DEPARTMENT OF ECOLOGY
State of Washington

# Report of Vessel Traffic and Vessel Traffic Safety

## *Strait of Juan de Fuca and Puget Sound Area*

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For more information contact:

Spill Prevention, Preparedness, and Response Program
P.O. Box 47600
Olympia, WA 98504-7600
Phone: 360-407-7455

Washington State Department of Ecology — www.ecology.wa.gov

- Headquarters, Olympia 360-407-6000
- Northwest Regional Office, Bellevue 425-649-7000
- Southwest Regional Office, Olympia 360-407-6300
- Central Regional Office, Union Gap 509-575-2490
- Eastern Regional Office, Spokane 509-329-3400

# Report of Vessel Traffic and Vessel Traffic Safety

## *Strait of Juan de Fuca and Puget Sound Area*


Spill Prevention, Preparedness, and Response Program

Washington State Department of Ecology

Olympia, Washington

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# Acknowledgements

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# Executive Summary

More than 20 billion gallons of oil moves through Washington each year by vessel, pipeline, rail, and road, and much of it travels through the Salish Sea to and from Washington refineries. Since 2012, an average of 46 percent of the oil moving through the state is crude oil.

Significant changes in the transportation of crude oil are occurring in the state. As changes have occurred in the volumes and types of oil, modes of transportation, and Ecology's understanding of the properties of the oil moved through the state, Washington is faced with new and evolving risk from an increase in movement of oils that could sink or submerge in water, including diluted bitumen. Additionally, new studies have provided an improved understanding of how these oils interact with the environment, expanding our understanding of the risk associated with their transport.

The Salish Sea is internationally regarded for its ecological, economic, and cultural significance. There has not been a major oil spill in the Salish Sea from collisions or groundings for over 20 years (Van Dorp & Merrick, 2016). This impressive record is a result of a comprehensive safety regime that includes international, federal, and state standards. Other contributing factors include regional collaborative efforts by government, tribes, and stakeholders through forums such as the Puget Sound Harbor Safety Committee (PSHSC), and proactive and voluntary measures taken by industry associations and responsible marine operators. At the same time, the unique ecosystem and resources of the Salish Sea, including declining populations of Southern Resident Killer Whales (SRKWs), are vulnerable to the damage an oil spill could cause.

As recent history has shown nationally and internationally, the low probability but high consequence of a major oil spill demands well-thought-out, continuing efforts to prevent a spill from occurring and to protect these sensitive areas. As oil movement continues to change and present new risks, it is more important than ever for the state to have adequate resources to continue to address impacts to public health and safety, cultural resources, the economy, and the environment.

## Legislative direction

The Washington State Legislature recognizes that oil is transported through Washington's marine waters and along its inland corridors along rivers, streams, and bays. Even with a strong safety regime, there is an ongoing risk of oil spills that could damage human health and the state's valuable environmental, tribal, and economic resources. The Legislature has identified oil spill prevention as the best method to protect these environments (Wash. Rev. Code § 90.56.005, 2015).

In 2018, the Legislature passed the Strengthening Oil Transportation Safety Act (E2SSB 6269). The Act directed the Washington State Department of Ecology (Ecology) to undertake several policy initiatives to help address new and evolving risks, including development of this report on vessel traffic and vessel traffic safety in the Strait of Juan de Fuca and Puget Sound area. The Act directed Ecology to consult with the Puget Sound Partnership (Partnership) and Washington

State Board of Pilotage Commissioners (BPC), as well as with stakeholders, tribes, and First Nations.

The Legislature asked Ecology to assess and evaluate several topics related to oil movement in the study area using existing current vessel traffic risk assessments and other available studies, and to develop recommendations for:

- Vessel traffic management and vessel traffic safety.
- The viability of tug escorts for oil tankers, articulated tug barges (ATBs), and other towed waterborne vessels or barges in reducing oil spill risk.
- The viability of an emergency response system in Haro Strait, Boundary Pass, and Rosario Strait in reducing oil spill risk.

See Appendix A for the full text of the Strengthening Oil Transportation Safety Act.

# Methods

In development of this report, Ecology relied on existing studies including vessel traffic risk assessments. Ecology did not conduct new analyses, with the exception of the economic impact analysis on applying tug escort and pilotage requirements to ATBs and tank barges. Ecology partnered with the Puget Sound Partnership (Partnership) and the Washington State Board of Pilotage Commissioners (BPC) in developing the report. Ecology also consulted with tribes, First Nations, and stakeholders. Literature and data review methodology, as well as details of tribal, First Nation, and stakeholder outreach, are described in Chapter 3.

## Economic impact methods

Ecology examined potential economic impacts of proposals for tug escorts, vessel size, and pilotage requirements. Ecology gathered data working with local stakeholders and key publically available sources to model costs of the baseline and proposed scenarios. The modeling provided comprehensive, data-based, dynamic results across 160 industries in the state, showing a net increase in jobs over 10 years and adding $77 million to Washington’s economy over the same timeframe. Methods, objectives, and results of the economic impact analysis are discussed in Chapter 10.

# Recommendations

Based on the assessment and evaluation presented in chapters 4 through 11, five recommendations have been developed. These recommendations are summarized below. More detail on each is provided in Chapter 12.

## Conduct rulemaking on tug escort requirements

Tug escorts can reduce the risk of a vessel incident that could result in a spill. Ecology recommends amending RCW 88.16.190 (1994) to direct the BPC to conduct rulemaking on tug escort requirements for oil laden tank vessels between 5,000 and 40,000 deadweight tons (DWT) when traveling beyond a point east of a line extending from Discovery Island Light south to New

Dungeness Light. The rulemaking must require tug escorts for Rosario Strait and connected waterways to the east.

## Evaluate effectiveness and funding of an emergency response system

A review of existing risk analyses and studies indicates that an emergency response system in Haro Strait and Boundary Pass similar to the Emergency Response Towing Vessel (ERTV) stationed at Neah Bay has the potential to reduce oil spill risks, but the studies reviewed were not specifically designed to support a final determination, nor did the studies address the issue of funding an ERTV system. The majority of vessels that would benefit from an ERTV would be inbound and outbound to and from Canada.

Ecology recommends a collaborative process to determine the potential effectiveness of ERTVs in Haro Strait and Boundary Pass. The process should include U.S. and Canadian stakeholders, tribes, and First Nations, and should result in recommendations to the Legislature and other governmental bodies, including tribes and First Nations.

## Develop Standard of Care for voluntary vessel speed reduction program

Although predominately addressed at the federal level, reducing vessel speeds can improve vessel safety, may reduce underwater noise, and reduce air pollution from ships.

Ecology recommends the PSHSC consider updating the Puget Sound Harbor Safety Plan (PSHSP) and develop Standards of Care (SOC) for a voluntary vessel speed reduction program.

## Develop Standard of Care for wheelhouse watch stander

Although under full purview of the federal government through the U.S. Coast Guard, changes to crewing levels on ATBs and tugs towing tank barges have been discussed as a potential way to reduce human error and decrease the likelihood of accidents.

Ecology recommends the PSHSC consider updating the PSHSP and develop SOC for a second watch stander in the wheelhouse of ATB and tug-towed tank vessels on certain routes and in specific conditions.

## Expand requirements for reporting oil movement and oil transfer information

Ecology receives information about the movement of crude oil (including diluted bitumen) by vessel, pipeline, and rail in the state that provides a good understanding of oil moving to destinations in the study area. However, reporting requirements vary by mode and do not provide information that allows Ecology to see the complete oil movement picture through the state.

Ecology recommends expanded reporting to fully understand the oil movement picture and evaluate all potential impacts for oil movement by rail, pipeline, and vessel statewide. The additional data would assist Ecology with determining the need for additional prevention and preparedness measures.

# Chapter 1: Introduction

Oil is transported through Washington's marine waters and along its inland corridors along rivers, streams, and bays. Even with a strong safety regime, there is an ongoing risk of oil spills that could damage human health and the state's valuable environmental, tribal, and economic resources. Recognizing the inherent risk involved in oil transport in our state, in 2004, the Legislature declared a "zero spills" goal for the state of Washington.

In 2018, Washington's Legislature passed the Strengthening Oil Transportation Safety Act (E2SSB 6269), which takes additional steps to protect the environment and Washingtonians from oil spill risks, including those from oils that may sink or submerge in water. The Act directed the Washington State Department of Ecology (Ecology) to undertake several policy initiatives to help address these new risks.

Under Section 206 of the Act, Ecology was directed to complete a report on vessel traffic and vessel traffic safety in the Strait of Juan de Fuca and Puget Sound, in consultation with the Puget Sound Partnership (Partnership) and Washington State Board of Pilotage Commissioners (BPC).

Section 206 of E2SSB 6269 follows:

> (1)(a) The department of ecology, in consultation with the Puget Sound partnership and the pilotage commission, must complete a report of vessel traffic and vessel traffic safety within the Strait of Juan de Fuca, Puget Sound area that includes the San Juan archipelago, its connected waterways, Haro Strait, Boundary Pass, Rosario Strait, and the waters south of Admiralty Inlet. A draft report, including recommendations, must be completed and submitted, consistent with RCW 43.01.036, to the legislature by December 1, 2018. The final report must be completed and submitted to the legislature by June 30, 2019.
>
> (b) In conducting the evaluation to produce the report, the department of ecology must rely only on existing current vessel traffic risk assessments and other available studies, consult with the United States coast guard, maritime experts, including representatives of covered vessels, onshore and offshore facilities, environmental organizations, tribes, commercial and noncommercial fishers, recreational resource users, provincial experts, representatives of the Salish Sea shared waters forum established in section 204 of this act, and other appropriate entities.
>
> (2) The report completed under subsection (1) of this section must include an assessment and evaluation of:
>
> (a) Worldwide incident and spill data for articulated tug barges and other towed waterborne vessels or barges;
>
> (b) Transport of bitumen and diluted bitumen;
>
> (c) Emerging trends in vessel traffic;
>
> (d) Tug escorts for oil tankers, articulated tug barges, and other towed waterborne vessels or barges, including a review of requirements in California and Alaska;

(e) Requirements for tug capabilities to ensure safe escort of vessels, including manning and pilotage needs;

(f) An emergency response system in Haro Strait, Boundary Pass, and Rosario Strait, similar to the system implemented by the maritime industry pursuant to RCW 88.46.130;

(g) The differences between locations and navigational requirements for vessels transporting petroleum;

(h) The economic impact of proposals for tug escorts and limitations on vessel size; and

(i) Situations, where oils, depending on their qualities, weathering, environmental factors, and method of discharge, may submerge or sink in water.

(3) The report required under subsection (1) of this section must include recommendations for:

(a) Vessel traffic management and vessel traffic safety; and

(b) The viability of the following in reducing oil spill risk:

(i) Tug escorts for oil tankers, articulated tug barges, and other towed waterborne vessels or barges. If tug escorts are determined in this assessment to reduce oil spill risk, the department of ecology must recommend specific requirements and capabilities for tug escorts;

(ii) An emergency response system in Haro Strait, Boundary Pass, and Rosario Strait, similar to the system implemented by the maritime industry pursuant to RCW 88.46.130. If the department of ecology determines such a system will decrease oil spill risk, it must also recommend an action plan to implement it.

(4) The definitions in this subsection apply throughout this section unless the context clearly requires otherwise.

(a) "Articulated tug barge" means a tank barge and a towing vessel joined by hinged or articulated fixed mechanical equipment affixed or connecting to the stern of the tank barge.

(b) "Waterborne vessel or barge" means any ship, barge, or other watercraft capable of traveling on the navigable waters of this state and capable of transporting any crude oil or petroleum product in quantities of ten thousand gallons or more for purposes other than providing fuel for its motor or engine.

(5) This section expires June 30, 2019. (E2SSB 6269 § 206, Wa. 2018)

## Report overview

This report includes an assessment and evaluation of:

- Worldwide incident and spill data for ATBs and other towed waterborne vessels or barges.

- Transport of bitumen and diluted bitumen oil.
- Emerging trends in vessel traffic.
- Tug escorts for oil tankers, ATBs, and other towed waterborne vessels or barges, including a review of requirements in California, Alaska, Massachusetts, and British Columbia.
- Requirements for tug capabilities to ensure safe escort of vessels, including manning (crewing) and pilotage needs.
- An emergency response system in Haro Strait, Boundary Pass, and Rosario Strait, similar to the system implemented by the maritime industry pursuant to RCW 88.46.130.
- The differences between locations and navigational requirements for vessels transporting petroleum.
- The economic impact of proposals for tug escorts, limitations on vessel size, and pilotage requirements.
- Situations, where oils, depending on their qualities, weathering, environmental factors, and method of discharge, may submerge or sink in water.

The report also includes recommendations for:

- Vessel traffic management and vessel traffic safety.
- The viability of tug escorts for oil tankers, ATBs, and other towed waterborne vessels or barges in reducing oil spill risk, and recommendations for specific requirements and capabilities for tug escorts.
- The viability of an emergency response system in Haro Strait, Boundary Pass, and Rosario Strait, similar to the system implemented by the maritime industry pursuant to RCW 88.46.130 and recommendations for further work.

To address these topics, this report is organized into the following chapters:

- **Chapter 1** presents legislative direction and describes the content and structure of the report.
- **Chapter 2** provides background and context for the report, including a description of the study area, regulatory framework, and previous studies.
- **Chapter 3** describes the methods used for literature review, data review, and tribal and stakeholder outreach.
- **Chapter 4** presents trends in vessel traffic, including historic and current vessel traffic and projection for future traffic
- **Chapter 5** presents international, national, and regional spill data for ATBs and other towed waterborne vessels or barges.
- **Chapter 6** describes situations where oils may sink or submerge in water.

- **Chapter 7** presents oil movement information specific to the transport of bitumen and diluted bitumen in and through the study area.
- **Chapter 8** provides a review of existing legal requirements for vessels transporting petroleum in Canadian and U.S. waters of the study area.
- **Chapter 9** provides and evaluation of tug escorts for oil tankers, ATBs, and other towed waterborne vessels or barges, a review of existing requirements in other states, and requirements for tug capabilities, including crewing and pilotage needs. This chapter also presents Ecology's recommendations with respect to tug escort requirements and voluntary prevention measures in the study area.
- **Chapter 10** provides a description of the economic impact of proposals for tug escorts, vessel size limitations, and pilotage requirements.
- **Chapter 11** provides an evaluation and assessment of development and implementation of an emergency response system in Haro Strait, Boundary Pass, and Rosario Strait, through evaluation of the current system in Neah Bay. This chapter also provides recommendations for next steps with respect to emergency response system development in the study area.
- **Chapter 12** presents a summary of Ecology's evaluation, conclusions, and recommendations developed as a result of our evaluation of the above topics.

# Purpose

As the volumes and types of oil, modes of transportation, and Ecology's understanding of the properties of the oil moved through the state have changed, Washington is faced with new and evolving risk from an increase in movement of oils that could sink or submerge in water. To keep Washington protected against oil spills, there is a need to evaluate the risk associated with the changes in order to make recommendations for appropriate spill prevention measures.

Through this report, Ecology presents legislators with information so they can make informed decisions about specific vessel safety measures. Specifically, the information evaluated for this report enabled Ecology to make recommendations about the use of tug escorts for ATBs or other towed waterborne vessels. The information also allowed Ecology to make recommendations about an emergency response system for Haro Strait, Boundary Pass, and Rosario Strait and recommendations for additional voluntary prevention measures.

# Chapter 2: Background and Context

This chapter provides background and context for the report by describing the existing regulatory framework, recent legislative action, and previous studies in the area. The chapter also defines the study area and provides a description of the study area waterways. It concludes by defining vessel terminology used throughout the report.

## Context

More than 20 billion gallons of oil moves through Washington each year by vessel, pipeline, rail, and road, and much of it travels through the Salish Sea to and from Washington refineries. Since 2012, an average of 46 percent of the oil moving through the state by vessel, pipeline, and rail is crude oil. In 2017, about 4.1 billion gallons, or 46.1 percent, of crude oil was delivered to Washington facilities by vessel (Washington State Department of Ecology, 2018c; Washington State Department of Ecology, 2018d; and Washington State Department of Ecology, 2018e). Significant changes in the transportation of crude oil are occurring in the state. In particular, volumes, types of oil, and modes of transportation have shifted over time. Ecology's understanding of the properties of oil moved through the state have also evolved and improved.

Historically, the majority of crude oil bound for refineries was delivered by tank ship from Alaska. This number has declined significantly in the last 10 years as delivery of crude oil by pipeline and rail has increased. From 2007 to 2011, an average of 6.6 billion gallons a year was imported by vessel to Washington refineries (Washington State Department of Ecology, 2018f). In 2017, 4.1 billion gallons were transported by vessel (Washington State Department of Ecology, 2018c).[1] The properties of some of the oils being transported also raise planning and response concerns. Although diluted bitumen has been moved in the study area for many years, Washington is faced with new and evolving risk involving oils that could sink or submerge in water.[2] This risk is a result of an increase in movement of oils that could sink or submerge in water, including diluted bitumen, as well as new studies that have provided an improved understanding of how these oils interact with the environment, expanding our understanding of the risk associated with their transport.

Additionally, in 2015, Congress lifted the federal export ban of crude oil as part of the 2016 Consolidated Appropriations Act. This recent change allows companies to transport crude oil to foreign markets without being limited by the current capacity of refineries to refine the oil first. This could potentially result in an increase of oil moving over water through the study area. See Chapter 7 for information on crude oil movement through the study area.

The Salish Sea is internationally regarded for its ecological, economic, and cultural significance. There has not been a major oil spill in the Salish Sea from collisions or groundings for over 20 years (Van Dorp & Merrick, 2016).[3] This impressive record is a result of a comprehensive safety regime that includes international, federal, and state standards. Other contributing factors include

[1] See Chapter 7 for further discussion.
[2] Washington State contingency planning requirements include planning standards that require plan holders to have access to equipment to locate, contain, and recover submerged oil. See Chapter 6 for further discussion.
[3] The VTRA 2015 final report defines a major spill as a spill greater than 10,000 gallons.

regional collaborative efforts by government, tribes, and stakeholders through forums such as the Puget Sound Harbor Safety Committee (PSHSC), and proactive and voluntary measures taken by industry associations and responsible marine operators. Specifics on existing international, federal, state, and voluntary Standards of Care (SOC) are discussed in this chapter and throughout this report. At the same time, the unique ecosystem and resources of the Salish Sea, including declining populations of Southern Resident Killer Whales (SRKWs), are vulnerable to the damage an oil spill could cause.

The low probability but high consequence of a major oil spill demands well-thought-out, continuing efforts to prevent a spill from occurring and to protect these sensitive areas. To keep Washington protected against oil spills, Ecology works with tribes and stakeholders, including industry, to evaluate changing risks and recommend appropriate spill prevention and preparedness measures. This collaborative work is foundational to the Ecology Spills Program's mission of protecting Washington's environment, public health, and safety, and enables progress towards Ecology's legislatively-directed goal of "zero spills." As oil movement continues to change and present new risks, it is more important than ever for the state to have adequate resources to continue to address impacts to public health and safety, cultural resources, the economy, and the environment.

# Existing safety measures

Robust processes are in place to minimize the risks of oil spills from commercial vessels. Starting in the early 1990s, significant changes have occurred in maritime safety. The safety of the vessel fleet has improved as newer vessels enter service that incorporate additional safety and stability requirements, and industry groups have improved how vessels are operated and managed.

Perhaps the most notable changes in vessel safety were amendments of the International Maritime Organization (IMO) International Convention for the Prevention of Pollution from Ships (MARPOL), and the passage of the Oil Pollution Act of 1990 (OPA 90).

MARPOL and OPA 90 included double hull requirements for tank vessels. A 2006 amendment to MARPOL limits maximum fuel tank sizes, and requires fuel tanks to be located away from the hull. The requirement applies to all ships with an aggregate fuel capacity of $600m^3$ and above, delivered after August 1, 2010 (International Maritime Organization, 2006).

OPA 90 increased federal oversight of maritime oil transportation by:

- "Setting new requirements for vessel construction, and crew licensing and manning.
- Mandating contingency planning.
- Enhancing federal response capability.
- Broadening enforcement authority.
- Increasing penalties.
- Creating new research and development programs.
- Increasing potential liabilities.
- Significantly broadening financial responsibility requirements." (U.S. Coast Guard, n.d.-b)

Many entities, including the IMO, the U.S. Coast Guard, Puget Sound Pilots, Ecology, industry associations, and the PSHSC, contribute to improving maritime safety and reducing the risk of oil spills from vessels. A brief overview of these organizations and associated safety practices is provided below.

## International Maritime Organization

The main role of the IMO is to create a regulatory and standards framework for the shipping industry that is effective, internationally agreed upon, adopted, and implemented. Their standards cover all aspects of international shipping—ship design, construction, equipment, crewing, operation, and disposal—to ensure that shipping remains safe, environmentally sound, energy efficient, and secure (International Maritime Organization, n.d.-c).

Key IMO conventions related to safety and oil spill prevention include:

- International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended.
- International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto and by the Protocol of 1997 (MARPOL).
- International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) as amended, including the 1995 and 2010 Manila Amendments.

## U.S. Coast Guard

The U.S. Coast Guard protects the maritime economy and the environment, defends the maritime borders, and rescues those in peril (U.S. Coast Guard, 2002). The U.S. Coast Guard operates through authorities as the Sector Commander; Officer in Charge, Marine Inspection; Captain of the Port; Federal On-Scene Coordinator; and Federal Maritime Security Coordinator. The U.S. Coast Guard is engaged locally with the Harbor Safety Committee.

U.S. laws and the Code of Federal Regulations (CFR) have incorporated IMO regulations and standards. The U.S. Coast Guard enforces compliance by foreign flagged vessels through its Port State Control authorities, and by U.S. flagged vessels through its Flag State authorities.[4]

Coast Guard missions related to oil spill prevention, safe navigation and vessel safety include:

- Port safety, waterways management, and port and coastal security.
- Aids to navigation.
- Port State Control.
- Vessel inspections.
- Oil spill response planning.
- Marine casualty investigations.

In addition to operating the Puget Sound Vessel Traffic Service (VTS), the Coast Guard participates in the Cooperative Vessel Traffic Service (CVTS) with Canada, described in Chapter

[4] The U.S. Coast Guard's Port State Control (PSC) program verifies that foreign flagged vessels operating in U.S. waters comply with applicable international conventions, U.S. laws, and U.S. regulations.

8. The CVTS is operated jointly by the U.S. and Canada, and "facilitates traffic movement and anchorages, avoids jurisdictional disputes, and renders assistance in emergencies in adjoining United States and Canadian waters" (33 CFR 161, 1994).

### 46 CFR Subchapter M

46 CFR Subchapter M, Towing Vessels, comprises relatively new safety measures administered by the Coast Guard (46 CFR 136, 2016). Subchapter M describes requirements for obtaining and renewing Certificates of Inspection (COI) for towing vessels. Towing vessels may choose from one of two options to get a COI: inspection by the Coast Guard; or establishing a Towing Vessel Safety Management System, with routine audits from approved third-party organizations. Subchapter M increases the types of towing vessels that require COI; and establishes standards for lifesaving equipment, firefighting, machinery and electrical systems, and watertight integrity. Subchapter M took effect in June of 2016, with a 6-year schedule of phase-in dates for existing vessels.

### QUALSHIP 21 and E-Zero

The Coast Guard also administers two incentive programs for non-U.S. flagged vessels to encourage and recognize commitment to strict compliance with national and international standards for safety, security, and the environment: Quality Shipping for the 21$^{st}$ Century (QUALSHIP 21), and E-Zero (U.S. Coast Guard, 2017).

Vessels meeting QUALSHIP 21 standards are posted on a U.S. Coast Guard website. Vessel names are also provided to Equasis, a public site promoting maritime safety and quality. Tank vessels in the QUALSHIP 21 program receive a reduced-scope inspection during annual Certificate of Compliance examinations. Freight vessels are eligible for three years of limited Port State Control oversight. Passenger vessels are not subject to reduced inspections, but do receive a certificate and recognition on Coast Guard and Equasis websites (U.S. Coast Guard, 2017).

The E-Zero designation provides an additional incentive for ships enrolled in QUALSHIP 21 for at least three years. To qualify for E-Zero designation, vessels must have zero Maritime Pollution detentions and zero environmental deficiencies in the U.S. over the past three years; zero letters of warning, notices of violation, or civil penalties related to Right Whale Mandatory Ship Reporting or speed restriction violations over the past five years; and must have an approved Ballast Water Management System installed (U.S. Coast Guard, 2017). Tank vessels with the E-Zero designation are permitted to conduct cargo operations within six months of their Certificate of Compliance annual examination due date and the Certificate of Compliance expiration date. Passenger vessels meeting E-Zero criteria receive a reduced scope examination for the environmental portion of their Certificate of Compliance periodic exams (U.S. Coast Guard, 2017).

## Pilotage

Compulsory pilotage is a tool used by many jurisdictions worldwide to increase marine safety and help prevent vessel accidents within their waters (Quick, n.d.). As discussed in Chapter 8, the Washington State Board of Pilotage Commissioners (BPC) regulates pilotage in Washington State through the Washington State Pilotage Act (Chapter 88.16 RCW). The intent of the law is to “prevent the loss of human lives, loss of property and vessels, and to protect the marine environment of the state of Washington through the sound application of compulsory pilotage provisions in certain of the state waters” (Wash. Rev. Code § 88.16.005, 1977).

Foreign-flagged vessels in Washington State pilotage districts are required to use a state-licensed pilot (Community Attributes, Inc., & Gleason & Associates, 2018). In addition, the Washington Legislature recognized that the “Puget Sound and adjacent waters have limited space for maneuvering a large oil tanker and that these waters contain many natural navigational obstacles as well as a high density of commercial and pleasure boat traffic. For these reasons, it is important that large oil tankers be piloted by highly skilled persons who are familiar with local waters and that such tankers have sufficient capability for rapid maneuvering responses” (Wash. Rev. Code § 88.16.170, 1991). To address this concern, the Legislature requires any registered oil tank ship of five thousand gross tons or greater to take a Washington State licensed pilot while navigating the Puget Sound (Wash. Rev. Code § 88.16.180, 1991).

In Canadian waters, the Pacific Pilotage Authority Canada (PPA) regulates pilotage and oversees the British Columbia Coast Pilots, which provide pilotage services. The Oregon Treaty of 1846 and a 2015 Memorandum of Agreement (MOA) between the PPA, BC Coast Pilots, and the Puget Sound Pilots Association provide guidance for pilotage coordination between the U.S. and Canada in the waters of the study area.

For Federal pilotage, the U.S. Coast Guard runs the licensing program.

See Chapter 8 for additional discussion of pilotage in Washington State and British Columbia.

## Tug escorts for tank ships

Tank ships in Washington and British Columbia waters require tug escort, as described in Chapter 9. In Washington, tank ships greater than 40,000 dead weight tons loaded with oil must be escorted (Wash. Rev. Code § 88.16.190 (1994), Wash. Admin. Code § 363-116-500 (1997)). The PPA established guidance for Canadian waters, requiring tug escort for tank ships greater than 40,000 dead weight tons loaded with liquids in bulk, and more stringent requirements for those carrying crude oil (Pacific Pilotage Authority, 2015). See additional discussion of tug escorts in Chapter 9.

## Neah Bay emergency response towing vessel

The Neah Bay emergency response towing vessel (ERTV) is described in Chapter 11. The ERTV is intended to prevent oil spills from ship and barge groundings. The establishment and use of the emergency response system ERTV is defined in RCW 88.46.130 (2009) and WAC 173-182-242 (2013).

The ERTV is available to serve vessels in the Strait of Juan de Fuca and off of Washington’s western coast from Cape Flattery light in Clallam County south to Cape Disappointment light in Pacific County (Wash. Rev. Code § 88.46.130, 2009). Required tug capabilities are outlined in the Emergency response system —Vessel planning standards in RCW 88.46.135 (2009) and discussed in Chapter 11.

## Washington State Department of Ecology

Ecology's Spill Prevention, Preparedness, and Response Program (Spills Program) focuses on preventing oil spills to Washington's waters and land, and planning for and delivering a rapid, aggressive, and well-coordinated response to oil and hazardous substance spills wherever they occur (Washington State Department of Ecology, 2018k). The Spills Program works with communities, industry, state and federal agencies, tribes, and other partners to prevent and prepare for oil spills. The Spills Program also responds to spills 24/7 from six offices located throughout the state and works to assess and restore environmental damage resulting from spills. Spills Program activities include:

- Preventing oil spills from vessels and oil handling facilities.
- Preparing for aggressive response to oil and hazardous material spills.
- Rapidly responding to and cleaning up oil and hazardous material incidents.
- Restoring public natural resources damaged by oil spills.

Core services include vessel inspections of commercial cargo and passenger vessels of 300 gross tons or more, facility inspections, oil transfer monitoring, plan review and approvals, contingency plan drills, development of Geographic Response Plans, technical assistance, environmental restoration, and 24/7 response to oil and hazardous materials spills.

### Voluntary Best Achievable Protection and Exceptional Compliance Program

Ecology also manages voluntary programs for the safe and pollution-free operation of tank vessels (Washington State Department of Ecology, 2018m). The goal of these programs is to recognize tank ship companies that go beyond minimum state, federal, and international safety and environmental requirements. Similar to the Coast Guard QUALSHIP 21 and E-Zero initiatives, the Voluntary Best Achievable Protection (VBAP) and Exceptional Compliance Program (ECOPRO) programs identify standards that represent many of the best practices found on tank vessels throughout the world.

VBAP and ECOPRO standards were developed jointly with industry representatives. The goal is to provide standards higher than those required by law but achievable by today's proactive marine transportation companies. The VBAP standards provide best achievable practices for 35 areas of vessel management and operation, including areas such as bridge resource management, spill preparedness, and shipboard emergency drills. ECOPRO provides additional measures for vessels exceeding the VBAP standards. Vessels meeting VBAP and ECOPRO standards receive public recognition, reduced fees for the Neah Bay ERTV, and reduced frequency of oil spill contingency plan compliance examinations by Ecology (Washington State Department of Ecology, 2018m).

## Industry associations and practices

Several marine transportation industry organizations develop standards of operation to ensure safety and environmental protection. These organizations engage in continuous activity to improve technical and operational safety standards throughout the industry.

### Classification societies

Classification societies are independent, non-governmental organizations that develop standards and best practices for the maritime, oil and gas industries. Ships are classified to verify the:

- Structural strength and integrity of essential parts of a ship's hull and its appendages.
- Reliability and function of the propulsion and steering systems, power generation and auxiliary systems.

They achieve this by applying their own rules and verifying compliance with international and/or national regulations on behalf of flag administrations.

Most commercial ships in the world are built to and surveyed for compliance with the standards developed by Classification Societies (International Association of Classification Societies, 2018).

Classification societies verify vessel plans prior to and during construction, wherever the vessel is built. Once in service, the vessel must receive periodic class surveys, carried out onboard the vessel. These surveys verify that the vessel meets the requirements for continuation of class. This is in addition to inspections which may be carried out by the U.S. Coast Guard or other agencies.

### American Petroleum Institute

The American Petroleum Institute (API) is an industry trade association that represents all aspects of the oil and natural gas industry including marine transporters. One of API's missions is to promote safety across the industry globally.

"API conducts or sponsors research ranging from economic analyses to toxicological testing" (American Petroleum Institute, n.d.). The organization also develops safety standards and recommended practices for safe operations, and it currently maintains nearly 700 safety standards and recommended practices. Many of these have been incorporated into state and federal regulations. They also certify oil and natural gas equipment used onboard vessels and at bulk oil marine terminals (American Petroleum Institute, n.d.).

### American Waterways Operators

The American Waterways Operators (AWO) is a trade organization representing the U.S. tugboat, towboat and barge industry (American Waterways Operators, n.d.). They have developed a program to assist tug and barge operators in developing safety management systems and assistance in complying with regulations. The AWO Responsible Carrier Program is a U.S. Coast Guard accepted Towing Safety Management System as defined in 46 CFR Subchapter M.

### Marine Exchange of Puget Sound

The Marine Exchange of Puget Sound (Exchange) provides communications and information services for over 75 members, including Puget Sound based steamship agents and operators, tug operators, ship chandlers, port authorities (Marine Exchange of Puget Sound, n.d.-a). The Exchange also communicates with state and federal agencies. The Exchange operates 24 hours a day, 365 days a year. The Exchange operates an Automatic Identification System (AIS) network, and tracks and monitors the arrival of commercial vessels to U.S. ports in Puget Sound and

Grays Harbor. The Exchange handles oil spill notifications and "is the official communications clearinghouse for the Washington State Maritime Cooperative, an emergency oil spill response organization serving Puget Sound and Grays Harbor" (Marine Exchange of Puget Sound, n.d.-a).

### Puget Sound Harbor Safety Committee

The mission of the PSHSC is to provide a proactive forum for identifying, assessing, planning, communicating, and implementing operational and environmental measures beyond statutory and regulatory requirements that promote safe, secure, and efficient use of Puget Sound and adjacent waters. The committee is made up of delegates appointed by broadly based organizations representing a span of interests focused on Puget Sound. Additionally, various governmental agencies formally support the work of PSHSC in advisory roles (Puget Sound Harbor Safety Committee, n.d.).

PSHSC takes responsibility for capturing existing standards and protocols as well as developing new standards and protocols that address environmental and operational elements of maritime operations that are somewhat unique and especially significant to Puget Sound. The standards and protocols have been compiled in the Puget Sound Harbor Safety Plan (PSHSP) which is intended to complement and supplement existing federal, state, and local laws and regulations by providing advice to mariners regarding unique conditions and requirements that may be encountered in Puget Sound and adjacent waters. These voluntary standards and protocols are not intended to supplant or otherwise conflict with the laws or regulations, nor are they intended to replace the good judgment of a ship's master in the safe operation of his/her vessel (Puget Sound Harbor Safety Committee, 2017).

### Vetting practices

Oil companies manage risks through screening vessels and terminals according to a set of minimum standards, including regulatory compliance. Over the past 25 years, oil companies have raised the standards for tank vessels through a process referred to as *vetting*. Vetting includes inspections and audits of vessels and terminals. While vetting practices are not mandatory, compliance is normally required to be eligible for contracts to carry oil.

The Oil Companies International Marine Forum (OCIMF) is a key organization that enables an effective global vetting system. The forum, established in 1970, develops safety and environmental protection standards and regulations in the maritime transportation and handling of oil. It also hosts data for charterers and regulatory authorities on tankers and barges through the Ship Inspection Report (SIRE) program (Oil Companies International Marine Forum, n.d.-a).

#### *Ship inspection report program*

The OCIMF introduced the Ship Inspection Report (SIRE) program to specifically address concerns about sub-standard shipping practices. The SIRE Program is a tanker risk assessment tool. It provides common information to charterers, ship operators, terminal operators and government bodies about the safety systems, practices, and material conditions of particular vessels.

SIRE inspections are conducted by third party auditors who meet OCIMF qualification requirements and use a uniform inspection protocol. More than 180,000 inspection reports are in the SIRE database (Oil Companies International Marine Forum, n.d.-b).

Incomplete or unsuccessful SIRE inspections can result in:

- Loss of contracts.
- Additional safety, equipment, and management requirements.
- Probationary periods where contracts are not awarded until SIRE inspection deficiencies are corrected.

*Tanker management and self-assessment*

The OCIMF also hosts the Tanker Management & Self-Assessment program (TMSA). This program provides a set of industry best practices for vessel operating companies to assess operator safety management systems. TMSA encourages companies to assess their safety management systems and create achievable plans for improvement (Oil Companies International Marine Forum, n.d.-c).

As with SIRE reports, results of TMSA assessments are shared among the oil handling supply chain and government regulators. The same conditional requirements of the SIRE are also applicable to the TMSA with respect to contracting.

*Terminal vetting*

Terminals also can be vetted by ship owners under the Marine Terminal Information System (MTIS). Compared to SIRE, it is a relatively new repository. It captures information offered by terminal operators about their physical arrangements such as depth and mooring, and the terminals' management systems (Oil Companies International Marine Forum, n.d.-d). Multiple terminals within the study area are represented in MTIS, including the Port of Seattle, Port of Tacoma, Port of Anacortes, Ferndale, and Cherry Point.

*Company vetting*

In addition to the OCIMF programs (SIRE, TSMA, and MTIS), individual companies may have their own vetting programs. Company vetting programs could exceed the requirements of SIRE and/or TSMA, as well as U.S. Coast Guard or Ecology requirements. They may also be specific to a particular voyage or route.

## Recent legislative action

The Washington State Legislature recognizes that vessels transport oil across some of Washington's most special and unique marine environments, which are sources for beauty, recreation, and economic livelihood. It has identified oil spill prevention as the best method to protect these environments (Wash. Rev. Code § 90.56.005, 2015).

As discussed above, a robust set of prevention and preparedness safety standards is in place to reduce the likelihood of incidents and oil spills in state waters. Changes in the way oil is transported and the types of oil being moved in Washington, along with better understanding of the properties of these oils, require a re-evaluation of oil spill risks and potential prevention measures. Washington leaders recognize these changes and passed the 2015 Oil Transportation Safety Act and the 2018 Strengthening Oil Transportation Safety Act. These bills direct Ecology to take action to address changing risks. In accordance with the 2015 Oil Transportation Safety Act, Ecology has:

- Adopted rules requiring contingency plans for railroads that transport oil by rail.
- Adopted rules requiring reporting of crude oil movement by facilities that receive crude oil by rail and by pipelines that transport crude oil through the state.
- Developed an equipment cache grant program.
- Developed Geographic Response Plans (GRPs) for inland areas of the state that could be impacted by oil spills from railroads.
- Completed vessel traffic risk and safety assessments.

As directed by the 2018 Strengthening Oil Transportation Safety Act, Ecology is:

- Establishing a Salish Sea Shared Waters Forum to exchange information to enhance oil spill prevention, preparedness and response measures.
- Reporting on vessel traffic and vessel traffic safety in the Strait of Juan de Fuca and Puget Sound.
- Updating contingency plan rules to address oils that may sink or submerge in water.
- Updating GRPs to address oils that may sink or submerge in water.
- Conducting reviews and prioritizing inspections of oil transfers where oils may submerge or sink.
- Preparing a report to the Legislature about oil spill program activities and funding.

Additionally, in March 2018, Washington Governor Jay Inslee established the Southern Resident Killer Whale (SRKW) Recovery and Task Force through Executive Order 18-02. The Governor charged the Task Force with development of a comprehensive report containing recommendations for recovering Southern Resident orcas. The executive order outlines the major threats to SRKWs that must be addressed, including two covered in this report: toxic contaminants and disturbance from vessel traffic and associated underwater noise. On November 16, 2018, the Task Force released final recommendations for potential actions, including actions related to oil spill prevention and underwater noise.

# Overview of previous studies

Since 2014, Ecology has developed or sponsored several studies to address the risks of oil moving through Washington. These studies have helped Ecology to understand some of the risks associated with the changes to oil transport in Washington, and have contributed to this report.

## 2014 Marine and Rail Oil Transportation Study

In April 2014, the Washington State Legislature directed Ecology to study potential risks posed from oil transported by rail and vessel and to identify ways to mitigate the risks. The study analyzed the risks to public health and safety and the environmental impacts associated with the transport of oil in Washington. Ecology worked with several partners to complete the study, including the Washington Utilities and Transportation Commission, Washington Emergency Management Division, tribes, other federal, state, and local agencies, informal and formal public and private committees, organizations, industry, and the public.

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 Utilities and Transportation Commission reviewed safety records for almost 350 rail crossings. 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.

The study resulted in 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 recommendations are a mix of risk mitigation steps at the federal and state levels addressing rail, marine, facility, emergency response, and oil spill planning response. They include direction on improving infrastructure, facility design, industry operational processes and practices; expanding sensitive area protections; emergency and spill response equipment caching; personnel training; and planning improvements. The study also identifies gaps in information which future studies should address.

Many of the recommendations regarding oil spill planning and response and emergency response have been addressed since publication of the study. Some key recommendations that have been implemented include:

- Modification of Washington's statutory definition of "facility" to include railroads that transport oil by rail and subsequent adoption of rules requiring contingency plans for these railroads.
- Adoption of rules requiring reporting of crude oil movement by facilities that receive crude oil by rail and by pipelines that transport crude oil through the state.
- Amendment of the statutory definition of "oil" to include bitumen, synthetic crude oil, and natural gas well condensate.
- Development of an equipment cache grant program to enhance emergency response capabilities.
- Funding for emergency management planners for the Washington Emergency Management Division to assist with local jurisdictions' Local Emergency Planning Committee hazardous materials response planning.
- Funding for continued GRP work and development of GRPs for inland areas of the state that could be impacted by oil spills from railroads.
- Ongoing funding for Ecology risk transportation experts, an update to the 2010 Puget Sound Vessel Traffic Risk Assessment, and a Vessel Traffic Evaluation and Safety Assessment (CRVTSA) for the Columbia River.

Other recommendations made in the Marine and Rail Oil Transportation Study are discussed in this report, including expanded tug escort requirements, evaluating the effectiveness of ERTVs, and increased situational awareness.

## 2015 Vessel Traffic Risk Assessment (VTRA)

Ecology sponsored the 2015 VTRA, which provides updated information about the risks of oil spills from commercial vessel traffic currently operating on the Salish Sea. It also modeled potential impacts from planned future developments as well as potential benefits from a variety of spill prevention measures.

The assessment was conducted by principal investigators from George Washington University and Virginia Commonwealth University. A workgroup with representatives from government, tribal, industry, and environmental organizations provided input and guidance to Ecology and the principal investigators. The updated assessment is based on 2015 vessel traffic data and builds upon previous assessments that incorporated vessel traffic data from 2005 and 2010.

The 2015 VTRA final report provides information to help government, tribes, and stakeholders answer complex and location-specific risk management questions. The report offers valuable insight into relative changes in risk and potential benefits that could be realized by a portfolio approach to risk reduction.

## 2015 and 2016 Salish Sea workshops

In January 2015, Ecology held a workshop (the Salish Sea Workshop: Vessel Oil Spill Risk Assessment and Management) in which participants identified several categories of risk for oil spills associated with vessel traffic patterns in the Strait of Juan de Fuca and the Salish Sea. Within each category, participants identified specific risk factors and began to identify mitigation measures to address each risk factor. This workshop led to the development of 225 initial risk reduction measures.

The 2016 Salish Sea Oil Spill Risk Mitigation Workshop built and expanded on the 2015 effort, incorporating new recommendations from studies and efforts that have taken place since January 2015. The workshop was sponsored by Ecology, with planning, workshop management, and reporting for the workshop provided by Dally Environmental and Veda Environmental under contract to Ecology. Participants for both workshops were invited from Washington State and British Columbia and included representatives from industry, state agencies, tribes and First Nations, Canadian and U.S. federal agencies, and non-governmental organizations.

The 2016 workshop concentrated on prevention-focused risk reduction measures to help reduce the risk of oil spills from vessel traffic in the Strait of Juan de Fuca and the Salish Sea. The risk reduction measure categories addressed in the 2016 workshop included anchorage, bunker/oil transfer, general waterways management, vessel movement, tug/escort, and coordination and information sharing.

The goal of the workshop was to develop specific actionable recommendations and associated implementation strategies to address the highest priority prevention-focused risk reduction measures for reducing and further preventing oil spills from vessel traffic in the Strait of Juan de Fuca and the Salish Sea. During the workshop, participants prioritized the initial list of 225 risk reduction measures through breakout group discussions and a dot exercise voting process. From this process, workshop participants prioritized nine measures and developed implementation plans.

The three topics of most interest for improved prevention efforts focused on transboundary coordination, an ERTV, and escort tugs. Two of these topics are specifically addressed within this report.

### 2017 Columbia River Vessel Traffic Safety Assessment (CRVTSA)

In 2015, the Oil Transportation Safety Act required Ecology to evaluate and assess vessel traffic management and vessel traffic safety within and near the mouth of the Columbia River. The Act directed Ecology to consult with tribes and stakeholders and determine: 1) the need for tug escorts for vessels transporting oil as cargo, 2) tug capabilities to achieve safe escort, and 3) the best achievable protection for vessels transporting oil as cargo. The Legislature also asked Ecology to develop recommendations for vessel traffic management and safety, including tug escort requirements.

Ecology hired Det Norske Veritas (DNV GL), an independent maritime vessel safety expert, to evaluate cargo oil spill risks on the Columbia River and the Columbia River Bar. Working with DNV GL, Ecology consulted with tribes and stakeholders through a series of workshops and meetings to determine evaluation inputs and to review results. The evaluation identified current safety practices and how these practices influence existing and future risks. Cargo oil spill risks on the Columbia River were modeled quantitatively for current vessel traffic and two potential future traffic cases.

Based on the findings of the CRVTSA, Ecology developed recommendations that include supporting collaborative maritime safety programs and seeking tethered tug escort of laden tank ships when tank ship traffic on the Columbia River increases.

## Study area

As directed by E2SSB 6269 (2018), this report focuses on the Strait of Juan de Fuca and Puget Sound area that includes the San Juan archipelago, its connected waterways, Haro Strait, Boundary Pass, Rosario Strait, and the waters south of Admiralty Inlet.

The study area encompasses the Strait of Juan de Fuca as well as the waters of Puget Sound from the Canadian Border to the north, Buoy J to the west, Olympia to the south, and inland areas of Washington to the east of existing oil pipelines and railroad routes along the Interstate 5 corridor. A map of the study area is shown in Figure 1 below.


**Figure 1: Study area**

## Characteristics of the study area waterways

The study area encompasses the marine waters of northwestern Washington State and the waterways of the Strait of Juan de Fuca, Haro Strait, and Boundary Pass, shared with British Columbia. These bodies of water, often referred to as the Salish Sea, are the gateway to two of the largest ports on the west coast of North America: Seattle/Tacoma, Washington and Vancouver, British Columbia.

The Salish Sea is a waterway rich in natural resources and is home to endangered salmon runs and an endangered SRKW population. Tribes and First Nations of the U.S. and Canada, respectively, derive physical, spiritual, and cultural value from these marine resources. Local fishing and aquaculture communities rely on clean, cool, waters of the Salish Sea for their livelihood. Tourism and other recreational uses comprise a significant economic sector of both Washington and British Columbia. Maritime commerce also comprises a significant economic sector of both Washington and British Columbia.

The Olympic Coast National Marine Sanctuary includes 3,188 square miles of marine waters off the rugged Olympic Peninsula coastline, a portion of which is within the study area. The sanctuary extends 25 to 50 miles seaward, covering much of the continental shelf and several major submarine canyons.

## Geography

In general, the waters of the Salish Sea are deep, and, compared to the dynamic channels and bays of East Coast, tend to change slowly. Therefore, descriptions of the waterway written for a 1997 report, *Scoping risk assessment: Protection against oil spills in the marine waters of northwest Washington State*, still accurately portray conditions that impact marine traffic when navigating these waters. See Figure 2 for waterway locations discussed below.

> The Strait of Juan de Fuca separates the south coast of Vancouver Island, Canada, from the north coast of Washington State. It is the principal waterway by which international and regional commerce moves to and from the Washington State ports of Port Angeles, Bellingham, Everett, Seattle, Tacoma, Olympia; the oil terminals at Anacortes and Ferndale; and the Canadian ports of Victoria, Vancouver and Roberts Bank.
>
> The Strait is approximately 80 miles long. From its mouth to Race Rocks (opposite Port Angeles), approximately 50 miles east, it averages 12 miles in width. From Race Rocks to Whidbey Island, its eastern boundary, approximately 30 miles further east, the Strait widens to 16 miles. The traffic lanes are approximately one nautical mile wide. There are very few dangerous shoal areas, and the waters are generally deep, except near the shoreline. The depth of water in the traffic lanes regularly used by commercial oceangoing ships generally ranges from over 600 feet at the entrance of the Strait to 100 feet near the eastern end of the Strait.
>
> The eastern portion of the Strait is the shipping crossroads of the waterway. Ocean going ships bound for Canada will turn north at Port Angeles, board pilots at Victoria, and proceed north via Haro Strait and Boundary Pass for Canadian ports on the Strait of Georgia. Ships for the United States board pilots at Port Angeles and proceed east through the Coast Guard Precautionary area. Those for south Puget Sound ports head due east for Admiralty Inlet, while shipping for Anacortes and Bellingham turn approximately northeast for Rosario Strait. Traffic separation schema are used in all cases. The crossroads area also sees a great deal of inland traffic trading between U.S. and Canada ports.

> The San Juan Islands lie north of the eastern Strait of Juan de Fuca. This archipelago lies within the United States boundary and is known to residents and tourists alike for its natural beauty. Haro Strait (width from 1½-6 nautical miles), flowing roughly on a north-south axis to the islands' west, and Boundary Pass (minimum width of 2 ½ nautical miles), running east to west to the Islands' north, separate them from Vancouver Island and the Canadian Channel Islands. Ships on this route must make three sharp course changes.
>
> The eastern rim of the waterway is marked by more areas of shallow water and extensive tidal marshes and mudflats in Padilla, Bellingham, Lummi, and Skagit Bays in Washington State, and Boundary Bay and Roberts Bank in Canada.
>
> Rosario Strait (1¾ - 4 nautical miles wide) bounds the San Juans to the east. Tankers bound for the Anacortes refineries transit the narrow Guemes Strait between Fidalgo and Guemes Islands and terminate in Padilla Bay. Those for Cherry Point and Ferndale transit the entire Rosario Strait and enter the Precautionary Area between Lummi Bay and Alden Bank for approach to the terminals.[5]
>
> The southeastern portion of the waterway runs from Port Townsend at the mouth of Admiralty Inlet to Olympia and Hammersley at the southern extreme. Washington's population centers are here, as are the heaviest marine traffic concentrations. Admiralty Inlet (2½ -5 miles width) runs roughly southeast for approximately 20 miles, past the mouth of the Hood Canal to Point No Point, where Puget Sound proper begins.
>
> The Puget Sound channel runs about 40 miles in length to Commencement Bay at Tacoma, passing by approaches to harbors at Everett, Kingston, Seattle, Eagle Harbor, and Bremerton. Tacoma Harbor is on Commencement Bay, south of which there is no traffic separation scheme. Passage south to Olympia is quite narrow (in many places less than one mile) and has a number of sharp turns and shallows to negotiate. The approaches to both Olympia and Hammersley narrow to less than ½ mile in width. (Dyer, Schwenk, Watros, & Bonnifaced, 1997, p.27-28)

Of the waters in the study area, the Haro Strait/Boundary Pass and Rosario Strait routes to the west and east of the San Juan Islands, respectively, contain the most shallow water hazards (rocks and reefs) in combination with relatively narrow channels and significant channel bends. Additionally, a significant tank vessel route from Anacortes north towards Ferndale and Cherry Point contains a choke point of just two-tenths of a mile wide between Huckleberry and Saddlebag Islands. These areas are of particular concern in the report, in part due to the described waterway features.

---

[5] A Precautionary Area is a "routing measure comprising an area within defined limits where ships must navigate with particular caution and within which the direction of traffic flow may be recommended." (65 Fed. Reg. 8917, 2000)

On the Rosario Strait route, shoals with depths less than ten fathoms (60 feet) include (from south to north) Lawson Reef, Belle Rock,[6] Black Rock, Lydia Shoal,[7] Buckeye Shoal, Peapod Rocks, and Clements Reef.[8] The passage through this route is a high concern for several reasons, including rocky shorelines, transit corridors limited by off-lying hazards, high currents, and distance from infrastructure. The currents in these waterways routinely reach two knots during both flood and ebb and on occasion can exceed three knots (Center for Operational Oceanographic Products and Services, 2013).

Also of importance with regard to oils that could sink or submerge in water, Puget Sound is made up of a series of underwater valleys and ridges with an average depth of 450 feet. A maximum depth of 930 feet occurs just north of Seattle. The Juan de Fuca Canyon reaches the opening of the Strait of Juan de Fuca, and is about 4 miles wide and at least 1,350 feet deep, twice the depth of the surrounding seafloor.

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[6] In October 2011, the cargo barge *St. Elias*, carrying 18 tons of Navy ordnance (explosives) and towed by the tug *Henry Brusco*, grounded on Belle Rock in the early morning hours. The barge, operating in a VTS-monitored area, toppled the lighted beacon on the rock, and the impact tore a 6-foot by 8-foot hole in the barge. The tug narrowly missed grounding as well. The explosive cargo prompted the U.S. Coast Guard to set a 2,000 yard safety zone around the barge. No oil spilled as a result of the grounding (Lynch, 2016).

[7] In May 2013, the laden tank barge *Puget Sounder* towed by the tug *Pacific Eagle* and operating in a VTS-monitored area, swung out of the Rosario traffic lane and snagged Buoy 11 marking Lydia Shoal. The tug and tow then dragged the buoy and its sinker to the south end of Rosario Strait. No oil spilled as a result of this incident, but a laden tank barge exited a traffic lane and passed close to, or over, a marked navigational hazard (Lynch, 2013).

[8] In December 1994, *Barge 101* towed by the tug *Mercury* and operating in a VTS-monitored area, grounded on Clements Reef while southbound towards Anacortes, Washington. The grounding of the single-hulled tank barge laden with diesel oil resulted in breaches of the Nos. 4 and 6 cargo tanks and released about 27,000 gallons of diesel to waters near the San Juan Archipelago (Office of Marine Safety, 1995).

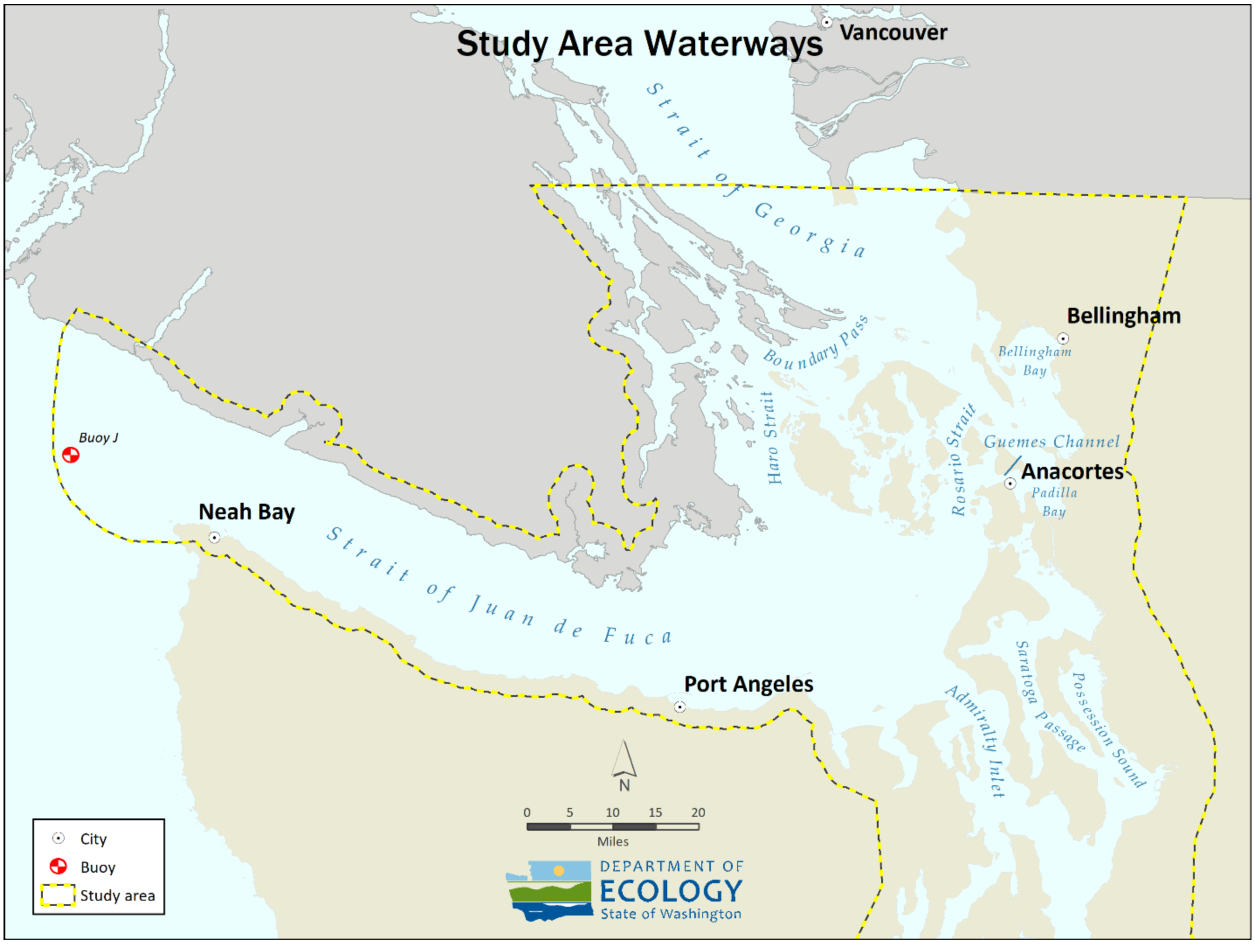


**Figure 2: Study area waterways**

## Weather

While the climate is changing (warming) over time, the following overview of the study area weather from the 1997 Dyer et al. report remains accurate.

> The weather in this region is noted for its maritime influence, which brings mild temperatures year round, wet winters; and dry summers. The matrix of channels, bays, and islands is the cause of highly variable effects such as fog and local breezes.
>
> During the summer, winds are predominantly from the northwest while southeast winds prevail during the winter along the Washington coast. In the Strait of Juan de Fuca, winds draw into the Strait from the northwest in the summer and out of the strait from the southeast in the winter.
>
> However, there are localized effects that influence wind flow. Two examples of exceptions to this general pattern exist: (1) in the area east of Port Angeles, winds are predominantly from the west during the entire year; (2) in the Ferndale-Anacortes area, southerly winds prevail ten months out of the year, while during January and December,

> winds from the north are predominant. Winds in Puget Sound generally blow to the north in winter and southerly in the summer. (Dyer et al., 1997, p.29)

The weather of the Salish Sea is subject to peculiarities of the topography of the region and include convergence zone formation and associated heavy rain and/or thunderstorms, channeling of winds, and very cold drainage winds (particularly in winter from the Fraser River valley). Fog, particularly during the summer and fall, can significantly reduce the visibility for mariners transiting the Salish Sea, effecting some waterways more than others. This fog can persist despite high winds (Lilly, 1983).

### Tides and currents

Surface waters of the Salish Sea exhibit a net outflow through the Strait of Juan de Fuca due to the inputs of rivers, particularly the Fraser River, with more saline water entering at depth to balance the surface flow. Tides are diurnal, and the tidal range can exceed 15 feet. The substantial water movement associated with such tidal ranges result in strong tidal currents. Tidal currents are particularly strong in the narrow channels in the north part of the study area, in particular the islands of the San Juan Archipelago. On the Rosario Strait route, for example, the currents routinely reach two knots during both flood and ebb and on occasion can exceed three knots (Center for Operational Oceanographic Products and Services, 2013). Tidal currents moderate through the main Puget Sound basin, then increase again in the southern waters of the study area as the waterways again narrow (Dyer et al., 1997).

## Vessel terms used in this report

The Legislature specifically mentioned the following vessel types for inclusion in the report: ATBs, other towed waterborne vessels or barges, oil tankers, and tug escorts. Ecology uses the following terms to describe these and other different vessel types throughout this report. These terms, as well as additional terms used throughout the report, are included in a glossary at the conclusion of the document.

- Articulated tug barge (ATB): A tank barge and a towing vessel joined by hinged or articulated fixed mechanical equipment affixed or connecting to the stern of the tank barge.[9]
- Cargo vessel: A self-propelled ship in commerce, other than a tank vessel or a passenger vessel, 300 or more gross tons, including but not limited to commercial fishing vessels and freighters. Liquefied Natural Gas (LNG), Liquefied Petroleum Gas (LPG), and Liquefied Gas (LG) tank ships are considered cargo vessels, as they are not certified to transport oil.[10]
- Escort tug: A tug specifically designed to provide adequate power to stop or control the direction of movement of the vessel that it is escorting.

[9] This differs from a traditional tug and tow, which connects the towing tug to the barge using ropes and/or wires.
[10] Puget Sound Pilots treat LNG, LPG, and LG tank ships as tank ships for the purposes of tug escort requirements.

- Passenger vessel: A ship of 300 or more gross tons with a fuel capacity of at least 6,000 gallons carrying passengers for compensation.
- Tank barge: A barge of any tonnage, engaged in the transport of oil, chemicals, tallows, or biologically derived plant oil.
- Tank ship (tanker): A self-propelled tank vessel of any gross tonnage, engaged in the transport of oil, chemicals, tallow, or biologically derived plant oils. These include oil tankers, chemical tankers, and oil/bulk/ore (O/B/O) vessels. Puget Sound Pilots treat LNG, LPG, and LG tank ships as tank ships for the purposes of tug escort requirements.
- Tank vessel: A vessel that is constructed or adapted to carry, or that carries oil in bulk as cargo, and that: operates on the waters of the state; or transfers oil in a port of place subject to the jurisdiction of the state. ATBs, tank barges, and tank ships are considered tank vessels.
- Towed vessel: For this report, Ecology considers tank barges to be towed vessels.
- Waterborne vessel or barge: Any ship, barge, or other watercraft capable of traveling on the navigable waters of this state and capable of transporting any crude oil or petroleum product in quantities of ten thousand gallons or more for purposes other than providing fuel for its motor or engine.[11]

[11] This includes tank ships, tank barges, and ATBs.

# Chapter 3: Methods

As directed by E2SSB 6269:

> In conducting the evaluation to produce the report, the department of ecology must rely only on existing current vessel traffic risk assessments and other available studies, consult with the United States coast guard, maritime experts, including representatives of covered vessels, onshore and offshore facilities, environmental organizations, tribes, commercial and noncommercial fishers, recreational resource users, provincial experts, representatives of the Salish Sea shared waters forum established in section 204 of this act, and other appropriate entities. (E2SSB 6269 § 206 (1)(b), Wa. 2018)

This chapter describes the methods used for Ecology's review of existing studies and literature, review of existing data, and consultation with tribes and stakeholders.

## Literature review methods

The report builds upon information Ecology collected in the 2014 Marine and Rail Oil Transportation Study, the 2015 Puget Sound Vessel Traffic Assessment Update, the 2016 Salish Sea Oil Spill Risk Mitigation Workshop, and the 2017 Columbia River Vessel Traffic Evaluation and Safety Assessment.

As directed by the bill, Ecology relied only on existing information to complete this report. Existing current information was defined as work developed preferably no earlier than 2005, from sources that are relevant and widely acknowledged as credible and reliable in their respective field. Examples of this information includes but is not limited to peer reviewed studies, published government studies, laws and regulations, and reports that are commonly cited or used by academia and high-level decision makers. New analyses were not conducted during development of this report, with exception of the economic impact analysis on tug escort and pilotage requirements. Ecology summarized and evaluated existing studies and reports, as well as summarizing and presenting existing data as required to meet some of the legislative direction in E2SSB 6269.

Ecology conducted an integrative literature review to assess and evaluate each topic area directed by the Legislature. Spills Program staff reviewed Ecology data, publications, and approved oil spill plans, sought input from tribes and stakeholders, and performed internet searches using general search engines and research-focused tools such as Google Scholar, WorldCat, and JSTOR.

From these searches, Ecology reviewed federal and state regulations, government reports and studies, risk assessments, vessel traffic and incident data, scholarly articles, industry papers, strategic plans, news stories, journal articles, and websites. Reports were retained based on their recency and relevance. Information obtained that is used in this literature review is referenced throughout this document and presented in the Reference section at the end of the report.

# Data methods

Several chapters of this report required review and presentation of data, including data on vessel traffic, incidents, and oil movement through the study area. The methods used to review sources of data are presented by chapter.

## Chapter 4 – Vessel traffic trends

Ecology publishes annual vessel entries and transits (VEAT) reports to share information about commercial vessel traffic in Washington waters.[12] The data for these reports includes data from Ecology, Marine Exchange of Puget Sound, Chamber of Shipping of British Columbia, and others. The data identifies vessels tracked by Ecology, including tank ships and tank barges transporting oil, and cargo and passenger vessels 300 gross tons and larger.

Ecology reviewed VEAT reports for the last 10 years and used this data to show the number of individual vessels as well as the number of entering transits through the Strait of Juan de Fuca for both Washington State and British Columbia.

## Chapter 5 – Oil spill and incident data

### International oil spill and incident data

Ecology identified one source with responsive information for worldwide oil spill information for tank barges: Data and statistics provided by the International Tanker Owners Pollution Federation Limited (ITOPF). No source was found for worldwide oil spill data for articulated tug barges (ATBs) or for non-spill incident data for ATBs and tank barges.

Ecology reviewed a number of other resources, including European Maritime Safety Agency data, IHS Maritime and Trade casualty reports, International Maritime Organization (IMO) statistical analyses and reports, and the Transportation Safety Board (TSB) websites of a variety of countries. With the exception of the TSB of Canada, described in the regional data discussion below, none of these sources contained sufficient information to augment the data provided by ITOPF.

### National oil spill and incident data

Ecology reviewed three sources with detailed information for national-level data on oil spills from barges in U.S. waters:

- The U.S. Coast Guard report, *Polluting Incidents In and Around U.S. Waters: A Spill/Release Compendium: 1969-2011*.
- An American Bureau of Shipping (ABS) study for the Bureau of Safety and Environmental Enforcement (BSEE)/Bureau of Ocean Energy Management (BOEM), *2016 Update of Occurrence Rates for Offshore Oil Spills*.

[12] All published VEAT reports are on Ecology's website: https://apps.ecology.wa.gov/publications/UIPages/PublicationList.aspx?IndexTypeName=Topic&NameValue=Vessel+Entries+And+Transits+(VEAT)+Reports+for+Washington+Waters&DocumentTypeName=Publication

- The U.S. Coast Guard – American Waterways Operators (AWO), *Annual Safety Report, December 12, 2017*.

No source for national-level, non-spill incident data was identified. Additionally, Ecology did not find national data that allowed ATB oil spill incidents to be examined separately from tank barge spills. Ecology conducted a preliminary review of U.S. Coast Guard Marine Information for Safety and Law Enforcement (MISLE) data and determined the resources required to compile the data and identify relevant incidents were beyond the scope of this report.

### Incident and spill rates

Ecology reviewed sources with incident and spill rates for tank barges to determine if the rates would add meaningful information to the report. Four sources discussed incident or spill rates:

- The ABS study for BSEE/BOEM develops 15-year spill rates, confidence intervals, and spill size distributions for oil spills from tank barges.
- The 2017 U.S. Coast Guard – AWO annual safety report shows a moving average of gallons of oil spilled by tank barges per million gallons transported.
- The 2015 Vessel Traffic Risk Assessment (VTRA) updated previous studies for the Strait of Juan de Fuca, Puget Sound, San Juan Islands, and connecting waterways, and provides calibrated accident rates for tank “focus vessels” (tank ships and ATBs) and tank barges.
- The Glosten Associates “Gateway Pacific Terminal vessel traffic and risk assessment study” includes average incident rates for a variety of vessel types, including tank ships, barges, and tugs, for the Strait of Juan de Fuca; Haro Strait/Boundary Pass and Rosario Pass; and Guemes Channel, Saddlebag, and Cherry Point.

Ecology determined that comparing the methodologies, data sources, time period of data collected, and results of these sources was beyond the scope of this report. However, a brief discussion of incident rates is provided in Chapter 5 to inform potential future work.

### Regional oil spill and incident data

Ecology reviewed Spills Program data for reported oil spills and vessel incidents in Washington and Oregon waters, and TSB of Canada data for the Canadian Pacific region.[13] Both sources of regional data allowed a more robust examination of oil spill and non-spill incidents (e.g. loss of propulsion or steering, grounding, fire, etc.) than was possible with worldwide and national-level data. Individual vessel names were available in both data sets, which allowed Ecology to assess ATB incidents separately from tank barge incidents. The Spills Program data contained more information on very small spills (less than one gallon) and incidents that occurred while moored.

[13] Ecology data includes incidents and oil spills reported to Ecology that occurred in Washington waters. This includes reported events within state waters where vessel traffic is managed by the Canadian Marine Communications and Traffic Services (MCTS). Data also includes some incidents and oil spills reported to Ecology that occurred in shared waters with Oregon (Columbia River), on the Willamette River, and on the Oregon coast. In this report, Ecology refers to these cases as occurring in Washington and Oregon waters. The Ecology data does not include all spills and incidents occurring in Oregon, however, including those that may have taken place on the Columbia and Willamette Rivers or along the coast.

The Canadian data included "near-miss" reports for ATBs, which was unique among the data reviewed — other sources did not report on near-miss events, with the exception of three lane departure incidents in Ecology's data.

## Chapter 6 – Transfers of potentially non-floating oils

Ecology's Advance Notice of Oil Transfer (ANT) System is a web-based application that records scheduled oil transfers and volumes over state waters. The ANT System was implemented in 2006 to record oil transfers of more than 100 gallons of bulk oil over the water, and it contains detailed information of an oil transfer submitted by the delivering vessel or facility. Information captured about each oil transfer includes date, time, location of transfer, deliverer, receiver, product type, quantity transferred, transfer type, and other information as provided by the submitter (Wash. Admin. Code § 173-180-215, 2006; Wash. Admin. Code § 173-184-100, 2006). The ANT system does not track oil movement specifically, but tracks regulated oil transfers over water. Ecology does not collect the origin or destination of the oil, but uses oil transfer data to infer a general idea of types and quantities of oil moving through the study area.

Ecology queried ANT data for oil transfers from 2017 and Quarter 1 of 2018 to examine types of oil moving within the study area. This data provided information on locations of oil transfers of potentially non-floating oils within the study area. Transfers with no location information were not included in Ecology's analysis.

### Data assumptions

Ecology assumes that the data is correct as entered and did not attempt to validate entries. However, data is entered into the ANT System by regulated facilities and vessels and errors are present, as there are no requirements to fix or update the information by the submitter once it is entered. The ANT system has been modified over time to help reduce entry errors, but given the nature of the data — the thousands of entries per year, and no easy way to validate each entry — errors in the data are expected. With the system improvements over time, the errors do not substantially affect the overall total volumes reported.

## Chapter 7 – Crude oil and diluted bitumen data

Ecology has oil transfer and oil movement data for the transport of oil by vessel, pipeline, and rail that is required by state law and state rules. The data was queried to provide information on volumes of diluted bitumen transported by each mode, where available. Other sources of data, including data from the Washington State Department of Commerce, the Pacific States-British Columbia Oil Spill Task Force (OSTF), and the National Energy Board of Canada (NEB), were reviewed to provide a better understanding of the volumes and locations that diluted bitumen is transported by in the study area.

### Vessel data

Ecology queried ANT data for oil transfers over water where a vessel delivered crude oil (including bitumen, Alberta light crude, Alberta heavy crude, and Bakken) to facilities in Washington that transfer crude oil.

The initial data query included all regulated oil transfers over water meeting the above criteria from 2009 through 2017. This included 3,392 transfers. Ecology narrowed the timeframe and evaluated and analyzed oil transfer entries for six years, from 2012 through 2017, because this is when Ecology began to understand the complexity of the oil types and began tracking it, when possible (Washington State Department of Ecology, 2018c).

*Data assumptions*

As described above, Ecology assumes the data is correct as entered and did not attempt to validate entries.

Certain vessels on certain routes are known to carry specific crude oils and other oil commodities. However, the origin of the oil or the type of crude oil is not intentionally captured. Typically the type of crude oil transferred is not specified when an oil transfer is submitted into the ANT system. For this report, the origins of these oils were gleaned from the thousands of transfer inspection visits and interviews conducted by Ecology inspectors in the past 11 years to ascertain patterns and changes to these dynamic commodity moves.

For example, certain tank ships typically carry Alaska North Slope (ANS) crude and certain tank barges carry products on routine passages within, into, and out of Washington. Assumptions are made using this past experience to help designate the types of crude oil moved. For example, one carrier is a common visitor to Washington that typically brings diluted bitumen from Canada and moves other oil types to and between terminals. Ecology made assumptions about the origin of the oil when they fit experience and route knowledge. Otherwise, no assumptions were made about the type of crude oil reported.

**Pipeline data**

Beginning in late 2016, pipelines transporting crude oil in or through Washington are required to submit biannual reports that provide the volume and state or province of origin of the crude oil (Wash. Admin. Code Chapter 173-185, 2016). Ecology reviewed biannual reports for the periods of July 1, 2016 through December 31, 2016, January 1, 2017 through June 30, 2017, and July 1, 2017 through December 31, 2017 to determine the volume and state or province of origin of crude oil transported through the state (Washington State Department of Ecology, 2018e).

Ecology has also received data from the Washington State Department of Commerce for several years for pipelines that move oil in the state. Pipeline data from Ecology's new reporting requirements was compared to Washington State Department of Commerce and appear to be consistent (Washington State Department of Ecology, 2018f).

*Data assumptions*

The Trans Mountain pipeline handles all types of crude oils including diluted bitumen, synthetic crude oils, and other crude oils from light to heavy. All crude oil by pipeline currently reported to Ecology under agency authority is reported as crude oil from Alberta. Ecology assumes that oil originating in Alberta and delivered by pipeline is either diluted bitumen or a crude oil that could weather or sink based on data available. Additionally, contingency plans for pipelines include a list of products transported by pipeline, indicating that oils transported through the pipeline have the potential for some portion of the oil to weather and sink. For review of volumes of diluted bitumen transported by pipeline, oil originating in Alberta was considered diluted bitumen.

**Rail data**

Beginning in late 2016, facilities receiving crude oil by rail are required to report all scheduled crude oil deliveries to be received by the facility each week for the succeeding seven-day period. Information reported by facilities on scheduled crude oil deliveries includes the region of origin of crude oil, the railroad route taken to the facility within the state (if known), scheduled time and volume in barrels (bbls) of the delivery, and American Petroleum Institute (API) gravity of the oil (Wash. Admin. Code Chapter 173-185, 2016).

Ecology queried ANT data for all rail deliveries of crude to a facility between October 1, 2016 and April 30, 2018. The results indicated 1,289 transfers of crude oil, including 128 crude oil transfers from railroads to facilities originating in Alberta or Saskatchewan (Washington State Department of Ecology, 2018d).

Crude by rail deliveries to Washington refineries in the study area began in about 2012. Prior to September 2016 when Ecology began receiving information on oil movement by rail, Ecology estimated volumes of crude oil by rail based on information from rail facility permit documents and environmental impact statements, and by comparing the information to known train movements, refinery throughput, and crude oil imports by vessels and pipelines.

