

- When a train collides with anything significant, there is a risk that emergency braking prior to impact, or the impact itself, will result in derailment.
- A collision with a pedestrian, bicyclist, motorcyclist, passenger car, van, pick-up, farm vehicle, or single-unit box truck is unlikely to cause derailment of a train.
- A semi-truck with a single or double trailer combination, which can weigh over 40 tons loaded, is capable of derailing a train in a collision in certain circumstances, and some of these vehicles may carry hazardous commodities.

UTC Study Scope

The UTC's analysis relies on readily available sources of information, primarily the railroad crossing databases of the FRA and the UTC. While these two databases are somewhat redundant, they also contain different data elements.

The UTC also used a variety of reference documents to help identify and rank various risk factors at railroad-highway grade crossings, in particular:

- *USDOT, Federal Highway Administration Railroad-Highway Grade Crossing Handbook*.
- *USDOT Guidance on Traffic Control Devices at Highway-Rail Grade Crossings*.
- *USDOT Manual on Uniform Traffic Control Devices (MUTCD)*. .
- *WSDOT Design Manual*.

The UTC identified 347 public grade crossings[298] along routes used by BNSF and UP to transport unit trains in Washington carrying crude oil. The routes include the following BNSF designations:

- Kootenai Subdivision, from the Idaho border to Spokane.
- Spokane Subdivision, in and near Spokane.
- Lakeside Subdivision, between Spokane and Pasco.
- Fallbridge Subdivision, from Pasco to Vancouver, Washington.
- Seattle Subdivision, between Vancouver and Seattle.
- Scenic Subdivision, from Seattle to Everett.

[298] Crossings between railroads and roadways that are under the jurisdiction of, and maintained by, a public authority.

- Bellingham Subdivision, from Everett to the Canadian border.
- Anacortes-Burlington Branch Line, between Burlington and Anacortes.
- Intalco-Cherry Point Branch Line, between Burlington and Cherry Point.

The routes also include UP's Oregon Subdivision from the Idaho border east of Spokane to the Oregon border southeast of Pasco.

The UTC reviewed database files for each crossing for a variety of data elements including identification numbers, location, street name, and a number of predetermined risk factors. Because semi-trucks pose the greatest risk to trains during a collision, the study mainly focuses on those crossings associated with known truck routes and/or an average annual daily traffic count (AADT) with truck traffic of 20% or more. However, there are a few crossings identified that have a lower truck traffic count. While these crossings have a low truck traffic count, they are identified because they have a higher exposure to a potential accident. Exposure is measured as the number of trains per day times the number of vehicles per day. The resulting number is used to determine exposure to a potential collision at the crossing. The higher the number, the more likely a collision may occur.

Risk Factors

Factors or characteristics that make certain railroad grade crossings more susceptible to a train-vehicle collision than others include:

- Crossings protected only by passive traffic control devices, such as cross-bucks and/or stop or yield signs.
- Crossings protected only by train-activated flashing lights.
- Crossings with limited sight distance down the tracks in one or both directions and not protected by automatic gates.
- Crossings with a significant grade, or slope, approaching the crossing and not protected by automatic gates.
- Crossings with nearby roadway intersections that may cause traffic to queue over the tracks and that are not protected by automatic gates.
- Roadways that cross the tracks at an acute angle at a crossing not protected by automatic gates.
- More than one mainline track intersects the roadway at a crossing not protected by automatic gates.
- The crossing exposure factor, i.e., the number of trains per day times the number of vehicles using the crossing per day, is at a level that poses a risk.

Application of Risk Factors at Crossings

In the analysis, the UTC discounted any risk that might have otherwise existed at a crossing protected by automatic gates. For crossings protected by signals and gates, the gates at a crossing are activated by a train approaching the crossing. On the train's approach, the gates are lowered, blocking traffic from crossing the tracks while a train is on its way or actually in the crossing. Automatic gates mitigate the hazards at a crossing to the extent that the crossing poses no greater risk than any other crossing. The UTC's analysis focused on crossings that are:

- Protected only by passive traffic control devices or flashing lights, experience truck traffic at more than 20% of AADT, and have one or more of the risk factors listed as numbers three through eight.
- Appear to be under-protected in general.

UTC Study Discussion

Trucks, especially truck-trailer semi combinations, have a more difficult time safely navigating highway grade crossings than other vehicles. Long vehicles and vehicles carrying heavy loads have longer braking distances and slower acceleration. Because of these characteristics, trucks may be exposed to a crossing for a greater length of time in proportion to their length than would be expected.

Several characteristics at crossings can present additional hazards to trucks. These include impaired sight distances in one or more of the approach quadrants, an angle of less than 60 degrees where the tracks cross the highway, and an approach grade or slope of more than 5%. Sight distance is critical at crossings protected by passive traffic control devices and those protected only by flashing lights, especially for trucks. At these crossings, a driver must be able to see far enough down the track in both directions to determine if sufficient time exists for moving his or her vehicle safely across the tracks prior to arrival of a train. This "clearing" sight distance is dependent upon maximum train speed and the acceleration characteristics of a vehicle. The UTC used in its analysis a universally accepted table from the *USDOT's Railroad-Highway Grade Crossing Handbook* to determine if a particular crossing has a sight distance problem in any quadrant.

Crossings where the tracks and highway meet at less than 90 degrees (less than perpendicular) are not ideal for a number of reasons. This study focuses on only two major reasons. First, there is a likelihood of impaired sight distance for trucks. Trucks generally have less direct visibility to the rear than other vehicles, and it is assumed that the visibility would be even more difficult if the driver had to look back over his or her shoulder to see if a train was coming. The second issue is shear factor, or the amount of movement a train experiences when it collides with a vehicle at a crossing. A train colliding with a heavy truck at an angle is more likely to derail than if the collision was at a 90-degree angle. The study assumes any crossing with an angle of 60 degrees or less is more difficult for trucks to traverse.

Every crossing has an "approach grade," which is defined as the slope of the road on its approach to a railroad-highway grade crossing. Crossings with an approach grade of more than 5% are problematic for all vehicles, but especially for trucks. Vehicles need acceleration to clear a crossing before a train that was just out of sight or just beyond the train detection circuitry reaches a crossing. Shorter vehicles are obviously able to clear a crossing before longer ones. Semi-trucks have relatively poor acceleration coupled with long lengths. They are particularly at risk at crossings with a steep approach grade.

The UTC used the following statistics from the *USDOT Rail-Highway Grade Crossing Handbook* to determine the relative risk of various crossing configurations:

- On a level surface, it generally takes a truck 3.8 times as long to accelerate through a crossing as a passenger car.
- On a grade of 5%, it can take a truck over five times as long to clear a crossing as a passenger car.
- A truck can take 40% longer to clear a crossing with an approach grade of 5% than a level crossing.

Crossings with steep approach grades can be particularly problematic for "lowboy" trucks. A lowboy truck is a semi-truck and trailer combination with two drops in deck height: one right after the gooseneck where the tractor attaches to the truck and one right before the wheels. This allows the deck to be extremely low compared with other trailers. Lowboys are used to haul heavy equipment such as bulldozers, industrial equipment, and excavators. Because of low ground clearance, it is possible for this type of truck to bottom-out on the tracks and either become unable to move or to damage the tracks in some way.

The UTC also reviewed data on crossings that seem to be under-protected in general and for truck traffic specifically. There are no set national or state standards for the level of protection to be installed at crossings. These decisions are made on a crossing-by-crossing basis by a team of qualified rail and highway safety professionals. There are, however, general guidelines that have been developed by the US Department of Transportation, Federal Highway Administration, and Washington State Department of Transportation. All guidelines use a "crossing exposure factor" to initially assess the appropriate level of protection. The exposure factor is the number of trains per day times the number of vehicles per day. The resulting number is used to determine the factor for exposure to a potential collision at the crossing. As described above, the higher the exposure factor, the more likely a collision could occur.

For the purposes of the analysis, the UTC used the following guidelines to identify potentially under-protected crossings, specifically:

- Crossings protected by passive traffic control devices where the exposure factor is greater than 1,500. [299]
- Crossings protected only by flashing lights where the exposure factor is greater than 4,000.[300]

UTC Crossing Study Findings and Recommendations

The UTC looked in depth at almost 350 crossings. In general, the analysis found that most crossings are protected at appropriate levels. There are several crossings, however, that represent a higher risk of possible train derailments due to the characteristics present at the crossing. Following are the number of crossings in each category, with findings and recommendations.

Finding

There are three crossings that present multiple unfavorable characteristics:

- A crossing on BNSF's Intalco-Cherry Point branch line near Ferndale: This crossing is protected by passive traffic control devices (cross bucks and stop signs), trucks account for more than 20% of total average annual daily traffic (AADT), and there is restricted sight distance in two quadrants. However, due to the nature of rail operations on the branch line, low train speeds, and low overall AADT, there is little chance of a train-truck collision at this crossing.
- A crossing on Union Pacific's Oregon Subdivision near the community of Eureka in southeast Washington: This crossing is protected only by flashing lights, trucks account for more than 20% of total AADT, the grade on one approach is more than five degrees, and there is restricted sight distance in one quadrant. However, this crossing has exceptionally low total AADT (10), and there is little chance of a train-truck collision at this crossing.
- A BNSF crossing near the town of Lind: The crossing is protected by passive traffic control devices (cross bucks and stop signs), and trucks account for more than 20% of total AADT. However, according to available data, this crossing has exceptionally low total AADT (10), and there is little chance of a train-truck collision at this crossing.

Recommendation: Take no further action on these three crossings.

[299] See Washington State Department of Transportation publication "WSDOT Local Agency Guidelines", April 2012, Page 32-2, which states that passive crossings (those protected by only a stop or yield sign) with an exposure factor that exceeds 1,500 should be considered for installation of automatic lights and gates.
[300] See US Department of Transportation, Federal Railroad Administration, publication "Guidance on Traffic Control Devices at Highway-Rail Grade Crossings", November 2002, Page 29, which states that crossings equipped with only a flashing light and that has an exposure factor that exceeds 4,000 should be considered for installation of automatic gates.

Finding

There is one crossing that appears to be somewhat at risk in the city of Everett. It is protected only by flashing lights, trucks account for 80% of a relatively high total AADT, and the crossing angle is less than 60%. However, Everett is a first-class city, and the UTC has no jurisdiction over this crossing.

Recommendation: Refer this crossing to the city of Everett and BNSF for review.

Finding

There are a total of ten crossings that have approach grades of five degrees or more and are protected by passive traffic control devices: two crossings on Union Pacific's Oregon Subdivision and the other eight on BNSF's mainline. Though none of these crossings show a high level of truck traffic, trucks do, or can, use all of them.

Six of the ten crossings have conditions present which indicate they do not need further review:

- One of the crossings has been recently reviewed due to a reconstruction project and was determined to have the appropriate level of protection.
- Four crossings have exceptionally low AADT (30 or less) and do not warrant further review.
- One crossing is within the city limits of Spokane, a first-class city, and is not within the UTC's jurisdiction.

Recommendation: Of the four remaining crossings, refer the crossing in the first-class city to the city of Spokane and BNSF for review. Convene a diagnostic review with BNSF to determine if the remaining three crossings (one each near Spokane, Lyle, and Stanwood) are protected at the appropriate level.

Finding

There are two crossings that have approach grades of five degrees or more and are protected only by flashing lights. One is on UP's Oregon Subdivision, and one is on BNSF's mainline. Though neither crossing shows a high level of truck traffic, trucks do use both of them.

Recommendation: Convene a diagnostic review with UP and BNSF to determine if these crossings are protected at the appropriate level.

Finding

There are 11 crossings which may be under-protected. Some of these crossings are protected by passive traffic control devices and the exposure factor is greater than 1,500, while others are protected by only flashing lights and the exposure factor is greater than 4,000. One crossing is within the city of Bellingham. The other ten are located near the cities of Spokane, Pasco, Mesa, White Salmon, Burlington, and Ferndale.

Recommendation: Refer the crossing in Bellingham, a first-class city, to the city and BNSF. Review the remaining ten crossings with the appropriate railroad officials to determine whether a diagnostic review is warranted.

Crossings in First-Class Cities

The UTC has jurisdiction under RCW 81.53 over the construction, closure, modification, and any other alteration to the intersection of a highway and a railroad track, commonly called a railroad crossing. However, RCW 81.53.240 provides, in part, that “Chapter 81.53 RCW is not operative within the limits of first-class cities”. This means the UTC does not have regulatory jurisdiction over any aspect of a crossing within a first-class city for the purposes of enforcing safety standards.

RCW 81.53.291 allows first-class cities, on a crossing-by-crossing basis, to seek UTC approval for the limited purposes of installing, modifying, or otherwise altering crossing signals or warning devices, apportioning costs and providing funding from the Grade Crossing Protective Fund. There are a few first-class cities that have opted-in to the petition process for selected crossings.

There are nine first-class cities in Washington, with almost 500 crossings within these cities, as shown in Table 29. Bremerton is the only first-class city with no crossings.

Table 29: First-Class Cities in Washington with Railroad Crossings

City	Number of Crossings
Aberdeen	15
Bellingham	24
Bremerton	0
Everett	25
Richland	14
Seattle	161
Spokane	82
Tacoma	132
Vancouver	29
Total	482

UTC staff performs on-site assessments of these 500 crossings at least once every three years to collect information to maintain a crossing inventory. Staff does not conduct the same in depth inspection with follow-up on any defects with the city or the railroad since UTC does not have jurisdiction. However, if UTC staff observes a severe defect at a crossing while on-site, staff contacts the appropriate stakeholder (railroad or road authority) and provides a courtesy notice of the condition. An analysis of the available data indicates that, for the calendar year 2013, motor vehicle accident data at crossings is as shown in Table 30.

Table 30: Analysis of Motor Vehicle Accident Rates at Railroad Crossings for 2013

City Type	Number of Accidents	Number of Crossings	Ratio of Accidents to Crossings
1st Class Cities	5	482	1.04
All Other Cities	21	2,174	0.96

Because first-class cities are exempt from UTC safety regulation. There is a potential gap in public safety for railroad crossings, although the accident data for crossings within and outside of first-class cities is similar.

These cities are free to open, close, modify, or otherwise alter railroad crossings without UTC knowledge or consent. This is problematic because UTC does not know whether the 482 crossings identified for first-class cities include all crossings. Cities can open their own crossings without notifying the UTC, so it is possible crossings exist that UTC has not identified and are not included in UTC railroad crossing inventory records.

UTC staff does not believe first-class city crossings are inherently more dangerous than other crossings. The 2013 accident data shows that the rate of accidents at first-class city crossings is similar to those at other public crossings. However, UTC is concerned that the lack of information presents a regulatory gap for these crossings. Additionally, it is not clear that each of the first-class cities has the resources and programs necessary to conduct appropriate safety inspections of crossings within the city.

Recommendations for Crossings in First-Class Cities

- Amend RCW 81.53 to allow first-class cities to opt-in to the UTC railroad crossing inspection and enforcement program. For those cities that choose to opt-in, UTC staff would conduct inspections, record defects, and ensure corrections were made, whether by the city or by the railroad.
- Amend RCW 81.53 to require first-class cities to inform the UTC when a crossing is opened or closed. The cities would not be subject to UTC approval before opening or closing crossings unless they request such action by the UTC.

Private Crossings

As discussed above, the UTC has jurisdiction over the construction, closure, modification, and any other alteration of highway-railroad crossings. RCW 81.53.010 defines highways as "all state and county roads, streets, alleys, avenues, boulevards, parkways, and other *public* places actually open and in use, or to be opened and used, for travel by the public".

This means the UTC does not have regulatory jurisdiction over any aspect of a road that is not in a public place, that is "open and in use, or to be opened and used for travel by the public". These non-public crossings are commonly called private crossings.

Private crossings over mainline railroad track present a safety hazard for persons using the crossing to cross the track, but also to railroads who are not required to blow their horns or whistles at such crossings. Private crossings are not always properly signed, so a driver of the vehicle over the crossing might not know he or she is approaching a railroad crossing. In addition, the crossing may have an approach grade or slope which may result in a vehicle getting stuck, or high-centered, on the track.

In its report, *Private Highway-Rail Grade Crossing Safety Research and Inquiry (Private Crossing Research Report, February 2010)*, the FRA defines private crossings as “intersections of highways and railroads on roadways either not open to public travel or not maintained by a public authority.” Private crossings include those that provide access to two separate sections of the same farm that lie on both sides of the railroad tracks, industrial plant crossings that provide access between two separate facilities of the same plant on either side of the tracks, or access to a residential site that lies across the tracks by way of a private road. The FRA does not regulate the safety of, or establish safety standards for, private crossings. Private crossings are generally governed by contracts between the railroad and the landowner.

In its report, the FRA reaches a number of conclusions about private crossings on a national basis. [301]

- Accidents at public crossings have decreased by almost 61% between 1985 and 2006; accidents at private crossings have decreased only 26%.
- Federal Section 130 funding is used for safety improvements at public crossings but cannot be used at private crossings. This lack of funding, combined with the high cost of making safety improvements, means private crossing safety improvements are rare.
- Accidents at public crossings generally involve automobiles. Accidents at private crossings generally involve semi-trucks and trailers.
- Requiring a minimum set of warning devices would, most likely, be effective in reducing the number of accidents at private crossings.

Accident statistics at private crossings, using the most recent five-year average, show the following:

- Nationally
    - Accidents at public crossings, as a ratio to million train miles traveled, is 2.72.
    - Accident ratio at private crossings is 0.40.
- Washington State
    - Accidents at public crossings, as a ratio to million train miles traveled, is 2.65.
    - Accident ratio at private crossings is 1.02.

[301] *Private Highway-Rail Grade Crossing Safety Research and Inquiry* (Private Crossing Research Report), February 2010.

In its *Private Crossing Research Report*, the FRA included a chart regarding state authority over private crossings.[302] Several states appear to have either limited or full jurisdiction over private crossing safety:

- Alaska is standardizing responsibility and treatment for private crossings.
- Minnesota is required by law to adopt rules establishing minimum safety standards for private crossings.
- Nebraska has jurisdiction over all crossings outside incorporated cities, including private crossings.
- New Jersey requires that railroads keep private crossings in good condition.
- New York may require warning devices at newly-established private crossings.
- North Carolina may require warning devices at private crossings on federally designated high-speed corridors.
- Oregon may require a railroad to install and maintain warning devices at private crossings.
- South Carolina requires the state to protect private crossings in the same manner as public crossings.
- Virginia prohibits the construction of private at-grade crossings but allows grade-separated private crossings.

Because neither Washington State nor the FRA have jurisdiction over private crossings, it presents a gap in public safety for private railroad crossings in this state.

- Private crossings are not inspected by UTC or FRA staff. Because neither agency has jurisdiction, staff does not inspect the safety conditions at private crossings. Even if such an inspection did occur, neither agency has the ability to enforce any safety standards.
- For the last five years, on average, Washington has a higher accident ratio (1.02 per million train miles) than the national average of 0.399.

Recommendations for Private Crossings

To address the gap in safety standards and inspection authority for private crossings, the UTC recommends the following:

- Amend Chapter 81.53 RCW to add a provision allowing the UTC jurisdiction over private crossings, limited to those crossings on the primary routes used for transportation of crude oil. The UTC's jurisdiction would be for the limited purposes of establishing and enforcing minimum safety standards, including signage.

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[302] *Private Highway-Rail Grade Crossing Safety Research and Inquiry* (Private Crossing Research Report), February 2010

- Increase staffing levels, and comparable appropriations, in the UTC budget to add one FTE in the rail safety section to provide the staffing resources necessary for the UTC to inspect and enforce minimum safety standards at selected private crossings.

Appendix B: In Depth: Crude-by-Rail Facilities and Marine Transport

Crude-by-rail transport delivers some crude oil directly to refineries, and the remaining crude oil to terminals that transfer the oil to tank vessels – tank ships (tankers), tank barges, and ATBs. These vessels then transport the oil to other refining facilities. The crude-by-rail transfer operations from rail tank cars to the facilities, and from terminals to tank vessels, and the ensuing tank vessel transport is superimposed onto existing complex port operations and vessel traffic in Puget Sound, the Lower Columbia River, Grays Harbor, and the outer coast. These patterns have already changed with the existing crude-by-rail traffic, as fewer tankers are bringing crude oil in for refining, and will change in the future with the full build-out of proposed facilities.

The changes to the overall system of port activities and vessel traffic brought about by crude-by-rail are complicated by an uncertain picture related to:

- Potential future operations at the proposed Gateway Pacific Terminal (GPT) that will handle exports and imports of coal and other dry commodities loaded onto bulk carriers in Bellingham.
- Potential future operations of the container ship terminal at Roberts Bank Terminal improvements and new Roberts Bank Terminal 2 in Port of Metro Vancouver, BC.
- Potential future operations of crude oil (diluted bitumen) exports from Kinder Morgan out of the Port of Metro Vancouver, BC.
- Potential exports of crude oil in the event of the lifting of the federal ban on crude exports.

Existing Safety Systems for Vessel Operations

Safety is addressed through a variety of federal and state regulations, guidelines, and best practices. Large commercial vessels must meet the following safety requirements:

- Port State Control – U. S. Coast Guard Sector Columbia River federal regulations.
- Washington State Regulations.
  - Vessel inspections to ensure compliance with State Accepted Industry Standards.
  - Vessel outreach for prevention of spills and incidents that may lead to spills.
  - Bunkering rule monitoring and educational outreach.
- Having Licensed Pilots on board – required from sea to berth, including over the bar.

Additionally, the following risk mitigation measures are in place:

- OPA90 required double hulls for tankers/tank barges.
- Protected fuel tanks per IMO regulation (2010 and later delivered vessels).
- Puget Sound, Grays Harbor and Lower Columbia River Harbor Safety Plan with standards of care.
- Automatic Identification System (AIS) use by commercial vessels.

There are international, federal and state safety requirements for vessel engineering design, regulations, and voluntary best practices help to reduce and mitigate accidents that may lead to spillage. For example, the Oil Pollution Act of 1990 (OPA90)[303] established double-hull requirements for tankers and tank barges by 2015, which reduces the likelihood of spillage in the event of a grounding, allision, or collision. In addition, the OPA90 Salvage and Marine Firefighting regulations are now also in effect. This increases the first-order response capability to reduce the leakage of oil from tank vessels in the event of a casualty.

In 2005, MARPOL regulations[304] required updated oil-water separators on newly-built vessels. Vessel designs and systems were voluntarily simplified and improved the separation and handling of waste oils in many new builds. This coincided with greater enforcement of waste oil dumping cases.

In 2010, MARPOL regulations stated that new vessels were required to have protected fuel tanks.[305] These greatly reduce the risk of a fuel oil spill. The fuel tanks are either separated from the hull with a double-hull or are of a design that has a calculated reduced outflow of oil. The design of tankage that meets the reduced outflow criteria is the centerline double bottom configuration. This is the standard configuration for bulk ships. Pre-2010 container ships, car carriers, and open hatch general cargo vessels have side fuel tanks that are much higher risk. A side impact on these vessels can breech a fuel tank. A side impact on a standard bulk ship design or a post-2010 vessel with protected fuel tanks is unlikely to impact a fuel tank.

In addition to the regulatory changes, fuel tankage and transfer systems have been voluntarily improved in many new environmental ship designs by:

- A reduction in the number of individual tanks.
- Having a cascading tank overflow system where any excess oil flows to another tank rather than out a vent on deck and then overboard.
- Improved oil transfer procedures, often including the Washington Bunker Rule requirements for all transfers.

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[303] 101 H.R.1465, P.L. 101-380 (33 US Code §40).
[304] IMO Resolution MEPC.107(49) 18 July 2003.
[305] MEPC 141(54) reg 12A on fuel tank protection.

The Ecology Spills Program has established Accepted Industry Standards WAC 317-3, which include:

- Cargo and passenger ship vessel inspections for safety management.
- Outreach – technical and lessons learned.
- Incident investigations and lessons learned.

The State Bunkering Rule WAC 317-40 provides for:

- Oil transfer monitoring.
- Educational outreach.
- Deliverer plan and training approvals.

In addition, there is the Exceptional Compliance (ECOPRO) voluntary tankship best practices program.[306] This program decreases risk through engineering and management guidelines that exceed regulatory requirements for tank ships and tank barges.

The EPA Vessel General Permit deals with incidental discharges from vessels. EPA's NPDES vessels program regulates incidental discharges from the normal operation of vessels consistent with section 402 of the Clean Water Act. Incidental discharges from the normal operation of vessels include, but are not limited to, ballast water, bilge water, gray water (e.g., water from sinks, showers), and anti-foulant paints (and their leachate). These discharges may result in negative environmental impacts via the addition of traditional pollutants or, in some cases, by contributing to the spread of aquatic invasive species.[307]

In the normal operations of vessels, there are leakages of lubricants.[308] EPA Environmentally Acceptable Lubes (EAL) regulations are now in force.[309] All oil to sea interface systems must now use EALs. This reduces the environmental impacts of operational lubricant discharges.

The International and U.S. Safety Management Systems & International Safety Management Code is a mandatory set of best practices that vessel operators must provide to their ships. At the next meeting of the IMO's Maritime Safety Committee, two Circulars which aim to strengthen the operational implementation of the ISM Code will be presented for approval. These Circulars place greater emphasis on performing internal annual audits and internal system reviews by qualified persons.

There are other voluntary programs that increase the safety of shipping, such as the U.S. Coast Guard (USCG) QUALSHIP 21[310] program. In its efforts to eliminate substandard shipping, the

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[306] Butorac and Stratton 2009.
[307] http://cfpub.epa.gov/npdes/home.cfm?program_id=350 National Pollutant Discharge Elimination System (NPDES).
[308] In Washington State port areas, an estimated 1,200 barrels of lubricants are discharged annually from stern tubes and other vessel machinery (Etkin 2010).
[309] US EPA 2011.

USCG has primarily focused its energy on improved methods to identify poor-quality vessels (targeting schemes), and to enforce compliance with international and U.S. standards. The quality of vessels visiting U.S. ports has improved in recent years, and hundreds of vessels are typically found with few or no deficiencies. The USCG intends to reward those high-quality ship, and provide incentives to encourage quality operations.

Another program is the ISO 14001 Environmental Management Certification.[311] ISO 14001 was first released in 1996 and revised in 2004 and is the world's most recognized and used framework for environmental management systems. It is generic and applicable to any type of organization, large or small, and within any business sector. ISO 14001 is based on the two concepts of continual improvement and regulatory compliance. The standard requires organizations to identify all environmental impacts and associated aspects and define environmental objectives and implement actions to improve processes in prioritized areas with significant aspects. ISO 14001 lays out a best practice for proactive management of the environmental impact of an organization.

The American Waterways Operators (AWO) Responsible Carrier Program[312] is intended to improve marine safety and environmental protection in the tugboat, towboat, and barge industry. The program aims to accomplish this objective by establishing preferred industry operating principles and practices as voluntary standards of conduct for tugboat and towboat companies. While the standards outlined in the Responsible Carrier Program meet or exceed current governmental standards for the operation of barges and towing vessels, they do not necessarily constitute an exhaustive catalogue of all potential safety practices that any particular company should undertake. Each company must determine for itself its own operational needs and the range of safety measures necessary to protect its employees, the public, and the environment. The program is not intended to supplant any existing safety procedures that a company may have in place in excess of the standards outlined herein. Finally, while the objective of the Responsible Carrier Program is to enhance safety and environmental protection in the tugboat and towboat industry, no program can be considered a panacea that will completely eliminate injuries, accidents, or pollution incidents.

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[310] https://www.uscg.mil/hq/cgcvc/cvc2/safety/qualship/Qualship_Pamphlet_Updated_23Jun11.pdf
[311] http://www.iso.org/iso/home/standards/management-standards/iso14000.htm
[312] The American Waterways Operators Responsible Carrier Program 2013 (http://www.americanwaterways.com/sites/default/files/legacy/commitment-safety/RCP.pdf)

With regard to liquid natural gas/liquid propane gas (LNG/LPG) safety, there are special considerations. Cargo carriage in the pressurized fleet comprises double cargo containment: hull and tank. All other gas carriers are built with a double hull structure, and the distance of the inner hull from the outer is defined in the gas codes. This spacing introduces a vital safety feature to mitigate the consequences of collision and grounding. Investigation of a number of actual collisions at the time the gas codes were developed drew conclusions on appropriate hull separations which were then incorporated in the codes. Collisions do occur within the class and, to date, the codes' recommendations have stood the test of time, with no penetrations of cargo containment having been reported from this cause. The double-hull concept includes the bottom areas as a protection against grounding and, again, the designer's foresight has proven of great value in several serious grounding incidents, saving the crew and surrounding population from the consequences of a ruptured containment system.[313,314]

Future Changes in Vessel Safety Systems

The ways in which existing safety systems for vessels may change in the future are:

- There will be fewer pre-2010 vessels, so that more vessels will have protected bunker fuel tanks, reducing the likelihood of spillage during accidents.
- More vessel operators will employ better environmental programs to reduce risk, including:
  - Voluntary best practices.
  - Additional vessel operators certified to ISO 14001 standards.
  - Regulatory required improvements.
  - Continued outreach by Ecology SPPR.
- New U.S. Jones Act ecobuild tankers may enter the trade, reducing spill risk.
- USCG escorts will be required for LNG/LPG gas carriers.
- USCG Waterway Suitability Studies will be required for LNG and LPG facilities.
- Additional vessel engineering design safety improvements will be on new builds calling at Columbia River ports, including:
  - Bunker tanks overflow systems.
  - Ballast water treatment systems.
  - Gray water/black water holding systems.

[313] Carriage of Liquefied Gases, UK P&I Club
[314] USCG completed a Waterway Suitability Study for the Bradwood Landing LNG import project. This study was reviewed by Bob Troyer at MSO Portland. A copy was not obtained due to confidential sensitive security information and the state public disclosure rule.

- Improved vessel navigation technology will be mandated or voluntarily used, including:
  - Electronic chart display and information systems (ECDIS)
  - Automatic Identification System (AIS) on smaller vessels.
  - Integrated bridge navigation systems.
- Further improvements in and compliance with SMS/ISM,[315] including engine room team management.
- Better compliance with EPA Vessel General Permits.
- Implementation of Washington State no-discharge zone for EPA-VGP.
- Involvement of the Pilots, who have been proactive in preparing for new types of vessels planning to call, in waterway suitability studies, and continuation, as an integral part of the safety system.
- Potential updates to the Ecology SPPR Accepted Industry Standards.
- Continued improvement of vessels and operations through design and best practices.
- Additional risk assessment and mitigation strategies from new waterway suitability studies and environmental impact studies.[316]
- Appropriate SPPR outreach to reduce the number of reported vessel emergencies.

Tank Vessel Sizes and Crude-by-Rail Unit Equivalents

Tankers used for liquid fuels are classified according to their capacity. Crude oil is typically traded in lots of around 500,000 barrels, the equivalent of 21 million gallons.[317] Transportation economics tend to call for its shipment in stem sizes of at least a minimum 400,000 barrels (16.8 million gallons). Several tanker "families" have grown up around key stem sizes. The 400,000-barrel range is carried in a Panamax tanker,[318] the 500,000-barrel range in an Aframax[319], the one million-barrel (42 million gallons) range in the Suezmax, two million barrel (84 million gallons) range in the VLCC (very large crude carrier), and three million barrel (126 million gallons) range in the ULCC (ultra-large crude carrier). [For comparison purposes, the tanker Exxon Valdez was a VLCC with a capacity of 62 million gallons. It spilled about 18% of that cargo load in Prince William Sound, Alaska, in March 1989.]

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315 Safety Management System and International Safety Management (ISM Code).

316 Some studies are currently in the environmental review process and are expected to be released as part of the draft environmental impact statements.

317 ABS. 2002. Surveyor, Winter 2002 http://web.archive.org/web/20070930043604/http://www.eagle.org/NEWS/pubs/pdfs/SurveyorWinter02.pdf

318 A tank vessel with a length of 750 feet, a draft of 41 feet, and a deadweight tonnage (DWT) of 60,000 to 80,000; the size limits are based on ships traveling through the Panama Canal.

319 Aframax does not refer to the West African trades, but rather, started out as a fiscal descriptor, first used by US oil majors to denote a class of tankers that gave certain advantages in a specific range of trades. Those trades did not involve African ports. They did, however, involve the tax authorities, and a means of dealing with them known as the "average freight rate assessment" scheme, or "afra".

The popular, flexible, market-oriented tanker nomenclature breaks the fleet into flexible families that correlate general ship capacities, typical routings, and, in round figures, commonly carried volumes of oil, or cargo stem sizes (Table 31).

Table 31: Oil Tankers Flexible Market Scale

Class	Length	Beam (Width)	Draft into Water	Typical Minimum DWT[320]	Typical Maximum DWT
Product Tanker	741 feet	79 feet	26 feet	10,000 DWT	60,000 DWT
Panamax	750 feet	106 feet	41 feet	60,000 DWT	80,000 DWT
Aframax	830.1 feet	145 feet	38 feet	80,000 DWT	120,000 DWT
Suezmax			52 feet	120,000 DWT	200,000 DWT
VLCC	1,080 feet	200 feet	66 feet	200,000 DWT	315,000 DWT
ULCC				320,000 DWT	550,000 DWT

Washington State limits the maximum size of tankers calling in Puget Sound to 125,000 DWT. The Polar tankers are actually downgraded Suezmax tankers. Most tankers going in and out of Vancouver, BC, are Aframax or Panamax tankers (due to draft limits). Most foreign tankers calling in Puget Sound are Aframax tankers, but some may be Panamax.

Grays Harbor and Columbia River would contain a mix of Panamax and Aframax, due to depth limitations. Little crude oil would be carried on a tanker of less than 60,000 DWT.

For purposes of estimating equivalent tankers, a large Aframax (120,000 DWT) is used to compare to a unit train, as the tankers calling in Puget Sound will be at the large end of that range. Alaska North Slope (ANS) crude oil has a density or specific gravity of about 0.86. As DWT includes fuel, this is consistent with 900,000 barrels (37.8 million gallons) of oil cargo. This works out to 12–13 crude-by-rail trains per tanker (a single crude-by-rail unit train of 100 cars holds three million gallons).

Crowley Maritime has ATBs with 327,000-barrel (13.7 million-gallon) capacity, 178,000-barrel (7.5 million-gallon) capacity, and 155,000-barrel (6.5 million-gallon) capacity[321]. The largest ATBs do not yet operate on the West Coast. Using the 155,000- or 178,000-barrel capacity, an ATB holds about two to three crude-by-rail trainloads.

[320] DWT = deadweight tonnage, a measure of the weight that a vessel can carry.
[321] Crowley Maritime. 2014. http://www.crowley.com/What-We-Do/Petroleum-and-Chemical-Transportation/Vessel/650-Class-Articulated-Tug-Barges-ATBs, accessed Sept. 22, 2014

Salish Sea/Puget Sound

The Puget Sound is a complex estuarine system of interconnected marine waterways and basins with one major outlet to the open Pacific Ocean: the Strait of Juan de Fuca. The actual Puget Sound is about 100 miles long and 10 miles wide, a total of 1,000 square miles. It contains several prominent islands: Anderson Island, Bainbridge Island, Blake Island, Camano Island, Fidalgo Island, Fox Island, Guemes Island, Harstine Island, Herron Island, Indian Island, Marrowstone Island, Maury Island, McNeil Island, Squaxin Island, Vashon Island, and Whidbey Island.

While, technically, the term “Puget Sound” refers only to the body of water shown in Figure 71, the term is often used more loosely to refer to the entire Puget Sound region. The Strait of Juan de Fuca and its approaches, as well as the Strait of Georgia, together with the Puget Sound, form the Salish Sea (Figure 72). In the context of this report, “Puget Sound” refers to the entire region.

Figure 71: Puget Sound

Figure 72: Map of Salish Sea. Image source: Canadian Geographic

The total extent of the Salish Sea is much larger – 6,900 square miles. It contains an archipelago, called the San Juan Islands, that sit between Rosario Strait on the east and Haro Strait/Boundary Pass on the west (Figure 73).

Figure 73: San Juan Islands and Surrounding Straits

Puget Sound Tank Vessel Traffic

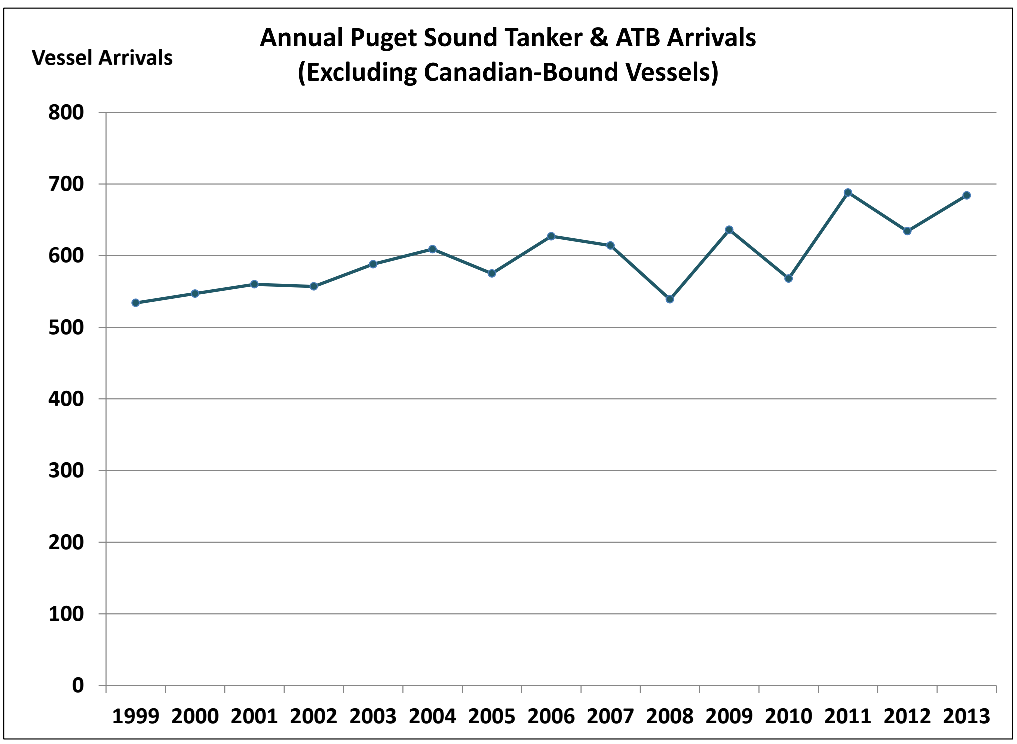
Oil Tankers

A great number of foreign and domestic tankers operate throughout the region. Domestic Trans-Alaska Pipeline System (TAPS) and foreign tankers bring in crude oil from Alaska and around the world. Domestic and foreign tankers bring in and take out a great deal of product. In addition, a large number of foreign tankers transit our waters to load crude oil and refined product out of the Westridge Marine Terminal in Vancouver, BC. Kinder Morgan sends about 40 crude oil tankers out of Westridge annually.[322] Table 32 shows the number of arrivals for 2013. Tankers and ATB arrivals to Puget Sound, excluding vessels bound for Canadian ports, are shown in Figure 74.

Table 32: VEAT Tanker Arrivals into Puget Sound in 2013[323]

Destination	Entering Transits	Individual Vessels
Ports in Puget Sound via Strait of Juan de Fuca	391	122
Ports in Puget Sound via Strait of Georgia, Haro Strait	12	10
Canadian Ports via Strait of Juan de Fuca	200	103

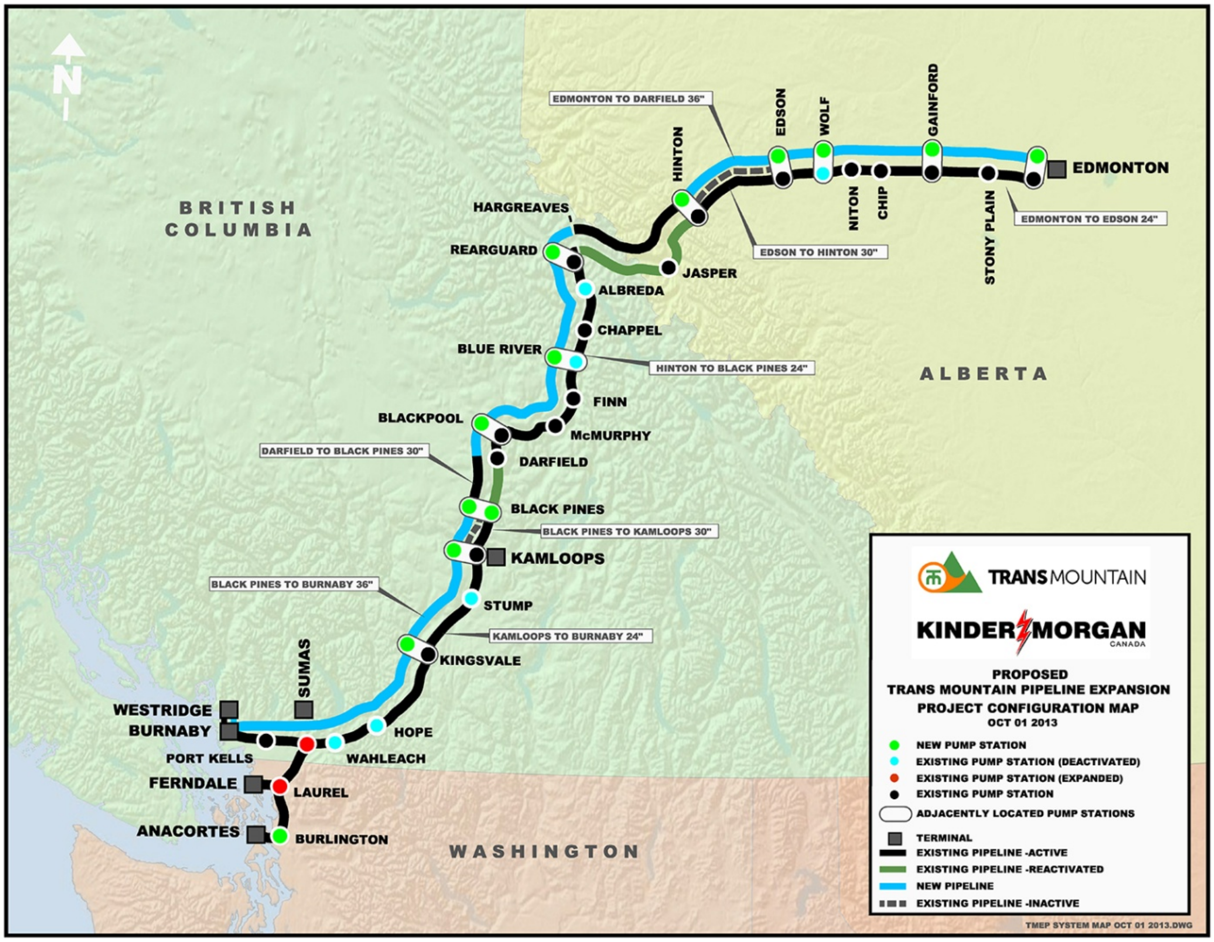
Figure 74: Annual Puget Sound Tanker/ATB Arrivals (Excluding Canadian-Bound Vessels)[324]



[322] Based on AIS data and data from Kinder Morgan sources.
[323] Washington Dept. of Ecology, 2013. https://apps.ecology.wa.gov/publications/SummaryPages/1408004.html
[324] Based on Ecology VEAT data.

The number of these Canadian crude exports are projected to increase dramatically if/when the Trans Mountain Pipeline[325] expansion from Alberta to Vancouver gets completed (Figure 75). The pipeline is operating at 12.6 million gallons per day transmission of both crude oil and refined products, but proposed expansion projects would bring that transmission up to 35.7 million gallons/day.

Figure 75: Trans Mountain Pipeline Expansion. Image source: Kinder Morgan Canada.



All oil tankers arriving into Washington waters are double-hulled. All laden oil tankers transiting to/from Washington ports must be accompanied by an adequate tug escort all points east and north from a line extending of the New Dungeness light to Discovery Island light (just east of Port Angeles). All laden crude tankers transiting to/from Canadian ports must be accompanied by an adequate escort tug between Race Rocks (south of Victoria) and East Point (at the eastern end of Boundary Pass).

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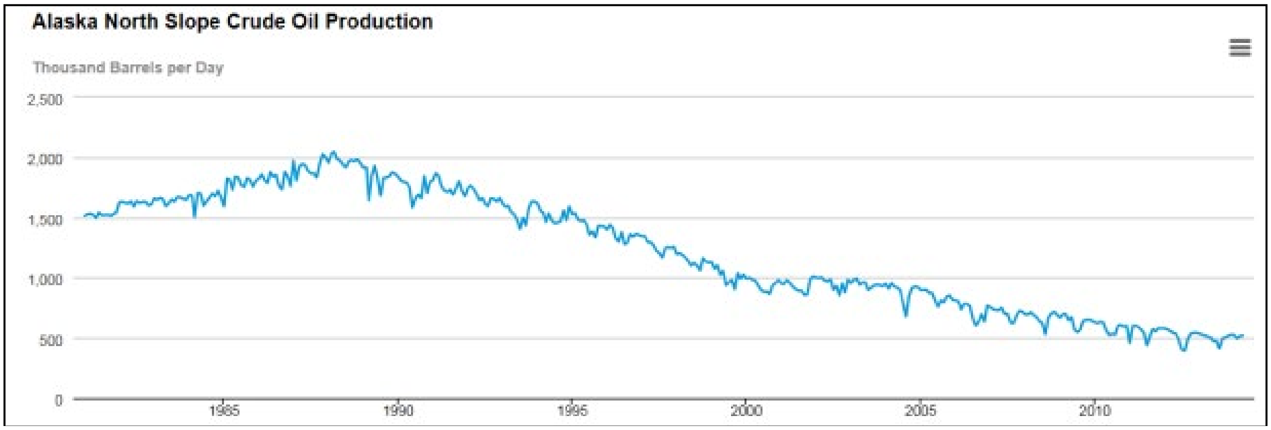
[325] The TransMountain Pipeline connects to all four of the northern Puget Sound refineries, BP Cherry Point, Conoco Phillips Ferndale, Shell Puget Sound Refinery, and Tesoro Anacortes. The pipeline enters Washington as a single 20-inch line near the Sumas River then splits at Laurel Station. A 16-inch line runs from Laurel Station to Ferndale where it meets up with a 24-inch line owned and operated by BP that connects to Cherry Point. A 20-inch line runs from Laurel Station to Burlington where it tapers to a 16-inch line terminating at Shell PSR where pipes could carry the product to neighboring Tesoro.

TAPS Trade Domestic Tankers

ANS crude is piped from the North Slope via the Trans-Alaska Pipeline System (TAPS) to the Valdez Marine Terminal where it is loaded onto ships for distribution to Washington and California refineries. Production of ANS has been in consistent declined for more than a decade (Figure 76). To counter this decline, U.S. West Coast refiners have looked increasingly to alternative crude sources to augment supply.

Figure 76: ANS Crude Production[326]



Three companies are transporting ANS crude from Valdez to Washington refineries. These tankers transit along the Pacific Coast from Alaska to California, and all enter and depart the Puget Sound region through the Strait of Juan de Fuca. All current TAPS trade tankers are ECOPRO-certified:[327]

- **Alaska Tanker Company (ATC):** Three vessels all with a capacity of approximately 1.3 million barrels. However, due to 125,000 DWT limit for Puget Sound, these vessels can only be loaded to just under one million barrels to enter our waters. Average age of these vessels is nine years old. ATC is a partnership between BP, Keystone, and OSG and carries crude for BP.
- **Polar Tankers:** Five vessels all with a capacity of approximately one million barrels. Average age of these vessels is 11 years old. Polar is a subsidiary of Conoco Phillips and supplies crude to Phillips 66, BP, Shell, Tesoro, and until recently U.S. Oil.
- **SeaRiver:** Two vessels with an average capacity of approximately 900,000 barrels. One of these vessels is 35 years old; the other is 36. Prior to January 2014, there was a third vessel on the run with a smaller capacity of 330,000 barrels and 17 years of age. New builds are in progress. SeaRiver is a subsidiary of Exxon and moves crude for BP, Shell, and Tesoro.

[326] Data from Energy Information Administration.
[327] Washington State Exceptional Compliance Program.

Domestic Product Tankers

Petroleum product moves up and down the West Coast on smaller domestic product tankers. Sometimes these tankers will move crude, but mostly, it is product moving between refineries and tank terminals. In the past, more companies were operating product tankers in this market, but currently there are just two:

- **Overseas Group (OSG):** Operates five domestic tankers in the region all with a capacity of around 330,000 barrels. These vessels range from three to seven years of age, with an average of five. OSG carries product primarily for Tesoro and BP along the U.S West Coast and Alaska. They have in the past filled in for TAPS trade tankers.
- **Crowley Petroleum Services:** Crowley operates two “state” Class tankers within Puget Sound for Military Sealift Command. Both are four years of age and carry about 330,000 barrels. These tankers often load at BP Cherry Point and discharge to facilities in Manchester, Vancouver, WA, and other U.S. West Coast locations. These tankers are ECOPRO-certified.

Foreign Tankers: Imports

Though foreign tankers do bring in a small amount of petroleum product, they primarily bring in crude from a variety of sources around the world in significant volumes. Crude sources and volumes which come into the West Coast PADD[328] 5 are tracked by the U.S. Energy Information Administration (EIA)[329] (Figure 77).

[328] Petroleum Administration Defense Districts (as in the map in Figure 93. The United States is divided into five Petroleum Administration for Defense Districts, or PADDs. These were created during World War II under the Petroleum Administration for War to help organize the allocation of fuels derived from petroleum products, including gasoline and diesel (or "distillate") fuel. Today, these regions are still used for data collection purposes. PADD 5 includes: Alaska, Arizona, California, Hawaii, Nevada, Oregon, and Washington.

[329] A principal agency of the U.S. Federal Statistical System responsible for collecting, analyzing, and disseminating energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment; EIA programs cover data on coal, petroleum, natural gas, electric, renewable and nuclear energy; EIA is part of the U.S. Department of Energy.

Figure 77: U.S. Petroleum Administration for Defense Districts

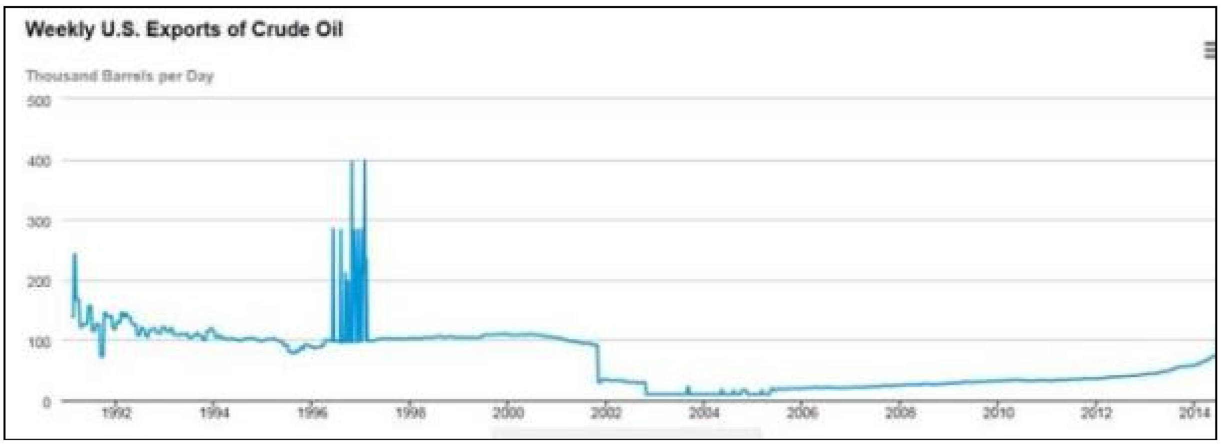
Much of that crude oil is transferred or lightered from larger VLCCs[330] and ULCCs[331] to smaller vessels at the West Coast lighterage area (140 miles off San Diego) or at tank terminals in Panama. Many of those smaller tankers regularly call in Washington State, commonly to BP Cherry Point.

Overall foreign crude volumes have fallen slightly in the last couple years, from 1.6 billion gallons in 2011 to about 1.2 billion gallons in 2013. In the same period there was an influx of Bakken crude-by-rail transport.

Foreign Tankers: Exports

In addition to bringing foreign crude to Washington, foreign tankers also take out a large volume of petroleum products for overseas export. In 2011, the volume these tankers took out of state was about 651 million gallons, a significant increase from the 284 million gallons for the 12-month period between October 1, 2007 and September 30, 2008. Nationally, the exportation of petroleum products has also risen dramatically, and in 2011 petroleum products became the top U.S. export measured by dollar value. The nation exports about 40 times the amount of product than crude oil (Figure 78). Washington State has followed this national trend.

Figure 78: U.S. Petroleum Product Exports (EIA Data)



Ecology last tallied up Washington State exports in 2011. That year, nearly 8.7 billion gallons of crude oil entered the state by vessel and pipe, but nearly 3.5 billion gallons of product were then exported interstate and overseas from the state as cargo and fuel. That means 40% of what came in then went back out.

Tank Barges

Tank barges range throughout the Puget Sound region, transiting most every major waterway and servicing most all ports. While most are traditional tow-wire barges in which a tug tows the

[330] Very large crude carriers, which have a deadweight tonnage of 200,000–315,000, as described in Table 32.
[331] Ultra large crude carrier, which have a deadweight tonnage of 320,000–550,000, as described in Table 32.

barge, there are an increasing number of Articulated Tug and Barges (ATBs), where the tug is connected to the barge by pins and pushes it.

Domestic Fleet

Crowley ATBs: Crowley operates two classes of purpose built ATB's along the U.S. West Coast and within Washington waters. The *550 Class* has a capacity of 155,000 barrels (6.51 million gallons), and the *650 Class* has a slightly larger capacity of 178,000 barrels (7.48 million gallons). At present none of Crowley's new 327,000-barrel (13.74 million-gallon) *750 Class* operate on the West Coast. Crowley's ATBs move both product and crude for a number of companies, performing bulk cargo moves between refineries and terminals. To give examples, a Shell contract vessel will move various clean products between Shell's facilities in Martinez, Anacortes, Seattle, and Vancouver BC. Crowley's ATBs are ECOPRO. In a new trade pattern, Crowley's ATBs are also increasingly moving crude, specifically railed-in Bakken shale from Clatskanie and piped-in oil sands from Westridge. Most of this is going to BP.

Harley Marine Services: Harley operates a family of tug and barge companies along the West Coast, the largest of which is Olympic Tug & Barge (OTB). OTB has the largest share of the bunkering market in Puget Sound with about 94%. OTB and other Harley entities also perform black oil terminal moves for Tesoro and Phillips 66 within the state and along the coast in barges ranging in size from 30,000–83,000 barrels (1.26 million–3.49 million gallons). They regularly supply Kinder Morgan Seattle, Paramount Pt. Wells, Targa Tacoma, and Tesoro Port Angeles. In a new trade pattern, Bakken crude from Clatskanie is being moved on Harley's barges. All of Harley's barges are double-hulled with a traditional tow wire, but plans are to build ATBs.

Kirby: U.S. barge giant Kirby jumped in big into the West Coast market after purchasing K-Sea Transportation in 2011. Their fleet consists of both traditional tow wire barges and ATBs. Unlike Crowley, many of Kirby's ATBs were not purpose built tandems but often consist of new barges with older tugs converted to pins. They carry clean products between West Coast refineries and terminals. They supply much of Tacoma's gasoline and diesel market from product loaded in Ferndale.

Sause Brothers: Sause operates state-of-the-art traditional tow wire barges along the West Coast. One of their barges regularly brings in Canadian oil sands crude from Vancouver, BC (Westridge) to U.S. Oil Tacoma. In 2013 alone, this 85,000-barrel (3.57 million-gallon) barge made 33 trips to U.S. Oil, bringing in approximately 105 million gallons of oil sands product. Sause also moves virgin gas-oil (VGO)[332] for Shell.

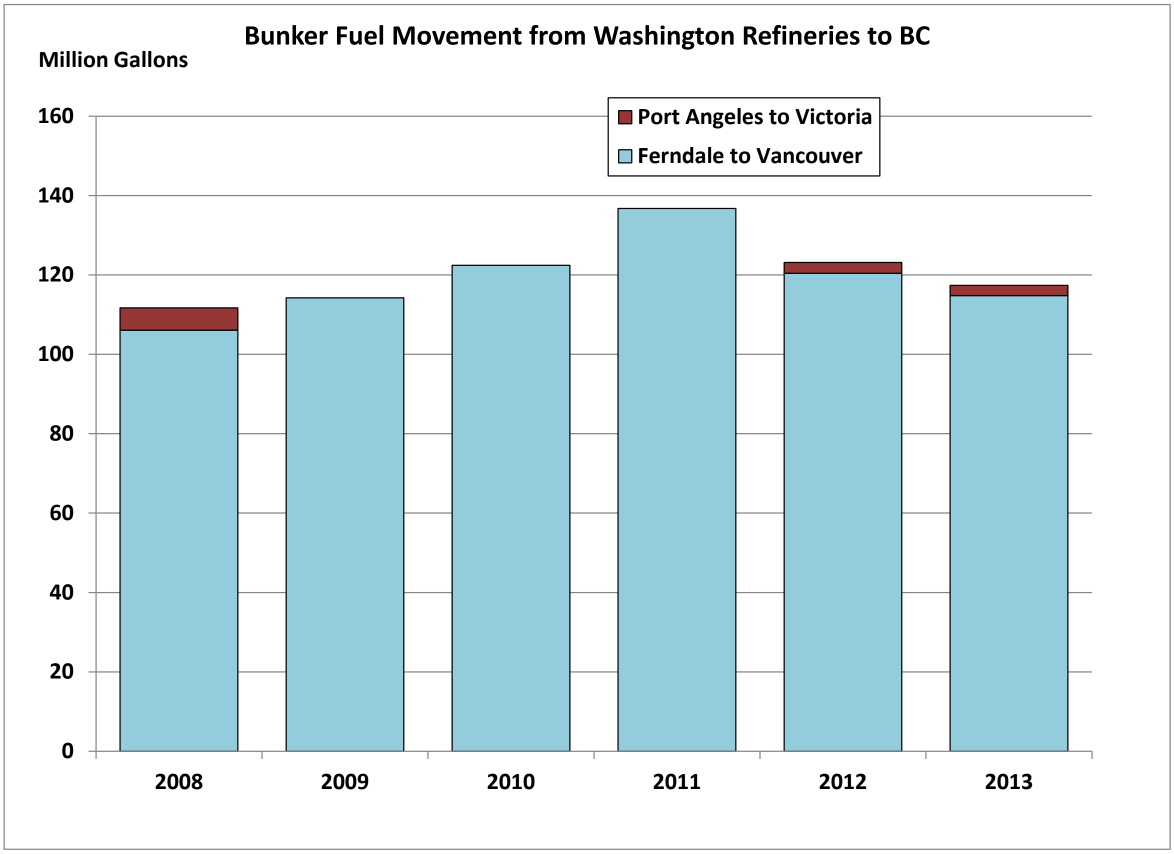
Global Marine Transportation (Maxum): Maxum operates a couple of small barges in the diesel bunkering and lube oil markets. By volume they are small, but they have a significant number of transits and transfers, operating in Seattle, Tacoma, Port Angeles, Bellingham, and Anacortes.

[332] A very light petroleum product, also called straight run, gas oil, cutter stock, light coker gas oil.

Canadian Fleet

Canadian-flagged tank barges bring "clean product"[333] down and take "dirty product"[334] up. They regularly supply Seattle and Tacoma with gasoline from Vancouver, BC and take intermediate fuel oil from Ferndale and other Puget Sound locations up to supply the Vancouver bunker market (Figure 79).

Figure 79: Annual Bunker Fuel Movement from Washington Refineries to British Columbia



The Canadian tank barge fleet consists of:

- **Island Tug and Barge (ITB):** ITB regularly brings in Canadian gasoline from Vancouver, BC to supply Kinder Morgan Seattle and Targa Tacoma on their 65,000-barrel (2.73 million-gallon) ATB. In 2013, they made 56 deliveries but are on pace to exceed that total in 2014. Prior to 2013, they also supplied Nustar Tacoma. ITB is an ECOPRO member.
- **Marine Petrobulk:** Operator of two 24,000-barrel barges which load Intermediate Fuel Oil from Phillips 66 Ferndale to supply the Vancouver, BC bunker market. Every year these vessels make a hundred or more round trips between the two ports, empty southbound, laden northbound. Marine Petrobulk is a VBAP member.

333 Clean petroleum products or "clean products" are liquid products refined from crude oil, whose color is less than or equal to 2.5 on the National Petroleum Association scale. Clean products include naphtha, jet fuel, gasoline, and diesel/gas oil.

334 Dirty petroleum product or "dirty product" is synonymous with fuel oil or residual fuel.

- **Aegean Marine Petroleum (West Coast Fuel Transport):** Moves bunker fuel to supply the Canadian market. Primarily loads out of Tesoro's Port Angeles facility or Paramount Point Wells for Tesoro. In the past, also loaded out of Anacortes and Tacoma. These vessels are VBAP members.

Puget Sound Oil Refineries

There are five refineries in Puget Sound with a current total operable capacity of approximately 631,700 barrels per day (230 million barrels per year if all run at full capacity).[335] This is the equivalent of 26.53 million gallons per day (full capacity), or 9.66 billion gallons annually. Four refineries are located in the North Sound and one is in Tacoma.

Refinery Imports

Statistics on the refinery imports of the five Puget Sound refineries are summarized in Table 33.

Table 33: Summary of Washington State Refinery Imports

Refinery	Capacity	Modes of Crude Oil Receiving	Berthings (2013)
BP Cherry Point (Blaine)	9,450,000 gal/day	Receives crude by tanker, tank barge, pipeline, and now rail. Over water in 2013 BP received > 80 million barrels of crude from: • ANS: (51% total) all on TAPS trade tankers (ATC, SeaRiver, & Polar) from Valdez. • Foreign (non-Canadian): (39% of total). Common for frequently calling foreign shuttle tankers to bring in wide variety of crudes from U.S. West Coast lighterage area and Panama. • Bakken: (9% of total)[336] Most of the crude was moved by Crowley ATBs, but nine were by traditional tank barges without IG systems operated by Kirby and Harley. • Canadian: (1% of total).[337] In 2014 BP also began receiving oil sands by Crowley ATB. All are loaded at the Westridge Terminal in Vancouver, BC.	92 tankers from Alaska (TAPS) 64 tanker s from foreign (non-Canadian) nations 57 crude-by-rail tank barges & ATBs from Port Westward (Clatskanie) Oregon crude-by-rail facility 5 ATBs from Canada
Phillips 66 (Ferndale)	4,242,000 gal/day	Receives crude by tanker, tank barge, pipeline, and now rail. Over water in 2013, Phillips 66 received almost 24 million barrels of crude, 97% of which was ANS, moved primarily on their Polar tankers. Starting in 2012, Phillips began bringing in Bakken crude on tank barges first from Targa Tacoma, then from Clatskanie Oregon.	72 tankers and 10 tank barges
Shell Puget Sound (Anacortes)	6,090,000 gal/day	Receives crude by tanker, tank barge, and pipeline. Plans to receive oil by rail in future. Over water in 2013 Shell received almost 30 million barrels of crude, 99% of which was ANS, moved on Polar, SeaRiver, and OSG tankers. They infrequently bring in foreign oil	80 tankers and 3 ATBs

[335] http://www.eia.gov/petroleum/refinerycapacity/table3.pdf
[336] This is a new trade pattern that began in December 2012.
[337] This is a new trade pattern since 2014.

Refinery	Capacity	Modes of Crude Oil Receiving	Berthings (2013)
		by foreign tanker and recently have taken some parcels of unconventional crudes from Crowley ATB.	
Tesoro (Anacortes)	5,040,000 gal/day	Receives crude by tanker, pipeline, and beginning in 2011, rail. Due to expansion of rail activities, new trade pattern has developed. Over water in 2013, Tesoro brought in < 4.4 million barrels crude, down from 19.5 million barrels in 2012 and 17 million barrels in 2011. While overall quantity of crude by vessel has declined, ratio of crude sources received over dock has remained relatively unchanged. A little over half is from foreign sources on foreign tankers and a little less than half is ANS from TAPS tankers.	Crude tanker counts dropped from 43 berthings (22 foreign / 21 domestic) in 2012 to 13 berthings (6 foreign / 7 domestic) in 2013.
U.S. Oil (Tacoma)	1,709,400 gal/day	Receives crude by tanker, tank barge, and, since 2012, rail. Only refinery not to receive oil by pipeline. Due to expansion of crude-by-rail activities, new trade pattern has developed. U.S. Oil is first refinery to wean itself off of ANS entirely. In 2012, U.S. Oil received 13 million barrels crude, 78% was arriving on Polar tankers (28 tanker berthings). Remaining 22% was Canadian oil sands loaded at Westridge Marine Terminal in Vancouver, BC (34 Sause Brothers barge berthings, 1 foreign tanker). In 2012, U.S. Oil only received 4.5 million barrels over water and last received ANS on 3/31/13. Since then it has been all Canadian sands by barge and Bakken shale by rail.	None (all by rail)
Total	26,531,400 gal/day		326 tankers 19 tank barges 48 ATBs

Important changes that have occurred in the last two years include:

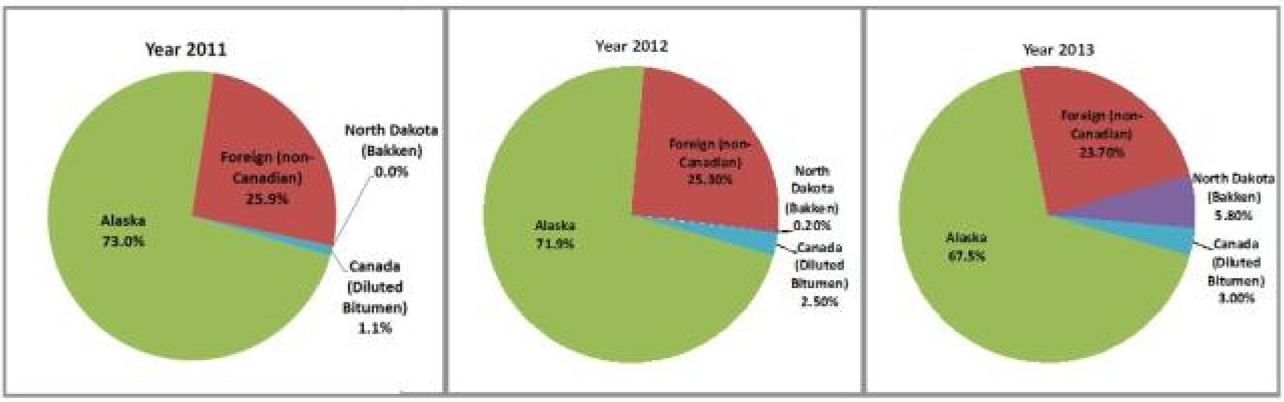
- BP Cherry Point Refinery began receiving ATBs with Canadian diluted bitumen in 2014.
- Phillips 66 Refinery began receiving Bakken crude on tank barges in 2012, first from Targa Tacoma, and then Port Westward in Clatskanie, Oregon.
- Tesoro Anacortes Refinery expanded its crude-by-rail activities.
- U.S. Oil Refinery completely changed over to receive crude oil directly from rail tank cars at the facility, rather than receiving this oil via tank vessels from another facility that originally received the crude from rail tank cars.

A breakdown of crude oil sources by tank vessel from 2011–2013 is in Table 34 and Figure 80.

Table 34: Crude Sources for Tank Vessels in Washington State Waters[338]

Crude Origin	2011		2012		2103	
	Gallons	% Total	Gallons	% Total	Gallons	% Total
Alaska	4,510,082,346	73.0%	4,259,294,676	71.9%	4,048,271,388	67.5%
Foreign (Not Canada)	1,598,520,084	25.9%	1,499,720,670	25.3%	1,424,656,128	23.7%
North Dakota Bakken	0	0.0%	12,537,000	0.2%	345,219,000	5.8%
Canada Diluted Bitumen	67,019,274	1.1%	149,421,720	2.5%	181,870,836	3.0%
Total	6,175,621,704	100%	5,920,974,066	100%	6,000,017,352	100%

Figure 80: Change in Origin of Crude Oil Transported by Tank Vessel in Washington Waters



In addition to crude, all refineries receive refined product to lesser degree. A full breakdown of petroleum receipts (crude and refined) for 2012–2013 are in Tables 35 and 36.

Table 35: Washington Refinery Refined Product and Crude Receipts 2012

Oil[339]	Refinery (Receipt in Million Gallons)					Total
	BP Cherry Point	Phillips 66	Shell Puget Sound	Tesoro	U.S. Oil	
Aviation Fuel	7.98	0.00	0.00	0.00	0.00	7.98
Bunker/HFO	0.00	1.18	2.10	2.81	16.00	22.09
Cat Feed/VGO	0.00	0.00	5.25	53.82	2.60	61.68
Diesel Oil	39.40	4.33	0.00	14.11	26.71	50.69
Gasoline	71.74	16.34	0.00	1.89	0.00	128.90
Kerosene/Jet	64.02	0.00	0.00	1.89	0.00	65.91
Other Refined	0.00	0.00	1.68	0.00	4.64	6.32
Total Refined	183.13	21.84	9.03	76.42	53.15	343.57
Crude Oil	2,256.42	1,015.33	1,281.36	819.43	548.43	5,920.97
Total All Oil	2,439.55	1,037.17	1,290.39	895.85	601.58	6,264.54
Crude Source						
ANS	52%	99%	97%	49%	78%	69.9%
Foreign	46%	0%	3%	51%	0%	28.1%
Oil Sands	1%	0%	0%	0%	22%	1.3%
Bakken/Shale	1%	1%	0%	0%	0%	0.7%

[338] Pipe and rail figures have been excluded, but figures for North Dakota (shale) arrived to Targa and Clatskanie by rail prior to being loaded onto barges for delivery to WA State refineries have been included.
[339] HFO = heavy fuel oil; VGO = virgin gas oil.

Table 36: Washington Refinery Refined Product and Crude Receipts 2013

Oil	Refinery (Receipt in Million Gallons)					Total
	BP Cherry Point	Phillips 66	Shell Puget Sound	Tesoro	U.S. Oil	
Aviation Fuel	0.00	0.00	0.00	0.00	1.05	1.05
Bunker/HFO	19.99	0.00	0.21	5.46	13.38	39.04
Cat Feed/VGO	3.15	5.67	5.75	109.77	0.00	124.34
Diesel Oil	5.54	0.00	0.55	17.35	13.10	23.22
Gasoline	28.35	13.44	0.00	0.00	0.00	72.24
Kerosene/Jet	4.25	0.00	0.00	0.00	0.00	4.25
Other Refined	0.67	0.00	7.77	1.26	0.00	9.70
Total Refined	61.95	19.11	14.28	146.56	31.94	273.84
Crude Oil	3,385.91	997.25	1,243.76	182.53	190.57	6,000.02
Total All Oil	3,447.87	1,016.35	1,258.04	329.09	222.51	6,273.86
Crude Source						
ANS	51%	97%	99%	46%	27%[340]	67.7%
Foreign	39%	0%	0%	54%	0%	23.7%
Oil Sands	1%	2%	0%	0%	73%	3.2%
Bakken/Shale	9%	1%	1%	0%	0%	5.5%

Refinery Exports

Washington State's refineries supply more than just Washington itself with refined petroleum products. They also supply other states, British Columbia, and other parts of the world with refined product, as well. Ecology counted up all the export barrels leaving our state in 2008 for the 12-month period of October 1, 2007 through September 30, 2008. At that time, 53 million barrels (2.23 billion gallons) of petroleum cargo were exported from Washington State. In 2011, the total cargo export number had increased to 62 million barrels (2.6 billion gallons). This overall export increase came entirely from a nine-million-barrel (378-million-gallon) increase in exports to foreign countries other than Canada (Figure 81). In other words, 42% of what came in over the water to Washington's refineries proceeded to go back out over the water during 764 tanker and tank barge berthings.

In addition to cargo exports, oil leaves Washington State as ship's bunkers. The primary bunker suppliers in Puget Sound are Tesoro, Phillips 66, and U.S. Oil. Typically a barrel of Puget Sound bunkers will be transferred five times before it leaves the state. First, it comes in to a refinery from a tanker, from there to a barge, then to a terminal, then onto another barge, and then finally onto a ship as fuel. The volume of bunkering in Puget Sound depends upon a variety of factors, including volume of vessel traffic, bunker prices, and fuel availability (Figure 82). About 11 million barrels (462 million gallons) of bunker fuel per year are loaded onto deep draft vessels and exported from Puget Sound. Olympic Tug and Barge vessels accounted for 94% of this total, the remainder coming from Maxum Petroleum and marine terminals.

[340] The last ANS US Oil Refinery received was on March 31, 2013. Since then, all receipts have been of CBR oils.

Figure 81: Oil Cargo Exports by Tanker and Tank Barge from Washington Refineries[341]

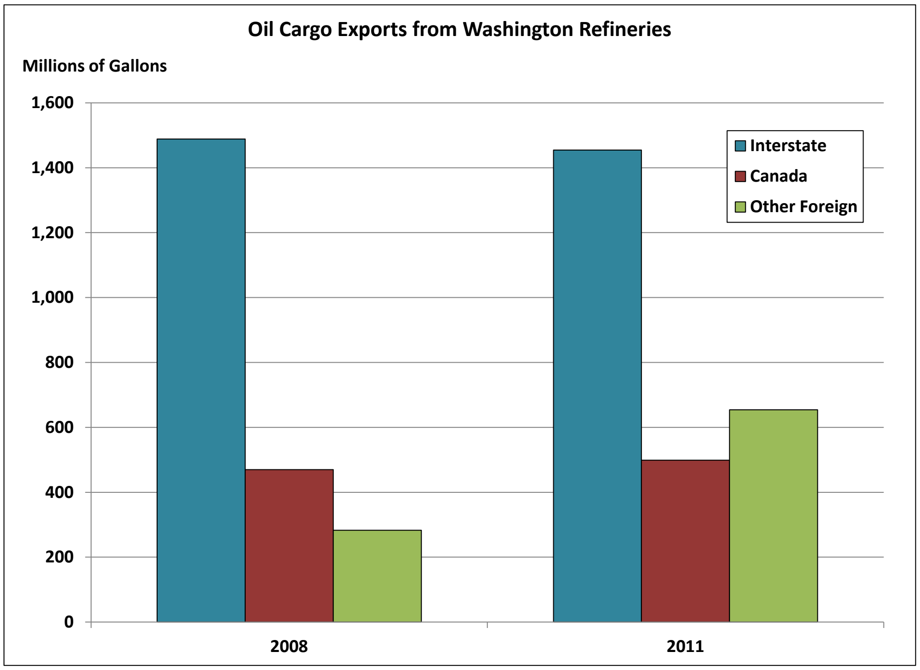
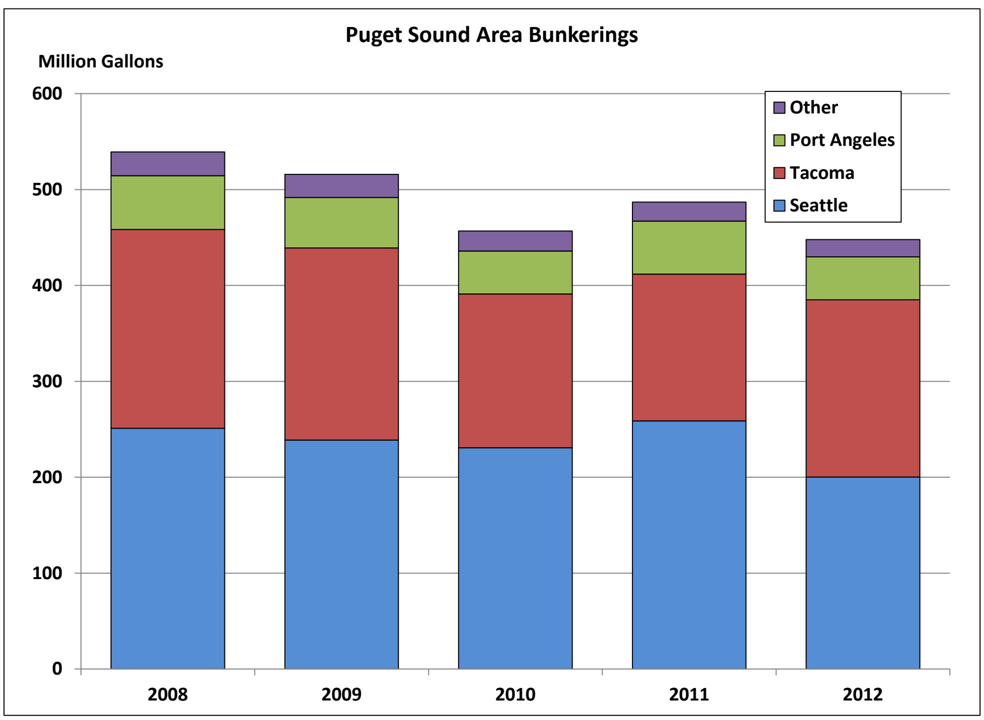


Figure 82: **Puget Sound Bunkerings**



[341] 2008 is actually the period 10/01/2007 – 09/30/2008.

Additionally, Washington State refineries supply the majority of the Vancouver, BC bunker market. In 2011, tugs and barges exported about 3.7 million barrels of bunker fuel during 286 transits from the state to supply Canadian-calling ships. This volume can be expected to increase with the Kinder Morgan pipeline expansion to Westridge Marine Terminal. Vessel traffic in Vancouver is expected to increase up to 240–300 tankers per year. If the Roberts Bank Terminal 2 expansion goes through, it will mean even more ship calls and more bunker fuel heading north. In addition to ships, an estimated 10 million barrels (420 million gallons) of oil is exported annually from Washington as aircraft fuel.

Puget Sound Marine Terminals

The existing marine terminals in the Greater Puget Sound area are summarized in Table 37.

Table 37: Marine Terminals in Greater Puget Sound

Facility	Refinery	Crude-by-Rail Terminal	Inbound Pipeline	Outbound Pipeline	Rail Rack	Truck Rack	Storage
Phillips 66 Tacoma			•			•	•
NuStar Tacoma			•			•	•
U.S. Oil Tacoma	•	•		•		•	•
Targa Sound Tacoma		•	•			•	•
BP Terminal Harbor Island			•		•		
Shell Products Harbor Island			•		•	•	•
KinderMorgan Harbor Island			•		•	•	•
Paramount Richmond Beach					•	•	•
Navy Depot Manchester						•	•
Naval Air Station Whidbey Island							•
Tesoro Port Angeles							•
Shell Puget Anacortes	•	**proposed**	•	•	•	•	•
Tesoro Anacortes	•	•	•	•	•	•	•
Phillips 66 Ferndale	•	**under construction**	•	•	•	•	
BP Cherry Point Blaine	•	•	•	•	•	•	•

Oil Terminals

There are ten oil terminals in Puget Sound that receive either tankers, tank barges, or both (Figures 83 and 84).

Figure 83: North Puget Sound Refineries, Terminals, and Anchorages[342]

342 Refineries are shown in red, terminals in blue, and anchorages in yellow.

Figure 84: South Puget Sound Refineries, Terminals, and Anchorages[343]

Nine of these terminals are in the South Sound; the other is in Port Angeles:

- **Tesoro Port Angeles Terminal (Port Angeles):** Black oil[344] and diesel are brought in by tank barge from Tesoro Anacortes Refinery. This tank terminal supplies the local paper mill and the Port Angeles bunker market.
- **Paramount Petroleum (Edmonds/Pt Wells):** Black oil and diesel are brought in by tanker and tank barge primarily from Tesoro's Anacortes and Nikiski refineries. This tank terminal supplies much of the Seattle bunker market for Tesoro.
- **Kinder Morgan (Seattle):** Black oil and diesel are brought in primarily by barge from Phillips 66 Ferndale refinery. Gasoline is brought in by barge from Vancouver, BC and by Olympic Pipeline. This terminal supplies local gasoline market by truck rack and supplies much of Seattle bunker market for Phillips.

[343] Refineries are shown in red, terminals in blue, and anchorages in yellow.
[344] Black oil is an industry term that refers to refined petroleum products that have an °API of 15 to 45, and thus are moderately heavy, between volatile oils and heavy oils and tars.

- **Maxum Petroleum (Seattle) (ex-Rainier Petroleum):** Supplier of marine diesel and lubricants by dock, tank barge, and truck. Supplied with diesel from Shell tanks on Harbor Island and by barge from BP Harbor Island (both of which are supplied by the Olympic Pipeline).
- **Shell Harbor Island (Seattle):** Receives clean product by tank barge, primarily Crowley ATB's, from the Shell refineries in Anacortes and California. Shore tanks also supplied by Olympic Pipeline.
- **BP Harbor Island (Seattle):** Receives clean product from tankers and tank barges, typically Crowley ATBs, from primarily the BP Cherry Point Refinery. Also receives by the Olympic Pipeline. Delivers diesel to Maxum and sometimes Harley Marine barges.
- **Manchester Navy Fuel Depot (Manchester):** Navy operated facility, receives clean product from Crowley tankers on Military Sealift Command contract and supplies Navy and USCG vessels at the dock. Loads Navy barges to resupply Naval Air Station Whidbey and other naval facilities.
- **Targa (Tacoma) (ex-Sound Refining):** Black oil and clean products brought in by regular tank barge runs (Kirby, Harley, and gasoline from Canada) from Phillips 66 Ferndale refinery. As part of a new trade pattern, Bakken crude was being brought in by rail to supply Phillips Ferndale by barge, but that traffic ceased pending regulatory approval. Plans are to start the rail back up and eventually take one unit train per day. Targa supplies much of Tacoma bunker market for Phillips.
- **Phillips 66 Tacoma Terminal (Tacoma):** Supplied with clean product by regular Kirby tank barge runs from Phillips 66 Ferndale refinery (about 10 barges per month / three million barrels/year). Also supplied by pipeline.
- **Nustar (Tacoma):** Supplied with clean product by pipeline. Up to January 2013 was supplied by frequent tank barge runs with gasoline from Canada. Infrequent deliverer of clean product to Kirby barges.

Container Terminals

The Puget Sound region is home to three of North America's busiest container ports: Vancouver, British Columbia (BC), Seattle, and Tacoma. All three are typically in or near the continent's top ten for numbers of TEUs[345] moved annually.

Recently, there has been some shifting going on between these ports. For example: Maersk moved from Tacoma to Seattle, and the Grand Alliance (OOCL, NYK, Hapag Lloyd) moved from Seattle to Tacoma.

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[345] TEU = twenty-foot equivalent unit; an inexact unit of cargo capacity often used to describe the capacity of container ships and container terminals; it is based on the volume of a 20-foot-long (6.1 m) intermodal container, a standard-sized metal box which can be easily transferred between different modes of transportation, such as ships, trains and trucks.

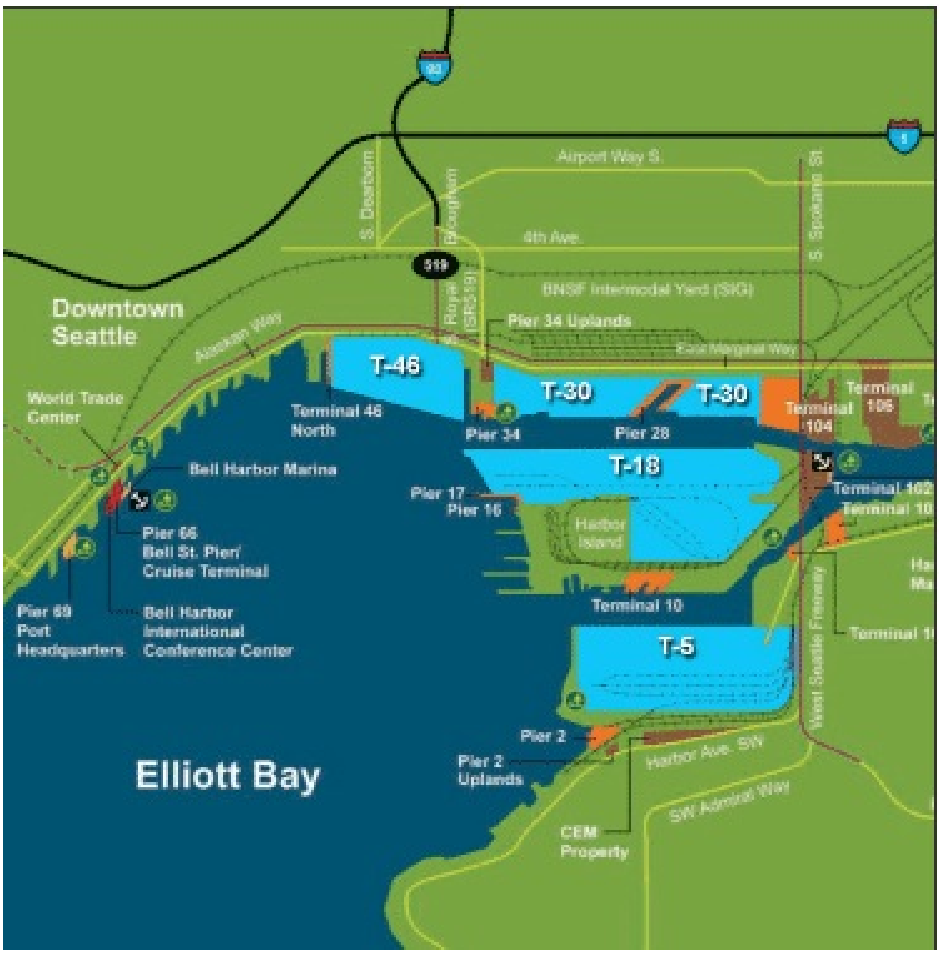
Many of these vessels take bunker fuel by barge during their port stays. Typical stem quantities range from 3,000 barrels to 30,000 barrels (126,000 to 1.26 million gallons) for intermediate fuel oil (IFO), with lesser amounts typical for LSFO (low-sulfur fuel oil) and marine diesel.

The Port of Seattle has four main container terminals (Figure 85):

- **T-5:** Westwood Shipping. T-5 has plans to close for five years for facility upgrades.
- **T-18:** Hanjin, Cosco, CMA CGM, Maersk, Matson, APL, Hyundai, Hamburg Sud, others.
- **T-30:** China Shipping (CSCL), others.
- **T-46:** Hanjin, Cosco, K-Line, MSC, Yang Ming.

Containers are also loaded onto barges bound for Alaska at P-16 and down the Duwamish waterway.

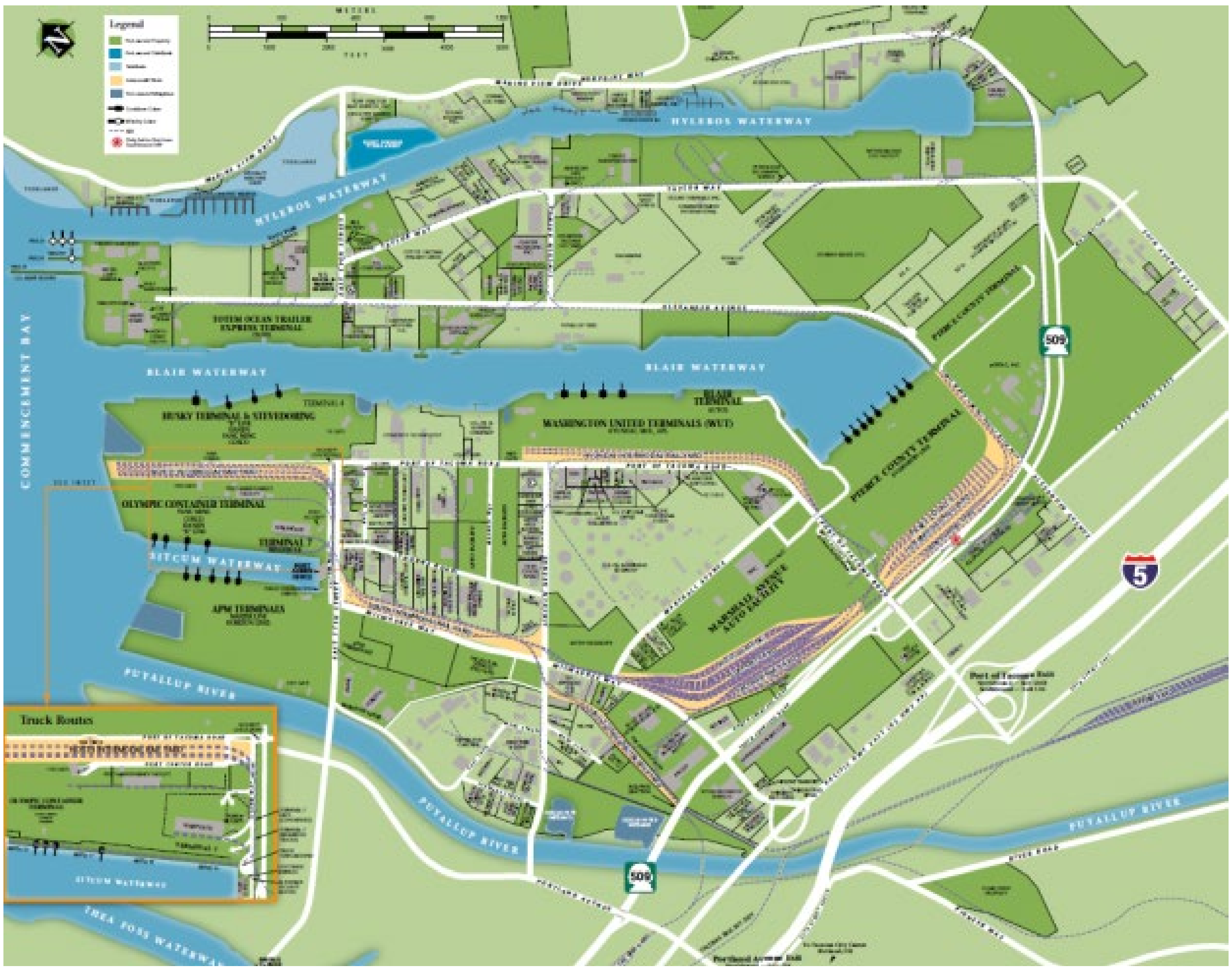
Figure 85: Port of Seattle Map Showing Container Terminals. Image source: Port of Seattle



The Port of Tacoma has several container terminals (Figure 86):

- **Husky Terminals (T-4):** Hanjin, Cosco, K-Line, Yang Ming.
- **Olympic Container Terminal (T-7):** Hanjin, Cosco, K-Line, Yang Ming.
- **Washington United Terminals (WUT):** Hyundai, MOL, APL.
- **APM Terminals (Maersk):** U.S. flagged Horizon vessels servicing Alaska and other locations. Average age of about 32 years. Regular bunkerers.
- **Pierce County Terminal (PCT):** Evergreen.
- **Tote:** Totem Ocean Trailer Express U.S. flagged Ro-Ro[346] vessels in Alaska trade.

Figure 86: Port of Tacoma Terminal Map[347]. Image source: Port of Seattle



[346] Ro-ro stands for "roll-on/roll-off" vessels that are designed to carry wheeled cargo, such as automobiles, trucks, and railroad cars that are driven onto the vessel using their own wheels or using a platform vehicle to tow the vehicles. The vessels have built-in ramps to allow the cargo to be rolled on and rolled off.