*Data assumptions*

Facilities receiving crude oil by rail are required to provide Ecology with the region of origin and the API gravity of the oil, but are not required to provide the product type (although it is optional). Facilities typically select Bakken (light crude oil) as the product type when the oil originates in North Dakota. For oil that originates in Alberta or Saskatchewan, facilities typically select crude oil as the product rather than a specific oil type. Some transfers from these regions show a product type of Alberta light crude or Alberta heavy crude, including the majority of transfers where the region of origin selected was Saskatchewan. In 2017, heavy crude oil accounted for 77 percent of crude exported from Canada, and both Alberta and Saskatchewan have exported more heavy crude than light crude for the last five years (National Energy Board of Canada, 2018).[14] Ecology assumed that any oil originating in Alberta or Saskatchewan, Canada is diluted bitumen.

Ecology assumes that the data is correct as entered and did not attempt to validate entries, although a review of data for errors is conducted weekly and facilities are contacted when there are questions about their entries. However, data is entered into the ANT System by regulated facilities and there may be errors or changes to transfer information after the schedule has been entered into the system. Facilities are not required to update the information in ANT if a change is made to the delivery schedule.

## Outreach methods

Ecology worked in consultation with the Puget Sound Partnership (Partnership) and Washington State Board of Pilotage Commissioners (BPC) to develop this report and recommendations.

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[14] National Energy Board of Canada (NEB) defines heavy oils as those with density greater than 875.7 kg/m3. This translates to an American Petroleum (API) gravity of 30.1. Ecology classifies oils with API gravities between 22.3-31.1 as medium crudes, 10-22.2 as heavy crudes, and 0-9.9 as extra heavy crudes.

Additionally, the Legislature directed Ecology to consult with stakeholders, including the U.S. Coast Guard, maritime experts, including representatives of vessels covered by oil spill contingency plans, onshore and offshore facilities, environmental organizations, tribes, commercial and noncommercial fishers, recreational resource users, provincial experts, and representatives of the Salish Sea Shared Waters Forum.

Working with the Partnership and BPC, Ecology has identified and consulted with tribes and additional stakeholders throughout report development, including federal, state, and provincial agencies (see Appendix B). To conduct outreach and consultation, Ecology developed a process to provide input on draft materials and in-person meetings and presentations.

Ecology's tribal and stakeholder outreach during development of the report included the following:

- Shared a preliminary list of existing studies and reports to inform the report. Ecology requested that tribes and stakeholders review the list and electronically provide suggestions for additional information to consider in developing the report. Tribes and stakeholders were also asked to review draft scopes developed for each topic area and electronically provide suggestions and edits.
- Sent status update emails to tribes and stakeholders.
- Held a web presentation to present the report development process to tribes and stakeholders, and to provide project scope and timelines for project milestones. The presentation was recorded and sent to tribes and stakeholders who were not able to attend, or who wanted to review the information again.
- Briefed the Puget Sound Harbor Safety Committee (PSHSC) at regularly scheduled meetings.
- Briefed the BPC at regularly scheduled meetings.
- Provided draft report sections to the Partnership and BPC for preliminary review.
- Provided the draft report to the Partnership, BPC, and tribes and stakeholders for a four-week comment period.
- Presented the draft report at the request of some of the PSHSC members, in which other stakeholders and tribes were invited. The PSHSC arranged the venue outside of their regularly scheduled meetings, which Ecology appreciates.
- Provided the draft report that was submitted to the Legislature to the Partnership, BPC, and tribes and stakeholders for an additional two-week comment period. During this time, Ecology met with interested tribes and stakeholders to discuss the report, including the recommendations.

Ecology reviewed and considered all tribal and stakeholder input prior to finalizing the report to submit to the Legislature, while working with the Partnership and the BPC.[15]

[15] Input received and Ecology's responses are available upon request.

# Chapter 4: Emerging Trends in Vessel Traffic

Section 206 (2)(c) of E2SSB 6269 directs Ecology to complete an assessment and evaluation of emerging trends in vessel traffic. Ecology developed the scope and goal statements below to guide this assessment and evaluation.

Scope: Using current, existing data, describe emerging trends for all types of vessel traffic (tank ships, cargo vessels, tank barges, and articulated tug barges (ATBs)), including how ship size is changing, and future planned facilities in the Salish Sea area.

Goal: Use historical data to briefly describe the changes in Puget Sound Salish Sea vessel traffic for the last 10 years, and use projected port growth to predict the trends in the next five to 10 years.

This assessment of emerging trends in vessel traffic provides information to assist in evaluating current and future vessel safety in the study area. Ecology first presents an overview of current vessel traffic, followed by historic and projected future vessel traffic.

## Overview of current vessel traffic

A vessel traffic assessment report prepared for Andeavor's (formerly Tesoro) proposed refinery upgrade describes areas of vessel traffic in the Salish Sea (Peterson & Rodino, 2016, p. 2-2 to 2-3):

- **Strait of Juan de Fuca** is an international waterway separating the U.S. and Canada. The Strait provides access to both Washington and Canadian ports.
- **Haro Strait and Boundary Pass** – Haro Strait connects the Strait of Juan de Fuca to Boundary Pass and the Strait of Georgia. It is the main route to the Port of Vancouver and other British Columbia ports.
- **Rosario Strait** is the easternmost channel between the Strait of Juan de Fuca and the Strait of Georgia and is used primarily by vessels bound for Cherry Point, Ferndale, Anacortes, and Bellingham, as well as tug and tow traffic between Washington and ports in British Columbia or to ports in Alaska via the Inside Passage.
- **Guemes Channel** stretches from Rosario Strait in the west to Padilla Bay in the east. Vessels passing through Guemes Channel are bound for Washington ports and refineries.

The above-referenced areas can be found in Figures 1 and 2.

The 2015 Vessel Traffic Risk Assessment (VTRA) of Northern Puget Sound and the Strait of Juan de Fuca used 2015 vessel traffic data from the Marine Exchange of Puget Sound to establish a base number of vessels operating in the Salish Sea study area (Van Dorp & Merrick, 2016, p. 4). In the VTRA 2015 base case:

- "The Strait of Juan de Fuca serves as the entrance to these US and Canadian ports and facilities and is transited by approximately 8,300 deep draft vessels annually, including arrivals and departures.
- Of these transit entrances and departures, approximately nine cargo focus vessels (bulk carriers, container ships and other cargo vessels) enter and leave the Strait of Juan de Fuca daily totaling about 6500 transits annually.
- Similarly, approximately 1,300 tank focus vessels (tankers, chemical carriers, articulated tug barges and oil barges) travel east and west annually (i.e. about 2 tank focus vessel per day enter and leave the Strait of Juan de Fuca in 2015)." (Van Dorp & Merrick, 2016, p.4)

Including north and south bound transits, about 5,500 of these deep-draft vessels travel to and from the Port of Vancouver, British Columbia, and about 3,700 (north and south bound) transit the entrance of the Puget Sound (at Admiralty Inlet).[16] This number of transits, 9,200, exceeds the 8,300 transits entering and leaving the Strait of Juan de Fuca, indicating that there are additional deep-draft vessel transits occurring internally as vessels shift locations (Van Dorp & Merrick, 2016).

There are also tug and barge movements, ferry operations, fishing vessels, and recreational vessels mixing with the deep-draft vessels. The U.S. Coast Guard Vessel Traffic Service (VTS) handles approximately 230,000 transits annually with about 170,000 of those being Washington State Ferries (Van Dorp & Merrick, 2016, p.4). "The Puget Sound Pilots assignments average at about 7,000 assignments annually which provides a good metric for how many deep-draft vessel movements there are on the US side" (Van Dorp & Merrick, 2016, p. 4).

Ecology reports on vessel entries and transits (VEAT) indicate vessel traffic has not changed significantly from 2015 to 2017, so the 2015 VTRA base number of vessels is a good approximation of deep-draft vessel transits in the Strait of Juan de Fuca (Washington State Department of Ecology, 2018a). [17]

Ecology data for 2017 included the following entering vessel transits:

- 4,302 cargo and passenger vessel entering transits to Washington and Canadian ports via the Strait of Juan de Fuca.
- 633 cargo and passenger vessel entering transits to Washington via the Strait of Georgia, Haro Strait, and Rosario Strait.
- 534 tank ships entering transits to Washington and Canadian ports via the Strait of Juan de Fuca.
- 53 tank ships entering transits to Washington via the Strait of Georgia, Haro Strait, and Rosario Strait.

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[16] These figures include internal movements between Washington and British Columbia, but do not include passenger vessel transits.

[17] Ecology's report on vessel entries and transits (VEAT) counts the number of individual vessels entering Washington waters and the number of entering transits each individual vessel makes.

- 234 tank barges entering transits to Washington ports via the Strait of Juan de Fuca and Rosario Strait. This is a subset of the 3,451 total tank barge transits in Puget Sound.
- 266 ATBs entering transits to Washington ports via the Strait of Juan de Fuca, Strait of Georgia, Haro Strait, and Rosario Strait. This is a subset of the 872 total ATB transits in Puget Sound.

# Looking back: Vessel traffic trends in the Salish Sea over the past 10 years

Ecology's VEAT reports for the last 10 years show the number of individual vessels as well as the number of entering transits through the Strait of Juan de Fuca for both Washington State and British Columbia.[18]

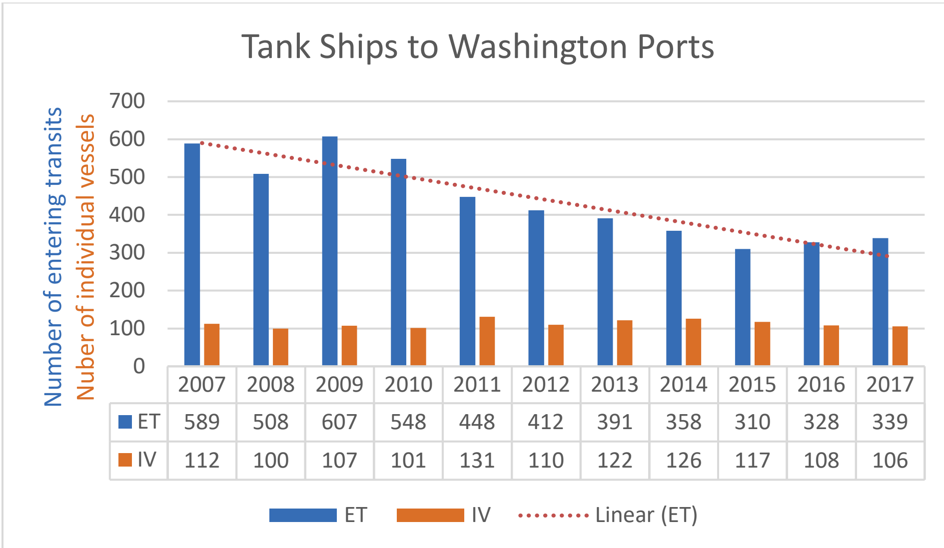
## Tank ships

**Washington ports – all tank ship types (crude, chemical, product) in aggregate**

Over the past 10 years, the number of individual tank ships entering through the Strait of Juan de Fuca for oil terminals and refineries in Washington State has stayed fairly consistent. However, the total number of entering transits made by these tank ships has decreased (Figure 3). The change reflects the fall in output from the Alaskan oil fields and an increase in crude oil arriving by rail and pipeline (U.S. Energy Information Administration, 2017; Washington State Department of Ecology, 2018f).[19]

The tonnage of tank ships operating in Puget Sound is restricted to 125,000 deadweight tons (DWT) or less by federal regulations (33 CFR § 165.1303, 1997). Because of these restrictions, the drop in entering transits is not due to larger tank ships making fewer entries. The reduced number of tank ship entries may be due in part to an increase in transits by articulated tug barges (ATBs) moving refined product to Canada, between Puget Sound refineries, and along the west coast (Washington State Department of Ecology, 2018a). This statement is supposition based on the data showing an increase in ATB transits while there is a decrease in tank ship transits. Ecology began reporting ATB transits separately from tank ships in 2011. In 2011, nine separate ATBs made 130 entering transits via the Strait Juan de Fuca. In 2017, fifteen ATBs made 170 entering transits through the Strait Juan de Fuca (Washington State Department of Ecology, 2018a).

[18] Entering transits multiplied by 2 equals both entering and departing transits.
[19] Data on crude oil movement by rail and pipeline is presented in Chapter 7.




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ET | 589 | 508 | 607 | 548 | 448 | 412 | 391 | 358 | 310 | 328 | 339 |
| IV | 112 | 100 | 107 | 101 | 131 | 110 | 122 | 126 | 117 | 108 | 106 |

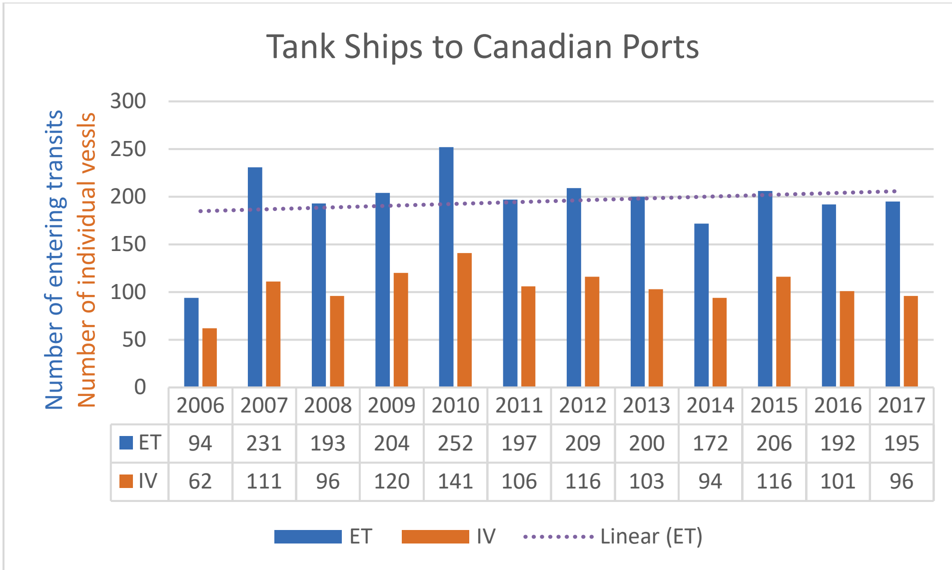
ET Entering Transit. IV Individual Vessel

**Figure 3: Tank ships entering from the Strait of Juan de Fuca to Washington ports, 2007 – 2017 (Washington State Department of Ecology, 2018a)**

### Port of Vancouver – all tank ship types (crude, chemical, product) in aggregate

Canadian ports saw a large increase in the number of individual tank ships and entering transits between 2006 and 2007. This was due in part to Kinder Morgan's purchase of the Trans Mountain Pipeline (TMPL) in 2005 and increasing the capacity to move diluted bitumen to market.[20] The construction was completed in stages and finished in 2008, increasing the capacity of the pipeline system from 260,000 to 300,000 barrels per day (bpd) (10,920,000 to 12,600,000 gallons per day (gpd)) (Past Project: Mount Robson & Jasper Park expansion, n.d.). The number of individual tank ships and entering transits has remained relatively stable since 2007.

[20] Information on diluted bitumen is presented in Chapter 7.




| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ET | 94 | 231 | 193 | 204 | 252 | 197 | 209 | 200 | 172 | 206 | 192 | 195 |
| IV | 62 | 111 | 96 | 120 | 141 | 106 | 116 | 103 | 94 | 116 | 101 | 96 |

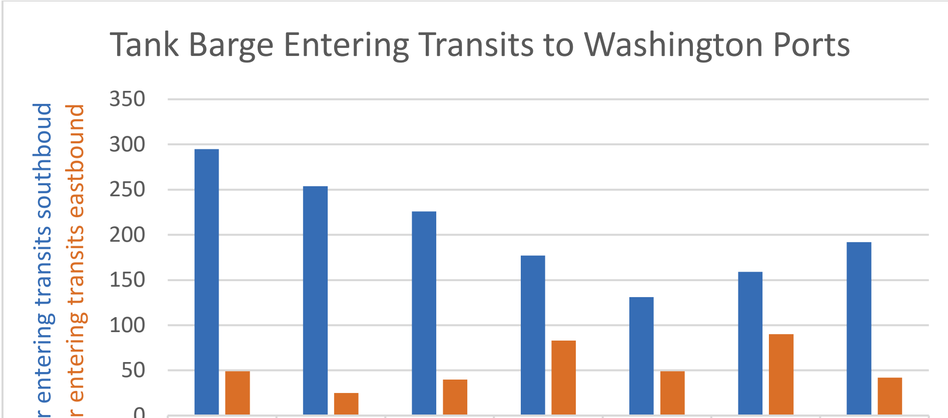
ET Entering Transits IV Individual Vessels

**Figure 4: Tank ships entering from the Strait of Juan de Fuca to Canadian ports, 2006 – 2017 (Washington State Department of Ecology, 2018a)**[21]

## Tank barges

Figure 5 shows the number of tank barges entering through the Strait of Juan de Fuca (eastbound transits) and the number entering through Rosario Strait (southbound transits).[22] These southbound barges are either transiting from Alaska along the Inside Passage or from terminals in British Columbia. According to Ecology's Advance Notice of Oil Transfer (ANT) System, the majority of tank barges and ATBs are carrying refined products (Washington State Department of Ecology, 2018a). One 85,000 barrel (3,570,000 gallon) tank barge moves diluted bitumen between the Westridge Terminal in British Columbia and U.S. Oil in Tacoma approximately twice a month (Washington State Department of Ecology, 2018c). Information about volumes of diluted bitumen transported through the study area is presented in Chapter 7.

[21] Table includes 2006 to show the additional tank ships and number of entering transits when Kinder Morgan completed the Trans Mountain pipeline expansion.
[22] The majority of tank barge and ATB traffic from Washington refineries to Alaska and British Columbia transit through Rosario Strait.




| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| ET S | 295 | 254 | 226 | 177 | 131 | 159 | 192 |
| ET E | 49 | 25 | 40 | 83 | 49 | 90 | 42 |

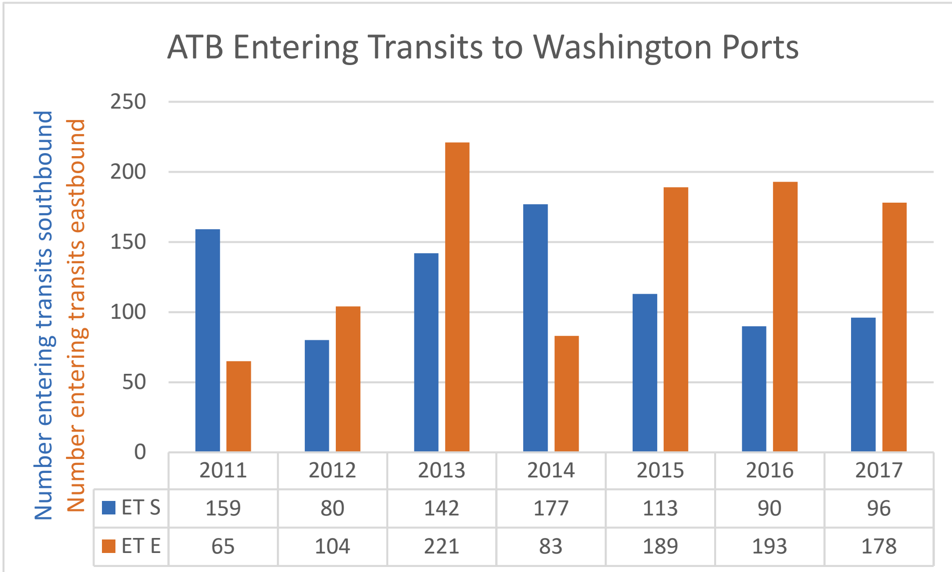
ET S: southbound entering transits ET E: eastbound entering transits

**Figure 5: Tank barge entering transits to Washington ports, 2011 – 2017 (Washington State Department of Ecology, 2018a)**[23]

## Articulated tug barges (ATBs)

Figure 6 shows the number of ATBs entering Washington through the Strait of Juan de Fuca and Rosario Strait. These southbound ATBs are either transiting from Alaska along the Inside Passage or from terminals in British Columbia.

[23] VEAT data includes the total number of tank barge transits. For 2015 to 2017, tank barge entering transits are broken into eastbound and southbound transits. For 2011 to 2014, the numbers for eastbound and southbound are estimates based on Automatic Identification System (AIS) and ANT data.



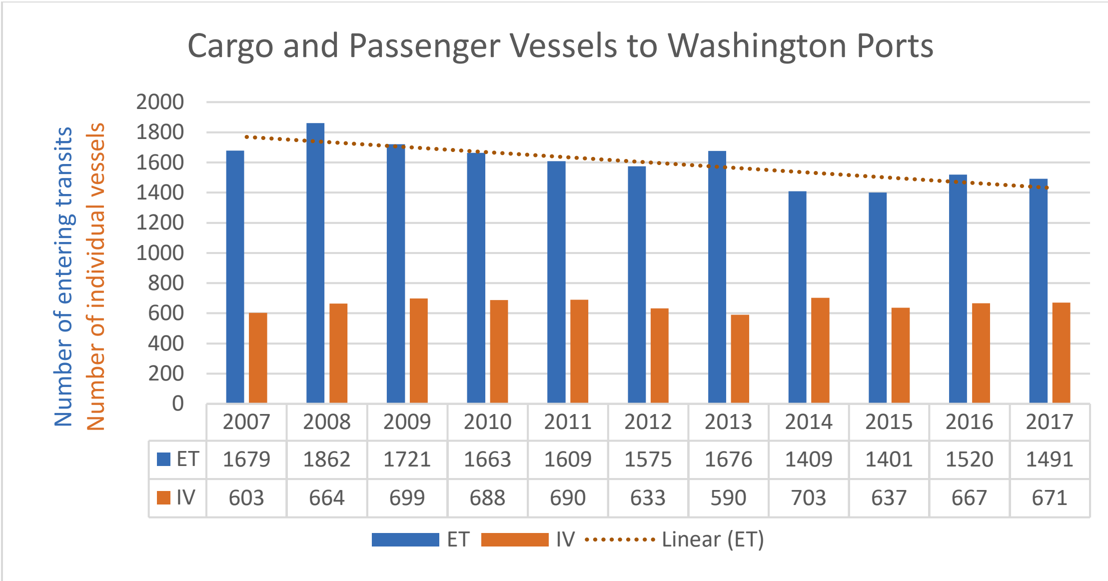

ET S: southbound entering transits  ET E: eastbound entering transits

**Figure 6: ATB entering transits to Washington ports, 2011 – 2017 (Washington State Department of Ecology, 2018a)**

## Cargo and passenger vessels

### Washington ports — all types of cargo and passenger vessels in aggregate

The global financial crisis that began in 2007-2008 resulted in a sharp decline in world trade volumes (IMF survey, 2009). In the Pacific Northwest, waterborne trade began to recover in 2011. As the global economy has recovered, cargo and passenger vessel numbers for Washington ports stayed fairly flat. Some of this can be attributed to a loss in market share to Canada, whose investment in port infrastructure and rail links to the U.S. Midwest have put it in competition with Washington ports (Washington State Department of Transportation, 2017).

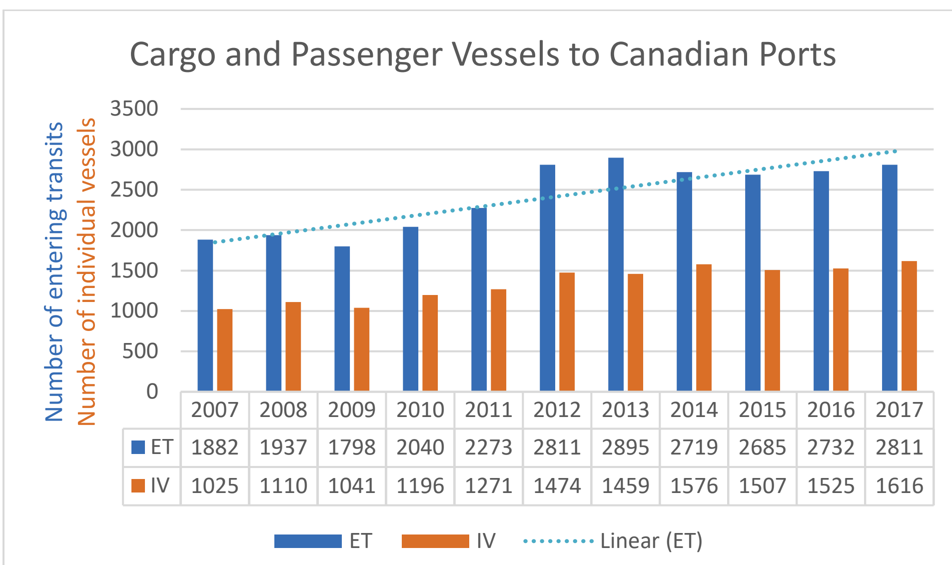



ET Entering Transits IV Individual Vessels

**Figure 7: Cargo and passenger vessels (container, bulker, ro-ro and vehicle, and general) entering from the Strait of Juan de Fuca to Washington ports, 2007 – 2016 (Washington State Department of Ecology 2018a)**

### Port of Vancouver — all types of cargo and passenger vessels in aggregate

The global financial crisis of 2007-2008 affected the Canadian ports with a drop in entering transits. As the global economy recovered, improvements in several Port of Vancouver terminals including the Westshore coal terminal, Cascadia and Pacific grain export terminals, and the Delta Port container terminal, contributed to an increase in vessel traffic from 2007 to 2012 (Xotta, n.d.). These numbers have leveled out in the last 6 years.




ET Entering Transits IV Individual Vessels

**Figure 8: Cargo and passenger vessels (container, bulker, ro-ro and vehicle, and general) entering from the Strait of Juan de Fuca to Canadian ports, 2007 – 2017 (Washington State Department of Ecology 2018)**

# Looking forward: Projected vessel traffic trends in the Salish Sea

## Tank ship and ATB vessel trends

In the absence of new facilities or expansion of current facilities, tank ship traffic trends for the Salish Sea show flat to modest decline. Tank ship traffic to ports in Vancouver, BC appear to have flattened out after the Trans Mountain expansion in 2007, and tank ship traffic to ports in Washington State show a steady decline (Washington State Department of Ecology, 2018a).

A large part of the decline in numbers are tank ships delivering crude to refineries in Washington. Simultaneously, there has been a steady increase in the number of ATBs and the amount of product moved by ATB between ports in Alaska, British Columbia, Washington, Oregon, and California. Based on this steady increase in ATB traffic and the plans of companies like Crowley Fuels LLC and Island Tug and Barge in Vancouver, BC to build new ATBs or tugs for ATB retrofits, it seems the trend for increased ATB traffic will continue (Crowley Maritime Corporation, 2018a; Hocke, 2017). Ecology's VEAT data shows an increase in ATB transits entering Washington waters from both the Strait of Juan de Fuca and from Rosario Strait from 224 in 2011 to 266 in 2017.

## Cargo and passenger vessel trends

If new facilities are not built, or existing facilities are not expanded, the cargo vessel traffic trends for the Salish Sea show flat to modest growth (Seaport Alliance, 2015; Washington State Department of Transportation, 2017; Metro Vancouver, 2013).

- Exports of resources such as coal, grain, and timber are expected to continue to fluctuate with market changes, without any significant growth or decline in the number of vessels required (Seaport Alliance, 2015).
- The majority of imports are containerized and the majority of these containers come from Asia, destined for the U.S. Midwest. Forecasts for trade with Asia show growth according to Washington and Vancouver, BC port planning documents; however, shippers utilizing containers have more options for discharge ports as ports along the American West, Gulf, and East coasts compete for a share of the market (Seaport Alliance, 2015; Washington State Department of Transportation, 2017; Metro Vancouver, 2013). Ecology notes that growth is dependent on the health of the U.S. and global economy and trade agreements with major partners.

Shipping companies are using the theory of economy of scale to bring larger container ships into the market (Merk, Busquet, & Aronietis, 2015; Washington State Department of Transportation, 2017). Although Washington and Canadian ports have worked to accommodate these giant ships with a capacity of 18,000 twenty-foot equivalent unit (TEU), larger ports such as Los Angeles-Long Beach and New York are expected to receive the majority of these vessels (Merk, et al., 2015).[24] However, as these ultra large container ships enter the market, this is also impacting the

[24] TEU (Twenty-foot Equivalent Unit) is a measure of unit equaling one 20 foot container

study area, with container ship size entering the Strait of Juan de Fuca increasing from an average of 6,000 – 8,000 TEUs to 10,000 – 12,000 TEUs (Penner, 2015).

**Washington State**

To accommodate deep-sea cargo and passenger vessels, Washington State has nine deep-draft ports in the Puget Sound: Port Angeles, Bellingham, Anacortes, Everett, Seattle, Tacoma, Olympia, Shelton, and Bremerton (Washington State Department of Transportation, 2017). The largest are the ports of Seattle and Tacoma, which have combined their business strategies to create the Northwest Seaport Alliance (NWSA). NWSA has the fourth-largest container throughput in North America and, with the other ports in Washington, is a major center for bulk and breakbulk cargoes, project and heavy lift cargoes, and automobiles and truck cargoes (Washington State Department of Transportation, 2017).

The NWSA published cargo forecasts in their 2015 strategic business plan (Seaport Alliance, 2015; Washington State Department of Transportation, 2017).

They expect:

- Modest growth in breakbulk and auto.
- Flat for dry bulk, logs and military cargo.
- High growth for liquid bulk.
- Modest growth for containers.

The NWSA strategic plan measures success by increasing container throughput from 3.4 million TEUs to 6 million TEUs by 2025 (Seaport Alliance, 2015). Although the NWSA does not have an estimate for the number of additional ships in their Strategic Plan, it is not anticipated the rise in TEUs will result in a large rise in container ship traffic as the increase in container ship size will be a factor (Merk, et al., 2015).

The ports of Port Angeles, Bellingham, Anacortes, Everett, and Olympia all have strategic plans designed to increase trade through these ports. If successful, they will not attract any significant new shipping to the Salish Sea, but will serve vessels that would have otherwise been bound for one of the bigger ports (Washington State Department of Transportation, 2017).

**The Port of Vancouver**

The Port of Vancouver is Canada’s largest port, and includes Vancouver Harbor, the Fraser River, and Roberts Banks. The port “operates across five business sectors: automobiles, breakbulk, bulk, container, and cruise,” and it moved 140 million metric tons of cargo in 2017 (Port of Vancouver, n.d.-f). Investments in infrastructure and efficiency upgrades have resulted in an increase in entering transits. The Port of Vancouver forecasts continued growth in both container cargoes and bulk cargoes in the coming years. In 2016, the Port of Vancouver had approximately nine vessels arriving per day, or about 3,160 vessel arrivals per year. According the Port of Vancouver, this would equal about 12 vessels a day by 2026, or 4,380 vessels a year (Xotta, n.d.). This represents a potential net change of 1,220 ships (or 2,240 transits), and a growth of nearly 40 percent over the decade. However, these numbers are predicated on the port’s ability to realize the planned projects and expansions, some of which are currently in the permitting phase.

## Projects and expansions

### Washington State

Currently, Terminal 5 in Seattle and the Husky Terminal, Pier 4, in Tacoma are being upgraded to each accommodate two 18,000 TEU container ships (Seaport Alliance, 2015). By upgrading these two terminals, increasing rail and road access to terminal properties, and optimizing existing terminal infrastructure, the NWSA strategic plan estimates an increase in container throughput from 3.4 million TEUs to 6 million TEUs by 2025 (Seaport Alliance, 2015). As mentioned previously, although the NWSA does not have an estimate for the number of additional ships in their Strategic Plan, it is not anticipated the rise in TEUs will result in a large rise in container ship traffic as the increase in container ship size will be a factor (Merk, et al., 2015). Washington State also has a robust domestic container ship trade with Alaska and Hawaii. NWSA is anticipating modest growth in these markets, but as the ships are liner vessels, this will likely not result in increased vessel traffic.[25]

Andeavor's (formerly Tesoro) Anacortes refinery is in the permit phase to upgrade its refinery. The project is called the Clean Products Upgrade Project (CPUP), and it will improve and expand the types of product produced at the refinery, including the manufacture and export of xylene. Andeavor anticipates this upgrade will increase vessel traffic by approximately five additional tank vessels a month (60 per year) carrying reformate and xylene. Approximately 40 of those vessels would be delivering additional reformate to the facility. The remaining 20 vessels would be exporting mixed xylenes. Reformate would be delivered to the facility by ATBs with a capacity of approximately 180,000 barrels (7,560,000 gallons) and would account for about 70 percent of the additional vessel traffic associated with the project. Xylene would be exported by tank ships with a capacity of approximately 330,000 barrels (13,860,000 gallons) and would account for about 30 percent of the additional vessel traffic associated with the project (Skagit County, 2017).

Currently, there are no new bulk or breakbulk terminals planned in Washington State Puget Sound ports. However, Washington's deep-draft ports are investing in upgrades to rail and road access, and other facility upgrades to increase efficiencies. Although the 2017 Marine Cargo Forecast and Rail Capacity Analysis forecasts growth in grain shipments and auto imports, these will be handled by existing facilities (Washington State Department of Transportation, 2017).

*Legislation with potential to impact projects and expansions*

In the late 1970s, Congress passed an amendment to the Marine Mammal Protection Act called the Magnuson Amendment. This legislation prohibits any federal agency from approving any increase in the volume of crude oil capable of being handled by a facility located in the Puget Sound, capping this amount at the levels they were in October 1977.[26] There was one attempt to repeal the amendment in 2005, which was defeated (Junejo and de Place, 2016). Unless repealed, this amendment makes building a new facility in the Puget Sound to export crude oil from Canada or the Midwest to Asia untenable. Any attempt by a current facility to export crude would also be untenable if a federal permit, license, or other authority was needed for any

[25] Liner vessels serve regular routes on fixed schedules.
[26] Unless the additional crude was to be refined for consumption in Washington State.

modification of the terminal, facility, or dock. The Magnuson Amendment only applies to crude oil; an increase in refined product moving through the state is not affected by this amendment.

In 2015, Congress lifted the Federal export ban of crude oil as part of the 2016 Consolidated Appropriations Act. This recent change allows companies to transport crude oil to foreign markets without being limited by the current capacity of refineries to refine the oil first. This could potentially result in an increase of oil moving over water through the study area if the Magnuson Amendment is repealed or if current facilities are able to export crude oil without needing any federal permits, licenses, or other approvals for modifications to their terminal, dock, or other facilities. Ecology is not aware of any crude oil being exported from Washington ports.

### Port of Vancouver

The Port of Vancouver has 27 major marine terminals and is improving and expanding several of them to meet forecasts for an increase in both container and bulk cargoes (Port of Vancouver, n.d.-d) (see Table 1).

**Table 1: Port of Vancouver terminal upgrades and expansions** (Metro Vancouver, 2013; Port of Vancouver, n.d.-d; BHP Billiton Canada Inc., n.d.; Vancouver Airport Fuel Facilities Corporation, n.d.; Port of Vancouver, 2015)

| Project | Description | Status | Vessel type and size | New transits per year |
|---|---|---|---|---|
| **Deltaport Container Terminal Expansion** | Infrastructure upgrade to increase capacity by 600,000 TEUs, to a total of 2.4 million TEUs. | In progress<br>Projected completion in 2018 | Container<br>Up to 18,000 TEUs | 35 - 45[27] |
| **Robert Banks Terminal 2** | A 3-berth container terminal at the Roberts Banks facility would add 2.4 million TEUs of container capacity. | In review | Container<br>Up to 18,000 TEU | Up to 260 |
| **Western, G3** | Grain export terminal – trans-ship approximately 8 million metric tons a year. | Projected completion in 2019 | Bulker<br>Panamax (55,000 – 80,000 DWT) | 100 to 150[28] |

[27] The berths are built to accommodate 18,000 TEU ships. For the purpose of estimating vessel capacity, it was assumed that containerships with 16,000 TEU capacity would call at the facility, which yields an estimated 38 visits per year to handle the 600,000 TEU expansion. The range of 35-45 was developed to account for the potential for larger or smaller vessels.

[28] Facility can handle larger vessels, but is expected to handle Panamax. Estimate is speculative as number of vessels is conditioned on grain availability and port congestion.

| Project | Description | Status | Vessel type and size | New transits per year |
|---|---|---|---|---|
| **DP World, Centerm Terminal** | On-terminal improvements to increase the maximum container handling capacity from 900,000 TEUs to 1.5 million TEUs. | Expected to start in 2018 | Container<br>Up to 18,000 TEU | 0 – expected to increase size, not number of vessels |
| **Fraser Surrey Docks Grain Terminal** | New facility would trans-ship up to 3.5 million metric tons of grain per year. | In project status | Bulker Handysize (43,000 - 55,000 DWT) to Panamax | 44 to 100 |
| **Fraser Surrey Docks U.S. coal export** | Development of a 4 million metric tons per year coal handling facility. Coal to be barged to Texada Island for loading onto ocean vessels. No information available about size or number of cargo ships out of Texada Island. | 2018 court decision to allow construction to proceed | Barges (4,000 metric tons capacity) to Texada Island | 320 barges Year 1; 640 Year 2 onward<br>Unknown number of deep-draft vessels |
| **Fraser Surrey Docks BHP Billiton – potash terminal** | Proposed export facility to receive, store and load potash onto bulk vessels. 8 million metric tons throughput. | Proposed, preliminary | Bulker Handysize to Panamax | 144 to 192 |
| **Fibreco Terminal** | Enhance terminal’s current wood pellet operations, add new grain export operations, and remove woodchip exporting infrastructure. | Approved subject to 64 permit conditions | New grain export facility with expanded berth capable of Panamax vessels | Not able to determine estimated grain throughput |
| **Westridge Marine Terminal** | Upgrade and expand in order to handle increased volume of crude | Permit approved subject to 157 permit conditions set by the NEB and 37 permit conditions of the Province of B.C. | Aframax tank ships | 325 to 408 |

| Project | Description | Status | Vessel type and size | New transits per year |
|---|---|---|---|---|
| **Neptune Bulk Terminal Improvements** | This project is expected to increase the capacity of the facility with greater efficiencies. | Construction was to begin in the summer of 2018 to be completed in 2020 | Panamax bulker | Approximately 15 to 36 |
| **Vancouver Airport Fuel Facility Consortium**[29] | Construction of a marine terminal to bring fuel to the airport. | Ground preparation was taking place in April 2017 | Barge to Panamax | 0 |

**Trans Mountain Pipeline expansion project**

With the Canadian government's announcement of their purchase of the TMPL from Kinder Morgan, there is an increased likelihood of completion of the Trans Mountain Pipeline System and Expansion Project (TMEP). The expansion would increase the carrying capacity by 590,000 bpd (24,780,000 gpd) from 300,000 bpd to 890,000 bpd (12,600,000 to 37,380,000 gpd from the Canadian Interior to southwest British Columbia (Austen, 2018). A description of the TMPL is provided in Chapter 7.

The Canadian government has approved the TMEP subject to 157 National Energy Board of Canada (NEB) conditions which must be met throughout the lifecycle of the project. The conditions include tug escort of outbound laden tank ships from the Westridge Marine Terminal to Buoy J and other measures that may mitigate oil spill risk (National Energy Board of Canada, 2016).

A 2013 study on the expansion project indicates:

> Westridge terminal currently has approximately 5 tankers (Aframax or Panamax class), 2 to 3 oil barges, and 1 to 2 jet fuel barges per month. Based on the pipeline expansion, 5 tanker loadings per month will increase to 34 tanker loadings per month. It is expected that the future mix of vessels will be primarily Aframax tankers to achieve the desired throughput at Westridge terminal. The current 2 to 3 export oil barges per month and 1 to 2 import jet fuel barges per month are not forecast to change. More details are available in Termpol 3.7.[30] (Moffatt & Nichol, 2013)

In its annual report, Kinder Morgan stated the combined capacity of the TMPL could potentially be further increased by over 300,000 bpd (12,600,000 gpd) to approximately 1.2 million bpd

[29] Not located at the Port of Vancouver, but located on Port of Vancouver property.
[30] Technical Review Process of Marine Terminal Systems and Transshipment Sites (TERMPOL) TERMPOL 3.7 – Transit Time & Delay Survey.

(50.4 million gpd), although there are no current plans to do so (Morningstar Document Research, 2018).[31]

Along with the TMPL, the Puget Sound Pipeline is also included in the purchase from Kinder Morgan and has the potential for an increase in capacity.

Kinder Morgan's annual report mentioned the Puget Sound Pipeline is capable of being expanded to increase its capacity to approximately 500,000 bpd (21 million gpd) from its current capacity of 240,000 bpd (10,080,000 gpd) (Morningstar Document Research, 2018). Kinder Morgan stated they will "continue to monitor market and industry developments to determine which, if any, further expansion projects on TMPL may be appropriate" (Morningstar Document Research, 2018, p.14).

# Summary

This chapter presented the current number and future trends of the deep-sea tank ship, tank barge, ATB, and cargo vessel traffic transiting the Salish Sea to and from ports in Washington State and British Columbia. Understanding vessel traffic and using available information to predict emerging trends is important for developing vessel traffic management and safety recommendations.

## Current vessel traffic

The Salish Sea is a busy and important entry point for international cargo moving to and from ports in South Asia and North America, as well as domestic coastwise cargo. The U.S. Coast Guard VTS handles approximately 230,000 transits annually with about 170,000 of those being Washington State Ferries. About 8,300 deep-draft vessels transit (inbound and outbound) the Strait of Juan de Fuca annually. Of these, about nine cargo vessels (bulk carriers, container ships, and others) and two tank vessels (tank ships, ATBs, tank barges) enter and leave the Strait daily.

Cargo arriving on deep-draft vessels destined for ports in both British Columbia and Washington State enter through the Strait of Juan de Fuca. The majority of these vessels are destined for British Columbia and transit through Haro Strait and Boundary Pass heading for the Strait of Georgia. Traffic heading for four of Washington's refineries as well as Anacortes and Bellingham utilize Rosario Strait, while vessels bound for the south Puget Sound travel through Admiralty Inlet. ATBs, tugs towing dry cargo and tank barges, ferries, fishing vessels, and recreational vessels also use these waterways, with much of the ATB and tank barge traffic transiting Rosario Strait.

## Anticipated vessel traffic trends

Anticipating trends in vessel traffic is difficult as much depends on the health of the global economy and a port's ability to attract a market share of the trade. Deep-draft cargo vessel traffic in the Salish Sea clearly showed a drop in 2009, corresponding to the 2007 – 2008 global

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[31] The information referenced pertains to statements made by the previous owner of Trans Mountain Pipeline which is now owned by the Government of Canada. Any plans to further expand the capacity of the Trans Mountain system would be evaluated based on market demand pursuant all applicable regulatory processes.

recession. As the global economy recovered, the volume of cargo moving through the ports has increased, with a corresponding increase in the number of deep-draft cargo vessels transiting the Salish Sea.

Based on the information reviewed, Ecology anticipates the following trends in vessel traffic:

- The number of tank ships transiting the Salish Sea will increase if the TMPL/Westridge Marine Terminal expansion is completed.
  - The project anticipates approximately 325 to 408 transits per year. Currently, there are approximately 60 tank ships per year visiting the Westridge terminal.
  - These tank ships would be traveling through Haro Strait and Boundary Pass, unlike the current majority of tank ships heading to Washington refineries, which transit Rosario Strait.
- Tank ship traffic to Washington ports could potentially increase if Washington's refineries upgrade or expand product types for export, or if refineries and oil terminals begin crude exports within the allowance of their existing approvals (e.g. permits, licenses, etc.).
  - U.S. law changed in late 2015 to allow the export of U.S. crude to foreign markets.
  - Washington's refineries and oil terminals could theoretically export crude oil received by vessel, rail, or pipeline.
  - Several projects have been proposed to allow crude oil to be exported by existing or new terminals in Washington State; however, none are moving forward as of June, 2018. Crude oil is not currently being exported from Washington ports.
  - Washington refineries are currently operating at close to maximum output; however, upgrades to improve or expand product types may result in an increase in tank ship traffic. At this time, Andeavor anticipates approximately five additional tank vessels per month carrying reformate and xylene if their CPUP project is approved.
- Tank barge movement in the Salish Sea has been fairly consistent over the last ten years, and the use of ATBs for oil movement between terminals is expected to continue.
- An increase in containerized cargo is anticipated for Canadian and Washington ports. At the same time, all sources indicate container ships will continue to increase in size.
  - The Port of Vancouver has been proactive in anticipating a market increase and, if planned terminals are built or expanded, additional container ships will be transiting the Salish Sea to British Columbia. Using the projected numbers from Table 1, this would be a potential increase of 295 to 305 container ships per year. In 2017, 748 container ships entered the Strait of Juan de Fuca heading to container ship terminals in British Columbia.
  - Washington State's port upgrades will accommodate larger containerships, which could accommodate the anticipated additional container cargo without a large increase in the number of ships.
- The number of dry bulk ships transiting the Salish Sea is anticipated to grow.

- The Port of Vancouver, BC has several terminal expansions which will increase the throughput tonnage of coal and grains.
- These terminals are designed to berth Panamax and Handysize bulk vessels, so the size of the vessels is not anticipated to grow.
- In 2017, 1,170 bulk carriers and general cargo ships entered through the Strait of Juan de Fuca to British Columbia. This number will increase as terminal expansion projects are completed. Table 1 indicates a potential of 300 to 475 additional vessels per year.
- Passenger ships are also increasing in size. Both Seattle and the Port of Vancouver can handle some of the largest ships being built. The cruise industry is expecting strong growth and both Seattle and the Port of Vancouver are expecting more passengers; however, with the larger ships this may not equate to more vessels.

# Chapter 5: Worldwide Incident and Spill Data for Articulated Tug Barges and Other Towed Waterborne Vessels

Section 206 (2)(a) of E2SSB 6269 directs Ecology to complete an assessment and evaluation of worldwide incident and spill data for articulated tug barges (ATBs) and other towed waterborne vessels or barges. Ecology developed the scope and goal statements below to guide this assessment and evaluation:

Scope: Summarize current, existing incident and spill data for ATBs, towed vessels, and tank barges, as defined in the bill.

Goals:

- Characterize the available data for incidents and oil spills at a high level.
- Discuss the geographic distribution of data and differences in data timeframes and units of measurement.
- To the extent possible, describe trends in incidents and oil spills over time, and compare the data and trends to available data/trends for other types of vessels (e.g., tank ships, cargo vessels).
- Present information for Washington State separately from global data.

Additionally, to inform Ecology's recommendations, this section considers whether the incident and spill data provide insights into potential risk reduction benefits of tug escorts for ATBs and tank barges, and an emergency response system in Haro Strait, Boundary Pass, and Rosario Strait. Detailed discussions of tug escorts and an emergency response system are provided in Chapters 9 and 11 of this report.

Ecology first discusses international and national-level data, followed by regional data that includes Washington/Oregon and the Canadian Pacific region. The overview of available data identifies known limitations and uncertainties. This chapter also includes a discussion about incident rates for tank barges and ATBs.

## Overview of available data

As described in Chapter 3, Ecology identified one source with worldwide oil spill information for tank barges: Data and statistics provided by the International Tanker Owners Pollution Federation Limited (ITOPF). No source was found for worldwide oil spill data for articulated tug barges (ATBs), or for non-spill incident data for ATBs and tank barges.

National-level data from the U.S. Coast Guard, the American Bureau of Shipping (ABS), and the U.S. Coast Guard – American Waterways Operators (AWO) provided information on oil spills from tank barges in U.S. waters. ATB spills were included in the tank barge data and could not be assessed separately. No source for national-level, non-spill incident data was identified. Ecology conducted a preliminary review of U.S. Coast Guard Marine Information for Safety and

Law Enforcement (MISLE) data and determined the resources required to compile the data and identify relevant incidents were beyond the scope of this report.

Large international and national level data sets provide clarity on trends over time. The average number of oil spills per year from tank barges, including ATBs, and the average volume of oil spilled per year has decreased dramatically since the 1970s, both internationally and in U.S. waters. These trends have continued while the volume of oil moved by tank barges in the U.S. has remained relatively constant.

Regional information for Washington and Oregon waters and the Canadian Pacific region comprise smaller data sets that do not show strong trends in the number of incidents per year over the available time periods. This regional data is more detailed, however, and provides information about oil spills from ATBs and from tank barges, and reports on non-spill incidents involving both ATBs and tank barges.

Ecology data and Transportation Safety Board (TSB) Canada data provide information about types of incidents (e.g. allision, grounding), which is useful when considering whether additional risk reduction measures, such as tug escorts or an emergency response system, could further reduce oil spill risks.

## International tank barge spill data

Data from ITOPF shows a decline in the number of tank barge spills worldwide per decade since the 1990s for spills greater than 7 metric tons, and a decline in the number of spills since the 1970s for spills greater than 700 metric tons, as shown in Figure 9 (International Tanker Owners Pollution Federation Limited, 2018a).[32]

[32] 1 metric ton is equal to approximately 320 gallons of crude oil at 40° API and 60° Fahrenheit (Saybolt, n.d.).

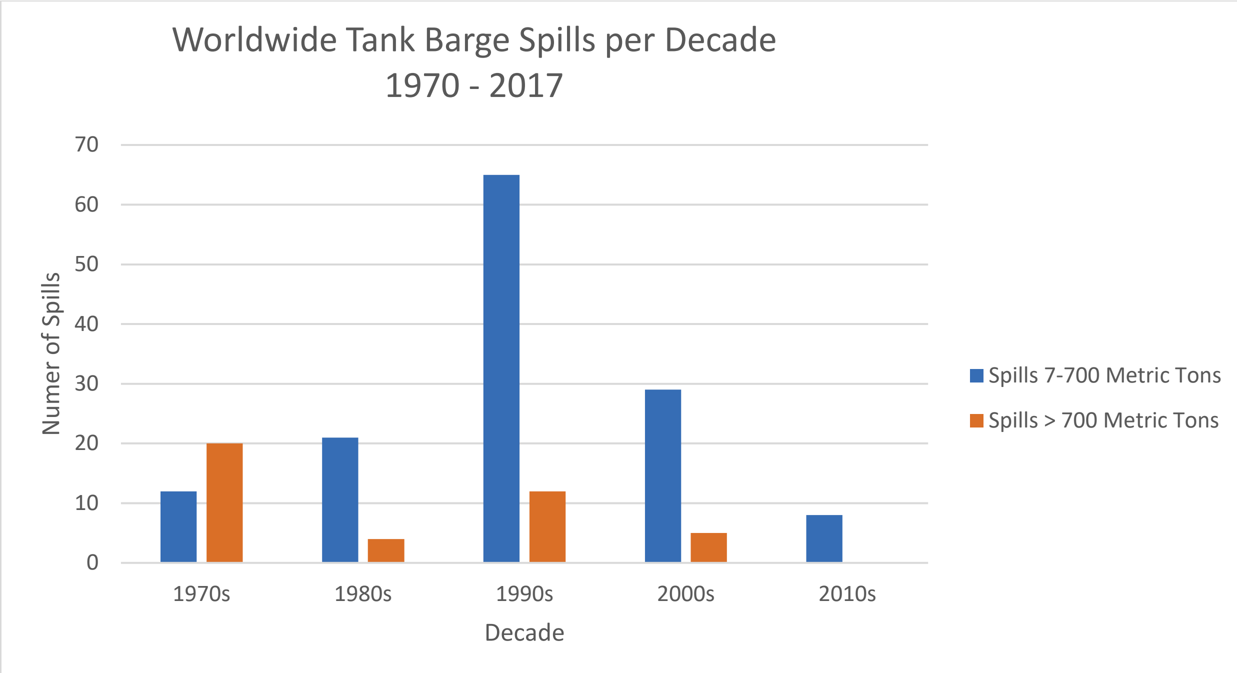



**Figure 9: Worldwide tank barge spills by decade, 1970 – 2017 (International Tanker Owners Pollution Federation Limited, 2018a)**

The decrease in oil spills over time indicates prevention measures (e.g., changes to international standards and regulations, the introduction of double hulls, improved operating practices) have had a positive effect in reducing the number of spills from tank barges. Descriptions of a number of these preventative measures are provided in Chapters 2 and 8.

Worldwide spill incidents for tank barges are summarized by type in Table 2. Allisions were responsible for over a third of all spills (68 of 176). Groundings were the next most frequent incident type, with 48 reports. Hull failures resulted in 17 spills, fires/explosions resulted in seven, and equipment failures were responsible for four spills. Thirty-two spills were listed with “other” or “unknown” (International Tanker Owners Pollution Federation Limited, 2018a).

**Table 2: Worldwide tank barge spills by decade and incident type, 1970 – 2017 (Table provided by International Tanker Owners Pollution Federation Limited, 2018a)**

| Decade | Allision/ collision | Grounding | Hull failure | Fire/ explosion | Equipment failure | Other | Unknown | Total |
|---|---|---|---|---|---|---|---|---|
| **1970s** | 12 | 13 | | 1 | | 4 | 2 | **32** |
| **1980s** | 10 | 4 | 3 | | 1 | 3 | 4 | **25** |
| **1990s** | 31 | 19 | 13 | 2 | 3 | 6 | 3 | **77** |
| **2000s** | 10 | 10 | 1 | 3 | | 4 | 6 | **34** |
| **2010s** | 5 | 2 | | 1 | | | | **8** |
| **Total** | **68** | **48** | **17** | **7** | **4** | **17** | **15** | **176** |

When considering the viability of tug escorts and an emergency response system, the prevalence of allision and grounding incidents in the ITOPF data suggests tug escorts could prove effective in some situations. Tug escorts "improve spill prevention by assigning one or more tugs to accompany certain ships through high-risk areas…the tugs can provide immediate assistance in the event of a steering or propulsion failure or navigational error, both of which may prevent a spill from occurring" (Nuka Research and Planning Group, LLC, 2015, p.20). The ITOPF data does not contain details about individual incidents, so Ecology could not determine whether tug escorts would have had the opportunity to intervene in the reported spills.

Assessing the potential benefit of an emergency response system would likely depend on the stationing and availability of an emergency response towing vessel (ERTV) in addition to the specific details of each incident.

# National spill data

## National tank barge spills

National data also shows a decreasing trend over time. Tank barge spills greater than one gallon in U.S. waters dropped steadily between 1973 and 2011, as shown in Figure 10 (U.S. Coast Guard, 2012).

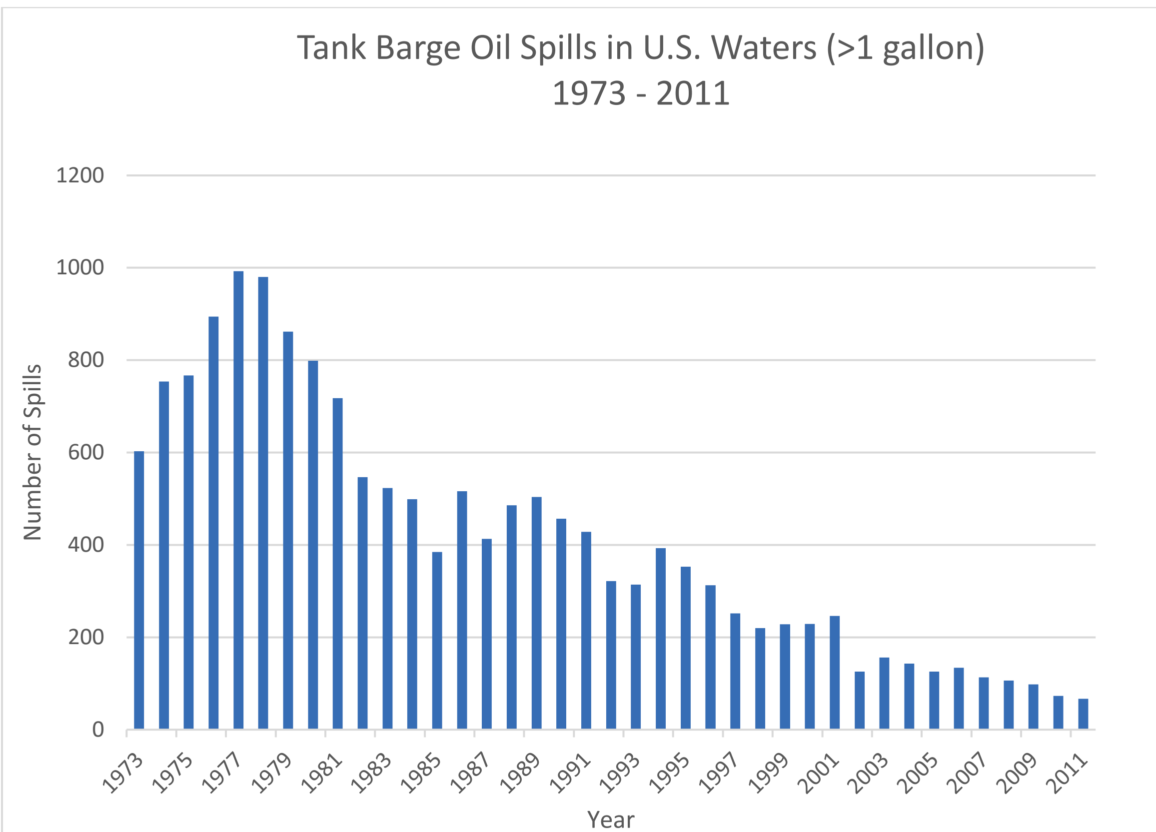



**Figure 10: Number of tank barge oil spills in U.S. waters, 1973 – 2011 (U.S. Coast Guard, 2012)**

This persistent downward trend in the number of spills from tank barges in U.S. waters has occurred while the volume of oil moved by barge has remained relatively constant, as discussed in Chapters 4 and 7, and as shown in data from an ABS Consulting, Inc. study for the Bureau of Safety and Environmental Enforcement (BSEE) and the Bureau of Ocean Energy Management (BOEM) in Figure 11 (2016).

Note that Figure 11 reports on spills greater than 1,000 barrels (bbl) (42,000 gallons), while the Coast Guard data shown in Figure 10 is for spills greater than 1 gallon. This results in a smaller number of reported spills in the ABS report for BSEE/BOEM than in the U.S. Coast Guard information, but the overall downward trend for these larger spills is similar to the results for spills in general.

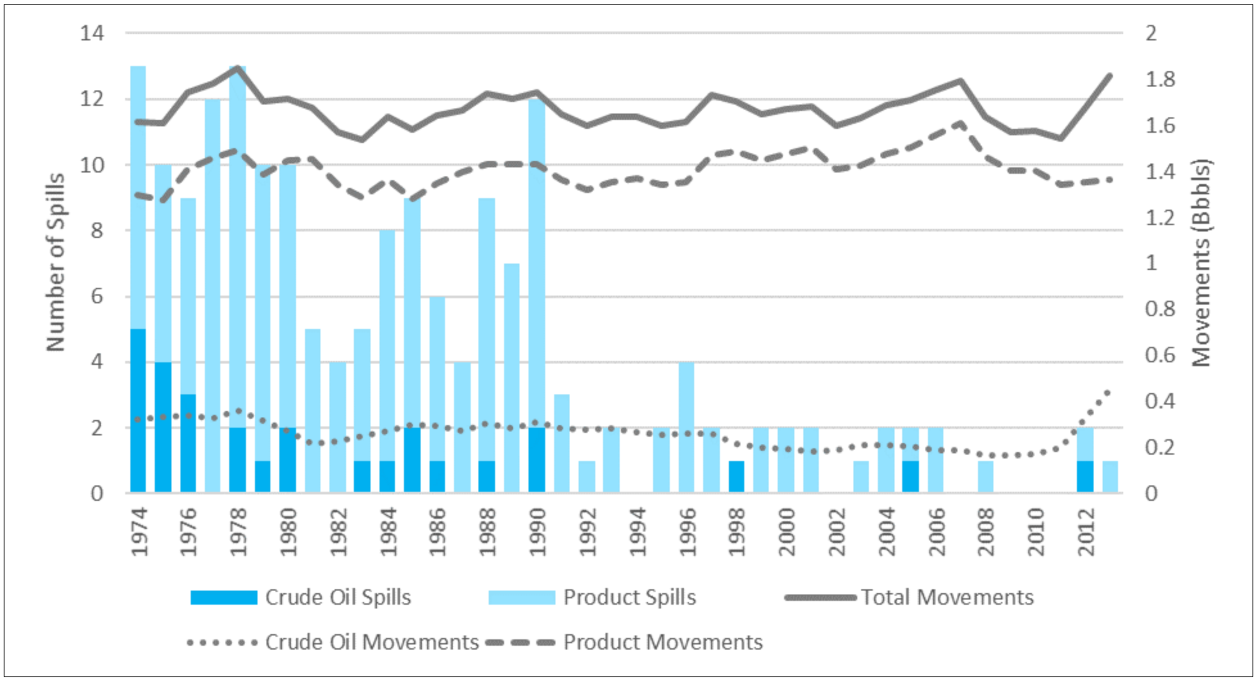



**Figure 11: Number of oil spills greater than 1,000 barrels from tank barges in U.S. waters compared to volume of oil moved by barge in billions of barrels, 1974 – 2013 (Excerpt from ABS Consulting, Inc., 2016, p.58)**

The volume of oil spilled by tank barges in U.S. waters has also decreased over time (see Figure 12).

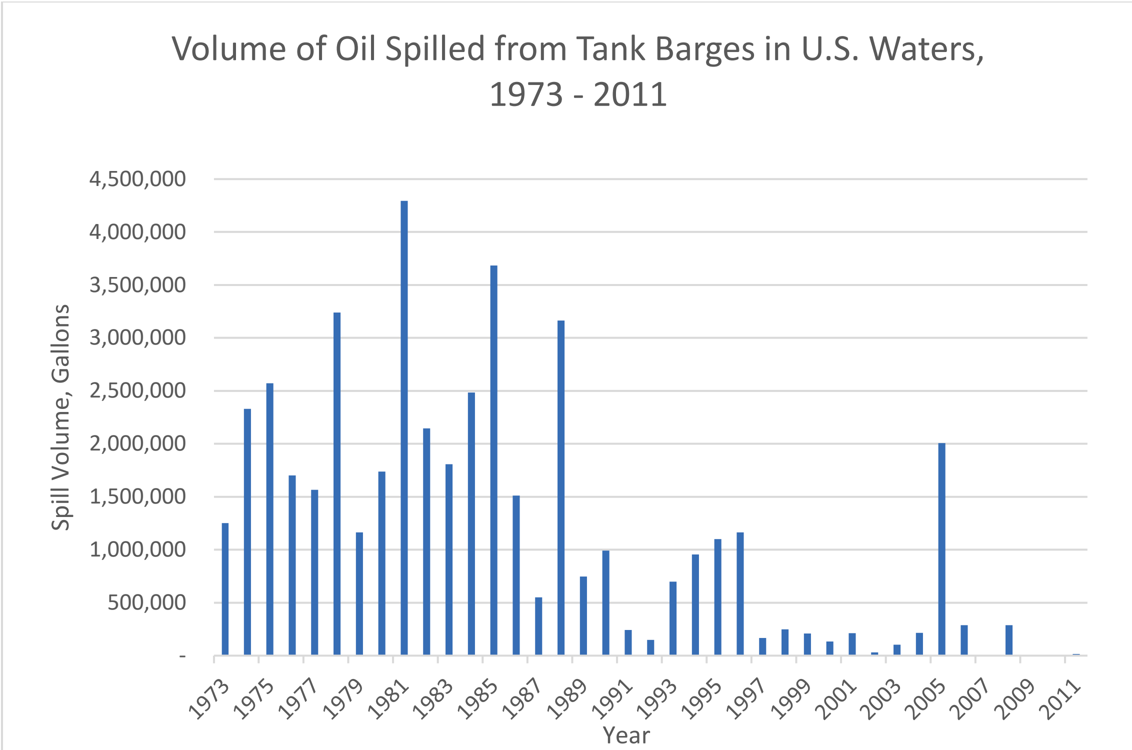



**Figure 12: Volume of oil spilled from tank barges in U.S. waters, 1973 – 2011 (U.S. Coast Guard, 2012)**

More recent data from the U.S. Coast Guard, which covers a shorter time period, indicates the overall decline in the volume of oil spilled from tank barges continued through 2016, although there were increases in 2014 and 2015, as shown in Figure 13 (U.S. Coast Guard–American Waterways Operators, 2017).

Notable in Figures 12 and 13 is the high volume of oil spilled in 2005 as a result of the tank barge DBL-152 spill. Tank barge DBL-152 struck a collapsed pipeline service platform in the Gulf of Mexico on November 11, 2005, spilling an estimated 1.9 million gallons (M gallons) of a heavy oil mixture.[33] Most of the oil was denser than seawater and sank to the bottom (NOAA Damage Assessment, Remediation, and Restoration Program, 2018). As shown in Figure 13, approximately 97,000 gallons total were spilled in 2005, not including the DBL-152 spill.

[33] The volume of oil spilled from tank barges in the U.S. Coast Guard data does not contain information on specific spills; Ecology reviewed this data to gain information about trends in oil spills from tank barges over time. The DBL-152 spill was called out individually in the data, however, which allows consideration of whether a tug escort may have had an opportunity to intervene. From available reports, this spill likely did not present an opportunity for intervention by an escort tug, had one been assigned.

***Chart 5 – Oil Spilled from Tank Barges***

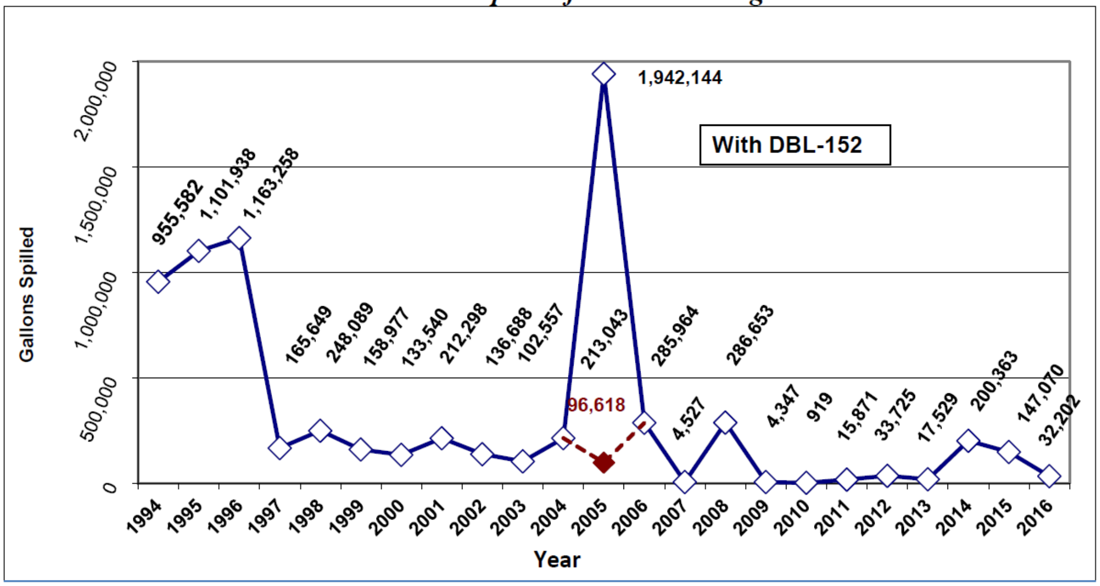



**Figure 13: Volume of oil spilled from tank barges in U.S. waters, 1994 – 2016 (Excerpt from U.S. Coast Guard–American Waterways Operators, 2017, p.5)**

## National tank barge spills compared to other vessel types

The number of spills from tank barges in U.S. waters is typically much smaller than the number of spills from non-tank vessels in a given year, as shown in Figure 14, an excerpt from the U.S. Coast Guard report *Polluting Incidents In and Around U.S. Waters: A Spill/Release Compendium: 1969-2011* (U.S. Coast Guard, 2012).

While difficult to determine from Figure 14, data tables in the referenced report indicate there is more variability when comparing the volume of oil spilled from tank barges to the volume spilled from tank ships and non-tank vessels (U.S. Coast Guard, 2012).

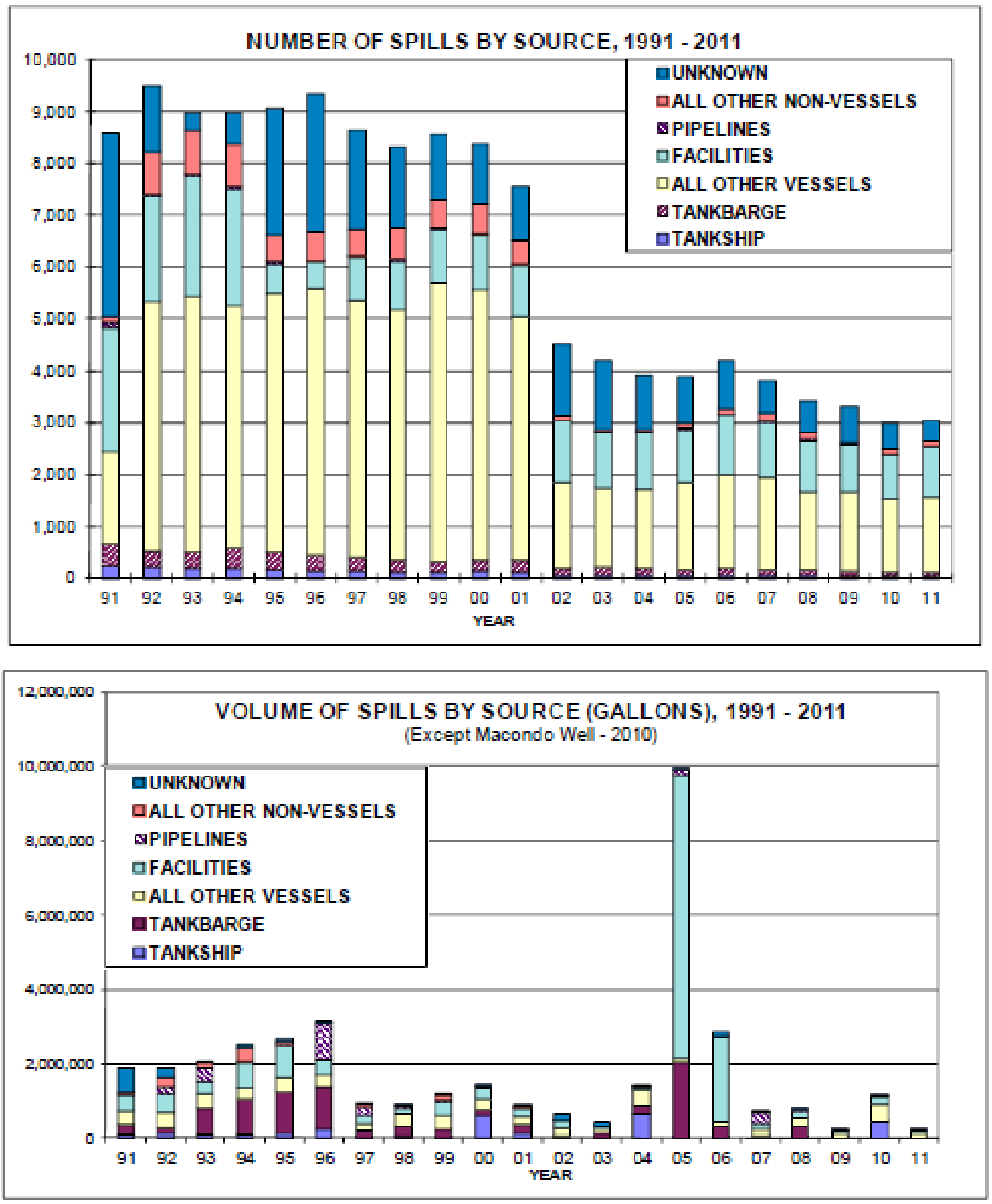
During the 39 years between 1973 and 2011, tank ships spilled more oil than tank barges: 67.9M gallons from tank ships compared to 45.2M gallons from tank barges. In the 20 years between 1991 and 2011, the time period shown on Figure 14, tank barges spilled more oil than tank ships, with 8.2M gallons spilled from tank barges and 2.6M gallons spilled from tank ships (U.S. Coast Guard, 2012).

Between 1973 and 2011, tank barges spilled more oil than non-tank vessels in 24 of the 39 years. Non-tank vessels spilled more oil than tank barges in the other 15 years. Tank barges spilled 29.1M gallons more than non-tank vessels during this time period: Tank barges spilled 45.2M gallons, and non-tank vessels spilled a total of 16.1M gallons (U.S. Coast Guard, 2012).

From 1991 to 2011, tank barges spilled more oil than non-tank vessels during seven years. Non-tank vessels spilled more oil than tank barges in the other 13 years. Tank barges spilled 2.5M gallons more than non-tank vessels during this time period (8.2M gallons spilled by tank barges compared to 5.7M gallons spilled by non-tank vessels) (U.S. Coast Guard, 2012).

As in the previous figures, the significant increase in the volume of oil spilled in 2005 shown in Figure 14 reflects the DBL-152 tank barge incident. The volume of oil spilled in 2010 includes oil released from the Deepwater Horizon, but does not include oil from the Macando Well. As described in the Compendium:

> The largest spill in U.S. waters began on April 20, 2010 with an explosion and fire on the mobile offshore drilling unit (MODU) DEEPWATER HORIZON. Subsequently, the MODU sank, leaving an open exploratory well to discharge crude oil into the Gulf of Mexico for several weeks. The incident occurred in the outer continental shelf leasing area known as Mississippi Canyon, block 252. The well itself was known as "Macondo" or "Macondo 252". The most commonly accepted spill amount from the Macondo well is approximately 206.6 million gallons, plus approximately 400,000 gallons of oil products from the MODU.
>
> For the 37-year period ending in 2009, Coast Guard databases contained investigations of more than 270,000 oil spills. The total spill amount recorded during that period was 240.7 million gallons. Thus, the oil discharged from the Macondo well is 86 percent of all oil discharged in the preceding 37 years. Statistically, that incident was an extremely rare, extremely severe event, resulting from unusual circumstances. As such, year-to-year comparisons are not appropriate with the Macondo spill amounts included. Also, the amount is too large to shown on the same graphs with the other spill data. Therefore, the charts on the following pages show the DEEPWATER HORIZON spill amount, but not the Macondo discharge. (U.S. Coast Guard, 2012, p.7)




Chart/Data Interpretation: 75.4% of the number of spills from 1991 - 2011 occurred from non-tank vessels. 29% of the volume of oil came from tank vessels (ships/barges); 41% from facilities and other non-vessels. (MACONDO well not included.)

**Figure 14: Number and volume of spills by source, 1991 – 2011, with interpretation (Excerpt from U.S. Coast Guard, 2012, Part I p.12)**

# International and national spill data comparison

Comparing Figures 9-14 and Table 2 indicates that while spills greater than one gallon in U.S. waters declined at a relatively linear rate since the 1970s, the number of large spills of refined products (greater than 1,000 bbls (42,000 gallons)) and the total volume of oil spilled from barges decreased rapidly, beginning in the late 1980s and 1990s. This supports the conclusion that the global, rapid decrease in the number of large spills and total volume of oil spilled is correlated with the implementation of prevention measures (e.g., changes to international standards and regulations, the introduction of double hulls, improved operating practices).

# Regional tank barge spill and incident data

Regional data on incidents and spills in Washington/Oregon waters and in the Canadian Pacific Region provide the most detailed information available. Ecology reviewed Spills Program data for reported oil spills and vessel incidents in Washington and Oregon waters, and TSB of Canada data for the Canadian Pacific region.[34] Both sources of regional data provided more detail than was available with the worldwide and national-level data, which allowed Ecology to assess ATB incidents separately from tank barge incidents. The data also provided information on non-spill incidents involving both tank barges and ATBs.

## Washington/Oregon incidents and spills

**Washington/Oregon tank barge incidents and spills**

Ecology recorded 45 tank barge incidents (not including ATBs) between 2008 and 2017 in Washington and Oregon waters (Washington State Department of Ecology, 2018b).[35] Twenty-six of the 45 tank barge incidents were oil spills, with a total amount spilled of approximately 1,998 gallons. Nineteen incidents did not involve an oil spill. Tank barge non-spill incidents and oil spills by number are shown in Figures 15 and 16.

Ecology has not conducted trend analysis on incident and oil spill data. The number of incidents and spills do not appear to increase or decrease consistently across the time period. This is likely due to the relatively infrequent nature of tank barge and ATB incidents and oil spills, and the limited number of years of data available for review. Ecology's review focused on incident types, vessel activities, and spill sizes.

[34] Ecology data includes incidents and oil spills reported to Ecology that occurred in Washington waters. This includes reported events within state waters where vessel traffic is managed by the Canadian Marine Communications and Traffic Services (MCTS). Data also includes some incidents and oil spills reported to Ecology that occurred in shared waters with Oregon (Columbia River), on the Willamette River, and on the Oregon coast. In this report, Ecology refers to these cases as occurring in Washington and Oregon waters. Ecology data does not include all spills and incidents occurring in Oregon, however, including those that may have taken place on the Columbia and Willamette Rivers or along the coast.

[35] Ecology reviewed data from January 1, 2008 through April 30, 2018. There were no tank barge or ATB oil spills or non-spill incidents reported in 2018 through April 30; this partial year of data with zero incidents is not included in the figures in this section. Years between 2008 and 2017 with zero incidents/oil spills are shown in the figures.

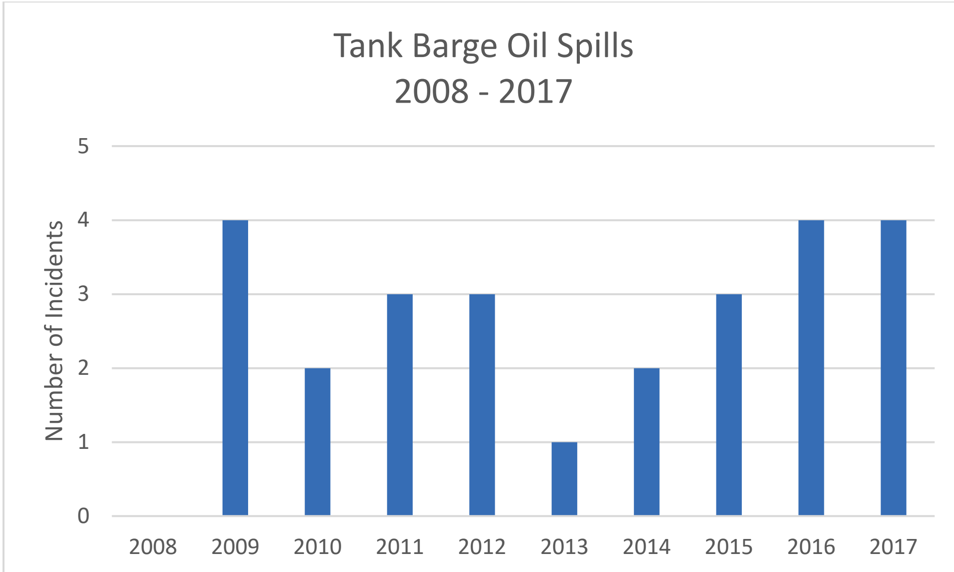



**Figure 15: Number of tank barge oil spills reported to Ecology, 2008 – 2017 (Washington State Department of Ecology, 2018b)**

Of the 26 tank barge oil spills in the Ecology data:

- Most spills were relatively small.
  - 12 spills were 1 gallon or less.
  - 18 were 10 gallons or less.
- Most spills occurred while the barge was moored.
  - 23 of the spills occurred while moored, resulting in approximately 1,989 gallons spilled.
- Three spills occurred while underway, resulting in approximately 9 gallons spilled.
  - One spill involved a grounding upstream of a lock on the Columbia River, resulting in a sheen while the vessel was in the lock (0 gallons reported spilled, sheen observed).
  - One spill resulted from a leaking generator fuel line (1 gallon spilled).
  - One spill was a leak of intermediate fuel oil (IFO 380) from cargo transfer piping (8 gallons spilled).

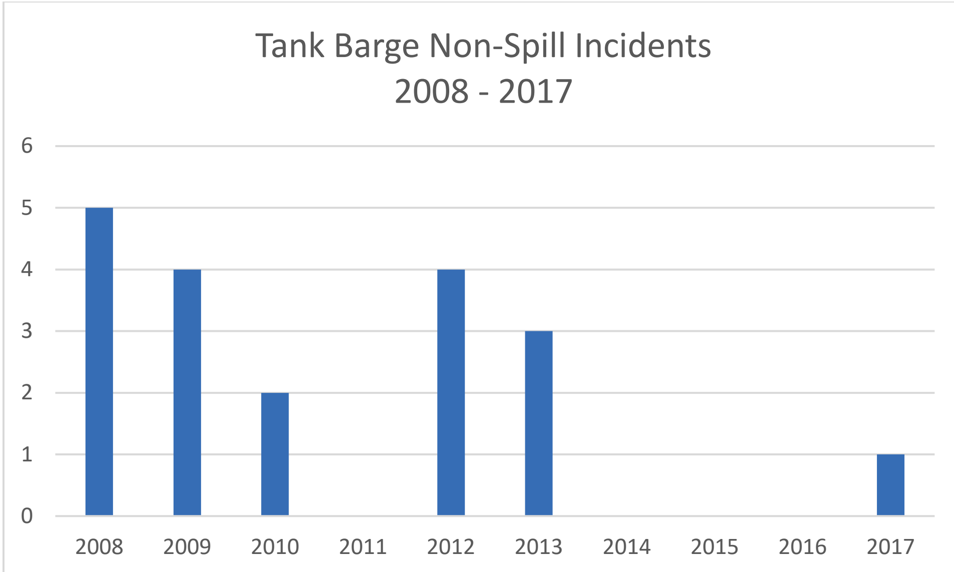



**Figure 16: Number of tank barge non-spill incidents reported to Ecology, 2008 – 2017 (Washington State Department of Ecology, 2018b)**

The 19 non-spill incidents included:

- Six groundings.
- Six allisions.
  - One incident involved a tug towing a tank barge exiting a traffic lane and running down a buoy.
- Two broken tow-wires.
- One partial loss of propulsion.
- Two safety threats involving tugs towing tank barges exiting a traffic lane.
- Two casualties classified as "other vessel casualty."
  - A cracked outer hull plate on a double hulled tank barge.
  - A loss of one generator on a tug towing a tank barge.

*Potential effect of tug escort*

Ecology reviewed tank barge oil spill and non-spill incident reports to gain insight into whether a tug escort, if assigned, could potentially have further reduced oil spill risks. This review was not a full investigation of each case.

None of the 26 oil spill incidents in Ecology's data indicated an opportunity existed for a tug escorting a towed tank barge within the Puget Sound to intervene.

- Twenty-three cases occurred while moored.
- One underway oil spill occurred upstream of a lock on the Columbia River, where towing operations and waterway characteristics are significantly different than the Puget Sound.

- The remaining two underway incidents involved leaks from piping.

Ecology identified seven of 19 non-spill incidents where a tug escort, if assigned, could have potentially further reduced the risk of the incident leading to an oil spill.

- In three cases, a tug towing a tank barge exited a traffic lane.
  - In one of these cases, the tug ran down a buoy, dragging the buoy and its anchor block off station.
- In two cases, tugs towing tank barges lost their tow wires.
  - In both cases, assist tugs responded to regain control of the barge.
  - An escort, if assigned and already present, would have eliminated the wait for an assist tug.
  - In one of these incidents, the tug towing the oil barge fouled a propeller with the tow bridle, and was unable to maneuver or control the barge.
- In one case, a tug lost propulsion due to a governor failure.
  - An assist tug responded.
  - An escort, if assigned and already present would have eliminated the wait for an assist tug.
- In one case, a tug getting underway from a dock with a tank barge could not control a turn due to wind speed and current.
  - The tug made hard contact with the pier, resulting in hole in the tug's hull.
  - An escort, if assigned and already present, could have helped control the barge while getting underway.

*Causes of Washington/Oregon tank barge oil spills and incidents*

Ecology data was the only source reviewed that contains information on spill and incident causes. Of the 26 tank barge spills between 2008 and 2017, 12 were caused by equipment/material failure, 11 were caused by human error, two spills were the result of organizational or management failure, and one was caused by external conditions (Washington State Department of Ecology, 2018b).[36]

Ten of the 19 non-spill incidents were caused by human error, four were the result of equipment/material failure, three cases report unknown causes, and two incidents list external conditions as the cause (Washington State Department of Ecology, 2018b).

Causes of oil spills and non-spill incidents are summarized in Figure 17.

[36] This is based on the designation of "immediate cause" in Ecology's data set which is consistent with the Pacific States / British Columbia Oil Spill Task Force (OSTF) Data Dictionary (Pacific States/British Columbia Oil Spill Task Force, 2018). The "contributing factors," which may have been significant, are omitted here for ease of discussion.

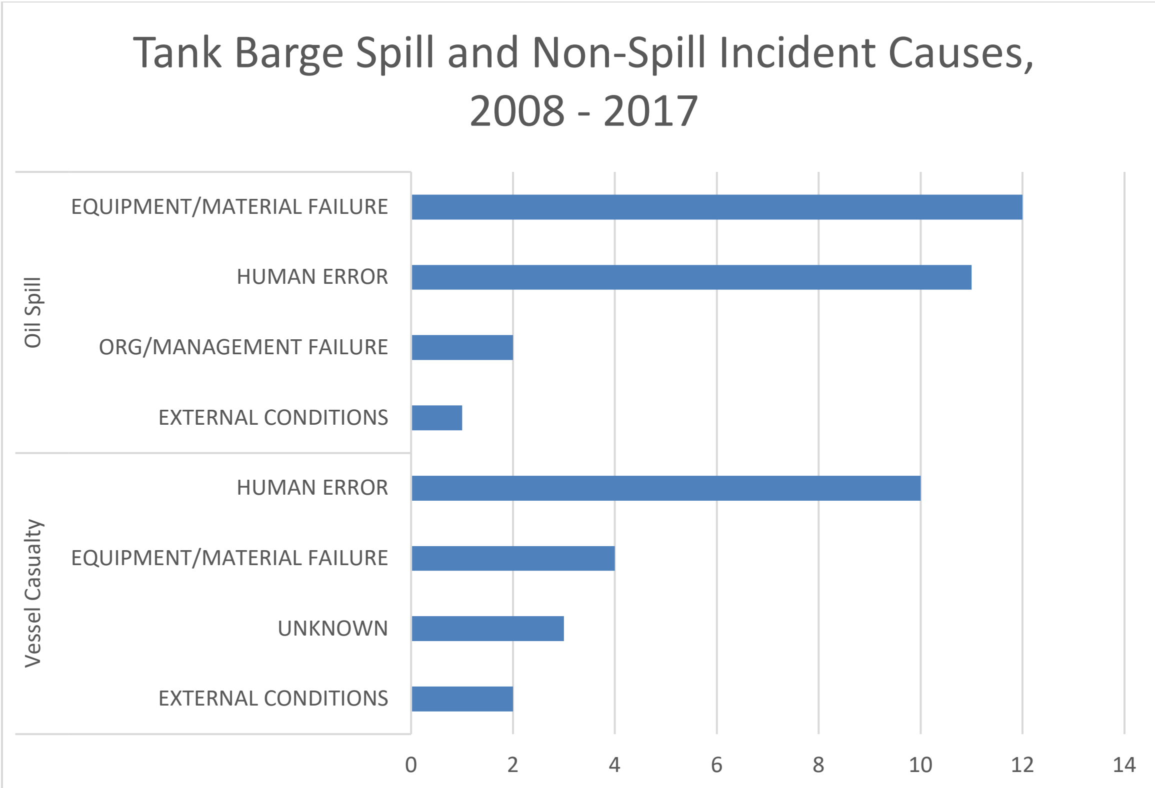



**Figure 17: Causes of tank barge oil spills and non-spill incidents for incidents reported to Ecology, 2008 – 2017 (Washington State Department of Ecology, 2018b)**

### Washington/Oregon ATB incidents and spills

Ecology data includes 20 ATB incidents, comprising four oil spills and 16 non-spill incidents (Washington State Department of Ecology, 2018b).

All four oil spills occurred while the vessel was moored. The total volume spilled from ATBs was less than 1 gallon. There was no apparent trend in spills over time. One spill per year occurred in 2012, 2013, and 2014. The fourth spill was in 2017. The four spills involved:

- A leak from a weld on cargo transfer piping (0.04 gallons spilled).
- A leak from a cracked weld on an ATB tug fuel tank (less than 1 gallon spilled).
- A spill from a spectacle blind valve, while the crew was checking valves in preparation for sea (0.1 gallons spilled).
- A mist from a tank vent while purging cargo tanks (0 gallons spilled).

The 16 non-spill incidents included:

- Seven losses of propulsion (total or partial).
    - One incident also involved a loss of electrical power.
- Four losses of steering (total or partial).
    - One incident also involved a loss of electrical power.

- Two losses of electrical power (not including the two incidents counted as loss of propulsion and loss of steering).
- One "fitness for service" incident.
  - Generator issues and a loss of lubrication to the tug-barge coupling system, as a result of the vessel taking on water in heavy seas near the entrance to the Columbia River. This incident generated a response by the Neah Bay ERTV. The Neah Bay ERTV is discussed in Chapter 11.
- One safety threat.
  - ATB entered the north-bound lane of a traffic separation scheme (TSS) while traveling south.
- One fire.

Non-spill incidents are summarized by year in Figure 18.

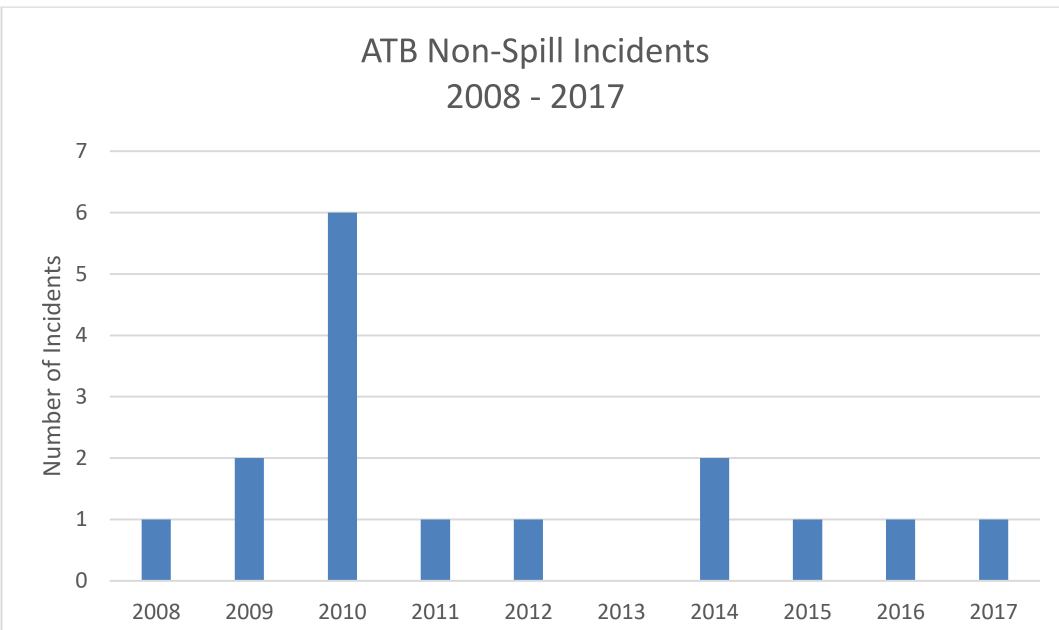



**Figure 18: ATB non-spill incidents reported to Ecology, 2008 – 2017 (Washington State Department of Ecology, 2018b)**

*Potential effect of tug escort*

Ecology reviewed ATB oil spill and non-spill incident reports to gain insight into whether a tug escort, if assigned, could potentially have further reduced oil spill risks. This review was not a full investigation of each case.

All four of the oil spill incidents occurred while the vessel was moored, with no opportunity for tug escort intervention.

Ecology identified four of 16 non-spill incidents where a tug escort, if assigned, could have potentially further reduced the risk of the incident leading to an oil spill.

- Two cases were complete loss of steering incidents.
    - One of the two incidents occurred shortly after the ATB got underway, and the tug that assisted with undocking was close by.
- One case was a complete loss of propulsion.
    - The ATB drifted for approximately four hours and 20 minutes while troubleshooting to restore propulsion.
    - The Neah Bay ERTV responded and stood by until the ATB restored propulsion.
- In one case, an ATB entered the northbound lane of a traffic separation scheme while traveling southbound.

*Causes of Washington/Oregon ATB oil spills and incidents*

Figure 19 summarizes the causes of ATB oil spills and non-spill incidents in Washington and Oregon waters. For the four ATB oil spills, two spills were caused by equipment/material failure, one spill was caused by organizational/ management failure, and the cause was unknown for one spill (Washington State Department of Ecology, 2018b).

Seven of the 16 non-spill incidents were caused by equipment/material failure. Six incidents list an unknown cause. Two incidents were caused by human error, and one by external conditions (Washington State Department of Ecology, 2018b).

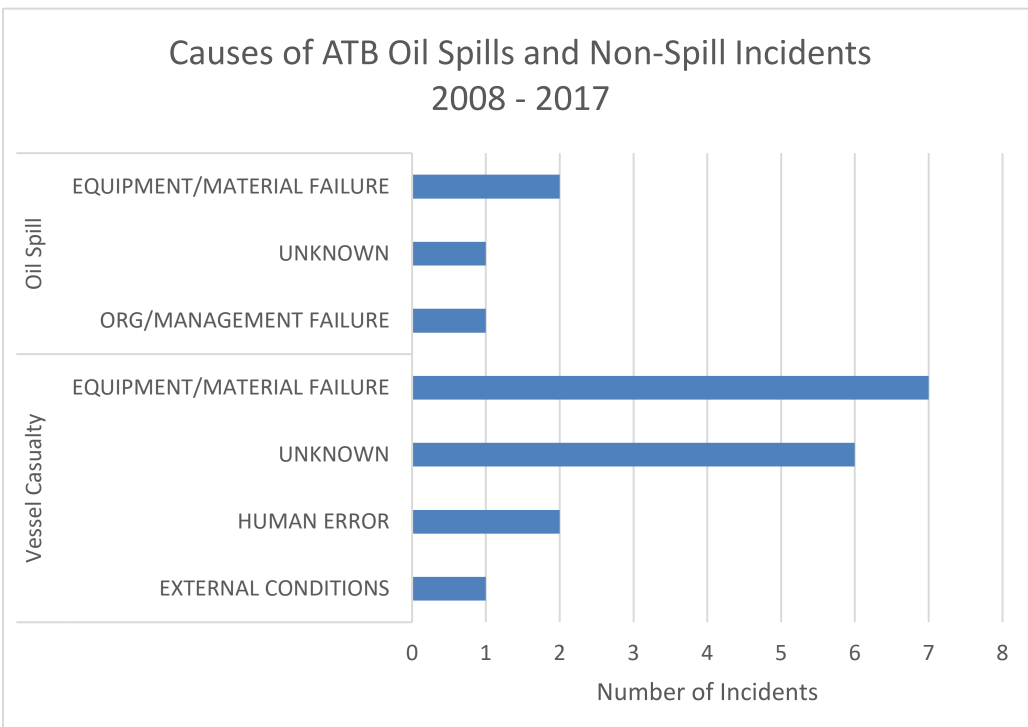



**Figure 19: Causes of ATB oil spills and non-spill incidents reported to Ecology, 2008 – 2017 (Washington State Department of Ecology, 2018b)**

## Canadian Pacific region incidents and spills

Ecology reviewed vessel incident and oil spill data for the Canadian Pacific region from the TSB of Canada. The data covers incidents between January 2004 and March 2018. The data includes several years with no tank barge or ATB incidents or oil spills in the Canadian Pacific Region, including the partial year of January through March, 2018. The figures in this section show data for the years 2004 through 2017, including years with zero incidents. The three months of 2018 data with no incidents is not included in the figures.

The TSB Canada data for the Pacific Region contains 16 tank barge incidents, including four oil spills, and 27 ATB incidents, with one oil spill (Transportation Safety Board of Canada, 2018).

Ecology has not conducted trend analysis on the TSB Canada data. The number of incidents and spills do not appear to increase or decrease consistently across the time period. This is likely due to the relatively infrequent nature of tank barge and ATB incidents and oil spills, and the limited number of years of data available for review. Ecology's review focused on the number of incidents and spills, and incident types.

### Canadian tank barge incidents and spills

Of the 16 tank barge incidents, four resulted in oil spills. The four oil spills occurred in 2004, 2006, 2008, and 2015 (Transportation Safety Board of Canada, 2018).

Figure 20 shows the tank barge incidents (including oil spills) by year.

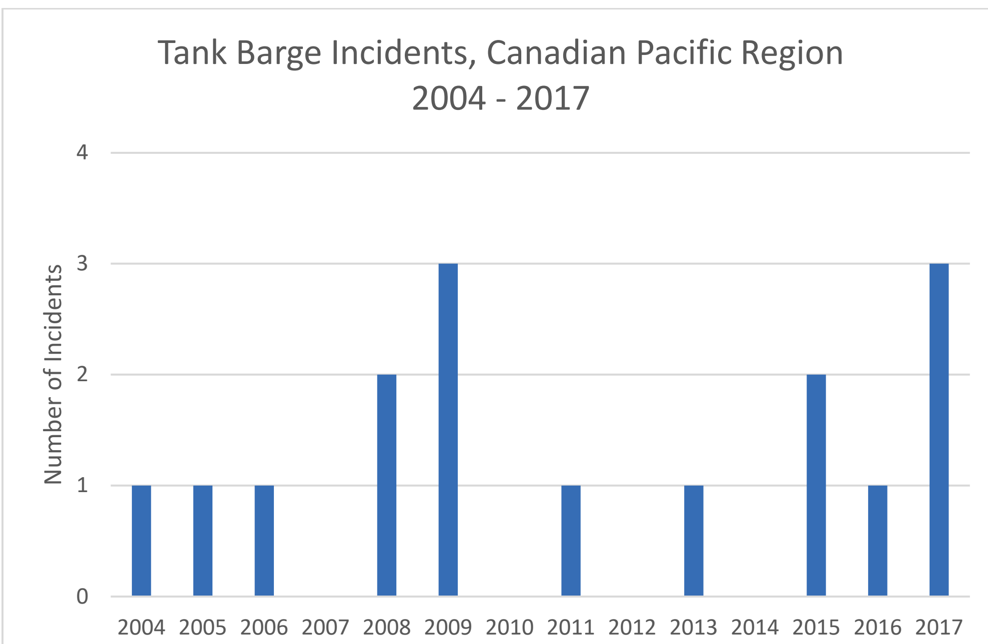



**Figure 20: Tank barge incidents in the Canadian Pacific region, 2004 – 2017 (Transportation Safety Board of Canada, 2018)**

Of the 16 tank barge incidents:

- Six were groundings.
- Three were allisions.
- Two were personnel casualties.[37]
- The five remaining cases included one of each:
    - A contact with the bottom incident.
    - A risk of sinking.
    - A cargo shift/loss.
    - An unfit for service case.
    - An intentional grounding.

Three of the four oil spills from tank barges were the result of groundings/bottom contact. The fourth spill was from the "unfit for service" case, with no other details provided.[38] All spills occurred while the barges were underway; it is not known if data is collected on incidents that occur while barges are moored.

**Canadian ATB incidents and spills**

As stated at the beginning of this section, there were 27 ATB incidents between January 2004 and March 2018, one of which resulted in an oil spill. Figure 21 shows the ATB incidents (including oil spills) by year.

[37] Person is killed or sustains a serious injury (Transportation Safety Board of Canada Regulations, 2014).
[38] The ship sustains damage that effects its seaworthiness or renders it unfit for its purpose (Transportation Safety Board of Canada Regulations, 2014).

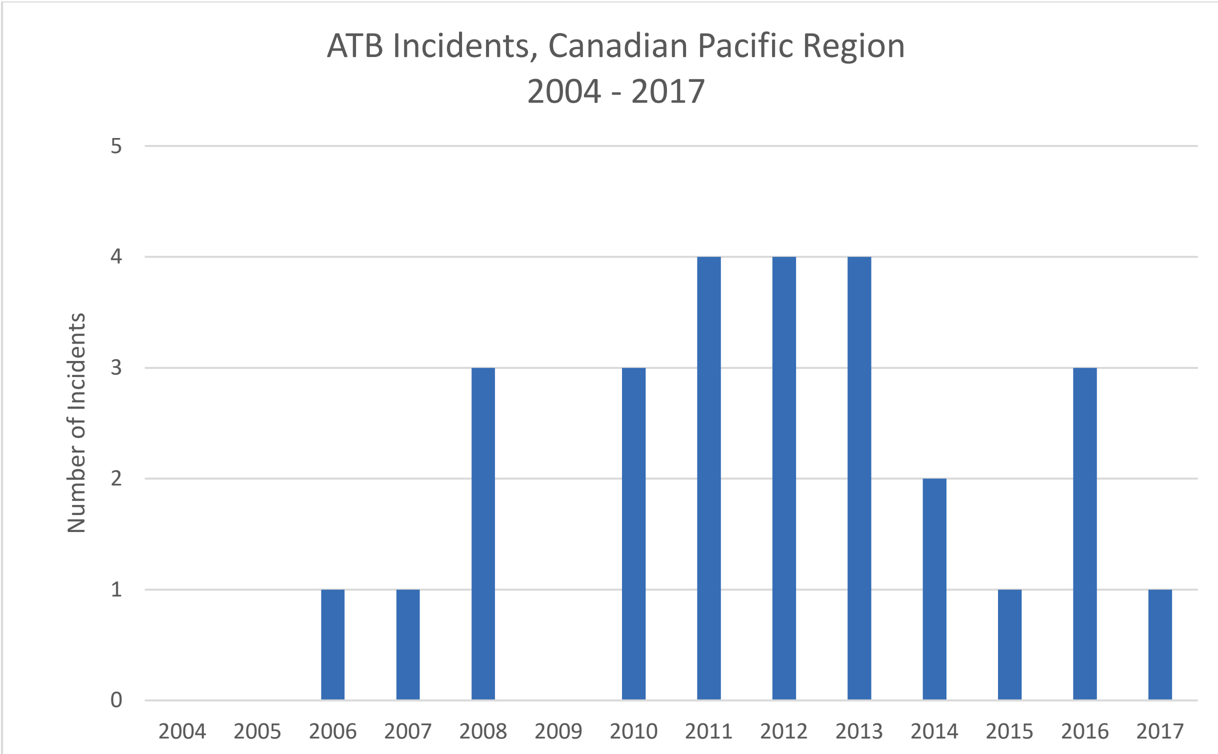



**Figure 21: ATB incidents in the Canadian Pacific region, 2004 – 2017 (Transportation Safety Board Canada, 2018)**

The data for the ATBs are notable in that 11 of the 27 incidents were "risk of striking" and 9 were "risk of collision" incidents. Other data reviewed did not include similar near-miss incidents, with the exception of three lane departure incidents in Ecology's data.[39] The remaining incidents included three machinery failure events, two groundings, one collision, and one fire (Transportation Safety Board of Canada, 2018).[40]

The one oil spill occurred during an ATB grounding in 2016: 29,000 gallons of fuel and lube oil were released from the ATB tug *Nathan E. Stewart*, which was coupled to Barge *DBL 55* (National Transportation Safety Board, 2017).

A second significant ATB incident occurred when high seas caused the loaded barge *Zidell Marine 277* to twist free from the tug *Jake Shearer* in November, 2017. The tug and its crew managed to keep the barge off the rocks and anchored it off Goose Island (Haig-Brown, 2018). No oil was spilled. This incident is documented in the TSB of Canada data as a tank barge incident.

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[39] Near miss: an incident that could have resulted in an accident (spill or non-spill) if not resolved or interrupted.
[40] Transportation Safety Board of Canada regulations state "risk of collision means a situation in which a ship comes so close to being involved in a collision that a threat to the safety of any person, property or the environment exists." Risk of striking is not defined in regulation. However, impacts between ships and objects are included in the definition of collision: "collision means an impact, other than an impact associated with normal operating circumstances, between ships or between a ship and another object" (Transportation Safety Board of Canada Regulations, 2014).

## Incident rates for tank barges and ATBs

In addition to searching for tank barge and ATB incident data, Ecology also looked for available information about the rate of incidents. Rates are expressed as the frequency of incidents for a measureable attribute, such as miles traveled, days in operation, or gallons of oil transported.

As stated in Chapter 3, Ecology reviewed four sources that developed incident rates for tank barges and ATBs, including:

- The ABS study for BSEE/BOEM develops 15-year spill rates, confidence intervals, and spill size distributions for oil spills from tank barges.
- The 2017 U.S. Coast Guard – AWO annual safety report shows a moving average of gallons of oil spilled by tank barges per million gallons transported.
- The 2015 Vessel Traffic Risk Assessment (VTRA) updated previous studies for the Strait of Juan de Fuca, Puget Sound, San Juan Islands, and connecting waterways, and provides calibrated accident rates for tank "focus vessels" (tank ships and ATBs) and tank barges.
- The Glosten Associates "Gateway Pacific Terminal vessel traffic and risk assessment study" includes average incident rates for a variety of vessel types, including tank ships, barges, and tugs, for the Strait of Juan de Fuca; Haro Strait/Boundary Pass and Rosario Pass; and Guemes Channel, Saddlebag, and Cherry Point.

Ecology determined that a comparison of the methodologies and results of these sources was beyond the scope of this report and would not measurably add to the conclusions. A brief summary of incident rates is provided below, to inform potential future work.

### ABS incident rates

In their 2016 report for BSEE/BOEM, ABS updated spill rates for tank barges in U.S. waters in two size categories (≥1,000 bbls (42,000 gallons) and ≥10,000 bbls (420,000 gallons) and two types of oil (refined products and crude oil). Rates were calculated using 15 years of data, 1992-2013. This time frame was selected because the data was relatively trendless (i.e., the rate of spills did not appear to be changing significantly over time) (ABS Consulting, Inc., 2016).

- Spills ≥1,000 bbls (42,000 gallons)
  - Refined product: 0.79 spills per billion barrels (Bbbl) of oil handled.
  - Crude oil: 0.59 spills per Bbbl oil handled.
- Spills ≥10,000 bbls (420,000 gallons)
  - Refined products: 0.14 spills per Bbbl handled.
  - Crude oil: 0.08 spills per Bbbl handled.[41]

[41] There were no crude oil spills of this size in the date range. The spill rate was calculated based on previous spill rates and assumptions about the ratio of the number of spills ≥1,000 barrels (42,000 gallons) and the number of spills ≥10,000 barrels (420,000 gallons).

## U.S. Coast Guard – AWO incident rates

The U.S. Coast Guard – AWO annual safety report provides a moving average of gallons of oil spilled by tank barges per million gallons transported. Figure 22 shows the moving average through 2015, and a projected average for 2016.

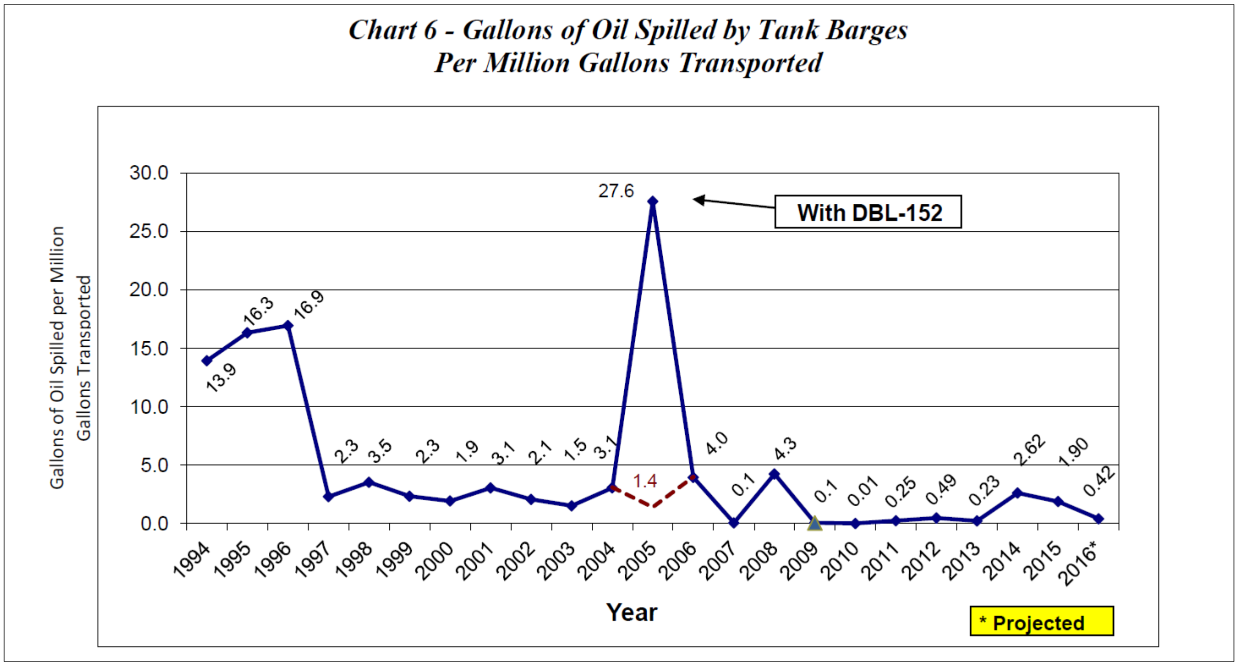


**Figure 22: Moving average, gallons of oil spilled by tank barges per million gallons transported (Excerpt from U.S. Coast Guard–American Waterways Operators, 2017, p.6)**

## 2015 VTRA incident rates

The 2015 VTRA updated previous studies for the Strait of Juan de Fuca, Puget Sound, San Juan Islands, and connecting waterways, and provides calibrated accident rates for tank "focus vessels" (tank ships and ATBs) and tank barges (Van Dorp & Merrick, 2016). Additional discussion of the 2015 VTRA methodology and results is provided in Chapter 9.

Using data from the U.S. and Canada for accidents that occurred within the VTRA study area between 1995 and 2015, and recalibrated accident rates to include additional data between 1990 and 2015, the 2015 VTRA principal investigators calculated the number of accidents per year that could result in an oil spill with a spill size between 0 and 1 $m^3$. The study assumed one cubic meter represented approximately 264 gallons (Van Dorp & Merrick, 2016).

- For tank "focus vessels" (tank ships and ATBs), the 2015 VTRA provides the following frequencies per type of accident with a potential spill size between 0 and 1 $m^3$ (264 gallons):
    - Allision: 0.238 accidents per year
    - Grounding: 0.056 accidents per year
    - Collision: 0.048 accidents per year

- For oil barges, the 2015 VTRA provides the following frequencies per type of accident with a potential spill size between 0 and 1 $m^3$:
  - Allision: 0.533 accidents per year
  - Grounding: 0.067 accidents per year
  - Collision: 0.400 accidents per year

## Glosten Associates Gateway Pacific Terminal incident rates

The Glosten Associates "Gateway Pacific Terminal vessel traffic and risk assessment study" includes average incident rates for a variety of vessel types, including tank ships, barges, and tugs, for the Strait of Juan de Fuca; Haro Strait/Boundary Pass and Rosario Strait; and Guemes Channel, Saddlebag, and Cherry Point (Kirtley, 2014).

Incidents rates were developed using accident data from 1995-2010, and were defined as the number of incidents per traffic day, where a traffic day is 24 hours of operation. Incident rates were developed for four types of operation (underway, maneuvering, anchored, and docked) for each type of vessel.

As a sample of the incident rates developed in the study, Table 3 provides the incident rates for tank barges underway.

**Table 3: Incident rates (IR) for tank barges underway for three waterway areas as developed for the Gateway Pacific Terminal Vessel Traffic Risk Assessment study (Excerpt from Kirtley, 2014, p.167)[42,43]**

| Type of incident | Strait of Juan de Fuca | Haro Strait/Boundary Pass & Rosario Strait | Guemes Channel, Saddlebag, & Cherry Point |
|---|---|---|---|
| **IR Collision** | 0.000310 | *0.000032* | 0.000538 |
| **IR Grounding** | *0.000071* | *0.000032* | *0.000041* |
| **IR Allision** | *0.000071* | *0.000032* | *0.000041* |
| **IR Cargo Transfer Error** | 0.00 | 0.00 | 0.00 |
| **IR Bunker Error** | 0.00 | 0.00 | 0.00 |
| **IR Other Non-impact Incident** | 0.000620 | *0.000032* | 0.001614 |
| **Sum** | ***0.001072*** | ***0.000127*** | ***0.002234*** |

[42] The gray shading and italicized text indicates that no accidents of this type were found in historical data. Incident rates for accidents with no historical data were calculated using a formula that assumes one accident of the incident type occurred. Additional explanations are provided in the report.

[43] Data sources cited in the Gateway Pacific study include Coast Guard records, Ecology records, and proprietary databases (Kirtley, 2014). Incident data from the Canadian Marine Communications and Traffic Services (MCTS) is not cited as a source. A comparison of MCTS data to vessel incident data in the Gateway Pacific report indicates more incidents were reported to MCTS than were included in the Gateway Pacific Vessel Traffic Risk Assessment characterization of historical accidents. As with all studies, if different data had been included in the analysis, the resulting incident rates would likely be different those than shown in the report.

# Key points for consideration

In addition to the overall trends and causes of spills and incidents, Ecology's review identified several key points for consideration.

## Most spills are small

Internationally, ITOPF reports that over 80 percent of oil spills from tank vessels are less than 7 metric tons. These spills are not included in their statistical and trend analysis, however, due to a lack of complete data (International Tanker Owners Pollution Federation Limited, 2018b).

Eighty-nine percent of the spills from all sources in U.S. Coast Guard data from 1973 – 2011 are 100 gallons or less (U.S. Coast Guard, 2012). These spills are included in their tables and charts, but details are not provided about the sources or causes of small spills. Some detailed information is available through MISLE data, which was not evaluated for this report due to the resources that would be required to compile the data and identify relevant incidents and spills.

TSB Canada data for the Pacific Region from 2004 – 2017 includes four reports of oil spills from barges/ATBs, but does not include spill volumes (Transportation Safety Board of Canada, 2018).

Ecology data on reported oil spills and vessel incidents in Washington was the only source reviewed that included detailed information on all incidents, and reported spills of all volumes. From 2008 – May of 2018, there were 26 oil spills from barges and four from ATBs. Twelve of the 26 spills from barges were 1 gallon or less. Eighteen of the spills were 10 gallons or less. The four ATB spills were all less than one gallon (Washington State Department of Ecology, 2018b).

## Most oil spilled is from the relatively small number of large spills

While the majority of reported oil spills are small, most of the total volume of oil spilled is the result of large spills. In the U.S. Coast Guard data from 1973 – 2011, 82 percent of the oil spilled from all sources was the result of spills greater than 100,000 gallons (U.S. Coast Guard, 2012). ITOPF statistics indicate that for the last 40 years, over 70 percent of oil spilled by tank vessels per decade is the result of the 10 largest incidents in that time period (International Tanker Owners Pollution Federation Limited, 2018b).

For incidents reported to Ecology between 2008 and 2018, 86 percent of the total volume of oil spilled by tank barges and ATBs was the result of one spill (Washington State Department of Ecology, 2018b).

## In the data reviewed, most tank barge incidents were groundings and allisions, and most ATB incidents were near miss events and equipment failures

In the international data, allisions were responsible for over a third of all spills (68 of 176). Groundings were the next most frequent incident type, with 48 reports (International Tanker Owners Pollution Federation Limited, 2018a).

Most tank barge and ATB spills reported to Ecology occurred while the vessel was moored. Twenty three of 26 tank barge spills, and all four ATB spills happened while moored. Twelve of

19 tank barge non-spill incidents reported to Ecology were groundings or allisions. Most ATB non-spill incidents in the Ecology data involved equipment failures (i.e., loss of electrical power, loss of steering). Many of the incidents (seven of the 16) involved a loss of redundancy, rather than a complete loss of capability (Washington State Department of Ecology, 2018b).

In the Canadian Pacific Region, three of four tank barge spills were the result of groundings, and nine of 16 tank barge incidents overall were groundings or allisions. The TSB Canada data for ATBs are notable in that 11 of the 27 incidents were "risk of striking" and nine were "risk of collision" incidents.[44] Other data reviewed did not include similar near-miss incidents, with the exception of three lane departure incidents in the Ecology data (Transportation Safety Board of Canada, 2018).

This data indicates the most common types of incidents experienced by tank barges and ATBs – allisions, groundings, "near-miss" events, and losses of propulsion, steering, or electrical power – are incidents where a tug escort, if assigned, could potentially provide a positive risk reduction benefit. The potential benefit of an emergency response system would likely depend on the stationing and availability of an ERTV. Tug escorts and an emergency response system are discussed in Chapters 9 and 11 of this report.

## Summary

This chapter presented international and national-level data on tank barge spills, followed by regional data that includes Washington/Oregon and the Canadian Pacific region on spills and incidents from tank barges and ATBs. This chapter also discussed incident rates for tank barges and ATBs.

Ecology identified one source for worldwide data and three sources for national-level data of tank barge oil spills. No sources were identified that provided worldwide or national data for ATB oil spills, or for non-spill incident data for tank barges and ATBs. Two sources provided regional information about tank barge and ATB oil spills and non-spill incidents in Washington/Oregon waters and in the Canadian Pacific Region.

Based on the information reviewed, Ecology concludes:

- Oil spills from tank barges have decreased over time, both internationally and in U.S. waters.
- Most oil spills are small; few sources provide detailed information on small spills.
- Of the total volume of oil spilled, most is from the relatively small number of large spills, reflecting the low probability and high consequence nature of oil spill risk.
- The decrease in oil spills over time indicates prevention measures (e.g., changes to international standards and regulations, the introduction of double hulls, improved

[44] Transportation Safety Board of Canada regulations state "risk of collision means a situation in which a ship comes so close to being involved in a collision that a threat to the safety of any person, property or the environment exists." Risk of striking is not defined in regulation. However, impacts between ships and objects are included in the definition of collision: "Collision means an impact, other than an impact associated with normal operating circumstances, between ships or between a ship and another object" (Transportation Safety Board of Canada Regulations, 2014).

operating practices) have had a positive effect in reducing the number of spills from tank barges, including ATBs, and the volume of oil spilled.

- Most tank barge oil spills reported in international data resulted from allisions and groundings.
  - While the data does not provide specific information about each spill, Ecology considers it reasonable to assume tug escorts may have been effective in some of these incidents.
- Twelve of 19 tank barge non-spill incidents reported to Ecology were groundings or allisions. Most ATB non-spill incidents in the Ecology data involved equipment failures (i.e., loss of electrical power, loss of steering). Many of the incidents (seven of the 16) involved a loss of redundancy, rather than a complete loss of capability.
- In the Canadian Pacific Region, three of four tank barge spills were the result of groundings, and nine of 16 tank barge incidents overall were groundings or allisions. The TSB Canada data for ATBs are notable in that most (20 of 27) incidents were "risk of striking" or "risk of collision" incidents.
- This data indicates the most common types of incidents experienced by tank barges and ATBs – allisions, groundings, "near-miss" events, and losses of propulsion, steering, or electrical power – are incidents where a tug escort, if assigned, could potentially provide a positive risk reduction benefit. Ecology reviewed tank barge and ATB oil spill and non-spill incident reports to gain insight into whether a tug escort, if assigned, could potentially have further reduced oil spill risks.
  - None of the tank barge or ATB oil spill incidents appeared to provide an opportunity for tug escort intervention.
  - Ecology identified seven of 19 tank barge non-spill incidents and four of 16 ATB non-spill incidents where a tug escort, if assigned, could have potentially further reduced the risk of the incident leading to an oil spill.
- The potential benefit of an emergency response system would likely depend on the stationing and availability of an ERTV. See Chapter 11 for further explanation of an emergency response system.

# Chapter 6: Assessing the Potential for Non-Floating Oils

Section 206 (2)(i) of E2SSB 6269 directs Ecology to complete an assessment and evaluation of "situations, where oils, depending on their qualities, weathering, environmental factors, and method of discharge, may submerge or sink in water." Ecology developed the scope and goal statements below to guide this assessment and evaluation.

Scope: Using current, existing data, describe the situations with Puget Sound and the Salish Sea where oils, depending on their qualities, weathering, environment, and discharge method may sink or submerge.

Goal: Assess existing data to describe situations in Puget Sound and the Salish Sea where oils may sink or submerge considering factors of weathering, environment, discharge method, and oil qualities.

In recent years, our understanding has evolved regarding the types of oils transported within the study area and the conditions under which oils may submerge into the water column or sink to the seafloor. This assessment defines the term "non-floating oil" and describes properties of oil, weathering, and water conditions that are indicators of non-floating oils. It then provides data on oil transfers of potential non-floating oils in the study area, including locations, volume, oil type, and frequency.

## Defining the term non-floating oil

When spilled and not immediately contained, most oil spreads across the surface of water pushed by waves, currents, and winds. This causes oil to thin out, potentially over large areas, becoming harder to recover as time passes. Historically, response preparedness has focused on strategies and tactics to contain and recover surface floating oil. However, not all oils float. These general definitions from the American Petroleum Institute (API) apply in this report (American Petroleum Institute, 2016b):

- Floating oil – spilled oil that remains on the surface of the water.
- Submerged oil – spilled oil in the water column, below the water surface, including oil that is in temporary suspension due to turbulence. Submerged oil may refloat or sink in the absence of turbulence.
- Sunken oil – spilled oil that is on the bottom of the water body.

In this report, the term non-floating oils is used to mean both submerged and sunken oils. Non-floating oil can become submerged in the water column or sink to the bottom. Some oils can float, submerge, and sink in a single spill. Furthermore, oil that has sunk to the bottom can become re-suspended and spread further by currents (American Petroleum Institute, 2016b). Figure 23 illustrates some behaviors of non-floating oil when spilled to water.

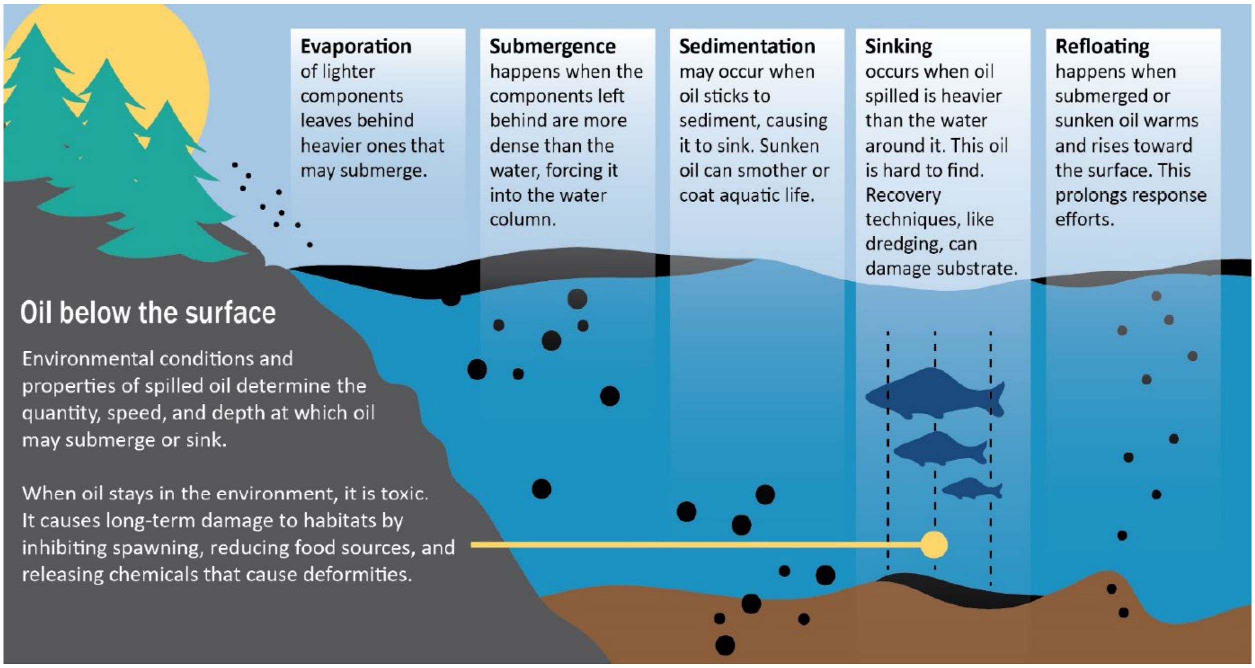


**Figure 23: Behaviors of non-floating oil when spilled to water (Washington State Department of Ecology, 2018i)**

# Properties of oil as non-floating indicators

Crude oil is made up of hydrocarbons ranging from volatile, light materials (such as propane and benzene) to more complex heavy compounds (such as bitumen, resins, and waxes). Refined petroleum products (such as gasoline or diesel) are made of smaller and more specific ranges of hydrocarbons. Some inherent properties of crude, refined oil, and waste petroleum products are indicators of whether it will float or not when spilled. An oil's persistence, viscosity, and density could all be strong determinants (American Petroleum Institute, 2016b).

The American Petroleum Institute gravity, or API gravity, is a measure of how heavy or light a petroleum liquid is that is related to density and specific gravity (Speight, 2008). The API gravity is reported in degrees and results in a general characterization of oil as light, medium, or heavy.

API gravity is used to define the following categories of oil:

- Light crude oil has an API gravity higher than 31.1°.
- Medium oil has an API gravity between 22.3 and 31.1°.
- Heavy crude oil has an API gravity below 22.3°.
- Extra heavy oil has an API gravity below 10.0° (Petroleum.co.uk, n.d.).

If an oil's API gravity is greater than 10, it is lighter and floats on water; if less than 10, it is heavier and sinks.

Washington State contingency planning regulations (Chapters 173-182 and 173-186 WAC) define oil in the following ways:

> “Oil" or "oils" means oil of any kind that is liquid at twenty-five degrees Celsius 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 in Table 302.4 of 40 C.F.R. Part 302 adopted August 14, 1989, under section 102(a) of the Federal Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by P.L. 99-499.
>
> "Persistent oil" means:
>
> (a) Petroleum-based oil that does not meet the distillation criteria for a nonpersistent oil. Persistent oils are further classified based on both specific and American Petroleum Institute (API) observed gravities corrected to 60°F, as follows:
>
> > (i) Group 2 - Specific gravity greater than or equal to 0.8000 and less than 0.8500. API gravity less than or equal to 45.00 and greater than 35.0;
> > (ii) Group 3 - Specific gravity greater than or equal to 0.8500, and less than 0.9490. API gravity less than or equal to 35.0 and greater than 17.5;
> > (iii) Group 4 - Specific gravity greater than or equal to 0.9490 and up to and including 1.0. API gravity less than or equal to 17.5 and greater than 10.00; and
> > (iv) Group 5 - Specific gravity greater than 1.0000. API gravity equal to or less than 10.0.
>
> (b) A nonpetroleum oil with a specific gravity of 0.8 or greater. These oils are further classified based on specific gravity as follows:
>
> > (i) Group 2 - Specific gravity equal to or greater than 0.8 and less than 0.85;
> > (ii) Group 3 - Specific gravity equal to or greater than 0.85 and less than 0.95;
> > (iii) Group 4 - Specific gravity equal to or greater than 0.95 and less than 1.0; or
> > (iv) Group 5 - Specific gravity equal to or greater than 1.0.
>
> “Nonpersistent or group 1 oil" means:
>
> (a) A petroleum-based oil, such as gasoline, diesel or jet fuel, which evaporates relatively quickly. Such oil, at the time of shipment, consists of hydrocarbon fractions of which:
>
> > (i) At least fifty percent, by volume, distills at a temperature of 340°C (645°F); and
> > (ii) At least ninety-five percent, by volume, distills at a temperature of 370°C (700°F).
>
> (b) A nonpetroleum oil with a specific gravity less than 0.8.
>
> "Nonpetroleum oil" means oil of any kind that is not petroleum-based, including but not limited to: Biological oils such as fats and greases of animals and vegetable oils, including oils from seeds, nuts, fruits, and kernels. (Wash. Admin. Code § 173-182-030, 2016)

Group 5 oils are inherently heavy and known to sink when spilled. An example of a Group 5 oil is asphalt. Initially, planning for non-floating oil spills focused solely on Group 5 oils. In recent years, there has been an evolution in understanding and the terminology used to talk about heavy sinking oils. It is understood that the risk of non-floating oil spills can exist in oils that may be classified as Group 3-5 because the inherent properties alone cannot be used to understand non-floating oils. Weathering patterns of the oil when spilled and properties of the waters in the study area must also be considered.

## Weathering and water properties as non-floating indicators

Spilled oil immediately begins undergoing weathering — physical and chemical changes that transform the original characteristics of the oil into something different (Transportation Research Board & National Research Council, 2003). Weathering includes spreading, evaporation, biodegradation, emulsification, oxidation, and dissolution into water. Evaporation of light components of the oil can lead to increases in density of the residual oil. When the density of the weathered oil is greater than the water it is spilled into, it will begin to sink.

Additionally, the properties of the water and the conditions under which the spill occurred also affect the behavior and weathering. The density of fresh water is commonly defined as 1.00 $g/cm^3$ and the densities of crude oils generally range from 0.7 to 0.99 $g/cm^3$. This means that most oils, potentially including diluted bitumen, will initially float on fresh water. The density of sea water is 1.03 $g/cm^3$, meaning that even the heaviest oils will usually float on seawater. This can change due to weathering. Salinity, oil to water density ratio, existence and extent of turbulence in the water, and the potential to encounter sediments are all additional indicators of the potential for oils to submerge or sink. Table 4 compares densities of typical crude oils and shows the effect of weathering on density.

**Table 4: Density comparison of typical crude oils and effects of weathering on density. Data in $g/cm^3$ at 15 degrees C; freshwater has a density of 1.00, seawater of 1.03. (Excerpt from National Academies of Sciences, Engineering, and Medicine, 2016, p.29, Table 2-3)**

| Type of crude oil | Density before release | Density after initial weathering (mass % loss in weathering) | Density after additional weathering (mass % lost in weathering) |
|---|---|---|---|
| **Light crude (Scotia Light)** | 0.77 | 0.80 (25%) | 0.84 (64%) |
| **Medium crude (West Texas Intermediate)** | 0.85 | 0.87 (10%) | 0.90 (32%) |
| **Heavy crude (Sockeye Sour)** | 0.94 | 0.97 (10%) | 0.98 (19%) |
| **Diluted bitumen (Cold Lake Blend)** | 0.92 | 0.98 (15%) | 1.002 (30%) |
| **Bitumen** | 0.998 | 1.002 (1%) | 1.004 (2%) |

Oils that are identified as API Group 3 or 4 are assumed to float, but under certain conditions may instead submerge or sink. Diluted bitumen is an example of this.

Bitumen is characterized by a high density and a high viscosity, and is generally denser than standard crude oils. At normal temperatures, bitumen is a tarlike substance (Toman, Curtright, Ortiz, Darmstadter, & Shannon, 2008). Due to its physical properties, in order to transport bitumen through pipelines, it is blended with a diluent (typically natural gas condensate or other very light products) to make "dilbit," or with synthetic crude oil that has been slightly refined to decrease viscosity to make "synbit" (Crosby et al., 2013).

When exposed to the environment, the lighter diluent compounds in diluted bitumen may evaporate, leaving residual bitumen that is more dense, viscous, and with a tendency to submerge beneath the water surface and potentially sink to the sediments (National Academies of Sciences, Engineering, and Medicine, 2016).

With diluted bitumen, this is variable. The individual selection of diluents varies depending on the buyer and seller of the oil. The type of diluent can strongly affect the weathering behavior of diluted bitumen, because the evaporation of a highly volatile diluent will more readily produce a heavy residue. Specific information about the diluents used is typically not publicly available.

Turbulence and sedimentation can also affect whether spilled oil will float or sink (American Petroleum Institute, 2016b). Sediment mixing happens by oil stranding on a shore and mixing with sandy sediments or by mixing with sediments in the water column by wave action, away from shore. Turbulence can drive an oil to submerge or sink and can result in sedimentation that increases an oil's density causing it to submerge or sink. Figure 24 illustrates the interaction of density, turbulence, and sedimentation in determining whether an oil will float, submerge or sink.

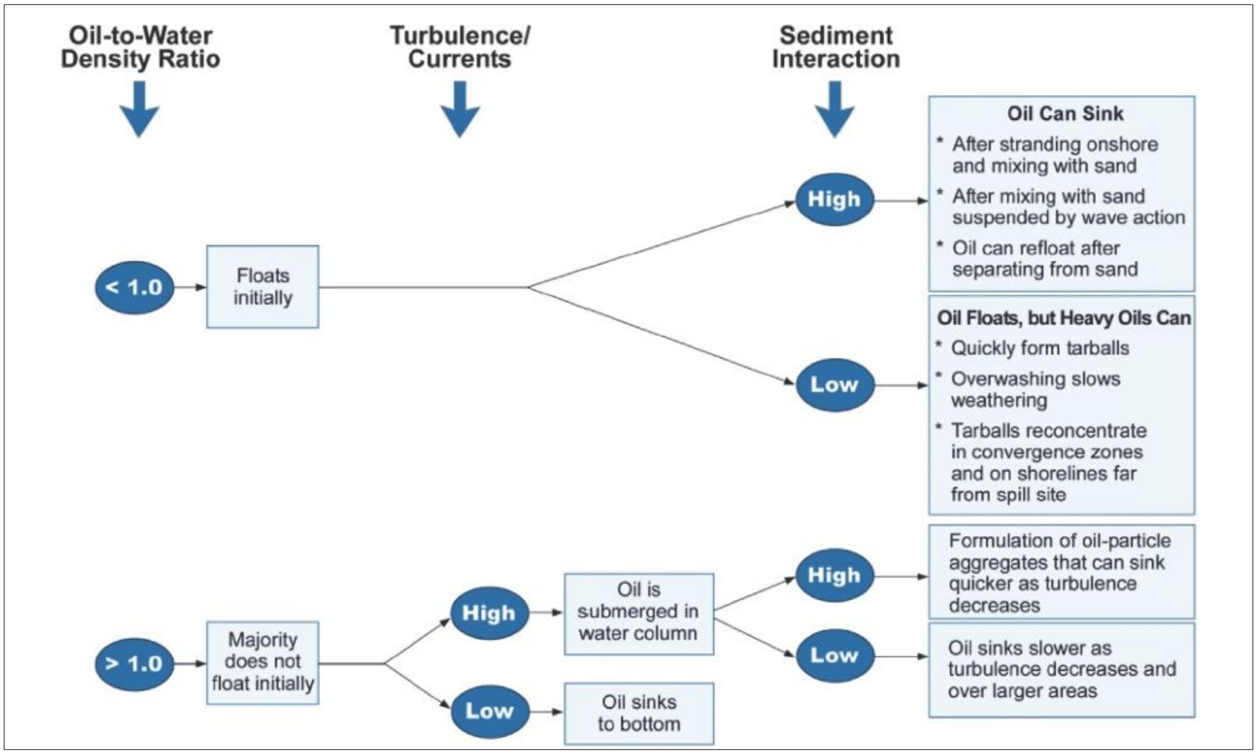


**Figure 24: Interaction of density, turbulence, and sedimentation in determining whether an oil will float, submerge, or sink (Excerpt from American Petroleum Institute, 2016, p.3 (Modeled after National Research Council, 1999))**

## Locations, volumes, oil type, and frequency of transfers of potentially non-floating oils

In the study area, the Strait of Juan de Fuca and Puget Sound are major transit corridors for crude oil and refined petroleum products transported by vessel. Based on the determining factors described above, a review of oil spill contingency plans for the State of Washington, and a review of data on reported vessel oil transfers for 2017 and Quarter 1 of 2018, Ecology has made some initial identification of locations, volumes, oil types, and frequency of transfers of potentially non-floating oils in the study area (Washington State Department of Ecology, 2018j).[45]

For the purposes of this report, non-floating oils refer to oils that “exhibit qualities which could, due to the oil characteristics, weathering, environmental factors, or how they are discharged, potentially cause the oils to submerge or sink. Examples of these types of oils include, but are not limited to, Diluted Bitumen, Group 5 Residual Fuel Oils, Low API Oil, Asphalt and Asphalt Products” (U.S. Coast Guard, 2016, p.51).

[45] State-approved contingency plan holders: https://ecology.wa.gov/Regulations-Permits/Plans-policies/Contingency-planning-for-oil-industry/Approved-contingency-plan-holders

All crude oils, even light oils such as Bakken crude, have the potential for some portion of the oil to weather and sink. Ecology's review of oil types transferred by vessel, pipeline, and rail across Washington identified the following products having potential non-floating properties, where cautious consideration should be made of the potential for it to sink/submerge when spilled to water.

**Table 5: Oil products and potential non-floating oil properties**

| Oil type | Potential non-floating oil properties |
|---|---|
| **All crude oils, including diluted bitumens transported from Canada, and Bakken oil**[46] | Due to oil-to-water density, water body characteristics in the study area |
| **Heavy fuel oils including those transferred to vessels in marine waters** | Due to oil-to-water density, water body characteristics in the study area |
| **Vacuum gas oil** | Due to oil-to-water density, water body characteristics in the study area |
| **Decant oil** | Due to oil-to-water density, water body characteristics in the study area |
| **Used and waste oils** | Due to their variability, water body characteristics in the study area |
| **Asphalt or asphalt products** | Group 5 oils, water body characteristics in the study area |

The locations, relative number, and relative volumes of commercial oil transfers of potentially non-floating oils within the study area were mapped using Ecology's data of reported vessel transfers for 2017 and Quarter 1 of 2018, and are displayed on Figures 25-27 below (Washington State Department of Ecology, 2018j).

[46] In general, most oil spill contingency plans do not identify oil by a common name. A plan may list crude oil generically as a type of oil transported, without further specification.

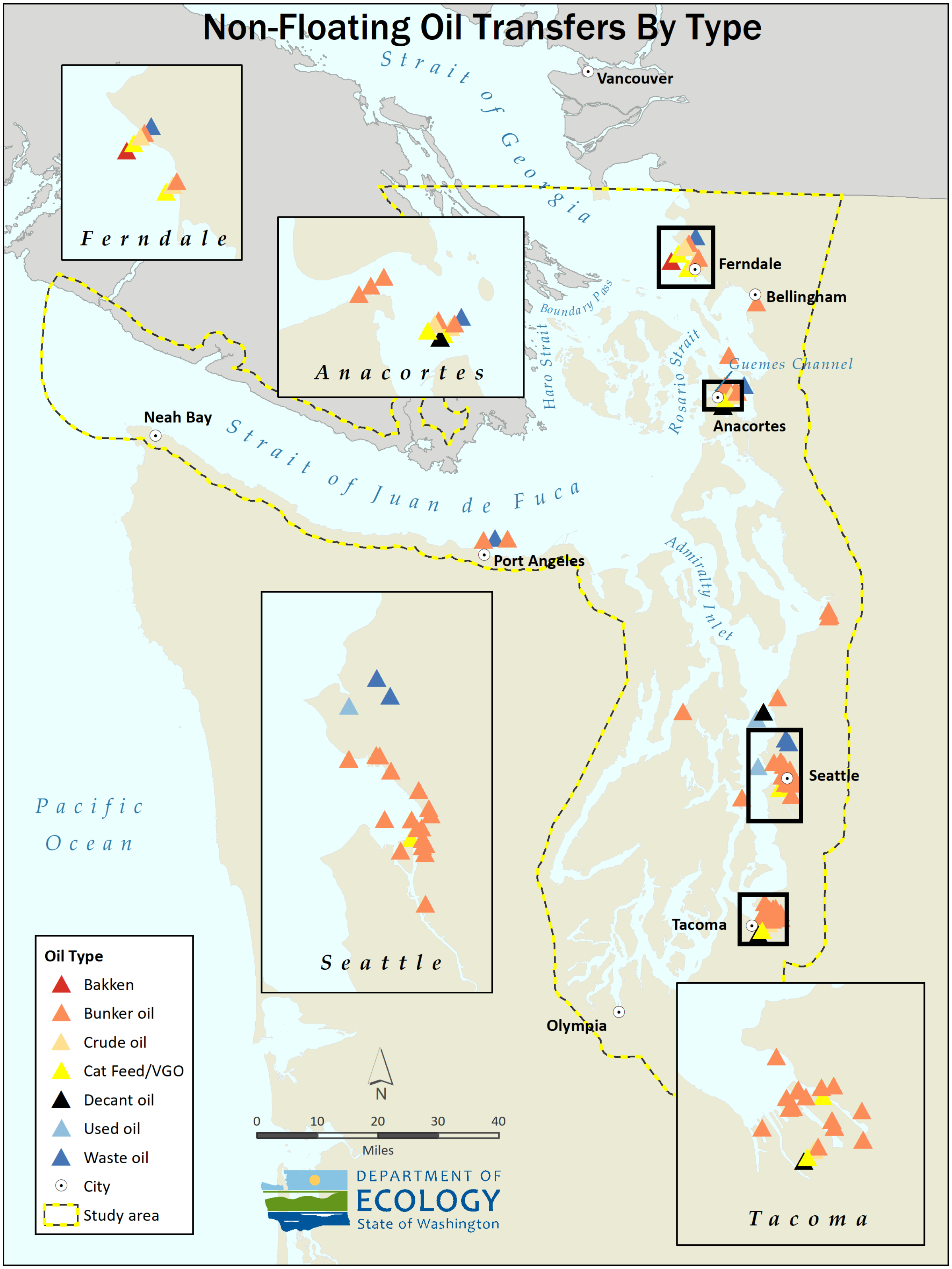


**Figure 25: Locations of oil transfers by type of potentially non-floating oils (Washington State Department of Ecology, 2018j)**

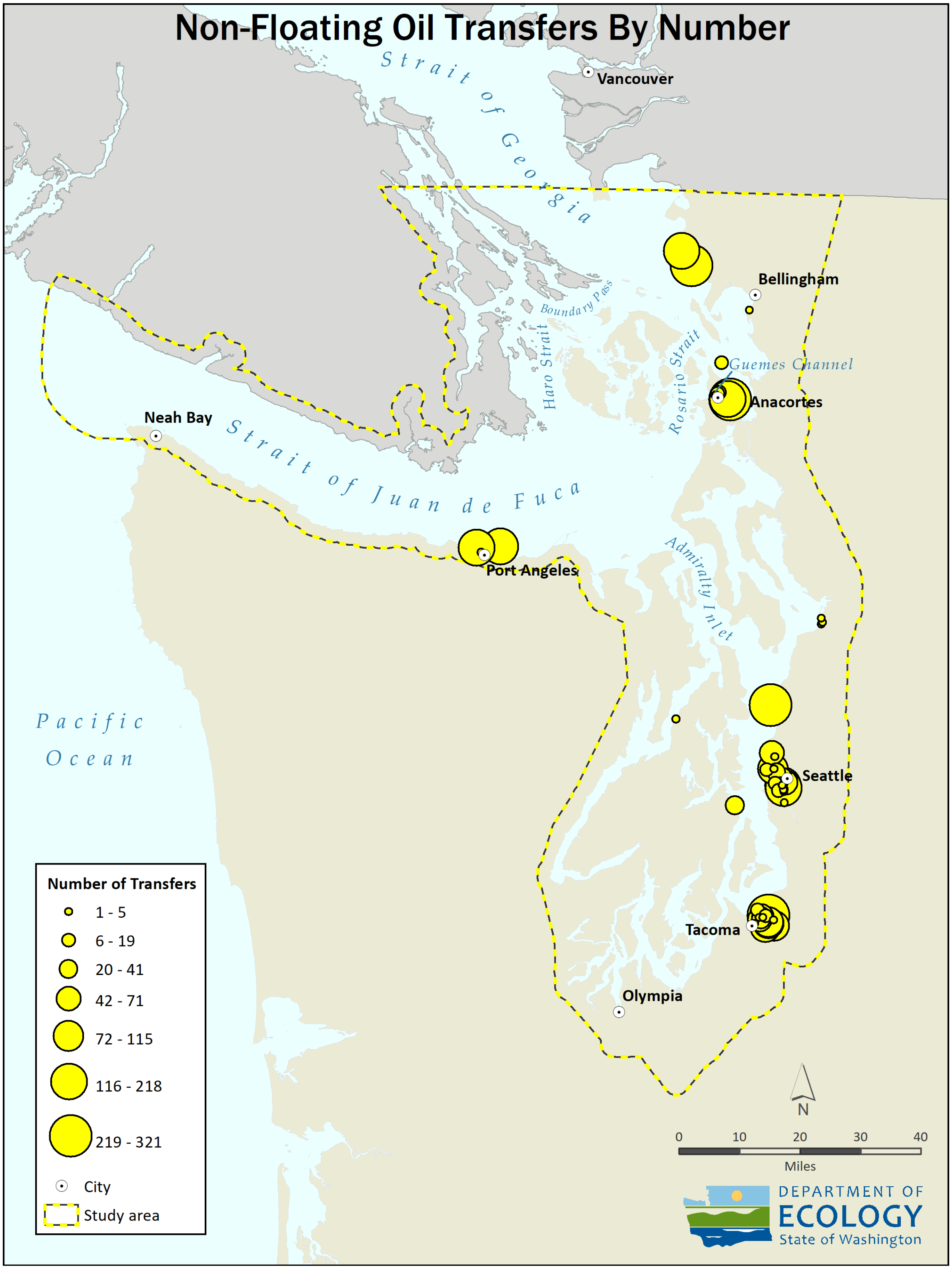


**Figure 26: Number of oil transfers of potentially non-floating oils (Washington State Department of Ecology, 2018j)**

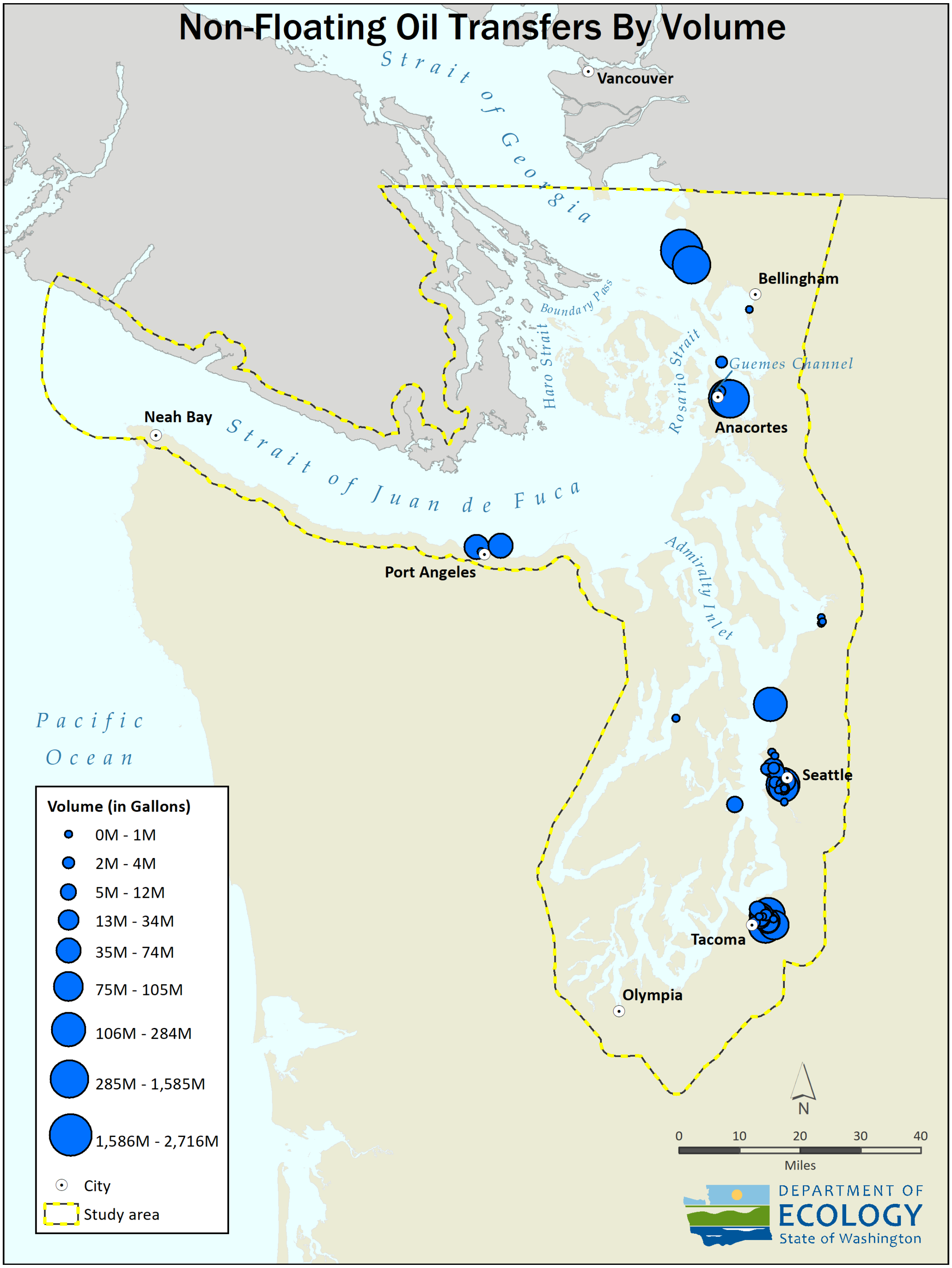


**Figure 27: Volume of oil transfers of potentially non-floating oils (Washington State Department of Ecology, 2018j)**

The data shows transfers of potentially non-floating oils at locations in the Strait of Juan de Fuca and Puget Sound, as well as volume and relative frequency. Transfers of these oils in the study area are concentrated around Seattle, Tacoma, Port Angeles, Anacortes, and the northern refineries north of Bellingham, although transfers do occur in other locations within the study area and along the Columbia River. Ecology notes that even though locations along the Columbia River are outside the scope of this report, the fresh water of the Columbia River further increases the risk of oil sinking. Additionally, rail transport of crude oils occurs in both marine and inland areas of Washington. This means it is important to prepare for the potential for an oil to sink in fresh waters, marine waters, shallow waters, deep water, as well as high current and high sediment waters. Movement of diluted bitumen by vessel, pipeline, and rail is discussed in Chapter 7.