[347] From *Port of Tacoma Truckers Guide.*

Dry Bulk Terminals

A wide range of dry bulk, liquid bulk, break-bulk, and specialized carriers call upon various ports within the greater Puget Sound region. These vessels typically enter/depart through the Straits of Juan de Fuca and Georgia and in addition to Vancouver, BC, Seattle, and Tacoma, and call upon Everett, Ferndale, Olympia, and Vancouver Island locations. A partial listing of trade goods and terminal locations is as follows:

- **Auto carriers:** Blair Terminal Tacoma
- **Logs:** Weyerhaeuser, Tacoma.
- **Metals:** Scrap steel at Schnitzer Tacoma. Steel billets at T-105 Seattle. Aluminum ingots at Port of Everett. Aluminum ore at Intalco Ferndale.
- **Heavy equipment:** Offloaded at Port of Everett.
- **Plane parts:** Boeing boxes at Port of Everett.
- **Explosives:** Indian Island.
- **Gypsum:** CertainTeed Gypsum, Seattle. GP Gypsum, Tacoma.
- **Tallow:** Pacific Northwest Terminals, Tacoma.
- **Molasses:** T-20, Seattle.
- **Cement:** LaFarge, Seattle. CalPortland, Seattle.
- **Coal:** Vancouver BC terminals.

Grain Terminals

There are two grain terminals within Puget Sound, Louis Dreyfus at T-86 Seattle and Temco in Tacoma. Typically callers to both terminals are tramp bulkers which do not frequent Washington waters. These vessels enter by the Straits of Juan de Fuca and are of various ages and condition and will often anchor for days, even weeks, in Elliott Bay or Commencement Bay before berthing at the terminal. Most of these vessels will bunker while at anchor, and a typical bunker stem will be about 268,800 gallons of fuel.

Crude-by-Rail Facility Changes for Puget Sound

There are five refineries in the Greater Puget Sound, of which three have already been receiving crude-by-rail shipments. Tesoro in Anacortes (Figure 87) has been receiving Bakken oil shipments by rail since September 2012. U.S. Oil Refinery in Tacoma has been receiving crude-by-rail shipments as of April 2013 (Figure 88). The U.S. Oil Refinery is undergoing a permitting process to increase the size of its rail facility by 75%. Construction is expected in late 2014. BP Cherry Point in Blaine has been receiving crude-by-rail shipments as of late December 2013 (Figure 89).

Figure 87: Tesoro Anacortes and Shell Puget Sound Refineries, Anacortes, Washington

Figure 88: U.S. Oil & Refining Company, Tacoma, Washington

Figure 89: BP Cherry Point Refinery, Blaine, Washington

A rail facility at the Phillips 66 Refinery in Ferndale is under construction with completion expected by the end of 2014 (Figure 90).

Figure 90: Phillips 66 Refinery, Ferndale, Washington

The last refinery, Shell Puget Sound Refinery (Shell PSR) in Anacortes (Figure 87) has proposed an expansion to incorporate crude-by-rail. It is undergoing the SEPA process. Shell PSR proposes to build a rail spur from the existing adjacent BNSF mainline onto Shell PSR property with equipment to pump oil from railcars into the refinery. The crude brought in by rail would replace some supply brought in by ship and would serve to maintain current production, not to increase capacity.

Shell PSR anticipates that it would receive approximately one unit train per day. Each unit train would include approximately four locomotives and approximately 102 oil tank railcars containing crude oil. The facility is being designed to receive a maximum of six unit trains per week, for a total of approximately 612 incoming fully loaded oil cars and 612 outgoing empty tank cars on a weekly basis.[348]

The project scope generally includes all of the following components:

- Arrival/departure rail track.
- Unloading area with two tracks and a concrete containment pad.
- Bad-order railcar tracks with repair facilities, personnel, operations building, and appurtenant facilities and limited parking.
- Perimeter inspection/security road.
- Pumps and below- and above-ground pipelines to connect the proposed project to the existing storage tanks.
- New road connections.
- Relocation of segments of the Olympic Pipeline, the Kinder Morgan Pipeline, and Puget Sound Energy power lines.
- New electrical power substation.
- Oil/water separator facilities and containment for a single-car spill.
- Stormwater facilities.

The rail extension for the crude unloading facility would extend from the existing BNSF rail line and spur (near South March Point Road) in a northwesterly direction approximately 5,500 feet to North Texas Road. The rail facility would consist of approximately 8,000 feet of unloading tracks with a concrete unloading pad, approximately 1,300 feet of track for temporary storage of railcars that are taken out of service for repair and maintenance, and about 7,200 feet of train-staging track.

Rail ingress and egress would be provided via a connection to the existing BNSF mainline located to the southeast, which would require modifications to the BNSF rail configuration. The rail project has been designed to avoid blocking East March Point Road, at the BNSF mainline crossing, during unloading by providing adequate rail track to move the train onto the Shell PSR site, beyond March Point Road.

[348] http://www.skagitcounty.net/Departments/PlanningAndPermit/shellpermit.htm

The crude-oil transfer station would include vent headers, a containment area, drain connections and collection header, and tank car grounding. An operations shelter, storage shed, electrical structure, and a small employee parking lot would also be constructed in proximity to the crude-oil transfer facility.

The proposed project would also include various site-preparation activities, including, but not limited to, clearing and grading, installation and construction of associated infrastructure improvements, such as stormwater infrastructure, and extension of existing services and utilities, including electricity, sanitary sewer, potable water, etc. Two existing pipelines and some Puget Sound Energy (PSE) power lines would have segments relocated. Two ponds are proposed to provide permanent stormwater control. An oil/water separator pond would also be provided on the west side of the rail, adjacent to the new facilities.

Another facility, Targa Sound Terminal[349] operates a petroleum tank farm on the Hylebos waterway along the northwest edge of the Tacoma Flats (Figure 91). The current volume of tankage within the facility is 970,000 barrels. After completion of new tank storage areas in 2014, the volume of tankage is expected to be approximately 980,000 barrels.

Figure 91: Targa Sound Terminal, Tacoma, Washington[350]. Image source: Targa Sound Terminal.

[349] In 1967, Sound Refining began operating the facility as an asphalt refinery, using crude oil as feedstock. In 1998, a Texas-based corporation purchased the assets of Sound Refining. Production stopped and it became a petroleum product tank farm. In 2004, the facility went under new management. In 2011, Sound Refining transitioned to Targa Sound (http://www.ecy.wa.gov/programs/swfa/industrial/oil_soundrefing.html).

[350] http://www.targasoundterminal.com/Services.html

The terminal had been receiving crude-by-rail unit trainloads of Bakken crude for transshipment to the Phillips 66 Ferndale Refinery by tank barge, but these operations are now occurring from Clatskanie, Oregon, in the Lower Columbia River. There are plans to start the crude-by-rail operations up again to eventually take one crude-by-rail unit train per day.

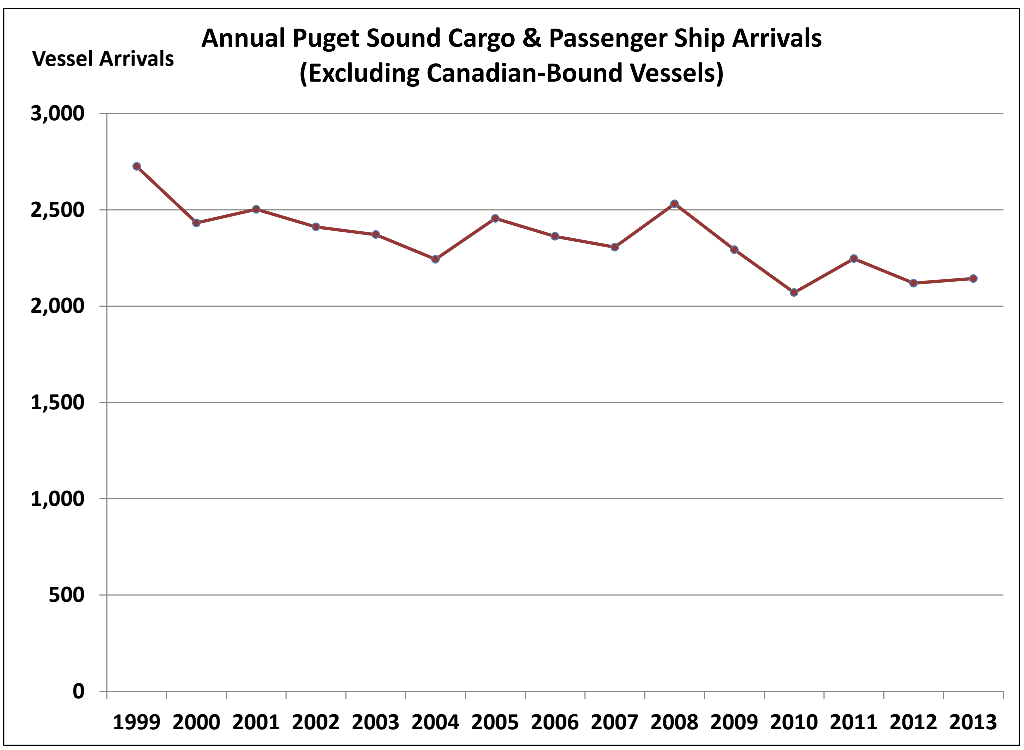
Puget Sound Cargo and Passenger Vessel Traffic

Cargo and Passenger (C&P) vessels include container ships, bulk carriers, cruise ships, fishing vessels, and other commercial non-tank vessels of 300 gross tons or more. In 2013, there were 2,143 C&P arrivals to Puget Sound ports and another 2,895 arrivals to Canadian ports in which the vessel transited Washington waters (Table 38 and Figure 92).

Table 38: VEAT Cargo and Passenger Ship Arrivals into Puget Sound in 2013[351]

Destination	Entering Transits	Individual Vessels
Puget Sound Ports via Strait of Juan de Fuca	1,676	590
Puget Sound Ports via Strait of Georgia and Haro Strait	467	173
Canadian Ports via Strait of Juan de Fuca	2,895	1,459

Figure 92: Annual Puget Sound Cargo & Passenger Ship Arrivals[352]



[351] Washington State Dept. of Ecology, 2013.
https://apps.ecology.wa.gov/publications/SummaryPages/1408004.html,
[352] Excluding Canadian-bound vessels.

These vessels have a considerable fuel capacity, with the largest carrying well in excess of 30,000 barrels. Many of these vessels bunker during their port stay, annually taking millions of barrels of varying grades of fuel. As of August 1, 2012, vessels must adhere to IMO North American Emission Control Area (ECA) Standards which limit the amount of sulfur in the fuel they burn within 200 nautical miles of the coast to 1%. In 2015, this limit will drop to 0.1%. This caused changes to the bunker-fuel market around the continent and around the state. Many C&P vessels are now burning dirtier fuels (IFO 500 and IFO 600 vs. IFO 380) while outside the ECA and the mandated cleaner fuels (LSFO and ULSD) while within it. Switching between dirty and clean fuels has also led to numerous loss-of-propulsion incidents, which have been well documented by the state of California.[353]

Puget Sound Ferries and Other Passenger Vessels

Cruise ships operate seasonally out of two Seattle terminals, Pier 66 and Pier 91. Cruise season begins in early May and runs until late September, and there are an expected 178 ship calls for 2014.[354] Each call lasts about nine hours, typically arriving at about 7am and departing about 4pm every day but Wednesday. Ships bunker while in port, some every arrival, others every other arrival. Annually these vessels take about 42 million gallons of fuel (IFO 380, LSFO, and ULSD).[355] Cruise ships arriving/departing from Seattle transit the Strait of Juan de Fuca and include a stop in Victoria. Cruise ships arriving/departing Vancouver, BC, transit the Inside Passage and Seymour Narrows.

Ferries and other passenger vessels often operate on routing outside of the Vessel Traffic separation scheme and often perpendicular to it (Figure 93).

- **Washington State Ferries:** Washington State Ferries operates the largest ferry system in the U.S. Twenty-two ferries cross Puget Sound and its inland waterways, carrying more than 22 million passengers to 20 different ports of call. From Tacoma to Sidney, BC, the ferries travel up and down the Puget Sound, acting as a marine highway for commercial users, tourists and daily commuters.
- **BC Ferries:** BC Ferries is one of the largest ferry operators in the world, providing year-round vehicle and passenger service on 25 routes to 47 terminals, with a fleet of 35 vessels. This ferry system is an essential transportation link that connects coastal communities and facilitates the movement of people, goods, and services.[356]
- **Other Passenger Vessels:** These include the Victoria Clipper vessels, the Victoria Express, the Blackball Ferry, and others.

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[353] California Department of Fish and Game, 2011, Preventing Loss of Propulsion after Fuel Switch to Low Sulfur Distillate Fuel Oil, https://nrm.dfg.ca.gov/filehandler.ashx?documentversionid=75544, accessed Oct 23, 2014
[354] Port of Seattle. 2014. http://www.portseattle.org/Cruise/Documents/2014_Cruise_Schedule.pdf,
[355] IFO = intermediate fuel oil; LSFO = low sulfur fuel oil; ULSD = ultra-low sulfur diesel.
[356] http://www.bcferries.com/

Figure 93: Washington State & BC Ferry Systems[357]

Puget Sound Fishing Vessels

Seattle is home to the North Pacific Fishing Fleet. Fisherman's Terminal in the Ballard ship canal moors a few hundred small, to mid-sized fishing vessels and a few large vessels, as well. These vessels enter and depart Puget Sound via the Straits of Juan de Fuca and Georgia seasonally according to fish openings. Typically, they fuel at Ballard Oil or Covich Williams. Many of the larger vessels do not transit the Ballard Locks and, instead, moor at Seattle's Pier 90 and Pier 91. Most of these vessels are in excess of 300 gross tons and often fuel by multiple tank trucks or at Maxum's Pier 15 dock.

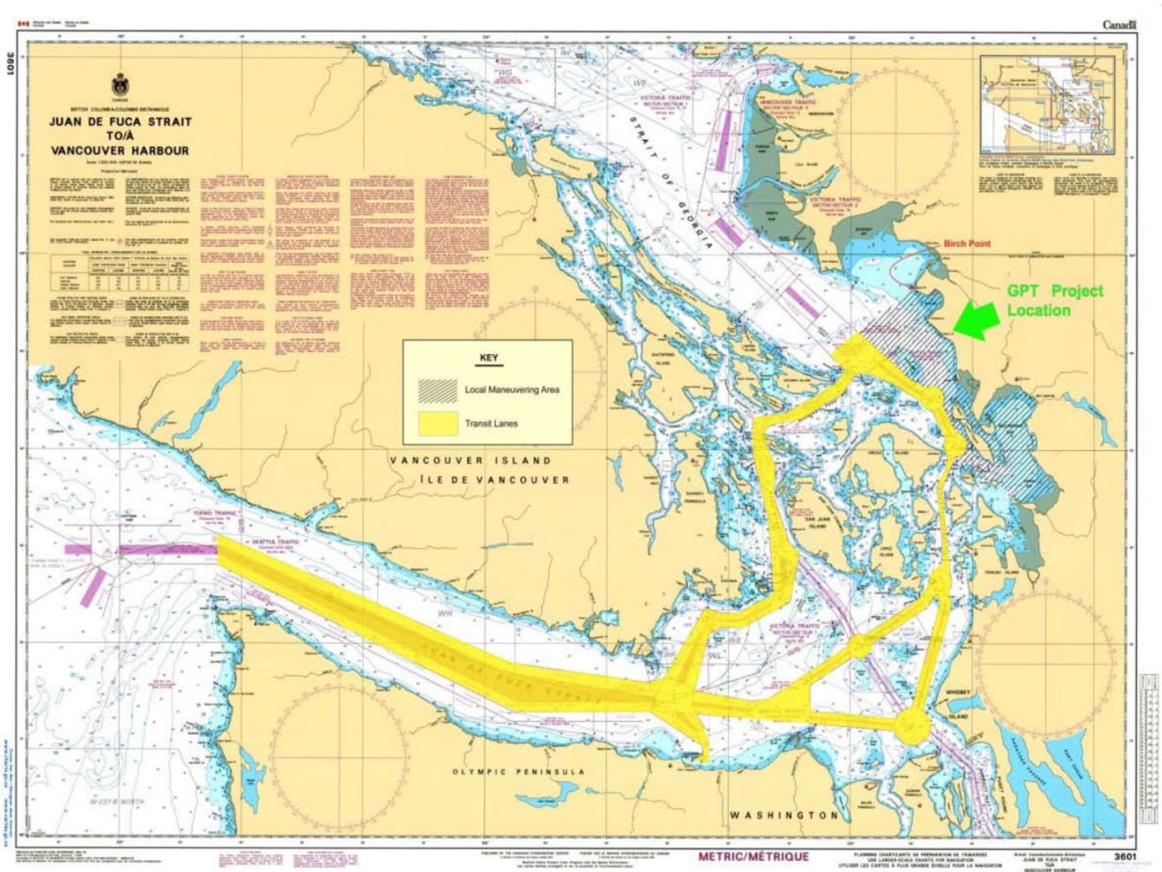
While the bulk of the fishing fleet calls Seattle home, a smaller but significant number of vessels tie up at Trident's facility in Tacoma, the sloughs and rivers surrounding Everett, in Bellingham Bay, and other locations throughout the region. There are also a large number of Canadian flagged fishing vessels up the Fraser River and other locations which transit our joint waters. Fishing vessels do not always adhere to the traffic-separation scheme.

[357] Washington State Ferry System shown with blue dashes; BC Ferry System shown with red dots; Blackball Ferry Coho (brown dots), and other passenger vessel routing (green dots)

Puget Sound Traffic Separation Scheme & VTS

Puget Sound and its entrances from the west, the Strait of Juan de Fuca, and, from the north, the Strait of Georgia, have a complex network of vessel traffic lanes and maneuvering areas related to port activity in Washington State and in British Columbia (Figure 94).

Figure 94: Strait of Juan de Fuca, Puget Sound, and Strait of Georgia Traffic Lanes[358]

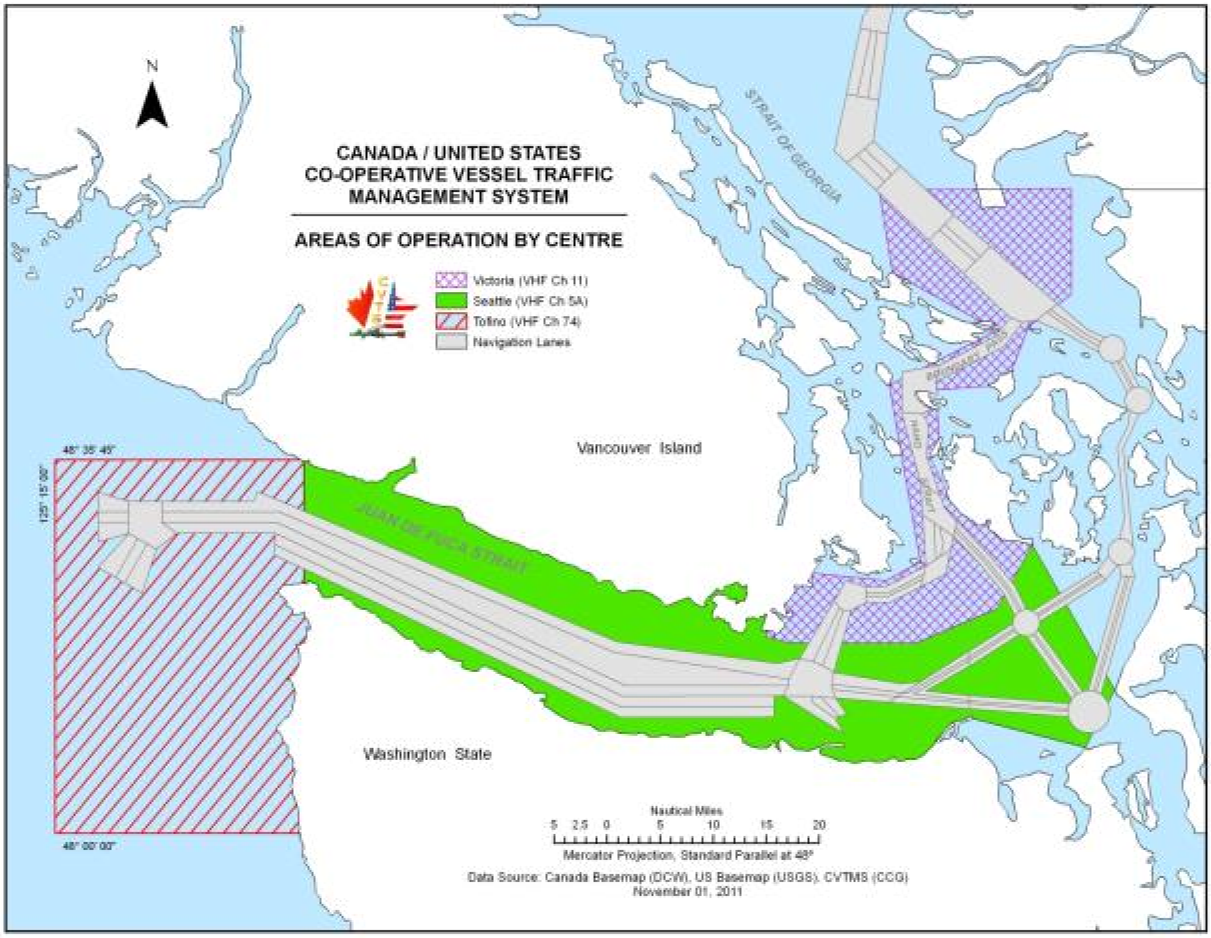


A Traffic Separation Scheme (TSS) exists for the Strait of Juan de Fuca and Puget Sound and is recognized by the International Maritime Organization (IMO). Puget Sound Vessel Traffic Service (PSVTS) provides timely information to participating vessels regarding traffic movement, weather, and hazards to navigation. Details of the regulations regarding participation with PSVTS can be found in the *PSVTS User's Manual* available through PSVTS or in the U.S. Code of Federal Regulations, chapter 33, part 161 (33 CFR 161).[359] This vessel traffic service operates in cooperation with Canadian authorities as part of the Canada/U.S. Cooperative Vessel Traffic Management System (Figure 95).

[358] From: *Changing Risk Picture in the Pacific Northwest* presentation by Dept. of Ecology at BC Ministry of Environment Symposium, March 2013. http://www2.gov.bc.ca/gov/DownloadAsset?assetId=51863321EB694420AC54EAAFFD1AA9AC&filename=changing_risk_northwest.pdf

[359] https://apps.ecology.wa.gov/publications/publications/99253.pdf

Figure 95: Canada/U.S. Cooperative Vessel Traffic Management System[360]. Image source: USCG



While PSVTS greatly improves the safety of navigation, and the TSS increases the predictability of vessel movements, mariners must be aware that there are limitations to the system and must maintain a sharp lookout for other vessels. Of particular concern are smaller vessels not participating with PSVTS that may operate in or near the TSS. These smaller vessels are not prohibited from the TSS, but they must abide by Rule 10 of the International Regulations for Preventing Collisions at Sea (COLREGS) while operating within the TSS.[361]

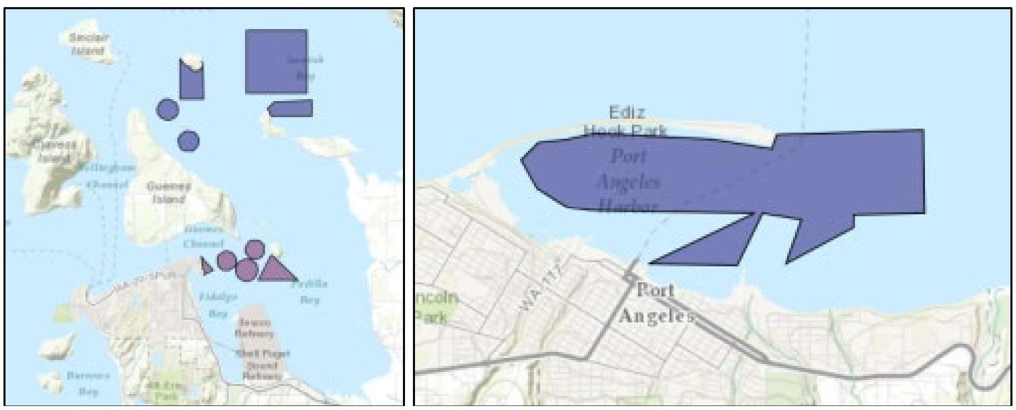
[360] Map from US Coast Guard: http://cgmarinesafety.blogspot.com/.
[361] In some cases a small non-VTS participating vessel (a vessel that is not required to participate and is not voluntarily participating in the VTS) is not detected by PSVTS due to rough seas, weather conditions, or poor radar return from the vessel. When this occurs, PSVTS will not be able to provide warning of a developing close-quarters situation. Therefore, for VTS participants, a sharp lookout remains a necessity, despite the additional safety provided by PSVTS. If a ship's watch is in doubt as to, or concerned with, the movement of another vessel (participant or non-participant) in PSVTS area they should take action consistent with the COLREGS. In addition, the ship's watch is encouraged to report this information to PSVTS as soon as possible via the designated VHF radio frequency. PSVTS may be able to assist in identifying the vessel and determine the vessel's speed and direction of movement. PSVTS may also be able to contact the vessel to warn of a developing close-quarters situation. The reporting of non-participating vessels operating in the TSS will also assist other ships in the area. Maintaining safety in the strait and sound requires the vigilance and active participation of all mariners using PSVTS and the TSS.

Puget Sound Anchorages

Tankers and ATBs tend to spend a great deal of time at Puget Sound area anchorages as they await berth or orders. The most common anchorages for tankers are located in the Anacortes/Vendovi area or inside Port Angeles Harbor (Figure 96). At any given time, it is likely that there is a large volume of oil on vessels at anchor at these locations.

At peak times, these favored anchorages can fill up at current vessel volumes, causing an overflow into Yukon Harbor, Bellingham Bay, and Elliott Bay. If the area saw an increase in tanker traffic, anchorage management would make for a prudent discussion.

Figure 96: Common Tanker Anchorages at Anacortes, Vendovi, and Port Angeles



Grain bulkers also have prolonged stays at anchorages, typically in Seattle's Elliott Bay and Tacoma's Commencement Bay. If the proposed GPT coal-export development goes through, this would likely add hundreds of vessels per year to the north sound anchorage queue.

Puget Sound Escort Practices

For tankers bound for Washington State ports, there is an escort practice as per 33 CFR 168 (for single-hull tankers over 5,000 GRT),[362] and as per State of Washington RCW 88.16.190 and WAC 363-116-500 (all tankers 40,000 DWT and over).[363, 364] For vessels bound for Vancouver, BC, there are interim operating rules for loaded crude-oil tankers in excess of 40,000 DWT transiting Haro Strait and Boundary Pass that require two pilots to be dispatched when transiting three miles north of East Point and the Victoria Pilot Station, as well as other specific escort-tug requirements (Figures 97 and 98).[365]

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[362] Gross registered tonnage (GRT) is the internal cubic capacity of the ship expressed in tons on the basis of 100 cubic feet per ton; this differs from DWT because it measures the area versus the weight.

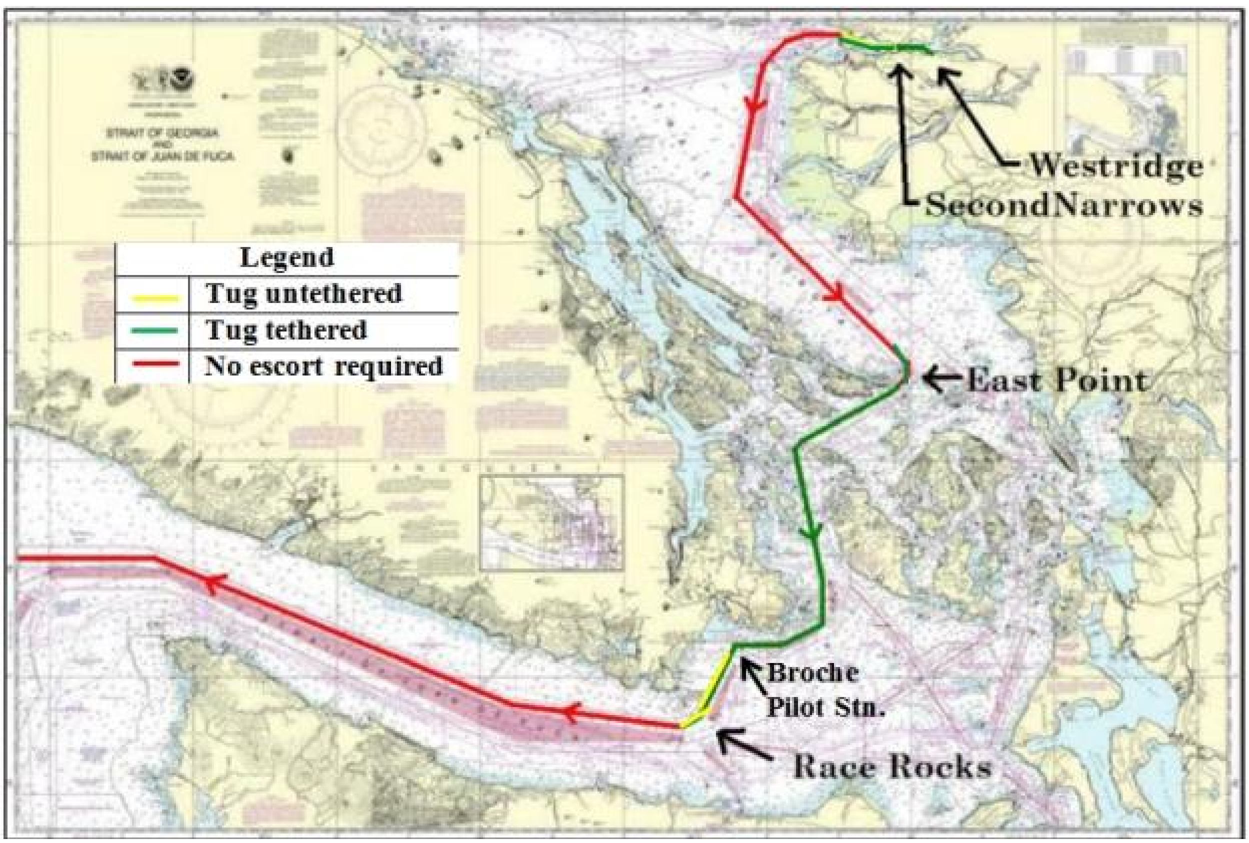
[363] http://www. mxsocal. org/oldweb/mx/pugethsp3. htm#a1

[364] Tug escort practices are also covered in detail in the Puget Sound Harbor Safety Plan's Standards of Care (Puget Sound Harbor Safety Committee 2012a).

[365] Pacific Pilotage Authority (Vancouver, BC) Notice to Industry No. 07/2013. *Operating Rules for Vessels Carrying Liquid Bulk, Fully or Partially Loaded, with Summer Dead Weight Tonnage (SWDT) of 40,000 or Greater.* October 11, 2013. 3 pp.

Figure 97: Locations for Tanker Escorts in Port of Vancouver, BC[366]

Figure 98: Escort Tug and Piloting Requirement Areas for Tankers Bound for BC[367]



[366] From: *Changing Risk Picture in the Pacific Northwest* presentation by Dept. of Ecology at BC Ministry of Environment Symposium, March 2013.

[367] Pilot required east of Broche Pilot Station.

U.S./Washington and Canadian Vessel Safety Systems

A comparison between the U.S. and Washington State vessel safety systems and the analogous Canadian systems is shown in Table 39.

Table 39: U.S./Washington and Canadian Vessel Safety System Comparison[368]

U.S./Washington State	Canada	Gap
Tug escorts for all loaded tankers inbound and outbound	Tug escorts for all loaded tankers inbound and outbound	None
Tug escorts required by state and federal law, enforced by USCG and state; rules leave it up to master/pilot to decide when to tether the tug and ship; all escorts must be in position for timely, effective response. When deemed appropriate by master/pilot to tether, geographic areas include, but not limited to: Rosario Strait, Guemes Channel, Turn Point of Haro Strait/Boundary Pass, between Saddlebag and Huckleberry I.	Tug escorts through negotiated voluntary standards, enforced by BC pilots	Essentially none. Rules imposed by Canada's Pacific Pilotage Authority[369], but no specific Canadian law; Canadian government agency.
One pilot required on all ships transiting east of Port Angeles	Two pilots required east of Victoria for loaded tankers	None
USCG/STCW[370] Safe Manning: Two licensed officers and two AB seamen	STCW Safe Manning: Two licensed officers and two AB seamen	None
Tanker speed 11 knots in congested waters, cannot exceed tugs.	Tanker speed 10 knots	None
Tanker size limited to 125,000 DWT east of Port Angeles; larger tankers accepted if not loaded beyond 125,000 MT	No tanker size limitation	Larger capacity tankers may transit Canadian waters, though there is no current or planned terminal capacity to accommodate larger tankers
Oil handling operations require booming prior to transfer ("pre-booming")	Pre-booming not required	Oil transfers in Canada not mandated to be boomed, though it is terminal requirement.
Vessel Traffic Service & Special Operating Areas	Vessel Traffic Service & Special Operating Areas	None. Jointly operated by U.S. and Canadian Coast Guards
Standby response tug required	No response tug required	Canada has no response tug requirement.
Tankers double-hulled	Tankers double-hulled	None

[368] Adapted from: *Changing Risk Picture in the Pacific Northwest* presentation by Dept. of Ecology at BC Ministry of Environment Symposium, March 2013.
[369] Pacific Pilotage Authority is a Canadian federal government agency.
[370] Standards of Training, Certification, and Watchkeeping. The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (or STCW), 1978 sets qualification standards for masters, officers and watch personnel on seagoing merchant ships. STCW was adopted in 1978 by conference at the International Maritime Organization (IMO) in London and entered into force in 1984. The Convention was significantly amended in 1995.

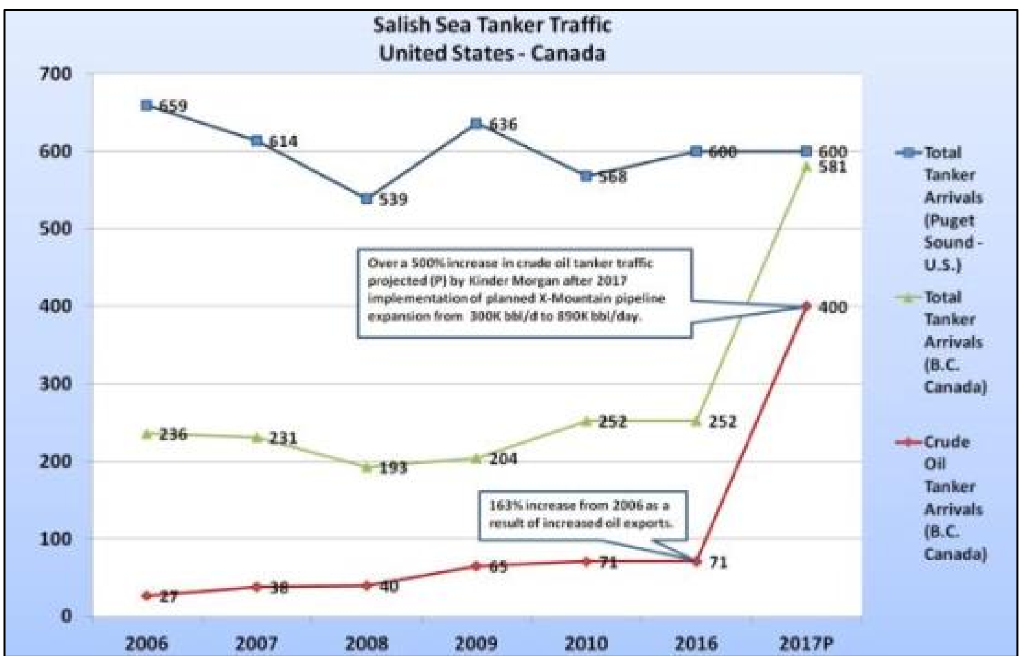
Changing Salish Sea Vessel Traffic Patterns

The vessel traffic patterns in Puget Sound, the Strait of Juan de Fuca, and its approaches, as well as the Strait of Georgia (Salish Sea), will likely change with future developments, altering the risk picture as well.

Tank vessel traffic-related risk is likely to change in the future, due to expansion of the Trans Mountain Pipeline from 300,000 barrels per day to 890,000 barrels per day (capacity 12.6 million to 37.4 million gallons per day), which could increase laden crude-oil-tanker traffic departing from Canadian ports by over 500% (about 400 new tankers) between 2016 and 2026. At the same time, however, the number of crude tankers going to Washington refineries is likely to be reduced due to higher pipeline volumes delivered. With the expansion of crude-by-rail deliveries to the refineries, there will also be reductions in crude tanker traffic going to Washington refineries. These changes have already begun, but will increase in the future.

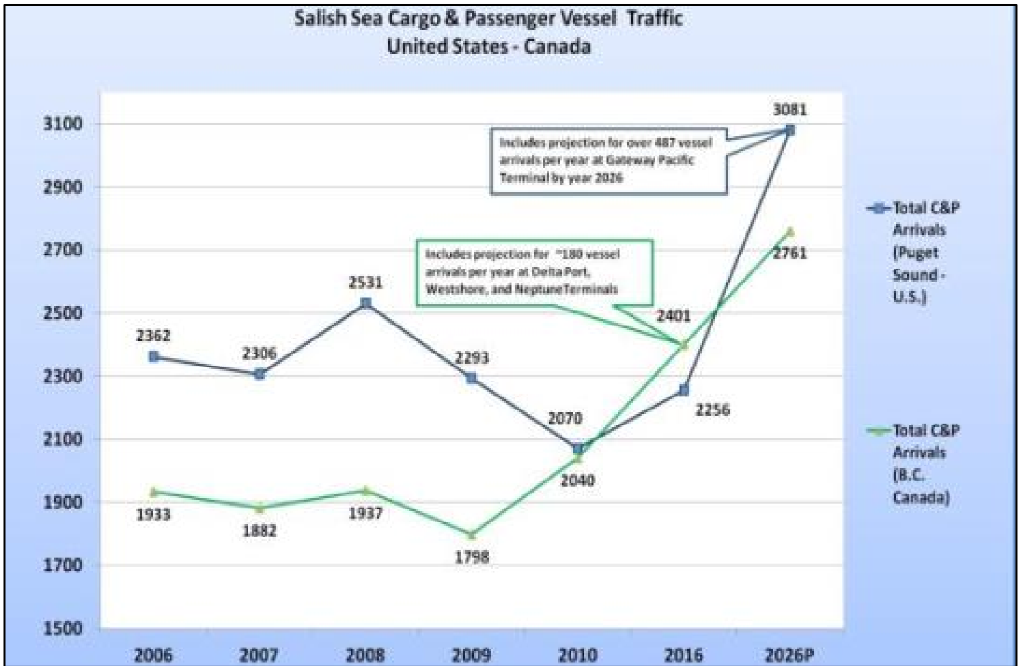
Figure 99 shows current and estimates of future tanker traffic in the Salish Sea. At the same time, there are also changes that are may occur with respect to cargo vessel traffic in the Salish Sea (Figure 100).

Figure 99: Salish Sea U.S./Canadian Tanker Traffic – Current and Projected Future[371]



[371] From: *Changing Risk Picture in the Pacific Northwest* presentation by Dept. of Ecology at BC Ministry of Environment Symposium, March 2013.

Figure 100: Salish Sea U.S./Canadian Cargo & Passenger Vessel Traffic – Current and Projected Future[372]



Projected changes that could impact vessel traffic in the Salish Sea include:

- Development of the Gateway Pacific Terminal (GPT) project at Cherry Point (Figure 101), which would represent more than 8% of the overall cargo vessel traffic within the Salish Sea at full operating capacity. GPT could represent 41% of the cargo shipping increase between 2016 and 2026; at half-capacity, approximately 221 vessels (144 Panamax vessels and 77 Capesize vessels) are expected to call at the GPT per year (about one vessel every other day). At full operational capacity, approximately 487 vessels per year are expected to call at the GPT (about 1–2 vessels every day).[373]

- Development of the Port of Metro Vancouver terminals, including the Roberts Banks Terminals[374] (Figure 102) and Neptune Terminal (Figure 103) projects in the Port of Metro Vancouver, which will represent 33% of the cargo shipping increase between 2011 and 2016.

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[372] From: *Changing Risk Picture in the Pacific Northwest* presentation by Dept. of Ecology at BC Ministry of Environment Symposium, March 2013

[373] http://gatewaypacificterminal.com/the-project/f-a-q/#VesselTrans

[374] Deltaport is one of two existing terminals at Roberts Bank Terminals, each independently operated. Roberts Bank Terminal 2 (RBT2) is being proposed as a third terminal at the site. RBT2 is a proposed new three-berth container terminal at Roberts Bank, Delta, BC. If built, the project would provide 2.4 million TEUs (twenty-foot equivalent lengths) of container capacity per year to meet forecast demand until 2030. Based on the current project schedule and subject to regulatory approvals (including an environmental impact statement), the proposed RBT2 project could begin operation in the mid-2020s. (http://www.robertsbankterminal2.com/about-the-project/roberts-bank-terminal-2-project/)

Figure 101: **Proposed Gateway Pacific Terminal Layout**

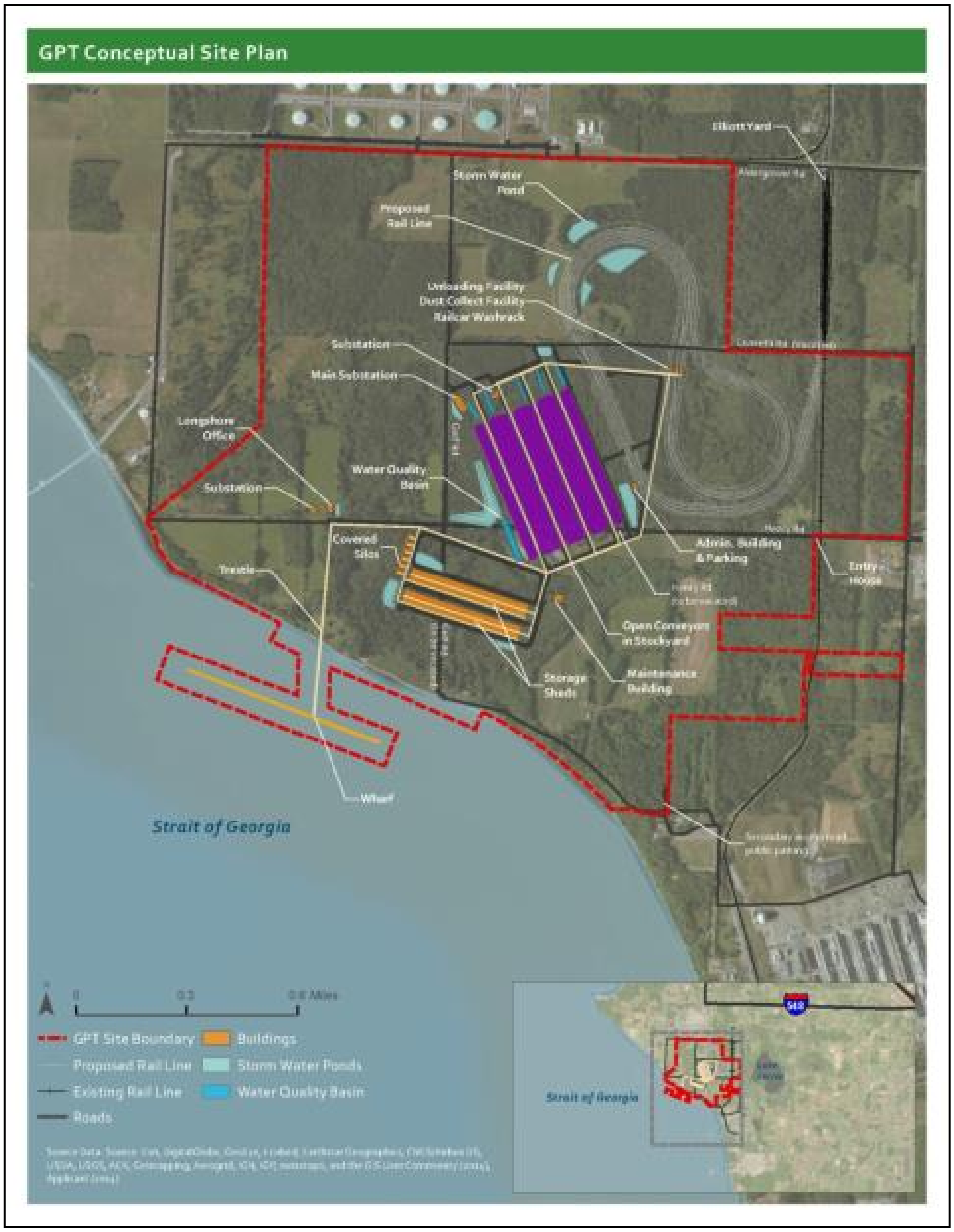
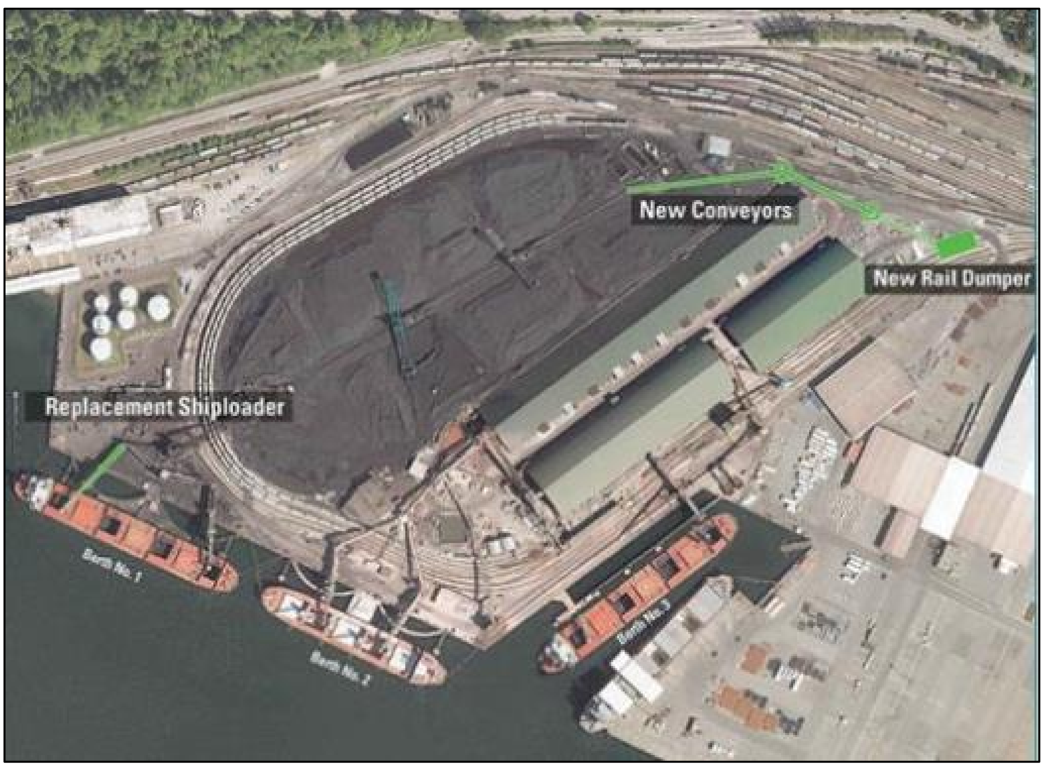


Figure 102: Proposed Roberts Bank Terminal 2 Project (Artist Rendering)[375]. Image source: port Metro Vancouver

Figure 103: Proposed Neptune Terminal Upgrades[376]. Image source: Neptune Terminals.



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[375] http://www.robertsbankterminal2.com/wp-content/uploads/Roberts-Bank-Terminal-2-Project-Preliminary-Environmental-Mitigation-Concepts-Discussion-Guide-and-Feedback-Form-WEB-September-2014.pdf

[376] http://www.neptuneterminals.com/explore-our-terminal/terminal-improvements/

Projections of Additional Canadian Traffic in Salish Sea

Traffic to and from Canadian ports travels through Boundary Pass, Haro Strait, and the Strait of Juan de Fuca. Current and projected vessel traffic for Port of Metro Vancouver projects are summarized in Tables 40 through 42. In addition to the traffic in the tables, there are about 100 additional chemical carriers projected by 2030. These would be perceived as tankers by the Washington State VETA system.

Table 40: Annual Vessel Projections for Deltaport & Westshore (Existing Roberts Bank Terminals)[377]

Year	Data Type	Cargo Volume (Million)		Annual Ship Calls			Annual Ship Movements		
		Container TEU	Coal Tonnes	Container	Coal[378]	Total	Container	Coal	Total
2010	Actual	1.54	24.7	245	246	491	594	492	1,086
2014	Predicted	1.74	25.0	260	250	510	624	500	1,124
2015	Predicted	2.02	26.0	260	260	520	624	520	1,144
2016	Predicted	2.28	27.0	312	270	582	728	540	1,268
2017	Predicted	2.55	28.0	364	280	644	832	560	1,392
2018	Predicted	2.85	29.0	364	290	654	832	580	1,412
2019	Predicted	3.00	30.0	364	300	664	832	600	1,432
2020	Predicted	2.40	31.0	312	310	622	728	620	1,348
2021	Predicted	2.40	32.0	312	320	632	728	640	1,368
2022	Predicted	2.40	33.0	312	330	642	728	660	1,388
2023	Predicted	2.40	34.0	312	340	652	728	680	1,408
2024	Predicted	2.40	35.0	312	350	662	728	700	1,428
2025	Predicted	2.40	35.0	260	350	610	624	700	1,324
2026	Predicted	2.40	35.0	260	350	610	624	700	1,324
2027	Predicted	2.40	35.0	260	350	610	624	700	1,324
2028	Predicted	2.40	35.0	260	350	610	624	700	1,324
2029	Predicted	2.40	35.0	260	350	610	624	700	1,324
2030	Predicted	2.40	35.0	260	350	610	624	700	1,324

377 Source: Projections of Vessel Calls and Movements at Deltaport and Westshore Terminals, Deltaport Terminal Road and Rail Improvement Project (DTRRIP), WorleyParsons Canada http://www.robertsbankterminal2.com/wp-content/uploads/Projections-of-Vessel-Calls-and-Movements-at-Deltaport-and-Westshore-Terminals.pdf

378 Note: Based on research, HEC projects the number of coal ships to be about 310 instead of 350 annual ship calls; the estimate in the table is too high, as it does not account for actual ship size growth experienced at Westshore Terminals.

Table 41: Projected Vessel Traffic for Other Port of Metro Vancouver Projects[379]

Project	Cargo Volume	Ship	Annual Calls
Fraser Surrey Docks Direct Coal Transfer Ships from Texada Island	8.0 Mtonnes	bulker	80
Richardson Grain Elevator (Terminal Expansion and Ship Capacity Increases)	5.0 Mtonnes	bulker	12
Neptune Terminals Coal Expansion	6.0 Mtonnes	bulker	60

Table 42: Potential Roberts Bank Terminal 2 Vessel Traffic

Year	Data Type	Annual Vessel Projections for RBT2	
		Million TEU	Annual Ship Calls
2025 (estimated)	Predicted	2.40	260

VTRA 2010 Study[380]

A key study conducted for the Salish Sea, the VTRA 2010 study,[381] focused on the potential impacts of three proposed facilities in the region:[382]

- The proposed Gateway bulk carrier terminal at Cherry Point, Washington.
- The Trans Mountain/Kinder Morgan pipeline expansion in Vancouver, BC.
- The coal, grain,[383] and container terminal expansions at Port of Metro Vancouver, BC.[384]

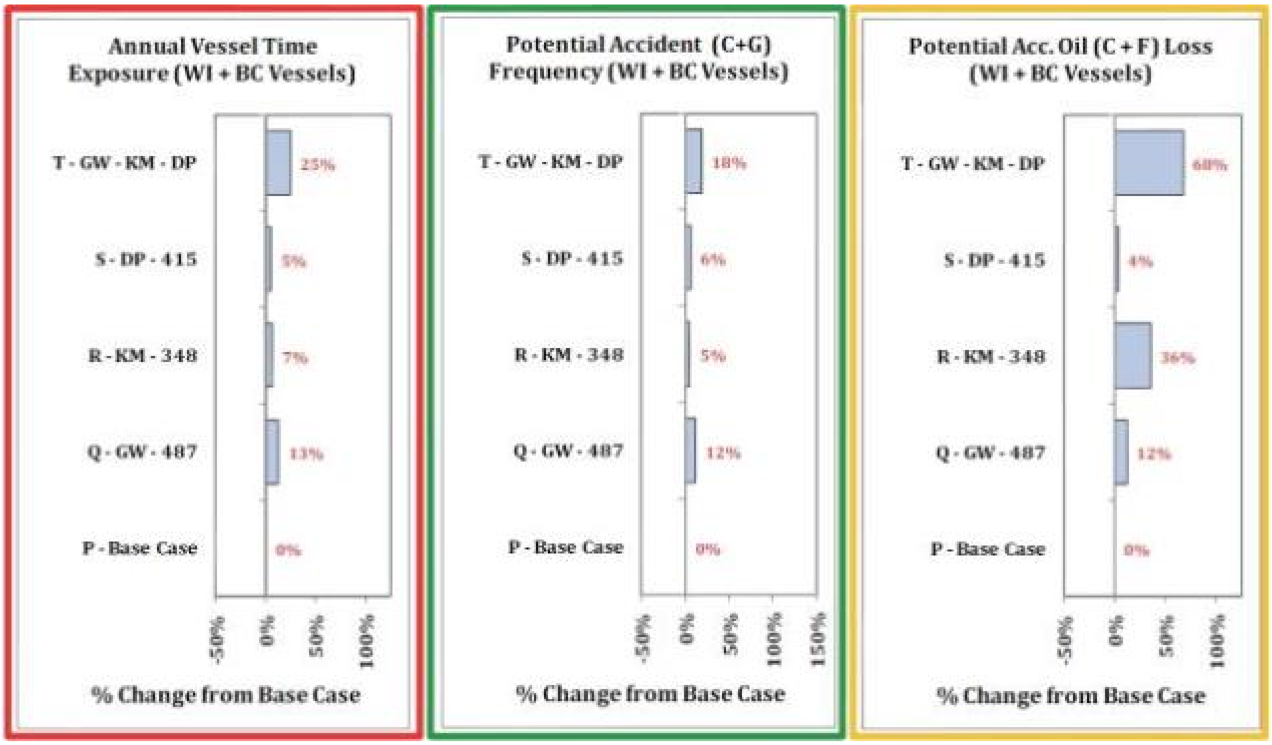
The study was conducted following concerns about the potential for large oil spills due to the presence of oil tankers in an every changing vessel traffic pattern. A previous analysis of the VTRA 2010 study demonstrated a reduction of oil transportation risk due to risk mitigation measures in place, the potential for large oil spills continues to be a prominent public concern heightened by proposed maritime terminal developments. The purpose of VTRA 2010 study was to evaluate potential changes in risk in light of the above three maritime terminal developments. The VTRA 2010 study was conducted because study sponsors and involved stakeholders want to ensure the potential vessel traffic risks associated with the maritime development projects named above are better understood, so that informed decisions can be made about additional risk-mitigation measures that would add to the continuous improvement efforts of the past.

[379] These data are estimated from project descriptions on the Port of Metro Vancouver website as of October 1, 2013. They are all advanced in the approval process or underway.
[380] A more comprehensive discussion of the VTRA 2010 study appears in Appendices L, M, and N.
[381] van Dorp and Merrick, 2014.
[382] Review of the VTRA 2010 study by HEC for this study indicates that the traffic assumptions for the "Delta Port" project (actually two independent terminals, one a coal facility, Westshore Terminals, and the other, a container terminal, Deltaport) were based upon information available at the study initiation (2005) that was incomplete or inaccurate or misinterpreted. This is an inherent risk with studies of this nature, and users of findings or conclusions should be cognizant of these issues.
[383] The VTRA 2010 study incorrectly states that there would be grain terminal expansions at Roberts Bank Terminals.
[384] Terminal expansions are proposed for Roberts Bank Terminals, of which Delta Port is an existing terminal that would not be associated with the expansion.

The major findings of the VTRA 2010 study were:[385, 386]

- Three large terminal projects (Trans Mountain, Deltaport, and Gateway)[387] have been proposed that, if approved and fully implemented, would collectively increase current cargo and tank vessel traffic in Puget Sound by about 25% over the next decade.
- Although shipping accidents leading to major spills are decidedly rare in Puget Sound (no spills from deep draft vessels in transit and none >10,000 gallons from oil barges in transit in past 20 years)—if the three projects are built—collectively, the modeled potential frequency of accidents, like groundings and collisions, could rise by 18% (Figure 104).

Figure 104: VTRA 2010 Overview Comparison of Changes from 2010 Base Case[388].



- The increased vessel traffic associated with these three large terminal projects, when fully implemented, could collectively increase potential oil loss across the Puget Sound by about 68%.
- More locally, because of the sizeable shift in the mix and volume of vessel traffic (potentially more tankers, more container ships, and more bulk-cargo carriers) going to and from Canada, and/or Cherry Point, the potential volume of oil that might be spilled in an accident in two

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385 Peer reviews of the VTRA 2010 study conducted by Rawson et al. 2014 on behalf of the Swinomish Indian Tribal Community have questioned the methodology and findings of the study. Their concerns include inaccuracies and gaps in fishing vessel data, issues concerning bunkering and anchoring, and the lack of discussion of additional hazards from the introduction of risk mitigation measures, such as tug and girting.

386 The vessel numbers in the VTRA 2010 findings have been questioned by HEC.

387 The VTRA 2010 study explicitly did not include Roberts Bank Terminal 2 in its analyses.

388 GW = Gateway Pacific Terminal; DP = Delta Port; KM = Kinder Morgan.

waterways, Haro Strait (west of the San Juan Islands) and the Buoy J zone (off the entrance to the Strait of Juan de Fuca), could more than triple.

- When a combination of six risk-mitigation measures—including availability of a supplemental emergency response tug, reduced container vessel speeds and reduced human error rates for oil barges—were applied to the simulated traffic from the three proposed terminal projects, the potential accident frequency fell to 11% below the current baseline.
- In light of the findings, the region should not ask what single risk-mitigation measure should be implemented, but what combination of measures could be applied and what current risk mitigation measures, such vessel traffic management, vessel inspections, and tug escorts can be further improved.

Columbia River

The Columbia River is the largest river in the Pacific Northwest. The lower Columbia River navigation channel is a narrow and winding channel subject to strong currents, shifting shoals and inclement weather. The channel is maintained to project depth of 43 feet and width of 600 feet. The distance between the mouth and the Ports of Portland and Vancouver is 106 nautical miles.

The longest straight stretch of river is only about two miles in length, and there are over 90 course changes between Astoria and the Portland Downtown Sea Wall.[389] The average flow of the Columbia River is 265,000 ft^3/s, with a maximum flow of 1,240,000 ft^3/s.[390]

The Columbia and Lower Willamette Rivers Project[391]

Today, the authorized Columbia & Lower Willamette project includes deep-draft navigation channels, pile-dike structures which stabilize the channel, stern buoys for ship traffic, and wildlife mitigation sites. The 600-ft wide, 43-ft deep navigation channel in the Columbia River generally follows the Oregon-Washington border and extends 106.5 miles from the mouth of the Columbia River (separate project) at the Pacific Ocean to Vancouver, Washington. The project also includes a 40-ft deep navigation channel along the lower 11.6 miles of the Willamette River. Numerous side channels have been developed to capitalize on the economic benefits of navigation on the Columbia River.

The Columbia River Channel Improvements project was completed in November 2010, which deepened the Columbia River navigation channel to 43 feet to accommodate the current fleet of international bulk cargo and container ships and improved the condition of the Columbia River estuary through the completion of environmental mitigation and restoration projects. There has already been $930 million in new commercial investments. The project was a collaborative

389 Columbia River Pilots, http://colrip.com/about/
390 Cubic feet per second.
391 US Army Corp of Engineers. 2014. http://www.nwp.usace.army.mil/Missions/Navigation/Channels/ColumbiaLWillamette.aspx,

effort between the Corps and the lower Columbia River Ports of Portland, Vancouver, Kalama, Longview and Woodland. This project supports $20 billion worth of U.S. products and 54 million tons of cargo annually. The Columbia River is the largest wheat and barley export gateway in the nation and the third largest grain export gateway in the world.

The 43-foot channel dredging project was completed in November 2010. Along with recent stern buoy installations at designated anchorages, this has allowed greater utilization of Panamax-size bulk ships. The number of these larger vessels has increased, while the number of smaller handy-size vessels is decreasing.

Columbia River Vessel Traffic

A comparison of the vessel types transiting the Columbia River in 2014 versus 2004 is shown in Table 43. There are additional vessels that use the waterway that are not captured in these data, including: cargo barge and tugs, vessel-assist tugs, and military, research, and commercial vessels.[392]

Table 43: Monthly Vessel Transits in the Columbia River 2004 – 2014[393]

Vessel Type	Sub-Type	Washington		Oregon	
		2014	2004	2014	2004
Cargo and Passenger	Panamax Bulk Ships	17	4	6	1
	Bulk Ships/Bulk/Log Ships	57	42	32	40
	Car Carriers	7	3	7	16
	Container Ships	0	0	10	19
	Cruise Ships (Large)	0	0	3	1
	General Cargo Ships	10	11	0	0
Articulated Tug and Barge (ATBs)		0	0	10	8
Tank Barge and Tugs		0	0	6	16
Tankers	Oil Tankers	1	0	5	8
	Chemical Tankers	3	3	0	1
	Total	95	63	79	110

The average age of vessels calling the river has been steadily dropping. This is due to the large number of new builds entering the maritime trades. Regular calling vessels in the Columbia River scrapped and replaced with new builds include:

- Six 30-year-old small bulkships with STX Pan Ocean = 36 vessel calls per year.
- Four 25-year-old general cargo ships with China Navigation Co. = 24 calls per year.
- Two 30-year-old chemical tankers = 12 calls per year.

These vessels alone translate into 70 ships calling in the Columbia River each year that are new ships, rather than 25+ year-old ships.

Columbia River vessel entries for the year 2013 totaled 1,454 entering transits.[394] The number of annual transits peaked in 1999 with 2,269 transits. Transits by vessel type in 2013 were:

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392 Occasional military, research, and commercial vessels enter to use repair facilities located in the Columbia River.
393 Portland Marine Exchange vessel arrival data (May 16, 2014 to June 15, 2014).

- Cargo and Passenger: 1,293
- Tankers: 63
- Tank Barges: 874
- ATBs: 201

Vessel types and cargo are summarized in Table 44. Most of these containerships and other cargo vessels are pre-2010 and do not have protected fuel tanks.

[394] Ecology Vessel Entry and Transits (VEAT) 2013.

Table 44: Columbia River Vessel Types and Cargo

Vessel Type	Cargo	Route/Locations
Bulk Carriers[395]	Grains	From Longview, Kalama, Vancouver, and Portland terminals
	Logs	From Longview berths and Astoria
	Petroleum Coke	From Longview B-5
	Soda Ash	From Portland B-411
	Bulk Materials	From Vancouver B-7 and Longview B-5
	Scrap Steel	From Portland Terminal 4 and Vancouver B-1
	Urea	To Port of Portland T-5 Simplot
	Cement	To Port of Portland at Ashgrove and Glacier docks
	Salt	To Longview Weyerhaeuser
	Alumina	To Longview Millennium
	Gypsum	To Rainier, Oregon
Containerships[396]	Containerized High-Value Imports	Port of Portland Terminal-6
General Cargo	Steel (Beams, Pipe, Rolled, Slabs)	All Columbia River Ports
	Wind Turbine Components	Ports of Vancouver and Longview
	Heavy Machinery	Ports of Vancouver and Longview
	Trucks (Western Star)	Port of Vancouver
Car Carriers[397]	Toyota, Hyundai, Honda, Subaru Cars	Portland Berths 415, 601, and 607 plus Vancouver Berth-10
Tankers[398]	Refined Fuel, Fas, Diesel, Jet, and Ethanol	To Portland Willbridge Terminals[399]
	Utah Crude[400]	Rail loaded onto tankers at Portland Chevron oil dock by Arc Terminals
	Sodium Hydroxide	To Vancouver B-5 NuStar
	Toluene	To Kalama Chemical
	Ammonia	On LPG gas ships to Portland T-5 Simplot
ATBs[401]	Fuels	Into Portland
	Crude	Out at Clatskanie
Tank Barges	Fuels, IFO (Ship Bunkers) and Asphalt	Into Portland terminals
	Ethanol	Into Portland
Freight Barges	Gravel; Logs; Wood Chips; Paper Product; Rock	n/a

[395] Mostly "tramps" having no long-term charters with regular trading routes. On the Columbia River Panamax-size bulkers (740 feet long, 40 – 50,000 gross tons) generally load grains. Other bulk products are usually taken on the smaller Handysize bulkers (600-650 feet long, 20-30,000 gross tons).
[396] These are the largest vessels routinely transiting the Columbia River. Post-Panamax size (900 feet long, 60,000 GT, 13.0 m draft). Most are pre-2010 and do not have protected fuel tanks.
[397] Most are pre-2010 and do not have protected fuel tanks.
[398] Smaller tankers, 600 feet long, 42 foot draft, 50,000 GT, 330,000 bbl capacity, single low-speed direct-drive diesel engine. Jones Act tankers.
[399] These are dependent on the Olympic Pipeline operation and capacity. Any disruption of flow from the pipeline results in more oil coming in by tanker/tank barge.
[400]http://arcxlp.com/terminal/portland-terminal/; http://ijpr.org/post/oil-trains-now-delivering-utah-crude-portland
[401] Crowley Marine. Crowley ATBs are ECOPRO.

Terminals on the Columbia River

There are numerous facilities in the Lower Columbia River, as summarized in Table 45.

Table 45: Terminals on the Columbia River

Commodity	Location (s)	Details
Grain	Longview EGT	The new grain terminal, Longview Export Grain Terminal (EGT), was completed in 2012. It brings in more bulk ships, particularly Panamax-size bulk ships. During the permitting process for the new facility, the increase in Panamax bulkers was determined non-significant thereby not requiring an environmental impact study.
	Kalama Export Vancouver UGE	Updates and expansions of existing Kalama Export and Vancouver UGE facilities: additional storage silos, updated and additional grain handling and vessel-loading equipment increasing loading rate, and higher capacity and more bulk ships
	Kalama Temco	Updates and expansion underway at Kalama Temco grain facility (Completion by end of 2014): new rail lines and rail offloading with capacity increase, new barge unloading dock and equipment with capacity increase, berth modifications providing for Panamax size bulkers, new ship loading equipment with capacity increase, will bring higher capacity and more bulk ships.
	Portland	n/a
Oil	Van B-5 NuStar	Tankships in, tank barges out; receives federal government jet fuel by MSC tanker to storage tanks; loads Tidewater barges heading upriver to Pasco then pipeline to Spokane Air Force Base. Tank farm stores Jet A, caustics, methanol, other chemicals. Jet A is only oil product transferred; customer is military; typically brought in via marine terminal from Foss oil tanker; stored at NuStar Annex tank farm, approximately 2 miles inland, and then pumped back over dock to Tidewater barge, then transported 200 miles upriver to Tesoro Pasco Terminal in Tri-Cities, which is tied into pipeline that serves Fairchild Air Force base near Spokane. NuStar in process of modifying facility to connect to Olympic Pipeline.
	Van B-5 Tesoro	Tank barges out; receives gasoline and diesel from Olympic Pipeline to storage tanks; truck racks for local distribution; loads Tidewater barges for Pasco distribution facilities. Associated tank farm sits on 5 acres inland with combined capacity of 11,568,816 gallons. Tank farm also connected to Olympic Pipeline and has truck rack. It handles gasoline, diesel, ethanol, additives and off-spec materials, but only diesel transferred across marine terminal. Typical operation involves Tidewater oil barge loaded up with diesel at facility, then transiting up Columbia to Tri-Cities tank farm facility for commercial/retail sale. *Facility is not to be confused with the Tesoro Savage Vancouver Energy Distribution Terminal proposal which would be located at Terminal 5.*
	Portland Oil Terminals (McCall Oil, Willbridge, Famm Oil, Tesoro, NuStar)	Have tankships and tank barges receiving for distribution: Fuels, lube oils, ethanol, bunkers, asphalt; loading tankers with Utah crude for shipment to West Coast refineries.
	Clatskanie Port Westward Columbia	ATBs out; crude-by-rail to storage then to Crowley ATBs (550 class, 155,000 barrel) for shipment to Shell Anacortes Refinery; in 2013, 110 oil trains traveled through Portland en route to the Columbia Pacific Bio-Refinery, which exports up to 600,000 barrels to West Coast refineries

Commodity	Location (s)	Details
	Pacific Bio-Refinery	each month; operation will reportedly end when the rail oil-receiving facility is completed at Shell Anacortes refinery.
	Tidewater Industrial Center	Two oil transfer docks. Fuel dock is used to fuel to fuel Tidewater's tug fleet with diesel from on-shore 31,656-barrel capacity tank farm. Tanks refilled by bringing in oil barges to dock. Barge 30 is work dock that stores lubrication oil (combined 2,200 gallons capacity) for tug fleet. Oil changes conducted at facility. Barge 30 tanks refilled by tank trucks.
Other Bulk Liquids (Chemicals – Non-Oil)	Kalama Chemical	All bulk liquid chemicals by come in on tankships; Kalama Chemical receives toluene shipments.
	Van B-5 NuStar	All bulk liquid chemicals by come in on tankships; Van B-5 NuStar receives sodium hydroxide (NaOH) and methanol.
	Portland T-5 Simplot	All bulk liquid chemicals by come in on tank ships. Portland T-5 Simplot receives ammonia shipments.

There are grain facilities at Longview, Kalama, Vancouver, and Portland. Recent notable changes in the grain trade are:

- The new grain terminal, Longview Export Grain Terminal (EGT), was completed in 2012. It brings in more bulk ships, particularly Panamax-size bulk ships. During the permitting process for the new facility the increase in Panamax bulkers was determined non-significant, thereby not requiring an environmental impact study.
- Updates and expansions of existing Kalama Export and Vancouver UGE facilities (Figure 105) with additional storage silos, updated and additional grain handling and vessel loading equipment increasing loading rate, and higher-capacity (Panamax-size) and more bulk ships are expected by the end of 2014.

There are also several oil terminals:

- Van B-5 NuStar has tankers coming in and tank barges going out to:
  - Receive federal government jet fuel by MSC tanker to storage tanks.
  - Load Tidewater barges heading upriver to Pasco, then pipeline to Spokane Air Force Base.
- Van B-5 Tesoro has tank barges going out to:
  - Receive gasoline and diesel from Olympic Pipeline to storage tanks.
  - Load truck racks for local distribution.
  - Load Tidewater barges for Pasco distribution facilities.
- Portland Oil Terminals (McCall Oil, Willbridge, Famm Oil, Tesoro, and NuStar) have tankers and tank barges that:
  - Receive fuels, lube oils, ethanol, bunkers, and asphalt for distribution.
  - Load tankers with Utah crude (crude-by-rail) for shipment to West Coast refineries.

Figure 105: Port of Vancouver, WA, with Grain Elevator. Image source: Port of Vancouver.

The Clatskanie Port Westward Columbia Pacific Bio-Refinery is handling crude-by-rail shipments with ATBs going out. The crude-by-rail shipments go to storage then to Crowley ATBs (550 class, 6.51 million gallons) for shipment to Shell Anacortes Refinery. In 2013, 110 oil trains traveled through Portland en route to the Columbia Pacific Bio-Refinery, which exports up to 25.2 million gallons to West Coast refineries each month, Operations will reportedly end when the rail oil-receiving facility is completed at Shell Anacortes refinery.

Chemicals and other non-oil bulk liquids are carried aboard tankers in the Lower Columbia River to the following terminals:

- Kalama Chemical – toluene.
- Van B-5 NuStar – NAOH, methanol.
- Portland T-5 Simplot – ammonia.

Other commodities are also handled, such as automobiles at Vancouver Terminal 4 (Figure 106).

Figure 106: Port of Vancouver, WA, Automobile Facility. Image source: Port of Vancouver.

Crude-by-Rail Facility Changes for the Columbia River

The NuStar Energy facility in Vancouver, Washington (Figure 107) is proposing to convert an existing 120,000-barrel methanol tank to one that would store crude oil. The company also plans to add rail-offload capability. It would handle one crude-by-rail train about every three days.

Figure 107: NuStar Energy Facility, Vancouver, Washington

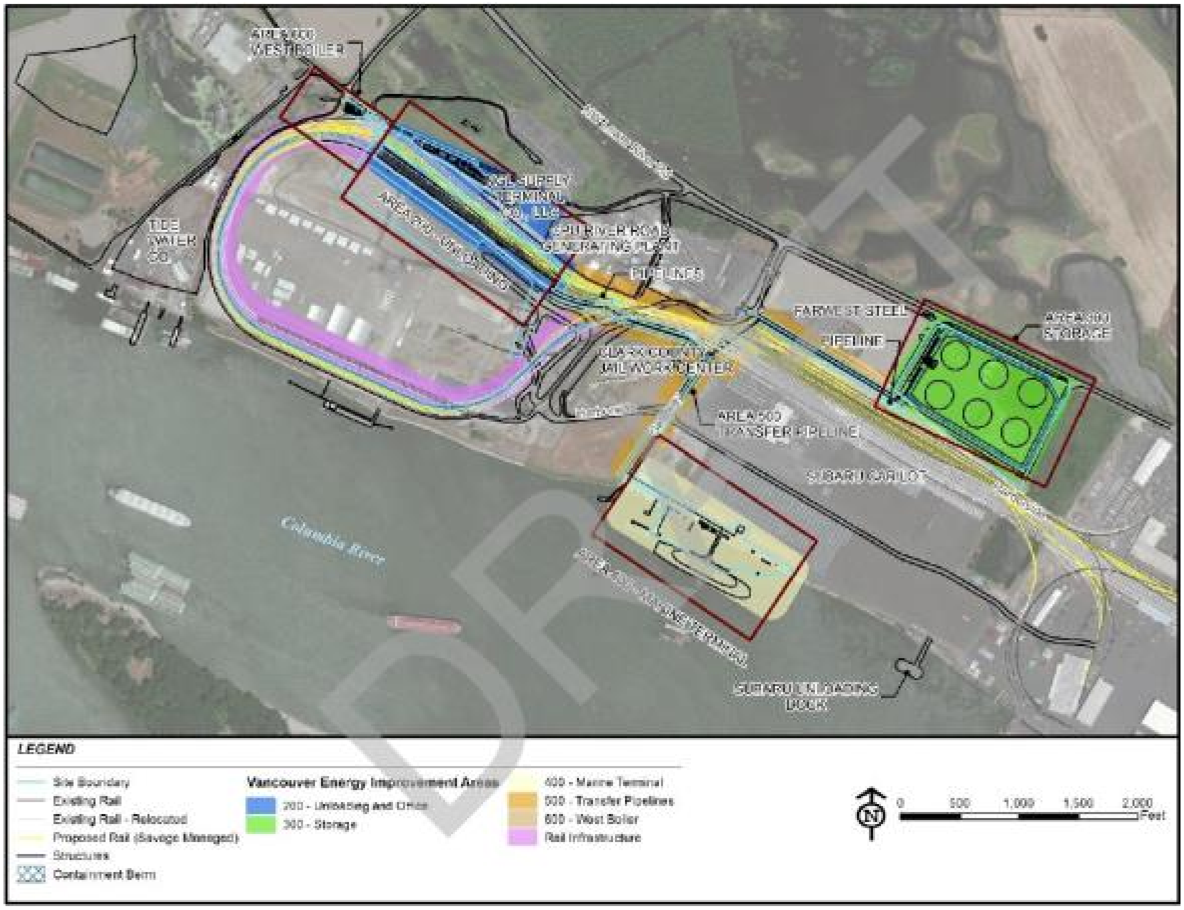
Vancouver Energy (formerly Tesoro Savage) is a proposed terminal facility that will handle up to 360,000 barrels of crude oil per day on a 42-acre site in the Port of Vancouver (Figures 108 and 109).[402] While initially it would transfer oil from one to two crude-by-rail unit trains per day, it is permitted to receive up to four.

After five public workshops beginning in mid-2013, the Board of Commissioners of the Port of Vancouver voted unanimously to approve the Vancouver Energy lease, which began a review and permitting process. The process is in its second step, review and permitting by the Energy Facility Site Evaluation Council (EFSEC), the agency in charge of reviewing and permitting large, energy-related projects in Washington. Throughout the process, the public has opportunities to attend hearings and submit comments to EFSEC. Once EFSEC completes its thorough review, it will make its recommendation to Governor Jay Inslee who will make the final decision. Vancouver Energy expects EFSEC to deliver its report to the Governor in early 2015. The Vancouver Energy SEPA Draft EIS was released in July 2014.[403]

Figure 108: Proposed Vancouver Energy Facility Location in Vancouver, Washington. Image source: Vancouver Energy.

[402] http://www.vancouverenergyusa.com/project-overview.html
[403] http://www.vancouverenergyusa.com/assets/pdeis_10_2014.pdf

Figure 109: Vancouver Energy Proposed Layout[404]. Image source: Vancouver Energy.



Columbia River Bunkering and Other Activities

Other marine commerce on the Columbia River includes cargo barges, passenger cruise ships, tour boats, commercial fishing charter boats, the Wahkiakum Cathlamet-Westport auto ferry, dredges, tugs, and launch-service boats. Recreational and tribal fishing-boat activity is heavy at various locations during open fishing seasons.

Vessel bunkering occurs in the Columbia River at all berths and designated anchorages. During the 12 months from June 16, 2013 to June 15, 2014, there were 352 covered vessel bunkerings conducted in the Lower Columbia River,[405] of which:

- 212 occurred in Oregon waters where pre-booming is not required.
- 140 occurred in Washington State waters, where:
    - 138 were pre-boomed.
    - Two were not pre-boomed, due to higher current conditions.

[404] From Vancouver Energy Draft EIS, 2014. http://www.vancouverenergyusa.com/assets/pdeis_12.17.14.pdf
[405] Ecology Spills Advanced Notice of Transfer (ANT) data

Vessel Incidents in Columbia River

During the last year, there were no bunker spills in the Columbia River.[406] Additionally, there were no spills from larger vessels (tank barges, ATBs, tankers, cargo and passenger vessels over 300 GT) during the previous year.[407]

During 2011 to 2014, there were 29 vessel emergencies with substantial threat of a spill in the Columbia River. Most of the emergencies were losses of propulsion. Human error was the most prevalent root cause in incidents where a cause was determined.[408]

Future Changes to the Columbia River Vessel Traffic

Future changes to the vessel traffic in the Columbia River and operations at Lower Columbia River ports include:

- More stern buoy installations at anchorages will enable more Panamax-size bulkers (70,000 ton, 740-feet length) to replace some of the smaller Handysize bulkers (30-40,000 ton, 650-feet length).
- The average age of vessels calling could continue to drop, as older ships are scrapped and new builds come online.
- More bulk ships are expected to call, and more could be the larger Panamax size.
- More tank ships and ATBs may transit, much of it due to crude-by-rail transport.
- The additional bulk ships may generate more bunkerings.
- Tank ships probably will not bunker in the Columbia River due to their regular trade to California and Puget Sound. Bunkers in the Columbia River would be barged in the Columbia River from California or Puget Sound, increasing the cost locally.
- More ships may call in the river, though they could generally be newer with safer more environmentally friendly engineering systems.
- The additional bulk ships may be the larger Panamax size:
  - The number of larger ATBs (Crowley 650 and 750 class) may increase.
  - The 50,000 GT-size oil tankers using the river may increase in number. Most of these could be transporting crude and chemicals out.
  - There may be LPG vessels similar to the current LPG/ammonia gas carriers calling in the river.
  - The older car carrier and container ships that serve the river could be replaced with new builds having safer and more environmentally friendly engineering systems.

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[406] Ecology Environmental Report Tracking System (ERTS) data.
[407] Ecology ERTS data query 6/1/2013 – 5/30/2014.
[408] Ecology Safety Advisory Bulletin 14-06, Publication Number 14-08-006.

- The volume of traffic on the river will likely increase:
  - More vessels could be at anchorages, causing crowding and potential swing-related groundings or collisions during low-water periods.
  - There may be more of a backlog of vessels awaiting transit following bar closure, due to weather and limited anchorages.
  - There may be periods of high traffic volume crossing the bar after it is reopened.
- The volume of oil and liquid chemical products being transported may increase, including more crude transport and persistent oil with higher pollution-damage potential.
- The number of bunkerings may increase with the greater number of bulk ships.
- Depending on the federal decision on domestic crude export, there may be more foreign tankers, if exports are approved. If exports are not approved, the status quo could remain with Jones Act tankers and ATBs only.

Existing Safety Systems in the Columbia River

The Columbia River has a difficult bar crossing and challenging navigation constraints. Licensed pilots are required for large commercial vessels operating on the Columbia River. Pilots possess extensive navigational experience, local knowledge, and ship-handling skills and are charged with safely and efficiently piloting vessels in all weather conditions, at all hours of the day and night, 365 days a year.

Bar Pilots are responsible for navigating ships over the Columbia River Bar.[409] The Bar Pilots also have the authority to close the bar to marine traffic during serious weather conditions, as can the U.S. Coast Guard. Bar Pilots turn large commercial vessels over to River Pilots for piloting the transit to Columbia River ports. The Columbia River Pilots[410] provide maritime pilotage services to all ports on the lower Columbia and Willamette Rivers.

Both the Columbia River Bar Pilots and the Columbia River Pilots are active in risk assessment, risk management, and overall safety on the Columbia River, as individual organizations and through participation in groups such as the LCRHSC.

There is no dedicated standby rescue tug for the Columbia River Bar; however, in the past, available tugs have been used to assist vessels.

[409] A system of bars and shoals at the mouth of the Columbia River spanning the U.S. states of Oregon and Washington; the bar is about 3 miles wide and 6 miles; the bar is where the river's current dissipates into the Pacific Ocean, often as large standing waves; the waves are partially caused by the deposition of sediment as the river slows, as well as mixing with ocean waves; the waves, wind, and current are hazardous for vessels of all sizes.
[410] http://colrip.com/about/

Unlike the open-water areas in Puget Sound, the Columbia River has a confined shipping channel with a limited depth of 43 feet and a defined navigation channel.

Large quantities of refined and residual oil, IFO ship bunkers, and asphalt, are already carried in tankers and tank barges transiting the river. Crude oil transport on the river began in 2012. Tankers moving oil on the Columbia River are smaller 50,000 GT tankers, rather than the 125,000 GT tankers in Puget Sound.

The natural features of the Columbia River act as both safety features and hazards. The natural hazards of the Columbia River include:

- The bar crossing has serious weather and currents, at times requiring expert navigational skills to transit.
- The lack of room to maneuver in the case of a loss of propulsion or steering can lead to rapid groundings, collisions, or allisions.
- Warrior rock is a rock outcropping adjacent to the shipping channel at river mile 88. This was the location of the 1984 Mobil Oil tanker grounding and spill.[411]
- The long shipping channel, 106 miles long by 600 feet wide, is narrow and twisting, so thorough passage planning is necessary for safe navigation.
- There are seasonal changes that could affect navigation, such as:
  - Low-water periods and swinging at anchor leading to soft groundings.
  - Flood-stage high-flow currents complicating maneuvering, especially for tug and barges.

A natural safety feature of the topography of the river bed is that the shipping channel is dredged in the sediment and silt river bottom. Incidents of a loss-of-steering or loss-of-propulsion emergency do occur. In most of the waterway, these incidents stabilize quickly with the vessel soft aground with little to no damage. The higher-risk areas are near the port facilities. Here the water depth allows vessel movement to and from the berths; there is more vessel congestion, and there are more obstructions, such as bridges.

Pre-2010 oil tankers having double-hull cargo tanks often have single-hull fuel-wing tanks in the engine room area. These are less likely to damage in an incident, but the post-2010 protected-fuel-tank requirement that applies to tankers does provide better prevention. The age and percentage of recent vessels calling in the Columbia River with protected fuel tanks is shown in Table 46. For bulk carriers, most of the remaining 46% that are pre-2010 builds have centerline double-bottom fuel tanks meeting the reduced outflow standard.

[411] The Mobil Oil tanker spill occurred on March 19, 1984 after a grounding at mile 88 of the Columbia River, near St. Helens, Oregon. A total of 4,000 barrels of heavy fuel oil spilled, resulting in the oiling of over 450 birds and cleanup costs and damages of nearly $3 million (about $5.25 million in current dollars) (Etkin 1998).

Table 46: Vessel Age and Fuel Tank Protection: Columbia River[412]

Vessel Type	Number	Average Age (years)	% With Protected Fuel Tanks
Bulk Ship	96	6.1	54 %
General Cargo Ship	9	6.9	44%
Container Ship	10	13.3	0%
Car Carrier	14	13.0	7%
Tanker	9	16.7	22%

Lower Columbia River Harbor Safety Committee Safety Plan guidelines[413] provide additional safety measures through clearly defined expectations for use of anchorages, towed barges, and navigation assistance.

The Columbia River Pilots' Vessel Movement Guidelines[414] are offered to vessel owners, operators, and agents to assist in planning vessel movements on the Columbia and Willamette River Pilotage Grounds. These are general guidelines, advisory in nature only, and are not intended to supersede or limit in any way the authority or judgment of any individual pilot. Every specific situation is unique with regard to the type and class of vessel, its operating condition and crew, the existing weather, river currents, and numerous other variable conditions. All final decisions remain within the discretion and authority of the pilot(s) dispatched to the job.

The Army Corps of Engineers has conducted various projects in the Columbia River, including: stern buoys and maintenance dredging projects and providing safe anchorage for Panamax-size vessels.

Marine fire safety on the Columbia River is provided by local fire agencies from Astoria to Portland-Vancouver working together to provide vessel firefighting capabilities.[415] In the aftermath of the 1982 Protector Alpha Fire in Kalama, Washington,[416] in which a lack of training, equipment and understanding resulted in the death of one Coast Guardsman and the critical injury of a firefighter, the USCG spearheaded the formation of an adhoc industry committee to review the challenges associated with shipboard fires. The Maritime Fire and Safety Association (MFSA) was established in November 1983. Membership is made up of 25 ports and private facilities along the lower Columbia and Willamette Rivers. They tasked themselves with developing a system to ensure an adequate, timely, and well-coordinated response to ship fires along the 110-mile shipping channel, which includes two states, seven counties, fourteen cities, seven port districts, and over 20 fire agencies.

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412 Columbia River traffic monthly data – From Portland Marine Exchange arrival data.
413 Lower Columbia Region Harbor Safety Plan published January 2012 (http://lcrhsc.org/documents/Lower_Columbia_Region_Harbor_Safety_Plan_published_January_2012.pdf)
414 Columbia River Pilots' Vessel movement Guidelines, VMG—03/18/14
415 FPAAC side of Marine Fire Safety Association (MFSA).
416 http://www.uscgnews.com/go/doc/4007/1383039/Multimedia-Release-Coast-Guard-commemorates-30th-anniversary-of-Protector-Alpha-tragedy

The Lower Columbia Marine Fire Safety Plan (the "Marine Fire Plan"), originally developed in 1984 and revised in 1991, provides for building a marine-fire-response capability along the Columbia and Willamette Rivers from the Portland/Vancouver harbor area to Astoria, near the mouth of the river. The purpose of the Marine Fire Plan is to set forth a comprehensive system that ensures fast, well-coordinated, and effective response to ship fire incidents in the Lower Columbia region.

MFSA proposed a per-vessel assessment to the membership. The membership approved the assessment as a stable funding source to deal with ongoing maintenance. Currently, the fee is collected from all ocean-going vessels that call at a member's dock. Some federal funding has been received by the MFSA to assist in equipment purchases and training, but the association did not want to become dependent upon this funding, so the membership's self-assessments have continued.

Initially, the purpose of the MFSA was to train and equip land-based firefighters for shipboard firefighting. The year 2008 saw the completion of over 92,000 hours of training and the purchase of equipment ranging from basic firefighting equipment to high-angle rope-rescue and CO_2-application equipment.

The current ATBs carrying crude on the Columbia River are full members of the ECOPRO program. Existing practice for LPG/ammonia-gas-carrier transits on the Columbia River is that USCG regulations require a USCG escort.

The analysis of the Columbia River safety systems indicates that:

- There are numerous adequately sized tugs along the river to provide ship-assist and salvage work.
- Unless already on scene, tugs would be unlikely to be able to respond to a vessel in distress on the Columbia River or at the entrance bar before the vessel grounded or allided with some structure.
- The voluntary safety programs and best practices are continually improving.
- Newer vessels with better environmental engineering systems are replacing older tonnage using the river.
- A standby tug at Astoria would provide a salvage resource but not an effective rescue resource for the Columbia River Bar.

Grays Harbor

Grays Harbor Vessel Traffic and Facilities

Grays Harbor is a highly sensitive environment with numerous natural and cultural resources. Its narrow channel and bar present challenges for ships and barges entering and leaving the harbor, especially laden oil-carrying tank vessels.

Grays Harbor is located on the outer coast of Washington and has a complex navigation route due to a breaking bar at the entrance, a constrained channel, and limited depth. Due to shoals and flats, the navigable channel into Grays Harbor narrows to 0.6 miles wide with a number of turns where course changes are required. Inside the bay, the navigation channel provides depths of 46 feet across the bar, thence 42 to 40 feet in the entrance, then 36 feet inside the bay to Cow Point, then 32 feet to Cosmopolis, about nine miles above the bay entrance.

A breaking bar at the entrance to Grays Harbor, coupled with strong and sometimes erratic currents, can present a navigational challenge to commercial and recreational vessels entering or leaving port. Periods of limited visibility due to fog, rain, and/or darkness can add to this challenge. Submerged sections of the north and south jetties at the Grays Harbor entrance extend seaward about 0.2 and 0.9 miles (respectively). Hazardous breakers can occasionally be present near these jetties, especially during periods of heavy weather. Pilotage rules for commercial traffic must be followed in order to reduce the risk of groundings, collisions, or other accidents.

Port of Grays Harbor Marine Terminals and Facilities

The Port of Grays Harbor's terminals are supported by large, paved, secured cargo yards, the Port's own on-dock rail system, and more than 104,000 square feet (9,661 square meters) of on-dock covered storage. The marine-terminal rail system includes more than 50,000 ft. of rail looping through the marina terminal complex (Figure 110).[417]

The Port of Grays Harbor has a variety of tenants who manage forest products, automobiles, biodiesel, methanol, and other liquid and dry-bulk products and operates four marine terminals. In addition to the port-operated facilities, there are several private deep-draft piers and wharves in the Hoquiam, Aberdeen, and Cosmopolis areas.