## Resources at risk from non-floating oil spills

As with other oil spill cleanup techniques, natural, cultural, and economic resources can be at risk of damages from the oil itself, or from the cleanup technique used to remove the oil. The Northwest Area Contingency Plan lists response considerations for non-floating oils (Northwest Area Committee, 2018). These include:

- Ecological sensitivity of sea floors and river bottoms vary in relative sensitivity. Seagrass beds, eelgrass beds, and kelp forests and more sensitive than a rocky substrate, sand, and mud. This information would need to be determined during a spill.
- The persistence of oil on the bottom depends on the permeability/porosity of substrate, the oil's density, and the adhesion properties of the oil. Persistence is also a function of bottom turbulence and currents. If the oil is in an ecologically sensitive area, the persistence of the oil warrants more timely removal action. If the oil is likely to remain in an area of relative lesser ecological significance, then removal actions can be more intrusive and pursued at a slower pace.
- Marine mammals, birds, and benthic invertebrate and fish communities may be directly disturbed by removal of oil from the bottom. They may be injured or disturbed by response vessels and equipment. They may be contaminated if oil is re-suspended in the water column, and their food sources may be contaminated or reduced.
- There may be known historic and archeological resources below the water or those that have not been located and charted. These may be uncovered and disturbed by cleanup operations.
- Underwater obstruction sand safety hazards such as electrical cables, underwater pipelines, and unexploded ordinance should be identified prior to beginning removal. Some areas of the bottom may have toxic contaminants present in the sediments which would best be left undisturbed.

Newly adopted changes to state laws provide Ecology with the direction and the funding to identify water column and seafloor resources at risk from non-floating oils (Wash. Rev. Code § 90.56.569, 2018). Geographic Response Plans (GRP) are being updated to describe important sensitive resources within the GRP areas including fish, habitat, water column species, and subsurface resources. GRPs will continue to detail booming strategies for floating oils, and will also include narrative descriptions of resources at risk from non-floating oils and an analysis of potential response tactics based on the area sensitivity and complexity.

## Overview of federal and state non-floating oil planning requirements

Federal and state regulations have been changing in response to the evolving recognition of non-floating oil potential (not just Group 5 oils). Traditional methods of detecting oil spills, like aerial observation, do not work when oil stops floating, as the oil is below the visible surface of the water. Spill response tactics – booming, skimming, in-situ burning – can remove floating oil but will no longer be effective when oil becomes non-floating. After oil sinks, response tactics to locate and recover the oil are limited by the *oil density* (near-neutral oil is suspended in the water column while negative buoyancy oil sinks to the bottom) and the *water depth*, which highlights the importance of aggressive prevention measures.

The success of recovery methods varies, but is usually limited when the oil is widely distributed and/or mixed with sediments and water (American Petroleum Institute, 2016b). In general, available methods are most successful when:

- Current speeds and wave conditions at the spill site are low.
- Oil viscosity allows it to be pumped.
- The water is relatively shallow.
- The sunken oil is concentrated in natural collection areas.

### Federal requirements

In 2016, the U.S. Coast Guard updated response contractor guidelines by creating a non-floating oil classification (U.S. Coast Guard, 2016). Group 5 oils and other heavy oils were merged and defined together as non-floating oils. The guidelines detail how response contractors should present a “concept of operations” to the Coast Guard for non-floating oil spills to support plan holders. The guidelines require a connection between inventory, personnel, and contractual assets and an elaboration of their capability to respond to non-floating oil spills. The regulations define four categories of capability: detection, recovery capabilities, storage capabilities, and environmental conditions and operating areas. A fifth category of *containment* could also be addressed, but is optional by oil spill response organizations. The guidelines also suggest that drills for non-floating oils be conducted under the federal government’s unannounced drill program.

In Washington, the following response contractors have federal certifications for non-floating oils response:

- Marine Pollution Control Corporation
- Clean Harbors Environmental Services
- National Response Corporation

- Marine Spill Response Corporation
- Global Diving and Salvage
- T&T Salvage, Inc.

Of these, all but two (Marine Pollution Control Corporation and T&T Salvage, Inc.) are approved Primary Response Contractors for the state of Washington.

## State requirements

Washington State contingency plan requirements for oils that sink were first adopted in 2011. As with the initial federal standards, the first iteration of the rules focused solely on Group 5 oils. Since then, as portions of rules were opened for updating, Ecology has applied its evolved understanding that oils other than Group 5 oils may also be non-floating. Currently, Washington has three differing planning standards that are not consistent between industry sectors:

- Planning standards for pipelines carrying crude oil (Wash. Admin. Code § 173-182-323, 2016).
- Planning standards for Group 5 oils (Wash. Admin. Code § 173-182-324, 2016). This applies to facilities other than railroads and to commercial vessels.
- Planning standards for railroads transporting crude oils (Wash. Admin. Code § 173-186-330, 2016).

These standards require plan holders to have access to equipment to locate, contain, and recover submerged oil. Equipment types include but are not limited to the following:

- Sonar, sampling equipment, or other methods for locating the petroleum oil on the bottom or suspended in the water column.
- Containment boom, sorbent boom, silt curtains, or other methods for containing the petroleum oil that may remain floating on the surface or to reduce spreading on the bottom.
- Dredges, pumps, or other equipment necessary to recover petroleum oil from the bottom and shoreline.
- Other appropriate equipment necessary to respond to a discharge involving the type of oil handled, stored, or transported.

The equipment must be available within 12 hours, which is a shorter period of time than the federal requirement of 24 hours.

The Legislature has directed Ecology to conduct rulemaking by December 2019 (Wash. Rev. Code § 88.46.0601, 2018; Wash. Rev. Code § 90.56.2101, 2018). One goal of the rulemaking is to eliminate the patchwork of regulations currently in place for all regulated contingency plan holders carrying, handling, storing, or transporting oils that exhibit qualities which could, due to the oil characteristics, weathering, environmental factors or how they are discharged, potentially cause the oils to submerge or sink. Greater detail in the regulation to ensure a capability based on depth is under consideration.

Finally, the Legislature also added a new requirement to conduct tabletop and deployment drills that address spills of potentially non-floating oils (Wash. Rev. Code § 88.46.220, 2018; Wash. Rev. Code § 90.56.275, 2018). The first on-water deployment to address non-floating oils took place in October 2018.

# Summary

In recent years, our understanding has evolved regarding how different types of oil behave during a spill. Oils that submerge or sink in water pose a substantial risk to the environment, human health, tribal and other cultural and historical resources, and the economy, and are a significant challenge to locate, contain, and cleanup. This chapter defined the term "non-floating oil" and described inherent properties of oil, weathering, and water conditions as indicators of when an oil may float, submerge or sink. This chapter also summarized data on oil transfers of potential non-floating oils in the study area, including locations, volume, oil type, and relative frequency.

In summary:

- Oils that are inherently heavier than water may submerge/sink when spilled.
- Oils that are lighter than water, but become heavier as the lighter fractions are lost through evaporation or other weathering, may submerge/sink when spilled.
- Oils can submerge/sink after mixing with sediments in waves or stranding onshore and mixing with sediments.
- Oil may refloat after sinking.
- Oils that become heavier than water due to formation of oil-particle aggregates under turbulent conditions may settle on the seafloor.
- Behavior of oil when an oil sinks may differ in seawater and freshwater environments, so the location where oil is spilled matters.
- Diluted bitumen crude oil from Canada is inherently heavy and may become non-floating when spilled to water.

Traditional methods of detecting oil spills, like aerial observation, do not work when oil stops floating, as the oil is below the visible surface of the water. After oil sinks, response tactics to locate and recover the oil are limited by the oil density (near-neutral oil is suspended in the water column while negative buoyancy oil sinks to the bottom) and the water depth.

The Northwest Area Contingency Plan has identified response considerations for non-floating oils, and federal and state regulations have been changing in response to the evolving recognition of non-floating oil potential (not just Group 5 oils). In 2018, Ecology received direction and funding from the Legislature to identify water column and seafloor resources at risk from non-floating oils (Wash. Rev. Code § 90.56.569, 2018). Ecology is addressing this direction through updates to GRPs that will describe important sensitive resources within the GRP areas and will include narrative descriptions of resources at risk from non-floating oils and an analysis of potential response tactics based on the area sensitivity and complexity.

Additionally, Washington state contingency plan requirements for oils that sink were first adopted in 2011 and focused on Group 5 oils. Since then, as portions of rules were opened for updating, Ecology has applied its evolved understanding that other oils may also be non-floating, resulting in planning standards that are inconsistent between industry sectors.

Ecology has been directed to conduct rulemaking by December 2019 with one goal of the rulemaking being to eliminate the patchwork of regulations currently in place for these oils (Wash. Rev. Code § 88.46.0601, 2018; Wash. Rev. Code § 90.56.2101, 2018). Ecology is also beginning to conduct drills to address spills of non-floating oils, as directed by RCW 88.46.220 and 90.56.275 (2018). The first drill of this kind took place in October 2018.

# Chapter 7: Transport of Bitumen and Diluted Bitumen

Section 206 (2)(b) of E2SSB 6269 directs Ecology to complete an assessment and evaluation of the transport of bitumen and diluted bitumen. Ecology developed the scope and goal statements below to guide this assessment and evaluation.

Scope: Describe the three current mechanisms of transporting diluted bitumen in the Salish Sea and Puget Sound area and volumes of these products transported by each mode.

Goal: Provide a thorough understanding of the volumes of bitumen and diluted bitumen transported by vessel, rail, and pipeline in and near the Strait of Juan de Fuca and Salish Sea.

The transport of bitumen and diluted bitumen from Canada to the United States has evolved over the last decade, creating a need for in-depth analysis and understanding of the spill risks posed by the three primary modes of transport: vessel, pipeline, and rail. This assessment of the transport of bitumen and diluted bitumen includes a brief overview of oil movement in Washington, then describes the current modes of transporting diluted bitumen in the Salish Sea and Puget Sound area, including historical oil movement, current volumes, and routes of transport for each mode. This assessment provides information to assist Ecology in evaluating risk from the transport of these oils in the study area.

## Oil movement overview

About 450 million barrels (bbl) (18.9 billion gallons) of oil (crude and refined) are transported in Washington State as cargo each year by three primary modes of transport: vessel, rail, and pipeline (Figure 28). This does not account for oil transferred or moved as fuel in the fuel tanks of vessels.

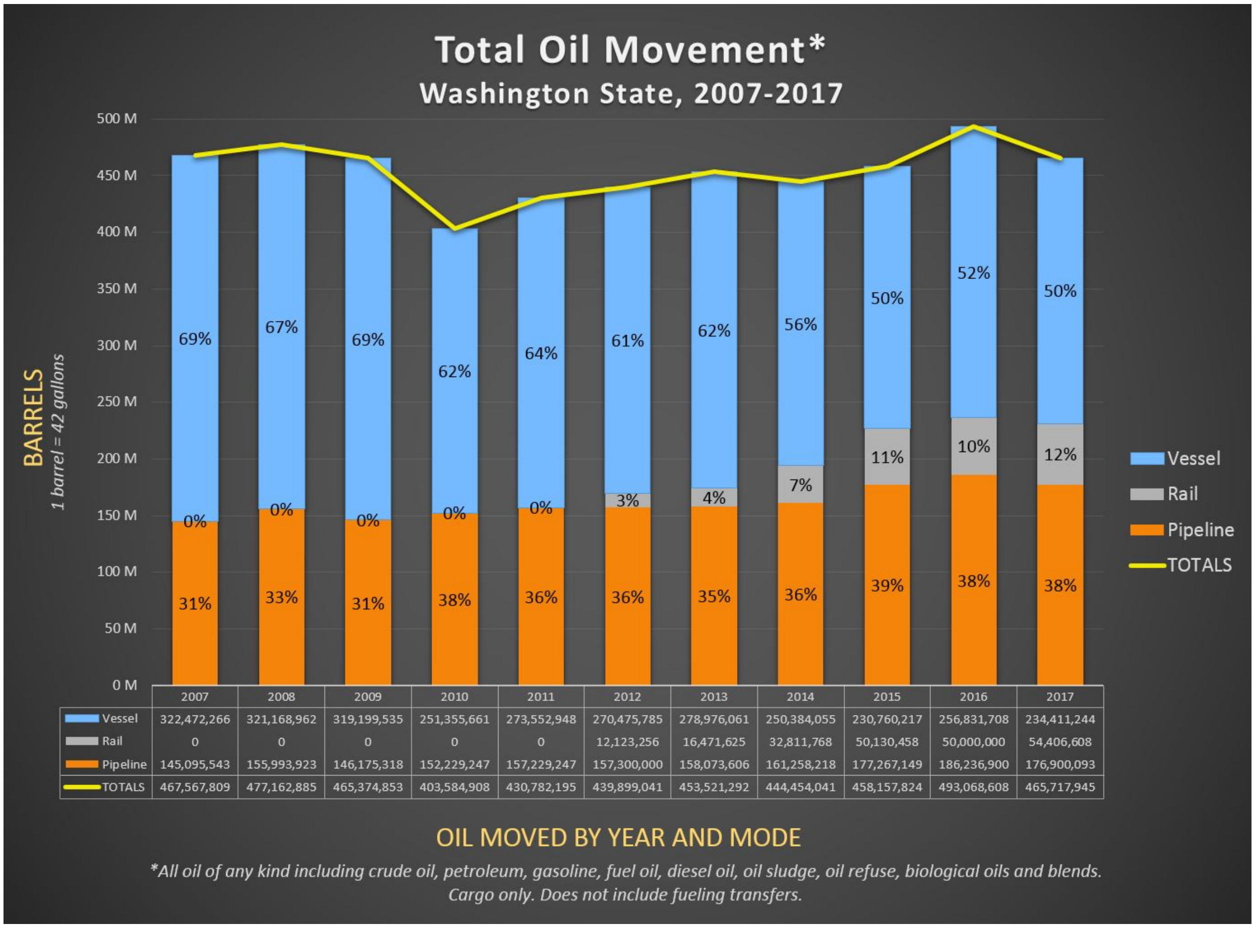


**Figure 28: Washington State total oil movement, 2007–2017 (Washington State Department of Ecology, Publication no. 17-08-014)[47]**

Since 2012, an average of 208 million bbls (8.7 billion gallons) (46 percent) of the total volume of all oil moved as cargo each year is crude oil, including Alaska North Slope (ANS) crude, Bakken crude from North Dakota, and diluted bitumen from Alberta (Washington State Department of Ecology, 2018c; Washington State Department of Ecology, 2018d; Washington State Department of Ecology, 2018e; Washington State Department of Ecology, 2018f).

## Diluted bitumen transport

As described in Chapter 6, diluted bitumen ("dilbit") is thick, heavy crude oil from Canada (known as oil or tar sands), mixed with a thinner type of oil or gas (the diluent) to allow it to flow and be transported. Major bitumen deposits in Canada are located in Alberta in three fields: Athabasca, Peace River, and Cold Lake (Crosby et al., 2013). To Ecology's knowledge, unprocessed or undiluted bitumen is not transported in Washington State. Ecology assumes that

[47] Oil Movement in Washington State: https://apps.ecology.wa.gov/publications/SummaryPages/1708014.html

the majority of Canadian crude oil transported into Washington is either diluted bitumen ("dilbit") or "synbit", or another crude oil that could weather and sink.

While transport of diluted bitumen through the study area is not new, properties of these oils are becoming better understood, and are important to consider when evaluating risks associated with oil movement. Diluted bitumen is transported from Canada to the United States by three primary transport modes – vessel, rail, and pipeline. These oils are transported in large volumes to Washington refineries. They are also transported through Washington to Oregon and California by vessel and rail, posing risks to many areas of the state outside of the study area.

These oils are transported over marine waters and along inland corridors along rivers, streams, and bays. Vessels transporting diluted bitumen travel near the San Juan Islands, through the Strait of Juan de Fuca, Rosario Strait, Haro Strait, and in close proximity to large populations. Pipelines moving diluted bitumen in Washington cross the Nooksack, Sumas, and Samish rivers, in addition to neighborhoods, schools, cities, and towns, and in close proximity to Bellingham Bay. Diluted bitumen transported by rail travels near numerous rivers, streams, and bays from the Canadian border south to the end of the study area, and also enters the study area from the south after traveling through eastern Washington and along the Columbia River.

## Vessel oil movement

### Historical oil movement, volumes, and trends

In the study area, the Strait of Juan de Fuca and Puget Sound are major transit corridors for crude oil and refined petroleum products transported by vessel.

Washington refineries receive on average approximately 4.9 billion gallons of imported crude oil by vessel each year (Washington State Department of Ecology, 2018c). This volume by tank ships has declined significantly over the last 10 years. This is a result of declining production of ANS crude — a staple for West Coast refiners since the 1970s — and an increasing supply of Canadian crude oil and Bakken crude oil being delivered by rail and pipeline. From 2007 to 2011, an average of 6.6 billion gallons a year was imported by vessel to Washington refineries (Washington State Department of Ecology, 2018f). In 2017, 4.1 billion gallons were transported by vessel (Washington State Department of Ecology, 2018c).

The majority of crude oil imported by tank ship comes from Alaska or places other than Canada. Much of this is a medium to heavy conventional crude oil and generally different than Canadian diluted bitumen.

The only known vessel movement of diluted bitumen from Canada to Washington is by tug and tank barge from Burnaby, BC to the US Oil refinery in Tacoma, Washington. While there is movement of diluted bitumen on other Washington waters (Columbia River), there is no other known movement of diluted bitumen by vessel in the study area at this time. Typically, about five tank ships per month (60 per year) and two to three tank barges per month are loaded with heavy crude oil (including diluted bitumen) at the Westridge Marine Terminal located in Burnaby, B.C. bound for Washington and other locations (Kinder Morgan Canada, 2015b). Most of this oil is transported out through the Strait of Juan de Fuca to domestic and foreign markets on large tank ships. In the last 6 year period, Washington received an average of 25 tank barges through the study area each year delivering about 80.6 million gallons of diluted bitumen a year to Tacoma. This totals about 483 million gallons of diluted bitumen delivered to Tacoma during this time and only by tank barge. No tank ships have delivered diluted bitumen to Tacoma to Ecology's knowledge. A low of 17 tank barges delivered diluted bitumen to Tacoma in 2015, with a high of 34 tank barges in 2012 (Washington State Department of Ecology, 2018c). The tank barges that transport diluted bitumen to Tacoma are much smaller than Aframax tank ships that move most of the diluted bitumen through the study area. Tank ship crude oil deliveries (non-diluted bitumen) to Tacoma dropped precipitously from 29 in 2012 to seven in 2013, and to one to three deliveries a year since 2013 (Washington State Department of Ecology, 2018c). This is explained by the significant influx of Bakken crude delivered by rail.

The other types of crudes received vary widely and the origins are not easily determined. In the northern refineries, there were an average of 317 crude oil deliveries per year delivering about 4.7 billion gallons per year from 2012 through 2017, with a high of 394 deliveries in 2013 and a low of 237 in 2015. The number of deliveries rose slightly in 2016 and 2017, but there are still about 100 fewer crude deliveries by vessel each year now than in 2012 (Washington State Department of Ecology, 2018c).

Diluted bitumen transported by vessel accounts for about 2 percent of all diluted bitumen transported to facilities in the study area. Even with this relatively small volume of diluted bitumen moving in state waters, it poses a significant risk given the mode of transit by tug and tank barge, number of transits, and peculiar waterways through which these tank vessels transit.

However, billions of gallons of diluted bitumen are exported from Canada each year by tank ships that transit outbound through Canada and Washington's shared waters of the Strait of Georgia, Haro Strait, and Strait of Juan de Fuca. Ecology has also been notified of a Kirby Offshore Marine articulated tug barge (ATB) exporting crude from Westridge Marine Terminal. A spill from these ships would significantly impact the study area.

**Vessel transit routes**

Tank barges transporting diluted bitumen to Washington originate from the Westridge Marine Terminal in Burnaby, BC (Kinder Morgan Canada, 2015b). This facility delivers diluted bitumen to tank barges and tank ships from the Trans Mountain Pipeline (TMPL). Laden tank ships leave the terminal passing through the Strait of Georgia, Haro Strait, and then out through the Strait of Juan de Fuca. Based on information provided by Kinder Morgan Canada, approximately 60 tank ships per year depart the Westridge Marine Terminal (Moffat & Nichol, 2013).[48] Chapter 4 provides more detailed information about vessel traffic in the study area.

Tank barges intended for Washington mostly transit through Rosario Strait as it is a more direct route to the destination in Tacoma. These barges travel about 150 nautical miles (NM) from the Westridge Marine Terminal to Tacoma. A non-stop transit could take about 20 hours. This route travels through the Strait of Georgia, passing Lummi Island and into Rosario Strait, Admiralty Inlet, and down through the Seattle/Tacoma transit area. This route includes areas with significant marine traffic and areas with high environmental sensitivity. One area, Rosario Strait, has relatively high tidal currents and a limited channel width that accommodates a single two-way vessel traffic lane.

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[48] The Government of Canada recently purchased the TMPL from Kinder Morgan.

## Pipeline oil movement

### Historical oil movement, volumes, and trends

The only known source of import or movement of diluted bitumen by pipeline is by the Puget Sound Pipeline to Washington's four northern refineries.[49] About 90 percent of diluted bitumen crude oil transported to Washington is transported west from Alberta to British Columbia and Washington State by the TMPL (Crosby et al., 2013). The TMPL handles all types of crude oils including diluted bitumen, synthetic crude oils, and other crude oils from light to heavy. This 715 mile pipeline originates in Edmonton, Alberta and ends in Burnaby, British Columbia. It ranges in diameter from 24 to 36 inches and has a capacity of 300,000 barrels per day (bpd) (12,600,000 gallons per day (gpd)).

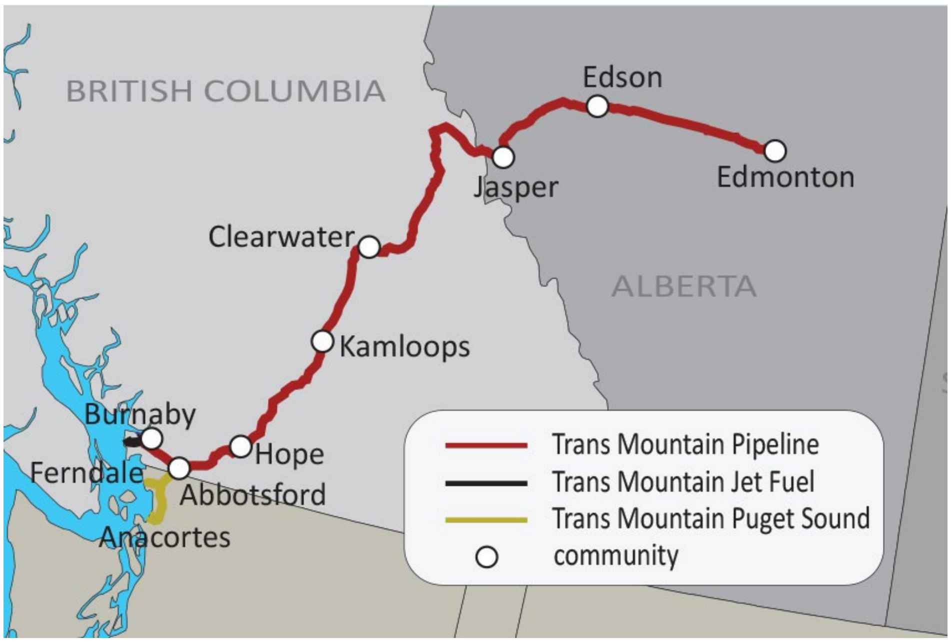


**Figure 29: Trans Mountain Pipeline (Kinder Morgan Canada, n.d.)**

As discussed in Chapter 4, the proposed expansion to this pipeline would increase capacity to 890,000 bpd (37,380,000 gpd) (Kinder Morgan Canada, 2013). If the system expansion is completed, up to 630,000 bpd (26,460,000 gpd) could be delivered to the Westridge Marine Terminal for distribution (Kinder Morgan Canada, 2013).

From 2003 to 2007, Washington State refineries received about 1.2 billion gallons of crude oil per year from Canada by pipeline, the majority of this being diluted bitumen or a crude oil that could weather and sink (Washington State Department of Ecology, 2018f). In 2008, these volumes began to increase. From 2013–2017, Washington State refineries received an average of 2.5 billion gallons of similar Canadian crude oil a year, with a high of 2.9 billion gallons received in 2016 (Washington State Department of Ecology, 2018e; Washington State

[49] The Puget Sound Pipeline was included in the Government of Canada's purchase of the TMPL from Kinder Morgan.

Department of Ecology, 2018f). In 2016, about 8,022,000 gpd were transported through the pipeline (Morningstar Document Research, 2018).

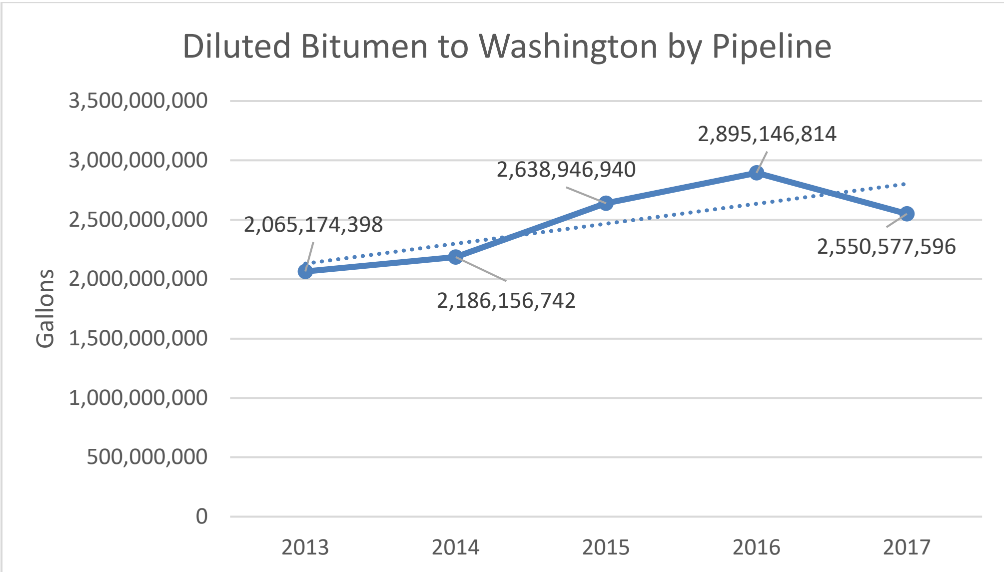


**Figure 30: Diluted bitumen to Washington by pipeline, 2013–2017 (Washington State Department of Ecology, 2018e; Washington State Department of Ecology, 2018f)**

### Route summary - Kinder Morgan Puget Sound system

Crude oil delivered to Washington State is transported through the TMPL to the Sumas Pump Station and the Sumas Terminal located in Abbotsford, British Columbia, where it is redirected into the Puget Sound Pipeline. The Puget Sound Pipeline is a 16 to 20 inch diameter petroleum pipeline 69 miles in length with a capacity of 240,000 bpd (10,080,000 gpd) (Kinder Morgan Canada, n.d.). From Abbotsford, it traverses south and west towards Bellingham along and crossing the Sumas River, crossing the Nooksack River, and through the communities of Sumas, Nooksack, and Everson to the Laurel Pump station just north of Bellingham. At Laurel, Washington, the Puget Sound pipeline splits, with one segment running west through Ferndale to BP Cherry Point and Phillips 66 refineries where it again crosses the Nooksack River. The other segment runs south through Bellingham along Lake Samish and into Skagit County, crossing the Samish River near Burlington before heading west and crossing the Swinomish Slough and along Padilla Bay to March Point in Anacortes where it supplies the Andeavor and Shell refineries (Figure 31).

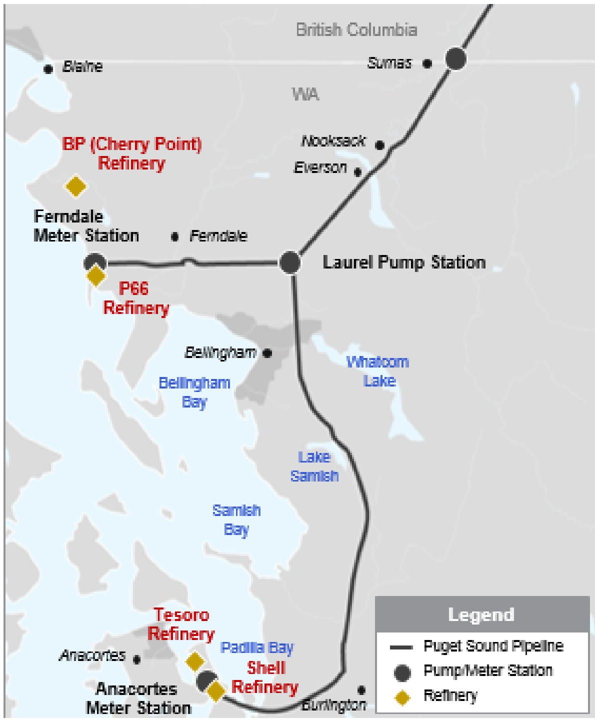


**Figure 31: Puget Sound Pipeline (Kinder Morgan Canada, n.d.)**

### Potential spill impacts

The Puget Sound Pipeline is a high volume pipeline that could cause a major spill if a rupture occurred. The pipeline traverses a large area where water and land impacts could be significant. A spill into the Nooksack River would significantly impact the river and could eventually impact Bellingham Bay. A spill into the Samish River or Swinomish Slough could significantly impact Padilla Bay. Significant impacts to the environment, cultural resources, and local economy would occur. Public health and community impacts could be significant as well due to the crude oil types being transported and the populated areas that could be exposed to the spill (Washington State Department of Ecology, 2017a).

## Rail oil movement

### Historical oil movement, volumes, and trends

Historically, bitumen crude oil originating in Canada has been primarily transported west by pipeline to British Columbia and Washington State. The TMPL that transports diluted bitumen reached near capacity several years ago resulting in the need for additional transport by rail. As a result, the use of rail tank cars to transport diluted bitumen to the west has increased significantly over the past several years, beginning in 2012. Growth in demand for rail capacity is expected to continue into the future.

Four of the five Washington State refineries, all within the study area, have invested heavily in rail facilities to offload crude oil delivered by rail from both Canada and North Dakota. The four crude by rail terminals have a combined capacity of 476,190 bpd (19,999,980 gpd) (Felleman, 2016). At full capacity, this translates to about seven trains of crude oil per day unloaded at refineries in the state. Based on data received by Ecology, an average of 2.2 trains per day deliver crude by rail to facilities in Washington.[50] The majority of oil delivered by rail is Bakken (91.4 percent). However, as markets and demand change, delivery of diluted bitumen to these refineries by rail could increase.

In addition, diluted bitumen destined for facilities in Oregon or California can transit through Washington on the way to out-of-state destinations, potentially resulting in more of this product traveling through the state than available data indicates. New facilities could also be developed in the Portland, Oregon area or in other locations along the Columbia, leading to more transport of diluted bitumen through the study area.

*Volumes*

Ecology reviewed oil movement by rail data from October 1, 2016 through April 30, 2018 to determine the volumes and routes of all crude and diluted bitumen moved by rail (Washington State Department of Ecology, 2018d). Ecology does not have detailed information on oil movement by rail prior to October 1, 2016. Ecology does not receive any information about crude oil or diluted bitumen transported through the state unless it is delivered to a Washington facility, and has no data on oil that may be transported by rail through Washington to ports along the Oregon side of the Columbia River to be exported by vessel or transported to other domestic ports. However, it is possible that this activity is occurring and that additional diluted bitumen could be transiting through Washington, possibly through the study area, south to the Columbia River. From review of various sources of vessel traffic, Ecology is aware of recent vessel transits of diluted bitumen exported from Portland, Oregon. The volume transported that passes through the state without stopping is not available to Ecology, and is not included in these calculations.

Between 2012 and 2016, Ecology estimated that crude oil moved by rail increased each year from about 509 million gallons in 2012 to about 2.2 billion gallons per year in 2016 (Washington State Department of Ecology, 2018f). The majority of the crude oil transported by rail is Bakken crude originating in North Dakota. In 2017, approximately 203 million gallons (9 percent) of the 2.3 billion gallons of crude transported by rail was diluted bitumen (Washington State Department of Ecology, 2018d). This is about 67 trains per month carrying any crude oil, and 6 trains per month carrying diluted bitumen.

**Table 6: Crude oil movement by rail, October 2016 through April 2018 (Washington State Department of Ecology, 2018d)**

| Totals | All Crude Oil | Diluted Bitumen |
|---|---|---|
| **Volume transported by rail (gallons)** | 3,622,007,130 | 312,395,286 |
| **Number of rail cars** | 126,821 | 10,938 |

The majority (91.4 percent) of crude oil delivered to Washington facilities by rail was Bakken crude from North Dakota. The remaining crude was diluted bitumen originating in Alberta (7.7 percent) or Saskatchewan (0.9 percent). The majority of the diluted bitumen transported by rail originates in Alberta (89.1 percent), with a small amount originating in Saskatchewan (10.9

[50] Each rail car holds 680 barrels (28,560 gallons) of oil, and there are on average 100 rail cars per unit oil train.

percent). Figure 32 shows volumes of all crude oil moved by rail, and the subset of diluted bitumen moved by rail from October 1, 2016 through April 30, 2018 (Washington State Department of Ecology, 2018d).

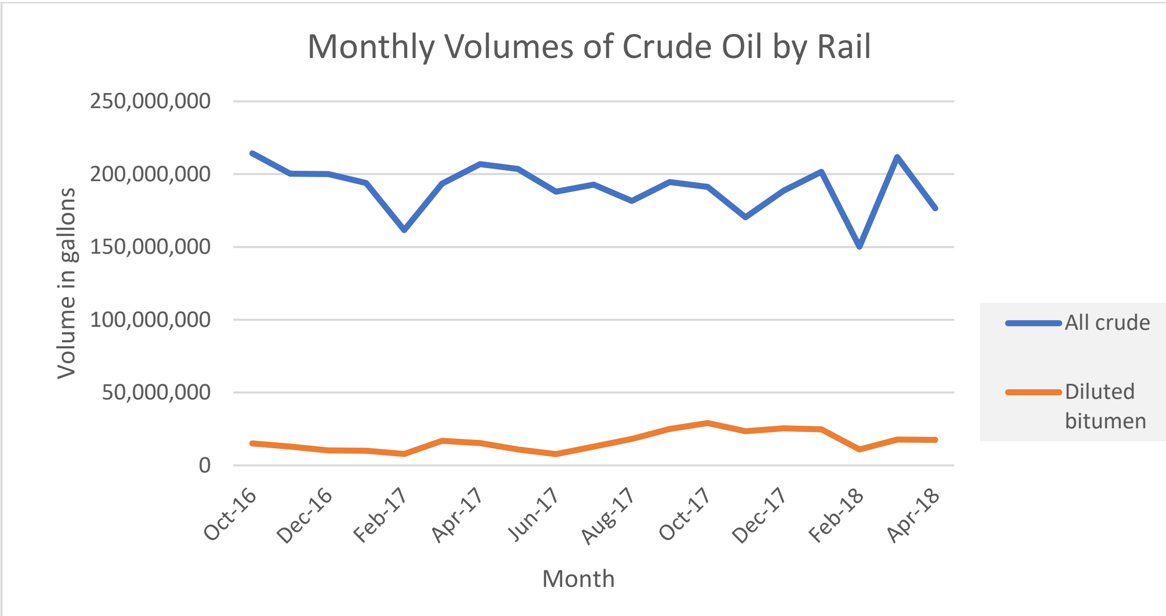


**Figure 32: Monthly volumes of crude oil by rail, October 2016 – April 2018 (Washington State Department of Ecology, 2018d)**

About 9 percent of total crude oil delivered by rail to facilities in Washington is diluted bitumen. Movement of all crude by rail has ranged between about 150 million gallons and 214 million gallons per month, and movement of diluted bitumen has varied from about 7.7 million gallons to about 29.1 million gallons per month. In 2017, approximately 203 million gallons of diluted bitumen was delivered to facilities in Washington by rail, with a majority of this moving through the study area (Washington State Department of Ecology, 2018d).

*Route summary*

Based on data received by Ecology since 2016, rail routes transporting crude oil enter the state from Idaho near Spokane and from British Columbia near Bellingham. Large segments of the rail routes travel along the Interstate 5 corridor, and cross or run next to major waterways, including the Columbia River and Puget Sound. Known railroad routes in the state are shown in Figure 33 below. Routes 1A, 1B, and 2 through 5 have been used to transport crude oil by rail since Ecology began collecting this information. Routes 3, 4, and 5 are partially or completely within the study area.

Rail routes through the study area generally follow the I-5 corridor, crossing or traveling near several waterways, including the Nooksack, Skagit, Stillaguamish, Snohomish, and Duwamish rivers, Puget Sound, Bellingham Bay, and Samish Bay. These routes pass through or very close to several cities, including Bellingham, Seattle, Tacoma, and Everett.

Between October 2016 and April 2018, the majority of crude oil transported through Washington entered the state near Spokane. Approximately 3.4 billion gallons of crude oil entered the state near Spokane and traveled southwest along Routes 1A or 1B before traveling along the Columbia River to the I-5 corridor and turning north, transporting oil into the study area. About 3 percent (106 million gallons) of this oil was diluted bitumen. When entering the state near Spokane, nearly all shipments of diluted bitumen have been shipped along Route 1B then transported along the south side of the Columbia River in Oregon. The remaining approximately 208.8 million gallons of crude oil entered the state from British Columbia into Whatcom County (Route 5), and over 206 million gallons (99 percent) of this was diluted bitumen (Washington State Department of Ecology, 2018d).

From either entry point, Spokane or Bellingham, diluted bitumen transported by rail is destined to facilities in Pierce, Skagit, and Whatcom counties in Washington. Approximately 206.3 million gallons of diluted bitumen was transported along Route 5 between October 2016 and April 2018, and about 141.6 million gallons was transported along Route 4. Because oil travels north into the study area from the south and south from British Columbia as far as Tacoma, the majority of diluted bitumen transported to facilities in the state travels through Pierce County. About 79 percent of diluted bitumen transported by rail through the state between October 2016 and April 2018 (247.6 million gallons) moved through Pierce County (Washington State Department of Ecology, 2018d). It is important to note that while Ecology has data that shows diluted bitumen transiting north to facilities in the study area from the south, and south to facilities in the study area from British Columbia, diluted bitumen could also be traveling south from British Columbia along routes 3, 4, and 5 to destinations in Oregon or California.

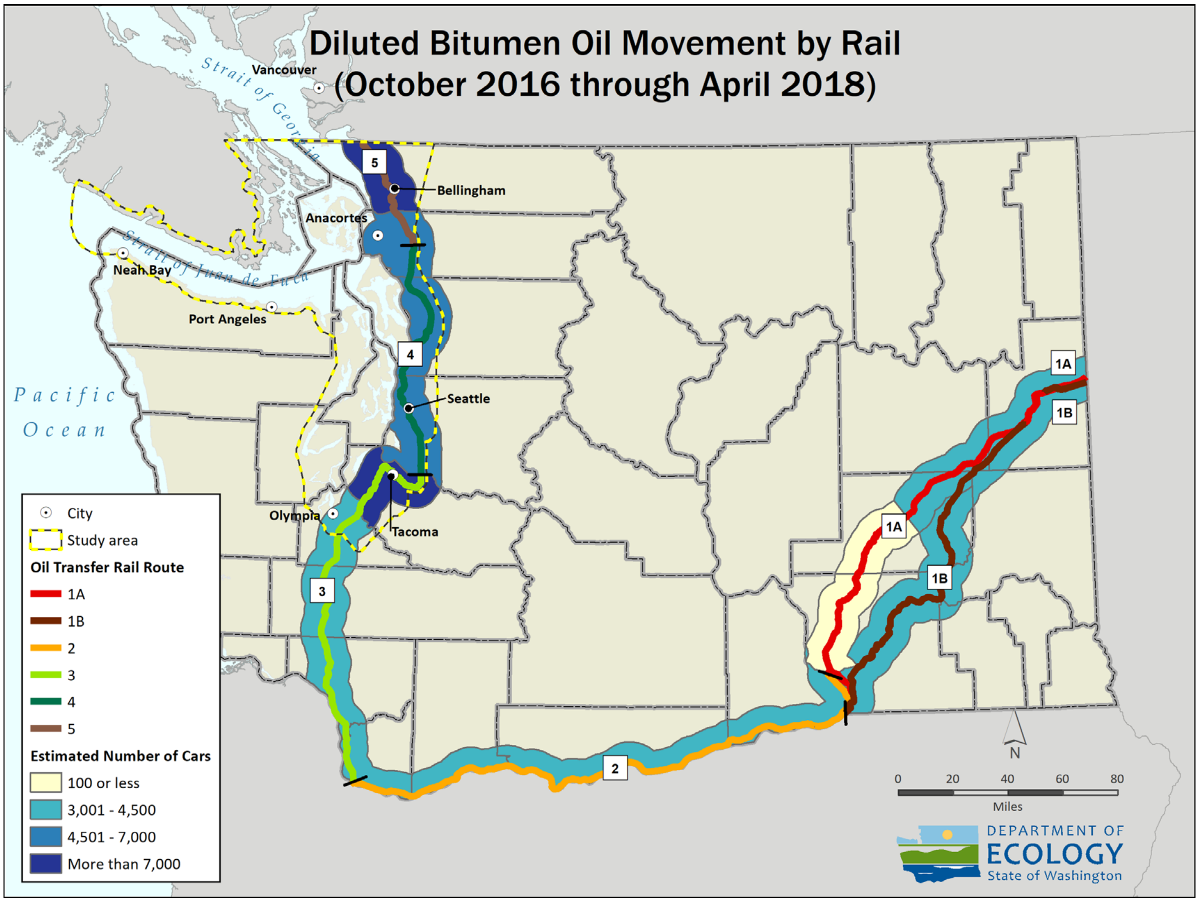


**Figure 33: Diluted bitumen oil movement by rail, October 2016–April 2018 (Washington State Department of Ecology, 2018d)**

## Summary of all modes

Historically, Canada has exported the majority of its crude oil by pipeline. In 2009, about 80 percent of crude oil transported in North America was by pipeline, 19 percent by vessel, and 0.3 percent by rail (Crosby et al., 2013). Routes of known transport of diluted bitumen in or through the study area are shown in Figure 34.

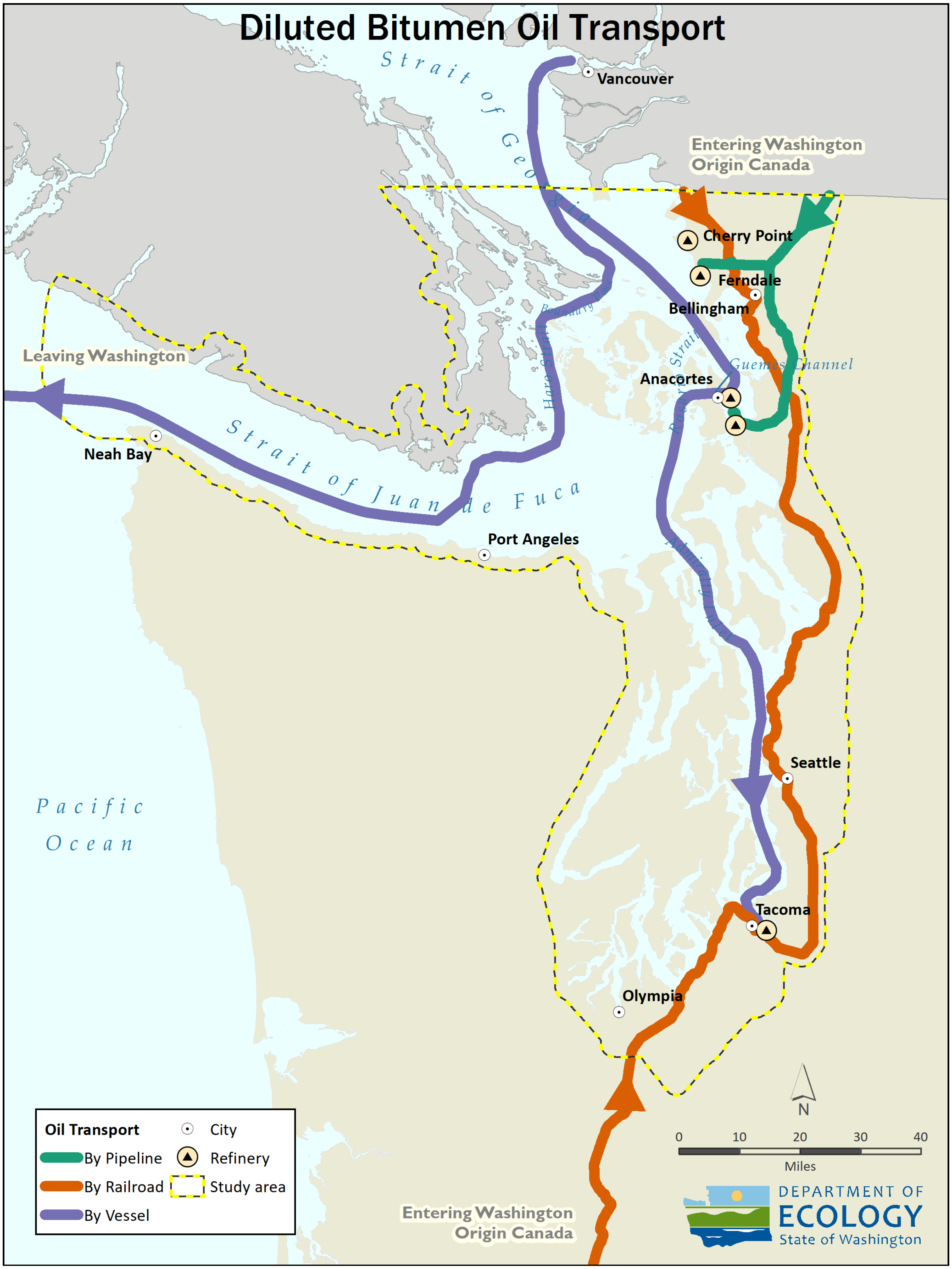


**Figure 34: Diluted bitumen transport in and through the study area**

The mode by which oil is moved has shifted over the last several years due to the development of crude by rail terminals in Washington. Between 2012 and 2016, Ecology estimated that crude oil moved by rail increased each year from about 509 million gallons in 2012 to about 2.2 billion gallons per year in 2016 (Washington State Department of Ecology, 2018f). This corresponds to a decrease in tank ship deliveries of (non-diluted bitumen) crude oil to facilities in southern Puget Sound since 2012 (Washington State Department of Ecology, 2018c).

Since 2012, an average of 208 million bbls (8.7 billion gallons) (46 percent) of the total volume of all oil moved each year is crude oil. In 2017, approximately 4.1 billion gallons of crude oil were delivered to Washington facilities by vessel, 2.6 billion gallons by pipeline, and 2.3 billion gallons by rail (Washington State Department of Ecology, 2018c; Washington State Department of Ecology, 2018d; and Washington State Department of Ecology, 2018e). See Figure 35 below for the percentage of total crude oil transported in Washington by mode in 2017.

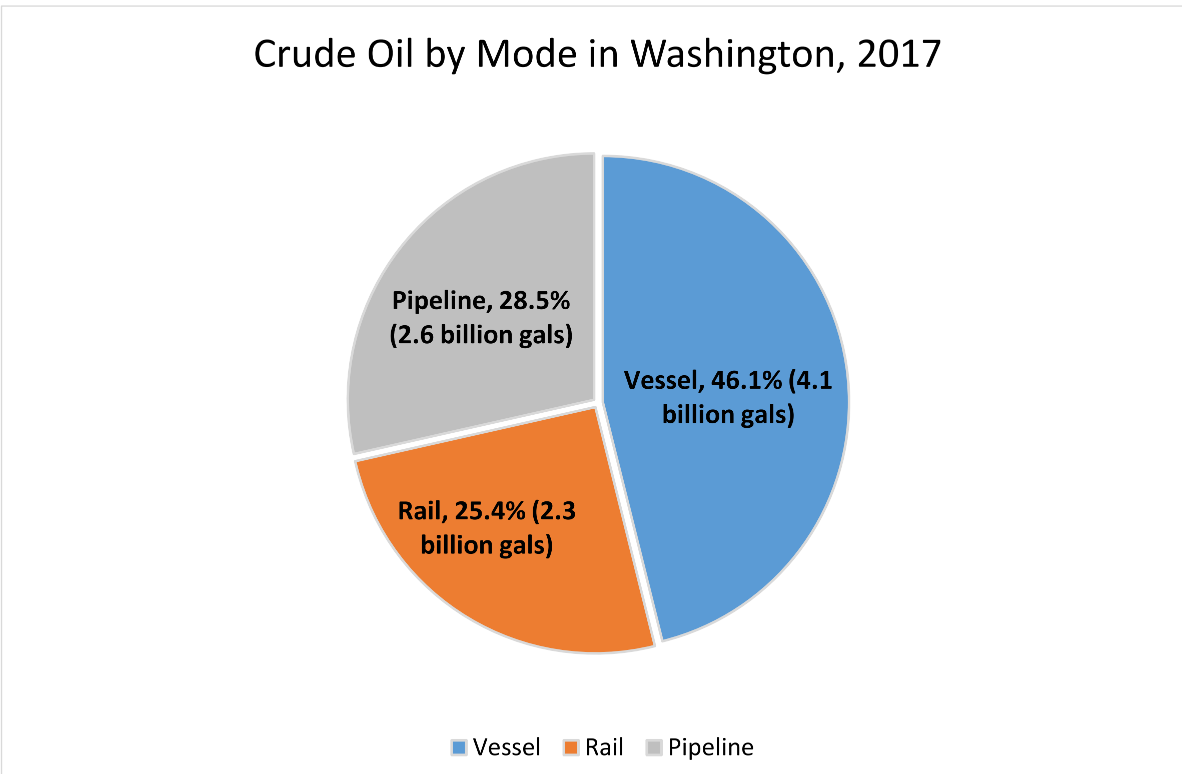


**Figure 35: Crude oil by mode in Washington, 2017 (Washington State Department of Ecology, 2018c; Washington State Department of Ecology, 2018d; Washington State Department of Ecology, 2018e)**

The majority of diluted bitumen from Canada delivered to Washington has been by pipeline. However, diluted bitumen transported by rail into and/or through the study area has increased significantly in the last several years. Diluted bitumen being imported from Canada by vessel appears to be stable as it is primarily moving to one facility in Tacoma.

In 2017, 2.8 billion gallons of diluted bitumen crude (31 percent of all crude moved) was moved by the three modes of transport—vessel, rail and pipeline—as follows:

- 90.6 percent by pipeline, 2.6 billion gallons
- 7.2 percent by rail, 203 million gallons
- 2.2 percent by vessel, 61.8 million gallons

(Washington State Department of Ecology, 2018c; Washington State Department of Ecology, 2018d; and Washington State Department of Ecology, 2018e). See Figure 36 below for the percentage of diluted bitumen crude oil transported in Washington by mode in 2017.

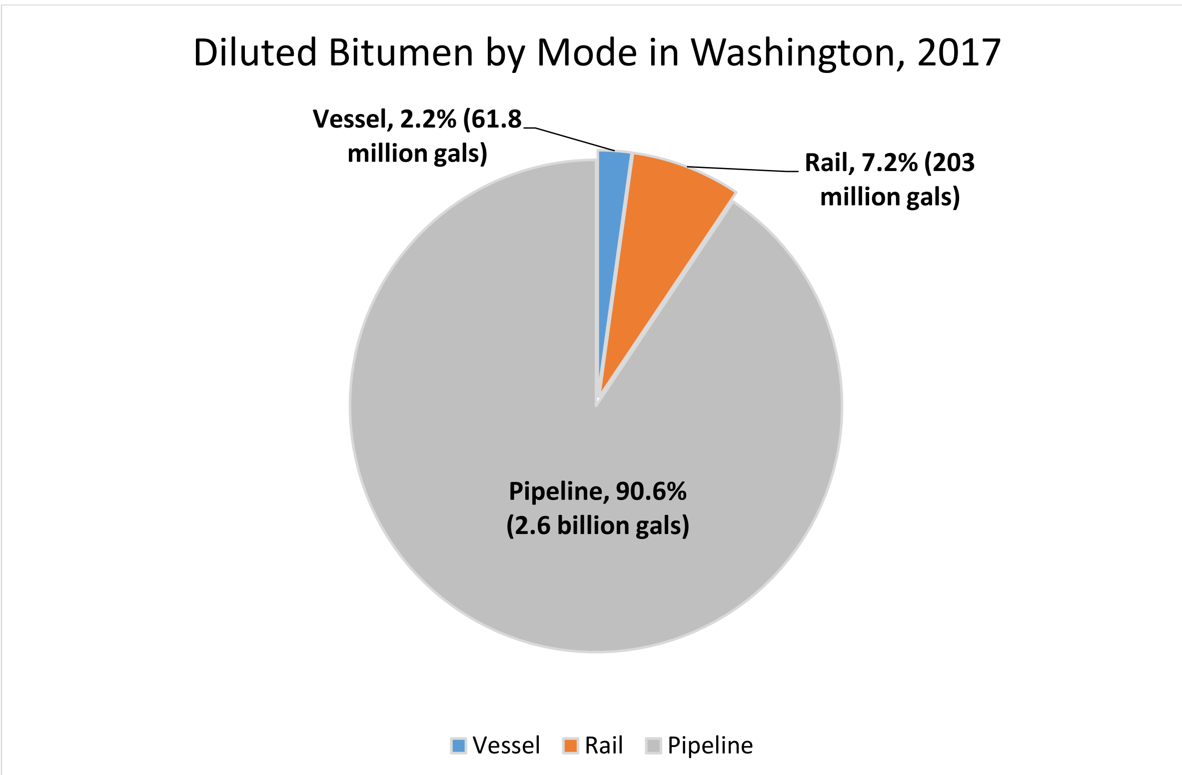


**Figure 36: Diluted bitumen by mode in Washington, 2017 (Washington State Department of Ecology, 2018c; Washington State Department of Ecology, 2018d; Washington State Department of Ecology, 2018e)**

## Summary

This section described the three current mechanisms of transporting diluted bitumen in the Salish Sea and Puget Sound area and provided volumes of these products transported by each mode. While transport of diluted bitumen through the study area is not new, its transport has evolved over the last decade. Additionally, properties of these oils are becoming better understood and are important to consider when evaluating risks associated with oil movement.

In 2017, about 91 percent of diluted bitumen moved into Washington State was by pipeline, 2 percent was moved by vessel, and 7 percent was moved by rail (Washington State Department of Ecology, 2018c; Washington State Department of Ecology, 2018d; and Washington State Department of Ecology, 2018e).

Diluted bitumen is inherently heavy with a likelihood of submerging in the water column or sinking. See Chapter 6 for an explanation of the risks posed by sinking and submerging oils. The movement of diluted bitumen adds to existing risk and brings its own particular concerns to the study area.

Historically, the majority of diluted bitumen from Canada delivered to Washington has been by pipeline. Based on data received under Washington's new reporting regulations diluted bitumen transported by rail into and/or through the study area appears to be increasing. Diluted bitumen imported from Canada by vessel appears stable as it is moving to one facility in Tacoma.

Movement of diluted bitumen by pipeline presents significant concern due to the pipeline's route traveling along and across the Sumas River, Nooksack River, and through the communities of Sumas, Nooksack, and Everson to the Laurel Pump station just north of Bellingham and south through Bellingham along Lake Samish and into Skagit County, crossing the Samish River near Burlington before heading west and crossing the Swinomish Slough and along Padilla Bay to March Point in Anacortes.

Movement of diluted bitumen by rail is relatively new and appears to be increasing. Volumes transported by rail could increase significantly if facilities in Washington begin exporting it by vessel or transporting it to other domestic ports. Additionally, it is possible for diluted bitumen to move down the I-5 corridor to Oregon for transfer to vessels outbound on the Columbia River. Ecology does not receive information about crude oil or diluted bitumen transported through the state by rail unless it is delivered to a Washington facility, so Ecology would not receive notification of these out-of-state transfers.

The volume of diluted bitumen imported from Canada by vessel appears stable. Although relatively small in volume when compared to overall crude oil movement, the movement of diluted bitumen by tug and tank barge from Canada to Tacoma is a concern because of the transit route through Rosario Strait and then south through Admiralty Inlet towards southern Puget Sound. Additionally, billions of gallons of diluted bitumen are exported from Canada each year by tank ships that transit outbound through Canada and Washington's shared waters of the Strait of Georgia, Haro Strait and Strait of Juan de Fuca.[51] This volume is expected to increase significantly if the Trans Mountain Pipeline System and Expansion Project (TMEP) is completed. Any spill from these ships would impact the study area.

From existing data, Ecology has a good understanding of how much diluted bitumen is transported by the three primary modes of transport and the risks associated with it. However, there are gaps in data collected for each mode. Improved data on origins, destinations, and type of oil would help determine the need for additional preventative measures.

[51] These tank ships are generally of a size required to take an escort.

# Recommendation

## Expand requirements for reporting oil movement and oil transfer information

Ecology receives information about the movement of crude oil (including diluted bitumen) by vessel, pipeline, and rail in the state that provides a good understanding of oil moving to destinations in the study area. However, reporting requirements vary by mode and do not provide information that allows Ecology to see the complete oil movement picture through the state. Expanded reporting is needed to fully understand the oil movement picture and evaluate all potential impacts for oil movement by rail, pipeline, and vessel statewide. The additional data would assist Ecology with determining the need for additional prevention and preparedness measures.

Ecology's reporting requirements for crude oil transported by vessel have existed since 2006, but have only been categorized specifically for bitumen or diluted bitumen for a short time period, and regulated transferring facilities typically do not select a specific type of crude when providing oil transfer data. Ecology also does not collect the origin, destination, or gravity of the oil. Expanded data requirements, to include the type of crude oil, the name of the tug towing the barge, and if the barge is laden, were identified as one of the top 24 risk mitigation measures during the 2016 Salish Sea Oil Spill Risk Mitigation Workshop (Washington State Department of Ecology, 2016).

Rail and pipeline reporting requirements are relatively new and analysis over a longer period of time is necessary to generate a clearer picture of how the movement of diluted bitumen is evolving. Pipelines are not required to submit information on the type of crude oil transferred, nor are they required to provide information on gravity of the oil. Facilities receiving crude oil by rail are not required to provide the product type.

Washington could benefit from additional reporting requirements for what types of oil are being moved, and where it is being moved to and from. This could require changes in statute and rule to implement. Oil movement has proven to continuously evolve over time and as demand and markets for oil change. Having near real-time, complete data for all three modes of transport would enhance the state's ability to stay informed and keep pace with the emerging risks associated with changes in oil movement.

# Chapter 8: Difference in Navigational Requirements for Vessels Transporting Petroleum

Section 206 (2)(g) of E2SSB 6269 directs Ecology to complete an assessment and evaluation of "differences between locations and navigational requirements for vessels transporting petroleum." Ecology developed the scope and goal statements below to guide this assessment and evaluation.

Scope: Describe the differences between Canadian and U.S. pilotage and waterways management.

Goal: Summarize the existing pilotage and traffic management systems currently in place in the U.S. and Canada, describe how U.S. and Canadian laws and practices interact, and summarize similarities between the two systems and possible areas for improved coordination.

This assessment of requirements for vessels transporting petroleum describes pilotage requirements for the U.S. and Canada, vessel traffic management, and other navigation requirements and voluntary safe navigation measures for these areas. The chapter concludes with a summary of areas of effective coordination between the systems and a summary of differences between the systems.

## Pilotage

Compulsory pilotage is a tool used by many jurisdictions worldwide to increase marine safety and help prevent vessel accidents within their waters (Quick, n.d.). Local compulsory pilotage helps reduce the risk of vessel accidents by providing visiting vessels with specialized local knowledge and effective communication with tugs and shore services in the local language (International Maritime Organization, n.d.-d). The International Maritime Organization (IMO) recognized the benefits of compulsory pilotage in their 1968 resolution A.159 (ES.IV), which states that governments "should organize pilotage services in those areas where such services would contribute to the safety of navigation in a more effective way than other possible measures and should, where applicable, define the ships or classes of ships for which employment of a pilot would be mandatory" (International Maritime Organization, 1968, p.10).

Ecology evaluated pilotage requirements for Washington State and British Columbia by describing authority, vessels that require a pilot, governance, geographic area of authority, navigation, and pilot qualifications.

### Washington pilotage

#### Authority

The Washington State Pilotage Act (Chapter 88.16 RCW) regulates pilotage in Washington State. The intent of the law is to "prevent the loss of human lives, loss of property and vessels, and to protect the marine environment of the state of Washington through the sound application of compulsory pilotage provisions in certain of the state waters" (Wash. Rev. Code § 88.16.005, 1977).

### Vessels that require a Washington State licensed pilot

Foreign-flagged vessels in Washington State pilotage districts are required to use a state-licensed pilot (Community Attributes, Inc., & Gleason & Associates, 2018). In addition, the Washington Legislature recognized that the "Puget Sound and adjacent waters have limited space for maneuvering a large oil tanker and that these waters contain many natural navigational obstacles as well as a high density of commercial and pleasure boat traffic. For these reasons, it is important that large oil tankers be piloted by highly skilled persons who are familiar with local waters and that such tankers have sufficient capability for rapid maneuvering responses" (Wash. Rev. Code § 88.16.170, 1991). To address this concern, the Legislature requires any registered oil tank ship of five thousand gross tons or greater to take a Washington State licensed pilot while navigating the Puget Sound (Wash. Rev. Code § 88.16.180, 1991).

There are some exemptions to Washington State compulsory pilotage. Vessels under 1,300 gross tons (ITC) and not more than 200 feet in length may be eligible for an exemption from Washington pilotage. If an exemption is granted, a letter will be issued to the vessel from the Washington State Board of Pilotage Commissioners (BPC). In addition, certain vessels are automatically exempt from Washington pilotage requirements. These automatically exempt vessels include:

- U.S. vessels on a voyage in which they are operating exclusively on their coastwise endorsement, their fishery endorsement, and/or their recreational (or pleasure) endorsement (Wash. Rev. Code § 88.16.070, 2017).[52]
- U.S. and Canadian vessels engaged exclusively in the coasting trade on the west coast of the continental United States (including Alaska) and/or British Columbia (Wash. Rev. Code § 88.16.070, 2017).

### Governance

The BPC regulates pilotage in Washington State, established by the Pilotage Act of 1935. Pilotage services for the Columbia River Bar and Columbia River are governed by the state of Oregon (Community Attributes, Inc., & Gleason & Associates, 2018).

### Geographic area

Washington State has two pilotage districts, Puget Sound and Grays Harbor.

*Puget Sound*

The Puget Sound district includes "all the waters of the state of Washington inside the international boundary line between the state of Washington, the United States and the province of British Columbia, Canada and east of one hundred twenty-three degrees twenty-four minutes

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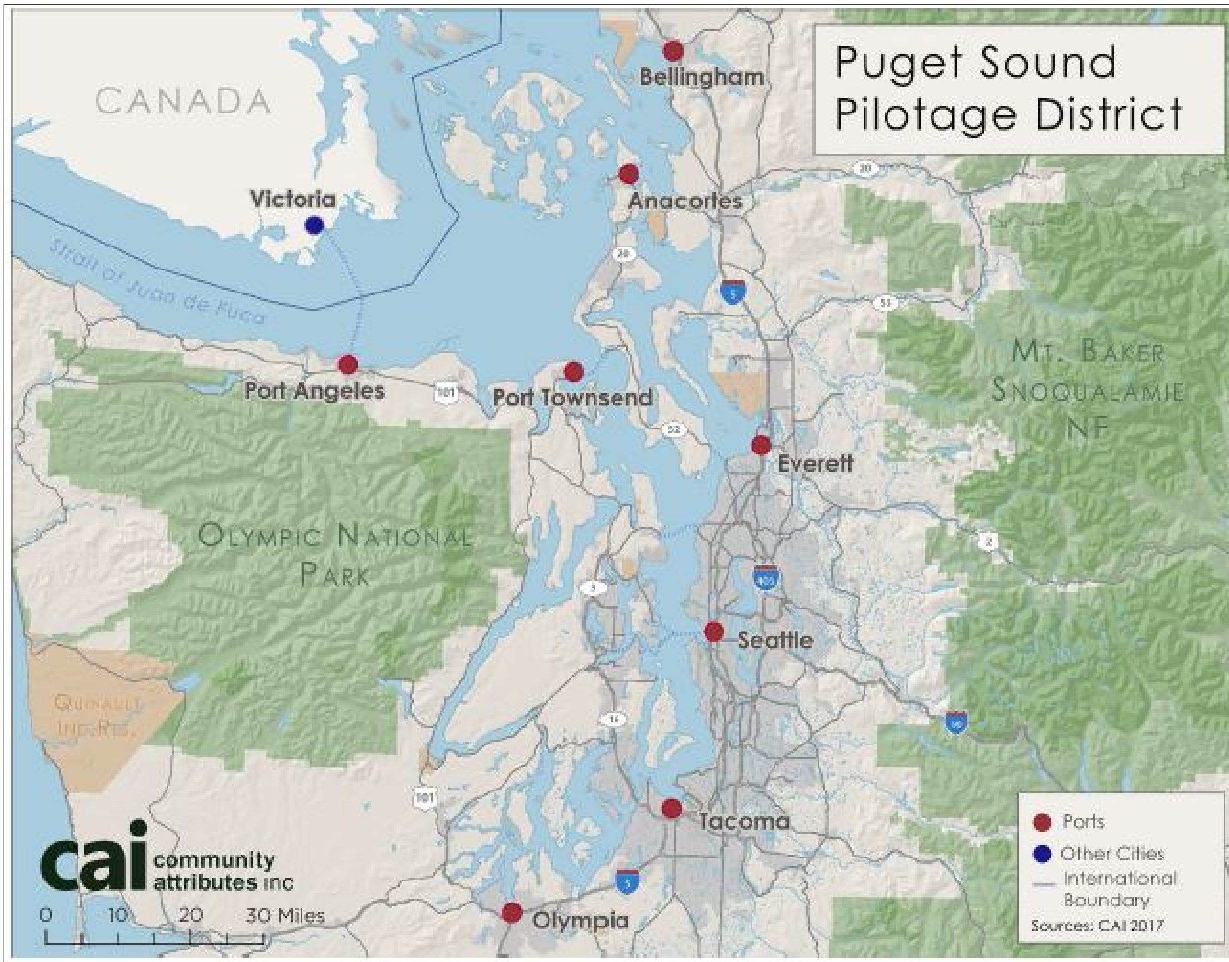
[52] This Washington pilotage exemption applies to most ATB and tank barges operating in Washington waters as a result of their typical routes. Coastwise trade is typically defined as the movement of goods or passengers between locations in the U.S. or the Exclusive Economic Zone (U.S. Coast Guard, n.d.-c). Vessels built in the United States, as well as some other categories of vessels, are eligible for a coastwise endorsement per 46 CFR 67.19. Additionally, federal law prohibits states from dictating state pilotage requirements on certain coastwise vessels (46 USC 85, 1998)

west longitude" (Wash. Rev. Code § 88.16.050, 1987). The Puget Sound District has 12 ports and more than two dozen anchorages spread over more than 7,000 square miles (Community Attributes, Inc., & Gleason & Associates, 2018). The Puget Sound district is shown in Figure 37.




*Note: the Puget Sound Pilotage District extends further norther to the Canadian border.*
*Source: Washington State Board of Pilotage Commissioners (2017).*

**Figure 37: Puget Sound Pilotage District (Excerpt from Community Attributes, Inc., & Gleason & Associates, 2018, p.6)**

In Puget Sound, the Puget Sound Pilots Association provides pilotage services. These services are supported by 52 pilots that are independent contractors, a pilot station, and two pilot boats in Port Angeles, with a dispatch operation and an administrative office in Seattle (Community Attributes, Inc., & Gleason & Associates, 2018).

*Grays Harbor*

The Grays Harbor District includes "all inland waters, channels, waterways, and navigable tributaries within Grays Harbor and Willapa Harbor" (Wash. Rev. Code § 88.16.050, 1987). "The Grays Harbor District covers approximately 280 square miles" (Community Attributes, Inc., & Gleason & Associates, 2018, p. 7). Grays Harbor has two pilots that are employed by the Port of Grays Harbor (Community Attributes, Inc., & Gleason & Associates, 2018).

#### Navigation

Puget Sound Pilots are veteran mariners with decades of experience navigating the waters of Puget Sound. Pilots "board oil tankers, cargo vessels, and cruise ships to guide them safely through Puget Sound waters" (Puget Sound Pilots, n.d.-a). Puget Sound Pilots publish general guidelines for vessels planning on transiting the restricted waterways or ports of Puget Sound. The guidelines discuss topics such as vessel spacing, horizontal and under-keel clearance, tank ships under escort, and other weather and port specific navigation topics (Puget Sound Pilots, 2018a).

#### Pilot qualifications

All Washington State licensed pilots are required to have an unrestricted federal pilotage endorsement as a condition of their Washington State Pilotage licensing. Requirements for obtaining an unrestricted federal pilotage endorsement include, among other requirements, meeting minimum sea time and bridge experience in the local waterways and drawing of local navigational charts from memory (Puget Sound Pilots, n.d.-b). The United States federal regulation for vessels that require an individual qualified to serve as a federal pilot are not described in this report, but are available for review in 46 CFR § 15.812 (2009).

Puget Sound Pilots applicants participate in written and simulator examinations. Successful applicants participate in a multi-year training program, which includes observation, training, and evaluation phases, as well as conning quizzes and local knowledge exams. The Puget Sound Pilots initial license has restrictions that may last up to 5 years. Washington State Pilot minimal qualifications are described in RCW 88.16.090 (2009). They include:

- Hold, *at a minimum,* license as master of steam or motor vessel of not more than 1600 gross registered tons upon oceans, near coastal waters, or inland waters, or equivalent.
- Successful completion of the BPC written exam and pilot evaluation.
- Hold an unrestricted federal pilotage endorsement certifying familiarity with local waters.
- Successful completion of a board specified training program, such as the Puget Sound Pilots training program.
- Periodic vessel simulator training.
- Annual physical exam.

### British Columbia pilotage

#### Authority

Under the Pilotage Act, BC Coast Pilots are "mandated to board and guide any foreign ship coming in or out of BC's ports for safety, efficiency, and environmental protection" (British Columbia Coast Pilots, n.d.).

### Vessels that require a Canadian Marine pilot

Per Pacific Pilotage Authority Canada (PPA) regulations, commercial vessels of 350 gross tons (ITC) or larger are required to use the services of a Canadian marine pilot while traveling in Canadian Pilotage waters. This includes combined tonnage of articulated tug barges (ATBs). Some vessels under 10,000 gross tons (ITC) may be eligible for a waiver from pilotage. If a waiver is granted a letter will be issued to the vessel from the PPA (Pacific Pilotage Authority, 2017a).

### Governance

The Pacific Pilotage Authority Canada (PPA) regulates pilotage in the waters of western Canada. The PPA reports to Parliament through the Minister of Transport. The mission statement of the PPA is to provide “safe, efficient pilotage by working in partnership with pilots and the shipping industry to protect and advance the interests of Canada” (Pacific Pilotage Authority, 2017a). The PPA oversees BC Coast Pilots Ltd., which is an independent fee-for-service organization with fees paid by foreign ship owners. There are over 110 BC Coast Pilots (British Columbia Coast Pilots, n.d.).

### Geographic area

The British Columbia compulsory pilotage area is shown in Figure 38. The area consists of the entire British Columbia coast, extending approximately two nautical miles (NM) from every major point of land. The shaded areas of the chart represent all navigable waters in British Columbia that are under pilotage rules (Pacific Pilotage Authority, 2012).

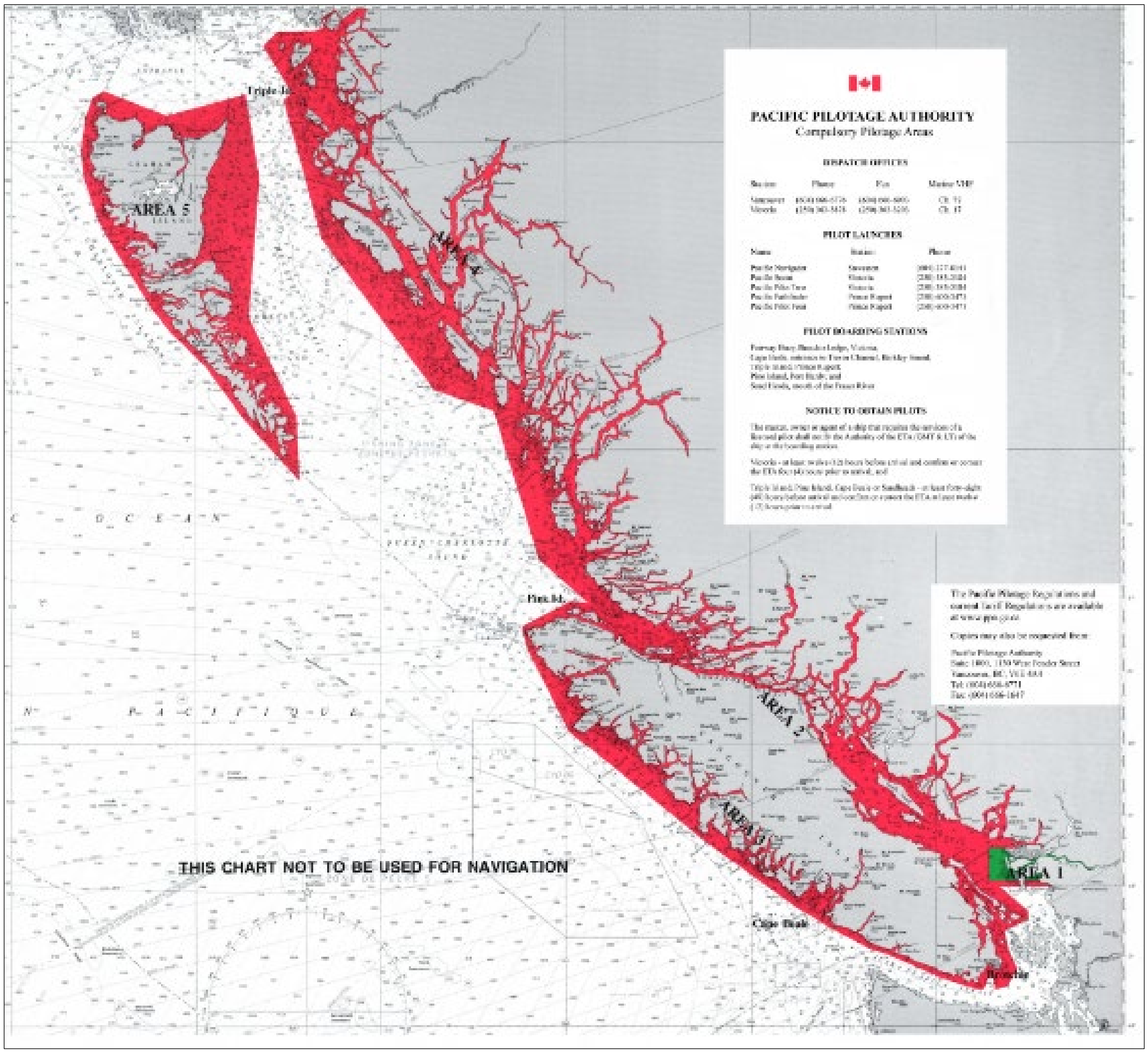



**Figure 38: BC compulsory pilotage areas (Retrieved from Pacific Pilotage Authority, 2012)**

## Navigation

The PPA publishes General Information for Agents that describes the pilot ordering and dispatch process, as well as assignments of when two pilots are required, daylight only ports, and special transition requirements for certain areas. The PPA also publishes industry notices to share information with shippers (Pacific Pilotage Authority, 2013).

## Pilot qualifications

The pilot training program for BC Coast Pilots is similar to that of Puget Sound Pilots, although the PPA encourages more local shadowing before applying. Minimal qualifications for BC Coast Pilots include:

- A valid master 550 GT, Near Coastal certificate of competency.
- Completion of the required number of familiarization trips, which varies based on candidate’s sea time.

- Required sea time:
  - A minimum of 700 days as a master on the BC coast; or 365 days as a master on the BC coast and 547 additional days in the region while holding a Watchkeeping Mate's certificate; or
  - 1,000 days on the BC coast while holding a Watchkeeping Mate's certificate.
- Successful completion of a general knowledge exam, local knowledge exam, and oral exam.
- Completion of a nine to 24 month-long apprenticeship program.
- Serve as a Class II (restricted) pilot for one year, then become a Class I pilot (BC Coast Pilots, n.d.).

## Coordination between Washington and British Columbia

The Oregon Treaty of 1846 and a 2015 Memorandum of Agreement (MOA) between the PPA, BC Coast Pilots, and the Puget Sound Pilots Association provide guidance for pilotage coordination between the U.S. and Canada in the waters of the study area.

### Oregon Treaty of 1846

The Oregon Treaty of 1846 governs the rights of Canada and the United States to move vessels between deep sea and ports in their respective territories through the contiguous waters of both countries. Under this treaty, BC Coast Pilots and Puget Sound Pilots may pilot vessels inbound and outbound through boundary waters (Pacific Pilotage Authority & The BC Coast Pilots Ltd., 2015).

### 2015 Memorandum of Agreement between PPA, BC Coast Pilot Ltd., and Puget Sound Pilots

This MOA documents considerations for vessels crossing the U.S./Canadian border when pilots from both U.S. and Canada are onboard. In these cases, the MOA provides agreed upon locations at which the pilotage of the vessel can safely be transferred between U.S. and Canadian pilots. The MOA makes it clear that the actual location of the transfer should be made by mutual agreement of the specific pilots onboard the vessel (Pacific Pilotage Authority & The BC Coast Pilots Ltd., 2015).

# Vessel traffic management

This section describes the vessel traffic management requirements of the U.S. Coast Guard Vessel Traffic Management, the Canadian Coast Guard Marine Communications and Traffic Service (MCTS), and the Cooperative Vessel Traffic Service (CVTS) between the U.S. and Canada. Ecology also presents other navigation requirements and voluntary measures for safe navigation in this section.

## United States Coast Guard

### Authority

The Vessel Traffic Service (VTS) Puget Sound or "Seattle Traffic" was established by the U.S. Coast Guard under the authority of the Ports and Waterways Safety Act (U.S. Coast Guard, 2013). More details are described in 33 CFR 161 (1994).

### Governance

VTS Puget Sound is operated by the U.S Coast Guard and is comprised of three major components:

1. A Vessel Movement Reporting System (VMRS).
2. A Traffic Separation Scheme (TSS).
3. A surveillance system including radar, Automatic Identification System (AIS), and closed circuit television. (U.S. Coast Guard, 2013)

### Purpose

The purpose of VTS Puget Sound is to "facilitate the safe, secure, and efficient transit of vessel traffic…." The primary function of VTS Puget Sound is to "facilitate good order and predictability on the Salish Sea waterways by coordinating vessel movements through the collection, verification, organization, and dissemination of information." To accomplish this, VTS Puget Sound uses the concept of a "continuum of traffic management", consisting of the following levels of control: monitor, inform, recommend, and direct (U.S. Coast Guard, 2013).

### Special requirements in the VTS area

There are several geographic areas of the Salish Sea with special navigational requirements. One area is the eastern San Juan Island Archipelago VTS Special Area. A full list of the additional requirements for operating in this area can be found in 33 CFR § 161.55(c) (2017).

### Vessels that must participate in VTS

According to the 2013 VTS Puget Sound user's manual, VTS participation requirements in U.S. navigable waters of the Salish Sea require full participation for the following VMRS User Class vessels:

- Power Driven 40 meters or greater in length while navigating.
- Every towing vessel of 8 meters or greater in length, while navigating (engaged in towing).
- Every vessel certificated to carry 50 or more passengers for hire, when engaged in trade (includes dead heading for passengers) (U.S. Coast Guard, 2013, p. 1-2).

The VTS Puget Sound user's manual also lists the following participation requirements for U.S. navigable waters of the Salish Sea:

**Table 7: Vessel participation requirements for vessels operating in U.S. navigable waters of the Salish Sea (Excerpt from U.S. Coast Guard, 2013, p.1-3)**

| Regulation | All Waterborne Craft (Not defined as VMRS or VTS User Class): 1-3 Minimal | VTS User Class: 1-6 Passive Participation | VMRS User Class: 1-7 Full participation |
|---|---|---|---|
| 1. Adherence to 1972 Collision Regulations (72 COLREGS). | ✓ | ✓ | ✓ |
| 2. Subject to VTS Measures (when VTS direction is issued under authority of 33 CFR 161.11). | ✓ | ✓ | ✓ |
| 3. Adherence to all other practices of safe navigation and prudent seamanship. | ✓ | ✓ | ✓ |
| 4. Shall monitor the designated VHF-FM VTS frequency for the area in which they are operating, and Channel 13. | | ✓ | ✓ |
| 5. Shall respond to VTS (Seattle Traffic) if hailed. | | ✓ | ✓ |
| 6. Shall comply with general VTS operating rules. | | ✓ | ✓ |
| 7. Shall make required reports to the VTS. See Section 2, Subpart B on reporting. | | | ✓ |

## Canada and British Columbia

### Authority

MCTS functions are "derived from a regulatory framework based primarily on the Canada Shipping Act, and the Safety of Life at Sea Convention (SOLAS)" (Canadian Coast Guard, 2018a).

### Governance

According to the Canadian Coast Guard (2018):

> The Canadian Coast Guard, Western Region, operates three Vessel Traffic Services Zones: Vancouver, Tofino, and Prince Rupert. The Vancouver zone includes waters from the northern tip of Vancouver Island, down the inside passage and the Gulf of Georgia to

> Victoria. The Vancouver zone is divided into four sectors managed by Victoria Marine MCTS, while the west coast of Vancouver Island and the central and north coast is managed by Prince Rupert.

In 2015, services for the Tofino MCTS were consolidated in to the Prince Rupert MCTS.

**Purpose**

The purpose of MCTS is to promote "safe and efficient navigation or environmental protection…" (S.C. 2001 c. 26 § 126, 2017). Also, "a marine communications and traffic services officer may…grant a clearance to the vessel to enter, leave or proceed within the VTS Zone" (S.C. 2001 c. 26 § 126, 2017). Additionally, MCTS "supports economic activities by optimizing traffic movement and facilitating industry ship/shore communications" (Canadian Coast Guard, 2018a).

**Vessels that must participate in MCTS**

According to the 2013 VTS Puget Sound user's manual, MCTS participation requirements in Canadian waters require full participation for the following vessels:

- Commercial power driven vessels 20 meters or greater in length.
- Pleasure craft 30 meters or greater in length.
- Fishing vessels 24 meters or greater in length, *and* 150 GT.
- Towing vessels 20 meters or greater in length, or, if the object being towed is 20 meters, or, overall length of tug and tow is 45 meters (U.S. Coast Guard, 2013, p. 1-4).

## Cooperative vessel traffic service

In 1979, the U.S. Coast Guard began close coordination the Canadian Coast Guard, establishing the CVTS to manage vessel traffic in adjacent waters, because "Established traffic management areas based not on international boundaries, but rather on geography and waterways provides the best possible seamless and safest collective service for the mariner" (U.S. Coast Guard, 2013, p. iv). The CVTS is operated jointly by the U.S. and Canada, and "facilitates traffic movement and anchorages, avoids jurisdictional disputes, and renders assistance in emergencies in adjoining United States and Canadian waters" (33 CFR 161, 1994). Authority for the coordination came from the Oregon Treaty of 1846.

**Traffic separation scheme**

The Traffic Separation Scheme (TSS) has been adopted by the IMO. Therefore, the TSS is subject to the IMO's International Regulations for Preventing Collisions at Sea, also known as COLREGS, and,

> …all vessels are expected to comply with the provisions of Rule 10 when operating in or near the TSS. The traffic lanes, separation zone, and TSS buoys that comprise the TSS are depicted on nautical charts, and International COLREGS apply everywhere in the VTS Puget Sound Area. (U.S. Coast Guard, 2014a)

There are IMO defined Precautionary Areas within U.S. and Canadian TSS where vessels must exercise caution. Many of the U.S. and Canadian precautionary areas are at TSS turns or junctions (U.S. Coast Guard, 2013).

### Geographic boundaries of VTS zones

The U.S. Coast Guard defines the VTS boundaries as "Strait of Juan de Fuca and its approaches, Puget Sound, the San Juan Island Archipelago, Haro Strait, Boundary Pass, and the Strait of Georgia are regions of the Salish Sea collectively managed by Seattle, Prince Rupert, and Victoria Traffic Services" (2013 p. ii). The service boundary line between these services — the "Exchange Line" — is independent of the International Boundary (U.S. Coast Guard, 2013).

A CVTS Agreement exists between Canada and the U.S.:

> …as part of the Agreement, Prince Rupert Traffic provides VTS for the offshore approaches to the Juan de Fuca Strait and along the Washington State coastline from 48 degrees north. Seattle Traffic provides VTS for both the Canadian and U.S. waters of Juan de Fuca Strait and Victoria Traffic provides VTS for both Canadian and U.S. waters of Haro Strait, Boundary Passage, and the lower Georgia Straits. (Canadian Coast Guard, 2018a)

Prince Rupert provides radar coverage for the approaches to the Strait of Juan de Fuca and west coast of Vancouver Island (Canadian Coast Guard, 2018a). Figure 39 shows the CVTS boundaries.

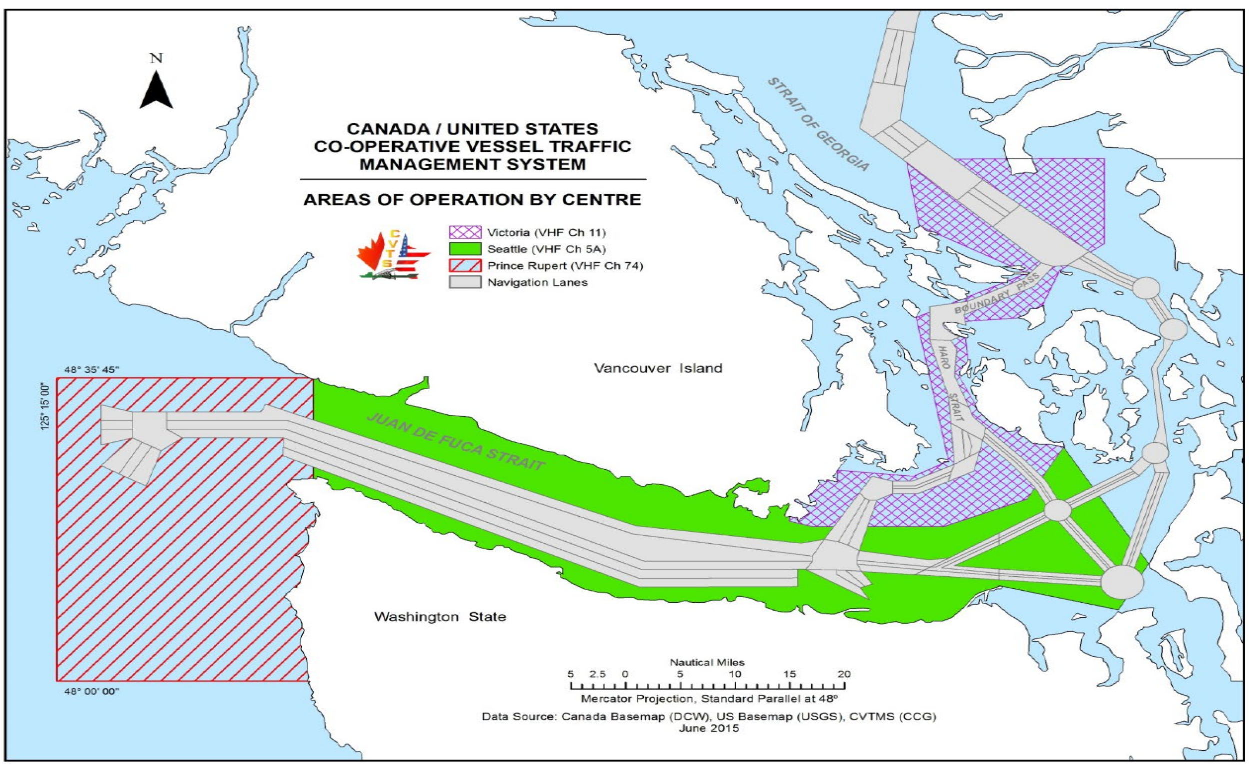



**Figure 39: CVTS areas of operation (Retrieved from Canadian Coast Guard, 2015)**

### Ongoing U.S. and Canadian coordination

In 1979, the governments of Canada and the U.S. signed a formal agreement, the Cooperative Vessel Traffic Services Agreement for the Juan de Fuca Region, that established the CVTS system for the Juan de Fuca region and its seaward approaches. This agreement also established the Joint Coordinating Group (JCG), the governing body for the CVTS. This group meets semiannually and includes members of the Canadian and U.S. Coast Guards (U.S. Coast Guard, 2013).

## Other navigation requirements

### Common international standards

There are many similarities in the navigation requirements in U.S. and Canadian waters. Vessels navigating in U.S. and Canadian waters follow the COLREGS. The COLREGS outline the navigational "rules of the road" which help prevent collisions (Washington State Department of Ecology, 2015). The International COLREGS apply throughout the entire report study area. In addition to the COLREGS, vessels operating in U.S. and Canadian waters also follow the International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers (STCW), which sets qualification standards for masters, officers and watch personnel on seagoing commercial vessels (Washington State Department of Ecology, 2015).

### Differences in tonnage restrictions

On the U.S. side, all tank vessels, U.S. or foreign flag, larger than 125,000 deadweight tons (DWT) bound for a port or place in the United States may not operate east of a line extending from Discovery Island Light to New Dungeness Light and all points in the Puget Sound area north and south of these lights (33 CFR 165, 1982). This is in contrast to the Canadian regulations which do not currently include any tonnage restriction for vessels operating in British Columbia waters. Tank ships currently servicing Kitimat in northern British Columbia are between 10,000 – 60,000 DWT, while those servicing Vancouver are up to and including the Aframax category (80,000 – 120,000 DWT) (Chamber of Shipping, n.d.). In addition, due to waterway restrictions, tank ships calling on oil terminals in the Port of Vancouver do not exceed 120,000 DWT (Port of Vancouver, n.d.-g).

### Automatic Identification System

AIS is a navigation safety communications system that is used to convey real time vessel information such as vessel name, course, speed, and position, as well as other important vessel details (U.S. Coast Guard, 2018). The U.S. and Canada each have their own unique requirements for AIS carriage by vessels. U.S. AIS carriage requirements are based on many factors including vessel length, operation, cargo, and horsepower and are found in 33 CFR § 164 (33 CFR 164, 2017). The Canadian AIS carriage requirements are also based on many factors including vessel tonnage and operation and can be found in Canada's Navigation Safety Regulations (SOR/2005-134) (Canadian Coast Guard, 2018b).

### Similarities in communicating information about navigational safety

The U.S. Coast Guard shares important information about navigational safety issues with waterways users through Broadcast Notice to Mariners as well as through weekly Local Notice to Mariners. The U.S. Coast Guard is also responsible for evaluating requests for marine events to determine whether they pose a significant hazard to the safety of life and to decide whether, and under which conditions, these events can be permitted.

The Canadian Coast Guard shares information about navigational safety issues with waterway users through Broadcast Notices to Shipping broadcast by the MCTS Centres. In addition, Notices to Shipping (NOTSHIPs) are used to communicate "navigational aid changes or defects, fishing zones, military exercises, dredging, or other marine hazards" (Canadian Coast Guard, 2017).

## Voluntary safe navigation measures

In addition to requirements for navigation and vessel traffic management, there are voluntary measures in place for safe navigation in U.S. and Canadian waters.

### Puget Sound Harbor Safety Plan Standards of Care

The Puget Sound Harbor Safety Committee (PSHSC) is a nonprofit organization formed to promote marine safety and whose members compromise industry, government, and advocacy groups interested in marine safety. The PSHSC developed and maintains the Puget Sound Harbor Safety Plan (PSHSP) "to enhance marine safety and environmental stewardship via risk-based decision making" (Puget Sound Harbor Safety Committee, 2017, p. 1). As part of the PSHSP, the PSHSC maintains "Standards of Care" (SOC), which are "procedures and practices, beyond regulatory requirements, that experienced and prudent maritime professionals follow to ensure safe, secure, efficient, and environmentally responsible maritime operations" (Puget Sound Harbor Safety Committee, 2017, p. 45). The SOC "are 'good marine practices' that are developed and published to provide a guide for maritime professionals to consider and incorporate into their decision making process. Standards of Care are not regulations, and thus not enforceable" (Puget Sound Harbor Safety Committee, 2017, p. 45). Examples of SOC topics include anchoring, bunkering operations, lightering, propulsion loss prevention, and tank ship escort operations (Puget Sound Harbor Safety Committee, 2017).

### Orca protection initiatives

There are a number of cross-border orca protection initiatives currently in place or under development by the Vancouver Fraser Port Authority's Enhancing Cetacean Habitat and Observation (ECHO) program and the Washington State Southern Resident Killer Whale (SRKW) Recovery and Task Force. The ECHO Program has a long-term goal to "develop mitigation measures that will lead to a quantifiable reduction in potential threats to whales as a result of shipping activities" (Port of Vancouver, n.d.-e). These initiatives invite vessels to voluntarily change some of their navigation practices (slowdowns and lateral lane shifts in specific geographic areas and times of year) to help protect the orca population.

Noise pollution from vessel traffic can disturb SRKWs and displace them from their preferred areas. Slowing vessels transiting Puget Sound can reduce noise. Because underwater noise from vessels is primarily caused by cavitation and turbulence from their propellers, slowing the rate of propeller rotation can assist with successful communication between orcas and echolocation, their main strategy in prey-finding and capture. Studies have shown that vessels operating at moderate or high speeds emit disproportionately louder noises, which have greater potential masking effects for echolocation (Houghton et al., 2015 and citations therein). One recent study cited anthropogenic marine noise as the second-largest negative influence on the annual growth rates of Southern Resident Killer Whale (SRKW) populations (Lacy et al., 2017). A slower speed was shown by a 2017 ECHO study to benefit the local orca whales by reducing the amount of underwater noise made by the vessel's propulsion (Vancouver Fraser Port Authority, 2018). In addition, faster vessel speeds increase the risk of collisions with vessels and orca fatalities. However, it should also be noted that ships traveling at slower speeds will be in the area longer, potentially decreasing the length of quiet intervals between ship movements. These quiet intervals may be advantageous for orca communication and foraging.

# Summary

This chapter described the existing pilotage and traffic management systems in place in the U.S. and Canada by summarizing management of these systems and describing coordination between the systems. In doing so, Ecology has summarized areas of effective coordination between the systems as well as areas where the systems differ.

## Similarities that benefit waterway safety

Navigational requirements in U.S. and Canadian waters are similar, and include adherence to international regulations and standards, including but not limited to the COLREGS and the International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers (STCW).

There is significant cooperation between Canada and the U.S. with regard to waterway safety and management. Both the U.S. and Canada use active vessel traffic services to reduce the risk of accidents and collisions within the waterways. While the U.S. VTS and Canadian MCTS each operate under their own unique authorities and vessel participation requirements, the overarching method of active vessel traffic management to enhance safe navigation and environmental protection remains the same. The CVTS agreement is an example of coordination between U.S. and Canada related to management of traffic in the shared waterways.

Both Washington State and Canada also make use of compulsory pilotage to ensure that large vessels operating within their waters are navigated by skilled mariners with intimate knowledge of the local waterway. While each pilotage district operates under its own unique authorities, the overarching method of using pilotage to enhance safe navigation and environmental protection remains the same.

In Washington, any registered oil tank ship of 5,000 gross tons or greater is required to take a Washington State licensed pilot while navigating the Puget Sound (Wash. Rev. Code § 88.16.180, 1991). In addition, foreign-flagged vessels in Washington State pilotage districts are required to use a state-licensed pilot (Community Attributes, Inc., & Gleason & Associates, 2018). There are some exemptions, which are discussed earlier in this chapter. In Canadian Pilotage waters, commercial vessels of 350 gross tons (ITC) or greater are required to use the services of a Canadian marine pilot. This includes the combined tonnage of articulated tug barges (ATBs). Some vessels under 10,000 gross tons (ITC) may be eligible for a waiver from pilotage (Pacific Pilotage Authority, 2017a).

The 2015 MOA between the PPA, BC Coast Pilots, and the Puget Sound Pilots Association is an example of successful coordination between Washington and BC related to pilotage in the shared waterways.

## Differences

Examples of differences discussed in this review include:

- Differences in the vessels that are required to participate in compulsory pilotage.
- Differences in criteria and process for obtaining waivers and exemptions from compulsory pilotage from the Washington BPC and from the PPA.
- Differences in criteria for mandatory vessel participation in the VTS or MCTS in U.S. and in Canadian waters.
- Differences in tonnage restrictions for vessels.
    - On the U.S. side, all tank vessels, U.S. or foreign flag, larger than 125,000 DWT bound for a port or place in the United States may not operate east of a line extending from Discovery Island Light to New Dungeness Light and all points in the Puget Sound area north and south of these lights (33 CFR 165, 1982).
    - Canadian regulations do not currently include any tonnage restriction for vessels operating in British Columbia waters (Chamber of Shipping, n.d.). However, due to waterway restrictions, tank ships calling on oil terminals in the Port of Vancouver do not exceed 120,000 DWT (Port of Vancouver, n.d.-g).

# Chapter 9: Tug Escort and Tug Capability Requirements

Section 206 (2)(d) of E2SSB 6269 directs Ecology to complete an assessment and evaluation of tug escorts for oil tankers (tank ships), articulated tug barges (ATBs), and other towed waterborne vessels or barges, including a review of requirements in California and Alaska.

Section 206 (2)(e) of E2SSB 6269 directs Ecology to complete an assessment and evaluation of requirements for tug capabilities to ensure safe escort of vessels, including manning (crewing) and pilotage needs.

In light of the likely interaction of Washington requirements for tug escorts of tank vessels with escort policies in place in or proposed for British Columbia, the scope of this assessment was expanded to include British Columbia. The state of Massachusetts's system of tug escorts for tank vessels was also added because they have a tug escort system specifically dedicated to tank barges.

This chapter presents the results of Ecology's assessments of tug escort and tug capability requirements. Ecology the developed scope and goal statements below to guide these assessments and evaluations.

Scope:

- Describe existing requirements at the Federal and state levels for tug escorts of tank ships, ATBs and other waterborne vessels or barges, including a review and comparison of requirements in California, Alaska, Massachusetts, and British Columbia.
- Describe requirements for tug capabilities needed to ensure the safe escort of vessels, including manning (crewing) and pilotage needs.

Goals:

- Describe current state and federal tug escort requirements for tank vessels and determine whether they reduce spill risk. If risk is reduced, make recommendations for new or improved tug escort requirements for Washington State.
- Assess and provide recommendations for the necessary physical capabilities and manning (crewing) levels of tugs performing escort duties for tank vessels in Washington State.

Finally, E2SSB 6269 specifies that this report will include recommendations for:

- "The viability of…tug escorts for oil tankers, articulated tug barges, and other towed waterborne vessels or barges. If tug escorts are determined in this assessment to reduce oil spill risk, the department of ecology must recommend specific requirements and capabilities for tug escorts" (E2SSB 6269 § 206 (3)(b)(i), Wa. 2018).
- Vessel traffic management and vessel traffic safety (E2SSB 6269 § 206 (3)(a), Wa. 2018).

Therefore, this chapter also reviews available information regarding the effectiveness of escort tugs in reducing the risk of oil spills resulting from tank vessel accidents. Specific recommendations for tug escort requirements and capabilities, as well as recommendations for voluntary prevention measures, are discussed in the summary of this chapter.

# Tug escort of oil tankers, ATBs, and towed tank barges

This section describes existing requirements at the federal, provincial, and state levels for tug escorts of tank ships, ATBs, and towed tank barges — specifically, a review of requirements for tank vessel escorts imposed by U.S. regulation and the state jurisdictions of Washington, California, Alaska, and Massachusetts. Requirements for tank vessel escorts for British Columbian waters are also reviewed. Ecology also presents variables to consider in tug escorts for tank vessels and information on the effectiveness of tug escorts in reducing the risk of oil spills.

Escort tug capabilities are described in this chapter, including where existing escort requirements contain minimum capabilities.

## Existing federal, state, and provincial tug escort requirements

To review, assess, and evaluate the escort requirements for tank vessels under federal and state requirements, Ecology presents existing requirements in a side-by-side comparison. Tables 8–11 provide such a comparison and in doing so provide information to answer the following questions:

- Which vessels must take a tug escort?
- In which waters are escorts required?
- How many escorts are required?
- What are the minimum requirements for tug escorts?

**Table 8: Vessels that must take a tug escort**

| Vessel type | Washington | Massachusetts | California | Alaska | U.S. Coast Guard | British Columbia |
|---|---|---|---|---|---|---|
| | Wash. Rev. Code § 88.16.190<br>Wash. Admin. Code § 363-116-500<br>PSHSC Plan | Mass. Gen. Laws ch.21M, §§1,6<br>314 CMR 19.00 | Cal. Gov't Code §8670.17.2<br>Cal. Code Regs. 14 CCR §§ 851.1 – 10.1 and 851.20 – 32 | Alaska Admin. Code tit. 18, § 75.027<br>PWS Tanker ODPCP[53]<br>RPG VERP[54] | 46 USC. § 3703<br>33 CFR 168 | Pacific Pilotage Authority – Notice to Industry |
| Tank ship | 40,000 DWT or more, no double bottom, and not in ballast, and lacking:<br>(a) Shaft horsepower in the ratio of one horsepower to each two and one-half deadweight tons; and<br>(b) Twin screws; and<br>(c) Two radars in working order and operating, one of which must be collision avoidance radar.<br>See also U.S. Coast Guard, 33 CFR 168. | Not applicable to self-propelled tank vessels. | Los Angeles/Long Beach (LA/LB) – inbound or inside the Federal Breakwater, and laden.[55]<br>San Francisco waters (SF) – capable of carrying 5,000 long tons or more of oil in bulk, underway and laden.[56] | All laden.[57]<br>See also U.S. Coast Guard, 33 CFR 168. | Puget Sound: 5,000 gross tons or more, single-hulled, laden.<br>Prince William Sound (PWS): 5,000 gross tons or more, laden.[58] | All ships with a Summer Deadweight Tonnage (SDWT) of 40,000 or greater transiting Haro Strait and Boundary Pass carrying liquids in bulk in excess of 6,000 metric tons.[59] |

[53] Prince William Sound (PWS) Tanker ODPCP – Tanker oil discharge prevention and contingency plan, developed to comply with Alaska Admin Code tit. 18, § 75 (1992).
[54] Six companies that operate tank ships serving Alyeska Pipeline Service Company (Alyeska) comprise the Response Planning Group (RPG) which adopted the Vessel Escort and Response Plan (VERP). The VERP used to be part of the Tanker Oil Discharge Prevention and Contingency Plan (ODPCP) approved by the State of Alaska, but now is a stand-alone guide for all tank ships carrying crude from Port Valdez and has no regulatory effect. Alyeska/SERVS (Ship Escort/Response Vessel System) contracts for, manages, and dispatches escort and sentinel tugs and is the response contractor under the TODPC.
[55] LA/LB rules define "laden tank vessel" as a tank vessel that is carrying 5,000 or more metric tons of oil in bulk as cargo. Also fully redundant, double-hulled tank ships with integrated navigation systems, as defined, are exempt from the requirement (Cal. Code Regs. 14 CCR § 851.22(f), 2012).
[56] SF rules require escorts for tank vessels capable of, and actually carrying 5,000 long tons or more of oil in bulk as cargo. Fully redundant tankers, as defined, and tank vessels shifting from berth to berth, or anchorage to anchorage, are not required to have a tug escort (Cal. Code Regs. 14 CCR § 851.4(d), 2006).
[57] Alyeska (RPG VERP) defines "laden tanker" as any tanker carrying crude oil or un-segregated ballast water greater than 0.5% of a vessel's maximum cargo capacity or 3,000 barrels (126,000 gallons), whichever figure is less.
[58] The Coast Guard Authorization Act of 2010 extended the requirement to have escorts in PWS to double-hulled tank ships 5,000 gross tons or more (Coast Guard Authorization Act of 2010, H.R. 3619, 2010).
[59] Summer deadweight tonnage refers to DWT at a summer load line based on International Convention on Load Lines standards.

| Vessel type | Washington<br>Wash. Rev. Code § 88.16.190<br>Wash. Admin. Code § 363-116-500<br>PSHSC Plan | Massachusetts<br>Mass. Gen. Laws ch.21M, §§1,6<br>314 CMR 19.00 | California<br>Cal. Gov't Code §8670.17.2<br>Cal. Code Regs. 14 CCR §§ 851.1 – 10.1 and 851.20 – 32 | Alaska<br>Alaska Admin. Code tit. 18, § 75.027<br>PWS Tanker ODPCP[53]<br>RPG VERP[54] | U.S. Coast Guard<br>46 USC. § 3703<br>33 CFR 168 | British Columbia<br>Pacific Pilotage Authority – Notice to Industry |
|---|---|---|---|---|---|---|
| Tank barge<br>ATB | No requirement | Carrying 6,000 barrels (252,000 gallons) of oil or more.[60] | LA/LB - All inbound or inside the Federal Breakwater, and laden.<br>SF – underway and capable of carrying 5,000 long tons or more of oil. | No requirement | No requirement | No requirement |
| LNG/ LPG vessels | 40,000 DWT or more, no double bottom, and not in ballast, and lacking:<br>(a) Shaft horsepower in the ratio of one horsepower to each two and one-half deadweight tons; and<br>(b) Twin screws; and<br>(c) Two radars in working order and operating, one of which must be collision avoidance radar. | Not applicable to self-propelled tank vessels. | No requirement | No requirement | No requirement[61] | All ships with a Summer Deadweight Tonnage (SDWT) of 40,000 or greater transiting Haro Strait and Boundary Pass carrying liquids in bulk in excess of 6,000 metric tons. |
| Cargo vessel | No requirement | No requirement | No requirement | No requirement | No requirement | No requirement |

[60] May request a waiver if no tug escort is available. Waiting for an escort has or may result in a significant disruption of energy services to the public, or a public health, safety or environmental emergency, or threat, or other unique circumstance warranting use of MassDEPs enforcement discretion.

[61] Escorts are only required for tank ships that carry international pollution category I cargoes as listed in 46 CFR 30.25-1 (2013).

**Table 9: Waters in which escorts are required**

| Vessel type | Washington<br>Wash. Rev. Code § 88.16.190<br>Wash. Admin. Code § 363-116-500<br>PSHSC Plan | Massachusetts<br>Mass. Gen. Laws ch.21M, §§1,6<br>314 CMR 19.00 | California<br>Cal. Gov't Code § 8670.17.2<br>Cal. Code Regs. 14 CCR §§ 851.1 – 10.1 and 851.20 – 32 | Alaska<br>Alaska Admin. Code tit. 18, § 75.027<br>PWS Tanker ODPCP<br>RPG VERP | U.S. Coast Guard<br>46 USC § 3703<br>33 CFR 168 | British Columbia<br>Pacific Pilotage Authority – Notice to Industry |
|---|---|---|---|---|---|---|
| Tank ship | Puget Sound east of a line between New Dungeness Light and Discovery Island Light. | No requirement | LA/LB – inside of, and 4 miles out from, the Federal Breakwater.[62]<br>SF – San Francisco, San Pablo and Suisun Bays.[63] | Prince William Sound (PWS) from Cape Hinchinbrook to berth. | Puget Sound: U.S. waters east of Port Angeles.[64]<br>PWS: U.S. waters from Hinchinbrook entrance to the Port of Valdez.[65] | Tethered escort in Boundary Pass and Haro Strait from 2 miles north of East Point to vicinity of Brotchie Ledge (Victoria).<br>In addition, for crude oil carriers of 40,000 SDWT or more in product:<br>Tethered escort from First Narrows to "QA" Buoy.<br>Untethered escort from "QA" Buoy to 2 miles north of East Point.<br>Untethered escort from Race Rocks to Buoy J. |

[62] Approaches to Los Angeles/Long Beach are divided into three zones seaward of the artificial reef called the Federal Breakwater. Zone 1 includes waters 2 miles out; Zone 2 includes waters 3.5 miles out; and Zone 3 includes waters 4 miles out. All inbound, laden tank *vessels* must take a tug escort in Zone 1. All inbound, laden tank *ships* with more than a 16.5 meter static deep-draft must take tug escorts in Zone 2. All inbound, laden tank *ships* with more than a 14 meter static deep-draft must take tug escorts in Zone 3.
[63] San Francisco waters are divided into 6 zones with Zone 1 beginning at the COREGS Demarcation Line and proceeding east through San Francisco, San Pablo, and Suisin Bays. Escorts are required for all tank vessels in Zones 1, 2, 4, and 6, but not in Zones 3 and 5. Escorts are not required for tank vessels underway in waters outside of Zones 1 and 6.
[64] Specifically, portions of the Strait of Juan de Fuca and Puget Sound east of a line between New Dungeness Light and Discovery Island Light, including Rosario and Haro Straits and the Strait of Georgia, subject to United States jurisdiction.
[65] Specifically, U.S. navigable waters within a line drawn from Cape Hinchinbrook Light to Seal Rocks Light, to a point on Montague Island at 60°14 6' North 146°59' West, and the waters of Montague Strait east of a line between Cape Puget and Cape Cleare.

| **Vessel type** | **Washington**<br>Wash. Rev. Code § 88.16.190<br>Wash. Admin. Code § 363-116-500<br>PSHSC Plan | **Massachusetts**<br>Mass. Gen. Laws ch.21M, §§1,6<br>314 CMR 19.00 | **California**<br>Cal. Gov't Code § 8670.17.2<br>Cal. Code Regs. 14 CCR §§ 851.1 – 10.1 and 851.20 – 32 | **Alaska**<br>Alaska Admin. Code tit. 18, § 75.027<br>PWS Tanker ODPCP<br>RPG VERP | **U.S. Coast Guard**<br>46 USC § 3703<br>33 CFR 168 | **British Columbia**<br>Pacific Pilotage Authority – Notice to Industry |
|---|---|---|---|---|---|---|
| Tank barge<br>ATB | No requirement | "Areas of Special Interest" – includes, but is not limited to, waters of Buzzards Bay (including the Cape Cod Canal), Mount Hope Bay, and Vineyard Sound. | LA/LB – 2 miles out from the Federal Breakwater and inside the Federal Breakwater.<br>SF – San Francisco, San Pablo and Suisun Bays. | No requirement | No requirement | No requirement |
| LNG/ LPG vessels | Puget Sound east of a line between New Dungeness Light and Discovery Island Light. | No requirement | No requirement | No requirement | No requirement | Tethered escort in Boundary Pass and Haro Strait from 2 miles north of East Point to vicinity of Brotchie Ledge (Victoria). |

**Table 10: Number of escort tugs required**

| Vessel type | Washington | Massachusetts | California | Alaska | U.S. Coast Guard | British Columbia |
|---|---|---|---|---|---|---|
| | Wash. Rev. Code § 88.16.190<br>Wash. Admin. Code § 363-116-500<br>PSHSC Plan | Mass. Gen. Laws ch.21M, §§ 1,6<br>314 CMR 19.00 | Cal. Gov't Code § 8670.17.2<br>Cal. Code Regs. 14 CCR §§ 851.1 – 10.1 and 851.20 – 32 | Alaska Admin. Code tit. 18, § 75.027<br>PWS Tanker ODPCP<br>RPG VERP | 46 USC § 3703<br>33 CFR 168 | Pacific Pilotage Authority – Notice to Industry |
| Tank ship | One or more depending on each tug's shaft horsepower compared the ship's DWT. | No requirement | LA/LB – up to 2 tugs to meet the forces required by a matrix based on the ship's deadweight tonnage (metric) (Cal. Code Regs. 14 CCR §§ 851.27-851.27.1, 2012).[66]<br>SF – up to 3 tugs with sufficient braking force to stop the escorted tank ship from a speed of 5 knots (Cal. Code Regs. 14 CCR § 851.9, 2001). | VERP:<br>Tank ships in ballast are escorted by sentinel tugs.[67]<br>Laden tank ships are escorted by a Primary and a Secondary escort, and an escort response vessel either as part of the convoy or underway during the transit.[68] | At least two escorts. | One tug that meets the definition of "escort tug."<br>Bollard pull requirements for escort tug are set based on vessel size. |
| Tank barge<br>ATB | No requirement | One qualified tug escort. | LA/LB – up to 2 tugs to provide ahead or astern static bollard pull depending on the aggregate DWT of the towing tug and barge.<br>SF – up to 3 tugs with sufficient braking force to stop the barge, and with a bollard pull equal to the barge's DWT. | No requirement | No requirement | No requirement |

[66] Only tractor tugs may be tank vessel escorts.
[67] Sentinel tugs are stationed Northern PWS (Valdez Port, Narrows and Arm), Central PWS (between Northern PWS and Hinchinbrook Entrance), and Hinchinbrook Entrance to assist tank ships in ballast or laden tank ships with a close escort in Central PWS.
[68] An escort response vessel is fitted with skimming and onboard storage capabilities for initial oil recovery appropriate to the tank ship escorted.

| Vessel type | Washington<br>Wash. Rev. Code § 88.16.190<br>Wash. Admin. Code § 363-116-500<br>PSHSC Plan | Massachusetts<br>Mass. Gen. Laws ch.21M, §§ 1,6<br>314 CMR 19.00 | California<br>Cal. Gov't Code § 8670.17.2<br>Cal. Code Regs. 14 CCR §§ 851.1 – 10.1 and 851.20 – 32 | Alaska<br>Alaska Admin. Code tit. 18, § 75.027<br>PWS Tanker ODPCP<br>RPG VERP | U.S. Coast Guard<br>46 USC § 3703<br>33 CFR 168 | British Columbia<br>Pacific Pilotage Authority – Notice to Industry |
|---|---|---|---|---|---|---|
| LNG/ LPG ship | One or more depending on each tug's shaft horsepower compared the ship's DWT. | | | | | One tug that meets the definition of "escort tug."<br>Bollard pull requirements for escort tug are set based on vessel size. |

**Table 11: Minimum requirements for tug escorts**

| Requirement | Washington | Massachusetts | California | Alaska | U.S. Coast Guard | British Columbia |
|---|---|---|---|---|---|---|
| | Wash. Rev. Code § 88.16.190<br>Wash. Admin. Code § 363-116-500<br>PSHSC Plan | Mass. Gen. Laws ch.21M, §§ 1,6<br>314 CMR 19.00 | Cal. Gov't Code § 8670.17.2<br>Cal. Code Regs. 14 CCR §§ 851.1 – 10.1 and 851.20 – 32 | Alaska Admin. Code tit. 18, § 75.027<br>PWS Tanker ODPCP<br>RPG VERP | 46 USC § 3703<br>33 CFR 168 | Pacific Pilotage Authority – Notice to Industry |
| Tug capabilities | Tug or tugs must have an aggregate shaft horsepower equivalent to 5% of the tank ship's DWT. | Twin screws, separately powered, aggregate shaft horsepower of 4,000 horsepower or greater, a minimum bollard pull of 50 tons, and firefighting equipped that meet American Bureau of Shipping classifications for Class 1 Fire Fighting Vessel and Maltese Cross AI (Towing Vessel).[69] | LA/LB – must meet standards for static bollard pull testing and certification, equipment, crewing, and training (Cal. Code Regs. 14 CCR § 851.23, 2006).<br>SF – must meet standards for braking force, crewing, training and equipment (Cal. Code Regs. 14 CCR § 851.8, 2006). | Tanker ODPCP: Prior to taking charge of an escort, masters and mates undergo formal training on escort/response functions. Crew must meet U.S. Coast Guard and SERVS requirements.<br>VERP: There are 8 classes of escort/response vessels. Primary escorts are either ASD, PWS Class (ETT) or PRT Class, or for tank ships 90,000 DWT or less, ASD or Protector Class.[70] | No requirement | At least 2 omni-directional thrusters, "Z-drive" or "Voith Schneider," have a winch adjustable from the wheel house, and master has a nearly 360° view.<br>Escort must have at least 50 ton bollard pull to escort ships with length overall (LOA) plus beam of less the 265 meters.<br>Escort must have at least 65 tons bollard pull to escort ships with LOA plus beam of 265 meters or more. |

[69] A tractor tug may be used if it meets the same horsepower, bollard pull, and firefighting requirements and is propelled by blades or screws that allow 360 degree propulsive thrust. Massachusetts also adopted minimum equipment standards for escorts, including two radios, fendering, line-handling equipment, tow lines, and braking force (314 Mass. Code Regs. 19.03(2), 2010).

[70] Class characteristics such horsepower, draft, bollard pull, propulsion are described in Table 4-1 of the VERP. ASD is azimuthing stern drive or Z-drive; ETT is enhanced tractor tug; PRT is prevention and response tug.

| Requirement | Washington | Massachusetts | California | Alaska | U.S. Coast Guard | British Columbia |
|---|---|---|---|---|---|---|
| | Wash. Rev. Code § 88.16.190<br>Wash. Admin. Code § 363-116-500<br>PSHSC Plan | Mass. Gen. Laws ch.21M, §§ 1,6<br>314 CMR 19.00 | Cal. Gov't Code § 8670.17.2<br>Cal. Code Regs. 14 CCR §§ 851.1 – 10.1 and 851.20 – 32 | Alaska Admin. Code tit. 18, § 75.027<br>PWS Tanker ODPCP<br>RPG VERP | 46 USC § 3703<br>33 CFR 168 | Pacific Pilotage Authority – Notice to Industry |
| Escort performance criteria | PSHSC – Escorts must be close to be able to timely and effectively respond given ambient sea and weather conditions, escort configuration, maneuvering characteristics of the tanker, emergency connection procedures, surrounding vessel traffic, and other factors that may affect response capability. | No requirement | LA/LB – At the direction of the tank vessel master or pilot, escort shall take action to influence the speed and direction of travel of the tank vessel in the event of a casualty, steering, or propulsion failure.<br>SF - Escorts must maintain a station-keeping distance of no more than 1000 feet ahead or aside, or 500 feet astern of the tank vessel. | Laden tank ships must be operated so the escort vessel is immediately available to assist (Alaska Admin. Code tit. 18, § 75.027(e), 2006).<br>VERP: Laden tank ships cannot exceed effective speed of escort. Speed limits are set for each segment of the transit. | Tugs, acting singly or jointly, must:<br>Tow a tank ship at 4 knots in calm conditions, and hold in steady position in a 45-knot headwind;<br>Hold a tank ship on course against 35° locked rudder at 6 knots; and<br>Turn a tank ship 90° going 6 knots with a free-swinging rudder within the tank ship's turning distance with rudder hard-over. | Escort is capable of safely applying steering and braking forces by a towline at six (6) knots or more. Can safely absorb forces generated at expected escort speeds, when tow is positioned at 90º to the tug centerline without immersing the deck edge. |

| Requirement | Washington | Massachusetts | California | Alaska | U.S. Coast Guard | British Columbia |
|---|---|---|---|---|---|---|
| | Wash. Rev. Code § 88.16.190<br>Wash. Admin. Code § 363-116-500<br>PSHSC Plan | Mass. Gen. Laws ch.21M, §§ 1,6<br>314 CMR 19.00 | Cal. Gov't Code § 8670.17.2<br>Cal. Code Regs. 14 CCR §§ 851.1 – 10.1 and 851.20 – 32 | Alaska Admin. Code tit. 18, § 75.027<br>PWS Tanker ODPCP<br>RPG VERP | 46 USC § 3703<br>33 CFR 168 | Pacific Pilotage Authority – Notice to Industry |
| Escort operation | Ship may not exceed the service speed of the tug or tugs. | No requirement | LA/LB –<br>8 knots maximum speed for tank ships with a DWT less than 60,000 metric tons.<br>6 knots maximum speed for tank ships with a DWT 60,000 metric tons or more.<br>Escorts must be tethered at the stern.<br>SF – Prior to the transit, an Escort Plan or Checklist must be completed and approved, which addresses, at a minimum: route, destination, vessel speed, position of the escort(s) relative to the tank vessel, how an emergency connection would be made, radio communications, and anticipated weather and tides. | Laden tank ships must have a tow line made up and ready to deploy while in state waters (Alaska Admin. Code tit. 18, § 75.027(f), 2006).<br>VERP:<br>Tank ships in ballast:<br>The master coordinates with the PWS VTS and stationed sentinel tugs using appropriate VHF radio frequencies.<br>Speed limit of 12 knots in Valdez Narrows.[71]<br>Safe speed when under ice escort (speed adjusted to provide the best reasonable opportunity for ice spotting consistent with safety).<br>Ladened tank ships:<br>Escorts must stay within ¼ mile of the tank ship. Escorts are tethered in North PWS. In Central PWS, the secondary escort may be a sentinel tug.<br>Hinchinbrook closed to outbound laden tank ships when winds exceed 45 knots or seas 15 feet.<br>Hinchinbrook sentinel tug is underway as a laden tank ship sails 17 miles into Gulf of Alaska. | Escorts must be in a position to timely and effectively respond to a propulsion or steering failure. Ship may not exceed speed at which escorts may be effective.[72] | Escort is tethered by the stern 2 miles north of East Point to Brotchie Ledge (Victoria), and stays with tank ship until Race Rocks.<br>Tank ship speed limit is 10 knots. |

| Requirement | Washington | Massachusetts | California | Alaska | U.S. Coast Guard | British Columbia |
|---|---|---|---|---|---|---|
| | Wash. Rev. Code § 88.16.190<br>Wash. Admin. Code § 363-116-500<br>PSHSC Plan | Mass. Gen. Laws ch.21M, §§ 1,6<br>314 CMR 19.00 | Cal. Gov't Code § 8670.17.2<br>Cal. Code Regs. 14 CCR §§ 851.1 – 10.1 and 851.20 – 32 | Alaska Admin. Code tit. 18, § 75.027<br>PWS Tanker ODPCP<br>RPG VERP | 46 USC § 3703<br>33 CFR 168 | Pacific Pilotage Authority – Notice to Industry |
| Pre-escort conference | No requirement[73] | Escort master shall contact the tank barge tow master to confirm the position of the tank barge, establish the radio frequency to be used, and anticipated direction of movement and destination, and other pertinent information. | LA/LB - Tank vessel master and pilot shall contact escort master(s) to confirm:<br>Number and position of escort(s)<br>Radio frequency<br>Route and destination of the tank vessel<br>Operations in the case of an unplanned event.<br>SF – The pilot or, if no pilot onboard, the tank vessel master shall initiate a pre-escort conference with the escort(s) to plan the transit as specified on the approved Checklist or Escort Plan. | VERP:<br>Provides a checklist for the pilot and tank ship and escort masters to cover in the conference. | Tank ship, pilot and escort master must confer (radio or in person) and at least discuss:<br>Destination, route, planned speed, other vessel traffic, anticipated weather, tide and sea, and other navigational considerations;<br>Communication, towing, steering, and propulsion equipment, and operational status;<br>Preparation, method and manner to make emergency towline connection;<br>Position and reaction time for escorts to assist, including pre-tethering, if appropriate;<br>Other relevant information. | Pilot, ship master and tug master shall discuss planned speed, passage plan, safe working load of hard points, positioning of escorts, VHF frequency for communications, predicted weather and sea conditions, any other relevant information. |

[71] Valdez Narrows and Valdez Arm are closed to traffic with sustained winds over 40 knots.
[72] Ship's speed may not exceed the speed at which an escort can reasonably be expected to safely bring a tank ship under control within navigational limits of the waterway, and given ambient sea and weather conditions, surrounding vessel traffic, hazards, and other factors reducing maneuvering room. Coast Guard's summary states that tank ships may transit at any speed unless prudent seamanship dictates otherwise.
[73] In June 2017, PSHSC adopted a Tanker Escort standard that requires the master of a tank ship required to have an escort to conduct a master-pilot-tug master conference prior to the escort.

Tug escort and pilotage requirements for tank ships are shown on the map below.

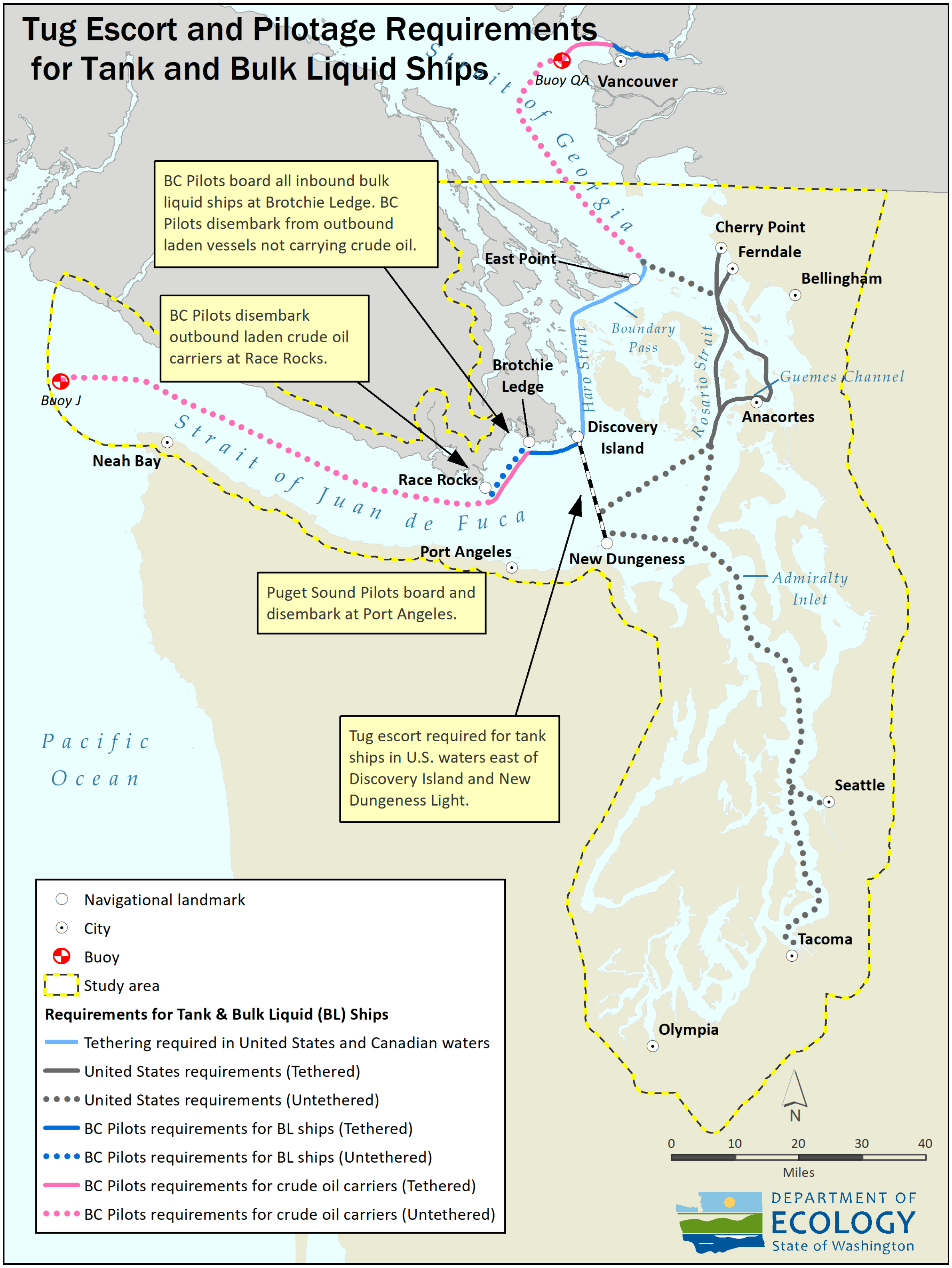



**Figure 40: Tug escort and pilotage requirements for tank and bulk liquid ships**

## Variables to consider in tug escorts for tank vessels

As illustrated in the previous tables, there are a number of variables to consider when deciding between approaches for requiring tug escorts of tank vessels. This section highlights some of those variables:

- Degree of state involvement.
- Type of tank vessel requiring escort.
- Use of zones.
- Speed limits and speed reductions.
- Tethered versus non-tethered tug escort.
- Manning (crewing).

**Degree of state involvement**

Since 1975, Washington's law identifies the waters in which a tank ship must have tug escort(s) when sailing laden, the minimum horse power required for the tug(s), and the expectation that the tank ship will not exceed the escort tug's speed (Wash. Rev. Code §§ 88.16.170-88.16.195, 1990-1994). The law left the selection of the appropriate tug or tugs to the tug company, ship's agent, and pilot. Using the federal requirements as a baseline for staffing and training, companies operating the tugs may determine the best level of staffing and the appropriate training of escort tug crews.

The Puget Sound Harbor Safety Committee (PSHSC) developed more detailed operating standards, "Standards of Care" (SOC), which are documented in the Puget Sound Harbor Safety Plan (PSHSP). Details for the use of escort tugs, such as when tethering is recommended and for which tank ships, the quality of the tow line attachment fittings, escort speeds, master-pilot-tug pre-escort conference, and diversion of the escort tug to other emergency situations are covered within the PSHSP (Puget Sound Harbor Safety Committee, 2017).

California and Massachusetts tug escort requirements are more detailed in regulation. California's regulations for tug escorts of tank vessels, for instance, detail how tug bollard pull will be measured, create an Escort Tug Inspection Program, and specify details of escort tug equipment, minimum escort tug crew size, and crew training requirements (Cal. Code Regs. 14 CCR § 851.23, 2006). Massachusetts requires escort tugs to be certified with the state, and requires the companies providing escort tug services to provide quarterly reports regarding their activities (Massachusetts Department of Environmental Protection, 2017a).

Alaska's tank ship tug escort system for Prince William Sound (PWS) and Valdez Arm is not described in state law, but results from the interplay between the state's Oil Discharge Prevention and Contingency Plan (ODPCP) requirements (Alaska Admin. Code tit. 18, § 75.425, 2017) and federal requirements for tank vessel escorts (33 CFR 168, 1994). Alaska gets input on the ODPCP from the Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) and determines whether the plan, including the tug escort system for tank ships, is adequate.

### Type of tank vessel requiring escort

Washington tug escort requirements apply to tank ships of 40,000 deadweight tons (DWT) not in ballast. Tank ships that meet certain hull, equipment redundancy, and horsepower requirements are exempted from the escort requirement (Wash. Rev. Code §§ 88.16.170-195, 1990).

California's requirements vary by six different harbors/ports within the state, but in general they apply to tank vessels (tank ships, tank barges, ATBs) carrying 5,000 or more tons of oil in bulk as cargo. Like Washington, California exempts tank ships from escort if they meet certain hull and equipment redundancy requirements (Cal. Code Regs. 14 CCR § 851, 2012).

Massachusetts's requirements for tug escorts are applicable to tank vessels, except self-propelled tank vessels, and the threshold for applicability of their requirement is the carriage of 6,000 or more bbls (252,000 gallons) of oil as cargo (Massachusetts Department of Environmental Protection, 2017a; Mass. Gen. Laws ch. 21M §§ 1,6 (2017); 314 CMR 19.00, 2010).

Alaska's system contains escort requirements for tank ships whether laden or in ballast, but the requirements differ based on their lading status (Response Planning Group, 2017).[74]

### Use of zones

Washington's law specifies that all laden tank vessels of a certain size have a tug escort when they operate east of a line crossing the Strait of Juan de Fuca from Dungeness Light to Discovery Island Light (British Columbia) (Wash. Rev. Code §§ 88.16.170-195, 1990-1994). Rosario Strait, Haro Strait, Boundary Pass, and other areas of concern require a tethered tug escort under the PSHSP SOC (Puget Sound Harbor Safety Committee, 2017). Rosario Strait has a tank ship speed limit under the SOC (Puget Sound Harbor Safety Committee, 2017). Traffic restrictions for certain vessels under federal regulation restrict crossing, meeting, and overtaking situations in Rosario Strait (33 CFR § 161.55, 2017).

Massachusetts sets "areas of special interest" which include Buzzards Bay, Cape Cod Canal, Mount Hope Bay, and Vineyard Sound (Mass. Gen. Laws ch. 21M §§ 1,6 (2017); 314 CMR 19.00, 2010). Like Washington, these areas largely delineate the area where the escort requirements apply.

California has separate regulations for six different harbors/ports within the state including San Francisco Bay. San Francisco Bay, in contrast to Puget Sound, is divided in regulation into six different escort zones. Requirements for a tug escort, escort tug braking force, escort tug equipment, escort tug stationing, and speed limits for the tank ship under escort vary by zone (Cal. Code Regs. 14 CCR §§ 851.1-851.10.1, 2006).

Alaska's PWS Tanker ODPCP, Section 2.1.6, describes the overall tug escort system. Under the PWS Ship Escort Response Vessel System (SERVS), laden tank ships may be escorted by one or two tugs, tethered to an escort tug, and/or have a sentinel escort vessel standing by, depending which of four separate zones the vessel is transiting (Response Planning Group, 2017).

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[74] *In ballast* is defined as having the lesser of 0.5 percent of maximum cargo capacity aboard or 3,000 barrels (126,000 gallons) aboard (Response Planning Group, 2017).

**Speed limits and speed reductions**

There are three clear advantages to reducing vessel speeds in certain waterways of the Salish Sea.

The first is vessel safety. A 2014 study of Puget Sound traffic concluded the following:

> Employing a simple, voluntary speed reduction program in Haro Strait, Boundary Pass, and Rosario Strait would allow additional time for pilots and/or masters to assess navigational situations and conditions, and to take countering action to prevent an incident, or reduce the impact of a casualty, if encountered. It would also reduce the stopping time/distance of a ship in the event of a propulsion or steering system failure, and allow additional time for assistance to arrive. Reducing vessel speed would also give ships' bridge teams more time to develop situational awareness. For these reasons, voluntary speed reduction is considered to be a highly effective management practice, second only to having a dedicated escort tug for the duration of the inbound or outbound transit from Port Angeles. (Kirtley, 2014, p.29)

The second advantage to slowing vessel speed are the potential benefits to the Southern Resident Killer Whale (SRKW) population in the Salish Sea. Noise pollution from vessel traffic can disturb SRKWs and displace them from their preferred areas. Slowing vessels transiting Puget Sound can reduce noise. Studies have shown that vessels operating at moderate or high speeds emit disproportionately louder noises, which have greater potential masking effects for echolocation (Houghton et al., 2015 and citations therein). One recent study cited anthropogenic marine noise as the second-largest negative influence on the annual growth rates of Southern Resident Killer Whale (SRKW) populations (Lacy et al., 2017). A slower speed was shown by a 2017 Vancouver Fraser Port Authority Enhancing Cetacean Habitat and Observation Program (ECHO) study to benefit the local orca whales by reducing the amount of underwater noise made by the vessel's propulsion (Vancouver Fraser Port Authority, 2018). In addition, faster vessel speeds increase the risk of collisions with vessels and orca fatalities. One part of the ECHO program asks shipping companies to voluntarily slow their vessels when the Southern Resident Killer Whales (SRKWs) are present in Haro Strait (Port of Vancouver, n.d.-e). However, it should also be noted that ships traveling at slower speeds will be in the area longer, potentially decreasing the length of quiet intervals between ship movements. These quiet intervals may be advantageous for orca communication and foraging.

The third advantage is limiting air pollution from ships. As an example, California's Air Resources Board measured the reduction in carbon dioxide and nitrogen oxides emission as vessel speed was reduced from cruising speed to 15 knots or below. Vessel speed reduction to 12 knots yielded reduction of 61 percent carbon dioxide and 56 percent nitrogen oxides (Miller et al., 2012).

Washington code addresses vessel speed limits by requiring tank ships not exceed the service speed of their escort tugs (Wash. Rev. Code § 88.16.195, 1990). The PSHSP refines this so that the tank ship must remain at a speed "…such that the escort(s) can reasonably expected to bring the tank vessel under control within the navigational limits of the waterway" (i.e. before running aground). In addition, tank ships transiting Rosario Strait should not exceed 10 knots (Puget Sound Harbor Safety Committee, 2017, p.104).

However, neither the Revised Code of Washington nor the PSHSP SOC address speed limits for cargo and passenger vessels, towed oil barges, or ATBs. Vessel speed is predominantly addressed at the Federal level (33 CFR 161, 1994; 33 CFR 165, 1982).

Some states do set specific speed limits for vessels while under tug escort. Alaska's system for PWS specifies six different maximum speeds along the route between Hinchinbrook Entrance and Port Valdez, the lowest speed being 6 knots for the transit through Valdez Narrows (Response Planning Group, 2017). California requires that the tank ship speed differ by area and zone within the area. For San Francisco Bay, tank ships are limited to 10 knots in four of the zones, and 8 knots in two of the zones. Tank barges are limited to 8 knots for their entire transit (Cal. Code Regs. 14 CCR §§ 851.1-851.10.1, 2006). Massachusetts's requirements do not incorporate speed limits in their escort regulations.

**Tethered versus non-tethered tug escort**

Washington requires escort tugs for tank ships not in ballast, but does not specify that they be tethered to the tank ship they are escorting (Wash. Rev. Code §§ 88.16.170-195, 1990-1994). Instead, tethering is suggested by the Tanker Escort SOC within the PSHSP. Six locations have been specified as areas where the tug escort should be tethered to the laden tank ship, including Rosario and Haro Straits, and Boundary Pass (Puget Sound Harbor Safety Committee, 2017). Laden tank ships going to or from a port in Canada under the guidance of British Columbia Coast Pilots are also required to be tethered when transiting Haro Strait and Boundary Pass.

On the Columbia River, a water body Washington shares with Oregon, tank ships and ATBs are unescorted.[75] However, the Lower Columbia Region Harbor Safety Plan specifies that, for towed tank barges:

> Tail/tag boats should be used for transit both inbound and outbound when:
>
> - The tow is a loaded oil barge of more than 25,000 barrels (1,050,000 gallons) capacity being towed astern. A loaded barge is defined as a barge carrying cargo of more than 25 percent of its cargo-carrying capacity….
>
> …Towing vessel masters and/or their respective operating companies should develop procedures to be followed for determining the necessity of tail/tag boats and how the tail/tag boat is to be used during the transit. The tag/tail boat should be of sufficient size, configuration, and horsepower to keep the towed barge behind the tugboat when full underway…Barges carrying oil should not be towed in tandem so that if the tow wire parts, the tug is free to recover the barge. (Lower Columbia Region Harbor Safety Committee, 2017, pp. 3-4)

A tail/tag boat is defined as "typically a smaller tug boat attached to the stern of an oil barge. The tag tug assists with steering the barge" (Washington State Department of Ecology, 2017b, p. 73).

[75] Ecology recommended that tethered escorts for tank ships be implemented should tank ship traffic on the Columbia River increase with any expanded oil facility capacity (Washington State Department of Ecology, 2017b).

Alaska's system calls for tethering of the primary escort vessel to a laden tank ship in Port Valdez, Valdez Narrows, and Valdez Arm — areas where the waterway leading to/from the Valdez oil terminal narrows substantially (Response Planning Group, 2017).

California and Massachusetts do not require an escort tug to be tethered to the tank vessels they are escorting.

**Manning (crewing)**

*Crewing of escort tugs*

The U.S. Coast Guard regulates crewing requirements of the tugs used in escort duty under 46 CFR 15 requirements (2009). The three companies in Washington currently providing escort services to tank ships are subject to these requirements. They are Foss Maritime, Crowley Maritime, and Starlight Marine Services (part of Harley Marine Services). The Tanker Escort SOC encourages pilots, tank ship companies, and tug companies to train on four escort maneuvers (hook-up, retard, assist, and oppose maneuvers) on a five-year refresher basis.

California's regulations requiring escort tugs of tank vessels provides detailed requirements for the minimum number of crew, their credentials, their maximum work hours, and training. In addition, escort tug operators are required to document compliance with these requirements and make them available to state regulators for review (Cal. Code Regs. 14 CCR §§ 851.1-851.10.1, 2006).

Massachusetts regulations specify that all escort tugs have crew that are certified on federal laws, and do not have duties that interfere with their ability to respond to an emergency during an escort operation (Mass. Gen. Laws ch. 21M §§ 1,6 (2017); 314 CMR 19.00, 2010).

Alaska's ODPCP for PWS specifies that escort tug crews receive certain training, practice towing exercises, and be subject to a substance abuse and medical monitoring program (Response Planning Group, 2017).

*Crewing of escorted vessel*

Crewing of escorted vessels is under the full purview of the federal government through the U.S. Coast Guard. Crewing requirements are addressed in federal law at 46 CFR Part M. For this reason, states do not actively regulate crewing of vessels in general.

Changes to crewing levels on ATBs and tugs towing tank barges (e.g., requiring an additional person in the wheelhouse of a towing vessel) have been discussed as a potential way to reduce human error and decrease the likelihood of accidents. The 2010 Vessel Traffic Risk Assessment (VTRA) found a 2 percent to 4 percent reduction in potential oil losses across the VTRA study area from measures that modeled the effects of reducing human error by 50 percent and 100 percent on tugs towing tank barges (Van Dorp & Merrick, 2014). Finally, tug escort companies are strongly encouraged to have one other crew member in addition to the boat operator on the bridge of the escorting tug during escorts (Puget Sound Harbor Safety Committee, 2017).

## The effectiveness of escort tugs in reducing the risk of oil spills

### How tug escorts mitigate risk

Tug escorts "improve spill prevention by assigning one or more tugs to accompany certain ships through high-risk areas...the tugs can provide immediate assistance in the event of a steering or propulsion failure or navigational error, both of which may prevent a spill from occurring" (Nuka Research & Planning Group, LLC, 2013 p. 20).

In addition, tug escorts mitigate risk by providing "scout" and "auxiliary bridge" functions. These later functions have been described as follows:

> As a scout, tug escorts provide redundant lookout and situation awareness functions to those provided on the tanker bridge, as well as physically distributed (from the tanker's bridge) perspectives on situational awareness, hazard avoidance and vessel positioning. In addition, tug escorts also serve as auxiliary bridges to the tanker bridge, providing redundant vessel positioning, situation awareness, hazard identification, and emergency response capabilities, as well as redundant bridge equipment to the tanker bridge. These are important roles and functions provided by the current tug escort system (Gray and Hutchison, 2004, pp.9-8 and 9-9).

When alternatives to tug escorts are considered, the potential loss of these important secondary functions must be considered in the whole risk reduction picture.

### Overview of oil spill risk analysis

A discussion of how effective escort tugs could be in reducing oil spills begins with an understanding of the nature of oil spill risk. Risk is a measure of the probability of an event and its potential consequence. Oil spills from tank vessels are relatively rare events that have had substantial consequences on the environment and society. As discussed in Chapter 5, the number of large oil spills and the volume of oil spilled from tank vessels has decreased since the 1970s, both globally and nationally. The decrease in oil spills over time indicates prevention measures (e.g. changes to international standards and regulations, the introduction of double hulls, improved operating practices) have had a positive effect in reducing the number of spills.

Estimating the risk of future events based on historical data of rare events is a complex process. A variety of qualitative and quantitative techniques may be used, based on the context of the study and the availability of resources, including data (Det Norske Veritas, 2002). Quantitative risk assessment methods include fault tree analysis, which looks at the underlying causes of incidents, and simulation, which models the behavior of a system (Det Norske Veritas, 2002).

Several studies have examined tank vessel oil spill risk in the Salish Sea. The variety of methods used for risk analysis, and the different contexts under which analysis was performed makes it challenging to compare results across studies. All of the studies reviewed for this report, however, support the conclusion that large oil spills from tank vessels are expected to be rare events. Chapter 5 provides an overview of incident rates for tank barges and ATBs. Tank vessel oil spill risks are discussed below.

To measure the consequence of an oil spill, the risk studies reviewed for this report either predicted the likelihood that oil would be released to the environment (Kirtley, 2014) or the likelihood of a release of a certain amount of oil, or both (Van Dorp & Merrick, 2016). None of the studies reviewed for this report provided an analysis of consequences of an oil spill in a specific environment, nor a model that would capture the impacts on water-dependent commerce, property values or use, recreational activities, aesthetics, and other potential oil spill impacts.

**Limitations of quantitative models**

All quantitative assessment projects face choices in the selection of data and models. The data and models used for an assessment will introduce some amount of uncertainty into the results. As described in an American Bureau of Shipping (ABS) guidance document for risk assessments for the marine and offshore oil and gas industries:

> *Model uncertainty*
>
> The models used in both the overall decision-making framework and in specific analyses that support decision making (e.g., risk analyses) will never be perfect. The level of detail in models and defined scope limitations will determine how accurately the model reflects reality. Often, relatively simple models focusing on the issues that the stakeholders agree to be most important suffice for decision making. Even if the data were perfect, the model used would generally introduce some uncertainty into the results.
>
> *Data uncertainty*
>
> Data uncertainty is an issue that raises much concern during decision making and can arise from any or all of the following:
>
> i. The data needed does not exist.
> ii. The analysts do not know where to collect or do not have the resources to collect the needed data.
> iii. The quality of the data is suspect (generally because of the methods used to catalog the data).
> iv. The data have significant natural variability, making use of the data complex.
>
> Although steps can be taken to minimize uncertainty in data, all measurements (i.e., data) have uncertainty associated with them. (American Bureau of Shipping, 2000, p.63)

Known areas of uncertainty are included in the descriptions of risk assessments below. Other areas of uncertainty may exist, and different participants in these assessments or readers of the assessment reports may have different views on the level of uncertainty introduced by the data and models used. Ecology's conclusions and recommendations were based on a consideration of all of the assessments, not solely on one model or data set.

**Tank vessel risk assessments**

*Study of tug escorts in Puget Sound*

In a 2003 report, the ABS quantitatively modeled risk for tank ships (Cross & Ballesio, 2003). Their model provided consequence frequency estimates for single engine room tank ships.[76] The two leading consequences of engine room failures were loss of propulsion and loss of steering. ABS estimated that a loss of propulsion could be expected on any given tank ship every two years, and a loss of steering could be expected in a 30 year period. These two types of incidents may result in powered[77] or drift vessel groundings, which ABS estimated to be the second and third most frequent events resulting in environmental damage (behind collisions) (Cross & Ballesio, 2003).

The ABS model data was combined with other studies addressing incident rates to derive, based on a six-hour transit, an average single propulsion/steering system tank ship per-transit loss of propulsion and loss of steering rate of $5.8 \times 10^{-04}$ and $2.3 \times 10^{-04}$ respectively (Gray & Hutchison, 2004). This implies such a tank ship could be expected to experience a loss of propulsion about every 1,700 transits, or a loss of steering every 4,300 transits. Per-transit rates for similar tank ships based on Puget Sound data over an eight year period were $4.8 \times 10^{-04}$ and $3.6 \times 10^{-04}$ for loss of propulsion and loss of steering respectively. However, Gray and Hutchison cautioned that the uncertainty in this Puget Sound data was large (2004).[78]

*2010 and 2015 Vessel Traffic Risk Assessment*

Additional modeling work was done in 2014 by George Washington University (GWU) and Virginia Commonwealth University (VCU) to update a 2005 VTRA model with 2010 vessel traffic data. The 2010 VTRA focused on the Strait of Juan de Fuca, Puget Sound, and the lower Strait of Georgia (jointly, the Salish Sea).

The 2010 VTRA represented the chain of events that could potentially lead to an oil spill. As shown in Figure 41, the causal sequence of events employed in the 2010 VTRA combined simulations, data, expert judgment, and models to evaluate potential changes in risk. The flowchart shows that situations can lead to incidents, incidents can lead to accidents, and accidents can lead to oil spills. The figure shows how each element in the flowchart is evaluated in the 2015 VTRA. Situations are evaluated using maritime simulation. The likelihood of incidents is developed using historical incident data. Accidents are evaluated based on historical accident data plus expert judgment collected during previous VTRA studies. Oil outflow is determined using an oil outflow model.

The figure also shows examples of risk management questions, which can be assessed through the VTRA collaborative analysis process. Risk management questions consist of potential risk

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[76] Specifically, "intermediate consequences" including loss of propulsion, loss of steering, fire initiation, etc.

[77] "…defined in escort discussions as a grounding (or allision) that occurs before the initial momentum of the ship has run out" (Gray, 2001).

[78] See Section 10.1.5 of Gray & Hutchinson's *Study of Tug Escorts in Puget Sound* (2004) for a full discussion of uncertainty and biases in incident rate probabilities. Sources of uncertainty cited in the report include a wide scatter in the estimates for failure rates; the use of equipment availability studies from design studies (as opposed to risk analysis studies for oil spills in the Puget Sound); and the use of historical data, which have several potential sources of uncertainty and bias.

reduction strategies, which act at different points of the causal flowchart. Three example risk management questions are shown in the figure. Traffic rule changes may interrupt the causal relationship between situations and incidents, enhanced escort requirements may interrupt the causal relationship between incidents and accidents, and double hull requirements may interrupt the causal relationship between accidents and oil spills.