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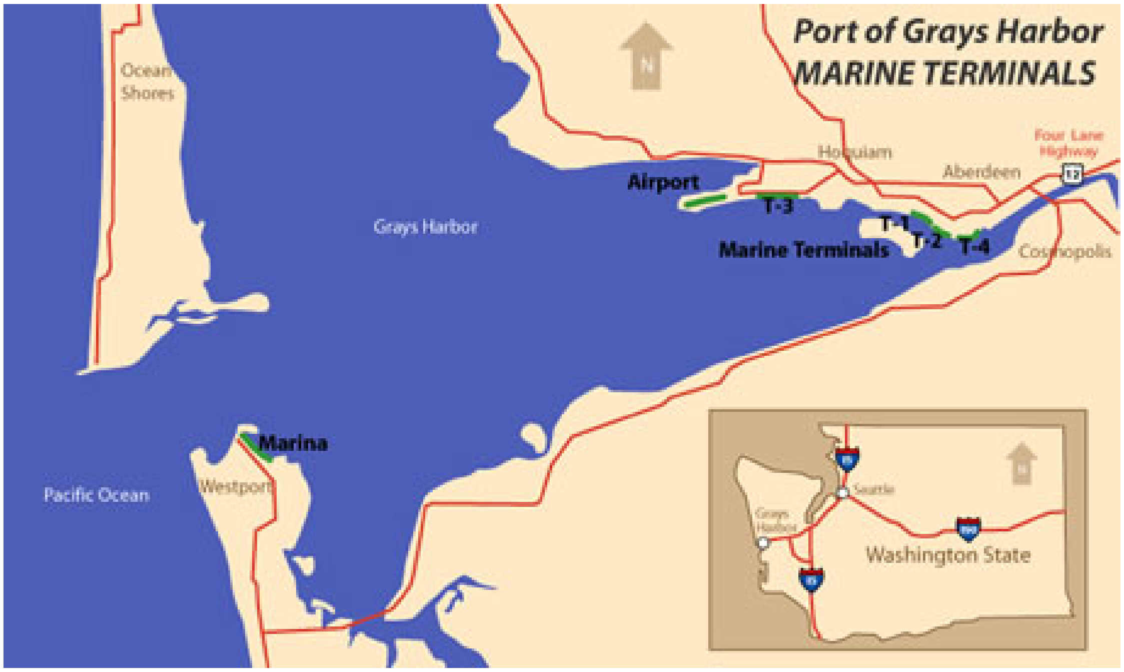
[417] http://portofgraysharbor.com/terminals/terminals.php

Figure 110: Port of Grays Harbor Marine Terminals. Image source: Port of Grays Harbor.



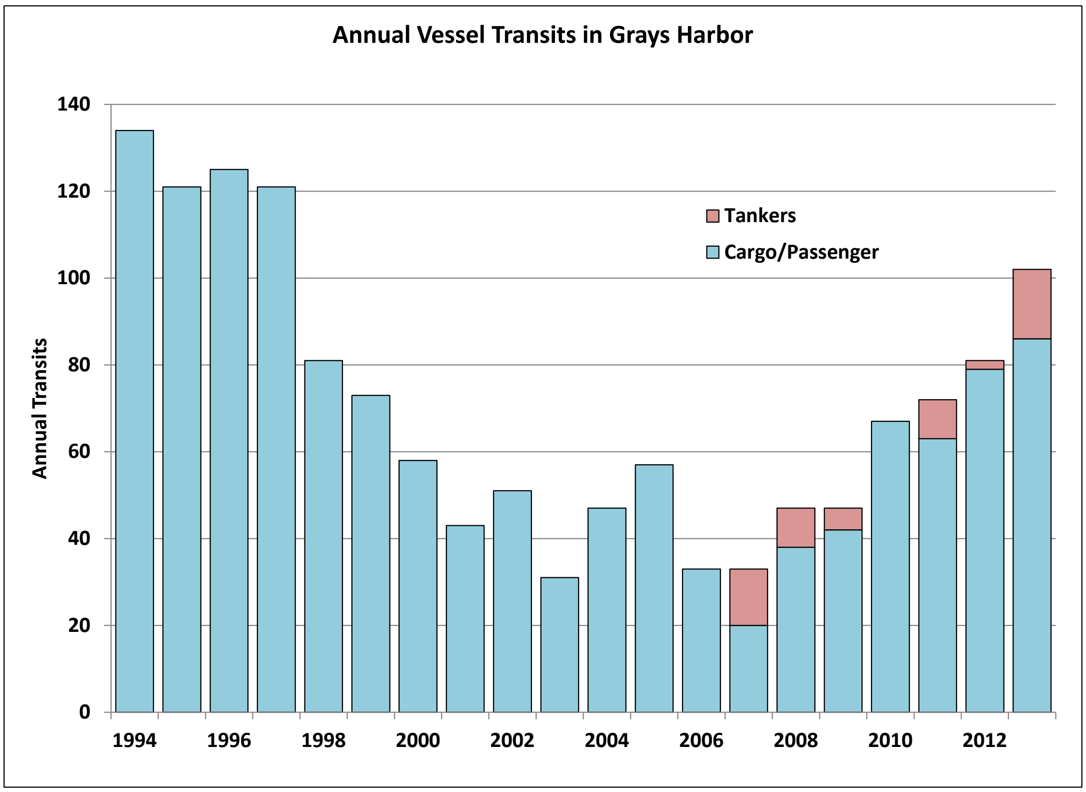
There is no formalized Vessel Traffic Service (VTS) in Grays Harbor. Vessel traffic is managed in cooperation between the Port of Grays Harbor, Grays Harbor Pilots, Vessel Agents, and the terminal tenants that ships call on. The Grays Harbor Safety Committee has published guidelines with standards of care in the Grays Harbor Safety Plan.

- **Terminal 1:** Terminal 1 is a barge- and liquid-loading facility, with adjacent uplands storage area. It provides liquid bulk-commodity shipping access to port customers Imperium and Westway Terminal Company.
- **Terminal 2:** Served by a rail loop, Terminal 2 is a state-of-the-art bulk facility that handles AGP grain and liquid bulk commodities.
- **Terminal 3:** Only an hour and a half from open sea, Terminal 3 is a 150-acre marine industrial site with a deep water terminal and on-site rail.
- **Terminal 4:** The port's largest marine terminal, Terminal 4, is a 1400 ft. long berth capable of handling two vessels. Equipped with dockside warehousing, paved uplands, and on-dock rail service, T4 serves as the primary RO/RO and breakbulk cargo terminal.

Grays Harbor Large Commercial Vessel Traffic

Grays Harbor has experienced economic growth in recent years, accompanied by increased tanker and cargo transport. Vessel arrival data shows more than a 200% increase in the arrival of tankers and cargo vessels since 2006. Bulk exports are the largest commodity handled at port facilities and are expected to increase further over the next few years, especially shipments of grain, soybeans, and other agricultural products. Roll-on-roll-off imports/exports and commercial tank ship traffic are also likely to increase. Large commercial vessels typically carry significant amounts of heavy and blended fuel oils and other petroleum products, raising the potential for sensitive resources to be impacted if an oil-spill incident were to occur. Vessel arrivals in Grays Harbor are summarized in Figure 111 and Table 47.

Figure 111: Annual Vessel Transits in Grays Harbor



There were 23 tanker arrivals in 2007 when Imperium began importing vegetable oil and exporting bio-fuel. Tanker numbers fell off sharply after that but have slowly been increasing as Imperium has increased operations and Westway's Grays Harbor Terminal has begun moving methanol through the port. According to the 2013 VEAT data, there were 17 entering transits by tankers in 2013, with zero ATBs or tank barges.

Table 47: Grays Harbor Entering Transits/Individual Vessels[418]

Year	Cargo/ Passenger Ships		Tankers		Fishing Vessels		Total	
	Transits	Vessels	Entering Transits	Vessels	Entering Transits	Vessels	Entering Transits	Vessels
1994	134	74	0	0	0	0	134	74
1995	121	77	0	0	0	0	121	77
1996	125	78	0	0	0	0	125	78
1997	121	86	0	0	0	0	121	86
1998	81	58	0	0	0	0	81	58
1999	73	53	0	0	0	0	73	53
2000	58	43	0	0	0	0	58	43
2001	43	32	0	0	0	0	43	32
2002	51	39	0	0	0	0	51	39
2003	31	27	0	0	0	0	31	27
2004	47	40	0	0	0	0	47	40
2005	57	41	0	0	0	0	57	41
2006	33	24	0	0	0	0	33	24
2007	20	10	23	13	0	0	43	23
2008	38	30	10	9	0	0	48	39
2009	42	30	5	5	1	1	48	36
2010	67	51	0	0	0	0	67	51
2011	63	45	9	9	0	0	72	54
2012	79	57	3	2	0	0	82	59
2013	86	62	17	16	0	0	103	78

Projected Changes for Grays Harbor Facilities

There are two facilities proposing to expand existing facilities to handle crude oil and other petroleum products by rail and vessel, Imperium Terminals and Westway Terminals. A third proposal is for a new facility to store and handle crude oil by rail and vessel, Grays Harbor Rail Terminal.

Imperium operates as Imperium Renewables, a biodiesel terminal with a throughput of 75,000 barrels per day (Figure 112). The facility began terminal operations in April 2007 and began manufacturing biodiesel in September 2007. The facility includes a tank farm consisting of 14 storage tanks with a storage capacity of 430,000 barrels. It has a significant rail infrastructure with:

- 90-railcar load/unload facility.
- Storage for over 500 railcars in a local rail years.
- Shipping and receiving of 350 railcars per month in 2014.

In addition, there are multiple truck racks and marine terminal access that is Panamax-vessel-capable (41-ft draft and 750-ft beam) and 100,000-350,000-barrel barge-capable.

418 VEAT data.

Figure 112: Imperium Renewables Facility in Hoquiam, Grays Harbor

Imperium proposes to expand its existing bulk-liquid-storage terminal to allow for the receipt, storage, and shipment of biofuels, such as ethanol, biodiesel, and additional feedstocks for biofuel production, such as used cooking oil/waste vegetable oil and animal fat, petroleum products including naphtha, gasoline, vacuum gas oil, jet fuel, No.2 fuel oil, No. 6 fuel and kerosene, crude oil, and renewable fuels such as renewable diesel and renewable jet fuel. Imperium is also applying for permits to store these bulk liquids. The bulk liquids could be shipped by rail, trucks, ships, or barges to and from the facility from the Port of Grays Harbor Terminal 1 (Figures 113 and 114).

Up to nine storage tanks would be constructed on the site to the north/northwest of Imperium's existing bulk-storage tanks. The new tanks would each have a capacity of 80,000 barrels (3.36 million gallons) for a project total storage capacity of up to 720,000 barrels (30.2 million gallons). The annual maximum throughput for the entire Imperium facility, including the expansion, would be 30 million barrels (1.26 billion gallons) per year. The tanks would be surrounded by a concrete containment wall with the capacity to contain the total volume of a single tank plus an allowance for precipitation.

The existing rail facility would be expanded. Approximately 6,100 feet of track in multiple new rail spurs would be constructed on site in connection with the existing rail line and the existing rail yard would be expanded. The railcar-containment area would have the capacity to contain the total volume of a single railcar plus an allowance for precipitation.

Figure 113: Proposed Layout of Imperium Crude-by-Rail Facility

Figure 114: Appearance of Proposed Imperium Crude-by-Rail Marine Terminal

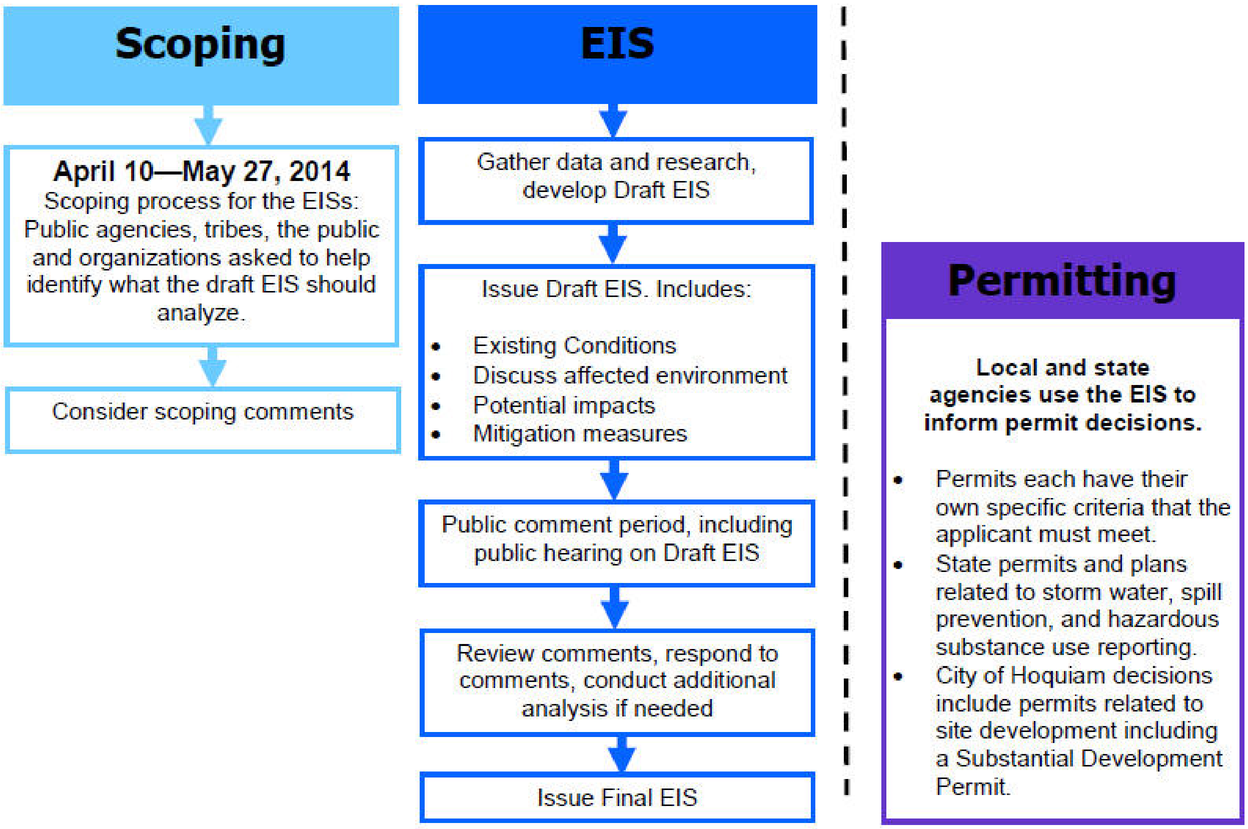
Pipelines would be installed connecting Terminal 1 with the tank farm. One 24-inch-diameter pipe and one 16-inch-diameter pipe would be constructed from the tank farm and routed across an existing pipe bridge over the existing rail line. The two pipes would be routed to Terminal 1 following a similar route as the existing Imperium tank-farm piping.

A marine vapor-combustion unit would be installed west of the existing Imperium tank farm and would be used to handle displaced vapors during vessel loading. A new building or buildings would be constructed on the site to replace the existing mobile trailers. The new buildings would provide offices and laboratory, maintenance, and warehouse facilities.

The company estimates that the terminal operations would handle a maximum of 730 unit trains a year (loaded and empty), or two unit trains per day. The company estimates that the terminal operations would handle up to 200 ships or barges a year (400 entry and departure transits), or one per day.

Imperium Terminal Services, LLC, requested the City of Hoquiam and Ecology to initiate scoping for an EIS on January 22, 2014. The initial scoping period began on April 10, 2014 and ended on May 27, 2014. To date, the EIS process is still ongoing (Figure 115).

Figure 115: Scoping and EIS Process for Imperium and Westway Terminals (Grays Harbor)[419]



Westway Terminals operates a methanol-storage facility at the Port of Grays Harbor. The facility includes a tank area consisting of four storage tanks with a total of 13.4 million gallons of storage and a rail yard. The facility receives and ships methanol via train, truck, and vessels. These existing operations will continue and are separate from the expansion proposal.[420]

Westway proposes expanding its existing bulk-liquid storage terminal to allow for the receipt of crude-oil unit trains, storage of crude oil from these trains, and shipment of crude oil by vessel and/or barge from Port of Grays Harbor Terminal 1.

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[419] http://www.ecy.wa.gov/geographic/graysharbor/terminals.html
[420] http://www.ecy.wa.gov/geographic/graysharbor/westwayterminal.html

According to the project proposal, the Westway expansion project would be done in two phases. Five new storage tanks would be constructed on the site to the south of Westway's existing bulk storage tanks. The new tanks would each have a capacity of 200,000 barrels (8.4 million gallons) for a projected total storage capacity of one million barrels (42 million gallons). The annual maximum throughput would be 17.8 million barrels (749.9 million gallons) per year. The tanks would be surrounded by a concrete containment wall with the capacity to contain the total volume of a single tank plus an allowance for precipitation.

The existing rail facility on the site would be expanded from two short spurs with a total of 18 loading/unloading spots to four longer spurs with a total of 80 loading/unloading spots. The railcar-containment area would have the capacity to contain the total volume of a single railcar plus an allowance for precipitation.

A new pipeline would connect the new tanks, via an existing pipeline bridge, to the Port's Terminal 1. Work performed on the terminal dock would be limited to the addition of loading arms and parts of a marine vapor combustion system.

There would be no in-water work. Construction of the expanded rail facility would involve demolition of an existing wood-frame warehouse and construction of additional office space and support facilities.

The company estimates that terminal operations would handle 458 unit trains a year (loaded and empty) or 1.25 trains every day. The company estimates that the terminal operations would handle 99 to 119 barges a year (198 to 238 entry and departure transits) or approximately one every two days.

Westway Terminals requested the City of Hoquiam and Ecology to initiate scoping for an EIS on January 22, 2014. The initial scoping period began on April 10, 2014 and ended on May 27, 2014. The EIS process is still ongoing (Figure 115).

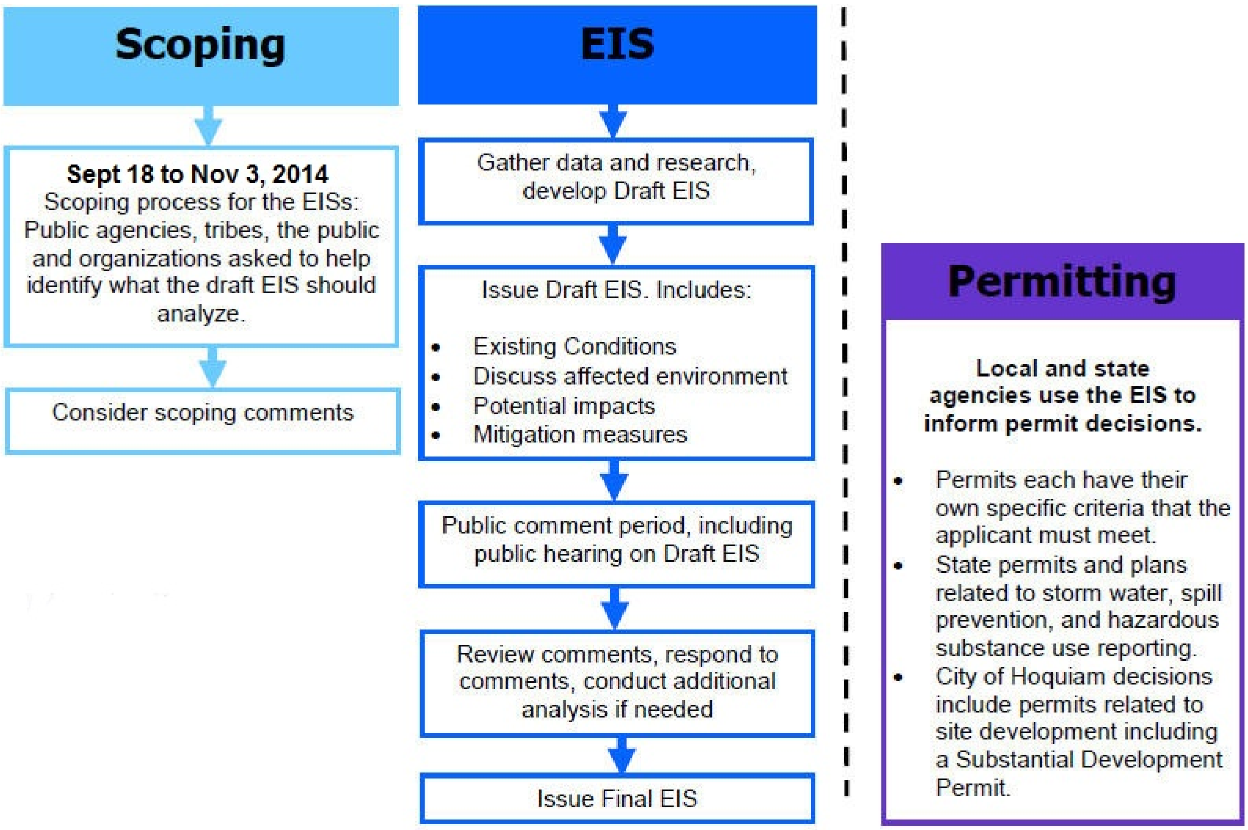
Grays Harbor Rail Terminal, LLC, is proposing a bulk liquids rail logistics facility at the Port of Grays Harbor Terminal 3 property. The facility will accommodate the receipt for transfer to marine vessels of 45,000 barrels per day on average of various liquid bulk materials, specifically, various types of crude oil and condensates.

The liquid bulk materials would be delivered to the proposed facility via unit trains in fully contained railcars, unloaded into on-site storage tanks, and then loaded onto barges or other marine vessels for delivery to refineries.

The proposed rail and off-loading facility includes four 20-car tracks and two 20-car off-loading or staging tracks. The liquid bulk materials would be stored in approximately six to eight above-ground storage tanks with secondary containment and internal floating roofs. The total combined storage would be approximately 800,000 -1,000,000 barrels. The facility is expected to handle three to five vessel calls per month.

The proposal is in the EIS process, with the scoping period occurring during September 18 and November 3, 2014 (Figure 116).

Figure 116: Scoping and EIS Process for Grays Harbor Rail Terminal Project[421]



If the crude-oil rail facilities planned for Grays Harbor come online, this will increase the number of tank-ship arrivals in that port and create a new crude-oil export business. The Port of Grays Harbor has three independent, potential projects under consideration by experienced developers. The three projects, as proposed, would result in 285 to 379 additional vessel calls, compared to 302 in 1972 (including 26 oil tankers). There would be 12 to 14 inbound unit trains per week if all three facilities operate at capacity.

[421] http://www.ecy.wa.gov/geographic/graysharbor/ghrt.html

Projected Increases in Grays Harbor Rail Traffic

The projected changes in rail traffic with the proposed crude-by-rail facility developments, should they be permitted, would be approximately 5.25 trains a day (includes loaded and empty trains), including:

- **Westway Terminals:** The company estimates that terminal operations would handle 458 unit trains a year (loaded and empty) or 1.25 trains every day.
- **Imperium Terminals:** The company estimates that the terminal operations would handle a maximum of 730 unit trains a year (loaded and empty), or two unit trains per day.
- **Grays Harbor Rail Terminal:** The company estimates that the terminal operations would handle a maximum of 730 unit trains a year (loaded and empty), or two unit trains per day.

Projected Increases in Grays Harbor Vessel Traffic

The projected changes in vessel traffic with the proposed crude-by-rail facility developments are summarized in Table 48. By 2030, the vessel traffic is expected to at least triple with respect to vessel transits.

Table 48: Predicted Number of Vessel Transits at Grays Harbor for Year 2030[422]

Vessel Type	2012 Transits[423]	Forecasted Transits by Year 2030		
		Imperium Scenario 1	Imperium Scenario 2	Imperium Scenario 3
		20% Tankers 80% ATBs	100% ATBs	100% Tankers
Imperium Liquid Bulk Vessels	30 tankers	346	400	228
Westway Liquid Bulk Vessels	6 tankers	238 ATBs		
Grays Harbor Rail Terminal	0	120 Tankers[424]		
Dry Bulk Carriers[425]	207	253		
Dry Bulk ATBs	68	85		
Total	311	1,042	1,096	924

[422] Worley Parsons 2014.
[423] Transit data for Imperium and Westway are from 2013.
[424] http://www.portofgraysharbor.com/downloads/crude-by-rail/USD_FAQ.pdf
[425] Includes ro/ro/passenger-cargo carriers

Outer Coast

Vessels of all types transit to and along the Washington coast to visit ports in Puget Sound, Grays Harbor, and the Columbia River. Additionally, there are vessels on “innocent passage”[426] which transit further off the coast.

The Offshore Vessel Traffic Risk Management Project has excellent information on West Coast vessel traffic. The traffic project dates from 2002; however, although coastal traffic has fluctuated with economic drivers over the last 10 years, it has not changed dramatically.

Outer Coast Tank and Non-Tank Vessel Traffic

Conclusions and recommendations from the 2002 Offshore Vessel Traffic Risk Management Project[427] on tank and non-tank vessel traffic were:

- Tankers carrying crude oil that are members of the Western States Petroleum Association (WSPA) transit at distances of 50 nautical miles or greater off the West Coast of the U.S. except when they are entering port or a traffic-separation scheme around a port.
- Non-WSPA owned or operated crude-oil tankers and refined-product tankers, including those operated by WSPA companies, are not subject to this agreement and may transit closer to shore.
- Generally, U.S. tankers comply with the Canadian voluntary Tanker Exclusion Zone (TEZ) off the West Coast of BC.
- Tank barges carrying crude oil and refined products travel 25 nautical miles or further off the West Coast, except when they are entering port or a traffic-separation scheme around a port, according to an American Waterways Operators (AWO) informal agreement.
- The tracks of dry-cargo ships and bulk carriers vary from three to 30 nautical miles and further offshore when transiting the West Coast.
- A vessel master’s decision to follow a specific track line is generally based upon prudence, weather, vessel traffic, and geography.
- Weather avoidance is a major consideration for all vessels, and vessel tracks may be altered to avoid heavy weather.
- The highest risk occurs when vessels approach the coast for a port entrance.

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[426] Innocent passage is a concept in law of the sea which allows for a vessel to pass through the territorial waters of another state, subject to certain restrictions. The UN Convention on the Law of the Sea defines innocent passage: Passage is innocent so long as it is not prejudicial to the peace, good order, or security of the coastal state. Such passage shall take place in conformity with this convention and with other rules of international law.
[427] Offshore Vessel Traffic Risk Management Project, 2002.

Outer Coast Passenger Cruise and Fishing Vessel Traffic

According to the 2002 Offshore Vessel Traffic Risk Management Project, cruise lines usually shift their fleet to Alaskan destinations during the spring for the summer operating season and return to the Caribbean in the fall while weather and visibility are good. About 90% of the cruise ships transit from the Panama Canal to Seattle or Vancouver, BC to start summer cruises from these ports through the Inside Passage to Alaska. Except during the seasonal shift, cruise-line traffic usually does not merge with coastal traffic that runs south from Cook Inlet to ports in Washington.

While exact locations of fishing activities vary with weather and season, the 2002 Offshore Vessel Traffic Risk Management Project concluded that seasonal fishing in locations along the outer coast and entrances to some ports may increase risk to vessel traffic. There is an increase in fishing-vessel traffic during the spring and summer months from Puget Sound to Cook Inlet. Fishing-vessel density is particularly high near the entrance to the Strait of Juan de Fuca.

Coastal Traffic Entering Puget Sound and Columbia River

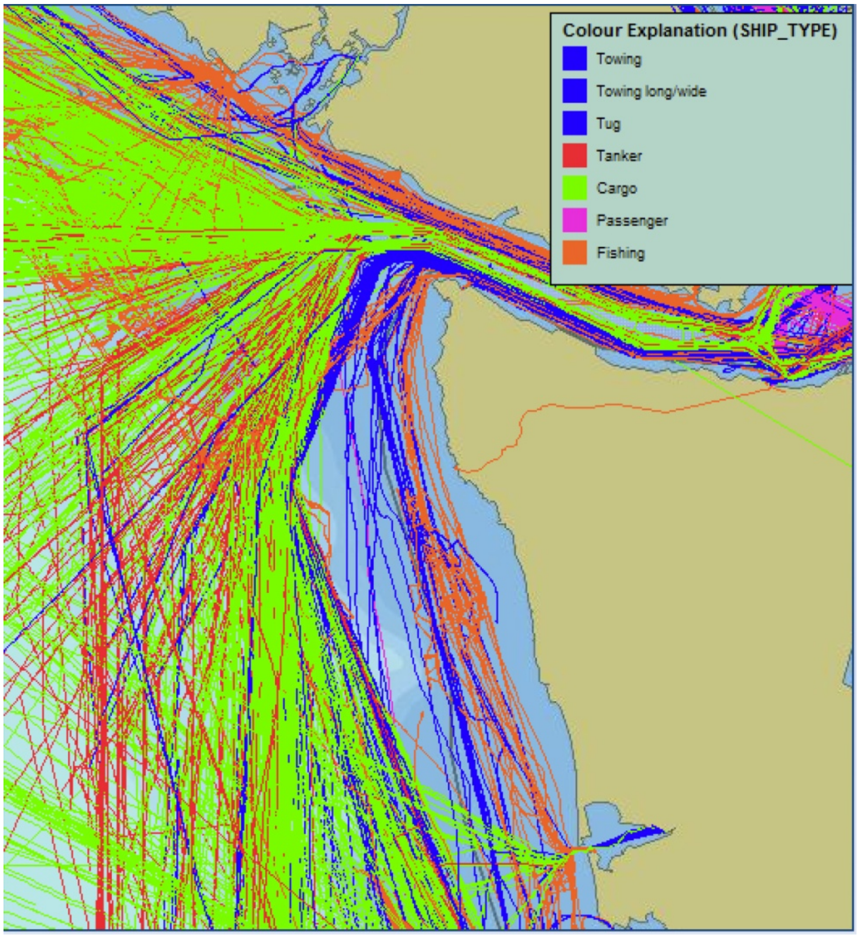
Vessel traffic with destinations in Puget Sound, Columbia River, and Grays Harbor[428] go through the waters of the outer coast, including through and around the Olympic Coast Marine Sanctuary Area to be Avoided and the Strait of Juan de Fuca (Figure 117).

Approximately 5,300 vessels enter and transit the Strait of Juan de Fuca yearly; 2,700 are destined for Washington ports in Puget Sound, and 2,600 destined for Canadian/BC ports. This includes over 800 tanker arrivals, 75% bound for U.S. refineries and 25% bound for Vancouver, BC.

BP Cherry Point Refinery in Puget Sound is receiving Bakken-crude-oil deliveries via Crowley Maritime ATB from the Columbia River. These ATBs move between Puget Sound and the Columbia River along the coast. BP has indicated that these transshipments would cease upon completion of the crude-by-rail facility onsite at the Cherry Point refinery complex. Communities on the Columbia River are supplied with fuel from tankers and barges loaded at Puget Sound and California refineries. These are not forecast to increase in significant amounts.

[428] From: *Changing Risk Picture in the Pacific Northwest,* presentation by Dept. of Ecology at BC Ministry of Environment Symposium, March 2013.

Figure 117: Vessel Traffic December 2012 – January 2013 Olympic Coast.



Appendix C: In Depth: Crude-by-Rail Emergency and Spill Response

Comprehensive Emergency Response Planning for Crude-by-Rail

Actions at the Federal Level

First responders are typically the first to arrive when a rail incident occurs and results in the release of oil, fire/explosion and or toxic fume emissions. First responders initiate immediate safety measures to protect the public. Local fire, law enforcement, rescue units and other local, county or state emergency management officials are responsible for carrying out local, county or state emergency response and evacuation plans.

The National Contingency Plan (NCP)[429] indicates that state or local officials may be responsible for conducting evacuations of affected populations. These first responders also may notify the National Response Center to elevate an incident for federal involvement, at which point the coordinating framework of the NCP would be applied.

At this time, the U.S. Department of Transportation (USDOT), Federal Rail Administration (FRA), and Pipeline and Hazardous Materials Safety Administration (PHMSA), which have jurisdiction over the regulation of railroads, do not have pending rulemaking or a regulatory proposal for comprehensive emergency response plans for the following: railcars of less than 42,000 gallon volumes, trains with block sections of railcars that may have volumes of one million gallons, or 100+ rail tank car unit trains which may be transporting a cumulative total of more than three million gallons of crude oil.

Current federal regulations require that railroads have either a “basic” response plan or a more “comprehensive” response plan, depending upon the volume capacity of the individual railcar transporting oil. Comprehensive plans are subject to FRA approval, and must ensure by contract or other approved means that personnel and equipment are able to handle a worst-case discharge. However, the regulatory threshold for the comprehensive response plan is an individual tank car holding more than 42,000 gallons. As the vast majority of the tank cars used today do not exceed 30,000 gallons of capacity, the comprehensive response plan requirement does not apply to almost the entire U.S. inventory of tank cars carrying oil. For tank cars carrying less than 42,000 gallons, railroads must prepare only “basic” response plans, which are not subject to FRA review, approval, or monitoring oversight. Thus, the recent growth of oil by rail transportation in the 30 tank car to 100+ tank car unit trains that can carry a cumulative volume of oil of from one to over three million gallons results in none of these trains being required to have a comprehensive response plan approved by any federal agency, or the state of Washington.

[429] 40 CFR Part 300 – National Oil and Hazardous Substances Pollution Contingency Plan

Comprehensive contingency planning regulations exist for the U.S. Coast Guard (USCG) for tank and non-tank vessels and marine transportation related facilities, the U.S. Environmental Protection Agency (EPA) for onshore non-marine transportation related facilities, the USDOT PHMSA for onshore and some offshore pipelines and the Department of the Interior's (DOI) Bureau of Safety and Environmental Enforcement (BSEE) requirements for Offshore Continental Shelf facilities and some offshore pipelines. Generally these federal agencies all require comprehensive emergency response plans that are the result of the Oil Pollution Act of 1990 (OPA90). USCG vessel requirements do not have an oil capacity minimum and EPA and DOT/PHMSA have substantial harm criteria that determines applicability of the comprehensive response plan requirements. While railroads must keep "basic" emergency response plans in their own files, the FRA does not monitor or review those plans. This means the plans are not available for first responders.

In the National Transportation Safety Board (NTSB) January 21, 2014, Letter/Safety Recommendation R-14-4 through-6 to PHMSA, NTSB stated:

> "In the preamble to the June 17, 1996, final rule, the Research and Special Programs Administration (RSPA) stated its belief that 42,000 gallons in a single packaging is an appropriate and reasonable liquid quantity for a finding that a release would cause substantial harm to the environment, and thus should be the threshold for comprehensive planning. However, RSPA noted that on the basis of available information, no rail carrier was transporting oil in a quantity greater than 42,000 gallons in tank cars. During 1996, when the rulemaking was being considered, there were only 67 tank cars listed in the AAR UMLER file with a capacity equal to or greater than 42,000 gallons. Only six of these cars were being used to transport oil or petroleum products.
>
> The NTSB finds that as written, the regulation circumvents the need for railroads to comply with spill response planning mandates of the federal Clean Water Act. Although the USDOT 42,000-gallon threshold for comprehensive response plan development is equivalent to an unrelated threshold contained in a spill prevention, control, and countermeasures rule administered by the EPA for non-transportation related oil storage facilities, the USDOT regulation is rendered ineffective because of its lack of applicability to any real-world transportation scenario. By limiting the comprehensive planning threshold for a single tank size that is greater than any currently in use, spill-planning regulations do not take into account the potential of a derailment of large numbers of 30,000-gallon tank cars, such as in Lac-Mégantic where 60 tank cars together released about 1.6 million gallons of crude oil."

According to an April 22, 2014 *Energy Wire* article:

> "In an April 10 letter responding to a Freedom of Information Act (FOIA) request from *Energy Wire,* FOIA officer Denise Kollehlon said the FRA's files "do not contain any records related to the active comprehensive 'oil spill prevention and response plans' for oil shipments."

Given the change in conditions and circumstances for oil shipments by rail since the FRA rule was adopted in the 1990s, there is now a gap in current federal regulations for trains having blocks of rail tank cars and 100+ unit trains.[430]

Former National Transportation Safety Board Chairwoman Deborah Hersman wrote in a January 2014 letter to FRA Administrator Joseph Szabo that without closely regulated response plans:

> "[Rail] carriers have effectively placed the burden of remediating the environmental consequences of an accident on local communities along their routes." Chairwoman Hersman reiterated her crude-by-rail concerns at a later date by stating crude-by-rail "can be a worst-case-scenario event, and we don't have provisions in place to deal with it, either on the industry side or for the first responders."

Actions in Other States

The state of New York in April 2014 issued *Transporting Crude Oil in New York State: A Review of Incident Prevention and Response Capacity*, a crude oil safety transportation report. The report was prepared jointly by the New York State Department of Environmental Conservation (NYSDEC), Health and Transportation, the New York State Division of Homeland Security, and the New York State Energy Research and Developing Authority.

The report sets out 11 proposed actions at the federal level, 11 actions that New York is undertaking and four recommendations to the shippers and the railroads which New York contends are necessary to ensure safe transportation of crude oil.

The NYS Department of Environmental Conservation (DEC), the EPA, and the USCG have partnered on several rail safety initiatives. These include reviewing and updating the NY/NJ Area Contingency Plan, working with the U.S. National Oceanic Atmospheric Administration (NOAA), prioritizing and developing Geographic Response Plans around NY, and increasing the coordination between the EPA and NYSDEC regarding spill prevention.

The June 2014 California report, *Oil By Rail Safety in California*, recommended improvement in the emergency preparedness and response program of the state, which included various actions such as the need to review and update local, state and federal response plans, improve emergency response capabilities, and increase emergency response training.

As of July 1, 2014, Minnesota implemented stricter oversight of railroad companies, requiring more railway inspections and providing for better emergency response training and preparedness in communities. Among these new requirements:

[430] On August 1, 2014, PHMSA released an ANPRM entitled, "Hazardous Materials: Oil Spill Response Plans for High-Hazard Flammable Trains", pertaining to 49 CFR Parts 130 and 174, comments are due 60 days from date of issuance.

- Prevention Plans Required – Requires railroad companies to submit disaster prevention plans to the state of Minnesota. This new law will require companies transporting hazardous materials to develop safety measures that help keep Minnesotans and the environment safe.
- Emergency Response Training – Requires railroads to provide emergency response training every three years to every fire department located along oil train routes. This training will help ensure Minnesota firefighters are prepared to respond to a disaster. This law also requires the Department of Public Safety to continue to provide training and response preparedness to emergency responders. This is paid for through an assessment on railroads and pipelines.
- Planning Emergency Responses – Requires railroads to file emergency response plans with the Minnesota Pollution Control Agency and to update these plans.
- Improving Response Capacity – Requires railroads to deploy enough equipment to clean up within a specified time period any spills or leaks that may occur. This means that those who cause accidents or disasters will be held responsible for cleaning them up.

Minnesota requires railroads to prepare oil spill plans without distinguishing whether the railroad is engaged in transport. Minnesota requires oil spill plans not only for railroad yards and fueling areas but also for trackage as well.

Spill Response Plans

A spill response plan is intended to help the transporter develop a response organization and ensure the availability of resources needed to respond to an oil release. According to 49 CFR 130.31, the plan also should demonstrate that the response resources will be available in a timely manner to reduce the severity and impact of a discharge. Federal regulations require all railroads that transport liquid petroleum oil to develop basic written response plans that describe the manner of response to discharges that may occur during transportation, take into account the maximum potential discharge, identify the private personnel and equipment available to respond to a discharge, and retain that plan on file at its principal place of business and at the dispatcher's office. A basic response plan is not reviewed or approved by any federal agency or the state of Washington.

When a discharge occurs into navigable waters of the U.S., the carrier is responsible for implementing the basic or comprehensive response plan.

Because trains typically travel many hundreds of miles, similar to tank vessels and pipelines, the response environments can present varied equipment needs, logistics, and containment strategies. Along a selected route, carriers would be better prepared to mitigate damage caused by releases of petroleum products if they identify and ensure by contract the personnel and equipment necessary to respond to petroleum product spills. Because there is no mandate for railroads to develop comprehensive plans or ensure the availability of necessary response resources, carriers have effectively placed the burden of remediating the environmental consequences of an accident on local communities along their routes. This is particularly true when a tank railcar incident occurs with a subsequent fire/explosion event coupled with potential evacuation due to the danger that may be present from fire and toxic fume emissions.

The NTSB recommended in their Safety Recommendation R-14-4 through-6 on January 21, 2014:

> "US Coast Guard regulations for marine tank vessels require spill response planning to address a worst-case discharge, which is defined as the entire cargo on the vessel. Planning to respond to maximum potential releases for trains transporting crude oil, many of which are configured in unit trains as "virtual pipelines" of tank cars, also must take into account the entire quantity of lading. Therefore, the NTSB recommends that PHMSA revise the spill response planning thresholds contained in 49 CFR Part 130 to require comprehensive response plans to effectively provide for the carriers' ability to respond to worst-case discharges resulting from accidents involving unit trains or blocks of tank cars transporting oil and petroleum products."

The NTSB in a letter/Safety Recommendation R-14-1 through-3 to the FRA Administrator on January 23, 2014 stated:

> "Although 49 CFR 130.31 requires comprehensive response plans to be submitted to the FRA, there is no provision for the FRA to review and approve plans, which calls into question why these plans are required to be submitted. The FRA would be better prepared to identify deficient response plans if it had a program to thoroughly review and approve each plan before carriers are permitted to transport petroleum oil products. In comparison to other DOT regulations for oil transportation in pipelines, an operator may not handle, store, or transport oil in a pipeline unless it has submitted a response plan for PHMSA approval. The NTSB strongly believes there must be an equivalent level of preparedness across all modes of transportation to respond to major disasters involving releases of flammable liquid petroleum products."

In Washington State, the oil spill contingency planning rule[431] requires contingency plans to be submitted by:

- Tank vessels and barges of any size.
- 300 gross-ton vessels engaged in commerce.
- Oil handling facilities that transfer product over the dock or by pipeline.
- Pipelines.
- Mobile facilities of which regulations require a less detailed response plan.

[431] Chapter 173-182 WAC.

Ecology has not extended regulations to rail tank cars.

This means there is currently both a federal and state gap in response planning by the responsible party for a potential major spill, fire and toxic emission release incidents.

Local, County, State Emergency Response Capability

Emergency response efforts commence at the local level upon notification to first responders. In the event of a spill or potential spill incident involving storage, transfer, or the transportation of hazardous materials, the first notification is generally to a local emergency dispatcher. Crude oil carried by rail tank car or tank vessel in the state of Washington travels through areas of dense population as well as through rural areas, small towns, and areas considered economically and environmentally sensitive.

Local emergency management is responsible for local risk assessments, response plans, and coordination of local incident response. This capability often resides with local fire departments as first responders. In the event of a crude oil accident, first responders secure the scene, provide medical care to victims, coordinate emergency evacuation if needed, and potentially extinguish fires that occur as a result. Dealing with these incidents can be delicate, as the low ignition point of Bakken crude oil makes it susceptible to additional fire/explosions involving the train or other equipment on the scene.

Bakken crude is considered a light, sweet, low-viscosity crude oil with quantities of light, volatile hydrocarbons and is highly flammable and easily ignited at normal temperatures by heat, static discharges, sparks or flames. Because of the presence of light volatiles in Bakken Crude, the potential for fire and explosion is the single largest risk to responder and public health. Also Bakken crude can have elevated levels of benzene, a known carcinogen that could impact responder and public safety if released into the environment. Accordingly, extreme caution needs to be exercised during the initial stages of response.

A 2011 National Fire Protection Association survey found that 77% of fire departments have at least some capabilities for hazmat emergency response. Those that do not are likely situated in rural areas. Many fire departments around the U.S. lack the specific training necessary to respond to these hazardous material incidents.

According to an Emergency Management Department (EMD) finding (see Appendix K), fire service agencies across Washington State report a lack of available fire suppressant foam trucks and trailers and support equipment e.g., high capacity/volume pump capability, air monitoring equipment (carbon monoxide, hydrogen sulfide, and benzene), oil spill response equipment and training to respond safely and effectively in the event of a crude oil derailment and fire. Most local emergency response organizations also do not have the resources to respond to a large fire resulting from a transportation incident, and spills that enter a waterway require resources generally provided by the responsible party/spiller and or by its response contractors.

EMD also conducted a survey of local fire departments and emergency managers concerning the current status of their jurisdiction regarding the transport through their area of trains carrying Bakken crude oil and the state of affairs of their response resources pursuant to personnel training and equipment (Appendix K). Although the survey responses were a small sample of the state's many fire service and emergency management organizations, it resulted in feedback from a good cross section of jurisdictional population density. The survey also resulted in feedback from jurisdictions having both paid and volunteer responders. All but one of the responses indicated that the rail line transits through or near populated areas and all but one stated that the rail line travels through or near natural resources.

The EMD survey showed that 59% of the respondents believe that their departments are not sufficiently trained or do not have the resources necessary to respond to a train derailment accompanied by a fire. A similar 62% do not have a HazMat plan that includes a derailment and fire event. Another 35% of the respondents stated they do not have an evacuation plan with 74% advising they have no knowledge of where a responsible party, e.g., railroad, has stockpiles of response resources. The survey results point out that 35% do not have a Type I Hazardous Response Team (HRT) either internally or access via a mutual aid agreement and 12% have no access to any type of HRT at all. It should also be noted that out of a total of 2,708, only 243 (9%) are Technician/Specialist Level, which is the training level permitted to perform offensive response.

Seattle's Fire Chief Alan Vickery stated:

> "No fire department in the state could immediately handle a Bakken oil train derailment and fire involving multiple cars. The primary objective is to evacuate the immediate area, protect exposures and let the fire burn itself out. This presents challenges in the urban environment."

Approximately 471 independent fire service departments and districts exist in the state of Washington. About 278 of these have rail in their jurisdictions, many of which are rural and rely on volunteers or are combination volunteer/career departments. Generally throughout the state, the EMD survey found that municipal fire departments report inadequate equipment and training and planning resources for the safe and effective response to potential crude oil derailments that are associated with fire. Public safety first responders and emergency managers are not adequately funded to obtain the addition equipment and training necessary to provide safe and effective responses. Additionally, depending on the severity of an incident, and the location of the incident, dependence on mutual aid between communities may be an important necessity as well as implementation of a large-scale, pre-developed evacuation plan.

On February 10, 2014, USDOT (PHMSA) hosted a meeting with emergency response and railroad industry stakeholders, FRA, Federal Motor Carrier Safety Administration (FMCSA), and Transport Canada to discuss preparedness to respond to incidents involving Bakken crude oil. The topics of discussion included:

- Current state of Bakken crude oil risk awareness.
- Current state of operational readiness/capability.
- Familiarity with bulk shippers emergency response plans/procedures.
- Available training resources (sources, accessibility, gaps in training).
- Needs of emergency responders/public safety agencies.

Some of the discussions resulted in some agreement amongst the participants such as:

- Public safety and other local officials need information and cooperation regarding hazardous materials trains traveling through their communities.
- Public safety and other local officials need to know routes of travel, frequency and other important information.
- The emergency response community has only recently been made aware of the significance of the bulk transportation of Bakken shale crude oil. There is not a full understanding of the chemistry and hazardous characteristics of this product; therefore, the readiness is insufficient.
- An examination of the likely and worst-case scenarios is needed in order to be properly prepared and trained for response.
- The ability to deliver effective training resources across the country is not practical (impossible to train 1.2 million responders), therefore, identifying those states/counties that have the highest volume/risk should be the priority.
- Most local fire and emergency response agencies do not have the resources, infrastructure, equipment or personnel to effectively respond to unit trains of 100+ tank cars carrying large volumes of flammable liquid.
- Most communities are not prepared for flammable liquid incidents. There is a need to make sure that routes can be mapped and to know what the capabilities are along those lines.

In April 2014, Elizabeth Harman, Assistant to the General President for Grants Administration & HazMat Training Division at the International Association of Fire Fighters, cited the sharp increase in the transportation of crude oil by rail, and the fact that most of the country's fire departments lack sufficient training to respond to hazardous materials incidents. "There are significant portions of the country where first responders are not prepared for an incident involving hazardous materials," said Harman, a certified fire service instructor. Harman told the House of Representatives Subcommittee on Railroads, Pipelines and Hazardous Materials that

65% of fire departments that respond to hazardous materials incidents have not trained all of their personnel for it. "This is an untenable situation that must be rectified," she said.[432]

The Washington State Council of Fire Fighters at its annual convention in Spokane in late June 2014 passed a resolution[433] attempting to ensure that local communities have enough resources to combat any oil explosions, spills and derailments. The lengthy resolution lays out concerns about the safety of the rail lines, the tanker cars, and the flammability of the crude oil, and the ability of local communities and firefighters to handle major crude oil accidents or explosions should they occur.

The EMD survey asked, "What three priorities would enhance firefighter safety?" Below are some representative responses:

- "A regional Hazmat team, locally located and capable to manage this type of incident."
- "Firefighting equipment such as foam equipped engines, firefighting appliances for establishing unmanned mate streams; a mutual aid response with the appropriate supplies (ample quantities of AFFF[434]); caches of foam suitable for the products being transported; Increased foam supplies and flammable liquid training; specialty tools needed to meet the requirements of spill or fire suppression."
- "Early intervention and support from the responsible rail company with hazmat, fire suppression and recovery equipment as well as expertise; Incident Command structure and personnel to handle large incident."
- "Rail provided resources for training and response planning on specific cargos such as crude oil; initial response training; continued training with rail companies; training for large incidents; training, equipment and advice from the railroad industry; guidelines and standard operating procedures (SOPs) need to developed and sit in place to manage a petroleum derailment; drills dealing with petroleum derailments; specific contact info, resource lists and tactics."
- "Dealing with the railroad in the initial stages of an incident can be difficult, so communication would be number one, with the ability to perform a large scale down wind monitoring program would be second."
- "Attempted to contact railroad for information on the railroad response to an incident, what equipment the railroad can provide for preplanning and training. Railroad-offered classes have only been on railroad crossings and safety when working around railcars."
- "Currently there is a bit of dispute over the hazard classification being applied to the oil shipped from Bakken. Fire service needs to know if current information is still valid. The

[432] http://www.mcclatchydc.com/2014/04/02/223274/firefighter-training-for-crude.html
[433] 2014 WSCFF Convention Resolution No. 14-33. http://www.envisioncc.org/WSCFF.pdf
[434] Aqueous film-forming foam.

industry and government need to quickly modify the information/materials so that accurate information is used in the planning process."

- "A series of recommendations for handling the emergencies and even a contact number for information sharing on appropriate response, training material and instructors, and the occasional class other than in major cities."
- "This is an issue of a lack of sufficient equipment, sufficient personnel and sufficient support for training and exercise events to address this type of incident."

The state of Washington has a number of plans that require review and updating pursuant to the transportation of diluted bitumen and Bakken crude.

The Washington State *Enhanced Hazard Mitigation Plan* (EHMP) is dated 2013. The EHMP assesses natural and technological (man-made) hazards in Washington State. Assessment is the initial step in the emergency management process that leads to mitigation against, preparedness for, response to, and recovery from hazards. Hazards have the potential of becoming disasters or emergencies that can adversely affect the people, environment, economy, and property of the state. Hazard assessment helps emergency managers rate the risk, determine vulnerability, and predict the adverse impact of disasters and emergencies. Emergency managers with good hazard assessments can effectively organize resources and develop comprehensive emergency management plans to minimize the impact of disasters and emergencies. The EHMP is currently under revision to include marine and rail transportation of diluted bitumen and Bakken crude oil.

There is a need to provide first responders with additional planning, training and response resources to respond to a train derailment with an associated spill, fire/explosion and toxic fume emissions. The amount of crude oil being transported exceeds emergency response capabilities. First responder planning, training and acquisition of response resources appear insufficient to meet current and future needs to ensure first responder and emergency managers have the ability to become proficient in and able to maintain proficiency in preparedness to respond to a crude oil transportation spill event with the potential of fire/explosion, toxic fume emission and evacuation. These response requirements need specialized resources when responding to incidents, foam suppressant materials and equipment, the ability to address potential human health concerns related to hazardous material exposures, etc.

Geographic Response Plans (GRPs)

GRPs are spill response strategies to guide the initial response to a spill of oil on water. They are created to reduce the time needed to make decisions during the initial response. A GRP provides the responders with essential information about the site, the equipment needed to carry out an effective response, access details, resources at risk from the spill and other information. The goal of a GRP is to ensure that the response to a spill is fast and effective, and that sensitive resources are protected and damages are reduced.

GRPs are developed through workshops and field work involving federal, state, and local oil spill emergency response experts, resource trustees, representatives from tribes, local governments, industry, ports, environmental organizations, pilots, communities and response contractors. Workshop participants identify resources, develop response strategies, and help prioritize the strategies based on potential oil spill origin points. It is important to involve local governments and local communities in the GRP development process.

Existing and potential new sites are visited in the field to gather data about the location. Many factors recorded during field work must be considered when developing response strategies, including: tides and tidal currents river speed and conditions, shoreline and resource sensitivity to oil, cultural resources, seasonal weather changes, equipment availability, site access, and more. Modifications are made as needed, and further details can be added to hone the strategy. The state of Washington relies on spills and drill exercises to provide efficacy test of the final strategies.

GRP protection strategies will be refined and enhanced as needed once a coordinated response has been established. Additional sensitive areas will be identified and additional response strategies beyond those listed in the GRP will be developed, based on incident specific assessments and input from resource trustees and persons with local knowledge.

Historically, the NWAC[435] and the RRT 10[436] have focused on marine GRPs along the major waterways since they represent areas where marine traffic posed a high spill risk. However, with greater risk inland due to tank barge transportation on inland rivers, and rail tank cars carrying crude from inland origins to coastal terminals and refineries, inland area GRPs need to be developed. It is worthwhile to note that:

- BNSF has developed its own set of response strategies for portions of the Columbia River. These have been identified as a gap because the plans should be incorporated into the published GRP in order to be available to all responders.
- Once developed, GRPs must be maintained and kept current or risk becoming an ineffective tool. This means modifying individual strategies after lessons learned at drills/spills, and fully reviewing and updating the entire plan at regular intervals, ideally once every five years. With current resources this schedule has not been achievable.
- GRPs develop strategies for floating oils which does not address submerged or sinking oils (Group V oils). Some portions of diluted bitumen and other heavy oils, may submerge beneath the water's surface. Group V oils are listed as products transported in the contingency plans of several Washington vessel operators and refineries but no site specific response strategies for sinking oils have been developed.

[435] Northwest Area Committee
[436] Regional Response Team

- GRPs are part of the Northwest Area Contingency Plan (NWACP). All regulated plan holders are required to have response plans that are consistent with the NWACP. Regulated plan holders include owners and/or operators of pipelines, marine vessels, and facilities. Rail owner/operators transporting petroleum, are not required to have comprehensive response plans that are consistent with the National Contingency Plan (NCP) or the Area Contingency Plan (ACP) (49 CFR 130.31 (b)) for rail tank cars of less than 42,000 gallons. Nearly all the rail operators in Washington State are only required to have a Basic Plan in compliance with 49 CFR 130.31 (a) which does not require consistency with the NCP & ACP and thus do not include nor require any GRPs. In the absence of a published GRP, some of the regulated plan holders (primarily the pipeline companies) have developed strategies which are published only as volumes of their contingency plan (these are usually labeled as "control points"). These are considered a gap because they have not been developed with input from the greater response community, have not been screened to avoid impacts to cultural resources, and are not prioritized.

On June 17, 2014, the NWAC Oil by Rail Task Force completed its *Geographic Response Plan Gap Analysis Report* which evaluated the current status of GRPs and provided a list of locations where gaps exist in GRP development along rail corridors. It must be noted that the NWAC report list is not entirely exhaustive; other gaps exist in GRP development that lie outside of rail corridors, but this was beyond the scope of the NWAC Working Group task.

The NWAC report lists specific areas that are seen as GRP gaps in the state and the NWAC report should be referenced to see the specific areas considered to be a GRP gap. These gaps are divided into four types:

- Outdated: These are areas along railroad corridors where published GRPs exist, but are out of date and need substantial review and revision (Figure 118).
- Technology: Areas where published GRPs exist, but have strategies that were not developed using the geospatial planning tools that we use today, or lacked important input from trustee agencies to determine where the spill risk exists, or were not screened to help avoid impact to known cultural resources (confidential data that only trustee agencies have), or have other gaps in their development (Figure 119).
- Unpublished: New areas where a rail or pipeline company created company specific spill strategies that need to be incorporated into GRPs so they will be published and accessible to contractors to test and update ("control points"). These control points may have other gaps as well: were not developed using the geospatial planning tools that we use today, or lacked important input from trustee agencies to determine where the spill risk exists, or were not screened to help us avoid impact to known cultural resources (confidential data that only trustee agencies have), or have other gaps in their development (Figure 120).
- Additional Strategies Needed: New areas where GRPs have never been developed or where additional strategies are needed to protect water bodies along railroad corridors (Figure 121).

Figure 118: NW Area GRP Gaps (Outdated Plans). Image source: NWAC Oil by Rail Task Force.

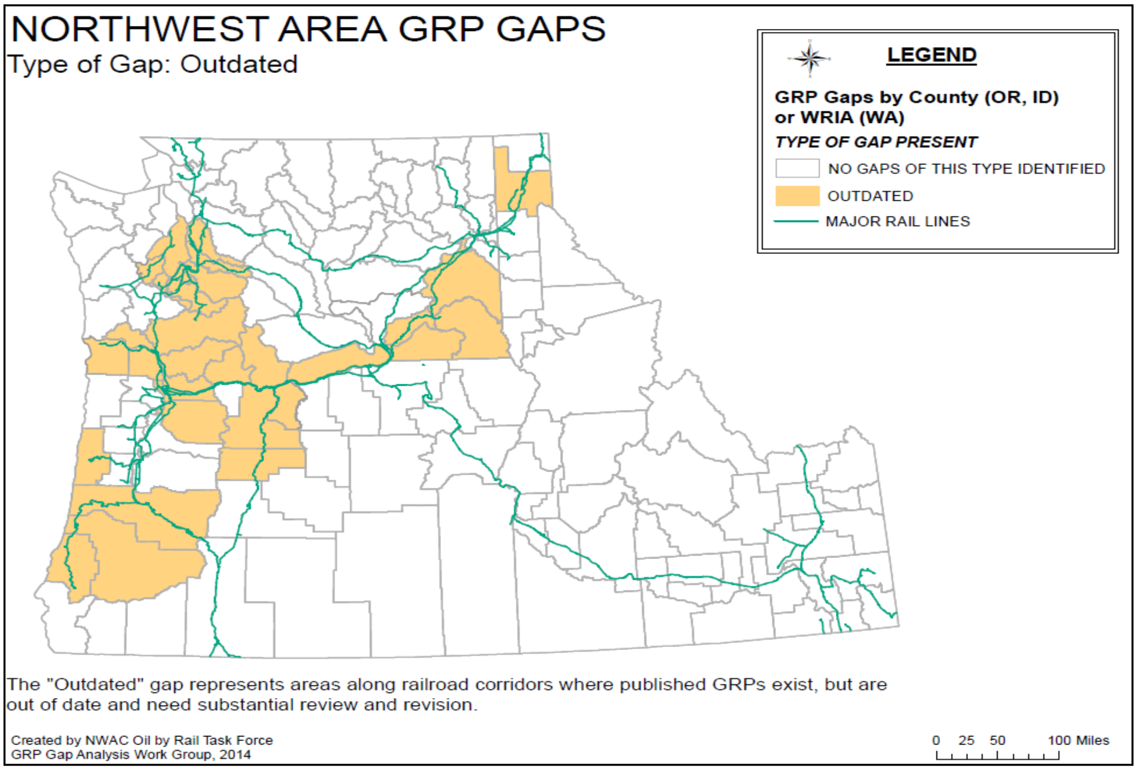


Figure 119: NW Area GRP Gaps (Technology Gaps). Image source: NWAC Oil by Rail Task Force.

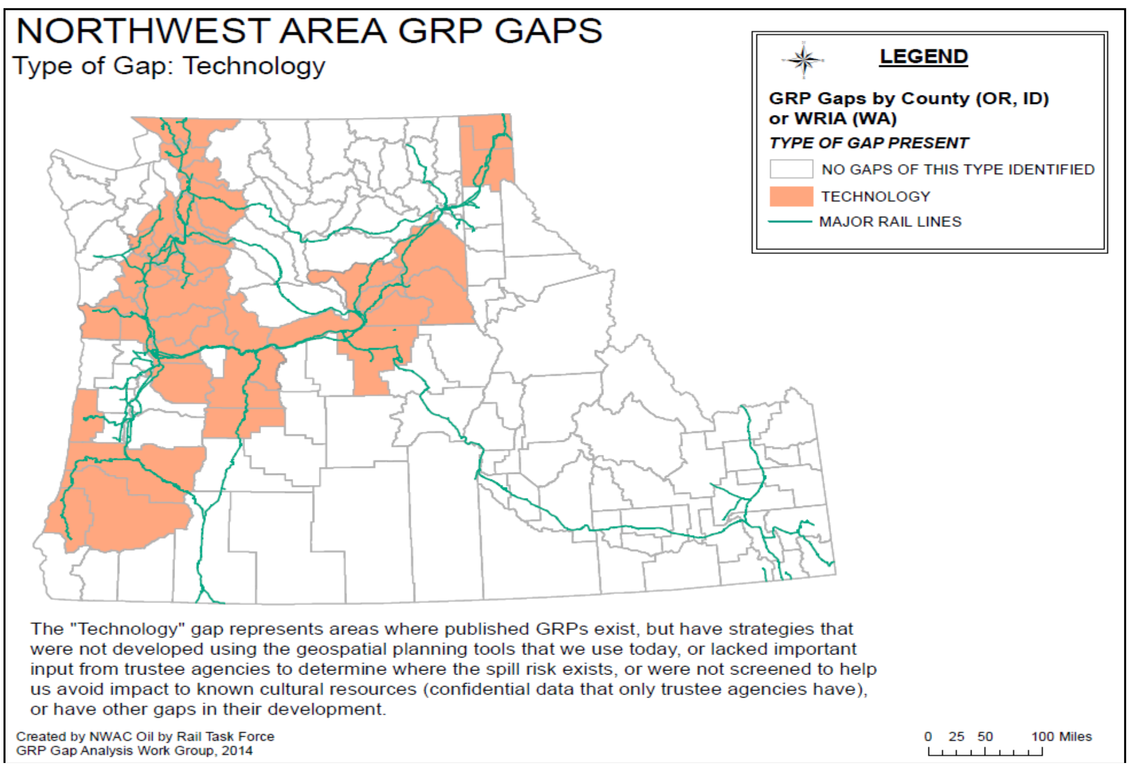


Figure 120: NW Area GRP Gaps (Unpublished). Image source: NWAC Oil by Rail Task Force.

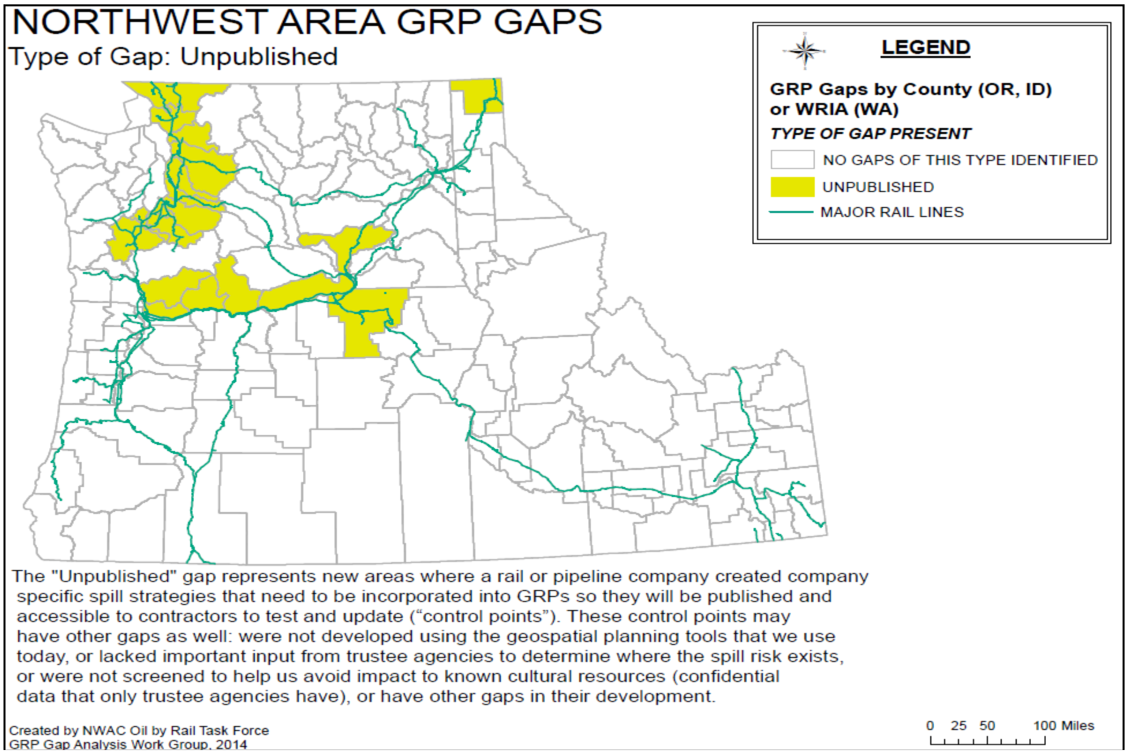


Figure 121: NW Area GRP Gaps (Additional Strategies Needed). Image source: NWAC Oil by Rail Task Force.

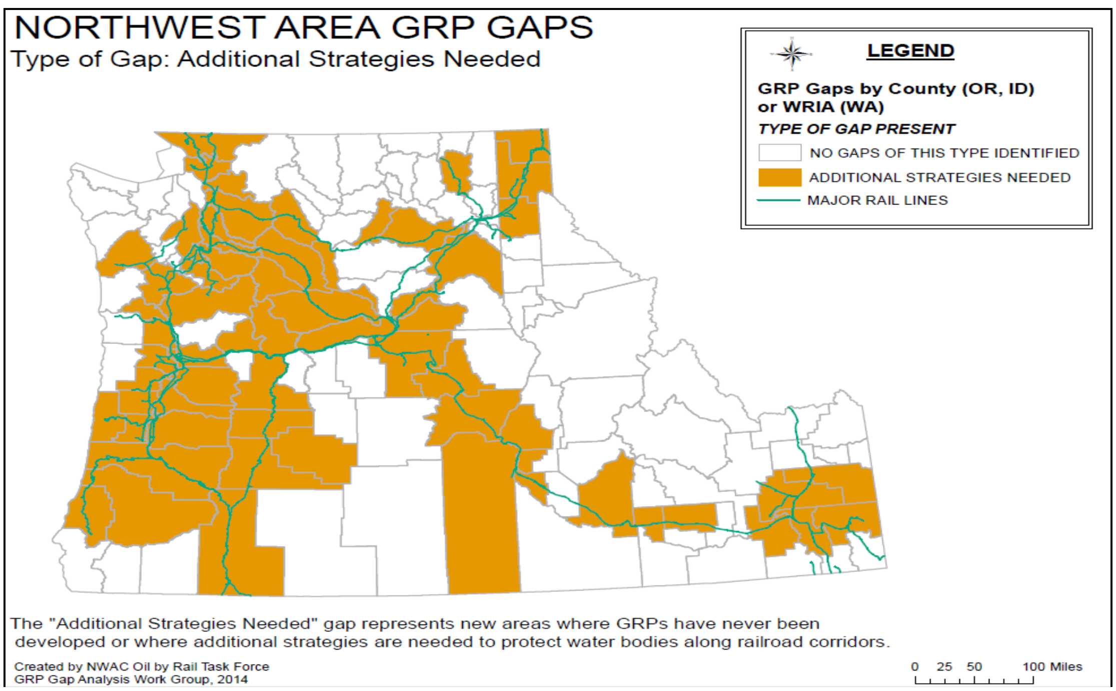
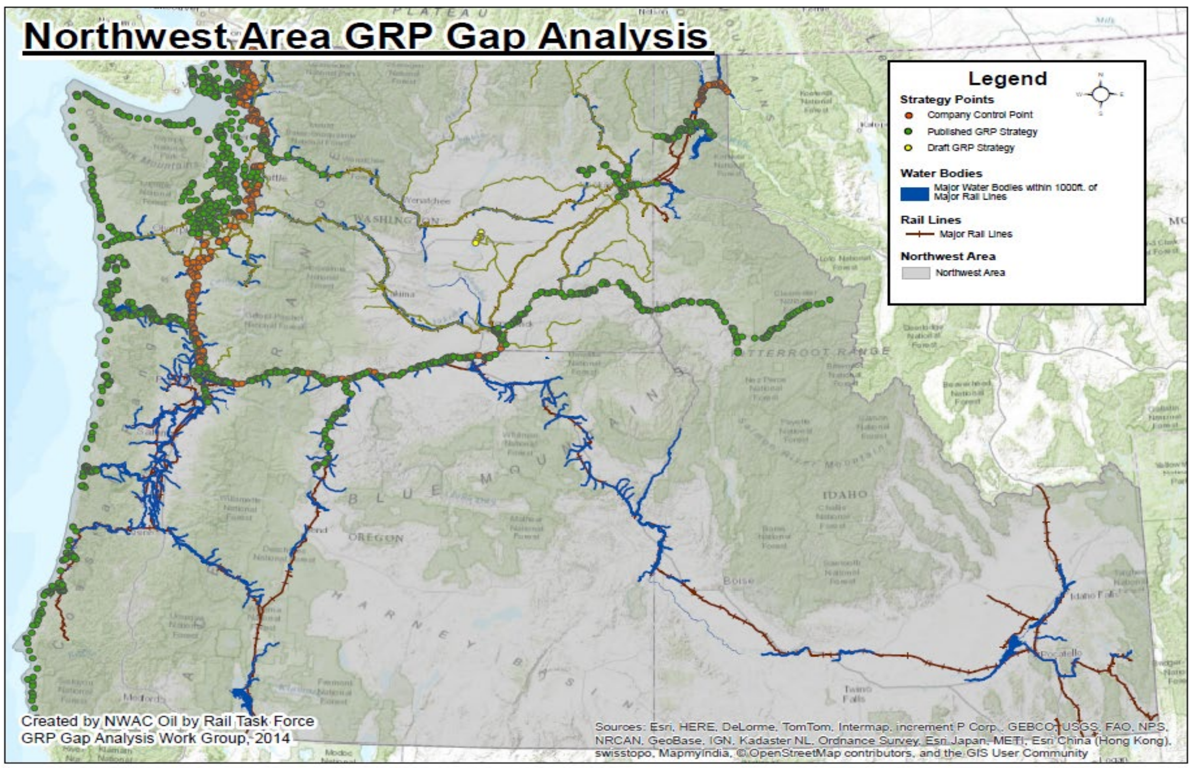


Figure 122 shows the oil spill response strategies that exist in the Northwest Area, including published GRP strategies, draft GRP strategies, and company control points, as well as water bodies that are within 1,000 feet of major rail corridors that could potentially carry oil. It is intended to show the location of response strategies in relation to water bodies potentially at risk from a spill, and highlight the areas that may be at risk and are clearly lacking response strategies.

Figure 122: Northwest Area GRP Gap Analysis Strategy Points, Rail Lines, and Strategies. Image source: NWAC Oil by Rail Task Force.



The majority of the published marine GRPs are also considered gaps because the resources needed to maintain and update these existing plans are insufficient. Many marine plans are out of date with lessons learned from drills/spills. Many chapters were not developed using geospatial planning technology and it is not certain that published response strategy locations have been screened to avoid impacts to known cultural resources.

It should be noted that the Legislature considered the GRP gaps to be critical and provided funding for Ecology to begin developing GRPs in the inland areas immediately. Priorities for GRP updates and development for 2014–2015 are shown in Table 49.

Table 49: GRP Update and Development Priorities 2014 – 2015

Geographic Response Plan Name:	Status	WRIA(s)	County(s)	Description
Lower Columbia River GRP	Update	24-Willapa; 25-Grays/ Elochoman; 26-Cowlitz; 27-Lewis; 28-Salmon/ Washougal	Pacific; Wahkiaku; Cowlitz; Clark; Skamania	The Lower Columbia River GRP extends from the mouth of the river where it drains into the Pacific Ocean to the Bonneville Dam. The current GRP has 160 strategies; 93 are in Oregon, and 67 are in Washington. This section of the Columbia River is at risk from marine tank, cargo, and vessel traffic; oil by pipeline; oil transfer terminals; as well as oil by rail. It is also used heavily for recreational boating.
Middle Columbia River GRP	Update	29-Wind/ White Salmon; 30-Klickitat; 31-Rock/Glade; 32-Walla Walla; 33-Lower Snake; 36-Esquatzel Coulee; 37-Lower Yakima; 40-Alkali/ Squilchuck	Skamania; Klickitat; Benton; Walla Walla; Franklin	The Middle Columbia River GRP covers a 195 mile reach of the river from the Bonneville Dam at approximately river mile 145 on the west, to river mile 340 on the east (located on the outskirts of the Tri-Cities metropolitan area), as well as a 2.8 mile section of the Snake River up to the Ice Harbor Dam. Several oil pollution threats are present within the middle Columbia, including: tank vessels and barges, rail lines, and a pipeline that crosses the Snake River near it's confluence with the Columbia River in Pasco.
Duwamish/ Green River GRP	New Area	9-Duwamish/ Green	King	The Green River sources in the Cascades, flows through the Green River Gorge and Valley into Auburn. It empties into the Duwamish River, which flows north through Seattle into Elliott Bay. The Green River/Duwamish GRP will cover the area between the Howard Hanson Dam and North Wind's Weir in Tukwila, at Cecil Moses Memorial Park. A petroleum pipeline and rail lines carrying crude oil cross the Duwamish, and a rail line parallels five miles of the Green River.
Lake Chelan GRP	New Area	47-Chelan	Chelan	Lake Chelan is a 50-mile long natural lake near the Wenatchee-Okanogan Natural Forests on the east side of the Cascades. Well-known for tourism and recreation, it is also home to a Superfund site: the decommissioned Holden copper mine. The GRP will include strategies to address the spill risks associated with cleanup of the Superfund site.
Lake Washington GRP	New Area	8-Cedar/ Sammamish	King	The Lake Washington GRP encompasses an area of approximately 34 square miles and is bordered by the cities of Seattle to the west, Bellevue and Kirkland to the east, Kenmore to the north and Renton to the south. Oil spill risks in the area include oil pipelines, vessel/boat traffic, road/bridge vehicle traffic, and aircraft transportation (including seaplanes).
Moses Lake/ Crab Creek GRP	New Area	42-Grand Coulee; 43-Upper Crab/Wilson; 41-Lower Crab	Grant; Lincoln	The plan covers all of Moses Lake and upstream waters of Crab Creek from the Stratford Road Bridge in Moses Lake to its crossing with Highway 2 near Reardan, WA. The plan is bordered by the Spokane River GRP to the north and northeast. Oil spill risks in the area include oil pipelines, railways, road/bridge vehicle traffic.

Geographic Response Plan Name:	Status	WRIA(s)	County(s)	Description
Nisqually River GRP	Update	11-Nisqually	Pierce; Thurston	The Nisqually River is located at the south end of Puget Sound in Thurston and Pierce Counties. The portion to be covered by the Nisqually River GRP extends from the LaGrande Dam to the lower end of the river at Nisqually National Wildlife Refuge. The river is crossed by a major petroleum pipeline, and it is intersected by rail lines potentially carrying oil in several locations. The current version of the GRP was developed before the Nisqually estuary restoration. The GRP update will consider those changes. The Nisqually River is also tidally influenced and could be at risk from oil spills from vessels or facilities in Puget Sound.
Clark/ Cowlitz GRP	Update	26-Cowlitz; 27-Lewis; 28-Salmon/ Washougal	Lewis; Clark; Cowlitz	The plan covers portions of Clark, Cowlitz, and Lewis counties from Vancouver north to Winlock. It includes sections of the Cowlitz, Coweeman, Kalama, Lewis, and Toutle rivers and many of the smaller streams and creeks that drain into them. The plan is bordered by the Lower Columbia River GRP to the south and west. Oil spill risks in the area include oil pipelines, railways, vessel/boat traffic, and road/bridge vehicle traffic.
Chehalis River GRP	New Area	23- Upper Chehalis; 22-Lower Chehalis	Grays Harbor; Thurston; Lewis	The Chehalis River runs through Lewis, Thurston and Grays Harbor counties and empties into Grays Harbor at Aberdeen. The Chehalis GRP will include waters upstream of the eastern boundary of the Grays Harbor GRP near Cosmopolis and cover 95 miles of the river as it winds east/southeast to Centralia and Chehalis, ending approximately 7 miles west of the Chehalis River South Fork. The Chehalis River is paralleled by rail lines carrying biodiesel, methanol and potentially crude oil to coastal refineries. The rail lines also cross Chehalis tributaries, including the Wynoochee, Satsop, Black and Skookumchuck rivers. Tidal influences near the mouth of the Chehalis River might push a spill in the harbor upriver into vulnerable sloughs and wetlands.

Response Resources for Crude-by-Rail and Marine Spills

Current Regulations

The Oil Pollution Act of 1990 (OPA90) required the development of Vessel Response Plans (VRP)[437] and Facility Response Plans (FRP)[438] to minimize the impact of oil spills, and NCP and Area Contingency Plans contain various requirements that individual plan holders must use in developing their plans and or actions to implement during a response. Comprehensive contingency planning regulations exist from the USCG for tank vessels,[439] non-tank vessels,[440] and marine transportation-related facilities,[441] from the EPA for onshore non-marine transportation related facilities,[442] from PHMSA for onshore and some offshore pipelines,[443] and from the DOI Bureau of Safety and Environmental Enforcement (BSEE) for Offshore Continental Shelf (OCS) facilities (including offshore oil wells and platforms) and some offshore pipelines.[444]

Washington State's oil spill contingency regulations are covered in WAC 173-182 Oil Spill Contingency Plan. The contingency planning rule has planning standards that require equipment to be strategically staged geographically so it can be cascaded throughout the state as needed.

Generally, all the federal agencies each require comprehensive emergency response plans that are the result of the OPA90 with state agencies implementing regulations at least as stringent as the federal requirements. USCG vessel requirements do not have an oil capacity minimum and EPA and DOT/PHMSA have substantial harm criteria[445] that determines applicability of the comprehensive response plan requirements. Washington State Department of Ecology has existing laws and rules which require contingency plans for over 300 GT vessels in commerce, tank vessels of any size, oil handling facilities and pipelines, but does not enforce regulations on rail hazardous materials transportation concerning spills from rail tank cars. While railroads must keep "basic" emergency response plans in their own files, the FRA does not monitor or review those plans.

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[437] A document that demonstrates a vessel's preparedness to respond to a worst case oil discharge.
[438] A document that demonstrates a facility's preparedness to respond to a worst case oil discharge; under the Clean Water Act, as amended by the Oil Pollution Act of 1990 (OPA90), certain facilities that store and use oil are required to prepare and submit these plans.
[439] 33 CFR Part 155.
[440] 33 CFR Part 155.
[441] 33 CFR Part 154.
[442] 40 CFR Part 112
[443] 49 CFR Part 194.
[444] 30 CFR Part 254.
[445] A facility may pose "substantial harm" according to the Facility Response Plan (FRP) rule if it: has a total oil storage capacity greater than or equal to 42,000 gallons and it transfers oil over water to/from vessels; or has a total oil storage capacity greater than or equal to one million gallons and meets one of the following conditions: does not have sufficient secondary containment for each aboveground storage area; is located at a distance such that a discharge from the facility could cause "injury" to fish, wildlife, and sensitive environments; is located at a distance such that a discharge from the facility would shut down a public drinking water intake; or fas had, within the past five years, a reportable discharge greater than or equal to 10,000 gallons. Section 112.20 of the Oil Pollution Prevention regulation (40 CFR 112) provides detailed information on these criteria.

Crude-by-Rail Impacts to Oil Spill Response Preparedness & Response

There are changes associated with the volume/frequency changes that need to be addressed and these may necessitate changes in response resource availability. Changes in Washington State that require a reevaluation of response resources include:

- Increased transportation of more volatile Bakken crude oil, which presents potential fire and explosion hazards.
- Changes in the transportation of heavier diluted bitumen or heated bitumen, which creates the potential for submerged and sinking oil scenarios under certain circumstances.
- Changes in transportation mode with increasingly more crude oil being transported by rail tank car, which means greater potential for inland spills.
- Changing patterns in the types of oils being transported in marine waters.
- Potential increases in vessel traffic and facilities in Grays Harbor that may increase the likelihood and nature of spills in this area.

Changing oil characteristics, changing transportation modes, and routes necessitate the re-evaluation of the sufficiency of oil spill response resources concerning response planning standards, response resource availability and response tactics. As stated in the NW Area Committee Emerging Risks Task Force Report:

> "Where the Northwest Area Contingency Plan (NWACP) has traditionally focused on response to spills of oil to marine waters, recent changes and future trends in modes of crude oil transportation in the NW Area reflect a geographic shift to inland areas with a focus on rail transportation. This will result in a change in response strategy and response resource utilization and may warrant a review of the distribution of response resources. Federal On-Scene Coordinators will need to re-focus Preparedness and Response resources from traditional marine-based scenarios to a broader range of scenarios and work with Plan-holders to ensure that transfer of custody issues - and associated response expectations - are clearly articulated within Contingency Plans."

Responsible Party and Financial Responsibility: Rail

Stakeholders in Rail Transportation of Crude Oil

The array of stakeholders in crude-by-rail transport includes:

- Tank Car Owner: The car owner, who often leases the cars to the shipper for use, is responsible for keeping the tank car in compliance with the Hazardous Materials Regulations (inspections/repairs, etc.).
- Shipper: The shipper is the party that certifies and offers the hazardous material package for transportation. The hazardous material must be properly classified and packaged by the shipper. The shipper will then submit shipping instructions and hazardous material

information to the transporter (carrier). The shippers are also required to provide and maintain emergency response information.

- Consignee: The consignee is the company receiving the shipment at the destination.
- Transporter (carrier): The transporter is required by federal law to transport from origin to destination hazardous materials that meet the USDOT requirements and as certified by the "shipper." Carriers are responsible for materials that are in transport on their system. Carriers usually operate on their own lines but often have trackage agreements in areas where they don't own the lines.
- Commodity Owner: In Washington State, the owner of the oil has responsibility to respond to incidents. The owner of the oil may be the shipper, consignee or a beneficial owner. The shipper would be contacted through the submitted emergency response contact listed on the shipping papers. It would be the shipper's responsibility to contact the owner of the oil. If using Chemtrec or another service provider the papers must identify the person (by name or contract number) who has a contractual agreement with the service provider.[446]
- Trackage Agreement: There are a variety of agreements that allow carriers to operate on lines owned by other companies. Regardless of whose trains are operating on the line, the track owner is responsible for the Emergency Response phase of the incident. Once the emergency is over, cleanup or other monitoring work may be transferred to the transporter. Where trackage rights do not exist the shipment continues to destination after transferring the material at an "Interchange Point." At this "Interchange Point" the responsibility shifts to the new line owner.

Issue of Liability and Responsibility Under Federal Framework

Tank cars are mostly owned by shippers and leasing corporations, not railroads. By law, the operator of any railroad in the U.S. cannot refuse to transport any cargo, no matter how hazardous, provided it conforms to applicable regulations.

Marine carriers can limit their liability as a condition of carriage. But uniquely in the case of rail, the railroad operator cannot insist on an agreement sharing the risk with the shipper. The railroad operator is liable for all costs in the event of an accident up to an unlimited amount.

In a September 8, 2013 article in *Business Insurance*,[447] Douglas McLeod wrote:

> "And while Class I railroads have longstanding experience with handling hazardous materials, smaller regional and short line railroads face more challenges, observers say. Until recently, for example, smaller railroads didn't usually handle heavy "unit trains" made up entirely of cars carrying one commodity, such as oil, that require much closer management, said Bill Anderson, president of Rail Services Inc., a railroad safety and claims consultant in Boise, Idaho.

[446] 49 CFR 172.201 (d).
[447] http://www.businessinsurance.com/article/20130908/NEWS05/309089995

> Track and other infrastructure on smaller railroads also may not be up to the maintenance standards of Class I carriers, said James R. Beardsley, managing director and global rail practice leader with Marsh Inc. in Washington. On the positive side, he added, trains on these tracks move more slowly, cutting the risk of a large-scale derailment.
>
> And for many smaller railroads, risk management practices haven't improved despite increases in self-insured retentions in recent years, meaning even basic steps such as securing engine cabs against trespassers are not always followed."

Smaller, local railroads carry relatively small liability limits: MMA (Montreal Maine & Atlantic) had only $25 million in liability coverage with XL Insurance Co. Ltd. in the Lac-Mégantic incident. For a railroad carrying high-risk cargo, "$25 million probably is not even prudent, much less adequate," according to Bill Anderson.

In contrast, the eight U.S. and Canadian Class I railroads generally carry more than $1 billion in liability coverage, he and other rail experts said. Class I railroads buy available market limits up to $1.5 billion excess of retentions of $25 million to $50 million or more.

Class II regional railroads[448] typically buy $25 million to $50 million in limits, with some buying up to $100 million, while short line s may buy as little as $5 million to $10 million, according to Dave Adamczyk, vice president in the railroad department of Liberty International Underwriters in Hunt Valley, Maryland.

The Lac-Mégantic, Quebec derailment occurred with Montreal Maine and Atlantic, a short line railroad transporting the crude from a Canadian Pacific (CP) yard to a refinery in New Brunswick, had $25 million in insurance. Montreal Maine and Atlantic promptly declared bankruptcy. Since then, the Canadian federal government and the province of Quebec have been covering most of the cost for the cleanup, and is in the process of suing Irving Oil, the company to which the crude was being shipped. Estimated costs are projected to be more than $400 million.

An article by Allan Woods Quebec Bureau, Published on Mon Jun 16, 2014 article states:[449]

> "The provincial government said it has already spent $126 million nearly one year after the July 6 derailment and explosions that killed 47 people and wiped out a large part of the city's downtown. It expects to spend at least another $283 million to complete the work, which includes clearing the wrecked buildings and decontaminating the soil, which was soaked with millions of liters of combustible crude oil."

[448] A railroad that hauls freight and is mid-sized in terms of operating revenue (as of 2011, a railroad with revenues greater than $37.4 million but less than $433.2 million for at least three consecutive years); switching and terminal railroads are excluded from Class II status. Railroads considered by the Association of American Railroads as "Regional Railroads" are typically Class II.

[449] http://www.thestar.com/news/canada/2014/06/16/quebec_claims_400_million_for_lacmgantic_train_disaster.html

For the most part energy companies that ship oil largely do not bear liability for an incident once their product is loaded onto a train. Under "common carrier" regulations, railroads cannot refuse a shipment of any kind of material assuming it meets proper regulations. In the Lac-Mégantic incident, a number of other companies such as Irving Oil, which was to refine the oil being carried on the train, as well as the firms that produced the crude oil and that leased the railcars, are also being sued in order to recoup enough money to cover the expenses and compensation costs incurred by the disaster.

In January 2014, the *Wall Street Journal*[450] published an article on how the railroads are insured, and whether they may be able to cover the costs of a catastrophic incident. In the *Wall Street Journal* article, Matthew K. Rose, executive chairman of BNSF Railway Corp., stated he would like to see a liability setup similar to a no-fault system the nuclear-power industry has. Under the U.S. 1957 Price-Anderson Act,[451] power companies contribute to an insurance fund, now totaling billions of dollars, to compensate the public and partly indemnify the industry in case of a nuclear accident.

According to the American Association of Railroads (AAR), insurance does not provide a viable means to fully mitigate this risk.

A BNSF July 22, 2008 presentation titled, *Ex Parte No. 677 (Sub-No.1) Common Carrier Obligation of Railroads- Transportation of Hazardous Materials,* stated:[452]

- The risks associated with these commodities we are required to assume as common carriers are unquantifiable and uncontrollable.
- The potential for an accident cannot be fully eliminated.
- Insurance is not commercially available to sufficiently protect us against catastrophic loss.
- There are limits on the availability of insurance, at ever-increasing cost.
- Our insurance costs increased substantially after 9/11.

The BNSF July 22, 2008 presentation also offered that BNSF's self-insured retention amounts to $25 million, and with its liability insurance, its total insurance came to $1 billion. Additionally:

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[450] http://online.wsj.com/articles/SB10001424052702304773104579268871635384130

[451] The Price-Anderson Act was enacted into law in 1957 and has been revised several times. It constitutes Section 170 of the Atomic Energy Act The latest revision was enacted through the "Energy Policy Act of 2005," and extended it through December 31, 2025. The main purpose of the Price-Anderson Act is to ensure the availability of a large pool of funds (currently about $10 billion) to provide prompt and orderly compensation of members of the public who incur damages from a nuclear or radiological incident no matter who might be liable. The Act provides "omnibus" coverage, that is, the same protection available for a covered licensee or contractor extends through indemnification to any persons who may be legally liable, regardless of their identity or relationship to the licensed activity. Because the Act channels the obligation to pay compensation for damages, a claimant need not sue several parties but can bring its claim to the licensee or contractor.

[452] Note: This presentation was discussing Hazardous Materials in general, not specifically crude oil.

- The market for railroad liability insurance has contracted substantially over the past several years.
- Five years ago, rails were able to purchase in excess of $1.5 billion in coverage. Today, available coverage is about $1.0 billion.
- Number of insurance companies willing to write freight railroad insurance has decreased, while the price charged for remaining coverage has increased dramatically.
- Required self-retention levels have also increased.

Oil Spill Liability Trust Fund

The Oil Spill Liability Trust Fund (OSLTF or Fund) is a billion-dollar fund established as a funding source to pay for removal costs and damages resulting from oil spills or substantial threats of oil spills to navigable waters of the U.S. The OSLTF is used for costs not directly paid by the polluter, referred to as the responsible party (RP).

The limitations to accessing the OSLTF are:

- The discharge (or substantial threat of discharge) must be into or on the navigable waters of the U.S. or adjoining shorelines or the Exclusive Economic Zone (EEZ).[453]
- In general, the maximum amount available from the OSLTF per incident is $1 billion or the balance in the OSLTF, whichever is less.
- Funding for federal removal (including response to a substantial threat) and natural resource damage pre-assessment activities is limited to the funds available in the OSLTF Emergency Fund, which receives an apportionment of $50 million on October 1st of each fiscal year (another $100 million can also be advanced from the OSLTF Principal Fund if necessary).
- Natural resource damage claims are limited to a maximum of $500 million per incident.

In a January 2011 memorandum,[454] the Internal Revenue Service (IRS) determined that to generate revenues for the oil spill trust fund, Congress only intended to tax conventional crude, and not tar sands or other unconventional oils. The Trust Fund is liable for tar sands oil spill cleanups without collecting revenue from oil sands transport. Also, the spill must be of oil, not other non-petroleum hazardous materials. The OSLTF can be used to pay for claims for any or all of the following:

- Uncompensated removal costs.
- Loss of profits or earning capacity.
- Loss of federal, state, or local government revenues.

[453] A sea zone prescribed by the United Nations Convention on the Law of the Sea over which a state has special rights regarding the exploration and use of marine resources, including energy production from water and wind; it stretches from the baseline out to 200 nautical miles from its coast. In colloquial usage, the term may include the continental shelf.
[454] http://www.irs.gov/pub/irs-wd/1120019.pdf

- Costs to state or local governments for increased public services.
- Loss of subsistence use of natural resources.
- Damages to real or personal property.
- Natural resource damages.

States may also present removal cost claims directly to the National Pollution Funds Center without first presenting them to the spiller.

Summary

Railroads have a common carrier obligation to transport all goods offered for transportation, including hazardous materials. This obligation ensures that railroads do not unreasonably discriminate between shippers. Thus, railroads may not refuse shipment on the basis of inconvenience or lack of profitability. Multiple parties are involved in the preparation, bulk packaging, handling and transportation of crude oil, yet the liability for an incident largely falls upon the transporter, e.g., railroad.

The impacts of a catastrophic incident can be high in cleanup costs, natural resources damages, damages to real and personal property, claims from personal injuries and potential fatalities. These costs may exceed the ability for the transporter to fully compensate and or pay for. Sufficient insurance coverage for these potential incident costs may not be available to the transporter. There is no requirement for rail carriers to provide any level of financial guarantees concerning ability to cover potential incident costs.