The 2010 VTRA models vessels underway in the study area. A variety of situations occur, such as vessels meeting one another, and vessels transiting to their destination along traffic separation schemes and navigational channels. While vessels are underway, there is a chance that an incident could occur (e.g., mechanical failure, human error). Incidents could then result in accidents (e.g., collision, allision, grounding), which might lead to an oil spill (Van Dorp & Merrick, 2014). The modeling used vessel incident rates from the 2005 study to extrapolate the potential average number of incidents per year for tank ships, ATBs, and tank barges (Van Dorp & Merrick, 2014). It is important to note that not all incidents lead to accidents, and not all accidents result in oil spills.

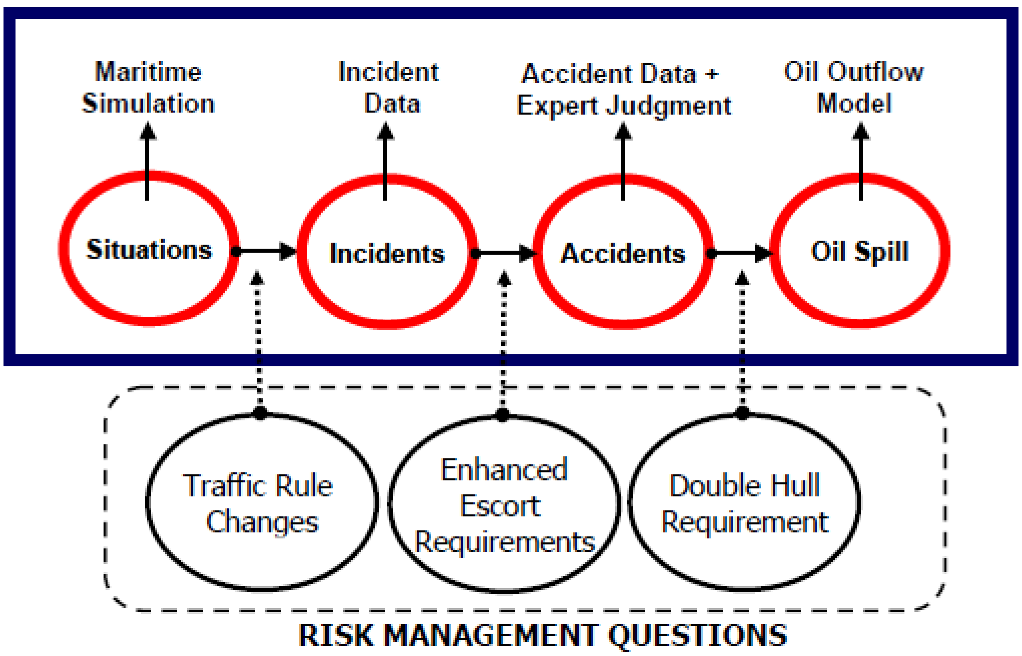


**Figure 41: Causal chain of events employed in the 2010 VTRA (Van Dorp & Merrick, 2014, p. 30).**

Building on the 2005 analysis, towed tank barges and ATBs in the 2010 VTRA were projected to experience potential incidents at a rate of $1x10^{-03}$ incidents per moving hour. Tank ships had a potential incident rate of $4x10^{-03}$ incidents per moving hour. The study authors applied the per hour potential incident rates to the 2010 vessel traffic data to estimate potential average numbers of vessel incidents per year. Approximately 25 tank barge potential incidents per year, 50 tank ship potential incidents per year, and 10 ATB potential incidents per year were projected for the study area (Van Dorp & Merrick, 2014). As described above, not all potential incidents in the model led to potential accidents.

The 2010 VTRA modeled four types of accidents: collisions, allisions, powered groundings, and drift groundings. Other types of oil spill incidents (e.g., errors during fueling or cargo transfer) were not modeled. Using a simulation of vessel traffic in the study area and the potential incident rates, the study estimated the total annual potential average number of accidents for the study area to be approximately 1.5 for tank barges, 0.4 for tank ships, and less than 0.2 for ATBs (Van Dorp & Merrick, 2014, p.83). Potential accident results are not predictions of the number of accidents that will occur; rather the numbers show the relative propensity for one type of accident versus another (Van Dorp & Merrick, 2014, p. 79). Potential oil losses were modeled using scenarios developed by the Marine Board of the National Academies Transportation Research Board (Van Dorp & Merrick, 2014).

In addition, the 2010 VTRA study measured the time oil spent within the study area, and the geographic distribution of oil, whether carried as cargo or as fuel. Oil carried on tank ships, tank barges, and ATBs comprised about 72 percent of the "oil time of exposure" (individually about 48, 21, and 3 percent respectively) (Van Dorp & Merrick, 2014). The remaining 28 percent of oil time of exposure was from other vessel types (Van Dorp & Merrick, 2014). This indicates that tank vessels present most of the exposure of oil to the potential of spillage as the result of an accident while transiting the Salish Sea—in other words, those vessels carrying oil as cargo have the most oil available to spill in the event of an accident.

In 2015, GWU/VCU updated the 2010 VTRA model. As described in the 2015 VTRA final report:

> The purpose of this vessel traffic risk assessment (VTRA) is to evaluate the combined potential changes in risk in light of a number of potential maritime terminal developments in various stages of their permitting processes potentially coming to fruition, and to inform the State of Washington, the United States Coast Guard, the Puget Sound Harbor Safety Committee, tribes, local governments, industry, non-profit groups in Washington State and British Columbia and other stakeholders in this maritime community of these potential changes in risk. The combined evaluated risk changes serves as an information source to these tribes and stakeholders to assist them as to what actions could be taken to mitigate potential increases in oil spill risk from large commercial vessels in the VTRA Study Area, should all or some of these terminal projects come to fruition. However, this study was not designed to measure the effectiveness of risk mitigation measures already in place (Van Dorp & Merrick, 2016, p. 1).

The update incorporated vessel traffic from 2015 and recalibrated potential accident rates to include additional data from 1990 – 2015, including accidents that occurred in Canadian waters within the VTRA study area (Van Dorp & Merrick, 2016). Potential accident rates were developed for tank "focus vessels" (tank ships and ATBs) and for tank barges, for different types of accidents (e.g., allision, grounding, and collision), for two oil spill size categories. Spill sizes were described as the potential amount of oil that could result from the accident in cubic meters ($m^3$). The study assumed one cubic meter represented approximately 264 gallons (Van Dorp & Merrick, 2016). The two spill sizes used for accident calibration were 0 to $1m^3$ (0-264 gallons) and $1m^3$ or more (264 gallons or more).

For accidents resulting in a potential oil spill with a size of 0 to 264 gallons, tank ships had an accident rate of 0.238 allisions per year, 0.056 groundings per year, and 0.048 collisions per year, for a total accident rate of 0.341 accidents per year. The calibrated accident rates for tank barges were 0.533 allisions per year, 0.067 groundings per year, and 0.400 collisions per year, for a total of 1.000 accident per year. Note these accident rates are lower than the 2010 model, due to the inclusion of more years of data with a small number of accidents, and 12 years of data from Canada during which there were no tank focus vessel or tank barge accidents (Van Dorp & Merrick, 2016).

A single accident rate of 0.08 accidents per year was provided for spills of 264 gallons or more for all types of focus vessels. The combined accident rate for spills of 0 to 264 gallons for all types of focus vessels was 4.31 accidents per year. Comparing the combined accident rates, spills resulting in an oil spill of 264 gallons or more represent 1.8 percent of the total. Spills resulting in an oil spill of 0 to 264 gallons were 98.2 percent of the total. Model results for the 2015 base case were calibrated to reflect these percentages: Approximately 98.2 percent of accidents in the 2015 VTRA model resulted in a spill of 0 to 264 gallons, and approximately 1.8 percent resulted in a spill of 264 gallons or more (Van Dorp & Merrick, 2016).

Potential oil losses in the 2015 VTRA are presented for four spill size categories: 0-1m$^3$ (0-264 gallons), 1-1,000m$^3$ (264-264,000 gallons), 1,000-2,500m$^3$ (264,000-660,000 gallons), and 2,500m$^3$ (660,000 gallons) and more. Combining the accident frequencies and the potential oil loss results allows the reader to observe changes in the likelihood and consequence of oil spills between the VTRA scenarios.

For the 2015 base case, approximately 98.2 percent of the accidents were in the 0 to 264 gallons size category, while potential oil losses were 0.5 percent of the total. The average spill size in this category was 2.64 gallons. Approximately 1.8 percent of accidents were in the 264 to 264,000 gallons size category, representing 45.3 percent of potential oil losses with an average spill size of 12,382 gallons. 0.01 percent of accidents were in the 264,000 to 660,000 gallons category, comprising 12.3 percent of potential oil losses with an average spill size of 427,416 gallons. The 660,000 gallon and more category also accrued 0.01 percent of the total number of accidents, and 42 percent of potential oil losses. The average spill size in this category was 1.79M gallons (Van Dorp & Merrick, 2016).[79]

The primary "what-if" case modeled in the 2015 VTRA added 1,600 vessels to the base case traffic. Potential accidents and potential oil losses are reported as percentages of the base case results. Numbers greater than 100 percent indicate an increase above the base case number of accidents or amount of oil spilled. In the 1,600 vessel what-if case, 108.9 percent (of potential base case accidents) were in the 0-1m$^3$ (0-264 gallons) size category, with 0.5 percent of potential oil losses. The average spill size was 0.01m$^3$ (2.64 gallons). The 1-1,000m$^3$ (264-264,000 gallons) spill size category had 1.9 percent of potential accidents and 72.8 percent of potential oil losses, with an average spill size of 69.2m$^3$ (18,269 gallons). 0.02 percent of potential accidents occurred in the 1,000-2,500m$^3$ (264,000-660,000 gallons) category, representing 20 percent of potential oil losses. The average spill size was 1,693m$^3$ (446,952 gallons). In the 2,500m$^3$ (660,000 gallons) and more category, 0.03 percent of potential accidents

[79] Accident percentages total to more than 100 percent due to rounding in the 2015 VTRA report.

resulted in 91.1 percent of potential oil losses with an average spill size of 5,413m$^3$ (1.43M gallons) (Van Dorp & Merrick, 2016).

The 2015 VTRA also showed geographic differences in the distribution of risk, and provided estimated probabilities of at least one accident potentially occurring within a 10-year period for the four spill size categories. Geographic differences in risk were described using 15 waterway zones, as shown in Figure 42. The waterway zones are further described in Appendix C.

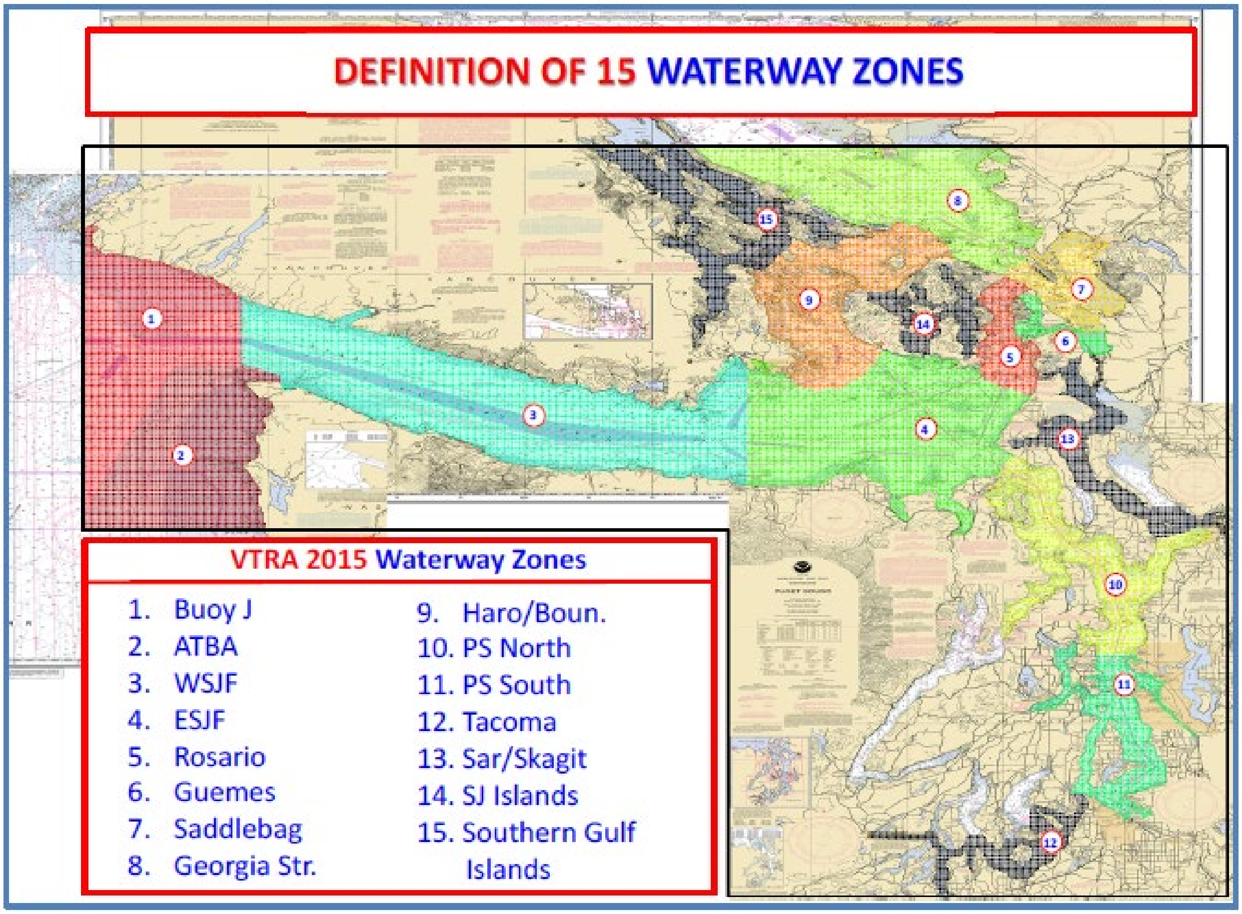


**Figure 42: Definition of waterway zones in the 2015 VTRA (Van Dorp & Merrick, 2016, p. 3)**

Geographic changes in risk between the 2015 base case and the primary "what-if" case are shown in Figure 43. Changes in potential oil loss and potential accident frequency are shown in both absolute and relative risk metrics. As described in the 2015 VTRA report:

> Similar to making a by-waterway-zone comparison in terms of overall POTENTIAL Oil Loss, such by-waterway-zone comparisons can also be made within a POTENTIAL Oil Loss Category. In the VTRA 2015 study those by-waterway-zone comparisons are made in terms of what is called an absolute risk metric not utilized in the prior VTRA 2005 and VTRA 2010 studies, specifically *the estimated probability of one or more accidents potentially occurring over a 10-year period per potential oil loss category*. The evaluation of these probability risk metrics is also a distinguishing feature of the VTRA 2015 study compared to the VTRA 2010 and VTRA 2005 studies. These probability risk

metrics relate directly to their evaluated POTENTIAL accident frequencies and the length of the time period over which these probabilities are estimated.[80] Both the probability of at least one accident per a period of time, on the one hand, and the POTENTIAL accident frequency per year, on the other hand, are considered absolute risk metrics. That being said, the evaluation of the probability risk metrics demonstrate through the wording "probability" that however small the POTENTIAL accident frequency may be for a particular POTENTIAL Oil Loss category, nonzero probabilities evaluated using the VTRA 2015 Model supports that the occurrence of these POTENTIAL events evaluated is not impossible and could in fact happen, however unlikely. The communication of such probability metrics per a specified period of time is advocated in [26].[81] As stated earlier, however, the VTRA 2015 Study concentrates more on relative comparisons between risk metrics evaluated for the five What-If scenarios and the Base Case 2015 Scenario and less on the absolute values of their respective analysis results. (Van Dorp & Merrick, 2016, p. 17) [Emphasis in original]

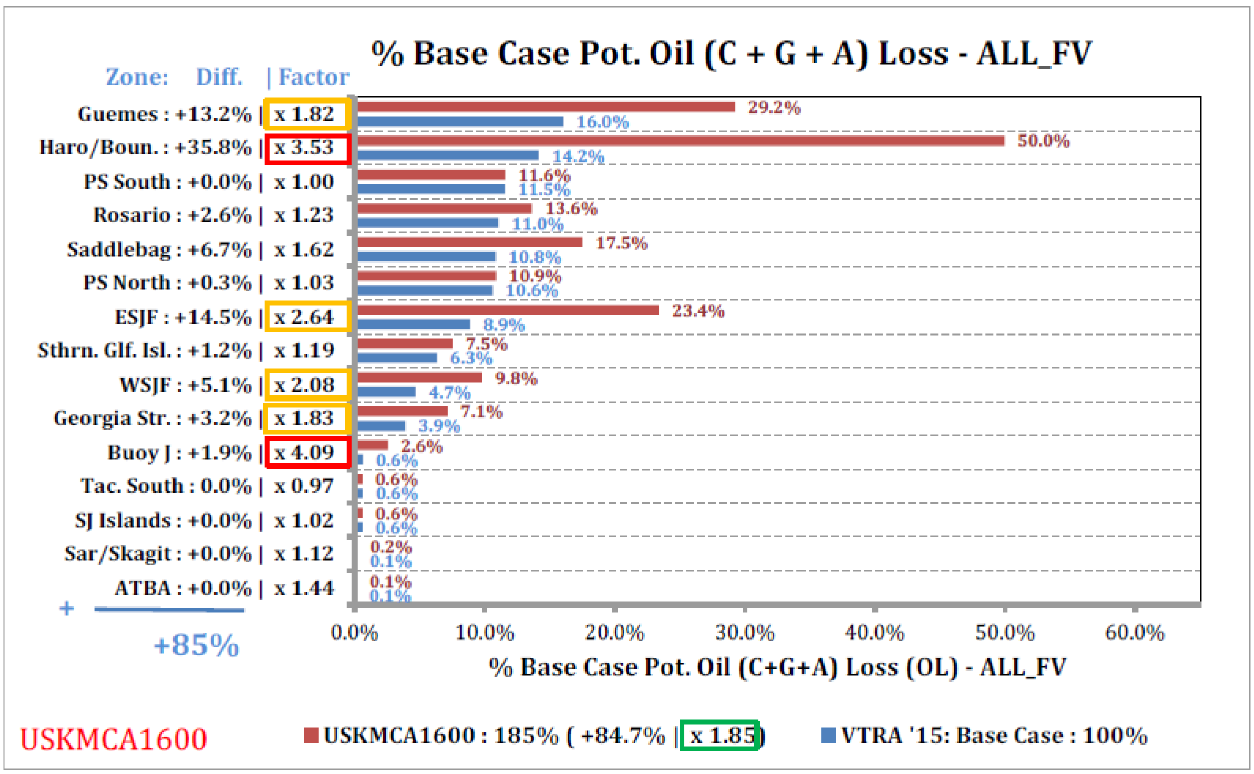


**Figure 43: Relative comparison of potential oil loss by waterway zone in the 2015 VTRA. Blue bars show the percentage of potential oil loss for the base case. Red bars show the percentage of oil loss for the primary "what-if" case, in terms of base case percentages. Absolute differences and relative multipliers in potential oil loss between the base case and the "what-if" case are shown**

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[80] These estimated probabilities $\hat{p}$ have a direct relationship $\hat{p}(\hat{f}|t) = 1 - e^{-\hat{f} \times t}$ to their estimated annual POTENTIAL accident frequencies $\hat{f}$, where $t$ equals the length of the time period. Thus $\hat{p}(\hat{f}|t)$ increases when the length of the time period $t$ increases and for a large enough POTENTIAL accident frequency $\hat{f}$ and a long enough time period $t$, $\hat{p}(\hat{f}|t)$ can mathematically attain an estimated value of 1 (Van Dorp & Merrick, 2016).

[81] Kousky & Kunreuther (2009).

**for each waterway zone on the y-axis. The figure shows an overall increase in potential oil loss of 85 percent for the "what-if" case, compared to the base case. (Van Dorp & Merrick, 2016, p. 128)**

After reviewing the what-if case model results, the 2015 VTRA workgroup, Ecology, and the principal investigators defined potential risk mitigation measures, which were organized into portfolios, or combinations of multiple measures. These include:

- Improvements to international and federal standards and practices for vessel safety and vessel traffic management that are in the process of being implemented.[82]
- Rescue tug(s) for Haro Strait and Boundary Pass, stationed in Sidney, BC.
- Tug escort for ATBs and towed oil barges in Puget Sound.
- Removal of the current size restriction (125,000 DWT) on oil tankers in Puget Sound.
- Escort of outbound tankers from Kinder Morgan's Westridge Marine Terminal to the Pacific Ocean.

The 2015 VTRA report provides detailed modeling results for individual risk mitigation measures and combinations of measures. Figure 44 provides an example of modeling results for the combined portfolio of the five risk mitigation measures described above.

[82] Due to the challenges of modeling the effects of regulatory changes, operational practices, and human behavior, analysis results for this risk reduction measure should be considered a "maximum benefit" evaluation. This is different than the results for the other risk mitigation measures, which were modeled with more conservative assumptions.

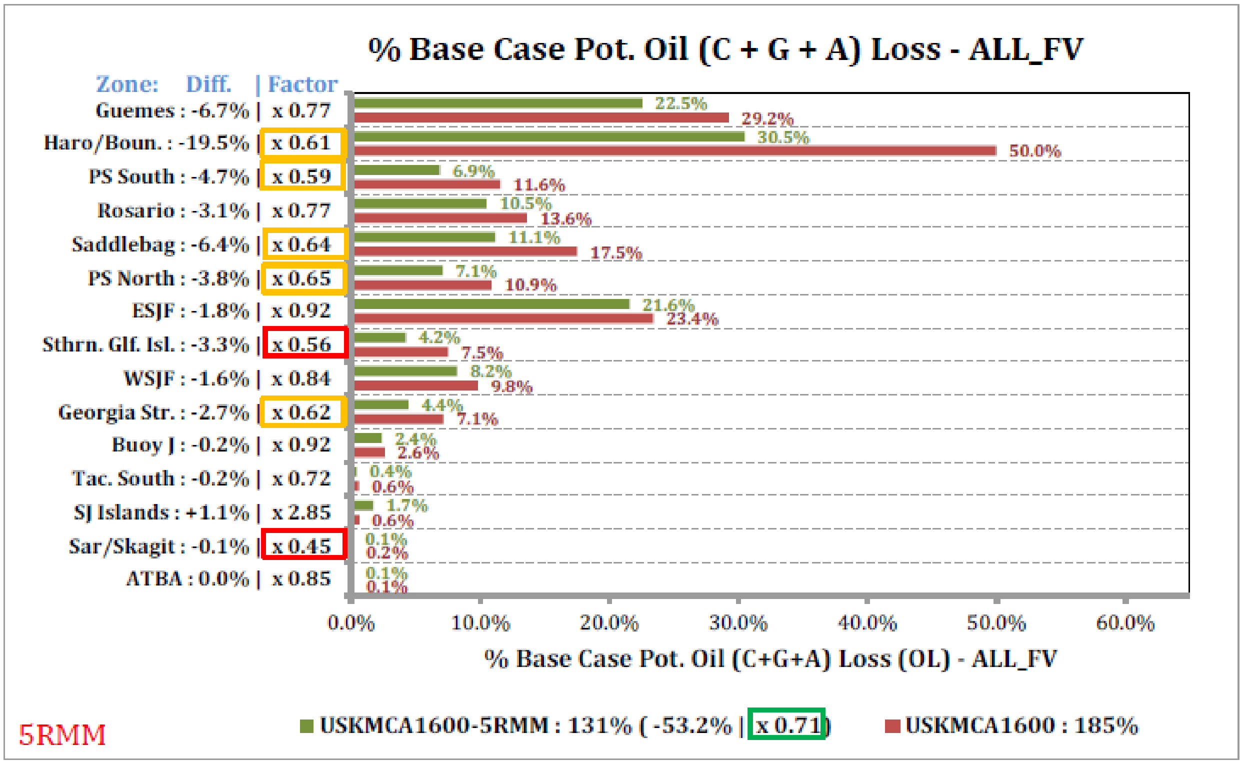


**Figure 44: Relative comparison of changes in potential oil loss for the 2015 VTRA primary "what-if" case with 5 potential risk reduction measures implemented (green bars) and the primary "what-if" case without risk reduction measures (red bars), expressed as percentages of base case potential oil loss. Absolute changes in potential oil loss, and relative multipliers are provided for each waterway zone in the y-axis. (Van Dorp & Merrick, 2016, p. 162)**

Additional discussion of 2015 VTRA results for tug escorts is described in the Tug Escort Effectiveness section of this chapter. A discussion of 2015 VTRA results for potential emergency response towing vessel (ERTV) stations is provided in Chapter 11.

### Tug escort effectiveness in mitigating tank vessel risk

*Glosten Pacific Terminal Vessel Traffic Risk Assessment*

A 2014 study of a planned coal terminal near Ferndale, Washington that would have substantially increased the number of large bulk carriers entering Washington waters, considered what risk reduction methods could be applied to these vessels. The authors concluded the following:

> Glosten believes mandatory tug escort is the most effective alternative management scheme because the tug is dedicated to a particular vessel for the duration of the inbound or outbound transit, essentially acting as a completely redundant power plant. The tug stays in close proximity to the ship and is able to provide assistance in the ways described above almost immediately. This is the only management scheme that enables the immediate application of braking power in the event of a loss of propulsion or other condition that renders the ship unable to maneuver (Kirtley, 2014, p. 29).

*2015 Vessel Traffic Risk Assessment*

The 2015 VTRA included modeling of a potential risk reduction measure that applied an untethered tug escort to all ATBs and towed tank barges operating east of Port Angeles (Van Dorp & Merrick, 2016). This potential risk reduction measure resulted in a decrease in potential oil loss of 3 percent, and an approximately 15 percent reduction in potential accident frequency, when compared to a scenario that added 1,600 vessels to the 2015 vessel traffic base case (Van Dorp & Merrick, 2016). The greatest decreases in potential oil losses were in the Rosario and the Saratoga/Skagit waterway zones. The greatest reductions in potential accident frequency were in the Puget Sound South and Guemes waterway zones (see Figure 42).

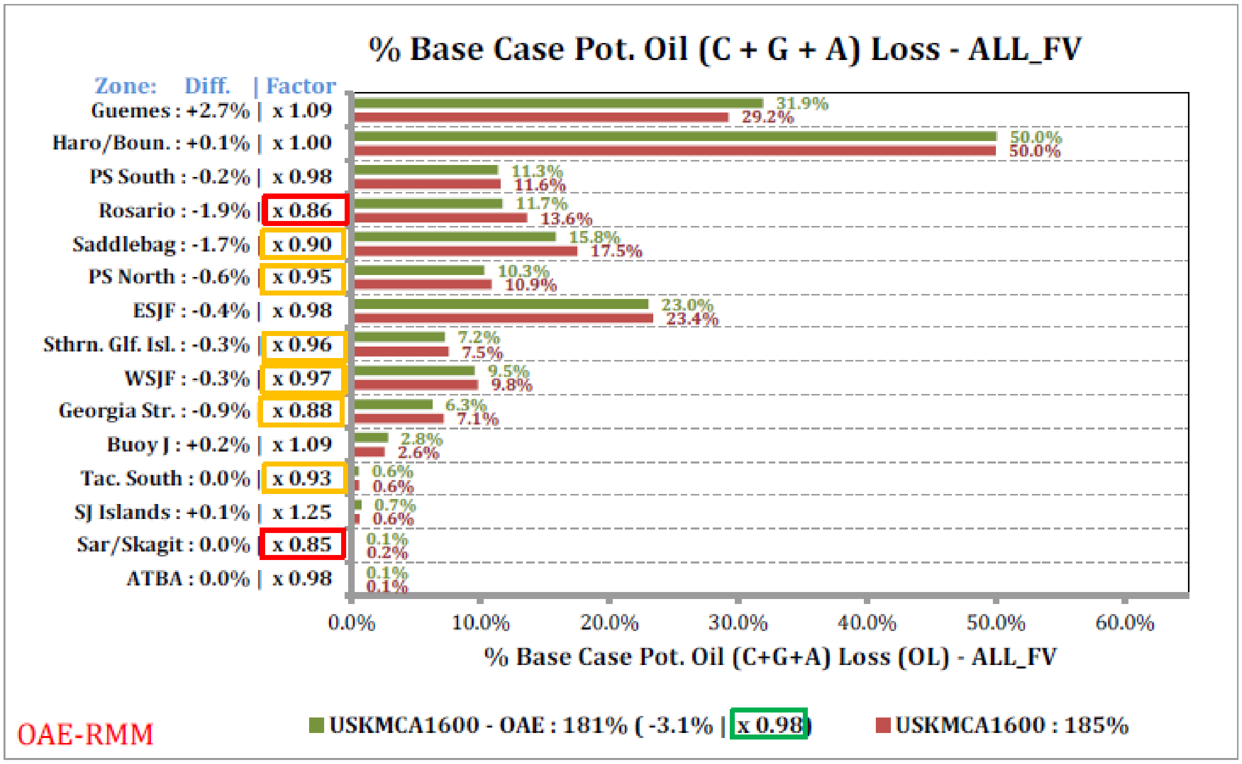


**Figure 45: Relative comparison of changes in potential oil loss for the 2015 VTRA primary "what-if" case (red bars) and a risk reduction measure (green bars) that modeled untethered tug escort of tank barges and ATBs east of Port Angeles, expressed as percentages of base case potential oil loss. Absolute changes in potential oil loss, and relative multipliers are provided for each waterway zone in the y-axis. The figure shows an overall decrease in potential oil loss of 3.1 percent with tug escorts modeled, compared to the primary "what-if" case. (Van Dorp & Merrick, 2016, p. 185)**

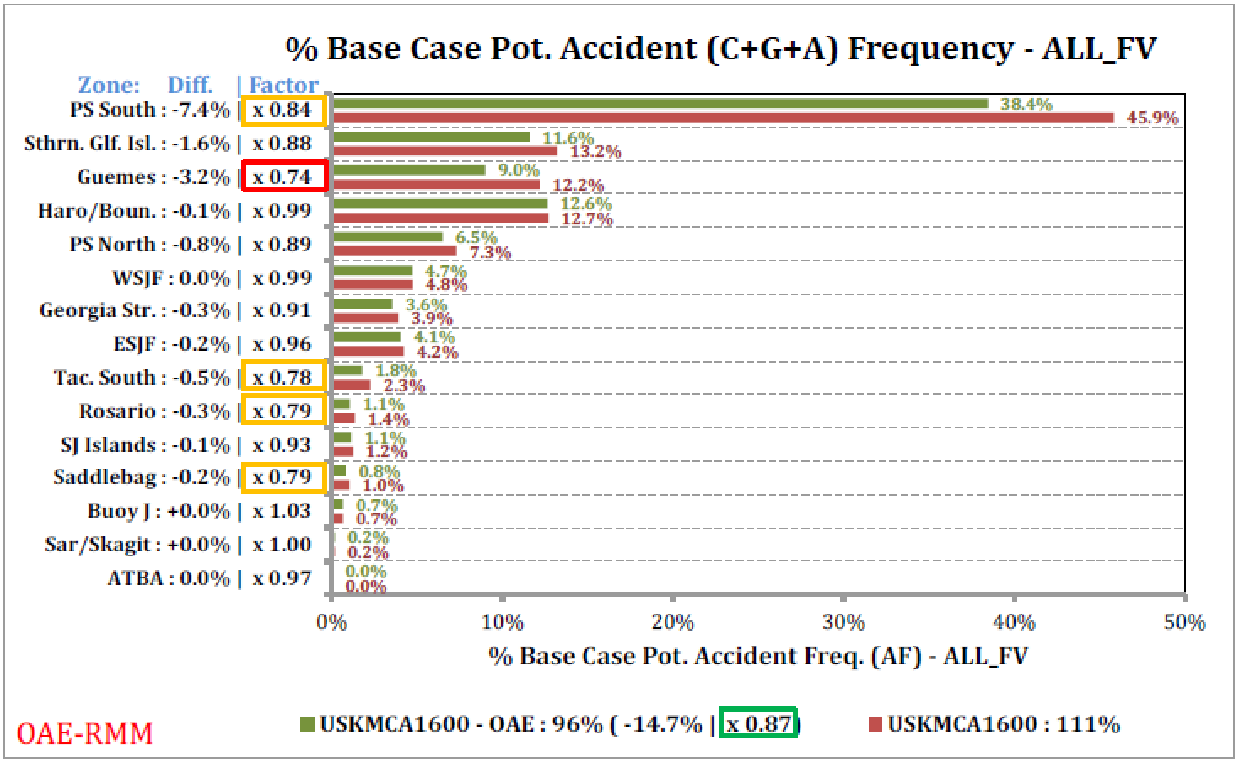


**Figure 46: Relative comparison of changes in potential accident frequencies for the 2015 VTRA primary "what-if" case (red bars) and a risk reduction measure (green bars) that modeled untethered tug escort of tank barges and ATBs east of Port Angeles, expressed as percentages of base case potential accident frequency. Absolute changes in potential accident frequency, and relative multipliers are provided for each waterway zone in the y-axis. The figure shows an overall decrease in potential accident frequency of 14.7 percent with tug escorts modeled, compared to the primary "what-if" case. (Van Dorp & Merrick, 2016, p. 185)**

It may be noted in Figures 45 and 46 that modeling untethered tug escorts for tank barges and ATBs resulted in overall increases in potential oil loss in four waterway zones, compared to the primary "what-if" case: the Guemes waterway zone (2.7 percent increase), the Buoy J waterway zone (0.2 percent increase), the Haro/Boundary waterway zone and the San Juan Islands waterway zone (both with 0.1 percent increase). Potential accident frequencies decreased or remained the same in all waterway zones. Three of the four waterway zones that showed an increase in potential oil losses had a decrease in potential accident frequency. The Guemes waterway zone had a 3.2 percent decrease, and the Haro/Boundary and San Juan Islands waterway zones each showed a 0.1 percent decrease. The potential accident frequency for the Buoy J waterway zone was unchanged.

The 2015 VTRA modeling results do not provide an explanation for the increase in potential oil losses. However, Ecology considers it reasonable to assume that having more vessels active in the waterway increased opportunities in the model for collisions, allisions, and groundings.[83] Tugs performing escort duties would follow the same regulatory and voluntary prevention

[83] At least one historical accident incorporated in the 2015 VTRA accident calibration involves a collision between a tank ship and an escorting tug, the 2002 collision between *Allegiance* and *Sea King* (Crowley v. Maritrans, 2008).

measures as other vessels operating in the Puget Sound. These measures include compliance with 46 CFR Subchapter M, which establishes requirements for U.S. flag towing vessels for obtaining and renewing a Certificate of Inspection (46 CFR § 136, 2016).

Tethered tug escorts were not modeled in the 2015 VTRA. It is possible that modeling tethered tug escorts would have produced different results for changes in potential oil losses and potential accident frequencies.

*Marine pilotage in Canada: A cost-benefit analysis*

A 2017 cost benefit study done for the Canadian Marine Pilots' Association, using the data from a 2004 study done for Ecology (Gray & Hutchison, 2004), calculated that the use of escort tugs in Vancouver, BC, reduced the risk of a tank ship grounding accident from $2.11 \times 10^{-03}$ to $1.8 \times 10^{-04}$ (0.211 percent to 0.018 percent) (Transportation Economics & Management Systems, Inc., 2017). This represents a twelve-fold reduction of risk below that of tank ships under pilotage only. The cost benefit study found:

> Pilotage has a relevant and direct role in respect of all incidents in the top two vessel accident categories: collision and powered grounding. It also plays an important role in respect of drift grounding accidents. When combined with the use of escort and standby tugs, there is complete and effective coverage of all drift grounding accidents. This level of safety is essential to the social license necessary for shipping operations. (Transportation Economics & Management Systems, Inc., 2017, p.3)

Washington's experience with escorted tank ships is similar to Vancouver's. There have been no underway groundings involving an escorted tank ship within the designated escort area, and the only collision involved an underway escort tug colliding with the tank ship it was escorting from which there was no significant pollution (Crowley v. Maritrans, 2008). In one notable incident in which the escort tug played a role, two tank ships were meeting within the escort-required area in the eastern Strait of Juan de Fuca. The inbound laden tank ship lost steering control and turned into the path of the outbound tank ship. Communication between the vessel pilots helped prevent collision. The escort tug tethered to the inbound tank ship as it continued to turn, and the tank ship regained steering control (Washington State Department of Ecology, 1996).

## Tug capability requirements to ensure safe escort of vessels

Escort tug capabilities were partially described in the previous section of this chapter where the existing escort requirements contain minimum tug capabilities, but additional information on escort tug capability is described in this section. This section presents concepts for escort tug capabilities, capabilities under existing requirements, developments in British Columbia that could impact tug escort capability requirements, and recommendations from previous studies regarding tank vessel escorts.

Crewing of the escort tugs was discussed in the previous section, and pilotage requirements are described in Chapter 8 of this report.

## Concepts for state-of-the-art escort tug capability

Since Washington established its tank ship escort law in 1975, a great deal of work has been done in developing tug designs specifically for the work of escorting tank ships. Significant advances came with the development of tractor tug design,[84] cycloidal propellers,[85] and azimuthing drives.[86] These advances, as well as advances in the hull form that pairs with these drive systems, have allowed escort tug operators to expand from the conventional direct towing mode, where the tug pulls on the tow line to turn or slow the escorted vessel, to other modes such as indirect towing, powered indirect towing, and transverse arrest. These new modes of maneuvering on a tow wire can generate forces in the range of 1.5 to 2.5 times the bollard pull of the tug's engines, making them more effective in maneuvering a large vessel in an emergency situation (Brooks & Slough, 1999; Allan & Molyneux, 2004).

A 2001 paper outlined the "principle of sufficiency," for escort system design. This principle provides that an escort system:

> …will have sufficient capability to achieve the required and desired standard of safety for a particular waterway. Benefits of this approach include:
>
> 1. It provides a constant standard of safety for all tankers, taking into consideration the size, speed and characteristics of each class of tankers using that waterway.
> 2. It specifically includes the effects of time delays and can account for tethered or untethered escort.
> 3. It allows for systematic speed regulation and tug specification.
> 4. It can take into account environmental effects (i.e., weather, currents). (Gray, 2001, p.3).

Such a system lends itself to a matrix approach to escort tug selection based on the above-mentioned variables for a specific tank vessel transit. A "systems analysis strategy" may be used to develop the consistent rules amenable to such a matrix, answering the question, "Given a tanker size and desired speed of transit, what is the type and size of tug(s) required in the case of a disabling casualty on board the tanker?" (Gray, 2001, p.5).

## Escort tug capabilities under existing requirements

### Washington

Washington law specifies that the tug(s) used to escort a laden tank ship have an aggregate shaft horsepower equivalent to five percent of the DWT of that tank ship (Wash. Rev. Code § 88.16.190, 1994). The same law prohibits any tank ship of greater than 125,000 DWT from proceeding into the Puget Sound escort area. This means that the maximum required horsepower

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[84] Tugs where the propellers are located in the forward part of the tug.
[85] Propellers that turn about an underwater vertical axis, and act on a basis similar to that of helicopter blades. A notable designer of such systems is Voith-Schneider.
[86] Also called z-drives—propeller housings can rotate 360 degrees allowing for rapid changes in thrust direction and eliminates the need for a conventional rudder.

for a single escort tug would be 6,250 shaft horsepower. There are several tugs operating in Washington that have sufficient shaft horsepower to carry out one-tug escort duties.

There are no additional equipment requirements for escort tugs included within Washington's tank ship escort law.

Despite the lack of specificity within the law, the tugs used for escort service in Washington are typically of a twin-propeller design due to horsepower and maneuverability needs, and typically of a tractor type, which are generally recommended for tank ship escort work. At least some of the tugs used for escort service also have enhanced firefighting capabilities. The PSHSP Tanker Escort SOC guidance states:

> Regardless of minimum state/federal performance requirements, tanker Master/Pilot are to confirm that escort vessel(s) assigned to the transit are tractor type in configuration and capable of Indirect, Powered indirect and direct mode of suitable power. (Puget Sound Harbor Safety Committee, 2017, pp.104-105)

### California

California's regulations regarding escort tug capability differ based on region (Cal. Code Regs. 14 CCR § 851, 2012). San Francisco and Los Angeles/Long Beach (LA/LB) are the largest of these regions. LA/LB determines the appropriate capability of the escort tugs (up to two) based on a matrix that considers the deadweight tonnage of the vessel to be escorted. The tugs used for escort service must have completed a bollard pull test and have that test on record with the local Marine Exchange and Harbor Safety Committee. Escort tugs must have two VHF radios, adequate fendering, power winches, and tow lines that are at least 1.5 times as strong as the tug's static bollard pull. San Francisco also uses a matrix to match escort tugs (up to three) with tank vessels based on a bollard pull test, and requires adequate fendering, power winches, a tow line 2.5 times as strong as the tug's static braking force, and some additional equipment (Cal. Code Regs. 14 CCR § 851, 2012).

### Massachusetts

Massachusetts's regulations require escort tugs to have two propellers with a separate power system for each of at least 4,000 horsepower and a minimum bollard pull of at least 50 tons, or be a tractor tug of at least 4,000 horsepower and a minimum bollard pull of at least 50 tons that can rotate thrust in a 360-degree arc (Mass. Gen. Laws ch..21M §§ 1,6 (2017); 314 CMR 19.00, 2010).

Escort tugs must also meet certain ABS classifications, including firefighting. Escort tugs must have two VHF radios, adequate fendering, power winches, tow lines that are at least 1.5 times as strong as the tug's static bollard pull, and "sufficient braking force to stop a Tank Vessel that is not self-propelled" (Mass. Gen. Laws ch..21M §§1,6 (2017); 314 CMR 19.00, 2010).

### Alaska

Alaska's escort system (SERVS) utilizes enhanced tractor tugs (ETT) and pollution response tugs (PRT) in combination during tank ship escorts (Response Planning Group, 2017). These vessels meet the federal requirements for escort tugs in PWS in that they are capable of:

(1) Towing the tanker at 4 knots in calm conditions, and holding it in steady position against a 45-knot headwind;

(2) ~~Stopping the tanker within the same distance that it could crash-stop itself from a speed of 6 knots using its own propulsion system;~~ [indefinitely suspended November 1994, 59 FR 54519]

(3) Holding the tanker on a steady course against a 35-degree locked rudder at a speed of 6 knots; and

(4) Turning the tanker 90 degrees, assuming a free-swinging rudder and a speed of 6 knots, within the same distance (advance and transfer) that it could turn itself with a hard-over rudder. (33 CFR § 168.50(b), 1994)

Alaska is currently using either cycloidal- or z-drive tugs in the range of 10,000 horsepower and 220,000 to 305,000 pounds (110 to 133 tons) of bollard pull (Response Planning Group, 2017).

PWSRCAC sponsored studies about specific capabilities of escort and sentinel tugs at Hinchinbrook Entrance. While performance standards were proposed for PWS tugs, the standards were specific to waters of PWS. These standards may be referenced but not adopted for Puget Sound without further study.

## Developments in British Columbia

### Pacific Pilotage Authority Notice to Industry

In December 2015, the Pacific Pilotage Authority Canada (PPA) issued a Notice to Industry outlining escort requirements for tank vessels in the Straits of Georgia, Haro Strait, Boundary Pass, English Bay, and the Strait of Juan de Fuca. To loosely summarize the requirements, all tank ships of 40,000 summer deadweight tonnes (SDWT) carrying in excess of 6,000 metric tons of liquids in bulk must have a tethered escort from two miles north of East Point (the northern gateway to Boundary Pass) to Brotchie Ledge (off Victoria, BC), and then an untethered escort to Race Rocks. In addition, tank ships laden with crude oil must have a tethered escort between First Narrows (Vancouver Harbor) to the “QA” Buoy (west of Point Grey in the Straits of Georgia), then an untethered escort to north of East Point.[87] Tank ships laden with crude oil then have the same tethered escort requirement through Boundary Pass and Haro Strait to Brotchie Ledge as other tank vessels, but maintain the tethered escort until Race Rocks, and then maintain an untethered escort to Buoy J at the west entrance to the Strait of Juan de Fuca (Pacific Pilotage Authority, 2015). See Tables 8 through 11 and Figure 40 for details.

### Trans Mountain Pipeline expansion project

If completed, the planned Trans Mountain Pipeline System and Expansion Project (TMEP) would increase pipeline capacity for crude oil, including diluted bitumen, to be moved to the

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[87] Summer deadweight tonnage refers to DWT at a summer load line based on International Convention on Load Lines standards.

Westridge Marine Terminal in British Columbia for export via tank ship. The government of Canada recently purchased the Trans Mountain Pipeline (TMPL).

The TMEP is expected to increase the number of laden tank ships transiting Haro Strait and Boundary Pass by about 350 per year (Moffatt & Nichol, 2013).

A 2015 filing by Trans Mountain with the National Energy Board of Canada (NEB) indicated the following:

> Trans Mountain will make it a requirement of acceptance for tankers nominated to load at Westridge to have a suitable arrangement for the proposed enhanced tug escort. Trans Mountain will develop a tug matrix for inclusion as part of its Tanker Acceptance Standard to prescribe minimum tug capabilities required upon departure of the tanker. The tug matrix will define the capabilities and number of tugs required for foreseeable meteorological and ocean conditions and based on tanker and cargo size. The tug matrix will be developed by a qualified third-party consultant, in conjunction with the tug operators and regulatory authorities.
>
> Tankers that do not commit to tug escort in the Juan de Fuca Strait during their laden passage shall be denied their approval to load at Westridge.
>
> To this end, Trans Mountain recently organized a meeting with Transport Canada, Pacific Pilotage Authority, Chamber of Shipping BC, tug operators, Robert Allan Ltd, Tetra Tech EBA and marine experts. A technical working group was struck at the meeting. The technical working group will develop the matrix described above for untethered tug escort of Project tankers for the Strait of Georgia and Juan de Fuca Strait. (Trans Mountain Pipeline ULC, 2015, p.4)

## Prior recommendations regarding tank vessel escorts

In 2004, the authors of the *Study of Tug Escorts in Puget Sound* recommended:

> …the requirements in state law RCW 88.16.190/195, as it now stands, are inadequate to ensure a tug escort that can reasonably be expected to avert a tanker grounding in the event of a propulsion or steering failure. Other than the horsepower requirement, RCW 88.16.190/195 and WAC 363-116-500 do not specify a performance standard for escort tugs.
>
> It is the opinion of the authors that the law should, as a minimum, contain provisions that require that the escort tugs be twin-screw vessels. In addition, it is the opinion of the authors that the law should specify that the selection of escort tug(s) be in accordance with the American Society of Testing and Materials (ASTM) Standard Guide for Escort Vessel Evaluation and Selection, Designation: F1878-98, adopted 1998 (Gray and Hutchison, 2004, pp. ix-x).[88]

In 2016, Ecology led the Salish Sea Oil Spill Risk Mitigation Workshop with about 75 participants representing U.S. and Canadian tribes, First Nations, and stakeholders (Washington State Department of Ecology, 2016). After beginning with 225 potential risk mitigation

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[88] See also Bureau Veritas, 2014 & 2017.

measures, the participants identified nine "priority risk mitigation measures" through an informal dot exercise voting process. The first of the nine identified priority measures was "Escort tank vessels including oil barges and ATBs in Puget Sound." More specifically, the recommended measure read:

> Implement tug escort of tank vessels including towed oil barges and articulated tug barges (ATBs) carrying greater than 5,000 long tons of oil as cargo throughout the entire Puget Sound east of Port Angeles. (Washington State Department of Ecology, 2016, p.32)

At this time, neither of these recommendations have been enacted into law.

# Summary

## Summary of tug escort of oil tankers, articulated tug barges (ATBs), and towed tank barges

This section assessed the use of escort tugs for tank vessels through the lens of U.S. states that have such systems in place. Specific variables were described that could shape future action on the use of escort tugs for tank vessels in Washington. It also provided information regarding the level of risk posed by tank vessels and described how the use of escort tugs mitigates that risk. Finally, it presented information from studies that evaluated the potential effectiveness of tug escorts.

The literature reviewed for this section highlighted:

- Both state and federal regulations requiring escort tugs for tank vessels prescribe the need for and the capabilities of the tug(s) and crew at varying levels of detail.
- Washington and Alaska escort requirements apply only to tank ships, while California requirements encompass tank ships, tank barges, and ATBs. Massachusetts escort requirements apply to non-self-propelled tank vessels (tank barges and ATBs).
- Washington is on the lower end of the regulatory spectrum in specifying detail of the escort system in regulation relative to the other states evaluated, but the local maritime community has specified additional voluntary standards through the PSHSC.
- Towing companies on the Columbia River utilize a tail/tag tug system under the Lower Columbia Region Harbor Safety Plan to mitigate the risk posed by laden tank barges on the Lower Columbia River.
- Within the Salish Sea, Washington and British Columbia require tug escort of tank ships greater than 40,000 DWT carrying oil (Washington) or liquid cargo (British Columbia).
    - o In Washington waters, the escort tug must have a minimum aggregate shaft horsepower of 5 percent of the deadweight tonnage of the tank ship. The PSHSP contains an SOC for tug escort of tank ships, which specifies areas where escort tugs should be tethered, tank ship deck fitting standards, escort speed, tug availability,

vessel master responsibilities, pre-escort conferences, tug escort manuals, and provisions for escort tugs to be diverted in case of emergency.
  - In Canadian waters, the PPA established rules which include the number of pilots, areas for tethered escort, tug capabilities and equipment, including minimum bollard pull and safe working loads, escort speeds, pre-escort conferences, and additional procedures for escorting crude oil tank ships.
- Tank barges have the highest potential accident frequency rate in the Salish Sea for tank vessels, followed by tank ships, and ATBs.
- Tank ships must be expected to suffer mechanical failures that could disable them and lead to a collision, powered grounding, or drift grounding. These failures are infrequent, but could be of high consequence.
- As mechanical failures go, losses of propulsion are expected to occur more frequently than losses of steering.
- Escort tugs mitigate the risk of a tank vessel accident (primarily groundings and allisions, but also collisions) when a mechanical failure occurs through their ability to attach and influence the motion of the afflicted vessel.
- Escort tugs may help prevent collisions from human error by providing additional situational awareness and serving as an "auxiliary bridge."
- Modeling results for the Puget Sound indicate that adding tug escorts to towed oil barges and ATBs could result in reductions in potential oil losses.
  - The 2015 VTRA modeled untethered tug escorts of towed oil barges and ATBs.
    - Model results showed an approximate 3 percent decrease in potential oil loss, and an approximate 15 percent decrease in potential accident frequency.
    - Potential oil losses increased in four waterway zones.
    - Potential accident frequencies decreased or remained the same in all waterway zones.
    - Risk reduction results could be different for tethered escorts.
- Experience with escort tugs in Vancouver, BC indicates a twelve-fold increase in protection against tank ship accidents as a result of system that incorporates escort tugs above the level of protection provided by the use of maritime pilots alone.
- Design of an escort system for tank vessels must consider:
  - The level of regulatory involvement desired or necessary.
  - The type of tank vessel to be escorted and its cargo status.
  - The number of escorts required.
  - The mechanical and crew capability of those escort tugs.
  - The use of zones to target specific escort speeds or practices.
  - The use of tethered versus untethered escort tugs.

  - Whether it is necessary to specify crew size or training above the level of existing regulation.
- Although predominately addressed at the federal level, reducing vessel speeds can improve vessel safety, may reduce underwater noise, and reduce air pollution from ships. Washington code addresses vessel speed limits by requiring that tank ships not exceed the service speed of their escort tugs, but neither the Revised Code of Washington nor the PSHSC SOC addresses speed limits or speed reductions for cargo and passenger vessels, towed oil barges, or ATBs.
- Although under full purview of the federal government through the U.S. Coast Guard, changes to crewing levels on ATBs and tugs towing tank barges have been discussed as a potential way to reduce human error and decrease the likelihood of accidents. Currently, tug escort companies are strongly encouraged to have one other crew member in addition to the boat operator on the bridge of the escorting tug during escorts.

## Summary of tug capability requirements

This section described some of the progress that has been made in escort tug design since Washington's escort law of 1975. The expectations of Washington, California, Massachusetts, and Alaska for escort tug capability was summarized, and the proposed method for choosing capable tugs matched to the laden tank ship being escorted in British Columbia was presented. Finally, recommendations previously made regarding tug escort capability in law and the extent to which tug escort law should apply were presented.

The literature reviewed for this section highlighted:

- The capabilities desirable in an escort tug for tank vessels share some commonalities such as high maneuverability, high horsepower, and propulsion redundancy. However, the choice of escort tug capabilities depends on the environment in which the escort occurs, the size and type of vessel to be escorted, the waterway characteristics, and the desirability of ancillary capacities such as firefighting.
- The U.S. states reviewed specify the capability of escort tugs at varying levels of detail.
  - Washington is on the lower end of the regulatory spectrum in specifying escort tug capability, but the local maritime community through the PSHSC has specified the recommended capability.
  - California uses a matrix approach to match the correct escort tug or tugs to the vessel to be escorted.
  - Canada appears to be on track to use a matrix approach to determine what tug or tugs to use to escort laden tank ships transiting the Strait of Juan de Fuca.
- A matrix approach to matching escort tug capability to the tank vessel on a given transit is a best practice.

- Many participants in the 2016 Salish Sea Oil Spill Risk Mitigation Workshop prioritized extending escort tug protection to tank barges and ATBs carrying larger quantities of oil in the Salish Sea as a spill prevention measure.
- A previous Ecology-sponsored study recommended that Washington's tank ship escort law be updated to provide more specificity regarding escort tug capability.

# Recommendations

## Conduct rulemaking on tug escort requirements

The Washington State Board of Pilotage Commissioners (BPC) has authority to impose tug escort requirements for vessels within Washington State waters. As discussed, tug escorts can reduce the risk of a vessel incident that could result in a spill.

Ecology recommends amending RCW 88.16.190 (1994) to direct the BPC to conduct rulemaking on tug escort requirements for oil laden tank vessels between 5,000 and 40,000 DWT when traveling beyond a point east of a line extending from Discovery Island Light south to New Dungeness Light. The rulemaking would direct the BPC to develop zones in Puget Sound to apply these rules. Zones would be determined by modeling and analysis. The rulemaking must require tug escorts for Rosario Strait and connected waterways to the east. As part of the rulemaking, the BPC could develop subsets of oil laden tank vessels between 5,000 and 40,000 DWT and/or situations which could preclude the requirements of the rulemaking for a given zone or vessel. The rulemaking should also evaluate potential impacts of increased marine noise as a result of additional vessel traffic and consider mitigation for underwater noise, especially on solo tugs returning from escort duty, to reduce impacts to Southern Resident Killer Whales.

Ecology should collaborate with the PSHSC to update the PSHSP and develop SOC for tug escort capabilities (e.g., bollard pull, tug equipment, detailed escort manuals) and escort procedures, including periodic performance testing, to reflect this change.

Ecology strongly encourages the Pacific Pilotage Authority Canada (PPA) to take an equivalent posture for Haro Strait and Boundary Pass for oil laden ATB and tug tow tank vessels calling to British Columbia ports. Ecology anticipates that the PPA would continue their practice of honoring the escort requirements of Washington, as a safety partner.

## Develop Standard of Care for voluntary vessel speed reduction program

Ecology recommends the PSHSC consider updating the PSHSP and develop SOC for a voluntary vessel speed reduction program. This program should complement the Vancouver Fraser Port Authority's voluntary vessel slowdown trial in British Columbia as part of their Enhancing Cetacean Habitat and Observation Program (ECHO). The voluntary program should focus on Haro Strait, Boundary Pass, and Rosario Strait. The process for development of the SOC should include discussion about specific application of the SOC for different vessel types, operations, schedules, and locations. The primary purpose for this new SOC would be for reducing oil spill risk, with a strong secondary purpose of potentially reducing noise impacts to affected orca populations.

## Develop Standard of Care for wheelhouse watch stander

Ecology recommends the PSHSC consider updating the PSHSP and develop SOC for a second watch stander in the wheelhouse of ATB and tug-towed tank vessels on certain routes and in specific conditions. The intent of this voluntary standard is to use existing crew to assist the watch stander in charge of navigation as a lookout in the wheelhouse. The applicability of this voluntary standard may be considered for all Puget Sound pilotage waters, east of a line extending from Discovery Island Light south to New Dungeness Light. However, the primary areas of focus for this voluntary standard should be on Haro Strait, Boundary Pass, and Rosario Strait and connected waters to the east.

The SOC should consider operating conditions where the second lookout would apply, e.g., during hours of darkness, in restricted visibility conditions, heavy weather, increased waterway traffic situations, Rules of Road (COLREGS), and possibly other situations or conditions. The primary purpose of this new SOC is to raise situational awareness and reduce the potential risk of marine casualties and oil spills.

# Chapter 10: Economic Impact for Proposals for Tug Escorts and Limitations on Vessel Size

Per E2SSB 6269, this chapter addresses the economic impact of proposals for tug escorts and limitations on vessel size. Restrictions on vessel size were not proposed, however, and are not analyzed here. Pilotage requirements have been included as part of this analysis because pilotage was initially considered as part of the rulemaking within the tug escort recommendation.

Oil and transport owners and operators incur costs associated with vessel traffic safety, including costs of pilotage and escorts. In this analysis, Ecology estimated the costs and economic impacts of:

- The status quo, including existing pilotage and escort requirements and practices.
- An alternative modeled scenario with additional pilotage and escort requirements.

Ecology estimated costs for escorts and pilotage for tank ships, tank barges, and articulated tug barges (ATBs). These costs are economic transfers between industries, and were used to model economy-wide short term and long term impacts to jobs and output in the state.

Although outside the scope of this study, additional emergency response towing vessels (ERTVs) have been considered in addition to expanded escort tugs. Until 2010, the state funded an ERTV stationed near Neah Bay. Today, the vessel is funded through a partnership among related maritime and industrial organizations. In its final year funded by the state, the Legislature appropriated $3.6 million for the Neah Bay ERTV (Washington State Department of Ecology, 2009).

## Scenarios

### Status quo

The status quo reflects existing vessel traffic safety requirements across Puget Sound, including existing pilotage and escort requirements, as well as common practices and agreements. These requirements are established by area of transit and vessel type, as summarized in Table 12 below for typical routes. Note that there are no existing requirements for tank barges. Ecology reviewed monthly Puget Sound Pilots tanker movement reports and identified the ATBs that were listed as being piloted. We then reviewed raw vessel entry and transit (VEAT) data for laden ATB transits (Washington State Department of Ecology, 2018a; Puget Sound Pilots, 2018b). We compared the number of transits made by ATBs that were listed as being piloted against the number of transits for all ATBs. Based on this review, Ecology assumed that 75 percent of laden ATB transits had a state licensed pilot onboard as a voluntary practice.

**Table 12: Status quo escort and pilotage requirements for laden tank ships**

| Destination | Puget Sound | Possession Sound/ Saratoga Passage | Admiralty Inlet | Eastern SJdF | Eastern SJdF | Haro Strait/ Boundary Pass | Rosario Strait | Guemes Channel | Saddlebag-Huckleberry Island/Viti Rocks | Georgia Strait – US | Destination |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Whidbey Island, (Navy)** | | # | # | # | X, P | | | | | | **Port Angeles** |
| **Manchester Dock, (Navy)** | # | | # | # | X, P | | Xt*, P | Xt*, P | Xt*, P | | **Anacortes** |
| **Seattle** | X, P | | X, P | X, P | X, P | | Xt*, P | | | X, P | **Ferndale, Cherry Pt.** |
| **Tacoma** | X, P | | X, P | X, P | X<br>P or Pc | Xt, Pc | Xt*, P | | | X<br>P or Pc | **Vancouver, BC** |

**Table 12b: Status quo escort and pilotage requirements for laden ATBs**

| Destination | Puget Sound | Possession Sound/ Saratoga Passage | Admiralty Inlet | Eastern SJdF | Eastern SJdF | Haro Strait/ Boundary Pass | Rosario Strait | Guemes Channel | Saddlebag-Huckleberry Island/Viti Rocks | Georgia Strait – US | Destination |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Whidbey Island, (Navy)** | | # | # | # | | | | | | | **Port Angeles** |
| **Manchester Dock, (Navy)** | # | | # | # | Pv | | Pv | Pv | Pv | | **Anacortes** |
| **Seattle** | Pv | | Pv | Pv | Pv | Pv | Pv | | | Pv | **Ferndale, Cherry Pt.** |
| **Tacoma** | Pv | | Pv | Pv | Pv or Pc | Pc | Pv | | | Pv or Pc | **Vancouver, BC** |

Legend for Table 12 and 12b:

- # – No known current transits of this type
- X – Escort
- Xt – Escort, tethered
- Xt* – Escort, tethered; Harbor Safety Plan Standard of Care (SOC), Puget Sound Pilots

- P – Pilot
- Pv – Pilot, voluntary practice
- Pc – Pilot, Canada

## Modeled scenario

The modeled scenario reflects existing and proposed vessel traffic safety requirements across Puget Sound, including pilotage and escort requirements, as well as common practices and agreements. These requirements are established by area of transit and vessel type, as summarized below for typical routes. Significant differences from the status quo include:

- Pilotage and escort requirements for laden tank barges.
- Preemptive requirements for routes on which there are currently no known transits.
- Additional escort requirements for ATBs.
- Required pilotage where it is currently a voluntary practice.

These requirements are summarized in Table 13 below.

Note that requirements for tank barges and ATBs en route to or from Vancouver, BC through the eastern Strait of Juan de Fuca (SJdF), Haro Strait/Boundary Pass, and the Strait of Georgia assume Canadian practices would match new requirements as they do under the status quo.

**Table 13: Modeled scenario escort and pilotage requirements for laden tank ships**

| Destination | Puget Sound | Possession Sound/ Saratoga Passage | Admiralty Inlet | Eastern SJdF | Eastern SJdF | Haro Strait/ Boundary Pass | Rosario Strait | Guemes Channel | Saddlebag-Huckleberry Island/Viti Rocks | Georgia Strait – US | Destination |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Whidbey Island, (Navy)** | | (X, P) | (X, P) | (X, P) | X, P | | | | | | **Port Angeles** |
| **Manchester Dock, (Navy)** | (X, P) | | (X, P) | (X, P) | X, P | | Xt, P | Xt, P | Xt, P | | **Anacortes** |
| **Seattle** | X, P | | X, P | X, P | X, P | | Xt, P | | | X, P | **Ferndale, Cherry Pt.** |
| **Tacoma** | X, P | | X, P | X, P | X<br>P or Pc | Xt, Pc | Xt, P | | | X, P or Pc | **Vancouver, BC** |

**Table 13b: Modeled scenario escort and pilotage requirements for laden tank barges**

| Destination | Puget Sound | Possession Sound/ Saratoga Passage | Admiralty Inlet | Eastern SJdF | Eastern SJdF | Haro Strait/ Boundary Pass | Rosario Strait | Guemes Channel | Saddlebag-Huckleberry Island/Viti Rocks | Georgia Strait – US | Destination |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Whidbey Island, (Navy)** | | X, P | X, P | X, P | X, P | | | | | | **Port Angeles** |
| **Manchester Dock, (Navy)** | X, P | | X, P | X, P | X, P | | Xt or T<br>P | Xt or Tt<br>P | Xt or Tt<br>P | | **Anacortes** |
| **Seattle** | X, P | | X, P | X, P | X, P | | Xt or Tt<br>P | | | X, P | **Ferndale, Cherry Pt.** |
| **Tacoma** | X, P | | X, P | X, P | X<br>P or Pc | Xt or Tt<br>Pc | Xt or Tt<br>P | | | X<br>P or Pc | **Vancouver, BC** |

**Table 13c: Modeled scenario escort and pilotage requirements for laden ATBs**

| Destination | Puget Sound | Possession Sound/ Saratoga Passage | Admiralty Inlet | Eastern SJdF | Eastern SJdF | Haro Strait/ Boundary Pass | Rosario Strait | Guemes Channel | Saddlebag-Huckleberry Island/Viti Rocks | Georgia Strait – US | Destination |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Whidbey Island, (Navy)** | | (X, P) | (X, P) | (X, P) | X, P | | | | | | **Port Angeles** |
| **Manchester Dock, (Navy)** | (X, P) | | (X, P) | (X, P) | X, P | | Xt, P | Xt, P | Xt, P | | **Anacortes** |
| **Seattle** | X, P | | X, P | X, P | X, P | | Xt, P | | | X, P | **Ferndale, Cherry Pt.** |
| **Tacoma** | X, P | | X, P | X, P | X<br>P or Pc | Xt, Pc | Xt, P | | | X<br>P or Pc | **Vancouver, BC** |

Legend for Table 13, 13b, and 13c:

- (blue shading) – New requirement with impact
- (green shading) – Altered existing requirement with impact
- (red shading) – New or altered existing requirement with no likely material impact
- ( ) – Theoretical if industry practices change and these transits occur
- Tt – Tag tug; smaller tug assisting at stern of oil barge
- X – Escort
- Xt – Escort, tethered
- P – Pilot
- Pv – Pilot, voluntary practice
- Pc – Pilot, Canada

# Methods

This section describes data used in this analysis, as well as the scope of analysis, cost model, changes in modeled scenario requirements, and the economic impact model. Any assumptions made by Ecology regarding transit, escort, pilotage, and cost data are described below. Additionally, for analysis of the status quo, Ecology assumes 75 percent of ATB transits currently include a Puget Sound pilot as a voluntary practice. For the modeled scenario, requirements for tank barges and ATBs en route to or from Vancouver, BC through the eastern SJdF, Haro Strait/Boundary Pass, and the Strait of Georgia assume Canadian practices would match new requirements as they do under the status quo.

## Scope of analysis

Ecology worked within a dynamic scope while completing this economic impact analysis. Although dynamic, the scope defined the boundaries of our analysis, and the following assumptions guided the scope of this analysis:

- Requirement to meet the content and time requirements specified in statute.
- Need to focus on activities directly related to the recommended safety actions and statutory requirements.
- Need to focus on the primary and direct economy-wide impacts from the recommended safety actions specified in the report (tug escorts, pilotage, size restrictions); this is in line with Ecology's current guidance for regulatory analyses for new and amended administrative rules.
- Option to discuss potential secondary impacts where time allowed, was appropriate to the larger conversation, and relevant to understanding the negative triple-bottom-line impacts from oil spills in Puget Sound.

## Data

To create a realistic estimate of existing and potential costs related to pilotage and escorts, Ecology collected data from various publically available sources, including tug escort and barge companies operating in the Salish Sea, the Washington State Board of Pilotage Commissioners (BPC), and publications from governmental, advocacy, and scientific organizations. Data focused on oil vessel transits, current vessel escorts operating in the Salish Sea, and pilotage operations in and around Puget Sound. Ecology consulted both internal and external subject matter experts throughout the research regarding data relevancy and accuracy as well as the structure of the models informing this economic analysis.

### Transits

For this analysis, a transit is defined as a complete one-way trip by an oil tank ship, ATB, or tank barge from one location to another originating or ending in Puget Sound, Strait of Juan de Fuca, or Strait of Georgia. Transit data was sourced from Ecology's annual vessel entries and transit (VEAT) report (Washington State Department of Ecology, 2018a). The number of individual transits was reflected by:

- Final destination.
- Anchor location and subsequent destination.

During the analysis, we identified a significant difference between the number of ATB transits in the VEAT report and the number of transits identified in comments received by stakeholders. As there is a difference between the granularity of VEAT data, and we wanted to limit this analysis to primary data sources to the extent possible, we did not use these alternative numbers provided. We do note, however, that a larger real number of piloted ATB transits would increase status quo and modeled scenario estimates by the same amount.

### Transit attributes and routes

Using Puget Sound pilotage tariffs invoices for the month of April 2018, Ecology identified 43 existing one-way transits that overlapped with the modeled scenario table (Table 13) (Board of Pilotage Commissioners, 2018b). Although the pilotage tariffs did not include tank barge transits and existing Ecology VEAT data do, pilotage tariffs were more appropriate for this analysis as the VEAT data include transits for activities outside of the scope of this publication (bunkering transits, etc.). Transits to and from Naval Stations at Whidbey Island and Manchester were not accounted for in this analysis.

Ecology calculated distance in nautical miles (NM) for most of the individual transits within Puget Sound using information provided by a tug escort company that operates in the Salish Sea (Foss Maritime Company, 2018). Several of the locations in the modeled scenario, including Vancouver, BC, Vendovi Island, and the Puget Sound Pilot Station near Port Angeles, were not included in the distance table. Transits to and from Vancouver, BC were calculated via a common maritime calculation website (Sea-Distances.org, n.d.). The remaining locations and transits were estimated using the following translations:[89]

- Puget Sound Pilotage Station = Port Angeles, ±4 NM.
- Vancouver to/from Cherry Point transits = Vancouver to/from Ferndale, ±3.75 NM.
- Vendovi Island = Anacortes, ±6.75 NM.

Transit distances ranged from 0 NM to 85 NM. Intra-harbor and docking and undocking transits were calculated as 0 NM, but estimated as taking two hours in accordance with tug escort rate schedules (Crowley Maritime Corporation, 2018b; Foss Maritime Company, 2017). Given that the modeled scenario combined the locations of Cherry Point and Ferndale, Ecology used average distance and time for transits between each of these locations and Port Angeles and the Puget Sound Pilotage station.

Transit times significantly informed cost estimates for both escort and pilotage. We estimated transit times using the industry standard of 10 knots for escorted transit plus two hours for docking and undocking, varying from two to 10.5 hours (Crowley Maritime Corporation, 2018b; Foss Maritime Company, 2017). We did not estimate costs associated with additional or very short shifts such as moving from anchor to dock in the same location.

### Escorts

All ATB and tank barge transits in the modeled scenario require an escort. Transits through Rosario Strait, Guemes Channel, and Saddlebag Island require a tethered escort.

Variables for tug escort cost modeling included the length and transit of the trip as well as whether or not the transit required tethering under the modeled scenario. Ecology obtained current tug escort rate schedules for Puget Sound (as of July 2018) posted on regionally operating tug escort companies' websites (Crowley Maritime Corporation, 2018b; Foss Maritime Company, 2017).

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[89] Distance translations were estimated using Google Maps and consulting Marinetraffic.com for common mooring locations and shipping lanes. Results were rounded to the nearest quarter NM.

Both companies provided hourly tug rates ranging from $1,100 per hour to $4,216 per hour. The significant range in estimates was likely related to the discrepancy between the two companies' pricing structures as well as in the diversity of their fleets. One company offered an hourly price range based on power and propulsion type and the other offered a single flat rate for all tugs. In terms of tug fleet, one had a fleet of tugs ranging from <1,000 horsepower to >8,000 horsepower while the other only operated tugs >4,800 horsepower (Crowley Maritime Corporation, 2018b; Foss Maritime Company, 2017). Ecology's assumption is that the high end of both tug power and related hourly estimates are far beyond the necessary capacity needed for moving a typical oil laden tank barge and, therefore, serves as a conservative input into our estimate.

Each company required supplemental costs for security (both at $50 per transit), fuel (both at 20 percent of total hourly cost), and tethering ($925 to $940 per transit). In addition to the total hourly cost, Ecology estimated two hours for docking and undocking for each transit, whether or not it originated at a port or mooring area.

Within the tug escort industry, rates are commonly negotiated and may deviate from those listed in companies' official rate schedules. Given this reality, Ecology believes it is most appropriate and accurate to use the numbers from the rate schedules as we are unable to account for the uncertainties that may arise during individual negotiations. Furthermore, Ecology's assumption is that escort rates determined by the rate schedule are more likely to decrease during negotiations than increase, meaning that the estimates provided in the analysis are conservative.

**Pilotage**

Using the total transit time for each of the 43 identified transits in the model scenario and the current Pilotage Rules in Chapter 363-116 WAC, Ecology estimated pilotage tariff rates for tank barge transits (2017). Relevant average tariff rates for oil tankers and ATBs on each of the 43 transits were calculated using actual pilotage tariff invoices for April 2018 (Board of Pilotage Commissioners, 2018b).

Tariffs for Washington State Pilots are recorded in WAC 363-116-300 and are updated annually by the BPC (2017).[90] As noted in the Washington State Joint Transportation Committee's (WSJTC) January 2018 report, no existing policy specifies rate-setting processes or methodologies for pilotage tariffs (Community Attributes, Inc. & Gleason & Associates, 2018). Given this limitation, Ecology chose to approach the methods for estimating potential pilotage tariffs using a simplistic and direct interpretation of the statute, realizing that some supplemental costs may not have been captured in our equation (delay, cancelation, etc.). This resulted in an average per-transit tariff half the size of that suggested by comments received from stakeholders. This may be partially explained by Ecology's transit data, which reflects fewer transits than the data provided by stakeholders. This may be explained by differences in transit counting methodologies. Our data also may not reflect very small moves such as from anchor to dock at a single location. Even so, we are confident that our use of primary data and independent approach are most appropriate to maintain quality of analysis and reduce underlying biases in data.

[90] SSB 6519, rate-setting responsibility for the tariffs moves to the Washington State Utilities and Transportation Commission as of July 1, 2019 (Wa. 2018).

Average pilotage tariff rates for tank barges were estimated using the average length overall (LOA) for a fleet of tug and barges from a single company that currently operates both tank barges and ATBs within the Salish Sea (Harley Marine Services, Inc., n.d.). The Pilotage Tariff's LOA Rate Schedule is determined by distance, which is separated into six categories, or Zones I through Zone VI, with varying amounts. Zones for transits were determined using real examples from the April 2018 tariff invoices (Board of Pilotage Commissioners, 2018b). Tonnage charges were all assumed to be the minimum rate ($500). The average combined gross tonnage for the sampled tugs and barges fell significantly below the minimum tier. Transit time and port location influenced the estimate significantly, including potential costs:

- British Columbia Direct Transit Charges (base charge plus additional transportation fees).
- Fees for additional pilots (transits >7 hours).
- Pilot boat fee (transits to or from the Port Angeles pilot station).
- Training surcharge (Ecology assumed two trainees per transit).
- Transportation to vessels on Puget Sound (varies greatly based on location).[91]
- Waterway and bridge charges (applied only to trips to or from Seattle or Tacoma).

Other supplemental costs related to pilotage may be required for specific real world transits made within our scenario model that Ecology was unable to include in our cost model. These costs were related to sailing and docking delays, vessel traffic, late payments, and other unique situations.

## Cost model

Costs were estimated based on matched combinations of vessel transits, vessel safety requirements, and associated escort and pilotage costs. Available data allowed for association of incremental cost estimates with 43 routes (origin-destination). These routes formed the basis of cost estimation structure (Table 14). Total annual costs (C) for the status quo and the modeled scenario are the sums of individual route (r) escort cost ($E_r$) or pilotage cost ($P_r$) and number of transits using that route ($T_r$).

#### Equation 1: Total costs

$$C = \sum_{r=1}^{43} T_r (E_r + P_r)$$

where:

C = total annual costs

r = route

$T_r$ = number of transits on route r

$E_r$ = unit escort cost for route r

[91] Pilot transportation fees are set annually in Wash. Admin. Code § 363-116-300 (2017). According to conversations with the BPC, transportation fees are based on average taxi fees to or from Seattle. Additional transportation fees are required for transits to or from Vancouver, BC.

$P_r$ = unit pilotage cost for route r

### Unit cost modeling

For estimates using incremental costs of services not currently required or represented directly in data, Ecology used estimated costs based on underlying trip characteristics (e.g., length, tonnage, zones, nautical distance, docking and time costs).

*Modeled escort unit costs*

Modeled escort costs ($E_r$) were a function of estimated hourly costs (E) and hours required for the route ($H_r$). Hourly costs were, in turn, a function of base rates and fees. For discussion of these rates and fees, and source data, see Data section, above.

**Equation 2: Unit escort cost by route**

$$E_r = E(H_r + 2)$$

where:

$E_r$ = unit escort cost for route r

E = hourly escort cost

$H_r$ = hours necessary for route r escort

**Equation 3: Hourly escort cost**

$$E = 1.2B + F$$

where:

E = hourly escort cost

B = base rate = hourly rate + security fee

Fuel fees are an additional 20 percent of the base rate

F = tether fee

*Modeled pilotage unit costs*

Modeled pilotage costs ($P_r$) were a function of various fees, tonnage, and length. The equation captured all data available to Ecology at the time of this analysis and may not account for situational supplemental costs (delay, cancelation, etc.). As previously noted, there is no established methodology for determining pilotage tariffs (Community Attributes, Inc. & Gleason & Associates, 2018). For complete discussion of these variables, see the Data section, above.

**Equation 4: Unit pilotage cost by route**

$$P_r = G + L_r + A_r + B_r + D_r + W_r + V_r + S_r + I_r + J_r$$

where:

$P_r$ = unit pilotage cost for route r

G = gross regulatory tonnage fee, constant

$L_r$ = length overall fee for route r
$A_r$ = trainee fee, assumes 2 trainees
$B_r$ = round/single trip transportation costs for route r
$D_r$ = pilot boat fee for route r
$W_r$ = waterway fee for route r
$V_r$ = Vancouver fee for route r
$S_r$ = second pilot fee for route r
$I_r$ = additional waterway charge for route r
$J_r$ = additional transportation charge for route r

**Matching transit data with cost data**

As transit data was defined on a variety of routes, Ecology matched each set of relevant transits for tank ships, tank barges (including barge transits within Puget Sound), and ATBs with one of the 43 routes defined for cost data. In cases where there was not an identical match of origin and destination, Ecology constructed additive trips with additional stops in order to avoid underestimating associated costs. This means costs may be overestimated for some routes. Over 99 percent of all transits could be matched with a route, excluding trips with an unknown destination. This means total costs could be underestimated for excluded routes. Total transits matched with each route were then used as inputs ($T_r$) to Equation 1. Note that raw data was available for one month (April, 2018) of pilotage costs charges, for comparison. Multiplying these costs by 12 months results in an annual cost three times as large as our estimated annual costs. This may be due to April of 2018 not being representative of the types and number of transits reflected in 2017 transit data. If, however, the raw data reflects common, yearlong trends in types and numbers of transit, the estimates for both status quo and modeled scenarios may be underestimated.

While Ecology was able to assume (based on tanker movement reports and transit data) that 75 percent of ATBs currently voluntarily use pilots, we could not comprehensively identify which routes this takes place on. We therefore estimated total ATB pilotage costs across all routes, and scaled the total cost by 75 percent to estimate the status quo ATB pilotage cost.

**Table 14: Escort fees and tank vessel tariffs by route**

| Starting port | Destination port | Time minutes | Nautical miles | Average escort fee | Average tariff tank ship | Average tariff ATB | Estimated tariff tank barge |
|---|---|---|---|---|---|---|---|
| Anacortes | Anacortes | 120 | 0 | $11,967 | $1,788 | $2,222 | $1,183 |
| Anacortes | Cherry Point | 264.6 | 24.1 | $16,945 | NA | $1,642 | $1,366 |
| Anacortes | Pilotage Station | 336 | 36 | $21,247 | $4,805 | NA | $1,723 |
| Anacortes | Port Angeles | 360 | 40 | $22,694 | $8,313 | NA | $1,390 |
| Anacortes | Seattle | 392.4 | 45.4 | $17,155 | $5,311 | $2,589 | $1,978 |
| Anacortes | Vancouver | 552 | 72 | $34,264 | $6,185 | NA | $5,167 |
| Anacortes | Vendovi Island | 160.5 | 6.75 | $10,672 | $4,398 | $1,587 | $1,301 |
| Cherry Point | Anacortes | 264.6 | 24.1 | $16,945 | NA | $1,642 | $1,366 |
| Cherry Point | Pilotage Station | 442.2 | 53.7 | $27,647 | $3,038 | $2,424 | $2,828 |
| Cherry Point | Port Angeles | 466.2 | 57.7 | $29,093 | $4,552 | NA | $2,510 |
| Cherry Point | Vancouver | 517.5 | 66.25 | $32,185 | $6,530 | $7,024 | $5,028 |
| Cherry Point | Vendovi Island | 224.1 | 17.35 | $14,504 | $2,680 | NA | $1,366 |
| Ferndale | Anacortes | 259.2 | 23.2 | $16,619 | $7,460 | NA | $1,354 |
| Ferndale | Pilotage Station | 436.8 | 52.8 | $27,322 | $4,276 | $2,346 | $2,803 |
| Ferndale | Port Angeles | 460.8 | 56.8 | $28,768 | $4,481 | NA | $2,485 |
| Ferndale | Seattle | 613.2 | 82.2 | $21,152 | NA | $2,382 | $3,361 |
| Fern/Cherry | Port Angeles | 463.5 | 57.25 | $28,931 | $4,534 | NA | $2,510 |
| Fern/Cherry | Pilotage Station | 439.5 | 53.25 | $27,484 | $3,245 | $2,365 | $2,828 |
| Port Angeles | Fern/Cherry | 463.5 | 57.25 | $28,931 | $3,636 | NA | $2,510 |
| Pilotage Station | Fern/Cherry | 439.5 | 53.25 | $27,484 | $5,217 | $2,346 | $2,828 |
| Pilotage Station | Anacortes | 336 | 36 | $21,247 | $4,224 | $2,003 | $1,723 |
| Pilotage Station | Cherry Point | 442.2 | 53.7 | $27,647 | $3,080 | NA | $2,828 |

| Starting port | Destination port | Time minutes | Nautical miles | Average escort fee | Average tariff tank ship | Average tariff ATB | Estimated tariff tank barge |
|---|---|---|---|---|---|---|---|
| Pilotage Station | Ferndale | 436.8 | 52.8 | $27,322 | $7,354 | $2,346 | $2,803 |
| Pilotage Station | Port Angeles | 144 | 4 | $8,752 | $2,174 | NA | $1,289 |
| Pilotage Station | Tacoma | 628.8 | 84.8 | $38,891 | $3,118 | NA | $3,073 |
| Pilotage Station | Vendovi Island | 376.5 | 42.75 | $23,688 | $3,376 | $1,935 | $1,723 |
| Port Angeles | Cherry Point | 466.2 | 57.7 | $29,093 | $2,116 | NA | $2,510 |
| Port Angeles | Ferndale | 460.8 | 56.8 | $28,768 | $8,197 | NA | $2,485 |
| Port Angeles | Pilotage Station | 144 | 4 | $8,752 | $2,395 | NA | $1,156 |
| Port Angeles | Port Angeles | 120 | 0 | $10,328 | $1,724 | NA | $823 |
| Port Angeles | Seattle | 519.6 | 66.6 | $32,311 | $4,160 | NA | $2,530 |
| Seattle | Pilotage Station | 495.6 | 62.6 | $30,865 | $4,299 | $2,155 | $2,878 |
| Seattle | Seattle | 120 | 0 | $6,883 | $1,399 | NA | $1,097 |
| Seattle | Tacoma | 272.4 | 25.4 | $16,490 | NA | $1,861 | $1,283 |
| Tacoma | Pilotage Station | 628.8 | 84.8 | $38,891 | $3,479 | NA | $3,073 |
| Tacoma | Seattle | 272.4 | 25.4 | $16,490 | NA | $1,587 | $1,283 |
| Tacoma | Tacoma | 120 | 0 | $6,883 | $1,557 | NA | $1,234 |
| Vancouver | Cherry Point | 517.5 | 66.25 | $32,185 | NA | $6,741 | $5,028 |
| Vancouver | Vendovi Island | 511.5 | 65.25 | $31,823 | $6,185 | $6,376 | $5,167 |
| Vendovi Island | Anacortes | 160.5 | 6.75 | $10,672 | $3,470 | NA | $1,366 |
| Vendovi Island | Cherry Point | 224.1 | 17.35 | $14,504 | $3,571 | $1,642 | $1,366 |
| Vendovi Island | Ferndale | 218.7 | 16.45 | $14,179 | $3,709 | $1,549 | $1,354 |
| Vendovi Island | Pilotage Station | 376.5 | 42.75 | $23,688 | $2,442 | NA | $1,723 |

## Incorporating changes in modeled scenario requirements

Regarding current practices that are not required under the status quo, Ecology assumed they would continue under the modeled scenario. Ecology acknowledges that voluntarily practices and transit paths or numbers might change if vessel owners or operators change routes or vessel types in order to minimize overall costs.

### Tank ships

Compared to the status quo, modeled scenario changes to requirements for tank ships affect:

- Segments of routes on which there are no currently known transits.
- Tethered escorts not currently required but performed under current practice, under the Puget Sound Harbor Safety Plan (PSHSP) Standards of Care (SOC) implemented by Puget Sound Pilots.

Ecology therefore estimated escort and pilotage costs for the modeled scenario identically to the status quo.

### Tank barges

There are no status quo escort or pilotage requirements for tank barges. Under the modeled scenario:

- Escorts or tethered escorts are added requirements on all segments of routes.
- Pilots are added requirements on all segments of all routes.

Ecology therefore estimated escort and pilotage costs for the modeled scenario:

- With escort or tethered escort costs for all routes.
- With pilotage costs for all routes.

### ATBs

Modeled scenario changes to requirements for ATBs affect:

- Segments of routes on which there are no currently known transits.
- All segments of routes, through added escort or tethered escort requirements.
- Twenty-five percent of ATBs that do not currently use pilots.

Ecology therefore estimated escort and pilotage costs for the modeled scenario:

- With escort or tethered escort costs for all routes.
- One-third larger than the status quo for pilotage costs, reflecting 75 percent of ATBs voluntarily using pilots under the status quo, increasing to all ATBs using pilots under the modeled scenario.

## Economic impact model

Ecology used the Regional Economic Models, Inc. Policy Insight+ (REMI PI+) model to estimate economy-wide impacts of escort and pilotage costs. This model combines multiple economic models and data to provide comprehensive, data-based, dynamic results across 160 industries in the state:

- Econometric: The underlying structure and responsiveness of the modeled state economy – internally and within the context of national and international trade – are based on advanced statistical techniques and broad data sourcing.
- Input-output: The state economy's inter-industry relationships and public sector are highly interconnected, and specifically modeled.
- General equilibrium: Short-run and long-run results are modeled as supply and demand reach a balance. The economy stabilizes over time with adjustments to prices, production, consumption, imports, exports, and other variables.
- Economic geography: The spatial dimension of the state economy is reflected through model components such as transportation costs, accessibility, labor market access and attributes.

Costs estimated for the status quo and the modeled scenario are transfers of funds to other industries, of payments to tug companies and pilots.

- As primary model inputs, Ecology assumed that escort and pilotage costs were incurred by petroleum product producers (production costs incurred by North American Industry Classification System (NAICS) code 324), and paid to tug escort and pilotage providers (sales received by NAICS code 488330). Additional transit costs were modeled as passed-through production costs.
- Costs are input as annual, in current real (inflation adjusted) dollars, over ten years.

# Results

## Primary results

### Status quo

Estimated total annual costs for the status quo are $31.8 million. These costs can be broken out by vessel and cost type.

**Table 15: Total transits and estimated costs for status quo**

| Totals | Tank ships | Tank barges | ATBs | Total |
|---|---|---|---|---|
| **Number of transits** | 1,066 | 1,294 | 236 | **2,596** |
| **Pilotage cost** | $4,087,627 | $0 | $401,203 | **$4,488,830** |
| **Escort cost** | $27,345,825 | $0 | $0 | **$27,345,825** |
| **Total cost** | **$31,433,452** | **$0** | **$401,203** | **$31,834,655** |

REMI PI+ results using primary input assumptions indicate that under the status quo, expenditure of these costs results in:

- Ongoing support for over 70 net jobs statewide. This includes an ongoing impact of approximately two jobs in petroleum products manufacturing, and support for nearly 50 jobs in marine transportation service provider industries such as tug and pilot services.
- Ongoing support for approximately $2 million in state output.

Note that these ongoing support values are based on the status quo reflecting established requirements and practices. This means, unlike REMI results for the modeled scenario and the difference between scenarios, below, the impacts reflect ongoing existing expenditures, and do not reflect an initial shock to the economy. See the Methods and Data sections above for discussion.

### Modeled scenario

Estimated total annual costs for the modeled scenario are $64.8 million. These costs can be broken out by vessel and cost type.

**Table 16: Total transits and estimated costs for modeled scenario**

| Totals | Tank ships | Tank barges | ATBs | Total |
|---|---|---|---|---|
| **Number of transits** | 1066 | 1294 | 236 | **2596** |
| **Pilotage cost** | $4,087,627 | $2,438,988 | $534,937 | **$7,061,552** |
| **Escort cost** | $27,345,825 | $25,061,871 | $5,364,619 | **$57,772,314** |
| **Total cost** | **$31,433,452** | **$27,500,859** | **$5,899,556** | **$64,833,867** |

REMI PI+ results using primary input assumptions indicate that under the modeled scenario, expenditure of these costs results in:

- A net statewide increase in employment of 242 jobs in the first year, levelling off near 154 jobs. This includes an initial loss of one job in petroleum products manufacturing, growing to a loss of five jobs in petroleum products manufacturing by 2028, and an initial increase of 112 jobs, levelling off near 98 jobs in marine transportation service provider industries such as tug and pilot services.
- A net statewide increase in output of $31 million, levelling off around $4 million by 2028.

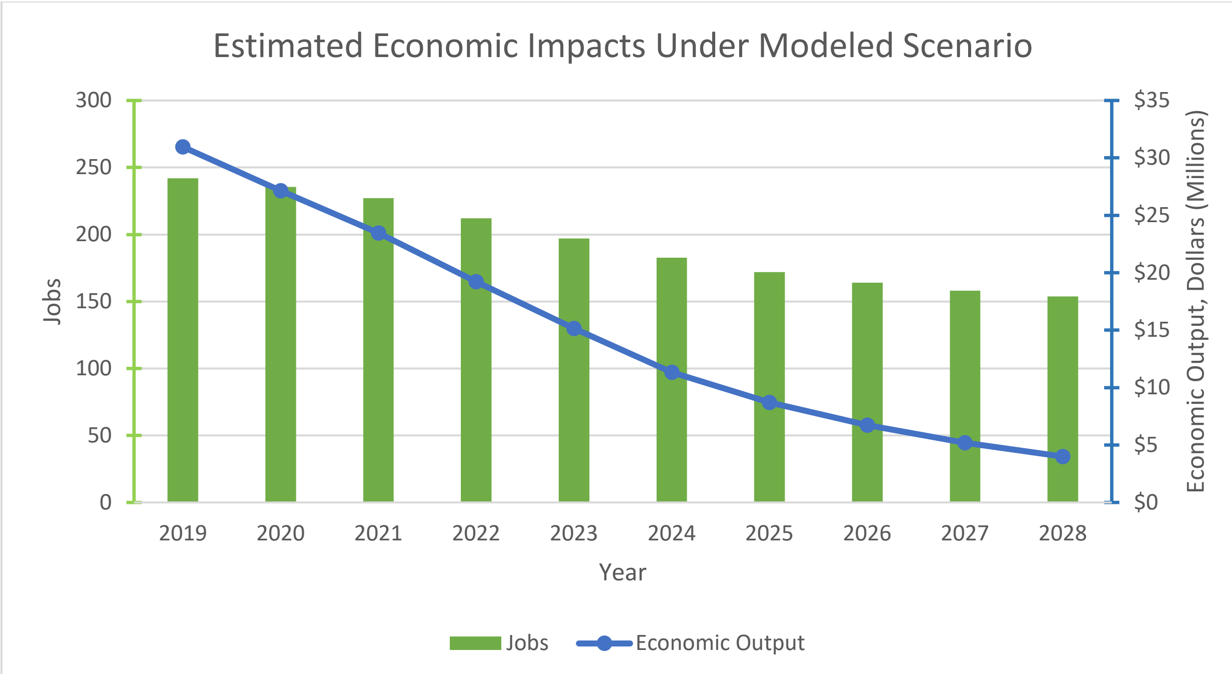


**Figure 47: Estimated economic impacts under modeled scenario**

# Comments on results

## Differences across scenarios

The difference in costs across scenarios is summarized below.

**Table 17: Cost increases (millions of $) under modeled scenario compared to status quo**

| Cost type | Tank ships | Tank barges | ATBs | Total |
|---|---|---|---|---|
| **Pilotage** | $0 | $2.4 | $0.1 | **$2.6** |
| **Escort** | $0 | $25.1 | $5.4 | **$30.4** |
| **Total** | **$0** | **$27.5** | **$5.5** | **$33.0** |

Ecology also examined differences in costs across scenarios by transit region, as defined in the map below.[92] Routes used in cost modeling were each assigned a region by likely route of transit between the identified beginning and endpoint. Routes that were identified in the transit data, but did not have a corresponding route based on pilotage or escort cost data (these were approximated by an overestimated piecewise route with additional stops), were categorized based on their overall original route.

[92] Breaking the scenario down into four transit regions allowed Ecology to better associate transit destination data with the waterways listed in the model. Ecology currently does not have transit data directly related to the waterways, but the grouping of waterways and destinations provides a strong assumption of routes taken for the different transits under consideration in this study. For example, Ecology can easily assume that the majority of transits to Vancouver, BC will travel through Haro Strait and Boundary Pass for either distance efficiency or to pick up a Canadian Pilot near Victoria, BC.

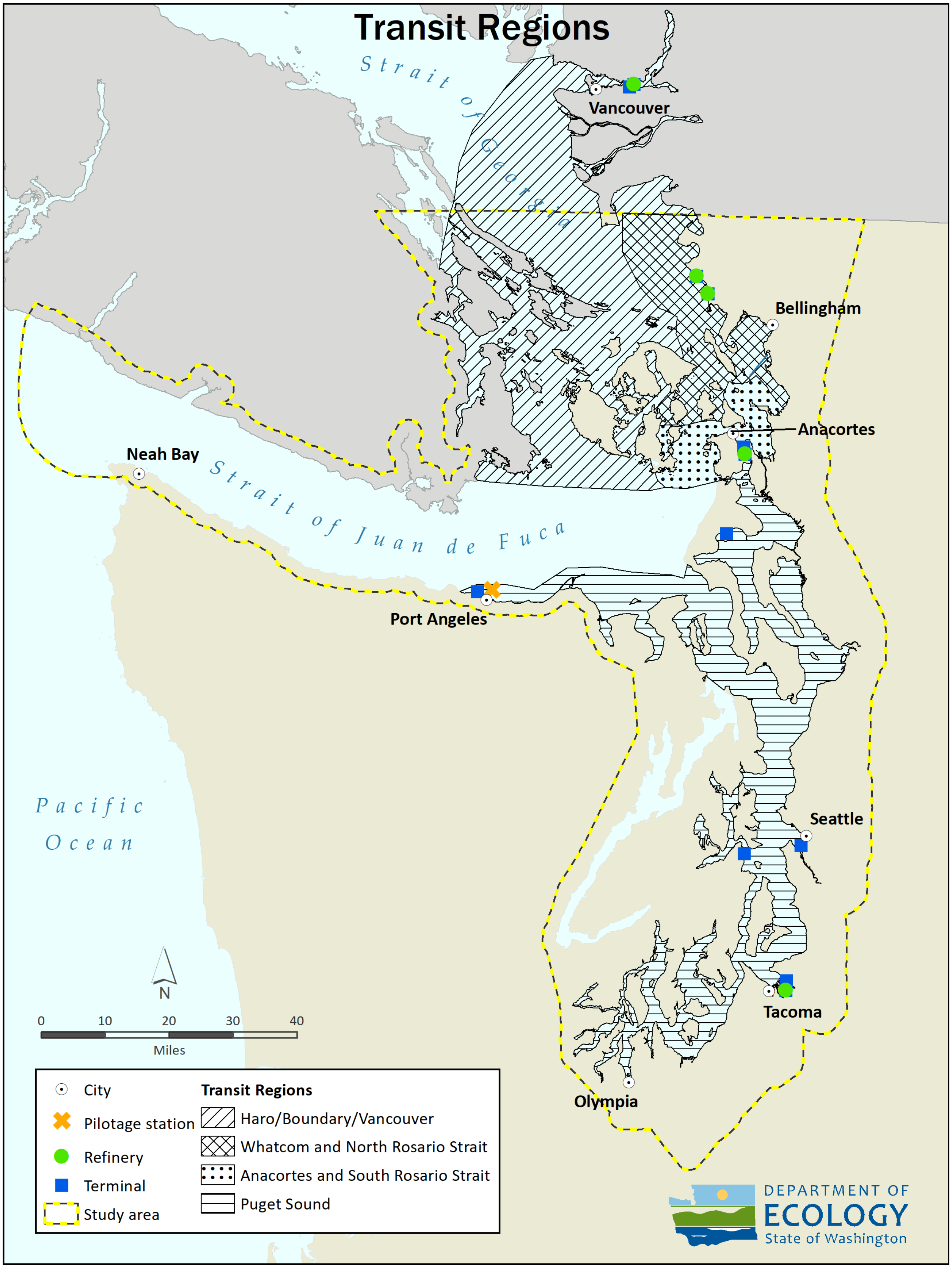


**Figure 48: Transit regions**

**Table 18: Cost increases (millions of $) under modeled scenario compared to status quo, by region**

| Transit region | Tank ships | Tank barges | ATBs | DIFFERENCE IN TOTAL COSTS BY REGION |
|---|---|---|---|---|
| **Haro/Boundary/Vancouver*** | $0 | $0 | $0 | **$0** |
| **Whatcom and N Rosario Strait** | $0 | $2.7 | $2.5 | **$5.2** |
| **Anacortes and S Rosario Strait** | $0 | $1.0 | $2.0 | **$3.0** |
| **Puget Sound** | $0 | $23.8 | $1.1 | **$24.8** |
| **DIFFERENCE IN TOTAL COST BY VESSEL TYPE** | **$0** | **$27.5** | **$5.5** | **$33.0** |

* Only tank ships (with zero cost difference between the status quo and modeled scenario) were included in the Haro/Boundary/Vancouver transit region, due to available information being limited to transit endpoints. Transit data did not allow for additional assumptions about tank barges and ATBs that may use this transit region, but this would likely shift cost differences from Rosario Strait regions.

REMI results for this difference in total expenditures indicate that a change from the status quo to the modeled scenario would result in:

- A net statewide increase in employment of 123 jobs in the first year, before prices and other economic variables adjust, levelling off near 78 jobs. This includes an initial loss of one job in petroleum products manufacturing, growing to a loss of two jobs in petroleum products manufacturing by 2028, and an initial increase of 57 jobs, levelling off near 50 jobs in marine transportation service provider industries such as tug and pilot services.
- A net statewide increase in output of $16 million, levelling off around $2 million by 2028.

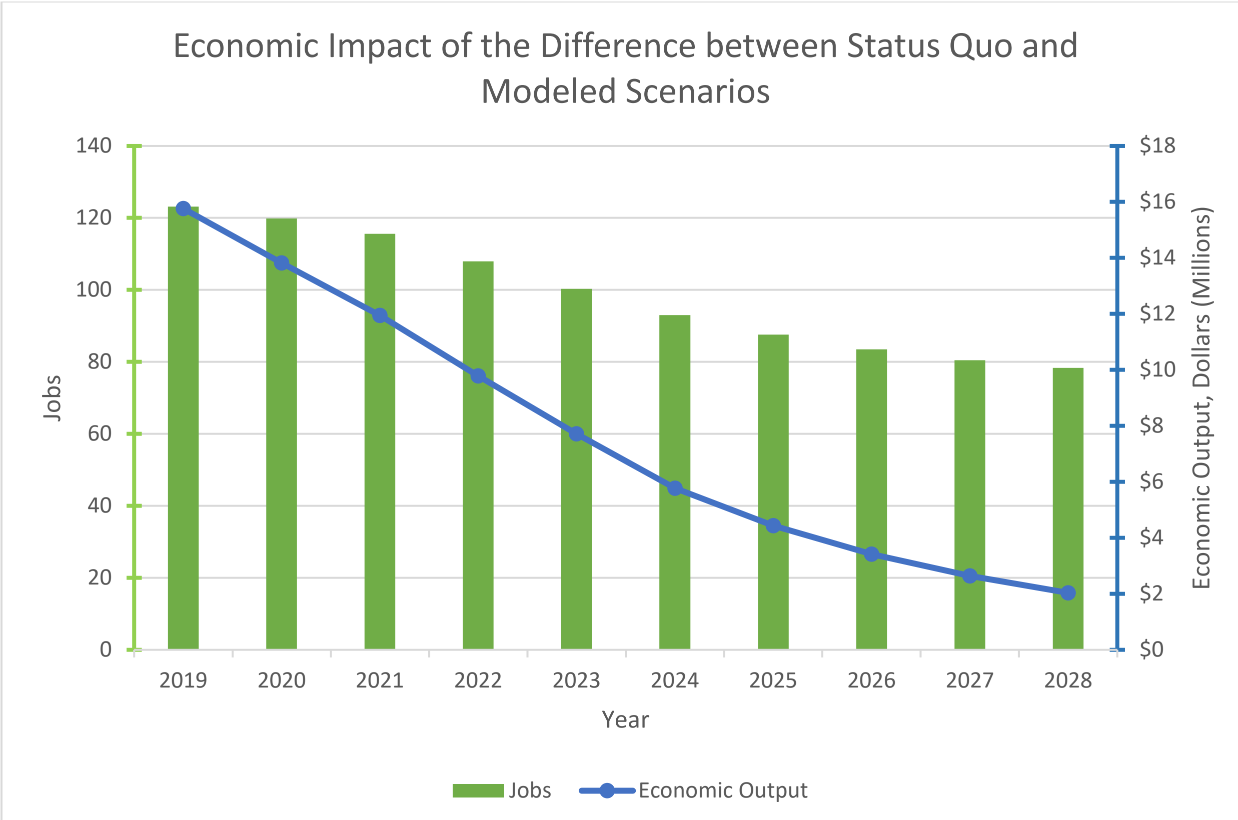


**Figure 49: Economic impact of the difference between status quo and modeled scenarios**

## Economy-wide impacts

The significant difference between total costs for the status quo and modeled scenario arises from two primary factors:

- The addition of escort and pilotage requirements for tank barges. While these are modeled as incurring generally lower pilotage costs than other vessels, the large number of transits within Puget Sound, and the addition of both types of vessel safety requirement increases costs significantly under the modeled scenario as compared to the status quo.
- The addition of escort requirements for ATBs. While not as large as the cost contribution of tank barges under the modeled scenario, the addition of escort requirements adds across-the-board costs for the ATB population.

The REMI modeling results reflect the overall operations of the state economy, within the broader scope of interstate and international imports and exports, labor and other geographic attributes, and price levels. This is reflected both in the inputs of costs to one industry being income for another, and in the results showing the responsiveness of industry and state employment and output to different types of costs and income. Industry attributes and interrelationships impact how and to what degree they respond to changes in expenditures or income. Industries like escort and pilot services that are relatively more labor-intensive are likely to respond more to income. Industries that are relatively large and broadly connected like petroleum production are likely to respond to costs less, or receive offsetting benefits from added activity in the broader economy.

The REMI results also indicate that under the modeled scenario, as compared to the status quo, the state and local government sector would experience an up to $1 million increase in output and demand.

The gradual adjustment of the economy over time is also reflected in the REMI results. While initial impacts may be large, they change and reach a new smaller equilibrium over time. These results also contextualize impacts within the state economy. None of the estimated impacts exceed one-tenth of one percent of overall state employment or output.

## Fuel-related impacts

Cost impacts to the petroleum sector raise questions of whether they result in increased fuel prices, negatively affecting households and industries that use petroleum fuels. We examined the REMI results for these potential impacts because they may be masked within the aggregate results reported in this chapter.

The REMI results indicate the modeled scenario, compared to the status quo, results in:

- A price increase of up to 0.01 percent in motor vehicle fuels, lubricants, and fluids.
- A price increase of up to 0.01 percent in fuel oil and other fuels.

As an illustration, a 0.01 percent increase in a statewide gasoline price of $3, is an increase of less than 1/3 of one cent.

These fuel price impacts are also a significant contributor to an overall price level increase for all goods of up to 0.001 percent. Note that even in light of this fuel price increase and the overall increase in the price level, there is approximately zero change in electricity and natural gas prices, and statewide personal disposable income increases by up to $9 million per year.

Some industries are more petroleum fuel intensive, and are potentially impacted more than other industries by changes in petroleum fuel prices, even if those changes are small. In the input-output matrix within the REMI model, we identified the top five industries heavily tied to output from the petroleum industry:

- Air transportation (NAICS 481)
- Truck transportation (NAICS 484)
- Water transportation (NAICS 483)
- Rail transportation (NAICS 482)
- Transit and ground passenger transportation (NAICS 485)

The limitations of the model do not allow us to explicitly identify the specific impact of modeled fuel price increases on the above industries (as isolated from combined impacts of all combined input price changes). We did, however, examine the overall impacts to these industries of the increased spending by the petroleum industry on tug escort and pilotage. The REMI results indicate that all of the above industries would experience zero or near-zero impact to output and employment as a result of the modeled expenditures.

## Unquantifiable impacts

There are additional elements that may not be included or well-reflected in these results. As mentioned, there are elements of the data and model that put upward or downward pressure on estimates. Where routes were missing, and modeled as additive segments of other routes, costs may be overestimated. Where transit data was excluded because of unknown information or no route match (less than one percent), costs may be underestimated. Omitted data, however, has limited incremental impact on the overall size of the results, due to the large number of transits included. Any assumptions made by Ecology regarding transit, escort, pilotage, and cost data are described in the Methods section of this chapter. Assumptions made on any unquantifiable imparts are discussed below.

### Anticipated benefits from added safety measures

This study operates under the assumption that additional escorts and pilotage on oil transits will influence a reduction in oil spills and their associated costs. A reduction in oil spills would have the benefit of avoided costs associated with spills. In Ecology's 2012 Final Cost-Benefit and Least Burdensome Alternative Analysis for the Oil Spill Contingency Plan (Chapter 173-182 WAC) rule update, Ecology estimated the total average cost of an oil spill in the San Juan Islands to be nearly $188 million and the total average cost of a spill in the Strait of Juan de Fuca to be roughly $43 million (Washington State Department of Ecology, 2012). Oil spill cost estimates are associated with typical economic losses from spills in Washington State related to impacts to fisheries, marine businesses and employees, vessel delays, state recreation and tourism, and other sectors. They are based on environmental and economic attributes, and response capabilities, assumed in the underlying modeling for an average spill.[93] We note that the true cost is likely significantly higher, as these quantified estimates do not include negative impacts to private property, tribal cultural values, non-use (existence and ecological) values for animals, endangered species values, quality of life impacts during a spill affecting shorelines or water access, or impacts to future generations. They are also not reflective of the high-end cost of a worst-case spill, for which initial damages would be higher, and disruptions from cleanup would be longer.

While previous research and publications have clearly shown the significant costs of spills, Ecology cannot clearly estimate cost savings from the additional protections in the modeled scenarios because the potential reduction in the occurrence or severity of oil spills is unknown.

### Behavioral changes

Other elements of uncertainty relate to behavioral changes not represented well in the primary cost model or REMI model. This might include changes to vessel types used for transport, changes to routes used, lags in market adjustment, or indirect economic outcomes arising from environmental impacts of increased escort vessel traffic. For example, firms may choose to use larger vessels to reduce the cost per unit transported, or change product sources or routes to take

[93] Modeling conducted by Etkin, D.S. (2005).

advantage of any economies of scale available in transit. If this is reflected in the economic relationships within and between industries (in the statistical and geographic relationships underlying the model), it may be captured to some extent in the REMI modeling. It may also impact spill risk.

Assuming the current labor markets for escort and pilotage services are at equilibrium under the status quo, the sudden significant increase in demand for these services may create shortages that drive up prices in these markets until the labor market can adjust. The REMI modeling is based on inflation-adjusted costs, and includes geographic, population, and labor market shifts. However, if there are barriers that delay necessary increases in services to meet demand – such as time needed to acquire additional escort tugs, or time needed to attract and certify pilots – initial costs estimated for the modeled scenario may be larger than estimated.

**Possible environmental impacts from increased escort traffic**

While additional pilotage and escorts will likely reduce the risk of oil spills within the Salish Sea, there may be small negative side effects of these safety measures. If the number of operating escort vessels grows proportionately to meet increased demand, there will likely be associated environmental impacts from increased tug escorts operations. These impacts will likely have negative economic consequences from impacts to human health, tourism, and ecological well-being. Ecology was unable to fully capture these impacts in the economic analysis due to uncertainty and the scope of this study.

Almost, if not all, tugboats operating in the Salish Sea run on powerful, large diesel engines that emit air pollutants including fine particulate matter ($PM_{2.5}$), nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOCs), and carbon dioxide ($CO_2$). Pollutants related to diesel exhaust have been linked to a number of human health issues and are a significant source of greenhouse gas emissions in Washington State. Previous research has suggested damage costs for diesel emissions in urbanized areas in excess of $1.6 million per ton for $PM_{2.5}$, $1,220 for VOCs, and $5,080 for NOx (ICF International, 2014).

According to the Puget Sound Clean Air Agency (PSCAA), about 25 percent of all diesel exhaust in the Puget Sound Region comes from the maritime sector. This includes exhaust from intra-port transportation (drayage trucks), cargo-handling equipment, locomotives, ferries, tugboats, and ocean-going vessels (Puget Sound Clean Air Agency, n.d.). Inventoried emissions from harbor vessels, which includes tugboats, have increased overall since 2005, despite significant reductions in sulfur dioxide ($SO_2$) emissions related to the use of Ultra-Low Sulfur Diesel fuels (Starcrest Consulting Group, LLC, 2018). The increase in total emissions is mostly related to additional greenhouse gas emissions, which contribute to climate change, and CO emissions from increased activity (energy consumed). As of 2016, at least 44 percent of commercial and government harbor vessels had unregulated Tier 0 diesel engines (Starcrest Consulting Group, LLC, 2018).

Additional tug escorts will increase vehicle traffic in and around Puget Sound. This may increase threats to sensitive marine fauna including ship strikes and anthropogenic noise. According to the National Oceanic and Atmospheric Administration (NOAA), Gray, Fin, Humpback, and Minke whales may be vulnerable to ship strikes in the Salish Sea and Strait of Juan de Fuca (National Oceanic and Atmospheric Administration, n.d.). Furthermore, research suggests that over 14 percent of observed whale strandings in Washington State showed signs of ship strikes (Douglas et al., 2008).

Increased marine traffic will also influence additional anthropogenic marine noise, which has been shown to have detrimental impacts on marine fauna by many publications spanning over 40 years (Williams et al., 2015). One recent study cited anthropogenic marine noise as the second-largest negative influence on the annual growth rates of Southern Resident Killer Whale (SRKW) populations (Lacy et al., 2017). See Chapter 8 for further discussion of the impacts of noise pollution from vessel traffic on SRKWs. However, recent unpublished research suggests that escorted transits may not significantly increase marine noise due to a sound "cloaking" effect that may occur when multiple vessels travel with one another (Veirs et al., 2018). Regardless, additional escort tugs traveling alone to and from the beginning or end of a transit, or other additional movement of associated support vessels, may increase marine noise pollution.

Despite the possible increase in marine noise from additional escorts, SRKWs will benefit from the reduced risk of oil spills the additional protection measure are likely to affect. A recent study estimated that a large oil spill in the Salish Sea would likely result in about 50 percent mortality among SRKWs and a small spill could result in about 12.5 percent mortality (Lacy, et al., 2017).

In addition to their intrinsic natural value, both transient killer whales and SRKWs contribute to Washington's economy. In 2008, the state's whale watching industry was responsible for over $61.4 million dollars in total expenditures and was growing at 3 percent annually, with the vast majority (>95 percent) of activity occurring in Haro Strait and Strait of Juan de Fuca (O'Connor, S, Campbell, R., Cortez, H. & Knowles, T., 2009).

## Summary

Estimated total annual costs for the status quo are $31.8 million. This reflects the costs of existing vessel traffic safety requirements across Puget Sound, including existing pilotage and escort requirements, as well as common practices and agreements.

Estimated total annual costs for the modeled scenario are $64.8 million. This reflects existing and proposed vessel traffic safety requirements across Puget Sound, including pilotage and escort requirements, as well as common practices and agreements. Significant differences from the status quo include:

- Pilotage and escort requirements for laden tank barges.
- Preemptive requirements for routes on which there are currently no known transits.
- Additional escort requirements for ATBs.
- Required pilotage where it is currently a voluntary practice.

The difference in costs across scenarios is summarized below.

**Table 19: Cost increases (millions of $) under modeled scenario compared to status quo**

| Cost type | Tank ships | Tank barges | ATBs | Total |
|---|---|---|---|---|
| **Pilotage** | $0 | $2.4 | $0.1 | **$2.6** |
| **Escort** | $0 | $25.1 | $5.4 | **$30.4** |
| **Total** | **$0** | **$27.5** | **$5.5** | **$33.0** |

Ecology also examined differences in costs across scenarios by transit region.[94]

**Table 20: Cost increases (millions of $) under modeled scenario compared to status quo, by region**

| Transit Region | Tank ships | Tank barges | ATBs | DIFFERENCE IN TOTAL COSTS BY REGION |
|---|---|---|---|---|
| **Haro/Boundary/Vancouver*** | $0 | $0 | $0 | **$0** |
| **Whatcom and N Rosario Strait** | $0 | $2.7 | $2.5 | **$5.2** |
| **Anacortes and S Rosario Strait** | $0 | $1.0 | $2.0 | **$3.0** |
| **Puget Sound** | $0 | $23.8 | $1.1 | **$24.8** |
| **DIFFERENCE IN TOTAL COST BY VESSEL TYPE** | **$0** | **$27.5** | **$5.5** | **$33.0** |

* Only tank ships (with zero cost difference between the status quo and modeled scenario) were included in the Haro/Boundary/Vancouver transit region, due to available information being limited to transit endpoints. Transit data did not allow for additional assumptions about tank barges and ATBs that may use this transit region, but this would likely shift cost differences from Rosario Strait regions.

The significant difference between total costs for the status quo and modeled scenario arises from two primary factors:

- The addition of escort and pilotage requirements for tank barges. While these are modeled as incurring generally lower pilotage costs than other vessels, the large number of transits within Puget Sound, and the addition of both types of vessel safety requirement increases costs significantly under the modeled scenario as compared to the status quo.
- The addition of escort requirements for ATBs. While not as large as the cost contribution of tank barges under the modeled scenario, the addition of escort requirements adds across-the-board costs for the ATB population.

[94] Breaking the scenario down into four transit regions allowed Ecology to better associate transit destination data with the waterways listed in the model. We currently do not have transit data directly related to the waterways, but the grouping of waterways and destinations provides a strong assumption of routes taken for the different transits under consideration in this study. For example, Ecology can easily assume that the majority of transits to Vancouver, BC will travel through Haro Strait and Boundary Pass for either distance efficiency or to pick up a Canadian Pilot near Victoria, BC.

While additional pilotage and escorts will likely reduce the risk of oil spills within the Salish Sea, there may be small negative side effects of these safety measures. If the number of operating escort vessels grows proportionately to meet increased demand, there will likely be associated environmental impacts from increased tug escorts operations, including emission of air pollutants (including greenhouse gases), and increased threats to sensitive marine fauna including ship strikes and anthropogenic noise. These impacts will likely have negative economic consequences from impacts to human health, tourism, and ecological well-being, including impacts to SRKW populations from increased vessel traffic. Ecology was unable to fully capture these impacts in the economic analysis due to uncertainty and the scope of this study.

# Chapter 11: Emergency Response System Similar to RCW 88.46.130 System for Haro Strait, Boundary Pass, and Rosario Strait

Section 206 (2)(f) of E2SSB 6269 directs Ecology to complete an assessment and evaluation of "(a)n emergency response system in Haro Strait, Boundary Pass, and Rosario Strait, similar to the system implemented by the maritime industry pursuant to RCW 88.46.130." Ecology developed the scope and goal statements below to guide this assessment and evaluation.

Scope: Describe the current emergency response system at Neah Bay, including industry management of it and contingency plan requirements for it, tug capabilities, requirement for drills and reports on its use. Describe the history of its use. Describe how a similar Emergency Response System could apply to Haro/Boundary/Rosario.

Goal: Summarize the Neah Bay emergency response towing vessel (ERTV) system including history of use, tug capabilities, and contingency plan and drill requirements. Assess the potential for a similar system in Haro/Boundary/Rosario.

E2SSB 6269 also specifies that this report will:

> …include recommendations for…the viability of…an emergency response system in Haro Strait, Boundary Pass, and Rosario Strait, similar to the system implemented by the maritime industry pursuant to RCW 88.46.130. If the department of ecology determines such a system will decrease oil spill risk, it must also recommend an action plan to implement it. (E2SSB 6269§ 206 (3)(b)(ii), Wa. 2018)

This review summarizes the Neah Bay ERTV system including history of use, tug capabilities, contingency plan requirements, and drill requirements. It also assesses the potential for a similar system in Haro Strait, Boundary Pass, and Rosario Strait and makes recommendations about an emergency response system for these areas.

## Neah Bay emergency response system

The emergency response towing vessel (ERTV) is stationed at Neah Bay to prevent oil spills from ship and barge groundings. The establishment and use of the emergency response system ERTV is defined in RCW 88.46.130 (2009) and WAC 173-182-242 (2013).

### History of the Neah Bay ERTV

The Neah Bay ERTV system was developed in an effort to prevent oil spills and protect the marine resources of the Strait of Juan de Fuca and the outer coast of Washington. Important resources in the area include the Makah Tribe's Usual and Accustomed marine area located at the marine transportation crossroads of the Strait of Juan de Fuca and the Pacific Ocean. Makah natural, cultural, and economic resources are placed at the entrance to a United States high volume port complex, Canada's largest port, the world's third largest naval complex, a national marine sanctuary, a national park, a national fish hatchery, and a national wildlife refuge.

Incidents including the 1988 *Nestucca* oil spill, 1989 *Exxon Valdez* oil spill, and the *Exxon San Francisco* and *Exxon Philadelphia* becoming disabled off the Washington coast in 1989 raised concerns of an oil spill (Washington State Department of Ecology, 2000). In 1991, the Washington Legislature called for the development of an emergency response system in the Strait of Juan de Fuca by July 1, 1992 (ESHB 1027, Wa. 1991).

A series of reports, studies, task forces, and other processes developed recommendations for the specifics of the emergency response system. Systems considered or tried included an ERTV, tug escorts, and a tug-of-opportunity system. In 1999, the *New Carissa* grounded on the Oregon Coast, causing a 40,000 gallon oil spill. In response to the grounding of the *New Carissa*, Congressman Norm Dicks secured funding for an ERTV that was contracted and in place March-April of 1999. Washington State provided funding for the ERTV during the winter of 1999-2000 through the Governor's emergency fund, and supplemented by the federal government. Beginning in 2000, the Legislature began appropriating funding for an ERTV at Neah Bay (Washington State Department of Ecology, 2000). The tug was initially funded during winter months only, but by 2008, the Legislature committed $3.6 million to fund a tug full-time and year-round (Howard, 2018).

Public funding continued until 2010, when management of the ERTV transitioned from the state to the regulated shipping industry, as it became an obligation to regulated commercial vessels through their contingency plans.

Today the ERTV is funded by U.S. regulated commercial vessels that transit to or from Washington ports through the Strait of Juan de Fuca. This includes tank vessels of any size, cargo vessels including fishing and freight vessels, and passenger vessels of 300 or more gross tons (Wash. Admin. Code § 173-182-030, 2016). The oil spill contingency plans for these vessel operators describe the conditions under which the tug would be called out and contain information about how to contact the tug when it is needed.

## Current operation of the Neah Bay ERTV

### Area of operation

The ERTV is available to serve vessels in the Strait of Juan de Fuca and off of Washington's western coast from Cape Flattery Light in Clallam County south to Cape Disappointment Light in Pacific County (Wash. Rev. Code § 88.46.130, 2009). The coverage area is shown on Figure 50. Should the ERTV be dispatched too far off station, regulated industry provides a back-up asset for the Neah Bay area.

### Tug capabilities

The required tug capabilities are outlined in the Emergency response system —Vessel planning standards in RCW 88.46.135 (2009). The ERTV must be capable of being underway within 20 minutes of call out, able to deploy 24 hours a day, and safely crewed to remain underway for a minimum of 48 hours. It also must be able to hold or tow a drifting vessel of 180,000 metric deadweight tons (DWT) and hold position within 100 feet of another vessel even in severe weather conditions. The ERTV must be equipped and able to deploy a ship anchor chain recovery hook and line throwing gun and capable of a bollard pull of at least seventy short tons.

It must also be staged with equipment for damage control patching, vessel dewatering, air safety monitoring, and digital photography (Wash. Rev. Code § 88.46.135, 2009).

The supplier for the ERTV is selected by a maritime industry stakeholders group. The current contract for ERTV services is with Foss Maritime. In August 2017, the tug *Denise Foss* was stationed at Neah Bay. The *Denise Foss* is expected to be the tug on station through the end of the current contract in 2020 (Marine Exchange of Puget Sound, n.d.-b).

### Funding and management oversight

The Marine Exchange of Puget Sound provides administrative services for the ERTV including invoicing, collection of vessel assessments, and payment of ERTV expenses (Washington State Department of Ecology, 2018g).

Total cost for the ERTV is shared between tank and non-tank vessel sectors, with assessments for each sector calculated separately. Credits are also available to acknowledge additional prevention measures such as independent dual propulsion, double hull for tank ships, protectively located fuel tanks, membership in Ecology's Exceptional Compliance Program (ECOPRO) for tank vessels, and certification under ISO 14001 (Marine Exchange of Puget Sound, n.d.-b).[95]

Although only regulated commercial vessels are subject to the ERTV requirement, the ERTV is available to any vessel in the transit area needing assistance and hired under a separate contract for all call outs (Marine Exchange of Puget Sound, n.d.-b). Additionally, both Ecology and the U.S. Coast Guard can call out and contract the ERTV if needed (Washington State Department of Ecology, 2018g).

### Drills

Among the oil spill drills required under WAC 173-182-710 (2016), a deployment drill of the ERTV is required at least once in each triennial drill cycle. Plan holders are also able to request drill credit for an actual deployment of the ERTV to respond to a spill or vessel emergency, as long as they follow the procedures in WAC 173-182-730 (2006).

## Usage of the Neah Bay ERTV

### History of usage of the ERTV

Despite the fact that the ERTV at Neah Bay was not initially stationed year-round, it has been deployed to assist vessels 68 times. This includes assistance to 20 vessels that were heading to or from Canada. Primarily, the ERTV has stood by a drifting vessel until it can make repairs or escorted a vessel experiencing a mechanical malfunction, except in 20 cases when the ERTV towed vessels that were drifting. The ERTV has covered a large geographic area to provide assistance—from several hundred miles west of the middle of Vancouver Island, to the north Oregon Coast, to as far east as the Strait of Juan de Fuca near Sooke Inlet, Vancouver Island

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[95] The Marine Exchange of Puget Sound is working to update the calculation for the ERTV assessment to reflect that all entering tank ships are double-hulled.

(Figure 50). Information on specific Neah Bay ERTV deployments can be found on Ecology's website.[96]

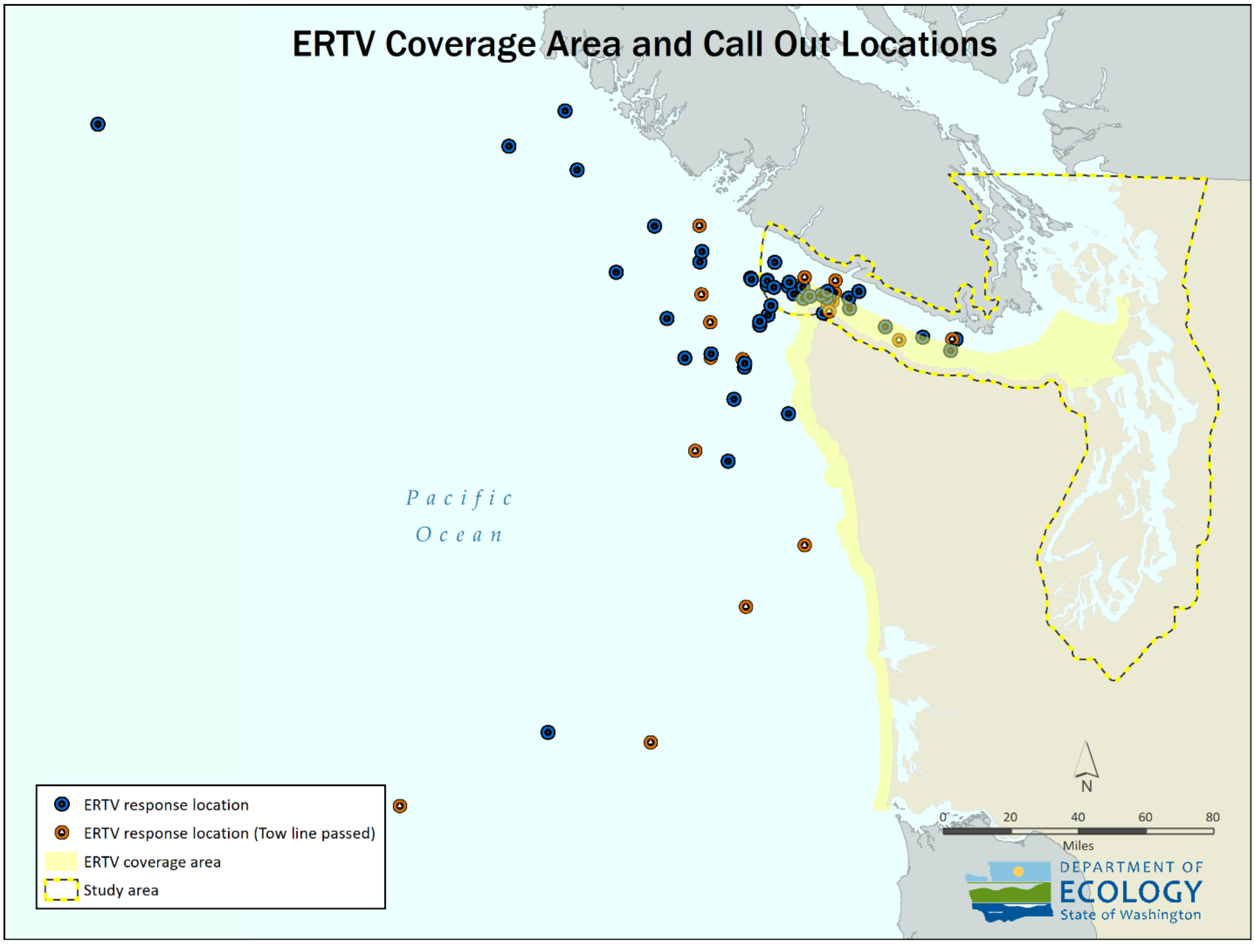


**Figure 50: Neah Bay ERTV coverage area and call out locations**[97]

A recent assist occurred in December 2017 when the 751-foot inbound cargo ship *Evmar*, with a fuel capacity for about 697,000 gallons of fuel oil, drifted quickly across the Strait of Juan de Fuca to within a mile of Vancouver Island's shores before being towed to safety to Port Angeles by the acting ERTV, *Denise Foss* (Figure 51).

[96] https://apps.ecology.wa.gov/coastalatlas/storymaps/spills/spills_sm.html?&Tab=nt2

[97] Map shows all tug call outs through July 31, 2018 except one call out that is outside of the range of this map, a January 2018 loss of propulsion where the Denise Foss traveled about 530 miles from Neah Bay to meet and tow the vessel.

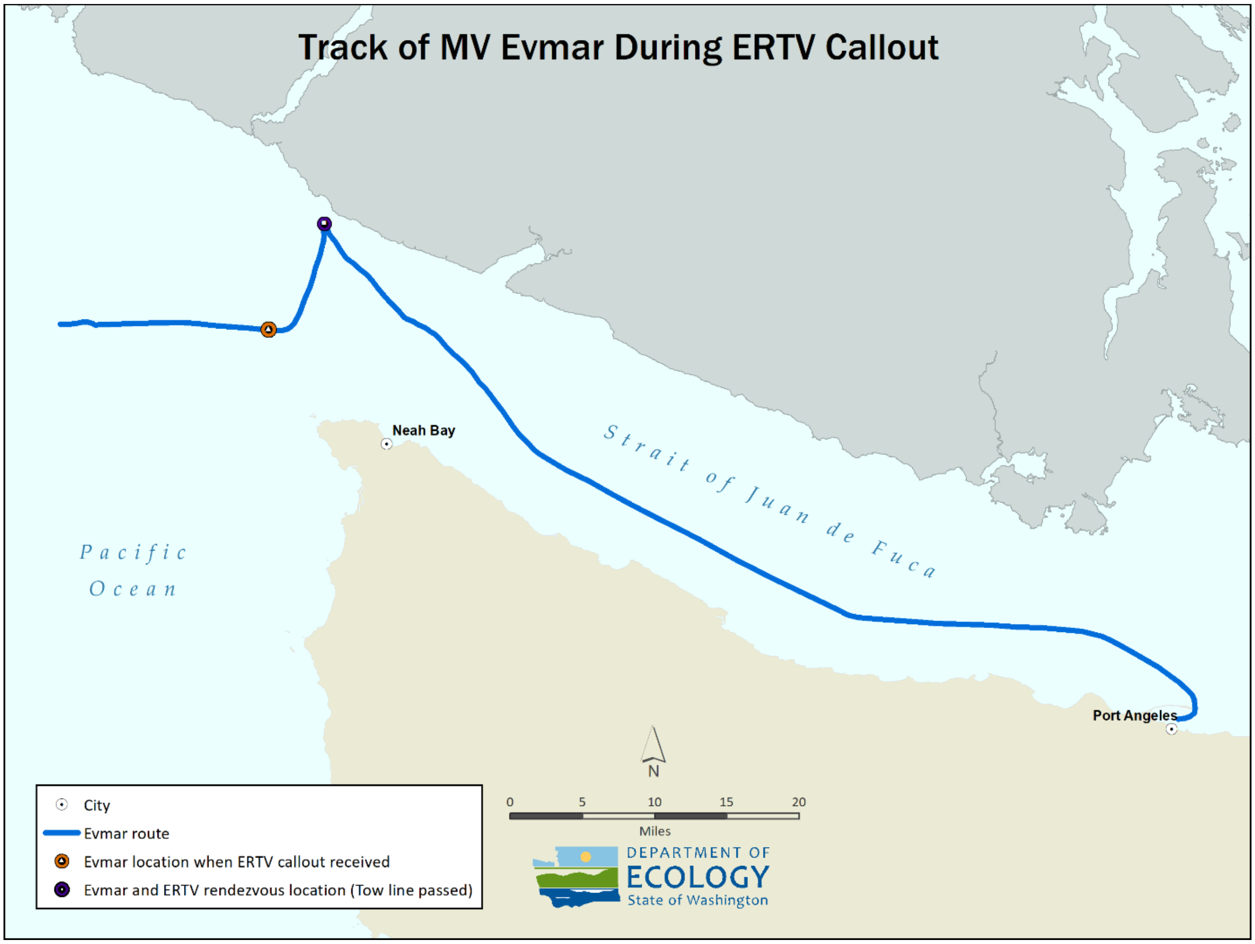


**Figure 51: Track of the *MV Evmar* during the ERTV callout showing the drift path towards Vancouver Island, and path while under tow by the tug *Denise Foss*.**

## Potential for emergency response system in Haro Strait, Boundary Pass, and Rosario Strait

Ecology has examined the nature of vessel traffic in the study area, history of incidents, and previous studies in order to arrive at conclusions and recommendations. Studies reviewed include:

- *2015 Vessel Traffic Risk Assessment* (VTRA) (Van Dorp & Merrick, 2016).
- 2014 *Gateway Pacific Terminal Vessel Traffic and Risk Assessment Study* (Kirtley, 2014).
- 2013 *West Coast Spill Response Study* (Nuka Research & Planning Group, LLC, 2013).
- 2004 *Study of Tug Escorts in Puget Sound* (Gray & Hutchison, 2004).

## Summarizing vessel traffic in the study area

The international boundary between the U.S. and Canada passes through Haro Strait and Boundary Pass to the Georgia Strait. As discussed in Chapter 8, a Cooperative Vessel Traffic Service (CVTS) is administered by the Canadian and U.S. Coast Guards which provides year-round radar and radio coverage 24 hours per day. As part of the CVTS, and with the cooperation of industry and the British Columbia Coast Pilots, a Special Operating Area (SOA) has been established at the intersection of Haro Strait and Boundary Pass in the vicinity of Turn Point Light. Puget Sound Vessel Traffic Service (VTS) provides radar and radio coverage for Rosario Strait (National Oceanic and Atmospheric Administration, 2018). See Chapter 8 for more information on VTS.

On average, there are about 8,300 annual transits by deep-draft vessels in and out of the Strait of Juan de Fuca (including arrivals and departures). Including north and south bound transits, about 5,500 of these deep-draft vessels travel to and from the Port of Vancouver, BC, and about 3,700 (north and south bound) transit the entrance of the Puget Sound (at Admiralty Inlet) (Van Dorp & Merrick, 2016).[98] Chapter 4 provides more information on vessel traffic, and describes historical vessel traffic volumes and potential future changes in vessel traffic in the study area.

As discussed in Chapter 4, ports in Washington and Canada anticipate low to moderate growth in the future, yet these projections could change if expansion projects in Canada are completed, or if new projects in Washington or British Columbia are developed in the future.

The 2010 and 2015 VTRAs discussed vessel traffic and relative risk for the study area. Haro Strait and Boundary Pass experience greater numbers of vessel transits and thus greater exposure to potential incidents that may lead to an oil spill (Van Dorp & Merrick, 2016), while Rosario Strait experiences significant traffic by laden tank vessels to and from refineries and terminals in northeast Puget Sound (Van Dorp & Merrick, 2014). The San Juan Islands are between these waterways with significant natural, cultural, recreational, and tribal resources. Additionally, the Canadian Gulf Islands to the northwest have similar exceptional resources.

## Oceans Protection Plan and other potential changes to mitigate risk in Canadian waters

The Government of Canada announced the development of an Oceans Protection Plan (OPP) which includes a $1.5 billion investment over five years in coastal protections designed to achieve an improved marine safety system (Transport Canada, 2016). This includes, among other things:

- 24/7 emergency management capacity for the Canadian Coast Guard in its three operational regions.
- Lease of two new Canadian Coast Guard vessels with the ability to tow large commercial ships, including tank ships. Additional towing capacity will be added to major Canadian Coast Guard vessels.

[98] These figures include internal movements between Washington and British Columbia, but do not include passenger vessel transits.

- Additional response equipment including booms, skimmers and storage.
- Increased training and exercises for spills on water.

In addition, the National Energy Board of Canada (NEB) has completed its review of the Trans Mountain Pipeline System and Expansion Project (TMEP) that would develop 987 kilometers (613 miles) of new buried pipeline to loop the existing Trans Mountain Pipeline (TMPL) and move oil from Edmonton, Alberta to Burnaby, BC. From Burnaby, the oil would be loaded onto to tank ships outbound to Pacific Rim destinations, the number of which would greatly increase due to the expansion (Chapter 4 discusses the TMEP and potential future vessel trends). The Canadian government has approved the Kinder Morgan TMEP subject to 157 NEB conditions which must be met throughout the lifecycle of the project. The conditions include tug escort of outbound laden tank ships from the Westridge Marine Terminal to Buoy J and other measures that may mitigate oil spill risk (National Energy Board of Canada, 2016).

## Assessing potential tug stations

As described earlier, an ERTV has been stationed at Neah Bay since 1999. Proposals to enhance or build new cargo or oil terminals in waters of British Columbia, and one in Washington waters, have generated interest in an ERTV for Haro and Rosario Straits. Four stations have been studied: Sydney, Victoria, and Bedwell Harbor, BC (Van Dorp & Merrick, 2016), and Lawrence Point in San Juan County, Washington (Gray and Hutchison, 2004). Criteria for choosing a strategic location to station an ERTV were not included in the studies. Additionally, pre-positioning of a multi-mission ERTV for Haro Strait/Boundary Pass was identified as number three of the top nine risk mitigation measures during the 2016 Salish Sea Oil Spill Risk Mitigation Workshop (Washington State Department of Ecology, 2016).

### 2015 Vessel Traffic Risk Assessment

As described in chapter 9, Ecology sponsored the 2015 VTRA to update the 2010 VTRA, a previous analysis of oil spill risks in the Salish Sea (Van Dorp & Merrick, 2016). Funded by the Makah Tribe and the Puget Sound Partnership (Partnership), the 2010 VTRA evaluated potential changes in oil spill risk within a defined study area based on three proposed marine terminals (Van Dorp & Merrick, 2014). The 2015 VTRA updated the 2010 report by incorporating 2015 vessel traffic, recalibrating the 2010 model to include additional accident data, updating the potential future scenarios considered in the analysis, and describing new potential risk reduction measures (Van Dorp & Merrick, 2016).

Two risk reduction measures in the 2015 VTRA examined the potential effects of stationing additional ERTVs to complement the existing ERTV at Neah Bay. In one case, a single additional ERTV was assumed to be stationed at Sidney, BC. A second case assumed two additional ERTVs: one stationed at Victoria, BC and one at Bedwell Harbor, BC.

The 2015 VTRA report includes graphic depictions of approximate escort coverage provided by the modeled ERTVs.

- Escort coverage, as used in the 2015 VTRA, describes the ability of an ERTV to respond to a vessel experiencing a loss of propulsion or loss of steering casualty, in order to prevent the vessel from grounding.

- Escort coverage is displayed using a color scale that ranges from red to green.
- A red square indicates a vessel in the location shown which experiences a loss of steering or loss of propulsion casualty would receive no benefit from the ERTVs modeled in the scenario (i.e., an escort benefit of 0).
- A green square indicates a vessel in that location would receive a benefit equivalent to being escorted by a dedicated tug (i.e., an escort benefit of 1).
- Colors between red and green, ranging from orange to yellow, indicate partial escort coverage. In these locations, a vessel experiencing a loss of propulsion or loss of steering casualty would receive an escort benefit between 0 and 1, indicating that the ERTVs modeled in the scenario provide some benefit, but do not offer the same level of protection against grounding accidents that a vessel would receive from a dedicated tug escort.

Figure 52 shows the approximate escort coverage for the existing ERTV stationed at Neah Bay, as modeled in the 2015 VTRA.

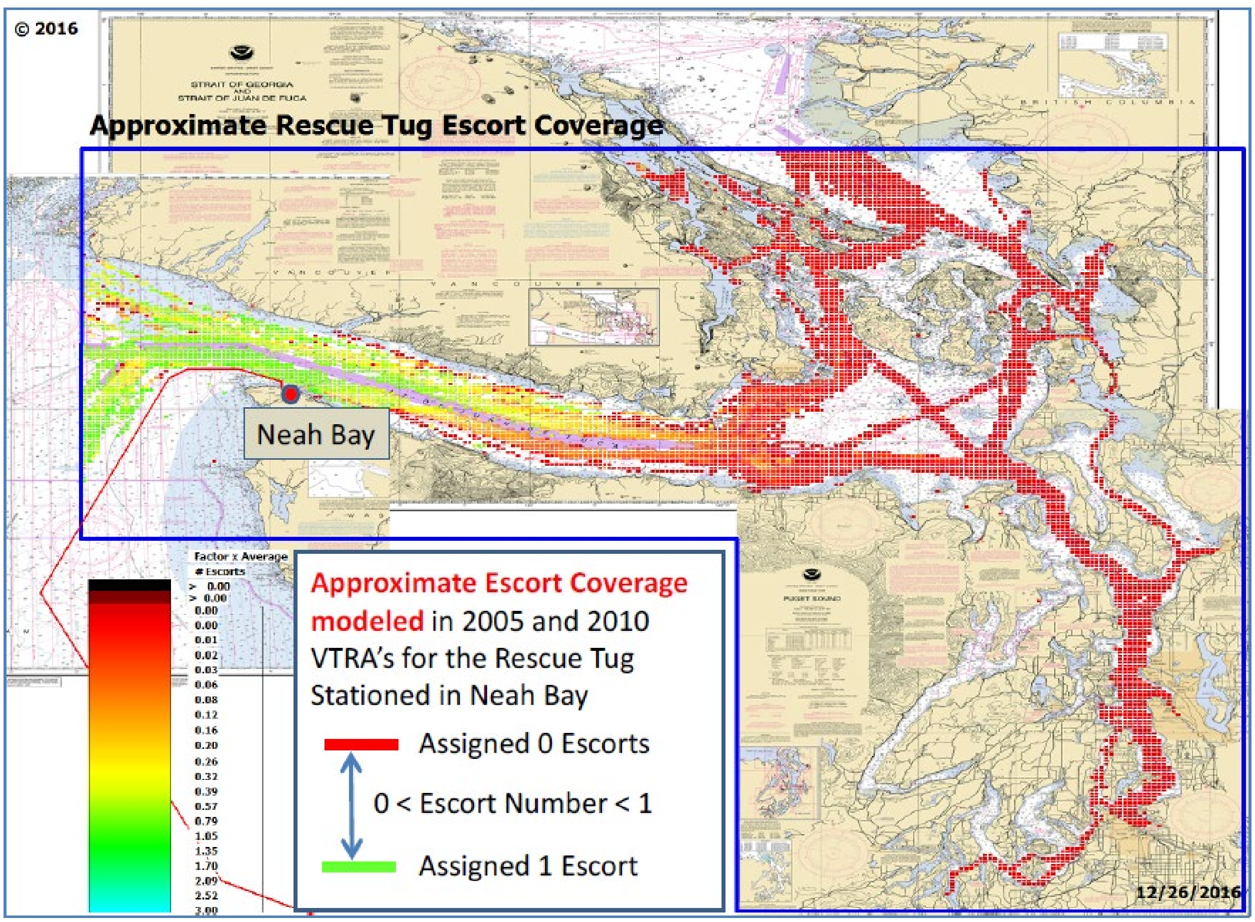


**Figure 52: Graphical representation of approximate escorting coverage modeled for the Neah Bay ERTV in the 2015 VTRA Model (Excerpt from Van Dorp & Merrick, 2016, p.151)**

As noted in the 2015 VTRA report, the graphical representation in Figure 52 indicates that the closer a vessel travels to Neah Bay, the larger the partial escort benefit assigned, with a maximum benefit of 1. Green represents the most effective response, while red indicates zero effectiveness. It is clear that the farther the ERTV must travel, the less time it has to prevent a grounding, allusion, or collision.

Figure 52 shows the Neah Bay ERTV, as modeled, provides some benefit for vessels in the Strait of Juan de Fuca and offshore, but does not provide coverage for vessels in Haro Strait, Boundary Pass, Rosario Strait, or the Puget Sound. The most benefit shown in Figure 52 is within an ellipse centered on Neah Bay that extends approximately 20 miles to the east and west.

Figures 53 and 54 show the approximate escort coverage for an additional ERTV stationed at Sidney, BC, and Victoria, BC, and Bedwell Harbor, BC, respectively.

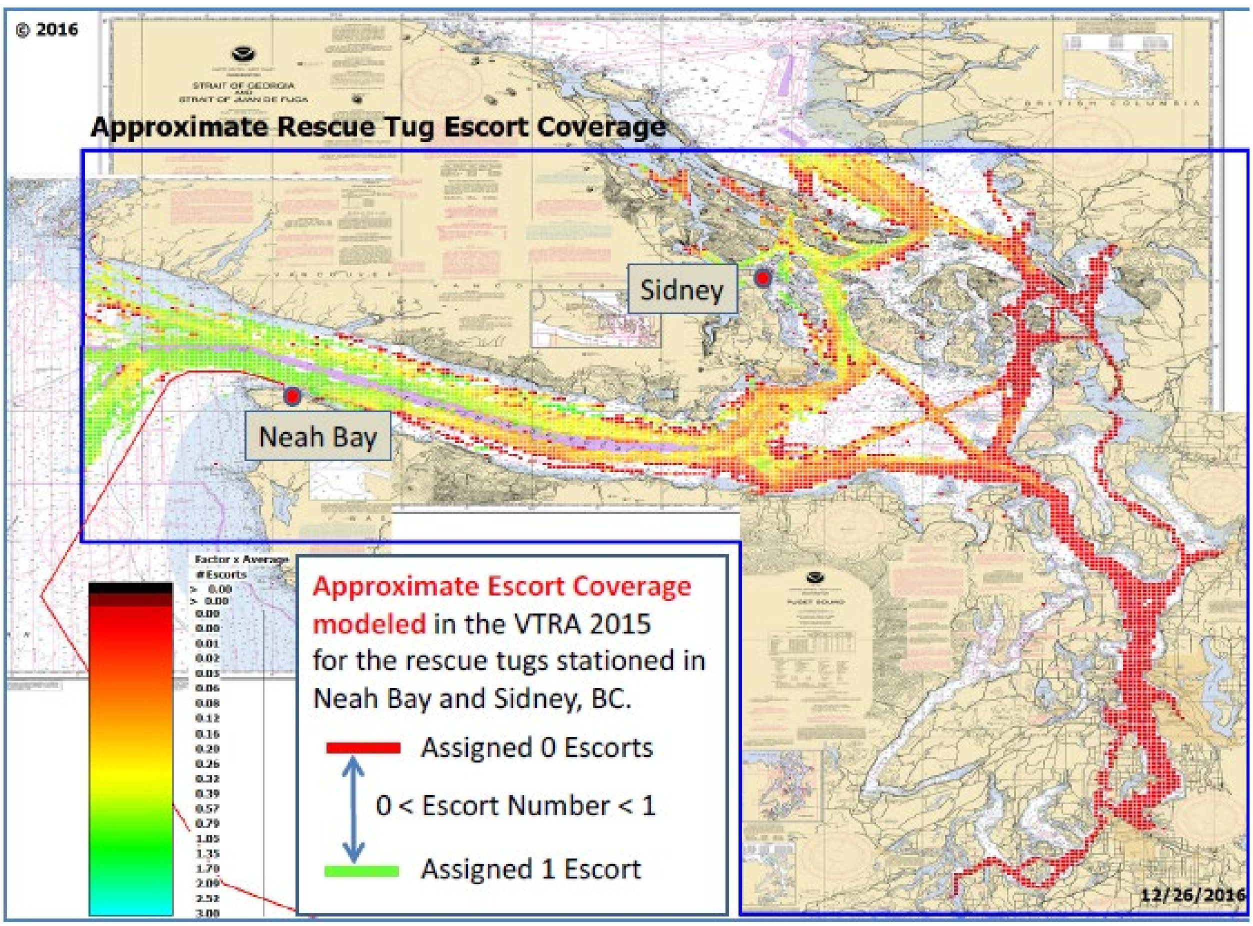


**Figure 53: Graphical representation of approximate escort coverage modeled for the Neah Bay and Sidney, BC ERTVs in the 2015 VTRA Model (Excerpt from Van Dorp & Merrick, 2016, p.152)**

The 2015 VTRA report describes the approximate escort coverage shown in Figure 53:

> One observes…predominantly yellow colors on average being assigned to focus vessels travelling through the Haro Strait/Boundary Pass and Southern Gulf

> Islands waterway zones indicating an assigned partial escort number benefit of about the value 0.3 attributable to the modeled Sidney, BC, rescue tug location…
>
> …More orange colors in the Haro Strait/Boundary Pass and Southern Gulf Islands indicate a partial escort number benefit being assigned in the VTRA model attributable to the modeled Sidney, BC, rescue tug location closer to the value of 0.15 (or even a lesser value the darker the orange color in the these grid cells).
>
> One does, however, observe some bright greener colored grid cells in the Haro Strait/Boundary Pass and Southern Gulf Islands waterway zones that are on average assigned in the VTRA model to those focus vessels travelling towards the modeled Sidney, BC, rescue tug location both North and South of Turn-Point (Van Dorp & Merrick, 2016, p.151).

As with Figure 52, Figure 53 shows the best coverage in vicinity of Neah Bay can be described as an ellipse centered on Neah Bay with a semi-major axis of approximately 20 miles. Around Sidney, the greatest benefit appears to be within a circle, with a center point within the waters of Haro Strait adjacent to Sidney Island, with a radius of approximately 8 to 10 miles.