Responses to Oil Train Accidents in Seattle

As an example of the complexity of a response to a crude-by-rail train accident in a highly-populated area, the Seattle Fire Department (SFD) provided the following information.

Oil trains enter Seattle from the south, moving along Airport Way between Interstate 5 and the King County International Airport. Heading northward toward Seattle's industrial district and train yards, the trains pass within 100 yards of both Safeco and CenturyLink fields prior to entering the Great Northern Tunnel at Washington Street. The trains then exit the tunnel immediately west of Victor Steinbrueck Park, moving along the Seattle waterfront to the Interbay train yard. Finally, the oil trains skirt the northeast edge of Magnolia and pass over the Ship Canal at the Ballard Locks. From that point on, the trains move along the ribbon of tracks between Puget Sound and the residential bluffs on their journey to refineries in the north.

Three Potential Types of Response Zones

The route that oil trains follow in Seattle can be divided into three types of fire response zones, each with their own challenges and advantages. The *Emergency Response Guide* lists an initial isolation and evacuation distance of one half mile for crude oil railcars involved in fire. However, in some instances, due to topography, this distance may be able to be reduced:

- **Industrial** – This includes the airport and Interstate 5 frontage, the SODO stadium and industrial districts, and the Interbay and Ballard rail/industrial areas. These areas offer relatively close access via roadways, and there are adequate hydrants/water mains servicing these areas. Fire intensity, the square footage of burning liquid, and the amount of available foam, would be the primary factors limiting firefighting operations.
- **Great Northern Tunnel** – The mile long, century-old tunnel is grandfathered out of the codes that regulate most train tunnels in the United States. It has no emergency exits or access, and no ventilation or lighting systems. The challenges of fighting a Class B fire inside this tunnel are immense- distance, extreme heat, limited air supply, and limited fire flow would probably preclude using standard firefighting tactics within the tunnel.
    - Dimensions: 30 feet wide x 28 feet high; one mile long; 159,000 square feet 3,960,000 cubic feet.
    - *If* the tunnel could be sealed, it would require approximately 14 carbon dioxide (CO_2) tank trucks (440,000 lbs. CO_2) to achieve a 69% concentration for extinguishment of both the Class A & Class B materials that would be burning inside the tunnel.
    - *If* the tunnel's floor was flat/level, it would require 98,742 gallons of foam solution to nominally cover its surface one inch deep for Class B extinguishment.
- **Waterfront** – This area includes downtown from Victor Steinbrueck Park north to Myrtle Edwards Park/Pier 90 and from the Ballard Locks to the northern city limits. In part of this zone, depending upon tides, a large platform Fireboat may be able to directly attack a railcar incident with foam master streams. Barring direct attack from the water, the Fireboat may be able supply foam solution to units on shore via large-diameter hose (LDH) supply lines. Incidents along the residential bluff area will be difficult to attack with fire streams, due to topographic challenges and the distance from roads and hydrants.

Seattle Fire Department Response to Railcar Fires

There are two Incident Type Codes that Dispatchers could conceivably enter into the Computer Aided Dispatch (CAD) system for a reported rail tank car fire/train derailment. Each provides the same dispatch of required units shown in Table 50.

Table 50: Seattle Fire Department Incident Type Codes

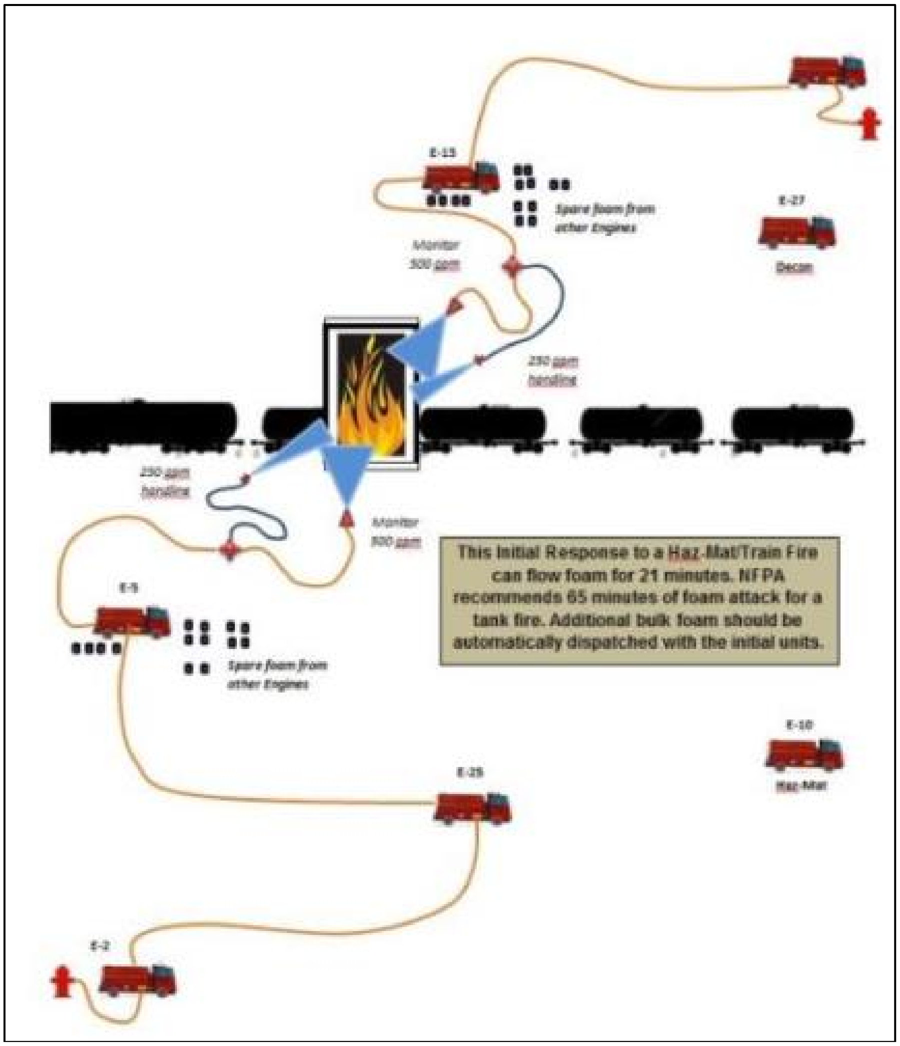
Type Code	Standard Response	Description	Related SOP
HAZF	5 Engines, 2 Ladders, 3 BCs, 1 Aid Car, 1 Medic Unit, Air 9, DEP1, SAFT2, DECON1, RIG HazMat Group E10, L1, A5, HAZ1, STAF10	Hazardous Materials with Fire	730
TRAINF	5 Engines, 2 Ladders, 2 BCs, 1 Aid Car, 1 Medic Unit, Air 9, DEP1, SAFT2, DECON1, RIG HazMat Group E10, L1, A5, HAZ1, STAF10	Train Derailment with Fire and/or HazMat	750

Currently, most Seattle Fire Department (SFD) FoamPro Engines (frontline units) are carrying four five-gallon containers of spare foam in addition to the nominal 10 gallons in the FoamPro supply tank. Spare engines (non-FoamPro) carry six five-gallon containers of foam. This provides 30 gallons of foam concentrate for each SFD engine in the city.

However, not all of this foam will be available for use at a Haz-Mat fire incident; the 10 gallons in the FoamPro supply tanks of many of the engines will remain unavailable for use. It cannot easily be transferred to the engine(s) actually pumping to the foam manifolds.

Using a rail/tank car fire scenario allows us to calculate SFD foam capabilities for a likely theoretical incident. Assuming that an Incident Commander assigned units to each side of a burning rail tank car, or to each end of a section of burning cars, foam timelines can be calculated for various fire flows that might be used on the Initial Response. Testing has shown that the maximum flow from the left rear foam discharge of SFD FoamPro Engines is approximately 850 gallons per minute (gpm). However, the following scenario uses a foam manifold flow of 750 gpm (see Figure 123).

Figure 123: Initial Response to a Hazmat Train Fire. Image source: National Fire Protection Association.



Initial Response Foam Capabilities

There will be approximately 160 available gallons of foam, 80 for each of two sides/divisions of the incident. *Available foam timelines for each of two sides, or divisions,* are in Table 51.

Table 51: Seattle Fire Department Initial Response Foam Capabilities

1 – 2.5" hoseline @ 250gpm[455]	1 – Monitor @ 500 gpm	1 – 2.5" line & 1- Monitor @ 750 gpm
• 1.25 gpm Novacool[456] • 1,250 ft² coverage • 64 minutes of foam flow	• 2.5 gpm Novacool • 2,500 ft² coverage • 32 minutes of foam flow	• 3.75 gpm Novacool • 3,750 ft² coverage • 21 minutes of foam flow

- A 2-11 response would provide five more Engines, but only 100 additional available gallons of foam, or 50 gallons of additional foam for each side of the incident. This would only increase the foam supply by 62%; monitor foam flow times would still be less than the National Fire Protection Agency (NFPA) recommended 65 minutes for tank fires.
- A Hose Wagon, with 375 gallons of foam, would increase available foam supplies by 335% over the Initial Response amounts, meeting NFPA recommendations and improving the chances of extinguishing the fire.
- Mandating that all engines carry six five-gallon containers of foam, rather than the 10-gallon supply tank and four spare containers commonly carried on FoamPro Engines, would increase the available foam on the initial response to 144% of current capabilities. This is incremental but would still be good practice (store two more in 2.5" hose bed).
- Novacool UEF (Universal Extinguishing Foam) is U.L. labeled for Class B application at 0.5%. Application rates are listed as: 0.16 gpm/ft² for hydrocarbon fires; and 0.2 gpm/ft² for polar solvent and tank fires.[457]

Recommended Updates to SFD Operations

- Drivers will need to refill the 10-gallon FoamPro supply tank every 2.5 minutes when pumping 750 gpm to a Foam Manifold. That is one five-gallon container lifted up to the top of the engine, and one container dumped, every 1:15 minutes. *Assign a Foam Support Company to assist each driver pumping a Foam Manifold at every incident.*
- Make policy adjustments as necessary to ensure that every Engine is carrying six five-gallon containers of foam onboard, in addition to the approximately 10 gallons in the FoamPro supply tank. Two containers can easily be stored at the forward end of the 2.5-inch hosebed, out of the way, but near the foam supply tank fill port. This incremental increase in each engine's foam storage will matter during a well involved Haz-Mat fire.

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[455] gpm = gallons per minute.

[456] Fire suppression foam that is a mixture of anionic, nonionic and amphoteric surfactants; it is biodegradable and does not contain any nonylphenolethoxylates (NPE's), fluorosurfactants, or glycol ethers.

[457] All foam flow calculations in this paper were based upon polar solvent/tank fire application rates.

- *Ensure that the SFD maintains the ability to deliver bulk foam* (such as a Hose Wagon) *to any incident in a timely manner- preferably in UNDER 20 minutes.* This could be palletized barrels of foam kept at a fire station with a flatbed truck and barrel hand trucks. It doesn't have to be a specialized apparatus. Consider automatically dispatching this resource to hazardous material incidents such as train fires, tank-farm fires, tanker fires, etc.
- Make available for any Haz-Mat/Foam incident, several empty barrels and associated electric foam pumps (run off of rig 12V systems) for moving foam from ground level up into the FoamPro supply tanks of engines pumping to Foam Manifolds.
- Remember to utilize mutual aid for Boeing Fire Department aircraft rescue and firefighting (ARFF) apparatus. These rigs have pump-and-roll capability along with high-flow foam master streams, and they can support crews trying to maneuver close to a fire to place unmanned monitors for fire control.

Examples of Incident Locations in Seattle

Following are three examples of oil train incident locations, along with an overview of each showing the *Emergency Response Guidebook* recommended initial isolation and evacuation distances for a railroad tank car on fire. The locations represent possible incidents in the south end of Seattle's industrial zone along the downtown waterfront, and in the north end, along the residential bluffs by Puget Sound (Figure 124 through Figure 129).

Figure 124: Military Road South from Northbound Interstate 5 (I-5)

Figure 125: Seattle Sound End Industrial Zone (Airport Way South/Military Road South) Initial Isolation and Evacuation Distance

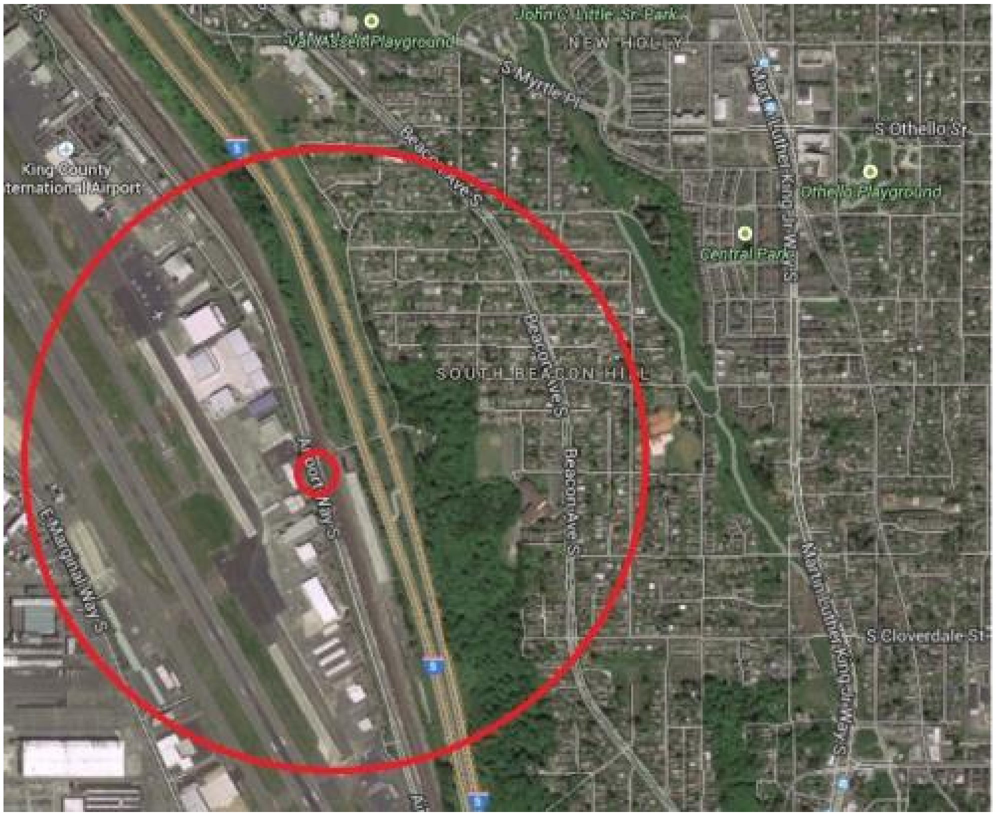


Figure 126: Seattle Downtown Waterfront (Alaskan Way and Broad Street) Initial Isolation and Evacuation Distance

Figure 127: Downtown Seattle Waterfront Evacuation and Initial Isolation Zone

Figure 128: Seattle North End Residential Bluffs Evacuation and Initial Isolation Zone

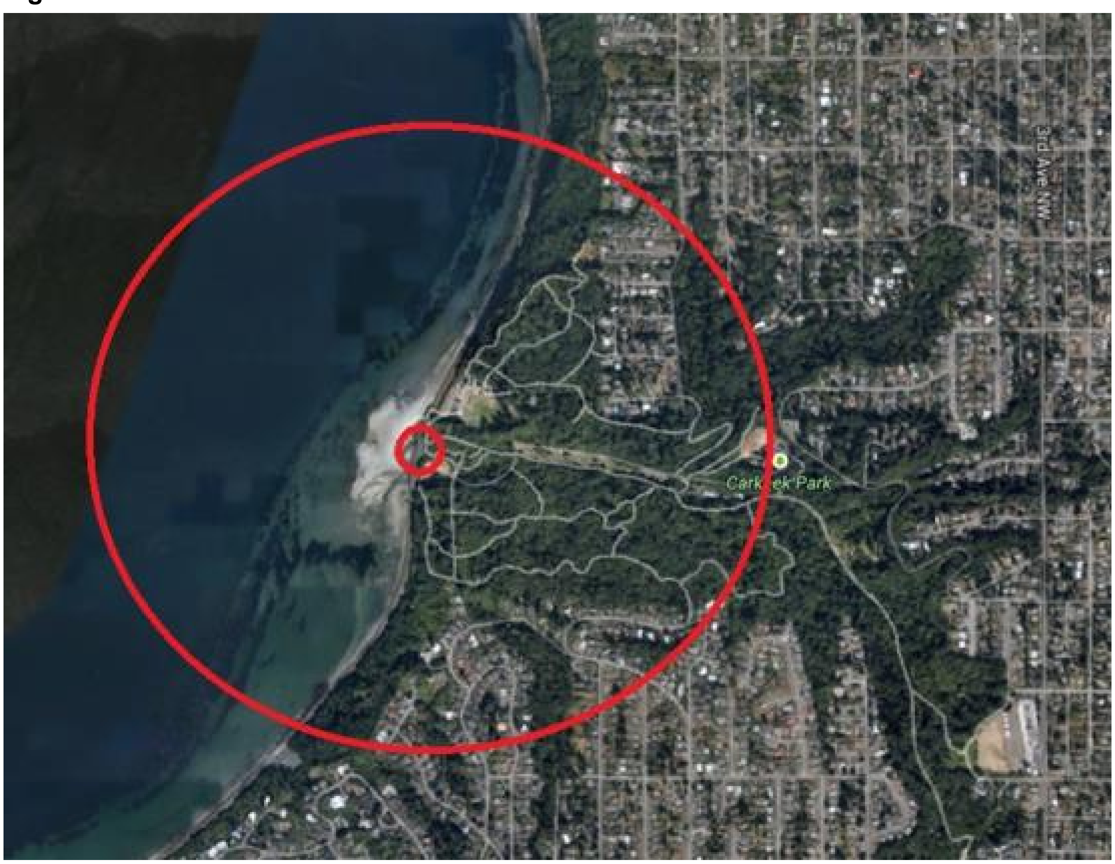


Figure 129: Oil Train Moving Along Beach at Carkeek Park

The directions in the *Emergency Response Guidebook* are shown in Figures 130 and 131.

Figure 130: Emergency Response Guidebook Potential Hazards and Public Safety Guidelines

GUIDE 128 — FLAMMABLE LIQUIDS (NON-POLAR/WATER-IMMISCIBLE) — ERG2008

POTENTIAL HAZARDS

FIRE OR EXPLOSION
- **HIGHLY FLAMMABLE: Will be easily ignited by heat, sparks or flames.**
- Vapors may form explosive mixtures with air.
- Vapors may travel to source of ignition and flash back.
- Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks).
- Vapor explosion hazard indoors, outdoors or in sewers.
- Those substances designated with a **"P"** may polymerize explosively when heated or involved in a fire.
- Runoff to sewer may create fire or explosion hazard.
- Containers may explode when heated.
- Many liquids are lighter than water.
- Substance may be transported hot.
- **If molten aluminum is involved, refer to GUIDE 169.**

HEALTH
- Inhalation or contact with material may irritate or burn skin and eyes.
- Fire may produce irritating, corrosive and/or toxic gases.
- Vapors may cause dizziness or suffocation.
- Runoff from fire control or dilution water may cause pollution.

PUBLIC SAFETY
- **CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.**
- As an immediate precautionary measure, isolate spill or leak area for at least 50 meters (150 feet) in all directions.
- Keep unauthorized personnel away.
- Stay upwind.
- Keep out of low areas.
- Ventilate closed spaces before entering.

PROTECTIVE CLOTHING
- Wear positive pressure self-contained breathing apparatus (SCBA).
- Structural firefighters' protective clothing will only provide limited protection.

EVACUATION

Large Spill
- Consider initial downwind evacuation for at least 300 meters (1000 feet).

Fire
- If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.

Page 202

Figure 131: *Emergency Response Guidebook* Emergency Response Guidelines

ERG2008

FLAMMABLE LIQUIDS (NON-POLAR/WATER-IMMISCIBLE)

GUIDE 128

EMERGENCY RESPONSE

FIRE

CAUTION: All these products have a very low flash point: Use of water spray when fighting fire may be inefficient.

CAUTION: For mixtures containing alcohol or polar solvent, alcohol-resistant foam may be more effective.

Small Fire

- Dry chemical, CO_2, water spray or regular foam.

Large Fire

- Water spray, fog or regular foam.
- Use water spray or fog; do not use straight streams.
- Move containers from fire area if you can do it without risk.

Fire involving Tanks or Car/Trailer Loads

- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
- Cool containers with flooding quantities of water until well after fire is out.
- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
- ALWAYS stay away from tanks engulfed in fire.
- For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

SPILL OR LEAK

- ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area).
- All equipment used when handling the product must be grounded.
- Do not touch or walk through spilled material. • Stop leak if you can do it without risk.
- Prevent entry into waterways, sewers, basements or confined areas.
- A vapor suppressing foam may be used to reduce vapors.
- Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers. • Use clean non-sparking tools to collect absorbed material.

Large Spill

- Dike far ahead of liquid spill for later disposal.
- Water spray may reduce vapor; but may not prevent ignition in closed spaces.

FIRST AID

- Move victim to fresh air. • Call 911 or emergency medical service.
- Give artificial respiration if victim is not breathing.
- Administer oxygen if breathing is difficult.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
- Wash skin with soap and water.
- In case of burns, immediately cool affected skin for as long as possible with cold water. Do not remove clothing if adhering to skin. • Keep victim warm and quiet.
- Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Page 203

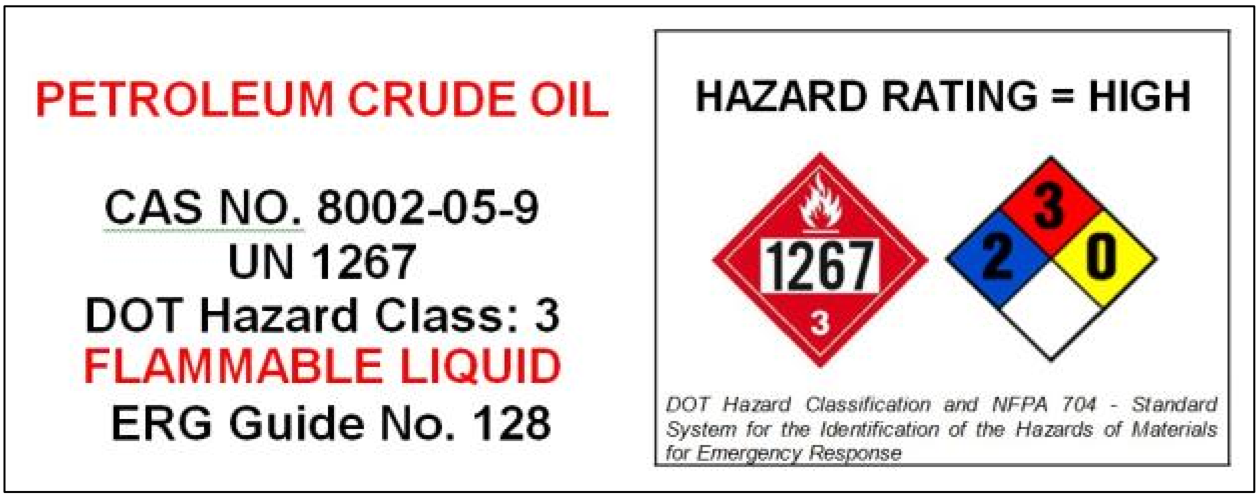
PHMSA/FRA/USFA Crude-by-Rail Transport Emergency Best Practices

In early October 2014, PHMSA, in partnership with the FRA and the U.S. Fire Administration's (USFA's) National Fire Academy, released the incident management best practices reference materials they developed in response to crude oil transportation incidents.[458]

Commodity Preparedness and Incident Management Reference Sheet

The reference materials include a depiction of the DOT classifications of petroleum crude oil, in particular shale oil (Figure 132).

Figure 132: DOT Hazard Classification for Petroleum Crude Oil



Transportation and Planning Considerations

- With the increased production of oil from shale reserves in states such as North Dakota and Texas, there has been a dramatic increase in the transportation of crude oil by rail. Rail shipments of crude oil from these regions are typically made using unit trains. Unit trains of crude oil are single-commodity trains that generally consist of over 100 tank cars, each carrying approximately 30,000 gallons of crude oil.
- Unit trains typically move from one location (e.g., shipper's production facility or sort term transloading facility) to a single destination (e.g., petroleum refinery). Given the usual length of these trains (over one mile long), derailments can cause road closures, create detours, and require response from more than one direction to access the scene of the incident.
- In the event of an incident that may involve the release of thousands of gallons of product and ignition of tank cars of crude oil in a unit train, most emergency response organizations

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458 http://www.phmsa.dot.gov/pv_obj_cache/pv_obj_id_D49E5CEF1AC2AB4A887FDA7364FDD00E87BE0200/filename/Petroleum_Crude_Oil_CERG.pdf

will not have the available resources, capabilities or trained personnel to safely and effectively extinguish a fire or contain a spill of this magnitude (e.g., sufficient firefighting foam concentrate, appliances, equipment, water supplies).

- Responses to unit train derailments of crude oil will require specialized outside resources that may not arrive at the scene for hours; therefore it is critical that responders coordinate their activities with the involved railroad and initiate requests for specialized resources as soon as possible.
- These derailments will likely require mutual aid and a more robust on-scene Incident Management System than responders may normally use. Therefore, pre-incident planning, preparedness and coordination of response strategies should be considered and made part of response plans, drills and exercises that include the shippers and rail carriers of this commodity.
- Tank cars carrying crude oil may also be found in general freight (manifest) trains that are made up of shipments of many different commodities from many different shippers. In these situations, emergency responders need to consider the potential impact that tank cars containing other hazardous commodities may have on tank cars containing crude oil if a release occurs, and vice-versa.
- To determine what specific commodities or hazardous materials may be involved, responders should contact the rail carrier's emergency contact number.

Hazard Summary

- Petroleum crude oil is a light to dark-colored liquid hydrocarbon containing flammable gasses. It is not a uniform substance and its physical and chemical properties may vary from oilfield to oilfield or within wells located in the same oilfield. Light, sweet crude oils contain flammable gasses such as butane and propane (unless it is known that the gasses have been removed). These gasses can readily ignite if released, when they come in contact with an ignition source. These crude oils may also contain hydrogen sulfide, a toxic inhalation hazard material, in the vapor space of the tank car. Due to the characteristics of crude oil, in an accident scenario, the behavior of this product may range from that of gasoline for the lighter (sweet) crude oils to diesel fuel for the heavier (sour) crude oils.
- Releases may create vapor/air explosion hazards indoors, in confined spaces, outdoors, or in sewers. Remove sources of heat, sparks, flame, friction and electricity, including internal combustion engines and power tools. Use caution when approaching the scene and positioning apparatus. Implement air monitoring as soon as possible to detect the presence of combustible gasses.
- Volatile vapors released from the spill area may create flammable atmospheres. Some crude oil vapors may be heavier than air and accumulate in low areas, and travel some distance to a source of ignition and flash back.

- When working in flammable atmospheres where any concentration of lower explosive limit (LEL)[459] exists, extreme caution must be taken to avoid creating ignition sources. This includes but is not limited to the use of non-sparking tools and intrinsically safe/explosion-proof equipment.
- The more volatile materials in crude oil may be present in air in high concentrations creating an inhalation hazard. There is also the possibility that the crude oil may contain varying concentrations of benzene or hydrogen sulfide. Products of combustion may also include toxic constituents. Responders should wear self-contained breathing apparatus (SCBA) to avoid potential exposure.
- Use water fog spray to cool containers, control vapors, and to protect personnel and exposures. Direct the cooling water to the top of the tank. There is some potential that containers of liquid that are not properly cooled may rupture violently if exposed to fire or excessive heat. Stay away from ends of tank(s) involved in fire, but realize that shrapnel may travel in any direction.
- *DO NOT APPLY WATER DIRECTLY INSIDE A TANK CAR*. Apply water from the sides of the tank car and from a safe distance to keep fire-exposed containers cool. Use unmanned fire monitors for cooling tank cars when available. Withdraw immediately in case of rising sound from venting pressure relief devices or discoloration of tank. If available, dry chemical extinguishing agents, such as potassium bicarbonate (i.e., Purple K) may also be used in conjunction with Class B foams.
- Improper application of fire streams may create a dangerous phenomenon known as a slopover, thereby increasing risks to emergency responders. A slopover results when a water stream is applied to the hot surface of burning oil. The water is converted into steam causing agitation of the liquid and burning oil to slop over the sides of the tank car. This can occur within 10 minutes of the product becoming involved in fire. Note: Slopover will not occur in a pool of crude oil on the ground.
- Hazardous combustion/decomposition products may be released by this material when exposed to heat or fire. These can include carbon monoxide, sulfur oxides, nitrogen oxides and aldehydes. Response personnel should exercise extreme caution on-scene and wear appropriate personal protective clothing and equipment, including respiratory protection.
- Apply Class B firefighting foam as you would on fires involving other hydrocarbons. Class B foam blankets prevent vapor production and ignition of flammable and combustible liquids. Foam is most effective on static fires that are contained in some manner. Firefighting foam is not effective on hydrocarbon fuels in motion (i.e., three dimensional fires) that include product leaking or spraying from manways, valves, fractures in the tank shell (e.g., rips, tears) or spills on sloping terrain.

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[459] The lowest concentration (percentage) of a gas or a vapor in air capable of producing a flash of fire in presence of an ignition source (arc, flame, heat).

- As a general rule, *DO NOT* flush crude oil spills with water. Most crude oils are not water soluble and will have a tendency to float on water. Some crude oils will sink and some fractions of crude oil are water soluble. For those crude oils that float on water, burning crude oil may be carried away from the immediate area and may reignite on the surface of the water.
- Prevent runoff from entering storm/sewer systems and sensitive areas, as this may create a serious hazard and potential environmental problems. Notify proper authorities, downstream sewer and water treatment operations, and other downstream users of potentially contaminated water. Runoff may be flammable and/or toxic and should be contained, treated and disposed of in accordance with applicable federal, state and local environmental regulations.

Railroad Safety Procedures

Emergency response personnel should always be aware of the potential for serious injury when working in and around railcars, tracks and related equipment. The following safe operating practices should be followed when involved in emergency response operations at the scene of a crude oil train derailment:

- Expect a train or rail equipment to move on any track from either direction at any time.
- Watch for movement in both directions before crossing tracks. If the tracks are clear, walk single file at a right angle to the rails.
- Trains can approach with little or no warning. You may not be able to hear them due to atmospheric conditions, terrain, noisy work equipment, or passing trains on other tracks. Stand a minimum of 25 feet away from the tracks if possible, and face the train when rail equipment is passing through.
- Always contact the railroad to advise them of your presence – they may not know that you are on-scene or that they have a problem. Work with the railroad to be sure the track is "blue flagged" – the railroad's version to provide protection by their lock-out, tag-out process.
- Never stand, walk or sit on railway tracks, between the rails or on the ends of ties. Never step on the rail - step over it. The rail can be a slip, trip, or fall hazard. Never put your feet on moveable parts of a railcar such as couplers, sliding sills or uncoupling levers.
- Do not occupy the area between adjacent tracks in multiple track territory when a train is passing. If crossing between two stationary railcars, ensure there is at least 50 feet between them.
- Be especially careful working in rail yards and terminal areas. Tank cars are pushed and moved, and can change tracks often. Cars that appear to be stationary or in storage can begin to move without warning. Be sure that any rail equipment is secured against movement (wheels chocked, hand brakes secured, etc.) before attempting to work on or near it. Keep at least 25 feet away from the end of a car or locomotive to protect yourself from sudden movement.

- Never move equipment across the tracks unless at an established road crossing or under the supervision of a railroad representative.
- If it is necessary to climb rail equipment, use three points of contact at all times. The ladders on rail equipment may curve around the car making it difficult to find the rung with your foot. The first step onto rail equipment is typically some distance off of the ground. When descending the ladder, step - do not jump from the last step. Normally, there is ballast around the tracks which can be uneven and shift, causing a fall hazard. Locomotive steps are considered ladders. Always face the locomotive going up and coming down.
- Never cross over or under rail equipment -- use the ladders, handholds and crossover platforms or walk around the attached equipment. Remember to block the feet and tie off ladders at the top. When laddering tank cars or box cars, always consider using two points of access - the second being a point of escape should the other become inaccessible for any reason. Plan to use your own ladders.
- Avoid the use of cell phones when within 25 feet of live tracks.
- Be aware of the location of structures or obstructions where clearances are close.
- Stay away from track switches since they can be remotely operated.

Pre-Incident Planning and Preparedness

- Emergency responders should determine the rail carriers of hazardous materials moving through their communities and ascertain if crude oil is one of the products being transported. This can be accomplished by contacting the individual rail carrier and requesting a list of the hazardous commodities transported through the community via the *Association of American Railroads (AAR) Circular No. OT-55* protocol. This information can assist in preparing emergency response plans and procedures.[460]
- Emergency responders should contact and engage the State Emergency Response Commission (SERC) and the Local Emergency Planning Committee (LEPC) within their jurisdiction. The SERCs and LEPCs can be valuable resources in obtaining information concerning the hazardous commodities being transported through the community, such as crude oil, as well as providing assistance with emergency planning, preparedness and response activities. LEPCs and emergency responders can seek planning information and commodity-specific training at http://www.transcaer.com/ and selecting a state or region to determine the designated contacts.
- Emergency responders should also contact the railroads to identify appropriate points- of-contact and the railroad's hazardous materials response personnel they are likely to interface with during an emergency. This can help to establish lines of communication and provide access to information and resources prior to an incident. The railroads can also provide extensive rail-specific emergency response training at no cost to emergency responders.

[460] Note: A copy of the latest version of AAR Circular OT-55 and other related hazardous materials reference materials can be downloaded at http://www.boe.aar.com/boe-download.htm.

Information may be obtained via the railroad's web site or by contacting their media/public relations department.

- Emergency responders should identify the appropriate 24-hour emergency contact numbers for the major (Class I) railroads and ensure they are listed in their emergency operations and response plans. The emergency contact numbers for the Class I railroads are listed below (Table 52).

Table 52: Emergency Contact Numbers for

Company	Emergency Telephone Number
BNSF Railway	(800) 832-5452
Canadian National (CN) Railway	(800) 465-9239
Canadian Pacific (CP) Railway	(800) 716-9132
CSX Transportation	(800) 232-0144
Kansas City Southern Rail Network	(877) 527-9464
Norfolk Southern Railroad	(800) 453-2530
Union Pacific Railroad	(888) 877-7267

- Emergency responders should establish contact with their state and local environmental protection agency representative(s) to identify potential air monitoring and spill control resource capabilities. These resources should be included in the organization's emergency response plan.
- Emergency responders should contact federal agencies such as the USCG to determine the level of assistance that may be provided in the event of a spill in navigable waterways located in their jurisdiction. This resource, as well as other federal resources, can be contacted through the National Response Center (NRC) at 1-800- 424-8802.
- Organizations should include a railroad annex in their emergency response plan that specifically addresses crude oil rail transportation emergency response operations. This annex should include:
    - Hazard analysis that identifies the potential risks to people and property.
    - Emergency contact lists.
    - Resource listings.
    - Equipment inventories.
    - Foam and water supply requirements for operations at remote sites.
    - Incident management system roles and responsibilities.
    - Mutual aid response assets.
    - Law enforcement scene security and control operations.

[461] Note: Emergency responders should also contact any Short Line or Regional Railroads that service their areas to obtain emergency contact information. These organizations should also be part of any pre-incident planning, preparedness and training/exercise activities.

- Support and recovery assets.

Emergency response plans and procedures should be developed in close coordination with the railroad since they will play a critical role in response and recovery operations. Tests and drills should be conducted to exercise the plan at regular intervals to identify any issues that might require corrective action prior to an actual incident.

Incident Management Principles

- Initial site management and control will be a critical benchmark in managing the problem.
- Isolate and secure the area. Establish a secure perimeter and entry control points to prevent unauthorized personnel from entering the scene. This can be accomplished with tape, barricades, traffic cones, or assigned fire service or law enforcement personnel.
- The location of the restricted area should be communicated to all impacted personnel operating on the scene. Begin a site assessment from a safe distance, upwind and uphill. An Incident Command Post (ICP) should be established outside the impacted area as soon as possible.
- Follow initial guidance provided by the Emergency Response Guidebook (ERG) if practical. Establish a Staging Area in the cold zone for responding equipment and personnel.
- The National Incident Management System (NIMS)[462] should be the framework used to manage all incident operations. Information on NIMS can be obtained at http://www.fema.gov/national-incident-management-system. Unified Command should be established that integrates those agencies and organizations with legal or jurisdictional responsibility. Liaisons should be provided at the ICP by assisting or cooperating agencies to ensure effective communication and coordination of resources.
- Due to the size, duration and complexity of these incidents, Incident Commanders should consider the possibility of additional support from regional or state All-Hazard Incident Management Teams (AHIMTs).
- AHIMTs are a multi-agency/multi-jurisdictional team for extended incidents formed and managed at the local, state or tribal level. It is a designated team of trained personnel from different departments, organizations, agencies and jurisdictions. AHIMTs are deployed as a team representing multiple disciplines who manage major and/or complex incidents requiring a large number of local, state or tribal resources. They do not assume command of the incident; they help local officials manage incidents that extend into multiple operational periods and require a written Incident Action Plan (IAP). These incidents can include weather-related disasters such as a tornado, earthquake, or flood or major hazardous materials incidents such as train derailments.

[462] A systematic, proactive approach to guide departments and agencies at all levels of government, nongovernmental organizations, and the private sector to work together seamlessly and manage incidents involving all threats and hazards—regardless of cause, size, location, or complexity—in order to reduce loss of life, property and harm to the environment.

- Emergency responders should anticipate a large number of liaison agencies operating at the scene (e.g., U.S. Coast Guard, Environmental Protection Agency, National Transportation Safety Board, Chemical Safety Board, private contractors). In addition, non-emergency regional and municipal agencies may have a role to play and need to be integrated into the command structure.
- The railroad will integrate its response assets into the public safety NIMS structure. While the exact structure will vary based on the scope and nature of the incident scenario, it will often be integrated as the Railroad Branch within the Operations Section.
- Large-scale incidents may require activation of the jurisdiction's Emergency Operations Center (EOC). The EOC should be fully staffed and the roles and responsibilities of all participating agencies must be clearly defined in the organization's emergency response plan.

Problem Identification

- Identify, confirm, and verify the presence of the hazardous material(s) and the extent of the problem. This can be done through shipping papers (i.e., train consist), placards, labels, container shapes, markings/colors and senses (e.g., observable plume).
- Identify the rail carrier and locate the train crew. The conductor will have the complete train manifest immediately available on the scene. Maintain contact with the conductor and crew until they are relieved by a railroad official(s).
- Notify the rail carrier's emergency operations center to have rail traffic stopped to avoid entering the location of the incident and to avoid further risk to personnel operating at the scene. Request that a copy of the train consist or wheel report be sent to the ICP.
- Responding railroad officials may also have copies of the train consist. In the absence of shipping papers, emergency responders should use binoculars from a safe distance upwind, and try to locate any 4-digit identification numbers on the placards (or orange panels) displayed on the railcars. If shipping papers, placards, markings, or labels are destroyed, the reporting marks and number on the railcar can be used to identify the commodities present.
- When contacting the railroad, provide as much of the following information as possible:
  - Your name, location, organization name and telephone number.
  - Location of incident (provide the railroad with the DOT Crossing Number or the railroad milepost so the specific location can be identified).
  - Type and number of containers involved.
  - Presence of markings, labels, reporting marks or placards on tank car.
  - Presence of smoke, fire or spill.
  - Extent of damage.
  - Topography.
  - Weather conditions.

- If pictures can be taken from a safe position, do so and send to a railroad representative as quickly as possible.

- Be aware of utilities that commonly run next to or in the railroad right-of-way. As part of your scene size up, look for downed signal and communication lines, power lines, buried utilities and above ground switch heating systems.

Hazard Assessment and Risk Evaluation

- The hazard assessment and risk evaluation process is a critical step to identify the level of danger posed by an incident involving the product(s), containers and their behavior, which is generally related to their physical and chemical properties.
- Risks refer to the probability of suffering harm or loss and are different at each incident and need to be evaluated by the Incident Commander.
- Emergency responders can use a number of reference materials such as the ERG, Safety Data Sheets (SDSs), technical specialists available by contacting the shipper or railroad, or contacting the Chemical Transportation Emergency Center (CHEMTREC) at 1-800-424-9300, or the 24-hour emergency contact telephone number required to be included on the shipping papers by the federal hazardous materials regulations.
- Evaluate the risks of personnel intervening directly in the incident. Consider the limitations of the people involved and the ability to have adequate resources available on site (e.g., sufficient firefighting foam concentrate, water supplies, appliances, equipment, trained personnel and technical expertise) and the ability to sustain operations for extended periods of time (hours or days).
- The level of risk will be influenced by all of the following factors:
  - Hazardous nature of the material(s) involved.
  - Quantity of the material(s) involved.
  - Type(s) of stress applied to the container and breach / release scenarios.
  - Proximity of exposures and nature of terrain.
  - Level of available resources (e.g., adequate foam supply, location of foam supply, response time and appliances/equipment).
- Emergency response personnel need to consider the following factors that may influence the behavior of a hazardous material:
  - Inherent properties and quantity of the material.
  - Design characteristics of the container.
  - Environmental factors (e.g., weather, topography, surrounding physical structures).
- The following factors should be considered to help estimate the potential impact of the problem:
  - Has the container been breached? If so, is product flowing?

- o Where will the container and its contents go if released?
- o Why are the container and its contents likely to go there?
- o How will the container and its contents get there?
- o When will the container and its contents get there?
- o What harm will the container and its contents cause when they get there?
- o How much material has been released? What is the proximity of the release to people, property and the environment?
- o Is the material on fire? Are other tank cars at risk of becoming involved?
- o Do you have the capability of successfully controlling fire spread, which in some cases may require a minimum of approximately 500 gallons per minute per exposed tank car?
- o Are adequate foam supplies and equipment available for post-fire operations that may last for several hours or days?

- For non-fire spill scenarios:
  - o Have the concentrations of any flammable or toxic vapors present been determined using air monitoring instruments? What are the flammability and toxicity readings?
  - o Has the need for continuous air monitoring been properly evaluated and discussed with technical specialists?
  - o Can sources of ignition be removed and/or eliminated?
  - o Are adequate foam supplies and equipment available for vapor suppression?[463]
- Based on the results of the hazard assessment and risk evaluation process, are there adequate resources available to respond to the scene within a reasonable timeframe so that intervention efforts will be successful?[464]
- Emergency responders should use the information and options selected as the foundation to develop an IAP for the incident. An IAP should be developed for any incident that has the potential to last at least 24 hours, and a new/updated IAP developed for each successive operational period.
- If your agency is not fully prepared and capable in terms of resources, equipment and properly trained personnel to intervene, defensive or non-intervention strategies will likely be the preferred strategic option.

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[463] Agencies should refer to the most recent edition of NFPA 11 - Standard for Low- Medium-and High-Expansion Foam for information concerning the specific requirements for foam application.

[464] An initial benchmark to assess your agency's capability to successfully manage an incident involving a unit train carrying crude oil is your operational capability to respond to and successfully manage a gasoline tank truck incident (which typically involves approximately 9,000 gallons of gasoline). With regard to quantity of product, one tank car of crude oil is equivalent to approximately three gasoline tank trucks. The potential magnitude of this type of incident must be considered when preparing emergency plans and operational procedures.

Select Proper Personal Protective Clothing and Equipment

- Assure that emergency responders are using the proper personal protective equipment (PPE) and clothing equal to the hazards present. Structural firefighting protective clothing (SFPC) and positive-pressure SCBA should be the initial level of PPE selected.
- Rescue should be performed from an uphill and upwind location, if possible.
- Any changes in the level of PPE should be based on the results of air monitoring operations. Continuous monitoring with a combustible gas indicator and instruments capable of detecting toxic components of crude oil vapors (e.g., hydrogen sulfide) are important in ensuring site safety. These instruments can include detector tubes or photoionization detectors (PIDs).
- Information and guidance on the selection of personal protective equipment for oil spill response is available in American Petroleum Institute (API) Recommended Practice (RP) 78 – Personal Protective Equipment Selection for Oil Spill Responders. Copies of the RP can be obtained by contacting API at (202) 682-8000 or on-line at www.api.org (Product No. G09801).

Logistics and Resource Management

- Order specialized equipment and technical resources early in the incident. If you are unsure of your initial resource requirements, always call for the highest level of assistance available. Do not wait to call for additional resources or activate mutual aid agreements.
- Establishing a Logistics Section early in the incident will be critical in providing the necessary support, resources and services to meet operational objectives. The size, scope and resources needed to successfully manage a crude oil rail transportation incident will overwhelm the capability of most emergency response agencies.
- Emergency planning and response agencies must identify their logistical needs, identify agencies or organizations that can meet those requirements, and effectively manage the resources available from those identified sources within the NIMS framework.
- The railroads will be the primary providers of logistical support and resources. Rail carriers can provide emergency response resources, air monitoring and environmental management capabilities, technical specialists and contractors to safely manage the consequences of a crude oil train derailment. For example, rail carriers may use the services of private contractors to provide air monitoring and toxicology assessments.
- The time required for assets to arrive on scene and initiate operations must be taken into account since long delays can diminish operational effectiveness. Logistics for access, positioning and movement should be considered, including the need for escorts to facilitate prompt access to the scene.
- Technical specialists and contractor support can also be made available from the shipper and can be obtained by contacting the 24-hour emergency telephone number provided on shipping papers or by contacting CHEMTREC at 1-800-424-9300.

- Emergency responders may also obtain assistance from the NRC by calling 1-800-424- 8802. For example, the NRC can provide 24-hour access to federal government agency resources and technical assistance. The NRC also serves as the EPA's Hazardous Materials Hotline and the USCG Oil Spill Hotline.

Select and Implement Response Objectives

- The initial stage of an incident involving crude oil should include an analysis of appropriate site-specific response procedures and potential effects that an incident would have on nearby life, property, critical systems and the environment.
- The ERG should be used by all emergency responders to obtain initial response guidance for crude oil incidents.
- Traditional firefighting strategies and tactics may not be effective in these situations. These incidents also need to be approached and managed as a hazardous materials problem to ensure that proper and appropriate technical assistance and the support of outside resources are notified and requested as soon as possible.
- Use the railroad's emergency telephone number to establish communication with the railroad and stay in constant communication with the railroad. If the train crew is disabled or unavailable, the train consist is available from the Railroad Emergency Telephone Number point-of-contact and can be sent to the scene via e-mail or fax.
- Confirm your location with the Railroad Emergency Telephone Number point-of-contact by observing mile posts or the individual grade crossing identification numbers at or near the scene.
- Coordinate operations with the railroad, chemical shippers and manufacturers, CHEMTREC and/or the shipper's 24-hour emergency contact to ensure that you have access to all the information available concerning the commodity and tank car(s) involved in the accident.
- Utilize the railroads' hazardous materials personnel when they arrive on scene. They can assist with size-up and damage assessment. These personnel have been specifically trained to respond to railroad emergencies and derailments.
- Based on the collection, evaluation and verification of response information, emergency responders need to determine whether the incident should be handled offensively, defensively or by non-intervention. Offensive tactics increase the risks to emergency responders.
- The following factors should be considered as part of developing the initial response strategy in Table 53.

Table 53: Factors for Consideration in Developing Initial Response Strategy

Question	Response Considerations
Are there any life-safety exposures in danger that responders must address right now? Can responders safely evacuate or protect in place?	Number of people to be protected, ability of public to move, available time, resources needed, adequate facilities to shelter evacuees.
Can responders safely approach the incident?	Location of the incident, access and terrain, number of tank car(s), extent of damage, size of spill, leak or fire involved.
Do responders fully understand the nature and scope of the problem?	Hazard assessment and risk evaluation must be completed and the results shared with technical specialists from the railroad and/or shipper.
If a fire is involved, do responders have immediate access to sufficient foam and water supplies that are required for effective fire control/suppression operations? If a spill is involved, do responders have the necessary spill control equipment readily available on-site? Can fire suppression agents be effectively applied to the tank car(s) involved? Can cooling water be effectively applied to any exposures impacted by direct flame impingement? If not on fire, can potential ignition sources be removed and/or eliminated?	Most fire departments will not have adequate foam, water or spill control resources for an initial attack on a crude oil derailment scenario with large fires. Defensive operations will likely be required until sufficient foam concentrate, water, spill control and related support resources are on-scene. Fire suppression agents and cooling water must be able to reach their intended targets to be effective. If access, supply or equipment is limited, the ability of suppression agents and cooling water to reach the affected area(s) will be diminished. Vehicle traffic may need to be curtailed. Automatic switching systems (i.e., industrial air conditioning units, traffic signals) need to be switched off, etc.
Will extinguishment improve or worsen the incident and what is the environmental impact of doing so?	In some situations, the best and safest response option may be defensive or non-intervention tactics which allow the fires to burn out. Attempting to extinguish the fire(s) may cause additional risk to personnel and damage to the environment. The decision to protect exposures and let the product burn must be considered.
Have appropriate notifications been made or has the organization's emergency response plan been activated?	These incidents cannot be safely and effectively managed alone. Additional technical support and resources must be requested immediately in accordance with the agency's emergency response plan. The railroads and shippers will be the primary means of technical support and resources and are an integral component of the organization's emergency response plans, procedures and operations.

The following examples (Tables 54 through Table 56) are provided as operational considerations for first responders regarding the scope, magnitude and resource requirements for responding to and managing a crude oil unit train derailment.

Table 54: Example A: Derailment No Fire (Spill)

Emergency Procedures
- Implement emergency response plan. - Ensure the railroad is notified via their Emergency Contact Number. - Call the 24-hour emergency contact number for the shipper listed on the shipping papers available from the train crew. If this information is not available from the train crew, contact the Railroad Emergency Contact Number. - Contact CHEMTREC at 1-800-424-9300 if there is no emergency contact telephone number listed for the shipper or other technical assistance is needed. - Conduct a hazard assessment and risk evaluation to determine the scope and magnitude of the problem, resource requirements and response options. Do not overlook obvious physical hazards that may be present such as damaged rail and other equipment that may have sharp/jagged edges. - Conduct continuous air monitoring as appropriate. - Confinement operations (i.e., spill control tactics) are a priority to limit the size and spread of the release – damming and diking may be required to limit the potential for the spill to migrate beyond the immediate area and cause extensive environmental damage. - If foam supplies and equipment are available on-site, foam should be applied for vapor suppression. - Refer to the ERG for recommended isolation distances.

Table 55: Example B: Derailment With Fire (Unit Train, 1 Car Release, Contained Spill, With Fire)

Emergency Procedures
□ Implement emergency response plan. □ Ensure the railroad is notified via their Emergency Contact Number. □ Call the 24-hour emergency contact number for the shipper listed on the shipping papers available from the train crew. If this information is not available from the train crew, contact the Railroad Emergency Contact Number. □ Contact CHEMTREC at 1-800-424-9300 if there is no emergency contact telephone number listed for the shipper or other technical assistance is needed. □ Conduct a hazard assessment and risk evaluation to determine the scope and magnitude of the problem, resource requirements and response options. Do not overlook obvious physical hazards that may be present such as damaged rail and other equipment that may have sharp/jagged edges. □ Conduct continuous air monitoring as appropriate. □ Confinement operations (i.e., spill control tactics) are a priority to limit the size and spread of the release – damming and diking may be required to limit the potential for the spill to migrate beyond the immediate area and cause environmental damage. □ If fire suppression strategies are selected, responders will need to refer to the ERG for recommended isolation distances. □ If fire suppression operations are initiated, responders need sufficient foam concentrate supplies, adequate water supply, foam appliances, equipment and properly trained personnel to effectively implement and sustain fire suppression and post-fire suppression operations. □ CRITICAL QUESTION: Do you have the ability to extinguish a single tank car containing 30,000 gallons of crude oil? Based on the guidance in NFPA 11, Standard for Low-Medium- and High-Expansion Foam (2011 edition) -- for a spill scenario greater than one (1) inch in depth, agencies will need a minimum of approximately 216 gallons of 3% foam concentrate available for the first 15 minutes of the operation based on a spill area of approximately 3,000 sq. ft. In addition, reapplication of foam will normally be necessary to maintain an adequate foam blanket. Note: If 1% foam concentrate is available and used, approximately 72 gallons of foam concentrate would be required for the first 15 minutes of the operations. □ If you do not have the capability to safely and effectively implement and sustain this strategy, defensive or non-intervention strategies should be pursued.

Table 56: Example C: Derailment With Fire (Unit Train, Multiple Car Release, Release, Spill, Fire

Emergency Procedures
Implement emergency response plan. Ensure the railroad is notified via their Emergency Contact Number. Call the 24-hour emergency contact number for the shipper listed on the shipping papers available from the train crew. If this information is not available from the train crew, contact the Railroad Emergency Contact Number. Contact CHEMTREC at 1-800-424-9300 if there is no emergency contact telephone number listed for the shipper or other technical assistance is needed. Conduct a hazard assessment and risk evaluation to determine the scope and magnitude of the problem, resource requirements and response options. Do not overlook obvious physical hazards that may be present such as damaged rail and other equipment that may have sharp/jagged edges. Conduct continuous air monitoring as appropriate. Confinement operations (i.e., spill control tactics) are a priority to limit the size and spread of the release – damming and diking may be required to limit the potential for the spill to migrate beyond the immediate area and cause environmental damage. If fire suppression strategies are selected, responders will need to refer to the ERG for recommended isolation distances. If fire suppression operations are initiated, responders need sufficient foam concentrate supplies, adequate water supply, foam appliances, equipment and properly trained personnel to effectively implement and sustain operations. The resource requirements to safely and effectively respond to an incident of this magnitude will exceed the capabilities of most emergency response organizations. In situations of this nature, the amount of foam concentrate that is required to be available on-site to begin suppression operations per NFPA 11 (2011 edition), -- for a spill scenario greater than one (1) inch in depth, is approximately 26,000 gallons of 3% foam concentrate for the first 15 minutes of the operation based on a spill area of approximately 360,000 sq. ft. In addition, reapplication of foam will normally be necessary to maintain an adequate foam blanket. Note: If 1% foam concentrate is available and used, approximately 8,666 gallons of foam concentrate would be required for the first 15 minutes of the operations. NOTE: THE STRATEGY FOR THIS TYPE OF INCIDENT THAT PROVIDES THE HIGHEST LEVEL OF SAFETY TO RESPONDERS IS DEFENSIVE TO PROTECT EXPOSURES OR NON-INTERVENTION.

Clean-up and Post-Emergency Operations

- Establish a decontamination corridor in the warm zone away from the contaminated area. Ensure that all protective clothing and equipment is isolated for proper disposal and/or cleaning.
- Ensure proper decontamination of emergency personnel before they leave the scene.
- Crude oil vapors can saturate protective clothing and be carried off-site. Personnel should monitor for hazardous vapors before removing PPE.
- Use a massive water rinse on the outer shell of protective clothing. Maintain appropriate respiratory protection throughout the decontamination process.
- Contain all runoff since it may contain harmful contaminants. Properly dispose of in accordance with applicable federal, state and local environmental regulations.
- Conduct a post-incident analysis to properly document the incident and identify follow-up activities.

Appendix D: In Depth: Basics on Oil Properties

Perhaps more than any other factor, the type of oil that is spilled will have a major effect on the degree and type of impacts that occur. The characteristics of crude oils and refined products with respect to their behavior in the environment (e.g., evaporation rate, viscosity), as well as their propensity to impact organisms by way of their toxicity, mechanical injury potential (adherence and smothering), and persistence, will influence ecological impacts.

General Oil Type Classifications

There are hundreds, if not thousands, of known oil types, including crude oils from many locations that differ with respect to properties, as well as a broad spectrum of refined products that are created from these crude oils. Each crude oil and each refined product is unique to the point that it can be "fingerprinted" forensically in spill cases based on its unique combination of hydrocarbon components and other contents, such as sulfur and heavy metals.

To asses potential impacts, the different oil types need to be grouped into a small number of categories that incorporate their general properties and ecological impact potential. These categories are generally based on the density (specific gravity) of the oils but also incorporate the concentrations of aromatics, which tend to be more toxic and evaporate more easily, versus concentrations of heavier components, which are less toxic but are highly persistent in the environment. Ultimately, these are the factors that will determine short- and long-term impacts on natural and socioeconomic resources. A typical simplified breakdown of oil types is shown in Table 57.

Table 57: Oil Type Classifications

Persistence Category[465]	Oil Types[466]	Examples in Category
Non-Persistent	Volatile Distillates	Jet fuel, kerosene, gasoline[467]
Low Persistent	Light Fuels	Diesel fuel, No. 2 fuel, home heating oil, marine diesel
	Light Crude	Light crude oils
Medium Persistent	Lube Oils	Lubricating oils
	Medium Crude	Medium crude oils
Heavy Persistent	Heavy Oils	Heavy fuel oil, bunker oils, Bunker A, Bunker B, Bunker C, intermediate fuel oil (IFO), No. 4 fuel, No. 5 fuel, No. 6 fuel, transmix,[468] residual oils/fuel, waste oil

[465] There is no standard method to determine oil persistence. For example, diesel fuel is sometimes classified as "persistent" and sometimes classified as "non-persistent" (See Davis et al. 2003; Etkin 2002).
[466] These categories have been used by the EPA in its assessment of spill impacts at EPA-regulated inland facilities (Etkin 2004).
[467] Gasoline can be separated out as a separate category if desired.
[468] A mixture of refined petroleum products that forms when transported in pipelines; the mixture is typically a combination of gasoline, diesel, and jet fuel, though heavier oils may also be included.

Volatile Distillates (Non-Persistent)

This category includes refined petroleum products that are highly toxic but evaporate relatively rapidly, such as gasoline, jet fuel, kerosene, crude condensate, and No. 1 fuel oil. In the U.S., this category is called "Group I Oil" that consists of hydrocarbon fractions at least 50% of which, by volume, distill at a temperature of 645ºF, and at least 95% of which, by volume, distill at a temperature of 700ºF. In general, volatile distillates exhibit all of the following behaviors:

- Highly volatile (evaporate completely within one to two days).
- Contain high concentrations of toxic soluble compounds.
- Capable of causing localized, severe impacts to surface and subsurface resources, and contaminating drinking water.
- Generally, because they evaporate so quickly, they are nearly impossible to clean up with conventional response tools.

Light Oils (Low Persistent)

This category incorporates crude oils and refined petroleum products that are quite toxic but also contain some persistent components. These oils do not evaporate as readily as volatile distillates. The category includes: No. 2 fuel, diesel fuel, light crude oil, gas oil, hydraulic oil, and catalytic feedstock. In the U.S., this category is called "Group II Oil", including crude oil and products that have a specific gravity less than 0.85 [API° >35.0]. In general, light fuels exhibit all of the following behaviors:

- Moderately toxic.
- Will leave a residue of up to one-third of the spill amount after a few days.
- Contain moderate concentrations of toxic soluble compounds.
- Capable of oiling surface and subsurface resources with long-term contamination potential.
- Generally possible to clean up with effective response tools.

Medium Oils (Medium Persistent)

This category includes crude oils and refined petroleum products that are moderately toxic and moderately persistent, such as most crude oils, and lube oil. This category would also include synthetic crudes. In the U.S., these oils are considered "Group III Oils", having a specific gravity between 0.85 and less than 0.95 [API° ≤35.0 and >17.5]. In general, these medium oils exhibit all of the following behaviors:

- About one-third will evaporate within 24 hours.
- Oil contamination can be severe and long-term.
- Oil impacts to waterfowl and fur-bearing mammals can be severe.
- Cleanup is most effective if conducted quickly.

Heavy Oils (Heavy Persistent)

This category includes crude oil and petroleum products that are persistent, though less toxic. This group includes heavy fuel oil, Bunker C, No. 5 or No. 6 fuel, most intermediate fuel oils, and heavy crude oils. This category would also include bitumen blends. In the U.S., these oils are classified as Group IV, having a specific gravity between 0.95 to and including 1.0 [API° ≤17.5 and >10.0]. In general, these heavy oils exhibit all of the following behaviors:

- Heavy oils with little or no evaporation or dissolution.
- Heavy contamination likely.
- Severe impacts to waterfowl and fur-bearing mammals through coating and ingestion.
- Long-term contamination of sediments possible.
- Weather slowly.
- Shoreline and substrate cleanup is difficult under all conditions.

Oils that have specific gravities over 1.0 [API° ≤ 10.0] are called "Low API° Oils" (or "LAPIOs"). In the U.S., these oils are classified as Group V. These oils are unique in that they can sink or remain submerged in the water column when spilled without needing aggregation with any sediment to otherwise increase their mass. In other ways, they behave and have impacts much as other heavier oils do and are thus included in this general category.

Oil Group Classifications

The EPA and USCG define petroleum-based oil groups based on specific gravity (density) as in Table 58.

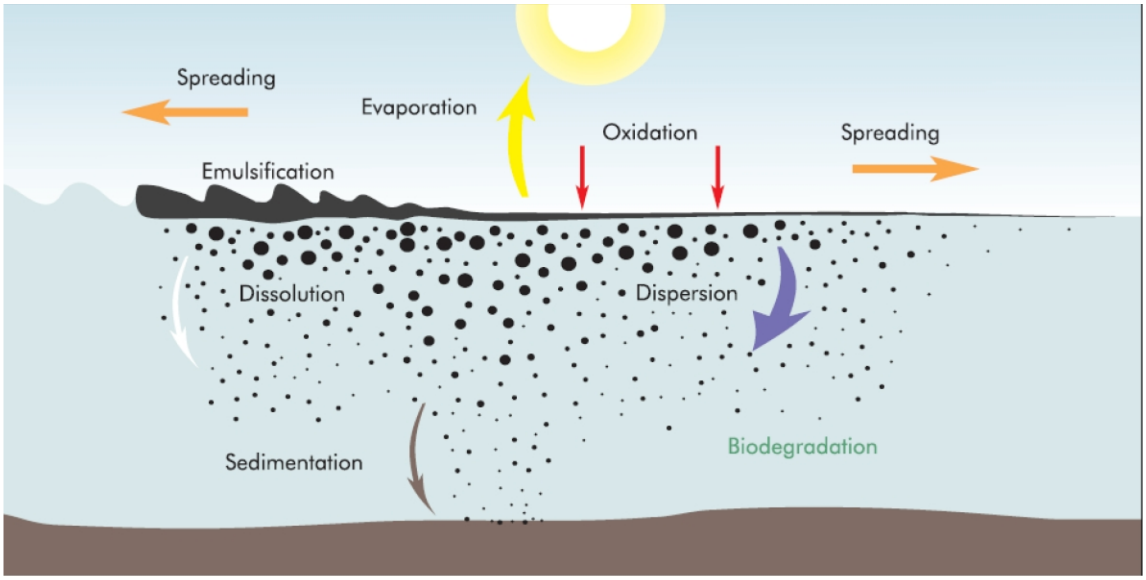
Table 58: Oil Groups and Examples

Group	Density	°API	Examples
Group I	Less than 0.80	>45.2	Gasoline, kerosene
Group II	0.8 – 0.85	45.2 – 34.8	Gas oil, light crude
Group III	0.85 – 0.95	34.8 – 17.3	Medium to heavy crudes; diluted bitumens
Group IV	> 0.95, <1.00	<17.3 to ≥ 10.0	Intermediate fuel oil (IFO 180), Bunker C
Group V	> 1.00	<10.0	Orimulsion, Boscan crude

Oil Weathering

The term “weathering” is used to describe the complex physical and chemical changes that occur after oil spills onto water or onto a substrate on land. Depending on the specific type of oil and its chemical makeup, and the environmental conditions (especially temperature) into which the oil spills, the various processes occur at different rates. These processes include spreading on the water surface, evaporation, emulsification, oxidation, dissolution, dispersion, sedimentation, and biodegradation (Figure 133). Weathering affects the nature of the oil, including toxicity, and its behavior. The changed properties of the oil often affect spill response as well.

Figure 133: Oil Weathering Processes. Image source: Mediterranean Decision Support System for Marine Safety.



Density and Sulfur Content

Density, the mass per unit volume of the oil, determines its buoyancy in water. Density is commonly expressed in grams per cubic centimeter (g/cm^3).[469] The density of oil increases with weathering (evaporation of volatile hydrocarbon components) and decreasing temperature. The density of oil affects its buoyancy and the possibility of sinking. Oil will sink if its density is higher than that of the water. It will also sink when it comes in contact with sediment or other particles or debris that makes the mixture heavier than water. Sunken oil presents challenges for spill response.

Oil density also affects the rate of natural dispersion, with denser oils dispersing more readily. Denser oils also spread faster on the water surface in the early stages of a spill. Denser oils are also more likely to form stable emulsions.[470] Dispersion, spreading, and emulsion formation all affect spill response costs. While natural dispersion will tend to reduce response costs, as there is less to effectively remove, spreading and emulsion formation both tend to increase costs. With oil spreading, it is more difficult to locate and contain oil for mechanical recovery or to effectively burn or chemically disperse the oil.

[469] Pure water has a density of 1 g/cm^3; seawater generally has a density of 1.03 g/cm^3. A g/cm^3 is the equivalent of a lb/ft^3.
[470] A water-in-oil emulsion is a stable emulsion of small droplets of water incorporated in oil. Oil spills on water may form stable water-in-oil emulsions that can have very different characteristics than the parent crude oil.

Density is commonly expressed in grams per cubic centimeter (g/cm^3) or in ºAPI. The units are related as:

$$^{o}API = (141.5 / sp.gr.) - 131.5$$

$$sp.gr. = \frac{141.5}{(^{o}API + 131.5)}$$

A low ºAPI oil has a high density and specific gravity, and a high ºAPI oil has a low density and specific gravity. A heavy oil is one with an ºAPI gravity less than 20°. Oil density increases with weathering (evaporation of volatile hydrocarbon components) and decreasing temperature. Densities of some common oils are in Table 59 and Figure 134. Table 60 shows ºAPI gravity for various crude oils, along with sulfur content, which determines whether an oil is "sweet" or "sour". Any sulfur content above 0.5% sulfur is considered "sour".

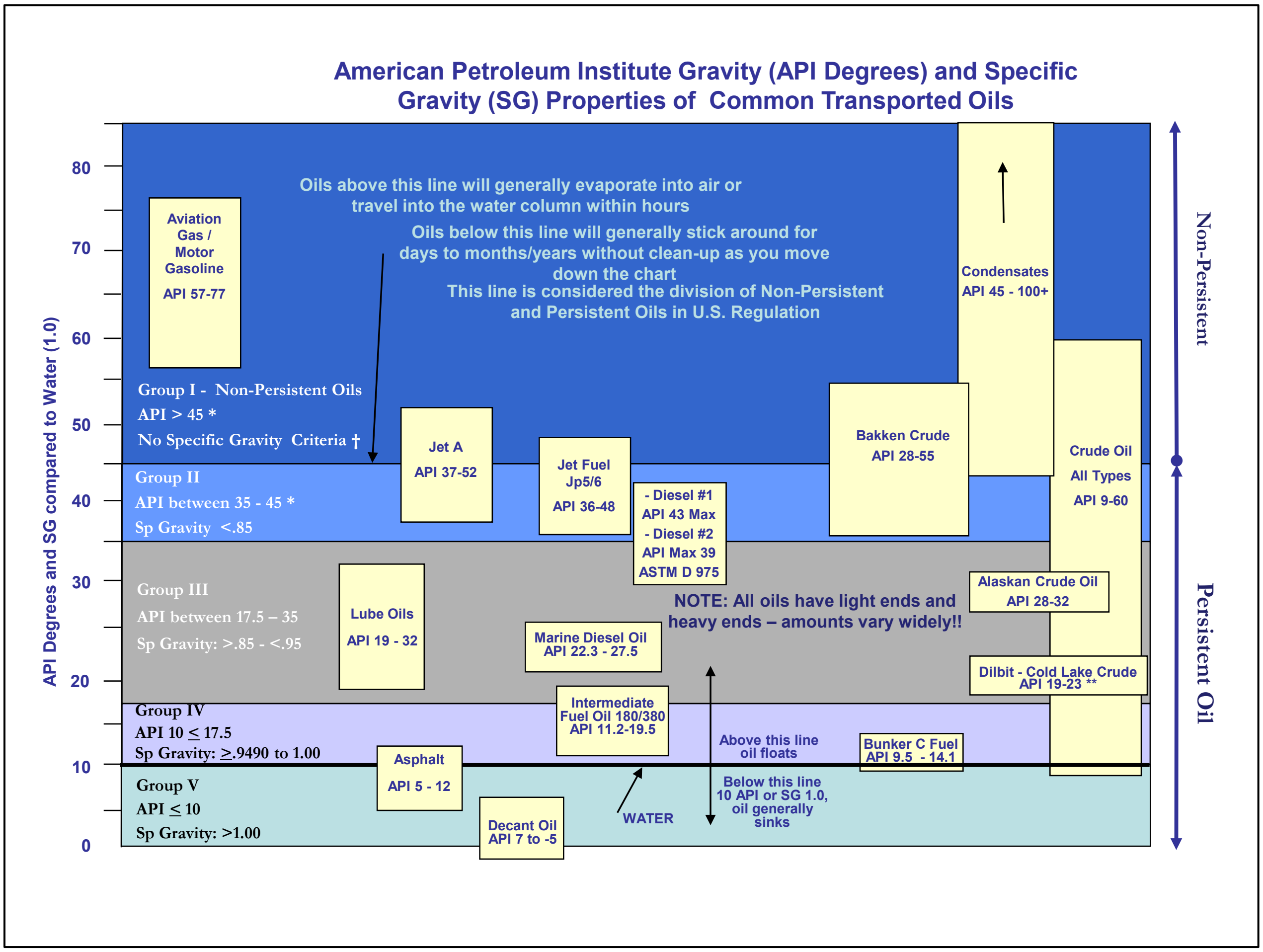
Table 59: Density for Selected Reference Oils

Oil Type	Specific Gravity (g/cm^3)	ºAPI
Heavier Crude	0.905	24.9
Alberta Crude	0.840	37.0
Alaskan North Slope	0.896	26.4
Sweet Louisiana Crude	0.845	35.9
Gasoline	0.750	57.2
Fuel #2 (Diesel)	0.838	37.4
Fuel #6	0.983	12.4
Gasoline	0.750	57.2

Table 60: ºAPI and Sulfur Content of Common Crude Oils

Crude	Origin	ºAPI	Heavy	Sulfur Content (% Mass)	Sour
Alaska North Slope	U.S.	31.9º		0.93%	✓
Albian Heavy (Athabasca)	Canada	19.6º	✓	2.10%	✓
Arab Extra Light	Saudi Arabia	39.4º		1.09%	✓
Arab Heavy	Saudi Arabia	27.7º		2.87%	✓
Arab Light	Saudi Arabia	32.8º		1.97%	✓
Arab Medium	Saudi Arabia	30.2º		2.59%	✓
Basrah Light	Iraq	30.5°		2.9%	✓
Bow River	Canada	24.7º		2.1%	✓
Brent Blend	United Kingdom	38.3°		0.37%	
Ceiba	Equatorial Guinea	29.9°		0.57%	✓
Cold Lake	Canada	21.2°		3.7%	✓
Djeno	Congo	27.0°		0.47%	
Escalante	Argentina	24.1°		0.19%	
ESPO Blend	Russia	34.8°		0.62%	✓
Gimboa	Angola	25.3°		0.56%	✓
Girassol	Angola	29.9°		0.32%	
Hungo Blend	Angola	29.1°		0.61%	✓
Kissanje Blend	Angola	29.8°		0.38%	
Lower Zakum	Abu Dhabi	39.8		1.02%	✓
Lula	Brazil	28°		<0.5%	
Marib Light	Yemen	48.9°		0.07%	
Marlim	Brazil	19.6	✓	0.67%	✓
Masila	Yemen	31.4°		0.54%	✓
Nemba	Angola	40.9°		0.18%	
Oman Blend	Oman	34°		2%	✓
Pazflor	Angola	25.6°		0.41%	
Plutonio	Angola	32.6°		0.39%	
Saharan	Algeria	45°		0.09%	
Saudi Arabia Light	Saudi Arabia	34°		-	-
Saudi Arabia Medium	Saudi Arabia	31°		-	-
Sokol Sweet Blend	Russia	36.7°		0.25%	
Syncrude Sweet Blend	Canada	30.5-33.6°		0.07-0.13%	
Vityaz (Sakhalin II)	Russia	34.6°		0.22%	
West Texas Intermediate	United States	39.6°		0.24%	
Zakum	Abu Dhabi	40.2°		1.01%	✓

Figure 134: Density of Common Transported Oils[471]



Evaporation

The most toxic substances in oil (e.g., benzene, toluene, ethylbenzene, and xylene) are also more likely to evaporate and disperse, which reduces the time they remain concentrated in the aquatic environment. The toxic effects of oil are usually realized in the first hours to days of a spill. Evaporation of the volatile hydrocarbons leaves behind the heavier, more persistent fractions of oil. Evaporation rates are dependent on temperature, with higher evaporation in warmer temperatures. Evaporation percentages of some common oils are shown in Table 61.

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471 Group I/II boundary uses California OSPR definition. **Dilbit (diluted bitumen) generally contains percentage of products heavier than water. †Group I oils determined by distillation criteria that one cannot easily use in field. Group II unbounded on light ends except Group I definition (33 CFR 155.1020). Note: California set lower boundary for pre-booming Group II oils at 45°API gravity. All else same as 33 CFR 155.1020. Salt water SG 1.025(+/– depending on locality). **SG for Group I & II comes from California's definition for oil types (CCR Title 14, Division 1, SubDivision 4, Chapter 1). †33 CFR 1020 Definitions: Non-persistent/Group I oil means petroleum-based oil that, at time of shipment, consists of hydrocarbon fractions: (1) At least 50% of which by volume, distill at 645°F; and (2) At least 95% of which by volume, distill at a temperature of 700°F.

Table 61: Evaporation Percentages for Selected Reference Oils

Oil Group	Representative Oil Type	Evaporation % (after 24 hours)	
		1ºC (33.8ºF)	15ºC (59ºF)
Volatile Distillate	Gasoline	88	88
Light Oil	Fuel #2 (Diesel)	16	34
Medium Oil	Crude	22	25
Heavy Oil	Fuel #6	6	4

The more oil that evaporates and changes its physical form, the less oil there is to remove mechanically, and the less oil that persists in the environment to impact natural and socioeconomic resources. At the same time, the presence of volatile components means that there will be at least some toxic impacts from the oil, which translates to ecological consequences as well.

Viscosity

Viscosity is a measure of the resistance of oil to flowing once in motion. Oil viscosity increases as weathering progresses and increases with decreasing temperature. Viscosity is one of the most important properties for spill behavior as it affects (1) spreading - the more viscous the oil, the more slowly it spreads and (2) emulsification – the more viscous the oil, the more stable the emulsion.

Viscosity also affects the effectiveness of certain spill response measures. Highly viscous oils are difficult to disperse chemically. Natural dispersion is also reduced in highly viscous oils. More viscous oils are difficult to recover with skimmers and pumps and thus tend to increase response costs.

Oil Pour Point Effect

The "pour point" of a particular oil is the lowest temperature at which the oil will still flow. Below this temperature the oil begins to develop an internal yield stress and, in essence, solidifies. If the ambient temperature is above the pour point of the oil, the oil will behave as a liquid. If the ambient temperature is below the pour point, the oil will behave as a semi-solid. The pour point temperature increases with weathering (evaporation of volatile components). Pour point affects spreading on the water surface. Oils that are at temperatures below their pour points will not spread and are more difficult to disperse. Viscosity increases dramatically at temperatures below the pour point.

Because oils will resist flowing toward skimmers or down inclined surfaces in skimmers, there are challenges in mechanical oil recovery at these temperatures. The solidification of the oil below its pour point also causes problems in storage and transfer. These factors can increase spill response costs because more work needs to be done manually.

Interfacial Tension

Interfacial tension is a measure of the surface forces that exist between the interfaces of the oil and water and the oil and air. Interfacial tensions (oil and air and oil and water) are insensitive to temperature, but are affected by evaporation. Interfacial tension affects the rate and type of spreading on the water surface as well as sheen[472] formation. Interfacial tension also affects emulsion rates and emulsion stability.

Since chemical dispersants[473] work by reducing the oil and water interfacial tension to allow a given mixing energy[474] to produce smaller oil droplets, the degree of interfacial tension in an oil will affect the ability of an oil to be chemically dispersed. Oils with high interfacial tensions are more difficult to disperse with chemical dispersing agents, and also disperse less naturally. This will tend to limit the effectiveness of dispersants and require more expensive mechanical methods for cleanup.

At the same time, mechanical recovery with oleophilic[475] skimmers (e.g., rope-mop and belt skimmers) work better on oils with moderate to high interfacial tensions. Increased effectiveness of mechanical recovery will reduce response costs. The more oil can be recovered on the water surface will result in less impacts to the shoreline. It is a tradeoff, however, in either case as oil spills have impacts no matter where the oil is spilled.

Adhesiveness and Mechanical Injury Potential

The adhesiveness of a particular oil type is the degree to which oil remains on a surface after contact and draining. This character has an effect on spill impacts by way of the amount of oil that will stick to surfaces, including shoreline substrates and structures (e.g., piers, boats, seawalls). Higher adhesion increases damage costs and increases shoreline cleanup costs. At the same time, adhesion can increase the effectiveness of some on-water recovery methods, including use of oleophilic skimming devices.

The adhesiveness of a specified oil is the degree to which oil remains on a surface after contact and draining. This character has an effect on spill impacts by way of the amount of oil that will stick to surfaces, including shoreline substrates and structures (e.g., piers, boats, seawalls). There is no standard methodology for determining adhesiveness. One methodology that has been applied is the measure of the grams of oil that stuck to a square meter of surface. This testing allows for a relative comparison of adhesiveness between various oils, as shown in Table 62.

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[472] A "sheen" is a very thin layer of oil on the water surface. Rainbow-colored sheens are generally 0.0003 mm thick. Silver sheens are usually about 0.0001 mm thick.
[473] Chemical substances used to enhance the breakup of oil into tiny droplets to allow for natural biodegradation and metabolism by microorganisms.
[474] Waves and sea state.
[475] Attracting oil.

Table 62: Adhesiveness for Selected Reference Oils[476]

Oil Group	Oil Type	Adhesion (g/m^2)
Medium Oil	Crude	28
Medium Oil	ANS Crude	28
Medium Oil	Alberta Sweet Mixed Blend Crude	13
Light Oil	Sweet Louisiana Crude	18
Heavy Oil	Intermediate Fuel Oil (IFO 180)	49
Volatile Distillate	Jet Fuel (Jet A/Jet A-1)	1
Volatile Distillate	Gasoline	1
Light Oil	Fuel #2 (Diesel)	6
Heavy Oil	Fuel #6	85

Oil can also cause "mechanical injury" based on its adhesive properties. This injury is caused by coating, fowling, or clogging of organisms and their appendages and apertures, such that movements and behaviors are mechanically inhibited.[477]

The Washington State Department of Ecology[478] developed a formula to calculate a relative mechanical injury index (on a scale of 0 to 5) based on specific gravity[479], as follows:

$$MechanicalInjury = \frac{(sp.gr. - 0.688)}{0.062}$$

The result is then rounded to the nearest 0.1 to derive the relative score, with higher scores denoting more mechanical injury. Since specific gravity can change with temperature (and weathering), mechanical injury is related to these factors as well. In higher temperatures, mechanical injury reduces slightly. Examples of mechanical injury rankings and other oil properties for eight reference oils are shown in Table 63.

Mechanical injury and coating impacts are related to persistence without having a toxicity component. The second category is related to socioeconomic impacts, particularly with regard to any longer-term impacts on fisheries, and the coating of shoreline features (e.g., tourist beaches, marinas, shore-front property). For the third category, response is affected by oil persistence in that shoreline (and soil sediment) cleanup operations, as well as most aspects of on-water recovery, are basically focused on the more persistent fractions of the spilled oil rather than on the volatile components that evaporate relatively quickly.

[476] SL Ross private communication.
[477] FrencM-HcCay et al. 2009.
[478] Washington Department of Ecology 2003.
[479] The density of the oil relative to water, which is the same as its density in g/cm^3.

Table 63: Mechanical Injury Rating for Selected Reference Oils

Oil Group	Representative Oil Type	Mechanical Injury Rank
Medium Oil	Crude	3.6
Medium Oil	ANS Crude	3.4
Medium Oil	Alberta Sweet Mixed Blend Crude	2.5
Light Oil	Sweet Louisiana Crude	2.5
Heavy Oil	Intermediate Fuel Oil (IFO 180)	4.9
Volatile Distillate	Jet Fuel (Jet A/Jet A-1)	2.0
Volatile Distillate	Gasoline	1.0
Light Oil	Fuel #2 (Diesel)	3.2
Heavy Oil	Fuel #6	5.0

Emulsification

A water-in-oil emulsion[480] is a stable emulsion of small droplets of water incorporated in oil. Oil spills on water may form stable water-in-oil emulsions that can have different characteristics than the parent crude oil. The tendency to form emulsions, the stability[481] of those emulsions, and the water content of stable emulsion are all important characteristics of an oil that can affect impacts as well as response.

Emulsification can have impacts on spill response and impacts. Emulsified oils can be persistent in the environment. Strongly emulsified oils are also highly viscous, often with 10 to 100 times the viscosity of the parent oil. Oils with relatively high concentrations of asphaltenes are most likely to form stable water-in-oil emulsions. Some heavy oils do not easily form emulsions because the high viscosity of the oil prevents the uptake of water. Some light or medium oils do not form an emulsion immediately, but once evaporation occurs and the asphaltene concentration increases, the emulsification process begins and usually proceeds quickly thereafter. Emulsions can present challenges for all types of response strategies, increasing costs and logistical concerns, such as increases in storage of collected oil (i.e., larger volume with oil/water mixture).

Persistence

The *persistence* of the oil in the environment can also affect the impacts of a spill. The heavier, more persistent fractions of oil are those that adhere to the feathers of birds and fur of mammals, as well as to shoreline and wetland communities. For birds and mammals, this coating can cause hypothermia. For organisms living along shoreline or in wetlands, this can cause smothering. Both smothering and hypothermia can result in mortality, which increases environmental

[480] Water-in-oil emulsion is colloquially called "chocolate mousse".
[481] Emulsion stability can be: low, which indicates the emulsion is unstable and will break quickly once removed from the mixing environment; moderate, which means the emulsion will break within a few hours; or high, which means the oil forms a very stable emulsion that is unlikely to break even after standing for 24 hours.

damages. The persistence of oil and the degree to which the oil adheres to shoreline substrates and penetrates those substrates will affect the degree of ecological consequences[482]

Initially, the oil "persists" on the water surface, i.e., stays as a "slick" or fragments of "slicks" or sheen for a certain amount of time before it evaporates, disperses, and/or dissolves. One method for approximating the time which oil stays on the water surface is to apply the following formulae based on spill volume.[483]

For crude oil spills greater than or equal to 1,000 barrels (42,000 gallons):

$$PD_{>1000bbl} = 0.0001S - 1.32T + 33.1$$

PD = persistence in days
S = spill size in barrels
T = water temperature in degrees Celsius

For spills less than 1,000 barrels:

$$PD_{<1000bbl} = 0.0034S + 2.02$$

Persistence on shorelines and in other parts of the environment (e.g., sediments) is not easily determined for specific types of oil. Persistence is a complex characteristic of oil related to viscosity, adhesiveness, and evaporative character that accounts for a given oil's duration in the environment before degrading.[484] The degree of persistence is determined primarily by the presence of heavier components, such as waxes, asphaltenes, and polar compounds. Persistence varies with wave energy, substrate permeability and exposure, and weathering.[485]

There is no direct measure of persistence since it depends on a number of other oil characteristics. It is usually measured in relative terms, comparing one oil type to others, and with regard to the amount of time that oil remains in the environment based on empirical data collected in the aftermath of historical spills. One example of a relative ranking for persistence of oil is that developed by Ecology, as shown in Table 64.

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482 Etkin et al. 2008a, 2008b; Davis et al. 2004.
483 SL Ross et al. 2003.
484 Davis et al. 2004.
485 "Weathering" is the physical and chemical breakdown of oil upon exposure to sunlight and air. Weathering processes are predominated by evaporation.

Table 64: Relative Ranking Scores for Classified Oils[486]

Oil Group	Representative Oil	Persistence56[487]	Anticipated Time in Environment
Medium Oil	Prudhoe Bay Crude Oil	5	5 – 10 years or more
Heavy Oil	Bunker C	5	5 – 10 years or more
Light Oil	No. 2 Fuel Oil	2	1 month to one year
Volatile Distillate	Gasoline	1	1 day to weeks
Volatile Distillate	Kerosene, Jet Fuel	1	1 day to weeks

The American Petroleum Institute (API)[488] reviewed persistence of crude oil and various petroleum products to assess the relative persistence of oil products in the aquatic environment and to rank oil products based on their persistence in the aquatic environment. The results of API's analysis with regard to persistence of various broad categories of petroleum products are shown in Table 65.

Table 65: Numerical Scale for Relative Oil Persistence in the Aquatic Environment[489]

Oil Group	Oil/Oil Product	Relative Persistence Rank[490]	Persistence Classification
Volatile Distillate	Gasoline	1	Relatively non-persistent
Volatile Distillate	Jet Fuel	2	Relatively non-persistent
Light Oil	No. 2 Fuel Oil	8	Relatively non-persistent
Medium Oil	Lube Oils	55	Slightly persistent
Light Oil	Light Crude Oil	320	Highly persistent
Heavy Oil	No. 6 Fuel Oil	400	Highly persistent
Medium Oil	Medium Crude Oil	450	Highly persistent
Heavy Oil	Heavy Crude Oil	590	Highly persistent
Heavy Oil	Residual Asphaltenes	1,600	Highly persistent

Figure 135 shows the persistent fraction of petroleum products in aquatic environments, expressed as percent of original material remaining in water, sediment, and soil. For each pair, the top bar represents the most persistent components and the bottom bar the least persistent components.

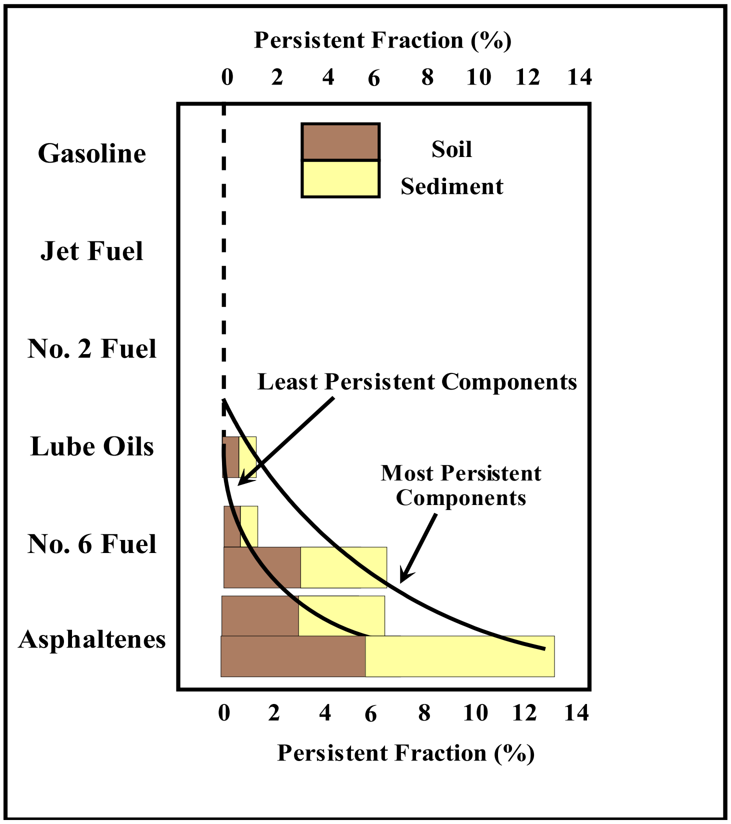
In addition, API (1995) discussed two aspects of persistence that need to be considered in terms of environmental impacts: toxicity-based and habitat-based concerns.

With regard to toxicity-based concerns for oil persistence, the report explains that there is low bioavailability of oil in the water column or dissolved fractions after the oil weathers. Weathering changes the characteristics of the oil in that various compounds evaporate or become less available due to aggregation through sedimentation, precipitation, or emulsification. Based on this fate of spilled oil, the API report states:

486 Based on Washington Department of Ecology 2003 (Washington DOE Damage Compensation Schedule)
487 Ranks are based on scale of 1 to 5 for least to most.
488 API 1995.
489 Based on API 1995.
490 Relative ranking with "1" being least persistent to "1,600" being extremely persistent.

"A common industry perspective is that the persistent oil compounds from a spill (e.g., residues, tar balls, mousse) are of low concern since they are not bioavailable. Thus multiplying a toxicity factor by a persistence factor in a compensation table seems illogical and is questioned. The argument is made that if the more persistent compounds are not bioavailable due to their form and low solubility, they cannot exert a toxic impact or cause biological injury."

Figure 135: Persistent Fraction of Petroleum Products on Aquatic Environments[491]



API's report (1995) also questions attempts to relate persistence and acute toxicity[492] as the latter involves brief exposure. Chronic effects could, however, be more appropriately related to the toxicity-based context of persistence.

The second area of concern with respect to oil persistence, according to the API report, is the physical or mechanical disruption due to the presence of oil residues in habitats. Residual oil can interfere with the normal physical characteristics of substrates and sediments and make them inhabitable. Oil residues can also agglomerate with inorganic and organic particles or debris and become ingestible. "This physical interference may persist for periods of time since the same

[491] American Petroleum Institute (API) 1995.
[492] Acute toxicity: the adverse affects of a substance that result from a single exposure or over the course of a relatively short period of time (usually less than 24 hours).

characteristics of the weathered hydrocarbons reduce their biological availability also allow them to persist as a potential habitat impediment," the report concludes.

> "The "bioavailability" of oil components is an important determinant of the degree to which residual oil will have an impact on ecosystems and organisms in the environment impacted by a spill. Bioavailability is the degree to which the oil components are in solution and can be absorbed by organisms to then have a physiological effect. The measure of bioavailability in oil spills has become a contentious area of research."

Oil Persistence on Water Surface

The oil "persists" on the water surface, i.e., the oil stays as a "slick" or fragments of "slicks" or sheen for a certain amount of time before it evaporates, disperses, and/or dissolves. The rate of evaporation will vary with oil type, with lighter oils (non-persistent and low persistent) evaporating more quickly and to a greater extent than heavier oils. Water temperature also affects the rate of evaporation, with evaporation increasing with temperature. For example, the estimated time on the water surface for crude oil spills (medium persistent) in Cook Inlet (Alaska) is shown in Table 66.

Table 66: Estimated Time on Water Surface for Crude Oil Spills in Cook Inlet[493]

Spill Volume (gallons)	Estimated Time on Water Surface	
	Summer (50ºF)	Winter (36ºF)
1	2.0	2.0
10	2.0	2.0
100	2.1	2.1
1,000	2.8	2.8
10,000	10.1	10.1
100,000	20.1	30.4
1,000,000	22.3	32.6
10,000,000	43.7	54.0
75,000,000	198.5	208.8

Toxicity

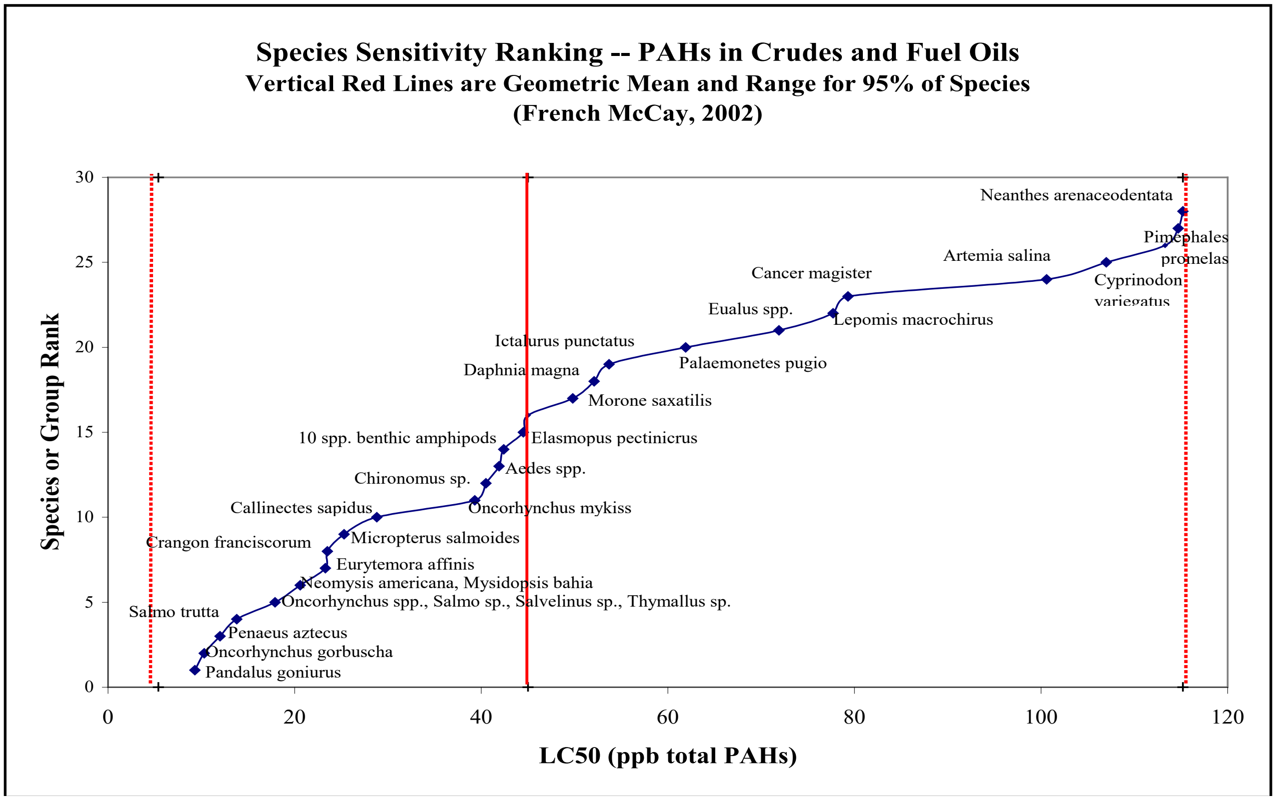
The toxicity of the oil determines the adverse effects and mortality of fish, wildlife, and invertebrates after short-term exposure (hours to days). Mortality as well as sub-lethal effects (e.g., reduced fecundity) is relevant to both environmental impacts, and socioeconomic impacts in as much as commercial fisheries, subsistence fishing and fishing-related cultural activities (particularly important in tribal areas), and recreational fishing are affected. Different organisms have different tolerances of exposure. The toxicity of the oil determines the adverse effects and mortality of fish, wildlife, and invertebrates after short-term exposure (hours to days). In the field, lethal and sub-lethal toxic effects are determined not only by the composition of the oil

[493] SL Ross Environmental Research et al. 2003

itself but also by the length of time that the susceptible organisms are exposed to the oil, i.e., the actual *dose exposure* (time x toxicity) that the organisms experience.

Oil toxicity is determined by the presence of aliphatics,[494] monoaromatic hydrocarbons,[495] and polycyclic aromatic hydrocarbons (PAH).[496] Toxicity is generally expressed in terms of "LC_{50}", which is the concentration at which 50% of the population of a particular species dies. The lower the LC_{50}, the lower the PAH concentration that causes mortality. Different organisms have different tolerances of exposure. Some species are particularly sensitive to exposure to hydrocarbons (Figure 136).

Figure 136: Species Sensitivity Rankings – PAHs in Crudes and Fuel Oils[497]



[494] Straight-chain hydrocarbons (e.g., alkanes)
[495] Benzene, toluene, ethylbenzene, xylenes, and alkyl-substituted benzenes.
[496] Also called "polynuclear aromatic hydrocarbons" (naphthalenes, phenanthrenes, fluorenes, dibenzothiophenes).
[497] French-McCay 2002.

Another method for determining relative toxicity is the acute toxicity relative ranking score.[498] The acute toxicity (OIL_{AT}) is determined by the relative composition of 1-, 2-, and 3-ringed aromatic compounds weighted by the aqueous solubility of the aromatic compounds. The Acute Toxicity Score is therefore based on the percentage of bioavailable components in the oil that could cause toxicity to fish, invertebrates, and wildlife. Bioavailable components are those that are soluble or semi-soluble in water (i.e., 1- to 3-ring aromatic compounds), such that they can dissolve from the oil into water and then be taken up by the organisms directly from the water or through the gut (if oil is ingested).

A raw acute toxicity relative ranking score (1 to 5) is calculated as follows:

$$OIL_{AT} = \frac{[(SOL_1 \cdot PCT_{WT1}) + (SOL_2 \cdot PCT_{WT2}) + (SOL_3 \cdot PCT_{WT3})]}{170}$$

Where:
SOL_i = solubility in seawater of i-ring aromatic hydrocarbons, where i = 1, 2 or 3

PCT_{WTi} = percent weight of i-ring aromatic hydrocarbons in the spilled oil, i = 1, 2 or 3

The weighted percentages and solubility quotients are divided by the value 107 to bring Prudhoe Bay crude oil, with a raw acute toxicity score of 96.3, to a ranked value of 0.9. The values are ranked relative to the most and least toxic substances on roughly a five-point scale with gasoline at the highest toxicity of 5.0. Examples of acute toxicity scores for the most common oils are shown in Table 67.

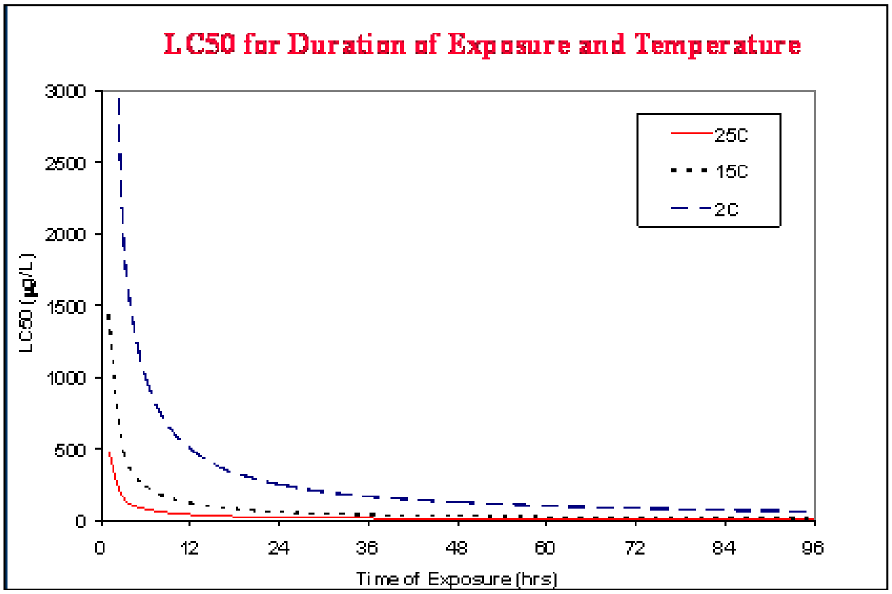
Table 67: Acute Toxicity Relative Ranking Scores for Common Oils[499]

Oil Group	Oil Type	Wash. Dept. of Ecology 2003 Ranking
Medium Oil	Crude oils	0.9 (Prudhoe Bay)
Heavy Oil	Heavy oils (Bunker C)	2.3
Light Oil	Diesel	2.3
Volatile Distillate	Gasoline	5.0
Volatile Distillate	Jet fuel	1.4

Toxicity varies by temperature and exposure time (Figure 137). In general, the greater the duration of exposure to toxic compounds, the higher the mortality. Toxicity decreases with increasing temperature. The longer the duration of exposure, the greater the mortality.

[498] Described in Washington Department of Ecology (2003) and Geselbracht and Logan (2003).
[499] Based on Washington Department of Ecology 2003.

Figure 137: Variation in LC_{50} at Different Temperatures and Time of Exposure



Overall Oil Impact Classifications

Taking into account all of the characteristics of the oils, the four oil groups have been classified with respect to their general impacts as in Tables 68 and 69 and in Figure 138. Based on the types of spills that had occurred in Washington and were likely to occur in the future, the Department of Ecology developed the Washington Compensation Schedule[500] for determining the damages associated with spills of different types of oil into marine and freshwater habitats.

Potential impacts are rated on a numerical scale from low to high, considering oil toxicity, persistence, and the vulnerability of the state's marine and aquatic resources at particular locations and in various types of water bodies. The oil properties of acute toxicity, mechanical injury, and persistence are used to characterize the behavior and impacts of the different oil types.

Table 68: Washington State Oil Class Ranking of Typical Oils[501]

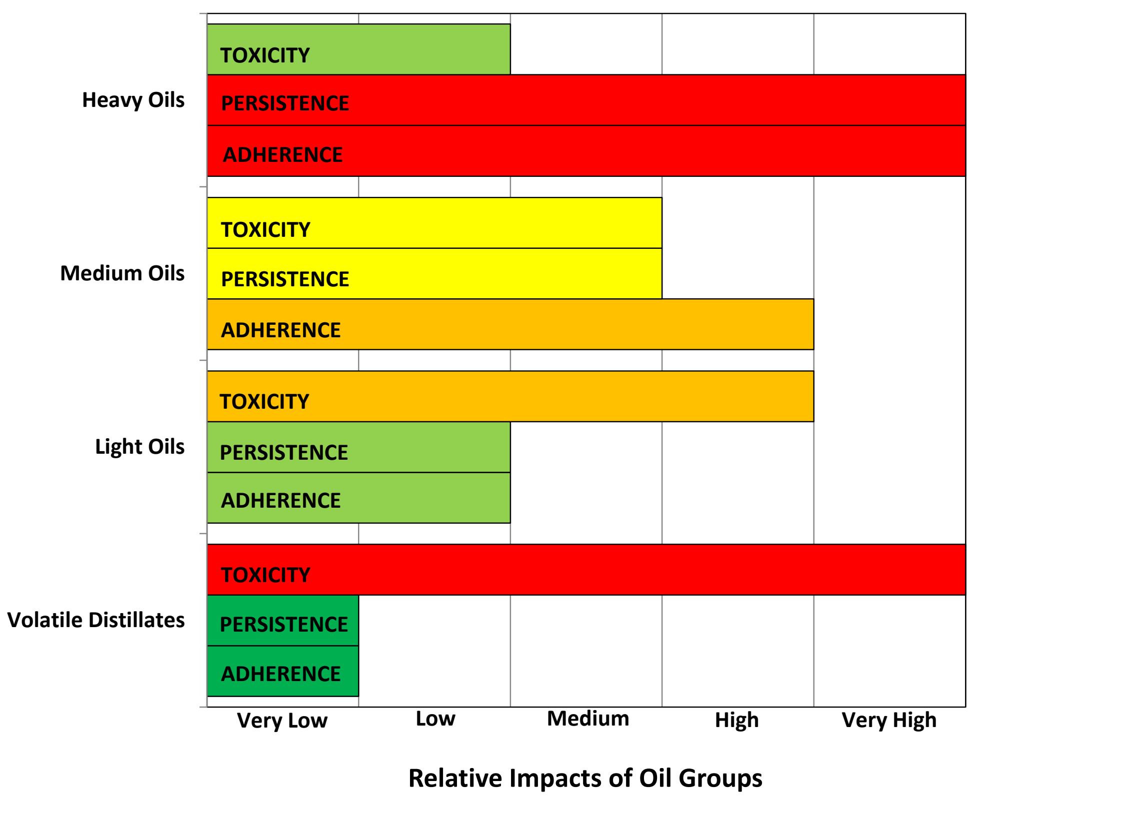
Oil Class	Acute Toxicity	Mechanical Injury	Persistence	Total
Prudhoe Bay Crude Oil	0.9	3.6	5	9.5
Bunker C	2.3	5	5	12.3
No. 2 Fuel Oil	2.3	3.2	2	7.5
Gasoline	5	1	1	7
Kerosene	1.4	2.4	1	4.8
Kerosene-Type Jet Fuel	1.4	2.4	1	4.8

500 WAC §173-183 "Pre-Assessment Screening and Oil Compensation Schedule Regulations"
501 WAC §173-183-340.

Table 69: Basic Relative Oil Properties as They Affect Wildlife and Habitats

Oil Group	Oil Impact		
	Toxicity	Persistence	Adherence
Volatile Distillates	High	Low	Low
Light Oils	High	Low	Low
Medium Oils	Medium	Medium	High
Heavy Oils (Including Sinking Oils)	Low	High	High

Figure 138: Impact Characteristics of Oil Groups (Oil Groups by Impact Type)[502]



[502] Source: Environmental Research Consulting, based on previous studies, including Etkin 2012.

Appendix E: In Depth: Properties of Crude-by-Rail Oils – Bakken Crude

Crude oil is highly variable with respect to content and thus has a wide range of physical and chemical properties. The components of crude oil are refined into a large number of products ranging from jet fuel, kerosene, and gasoline, made from the lightest ends, to diesel, through to heavier components, which are used to make heavy fuel oils, and the heaviest components that make asphalts. Crude oils from different regions and reservoirs have different proportions of these components. Alaska North Slop (ANS) crude is generally heavier than South Louisiana crude but not as heavy as some types of Venezuelan crude. Even when taken from the same oil fields, crude properties may change over time, as different depths and areas within the same field are used.

Recent changes in the transportation of crude oil into and through the state of Washington have primarily involved the transport by rail of two types of crude oil: Bakken crude from North Dakota,[503] and diluted bitumen[504] (see Appendix F in this report) from Alberta, Canada. These two categories of crude oils are vastly different from each other and also vary considerably within each category. The properties of these two categories of crude oil present unique challenges for spill response and may cause different types of environmental impacts than oils that have been previously transported, stored, and used in the state. These oils may not easily fit into the categories described under the Washington Compensation Schedule above.

According to WAC §173-183-340, in cases where the spilled oil is not described by any of the oil classes listed (as in Table 68), or is a mixture of oils, the Washington State Department of Ecology shall determine the acute toxicity, mechanical injury, and persistence scores based on the methodologies described under Acute Toxicity, Mechanical Injury, and Persistence above to the extent possible.

Basic Properties of Bakken Crude

The characteristics of Bakken crude and the way in which to classify it for regulations related to transport and handling, and for preparing for spill responses and potential public health and safety issues, has been a matter of considerable disagreement.

Samples of Bakken crude are depicted in Figure 139. It has a low viscosity and flows much more like diesel or gasoline than a crude oil. It has been described as looking like “two-stroke oil mixed with gasoline.”

[503] Often referred to as “North Dakota Sweet”.
[504] Various forms of diluted bitumen have been transported into Washington from Canada via pipeline since the 1980s. The distinct change in the last couple of years is the transport by rail.

Figure 139: Appearance of Bakken Crude Spilled from Barge E2MS 303 Lower Mississippi River[505]

Bakken crude oil, or North Dakota sweet crude, exhibits the properties shown in Table 70. In the table, Bakken crude is compared with West Texas Intermediate crude, which is often used as a "standard" crude oil for comparison purposes.

Table 70: Properties of Bakken Crude (North Dakota Sweet Crude)[506]

Test	Unit	Results	
		North Dakota Sweet	West Texas Intermediate[507]
Carbon Residue	%	0.54	1.69
Density	°API	42.1	39
Hydrogen Sulfide (H_2S)	ppm	<1	<1
Metals – Nickel – Pitch	ppm	7.8	28
Metals – Nickel – Whole	ppm	0.6	3
Metals – Vanadium – Pitch	ppm	6.6	42
Metals – Vanadium – Whole	ppm	0.4	5.2
Organic Chlorides – Naphtha	ppm	<1	-
Organic Chlorides – Whole	ppm	<1	<1
Pour Point	degrees F	<-27.4	<-27.4
Reid Vapor Pressure (RVP)	psia	5.94	4.86
SALT	lb/MB	63.4	64.3
Sulfur	%	0.0955	0.428
TAN E[508]	mg KOH/g	<0.1	0.4
Viscosity (SSU) @ 100°F		33.7	37.9
Viscosity (SSU) @ 60°F		37.7	45.6
Viscosity (SSU) @ 80°F		35.3	41.1

505 Source: NOAA.
506 Results based on North Dakota sweet sample (Lab Reference US320-0060054) taken 14 January 2014 and WTI sample (Lab Reference US320-0054517) taken 1 March 2013 as reported on www.caplinepipeline.com.
507 West Texas Intermediate crude has traditionally been used as a benchmark against which the properties of other crudes are measured (Miller et al. 2010).
508 Total Acid Number. The units are in milligrams of potassium hydroxide (KOH) per gram.

Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX)

Samples of Bakken crude oil that spilled in the Lac-Mégantic incident in Quebec were analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX) content for the Transportation Safety Board of Canada, with the results shown in Table 71.[509] These natural constituents of crude oil are the most toxic and soluble components. They readily enter soil and groundwater during accidental spills. BTEX compounds are classified as priority pollutants by Environment Canada and the USEPA. The results indicate that the BTEX compositions of the Bakken crude samples are comparable to typical crude oils, such as West Texas Intermediate crude. The levels of BTEX compounds measured at the site of the Lac-Mégantic incident were reported to be well above recommended exposure limits in the portions of the derailment site that were extensively contaminated with the spilled crude oil.

Table 71: BTEX Testing Conducted on Lac-Mégantic Incident Bakken Crude Samples

Analyte	Analytical Results (ppm)[510]					Comparison	
	Sample 1	Sample 2	Sample 3	Sample 4	Average	Gasoline	WTI Crude[511]
Benzene	1,850	1,720	1,800	1,470	1,663	49,000	1,380
Toluene	3,170	2,870	2,920	2,770	2,933	250,000	2,860
Ethylbenzene	850	768	789	852	815	30,000	1,120
m/p-Xylene	3,500	3,300	3,310	2,890	3,250	-	4,290
o-Xylene	1,660	1,560	1,620	1,500	1,585	-	-

Alkane and Aromatic Profiles

Testing conducted at Louisiana State University for NOAA has provided further detail on the hydrocarbon profiles (alkanes and aromatics) for Bakken crude (Table 72). These are other components of oil that have a bearing on toxicity. Polycyclic aromatic hydrocarbons (PAHs) are also persistent in the environment.

[509] *Transportation Safety Board of Canada Laboratory Report LP148/2013.*
[510] Parts per million. Samples are from different tank cars involved in the derailment and spill.
[511] West Texas Intermediate crude.

Table 72: Bakken Crude Oil Testing Conducted at Louisiana State University[512]

Alkane Profile		Aromatics (PAH) Profile	
Alkane Analyte	Concentration (mg/Kg)	Aromatic Analyte	Concentration (mg/Kg)
nC-10 Decane	2,600	Naphthalene	750
nC-11 Undecane	2,600	C1-Naphthalenes	1,600
nC-12 Dodecane	2,600	C2-Naphthalenes	2,000
nC-13 Tridecane	2,500	C3-Naphthalenes	1, 400
nC-14 Tetradecane	2,400	C4-Naphthalenes	690
nC-15 Pentadecane	2,000	Fluorene	130
nC-16 Hexadecane	1,800	C1-Fluorenes	340
nC-17 Heptadecane	1,700	C2-Fluorenes	390
Pristane	960	C3-Fluorenes	300
nC-18 Octadecane	1,500	Dibenzothiophene	53
Phytane	770	C1-Dibenzothiophenes	170
nC-19 Nondecane	1,300	C2-Dibenzothiophenes	220
nC-20 Eicosane	1,300	C3-Dibenzothiophenes	160
nC-21 Heneicosane	1,100	Phenanthrene	290
nC-22 Docosane	1,000	C1-Phenanthrenes	680
nC-23 Tricosane	940	C2-Phenanthrenes	660
nC-24 Tetracosane	890	C3-Phenanthrenes	400
nC-25 Pentacosane	600	C4-Phenanthrenes	200
nC-26 Hexacosane	510	Anthracene	6.1
nC-27 Heptacosane	350	Fluoroanthene	4.2
nC-28 Octocosane	300	Pyrene	8.9
nC-29 Nonacosane	250	C1-Pyrenes	68
nC-30 Tricontane	230	C2-Pyrenes	94
nC-31 Hentriacontane	150	C3-Pyrenes	96
nC-32 Dotriacontane	120	C4-Pyrenes	54
nC-33 Tritriacontane	100	Naphthobenzothiophene	11
nC-34 Tetratriacontane	90	C1-Naphthobenzothiophenes	48
nC-35 Pentatriacontane	92	C2-Naphthobenzothiophenes	37
Total Alkanes	30,752	C3-Naphthobenzothiophenes	22
		Benzo (a) Anthracene	5.5
		Chrysene	36
		C1-Chrysene	100
		C2-Chrysene	100
		C3-Chrysene	54
		C4-Chrysene	19
		Benzo (b) Fluoroanthene	2.3
		Benzo (k) Fluoroanthene	1.6
		Benzo (e) Pyrene	6.6
		Benzo (a) Pyrene	1.0
		Perylene	0.92
		Indeno (1,2,3 – cd) Pyrene	0.20
		Dibenzo (a,h) Anthracene	1.3
		Benzo (g,h,i) Perylene	1.2
		Total Aromatics	11,203

[512] Data provided by NOAA.

Bakken Crude Volatility and Flammability

The property of greatest concern for Bakken crude is its volatility. Concern about the volatility of Bakken crude followed the July 6, 2013 accident in Lac-Mégantic, Quebec, Canada, in which a train derailed near the center of a town, causing an explosion that resulted in the deaths of 47 people.

Even if volatility is the major concern, measuring it and classifying crude oils with respect to potential for flammability is not straightforward. The Reid Vapor Pressure (RVP),[513] which is often used to measure volatility, or how quickly a petroleum product or fuel evaporates, varies from one sample to another. According to ASTM Standard D-323, an RVP of less than 26 psi is considered "low volatility". In five different samples of North Dakota sweet crude taken on five different dates roughly one year apart, the RVP varied from 5.94 psia[514] to a high of 9.70 psia, a difference of nearly 39%. Other properties, such as density (°API), varied by less than 0.5% between sampling dates.[515]

In Capline Pipeline tests of a large number of crudes,[516] RVP varied from a low of 0.623 psia for UK Foinaven crude to a high of 10.0 psia for Nigerian Forcados/Oco Condensate Blend. Bakken crude (North Dakota sweet) falls into the middle.

The presence of increasing amounts of dissolved gases and other light ends (methane, ethane, propane, butanes, and pentanes) increases the crude oil's vapor pressure, lowering its flashpoint and lowering its initial boiling point. According to an American Fuel & Petrochemical Manufacturers (AFPM)[517] study, Bakken crude oil is within the norm with respect to the hazard characteristics of a light crude oil. The AFPM study had results as in Table 73. The survey showed maximum RVPs of 15.4 psia, considerably higher than those in the Capline testing.

The American Petroleum Institute (API) analyzed more than 200 samples of Bakken and other types of crude, primarily West Texas Intermediate (WTI) crude, which is often used as a "standard" oil for comparison, and reported the results as shown in Table 74. The overall conclusion of this analysis was that Bakken crude oil is "very similar to other light crudes."

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[513] RVP is defined as the absolute vapor pressure exerted by a liquid at 100°F as determined by the test method ASTM D-323.
[514] psia = pounds per square inch (absolute).
[515] Based on data from www.caplinepipeline.com.
[516] www.caplinepipeline.com.
[517] AFPM 2014.

Table 73: AFPM Survey of Bakken Crude Oil Characteristics[518]

Characteristic	Reported Values	Hazmat Transportation Regulatory Implications
Flashpoint	Range: -74.2° F – 122°F	Bakken crude oils meet the criteria for Packing Group I, II, or III flammable liquids or as combustible liquids.[519]
Initial Boiling Point	Range: 35.96°F – 152.42°F	Bakken crude oils with an initial boiling point of 35°C or less meet criteria for Packing Group I flammable liquids; others for Packing Group II or III flammable liquids or combustible liquids according to flashpoint.
Vapor Pressure at 50°C (122°F)	Maximum: 16.72 psia	All Bakken crude oils have a vapor pressure below 43 psia at 50°C and must be transported as liquids.
Reid Vapor Pressure at 38°C (100.4°F)	Maximum:15.4 psia	Not used by the regulations; confirm the vapor pressure at 50°C is well below the above 43psia limit, and Bakken crude oils must be transported as liquids.
Rail tank car pressures on delivery	Maximum:11.3 psig	Demonstrates that Bakken crude may be safely transported in DOT Specification 111 tank cars.[520]
Flammable gas content	Maximum:12.0 liquid volume %	None; with the vapor pressures of all Bakken crudes oils examined not exceeding a vapor pressure of 43 psia at 50°C, all Bakken crude oils examined must be transported as liquids.
Hydrogen sulfide content in vapor space	Most H_2S concentrations below OSHA STEL; one reported maximum level of 23,000 ppm	None when low values are experienced; additional hazard communication to warn of the presence of H2S when inhalation hazard levels are encountered.[521]
Corrosivity	NACE B+ or B++	Data and experience indicate that Bakken crude oil does not corrode steel at a rate of ¼ inch per year or more, so that Bakken crude oil is not a corrosive liquid.

518 Wybenga 2014.
519 The Bakken crude data submitted included only one sample that qualified as a combustible liquid, which had a lower risk than other flammable liquids.
520 §179.201-1 provides summary specifications for DOT-111 rail tank cars. Earlier DOT 111's were designed to a 240 psig burst pressure whereas later designs are designed to a minimum burst pressure of 500 psig. Based on §179.15(b)(2)(ii) the minimum pressure relief valve settings for tank cars with a minimum burst pressure of 240 psig, is 35 psig and for 500 psig designs the minimum setting is 75 psig.
521 See §172.327.

Table 74: Crude Oil Data Properties: Bakken Oil Compared with Other Light Crudes[522]

Characteristic	Value	Other Light Crudes	Bakken Crude	API Conclusion
Vapor Pressure PSI (ASTM D6377)	Average	7.24	11.81	There is no practical difference in vapor pressures.
	Maximum	1.43	3.60	
	Minimum	11.46	15.37	
Sulfur Weight % (ASTM D4294)	Average	0.14	0.10	There is no practical difference in sulfur weight.
	Maximum	0.01	0.02	
	Minimum	0.64	0.25	
API Gravity (ASTM D5002)	Average	40.36	42.66	Gravity is as expected for light crude.
	Maximum	34.40	38.60	
	Minimum	46.90	47.07	
Initial Boiling Point °F (ASTM D86)[523]	Average	101.94°F (PG II)	91.96°F (PG I)	Initial boiling points solidly within range of Hazard Class 3.
	Maximum	83.40°F (PG I)	79.10°F (PG I)	
	Minimum	182.80°F (PG II)	150.80°F (PG II)	

The API analyses indicate that Bakken crude is a Class 3 flammable liquid, which means that it has a flash point of not more than 141°F. The average flash point of light crudes is 101.94°F, whereas the flash point for Bakken crude is somewhat lower at 91.96°F.

The analyses indicate also that Bakken crude is classified as Packing Group I (PG I), except at the minimum measurements for those samples for which the initial boiling point is 150.8°F. Other light crudes are classified as Packing Group II (PG II), except for those that have a maximum initial boiling point of 83.40°F. The PG I classification encompasses substances that pose a high hazard level; PG II encompasses substances that have a medium hazard level.

API maintains that Reid Vapor Pressure (RVP) is not a good indicator of flammability based on preliminary analyses of simulations using the Fire Effects on Tank Cars (AFFTAC) Model.[524] The API Crude Oil Physical Properties Ad Hoc Group is considering if other crude oil properties are more appropriate in the selection of rail tank cars for transport (e.g., ignitability, flammability, light-end volumetric percent).

A more reliable and accurate measure of volatility is the analysis of distillation assays. Table 75 shows a comparison between the assay of Bakken crude and those for West Texas Intermediate (WTI) crude and Louisiana Light Sweet (LLS) crude. According to this type of assay, Bakken crude has twice as much volatile light-end components as WTI, and 1.7 times as much as LLS.

522 API 2014.
523 PG = "packing group". Packing Group (PG) I has an initial boiling point of 95°F or less; PG II has a flash point of 73°F or less and an initial boiling point of greater than 95°F. PG I encompasses substances that pose a high hazard level; PG II encompasses substances that have a medium hazard level.
524 API 2014.

Table 75: Crude Oil Assays – Bakken vs. Other Light Crudes[525]

Assay Components		Bakken	West Texas Intermediate	Louisiana Light Sweet
API Gravity	Degrees (°API)	>41	40.0	35.8
Sulfur	Weight %	<0.2	0.33	0.36
Distillation Yield	Volume %			
Light Ends	C1 – C4	3	1.5	1.8
Naphtha	C5 – 330°F	30	29.8	17.2
Kerosene	330 – 450°F	15	14.9	14.6
Diesel	450 – 680°F	25	23.5	33.8
Vacuum Gas Oil	680 – 1,000°F	22	22.7	25.1
Vacuum Residue	1,000+°F	5	7.5	7.6
	Total	100	100	100

Relative Viscosity of Bakken Crude

The viscosities of some common substances in comparison with Bakken crude are shown in Table 76. Bakken crude has a low viscosity and flows easily. It resembles dark coffee with respect to its color and tendency to flow.

Table 76: Viscosity of Bakken Crude Compared with Common Substances[526]

Liquid	Viscosity (cSt)
Water	1
Bakken Crude[527]	6.5
Kerosene	10
SAE 10 Motor Oil	100
Glycerin or Castor Oil	1,000
Corn Syrup	10,000
Molasses	100,000
Peanut Butter	1,000,000

Other Components of Bakken Crude

The sulfur content of Bakken crude has been generally low (0.17–0.20%), which makes it a "sweet crude". Some samples have been even lower in sulfur content – 0.142%. There is, however, the potential for higher sulfur content in some shipments of Bakken as there have been reports of crude blending at the source oilfield.

Sampling studies conducted on Bakken crude indicate that there is no particular concern regarding naturally-occurring radioactive materials (NORM). NORM elements, such as uranium, thorium radium, radon, and potassium, are present in some geologic formations,

[525] Hill et al. 2011.
[526] From Crude Oil & Response Considerations presented in May 2014 at EPA Region 10 Emergency Management Program Northwest Area Committee/Regional Response Team Meeting, Boise, Idaho.
[527] At 77°F, Bakken has a viscosity of 6.505. At 104°F, its viscosity is lower at 4.7.

including some oil and gas formations. Radium (^{226}Ra and ^{228}Ra) is the most common NORM in oilfields, especially in northern Texas and along the Gulf Coast.

NORM generally precipitate out onto pipelines, tanks, and sludges at oil production sites. It would be found in soils from spills and produced water tanks at the production sites after separation from oil. There is almost no water in rail tank cars that have been tested. A recent EPA sample showed no detectable NORM or levels of radiation at background (<10 µR/h) and well below typical state action (e.g., Texas and Louisiana have action levels at 50 µR/h).[528]

PHMSA Operation Safe Delivery

In response to the Lac-Mégantic incident, PHMSA embarked on a project "Operation Classification in the Bakken Shale Formation" to ensure that shippers were properly classifying crude oil for transportation in accordance with federal regulations and for better understanding of the unique characteristics of mined gases and oils from the Williston Basin in North Dakota.[529]

PHMSA concluded:

> "After months of unannounced inspections, testing, and analysis, Operation Classification has determined that the current classification applied to Bakken crude is accurate under the current classification system, but that the crude has a higher gas content, higher vapor pressure, lower flash point and boiling point and thus a higher degree of volatility than most other crudes in the U.S., which correlates to increased ignitability and flammability.
>
> Importantly, our review of crude oil transportation data also confirmed that large volumes of this crude are moving at long distances across the country. At any given time, shipments of more than two million gallons are often traveling distances of more than one thousand miles. Put simply, Operation Classification determined that the U.S. is currently shipping a crude oil product with a higher gas content, lower flash point, lower boiling point and higher vapor pressure than other crude oils in large amounts and for long distances."

In July 2014, PHMSA released a report that included the results of its testing of samples of Bakken crude oil as of May 2014. The intent of Operation Safe Delivery's sampling and analysis component was to determine if shippers are properly classifying crude oil for transportation. The intent was also to quantify the range of physical and chemical properties of crude oil.

[528] From Crude Oil & Response Considerations presented in May 2014 at EPA Region 10 Emergency Management Program Northwest Area Committee/Regional Response Team Meeting, Boise, Idaho.
[529] http://www.phmsa.dot.gov/hazmat/osd/calltoaction

The tests conducted are summarized in Table 77.

Table 77: PHMSA Sampling and Testing Activities Summary

# Samples	Period	Tests Completed	Test Lab	Mean Ambient Temps
14	August 2013	Flash Point	Minnesota Valley	78°F
21	September – October 2013	Flash Point, Boiling Point	Intertek	44 – 66°F
12	November 2013	Flash Point, Boiling Point, °API, Gas/Liquid Composition, Water/Sediment Content, Sulfur Content, H_2S Content, BTEX	Intertek	24°F
88	February – May 2014	Flash Point, Boiling Point, Reid Vapor Pressure, True Vapor Pressure, Gas/Liquid Composition, H_2S Content, BTEX, Corrosion (Steel/Aluminum)	Intertek	10 – 55°F
135 - Total Samples Tested				

The testing shown in Table 78 led to the following conclusions:

- Based on the results obtained from sampling and testing of the 135 samples from August 2013 to May 2014, the majority of crude oil analyzed from the Bakken region displayed characteristics consistent with those of a Class 3 flammable liquid, PG I or II, with a predominance to PG I, the most dangerous class of Class 3 flammable liquids. Based on our findings, we conclude that while this product does not demonstrate the characteristics for a flammable gas, corrosive liquid or toxic material, it is more volatile than most other types of crude, which correlates to increased ignitability and flammability.
- Bakken crude's high volatility level – a relative measure of a specific material's tendency to vaporize – is indicated by tests concluding that it is a "light" crude oil with a high gas content, low flash point, low boiling point, and high vapor pressure. The high volatility of Bakken crude oil, and its identification as a "light" crude oil, is attributable to its higher concentrations of light end hydrocarbons. This distinguishes it from "heavy" crude oil mined in other parts of the United States.
- Given Bakken crude oil's volatility, there is an increased risk of an incident involving this material due to the volume that is transported, the routes, and the extremely long distances it is moving by rail. Trains transporting this material, referred to as unit trains, routinely contain more than 100 tank cars, constituting at least 2.5 million gallons within a single train. Unit trains only carry a single type of product, in this case flammable crude oil. These trains often travel over a thousand miles from the Bakken region to refinery locations along the coasts.

Table 78: PHMSA Operation Safe Delivery Testing Results[530]

Company Name	City	Flash Point °F	Initial Boiling Point °F	VPCR 0.02 @122 °F (psia)	VPCR 4 @100 °F (psia)	Methane (% Vol)	Ethane (% Vol)	Propane (% Vol)	Butane (% Vol)	Hydrogen Sulfide (H_2S)	Corrosivity (% Weight Loss)
Bakken Oil Express LLC	Dickinson, ND	< 50	88.1	27	11.1	0	0.2079	1.2461	3.1643	< 1	
		< 50	89.3	27.8	11.4	0	0.2256	1.2991	3.2295	< 1	
		< 50	97.5	25.7	11.1	0	0.2015	1.2461	3.1735	< 1	
		< 50	93.1	27.7	12.2	0	0.2586	1.4587	3.4972	< 1	0**
		< 50	89	29.8	12.5	0	0.2206	1.3773	3.423	< 1	
		< 50	93.6	28.3	12.7	0	0.2574	1.4409	3.3963	< 1	
		< 50	92.1	26.9	10.8	0	0.1746	1.0088	2.8672	< 1	
		< 50	89.4	26.7	10.7	0	0.1735	1.0093	2.8324	< 1	
		< 50	92.3	23.4	10.5	0	0.184	1.0543	2.9483	< 1	
		< 50	83.8	24.3	11.6	0	0.2233	1.3951	3.4341	< 1	
		< 50	86.2	28.2	12.4	0	0.2347	1.384	3.3272	< 1	
		< 50	87.2	30.2	12.5	0	0.2251	1.4192	3.4896	< 1	
Dakota Plains/ Strobel Starostka	New Town, ND	< 50	90.5	31.2	13.1	0	0.2192	1.5254	3.735	< 1	0**
		< 50	92.8	28.6	11.8	0	0.1379	1.279	3.521	< 1	
		< 50	86.4	27.7	12.2	0	0.1359	1.2462	3.4476	< 1	
Enbridge Rail LLC	Beuthold, ND	< 50	89	26.4	11.1	0	0.1975	1.2624	3.1692	< 1	
		< 50	92.5	26.8	11.2	0	0.2182	1.3064	3.2112	< 1	
EOG Resources	Stanley, ND	< 50	85.7	28.5	13.3	0	0.2099	1.5419	3.7439	< 1	
		< 50	86.8	29.4	13.4	0	0.2112	1.5539	3.7434	<1	
Plains Marketing LLP	Ross, ND	< 50	80.6	29.0	15.1	0	0.2858	1.9851	4.4043	<1	
		< 50	83.8	29.0	13.3	0	0.3158	2.0843	4.48	<1	
Inergy Crude Logistics LP	Epping, ND	< 50	84.9	28.7	13.6	0	0.2963	1.5604	3.5526	<1	
		< 50	84.7	29.8	13.6	0	0.2965	1.606	3.6625	<1	
Great Northern Gathering & Marketing	Fryburg, ND	< 50	87.0	27.1	11.3	0	0.3138	1.617	3.8413	<1	
		< 50	90.8	26.4	11.1	0	0.3204	1.5856	3.7071	<1	
Basin Transload/ Global Stampede	Stampede, ND	<50	88.1	25.5	12.5	0	0.2685	1.7044	3.8848	<1	
		<50	87.7	29.5	12.9	0	0.3153	1.9675	4.4686	<1	
Musket Corp.	Dickinson, ND	<50	84.5	28.7	13.4	0	0.2410	1.5076	3.6036	<1	
		<50	88.0	28.1	13.3	0	0.2711	1.6539	3.9135	<1	

[530] Crude samples taken during February – March 2014. Individual sample results.

Company Name	City	Flash Point °F	Initial Boiling Point °F	VPCR 0.02 @122 °F (psia)	VPCR 4 @100 °F (psia)	Methane (% Vol)	Ethane (% Vol)	Propane (% Vol)	Butane (% Vol)	Hydrogen Sulfide (H_2S)	Corrosivity (% Weight Loss)
Red River Supply	Williston, ND	< 50	88.7	28.4	13.0	0	0.2631	1.3361	3.0534	<1	
		<50	89.0	29.1	13.3	0	0.3444	1.7621	4.0086	<1	
		<50	87.5	28.6	12.9	0	0.3953	1.9241	4.3453	<1	
Great Northern Gathering & Marketing	Fryburg, ND	<50	91.7	26.8	11.2	0	0.2265	1.4366	3.7671	<1	
Basin Transload/ Global Beulah	Beulah, ND	<50	83.3	30.0	11.8	0	0.2270	1.3635	3.5145	<1	
		<50	87.3	26.3	10.6	0	0.1877	1.3101	3.566	<1	
		<50	88.1	25.2	11.2	0	0.2195	1.4373	3.9621	<1	
EOG Resources	Stanley, ND	< 50	87.9	26.6	12.1	0	0.2312	1.5577	3.7271	<1	
		<50	89.3	28.3	12.6	0	0.2393	1.5617	3.6901	<1	
Enbridge Rail LLC	Beuthold, ND	<50	93.6	26.4	11.4	0	0.1743	1.1727	3.062	<1	
		<50	88.9	26.1	11.3	0	0.1645	1.1517	3.0522	<1	
Savage	Trenton, ND	<50	84.4	27.5	12.7	0	0.2583	1.5151	3.5849	<1	
		<50	87.1	28.7	13.1	0	0.2480	1.4652	3.5252	<1	
		<50	88.8	30.0	13.1	0	0.2667	1.5277	3.5926	<1	
		<50	84.1	29.2	13.2	0	0.2743	1.5579	3.6289	<1	
		<50	85.0	26.1	13.1	0	0.2364	1.4313	3.4846	<1	
		<50	86.6	29.5	13.0	0	0.2251	1.4072	3.4837	<1	
Plains All American	New Town, ND	<50	83.7	31.2	13.3	0	0.2538	1.6544	3.9182	<1	
		<50	82.7	28.1	13.4	0	0.2456	1.6288	3.8824	<1	
		<50	87.3	30.1	13.6	0	0.2062	1.5219	3.7927	<1	
		<50	87.3	29.7	13.4	0	0.2602	1.6871	3.9719	<1	
		<50	86.9	29.0	13.5	0	0.2584	1.6681	3.9274	<1	
		<50	86.7	32.1	14.1	0	0.2649	1.6666	3.8536	<1	
Basin Transload/ Global Stampede	Stampede, ND	<50	88.5	28.6	12.8	0	0.2709	1.5797	3.7126	<1	
		<50	90.8	29.2	13.2	0	0.2988	1.6097	3.6708	<1	
		<50	86.7	28.0	N/A	0	0.2590	1.5127	3.6046	<1	
		<50	89.2	27.8	13.0	0	0.2869	1.6188	3.7266	<1	
		<50	89.8	29.1	13.3	0	0.2495	1.4623	3.5335	<1	
		<50	91.3	27.2	13.2	0	0.2940	1.6143	3.7120	<1	
Basin Transload/ Global Beulah	Beulah, ND	<50	92.3	24.9	10.1	0	0.1556	0.9818	2.7378	<1	

Company Name	City	Flash Point °F	Initial Boiling Point °F	VPCR 0.02 @122 °F (psia)	VPCR 4 @100 °F (psia)	Methane (% Vol)	Ethane (% Vol)	Propane (% Vol)	Butane (% Vol)	Hydrogen Sulfide (H_2S)	Corrosivity (% Weight Loss)
Bakken Oil Express LLC	Dickinson, ND	<50	88.0	26.1	12.2	0	0.2476	1.3834	3.3223	< 1	
		<50	87.7	26.3	11.7	0	0.2320	1.3385	3.2275	< 1	
		<50	88.9	20.3	11.6	0	0.2368	1.333	3.2269	< 1	
		<50	92.9	26.8	11.7	0	0.2235	1.3089	3.2207	< 1	
		<50	87.1	27.2	11.9	0	0.2034	1.2410	3.1276	< 1	
		<50	92.1	27.0	11.8	0	0.2330	1.3208	3.2072	< 1	
		<50	92.3	27.4	11.7	0	0.2211	1.2849	3.1663	< 1	
EOG Resources	Stanley, ND	<50	89.6	27.20	12.24	0	0.1845	1.4065	3.5213	<1	
		<50	86.6	27.02	12.03	0	0.1849	1.3732	3.4601	<1	
		<50	94.0	26.80	12.24	0	0.1913	1.4155	3.5186	<1	
Hess Corporation	Tioga, ND	<50	79.1	25.26	13.64	0	0.2170	1.7327	4.1573	<1	
Enbridge Rail LLC	Beuthold, ND	<50	88.5	39.36	11.31	<0.01	0.1900	1.2000	3.0700	< 1	
		<50	87.2	24.71	10.97	<0.01	0.2100	1.3200	3.3100	n/a	
		<50	85.9	26.35	11.29	<0.01	0.2100	1.2900	3.2400	n/a	
Plains Marketing LLP	Ross, ND	< 50	84.2	36.73 (0.05)	14.28	<0.01	0.2900	1.9500	4.4400	n/a	
Great Northern Gathering & Marketing	Fryburg, ND	< 50	86.7	37.31	11.12	<0.01	0.2000	1.1600	3.0500	n/a	
Dakota Plains/ Strobel Starostka	New Town, ND	< 50	84.1	31.12	11.47	<0.01	0.1500	1.2400	3.3200	n/a	

Bakken Crude Oil Conditioning

On December 9, 2014, the Industrial Commission of North Dakota issued new conditioning standards, requiring all crude oil produced in the Bakken Petroleum System[531] to be conditioned to remove lighter, volatile hydrocarbons, and thereby make the oil safer to transport by railroad.

The new standards seek to (1) address safety concerns stemming from several high-profile train derailments in Quebec, North Dakota, Alabama, and Virginia in the past year, and (2) complement continuing efforts by the U.S. Department of Transportation (USDOT) to improve transportation of crude and ethanol by rail.

According to the North Dakota Industrial Commission Oil and Gas Division:[532]

> First, this Commission order was written as a matter of safety. Rail accidents across the country have drawn attention for the need to better understand how Bakken oil is produced and processed at the well site. The commission initially received 1,114 pages of testimony from 33 groups or individuals, all providing input on how Bakken crude oil is produced and how to make it as safe as possible to transport. Subsequent to the November 13, 2014 Industrial Commission meeting, the record was opened and an additional 141 pages of testimony from 25 groups or individuals were provided on the working draft order.
>
> Second, the resulting order is based on science from the testimony received. The goal is to produce crude oil that does not exceed a Vapor Pressure of 13.7 pounds per square inch (psi). National standards recognize oil with a Vapor Pressure of 14.7 psi or less to be stable. Allowing for a Vapor Pressure of 13.7 psi or less, adjusts for an error margin of one psi in the sampling procedures and measurement equipment. It is important to note that winter blend gasoline has a Vapor Pressure of 13.5 psi.
>
> An estimated 80% of Bakken wells will be able to produce a product below 13.7 psi Vapor Pressure by complying with temperature and pressure parameters detailed in paragraphs 2a through 2c of the commission order.
>
> (a) Operate all well-site crude oil conditioning equipment within flow rate, pressure, and temperature ranges specified by the manufacturer.
>
> (b) Operating at a pressure of no more than 50 psi must heat fluid to at least 110 degrees Fahrenheit.

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[531] As defined in the Order, the Bakken Petroleum System comprises the Bakken, Bakken/Three Forks, Three Forks, and Sanish Pool Formations.
[532] Press release from Industrial Commission of North Dakota, December 9, 2014, "Industrial Commission Adopts New Standards to Improve Oil Transportation Safety" (DMR Order 25417). 7 p.

(c) Operating at a pressure greater than 50 psi must heat fluid to at least 110 degrees Fahrenheit and install equipment to recover vapors from the crude oil storage tanks.

Roughly 15% of Bakken wells operate equipment described in item 2d. Operators will need to demonstrate through sampling and testing in compliance with national standards that the resulting product does not exceed a Vapor Pressure of 13.7 psi.

(d) Operating at temperatures and pressures not described in paragraphs (b) or (c) must demonstrate through sampling and testing in compliance with national standards that Vapor Pressure is no greater than 13.7 psi.

The remaining 5% of estimated wells are expected to seek alternative methods for conditioning or stabilizing crude oil and must request approval from the commission through notice and hearing.

(e) Facilities utilizing alternate methods for crude oil conditioning other than separators and/or emulsion heater-treaters will only be approved after due notice and hearing.

Finally, the standards described in the order are enforceable. The Oil and Gas Division's more than 30 field inspectors can visually inspect gauges on facility equipment to determine operating temperatures and pressures while oil and gas measurement staff can review and approve Vapor Pressure testing. Additional Department of Mineral Resources staff has been included in the Governor's budget for dedication to western North Dakota. Operators found in violation of the order could be subject to a penalty of $12,500 a day. The order is effective April 1, 2015.

In conclusion, with the strong science and enforceability of this order, the state of North Dakota will be requiring that every barrel of Bakken crude oil will be conditioned.

North Dakota's conditioning standards complement ongoing federal efforts to address the safety issues arising out of the substantial increase in rail shipments of crude and ethanol in the United States. Currently, the Federal Rail Administration (FRA) is responsible for rail safety in North Dakota, while the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) regulates tracks, train routes and speeds, and rail tank car specifications. On August 1, 2014, PHMSA issued a Notice of Proposed Rulemaking proposing enhanced tank car standards, a classification and testing program for crude oil, and new operational requirements for "high-hazard flammable trains." The USDOT also released a report summarizing analyses of Bakken crude oil data gathered by PHMSA and the FRA. Contrary to reports prepared by industry, the USDOT report concluded that crude from the Bakken region tends to be more volatile and flammable than other types of crude oils.

One industry study on catalytic conditioning of Bakken crude oil showed the results in Table 79. The density (°API) is higher and the flash point is higher for the conditioned Bakken oil.

Table 79: Laboratory Test Date for Baseline Bakken Crude and Conditioned Bakken Product[533]

Test	Bakken Crude Feedstock	Conditioned Bakken Product
°API (D1298)	43	37.2
Flash point (D93)	20°C (68°F)	30°C (86°F)
Vapor Pressure (D6377)	8.48 PSI (58.5 kPa)	1.2 PSI (8.27 kPa)
D86 Initital Boiling Point	38°C (100.4°F)	92°C (197.6°F)

Response Considerations for Bakken Crude Spills

There is fairly limited experience with Bakken crude spills from which to draw general recommendations for response, but two responses have been documented to some extent: the Lynchburg, Virginia (Figures 140 and 141) and Aliceville, Alabama (Figures 142 through Figure 145) crude-by-rail derailment incidents.[534]

In both cases, some of the oil burned, but some ended up in water, and in the Alabama case in wetland areas. The oil floated on the water surface and was carried downstream by currents. The light nature of the oil led to high evaporation rates, reducing the amount of oil in the water and on substrates.

Sorbent- and containment-booming, along with water spraying methods, were used to corral oil for skimming and vacuum pumping. Sorbent pompoms and pads were used in some areas. These are all conventional forms of spill response.

[533] Catalytic Resource LLC. *White Paper: Catalytic Conditioning of Bakken Crude Oil.*
[534] From Crude Oil & Response Considerations presented in May 2014 at EPA Region 10 Emergency Management Program Northwest Area Committee/Regional Response Team Meeting, Boise, Idaho.

Figure 140: Lynchburg, Virginia, Bakken Crude Spill

Figure 141: Lynchburg, Virginia, Sheen of Bakken Crude in River

Figure 142: Aliceville, Alabama, Bakken Spill Cleanup: Sorbent Pompoms

Figure 143: Aliceville, Alabama, Bakken Spill Cleanup: Containment Booming

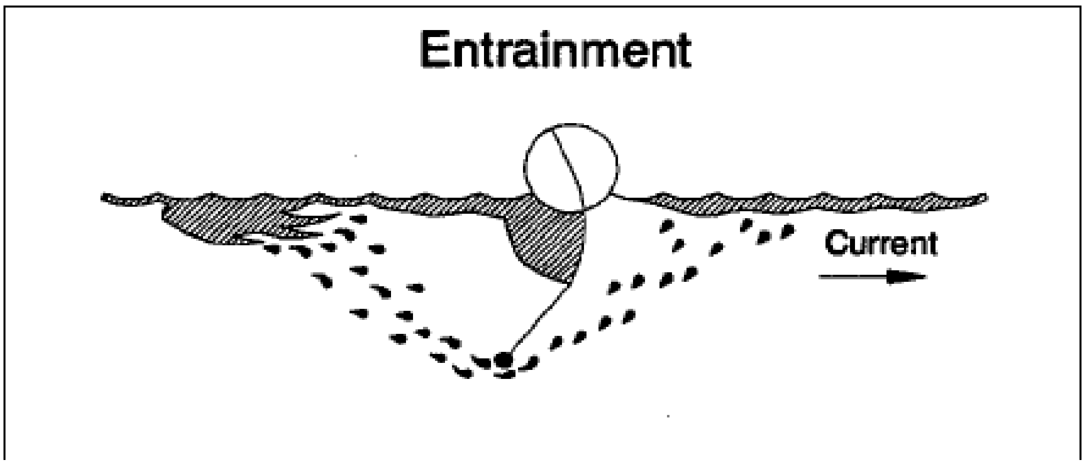
Figure 144: Aliceville, Alabama, Bakken Spill Cleanup: Booming, Vacuum Trucks, Water Spraying[535]

Figure 145: Aliceville, Alabama, Bakken Spill Cleanup: Sorbent Pads[536]

[535] From Crude Oil & Response Considerations presented in May 2014 at EPA Region 10 Emergency Management Program Northwest Area Committee/Regional Response Team Meeting, Boise, Idaho.
[536] From Crude Oil & Response Considerations presented in May 2014 at EPA Region 10 Emergency Management Program Northwest Area Committee/Regional Response Team Meeting, Boise, Idaho.

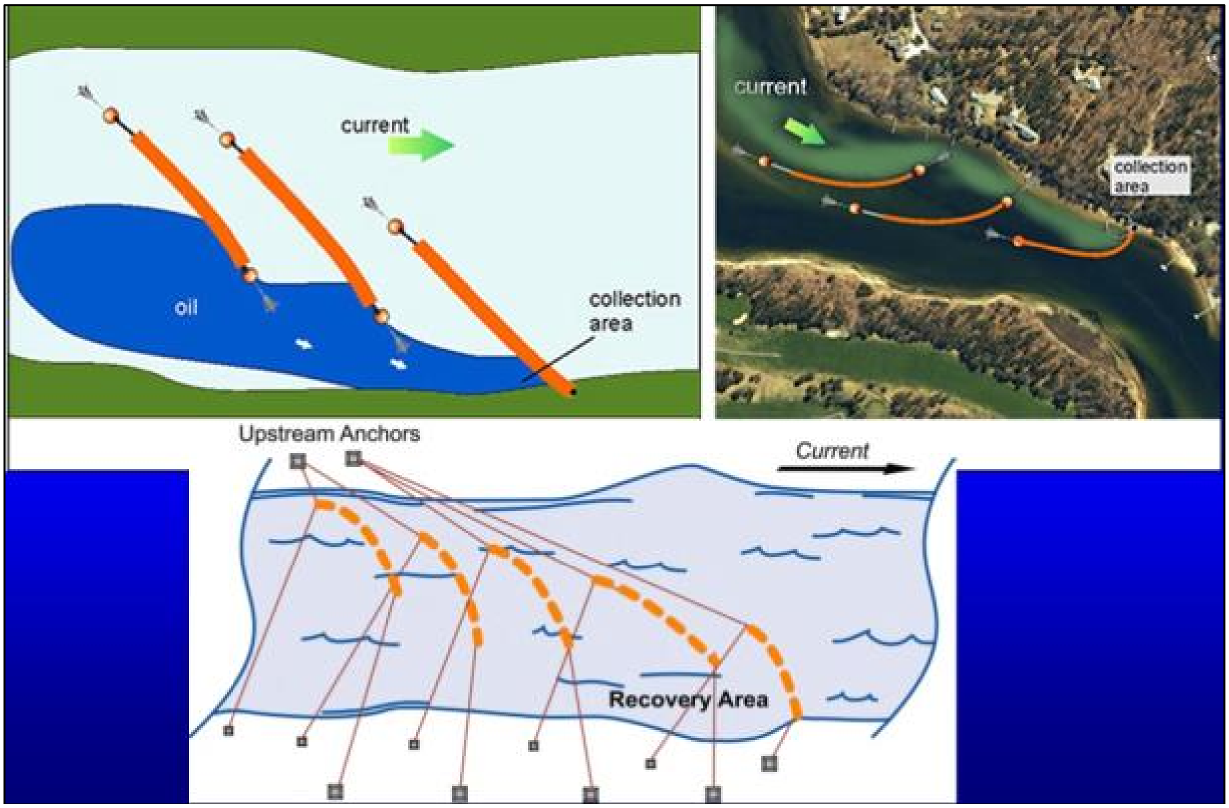
Given the possibility that the spills in Washington would occur in streams or rivers, fast-water booming techniques might be necessary. These strategies counteract, to the extent possible, the effect of oil entrainment[537] or going under the booms due to the fast currents. In general, oil will go under the boom, regardless of its depth into the water, if the current exceeds 0.7 to 1.0 knots (Figure 146). Placing the booms at angles to the current helps to counteract this effect to some extent (Figure 147). These are techniques that are not specific to Bakken crude but rather to spills to inland streams and rivers.

Figure 146: Boom Entrainment



[537] The process of oil going into the water column (below the water surface) due to winds or currents, including the process of oil going under a floating boom.

Figure 147: Fast-Water Booming



Appendix F: In Depth: Properties of Crude by Rail Oils – Diluted Bitumen and Related Oils

Another type of crude oil that is beginning to be transported by rail is diluted bitumen, also known as "dilbit" or Canadian "tar sands oil". This broad category encompasses a number of different types of bitumen blends.

The properties vary by location and by season. Diluted bitumen is a petroleum product produced by mixing bitumen (a highly viscous or solid asphaltic material) with light petroleum compounds (e.g., gas condensate or gas range oil), which are the diluent. Typically, the ratio of bitumen to diluent is 70:30 or 30% diluent. There is a heavier form of diluted bitumen called "railbit", which has only 15% diluent in the mixture. Diluted bitumen is considered to be a heavy crude, but it varies considerably from other conventional heavy crudes. Diluted bitumen has been transported via pipeline into Washington for some time, but the transport by rail tank car is a relatively new phenomenon. There are also tank barges that carry heated bitumen.

Basic Properties of Diluted Bitumen and Related Oils

Bitumen is the heavy crude oil that remains in the geologic formation after in-situ biodegradation processes occur in regions of Alberta, Canada (Figure 148).

Diluted bitumen is created by adding naphtha-based oils including natural gas condensate. While approximately 75wt%[538] of the condensate has a low boiling point of 399.2°F, the overall boiling point of the diluted bitumen product remains high at 975.2°F. This is important because it means a small fraction <20wt% will evaporate rapidly during a spill, but the remaining fraction will not. The slower evaporation of the remaining fraction reduces the potential air quality issues for responders and the public. "Synbit" is made by diluting bitumen by using synthetic crude oil ("syncrude") from refineries. Like "dilbit", synbit maintains a high boiling point for the majority of the material.

Diluted bitumen (dilbit and synbit) that is transported through pipelines must meet certain specifications for viscosity, density, and acidity. To meet these specifications, the bitumen requires diluent by lighter oils, 30% for dilbit and 50% for synbit by volume.

Properties of diluted bitumen products are summarized in Table 80.

[538] Percent by weight.

Figure 148: Map of Athabasca, Cold Lake, and Peace River Oil Sands in Alberta, Canada[539]. Image source: Alberta Geologic Survey.

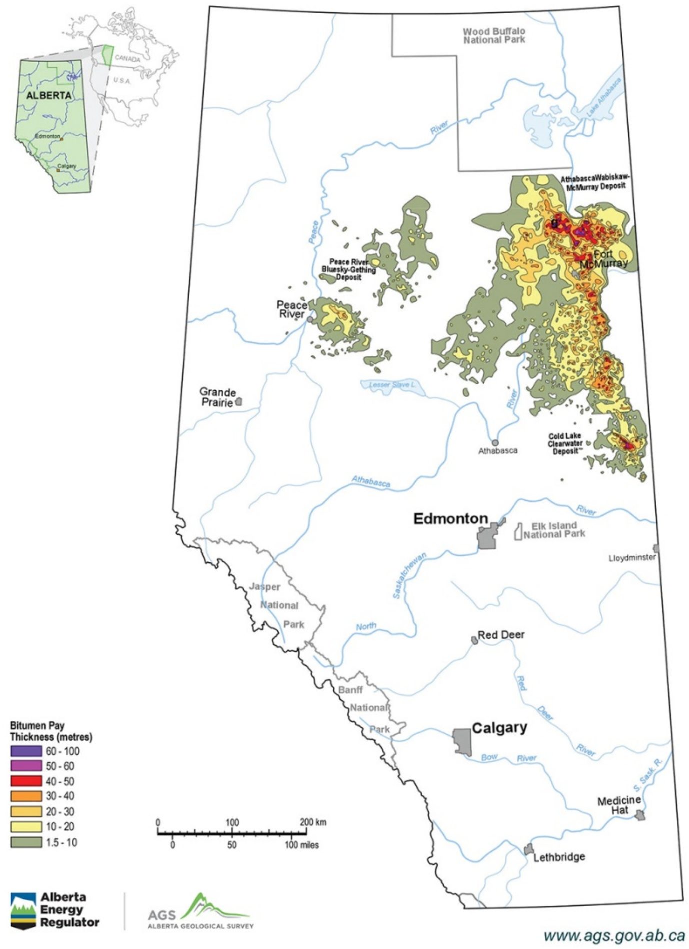


Table 80: Selected Physical Properties and Chemical Data for Diluted Bitumen Products[540]

Name	Density (kg/m³)	Sulfur (wt%)	Sediment (ppmw)	Light Ends[541] Volume %	BTEX Volume %
Condensate Blends					
Access Western Blend	922.9 ± 4.6	3.94 ± 0.09	89 ± 8	24.1 ± 1.7	1.20 ± 0.15
Borealis Heavy Blend	927.4 ± 5.2	3.67 ± 0.29	94 ± 27	24.1 ± 1.7	0.99 ± 0.09
Christina Dilbit Blend	924.9 ± 5.2	3.88 ± 0.09	88 ± 41	22.8 ± 2.2	1.12 ± 0.17
Cold Lake	927.7 ± 5.0	3.78 ± 0.08	94 ± 42	20.4 ± 1.5	1.06 ± 0.17
Peace River Heavy	930.5 ± 4.7	5 ± 0.1	97 ± 30	22.4 ± 1.1	1.02 ± 0.09
Statoil Cheecham Blend	928.8 ± 4.5	3.81 ± 0.09	169 ± 99	24.1 ± 2.3	1.06 ± 0.14
Western Canadian Select	928.1 ± 4.3	3.50 ±0.07	284 ± 23	18.3 ± 1.3	0.83 ± 0.12
Blends Other than Condensate					
Borealis Heavy Blend	927.4 ± 5.2	3.67 ± 0.29	94 ± 27	24 ± 1.7	0.99 ± 0.09
Statoil Cheecham Blend	928.8 ± 4.5	3.81 ± 0.09	169 ± 99	24.1 ± 2.3	1.06 ± 0.13

539 Alberta Geological Survey as in Government of Canada 2014.
540 Government of Canada 2014, and Crude Quality Inc., 2013. www.crudemonitor.ca/home.php, accessed September 2013.
541 Light Ends compromise the sum of all butanes through decanes, inclusive.

Name	Density (kg/m^3)	Sulfur (wt%)	Sediment (ppmw)	Light Ends[541] Volume %	BTEX Volume %
Long Lake Heavy	932.6 ± 3.6	3.21 ± 0.16	18	15.9 ± 1.2	0.94 ± 0.10
Statoil Cheecham Synbit	930.5 ± 4.2	3.07 ± 0.09	71 ± 11	13.4 ± 1.3	0.76 ± 0.09
Surmont Heavy Blend	936.1 ± 3.8	3.08 ± 0.11	101 ± 42	11.3 ± 0.9	0.59 ± 0.09
Suncor Synthetic H	936.5 ± 2.2	3.07 ± 0.09	39	10.4 ± 1.0	0.44 ± 0.08
Albian Heavy Synthetic	938.7 ± 3.5	2.46 ± 0.23	784 ± 229	23.3 ± 1.4	0.94 ± 0.14

In combining the diluent (e.g., condensate) with the bitumen, it does not create a two-phase mixture of bitumen and diluent. The resulting mixture is a new, cohesive blended product.

Floating/Non-Floating Properties of Diluted Bitumen

Group V oils that are heavier (more dense) than freshwater will sink into water with a density of 1.0. According to laboratory and mesoscale weathering experiments, diluted bitumen products have physical properties much aligned with a range of intermediate fuel oils and other heavy crude oils. Generally, depending on the initial blend and state of weathering, diluted bitumen products are not characterized as non-floating oils.[542]

Even Group III and IV oils can become neutrally or negatively buoyant (i.e., sink) in freshwater or saltwater through various mechanisms, especially if the oil comes in contact with sediment in a high-energy setting (i.e., in nearshore surfzone areas).[543]

Diluted bitumen's potential for sinking after weathering (i.e., losing its light fractions to evaporation) was the impetus for a series of tank test studies on the behavior of diluted bitumen when spilled into freshwater[544] or brackish[545] marine waters.[546]

Mesoscale weathering experiments done in Gainford, Alberta[547] showed that Cold Lake and Access Western Blend diluted bitumen blends exhibited properties typical of a heavy, "conventional" crude oil as they weathered, but in no instance was any oil observed to have sunk after 10 days of weathering on 20 ppt brackish water under varied physical conditions. The physical properties of weathering oil measured during those tests showed that diluted bitumen spilled into fresh, brackish, or saltwater will stay on the water surface for days unless another mechanism mixes it into the water column, as would be the case for most Group III and IV oils. Only after extensive weathering, or mixing with suspended particulate material, may some portion of weathered dilbit become submerged or sink.

542 Polaris Applied Sciences 2013.
543 National Research Council 1999.
544 SL Ross 2010.
545 Water that has 0.05–3% dissolved salts compared with <0.05% for freshwater and 3–5% for seawater.
546 Witt O'Brien's et al. 2013.
547 Witt O'Brien's et al. 2013.

In another series of studies conducted by the Government of Canada on two diluted bitumen products that represented the highest volume transported by pipeline in Canada during 2012–2013, Access Western Blend and Cold Lake Blend, the researchers concluded:[548]

- Like conventional crude oil, both diluted bitumen products floated on saltwater (free of sediment), even after evaporation and exposure to light and mixing with water.
- When fine sediments were suspended in the saltwater, high-energy wave action mixed the sediments with the diluted bitumen, causing the mixture to sink or be dispersed as floating tarballs.[549]
- Under conditions simulating breaking waves, where chemical dispersants have proven effective with conventional crude oils, a commercial chemical dispersant (Corexit 9500) had quite limited effectiveness in dispersing diluted bitumen (dilbit).
- Application of fine sediments to floating diluted bitumen was not effective in helping to disperse the products.
- The two diluted bitumen products display some of the same behaviors as conventional petroleum products (i.e., fuel oils and conventional crude oils), but also some key differences, notably for the rate and extent of evaporation.

The four major factors that have a bearing on whether spilled oil, including diluted bitumen, will float, become neutrally buoyant (suspended in the water column), or sink are:

- Density of the oil, which may change with weathering (evaporation).
- Salinity of the water (i.e., density of the water relative to the oil).
- Amount of sediment in the water.
- Turbidity of the water (stirring up sediment and breaking oil into smaller droplets).

As long as the oil is less dense than the water, it will float. It may temporarily become submerged in the water column if broken into smaller droplets in turbulent water, but in those cases, the oil will refloat under more calm water conditions. If the oil becomes heavier than the water, either by becoming attached to sediment particles, or, less commonly, by having enough of the lighter ends evaporate to increase the density, it will become neutrally buoyant or sink.

Since salt and brackish[550] water (e.g., water in estuaries) is heavier than freshwater, it takes more of an increase in density to cause oil to sink in salt or brackish water than in freshwater, where the density of water is 999.97 kg/m^3 – or essentially 1,000 kg/m^3 or 1.0 g/ml. Seawater is denser than freshwater and has an average density of 1.025 g/m^3, though it may be as high as 1.028

[548] Government of Canada 2014.
[549] The use of the term "tarball" follows convention in the literature and refers to the consistency of floating, heavily-weathered oil. It does not describe the chemical composition of the product.
[550] Brackish water has 0.05–3% dissolved salts compared with <0.05% for freshwater and 3–5% for seawater.

g/m^3. Brackish water in estuaries varies in density between 1.0 to 1.025 g/m^3. For this reason, a heavy oil with a density of 1.01 g/m^3 would float in seawater but sink in a freshwater lake or in an estuary.

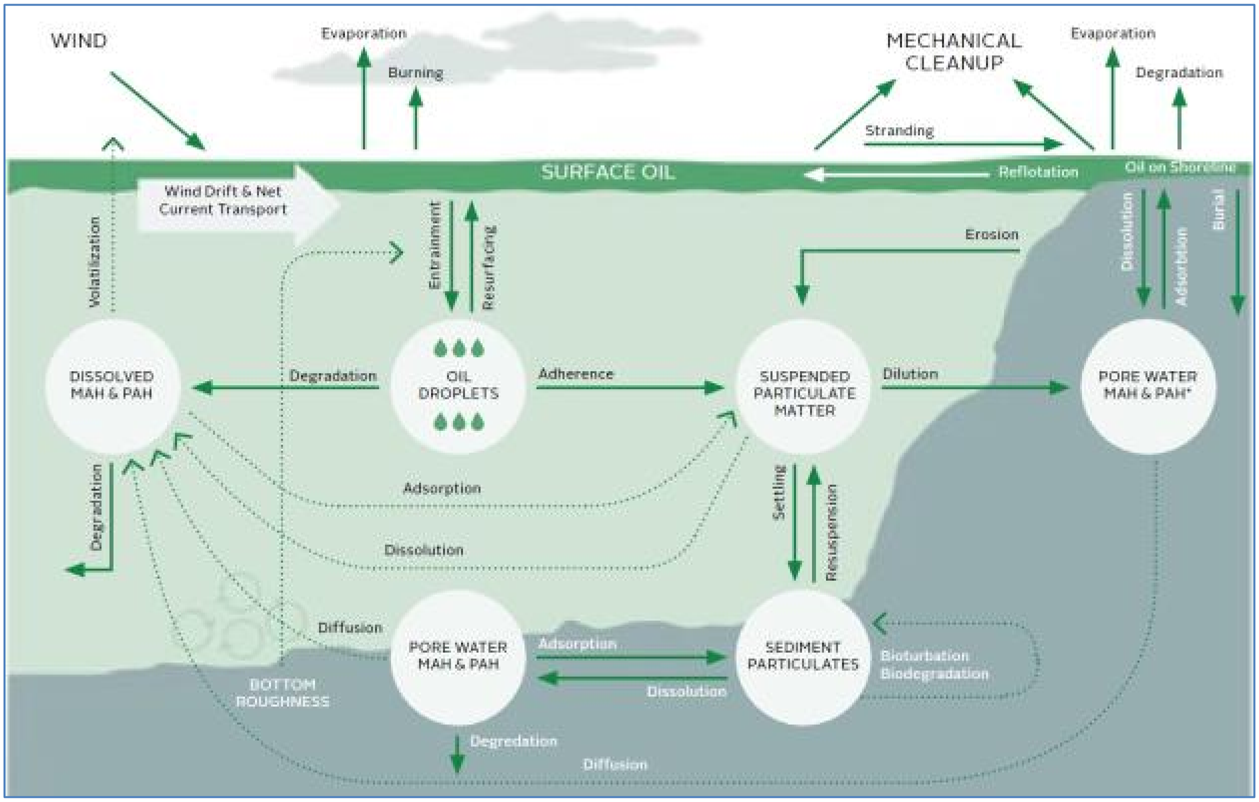
When oil mixes with sediment particles (e.g., sand in the surf zone of a beach), the combinations of sediment and oil – called "oil-mineral aggregates" (OMA) – can become heavier than water to cause sinking. OMA formation is more likely to occur in the following situations:

- The oil is in fine droplets.
- There is a large sediment load in the water column.
- There is a lot of turbulence in the water, which increases the number of smaller oil droplets, stirs up sediment from the bottom, and increases the likelihood of contact between the oil droplets and sediment particles.

OMA sinking is more likely to occur in freshwater than salt or brackish water because of the greater likelihood that the density of the OMA will be higher than the water density. The OMA density has to be somewhat higher to sink in salt or brackish water.

If diluted bitumen were to spill into a freshwater or estuarine system, as would occur in inland areas of Washington State, or the Columbia River, it would undergo the processes shown in Figure 149.

Figure 149: Simulated Oil Fate Processes in Lakes and Rivers[551]. Image source: Enbridge Northern Gateway Project Joint Review Panel.



Given that there may be sediment in the river, stream, or lake, it is possible for the diluted bitumen to create OMAs and sink. This would be most likely in a shallower stream with a rapid current, high sediment load, and turbulent waters that stir up the bottom sediment and break the oil into smaller droplets.

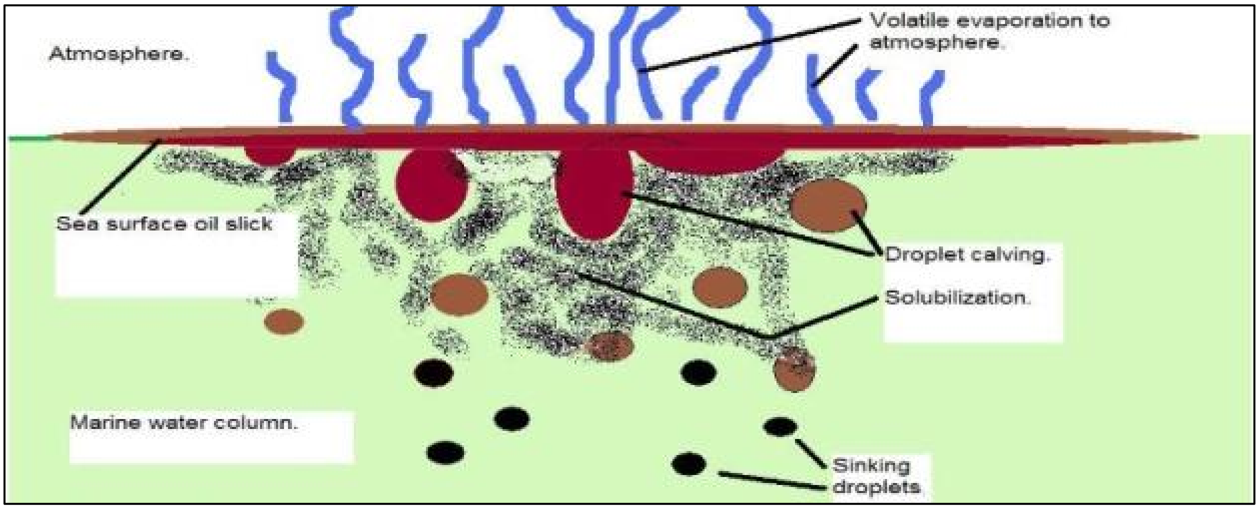
In marine waters, the oil would undergo similar processes, but it is less likely that the oil would sink due to the salinity of the water causing an increase in the density of the water.

Weathering as Cause of Diluted Bitumen Sinking

Theoretically, if enough of the light ends of an oil evaporate, the overall density of the oil would increase, perhaps enough to cause the density to be more than that of freshwater or even saltwater (Figure 150). The phenomenon of "evapo-sinking" has been proposed as an explanation for the sinking of some of the spilled oil during the Macondo MC-252 (Deepwater Horizon) spill in the Gulf of Mexico.[552]

[551] From: http://gatewaypanel.review-examen.gc.ca/clf-nsi/dcmnt/rcmndtnsrprt/rcmndtnsrprtvlm2chp6-eng.html. MAH refers to monocyclic aromatic hydrocarbons (such as benzene, toluene, ethylbenzene, and xylene – combined, BTEX), and PAH refers to the lighter polycyclic aromatic hydrocarbons. These compounds are both volatile and relatively soluble in water.
[552] Thibodeaux 2013.

Figure 150: Evaporation/Dissolution from a Sea Surface Slick[553]. Image source: Louisiana State University.



There is anecdotal evidence that this evaporative sinking phenomenon can occur, e.g., the Lake Wabamun spill in Alberta in which 185,000 gallons of heavy fuel oil spilled from 40 rail tank cars into a freshwater lake after a derailment in 2005.[554] There is also evidence that this phenomenon may have explained the sinking of Bunker C (heavy fuel oil with a density of 0.967) spilled from the USNS Potomac in 1977.[555]

When spilled into water, lighter hydrocarbon fractions of the entire diluted bitumen blend begin to evaporate. As lighter fractions evaporate, the viscosity of the weathered diluted bitumen would increase, and evaporation of remaining lighter fractions would be progressively inhibited.

Evaporative studies of diluted bitumen blends (e.g., Cold Lake) have shown that the first few hours of exposure to air results in the rapid loss of portions of the diluent with resulting increases in density and viscosity. Evaporative loss rates are affected by air temperature, oil surface area and thickness on the water surface, and wind conditions.[556] But, the studies also showed that because of the minimal light-end content of the diluted bitumen, the final evaporative loss of diluted bitumen was similar to ANS crude. The diluted bitumen exhibited an 8% volume loss through evaporation. This corresponds to an 8% increase in density. In freshwater, this may cause the oil to become heavier than water. It is unlikely to cause submergence in marine waters or even most estuarine waters, however.

Response Considerations for Diluted Bitumen Spills

A number of reports have expressed concerns about the potentially greater likelihood of diluted bitumen spills during pipeline or rail tank car transport than conventional crude oil spills, and

[553] Thibodeaux et al. 2011.
[554] Fingas et al.
[555] Michel and Galt 1995.
[556] Brown and Nicholson, 1991; SLRoss 2010a.

that these spills cause greater impacts to the environment,[557] though other stakeholders and organizations have questioned those conclusions.[558] A 2013 study released by the National Research Council (NRC)[559], found that the characteristics of diluted bitumen do not increase the likelihood of spills due to higher corrosivity of diluted bitumen product. [See section on Corrosivity below.]

While most of the research and focus of public attention has been on spills of diluted bitumen from pipelines, these pipeline incidents have caused concerns about potential impacts of diluted bitumen spills from crude-by-rail incidents as well. Issues of potentially higher corrosivity of diluted bitumen as relates to pipeline transmission have also been raised for transport in rail tank cars. According to a study by the U.S. Congressional Research Service:[560]

> "The extent to which these findings are applicable to rail transport of crude is open to debate, as rail tanker cars may have different operating parameters (e.g., temperature) and physical standards (e.g., wall thickness), or may transport different forms of oil sands-derived crude oil, decreasing the relevance of the NRC[561] findings.
>
> However, observations in the aftermath of a 2010 pipeline spill are consistent with the assertion that dilbit may pose different hazards, and possibly different risks, than other forms of crude oil. On July 26, 2010, a pipeline owned by Enbridge Inc. released approximately 850,000 gallons of dilbit into Talmadge Creek, a waterway that flows into the Kalamazoo River in Michigan.[562] Three years after the spill, response activities continued,[563] because, according to EPA, the oil sands crude "will not appreciably biodegrade."[564] The dilbit sank to the river bottom, where it mixed with sediment, and EPA has ordered Enbridge to dredge the river to remove the oiled sediment.[565] As a result of this order, Enbridge estimated in September 2013 its response costs would be approximately $1.035 billion,[566] which is substantially higher than the average cost of cleaning up a similar amount of conventional oil.[567]

Transport Canada, in its review of the Enbridge Northern Gateway Pipeline project, concluded that "it had not heard anything new in evidence that led it to believe that a response organization

[557] Summarized in Fritelli et al. 2014; Swift et al. 2014.
[558] Crude Quality Inc., Report regarding the U.S. Department of State Supplementary Draft Environmental Impact Statement, May 2011; and Energy Resources Conservation Board, Press Release, "ERCB Addresses Statements in Natural Resources Defense Council Pipeline Safety Report," February 2011.
[559] National Research Council 2013.
[560] Fritelli et al. 2014.
[561] National Research Council 2013.
[562] National Transportation Safety Board, Accident Report: Enbridge Incorporated Hazardous Liquid Pipeline Rupture and Release- Marshall, Michigan, July 25, 2010, July 2012, at http://www.ntsb.gov/.
[563] For more up-to-date information, see EPA's Enbridge oil spill website at http://www.epa.gov/enbridgespill/.
[564] Letter from Cynthia Giles, U.S. Environmental Protection Agency, to U.S. Department of State, April 22, 2013.
[565] EPA Removal Order, March 14, 2013, athttp://www.epa.gov/enbridgespill/ar/enbridge-AR-1720-attachment_e.pdf
[566] See Enbridge Inc., Third Quarter Financial Report, 2013, at http://www.enbridge.com/~/media/www/Site%20Documents/Investor%20Relations/2013/2013_ENB_Q3_Report.pdf
[567] Based on cost estimates prepared in 2004. (See: Etkin 2004).

would not treat a dilbit spill as a blended crude oil product. It said that the current response regime was set up to respond to such spills."[568]

The Enbridge Northern Gateway Review Panel released the following conclusions on the environmental behavior of diluted bitumen in its review of the project as part of its environmental impact assessment process:[569]

- "The Panel acknowledges the variety of opinions from experts regarding the behavior and fate of oil spilled in aquatic environments. These experts generally agreed that the ultimate behavior and fate of the oil would depend on a number of factors, including the volume of oil spilled, the physical and chemical characteristics of the product, and the environmental conditions at the time.
- The Panel finds that likely oil behavior and potential response options can be predicted from knowledge of the type of oil spilled and its physical and chemical characteristics. Details of oil behavior and response options cannot be specified until the actual circumstances of a spill are known.
- The Panel is of the view that, if placed along a spectrum of [oil properties with respect to the] tendency to submerge,; persistence, and recovery difficulty, dilbit [diluted bitumen] would be on the higher end of the spectrum, similar to other heavy oil products [in other words, diluted bitumen has a higher tendency to submerge, is more persistent, and is more difficult to remove than other oils, and is thus similar to other heavy oil products].
- The Panel accepts evidence from previous spills showing that, in response to circumstances at the time, the behavior of heavier oils, including conventional oils and synthetic crudes, can be dynamic. Some oil floats, some sinks, and some is neutrally buoyant and subject to submergence and overwashing.
- Although the project would transport different types of oil, the majority of the evidence presented during the hearing process focused on whether dilbit is likely to sink when spilled in an aquatic environment. In light of this, the Panel has chosen to focus its views on dilbit. The Panel heard that the fate and behavior of dilbit has not been studied as much as that of other oils.
- Although there is some uncertainty regarding the behavior of dilbit spilled in water, the Panel finds that the weight of evidence indicates that dilbit is no more likely to sink to the bottom than other heavier oils with similar physical and chemical properties. The Panel finds that dilbit is unlikely to sink due to natural weathering processes alone, within the time frame in which initial, on-water response may occur, or in the absence of sediment or other particulate matter interactions. The Panel finds that a dilbit spill is not likely to sink as a continuous layer that coats the seabed or riverbed."

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568 http://gatewaypanel.review-examen.gc.ca/clf-nsi/dcmnt/rcmndtnsrprt/rcmndtnsrprtvlm2chp6-eng.html
569 http://gatewaypanel.review-examen.gc.ca/clf-nsi/dcmnt/rcmndtnsrprt/rcmndtnsrprtvlm2chp6-eng.html

The Panel accepted the following facts in reaching its findings:[570]

- "The maximum initial density of the dilbit would be 940 kg/m^3 [0.94 g/cm^3], in conformance with the proposed pipeline tariff specification. When initially spilled, the density would be less than that of fresh water or salt water, making dilbit a floating oil.
- Experts agreed that dilbit is not a simple two-phase mixture of bitumen and condensate, but is instead a new, cohesive, blended product. When spilled into water, lighter hydrocarbon fractions of the entire blend would begin to evaporate. As lighter fractions evaporate, the viscosity of the weathered dilbit would increase, and evaporation of remaining lighter fractions would be progressively inhibited.
- Past examples of spills do not indicate that products similar to dilbit are likely to sink within the timeframe for response options, or in the absence of sediment or other suspended particulate matter interactions.
- Dilbit may sink when it interacts with sediment or other suspended particulate matter, or after prolonged weathering.
- Bench-top and wave-tank testing indicated that dilbit is not likely to sink due to weathering alone within a short to medium timeframe. The evidence indicated that multiple factors, such as the interaction between density, viscosity, potential emulsion formation, and environmental conditions, must all be examined together in considering the fate of spilled oil, including the possibility of sinking. Much of the evidence that the Panel heard did not consider these factors collectively.
- The weight of evidence indicates that, when spilled in water, dilbit with a maximum density of 940 kilograms per cubic meter would behave similarly to an intermediate fuel oil or lighter heavy fuel oil with a density less than 1,000 kilograms per cubic meter. Various experts, including those involved in spill response, said that these products provide reasonable analogs for dilbit behavior as it relates to oil spill response.
- Transport Canada said that a response organization would be likely to treat a dilbit spill as a blended crude oil product spill."

The panel further concluded that: [571]

> "If dilbit sinks due to weathering over the longer-term, or due to interactions with sediment or suspended particulate matter, the evidence indicates that such sinking would likely be patchy in distribution and not likely to result in widespread, thick mats of fresh, sunken oil on the bottom of the watercourse or ocean. In the marine environment, sinking is most likely in nearshore areas or as smaller particles of oil in deeper waters. Except in certain nearshore areas, suspended sediment concentrations throughout most of the Confined Channel Assessment Area and Open Water Area are not likely to be high enough to cause sinking of

[570] http://gatewaypanel.review-examen.gc.ca/clf-nsi/dcmnt/rcmndtnsrprt/rcmndtnsrprtvlm2chp6-eng.html
[571] http://gatewaypanel.review-examen.gc.ca/clf-nsi/dcmnt/rcmndtnsrprt/rcmndtnsrprtvlm2chp6-eng.html

larger aggregations of oil or oil emulsions. In rivers and lakes, sinking of oil-sediment mixtures would be most likely in areas of low turbulence or slow current.

Although the evidence does not indicate that dilbit is prone to sink in the marine environment, it clearly indicates that dilbit would be subject to emulsion formation and temporary submergence. This would cause challenges in tracking and recovering spilled dilbit. The Panel notes that other heavier conventional and synthetic crudes carried by the project may also be prone to submergence, depending on environmental circumstances."

The experience with the July 2010 Enbridge pipeline spill of over 843,000 gallons[572] of diluted bitumen into the Kalamazoo River in Marshall, Michigan, led responders to conclude that issues with submerged oil were a major challenge in the cleanup operations. In this spill a pipeline spilled diluted bitumen and the oil flowed into Talmadge Creek, a tributary to the Kalamazoo River. Heavy rains carried the floating oil 35 miles downstream before the oil was contained.[573] Hundreds of acres of wetlands were impacted.

A portion of the oil became submerged, likely due to interactions with stream sediment. Spill response issues ensued with submerged oil, especially in three impoundment areas: Ceresco, Battle Creek Mill Ponds, and Morrow Lake Delta/Fan. These areas required dredging operations (Figure 151).[574, 575,]

Over 300 individuals suffered adverse health effects from exposure to benzene, according to a Michigan Department of Community Health study. Residents of six homes self-evacuated. Air quality conditions (benzene concentrations) were deemed safe after 17 days. [576]

Cleanup costs were estimated to be at least $800 million, making it the most expensive onshore (inland) spill in U.S. history.

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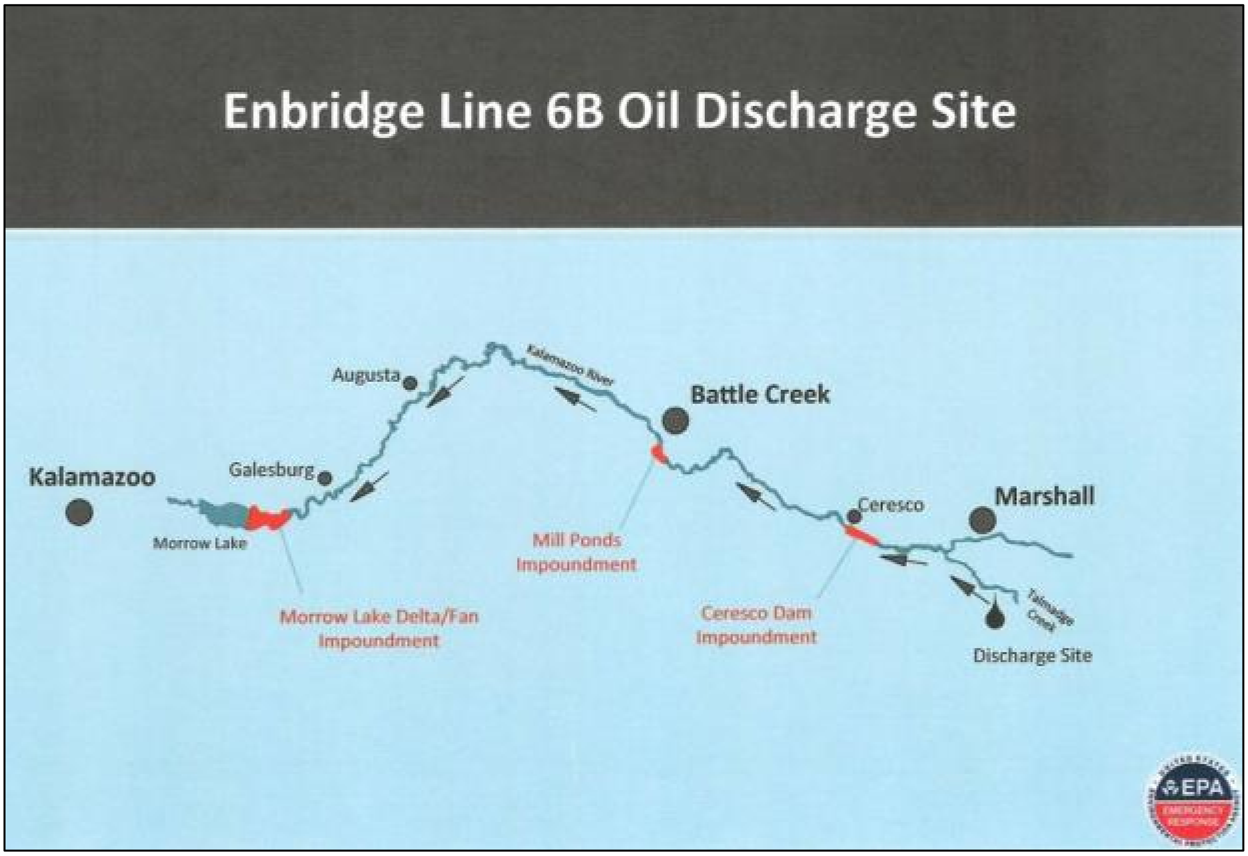
572 The US Environmental Protection Agency (EPA) reported that the spill involved 20,082 barrels, the equivalent of 843,444 gallons. Some estimates are higher, to as much as one million gallons.
573 US Department of Transportation, Pipeline and Hazardous Materials Notice of Probable Violation and Proposed Civil Penalty CPF 3-2012-5013. 29 p.
574 http://app.ntsb.gov/news/2012/120710.html
575 National Transportation Safety Board. 2012. *Enbridge Incorporated Hazardous Liquid Pipeline Rupture and Release, Marshall, Michigan, July 25, 2010*. Pipeline Accident Report NTSB/PAR-12/01.
576 Michigan Department of Community Health. 2010. *Acute Health Effects of the Enbridge Oil Spill*. 24 p.

Figure 151: Enbridge Pipeline Spill in Kalamazoo River[577]. Image source: US EPA.



Shoreline or Ground Impacts of Diluted Bitumen Spills

Oil spilled onto ground or onto shorelines, including river banks, will tend to spread, move downslope, evaporate, and penetrate into substrates. Ambient temperature, substrate grain sizes, substrate saturation (water), and additional components on or in substrate, such as organic matter, vegetation, roots, and snow, will affect the rate of penetration into substrates. Oil penetration into substrate is a function of oil viscosity (affected by temperature and emulsion, if stranded after being on water) and effective permeability (measured relative to the viscosity of the stranded oil).[578] One study found that diluted bitumen will spread and penetrate less into sand than the comparable crudes in the event of a spill.[579]

Table 81 shows oil penetration and the evaporative loss of Cold Lake bitumen blend that had been artificially weathered for 24 hours from four types of shoreline material at 50°F. Evaporative loss for stranded diluted bitumen was highest on mixed sediment in low energy conditions, reaching 9.5% by the end of 48 hours after application.

[577] http://www.epa.gov/enbridgespill/ar/enbridge-AR-1719.pdf
[578] Etkin et al. 2007, 2008a, 2008b; Witt O'Brien's et al. 2014.
[579] Tsaprailis et al. 2013.

Table 81: Summary of Cold Lake Bitumen Blend Evaporation in Sediments[580]

Site Type	Sediment Characteristics			Evaporation		Substrate Penetration
	% Shell Fragments	Sorting	Sand	Hours	%	
Low energy mixed sediment	10 – 60%	Wide variation; all sizes up to 4 cm	Top 3" of shore at mid-tide point	8	2.5	Low water retention, resulted in high oil permeability
				15	5	
				24	7.2	
				36	8.8	
				48	9.5	
High energy mixed sediment	10%	Wide variation of well-rounded rock sizes; 10 cm to 5 mm	Small amount	8	2	
				15	3	
				24	3.8	
				36	4.5	
				48	4.7	
Low energy sand sediment	-	Well sorted sandy shore	Tidal flat sandy beach	8	1	High penetration at top 1 mm; below 1 mm wet sediment has low oil permeability
				15	2	
				24	3.4	
				36	4	
				48	4.6	
Low energy estuary sand sediment	-	Well sorted sandy shore	Fine sediment, sand from estuary beach	8	0.8	
				15	1	
				24	1.8	
				36	2.1	
				48	2.2	

Corrosivity

A major concern expressed by various environmentalist non-governmental organizations (NGOs) is the relatively higher "corrosivity" of diluted bitumen derived from oil sands[581] compared with conventional crude oils. The concern is that the transport of diluted bitumen in pipelines or in rail tank cars will lead to a higher rate of spills due to internal corrosion. According to a widely-disseminated 2011 report from the National Resources Defense Council, diluted bitumen is more acidic, more viscous, higher in sulfur content, and more abrasive than conventional crude, and it runs at higher temperatures and pressure in pipelines.[582]

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[580] Witt O'Brien's et al. 2013, as derived from Brown et al. 1992.

[581] Oilsands are a naturally occurring mixture that typically contains 10-12 % bitumen, 80-85 % minerals (clays and sands) and 4-6 % water. Bitumen is a mixture of large hydrocarbon molecules containing up to 5% sulphur compounds by weight, small amounts of oxygen, heavy metals, and other materials. Physically, bitumen is denser than water and more viscous than molasses (sometimes existing as a solid or semi-solid). Bitumen-containing oilsand deposits are found in over 70 countries, but three quarters of the world's known reserves are in Canada and Venezuela. Oilsands represent about 66% of the world's total reserves of oil. Most of the oilsands in Canada are located in three principal deposits in Northern Alberta: Athabasca, Cold Lake, and Peace River; the deposits encompass nearly 77,000 km^2 land area. The first Canadian oilsands mining operations started in 1967, the second began in 1978, and the third began in 2003. Currently several more mining operations are either under development or commercial consideration. In 2005, oilsands accounted for 50% of Canada's total crude oil output. (Papavinasam 2012).

[582] Swift et al. 2011.

The claim that diluted bitumen is more corrosive than other crude oils has been evaluated in several research studies. One study conducted at Battelle Memorial Institute[583] concluded the following:

- The characteristics of diluted bitumen are not unique and are comparable to conventional crudes.
- A relative measure of similarity developed to compared crude oils did not indicate that crude derived from diluted bitumen is significantly more corrosive than any other oil.
- Diluted bitumen oils have corrosivity similar to heavy sour conventional oils.
- The experience of operators transporting diluted bitumen does not indicate that it behaves differently from typical crudes.
- Internal examinations of pipelines transporting diluted bitumen appear no different after many years of service than those shipping conventional crude.
- Data reported to PHMSA show no releases from pipelines transporting Canadian crudes and caused by internal corrosion during the years 2002 through early 2011.

The Battelle researchers developed a pipeline oil similarity index (POSI) that is calculated as:

$$POSI = \frac{\frac{Sulfur(wt\%)}{3.16} + \frac{Sediment(ppmw)}{294} + \frac{Salt(ptb)}{71.5}}{3}$$

The POSI essentially compares crude oils with the heavy sour conventional crude oil designated as Western Canadian Blend (WCB). The values in the denominators are for WCB, so that the POSI for WCB is 1.0. The POSI does not, in and of itself, measure corrosivity but rather measures parameters that are common properties of oil. If the values are close to those of oils known not to exhibit corrosivity, then these oils should be expected to be equally non-corrosive. A list of crude oils and their associated POSI values are shown in Table 82.

The POSI of the Mexican heavy sour conventional crude oil is greater than the Canadian and Colombian crude oils, and the POSI values of all Canadian heavy sours are also less than the Colombian crude oil. Six of the seven heavy sour dilbit crude oils had POSI values less than the control, and the seventh dilbit crude oil had the same value as the control (WSB). The POSI for the heavy sour synbit and dilsynbit crude oils were either slightly greater or less than the control. All of the medium sour crude oils had POSI values less than the control, and the light sour Canadian oil was only slightly greater than the control. The researchers concluded that while it is clear that the POSI approach does not indicate that crude oil derived by diluted bitumen is more corrosive than any other oil, it also shows that the dilbit oils, in particular, likely have

[583] Hinden and Leis 2012.

corrosivities close to, or less than, other heavy sour conventional oils commonly used in North America. In other words, based on the information available, diluted bitumen poses no more of a corrosion risk to pipelines than conventional crudes.

Table 82: Crude Oils and their Pipeline Oil Similarity Index[584]

Country	Crude Type	Crude Name	POSI
Canada	Heavy Sour - Conventional	Bow River North	0.82
		Bow River South	0.62
		Fosterton	0.63
		Lloyd Blend	1.02
		Lloyd Kerrobert	0.92
		Smiley-Coleville	0.66
		Western Canadian Blend (WSB) - control	1.00
	Heavy Sour – Dilbit	Access Western Blend	0.69
		Cold Lake	0.65
		Peace River Heavy	0.81
		Seal Heavy	0.79
		Statoil Cheecham Blend	0.64
		Wabasca Heavy	0.70
		Western Canadian Select	1.01
	Heavy Sour – Synbit	Long Lake Heavy	0.59
		Surmount Heavy Blend	0.53
	Heavy Sour – Dilsynbit	Albian Heavy Synthetic	1.21
	Medium Sour	Midale	0.89
		Mixed Sour Blend	0.63
		Sour High Edmonton	0.55
	Light Sour	Light Sour Blend	1.09
Mexico	Heavy Sour	Maya	2.60
	Medium Sour	Isthmus	0.69
Colombia	Heavy Sour	Rubiales	1.26

Another study conducted by Alberta Innovates Energy and Environment Solutions[585] examined the concerns that dilbit has higher acid, sulfur, and chloride salt concentrations, as well as higher concentrations of more abrasive solids. The study also examined the issue of higher operating temperatures that would make dilbit more corrosive, leading to a higher failure rate than observed for pipelines transporting conventional crude.

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[584] Hinden and Leis 2012.
[585] Been 2011.

The assertions made by the National Resource Defense Council and the U.S. Department of State[586] regarding the increased corrosivity of diluted bitumen and corrosion concerns in general were addressed as follows. Note that while the particular responses are addressed towards pipelines issues, there are parallel concerns about rail tank cars.

Assertion 1: Dilbit contains 15 to 20 times higher corrosive acid concentrations than conventional crude oil.

Under refinery conditions and temperatures, naphthenic acids compounds can be corrosive. Naphthenic acids are a group of organic acids measured in terms of a total acid number (TAN), which is obtained by titration of the oil with KOH. TAN numbers have, therefore, the units of mg KOH/g. Crude oils with TAN values greater than 0.5 are generally considered corrosive. However, recent work has indicated that not all naphthenic acids are equally corrosive and the acid groups attached to large hydrocarbon molecules found in heavy crudes and dilbits are more stable and less corrosive.[587] Consequently, the TAN number is not necessarily reflective of the corrosivity of crude at elevated temperatures.

Results indicate a higher TAN for dilbits A and C, whereas dilbit B and dilsynbit A are comparable to the conventional heavy sour crudes. Research is continuing into the effects of these parameters at refineries, where upgrading of materials and the use of inhibitors can be used to mitigate any increase in corrosivity.[588] However, the acids are too stable to be corrosive under transmission pipeline temperatures. On the contrary, long chain organic acids have been found to decrease the corrosion rate at room temperature.[589] Furthermore, a number of Californian crudes have TAN numbers up to 3.2, and these crudes have been produced and transported by pipeline throughout California for many years.[590]

Assertion 2: Dilbit contains five to ten times as much sulfur as conventional crudes; the additional sulfur can lead to the weakening or embrittlement of pipelines.

Under refinery conditions and temperatures, organic sulfur compounds can be corrosive. A wide variety of sulfur compounds are present in crude oil, which, when heated, will be released as corrosive hydrogen sulphide. The release of hydrogen sulphide again depends on the stability of the organic sulfur compound, and high temperatures between 220º and 400º C are required. With a wide variety of sulfur compounds and stabilities, the sulfur content of crude is also not a good measure of the corrosivity of crude at refinery conditions.[591]

[586] Swift et al. 2011; US Department of State 2011.
[587] Kane et al. 2006; Messer et al. 2004; Dettman et al. 2009; Dettman et al. 2010.
[588] Kane et al. 2006.
[589] Ayello et al. 2011.
[590] Sheridan et al. 2006.
[591] Dettman et al. 2010.

Under transmission pipeline temperatures, organic sulfur compounds are too stable to be corrosive. At room temperature, sulfur-containing compounds were found to have no effect or resulted in a decrease in the corrosion rate.[592]

The sulfur content does not correlate to the hydrogen sulfide content, which is not typically reported. As an example, two Mexican crudes with sulfur contents of 3.4% and 0.9% contained 100 ppm and 116 ppm of H_2S, respectively.[593] Small concentrations of H_2S may be present in sour as well as sweet crudes. Concentrations could vary from a few ppm to over a hundred ppm. The CRW diluent is limited to 20 ppm of H_2S. Although the H_2S concentrations in dilbits are not available, there is no indication that these levels would be higher than in conventional crudes. If available hydrogen sulfide could separate from the oil into an aqueous phase in the pipeline, the corrosivity of the water could increase. This would be valid for all oil systems and not specific to dilbit lines.

Assertion 3: Dilbit has a high concentration of chloride salts, which can lead to chloride stress corrosion cracking in high temperature pipelines.

The highest chloride salt concentration was observed for the conventional light sour crude, Light Sour Blend, with the dilbits displaying some of the lowest salt concentrations. Chloride salts can lead to the formation of strong hydrochloric acid in the presence of steam at upgrading and processing temperatures greater than 150°C, which can result in serious corrosion problems.[594] These conditions are not encountered in transmission pipelines. In fact, it has been shown that high salinity brines in contact with oils did not affect the corrosion rate.[595] Chloride stress corrosion cracking can be an issue in stainless steel equipment, but is not a mechanism encountered in carbon steel transmission pipelines.[596]

Assertion 4: Oil sands crude contains higher quantities of abrasive quartz sand particles than conventional crude, which can erode the pipelines.

The sediment content of oil sands crude is below the limit of 0.5 volume percent (water + sediment) specified in the pipeline tariffs.[597] The sediment levels of the dilbit crudes were comparable to, or lower than, the conventional crudes, except for the dilsynbit crude (Albian Heavy Synthetic Crude) with an oil sands mining origin, which showed more than double the quantity of solids than most other crudes. However, at ~800 ppmw (~0.027 volume percent), it is still well below the limit set by regulatory agencies and industry.

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[592] Ayello et al. 2011.
[593] US Department of State 2011.
[594] Kaur 2009.
[595] Stroe et al. 2011.
[596] McIntyre 1987.
[597] NEB 2008; NEB 2010; FERC 2011.

Assertion 5: It has been suggested that dilbit could be up to 70 times more viscous than conventional crude oil. It has been claimed that the increase in viscosity creates higher temperatures as a result of friction.

The dilbit crudes have similar °API (densities) and viscosities to the conventional heavy sour crudes. All of the crudes are well above the minimum of 19 °API gravity; only dilsynbit crude (Albian Heavy Synthetic Crude) has an average value below 20 at 19.5 °API gravity. Also, the viscosities are well below the limited receipt viscosity of 350 cSt specified by the crude petroleum tariffs.[598] The lower the viscosity, the easier the oil flows, where water has a viscosity of one cSt at 20°C. The viscosity is sensitive to temperature and will increase at colder temperatures. To compensate for fluctuations in viscosity as a result of varying seasonal temperatures, the amount of diluent added to the crude will be adjusted to control the viscosity to the desired level.

Assertion 6: The Alberta pipeline system has had approximately 16 times as many spills due to internal corrosion than the U.S. system, indicating that the dilbit is much more corrosive than the conventional oil that is primarily flowing through U.S. lines.

The data are not comparable as a broader range of pipelines, as well, as smaller incidents are included in the Canadian data than in the PHMSA. The U.S. had 52.475 miles of crude oil pipelines in 2008, whereas Alberta had 11,187 miles in 2006. The data are relatively comparable, except that U.S. pipelines experienced 30% more internal corrosion per pipeline mile than Alberta pipelines. Alberta had a 16% higher overall failure rate than U.S. pipelines.

Assertion 7: An increased risk of internal corrosion may be related to the sediment composition of dilbits and specific sediment characteristics, including particle hardness and size distribution.

Analyses did not indicate a much higher content of sediments for the dilbit crudes compared to the conventional crudes, except for dilsynbit crude (Albian Heavy Synthetic Crude). The data, however, only indicate the total amount of sediments and do not provide information on the size distribution. It is unknown how the solids in the conventional crudes compare to those in dilbits. Analyses of pipeline deposits obtained from pigging operations have indicated the presence of larger solids to over 400 microns.[599] Most of the solids, however, were fine particles less than 44 microns in diameter, where the larger and fine particles consist primarily of silica sand and iron compounds. The larger sand particles were uniformly coated with fine clays surrounded by a film of water in oil. Under low-flow conditions, these particles are heavy enough to precipitate out with the water, oil products, and possibly asphaltenes, forming a sludge deposit. Sludge deposits are mixtures of

[598] NEB 2008; NEB 2010; FERC 2011.
[599] Place et al. 2008.

hydrocarbons, sand, clays, corrosion by-products, biomass, salts, and water. One might expect deposition of sludge to occur at the lowest spots. However, Enbridge observed under-deposit corrosion in their dilbit lines near over-bends, which are locations of low fluid shear stress (low fluid flow pressure). Little is known about the sludge deposition mechanism, and it is not known if sludge formation would occur in the presence of only fines.

Assertion 8: A combination of chemical corrosion and physical abrasion can dramatically increase the rate of pipeline deterioration.

In the field, the pipeline is protected by coatings and cathodic protection. Increased temperatures may result in coating disbondment, which would expose the bare pipe to the soil environment, which can be corrosive-containing water, dissolved oxygen, and carbon dioxide. Together with fluctuating pipeline operating stresses, this has resulted in stress corrosion cracking (or fatigue cracking) of pipelines covered with tape or asphalt coatings. These coatings can behave as shielding coatings, preventing the secondary protection of applied cathodic current. The Keystone pipeline is coated with Fusion Bonded Epoxy (FBE), which is considered permeable to the cathodic protection current. Temperatures up to 60ºC have indicated a higher rate and extent of coating disbondment, but it has also been shown that, in the presence of cathodic protection, the pipe will remain protected, and blistering and coating disbondment does not present an integrity threat to a pipeline.[600] No stress corrosion cracking failures have been reported for FBE coatings in over 40 years of experience.

Assertion 9: As a result of the high viscosity of dilbit, pipelines operate at temperatures up to 158ºF, whereas conventional crude pipelines generally run at ambient temperatures. The high temperature would increase the corrosion rate which doubles with every 20ºF increase in temperature.

An increase in the temperature can increase the rate of corrosion if the corrosion mechanism is controlled by kinetics or diffusion. There are, however, many other factors that affect the rate of corrosion such as scale formation, limiting concentration of reactants, or chemical reactions. Especially in a complex aqueous environment, possibly with dissolved organics, acid gases, oxygen, sub-micron clay particles, etc., the corrosion rate can either increase or decrease as a function of temperature. The concentration of oxygen or carbon dioxide is generally not known and, if present, may change along the length of the pipeline. The most likely internal corrosion mechanism in dilbit pipelines consists of underdeposit corrosion as a result of sludge formation. Microbiologically-induced corrosion could play a dominant role in the corrosion process. Complex populations containing multiple types of bacteria are known to be present and support each other's viability such as sulfate reducing bacteria (SRB), heterotrophic aerobic bacteria (HAB), and acid producing bacteria (APB) [48]. These bacteria are most active between 10ºC and 40ºC. Consequently, higher temperatures

[600] Been et al. 2005.

up to 70ºC may reduce the corrosion rate underneath sludge deposits, if the mechanism is controlled by microbial action.

Little is known about the controlling factors of corrosion underneath sludge deposits, and it is recommended that research continue to improve our understanding of sludge formation, the resulting corrosion mechanism, the role of dilbit chemistry and solids, mitigation practices and frequencies, and preventive measures. Enbridge has been quite successful in mitigating underdeposit corrosion through a pigging and inhibition program. However, there are still many uncertainties regarding the effectiveness of each and the required frequency.[601]

Assertion 10: Dilbit pipelines may be subject to a higher incidence of external stress corrosion cracking.

In the field, the pipeline is protected by coatings and cathodic protection. Increased temperatures may result in coating disbondment, which would expose the bare pipe to the soil environment, which can be corrosive containing water, dissolved oxygen and carbon dioxide. Together with fluctuating pipeline operating stresses, this has resulted in stress corrosion cracking (or fatigue cracking) of pipelines covered with tape or asphalt coatings. These coatings can behave as shielding coatings, preventing the secondary protection of applied cathodic current. The Keystone pipeline is coated with Fusion Bonded Epoxy (FBE), which is considered permeable to the cathodic protection current. Temperatures up to 60ºC have indicated a higher rate and extent of coating disbondment, but it has also been shown that, in the presence of cathodic protection, the pipe will remain protected, and blistering and coating disbondment does not present an integrity threat to a pipeline.[602] No stress corrosion cracking failures have been reported for FBE coatings in over 40 years of experience.

In another study conducted by Canmet MATERIALS,[603] researchers evaluated four properties identified as being correlated with corrosion:

- Locations where water accumulates in a pipeline.
- Type of emulsion.
- Wettability.
- Change in the corrosion rate of the aqueous phase in the presence of crude oil.

[601] Place et al. 2008.
[602] Been et al. 2005.
[603] Collier et al. 2012.

The maximum average corrosion rate of carbon steel in brine with crude oil was found to be 2.1 ± 1.9 mpy,[604] compared to 19 ± 2.8 mpy for the brine alone. Corrosion rate (in mils per year) was calculated as:

$$CorrRate = \frac{3.45x10^{6} \cdot \Delta m}{dAt}$$

Where Δm = mass loss in grams after correction for mass loss due to cleaning[605]

d = density of iron (7.86 g/cm^3)

A = average surface area of iron coupons[606]

t = test duration in hours.

Based on their effect on the corrosivity of the brine solution, the crude oils were classified as inhibitive hydrocarbons according to the guidelines set out in *ASTM Standard Guide G205: Standard Guide for Determining Corrosivity of Crude Oils*.

Another study conducted by a group of researchers at CanmetMATERIALS, CanmetENERGY, and Ammonite Corrosion Engineering, Inc.[607] on corrosion conditions in pipelines, as well as in the upstream and downstream parts of oil transmission, concluded that the possibility of corrosion in oil transmission pipelines is low. The low corrosion possibility is due to the fact that the corrosive and erosive materials are removed upstream of the pipelines; the operating conditions of pipelines are mild conditions [(lower water content (typically less than 0.5% by volume) and lower temperature (typically less than 50ºC)] in which the corrosive species (naphthenic acid and sulfur) do not influence corrosion.

The general conclusion from these studies is that there is no increased risk of corrosivity with diluted bitumen being transported through pipelines. These results may be applied to rail tank cars, as appropriate.

[604] Mils per year.
[605] The metal pieces being tested were cleaned.
[606] Coupons are the circular pieces of iron used to test corrosion rates.
[607] Papavinsam et al. 2012.

Appendix G: In Depth: Oil Spill Impacts in Washington

The potential environmental impacts of an oil spill are dependent on a large number of factors, but most particularly:

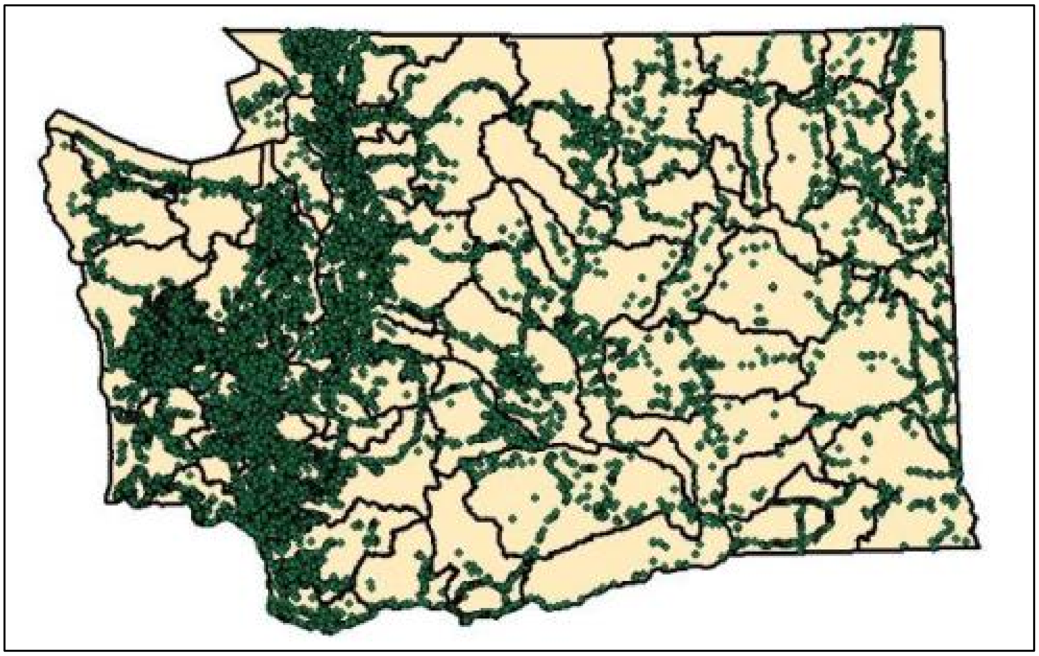
- Type of oil (chemical and physical properties, toxicity, adherence, persistence).
- Spill location (habitat types, species present).
- Time of year (nesting season, reproductive cycles, migration patterns).

These three factors play into the type of impact that might be expected from an oil spill. In a 2009 study conducted for the Washington Joint Legislative Audit and Review Committee (JLARC) and the Washington State Department of Ecology,[608] these three factors were analyzed by mapping the state's marine, estuarine, and inland areas for sensitivity to different types of oils in different seasons. The sensitivity mapping was heavily based on Ecology's Washington Compensation Schedule methodology.[609] The sensitivity mapping included:

- Habitat vulnerability to oil's propensity to cause impact by acute toxicity, mechanical injury, and persistence
- Marine bird vulnerability
- Marine mammal vulnerability
- Marine fish vulnerability
- Shellfish vulnerability
- Salmon vulnerability
- Recreation vulnerability
- Freshwater vulnerability
- Barriers to natural fish movement (Figure 152)
- Urbanization
- Condition of riparian (river bank) vegetation
- Streambed condition
- Condition of floodplains
- Land use of watersheds
- Flow alteration of water due to impoundment
- Water quality

[608] State of Washington JLARC 2009; Etkin et al. 2009; French-McCay et al. 2009.
[609] Chapter 173-183 WAC.

Figure 152: Coverage of Washington State Fish Barrier Data[610]. Image source: WA Department of Fish & Wildlife.



The study results indicated that the impact risk was highest for the heavy fuels, followed by crude oil; lower for light oils and gasoline, which are similar for a given zone; and lowest for jet fuel and non-petroleum oils. This trend is related to the higher persistence and mechanical injury scores (measuring propensity to coat and foul organisms) of the heavier oils, which therefore have more impact on birds, mammals, habitats, and recreation then the non-persistent oils.

The seasonal variation of the impact risk scores was relatively small, because seasonal highs for some resources are balanced by different seasonal patterns for other resources; however, the scores are higher in spring and summer than in fall or winter.

Marine and Estuarine Waters

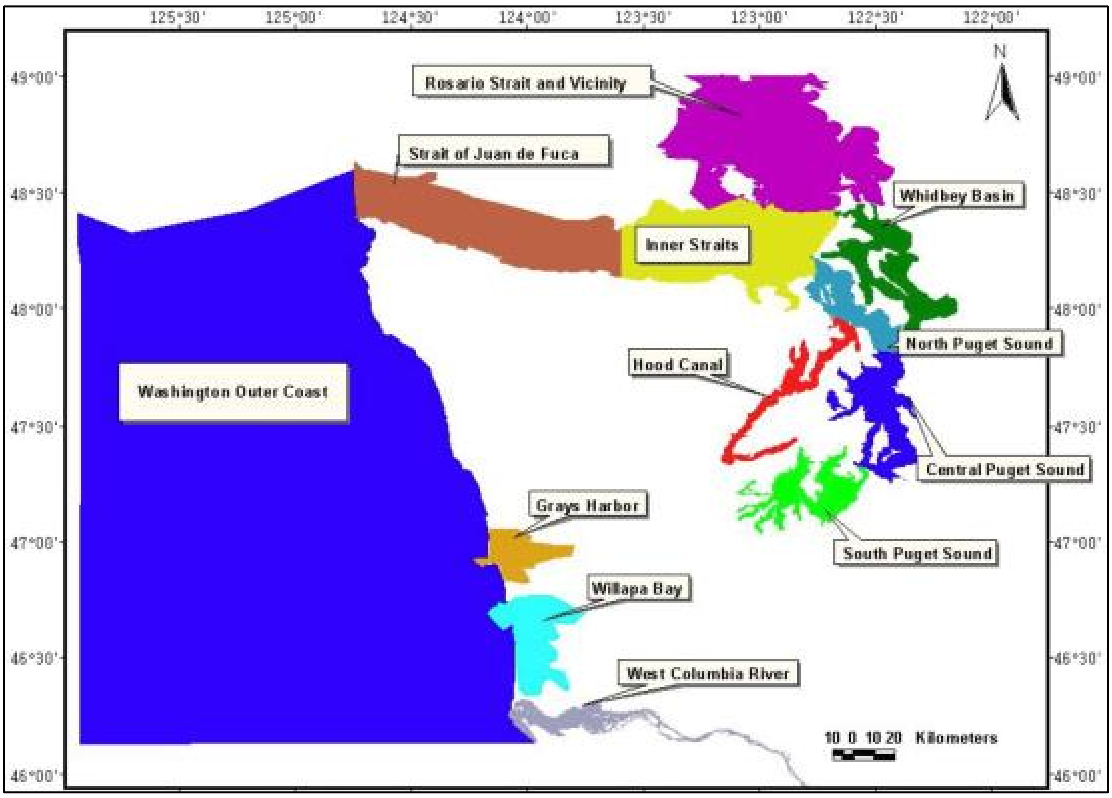
In Table 83, the "normalized" impact scores of different oil types on marine and estuary waters (Figure 153) are shown by season. The normalization of the scores shows the relative impacts of the oils/seasons compared to each other. The lowest impact would be for jet fuel or organic oils in fall and winter. The impacts of a spill of heavy oil in spring would be three times as high.

[610] The fish barrier data include the WSDOT fish barrier data, ECY dams information, and other fish barrier data.

Table 83: Normalized Impact Risk Scores: Oil Type/Season Averaged over Estuarine/Marine Zones[611]

Oil Category	Spring	Summer	Fall	Winter
Crude Oils	2.30	2.16	2.02	2.03
Heavy Oils	3.01	2.82	2.63	2.65
Light Oils	1.82	1.71	1.59	1.59
Gasoline	1.73	1.62	1.51	1.52
Jet Fuel	1.15	1.07	1.00	1.00
Non-Petroleum Oils	1.15	1.07	1.00	1.00

Figure 153: Estuarine and Marine Zones of Washington State[612]**. Image source: Applied Science Associates.**



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611 French-McCay et al. 2009.
612 French-McCay et al. 2009.

Averaged across the four seasons, the impacts of different oil types by marine and estuarine zone are shown in Table 84. Again, the numbers have been normalized.

Table 84: Normalized Impact Risk Scores for Estuarine/Marine Zones by Oil Type[613]

Zone	Crude Oils	Heavy Oils	Light Oils	Gasoline	Jet Fuel	Non-Petroleum
Outer Coast	2.92	3.87	2.33	2.33	1.48	1.48
Grays Harbor	3.09	4.01	2.42	2.27	1.51	1.51
Willapa Bay	3.55	4.63	2.79	2.62	1.74	1.74
Strait of Juan de Fuca	2.16	2.82	1.66	1.50	1.00	1.00
Inner Straits	3.83	5.00	3.08	2.96	1.91	1.91
Rosario Strait	3.08	4.04	2.46	2.37	1.55	1.55
Whidbey Basin	3.24	4.24	2.57	2.44	1.63	1.63
Northern Puget Sound	3.52	4.58	2.81	2.66	1.77	1.77
Central Puget Sound	2.41	3.17	1.88	1.78	1.19	1.19
South Puget Sound	3.04	3.96	2.38	2.28	1.51	1.51
Hood Canal	2.44	3.20	1.91	1.80	1.18	1.18
West Columbia River	3.22	4.16	2.54	2.37	1.63	1.63

Inland Areas

The highest impact risk for the inland zones (Figure 154) is in the Olympic Peninsula zone, followed by West of Cascades, and then East of Cascades. The Columbia River-Snake River and Lake Union-Lake Washington have lower scores due to urbanization, fish barriers,[614] and impoundments in the watershed.

613 French-McCay et al. 2009.

614 Screens installed to protect endangered species of fishes that would otherwise be harmed or killed when passing through industrial facilities such as steam electric power plants, hydroelectric generators, petroleum refineries, chemical plants, farm irrigation water, and municipal drinking water treatment plants.

Figure 154: Inland Zones of Washington State with Individual Water Resource Inventory Areas[615]. Image source: Applied Science Associates.

Averaged across the four seasons, the normalized risk scores for impacts of different oil types by inland zone are shown in Table 85.

Table 85: Normalized Impact Risk Scores for Inland Zones by Oil Type[616]

Zone	Crude Oils	Heavy Oils	Light Oils	Gasoline	Jet Fuel	Non-Petroleum
Lake Union/ Lake Washington	1.98	2.56	1.56	1.46	1.00	1.00
East Columbia River/Snake River	2.46	3.19	1.94	1.81	1.24	1.24
Olympic Peninsula	5.29	6.85	4.18	3.90	2.67	2.67
West of Cascade Mountains	4.85	6.28	3.83	3.57	2.45	2.45
East of Cascade Mountains	3.79	4.91	3.00	2.79	1.92	1.92

[615] French-McCay et al. 2009.
[616] French-McCay et al. 2009.

Appendix H: Summary July 23, 2014, USDOT NPRM

High-Hazard Flammable Train (HHFT)

The proposed regulation defines an HHFT as a train carrying 20 or more cars of a Class 3 flammable liquid. According to PHMSA, Bakken crude should be in Packing Group I (the most dangerous packing group) as a Class 3 flammable liquid. Other crude oils may be in Packing Group II or III (less dangerous packing groups), but will still be Class 3 flammable liquids. The proposed regulation requests comments on:

- How the HHFT designation affects operating practices and trains carrying other Class 3 flammable liquid.
- The costs and benefits to including flammable gas and combustible liquids to the definition of HHFT.
- The risks posed by hazardous materials when in HHFTs.

PHMSA did not include an oil spill response proposal in this regulation but did release an Advance NPRM on comprehensive oil spill response plans.

Classification/Characterization of Mined Gases and Liquids

The proposed regulations require offerors to ensure the proper classification and characterization of the materials they offer for shipment. As such, an offeror must develop a sampling and testing program for all mined gases and liquids (including crude oil) that addresses:

- Frequency of sampling and testing.
- Sampling at points along supply chain.
- Sampling methods to ensure a representative sample of entire mixture.
- Testing methods.
- Statistical justification of sampling frequency.
- Duplicate samples for quality assurance. Program will be certified and available to the USDOT.

The proposed regulation requests comments on:

- Clarity in the guidelines.
- More or less specificity needed regarding components of sampling and testing program.
- Incentives for offerors already using the safest packaging and equipment standards.
- Differences in processes and costs for classification of mined gases versus mined liquids.

- Description of the variability that exists across region due to location, time, temperature, or mining methods.

Rail Routing Risk Assessment

Proposed regulation requires carriers to consider 27 safety and security factors in routing assignments:

- Volume of hazardous materials.
- Presence and characteristics of railroad facilities.
- Presence or absence of signals and train control systems.
- Single versus double track.
- Environmentally sensitive areas.
- Emergency response along route.
- Rail traffic density.
- Track type, class, and maintenance.
- Presence or absence of wayside hazard detectors.
- Frequency and location of track turnouts.
- Population density.
- Areas of high consequence.
- Trip length for route.
- Track grade and curvature.
- Number and types of grade crossings.
- Proximity to iconic targets.
- Venues along the route.
- Presence of passenger traffic along route.
- Speed of train operations.
- Measures in place to address safety and security risks.
- Overall times in transit.
- Proximity to enroute storage or repair facilities.
- Availability of practicable alternative routes.
- Training and skill level of crews.
- Known threats.
- Past incidents.
- Impact on rail network traffic and congestion.

The proposed regulation requests comments on:

- The extent routing requirements would change operational practices for small railroads, and the benefits and costs in applying requirements to small railroads.
- Whether voluntary compliance to the above standards has changed operational practices for crude oil shipments.

Notifications to State Emergency Response Commissions

The proposed regulation codifies the FRA's emergency order requiring that railroads report to state SERCs movements of Bakken crude in excess of one million gallons. The proposed regulation requests comments on whether:

- The reporting should continue to be only for Bakken crude of a million or more gallons.
- A different reporting threshold should be used; smaller numbers of train cars be required to report.
- Reports should be considered sensitive or security documents.
- Railroads should contact local responders directly.
- PHMSA should place restrictions on the states that hold the reports.

Restricted Operating Speeds

The proposed regulation identifies speed as a contributing factor in derailments and sets the maximum speed for HHFT's at 50 mph. If a carrier does not have an enhanced braking system, the speed for HHFT's would be 30 mph. If the HHFT contains a tank car not meeting the DOT 117 specifications, then the railroad would have to operate the train under a reduced speed. The proposed regulation requests comments on the preferred options:

- 40 mph in all areas.
- 40 mph in high threat urban areas (Seattle is the only one in Washington State).
- 40 mph in areas with 100,000+ population.

FRA also asks for comments on:

- Cost per hour of delayed HHFT.
- Effects of a 40 mph restriction on other traffic on network.
- Safety benefits of speed restrictions with enhanced braking.
- Other than kinetic energy, other factors that would refine calculation to reduce risk.
- Extent 40 mph would divert rail traffic to other lines or other modes (trucks).
- Other geographic delineations in addition to HTUA and population to consider.
- Benefits and costs of excluding jacketed CPC 1232 cars from proposed 40 mph.

Enhanced Braking Systems

The proposed regulation requires HHFTs to be equipped with alternative brake signal propagation system. The braking systems discussed in the NPRM are: (1) electronic-controlled pneumatic brake system (ECP), which sends a braking signal to all cars in the train, reducing time before brakes are engaged; (2) distributed power (DP), which provides control of a number of locomotives dispersed throughout a train from a controlling locomotive; and (3) two-way end-of-train (EOT) devices that include two pieces of equipment linked by radio that initiate an emergency brake application command.

The proposed regulation requests comments on:

- Market price of ECP brakes ($3,000 on new, $5,000 on retrofit, and $79,000 for locomotive listed as estimate).
- Benefits of combining speed restrictions with braking system.
- Annual capacity to install ECP, DP, and EOT systems.

New and Existing Tank Car Standards

The proposed regulation creates the DOT Specification 117 tank car. All new HHFT construction, after October 1, 2015, will meet or exceed the DOT-117 standards. The proposed regulation requests comments on three options for possible tank car standards (Table 86):

- **Option 1**: PHMSA and FRA Designed Car which includes wall thickness of 9/16 inch, minimum 11 gauge jacket, full height head shield of ½ inch, ECP brakes, thermal protection with reclosing pressure relief device, bottom outlet handle removed or designed to prevent unintended release, and top fitting protection system and nozzle (roll over protection)
- **Option 2**: AAR 2014 Car – Design that BNSF used in its purchase of 5,000 tank cars. Same safety measures as Option 1 except there is no roll over protection and no ECP brakes.
- **Option 3**: Enhanced jacketed CPC-1232. The wall thickness is 7/16 inch, full height head shield of ½ inch, and 11 gauge jacket. No ECP brakes and no roll over protection.

Table 86: Summary of Options for Rail Tank Car Standards (Post October 1, 2015)[617]

Feature	Option 1 PHMSA/FRA Designed Tank Car	Option 2 AAR 2014 Tank Car	Option 3 Enhanced CPC-1232 Tank Car
Wall Thickness	9/16	9/16	7/16
Steel = AAR TC-128 Grade B Normalized	✓	✓	✓
Head Shield = Full Head Shield, ½ inch	✓	✓	✓
Thermal Protection[618]	✓	✓	✓
Reclosing Pressure Relief Device	✓	✓	✓
Jacket[619]	✓	✓	✓
Bottom Outlet Handle[620]	✓	✓	✓
Top Fittings Protection	TIH 9 mph rollover	AAR App. E 10.2.1	AAR App. E 10.2.1
Braking[621]	ECP Brakes	DP or EOT	DP or EOT
286k GRL Authorized	✓	✓	✓

The regulation has also asked for comments on: (a) possibility of decreased capacity in new car; (b) additional safety measures needed; and (c) impacts of increased size, weight on track safety, braking and loading practices.

Tank Car Phase-Out – DOT 111

The proposed regulation calls for the use of the new tank car, DOT Specification 117, for HHFTs. The DOT 111 can be repurposed, retrofitted, or retired according to the timeline in Table 87. The proposed regulation requests comments on the phase out timeline of the DOT 111.

Table 87: Timeline for Continued Use of DOT Specification 111 Tank Cars in HHFT Service

Packing Group	DOT-111 Not Authorized After
I (including Bakken)	October 1, 2017
II	October 1, 2018
III	October 1, 2020

617 ✓ = required under the Proposed Rules.
618 In accordance with 49 CFR §179.18.
619 Minimum 11-gauge jacket constructed from A1011 steel and weathertight.
620 Bottom outlet handle removed or designed to prevent unintended actuation during train accident.
621 ECP = electronically-controlled pneumatic brakes; DP = distributed power; EOT = end of train device.

Appendix I: Multi-Agency Comments on July 23, 2014, USDOT NPRM

September 26, 2014

Secretary Anthony Foxx
Department of Transportation
1200 New Jersey Avenue SE
Washington, DC 20590

Administrator Cynthia L. Quarterman
Pipeline and Hazardous Materials Safety Administration
Department of Transportation
1200 New Jersey Avenue SE
Washington, DC 20590

Re: Docket No. PHMSA-2012-0082 (HM-251), Enhanced Car Standards and Operational Controls for High-Hazard Flammable Trains – Notice of Proposed Rulemaking

Dear Secretary Fox and Administrator Quarterman:

In response to train accidents and incidents involving trains transporting large volumes of flammable liquids, on July 23, 2014, the Pipeline and Hazardous Materials Safety Administration (PHMSA), in coordination with the Federal Railroad Administration (FRA), two agencies within the United States Department of Transportation (USDOT), issued a Notice of Proposed Rulemaking (Notice or NPRM). In that Notice, those agencies proposed new requirements for trains transporting Class 3 flammable liquids, including tank car standards, and changes to existing rules offering the flammable liquids for transportation.

The Washington Utilities and Transportation Commission (UTC), the Washington Department of Ecology (Ecology), the Washington State Department of Transportation (WSDOT), and the Emergency Management Division of the Washington Military Department (EMD) jointly file these comments for Washington State in response to the NPRM.

The UTC has authority over railroad safety in the State, and conducts safety inspections under the FRA's State Participation Program. Ecology is responsible for the oil spill prevention, preparedness, and response plans for the State. WSDOT oversees the management of the Amtrak Cascades, intercity passenger rail service along the Pacific Northwest Rail Corridor, one of 11 federally-designated passenger rail corridors in the United States. In addition, WSDOT owns a short-line rail system and is responsible for the State Rail Plan and freight rail and marine transportation policy. EMD is the State agency responsible for assisting with and managing the

State response to natural and human-made disasters and leads the State Emergency Response Commission (SERC).

Given the various roles of these State agencies and their shared interest in ensuring the public safety of the citizens and protecting the unique natural resources of Washington State, the agencies jointly file these comments.

Washington State, the 20th largest State in the nation has a total land areas of 66,544 square miles.[622] There are 3,157 miles of railroad track in the State, ranking it 22nd in the nation for track mileage. Traditionally, crude oil has been shipped to the State by waterborne transportation. However, in recent years, there has been an exponential increase in the amount of crude oil shipped to and through Washington State by rail. In 2013, approximately 280 million barrels of oil were shipped by rail through the United States[623] with approximately 17 million barrels being shipped through Washington.[624] This movement of oil by rail in Washington is projected to more than triple in 2014, increasing to 55 million barrels.[625]

Washington State is home to one of the richest and most diverse landscapes in the world, with abundant natural and economic resources and communities, including the inland marine waters and estuaries of Puget Sound, the mighty Columbia River, the volcanic Cascade Mountain range, fertile agricultural lands, and populous cities. The majority of the transportation of oil by rail in Washington enters the State at the border with Idaho near Spokane, crosses the Spokane River, travels to Pasco, and then westward along the Columbia River along the Columbia River Gorge to Vancouver, Washington. Leaving Vancouver by rail, the oil travels north to Tacoma, than along the Puget Sound through Seattle, the most populous city in the State, on its way to Anacortes and Ferndale, near the Canadian border. Empty cars will often, though not always, travel east across the Cascades through Wenatchee on their way out of the State through Spokane.

When crude oil is carried by rail it is typically transported in unit trains, i.e., trains made up entirely of one type of cargo. These unit trains can contain more than 100 tank cars with the potential for impact on the State's natural resources in the event of a spill or fire. The increased risks identified in the NPRM associated with the transportation of crude oil by rail necessitate immediate and comprehensive action by the USDOT on enhancing tank car standards and operational controls for high-hazard flammable trains with the goal of reducing derailments, incidents, accidents and spills, and increased transparency about the transportation of these flammable liquids.

I. High-Hazard Flammable Train

[622] http://www.Statemaster.com/graph/geo_lan_are-geography-land-area.
[623] *US Rail Transportation of Crude Oil: Background and Issues for Congress*, Congressional Research Services, May 2014.
[624] http://www.Statesmanjournal.com/story/news/2014/05/26/west-coast-oil-trains/9605759/ (Article no longer published on the Statesman Journal website.)
[625] Senator Murray Press Release on DOT NPRM on Tank Standards, July 2014.

The NPRM defines high-hazard flammable trains (HHFT) as any train comprised of 20 or more cars transporting Class 3 flammable liquids. The Association of American Railroads (AAR) similarly defined a "key train" as any train with 20 carloads or intermodal portable tank loads of any combination of hazardous materials. The AAR goes further to define a "key train" as any train with one tank carload of Poison or Toxic Inhalation Hazard (PIH or TIH). The NPRM asks for comments on (a) how the HHFT designation affects operating practices and train carrying other Class 3 flammable liquids; (b) the costs and benefits to including flammable gas and combustible liquids in the definition of HHFT; and (c) the risks posed by hazardous materials when in high-hazard flammable trains.

Washington State supports the USDOT's proposal to address specifically train carrying Class 3 flammable liquids. Washington State requests that the definition of high-hazard flammable trains also include any train carrying one or more tank carloads of a Packing Group I, Class 3 liquid. The risks associated with Packing Group I, Class 3 liquids, which include Bakken crude, should receive the same precautions and mitigation factors associated with PIH and TIH. Further, because of the exponential increase in the transportation of Bakken crude, the volatility associated with the commodity, as well as the amount of such hazardous materials moving into and through Washington, it is necessary to take this precaution in the interest of public safety and protection of the State's natural resources. For these reasons, Washington State recommends amending the definition of high-hazards flammable trains as follows, with changes marked in bold:

§171.8 Definitions

* * * * *

High-hazard flammable train *means a single train carrying 20 or more carloads of a Class 3 flammable liquid* ***or a single train carrying one carload of a Packing Group I, Class 3 flammable liquid.***[626]

* * * * *

II. Classification and Characterization of Mined Liquids and Gases

The development of a sampling and testing program, outlined in the NPRM, regarding the classification and characterization of mined gases and liquids is an important step to ensuring public safety with the movement of HHFTs. The NPRM asks for comments on: (a) clarity in the guidelines; (b) specificity needed regarding a sampling and testing program; (c) incentives for offerors already using the safest packaging and equipment standards; (d) differences in the

[626] Packing group means a grouping according to the degree of danger presented by hazardous materials. Packing Group I poses the greatest danger.

processes and costs of mined gases versus mined liquids; and (e) the variability that exists in product.

Focusing on items (b) and (e) of this issue, Washington State requests that the programs and results from this sampling and testing be made immediately available to the States. One of the most important steps that USDOT must take during this rulemaking, which is beyond those options in the NPRM, but something that communities and first responders in Washington State have requested numerous times, is the need for better communication and access to more complete information about the materials being shipped through the State. It is not enough to say that there is a sampling and testing program in place when those results and the criteria are not made available for review. Another missing component to the sampling and testing program is an independent analysis, whether through random auditing or a third-party annual audit.

Further, Washington State supports the classification of Bakken crude as a Packing Group I, Class 3 materials. Given the variability of Bakken crude, Washington State strongly recommends further analysis of Bakken crude and the current extraction techniques with the goal of reducing the volatility of the product prior to transport. Depending on the region, time of year, and mining techniques, Bakken crude is significantly more volatile than other crude oils. The State agencies propose the following change to the proposed rule on sampling and testing to mitigate concerns with variability, with changes marked in bold:

§ 173.41 Sampling and testing program for mined gas and liquid.

(a) General. Mined gases and liquids, such as petroleum crude oil, extracted from the earth and offered for transportation must be properly classes and characterized as prescribed in § 173.22 of this subpart, in accordance with a sampling and testing program which specifies at a minimum:

1. *A frequency of sampling and testing that accounts for appreciable variability of the material, including the time, temperature, method of extraction (including chemical use), and location of extraction;*
2. *Sampling at various points along the supply chain to understand the variability of the material during transportation;*
3. *Sampling methods that ensure a representative sample of the entire mixture, as packaged, is collected;*
4. *Testing methods that enable complete analysis, classification, and characterization of the material under the HMR;*
5. *Statistical justification for sample frequencies;*
6. *Duplicate samples for quality assurance purposes; and*
7. *Criteria for modifying the sampling and testing program.*

(8) ***<u>Independent third-party auditing on a set schedule.</u>***

(b) <u>Certification.</u> Each person who offers a hazardous material for transportation shall certify, as prescribed by § 172.204 of this subchapter, that the material is offered for transportation in accordance with this subchapter, including the requirements prescribed by paragraph (a) of this section.

(c) <u>Documentation, retention, dissemination of program.</u> The sampling and testing program must be documented in writing and must be retained for as long as it remains in effect. The sampling and testing program must be reviewed at least annually and revised and/or updates as necessary to reflect changing circumstances. The most recent version of the sampling and testing program, or relevant portions thereof, must be available to the employees who are responsible for implementing it. When the sampling and testing program is updated or revised, all employees responsible for implementing it must be notified, and all copies of the sampling and testing program must be maintained as of the date of the most recent revision.

(d) <u>Access by DOT and the State to a copy of program documentation.</u> *Each person required to develop and implement a sampling and testing program must maintain a copy of the sampling and testing program documentation (or an electronic file thereof) that is accessible at, or through, its principal place of business, and must make the documentation* ***<u>immediately</u>*** *available upon request of an authorized official of the Department of Transportation* ***<u>or a designated representative of a State.</u>***

III. Rail Routing

The NPRM lists 27 safety and security factors considered in the routing of HHFTs. Washington State finds that this rail routing risk assessment if critically necessary given the significant scenic areas, natural and economic resources, and communities through which oil is transported by rail in the State. Washington State strongly encourages making routing risk assessments and factors used in route selection available to State agencies and local responders. The NPRM appears to assume that the railroads simply need to consider the 27 factors but does not explain how they are used or why certain routes are chosen. The USDOT should consider weighting the factors, giving priority to factors related to public safety and environmental concerns.

In addition, we believe USDOT should mandate sharing this information as well as operational data about the number and timing of trains carrying crude oil within the State and local governments. This is of great concern to Washington and the USDOT must address this gap in this rulemaking.

Finally, Washington State supports the work of United States Senators Patty Murray and Susan Collins in developing the Short Line Rail Safety Institute. Washington State believes the Institute is a positive step in mitigating the risks associated with shipping hazardous materials and strongly encourage the continued support from USDOT on this initiative.[627]

IV. Notification to State Emergency Response Commissions of Petroleum Crude Oil Train Transportation

The USDOT's emergency order, DOT-OST-2014-0067, requiring that railroads notify the State Emergency Response Commission (SERC) when transporting more than a million gallons, approximately 35 tank cars, of Bakken crude oil was a necessary first step. We strongly encourage USDOT to expand the scope of the emergency order to include any movement of any crude oil types in excess of 42,000 gallons, approximately 1.5 tank cars. Broadening the scope of the emergency order would allow for better preparation by the local response community and a more complete understanding of the type of oil moving through our cities and towns. This information is necessary for first responders, but also for those that are tasked with the cleanup of any spill. The different types of crude oils present very different logistical problems in terms of cleanup which may require special equipment in some locations. The need for our State and local first responders to be prepared for a spill or catastrophic accident should outweigh any claimed security sensitivity. The information contained within those reports should be available and posted online for ease of access by local responders and other organizations in the event of an accident or spill.

V. Speed Restrictions

On February 21, 2014, Secretary Foxx sent a letter to the President and Chief Executive Order of the AAR requesting that AAR and its members subscribe to voluntary actions to improve the safe transportation of crude oil by rail, which included speed restrictions. The industry complied with the voluntary speed restrictions. Washington State supports the USDOT setting in rule speed reduction standards.

The NPRM sets a speed restriction of 50 mph on HHFTs that meet enhanced standards and requests comments on operating speeds on HHFTs not meeting enhanced standards of (a) 40 mph in all areas; (b) high threat urban areas (which include only Seattle, Bellevue, and Vancouver in Washington); and (c) 40 mph in areas with a population of 100,000 or more. The NPRM also requests comment on costs associated with delays from speed restrictions, effects on traffic network, safety benefits of speed restrictions, diversion of traffic to other forms of transportation, and other geographic delineations to consider.

Because there are populated areas in Washington at risk other than the three cities of Seattle, Bellevue, and Vancouver, Washington State encourages the adoption of a reduced speed of no more than 40 mph for HHFTs moving through populated areas in excess of 100,000 people, if the HHFT meets new tank car standards and had enhanced braking system in place. However,

[627] http://www.murray.senate.gov/public/index.cfm/2014/5/oil-trains-murray-collins-lead-bipartisan-push-for-increased-safety-resources-on-short-line-railroads.

the basis for determining an “area” of population in excess of 100,000, such as square acres, county lines, or other factors, should provide for the maximum protection possible, and should be made clear in the rule. Special consideration should also be given to areas deemed by the State to be environmentally sensitive (e.g., the Columbia River Gorge National Scenic Area) or of cultural importance, such as usual and accustomed Tribal fishing areas.

BNSF voluntarily restricts maximum speed of loaded bulk trains to 45 mph and allows empty unit bulk trains to operate at maximum track speed. Washington State supports a maximum speed of 45 mph, outside of populated areas, for all HHFTs that meet new tank car standards and enhanced braking system requirements that are the subject of the NPRM, unless otherwise restricted by other maximum speed requirements.

While Washington State supports phasing out the DOT-111 model tank car as quickly as possible, it supports the NPRM recommendation for an immediate speed restriction of 30 mph for any HHFT that does not meet revised tank car standards or have an enhanced braking system in place.

However, Washington State recognized that speed reductions of HHFT freight movements below 40 mph on shared freight and passenger rail corridors could affect on-time performance of intercity and commuter passenger trains. Passenger train on-time performance is governed by agreements with BNSF and changes in law may require renegotiation of these agreements, impacting federal required on-time performance standards. Freight movements, particularly expedited or time-sensitive shipments, including agricultural commodities, could also be impacted. Further analysis of the causes of derailments and the role that train speed plays should be considered.

VI. DOT Specification 117 – Prescribed Car

The proposed options for new tank car standards are an important component of the NPRM. These options include (see Table 88).

The DOT Specification 111 tank car is not appropriate for the transportation of highly flammable liquids such as Bakken crude oil. Washington State supports the adoption of the PHMSA and FRA-designed DOT Specification 117 tank car (Option 1). The additional wall thickness, enhanced braking system, and roll-over protection afforded by this option is necessary to better safeguard the public as more crude oil is being transported by rail. In addition, Washington State requests that those companies that invested in the AAR 2014-designed car before the adoption of this rule, which is similar in most ways to the PHMSA and FRA model, should not be penalized for improving the safety of the tank cars, and should be allowed to utilize the cars for their full economic lifespan.

Washington State had additional concerns regarding the impact on railroad track of the increased weight of the DOT Specification 117 tank car, the increased traffic, and the number of cars in unit trains. This additional risk to public safety and the environment by HHFTs warrants an increased inspection frequency on rail corridors that will be used for HHFTs. Washington State suggests the inspection frequency should be "twice weekly with at least one calendar day interval between inspections."

Table 88: DOT Specification 117 – Prescribed Car Options

Tank Car	Head Shield	Shell	Jacket	Top Fittings Protection[628]	Thermal Protection	Braking
Option 1: PHMSA and FRA Designed Tank Car	Full-height, ½ inch thick head shield	9/16 inch Minimum	Minimum 11-gauge jacket constructed from A1011 steel or equivalent. Jacket must be weather-tight.	TIH Top fittings protection system and nozzle capable of sustaining, without failure, roll-over accident at speed of 9 mph.	Thermal protection system in accordance with § 179.18	Electronic Controlled Pneumatic (ECP) brakes
Option 2: AAR 2014 Tank Car	Full-height, ½ inch thick head shield	9/16 inch Minimum	Minimum 11-gauge jacket constructed from A1011 steel or equivalent. Jacket must be weather-tight.	Equipped per AAR Specifications Tank Cars, Appendix E, paragraph 10.2.1	Thermal protection system in accordance with § 179.18	Trains with Distributed Power (DP) or End of Train (EOT) devices.
Option 3: Enhanced CPC-1232 Tank Car	Full-height, ½ inch thick head shield	7/16 inch Minimum	Minimum 11-gauge jacket constructed from A1011 steel or equivalent. Jacket must be weather-tight.	Equipped per AAR Specifications Tank Cars, Appendix E, paragraph 10.2.1	Thermal protection system in accordance with § 179.18	Trains with Distributed Power (DP) or End of Train (EOT) devices.

VII. DOT Specification 111 Tank Car Phase-Out

The NPRM proposes to require the use of the new DOT Specification 117 tank car and calls for the phase-out of the DOT Specification 111, accordingly. The DOT-111 will be allowed to be repurposed, retrofitted, or retired according to a proposed timetable set forth in the NPRM. The phase-out of DOT Specification 111 tank cars for HHFTs is necessary and Washington State supports the decision to move to a more robust tank car design.

However, not all tank cars that fall under DOT Specification 111 are the same. Washington State requests that DOT Specification 111 tank cars that meet the AAR CPC-1232 standards and were built after October 1, 2011, be allowed to continue in service for their economic life, except for the transportation of Packing Group I materials past October 1, 2016. Further, Washington State recommends that the proposed timeline for phasing-out DOT-111 tank cars should be expedited

[628] Appendix references in this table refer to the document *AAR Specifications of Tank Cars*.

for Packing Group I and II materials by a year, with the result that DOT-111 tank cars, excluding those complying with CPC-1232 standards, should not be used to transport Packing Group I materials after October 1, 2016. Similarly, Packing Group II materials should not be transported in DOT-111 tank cars, excluding those complying with CPC-1232 standards, after October 1, 2017. (See Table 89.) Washington State's proposal maintains the focus on public safety, which should be paramount in the decision on this rule.

Table 89: Washington State Recommended Timeline for Discontinued Use of DOT Specification 111 Tank Cars in HHFT Service

Packing Group	DOT-111 Not Authorized After
I (Including Bakken)	October 1, 2016
II	October 1, 2017 (excluding CPC-1232)
III	October 1, 2010 (excluding CPF-1232)

Due to uncertainties regarding adequate characterization of crude oil properties such as corrosivity, Washington State recommends that all existing tank cars more than 10 years old have a thorough tank shell thickness survey to ensure the tank is suitable for Packing Group II and III Class 3 liquids. Any tank that shows signs of corrosion should be taken out of crude, ethanol, and any other Packing Group I or II service immediately.

VIII. Conclusion

Washington State encourages the USDOT to adopt swiftly rules in this proceeding that will protect the safety of the citizens of Washington and other States and the significant natural and economic resources and communities in Washington. The number of trains carrying large amounts of crude oil into and through the State are increasing dramatically and the USDOT must continue its recent efforts to increase the safety and transparency of crude oil transportation by rail. Washington State strongly supports the direction of the NPRM on enhanced tank car standards and operational controls for high-hazards flammable trains and encourages the USDOT not to reduce the stringency of regulations for such trains.

Sincerely,

Steven V. King, UTC Executive Director and Secretary
Lynn Peterson, WSDOT Secretary
Maia D. Bellon, Ecology Director
Robert Ezelle, EMD Director

Appendix J: Multi-Agency Comments on Federal (PHMSA) Advanced Notice of Proposed Rulemaking (ANPRM): Hazardous Materials: Oil Spill Response Plans for High-Hazard Flammable Trains[629]

September 17, 2014

Secretary Anthony Foxx
Department of Transportation
1200 New Jersey Avenue SE
Washington, D.C. 20590

Administrator Cynthia L. Quarterman
Pipeline and Hazardous Materials Safety Administration
Department of Transportation
1200 New Jersey Avenue SE
Washington, D.C. 20590

Re: Docket No. PHMSA–2014–0105 (HM–251B), Hazardous Materials: Oil Spill Response Plans for High-Hazard Flammable Trains - Advanced Notice of Proposed Rulemaking

Dear Secretary Foxx and Administrator Quarterman:

In response to train accidents and incidents involving trains transporting large volumes of flammable liquids, on August 1, 2014, the Pipeline and Hazardous Materials Safety Administration (PHMSA) and the Federal Railroad Administration (FRA), referred to jointly here as the USDOT, issued an Advanced Notice of Proposed Rulemaking (Notice or ANPRM). In that Notice, the USDOT seeks comment on potential revisions to its regulations that would expand the applicability of comprehensive oil spill response plans (OSRPs) to high-hazard flammable trains (HHFTs).

[629] 40 CFR Parts 130 and 174 Docket No. PHMSA-2014-0105 (HM-251B) RIN 2137–AF08 *Federal Register* Vol. 79, No. 148, August 1, 2014, pp. 45,709–45,083

The Washington State Department of Ecology (Ecology), the Washington State Department of Fish and Wildlife (WDFW), and the Washington State Department of Natural Resources (DNR) jointly file these comments in response to the ANPRM.

Ecology is responsible for the oil spill prevention, preparedness, and response plans in the state. WDFW and DNR act as the state trustees of resources at risk of damage from oil spills, including fish, wildlife, aquatic lands, and shellfish. Given the various roles of each state agency and our shared interest in ensuring the public safety of the citizens of Washington State and protecting the unique natural resources of the state, the agencies are filing joint comments.

Washington State has a total land area of 66,544 square miles and is the 20th largest state in the nation.[630] There are 3,157 miles of railroad track in the state, ranking it 22nd in the nation for track mileage. Traditionally, crude oil has been shipped to the state by waterborne transportation. However, in recent years, there has been an exponential increase in the amount of crude oil shipped to and through Washington State by rail. In 2013, approximately 280 million barrels of oil were shipped by rail through the United States[631] with approximately 17 million barrels of oil being shipped through Washington.[632] This movement of oil by rail in Washington is projected to more than triple in 2014, increasing to 55 million barrels.[633]

Washington State is home to one of the richest and most diverse landscapes in the world, with significant natural and economic resources and communities, including the inland marine waters and estuaries of the Puget Sound, the mighty Columbia River, the volcanic Cascade mountain range, fertile agricultural lands, and populous cities. The majority of the transportation of oil by rail in Washington enters the state at the border with Idaho near Spokane, crosses the Spokane River, travels to Pasco and then westward along the Columbia River Gorge to Vancouver. Leaving Vancouver by rail, the oil travels north to Tacoma, then along the Puget Sound through Seattle, the most populous city in the state, on its way to Anacortes and Ferndale, near the Canadian border. Empty cars will often travel east, though not always, across the Cascades through Wenatchee on their way out of the state through Spokane.

Crude oil is usually transported in unit trains; i.e., trains made up entirely of one type of cargo. These unit trains can contain more than 100 tank cars, with the potential for significant impact on the state's natural resources in the event of a spill or fire. The increased risks identified in the ANPRM associated with the transportation of crude oil by rail necessitate immediate and comprehensive action by the USDOT on oil spill response plans to ensure that railroads and local communities are prepared to respond to the increased risk of oil spill from rail incidents.

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[630] http://www.statemaster.com/graph/geo_lan_are-geography-land-area.

[631] U.S. Rail Transportation of Crude Oil: Background and Issues for Congress, Congressional Research Services, May 2014.

[632] http://www.statesmanjournal.com/story/news/2014/05/26/west-coast-oil-trains/9605759/. (This article is no longer available on the Statesman Journal website.)

[633] Senator Murray Press Release on DOT NPRM on Tank Standards, July 2014.

I. Oil Spill Response Plan Thresholds

The threshold for applying basic (>3500 gallons per package) or comprehensive (>42,000 gallons per package) OSRPs is not adequate for transport of oil by rail. As noted below, the transport of oil by rail presents a variety of risks that are not solely attributable to flammability of oil in transport, and therefore OSRPs should apply to all railroads carrying oil in bulk. As the ANPRM seeks comment on specific thresholds, we recommend that the threshold for comprehensive OSRPs be set at 3,500 gallons, equivalent to the current requirement for basic OSRPs.

Oil spills can threaten some of Washington's most productive and valuable ecosystems. All spills can threaten public health, safety, the environment, and ultimately damage the state's economy and quality of life. Almost 2,500 miles of major rivers in Washington run within 1,000 feet of a rail line. An incident involving oil transported by rail in bulk could adversely and significantly impact the natural resources and economic health of the state.

Oil spills of any size, depending on product type and location, threaten productive and valuable ecosystems, killing birds and marine life, contaminating beaches, shellfish, and groundwater. Spilled oil poses serious threats to fresh water and marine environments. It affects surface resources and a wide range of subsurface organisms that are linked in a complex food chain that includes human food resources. Significant oil spills can cause millions of dollars in damage to important industries, including shellfish production, fishing, tourism, and recreation.

Because of the impact that spills can have on Washington's environmental and economic health, there should be one set of comprehensive requirements for all railcars transporting more than 3,500 gallons of oil.

II. Planning Standards

Washington strongly urges that 49 CFR Part 130 be revised to establish standards that at least require the following:

- *Plan Review and Approval:* 33 USC 1321(j) expressly requires the President to review and approve the oil spill response plans. However, the current 49 CFR 130 does not provide for any type of review. Review and approval are a mandate delegated to USDOT and cannot be ignored by PHMSA and the FRA. There should be clear, specific criteria for plan review and approval, including submittal and review timeframes. See WAC 173-182-120; 140; 142.
- *Drills & Exercises:* A robust drills and exercise program, including announced and unannounced exercises following NPREP. We recommend the Washington model; see also WAC 173-182-700 – 740.

- *Spill Management Team:* Trained Spill Management Team requirements, capable of staffing a Unified Command for response to at least the reasonable worst-case spill. See WAC 173-182-280
- *Oil Spill Response Contractor:* Required use of an oil spill cleanup contractor whose personnel and equipment has at least been inspected and tested. We recommend the Washington model; see WAC 173-182-800
- *Performance Cleanup Standards:* Address response resource arrival times cascaded in over time. Specifically, on-water recovery equipment, containment (boom), temporary storage of recovered materials, and staffing. U.S. Coast Guard - see 33 CFR 154 (facilities) and 155 (vessels).
- *Financial Responsibility:* Require a minimum amount of demonstrated financial resources to pay for response, cleanup, remediation, natural damage assessment, and restoration costs, based on the reasonable worst-case spill volume.
- *Shoreline Cleanup Standards:* Contracts for adequate equipment and personnel to address different shoreline types and local environmental conditions should be identified in all plans.
- *Sensitive Site Strategies:* OSRP plan holders should work with area planning committees to develop Geographic Response Plans along rail routes adjacent to or crossing navigable waters. The plans should require use of strategies to protect identified environmentally, economically, and culturally sensitive areas, protected within certain time frames, with adequate response resources. These are provided for in the Area Contingency Plans (ACP) developed by the U.S. Coast Guard and the Geographic Response Plans (GRP) developed by U.S. Environmental Protection Agency. For existing ACPs and GRPs, the railroads merely have to agree in their response plan to use the ACPs and GRPs.
- *Dedicated & Non-dedicated Response Resources:* In order to ensure that response equipment and personnel can arrive within the first six hours (or other set time), these resources, including personnel, temporary storage and vessels, must be dedicated solely oil spill response. Boom and skimmers by function and design are always considered dedicated.
- *Waste Storage & Management:* Plans requirements should include identification of temporary storage for all recovered oil and oily waste, up to two times the RWCS volume.
- *Incident Command System:* Require the use of NIMS, and the incident command system developed and used by the U.S. Coast Guard and U.S. Environmental Protection Agency in their *Incident Management Handbook – 2014*.
- *Group V Oils:* Require planning for oils that are heavier than water and will sink. Examples of this type of oil could be Canadian Tar Sands and asphalts.
- *Oiled Wildlife Care:* Identify applicable federal requirements for assessing oiled-wildlife impacts and wildlife rescue and rehabilitation. Describe the equipment, personnel, resource and strategies for compliance with these requirements. Require the use of oiled-wildlife

contractors whose personnel and equipment has at least been inspected and tested. We recommend the Washington model; see WAC 173-182-800.

- *Oiled Wildlife Performance Standard:* The plan should address oiled wildlife resource arrival over time. Specifically, appropriate rehabilitation equipment and shelters, search and collection equipment; transportation equipment; wildlife hazing equipment; and necessary staffing (including ICS positions). In Washington, handlers of oil must indicate how they will provide the necessary resources within twenty-four hours of spill notification (WAC 173-182-540).
- *Fire Fighting:* Identify how fires will be addressed. Compare on-water firefighting and salvage requirements of the U.S. Coast Guard.
- *Training:* More details in the plan regarding specific incident command position staffing training.
- *Agent for Service of Process:* Require someone who will be available to receive legal process.

III. Public Disclosure of Oil Spill Response Plans

PHMSA should require that all response plans be provided to State Emergency Response Commissions (SERCs), Tribal Emergency Response Commissions (TERCs), and LEPCs and state agencies designated authority as State on Scene Coordinators. As noted by the National Transportation Safety Board, "carriers have effectively placed the burden of remediating the environmental consequences of an accident on local communities along their routes." [634] Giving SERCs, TERCs, and LEPCs access to OSRPs would at least partially ameliorate this situation, giving local communities access to information on railroad response resources and spill management teams.

IV. Applicability

OSRPs should apply to oil in transport, not only to high hazard flammable trains of a certain threshold. The environmental, economic, and public health risks associated with the transport of oil by rail are not solely attributable to flammability of oil in transport. Comprehensive oil spill plans are required for vessel transport and near shore terminals, not because of the inherent risk of fire or explosion, but because of the threat of environmental damage from toxicological, mechanical, and persistence characteristics of oil introduced into the aquatic environment of navigable waters. The same logic should apply to spills of oil from oil trains and OSRPs should apply to all railroads carrying oil in bulk.

[634] Safety Recommendation (SR) R-14-005, National Transportation Safety Board, http://www.ntsb.gov/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=R-14-005.

V. Savings Clause

PHMSA is implementing 33 USC sec. 1321, which is sec. 311 of the Federal Water Pollution Control Act. Subsection (o)(2) of that law states:

(2) Nothing in this section shall be construed as preempting any State or political subdivision thereof from imposing any requirement or liability with respect to the discharge of oil or hazardous substance into any waters within such State, or with respect to any removal activities related to such discharge.

This clearly preserves state authority to adopt requirements for response plans from railroads. PHMSA's rulemaking should confirm this understanding in its Federalism analysis.

On behalf of the citizens of the state of Washington, the DOE, WDFW, and DNR encourage the USDOT to swiftly adopt rules in this proceeding that will protect the safety of the citizens of Washington and other states and the significant natural and economic resources and communities in Washington. The number of trains carrying significant amounts of crude oil into and through the state is increasing and the USDOT must continue its recent efforts to increase the safety and transparency of crude oil transportation by rail. The Washington State agencies strongly support the direction of the ANPRM on oil spill response plans and encourage the USDOT to increase the response capacity of railroads and local communities.

Sincerely,

Maia D. Bellon
Director, Washington State Department of Ecology

Peter Goldmark
Commissioner of Public Lands, Department of Natural Resources

Phil Anderson
Director, Washington State Department of Fish and Wildlife

Appendix K: Washington State EMD Emergency Response Survey

Hazardous Materials Response Plan Review

History and Background

The Marine and Rail Oil Transportation Study required the review of jurisdictional and tribal hazardous materials plans to assess how well, if at all, the plans addressed emergency response to crude-by-rail incidents with explosion and/or fire. The following provides background knowledge and a brief summary of the process used to collect and analyze the data.

Administrative Network

Washington State law requires all political subdivisions have an emergency management program. Each political subdivision is to develop of a Comprehensive Emergency Management Plan (CEMP). A component of the CEMP is Emergency Support Function (ESF): 10 Oil and Hazardous Materials.

In 1986, Congressed passed the Emergency Planning and Community Right-to-Know Act (EPCRA) in response to public concern of no knowledge of the hazardous and toxic materials in their communities. The following three bullets explain the EPCRA network, and how it connects federal government with community members for community right-to-know.

- The Governor of each state designated a State Emergency Response Commission (SERC). The SERCs, in turn, designated about 3,500 national local emergency planning districts and appointed LEPCs for each district. The SERC supervises and coordinates the activities of the LEPC, establishes procedures for receiving and processing public requests for information collected under EPCRA, and reviews local emergency response plans.
- The Chief Executive Office of the tribe appoints the Tribal Emergency Response Commissions (TERCs). TERCs have the same responsibilities as the SERCs.
- The LEPC membership must include, at a minimum, local officials including police, fire, civil defense, public health, transportation, and environmental professionals, as well as representatives of facilities subject to the emergency planning requirements, community groups, and the media. The LEPCs must develop an emergency response plan, review it at least annually, and provide information about chemicals in the community to citizens.

Washington has 44 LEPCs, one for each of the 39 counties and five large cities. City LEPCs are established due to population and/or request by political officials.

The coordination and administrative support for the SERC is a function of EMD. EMD facilitates the plan review process with the SERC for compliance with the EPCRA planning elements.

Planning Requirement

Washington State law and EPCRA each have a legislative requirement that local jurisdictions and Tribal Governments develop hazardous materials response plans. Any LEPC has the option to write their ESF 10: Oil and Hazardous Materials section in such a way that it meets these two planning mandates.

Each political subdivision is to submit their CEMP, which includes ESF 10: Oil and Hazardous Materials to Washington Emergency Management Division (EMD) every five years for review for consistency with the state CEMP. (The five year review cycle reflects pending update to WAC 118-30.)

EPCRA does not require the same schedule for plan updates and reviews. When initially developed, EPCRA requires the plan to be submitted to the SERC for review for compliance. Each LEPC is to update their plan annually but is not required to resubmit.

Study Process

As an ongoing responsibility, EMD planners and SERC members review all available jurisdictional ESF 10s and Hazardous Materials Response Plans as submitted by political subdivisions and LEPCs. EMD and the SERC maintain a database with pertinent information in order to verify plan submission, and track and verify compliance (Table 90, Figures 155-156).

Table 90: Local Emergency Planning Committee Survey Results[635]

Population Density[636]	Active LEPC	Interaction w/Elected Officials	Interaction w/First Responders	Interaction w/Rail	Hazardous Materials Response Plan	Plan Reviewed & Approved[637]	Does Plan Address Crude-by-Rail?
10	Yes	Yes	Yes	No	Yes	No Answer	No
103	Yes	No	Yes	No Answer	Yes	Yes	No
25	Yes	Yes	Yes	Yes	Yes	Yes	No
676	Yes	Yes	Yes	Yes	Yes	Yes	No
3,228	Yes	Yes	Yes	No	Yes	Yes	No Answer
7,251	Yes	No	Yes	Yes	Yes	No Answer	Unknown
90	Yes	Yes	Yes	Yes	Yes	Yes	No
21	Yes	Yes	Yes	No	Yes	Yes	Yes
63	No	NA	NA	No	Yes	No Answer	No
33	Yes	Yes	Yes	No	Yes	No Answer	No
38	Yes	Yes	Yes	No	No	NA	NA
913	Yes	Yes	No	Yes	Yes	Yes	Yes
11	No	No	No	No	Yes	Yes	Yes
31	Yes	Yes	Yes	No	Yes	Yes	No
63	Yes	Yes	Yes	Yes	Yes	Yes	No
9	Yes	Yes	Yes	Yes	Yes	No Answer	Yes
476	Yes	No	Yes	Yes	Yes	Yes	No
68	Yes	Yes	Yes	Yes	Yes	Yes	No
7	No Answer	No Answer	No Answer	No Answer	No Answer	No Answer	No Answer
342	Yes	Yes	Yes	Yes	Yes	Yes	No
267	Yes	Yes	Yes	Yes	Yes	Yes	Yes
18	No	No	No	No	No	NA	NA
349	No	No	No	No	No	NA	NA
96	Yes	No	Yes	Yes	Yes	Yes	No
2,987	Yes	Yes	Yes	No	Yes	Yes	No
	80% Yes	64% Yes	76% Yes	48% Yes	84% Yes		20% Yes

[635] "Unknown", "NA" and "No Answer" are considered "No".
[636] US Census Bureau 2010 census data (persons per square mile).
[637] EMD records identify one LEPC having a Hazardous Materials Response Plan that complies with the nine EPCRA requirements.

Figure 155: Date Last HazMat Response/ESF 10 Oil and HazMat Plan Submitted for State Review

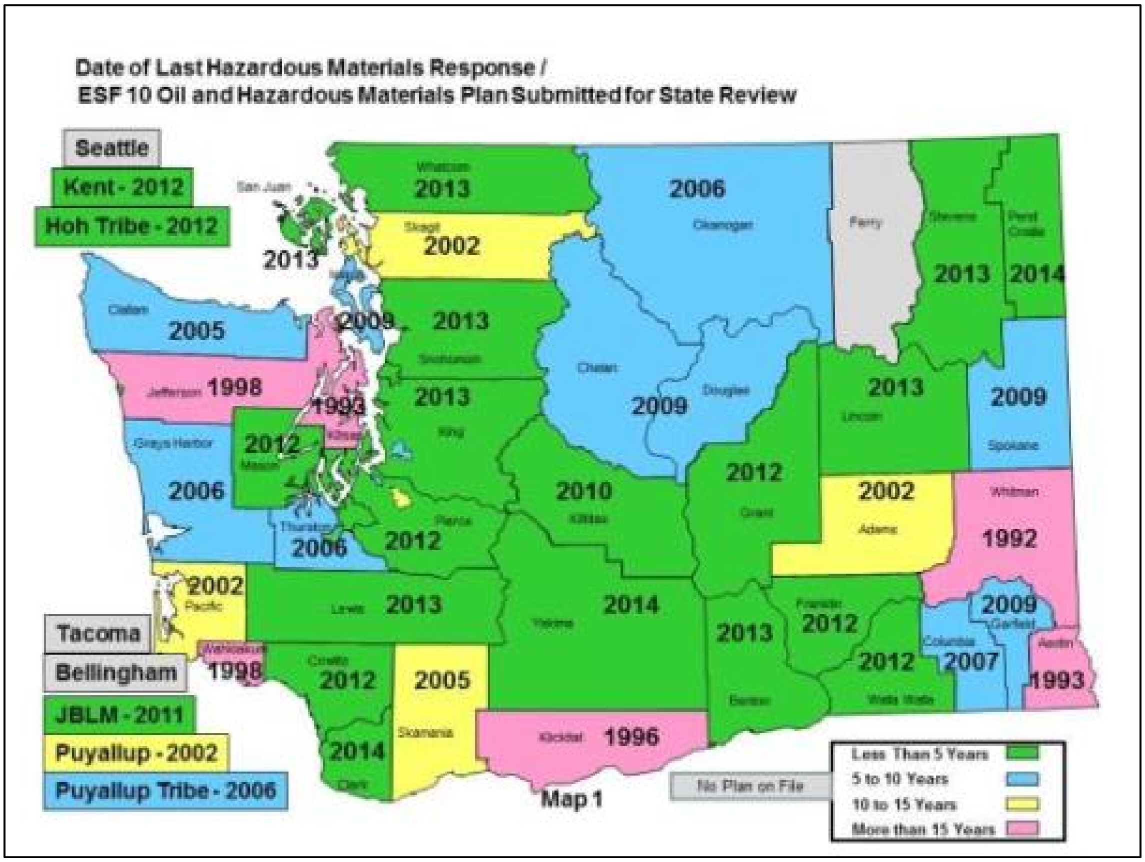
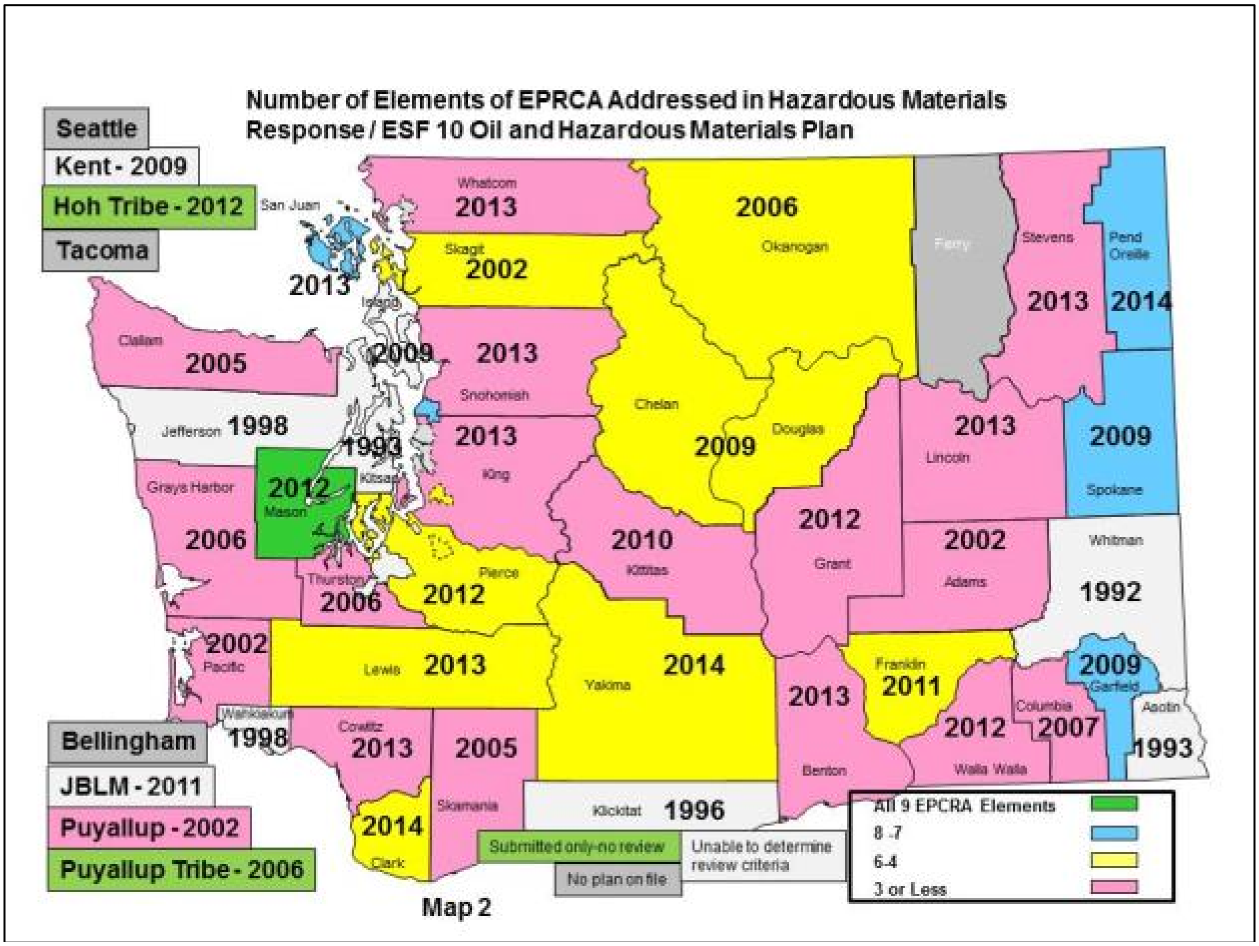


Figure 156: Elements of EPRCA Addressed in HazMat Response/ESF 10 Oil and HazMat Plan



As part of the Marine and Rail Oil Transportation Study, LEPCs and TERCs received electronic surveys the week of June 2, 2014, with a requested fast turnaround of June 11, 2014. Due to heightened interest these groups demonstrated in conferences, meetings, letters, and telephone calls, the technical team anticipated an energetic response with lots of data. The technical team received less than a dozen responses by the June 11 deadline.

For reasons unknown, the response to the survey was disappointing even with the additional effort described in the *First Responder Data Collection* section. Twenty-five of the 44 LEPCs responded, resulting in a 57% response. Four of the 33 Tribal governments responded, resulting in a 12% response.

Study Results

Twenty percent of the plans reviewed for this study addressed crude-by-rail emergency response. While 84% of the LEPCs report they have a hazardous materials response plan, only 20% included flammable or petroleum incidents. Of the 21 (64%) LEPCs reporting a plan reviewed by the SERC, 10 report the plan was approved by the SERC. These numbers appear favorable, but actually only one of the submitted hazardous materials response plans was reviewed by the

SERC and determined EPCRA compliant (based on SERC records). The data from the survey suggest a gap between meeting EPCRA and Washington State emergency management planning requirements, and communicating plan review findings to the political subdivision and/or the LEPC submitting the plan. Another gap is the political subdivision's/LEPC's ability to submit an EPCRA compliant hazardous materials response plan/ESF 10: Oil and Hazardous Materials. One interesting observation is a political subdivision with an inactive LEPC produced the only plan that was EPCRA compliant.

First Responder Data Collection

History and Background

The Marine and Rail Oil Transportation Study timeline gave little opportunity to use a variety of data collection methodologies. EMD chose the survey for a quick turnaround of information. EMD developed three electronic surveys with purpose statements, specific to each of the three groups selected to receive the surveys. Local Emergency Planning Committees (LEPCs), Tribal Emergency Response Commissions (TERCs), and the Washington Fire Chiefs (WFCs) received the survey as they all have to potential to be First Responders. These three groups know their respective jurisdictions as well as anyone and have knowledge and experience to address the hazard potential, scope, and incident parameters of Bakken crude oil transportation by rail within their respective jurisdictions and governments. The state has 44 LEPCs (comprised of the 39 counties and the cities of Bellingham, Kent, Seattle, Puyallup, and Tacoma), approximately 471 fire departments/districts, and 33 tribes (includes federally and non-federally recognized). Of the 471 fire departments and districts, 236 have rail within their jurisdictions. EMD emailed the survey to all LEPC coordinators, fire chiefs, and Tribal emergency managers, with a statement of importance on providing input to the Governor's study.

Process

The LEPCs and TERCs received the electronic surveys the week of June 2, 2014, with a requested turnaround of June 11, 2014. The Washington Fire Chiefs survey dissemination took longer due to a Washington Fire Chiefs Association conference occurring that same week. Due to heightened interest these groups demonstrated in conferences, meetings, letters, and telephone calls, the technical team anticipated an energetic response with lots of data. The technical team received less than a dozen responses by the June 11 deadline.

EMD rewrote and resent mail messages to the original recipients and added specialty groups (such as hazardous materials response teams) in an effort to collect more data. EMD made phone calls to those who received the survey to alleviate any hurdle interfering with the process. Tribal representatives and liaisons encouraged Tribal emergency managers to respond. The team used every chance to encourage people to respond, explain the importance of their response, the purpose of the study, and its intended outcomes. As time progressed, any reference to a deadline associated with the survey was waived and all information was collected.

The response to the survey remained disappointing, especially from WFCs and TERCs. The LEPCs were more promising with 25 of the 44 LEPCs responding, resulting in a 57% response. Four of the 33TERCs responded, resulting in a 12%. Thirty-four of the 236 fire districts and municipal departments having rail traffic in their jurisdictions responded, resulting in a 14% response. While a small sampling, the surveys provided feedback from a good cross section of jurisdictional population density, emergency responder capabilities, and likely a good indication of the actual situation statewide.

LEPC Survey Results

EMD electronically sent each of the 44 LEPC coordinators the survey. Twenty-five percent completed and returned the survey. Of the 25 responding LEPCs, 80% have active (meet no less than once per calendar quarter) LEPCs, 64% interact with local officials (specifics to the interaction were not asked), and 76% interacted with local First Responders with some serving as committee members. Less than half of the 25 responding LEPCs report any interaction with the railroad companies having track within their jurisdictions. Of the 84% having hazardous materials response plans, only 20% address crude-by-rail incidents. More detailed information on hazardous materials response plans is located in the *Hazardous Materials Response Plan Review* section.

WFC Survey Results

Within the state, 236 fire departments/districts have rail within their respective jurisdictions. Of the 236, 34 responded (Table 91). The map in Figure 157 shows the locations of those responding. The 34 fire departments/districts represent 2,708 firefighters, paid and volunteer, with a broad range of available resources. Even the most metropolitan, best-equipped departments consider themselves ill prepared to respond to a crude-by-rail with related explosion and/or fire incident. Just ten percent of the firefighters are trained to Hazardous Materials Technician or Specialist levels which are levels necessary to offensively fight a crude-by-rail related explosion and/or fire. Twenty-nine percent of the fire departments are equipped with Type 1 Hazardous Materials Response Teams (HMRTs) or has access to one through mutual aid agreements. The following definitions describe the degree of knowledge and technical skill specific to each team level.

- A "Type 3" Hazardous Material Response Team (HMRT) is one that is appropriately equipped and trained to handle, and can function in all categories, for all *known* industrial chemical hazards, in liquid, aerosol, powder, and solid forms. They are not expected to be fully equipped to intervene and handle vapor/gas emergencies, nor incidents involving WMD chemical and biological substances.
- A "Type 2" HMRT is one that meets all "Type 3" requirements, and is appropriately equipped and trained to handle, and can function in all categories, for all *unknown* industrial chemical hazards, in liquid, aerosol, powder, solids, and vapor/gas forms. They are not

expected to be fully equipped to intervene and handle incidents involving WMD chemical and biological substances.

- A "Type 1" HMRT is one that meets all "Type 3" and Type 2" requirements, and is appropriately equipped and trained to handle, and can function in *all* categories, for all known and unknown WMD chemical and biological substances.

Of these teams, the "Type 1" HMRT is equipped and staffed to fight a crude-by-rail incident with fire and/or explosion.

Fifty-nine percent of the fire departments/districts have no relationship with the rail carriers within their jurisdictions, and 74% have no knowledge of railroad caches of firefighting equipment. Sixty-two percent report their hazardous materials response/ESF 10: Oil and Hazardous Materials plans do not address crude-by-rail with related fire and/or explosion, and 35% of the plans do not include evacuation procedures.

The survey asked, "What three priorities would enhance firefighter safety?" Below are some selected responses.

- A regional hazardous materials team, locally located and capable to manage this type of incident.
- Firefighting equipment such as foam equipped engines, firefighting appliances for establishing unmanned mate streams; a mutual aid response with the appropriate supplies; caches of foam suitable for the products being transported; increased foam supplies and flammable liquid training; specialty tools to meet the requirements of spill or fire suppression.
- Early intervention and support from the responsible rail company with hazmat, fire suppression and recovery equipment as well as expertise; incident Command structure and personnel to handle a large incident.
- Rail provided resources for training and response planning on specific cargos such as crude oil; initial response training; continued training with rail companies; training for large incidents; training, equipment, and advice from the railroad industry; guidelines and standard operations procedures need to be developed and implemented to manage a petroleum derailment; drills dealing with petroleum derailments; specific contact information, resource lists, and tactics.
- Dealing with the railroad in the initial stages of an incident can be difficult, so communication would be number one, and the ability to perform a large-scale downwind monitoring program would be second.
- Attempted to contact railroad for information on the railroad's response to an incident, what equipment the railroad can provide for preplanning and training. Railroad-offered classes have only been on railroad crossings and safety when working around railcars.

- Currently there is a bit of dispute over the hazard classification being applied to the oil shipped from Bakken. Fire service needs to know if current information is still valid. The industry and government need to quickly modify the information/materials so that accurate information is used in the planning process.
- A series of recommendations for handling the emergencies and even a contact number for information sharing on appropriate response, training material and instructors, and the occasional class other than in major cities.

TERC Survey Results

Of the four TERCs that responded, two have no rail on the reservation. One has a short line railroad that does not carry the reporting threshold of crude oil as required by U.S. Emergency Order Requiring Stricter Standards to Transport Crude Oil by Rail March 6, 2014. The fourth TERC reports one BNSF rail carrier affecting reservation residents, with the potential to damage natural resources and protected areas. The western reservation boundary runs along Puget Sound. The tribe states a cooperative relationship with the county's LEPC.

Summary

The information collected through the survey process is as expected. Bakken crude oil is a new hazard and more information is needed to give the average fire chief, and LEPC and TERC coordinator knowledge and skills to adequately plan for a crude-by-rail incident. Investments need to be made in the development and delivery of specialized training, and purchase or sharing of equipment. Energize efforts to communicate among stakeholders to build relationships for effective and unified response. Much more needs to be done.

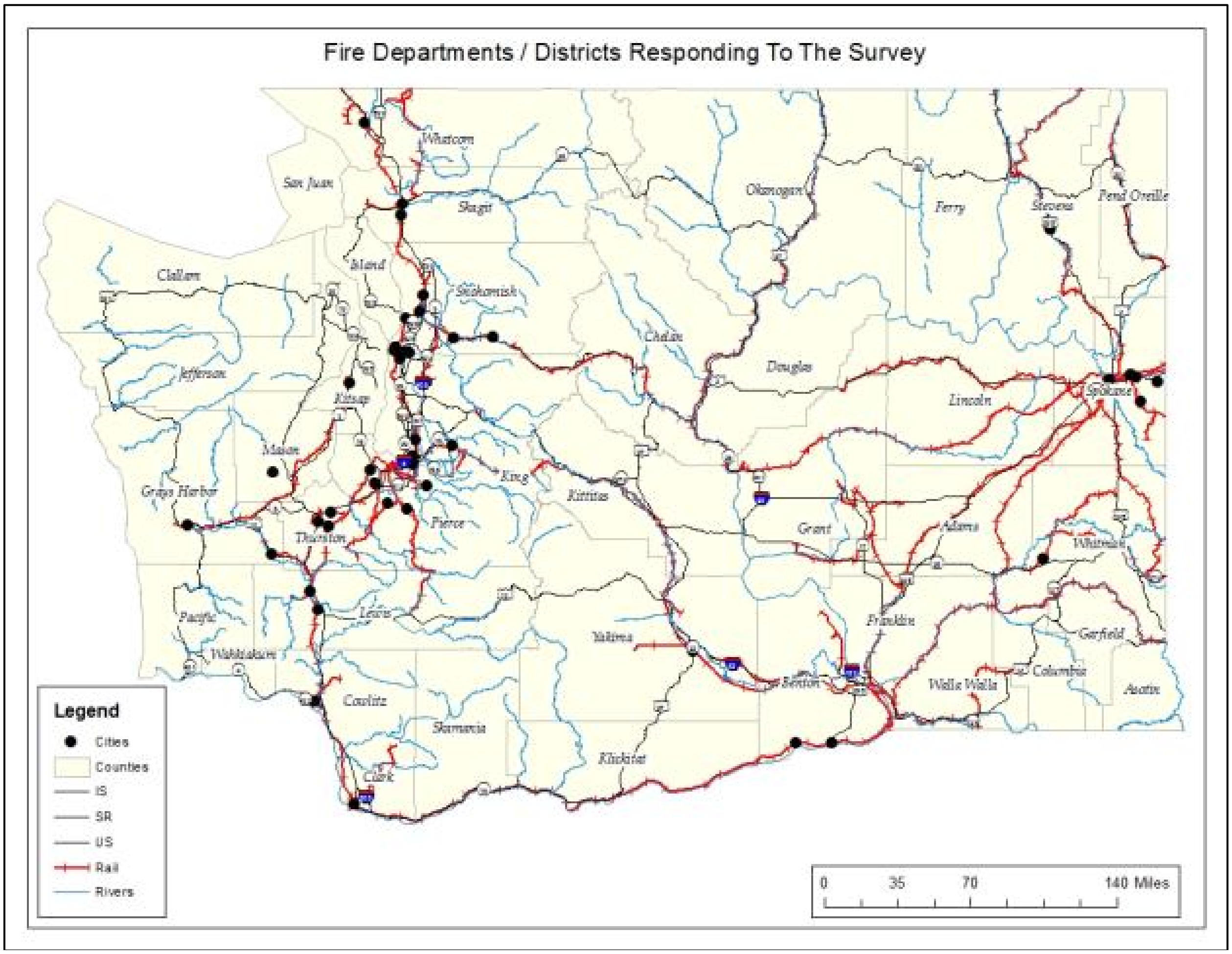
Table 91: Washington Fire Chiefs Survey Results[638]

Community Type	Total Personnel Paid or Volunteer	Trained: HazMat Technician	Trained: HazMat Specialist	HRT Type I	HRT Type II	HRT Type III	HRT Avail. or Mutual Aid	Plume Modeling Capability or Mutual Aid	HazMat Plan w/Derail & Fire	FF Trained & Equip'd for Derail w/Fire	Knowledge of RR Equip. Caches	Evac. Plan
Rural	2P/20V	0	0	No	No	No	No	Yes/MA	Yes	No	No	Yes
Urban	180P/0V	21	6	Yes	--	--	--	Yes	Yes	Yes	No	Yes
Rural	49P/5V	0	0	No	--	--	Yes-1	Yes/MA	No	No	No	Yes
Urban	49P/5V	0	0	No	No	No	Yes-3	Yes/MA	No	Yes	No	No
Combination	35P/0V	0	0	No	No	No	No	No	No	No	No	Yes
Rural	1P/24V	0	0	No	No	No	No	No	No	No	No	No
Urban	108P/0V	2	0	Yes	--	--	--	Yes	No	Yes	Yes	Yes
Rural	0P/24V	0	0	No	No	No	Yes-3	Yes	No	No	No	No
Urban	180P/0V	25	15	Yes	--	--	--	Yes/MA	Yes	Yes	No	Yes
Urban	97P/0V	0	0	No	No	No	Yes-1	Yes/MA	No	No	No	Yes
Combination	80P/50V	0	0	No	No	No	Yes-1	Yes/MA	No	No	Yes	Yes
Rural	12P/0V	0	0	No	No	No	No	No	No	Yes	No	Yes
Rural	5P/32V	0	0	No	No	No	No	Yes	No	Yes	Yes	No
Combination	60P/15V	8	0	No	Yes	No	--	Yes/MA	Yes	Yes	No	No
Urban	130P/0V	15	0	Yes	--	--	--	Yes/MA	Yes	Yes	No	No
Urban	35P/5V	0	0	No	No	No	Yes-1	Yes	No	No	Yes	Yes
Urban	160P/0V	53	1	Yes	--	--	--	Yes/MA	Yes	Yes	Yes	Yes
Urban	85P/20V	14	0	Yes	--	--	--	Yes/MA	Yes	No	No	No
Urban	22P/0V	0	0	No	No	No	Yes-1	No	Yes	No	No	Yes
Combination	180P/20V	25	0	Yes	--	--	Yes-1	Yes	Yes	Yes	Yes	No
Rural	0P/40V	0	0	No	No	No	Yes-2	Yes	No	No	No	No
Suburban	42P/24V	9	0	No	No	Yes	--	Yes/MA	Yes	Yes	No	Yes
Urban	25P/0V	7	0	No	No	No	Yes-1	Yes	No	No	No	No
Urban	10P/6V	0	0	No	No	No	No	Yes/MA	Yes	No	No	Yes
Urban	320P/0V	21	18	Yes	-	-	-	Yes	Yes	Yes	Yes	Yes
Rural	40P/45V	0	0	No	No	No	Yes-1	Yes	No	No	No	Yes

638 FF = firefighter; P = paid; V = volunteer; MA = mutual aid.

Community Type	Total Personnel Paid or Volunteer	Trained: HazMat Technician	Trained: HazMat Specialist	HRT Type I	HRT Type II	HRT Type III	HRT Avail. or Mutual Aid	Plume Modeling Capability or Mutual Aid	HazMat Plan w/Derail & Fire	FF Trained & Equip'd for Derail w/Fire	Knowledge of RR Equip. Caches	Evac. Plan
Urban	182P/0V	0	0	No	No	No	Yes-1	Yes/MA	Yes	Yes	Yes	Yes
Rural	0P/32V	0	0	No	No	No	No	No	No	No	Yes	Yes
Combination	15P/35V	0	0	No	No	No	Yes-1	Yes/MA	No	Yes	No	Yes
Combination	100P/40V	2	0	NA	NA	NA	No	No	No	No	No	Yes
Urban	38P/14V	0	0	No	No	No	Yes-2	No	No	No	No	Yes
Combination	38P/52V	1	0	No	No	No	Yes-2	Yes/MA	No	No	No	No
Rural	0P/30V	0	0	No	No	Yes	Yes-1	Yes/MA	No	No	No	No
Rural	6P/14V	0	0	No	No	No	Yes-1	Yes/MA	No	No	No	Yes
	2,708 Total FF	203 = 8% Yes	40 = 2% Yes	23% = Yes				79% Yes	38% Yes	41% Yes	26% Yes	65% Yes

Figure 157: Fire Departments/Districts Responding to the Survey



Survey

Washington Emergency Management Division (WEMD), in partnership with Washington Department of Ecology, is conducting the Marine and Rail Crude Oil Transportation Study financed by Governor Inslee's 2014 budget. WEMD is to provide research and input on the preparedness of local and Tribal jurisdictions to respond to oil by rail incidents. This survey is the first step in obtaining that research and input, and is designed to encourage dialogue. Use the "Explain" boxes to provide details on current conditions within the jurisdiction, specific to the resources and training needed to prepare for and respond to such an incident.

Your speedy completion and return of this survey is critical. In order for you input to be integrated into the study, I must receive it **No Later Than June 11, 2014.**

My contact information is:

Karen Ferreira
Emergency Planning Coordinator
Washington Emergency Management Division
20 Aviation Drive
Camp Murray, WA 98430
253.512.7057
Karen.ferreira@mil.wa.gov

Marine and Rail Crude Oil Transportation Study

1. Is there an active short line and/or mainline railroad in your jurisdiction? Yes ☐ No ☐

   If no, save the survey and return it to Karen.ferreira@mil.wa.gov
2. Who are the rail carriers? (Check all that apply) BNSF ☐ Union Pacific ☐ Shortline ☐
3. How often does a train travel through your jurisdiction?
4. Has rail traffic increased over the last year? Yes ☐ No ☐ Explain
5. Are the railroad tracks near populated areas, such as multi-family housing, schools, shopping centers, hospitals and medical care facilities, industry hub, etc.? Yes ☐ No ☐ Explain
6. Do the railroad tracks pass near any natural resources, such as agricultural centers, rivers or other bodies of water, marshes and wetlands, animal sanctuary, aquifer, etc? Yes ☐ No ☐ Explain

7. What type of safety devices are installed at rail crossings? Flashing lights? Traffic arms? Explain
8. Estimate the average length or number of cars for freight trains passing through your jurisdiction. Are the cars placarded? Yes ☐ No ☐ Explain
9. Does rail traffic impact your jurisdiction? Impacts may include blocking traffic for extended periods of time, disturbing sleep and other routines, isolating areas of the community, interfering with emergency response and / or health care. Yes ☐ No ☐ Explain
10. Has a train ever derailed in your jurisdiction? Yes ☐ No ☐ If yes, what was the impact and corresponding response activities?
11. What population do you serve?
12. Are you rural or urban?
13. How many personnel are in your department?
14. Number of fire personnel paid? Number of Volunteers?
15. Are you an airport-based fire department? Yes ☐ No ☐ If yes, describe they type of airport:
16. If you are airport-based, is foam part of your firefighting arsenal? Yes ☐ No ☐ If yes, what type?
17. Without mutual aid, what resources are dispatched for a first-alarm fire?
18. How many fire fighters are trained to hazardous materials:

    Awareness?

    Operations or 40-hour HAZWOPER?

    Technician?

    Specialist?
19. Does your department have a hazardous materials response team (HMRT)?

    Type One? ☐ Type Two? ☐ Type Three? ☐
20. If not, is one available through mutual aid?

    Type One? ☐ Type Two? ☐ Type Three? ☐
21. Are you able to do plume modeling? Yes ☐ No ☐ If not, is it available through mutual aid?

    Yes ☐ No ☐ Explain

22. Does your department hazardous materials plan include fire response to a train derailment with fire? Yes ☐ No ☐ Explain
23. Are your fire fighters trained and equipped to respond to a train derailment with a resulting oil spill and fire? Yes ☐ No ☐ Explain
24. Do you know who and how to contact the owners of the train if an accident were to occur? Yes ☐ No ☐ Explain
25. Do you know of caches of railroad equipment used for emergencies in your jurisdiction? Yes ☐ No ☐ Explain
26. Do you regularly participate in the jurisdiction's Local Emergency Planning Committee (LEPC)? Yes ☐ No ☐ Explain
27. Does your jurisdiction have an evacuation plan? Yes ☐ No ☐ If yes, does it address large-scale evacuations? Yes ☐ No ☐ Has it been tested in an actual evacuation or in an exercise? Yes ☐ No ☐ Explain
28. What secondary impacts from a crude oil rail derailment and resulting fire are likely if such an incident would occur in your jurisdiction? Explain Is there a seasonal variation to the impacts? Yes ☐ No ☐ Explain
29. What would enhance your fire fighter's safety when responding to a train derailment involving an oil spill and explosive fire? Discuss your top three priorities
30. Explain, in your opinion, what crude oil rail transportation information currently not available from the railroads that would help you manage a train derailment with resulting oil spill and fire.

Please save your completed survey to your computer and attach it to your email to Karen.ferreira@mil.wa.gov

If you wish to send it by mail, send it to:

Karen Ferreira
Washington Emergency Management Division
20 Aviation Drive
Camp Murray, WA 98430

Appendix L: Salish Sea Workshop: Vessel Oil Spill Risk Assessment & Management Handbook

DEPARTMENT OF
ECOLOGY
State of Washington

Salish Sea Workshop: Vessel Oil Spill Risk Assessment & Management Handbook

Whatcom County Emergency Operations Center
3888 Sound Way, Bellingham, WA 98226
January 7 and 8, 2015

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Contract No. C1400276

Introduction

The Salish Sea Workshop: Vessel Oil Spill Risk Assessment & Management is focused on managing risk in the geographic region of the Salish Sea, including the northern Puget Sound/Straits of Georgia areas, east of approaches to Neah Bay, north to Vancouver, BC, and south to Admiralty Inlet near Port Townsend, Washington. The workshop is co-sponsored by the Washington Department of Ecology and Puget Sound Partnership. The workshop is being hosted by the Port of Bellingham at the Whatcom County Emergency Operations Center. Attendance will include representatives from a broad spectrum of governmental organizations from Washington State, the United States, British Columbia, Canada, Tribal Nations, First Nations, and from the marine industry, environmental advocacy groups, and other interested stakeholders.

The goals for this technical workshop are to:

- Assess risk factors for Salish Sea vessel spill incidents based on previous studies.
- Consider and rank risk reduction options for the prevention of vessel spill incidents.
- Develop implementable action items on risk reduction options on a transboundary basis.

The format will include informative presentations on vessel risk studies that have been conducted in the last few years and on best operating practices. Following this, technical working sessions will be conducted aimed at moving forward with action items on risk reduction options to prevent vessel spill incidents. The review of Salish Sea vessel traffic studies will also inform the development of a list of specific issues of relatively higher concern with respect to:

- Specific waterway hot spots (areas of relatively higher risk), including, but not limited to:
  - Chokepoints in shipping lanes.
  - Anchorages and anchoring practices.
  - Bunker barge transits.
  - Average and peak shipping traffic and anchorage patterns.
  - Weather and sea state issues.
- Potential impact of changes in rail transport (coal, crude oil, other commodities) on future patterns of vessel traffic.
- Existing vessel operating practices that have relatively higher risk – actual incidents.
- Geographic locations of greatest risk.

While recognizing their importance to the overall issue of vessel risk in the Salish Sea, this particular workshop will specifically not include the following topics:

- Acceptability of vessel-related risk.
- Permitting, environmental impact statement/environmental assessment processes, or acceptability of existing and proposed facility projects.
- Spill response capability, preparedness, and planning.
- Environmental and socioeconomic impacts of vessel-related spills.

- Crude or coal train impacts. [639]

Limiting the scope of the workshop agenda will allow participants to connect assumptions, findings, and recommendations from Salish Sea studies to develop a consolidated list of actionable recommendations on vessel spill prevention, and move forward with actions to enhance public safety and environmental protection.

Purpose of the Salish Sea Workshop Handbook

The purpose of the Salish Sea Workshop Handbook is to:

1) Give attendees baseline familiarity with risk assessment terminology and these risk assessment processes, providing a brief synopsis of the major findings of the studies for review prior to the Workshop. The intent is that so participants might familiarize themselves with the studies to help facilitate meaningful discussion and the development of actions related to vessel risk reduction options at the workshop.
2) Provide a reference document of tables, figures, and other information that will assist workshop delegates in the working sessions.

The Salish Sea Workshop Handbook is not an official assessment of the validity of any of the studies and is not part of any environmental impact statement or environmental assessment processes for any of the proposed, pending, or existing facilities associated with any of the vessel traffic studies. The handbook does not express any official findings or positions on the part of the Washington Department of Ecology, the Puget Sound Partnership, Environmental Research Consulting, or any represented entities or participants at the Salish Sea Workshop.

For those participants who would like to review the actual studies in greater detail, links to websites that provide the reports and other information are included at the end of the handbook.

General Comparison of Salish Sea Vessel Risk Studies

The first part of the Salish Sea Workshop will involve a review of vessel traffic-related studies in order to develop a common understanding of the assessed risks of accidents (likelihood and types of incidents) that may lead to spills from vessels. There will be brief presentations on each of the following studies:

- Vessel Traffic Risk Assessment 2010.[640]
- BP Cherry Point Dock Expansion Project.[641]
- Gateway Pacific Terminal.[642]

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[639] Potential effects of crude and/or coal train traffic capacity and operations with respect to effects on vessel traffic in the Salish Sea may be covered as part of the discussions at the workshop (e.g., changes in tanker and ATB traffic in the Salish Sea associated with crude-by-rail oil operations at proposed Columbia River or Grays Harbor facilities).

[640] van Dorp and Merrick 2014.

[641] The Glosten Associates et al. 2013; van Dorp and Merrick 2008.

[642] The Glosten Associates et al. 2014.

- Trans Mountain Pipeline Expansion Project Studies.[643]
- Roberts Bank Terminal2 (RBT2).[644]
- Washington State Marine & Rail Oil Transportation Study (Draft).[645]

Table 92 provides a general comparison to inform participants of the origin of each of these studies.

Table 92: General Comparison of Salish Sea Vessel Risk Studies[646]

Criteria	VTRA 2010: Preventing Oil Spills from Large Ships and Barges in Northern Puget Sound & Strait of Juan de Fuca (2014)	BP Cherry Point Dock Expansion (TGA VTA) (2013)[647]	Gateway Pacific Terminal (GPT) Vessel Traffic and Risk Assessment Study (VTARAS) (2014)	Trans Mountain Expansion Project (TMEP) (Kinder Morgan) (2013)	Roberts Bank Terminal 2
Client(s)	Puget Sound Partnership Makah Tribal Council	Cardno Entrix (for BP)	SSA Marine	TERMPOL[648]	Port of Metro Vancouver
Authors	George Washington U. VA Commonwealth U.	Glosten Associates Northern Economics ERC	Glosten Associates Northern Economics ERC	Det Norske Veritas-GL	HEMMERA Herbert Engineering Corp. ERC
Supervision	Puget Sound Harbor Safety Committee	US Army Corps	Ecology Lummi Nation	National Energy Board	National Energy Board
General Study Area (US)	Puget Sound Strait of Juan de Fuca Outer Coast	Northern Puget Sound Strait of Juan de Fuca	Northern Puget Sound Strait of Juan de Fuca	Northern Puget Sound Strait of Juan de Fuca	Northern Puget Sound Strait of Juan de Fuca
General Study Area (Canada)	Georgia Strait Haro Str. – Boundary Pass West Strait Juan de Fuca East Strait Juan de Fuca	Haro Str. - Boundary Pass West Strait Juan de Fuca East Strait Juan de Fuca	Haro Str. - Boundary Pass West Strait Juan de Fuca East Strait Juan de Fuca	Haro Str. - Boundary Pass West Strait Juan de Fuca East Strait Juan de Fuca Strait of Georgia	Haro Str. - Boundary Pass West Strait Juan de Fuca East Strait Juan de Fuca Strait of Georgia

643 Kinder Morgan (Canada) 2013a, 2013b.
644 The RBT2 vessel traffic study will not be available at the time of the Salish Sea Workshop in January 2015; only publicly-available information will be able to be presented at the workshop.
644 Etkin et al. 2014.
645 Etkin et al. 2014.
646 The 2014 Marine & Rail Oil Transportation Study (Ecology) is not included in this comparison because it is not a quantitative vessel traffic risk study.
647 Two detailed technical studies were conducted on vessel traffic and spills associated with the BP Cherry Point Dock Expansion – the GWU VTRA, which was used to assess the incremental risk of vessel accidents and potential oil spills based on current and future vessel traffic calling at BP Cherry Point dock (van Dorp et al. 2008); and the TGA VTA, which was used to estimate changes in vessel traffic accident risk and the associated risk of oil spills attributable to the upper limit of forecasted vessel traffic calling at BP Cherry Point dock (The Glosten Associates et al. 2013).
648 TERMPOL: Technical Review Process of Marine Terminal Systems and Transshipment Sites – a Canadian federal initiative that assesses the safety and risks associated with oil and gas tanker movements to, from, and around Canada's marine terminals.

Criteria	VTRA 2010: Preventing Oil Spills from Large Ships and Barges in Northern Puget Sound & Strait of Juan de Fuca (2014)	BP Cherry Point Dock Expansion (TGA VTA) (2013)[647]	Gateway Pacific Terminal (GPT) Vessel Traffic and Risk Assessment Study (VTARAS) (2014)	Trans Mountain Expansion Project (TMEP) (Kinder Morgan) (2013)	Roberts Bank Terminal 2
Part of Environmental Impact Statement or Environmental Assessment Process	No	Yes	Yes	Yes	Yes
Report Status	Released January 2014	First vessel traffic study released in 2008; Follow up vessel traffic analysis released in 2013. Draft EIS report released May 2014	Presented to Ecology November 2014 Public release December 2014	Released December 2013	In Environmental Assessment (EA) process; To be released Spring 2015
Current Risk Analyzed	2010	2010	2010	no	n/a
Future Risk Projected	n/a	2030	2019	2018	n/a
Future Scenarios Analyzed	Gateway Pacific Terminal Trans Mountain Expansion Delta Port Changes All Three Operational	With North Wing Without North Wing	With GPT Without GPT Cumulative Traffic	With TMEP Without TMEP With/Without Risk Mitigation Strategies	n/a
Accounts for BP Cherry Point Traffic	Yes	Yes	Yes	Yes	Yes
Accounts for GPT Traffic	Yes	Yes	Yes	Yes	Yes
Accounts for Trans Mountain	Yes	Yes	Yes	Yes	Yes
Accounts for RBT2 Traffic	No	No	No	No	Yes
Accounts for Crude-by-Rail Vessel Traffic Changes	No	No	Partially	No	No

Vessel Traffic Projections for the Salish Sea

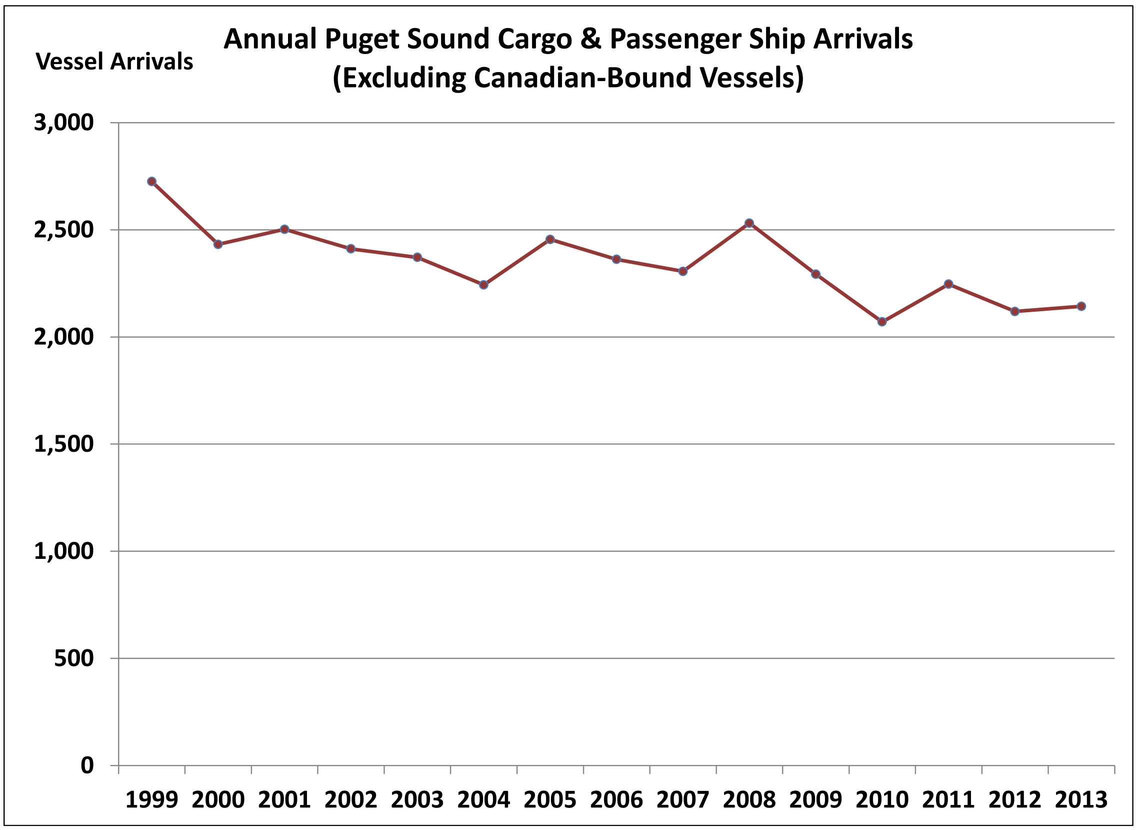
This information is provided to inform Salish Sea Workshop participants of current and changing traffic patterns in the Salish Sea.

Puget Sound Cargo and Passenger Vessel Traffic

Cargo and Passenger (or C&P) vessels include container ships, bulk carriers, cruise ships, fishing vessels, and other commercial non-tank vessels of 300 gross tons or more. Over the last decade there has been a general trend down in annual Puget Sound Cargo & Passenger Ship Arrivals (Figure 158). In 2013 there were:

- 2,143 C&P arrivals to Puget Sound ports.
- 2,895 arrivals to Canadian ports in which the vessel transited Washington waters.

Figure 158: Annual Puget Sound Cargo and Passenger Ship Arrivals[649]



[649] Excluding Canadian-bound vessels.

Changing Salish Sea Vessel Traffic Patterns

The vessel traffic patterns in Puget Sound, the Strait of Juan de Fuca and its approaches, as well as the Strait of Georgia (Salish Sea) will likely change with future developments. Projected changes that could impact vessel traffic in the Salish Sea include:

Development of the Gateway Pacific Terminal (GPT) project at Cherry Point

- Would represent more than 8% of the overall cargo vessel traffic within the Salish Sea at full operating capacity. GPT could represent 41% of the cargo shipping increase between 2016 and 2026; at half-capacity, approximately 221 vessels (144 Panamax vessels and 77 Capesize vessels) are expected to call at the GPT per year (about one vessel every other day). At full operational capacity, approximately 487 vessels per year are expected to call at the GPT (about 1–2 vessels every day).[650]

Development of the Port of Metro Vancouver

- Including the Roberts Banks Terminals[651] and Neptune Terminal projects, which will represent 33% of the cargo shipping increase in the Salish Sea between 2011 and 2016.

Tank vessel traffic-related risk likely to change in the future due to expansion of the Trans Mountain Pipeline.

- The Trans Mountain pipeline expansion, currently in application process, will increase product moved by pipeline from 300,000 barrels per day to 890,000 barrels per day (capacity 12.6 to 37.4 million gallons per day).
- This could increase laden crude oil tanker traffic departing from the Westridge terminal in Vancouver from roughly 60 tankers to roughly 400 tankers annually.

At the same time that these increases might occur, the number of crude tankers going to Washington refineries is likely to be reduced due to higher pipeline volumes delivered. With the expansion of crude-by-rail deliveries to the refineries, there will also be reductions in crude tanker traffic to Washington refineries. These changes have already begun, but will increase in the future. Figure 159 shows current and estimates of future tanker traffic in the Salish Sea. Additionally, Figure 160 shows changes that may occur with respect to cargo vessel traffic in the Salish Sea.

[650] http://gatewaypacificterminal.com/the-project/f-a-q/#VesselTrans

[651] Deltaport is one of two existing terminals at Roberts Bank Terminals, each independently operated. Roberts Bank Terminal 2 (RBT2) is being proposed as a third terminal at the site. RBT2 is a proposed new three-berth container terminal at Roberts Bank, Delta, BC. If built, the project would provide 2. 4 million TEUs (twenty-foot equivalent lengths) of container capacity per year to meet forecast demand until 2030. Based on the current project schedule, and subject to regulatory approvals (including an environmental impact statement), the proposed RBT2 project could begin operation in the mid-2020s. (http://www.robertsbankterminal2.com/about-the-project/roberts-bank-terminal-2-project/)

Figure 159: Salish Sea U.S. /Canadian Tanker Traffic – Current and Projected Future[652]

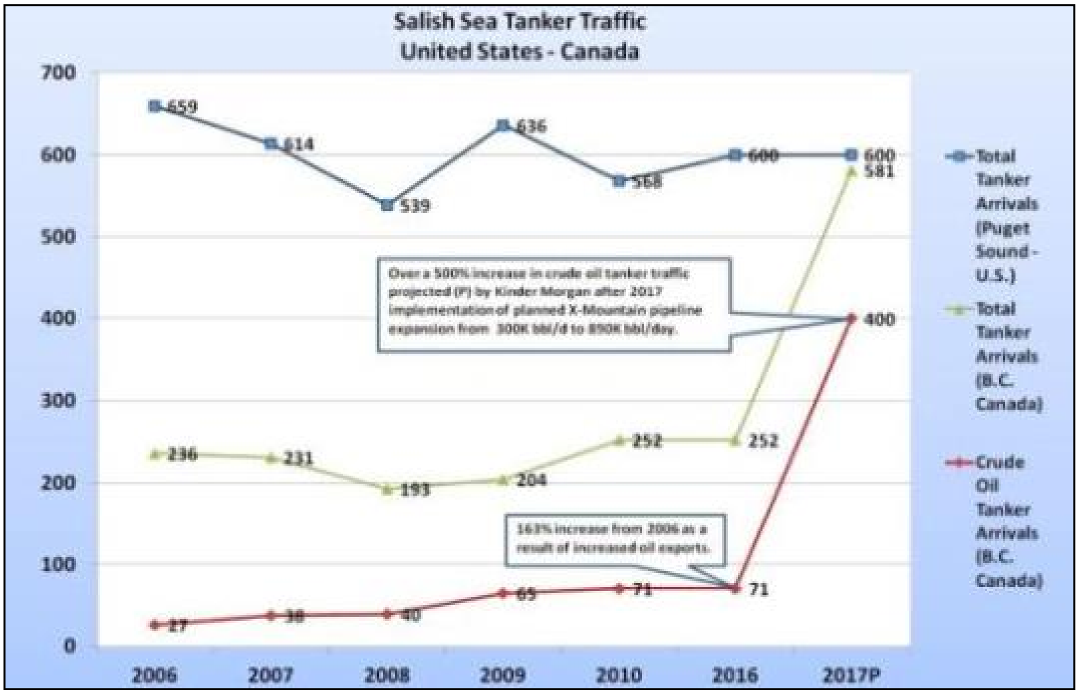
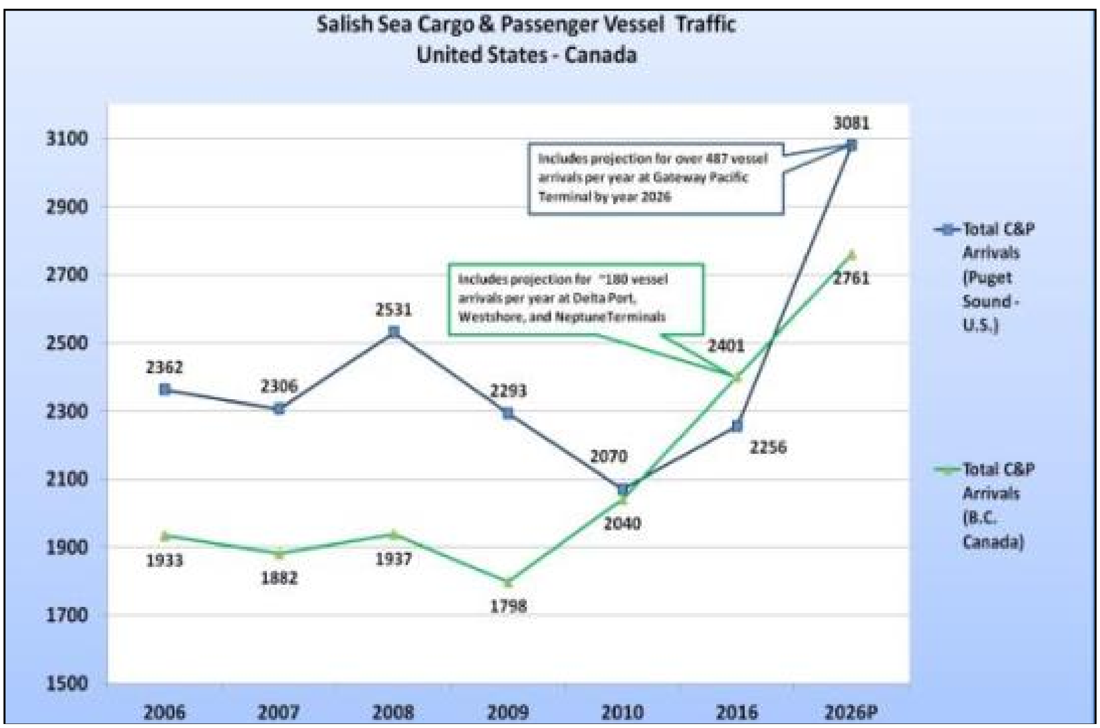


Figure 160: Salish Sea U.S. /Canadian Cargo & Passenger Vessel Traffic – Current and Projected Future[653]



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[652] From: *Changing Risk Picture in the Pacific Northwest* presentation by Dept. of Ecology at BC Ministry of Environment Symposium March 2013.
[653] From: *Changing Risk Picture in the Pacific Northwest* presentation by Dept. of Ecology at BC Ministry of Environment Symposium March 2013

Existing Risk Reduction Measures in the Salish Sea[654]

It is important to understand existing measures to prevent marine accidents in the Salish Sea when discussing further protections that should be implemented. Existing protections include:

- Vessel certification by U.S. Coast Guard.
- Oil Pollution Act of 1990 (OPA90) requirements:
  - Double hulls on tankers.
  - Oil spill contingency and response plan with response-trained crew on board.
  - Financial liability.
- Limitations on tankers of greater than 125,000 Deadweight Ton (DWT), a measure of how much weight a ship is carrying, in the U.S. waters of the greater Puget Sound:
  - U.S. -flagged vessels of greater than 125,000 DWT may enter Puget Sound and transit into Puget Sound if an additional load line had been established on the vessel's hull indicating the waterline with a loaded cargo of up to 125,000 DWT.
- Certified pilotage requirements for transits through U.S. and Canadian waters in greater Puget Sound and the Strait of Georgia:
  - Beginning in October 2013, two pilots are required for tank vessels greater than 40,000 DWT in Boundary Pass and Haro Strait transiting to/from Canadian ports.
- U.S. Captain of the Port authority in enforcing regulations (Puget Sound Harbor Safety Committee established under this authority).
- Vessel traffic management:
  - Puget Sound and Cooperative Vessel Traffic SysteMs.
- Designated traffic lanes:
  - Separation zone.
  - Smaller vessel lanes adjacent to primary lanes to separate larger faster traffic from slower traffic.
  - Intersections with precautionary areas for turning or crossing traffic.
- Additional operating rules at Special Operating Areas:
  - Turn Point Special Operating Area (northern segment of Haro Strait) – restriction of multiple vessels of 100 meters (325 feet) from transiting area at the same time unless moving in same direction.
  - Eastern San Juan Island Archipelago Vessel Traffic Service Special Area – restriction to one-way traffic for vessel greater than 100 meters (325 feet) and 40,000 DWT and higher.
- Tank ship security zone of 1,500 feet.
- Tug escort assist requirements.
  - Laden tankers 40,000 DWT or greater in Puget Sound east of line from Discovery Island to New Dungeness Light.
  - Escort tug and two pilots for 40,000 DWT vessels transiting Haro Strait and Boundary Pass to Canadian ports.

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[654] Adapted from From: Cardno Entrix 2014.

- Tankers with/without redundant propulsion and steering are required to have tethered tug(s) when transiting Rosario Strait, Haro Strait, and Boundary Pass.
  - Emergency response towing vessel (ERTV) or ocean-going tug stationed at Neah Bay to assist vessels in distress in Washington coastal waters and western reach of Strait of Juan de Fuca.
- Limitation of vessel speed:
  - Whenever vessel accompanied by required escort, vessel speed may not exceed speed service of escort.
  - Vessel speed restricted to 10 knots in Rosario Strait.
  - Vessels escorted under Canadian Pacific Pilotage Authority may not exceed 10 knots (primarily Haro Strait and Boundary Pass).
- Vessels entering U.S. waters must meet standards of crewing, equipment, and contingency planning required by the U.S. Coast Guard. When vessels are bound for U.S. ports (e.g., BP Cherry Point) they must meet standards to be permitted to moor and discharge or load cargo through 96-hour Advanced Notice of Vessel Arrival (describes vessel, registration, type and amount of cargo, five previous ports of call, individual crew members, security status, and contact information), which determines whether vessel will be allowed to enter and whether the USCG should inspect the vessel prior to entering.
- Puget Sound Harbor Safety Plan, which includes set of Standards of Care (SOCs) or operating procedures that all members of the industry have agreed to abide by when operating in Puget Sound, including procedures for:
  - Anchoring.
  - Bridge management.
  - Bunkering:
    - Advanced notification of oil transfer.
    - Limits on weather conditions.
    - Specific manning responsibilities.
    - Tug availability in certain weather conditions.
    - Pre-booming or boom availability requirements.
    - Vessel Response Plan and certain response equipment for spills.
    - Set flow rate criteria.
  - Equipment failures.
  - Heavy weather.
  - Hot work.
  - Lightering.
  - Line handling.
  - Propulsion loss prevention.
  - Restricted visibility.
  - Tanker escort.
  - Towing.
  - Under-keel clearance.

2014 Vessel Traffic Risk Assessment (VTRA 2010)

VTRA 2010 was conducted following concerns about the potential for large oil spills due to proposed maritime terminal developments. The purpose of VTRA 2010 Study was to evaluate potential changes in risk considering maritime terminal developments, based on the following scenarios:

- The proposed Gateway bulk carrier terminal at Cherry Point, Washington, only in operation.
- The Trans Mountain /Kinder Morgan pipeline expansion in Vancouver, BC, only in operation.
- The coal, grain,[655] and container terminal expansions at Port of Metro Vancouver, BC, only in operation.[656]
- All three scenarios operating at the same time.

The VTRA 2010 study was conducted because study sponsors and involved stakeholders wanted to ensure the potential vessel traffic risks associated with the maritime development projects named above are better understood, thereby informed decisions can be made about additional risk mitigation measures.

VTRA 2010 study focused on the potential impacts of three proposed facilities in the region based on 15 Waterway Zones throughout the Salish Sea. [657]

Major Findings

- Three large terminal projects (Trans Mountain, Deltaport, and Gateway)[658] have been proposed that, if approved and fully implemented, would collectively increase current cargo and tank vessel traffic in Puget Sound by about 25% over the next decade.
- Shipping accidents leading to major spills are rare in Puget Sound (no spills from deep draft vessels in transit and none >10,000 gallons from oil barges in transit in past 20 years), but if the three projects are built collectively, the modeled potential frequency of accidents, like groundings and collisions, could rise by 18%.
- The increased vessel traffic associated with these three large terminal projects, when fully implemented, could collectively increase potential oil loss across the Puget Sound by about 68% (percentage needs to be taken into context of entire report).
- The potential volume of oil that might be spilled in an accident in two waterways—Haro Strait (west of the San Juan Islands) and the Buoy J zone (off the entrance to the Strait of Juan de Fuca)—could more than triple.

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[655] The VTRA 2010 study incorrectly states that there would be grain terminal expansions at Roberts Bank Terminals.

[656] Terminal expansions are proposed for Roberts Bank Terminals, of which Delta Port is an existing terminal that would not be associated with the expansion.

[657] Review of the VTRA 2010 study by HEC for this study indicates that the traffic assumptions for the "Delta Port" project (actually two independent terminals, one a coal facility, Westshore Terminals, and the other, a container terminal, Deltaport) were based upon information available at the study initiation (2005) that was incomplete or inaccurate.

[658] The VTRA 2010 study explicitly did not include Roberts Bank Terminal 2 in its analyses.

- This is because of the sizeable shift in the mix and volume of vessel traffic (potentially more tankers, more container ships and more bulk cargo carriers) going to and from Canada and/or Cherry Point.

- When a combination of six risk mitigation measures—including availability of a supplemental emergency response tug, reduced container vessel speeds and reduced human error rates for oil barges—were applied to the simulated traffic from the three proposed terminal projects, the potential accident frequency fell to 11% below the current baseline.
  - The study evaluated the potential effectiveness of various risk reduction measures (risk mitigation measures), as summarized in Table 93.

Table 93: VTRA 2010 Risk Mitigation Measure Analysis Result Summary[659]

Risk Mitigation Measure(s)							Change in Potential Accident Frequency Relative to Base Case	Change in Potential Oil Spillage Relative to Base Case
ATBs adhering to one-way Rosario traffic regime	Cape class bulk carrier given benefit of one escort on Haro routes	All vessels given benefit of one escort on Haro routes	Cape class bulkers, laden tankers, ATBs given benefit of escort tug on Rosario routes	For scenario with GPT, Trans Mtn, and Deltaport full build-out	No bunkering support at GPT	Max speed of 17 knots for container-ships		
							+18%	+68%
■		■	■	■	■	■	-29%	-44%
■							0%	0%
	■						-2%	-4%
		■					-7%	-24%
			■				-8%	-12%

- In light of the findings, the region should not ask what single risk mitigation measure should be implemented, but what combination of measures could be applied and what current risk mitigation measures, such vessel traffic management, vessel inspections, and tug escorts can be further improved.
- There is need for a trans-boundary (US and Canadian waters) electronic data source where vessel type is consistently defined and verified beyond cargo focus vessel or tank focus vessel classifications.
  - Without currently possessing a common and consistently recorded vessel identifier or vessel type classification, Vessel Traffic Operations Support System and ship Automatic Identification System require vetting at the individual vessel level for the VTRA 2010.
  - It would be equally beneficial if such dataset records captured at minimum cargo levels (laden, unladen, 50% laden, etc.) and cargo type.
  - There is a need for consistently electronically recording the barge type and cargo content of tug-tows.

[659] For scenario with GPT, Trans Mountain (Kinder Morgan), and Deltaport full build-out.

- Studies such as the VTRA would benefit from the availability of such a data source, and having this information available would also help responders during a response were a spill to occur.

Projected Increase by Waterway Zone

The projected increase in oil spillage by waterway zone with all three projects is shown in Table 94.

Table 94: VTRA 2010 Projected Increases in Oil Spillage[660] for All Three Projects Operating

Waterway Zone	% Base Case[661]	GPT-KM-DP % of Base Case	Increase in Spillage Volume
Guemes	17.0%	22.3%	5.3%
Rosario	14.9%	15.5%	0.6%
Saddlebag	13.4%	12.6%	-0.8%
Puget Sound South	10.0%	10.0%	0.0%
Puget Sound North	10.0%	10.3%	0.3%
East Strait Juan de Fuca	9.8%	23.8%	**14.0%**
Haro Str. /Boundary Pass	9.8%	46.7%	**36.9%**
West Strait Juan de Fuca	4.8%	9.8%	5.0%
Islands Trt	4.8%	6.5%	1.7%
Georgia Strait	3.9%	7.1%	3.2%
Buoy J	0.6%	2.5%	1.9%
Tacoma South	0.4%	0.4%	0.0%
ATBA	0.2%	0.2%	0.0%
Sar/Skagit	0.2%	0.2%	0.0%
San Juan Islands	0.1%	0.3%	0.2%
Total	**100%**	**168%**	**68.0%**

BP Cherry Point Dock Expansion Project

In 1971, the BP Cherry Point dock was permitted for construction of two berths, although ultimately only one berth (the South Wing) was constructed initially. In 2001, the second berth (the North Wing) was constructed and became operational. In November 2000, a lawsuit was initiated against the U.S. Army Corps of Engineers concerning the adequacy of the National Environmental Policy Act environmental review for permitting the North Wing. The litigation required preparation of a vessel traffic study and completion of an environmental impact statement focused on the potential increased risk of vessel spills associated with operation of the North Wing. Two vessel traffic studies were performed for this, the George Washington University Vessel Traffic Risk Assessment in 2008, and The Glosten Associates, Inc., Vessel Traffic Assessment in 2013.

[660] Due to collisions and groundings. Percentages need to be taken into context of entire report.
[661] Percent of total oil spills without GPT, Kinder Morgan (Trans Mountain), or Deltaport (RBT2).

George Washington University Vessel Traffic Risk Assessment, 2008

The 2008 George Washington University (GWU) VTRA for BP Cherry Point was based on a projected maximum of 323 annual vessel calls.

Major Findings

- Current (2005) annual accident potential and expected oil outflow was reduced or changed very little in all but one of the subareas with operation of the North Wing.
  - The Haro Strait – Boundary Pass subarea showed an increase in both annual accident potential and oil outflow.
- Future (2025) annual accident potential:
  - Highest in the Cherry Point and Guemes Channel subareas, but potential oil outflow was significantly reduced (Guemes Channel) or remained essentially the same (Cherry Point) with operation of the North Wing.
  - Annual oil outflow was predicted to be relatively high in Rosario Strait and to increase in the high-range vessel traffic forecast case, but the potential for accidents in Rosario Strait was relatively low and fell with the operation of the North Wing.
- Prohibiting the use of the Saddlebag Route, extension of escort tugs from Port Angeles to Neah Bay, and permanent stationing of a tug at Neah Bay are unlikely to change the degree of environmental risk associated with vessel traffic calling at the BP Cherry Point dock.

The Glosten Associates, Inc., Vessel Traffic Assessment, (2013)

A second vessel traffic study assessing the impacts of the upper limit of the BP forecast for future vessel traffic was conducted to incorporate 420 vessel calls – a 30% increase over the levels studied in the 2008 GWU VTRA. The risk of vessel incidents (accidents that could potentially lead to spillage) and spills increases slightly with the increased vessel calls associated with the upper limit. The results are summarized in Table 95 through Table 99.

Table 95: Summary of Incremental Risk Analysis Results in TGA VTA

Case	1	2	3	4	5	6	7
Year	2010	2010	2010	2030	2030	2030	2030
North Wing	No	No	Yes	No	Yes	No	Yes
South Wing	Maximum capacity	Actual calls	Actual calls	Maximum capacity	North + South 420 calls	Maximum capacity	North + South 420 calls
Traffic Group	2010	2010	2010	2030 general	2030 general	General + cumulative[662]	General + cumulative
Average Potential Incidents	27.78	27.62	27.62	34.35	34.85	46.14	46.66
Average Potential Spills	9.99	9.89	9.88	12.39	12.68	16.58	16.97
50th Percentile Spill (Gallons)	985	975	961	1,109	1.193	2,141	2,396
95th Percentile Spill (Gallons)	90,900	86,172	81,620	62,644	69,617	95,490	114,977

Table 96: TGA VTA 2010 Current Conditions Comparison

Risk Statistic	Case 2	Case 3	Change (%)
	South Wing	North/South Wings	
Average annual potential incidents	27.62	27.62	0 (0%)
Average annual potential spills	9.89	9.88	-0.01 (0%)
50th percentile potential spill volume (gallons)	975	961	-14 (-1%)
50th percentile potential spill volume (gallons)	86,172	81,620	-4,552 (-5%)

[662] "Cumulative traffic" is projected non-BP traffic generated by proposed GPT, Trans Mountain expansion, and future oil production on Alaska Outer Continental Shelf.

Table 97: TGA VTA 2030 Future Conditions Comparison

Risk Statistic	Case 4	Case 5	Change (%)
	South Wing	North/South Wings	
Average annual potential incidents	34.35	34.85	0.50 (1%)
Average annual potential spills	12.39	12.68	0.29 (2%)
50th percentile potential spill volume (gallons)	1,109	1,193	84 (8%)
50th percentile potential spill volume (gallons)	62,644	69,617	6,973 (11%)

Table 98: TGA VTA Regional Subarea Incident Risk Comparison

Subarea	Case 2	Case 3	Case 2 vs. Case 3	Case 4	Case 5	Case 4 vs. Case 5	Case 7	Case 5 vs. Case 7
	South	North + South		South	North + South		North + South	
East Strait Juan de Fuca	6.41	6.41	0	7.32	7.36	1%	10.18	27%
Haro StrBoundary Pass	0.73	0.74	1%	0.92	0.91	-1%	1.87	51%
Guemes/Fidalgo	5.54	5.51	-1%	6.84	6.82	-<1%	8.17	17%
Saddlebag	3.89	3.85	-1%	6.15	6.15	0%	8.21	25%
Rosario Strait	0.80	0.84	5%	0.90	0.91	1%	1.25	27%
Cherry Point	6.78	6.79	<1%	8.13	8.51	5%	12.20	30%

Table 99: TGA VTA Regional Subarea Spill Risk Comparison

Subarea	Case 2	Case 3	Case 2 vs. Case 3	Case 4	Case 5	Case 4 vs. Case 5	Case 7	Case 5 vs. Case 7
	South	North + South		South	North + South		North + South	
East Strait Juan de Fuca	2.22	2.20	-3%	2.39	2.38	-<1%	3.55	33%
Haro StrBoundary Pass	0.15	0.16	6%	0.19	0.19	0%	0.36	47%
Guemes/Fidalgo	2.32	2.36	2%	2.97	2.95	-<1%	3.53	16%
Saddlebag	1.29	1.26	-2%	2.29	2.29	0%	2.93	22%
Rosario Strait	0.11	0.12	8%	0.12	0.13	8%	0.16	19%
Cherry Point	2.93	2,93	0%	3.48	3.76	8%	5.19	28%

Gateway Pacific Terminal Project

Pacific International Terminals, a subsidiary of SSA Marine, has proposed building a deep-water marine terminal at Cherry Point in Whatcom County. The Gateway Pacific Terminal Project (GPT) study compared three basic cases:

Baseline traffic for the year 2019 assuming no GPT project (Case A).

- Historic traffic volumes extrapolated to 2019 including legacy Alaska crude and foreign crude oil imports.
- Deltaport Expansion 2010.
- Westshore Expansion 2012.
- Second Westshore Expansion 2017.
- Neptune Expansion 2015.
- BP Rail 2013.
- Tesoro Rail 2012.
- Phillips 66 Rail – under construction.

Baseline traffic for the year 2019 assuming GPT project (Case B).

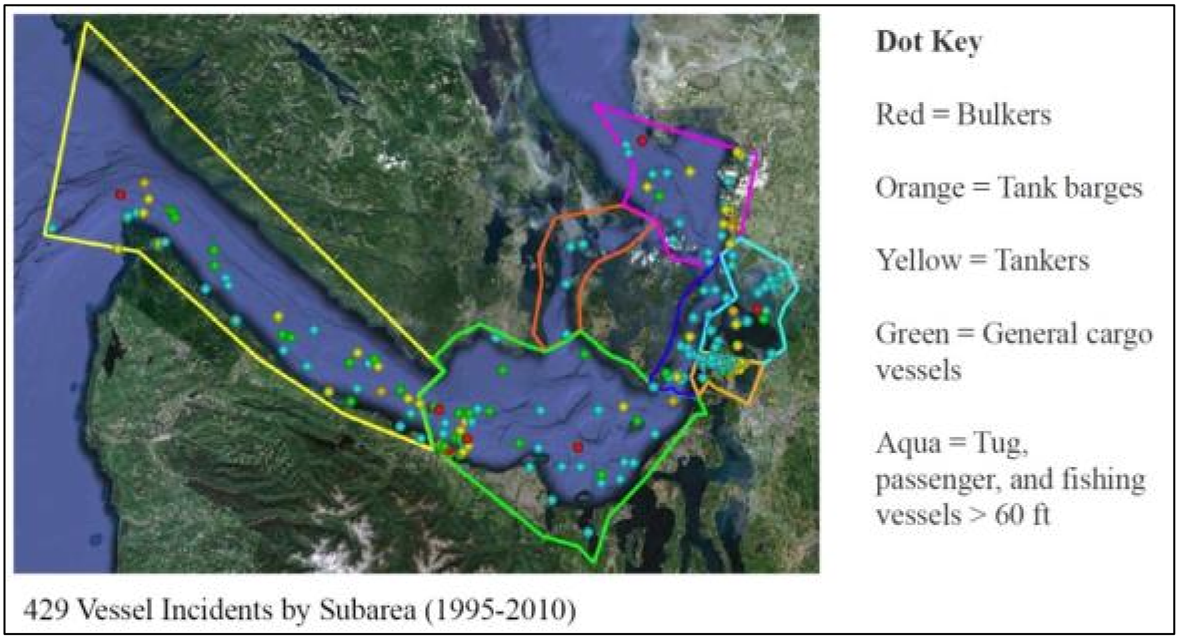
- Case A traffic.
- 318 Panamax vessels.
- 169 Capesize vessels.
- GPT assist tugs.
- GPT bunkering barges.

GPT plus cumulative traffic from Trans Mountain pipeline expansion and crude-by-rail to Shell (Case C).

- Case B traffic.
- Trans Mountain Expansion.
- Shell Rail Terminal.

Rates of incidents (defined as vessel events that did or could potentially have led to a spill) were based on historical data from 1995 – 2010 by vessel type, incident type, activity (transit, maneuvering, docking), and vessel type. Incidents are shown by vessel type and geographic zone in Figure 161. Note that not every incident resulted in a spill. Some of the incidents involved causes other than impact (collision, allision, or grounding), such as transfer errors, equipment failure, or other discharge-related events.

Figure 161: GPT Study Vessel Incidents



Major Findings

The cumulative probability distribution functions for incidents by case are shown in Figure 162. The cumulative probability distribution functions for spills by case are shown in Figure 163.

Figure 162: Cumulative Distribution Function of Total Annual Number of Incidents

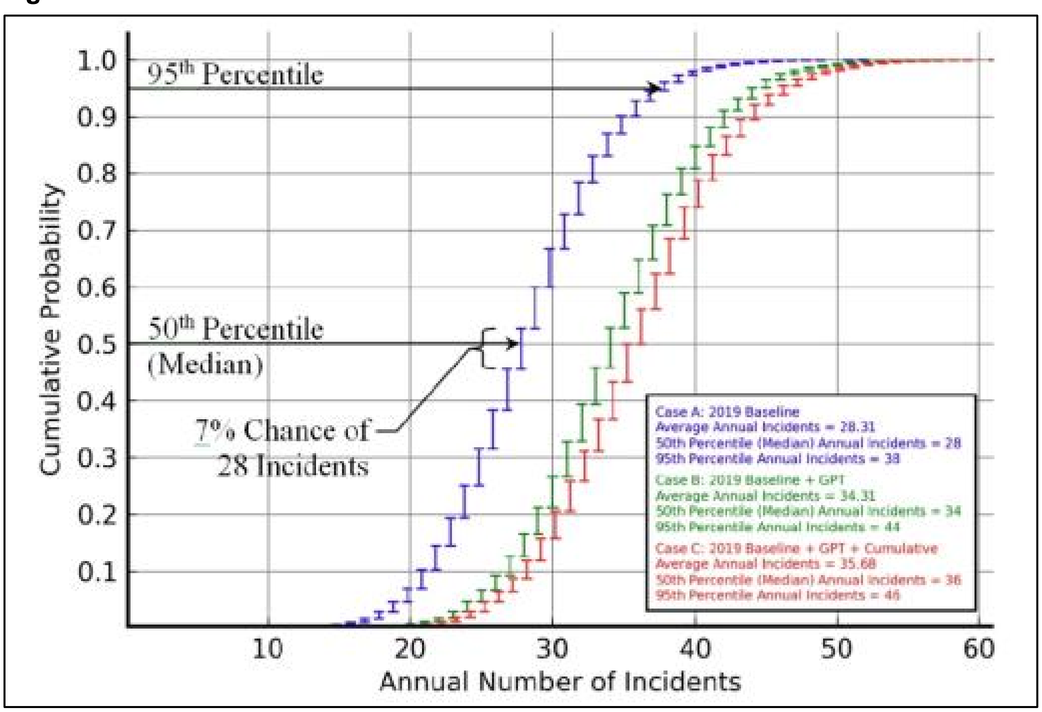
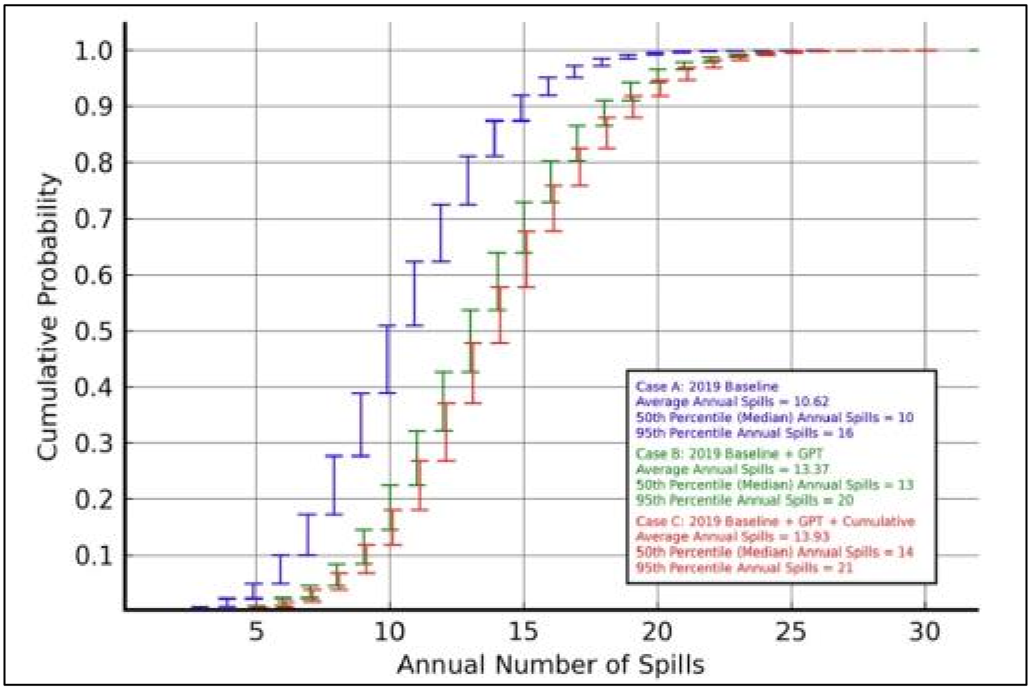


Figure 163: Cumulative Distribution Function of Total Annual Number of Spills



The results are summarized in Table 100. Spill volume results are shown in Figure 164 and Table 101.

Table 100: GPT Study Summary of Results for All Geographic Subareas[663]

Case	Projected Annual Incidents 2019			Projected Annual Spills 2019		
	Average	Median	95th Percentile	Average	Median	95th Percentile
Case A Baseline	28.31	28	38	10.62	10	16
Case B Baseline + GPT	34.31	34	44	13.37	13	20
Case C Baseline + GPT + Cumulative	35.68	36	46	13.93	14	21
Increase Case B vs. Case A	21.2%	21.4%	15.8%	25.9%	30.0%	25.0%
Increase Case C vs. Case A	26.0%	28.6%	21.1%	31.2%	40.0%	31.3%

663 The results are shown as the average, median (50th percentile), and high (95th percentile) outcomes of the Monte Carlo simulation. The expected outcome in the range of results.

Figure 164: GPT Oil Spillage (Outflow) Results

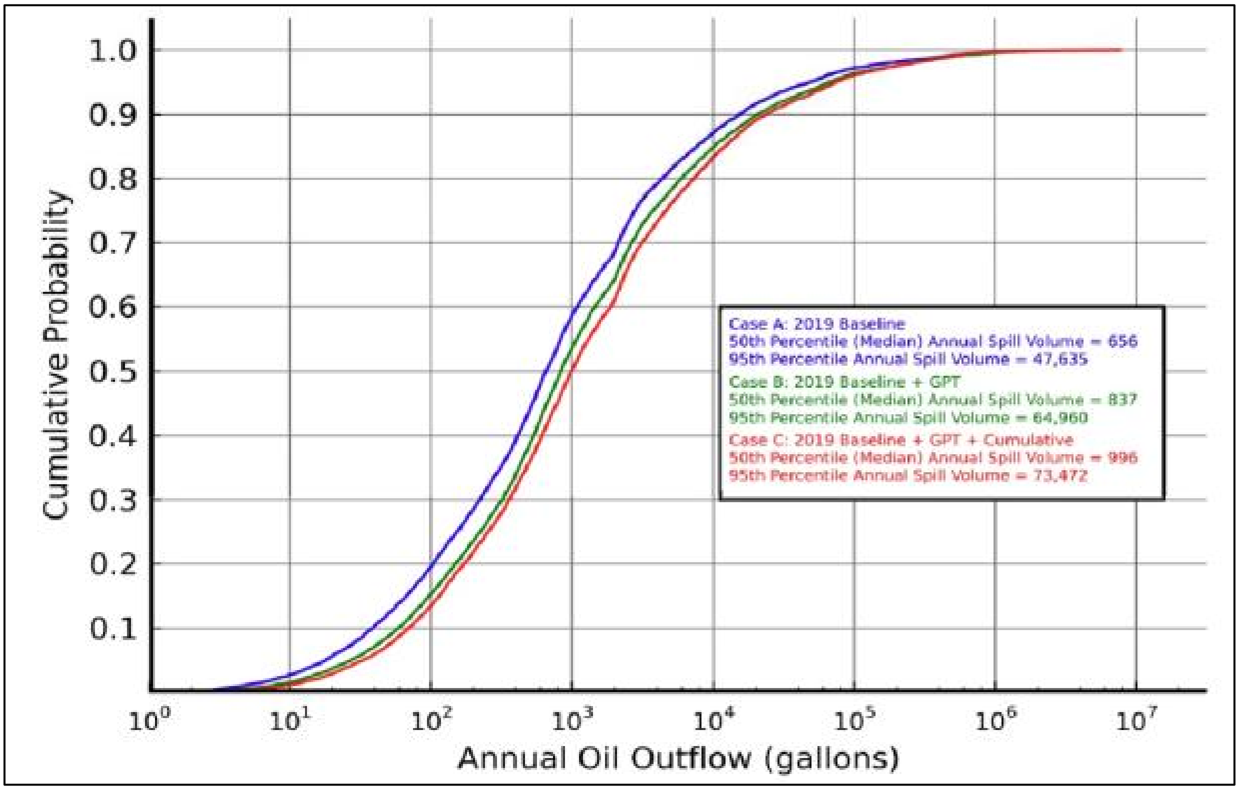


Table 101: GPT Study Summary of Oil Outflow Results for All Geographic Subareas[664]

Case	Projected Annual Oil Outflow 2019	
	Median	95th Percentile
Case A (Baseline)	656	47,635
Case B (Baseline + GPT)	837	64,960
Case C (Baseline + GPT+ Cumulative)	996	73,472
Increase Case B vs. Case A	27.6%	36.4%
Increase Case C vs. Case A	51.8%	54.2%

Summary of Findings on Anchorage Capacity

- Based upon averages derived from 2006 – 2010, data shows 23.6% utilization and a daily average of 13.4 available anchorages; in practice anchorage availability varies day to day.
- GPT-calling bulkers are predicted to queue at-anchor while waiting for an available berth. The probability that the number of vessels in the queue will exceed the number of available anchorage spaces (13) is less than 1%.
- USCG feedback suggests that existing anchorages have sufficient capacity to accommodate increased traffic.

[664] The results are shown as the average, median (50th percentile), and high (95th percentile) outcomes of the Monte Carlo simulation. The expected outcome in the range of results.

Summary of Findings on Potential Additional Bunkering

- GPT-calling bulkers and assist tugs are forecast to bunker between 2.19 and 4.34 million bbls within the study area.
- This forecasted volume represents an increase of 122% to 243% over 2011 volumes.
- The actual amount of increase will likely be very dependent upon the price differential between bunker fuel in Port Angeles and bunker fuel in Asia.

Summary of Findings on Potential Vessel Traffic Increase

- GPT-based vessel traffic will add 2,805 vessel traffic days[665] over the baseline forecast in 2019.
- GPT-based vessel numbers include bulkers, assist tugboats, and vessels to support the projected increase in bunkering.
- The greatest increase in traffic (33%) will be in the Cherry Point subarea where the proposed GPT project would be located.

Summary of Findings on Potential Cargo and Fuel Oil Spills

- Modeling predicts an increase of 2.75 (26%) in the average number of dry bulk and fuel oil spills from the proposed GPT vessel traffic.
- Proposed GPT vessel traffic median outflow increases of 181 gallons (28%) is predicted by the model.
- Modeling also predicts a potential increase in the median total annual reported dry bulk cargo outflow from zero to 7,376 cubic feet with the addition of the proposed GPT.

The GPT study identified risk event stages and reduction options as shown in Tables 102 and 103.

Table 102: Risk Event Stages[666]

Stage	Intervention Stage	Description
0	No cause	No risk or inadequacies are assumed. A Stage 0 Risk Reduction Option is simply preventative and proactive. It studies or supports the underlying base conditions in the system and may also indirectly reduce risk in one or more later stages.
1	Basic and root cause	Inadequate skills, knowledge, equipment, management, maintenance
2	Immediate cause	Human error, equipment failure
3	Incident	Propulsion failure, steering failure, navigational aid failure, bunker error, cargo transfer error, other non-impact errors, impact accidents[667]
4	Spill	Collision, grounding, allision, or other incident that resulted in spill
5	Spill volume	Consequence in this context is spilled contaminant volume.
6	Environmental impact	Impact of contaminant outflow.

[665] A "traffic day" is a unit of measure that involves a vessel traveling for twenty-four hours.
[666] Based on The Glosten Associates et al. 2014. The green-shaded columns represent stages of intervention that will be addressed in the Salish Sea Workshop with respect to developing risk reduction measures.
[667] Impact accidents include groundings, collisions, and allisions.

Table 103: Risk Reduction Options Classification[668]

	Risk Reduction Option	Intervention Stage						
		0	1	2	3	4	5	6
		Preventive & Proactive	Basic/Root Causes	Immediate Cause	Incident	Spill	Spill Volume	Impact
Vessel Traffic Risk Assessment and Other Study								
1	Operational risk assessments and workshop (Bulkers and tugs, including hiring agent)	■	■	■	■	■	■	■
2	Review protocol and applicability of Harbor Safety Committee Standard of Care to larger Capesize vessels	■						
Vessel Traffic Management								
3	Vessel traffic separation *Establish voluntary traffic guidelines in vicinity of Cherry Point and Ferndale facilities*	■	■	■				
4	Vessel speed *Reduce vessel speed to:* *Reduce potential mechanical energy of powered groundings and collisions;* *Provide for better situational awareness*		■	■	■			
5	Vessel arrival phasing *Schedule vessel arrivals to reduce queuing*		■	■	■			
6	Vessel routing *Port access, one-way schemes*		■					
7	Anchorage management for tugs and tank barges supporting GPT vessels	■	■					
8	Pilots and VTS coordinate movements outside shipping lanes		■	■				
Vetting Programs and Vessel Inspection								
9	Vetting program (bulkers and tugs) *Additional voluntary vessel inspection to assess compliance with regulations or performance beyond requirements*	■	■	■			■	■
10	Employ, train, and deploy additional inspectors, as needed	■	■					
11	Request insurance – for both bulkers and tugs *Insurers may request vetting*		■					
Crewing								
12	2nd officer on bridge (west of Port Angeles)	■	■	■				
13	Bridge resource management *As per Standards of Training, Certification, and Watchkeeping (STCW)*	■	■	■				
14	Engine room management *As per Standards of Training, Certification, and Watchkeeping (STCW)*	■	■	■				
On-Board Technology								

[668] Based on The Glosten Associates et al. 2014.

Risk Reduction Option		Intervention Stage						
		0	1	2	3	4	5	6
		Preventive & Proactive	Basic/Root Causes	Immediate Cause	Incident	Spill	Spill Volume	Impact
15	New technology *Navigation systems, rudder monitor*	■	■	■	■	■	■	■
16	Redundant technology, redundant propulsion	■	■	■				
17	Internally protected fuel tanks *Fuel tanks located within double hull so that fuel tank bulkheads are isolated from outer hull*					■		
18	Tow bit integrity on bulk cargo ships	■						
High-Risk Vessels								
19	Pre-deploy tugs under “high-risk-vessel” by vessel profiling	■	■					
Data Collection of Risk Assessment, Emergency Notification & Risk Communication								
20	Near-miss reporting system for vessels’ overall time in system spent: *Maneuvering* *At Anchor* *At Dock*	■						
Standard Operational Procedures (SOPs) – Vessels								
21	Fuel switching requirements *Encourage adoption of Puget Sound Harbor Safety Committee Standards of Care for fuel switching to reduce likelihood of propulsion failures*		■	■	■			
22	Conditional equipment monitoring program with sufficient crew and training	■	■	■				
23	Closed hatches *Closed hatches when able to reduce fire or explosion risk during cargo transfer operations and transit*	■	■					
Ballast Water (BW) Systems and Operations[669]								
24	Ballast water (BW) treatment systems on vessel							■
25	Emergency BW treatment systems deployable from dock							■
26	*Offloading all untreated ballast water to onshore*							■
27	Ballast water open ocean exchange program *Empty ballast tanks and re-fill with local water mid-trans-ocean voyage*	■	■	■				■
28	Ballast water open ocean exchange monitoring and testing	■						■
Standard Operating Procedures (SOPs) & Technology – Mooring								
29	Complete engineering study of vessel mooring equipment and procedures	■						
30	Mooring line technology specification *Winches, quick release, dock lines, etc.*		■					

[669] Ballast water issues are outside the scope of the Salish Sea Workshop.

	Risk Reduction Option	Intervention Stage						
		0	1	2	3	4	5	6
		Preventive & Proactive	Basic/Root Causes	Immediate Cause	Incident	Spill	Spill Volume	Impact
31	Mooring lines deployment and management *To reduce chance of vessel break-away:* *Monitor mooring line tension on all facility mooring line hooks* *Establish wind/wave thresholds for doubling mooring lines or arranging standby tug*		■					
Standard Operating Procedures (SOPs) & Technology – Oil Transfer Operations								
32	At-dock transfer: Dock watchstanding		■	■	■	■	■	
33	At-dock transfer: Limit other operations ongoing *Bunker, internal fuel transfer*		■					
34	At-dock internal transfer: Pre-booming around vessels and under dock		■	■				■
35	Bunkering: Effective training, testing, and staffing		■					
36	Bunkering: Spill response equipment pre-staged			■	■	■		
37	Bunkering: Study preferable alternative bunkering locations, including at wharf. If study indicates wharf is preferred location, then study safety and potential special procedures for bunkering at wharf.	■	■	■	■			
Standby, Rescue, Escort, and Assist Tugs								
38	Standby emergency response towing vessel *Study potential effectiveness by location*		■	■				
39	Escort tugs for Capesize ships	■	■	■	■	■		
40	Review tug capacity (horsepower) available and needed for larger vessels	■						
41	Review procedures of Canadian tugs handling Capesize vessels	■						
42	Tug pilot training program for handling large ships (simulation)	■						
43	Tug standby protocols *To limit interference with traffic and fishing:* *Establish protocols* *Provide queuing buoy or standby facility*	■	■	■				
44	Study tug routing *In or out of lanes?* *Practice avoidance*	■	■					
45	New technology in assist tugs *Line handling* *Personnel safety*	■	■	■	■	■	■	■
46	"Team training" tugs/bulkers at/near dock *Simulate stoppage* *Practice maneuvers* *Appropriate pair fittings*	■	■					
Other Actions								
47	Educational program for small vessel operators	■						
48	Partnership with tribal nations (GPT, OTB)	■	■					
49	Increase visibility of small vessels			■				

Trans Mountain Expansion Project (TMEP)

The TMEP (Figure 165) proposes twinning the existing pipeline, where possible, between Strathcona County, Alberta to Burnaby, British Columbia. The route that tankers will use to access the Westridge terminal in order to load product from the expansion of the Trans Mountain pipeline is through the shared waters of Washington and British Columbia, as seen in Figure 166. [The Salish Sea Workshop will focus on this increased traffic, not on any aspect of the pipeline.]

Figure 165: Trans Mountain Expansion Project Configuration Map. Image source: Kinder Morgan.

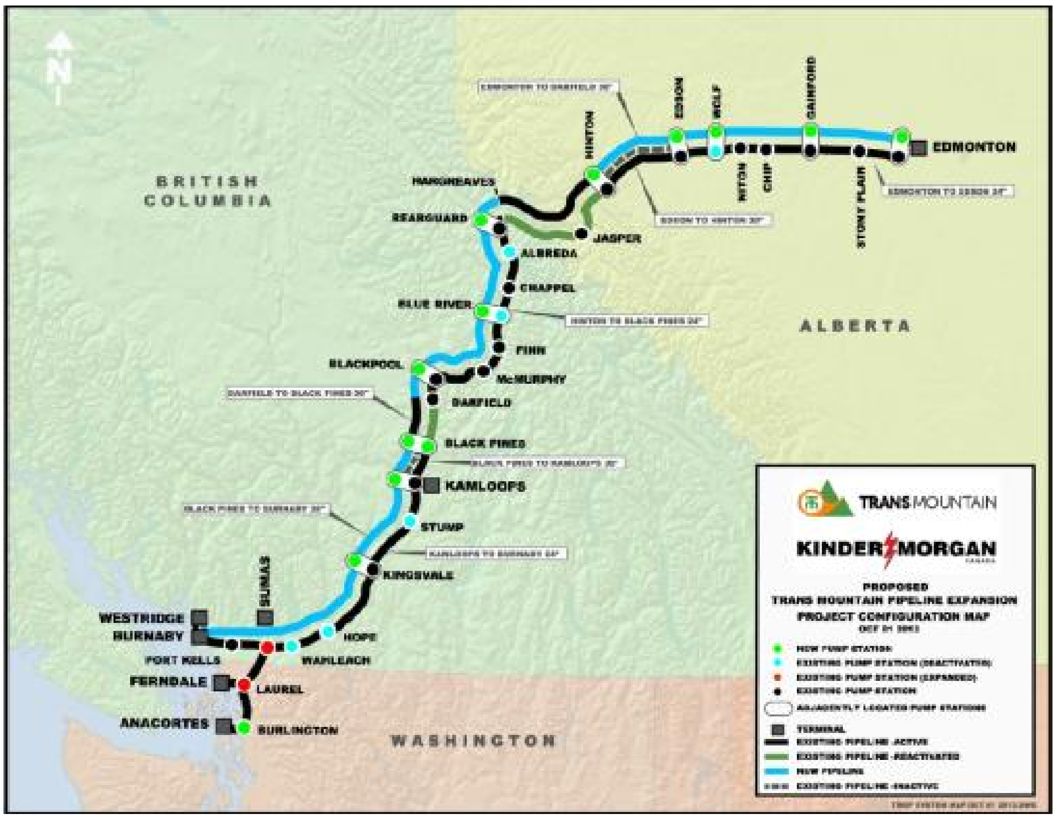
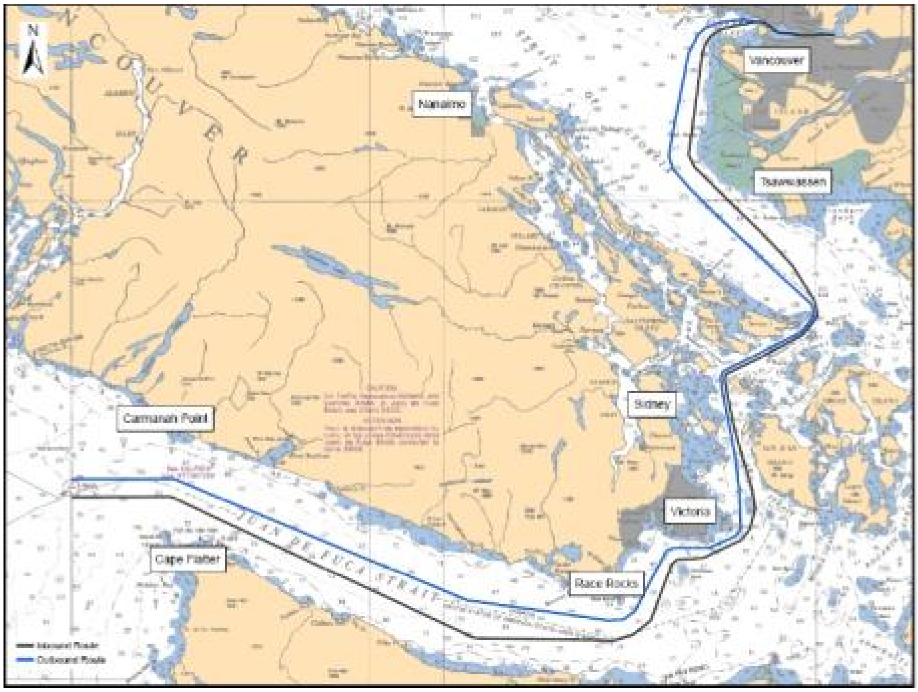


Figure 166: Inbound and Outbound Vessel Traffic Routes for Trans Mountain Project



Increase in Vessel Traffic due to TMEP

The increases in vessel traffic with the TMEP are show in Tables 104 and 105.

Table 104: Increase in Number of Tanker Sailings from TMEP Tanker Traffic

Cross Section	Projected Tanker Sailings in 2018 Without TMEP	Additional Sailings of Tankers from TMEP	% Increase
Victoria	1,515	696	46%
Haro Strait	495	696	141%
Strait of Georgia	487	696	143%
Burrard Inlet	486	696	143%
Westridge Terminal	333	696	209%

Table 105: Increase in Number of All Vessel Sailings from TMEP Tanker Traffic

Cross Section	Projected Vessel Sailings in 2018 Without TMEP	Additional Sailings of Tankers from TMEP	% Increase
Victoria	19,840	696	4%
Haro Strait	9,505	696	7%
Strait of Georgia	18,727	696	4%
Burrard Inlet	13,061	696	5%
Westridge Terminal	7,332	696	9%

Identified Existing Oil Spill Prevention Measures

Existing oil spill prevention measures identified in the Trans Mountain study are:

- Inspection of vessels under Port State Control.
- Screening of vessels by charterer and terminal operator.
- Aids to navigation.
- Traffic Separation Scheme.
- Oversight by VTS.
- Mandatory pilotage.
- Mandatory use of modern navigation equipment Electronic Chart Display and Information System, AIS, Radar.
- Mandatory use of escort tugs.
- Mandatory participation in spill response regime.

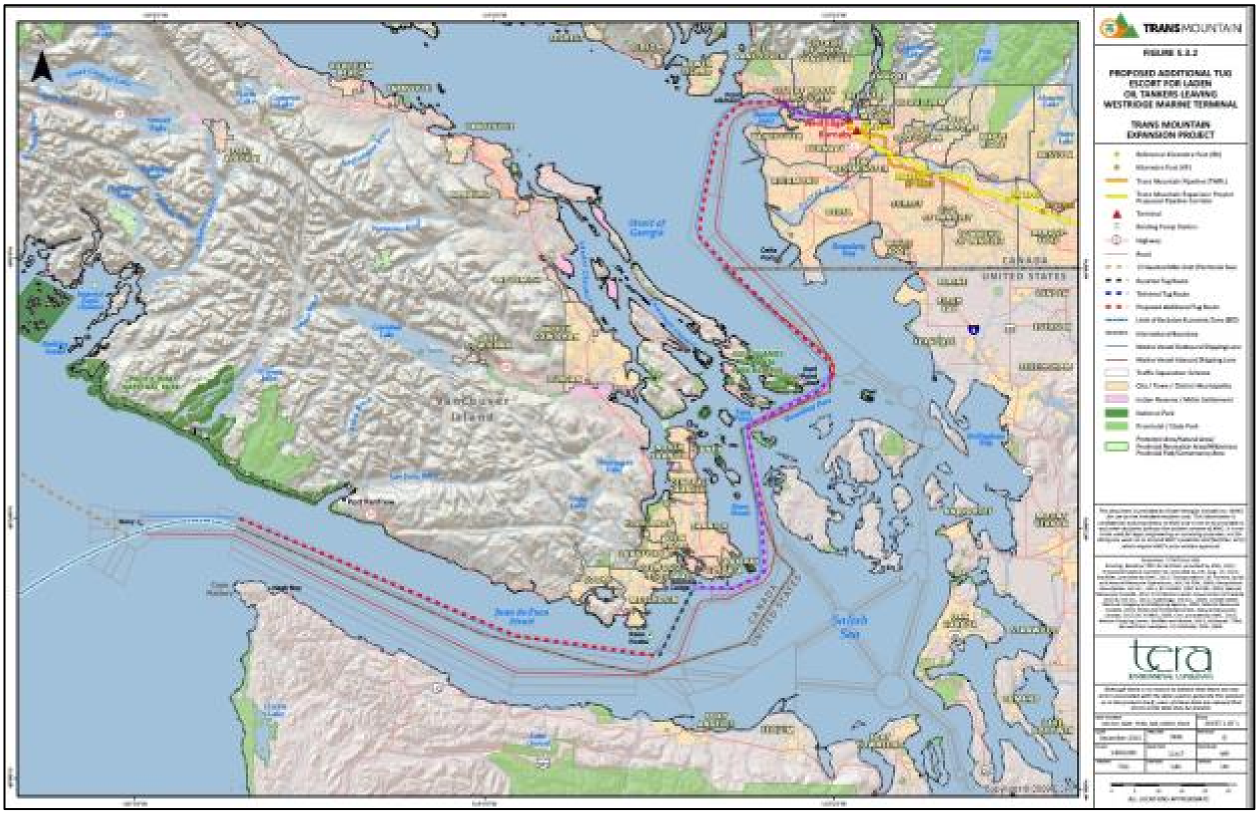
Risk Reduction Measure Findings

To offset the effect of increased Trans Mountain project-related tanker traffic, a number of enhancements were recommended to raise the level of care and safety in the study area well above globally accepted shipping standards, including:

- Extending dedicated escort tugs for laden Trans Mountain project-related tankers throughout Strait of Georgia and Strait of Juan de Fuca (Figure 167).
- Implementing a Moving Safety Zone (MSZ)[670] around laden tankers.
- Improvements to the oil spill response regime for the area.[671]

[670] An MSZ is defined by Transport Canada as "a defined area, which for safety and environmental purposes access is limited to persons, ships or objects authorized by the Coast Guard. Such a zone may be stationary and described by fixed limits, or it may be described as an area around a ship or object in transit."
[671] Spill response is outside of the scope of the Salish Sea Workshop.

Figure 167: Proposed Additional Escort Tug for Trans Mountain Expansion Project



Probabilities of Oil Spills Related to Trans Mountain Tanker Traffic

The study calculated the probability of a worst-case oil spill related to Trans Mountain tanker transport as shown in Table 106. The table also shows the estimated reduction in spills with the addition of navigational safety controls.

Table 106: Probabilities of Oil Spills Related to Trans Mountain Tanker Traffic

Spill Scenario	Statistic For All Accident Categories	2018 Without Project	2018 + Project With No Additional Navigational Safety Controls	Project + Additional Tug Escort of Project Tankers	Project + Tug Escorts and Moving Safety Zone
Credible Worst-Case 104,000 bbl	Combined Return Period in Years	1 in 3,093 years	1 in 456 years	1 in 1,326 years	1 in 2,366 years
	Annual Probability	0.000323	0.002193	0.000754	0.000423
Mean Case 52,000 bbl	Combined Return Period in Years	1 in 619 years	1 in 91 years	n/a	1 in 473 years
	Annual Probability	0.001616	0.010989	n/a	0.002114
Any Oil Spill	Combined Return Period in Years	1 in 309 years	1 in 46 years	n/a	1 in 237 years
	Annual Probability	0.003236	0.021739	n/a	0.004219

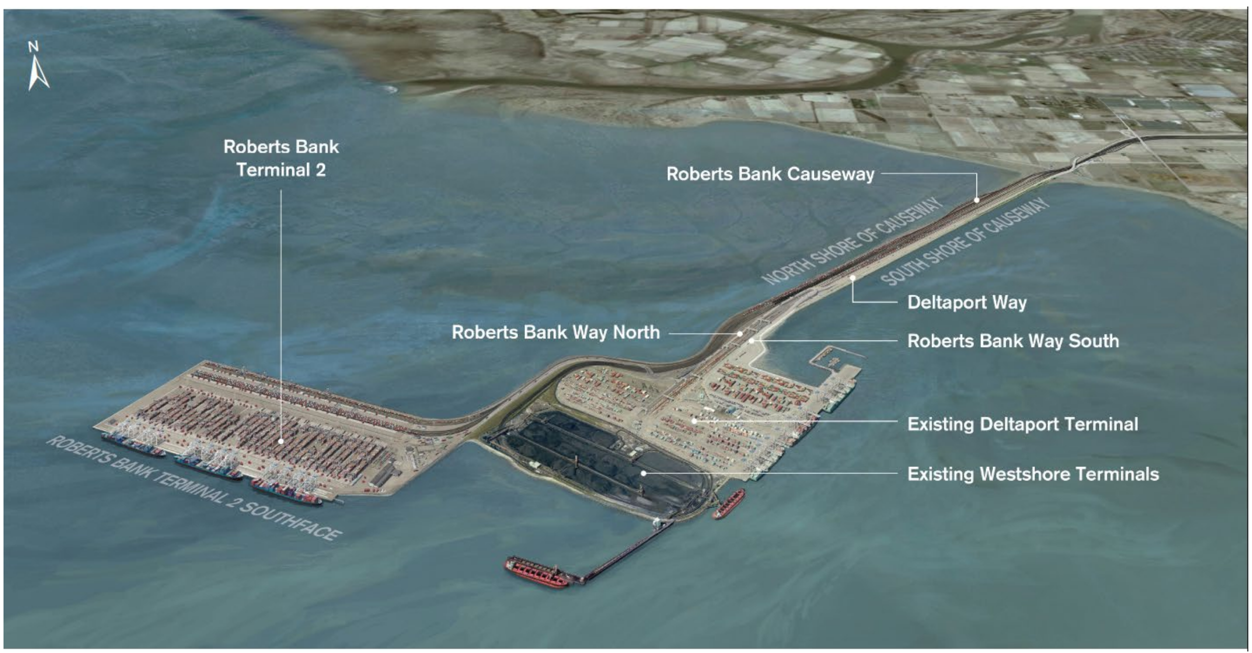
Port of Metro Vancouver Roberts Bank Terminal 2 Project (RBT2)

The vessel traffic study for the proposed RBT2 project has been completed, but will not publicly available at the time of the Salish Sea Workshop. According to Port of Metro Vancouver, it should be available Winter/Spring 2015. The following is a brief description of what is known about the potential vessel traffic associated with RBT2 and other terminals in the Port of Metro Vancouver area based on public information.

Development of the Port of Metro Vancouver terminals including the Roberts Banks Terminals[672] and Neptune Terminal Coal Expansion projects in the Port of Metro Vancouver will represent 33% of the cargo shipping increase between 2011 and 2016.

Deltaport is one of two existing independently operated terminals at Roberts Bank Terminals, Delta, BC. RBT2 is a proposed new three-berth container terminal (Figure 168). If built, the project would provide 2.4 million TEUs (twenty-foot equivalent lengths) of container capacity per year to meet forecast demand (demand forecasted until 2030). Based on the current project schedule, and subject to regulatory approvals (including an environmental impact statement), the proposed RBT2 project could begin operation in the mid-2020s.

Figure 168: Roberts Bank Terminal 2



672 Deltaport is one of two existing terminals at Roberts Bank Terminals, each independently operated. Roberts Bank Terminal 2 (RBT2) is being proposed as a third terminal at the site. RBT2 is a proposed new three-berth container terminal at Roberts Bank, Delta, BC. If built, the project would provide 2.4 million TEUs (twenty-foot equivalent lengths) of container capacity per year to meet forecast demand until 2030. Based on the current project schedule, and subject to regulatory approvals (including an environmental impact statement), the proposed RBT2 project could begin operation in the mid-2020s. (http://www.robertsbankterminal2. com/about-the-project/roberts-bank-terminal-2-project/)

Traffic Patterns

Traffic to and from Canadian ports travel through Boundary Pass, Haro Strait, and the Strait of Juan de Fuca. Current and projected vessel traffic for Port of Metro Vancouver projects are summarized in Tables 107 through Table 109. In addition to the traffic in the tables, there are about 100 additional chemical carriers projected by 2030.

Table 107: Annual Vessel Projections for Deltaport & Westshore (Existing Roberts Bank Terminals)[673]

Year	Data Type	Cargo Volume (Million)		Annual Ship Calls			Annual Ship Movements		
		Container TEU	Coal Tonnes	Container	Coal[674]	Total	Container	Coal	Total
2010	Actual	1.54	24.7	245	246	491	594	492	1,086
2014	Predicted	1.74	25.0	260	250	510	624	500	1,124
2015	Predicted	2.02	26.0	260	260	520	624	520	1,144
2016	Predicted	2.28	27.0	312	270	582	728	540	1,268
2017	Predicted	2.55	28.0	364	280	644	832	560	1,392
2018	Predicted	2.85	29.0	364	290	654	832	580	1,412
2019	Predicted	3.00	30.0	364	300	664	832	600	1,432
2020	Predicted	2.40	31.0	312	310	622	728	620	1,348
2021	Predicted	2.40	32.0	312	320	632	728	640	1,368
2022	Predicted	2.40	33.0	312	330	642	728	660	1,388
2023	Predicted	2.40	34.0	312	340	652	728	680	1,408
2024	Predicted	2.40	35.0	312	350	662	728	700	1,428
2025	Predicted	2.40	35.0	260	350	610	624	700	1,324
2026	Predicted	2.40	35.0	260	350	610	624	700	1,324
2027	Predicted	2.40	35.0	260	350	610	624	700	1,324
2028	Predicted	2.40	35.0	260	350	610	624	700	1,324
2029	Predicted	2.40	35.0	260	350	610	624	700	1,324
2030	Predicted	2.40	35.0	260	350	610	624	700	1,324

[673] Source: Projections of Vessel Calls and Movements at Deltaport and Westshore Terminals, Deltaport Terminal Road and Rail Improvement Project (DTRRIP), WorleyParsons Canada http://www.robertsbankterminal2.com/wp-content/uploads/Projections-of-Vessel-Calls-and-Movements-at-Deltaport-and-Westshore-Terminals.pdf

[674] Note: Based on research, Etkin et al. 2014 projects the number of coal ships to be about 310 instead of 350 annual ship calls; the estimate in the table is too high as it does not account for actual ship size growth experienced at Westshore Terminals.

Table 108: Projected Vessel Traffic for Other Port of Metro Vancouver Projects[675]

Project	Cargo Volume	Ship Type	Annual Calls
Fraser Surrey Docks Direct Coal Transfer Ships from Texada Island	8.0 Mtonnes	bulker	80
Richardson Grain Elevator (Terminal Expansion and Ship Capacity Increases)	5.0 Mtonnes	bulker	12
Neptune Terminals Coal Expansion	6.0 Mtonnes	bulker	60

Table 109: Potential Roberts Bank Terminal 2 Vessel Traffic

Year	Data Type	Annual Vessel Projections for RBT2	
		Million TEU	Annual Ship Calls
2025 (estimated)	Predicted	2.40	260

In 2010, 120 bulkers over 100,000 tons DWT berthed at the Canadian Westshore Terminals at the Roberts Bank terminal complex. Of these, over 100 were greater than 150,000 DWT tons and 15 over 200,000 DWT tons. Thus the CVTS and MCTS, pilots and ship masters of ships traveling in Haro Strait and Boundary Pass do, in fact, have experience with Capesize bulk carriers. This suggests a risk mitigation measure to consider these "high-risk" vessels and require the potential Gateway Pacific Terminal Capesize traffic to be escorted. At least initially, this mitigation measure may not be cost-effective.[676]

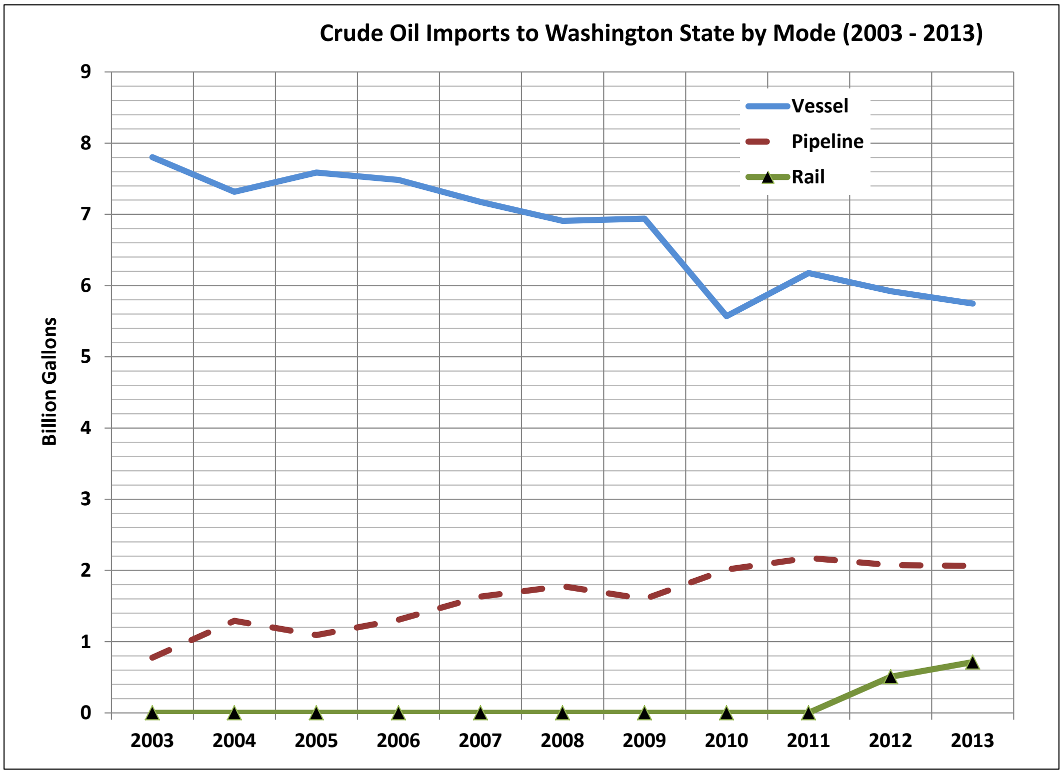
2014 Marine and Rail Oil Transportation Study

The draft 2014 Marine and Rail Oil Transportation Study involves a qualitative analysis of the entire system of crude oil transport in the State of Washington particularly with respect to the changes brought about by the transport of crude oil by rail and its associated marine vessel traffic and facilities. This brief synopsis focuses on the effects on vessel traffic in the Salish Sea.

The capacity of Washington's refineries has not substantially changed over the last decade. Annual crude oil imports remained steady in volume at about 8.5 billion gallons. The mode of transportation has shifted away from tank vessel to increases in pipeline and rail tank car. Washington State crude oil imports over the last decade by mode are shown in Figure 169.

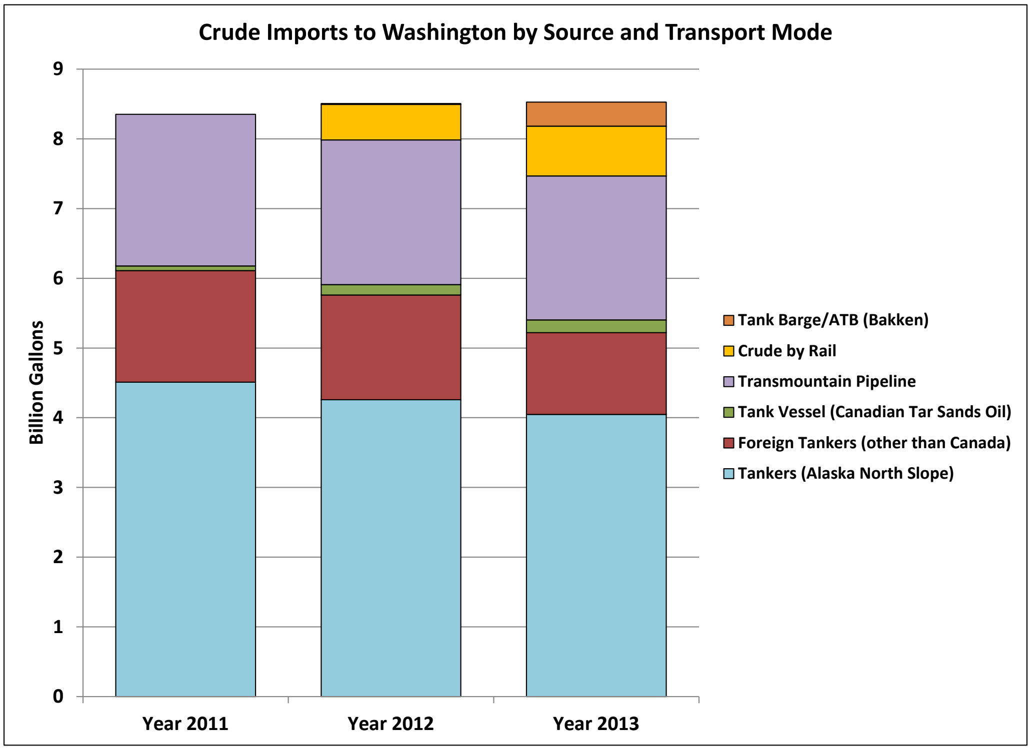
[675] These data are estimated from project descriptions on the Port of Metro Vancouver website as of October 1, 2013. They are all advanced in the approval process or underway.
[676] Note not all the experience is good, a Capesize bulker allided with the coal terminal in late 2012, however an escort would not have prevented it.

Figure 169: Changes in Crude Oil Import Transport Mode in Washington 2003–2013



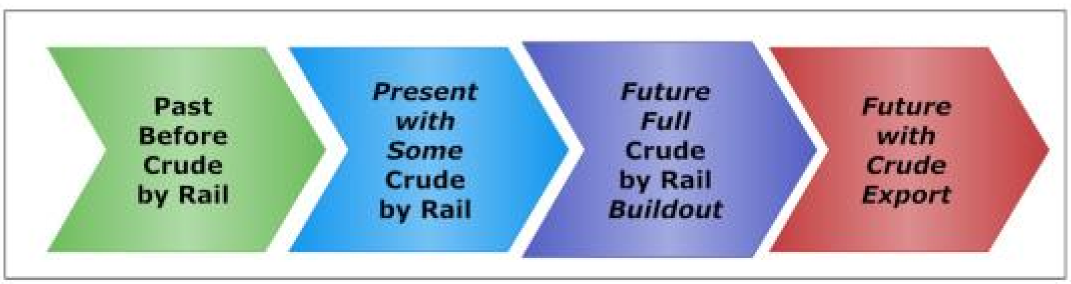
These data do not include the transport of refined petroleum products. A more detailed breakdown of types of crude oil being imported into the state for the last three years is in Figure 170.

Figure 170: Crude Imports to Washington by Source and Transport Mode for 2011–2013



Four situations were considered in a comparative analysis of risks and impacts to public health and safety, tribal treaty rights, environmental resources, and the economic resources of Washington State (Figure 171).

Figure 171: Four Crude-by-Rail Situations for Comparative Risk Analysis in Washington



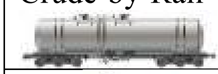
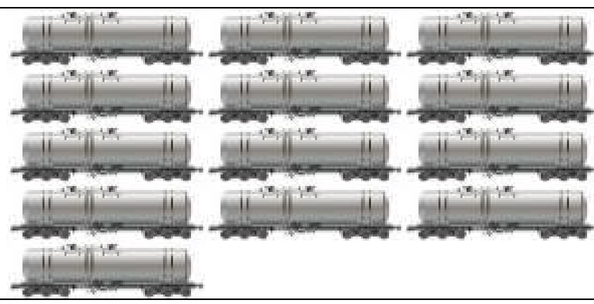
The overall analysis is based on the conceptual model of oil movement into and out of Washington State, as shown in Figure 172. This conceptual model includes current and potential future transport should the full build-out and expansion of proposed facilities in Puget Sound, Grays Harbor, and the Lower Columbia River occur.

In the model, diluted bitumen from Canada continues to move by pipeline and rail from Canada (to refineries in northern Puget Sound), but volumes are increasing due to changes on the Canadian side. Bitumen is also moved by rail, though research continues to fully understand the volumes, the properties of the oil and the rail routes. Today, Bakken oil transported by rail comes through Spokane to facilities on the Columbia River and Puget Sound. The bulk of crude-by-rail traffic is currently going through the Columbia River Gorge, but in the future could transit over other rail routes. Facilities on the west side receive the oil by rail, store it, and then export the oil by tanker and tank barge to Puget Sound and California.

Today a federal ban on crude oil export in the United States prevents some of these oils from being transported out of the country. However, bitumen and refined oils from Canada may be exported from Columbia River, Grays Harbor, or Puget Sound facilities to international markets since it would be non-U.S. crude oil.[677] The possibility of exporting to international markets pre-treated Bakken crude oil, which has been partially refined to remove the most volatile components at the well sites, has also been raised.

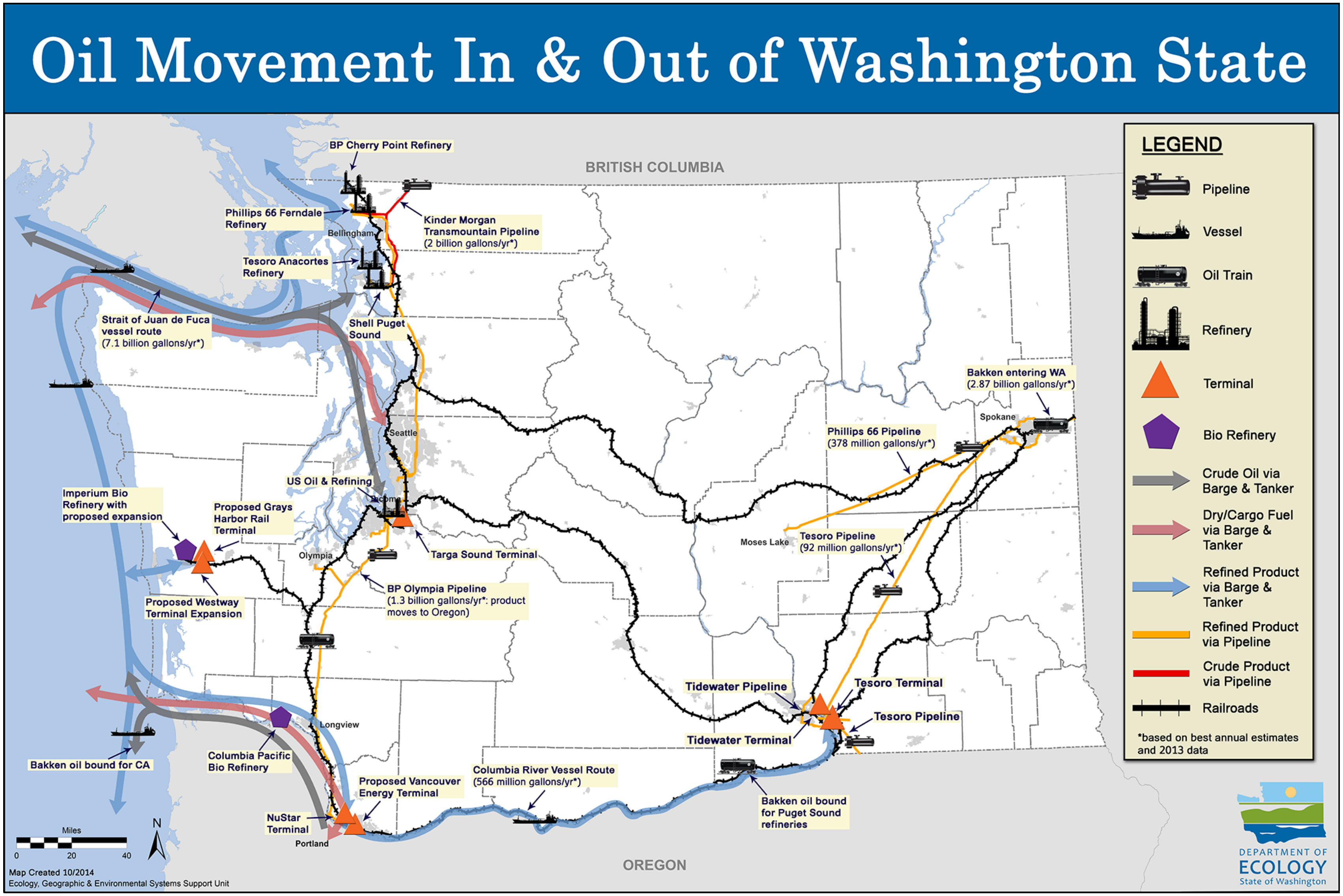
Each crude-by-rail unit train of 100 cars[678] holds about 3 million gallons.[679] This translates to two to three trainloads per ATB or about 12 to 13 trainloads per Aframax tanker (Table 110).[680]

Table 110: Crude-by-Rail Transit Mode Volume Equivalencies

Transport Mode	Capacity	Crude-by-Rail Unit Train Equivalents (100-Car Trains)
Crude-by-Rail Unit Train 	3 million gallons	
 ATB	9 million gallons	
Aframax Tanker 	33 million gallons	

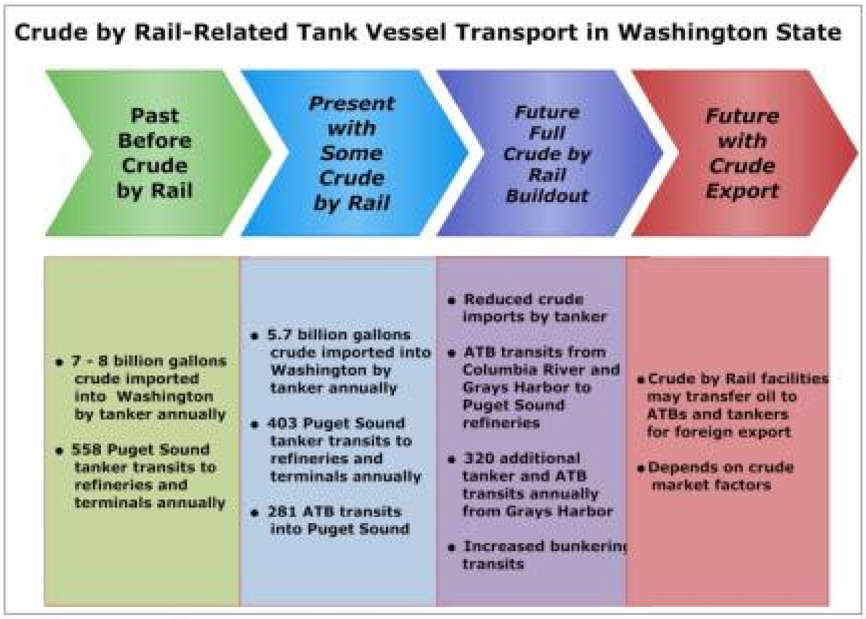
[677] The primary laws prohibiting crude exports are the Mineral Leasing Act of 1920, the Energy Policy and Conservation Act of 1975, and the Export Administration Act of 1979.
[678] Note that unit trains can include more than 100 cars, but this is the typical arrangement.
[679] Each of the 100 tank cars in a CBR unit train holds about 30,000 gallons, regardless of the tank type.
[680] A tanker smaller than 120,000 deadweight tonnage.

Figure 172: Conceptual Model of Potential Future Oil Movement into and out of Washington



If the volume transported increases to 59 trains weekly, as estimated for 2020, there may be 28 ATBs or five tankers per week. With 113 trains weekly, as estimated for 2035, this would double again. Based on data available at this time, the changes in Washington State's tank vessel transport system are summarized in Figure 173.

Figure 173: Crude-by-Rail-Related Tank Vessel Transport in Washington



The potential impacts of crude-by-rail on the Salish Sea include:

- A reduction in the amount of oil *imported into Washington State* by tanker;
- The potential addition of ATB and tanker transits into Puget Sound from Grays Harbor and Columbia River facilities to deliver crude oil and/or for bunkering; and
- The potential for even more bunkering transits if there is crude export.

Reference Maps

Figures 174 and 175 provide approximate locations of the facilities that may be discussed at the workshop. Figures 176 and 177 show the traffic separation scheme and traffic network, respectively.

Operating facilities

Operating facilities with crude –by-rail expansion plans

Proposed or planned facilities

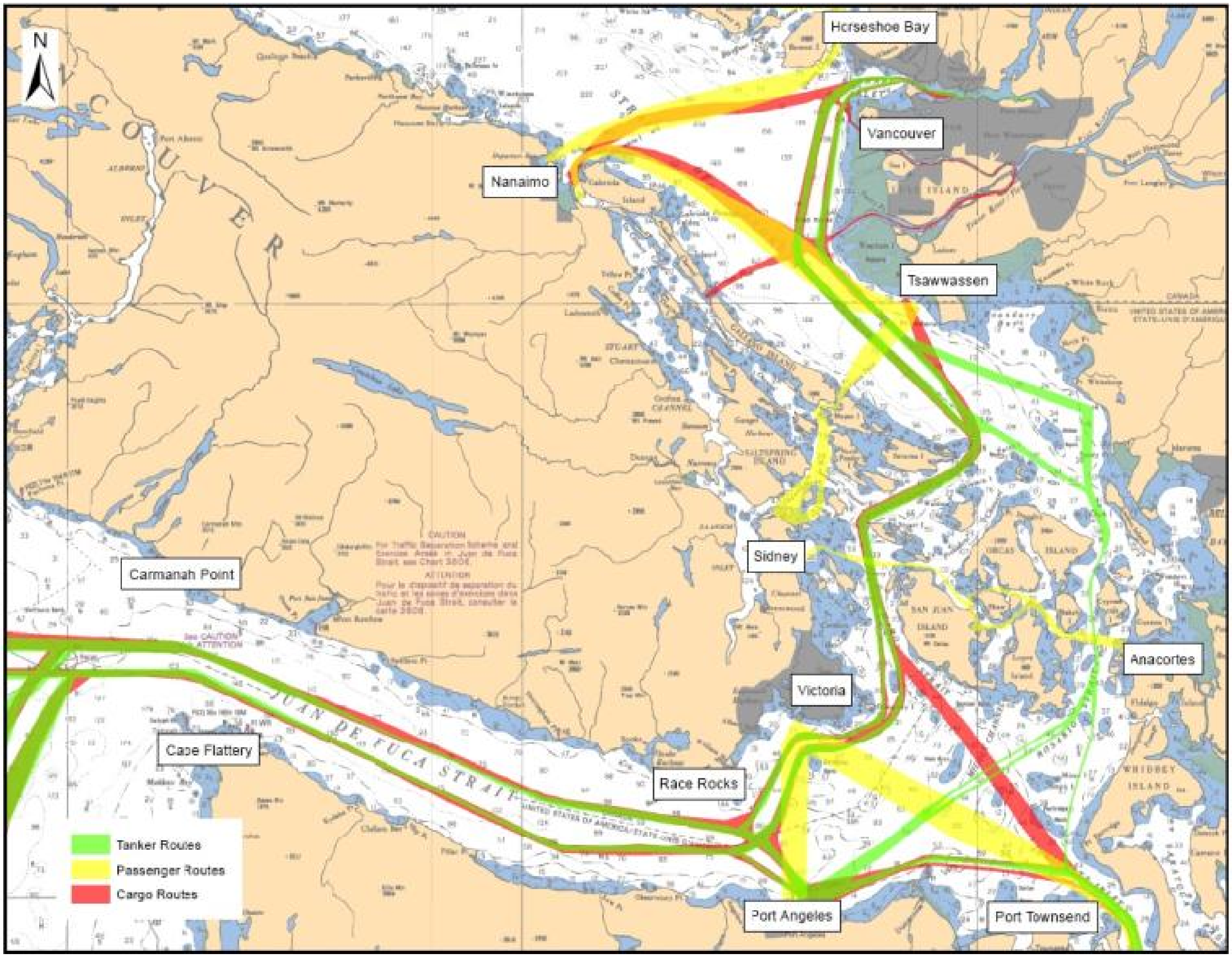
Figure 174: Northern Facilities

Figure 175: Southern Facilities (Puget Sound, Grays Harbor, Columbia River)[681]

[681] Facilities in Grays Harbor and the Columbia River are not themselves situated in the Salish Sea, but vessel traffic from these facilities may impact the Salish Sea.

Figure 176: Vessel Traffic Separation Lanes

Figure 177: Salish Sea Vessel Traffic Network



U.S. /Canadian Vessel Safety System Comparison

The US and Canadian vessel safety systems are compared in Table 111.

Table 111: U.S. /Washington and Canadian Vessel Safety System Comparison[682]

U.S. /Washington State	Canada	Gap
Tug escorts for all loaded tankers inbound and outbound	Tug escorts only for loaded crude oil tankers (outbound)[683]	In Canada, product tankers do not require a tug escort
Tug escorts required by State and federal law, enforced by USCG and state; Rules leave it up to master/pilot to decide when to tether the tug and ship; All escorts must be in position for timely, effective response. When deemed appropriate by master/pilot to tether, geographic areas include but not limited to: Rosario Strait, Guemes Channel, Turn Point of Haro Strait/Boundary Pass, between Saddlebag and Huckleberry I.	Tug escorts through negotiated voluntary standards, enforced by BC pilots	Essentially none. Rules imposed by Canada's Pacific Pilotage Authority,[684] but no specific Canadian law; Canadian government agency
One pilot required on all ships transiting east of Port Angeles	Two pilots required east of Victoria for loaded tankers	None
USCG/STCW[685] Safe Manning: Two licensed officers and two AB seamen	STCW Safe Manning: Two licensed officers and two AB seamen	None
Tanker speed 11 knots in congested waters, cannot exceed tugs	Tanker speed 10 knots	None
Tanker size limited to 125,000 DWT east of Port Angeles; larger tankers accepted if not loaded beyond 125,000 MT	No tanker size limitation	Larger capacity tankers may transit Canadian waters, though there is no current or planned terminal capacity to accommodate larger tankers
Oil handling operations require booming prior to transfer ("pre-booming")	Pre-booming not required	Oil transfers in Canada not mandated to be boomed, though it is terminal requirement
Vessel Traffic Service & Special Operating Areas	Vessel Traffic Service & Special Operating Areas	None. Jointly operated by U.S. and Canadian Coast Guards
Standby response tug required	No response tug required	Canada has no response tug requirement
Tankers double-hulled	Tankers double-hulled	None.

682 Adapted from: *Changing Risk Picture in the Pacific Northwest* presentation by Dept. of Ecology at BC Ministry of Environment Symposium March 2013.
683 See Figure 98. Note that a tethered-tug is required between 2 nm north of East Point and Broche.
684 Pacific Pilotage Authority is a Canadian federal government agency.
685 Standards of Training, Certification, and Watchkeeping. The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (or STCW), 1978 sets qualification standards for masters, officers and watch personnel on seagoing merchant ships. STCW was adopted in 1978 by conference at the International Maritime Organization (IMO) in London, and entered into force in 1984. The Convention was significantly amended in 1995.

Handbook References

Cardno Entrix. 2014. *BP Cherry Point Dock Draft Environmental Impact Statement.* Prepared for US Army Corps of Engineers, Seattle District. May 2014. 444 p.

Det Norske Veritas (DNV). 2013. *Trans Mountain Pipeline Expansion Project: TERMPOL 3. 5: General Risk Analysis and Intended Methods of Reducing Risks.* DNV Doc. No. /Report No. : 167ITKV-9/PP061115. 25 November 2013. 454 p.

Etkin, D. S., J. Joeckel, A.H. Walker, D. Scholz, C. Moore, C. Baker, D. Hatzenbuhler, R.G. Patton, E. Lyman, and D. Culpepper. 2014. *Washington State Marine & Rail Oil Transportation Study: Findings and Recommendations.* Draft. Prepared by Environmental Research Consulting, SEA Consulting Group, Herbert Engineering Group, MainLine Management, Inc., and The Culpepper Group. 1 December 2014. 496 p.

Kinder Morgan (Canada). 2013. *Trans Mountain Pipeline Expansion Project: An Application Pursuant to Section 52 of the National Energy Board Act. Volume 8A: Marine Transportation.* December 2013. 882 p.

Kinder Morgan (Canada). 2013. *Trans Mountain Pipeline Expansion Project: An Application Pursuant to Section 52 of the National Energy Board Act. Volume 8C: TERMPOL Reports.* December 2013. 173 p.

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Ocean Shipping Consultants. 2014. *Container Traffic Forecast Study – Port Metro Vancouver, June 2014.* Prepared for Port Metro Vancouver by Ocean Shipping Consultants, HaskoningDHV UK Ltd., Surrey, England.

The Glosten Associates, Inc., Environmental Research Consulting, and Northern Economics, Inc. 2013. *BP Cherry Point Vessel Traffic Analysis. Draft Study Report.* Prepared for Cardno Entrix, Seattle, WA. (File No. 12121. 01) 15 May 2013. 640 p.

The Glosten Associates, Inc., Environmental Research Consulting, and Northern Economics, Inc. 2014. *Gateway Pacific Terminal Vessel Traffic and Risk Assessment Study.* Prepared for Washington State Department of Ecology, Pacific International Terminals, Inc., and Lummi Natural Resources Department. 4 November 2014. 640 p.

van Dorp, J.R., and J. Merrick. 2014. *2014 VTRA 2010 Final Report: Preventing Oil Spills from Large Ships and Barges in Northern Puget Sound & Strait of Juan de Fuca.* Prepared for Washington State Puget Sound Partnership. 163 p.

van Dorp, J.R., J.R.W. Merrick, J.R. Harald, and M. Grabowski. 2008. *Assessment of Oil Spill Risk due to Potential Increased Traffic at Cherry Point, Washington, Final Report.* Submitted to BP on 31 August 2013.

Worley Parsons Canada. 2011. *Projections of Vessel Calls and Movements at Deltaport and Westshore Terminals: Deltaport Terminal Road and Rail Improvement Project (DTRRIP).* Report No. 09409-04-GE-90003-500- Rev B. Prepared for Port of Metro Vancouver. 28 November 2011.

On-Line Report Resources for Vessel Traffic Study Reports

BP Cherry Point Dock
http://www. seas. gwu. edu/~dorpjr/tab4/publications_VTRA_Final_Report. html

http://www. nws. usace. army. mil/Portals/27/docs/regulatory/NewsUpdates/BPDock2014/Appendix_D_Vessel_Traffic_Analysis. pdf

http://www. nws. usace. army. mil/Portals/27/docs/regulatory/NewsUpdates/BPDock2014/BP%20Cherry%20Point%20Dock%20DEIS%20May%202014. pdf

Gateway Pacific Terminal (GPT)
http://www.eisgatewaypacificwa.gov/sites/default/files/content/files/20141104_Vessel_Traffic_and_Risk_Assessment_Study-Glosten_small_0.pdf

http://www. eisgatewaypacificwa. gov/resources/project-library/

Roberts Bank Terminal 2/Deltaport/Westshore
http://www. robertsbankterminal2. com/wp-content/uploads/Projections-of-Vessel-Calls-and-Movements-at-Deltaport-and-Westshore-Terminals. pdf

http://www. robertsbankterminal2. com/wp-content/uploads/Port-Metro-Vancouver-Container-Traffic-Forecast-Ocean-Shipping-Consultants-June-2014. pdf

Trans Mountain (Kinder Morgan)
http://Trans Mountain . s3. amazonaws. com/application/V8C_TR_8C_12_To_S08_TERMPOL_RPTS. pdf

http://Trans Mountain . s3. amazonaws. com/application14/V8A_MAR_TRANS_ASSESS/003. html?zoom=0. 5866310160427808&sidebar=thumbnails

http://Trans Mountain . s3. amazonaws. com/application/V8C_0_to_TR_8C_02_TERMPOL_RPTS. pdf

VTRA 2010
http://www. seas. gwu. edu/~dorpjr/tab4/publications_VTRA_Update_Reports. html

Washington State Marine & Rail Oil Transportation Study (Ecology)
https://apps.ecology.wa.gov/publications/SummaryPages/1408015. html

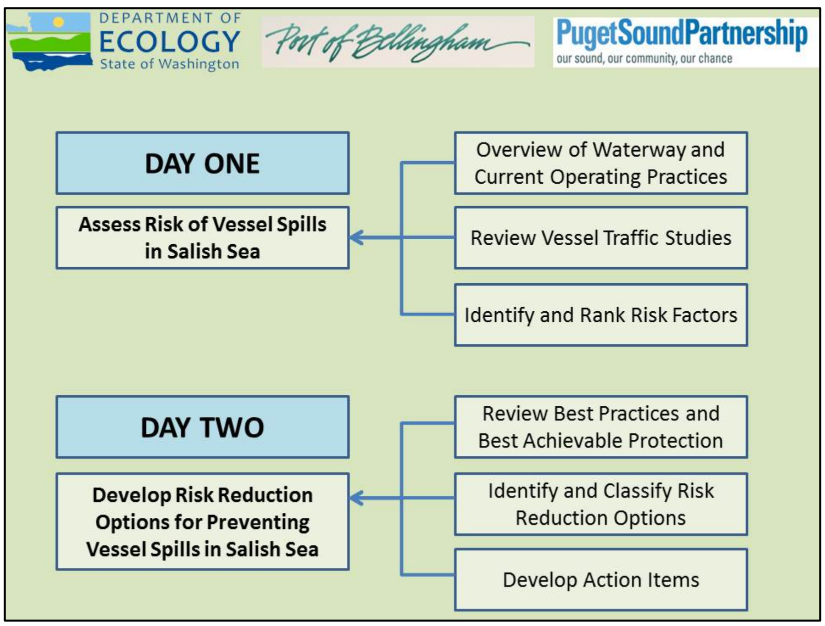
Appendix M: Salish Sea Workshop: Vessel Oil Spill Risk Assessment and Management Summary

The *Salish Sea Workshop: Vessel Oil Spill Risk Assessment and Management* was held on January 7–8, 2015. The workshop was co-sponsored by the Washington Department of Ecology and the Puget Sound Partnership. The Port of Bellingham hosted the event at the Whatcom County Emergency Operations Center in Bellingham, Washington.

Workshop Approach

The goal of the workshop was to connect assumptions, findings, and recommendations from Salish Sea studies to develop a consolidated list of actionable recommendations to move forward with actions to enhance public safety and environmental protection. The overall plan for the workshop is shown in Figure 178.

Figure 178: General Plan for Salish Sea Workshop



In order to facilitate the discussion and allow sufficient time to focus on specific areas of concern, a list of workshop topics for consideration and a list of topics that the workshop would not cover were presented. The topics outside that would not be covered were recognized as important, but outside of the scope of the workshop. Workshop topics included, but were not limited to:

- Vessel traffic in, or going out/in, the Salish Sea.
- Assessing risk factors for vessel accidents that may lead to spills.
- Risk reduction measures to prevent or reduce incidence of spills.
- Waterway geographic hot spots.

- Vessel practices that may increase risk.
- Bunkering practices.
- Future vessel traffic changes.
- Potential impacts of changes in rail transport as related to vessel traffic.
- Best practices for marine traffic.
- Vessel best operating practices.
- Trans-boundary solutions.

Topics outside the scope of the workshop were identified as:

- Acceptability of vessel traffic risk.
- Acceptability of vessel spill risk.
- Vessel traffic in Grays Harbor.
- Vessel traffic in Columbia River.
- Permitting/Environmental Impact Statement/Environmental Assessment of facilities.
- Response capability/preparedness.
- Environmental impacts of spills.
- Socioeconomic impacts of spills.
- Acceptability of crude or coal trains.
- Crude or coal train impacts.
- Pipeline spills.
- Pipeline project permitting.
- Facility spills/at-dock spills.

The Salish Sea Workshop included a series of presentations to complement the Handbook (Appendix L in this report) and to review the basic findings of the various vessel traffic-related studies conducted in the last several years. These presentations may be viewed at www.ecy.wa.gov/programs/spills/prevention/prevention_section.htm

On the first day, in addition to reviewing the vessel traffic studies and the general overview of the Salish Sea waterways and current operating practices, the attendees participated in a group discussion to assess the overall risk of vessel accidents and to identify specific issues of concern. Breakout groups focused on specific issues of concern regarding risk and later reported back to the larger group for a general discussion.

On the second day, the focus was on risk mitigation measures. Presentations by industry on best operating practices, along with presentations on two voluntary best practices programs, were followed by a discussion of risk mitigation measures. Again, breakout groups focused on specific measures and later reported back to the larger group. Action items were identified for follow-up. Selected panel members helped to facilitate the group discussions on both days.

Agenda

Wednesday, 7 January 2015

Opening

Risk Assessment Session
Overview of Waterway and Current Operating Practices [Presentation with Q&A]

Review of Salish Sea Studies
- VTRA 2010 [Presentation with Q&A]
- BP Cherry Point & Gateway Pacific Terminal [Presentation with Q&A]
- Trans Mountain [Presentation with Q&A]
- Roberts Bank Terminal 2 [Presentation with Q&A]
- Marine & Rail Oil Transport Study [Presentation with Q&A]

Summary of Risks
- Assessment of Vessel Accident Risks [Panel/Group Discussion]
- Specific Issues of Relatively Higher Risk [Breakout/Group Discussion]
- Consensus on Risk Factors and Ranking [Group Discussion]

Thursday, 8 January 2015

Review of Day's Goals and Process

Best Practices Session
- Best Operating Practices [Industry Panel/Presentations with Q&A]
- Best Achievable Protection [Panel Presentation with Q&A]

Risk Reduction Session
- Risk Reduction Options: Evaluation/Ranking [Breakout/Group Discussion]
- Classification of Risk Reduction Options for Action [Group Discussion]
- Next Steps/Assignment of Tasks for Actionable Items [Panel/Group Discussion]

Participants

The goal of selecting participants to the Salish Sea Workshop was to get a broad representation of technical experts on vessel oil spill risk assessment and management on a multi-national basis (US, Canada, and multiple Tribal and First Nations). Invitations were sent to representatives from Tribal and First Nation governments, US and Canadian government officials, Washington State and BC officials, industry, and non-governmental organizations involved in environmental advocacy. Invited participants are shown in Table 112.

Table 112: Participants Invited to Salish Sea Workshop

Entity Type	US	Canada
Tribal/First Nations Governments	Lummi Makah Nooksack Point No Point Treaty Council Port Gamble S'Klallam Stillaguamish Tulalip Swinomish Lower Elwa Klallam Jamestown S'Klallam Northwest Indian Fisheries Comm.	Beecher Bay Pacheedaht Tsleil-Waututh Malahat Tsawout Cowichan Ditidaht Esquimalt
Government Agencies	US Coast Guard National Oceanic and Atmostpheric Administration NOAA Marine Sanctuaries Whatcom County Sheriff San Juan County Council Washington State Ferries Alaska Ferries Washington Department of Ecology Puget Sound Partnership Utilities & Transportation Comm]. US Army Corps of Engineers	Canadian Consulate Canadian Coast Guard Islands Trust Transport Canada BC Ministry of Environment
Non-Governmental Organizations	Pacific States/BC Task Force Friends of the Earth Friends of the San Juans Washington Environmental Council	
Industry	Alaska Tanker Company BNSF BP Cherry Point Crowley Petroleum Foss Maritime	BC Pilots BC Chamber of Shipping Council of Marine Carriers Island Tug & Barge Seaspan

Entity Type	US	Canada
	Green Marine Harley Marine Services Pacific Merchant Shipping Assoc. Polar Tankers Port of Bellingham Puget Sound Marine Exchange Puget Sound Harbor Safety Comm. Puget Sound Pilots SSA Marine/Gateway Pacific Term. Washington State Petroleum Assoc. American Waterways Operators Washington Public Ports Assoc. SeaRiver Maritime Chevron	Smit Marine Trans Mountain Suncor Port of Metro Vancouver
Consultants/ Facilitators	Environmental Research Consulting Herbert Engineering Corp. MainLine Management Inc. George Washington University	

Synopsis of Workshop Proceedings

Synopsis – Day 1

The following is a summation of the proceedings for the first day of the Salish Sea Workshop. It is not a word-for-word transcript.

Welcoming Remarks by Scott Ferguson, Washington Department of Ecology
Mr. Ferguson noted that a similar event was held approximately 15 years ago. He mentioned that there were recent previous studies on the subject and the goal over the next two days of the Workshop would be to try and bring together the fine work that was done in those studies.

Introductory Remarks by Capt. Joe Raymond of the U.S. Coast Guard
Capt. Raymond also welcomed everyone and said that he thinks that what was being done in the Salish Sea is as good as anywhere in the world. USCG Command staff compared Puget Sound with other large U.S. ports and was very pleased with the results. He urged the group not to get "caught up in the numbers" but to focus on the process. He stated that he thought that the number of ships in the Salish Sea should not be the primary concern, but rather that the size and complexity of the ships should be the issue. He noted that the number of ship calls are down 800 ships annually from a number of years ago. He also said that he thought the greatest threat today from oil spills is from fishing and recreation vessels as it relates to the number and volume of spills. He also noted that violation of "Rule 10" is also a problem, i.e., smaller vessels getting into the large vessel shipping lanes.

Miriam Van Roosmalen, Canadian Coast Guard
Ms. Van Roosmalen emphasized the shared waterways and interests between Canada and the U.S. She stated that prevention and response were key issues and cited the presence of Port Metro Vancouver, the BC Ministry of Transportation, and Transport Canada as indicative of Canadian interest in the issues in the Salish Sea.

Lisa Copeland, Washington Department of Ecology
Ms Copeland told the group that she would be facilitating the schedule and discussions and that identification of "Risk Factors" would be the key focus of the day's efforts.

Capt. Mike Moore, Pacific Merchant Shipping Association: Presentation
Capt. Moore provided an overview of the current system in Puget Sound. He stated that risk management, risk assessment and risk mitigation were key issues. He said that a risk-based approach is necessary:

- Evaluate ship traffic and the waterways.
- Implement risk mitigation measures.
- Incorporate international and federal standards, noting that each state cannot have its own set of standards.
- Regulatory and non-regulatory requirements have to be considered.
- Continuous improvement should continue to be implemented.

Capt. Moore also noted that there is a diverse vessel traffic mix in Puget Sound/Salish Sea. He noted that deep draft vessel volumes have gone from 3,247 in 1992 to 2,621 in 2014. He noted that container ships have gotten bigger while other ships have remained about the same size over the period and that the number of Articulated Tug Bargess (ATB) movements have grown. He further noted that cargo vessel ship numbers are down by 830, and tanker ship arrivals are down 216 in number from the peak in year 2000, but that cruise ship numbers are up.

Capt. Moore presented a slide on the ways in which vessel risk is managed:

- Leverage deep, wide waterways for safety.
- Added vessel traffic lanes.
- Improves VTS with technology and training.
- Movement planning using Radar/AIS.

He discussed the Cooperative Vessel Traffic Service (CVTS) between Canada and U.S. and noted that it is seamless. Capt. Moore described when VTS intervenes, i.e., when a vessel leaves its waterway lane. He presented a slide on Compliance Targeting Matrix, which described the process of vessel entry into Puget Sound:

- 96-hour advance notice of arrival.
- Risk-based screening of vessels prior to entry into Puget Sound to deny entry, require operational measures, or to target for inspection under Port State Control.
- Pre-arrival safety tests.
- Requirement to check into the vessel traffic systems.

Capt. Moore noted that the vessel entrance point has been moved further out from Neah Bay. He stated that U.S. and Canadian Pilots are comparable and that laden tanker escort tugs are also comparable.

Capt. Moore then described the purpose of the Puget Sound Harbor Safety Committee (PSHSC), which was formed in 2000. He noted that the PSHSC is non-regulatory but develops Standards of Care for maritime operations in Puget Sound and developed the Harbor Safety Plan.

He noted the results of efforts of the PSHSC and other similar entities in the U.S. There has been a decreased volume of oil spills and the number of spills nationally. Seven million gallons were spilled in the 1970s, reduced to 500,000 gallons in 1999. There have been very few deep draft spills due to collisions or groundings. He noted that the worldwide trend in spills and incidents are also down and that Puget Sound has the lowest incidents in U.S. Maritime Districts. In summary, Capt. Moore stated that Puget Sound has a very safe system but that is necessary to continue to adapt to changes as they occur, i.e., volume of vessel traffic, vessel sizes, cargo mixes, etc.

Scott Ferguson, Washington Department of Ecology
Mr. Ferguson described the issues from the State's (Ecology's) perspective, the human factor perspective. He noted that Ecology works closely and mutually with the USCG and the U.S. EPA. He challenged the workshop group to consider ways in which to take all the studies completed over the previous 6 to 7 years and tie them all together for continued improvement in risk management.

Dr. Rene van Dorp, George Washington University: Presentation[686]
Dr. van Dorp, a co-developer of the VTRA 2010 simulation model, gave a presentation on "Vessel Traffic Risk Assessment." Dr. van Dorp's presentation began with a demonstration of the balance between assumptions and uncertainty, using a "coin toss" analogy to demonstrate that balance. That demonstration segued into discussion on the objective of minimizing average

[686] See Appendix N.

potential oil loss, although there can also be an individual incident risk perspective. He further identified an oil spill causal chain of events with a slide:

- The maritime situation.
- Incident data.
- Expert judgment and data.
- Oil outflow model.

Dr. van Dorp helped develop the VTRA 2010 simulation model to support the analysis approach to risk management and risk mitigation by focusing on:

- A focus on "average" risk by changing assumptions of a "Base Case," with system-wide changes in assumptions up or down.
- He noted that 15 different waterway zones in the Salish Sea were analyzed. Analysis was performed on "grid cells" that are approximately ½ a nautical mile by ½ a nautical mile.
- Analysis results are displayed in 2-dimensional or 3-dimensional graphics.
- The Base Case involved 10,000 grid cells with 1.8 vessel to vessel traffic situations (1 to 7,000 per cell).
- Grounding analysis involved 4,000 grid cells with 10,000,000 vessel to vessel situations.
- Vessel Time Exposure (VTE) – 75% of the vessels involved were non-focused vessels, i.e., fishing boats, recreation boats, ferries, etc. 17% of the total vessels were cargo vessels, and 55% of that number were bulk carriers.

Dr. van Dorp noted that previous studies focused on specific vessel movements, while VTRA looks at all vessel movements. He further discussed oil vessel time exposure based on different geographic risk and tankers vs. ATBs and bunker fuel vessels.

He described how using the "Base" situation, Benchmark scenarios were developed for sensitivity analysis. The conclusion reached was that if all projects happen at the same time, risk increases significantly for the percent of oil loss through collision or grounding spills. He noted that in addition to the grid analyses performed, an analysis of the larger waterway zones was performed in the VTRA 2010.

Dr. Dagmar Schmidt Etkin, Environmental Research Consulting: Presentation
Dr. Etkin pointed out that BP Cherry Point is operational while GPT is still a proposed facility. The analyses she participated in focused on vessel incidents vs. spills and on geographic areas (straits, for example) and historical incident data. Baseline vessel traffic was forecast to 2019 using projected traffic growth, although the BP analyses projected out to 2030 (420 ship calls annually in 2030). The recommendations developed were that no additional risk mitigation measures were necessary as existing regulations were deemed sufficient.

The GPT Study projected out to 2019 with and without the GPT facility. Trans Mountain and Shell Oil by Rail also were added to the 2019 analysis. Findings from the study included that available anchorages are sufficient for the vessel volumes, there would necessarily be additional bunkering, and that there would be additional vessel transits through the Salish Sea (total potential of 2,085). A comprehensive list of risk reduction measures was presented and discussed.

Michael Davies, Kinder Morgan, Trans Mountain: Presentation
Mr. Davies provided a project overview – the application to construct the second pipeline is currently in the Canadian regulatory review process. He said his goal in this presentation was to present the Marine part of the project.

The current pipeline has been in operation since 1953 and this project is to "twin" the pipeline, essentially along, but not totally within, the existing pipeline right-of-way. Twining the pipeline would increase throughput from 300,000 bbl/day to 890,000 bbl/day of diluted bitumen. He said that U.S. growth in oil production has reduced U.S. demand so they are trying to expand their market reach in California, the U.S. Gulf of Mexico, and Asia.

Today's facility in Vancouver has one berth and the project proposes expansion to 3 berths. Vessel calls would increase from 5/month today to 34/month in full production. The original plan projected the expanded facility would be open in 2017 but that has slipped somewhat. The current projection is expansion opening in mid-2018.

Tankers calling at the facility are and would be 120,000 DWT maximum (Aframax), each of which can handle 580,000 to 590,000 bbl's of bitumin. He stated that various studies have been performed on the risk associated with the growth in oil transport through the proposed facility and all have yielded similar results. The model Trans Mountain utilized focused on absolute risk of a spill while the VTRA model focuses on a range of risk.

To support its application during the Canadian regulatory review, Trans Mountain requested a TERMPOL review by Transport Canada. A TERMPOL review is a quantitative risk assessment and was published in December 2014. It included vessel traffic growth forecast from 2018 to 2028 and the conclusion reached was that existing maritime regulations are sufficient.

Dr. Colin Moore, Herbert Engineering Corp. Presentation
Dr. Moore indicated that his charge for Port of Metro Vancouver (PMV) during the Environmental Assessment (EA) process was to assess vessel volume changes if the proposed facility is constructed. Colin stated that projections of changes in vessel traffic volumes are notoriously uncertain. He indicated that the number of container ships is expected in 2030 to be the same as today due to ship size increases, and he believes the same will apply to Westshore export coal. Dr. Moore talked about other PMV expansion initiatives on the South Shore and the North Shore (Centerm, Neptune, etc.).

Dr. Moore reviewed the projected vessel volumes that could call at Terminal 2 at full operation, which is projected to be about 260/year, with the same number calling at Deltaport at Roberts Bank. He noted that currently about 3,000 vessels call at PMV each year and the projection for 2030 is for 4,500 to 5,000 vessel calls at PMV facilities.

Scott Ferguson, Washington Department of Ecology: Presentation
Mr. Ferguson gave a synopsis of the Marine and Rail Oil Transport Study. He noted that the study, which had been presented to the Governor's office and the Legislature in draft form, provided 43 total recommendations related to issues involving the transportation of crude oil within the State. He stated his focus was to review the marine part of the study and its findings.

Mr. Ferguson's presentation reviewed the marine findings and recommendations in the draft final report. He stated that the process cannot stop with finalization of the current study. Efforts addressing risk have to continue due to the changing energy picture.

Panel/Group Discussion, Assessment of Vessel Accident Risk

Panelists:
Dr. Rene van Dorp, George Washington University
Capt. Steven Brown, Chamber of Shipping (British Columbia)
Capt. M. W. Raymond, US Coast Guard (Captain of the Port, Sector Puget Sound)
John Veentjer, Puget Sound Marine Exchange

Dr. van Dorp indicated he is encouraged by other study work and suggested a fundamental question should be how can risk be minimized through mitigation. He suggested an important question is will the proposed projects that have been identified occur, and if so, which ones and when?

Mr. Veentjer said that it is necessary to keep aware of the risk factors – increase in number of vessels, increasing vessel sizes, changing vessel types, and trying to determine where vessel increases are going to occur. He noted that the Puget Sound Marine Exchange tracks vessels for its members.

Capt. Raymond noted while absolute levels have been reduced, we need to continue to focus on how we can bring it down more. He encouraged the continued expanded use of technology, particularly simulation – comment: learn from simulations rather than from real incidents. He noted that there needs to be better coordination with Tribal areas regarding fisheries versus anchorages.

Capt. Brown noted that the West Coast of Canada is the longest piloted area in North America with 100 Pilots. He said that fendering systems have stayed the same but ships have gotten larger, which is an example of an infrastructure issue. He also noted that there are very few dry docks available to deal with a vessel casualty. He said that small craft interference with larger ships by being in the wrong place should be dealt with more strickly. He also said that there has to be solid communications to avoid errors and that we have to maintain the context of today's discussion going forward. He noted that comparably the Salish Sea handles much fewer ships than Singapore or Rotterdam, as examples.

Tribal Government Representatives

Several Tribal representatives said that it is large ships interfering with small craft fishers. The question is how do you go from shipping lanes to piers and back without affecting fishing areas? It was noted that huge cargo ships are the size of super tankers and questions whether they should even be allowed through the Straights of San Juan de Fuca. Tribes also see ballast water discharge as an issue because of potential negative impacts on native species. It was noted that tugs are also a major interference with Tribal Fishing Rights.

Fred Felleman, Friends of the Earth

Mr. Felleman stated that he appreciates the tri-lateral discussions and noted that most of the major growth is in Canada. He stated that the U.S. Coast Guard and their Canadian counterparts need a common level of sharing information and coordination. For example, he wondered if the definition of an "incident" was the same between the two jurisdictions.

Washington Environmental Council

The impact of crude-by-rail on marine traffic needs to be considered – more ATBs, for example.

Pilots

A pilot noted that the largest tanker vessels that can come into Puget Sound are 125,000 DWT, while the largest container ships are 140,000 DWT. The container ships are more maneuverable, however. It was stated was the worst thing that could happen is if the kind of get-together the workshop is providing does not happen. Pilots do not want to see the ability of pilots decreased by an overburdened system. Pilots are employed to mitigate risks, not to take them.

Washington State Ferries

The representative from Washington State Ferries (WSF) wants the WSF LNG study to be included in the Marine & Rail Oil Transportation Study.[687] She noted that one thing that had not been discussed yet is sabotage and terrorism risks.

Other Comments

One attendee expressed concern about uninspected fishing vessels and operating competency of fishing and recreation vessels. It was noted that the largest risk is to not have this kind of meeting. It was suggested that the U.S. Navy needs to be involved in this kind of gathering.

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[687] Demay et al. 2014; Qiao et al. 2013. The results of this study were included in the final draft of this study.

Risk Identification Breakout Groups
The workshop participants went to breakout groups for the purpose of identifying and prioritizing risks. After the breakout period, each group reported back with identified items with priority rankings. There was considerable overlap among certain items considered, which were:

- VTRA 2010[688]
- Weather
- Anchorages
- Bunker Operations
- Tribal/Cultural Rights
- Ship Sizes
- Escort Tugs and Rescue Tugs
- Crude-by-Rail Impacts
- Geographical Locations
- Other (Manning, Training, Human Error, etc.)

Weather Breakout Group
The overall risk landscape related to weather includes:

- Weather issues may increase accidents due to visibility, maneuvering issues, effects on mariners (e.g., fatigue).
- Weather events may be changing in intensity and frequency.
- Weather events cannot be controlled, but require preparedness and reactive measures.

The risk factors identified within the Weather group were:

- Transit issues during reduced visibility weather conditions.
- Transit issues during night operations.
- Inability to berth.
- Anchorage availability may be reduced.
- Increased fatigue during weather events.
- Increased storminess due to climate change.
- Port capacity concerns with increased sea level rise in South Puget Sound.
- Changes to currents and tides.
- Earthquake events/tsunamis.
- Transfer operations risks during high sea state and winds – adequacy of pre-booming and other transfer precautions.

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[688] This breakout group was organized to allow participants to ask additional questions and discuss the VTRA 2010 model. The VTRA 2010 model was not being considered as a risk factor.

Anchorages Breakout Group
The overall risk landscape related to anchorages includes:

- Anchorage capacity may change with size of vessels (anchorages were established when vessels were smaller; anchorages can accommodate fewer larger vessels).
- Vessel traffic studies indicate that anchorage capacity should be sufficient even with changes in vessel traffic.

The risk factors identified within the Anchorages group were:

- Refineries have insufficient storage on land so crude oil frequently is temporarily stored on anchored tankers. [689]
- Concern about sufficiency of anchorage areas during high weather conditions.
- Cherry Point anchorage is exposed to weather and seldom used.
- Anchorages were established when vessels were smaller; fewer larger vessels can be accommodated.

Bunker Operations Breakout Group
The overall risk landscape for bunkering operations includes:

- Bunkering activity is expected to increase resulting in more transfer- and transit-related risk.
- As of January 1, 2015, heavy fuel oils (HFO) are being replaced by LNG and/or low sulfur diesel.
- The consequences from spills are expected to change with the shift to LNG and low sulfur diesel.
- The shift from HFO to diesel means the diesel capacity of vessels is larger and there is a greater potential volume of diesel spillage.
- Ocean-going vessels will still carry HFO for travel at sea.
- HFO bunkering will still occur for vessels going to sea.
- Ferries bunker at terminals, which are often located in environmentally-sensitive areas.

The risk factors identified within the Bunker Operations group were:

- Lack of manning standard on towed barges (wheelhouse while underway).
- Fatigue (long work hours) could increase accident rates.
- Bunkering barge inspection concerns.
- Lack of knowledge of bunkering for cross-boundary vessel transits.

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[689] Different crude oil types cannot be mixed in storage tanks at refinery. Due to differences in types of crude oil being imported to refineries (no longer just Alaska North Slope crude), the crude oil cannot be transferred to the facility unless there is an oil-type specific storage capacity available.

Tribal/Cultural Rights Breakout Group
The risk landscape related to tribal and cultural rights includes:

- The Salish Sea area includes numerous tribal and First Nations that have treaty rights, Usual and Accustomed (U&A) fishing area, for the use of waterways for fishing and other cultural activities.
- The use of the waterways for fishing and cultural activities conflicts with commercial vessel traffic uses creating four types of risk:
  - Resource impacts (i.e., fish, marine mammals, and other marine organisms).
  - Fisherman access.
  - Fisherman safety.
  - Impacts to equipment (boats, nets, crab pots, etc.).
- There are conflicts between commercial vessel operations and tribal fishing and other cultural activities due to such factors as:
  - Fishing is best near traffic lanes.
  - Advance notification of fishing areas is difficult (changes daily, unpredictable in advance).
  - Sharing information on fishing activities sensitive.
  - Fishermen view large ships as impacting fishing.
  - Operators of large ships view fishing vessels as hazards that are difficult to see/difficult to make avoidance maneuvers.

The risk factors identified by the breakout group were:

- Anchorage areas in multiple fishing catch areas.
- Tug routes in multiple fishing catch areas.
- Impacts to resources, gear.
- Safety risk for fishermen.
- Ferry routes near multiple fishing catch areas.
- Traffic separation zones in multiple fishing catch areas.
- Transits from traffic lanes to individual ports in multiple fishing catch areas.
- Vessel traffic does not stay in vessel traffic lanes, interfering with fishing practice.
- Wakes of ships cause safety issues for small fishing vessels.
- General safety risk for fisherman.
- Potential for fishing gear loss.
- Ballast water impact of fishing areas.
- Hull fouling concerns for fishing areas due to ban on tributylin.

Ship Sizes Breakout Group

The overall risk landscape with respect to ship size issues includes:

- Changes in the relative and absolute numbers of vessel types changes risks.
- Changes in the sizes of some vessel types will result in fewer numbers of larger vessels.

The breakout group identified the following risk factors:

- Becoming accustomed to technology: AIS,[690] ECDIS,[691] PPU,[692] routes, speed over ground, radar alarms.
- Increase in traffic increases user conflict (e.g., military, recreation, ferries, fishing, commercial traffic).
- Larger vessels increase risk of grounding; fewer vessels decrease risk of collision.
- Mooring lines no longer horizontal with larger vessels.
- Fendering problems – some docks not suited for larger vessels.
- Larger vessels may cause issues for escort/rescue tugs with respect to bollard pull, bitts, moorage makeup.
- More vessels cause problems with VTS (capacity, role, coverage).
- Bulkers (Capesize).
- Greater risk with certain vessels.
- Definition of higher-risk vessels.
- Probability of spilling/accident vs. potential consequences of spill (oil/cargo type, potential volume, location).
- Increased ATB traffic (>40,000 DWT) due to crude-by-rail changes.
- Increased size of containerships.
- Rule 10 compliance (traffic separation schemes; VTS).
- Rule 9 issues (conduct of vessels in narrow channels).
- Lack of knowledge and compliance of Rule 10 by small craft and "frogger" problem when crossing shipping lanes.

Escort Tugs and Rescue Tugs Breakout Group

The breakout group identified the following risk factors related to tugs:

- Tug availability/distribution during high-wind event.
- Half of tug escorts need to be modeled/studied/evaluated.
- Winches – rend and recover (e.g., for Strait of Juan de Fuca).

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[690] Automated identification system
[691] ECDIS = Electronic Chart Display and Information System
[692] Portable piloting units

- Lack of tug escorts for ATBSs.
- Speed issues with tug escorts.
- Lack of regulatory standards and certification (e.g., Canada, BC) for tug escort companies.
- Lack of response tugs with spill response capability and storage.[693]

Crude-by-Rail Impacts Breakout Group[694]

The crude-by-rail changes in the region change the risk landscape for the Salish Sea because there exists a potential for increase in tanker/ATB traffic related to export of crude due to lift of crude export ban; and/or the impact of North Dakota Bakken oil stabilization (partial refining) decision. If destabilized (conditioned) Bakken oil is considered a refined product rather than a crude oil, the regulations regarding export are different.

The breakout group identified the following risk factors:

- Increase in ATB traffic – concern that ATBs not as well regulated.
- Handling of Bakken crude – unfamiliarity with volatile crude oil.
- Railroad accidents near waterways due to natural events (landslides, earthquakes, weather), derailments, or vandalism/sabotage/terrorism.

Other (Manning, Training, Human Error, etc.) Breakout Group

The "Other" breakout group identified miscellaneous risk factors not captured in other categories, including:

- Lack of coordinated effort to record and evaluate vessel incidents.
- Funding for inspection programs.
- Marine spatial planning.
- Non-tank vessel response plans and enforcement of pre-arranged salvage contracts.
- Aging pilots.
- Cross-border coverage of response insurance and responder immunity.
- Concern about over-dependence on technology for navigation leading to navigational failure.
- Lack of understanding about causes of mechanical failures and fire/explosion incidents.
- Security concerns.

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[693] Note that spill response and response preparedness were considered to be "deferred topics" for this workshop.
[694] The discussion of crude-by-rail impacts was limited to the ways in which vessel traffic may be affected.

Geographical Locations Breakout Group

The Geographic Locations breakout group discussed many factors that overlapped with those in other groups. There are some geographic locations in the Salish Sea that are at greater risk due to the higher likelihood of an incident, a greater magnitude of incident with respect to spill volume, and/or due to the greater sensitivity of the environment, cultural, Tribal, and socioeconomic resources.

A variety of risk factors were identified by the breakout group:

- Rosario Strait/Cherry Point area – issues with management of traffic due to increase, change in traffic, and/or increase in traffic congestion.
- Rosario Strait/Cherry Point area – concern over ferry delays, medical emergencies, due to increased Rosario Strait traffic.
- Concern about the "maximum capacity" of the Salish Sea by waterway due to the higher number of vessels with the full build-out of projects.
- Concern about the appropriate availability of escort tugs with sufficient bollard pull to be capable to deal with high-risk vessels – tankers and non-tank vessels.
- Concern that Salish Sea narrow channels have not been properly identified.
- Concern about designated bunkering sites.
- Need for improvement in safety for commercial and non-commercial craft, as well as public (NOAA, USCG, Department of Defense) use of waterways.
- With many natural resources and sensitive shorelines and waterway areas in the Salish Sea, it is important to evaluate traffic related to geography, particularly the interface at the Strait of Georgia boundary.
- Anchorage locations and size conflicts with fishing vessels in many locations.
- Concern about "misinformation" of data sharing and roles of the CVTS for shared waterway routing.
- Geographic locations of particular concern identified as (in rank order, highest to lowest):
    1. Haro Strait/Boundary Pass/Turn Point.
    2. Georgia Strait/Rosario Strait.
    3. "Mixing bowl" of Port Angeles/Victoria.
    4. East of Vendovi/Hale Passage.
    5. Strait of Juan de Fuca Entrance.
    6. Admiralty Inlet South.
    7. Approaches to San Juan Islands.

Synopsis – Day 2

The following is a summation of the proceedings for the second day of the Salish Sea Workshop. It is not a word-for-word transcript.

Best Operating Practices Panel and Group Discussion
Panelists:
Capt. Jonathan Ward, Puget Sound Pilots
Brian Young, Pacific Pilotage Authority (Canada)
Capt. Robert Wenz, Alaska Tanker Company
Mike Moore, Pacific Merchant Shipping Association
Brian Stansbury, Seaspan[695]

Capt. Jonathon Ward, Puget Sound Pilots
Capt. Ward described tanker escort procedures and showed pictures of tanker escort drills that were conducted in September 2014 for bollard pull testing – static and dynamic.

He defined two types of escorting – tethering with a line to the bow of a ship (used in areas with tight confines, such as in the Rosario Strait) and non-tethered escorting. He stated that non-tethering is more common in more open areas, such as in the Seattle and Tacoma port areas. Capt. Ward described the static and dynamic testing done in September and how tugs address pull requirements that exceed static limits by using dynamic pull procedures (tugs pivot sidewise to the vessel attached to, which allows pull tension to exceed static limits). He explained that vessels over 50,000 DWT have to have a "strong point" that will allow up to 200,000 tons of pull tension. Vessels under 50,000 DWT have to have a strong point allowing up to 100,000 tons of pull tension.

He stated that foreign ships often to not have a strong point adequate for pull "spikes" in tension, which can require a second tug be tethered to the vessel. Use of the second tug is something the pilots would rather not do, they would much rather the vessels have adequate strong points for the size of the vessel. Capt. Ward further stated that the Puget Sound Pilots want to cooperate with Canadian pilots to ensure that procedures are similar and consistent.

Capt. Brian Young, Pacific Pilotage Authority (PPA) of Canada: Presentation[696]
Capt. Young stated that the entire Canadian coast between Alaska and Washington requires pilotage. He noted that prevention is best cure for spills – "you don't have to clean it up if you don't spill it." He also noted that there have not been any major spills in Canadian waters for 50 – 60 years. He emphasized that it is not prudent to cut costs in training pilots. Capt. Young said that the PPA has a policy for major port terminal expansions and for new terminals, focused on:

- Bathymetry (water depth and sea bottom conditions)

[695] Seaspan is an association of Canadian shippers.
[696] See Appendix N.

- Simulations
- Training

Capt. Young explained that every Canadian pilot has his own lap top which is separate from the vessel systems he is piloting. The pilots also have "pull" certification for all tugs. Two pilots are on board during "tethered" operations and all vessels are required to provide information on their mooring arrangements and verify the position of the pulling bollards to one of the two pilots. Tethered operations are required through Boundary Pass and Haro Strait for all tankers over 40,000 DWT, regardless of commodity. He believes that the PPA and other agencies have identified all risks and developed the appropriate mitigations.

Capt. Young then discussed vessel transits through the Second Narrows. The policy is that loaded tankers in the 120,000 DWT class can only transit the Narrows in daylight in slack water conditions, noting that slack water is for about one hour, twice a day, and vessels subject to the policy require about 30 minutes to transit through the Second Narrows. He clearly stated that PPA pilots will not violate that policy.

Capt. Robert Wenz Alaska Tanker Company: Presentation
Capt. Wenz presented a shippers view, noting that ATC was formed in 1999 by BP Oil Shipping Company USA, Keystone Shipping Company, and OSG Ship Management. ATC has had no spills since 2003, and he noted that it took a few years from the company's formation to get the policies and procedures in place that minimizes spill risk as much as possible. He also noted that accountability and leadership has to be on the ship, not in an office, and that ATC has an extensive employee training program and monitoring/mentoring system in place.

Capt. Mike Moore, for Pacific Merchant Shipping Association
Capt. Moore noted that he helped set up the Puget Sound Harbor Safety Committee to develop and measure "best practices" and a "standard of care." He noted that "standards of care" are flexible in how they are developed, can adjust as needed, and over time they are almost the equivalent of rules according to the courts.

He discussed the Tesoro Vetting Program, stating that vetting is the first line of defense: every vessel that comes into the system is vetted for equipment and personnel. A physical inspection of each vessel is performed every six months. The vetting system issues a single approval per vessel and is not a blanket approval for a ship line. The second line of defense is internal expertise at each Tesoro facility, on the vessels, and at piers handling Tesoro products.

Capt. Brian Stansbury, Seaspan Marine, North Vancouver BC: Presentation
Capt. Stansbury described Seaspan's approach to incident management. The key components he mentioned were audits (internal, external, and governmental) and training. He said that a 3-point inspection of all oil barges occurred at departure and arrival points and that assist tugs are used on all arrivals and departures. Capt. Stansbury also noted that all oil barges are double-hulled.

Best Voluntary and Achievable Protection, Panel and Group Discussion
Panelists (in addition to above):
Alice Helker, Washington Department of Ecology
Dr. Eleoner Kirtley, Green Marine

Alice Helker, Washington Department of Ecology: Presentation
Ms. Helker described DOE's voluntary compliance programs – VPAP and ECOPRO. The ECOPRO program involves a higher set of standards than does the VPAP program. Under ECOPRO, tank vessels are audited every three years to ensure standards are being adhered to. Alice noted that there are currently eight ECOPRO and two VPAP vessel operators in the state. There are now 35 voluntary standards in place, which are higher than international or federal regulations.

She noted that about 60% of the vessels operating in Washington waters are in one of the two programs. Companies in one of the two programs often have lower insurance rates. She noted that a significant drawback to the programs is that they are voluntary and so only attract "good players." Ms. Helker noted that the programs are currently only for tank vessels but could be broadened for other cargo vessels.

Dr. Eleanor Nick Kirtley, Green Marine: Presentation
Dr. Kirtley noted that Green Marine has a voluntary environmental certification program for terminals, ports and ship owners, noting that there are environmental issues for each. Once joined in the program, each has one year to exceed regulation requirements (known as Level 1). There are five levels with "5" being the highest achievement. She stated that the Green Machine process offers a "Best Practices" benchmark to follow.

Capt. Raymond, U.S. Coast Guard: Address on VTS
Capt. Raymond gave a brief presentation on VTS (Vessel Tracking System) from about a "30,000-foot" overview. He said that there are 12 VTS areas in the U.S., but all are different based on geography. The Puget Sound VTS is the largest and is cooperative with Canada, which has 22 VTS areas.

He described VTS as a risk-mitigation tool and noted that Canada and the U.S. have bi-lateral discussions every 3 months to share procedures and changes in operations and policies. He noted that data is shared back and forth between the two countries and that there are direct communication links, noting that the whole arrangement creates a level of redundancy not available anywhere else in North America.

Risk Reduction Options, Evaluation/Rankings: Breakout Groups and Group Discussion
The purpose of this session was to discuss the identification and classification of risk reduction options for action based on the previously identified risk factors.

Identified risk mitigation measures for consideration for each of the risk categories, included:

Geography

- Transparency and sharing of waterway incident data (Action Item).
- Funding source for cross-border and coordination meetings.
- Education for recreational boaters (Action Item).
- Funding for training and education of next generation of pilots.
- Proper identification of Salish Sea narrow channels.
- Determining what is actual maximum capacity of the channels.

Anchorages

- Can there be more anchorages? (Action Item, USCG to review anchorages and capacity)
- Define the "heavy weather" standard of care and monitor.
- Require laden tankers specify they are laden tankers when making an anchorage reservation.
- Noted: you cannot mix different types of crude and there is insufficient land side storage to unload an entire tanker, causing the vessel to have to re-anchor.

Ship Sizes

- Escorts and tethering requirement for high-risk vessels?
- Escort and tethering requirement for ATBs over 40,000 DWT?
- Protective fuel tanks for high-risk vessels?
- Should vessel speeds for container ships be addressed?
- To reduce risk, consider balance of voluntary, regulatory, legislation and international standards?

Bunkering

- Separate towing vessels for bunkering?
- Fatigue and work hour issue in towing sector.
- Towing vessels inspection protocols?
- U.S. /Canada sharing of best practices.
- Investigate bunkering transits (Action Item).

Weather

- Should there be reduced speed requirements in impaired weather?

Tribal Fishing Rights

- Tribes want safe access to fishing rights agreement areas.
- Require radar reflectors on fishing boats?
- Fishing rights in Ferry lanes is an issue.
- Develop traffic lanes between switching lanes and ports.
- Designate vessel waiting areas to avoid fishing areas.
- Require fishing boat captains to have more formal training?
- Ballast water treatment issue for fishing areas, anti-fouling chemicals.
- Educate fishermen on the lack of mobility of large ships.
- Tribes to notify authorities to determine fishing openings – marine spatial planning (Action Item).

Comment from tribal representatives: We are discussing issues as an absolute risk versus a relative risk, while the Tribes view the issues as "perceived risk." To address the perceived risk issue, it is important to bring the Tribes into the "rewards" at the end.

Tug Boats and Pilots

- Like in Canada, require escorts for all liquid bulk carriers, regardless of commodity.
- Should double escorts be required for liquid bulk carriers?
- Require rend/recover winches on vessels.
- Coordinate cross-border standards for piloting.
- Should a multi-mission tug be stationed in the Haro Strait, similar to Neah Bay?
- Who pays for the multi-mission tug if stationed in Haro Strait?

Other Issues

- Who records and evaluates incidents and how is that information shared?
- What are the funding sources?
- Need robust pilot recruitment
- How is cross-border liability to be accounted for?

Discussion at the Salish Sea Workshop regarding possible action for follow-up included:

- Puget Sound Partnership proposed a meeting to coincide with the June 2015 Clean Pacific Conference to further discuss Salish Sea Workshop topics.
- Makah Nation proposed a Trans-Boundary Shipping Summit in the near future to further discuss and address vessel incident risk in the Salish Sea.

Action Items Identified

A few specific Action Items were identified, including:

- Education for recreational boaters regarding Rule 10. It was determined that Washington Parks and Recreation has final responsibility, but Ecology will lead for the purpose of ensuring that Rule 10 is incorporated into recreational boaters understanding of requirements. San Juan County may participate also.
- Analyze a way to minimize transit between bunkering points and final destinations.
- Collect and analyze status of current and future anchorages (Coast Guard).
- A sub-committee from the Harbor Safety Committee to be charged with re-visiting bunkering standards of care.
- Assign large ship issues to Harbor Safety Committee and cross-border relationships – an action item it was noted was already in place.

Though the vast majority of participants expressed that a great deal of progress had been made at the workshop, it was to be viewed as only a beginning. There should be further follow-up meetings of various sub-groups, the formation of committees, and other activities to move forward with the goals of the workshop to develop and carry out action items.

Since the goal of the workshop was to connect risk factors with risk mitigation measures to the extent possible on a multi-national, transboundary basis, the risk factors were matched up measures as shown in Tables 113 through 121. These tables are intentionally incomplete. Their purpose is to act as "living documents" that can be updated moving forward. Of particular concern is identifying transboundary shared priorities and shared solutions.

Table 113. Weather-Related Vessel Risks Identified and Evaluated at the Salish Sea Workshop

Overall Risk Landscape • Weather issues may increase accidents due to visibility, maneuvering issues, effects on mariners (e.g., fatigue). • Weather events may be changing in intensity and frequency. • Weather events cannot be controlled, but require preparedness and reactive measures.					
Identified Risks		Risk Mitigation		Trans-Boundary Shared Issues	
Rank Within Category	Factor	Rank Within Category	Risk Mitigation Measure	Priorities	Solutions
	Transit issues during reduced visibility weather conditions		Reduced speeds with impaired visibility		
	Transit issues during night operations				
	Inability to berth				
	Anchorage availability may be reduced				
	Increased fatigue during weather events				
	Increased storminess due to climate change				
	Port capacity concerns with increased sea level rise in South Puget Sound				
	Changes to currents and tides				
	Earthquake events / tsunamis				
	Transfer operation risks during high sea state and winds – adequacy of pre-booming and other transfer precautions				

Table 114. Ship Sizes and Changes in Shipping-Related Vessel Risks Identified and Evaluated at the Salish Sea Workshop

Overall Risk Landscape

- Changes in the relative and absolute numbers of vessel types changes risks.
- Changes in the sizes of some vessel types will result in fewer numbers of larger vessels changing risk.

Identified Risks		Risk Mitigation		Trans-Boundary Shared Issues	
Rank Within Category	**Factor**	**Rank Within Category**	**Risk Mitigation Measure**	**Priorities**	**Solutions**
	Technology, AIS, ECDIS, PPU, routes, SOG, radar alarms		Increase redundant control systems		
	Increase in traffic increases user conflict (e.g., military, recreation, ferries, fishing, commercial traffic)				
	Larger vessels increase risk of grounding; fewer vessels decrease risk of collision				
	Mooring lines no longer horizontal				
	Fendering problems – some docks not suited for larger vessels		Examine facility design adequacy		
	Larger vessels may cause issues for escort/rescue tugs with respect to bollard pull, bitts, moorage makeup		Examine adequacy of dock/transfer mechanism, bollards		
	More vessels may cause issue with VTS (capacity, role, coverage)		• Cooperative VTS (Canada/US) already in place in shared waterway • VTS review for process change, hardware change, and public education	Cooperative VTS (Canada/US) already in place in shared waterway	Cooperative VTS (Canada/US) already in place in shared waterway
	Bulkers (Capesize)		Newer guidelines		
	Greater risk with certain vessels		Escort of higher-risk vessels with tethering		

Overall Risk Landscape • Changes in the relative and absolute numbers of vessel types changes risks. • Changes in the sizes of some vessel types will result in fewer numbers of larger vessels changing risk.					
Identified Risks		**Risk Mitigation**		**Trans-Boundary Shared Issues**	
Rank Within Category	**Factor**	**Rank Within Category**	**Risk Mitigation Measure**	**Priorities**	**Solutions**
	Definition of higher-risk vessels probability of spilling/accident vs. potential consequences of spill (oil/cargo type, potential volume, location)		Identify higher-risk vessel that might require special precautions: • Tanker > 40,000 DWT • Non-protected bunker tanks • Spot bulkers • Class society • Geographic location • Crew language/culture • Fuel – e.g., switching type for Emission Control Area (ECA) • Bitt and bollard certifications		
	Increased ATB traffic (>40,000 DWT) due to crude-by-rail changes		Escort of ATBs with tethering		
	Increased size of containerships		Reduce speed		
	Rule 10 compliance (traffic separation schemes; VTS) Rule 9 issues (conduct of vessels in narrow channels)		• Education • Balance with tribal treaty rights • AIS requirement for all • Strong Harbor Safety Committee critical to work on these and other emergency issues as governance method		
			To reduce risk, always consider balance of voluntary, regulatory, legislative, and international instruments		
		1	Keep up with technology – VTS,[697] AIS,[698] PPU[699]		
		2	Ship handling, fendering dock systems, tugs, routes		

[697] Vessel traffic service
[698] Automated identification system
[699] Portable piloting units

Overall Risk Landscape • Changes in the relative and absolute numbers of vessel types changes risks. • Changes in the sizes of some vessel types will result in fewer numbers of larger vessels changing risk.					
Identified Risks		**Risk Mitigation**		**Trans-Boundary Shared Issues**	
Rank Within Category	**Factor**	**Rank Within Category**	**Risk Mitigation Measure**	**Priorities**	**Solutions**
		3	VTS, cross-border communications	Cooperative VTS (Canada/US) already in place in shared waterway	Cooperative VTS (Canada/US) already in place in shared waterway
		HIGH	PSHSC to investigate issues regarding ship size		
	Lack of knowledge and compliance of Rule 10 by small craft and “frogger” problem when crossing shipping lanes	HIGH	Rule 10 outreach and enforcement with smaller vessels Incorporation of Rule 10 education into boater safety course sponsored by WA State Parks & Recreation – taken on by San Juan County		

Table 115: Anchorage-Related Vessel Risks Identified and Evaluated at the Salish Sea Workshop

Overall Risk Landscape • Anchorage capacity may change with size of vessels (anchorages were established when vessels were smaller; anchorages can accommodate fewer larger vessels); • Vessel traffic studies indicate that anchorage capacity should be sufficient even with changes in vessel traffic					
Identified Risks		Risk Mitigation		Trans-Boundary Shared Issues	
Rank Within Category	Factor	Rank Within Category	Risk Mitigation Measure	Priorities	Solutions
	Refineries have insufficient storage on land so crude oil frequently temporarily stored on anchored tankers[700]		Standard of Care for anchored vessels in Puget Sound works well Laden tankers at anchor advise VTS about laden cargo condition during anchor reservation Analyze data to characterize anchorage usage with regard to tanker storage and other use Unclear definition of "storage" status for tankers on water		
	Concern about sufficiency of anchorage areas during high weather conditions Cherry Point anchorage is exposed to weather and seldom used		Standard of Care for anchored vessels in Puget Sound works well Consider establishing more anchorages (away from ferry lanes)		
	Anchorages were established when vessels were smaller; fewer larger vessels can be accommodated		USCG is currently reviewing anchorage capacity and locations for larger vessels Add anchorages to reduce congestion (away from ferry lanes)		

[700] Different crude oil types cannot be mixed in storage tanks at refinery. Due to differences in types of crude oil being imported to refineries (no longer just Alaska North Slope crude), the crude oil cannot be transferred to the facility unless there is an oil-type specific storage capacity available.

Table 116: Crude-by-Rail-Related Marine Issues

<table>
<tr><td colspan="6">Overall Risk Landscape
There exists a potential for increase in tanker/ATB traffic related to export of crude:
Due to lift of crude export ban; and/or
Impact of North Dakota Bakken oil stabilization (partial refining) decision.</td></tr>
<tr><th colspan="2">Identified Risks</th><th colspan="2">Risk Mitigation</th><th colspan="2">Trans-Boundary Shared Issues</th></tr>
<tr><th>Rank Within Category</th><th>Factor</th><th>Rank Within Category</th><th>Risk Mitigation Measure</th><th>Priorities</th><th>Solutions</th></tr>
<tr><td></td><td>Increase in ATB traffic – concern that ATBs not as well regulated</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Handling of Bakken crude – unfamiliarity with volatile crude oil</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Railroad accidents near waterways due to natural events (landslides, earthquakes, weather), derailments, or vandalism/sabotage/terrorism</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Ballast water issues if facilities become exporters</td><td></td><td></td><td></td><td></td></tr>
</table>

Table 117: Tribal Fishing/Cultural Rights (U&A)

<table>
<tr><td colspan="6">Overall Risk Landscape
• The Salish Sea area includes numerous tribal and First Nations that have treaty rights (U&A) for the use of waterways for fishing and other cultural activities.
• The use of the waterways for fishing and cultural activities conflicts with commercial vessel traffic uses, creating four types of risk:
o Resource impacts (i.e., fish, marine mammals, and other marine organisms);
o Fisherman access;
o Fisherman safety; and
o Impacts to equipment (boats, nets, crab pots, etc.).
• There are conflicts between commercial vessel operations and tribal fishing and other cultural activities due to such factors as:
o Fishing is best near traffic lanes;
o Advance notification of fishing areas is difficult (changes daily, unpredictable in advance);
o Sharing information on fishing activities sensitive;
o Fishermen view large ships as impacting fishing; and
o Operators of large ships view fishing vessels as hazards that are difficult to see/difficult to make avoidance maneuvers.</td></tr>
<tr><th colspan="2">Identified Risks</th><th colspan="2">Risk Mitigation</th><th colspan="2">Trans-Boundary Shared Issues</th></tr>
<tr><th>Rank Within Category</th><th>Factor</th><th>Rank Within Category</th><th>Risk Mitigation Measure</th><th>Priorities</th><th>Solutions</th></tr>
<tr><td></td><td>Anchorage areas in multiple fishing catch areas
Impacts to resources, gear</td><td></td><td>Avoidance of particularly sensitive environmental and culturally important areas (i.e., no anchoring, etc.)</td><td></td><td></td></tr>
<tr><td></td><td>Tug routes in multiple fishing catch areas
Impacts to resources, gear
Safety risk for fishermen</td><td></td><td>Designate tug loitering areas
Notify COTP when and where there are fishery openings (examine possibility of making current notifications earlier than current practice)</td><td></td><td></td></tr>
<tr><td></td><td>Ferry routes near multiple fishing catch areas
Impacts to resources, gear
Safety risk for fishermen</td><td></td><td>Safety distance for ferry lanes
Notification to ferries of locations of nets
Educate fishermen on maneuverability/ visibility of large vessels, including ferries
Notify COTP when and where there are fishery openings (examine possibility of making current notifications earlier than current practice)</td><td></td><td></td></tr>
</table>

Overall Risk Landscape					

Overall Risk Landscape
• The Salish Sea area includes numerous tribal and First Nations that have treaty rights (U&A) for the use of waterways for fishing and other cultural activities.
• The use of the waterways for fishing and cultural activities conflicts with commercial vessel traffic uses, creating four types of risk:
  ○ Resource impacts (i.e., fish, marine mammals, and other marine organisms);
  ○ Fisherman access;
  ○ Fisherman safety; and
  ○ Impacts to equipment (boats, nets, crab pots, etc.).
• There are conflicts between commercial vessel operations and tribal fishing and other cultural activities due to such factors as:
  ○ Fishing is best near traffic lanes;
  ○ Advance notification of fishing areas is difficult (changes daily, unpredictable in advance);
  ○ Sharing information on fishing activities sensitive;
  ○ Fishermen view large ships as impacting fishing; and
  ○ Operators of large ships view fishing vessels as hazards that are difficult to see/difficult to make avoidance maneuvers.					

Identified Risks		**Risk Mitigation**		**Trans-Boundary Shared Issues**	
Rank Within Category	**Factor**	**Rank Within Category**	**Risk Mitigation Measure**	**Priorities**	**Solutions**
	Traffic separation zones in multiple fishing catch areas Transits from traffic lanes to individual ports in multiple fishing catch areas		Develop traffic lanes for fishing between shipping lanes and individual or multiple piers Educate fishermen on maneuverability/visibility of large vessels, including ferries Notify COTP when and where there are fishery openings (examine possibility of making current notifications earlier than current practice)		
	Vessel traffic does not stay in vessel traffic lanes, interfering with fishing practice		Notify COTP when and where there are fishery openings (examine possibility of making current notifications earlier than current practice)		
	Wakes of ships cause safety issues for small fishing vessels		Notify COTP when and where there are fishery openings (examine possibility of making current notifications earlier than current practice)		

Overall Risk Landscape					
• The Salish Sea area includes numerous tribal and First Nations that have treaty rights (U&A) for the use of waterways for fishing and other cultural activities. • The use of the waterways for fishing and cultural activities conflicts with commercial vessel traffic uses, creating four types of risk: ○ Resource impacts (i.e., fish, marine mammals, and other marine organisms); ○ Fisherman access; ○ Fisherman safety; and ○ Impacts to equipment (boats, nets, crab pots, etc.). • There are conflicts between commercial vessel operations and tribal fishing and other cultural activities due to such factors as: ○ Fishing is best near traffic lanes; ○ Advance notification of fishing areas is difficult (changes daily, unpredictable in advance); ○ Sharing information on fishing activities sensitive; ○ Fishermen view large ships as impacting fishing; and ○ Operators of large ships view fishing vessels as hazards that are difficult to see/difficult to make avoidance maneuvers.					
Identified Risks		**Risk Mitigation**		**Trans-Boundary Shared Issues**	
Rank Within Category	**Factor**	**Rank Within Category**	**Risk Mitigation Measure**	**Priorities**	**Solutions**
	General safety risk for fisherman		Require/encourage use of radar reflectors and participation in AIS Training and certification of watchkeepers on fishing vessels Educate fishermen on maneuverability/visibility of large vessels, including ferries Notify COTP when and where there are fishery openings (examine possibility of making current notifications earlier than current practice)		
	Potential for fishing gear loss		Revive recommendations from the Lummi tribal gear loss workshop[701]		
	Ballast water impact of fishing areas Hull fouling concerns for fishing areas due to ban on tributyltin		Develop safe, effective, and reliable ballast water treatment and hull fouling (bio-fouling) measures		

[701] A fishing gear loss workshop was held by Lummi Nation, but the lessons learned may be more broadly applied to other tribal and First Nations.

Table 118: Escort Tugs & Rescue Tugs

Overall Risk Landscape Escort and rescue tugs are an important part of the safety system in the Salish Sea, but there are limitations to their safe and effective operation that need to be considered and improved upon.					
Identified Risks		**Risk Mitigation**		**Trans-Boundary Shared Issues**	
Rank Within Category	**Factor**	**Rank Within Category**	**Risk Mitigation Measure**	**Priorities**	**Solutions**
	Tug availability/distribution during high-wind event		Standard of Care for tug availability in heavy weather in Puget Sound works well		
			PSP[702] submitted draft of >/< 40,000 DWT usage of escort tugs Changes for toxic cargo (e.g., toluene, diluents) Bollard pull/bitts/information needs/availability		
	Half of tug escorts need to be modeled/studied/evaluated				
	Winches – rend and recover (e.g., for Strait of Juan de Fuca)				
	Lack of tug escorts for ATBS				
	Speed issues with tug escorts				
	Lack of regulatory standards and certification (e.g., Canada, BC) for tug escort companies		Coordinated bilateral standards for tug escorts, e.g.: Tethered vs. non-tethered Mirrored standard for Boundary Pass/Haro Strait/ Strait of Georgia/East Point		
			Evaluate permanent rescue tug near Boundary Pass/Haro Strait (e.g., Roche Harbor, Sidney) meeting		
			Define operating parameters (size, type of cargo) for Pender Harbor		
			PSHSC already looking at tug escorts for tankers (Puget Sound Pilots)		
			Improve safety on fishing boats: • Keep list of issues; • Continuous review on addressing these issues; • Interject when necessary or opportunity arises.		

[702] Puget Sound Partnership

Table 119: Bunkering-Related Vessel Risks Identified and Evaluated at the Salish Sea Workshop

Identified Risks		Risk Mitigation		Trans-Boundary Shared Issues	
Overall Risk Landscape • Bunkering activity is expected to increase resulting in more transfer- and transit-related risk. • As of January 1, 2015, heavy fuel oils (HFO) are being replaced by LNG and/or low sulfur diesel. • The consequences from spills are expected to change with the shift to LNG and low sulfur diesel. • The shift from HFO to diesel means the diesel capacity of vessels is larger and there is a greater potential volume of diesel spillage. • Ocean-going vessels will still carry HFO for travel at sea. • HFO bunkering will still occur for vessels going to sea. • Ferries bunker at terminals, which are often located in environmentally-sensitive areas.					
Rank Within Category	**Factor**	**Rank Within Category**	**Risk Mitigation Measure**	**Priorities**	**Solutions**
	Lack of manning standard on towed barges (wheelhouse while underway)				
	Fatigue (long work hours) could increase accident rates		US Code 8104 – 12-hour towing vessel (license personnel); 7/5 rotation for license		
	Bunkering barge inspection concerns		US Code 8104 Subchapter requiring an SMS[703]; vessels previously uninspected now inspected		
			Watch alarm; Two-person lookout during RNA[704] or reduced visibility operations		
			Load/discharge plans reviewed at DOI between PICs to Canada (WAC 317. 40)		
			Advanced notice of transfer (ANT) relayed to all areas		
			Bustar type boom on standby if over S&E threshold		
	Lack of knowledge of bunkering for cross-boundary vessel transits				
		HIGH	Investigate minimizing transits between bunkering locations and final locations (Ecology, Olympic Tug & Barge, Kirby)		
		HIGH	Subcommittee of PSHSC revisit bunkering Standards of Care		

703 Safety Management System
704 Regulated Navigation Areas

Table 120: Geographic Areas of Greater Vessel Risk Identified and Evaluated at the Salish Sea Workshop

Overall Risk Landscape There are some geographic locations in the Salish Sea that are at greater risk due to the higher likelihood of an incident, a greater magnitude of incident with respect to spill volume, and/or due to the greater sensitivity of the environment, cultural, Tribal, and socioeconomic resources.					
Identified Risks		**Risk Mitigation**		**Trans-Boundary Shared Issues**	
Rank Within Category	**Factor**	**Rank Within Category**	**Risk Mitigation Measure**	**Priorities**	**Solutions**
	Rosario Strait/Cherry Point area – issues with management of traffic due to increase, change in traffic, and/or increase in traffic congestion.				
	Rosario Strait/Cherry Point area – concern over ferry delays, medical emergencies, due to greater Rosario Strait traffic.				
	Concern about the "maximum capacity" of the Salish Sea by waterway due to the higher number of vessels with the full build-out of projects.				
	Concern about the appropriate availability of escort tugs with sufficient bollard pull to be capable to deal with high-risk vessels – tankers and non-tank vessels.				
	Concern that the Salish Sea narrow channels have not been properly identified.		Properly identify Salish Sea narrow channels.		
	Concern about designated bunkering sites.				
	Need for improvement in safety for commercial and non-commercial craft, as well as public (NOAA, USCG, Department of Defense) use of waterways.				
	With many natural resources and sensitive shorelines and waterway areas in the Salish Sea, it is important to		Locate a funding source for cross-border and coordination meetings regarding risk		

Overall Risk Landscape There are some geographic locations in the Salish Sea that are at greater risk due to the higher likelihood of an incident, a greater magnitude of incident with respect to spill volume, and/or due to the greater sensitivity of the environment, cultural, Tribal, and socioeconomic resources.					
Identified Risks		**Risk Mitigation**		**Trans-Boundary Shared Issues**	
Rank Within Category	**Factor**	**Rank Within Category**	**Risk Mitigation Measure**	**Priorities**	**Solutions**
	evaluate traffic related to geography, particularly the interface at the Strait of Georgia boundary.		analyses.		
	Anchorage locations and size conflicts with fishing vessels in many locations.				
	Concern about "misinformation" of data sharing and roles of the CVTS for shared waterway routing.		Transparency and sharing of waterway incident data	This was identified as a shared priority by US and Canadian Coast Guards.	
	Geographic locations of particular concern				
1	Haro Strait/Boundary Pass/Turn Point.				
2	Georgia Strait/Rosario Strait.				
3	"Mixing bowl" of Port Angeles/Victoria.				
4	East of Vendovi/Hale Passage.				
5	Strait of Juan de Fuca Entrance.				
6	Admiralty Inlet South.				
7	Approaches to San Juan Islands.				

Table 121: Other Vessel Risks Identified and Evaluated at the Salish Sea Workshop

Identified Risks		Risk Mitigation		Trans-Boundary Shared Issues	
Rank Within Category	Factor	Rank Within Category	Risk Mitigation Measure	Priorities	Solutions
	Lack of coordinated effort to record and evaluate vessel incidents		Discussion regarding definitions of incidents in Salish Sea Data sharing between USCG and CCG In incident data separate bunkering vessels and towing vessels		
	Funding for inspection programs				
	Marine spatial planning				
	Non-tank vessel response plans and enforcement of pre-arranged salvage contracts				
	Aging pilots		Robust pilotage recruitment Anticipate demographic change to maintain standards in light of five-year credential requirements		
	Cross-border coverage of response insurance and responder immunity		Evaluate cross-border response tug constraints		
	Concern about over-dependence on technology for navigation leading to navigational failure				
	Lack of understanding about causes of mechanical failures and fire/explosion incidents				
	Security concerns		Use lessons of collaboration from ship rider program from enforcement mission and use it now as a tool for prevention		