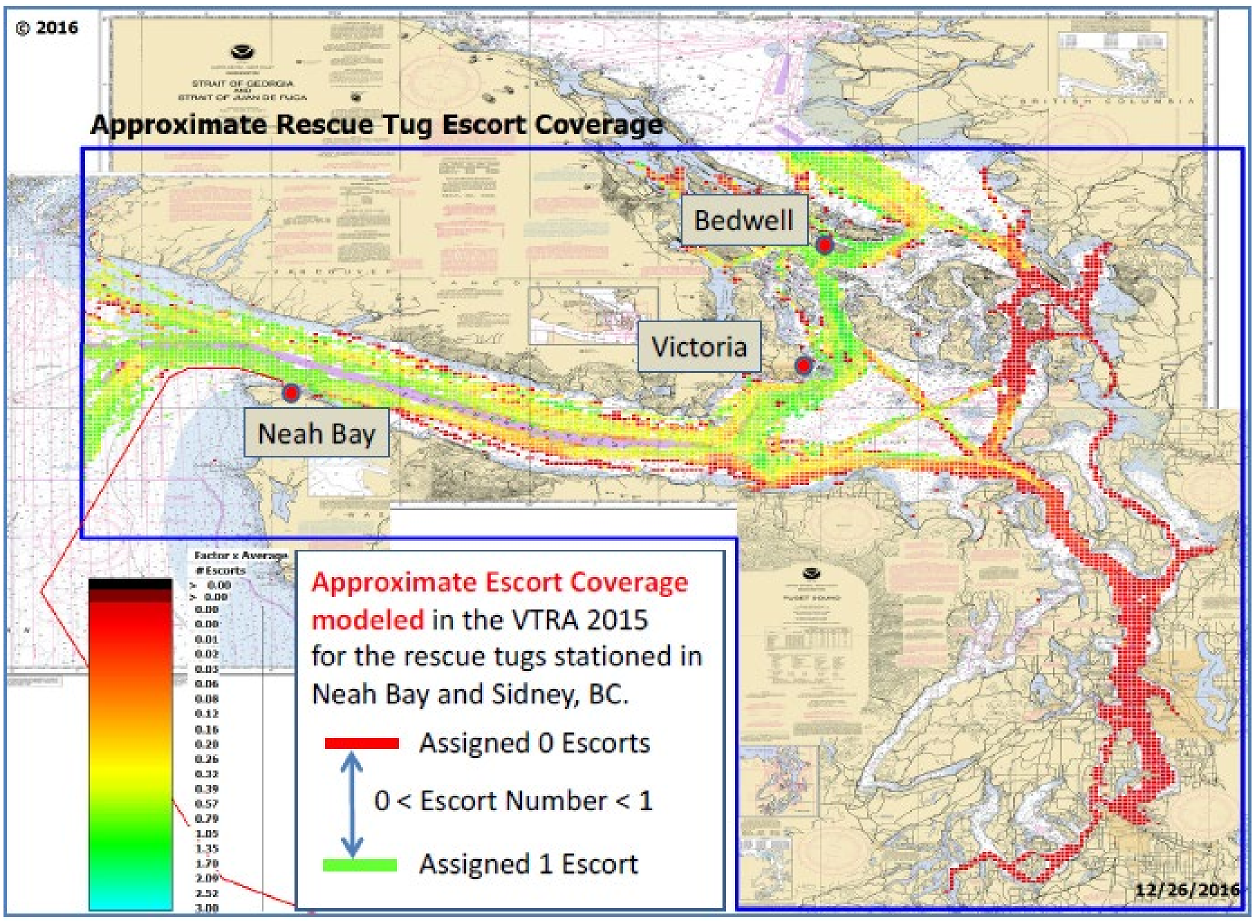


**Figure 54: Graphical representation of approximate escort coverage modeled for the Neah Bay, Victoria, BC, and Bedwell Harbor, BC ERTVs in the 2015 VTRA Model (Excerpt from Van Dorp & Merrick, 2016, p.152).**

Comparing Figures 53 and 54, the model predicts that an ERTV stationed in Victoria, BC and in Bedwell Harbor, BC would provide better escort coverage for Haro Strait, Boundary Pass, and the Southern Gulf Islands, relative to a single ERTV stationed at Sidney, BC. In Figure 54, the area of escort coverage that approximates the benefit of a dedicated tug escort extends nearly continuously from the southern Strait of Georgia through Boundary Pass and Haro Strait.

Other areas in the 2015 VTRA study area, including Rosario Strait and Puget Sound, receive little to no benefit from the two additional ERTVs shown in Figure 54.

### 2014 Gateway Pacific Terminal Vessel Traffic and Risk Assessment Study

In 1991, Pacific International Terminals (PIT) applied to develop a marine terminal at Cherry Point, Washington to be known as the Gateway Pacific Terminal (GPT). Ecology oversaw an analysis by PIT of the additional ship traffic that would result from the proposed GPT. Additional topics were suggested for the analysis by the Lummi Nation and agreed to by Ecology and PIT. The vessel traffic and risk assessment study was conducted by The Glosten Associates, Inc. and published in 2014. The study area included the designated Puget Sound vessel transit lanes in the Strait of Juan de Fuca, Rosario Strait, Boundary Pass, and Haro Strait, the maneuvering area near the proposed GPT at Cherry Point, the local anchorage areas, and the transit routes for assisting GPT traffic (Kirtley, 2014).

The study considered the potential effectiveness of alternative vessel traffic management schemes including the use of standby rescue or response tugs. The analysis considered the likelihood that use of response tugs could prevent a collision, allision, or grounding of any vessel traffic in the study area. Kirtley (2014) found:

> …one or more ERTVs could be stationed in Haro Strait and/or Rosario Strait to respond to disabled vessels on those routes, including vessels bound to and from GPT. However, due to the comparatively narrow geography surrounding these waterways, there is limited sea room (i.e. time) for ERTV response in the event of propulsion, steering, or control system failure…It is likely that in many cases a Tug of Opportunity would be able to respond more quickly than pre-positioned ERTVs, under the existing International Tug of Opportunity System (ITOS). For this reason, this management scheme is considered less effective than voluntary speed reduction, which is more preventative in nature. (p. 30)

### Additional studies of tug response options

The British Columbia Ministry of Environment commissioned a report to provide an assessment of the current oil spill prevention and response regime on the west coast. Nuka Research conducted a study, which included information and analysis to "provide one perspective on what a world-class system might look like on Canada's west coast" (Nuka Research & Planning Group, LLC, 2013, Vol. 1 p.3).

In a discussion of ERTVs, the Nuka study found:

> Unlike escort tugs, rescue tugs do not accompany vessels along transit routes, but are available to respond to a navigational emergency and potentially prevent or mitigate and accident or spill. There are no rescue tugs stationed in BC, but there is a rescue tug stationed just over the US border in Neah Bay, Washington…that could provide some emergency towing support to an incident in BC waters, if the State of Washington allows

> the tug to be released, though there is no specific mechanism designed to facilitate this. BC currently relies on a tug-of-opportunity system for rescue services. A tug of-opportunity system provides a less costly but also less certain rescue tug response capacity by relying on nearby commercial tugs to provide rescue services, if needed. The Canadian and US vessel traffic services track tug availability as part of the International Tug of Opportunity System (ITOS), which allows for a quick assessment of nearby tugs in the event of an emergency. There is no guarantee that appropriately sized or capable tugs-of opportunity will be available or proximate to the vessel in need of assistance. If a tug-of-opportunity already has a vessel or barge in tow, there may be additional delays associated with safely releasing the primary tow so that the tug can respond to the emergency. Tugs-of-opportunity can be an effective prevention measure for certain types of accidents (i.e. drift groundings), but would not be as effective as an escort tug in preventing collisions or powered groundings (U.S. Coast Guard, 1999). (Nuka Research & Planning Group, LLC, 2013, Vol. 1 pp.23-24) [99]

Ecology notes that the ITOS no longer exists as a formal program, but the concern raised in the Nuka study about the uncertain availability of a near-by tug to respond to a vessel casualty remains valid (Allan & Phillips, 2013).

When the ITOS system was in place with voluntary participation from towing companies, the U.S. Coast Guard study cited in the Nuka report estimated that ITOS tugs would likely result in a reduction of 3 to 6 percent of drift groundings. ITOS was evaluated as the least effective of eight oil spill prevention methods studied by the Coast Guard (U.S. Coast Guard, 1999).

The naval architecture firm Robert Allan, Ltd reviewed Canadian towing vessels to assess the capability of potentially available tugs to provide rescue and escort services. Their report found that out of 1,200 tugs registered in the Canadian Pacific Region, only 32 had the size, horsepower, and bollard pull to be considered candidates for rescue or escort duties. Of these, eight were evaluated as being capable of performing rescues, and three were identified as suitable for escort or rescue operations in the Strait of Juan de Fuca (Allan & Phillips, 2013). While beyond the scope of the report, the firm attempted to identify the approximate number of U.S. registered tugs which could be in the vicinity of North Puget Sound or Strait of Juan de Fuca. The study found 55 tugs of a size that could be considered capable of rendering rescue towing capability, and 25 tugs with more than 60 tons bollard pull (Allan & Phillips, 2013).

From these studies, Ecology concludes that a tug-of-opportunity system should best be considered a contingency strategy, rather than a primary oil spill prevention tool. There are significant uncertainties associated with the availability of a capable tug in the right location, the ability of the towing company to change the tasking of the tug to participate in a rescue attempt, the level of training and proficiency of the crew, and the presence of emergency towing equipment. While steps can be taken to reduce some of these uncertainties through planning,

[99] Ecology notes that the current ERTV stationed at Neah Bay does respond to vessels inbound and outbound from British Columbia. The Neah Bay ERTV is available to serve vessels in the Strait of Juan de Fuca and off of Washington's western coast from Cape Flattery Light in Clallam County south to Cape Disappointment Light in Pacific County (Wash. Rev. Code § 88.46.130, 2009).

communications, and training, Ecology's review of existing studies and data does not support a recommendation of tugs-of-opportunity as a quantifiable risk reduction measure.

## Consideration of a sentinel tug as an emergency response system

In 2004, Ecology sponsored a study of Washington's tug escort system. The topic of tug escorts was discussed in more detail in Chapter 9. However, this 2004 study also identified the potential use of a sentinel tug as an emergency response measure, so it is discussed in this section. Gray and Hutchison (2004) state that "a sentinel-tug system is recommended as an alternative to tug escort for redundant-system tankers, provided it is developed as part of an overall system to reduce risk of oil spill for tanker transits of Puget Sound" (p.12-1). They recommended further evaluation of this option.

This study considered the sentinel tug as an alternative to escort tugs. The system that was proposed was to pre-position a sentinel tug near Lawrence Point in Rosario Strait any time that a redundant-system tank ship subject to state tug escorts was entering Puget Sound waters and traveling east of a line between Dungeness Light and Discovery Island Light. The tug would remain on station at Lawrence Point until the tank ship arrived at its destination at Cherry Point or March Point. The purpose of the sentinel tug was to escort the tank ship if it had a single system failure while transiting the area. Because the study addressed redundant-system tank ships, even with a single failure the tank ship would still be capable of proceeding without a significant loss of maneuverability. The sentinel tug would be dispatched to escort the tank ship to anchorage, the dock, or open water, and the tank ship would proceed under its own power (Gray & Hutchison, 2004).

The time required for the sentinel tug to reach the tank ship varies on the location of the tank ship, speed of the tug, and ocean conditions. However, the study determined that all of North Puget Sound (defined as Rosario Strait to Cherry Point) could be reached within two hours by a tug from the pre-positioned location at Lawrence Point. The study found that pre-positioning a sentinel tug for transits of redundant-system tank ships reduces the probability of grounding when compared with the non-escort of the same type of tank ships (Gray & Hutchison, 2004). Gray & Hutchison (2004) recommended considering a sentinel tug as a part of an overall system to reduce the risk of groundings of transiting tank ships.

## Funding options for an ERTV

Funding options for a potential ERTV in Haro Strait, Boundary Pass, and Rosario Strait will depend on the location and type of system developed. Options could include:

- Cross border public funding
- Combination of public/private funding
- Private funding similar to the Neah Bay ERTV

The history of funding for the Neah Bay ERTV and the shift from temporary funding provided through federal and state funds to the current system of funding through regulated industry could inform the development of the new system. Consideration should be given to ensure that funding addresses the risk borne by vessels traveling through the area to both U.S. and Canadian ports.

This is consistent with legislative direction Ecology received from the Washington State Legislature in 2009 regarding cost sharing for the Neah Bay Tug (ESSB 5344, Wa. 2009).

## Summary

The risk reduction provided by an emergency response system would be highly dependent on a variety of factors, including where a new ERTV was stationed; the distance from the ERTV to a vessel in need of assistance when an incident occurred; weather and tidal current conditions during an incident; and how quickly the ERTV could get underway, transit to the incident vessel, and begin providing assistance.

There are also significant differences between the waters surrounding the San Juan archipelago and the Strait of Juan de Fuca, which should be considered when comparing a potential new emergency response system to the existing ERTV at Neah Bay. These differences include the relatively narrow and navigationally complex waterways of Haro Strait, Boundary Pass, and Rosario Strait; the lack of an immediately identifiable location within Washington to station an ERTV; and the distances between Haro and Rosario Straits, which would likely preclude one ERTV from effectively providing a benefit to both areas.

Two risk reduction measures in the 2015 VTRA examined the potential effects of stationing additional ERTVs to complement the existing ERTV at Neah Bay. In one case, a single additional ERTV was assumed to be stationed at Sidney, BC. A second case assumed two additional ERTVs: One stationed at Victoria, BC and one at Bedwell Harbor, BC.

The 2015 VTRA results showed a 1.2 percent reduction in potential oil loss for the entire VTRA study area by stationing an additional ERTV at Sidney, BC. The 2015 VTRA also provides graphical representations of the approximate escort coverage provided by ERTVs modeled at Sidney, Victoria, and Bedwell Harbor. An ERTV stationed at Sidney could provide some benefit for vessels in Haro Strait and Boundary Pass, although the coverage provided would not be as extensive as the protection offered by the Neah Bay ERTV for the Strait of Juan de Fuca and the adjacent coastal waters. Comparing the graphical representations in the 2015 VTRA, the model predicts that an ERTV stationed in Victoria, BC and in Bedwell Harbor, BC would provide better escort coverage for Haro Strait, Boundary Pass, and the Southern Gulf Islands, relative to a single ERTV stationed at Sidney, BC (Van Dorp & Merrick, 2016).

However, another study concluded that:

> One or more ERTVs could be stationed in Haro Strait and/or Rosario Strait to respond to disabled vessels on those routes, including vessels bound to and from GPT [Gateway Pacific Terminal]. However, due to the comparatively narrow geography surrounding these waterways, there is limited sea room (i.e. time) for ERTV response in the event of propulsion, steering, or control system failure…For this reason, this management scheme is considered less effective than voluntary speed reductions, which is more preventative in nature (Kirtley, 2014).

In considering the potential effectiveness of an ERTV in Rosario Strait, Ecology considered existing traffic patterns. Most commercial vessels transiting Rosario Strait are tank ships, which are currently escorted, and tugs towing tank barges and articulated tug barges (ATBs), which are being recommended for escort in this report. This escort scheme could affect the potential utility of an ERTV in Rosario Strait. Most of the ERTV information Ecology reviewed focused on an ERTV in Haro Strait/Boundary Pass. Given the lack of analysis of an ERTV in Rosario Strait, Ecology does not have enough information to draw a conclusion about the potential effectiveness of such a system in that area.

Consideration of the potential effectiveness of one or more ERTV(s) in Haro Strait/Boundary Pass should include U.S. federal, Canadian federal, provincial, First Nation, governments, and non-governmental and industry organization's participation.

- Most of the current and projected vessel traffic transiting Haro Strait/Boundary Pass consists of foreign-flag vessels calling on ports in Canada (see discussion in Chapter 4).
- A response to a vessel casualty in Haro Strait/Boundary Pass has a significant chance of involving cross-border resources, and a vessel in distress could cross the international border during an incident.
- Canada's implementation of the OPP could impact the need for, and requirements of, an ERTV system.
    - The Canadian Coast Guard will lease two new vessels that have the ability to tow large commercial ships.
    - Towing capacity will be added to major Canadian Coast Guard vessels on the East and West coasts.
    - The Government of Canada will work with provincial and Indigenous partners to develop a plan for the best location and most effective use of these new vessels and resources.
    - In a response to a Transport Canada survey, Ecology recommended the Canadian government consider positioning towing capacity to respond to a vessel incident in Haro/Strait Boundary Pass.
- Analysis of where to station an ERTV to provide effective coverage of Haro Strait/Boundary Pass should include potential Canadian locations.
- Designing, funding, implementing, administering, and operating a new ERTV system for Haro Strait/Boundary Pass would likely rely on bi-lateral agreements.

Additionally, given that the current ERTV stationed at Neah Bay does respond to vessels inbound and outbound from British Columbia, it would be advisable to consider the Neah Bay ERTV as part of any larger cost-sharing discussion between Canadian federal and provincial governments, the United States Federal Government, and Washington State. This is consistent with legislative direction Ecology received from the Washington State Legislature in 2009 regarding cost sharing for the Neah Bay tug (ESSB 5344, Wa. 2009).

# Recommendations

## Evaluate effectiveness and funding of an emergency response system

A review of existing risk analyses and studies indicates that an emergency response system in Haro Strait and Boundary Pass similar to the ERTV stationed at Neah Bay has the potential to reduce oil spill risks, but the studies reviewed were not specifically designed to support a final determination, nor did the studies address the issue of funding an ERTV system. The majority of vessels that would benefit from an ERTV would be inbound and outbound to and from Canada.

Ecology recommends a collaborative process to determine the potential effectiveness of ERTVs in Haro Strait and Boundary Pass. The process should include U.S. and Canadian stakeholders, tribes, and First Nations, and should result in recommendations to the Legislature and other governmental bodies, including tribes and First Nations.

The process should address the following topics:

- Stakeholder, tribal, and First Nation interests in stationing additional ERTV(s).
- Types of vessels and casualties the potential ERTV(s) would be expected to respond to.
- Required capabilities and equipment of the ERTV and towed vessels.
    - Including consideration of multi-mission capabilities (e.g., emergency response, towing, firefighting, preliminary oil spill response, personnel rescue and recovery), which could be roving in nature.
- The suitability, acceptability, and feasibility of candidate locations for hosting an ERTV.
- The potential benefits of an emergency response system for a given location.
    - Ecology's literature review provides a summary of existing high-level modeling of three potential locations.
    - More detailed analysis would be needed to consider a wider range of potential sites, determine optimal ERTV coverage and potential benefits, conduct cost/benefit analysis, and inform decision-making.
- Procedures for operations, administration, and logistics.
- Cross-boundary response considerations.
- Funding and contracting roles, responsibilities, and commitments.

Regarding the current ERTV at Neah Bay, Ecology recommends engagement with Canadian federal and provincial governments to propose a cost-sharing arrangement for vessels transiting to Canadian ports. These vessels currently receive the benefit of having an ERTV at Neah Bay without supporting its continued presence. Projected increases in vessel traffic through the Strait of Juan de Fuca to Canadian ports will exacerbate this situation.

# Chapter 12: Conclusion and Recommendations

Throughout this report, Ecology has evaluated several topics related to vessel traffic and vessel traffic safety in the study area to present legislators with information needed to make informed decisions about specific vessel safety measures.

This chapter presents a summary of Ecology's findings and includes recommendations developed as a result of Ecology's evaluation.

## Conclusion

### Vessel traffic

The Salish Sea is a busy and important entry point for international cargo moving to and from ports in South Asia and North America, as well as domestic coastwise cargo. The U.S. Coast Guard Vessel Traffic Service (VTS) handles approximately 230,000 transits annually with about 170,000 of those being Washington State Ferries. About 8,300 deep-draft vessels transit (inbound and outbound) the Strait of Juan de Fuca annually. Of these, about nine cargo vessels (bulk carriers, container ships, and others) and 2 tank vessels (tank ships, articulated tug barges (ATBs), tank barges) enter and leave the Strait daily.

Cargo arriving on deep-draft vessels destined for ports in both British Columbia and Washington State enter through the Strait of Juan de Fuca. The majority of these vessels are destined for British Columbia, and transit through Haro Strait and Boundary Pass heading for the Strait of Georgia. Traffic heading for four of Washington's refineries as well as Anacortes and Bellingham utilize Rosario Strait, while vessels bound for the south Puget Sound travel through Admiralty Inlet. ATBs, tugs towing dry cargo and tank barges, ferries, fishing vessels, and recreational vessels also use these waterways, with much of the ATB and tank barge traffic transiting Rosario Strait.

As the global economy has recovered since the 2007 – 2008 recession, the volume of cargo moving through ports has increased, with a corresponding increase in the number of deep-draft cargo vessels transiting the Salish Sea.

The number of tank ships transiting the Salish Sea will increase if the Trans Mountain Pipeline (TMPL) Westridge Marine Terminal expansion is completed, which anticipates approximately 325 to 408 transits per year. Currently there are approximately 60 tank ships per year visiting the Westridge terminal. These tank ships would be traveling through Haro Strait and Boundary Pass, unlike the current majority of tank ships heading to Washington refineries, which transit Rosario Strait.

Tank ship traffic to Washington ports could also potentially increase if Washington's refineries upgrade or expand product types for export, or if refineries and oil terminals begin crude exports as a result of the lifting of the crude oil export ban in 2015. Ecology is not aware of any crude oil currently being exported from Washington ports. However, if planned upgrades at Andeavor's Anacortes refinery are approved, approximately five additional tank ships a month carrying reformate and xylene are expected.

Tank barge movement in the Salish Sea has remained fairly consistent over the last decade, and the use of ATBs for oil movement between terminals is expected to continue.

The volume of containerized cargo is anticipated to increase for Canadian and Washington ports, with an expected increase of 295 to 305 container ships per year if projects in British Columbia are completed. However, container ships are expected to increase in size, and Washington's port upgrades will accommodate these larger ships, so container cargo could increase without a large increase in the number of container ships.

The number of dry bulk ships transiting the Salish Sea is anticipated to grow as terminal expansions in British Columbia are completed, with a potential increase of 300 to 475 vessels per year. The size of these vessels is not expected to increase. Additionally, the cruise industry is expecting strong growth. However, passenger ships are increasing in size so this growth may not result in additional vessel traffic through the study area.

## Incident and spill data

Oil spills from tank barges have decreased over time, both internationally and in U.S. waters, and most oil spills are small. The majority of oil spilled from these vessels is a result of a small number of large spills, reflecting the low probability and high consequence nature of oil spill risk. The decrease in oil spills over time indicates prevention measures (e.g. changes to international standards and regulations, the introduction of double hulls, improved operating practices) have had a positive effect in reducing the number of spills from tank barges, including ATBs, and the volume of oil spilled.

In the international data, allisions were responsible for over a third of all spills. Groundings were the next most frequent incident type.

Most tank barge and ATB spills reported to Ecology occurred while the vessel was moored. Twenty three of 26 tank barge spills, and all four ATB spills happened while moored. Twelve of 19 tank barge non-spill incidents reported to Ecology were groundings or allisions. Most ATB non-spill incidents in the Ecology data involved equipment failures (i.e., loss of electrical power, loss of steering). Many of the incidents were a loss of redundancy, rather than a complete loss of capability.

In the Canadian Pacific Region, three of four tank barge spills were the result of groundings, and nine of 16 tank barge incidents overall were groundings or allisions. The TSB Canada data for ATBs are notable in that most (20 of 27) incidents were "risk of striking" or "risk of collision" incidents.

This data indicates the most common type of incidents from tank barges and ATBs – allisions, groundings, "near-miss" events, and losses of propulsion, steering, or electrical power – are situations where a tug escort, if assigned, could potentially provide a positive risk reduction benefit.

Ecology reviewed tank barge and ATB oil spill and non-spill incident reports to gain insight into whether a tug escort, if assigned, could potentially have further reduced oil spill risks. None of the tank barge or ATB oil spill incidents appeared to provide an opportunity for tug escort intervention. Ecology identified seven of 19 tank barge non-spill incidents and four of 16 ATB non-spill incidents where a tug escort, if assigned, could have potentially further reduced the risk of the incident leading to an oil spill. The benefit of an emergency response systems for these incidents would likely depend on the stationing and availability of an emergency response towing vessel (ERTV).

## Non-floating oils

In recent years, our understanding has evolved regarding how different types of oil behave during a spill. Oils that submerge or sink in water pose a substantial risk to the environment, human health, tribal and other cultural and historical resources, and the economy, and are a significant challenge to locate, contain, and cleanup. In summary:

- Oils that are inherently heavier than water may submerge/sink when spilled.
- Oils that are lighter than water but become heavier as the lighter fractions are lost through evaporation or other weathering may submerge/sink when spilled.
- Oils can submerge/sink after mixing with sediments in waves or stranding onshore and mixing with sediments.
- Oil may refloat after sinking.
- Oils that become heavier than water due to formation of oil-particle aggregates under turbulent conditions may settle on the seafloor.
- Behavior of oil when an oil sinks may differ in seawater and freshwater environments, so the location where oil is spilled matters.
- Diluted bitumen crude oil from Canada is inherently heavy and may become non-floating when spilled to water.

Traditional methods of detecting oil spills, like aerial observation, do not work when oil stops floating, as the oil is below the visible surface of the water. After oil sinks, response tactics to locate and recover the oil are limited by the oil density (near-neutral oil is suspended in the water column while negative buoyancy oil sinks to the bottom) and the water depth.

The Northwest Area Contingency Plan has identified response considerations for non-floating oils, and federal and state regulations have been changing in response to the evolving recognition of non-floating oil potential (not just Group 5 oils). In 2018, Ecology received direction and funding from the Legislature to identify water column and seafloor resources at risk from non-floating oils. Ecology is addressing this direction through updates to Geographic Response Plans (GRP) that will describe important sensitive resources within the GRP areas and will include narrative descriptions of resources at risk from non-floating oils and an analysis of potential response tactics based on the area sensitivity and complexity.

Additionally, Washington State contingency plan requirements for oils that sink were first adopted in 2011 and focused on Group 5 oils. Since then, as portions of rules were opened for updating, Ecology has applied its evolved understanding that other oils may also be non-floating, resulting in planning standards that are inconsistent between industry sectors.

Ecology has been directed to conduct rulemaking by December 2019 with one goal of the rulemaking being to eliminate the patchwork of regulations currently in place for these oils.

Ecology is also beginning to conduct drills to address spills of non-floating oils as directed by RCW 88.46.220 and 90.56.275. The first drill of this kind took place in October 2018.

**Movement of diluted bitumen**

While transport of diluted bitumen through the study area is not new, its transport has evolved over the last decade. Additionally, properties of these oils are becoming better understood, and are important to consider when evaluating risks associated with oil movement.

Diluted bitumen is transported through the study area by vessel, pipeline, and rail. In 2017, about 91 percent of diluted bitumen moved into Washington State was by pipeline, 2 percent was moved by vessel, and 7 percent was moved by rail.

Historically, the majority of diluted bitumen delivered to Washington has been by pipeline. Movement of diluted bitumen by pipeline presents concerns due to the pipeline's route traveling along and across several waterways, and passing through several communities.

Movement of diluted bitumen by rail is relatively new and appears to be increasing. Volumes transported by rail could increase significantly if facilities in Washington begin exporting it by vessel or transporting it to other domestic ports. Additionally, it is possible for diluted bitumen to move down the I-5 corridor to Oregon for transfer to vessels outbound on the Columbia River. Ecology does not receive information about crude oil or diluted bitumen transported through the state by rail unless it is delivered to a Washington facility, so Ecology would not receive notification of these out-of-state transfers.

The volume of diluted bitumen imported from Canada by vessel appears stable. Although relatively small in volume when compared to overall crude oil movement, the movement of diluted bitumen by tug and tank barge from Canada to Tacoma is a concern because of the transit route through Rosario Strait and then south through Admiralty Inlet towards southern Puget Sound. Additionally, billions of gallons of diluted bitumen are exported from Canada each year by tank ships that transit outbound through Canada and Washington's shared waters of the Strait of Georgia, Haro Strait, and Strait of Juan de Fuca.[100] This volume is expected to increase significantly if the Trans Mountain Pipeline System and Expansion Project (TMEP) is completed. Any spill from these ships would impact the study area.

From existing data, Ecology has a good understanding of how much diluted bitumen is transported by the three primary modes of transport and the risks associated with it. However, there are gaps in data collected for each mode. Improved data on origins, destinations, and type of oil would help determine the need for additional preventative measures.

## Navigational requirements

Ecology described the existing pilotage and traffic management systems in place in the U.S. and Canada by summarizing management of these systems and describing coordination between the systems. In doing so, Ecology has summarized areas of effective coordination between the systems as well as areas where the systems differ.

[100] These tank ships are generally of a size required to take an escort.

### Similarities that benefit waterway safety

Navigational requirements in U.S. and Canadian waters are similar, and include adherence to international regulations and standards, including but not limited to the IMO's International Regulation for Preventing Collisions at Sea (COLREGS) and the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW).

There is significant cooperation between Canada and the U.S. with regard to waterway safety and management. Both the U.S. and Canada use active vessel traffic services to reduce the risk of accidents and collisions within the waterways. While the U.S. Vessel Traffic Service (VTS) and Canadian Marine Communications and Traffic Service (MCTS) each operate under their own unique authorities and vessel participation requirements, the overarching method of active vessel traffic management to enhance safe navigation and environmental protection remains the same. The Cooperative Vessel Traffic Service (CVTS) agreement is an example of coordination between U.S. and Canada related to management of traffic in the shared waterways.

Both Washington State and BC also make use of compulsory pilotage to ensure that large vessels operating within their waters are navigated by skilled mariners with intimate knowledge of the local waterway. While each pilotage district operates under its own unique authorities, the overarching method of using pilotage to enhance safe navigation and environmental protection remains the same.

In Washington, any registered oil tank ship of 5,000 gross tons or greater is required to take a Washington State licensed pilot while navigating the Puget Sound (Wash. Rev. Code § 88.16.180, 1991). In addition, foreign-flagged vessels in Washington State pilotage districts are required to use a state-licensed pilot (Community Attributes, Inc., & Gleason & Associates, 2018). There are some exemptions, which are discussed in Chapter 8. In Canadian Pilotage waters, commercial vessels of 350 gross tons (ITC) or greater are required to use the services of a Canadian marine pilot. This includes the combined tonnage of ATBs. Some vessels under 10,000 gross tons (ITC) may be eligible for a waiver from pilotage (Pacific Pilotage Authority, 2017a).

The 2015 Memorandum of Agreement (MOA) between the Pacific Pilotage Authority Canada (PPA), BC Coast Pilots, and the Puget Sound Pilots Association is an example of successful coordination between Washington and BC related to pilotage in the shared waterways.

### Differences

Examples of differences discussed in this review include:

- Differences in the vessels that are required to participate in compulsory pilotage.
- Differences in criteria and process for obtaining waivers and exemptions from compulsory pilotage from the Washington Board of Pilotage Commissioners (BPC) and from the Pacific Pilotage Authority.
- Differences in criteria for mandatory vessel participation in the VTS or MCTS in U.S. and in Canadian waters.
- Differences in tonnage restrictions for vessels.

- On the U.S. side, all tank vessels, U.S. or foreign flag, larger than 125,000 deadweight tons (DWT) bound for a port or place in the United States may not operate east of a line extending from Discovery Island Light to New Dungeness Light and all points in the Puget Sound area north and south of these lights (33 CFR 165, 1982).
- Canadian regulations do not currently include any tonnage restriction for vessels operating in British Columbia waters (Chamber of Shipping, n.d.). However, due to waterway restrictions, tank ships calling on oil terminals in the Port of Vancouver do not exceed 120,000 DWT (Port of Vancouver, n.d.-g).

## Tug escorts and capability requirements

Existing state and federal regulations requiring escort tugs for tank vessels prescribe the need for and the capabilities of the tug(s) and crew at varying levels of detail. Washington and Alaska escort requirements apply only to tank ships, while California requirements encompass tank ships, tank barges, and ATBs. Massachusetts escort requirements apply to tank barges and ATBs.

Within the Salish Sea, Washington and British Columbia require tug escort of tank ships greater than 40,000 DWT carrying oil (Washington) or liquid cargo (British Columbia).

In Washington waters, the escort tug must have a minimum aggregate shaft horsepower of 5 percent of the deadweight tonnage of the tank ship. The Puget Sound Harbor Safety Plan (PSHSP) contains a voluntary Standard of Care (SOC) for tug escort of tank ships, which specifies areas where escort tugs should be tethered, tank ship deck fitting standards, escort speed, tug availability, vessel master responsibilities, pre-escort conferences, tug escort manuals, and provisions for escort tugs to be diverted in case of emergency.

In Canadian waters, the PPA established rules which include the number of pilots, areas for tethered escort, tug capabilities and equipment, including minimum bollard pull and safe working loads, escort speeds, pre-escort conferences, and additional procedures for escorting crude oil tank ships.

Washington is on the lower end of the regulatory spectrum in specifying detail of the escort system in regulation relative to the other states evaluated. In addition, a previous Ecology-sponsored study recommended that Washington's tank ship escort law be updated to provide more specificity regarding escort tug capability. However, the local maritime community has specified additional voluntary standards through the Puget Sound Harbor Safety Committee (PSHSC).

Escort tugs mitigate the risk of a tank vessel accident (primarily groundings and allisions, but also collisions) when a mechanical failure occurs through their ability to attach and influence the motion of the afflicted vessel. Modeling results for the Puget Sound indicate that adding tug escorts to towed oil barges and ATBs could result in reductions in potential oil losses. The 2015 VTRA modeled untethered tug escorts of towed oil barges and ATBs and showed an approximate 3 percent decrease in potential oil loss, and an approximate 15 percent decrease in potential accident frequency. Potential oil losses increased in four waterway zones, and potential accident frequencies decreased or remained the same in all waterway zones. Experience with escort tugs in Vancouver, BC indicates a twelve-fold increase in protection against tank ship accidents as a result of a system that incorporates escort tugs above the level of protection provided by the use of maritime pilots alone. Additionally, escort tugs may help prevent collisions from human error by providing additional situational awareness and serving as an "auxiliary bridge".

Design of an escort system for tank vessels must consider:

- The level of regulatory involvement desired or necessary.
- The type of tank vessel to be escorted and its cargo status.
- The number of escorts required.
- The mechanical and crew capability of those escort tugs.
- The use of zones to target specific escort speeds or practices.
- The use of tethered versus untethered escort tugs.
- Whether it is necessary to specify crew size or training above the level of existing regulation.

The choice of escort tug capabilities depends on the environment in which the escort occurs, the size and type of vessel to be escorted, the waterway characteristics, and the desirability of ancillary capacities such as firefighting.

The U.S. states reviewed specify the capability of escort tugs at varying levels of detail. A matrix approach to matching escort tug capability to the tank vessel on a given transit is a best practice. Washington is on the lower end of the regulatory spectrum in specifying escort tug capability, but the local maritime community has specified the recommended capability through the PSHSC.

Many participants in the 2016 Salish Sea Oil Spill Risk Mitigation Workshop prioritized extending escort tug protection to tank barges and ATBs carrying larger quantities of oil in the Salish Sea as a spill prevention measure.

**Economic impacts for proposals of tug escorts**

Ecology evaluated the economic impact of proposals for tug escorts. Pilotage requirements were also included as part of the analysis because pilotage was initially considered as part of the rulemaking within the tug escort recommendation. Oil and transport owners and operators incur costs associated with vessel traffic safety, including costs of pilotage and escorts. In the analysis, Ecology estimated the costs and economic impacts of:

- The status quo, including existing pilotage and escort requirements and practices.
- An alternative modeled scenario with additional pilotage and escort requirements.

Ecology estimated costs for escorts and pilotage for tank ships, tank barges, and articulated tug barges (ATBs).

Estimated total annual costs for the status quo are $31.8 million. This reflects the costs of existing vessel traffic safety requirements across Puget Sound, including existing pilotage and escort requirements, as well as common practices and agreements.

Estimated total annual costs for the modeled scenario are $64.8 million. This reflects existing and proposed vessel traffic safety requirements across Puget Sound, including pilotage and escort requirements, as well as common practices and agreements. Significant differences from the status quo include:

- Pilotage and escort requirements for laden tank barges.
- Preemptive requirements for routes on which there are currently no known transits.
- Additional escort requirements for ATBs.
- Required pilotage where it is currently a voluntary practice.

The difference in costs across scenarios is summarized below.

**Table 21: Cost increases (millions of $) under modeled scenario compared to status quo**

| Cost type | Tank ships | Tank barges | ATBs | Total |
|---|---|---|---|---|
| **Pilotage** | $0 | $2.4 | $0.1 | **$2.6** |
| **Escort** | $0 | $25.1 | $5.4 | **$30.4** |
| **Total** | **$0** | **$27.5** | **$5.5** | **$33.0** |

Ecology also examined differences in costs across scenarios by transit region.[101]

**Table 22: Cost increases (millions of $) under modeled scenario compared to status quo, by region**

| Transit Region | Tank ships | Tank barges | ATBs | DIFFERENCE IN TOTAL COSTS BY REGION |
|---|---|---|---|---|
| **Haro/Boundary/Vancouver*** | $0 | $0 | $0 | **$0** |
| **Whatcom and N Rosario Strait** | $0 | $2.7 | $2.5 | **$5.2** |
| **Anacortes and S Rosario Strait** | $0 | $1.0 | $2.0 | **$3.0** |
| **Puget Sound** | $0 | $23.8 | $1.1 | **$24.8** |
| **DIFFERENCE IN TOTAL COST BY VESSEL TYPE** | **$0** | **$27.5** | **$5.5** | **$33.0** |

* Only tank ships (with zero cost difference between the status quo and modeled scenario) were included in the Haro/Boundary/Vancouver transit region, due to available information being limited to transit endpoints. Transit data did not allow for additional assumptions about tank barges and ATBs that may use this transit region, but this would likely shift cost differences from Rosario Strait regions.

[101] Breaking the scenario down into four transit regions allowed Ecology to better associate transit destination data with the waterways listed in the model. We currently do not have transit data directly related to the waterways, but the grouping of waterways and destinations provides a strong assumption of routes taken for the different transits under consideration in this study. For example, Ecology can easily assume that the majority of transits to Vancouver, BC will travel through Haro Strait and Boundary Pass for either distance efficiency or to pick up a Canadian Pilot near Victoria, BC.

The significant difference between total costs for the status quo and modeled scenario arises from two primary factors:

- The addition of escort and pilotage requirements for tank barges. While these are modeled as incurring generally lower pilotage costs than other vessels, the large number of transits within Puget Sound, and the addition of both types of vessel safety requirement increases costs significantly under the modeled scenario as compared to the status quo.
- The addition of escort requirements for ATBs. While not as large as the cost contribution of tank barges under the modeled scenario, the addition of escort requirements adds across-the-board costs for the ATB population.

While additional pilotage and escorts will likely reduce the risk of oil spills within the Salish Sea, there may be small negative side effects of these safety measures. If the number of operating escort vessels grows proportionately to meet increased demand, there will likely be associated environmental impacts from increased tug escorts operations, including emission of air pollutants (including greenhouse gases), and increased threats to sensitive marine fauna including ship strikes and anthropogenic noise. These impacts will likely have negative economic consequences from impacts to human health, tourism, and ecological well-being, including impacts to SRKW populations from increased vessel traffic. Ecology was unable to fully capture these impacts in the economic analysis due to uncertainty and the scope of this study.

**Vessel speed limits and speed reductions**

Although predominately addressed at the federal level, reducing vessel speeds can improve vessel safety, may reduce underwater noise, and reduce air pollution from ships. Washington code addresses vessel speed limits by requiring that tank ships not exceed the service speed of their escort tugs, but neither the Revised Code of Washington (RCW) nor the PSHSC SOC addresses speed limits or speed reductions for cargo and passenger vessels, towed oil barges, or ATBs.

**Manning (Crewing)**

Although under full purview of the federal government through the U.S. Coast Guard, changes to crewing levels on ATBs and tugs towing tank barges have been discussed as a potential way to reduce human error and decrease the likelihood of accidents. Currently, tug escort companies are strongly encouraged to have one other crew member in addition to the boat operator on the bridge of the escorting tug during escorts.

## Emergency response system

The risk reduction provided by an emergency response system would be highly dependent on a variety of factors, including where a new ERTV was stationed; the distance from the ERTV to a vessel in need of assistance when an incident occurred; weather and tidal current conditions during an incident; and how quickly the ERTV could get underway, transit to the incident vessel, and begin providing assistance.

There are also significant differences between the waters surrounding the San Juan archipelago and the Strait of Juan de Fuca, which should be considered when comparing a potential new emergency response system to the existing ERTV at Neah Bay. These differences include the relatively narrow and navigationally complex waterways of Haro Strait, Boundary Pass, and Rosario Strait; the lack of an immediately identifiable location within Washington to station an ERTV; and the distances between Haro and Rosario Straits, which would likely preclude one ERTV from effectively providing a benefit to both areas.

The 2015 VTRA examined the potential effects of stationing additional ERTVs to complement the existing ERTV at Neah Bay. Results showed a 1.2 percent reduction in potential oil loss for the entire VTRA study area by stationing an additional ERTV at Sidney, BC. The 2015 VTRA also provides graphical representations of the approximate escort coverage provided by ERTVs modeled at Sidney, Victoria, and Bedwell Harbor. An ERTV stationed at Sidney could provide some benefit for vessels in Haro Strait and Boundary Pass, although the coverage provided would not be as extensive as the protection offered by the Neah Bay ERTV for the Strait of Juan de Fuca and the adjacent coastal waters. Comparing the graphical representations, the model predicts that an ERTV stationed in Victoria, BC and in Bedwell Harbor, BC would provide better escort coverage for Haro Strait, Boundary Pass, and the Southern Gulf Islands, relative to a single ERTV stationed at Sidney, BC (Van Dorp & Merrick, 2016).

However, another study concluded that, due to the narrow geography of Haro and Rosario Straits, voluntary speed reductions would be more effective than placement of an ERTV in these areas (Kirtley, 2014).

In considering the potential effectiveness of an ERTV in Rosario Strait, Ecology considered existing traffic patterns. Most commercial vessels transiting Rosario Strait are tank ships, which are currently escorted, and tugs towing tank barges and ATBs, which are being recommended for escort in this report. This escort scheme could affect the potential utility of an ERTV in Rosario Strait. Most of the ERTV information Ecology reviewed focused on an ERTV in Haro Strait/Boundary Pass. Given the lack of analysis of an ERTV in Rosario Strait, Ecology does not have enough information to draw a conclusion about the potential effectiveness of such a system in that area.

Consideration of the potential effectiveness of one or more ERTV(s) in Haro Strait/Boundary Pass should include U.S. federal, Canadian federal, provincial, First Nation, governments, and non-governmental and industry organization's participation.

Additionally, given that the current ERTV stationed at Neah Bay does respond to vessels inbound and outbound from British Columbia, it would be advisable to consider the Neah Bay ERTV as part of any larger cost-sharing discussion between Canadian federal and provincial governments, the United States Federal Government, and Washington State. This is consistent with legislative direction Ecology received from the Washington State Legislature in 2009 regarding cost sharing for the Neah Bay tug (ESSB 5344, Wa. 2009).

## Recommendations

Five recommendations were developed as a result of this evaluation and assessment.

## Conduct rulemaking on tug escort requirements

The BPC has authority to impose tug escort requirements for vessels within Washington State waters. As discussed, tug escorts can reduce the risk of a vessel incident that could result in a spill.

Ecology recommends amending RCW 88.16.190 (1994) to direct the BPC to conduct rulemaking on tug escort requirements for oil laden tank vessels between 5,000 and 40,000 DWT when traveling beyond a point east of a line extending from Discovery Island Light south to New Dungeness Light. The rulemaking would direct the BPC to develop zones in Puget Sound to apply these rules. Zones would be determined by modeling and analysis. The rulemaking must require tug escorts for Rosario Strait and connected waterways to the east. As part of the rulemaking, the BPC could develop subsets of oil laden tank vessels between 5,000 and 40,000 DWT and/or situations which could preclude the requirements of the rulemaking for a given zone or vessel. The rulemaking should also evaluate potential impacts of increased marine noise as a result of additional vessel traffic and consider mitigation for underwater noise, especially on solo tugs returning from escort duty, to reduce impacts to Southern Resident Killer Whales.

Ecology should collaborate with the PSHSC to update the PSHSP and develop SOC for tug escort capabilities (e.g., bollard pull, tug equipment, detailed escort manuals) and escort procedures, including periodic performance testing, to reflect this change.

Ecology strongly encourages the Pacific Pilotage Authority Canada (PPA) to take an equivalent posture for Haro Strait and Boundary Pass for oil laden ATB and tug tow tank vessels calling to British Columbia ports. Ecology anticipates that the PPA would continue their practice of honoring the escort requirements of Washington, as a safety partner.

## Evaluate effectiveness and funding of an emergency response system

A review of existing risk analyses and studies indicates that an emergency response system in Haro Strait and Boundary Pass similar to the ERTV stationed at Neah Bay has the potential to reduce oil spill risks, but the studies reviewed were not specifically designed to support a final determination, nor did the studies address the issue of funding an ERTV system. The majority of vessels that would benefit from an ERTV would be inbound and outbound to and from Canada.

Ecology recommends a collaborative process to determine the potential effectiveness of ERTVs in Haro Strait and Boundary Pass. The process should include U.S. and Canadian stakeholders, tribes, and First Nations, and should result in recommendations to the Legislature and other governmental bodies, including tribes and First Nations.

The process should address the following topics:

- Stakeholder, tribal, and First Nation interests in stationing additional ERTV(s).
- Types of vessels and casualties the potential ERTV(s) would be expected to respond to.
- Required capabilities and equipment of the ERTV and towed vessels.
    - Including consideration of multi-mission capabilities (e.g., emergency response, towing, firefighting, preliminary oil spill response, personnel rescue and recovery), which could be roving in nature.

- The suitability, acceptability, and feasibility of candidate locations for hosting an ERTV.
- The potential benefits of an emergency response system for a given location.
  - Ecology's literature review provides a summary of existing high-level modeling of three potential locations.
  - More detailed analysis would be needed to consider a wider range of potential sites, determine optimal ERTV coverage and potential benefits, conduct cost/benefit analysis, and inform decision-making.
- Procedures for operations, administration, and logistics.
- Cross-boundary response considerations.
- Funding and contracting roles, responsibilities, and commitments.

Regarding the current ERTV at Neah Bay, Ecology recommends engagement with Canadian federal and provincial governments to propose a cost-sharing arrangement for vessels transiting to Canadian ports. These vessels currently receive the benefit of having an ERTV at Neah Bay without supporting its continued presence. Projected increases in vessel traffic through the Strait of Juan de Fuca to Canadian ports will exacerbate this situation.

## Develop Standard of Care for voluntary vessel speed reduction program

Ecology recommends the PSHSC consider updating the PSHSP and develop SOC for a voluntary vessel speed reduction program. This program should complement the Vancouver Fraser Port Authority's voluntary vessel slowdown trial in British Columbia as part of their Enhancing Cetacean Habitat and Observation Program (ECHO). The voluntary program should focus on Haro Strait, Boundary Pass, and Rosario Strait. The process for development of the SOC should include discussion about specific application of the SOC for different vessel types, operations, schedules, and locations. The primary purpose for this new SOC would be for reducing oil spill risk, with a strong secondary purpose of potentially reducing noise impacts to affected orca populations.

## Develop Standard of Care for wheelhouse watch stander

Ecology recommends the PSHSC consider updating the PSHSP and develop SOC for a second watch stander in the wheelhouse of ATB and tug-towed tank vessels on certain routes and in specific conditions. The intent of this voluntary standard is to use existing crew to assist the watch stander in charge of navigation as a lookout in the wheelhouse. The applicability of this voluntary standard may be considered for all Puget Sound pilotage waters, east of a line extending from Discovery Island Light south to New Dungeness Light. However, the primary areas of focus for this voluntary standard should be on Haro Strait, Boundary Pass, and Rosario Strait and connected waters to the east.

The SOC should consider operating conditions where the second lookout would apply, e.g., during hours of darkness, in restricted visibility conditions, heavy weather, increased waterway traffic situations, Rules of Road (COLREGS), and possibly other situations or conditions. The primary purpose of this new SOC is to raise situational awareness and reduce the potential risk of marine casualties and oil spills.

### Expand requirements for reporting oil movement and oil transfer information

Ecology receives information about the movement of crude oil (including diluted bitumen) by vessel, pipeline, and rail in the state that provides a good understanding of oil moving to destinations in the study area. However, reporting requirements vary by mode and do not provide information that allows Ecology to see the complete oil movement picture through the state. Expanded reporting is needed to fully understand the oil movement picture and evaluate all potential impacts for oil movement by rail, pipeline, and vessel statewide. The additional data would assist Ecology with determining the need for additional prevention and preparedness measures.

Ecology recommends:

- For oil transfers over water, expanding reporting requirements to include specific type of crude oil transferred, as well as origin, destination, and American Petroleum Institute (API) gravity of the oil.
- For pipelines, expanding reporting requirements to include specific type of crude oil transported and API gravity of the oil.
- For facilities receiving crude oil by rail, expanding reporting requirements to include specific type of crude oil transferred.

This could require changes in statute and rule to implement.

Oil movement has proven to continuously evolve over time and as demand and markets for oil change. Having near real-time, complete data for all three modes of transport would enhance the state's ability to stay informed and keep pace with the emerging risks associated with changes in oil movement.

## Closing

The Salish Sea is internationally regarded for its ecological, economic, and cultural significance. As changes have occurred in the volumes and types of oil, modes of transportation, and Ecology's understanding of the properties of the oil moved through the state, Washington is faced with new and evolving risk from an increase in movement of oils that could sink or submerge in water. Even with a robust set of prevention and preparedness safety standards in place to reduce the likelihood of incidents and oil spills in state waters, there is an ongoing risk of oil spills that could damage human health and the state's valuable environmental, tribal, and economic resources. Through this assessment and evaluation, Ecology has developed the above recommendations to strengthen the existing prevention and preparedness efforts in order to prevent spills and to protect these sensitive areas.

# Glossary, Acronyms, and Abbreviations

## Glossary of terms

Allision: Vessel striking a fixed or semi-fixed object such as a pier, bridge, an anchored vessel, or buoy.

API gravity: A measure of how heavy or light a petroleum liquid is that is related to density and specific gravity.

Aframax: A medium-sized crude tank ship between 80,000 to 120,000 DWT. The average Aframax carrying capacity is 750,000 barrels (31,500,000 gallons).

Articulated tug barge: A tank barge and a towing vessel joined by hinged or articulated fixed mechanical equipment affixed or connecting to the stern of the tank barge.

Ballast water: Any water and matter taken on board a vessel to control or maintain trim, draft, stability, or stresses of the vessel, without regard to the manner in which it is carried.

Bollard pull: The documented maximum continuous pull obtained from a static bollard pull test.

Bunker oil: A generic term for oil used as fuel aboard vessels.

Cargo vessel: A self-propelled ship in commerce, other than a tank vessel or a passenger vessel, 300 or more gross tons, including but not limited to commercial fishing vessels and freighters. Liquefied Natural Gas (LNG), Liquefied Petroleum Gas (LPG), and Liquefied Gas (LG) tank ships are considered cargo vessels, as they are not certified to transport oil.[102]

Casualties: Event involving a vessel that results in grounding; stranding; foundering; flooding; collision; allision; explosion; fire; reduction or loss of a vessel's electrical power, propulsion, or steering capabilities; failures or occurrences, regardless of cause, which impair any aspect of a vessel's operation, components, or cargo; any other circumstance that might affect or impair a vessel's seaworthiness, efficiency, or fitness for service or route; or any incident involving significant harm to the environment.

Collision: Vessels striking each other.

Contributing factors: Factors that contributed to, or worked in concert with, the immediate cause in an error-chain leading to, or worsening of, a spill, spill-threat, near-miss, or other event. Multiple contributing factors may be associated to an incident.

Deadweight tonnage: The sum of the weights of cargo, fuel, fresh water, ballast water, provisions, passengers, and crew. Deadweight tonnage may be measured in metric tons or long tons.

Diluted bitumen: Thick, heavy crude oil from Canada (known as oil or tar sands), mixed with a thinner type of oil or gas (the diluent) to allow it to flow and be transported.

[102] Puget Sound Pilots treat LNG, LPG, and LG tank ships as tank ships for the purposes of tug escort requirements.

Emergency response towing vessel (ERTV): A rescue tug stationed at a central location with a defined area of operation that has as its primary mission response and assistance to a vessel that has lost steering, propulsion, or is otherwise in distress. In this report, ERTVs are synonymous with rescue tugs.

Entering transit: The passage of a vessel from sea or from Canadian waters into Washington State waters, regardless of destination. The trip back to sea is not counted. A vessel may be credited with multiple entering transits over a specified period, such as a calendar year. Entering transits on the Columbia River that call at a Washington port and an Oregon port during a single voyage on the Columbia River are counted as an entering transit bound for a Washington port.

Escort tug: A tug specifically designed to provide adequate power to stop or control the direction of movement of the vessel that it is escorting.

Ferry: Any ferry boat 300 gross tons or larger operating in Washington State waters. Ferries with a fuel capacity of fewer than 6,000 gallons are not regulated by Ecology, even if they are 300 gross tons or larger.

Gross tons: The approximate volume of useable cargo space within a ship.

Grounding: Vessel striking the waterway bottom with enough force to damage the vessel and cause the release of oil.

Handysize: A smaller vessel between about 43,000 to 55,000 DWT.

Immediate cause: The most direct factor (action, inaction, failure, or condition) that immediately preceded and resulted in a spill, spill-threat, near-miss, or other event. Only one immediate cause may be associated to an event.

Incident: An event that may or may not result in an accident or an oil spill.

Individual vessel: A vessel counted only once within a specified time period (such as a calendar year), even if the vessel calls in Washington State waters more than once during the specified time period.

Laden: A vessel descriptor indicating that cargo is onboard. In this report, this always refers to oil cargo. This definition applies throughout the report unless a more specific definition is provided based on regulatory requirements for other areas evaluated.

Liner vessel: Vessels that serves a regular route(s) on fixed schedules.

Loss of propulsion: The failure of the propulsion system to propel the vessel as designed, potentially a precursor to a spill. The shutdown of a vessel’s propulsion system while underway to complete repairs is considered a loss of propulsion.

Moored: A vessel secured to the ground (e.g., a wharf, pier, or quay) other than anchoring with a single anchor.

Near miss: An incident that could have resulted in an accident (spill or non-spill) if not resolved or interrupted.

Non-floating oil: In this report, the term non-floating oil is used to mean both submerged and sunken oil. Non-floating oil can become submerged in the water column or sink to the bottom.

Non-tank vessel: Any vessel that isn't a tank vessel, and for the purposes of this study, meets the definition of a cargo vessel.

Oil: "Oil" as defined in RCW 88.40 and 90.56.

Panamax: The largest size vessel that can fit through the locks in the old part of the Panama Canal. These vessels are between about 60,000 and 80,000 DWT.

Partially redundant propulsion and steering: Two engines and two rudders, where the propulsion systems and steering systems are not independent from each other. A single failure could result in a loss of propulsion and/or steering.

Passenger vessel: A ship of 300 or more gross tons with a fuel capacity of at least 6,000 gallons carrying passengers for compensation.

Pilot: A person who has demonstrated expert local knowledge of a particular waterway. They also have experience in ship handling, seamanship, and vessel navigation.

Pilotage: The provision of a service of specially qualified navigators having local knowledge who assist in the navigation of vessels in particular areas.

Precautionary Area: A routing measure comprising an area within defined limits where ships must navigate with particular caution and within which the direction of traffic flow may be recommended.

Puget Sound Harbor Safety Committee (PSHSC): A nonprofit organization formed to promote marine safety and whose members comprise industry, government, and advocacy groups interested in marine safety. Tank ship escort recommendations are included in PSHSC's Harbor Safety Plan.

Redundant propulsion and steering: Two independent propulsion and steering systems. A single failure could not result in a loss of propulsion and/or steering.

Rescue tug: A tug stationed at a central location within a defined area of operation that has as its primary mission response and assistance to a vessel that has lost steering, propulsion, or is otherwise in distress. The Neah Bay ERTV is a rescue tug.

Sentinel tug: A rescue tug that is pre-positioned when certain vessels are in transit in the tug's area of operation.

Study area: In this report, the study area encompasses the Strait of Juan de Fuca as well as the waters of Puget Sound from the Canadian Border to the north, Buoy J to the west, Olympia to the south, and inland areas of Washington to the east of existing oil pipelines and railroad routes along the Interstate 5 corridor.

Tag tug: Typically a smaller tug boat attached to the stern of an oil barge. The tag tug assists with steering the barge.

Tank barge: A barge of any tonnage, engaged in the transport of oil, chemicals, tallows, or biologically derived plant oil.

Tank ship (tanker): A self-propelled tank vessel of any gross tonnage, engaged in the transport of oil, chemicals, tallow, or biologically derived plant oils. These include oil tankers, chemical tankers, and oil/bulk/ore (O/B/O) vessels. Puget Sound Pilots treat LNG, LPG, and LG tank ships as tank ships for the purposes of tug escort requirements.

Tank vessel: A vessel that is constructed or adapted to carry, or that carries oil in bulk as cargo, and that: operates on the waters of the state; or transfers oil in a port of place subject to the jurisdiction of the state. Articulated tug barges (ATBs), tank barges, and tank ships are considered tank vessels.

Towed vessel: For this study, Ecology considers tank barges to be towed vessels.

Traditional tug and tow: Tug and tow where the towing tug is connected to the barge using ropes and/or wires.

Tug: In this report, tug refers to towing operations in general, including traditional tows, ATBs, and support vessels.

Tug-of-opportunity: A tug employed primarily as a tow vessel, escort vessel, harbor assist vessel, or other commercial activity that may respond and assist a vessel that has lost propulsion, steering, or is otherwise in distress.

Twenty-foot Equivalent Unit (TEU): A measure of unit equaling one 20 foot container.

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 (AIS) to keep track of vessel movements and provide navigational safety in a limited geographical area.

Waterborne vessel or barge: Any ship, barge, or other watercraft capable of traveling on the navigable waters of this state and capable of transporting any crude oil or petroleum product in quantities of ten thousand gallons or more for purposes other than providing fuel for its motor or engine.

## Acronyms

| | |
|---|---|
| ABS | American Bureau of Shipping |
| AIS | Automatic Identification System |
| ANS | Alaska North Slope |
| ANT | Advance Notice of Oil Transfer |
| API | American Petroleum Institute |
| ATB | Articulated tug barge |
| AWO | American Waterways Operators |

| | |
|---|---|
| ASTM | American Society for Testing and Materials |
| BOEM | Bureau of Ocean Energy Management |
| BPC | Washington State Board of Pilotage Commissioners |
| BSEE | Bureau of Safety and Environmental Enforcement |
| CFR | U.S. Code of Federal Regulations |
| COI | Certificates of Inspection |
| COLREGS | International Regulations for Preventing Collisions at Sea |
| CPUP | Clean Products Upgrade Project |
| CRVTSA | Columbia River Vessel Traffic Safety Assessment |
| CVTS | Cooperative Vessel Traffic Service |
| DNV GL | Det Norske Veritas |
| E2SSB | Engrossed Second Substitute Senate Bill |
| ECOPRO | Exceptional Compliance Program |
| ERTV | Emergency Response Towing Vessel |
| ESHB | Engrossed Substitute House Bill |
| ESSB | Engrossed Substitute Senate Bill |
| ETT | Enhanced tractor tug |
| GPT | Gateway Pacific Terminal |
| IMO | International Maritime Organization |
| ITC | International Tonnage Convention |
| ITOPF | International Tanker Owners Pollution Federation Limited |
| ITOS | International Tug of Opportunity System |
| JCG | Joint Coordinating Group |
| LNG/LPG | Liquefied Natural Gas/Liquefied Petroleum Gas |
| LOA | Length overall |
| MARPOL | International Convention for the Prevention of Pollution from Ships |
| MCTS | Marine Communications and Traffic Service |
| MISLE | Marine Information for Safety and Law Enforcement |

| | |
|---|---|
| MOA | Memorandum of Agreement |
| MTIS | Marine Terminal Information System |
| NAICS | North American Industry Classification System |
| NEB | National Energy Board of Canada |
| NOAA | National Oceanic and Atmospheric Administration |
| NWSA | Northwest Seaport Alliance |
| OCIMF | Oil Companies International Marine Forum |
| ODPCP | Oil Discharge Prevention and Contingency Plan |
| OPA 90 | Oil Pollution Act of 1990 |
| OPP | Oceans Protection Plan |
| OSTF | Pacific States-British Columbia Oil Spill Task Force |
| PIT | Pacific International Terminals |
| PPA | Pacific Pilotage Authority Canada |
| PSCAA | Puget Sound Clean Air Agency |
| PSHSC | Puget Sound Harbor Safety Committee |
| PSHSP | Puget Sound Harbor Safety Plan |
| PWS | Prince William Sound |
| PWSRCAC | Prince William Sound Regional Citizens' Advisory Council |
| QUALSHIP 21 | Quality Shipping for the 21$^{st}$ Century |
| REMI | Regional Economic Models, Inc. |
| RCW | Revised Code of Washington |
| RPG | Response Planning Group |
| SERVS | Ship Escort Response Vessel System |
| SIRE | Ship Inspection Report |
| SOA | Special Operating Area |
| SOLAS | International Convention for Safety of Life at Sea |
| SOC | Standard(s) of Care |
| SRKW | Southern Resident Killer Whale |

| | |
|---|---|
| SSB | Substitute Senate Bill |
| STCW | Standards of Training, Certification, and Watchkeeping for Seafarers |
| TEU | Twenty-foot Equivalent Unit |
| TMEP | Trans Mountain Pipeline System and Expansion Project |
| TMPL | Trans Mountain Pipeline |
| TMSA | Tanker Management and Self-Assessment |
| TSB | Transportation Safety Board |
| TSS | Traffic Separation Scheme |
| USC | United States Code |
| VBAP | Voluntary Best Achievable Protection |
| VEAT | Vessel Entries and Transits |
| VERP | Vessel Escort and Response Plan |
| VMRS | Vessel Movement Reporting System |
| VTRA | Vessel Traffic Risk Assessment |
| VTS | Vessel Traffic Service |
| WAC | Washington Administrative Code |
| WSJTC | Washington State Joint Transportation Committee |

## Abbreviations and units of measure

| | |
|---|---|
| bbl | barrel(s) |
| Bbbl | Billion barrel(s) |
| Bpd | barrels per day |
| °C | degrees Celsius |
| DWT | deadweight ton |
| Gpd | gallon per day |
| M gallons | million gallons |
| NM | nautical miles |
| TEU | Twenty-foot equivalent unit |

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# Appendices

## Appendix A. E2SSB 6269 – Oil transportation safety

CERTIFICATION OF ENROLLMENT

ENGROSSED SECOND SUBSTITUTE SENATE BILL 6269

Chapter 262, Laws of 2018

65th Legislature

2018 Regular Session

OIL TRANSPORTATION SAFETY

EFFECTIVE DATE: June 7, 2018—Except for sections 102, 103, and 206, which become effective April 1, 2018.

Passed by the Senate March 3, 2018, Yeas 42 Nays 7

CYRUS HABIB, President of the Senate

Passed by the House March 7, 2018, Yeas 62 Nays 35

FRANK CHOPP, Speaker of the House of Representatives

CERTIFICATE

I, Brad Hendrickson, Secretary of the Senate of the State of Washington, do hereby certify that the attached is ENGROSSED SECOND SUBSTITUTE SENATE BILL 6269 as passed by Senate and the House of Representatives on the dates hereon set forth.

BRAD HENDRICKSON, Secretary

Approved March 23, 2018 9:35 AM FILED March 26, 2018

JAY INSLEE, Governor of the State of Washington

Secretary of State, State of Washington

ENGROSSED SECOND SUBSTITUTE SENATE BILL 6269

Passed Legislature - 2018 Regular Session

State of Washington 65th Legislature 2018 Regular Session

By Senate Ways & Means (originally sponsored by Senators Ranker, Rolfes, Carlyle, Darneille, Hasegawa, Pedersen, Conway, Keiser, Hunt, Frockt, Kuderer, Chase, Liias, and Saldaña; by request of Department of Ecology)

READ FIRST TIME 02/22/18.

AN ACT Relating to strengthening oil transportation safety; amending RCW 82.23B.020, 88.46.060, 88.46.220, 88.46.167, 90.56.210, 90.56.240, and 90.56.569, reenacting and amending RCW 82.23B.010; adding new sections to chapter 88.46 RCW; adding new sections to chapter 90.56 RCW; creating new sections; providing an effective date; providing expiration dates; and declaring an emergency.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF WASHINGTON:

PART 1

REVENUE

<u>NEW SECTION</u>. Sec. 101.

(1) The legislature finds that:

(a) The 2004 legislature declared a zero spills goal for the state of Washington. When a spill occurs, there is severe and irreversible damage to the environment, human health, tribal and other cultural and historical resources, and the economy. Fish, orcas, wildlife habitats, shellfish beds, archaeologically sensitive areas, clean air, and public facilities are put at risk when spills occur in the state of Washington.

(b) The department of ecology's oil spill program faces a critical funding gap due to the lack of adequate revenue to fully fund the prevention and preparedness services required by state law, including the 2015 oil transportation safety act. Moreover, the program has endured a decline in capacity and resources to fully utilize its existing authority for critical needs, like vessel inspections and developing spill response plans. Without an adequate investment in revenue, there will be a continued decline in required prevention and preparedness services, causing an increased risk of oil spills in the state of Washington and our shared waters with the Canadian transboundary region.

(c) While oil transported into the state by rail and tank vessels is taxed to fund the oil spill program's oil spill prevention and preparedness activities, a third method of transport, pipelines, currently is not taxed, despite it generating a sizeable oil spill risk.

(d) Some oils are inherently heavy and are likely to stay submerged in the water column or sink to the bottom of a water body. In addition, many oils, depending on their qualities, weathering, environmental factors, and method of discharge, may also submerge or sink in water. Oils that submerge or sink in water pose a substantial risk to the environment, human health, tribal and other cultural and historical resources, and the economy and are a significant challenge to cleanup. Oils are currently being transported by vessels, trains, and pipelines in large volumes in our state, with increased volumes of heavy oils being transported by vessel through our shared waters from Canada. As knowledge about how oils submerge or sink in water grows and technological advances to respond are developed, preventing and preparing for these spills must be updated.

(2) Therefore, the legislature intends to provide adequate revenue to fully fund prevention and preparedness services required by state law, as well as direct the department of ecology to specifically address the risks of oils submerging and sinking and more extensively coordinate with our Canadian partners in order to protect our state's economy and its shared resources.

Sec. 102. RCW 82.23B.010 and 2015 c 274 s 13 are each reenacted and amended to read as follows:

The definitions in this section apply throughout this chapter unless the context clearly requires otherwise.

(1) "Barrel" means a unit of measurement of volume equal to forty-two United States gallons of crude oil or petroleum product.

(2) "Bulk oil terminal" means a facility of any kind, other than a waterborne vessel, that is used for transferring crude oil or petroleum products from a tank car or pipeline.

(3) "Crude oil" means any naturally occurring hydrocarbons coming from the earth that are liquid at twenty-five degrees Celsius and one atmosphere of pressure including, but not limited to, crude oil, bitumen and diluted bitumen, synthetic crude oil, and natural gas well condensate.

(4) "Department" means the department of revenue.

(5) "Marine terminal" means a facility of any kind, other than a waterborne vessel, that is used for transferring crude oil or petroleum products to or from a waterborne vessel or barge.

(6) "Navigable waters" means those waters of the state and their adjoining shorelines that are subject to the ebb and flow of the tide, including the Columbia and Snake rivers.

(7) "Person" has the meaning provided in RCW 82.04.030.

(8) "Petroleum product" means any liquid hydrocarbons at atmospheric temperature and pressure that are the product of the fractionation, distillation, or other refining or processing of crude oil, and that are used as, useable as, or may be refined as a fuel or fuel blendstock, including but not limited to, gasoline, diesel fuel, aviation fuel, bunker fuel, and fuels containing a blend of alcohol and petroleum.

(9) "Pipeline" means an interstate or intrastate pipeline subject to regulation by the United States department of transportation under 49 C.F.R. Part 195 in effect on the effective date of this section, through which oil moves in transportation, including line pipes, valves, and other appurtenances connected to line pipes, pumping units, and fabricated assemblies associated with pumping units.

(10) "Tank car" means a rail car, the body of which consists of a tank for transporting liquids.

((~~(10)~~)) (11) "Taxpayer" means the person owning crude oil or petroleum products immediately after receipt of the same into the storage tanks of a marine or bulk oil terminal in this state and who is liable for the taxes imposed by this chapter.

((~~(11)~~)) (12) "Waterborne vessel or barge" means any ship, barge, or other watercraft capable of traveling on the navigable waters of this state and capable of transporting any crude oil or petroleum product in quantities of ten thousand gallons or more for purposes other than providing fuel for its motor or engine.

Sec. 103. RCW 82.23B.020 and 2015 c 274 s 14 are each amended to read as follows:

(1) An oil spill response tax is imposed on the privilege of receiving: (a) Crude oil or petroleum products at a marine terminal within this state from a waterborne vessel or barge operating on the navigable waters of this state; or (b) crude oil or petroleum products at a bulk oil terminal within this state from a tank car or pipeline. The tax imposed in this section is levied upon the owner of the crude oil or petroleum products immediately after receipt of the same into the storage tanks of a marine or bulk oil terminal from a tank car ((~~or~~)), pipeline, waterborne vessel, or barge at the rate of one cent per barrel of crude oil or petroleum product received.

(2) In addition to the tax imposed in subsection (1) of this section, an oil spill administration tax is imposed on the privilege of receiving: (a) Crude oil or petroleum products at a marine terminal within this state from a waterborne vessel or barge operating on the navigable waters of this state; or (b) crude oil or petroleum products at a bulk oil terminal within this state from a tank car or pipeline. The tax imposed in this section is levied upon the owner of the crude oil or petroleum products immediately after receipt of the same into the storage tanks of a marine or bulk oil terminal from a tank car ~~or~~, pipeline, waterborne vessel, or barge at the rate of four cents per barrel of crude oil or petroleum product.

(3) The taxes imposed by this chapter must be collected by the marine or bulk oil terminal operator from the taxpayer. If any person charged with collecting the taxes fails to bill the taxpayer for the taxes, or in the alternative has not notified the taxpayer in writing of the taxes imposed, or having collected the taxes, fails to pay them to the department in the manner prescribed by this chapter, whether such failure is the result of the person's own acts or the result of acts or conditions beyond the person's control, he or she, nevertheless, is personally liable to the state for the amount of the taxes. Payment of the taxes by the owner to a marine or bulk oil terminal operator relieves the owner from further liability for the taxes.

(4) Taxes collected under this chapter must be held in trust until paid to the department. Any person collecting the taxes who appropriates or converts the taxes collected is guilty of a gross misdemeanor if the money required to be collected is not available for payment on the date payment is due. The taxes required by this chapter to be collected must be stated separately from other charges made by the marine or bulk oil terminal operator in any invoice or other statement of account provided to the taxpayer.

(5) If a taxpayer fails to pay the taxes imposed by this chapter to the person charged with collection of the taxes and the person charged with collection fails to pay the taxes to the department, the department may, in its discretion, proceed directly against the taxpayer for collection of the taxes.

(6) The taxes are due from the marine or bulk oil terminal operator, along with reports and returns on forms prescribed by the department, within twenty-five days after the end of the month in which the taxable activity occurs.

(7) The amount of taxes, until paid by the taxpayer to the marine or bulk oil terminal operator or to the department, constitutes a debt from the taxpayer to the marine or bulk oil terminal operator. Any person required to collect the taxes under this chapter who, with intent to violate the provisions of this chapter, fails or refuses to do so as required and any taxpayer who refuses to pay any taxes due under this chapter, is guilty of a misdemeanor as provided in chapter 9A.20 RCW.

(8) Upon prior approval of the department, the taxpayer may pay the taxes imposed by this chapter directly to the department. The department must give its approval for direct payment under this section whenever it appears, in the department's judgment, that direct payment will enhance the administration of the taxes imposed under this chapter. The department must provide by rule for the issuance of a direct payment certificate to any taxpayer qualifying for direct payment of the taxes. Good faith acceptance of a direct payment certificate by a terminal operator relieves the marine or bulk oil terminal operator from any liability for the collection or payment of the taxes imposed under this chapter.

(9)(a) All receipts from the tax imposed in subsection (1) of this section must be deposited into the state oil spill response account. ((~~All~~))

(b) Beginning in fiscal year 2019 and each fiscal year thereafter, the first two hundred thousand dollars of receipts from the tax imposed in subsection (2) of this section ((~~shall~~)) must be deposited into the military department active state service account created in RCW 38.40.220, and the remainder of the receipts from the tax imposed in subsection (2) of this section must be deposited into the oil spill prevention account.

(10) Within forty-five days after the end of each calendar quarter, the office of financial management must determine the balance of the oil spill response account as of the last day of that calendar quarter. Balance determinations by the office of financial management under this section are final and may not be used to challenge the validity of any tax imposed under this chapter. The office of financial management must promptly notify the departments of revenue and ecology of the account balance once a determination is made. For each subsequent calendar quarter, the tax imposed by subsection (1) of this section shall be imposed during the entire calendar quarter unless:

(a) Tax was imposed under subsection (1) of this section during the immediately preceding calendar quarter, and the most recent quarterly balance is more than nine million dollars; or

(b) Tax was not imposed under subsection (1) of this section during the immediately preceding calendar quarter, and the most recent quarterly balance is more than eight million dollars.

NEW SECTION. Sec. 104. The department of ecology shall provide a report to the legislature by July 1, 2020, on the following:

(1) A description of activities conducted by the department's oil spill program that are expected to continue after fiscal year 2019, and activities that are not expected to continue after fiscal year 2019;

(2) recommendations regarding potential sources of funding for the department's oil spill program;

(3) recommendations regarding the allocation of funding from the taxes established in RCW 82.23B.020 among various state agencies, including whether funding should be discontinued or reduced for any agency; and

(4) a forecast of the department's oil spill program funding needs after fiscal year 2019.

PART 2

VESSELS

Sec. 201. RCW 88.46.060 and 2011 c 122 s 6 are each amended to read as follows:

(1) Each covered vessel shall have a contingency plan for the containment and cleanup of oil spills from the covered vessel into the waters of the state and for the protection of fisheries and wildlife, shellfish beds, natural resources, and public and private property from such spills. The department shall by rule adopt and periodically revise standards for the preparation of contingency plans. The department shall require contingency plans, at a minimum, to meet the following standards:

(a) Include full details of the method of response to spills of various sizes from any vessel which is covered by the plan;

(b) Be designed to be capable in terms of personnel, materials, and equipment, of promptly and properly, to the maximum extent practicable, as defined by the department, removing oil and minimizing any damage to the environment resulting from a worst case spill;

(c) Provide a clear, precise, and detailed description of how the plan relates to and is integrated into relevant contingency plans which have been prepared by cooperatives, ports, regional entities, the state, and the federal government;

(d) Provide procedures for early detection of spills and timely notification of such spills to appropriate federal, state, and local authorities under applicable state and federal law;

(e) State the number, training preparedness, and fitness of all dedicated, prepositioned personnel assigned to direct and implement the plan;

(f) Incorporate periodic training and drill programs consistent with this chapter to evaluate whether personnel and equipment provided under the plan are in a state of operational readiness at all times;

(g) Describe important features of the surrounding environment, including fish ((~~and~~)) habitat, water column species and subsurface resources, wildlife habitat, shellfish beds, environmentally and archaeologically sensitive areas, and public facilities, that are: (i) Based on information documented in geographic response plans and area contingency plans, as required under RCW 90.56.210; or (ii) for areas without geographic response plans or area contingency plans, existing practices protecting these resources used for similar areas. The departments of ecology, fish and wildlife, natural resources, and archaeology and historic preservation, upon request, shall provide information that they have available to assist in preparing this description. The description of archaeologically sensitive areas shall not be required to be included in a contingency plan until it is reviewed and updated pursuant to subsection (9) of this section;

(h) State the means of protecting and mitigating effects on the environment, including fish, shellfish, marine mammals, and other wildlife, and ensure that implementation of the plan does not pose unacceptable risks to the public or the environment;

(i) Establish guidelines for the use of equipment by the crew of a vessel to minimize vessel damage, stop or reduce any spilling from the vessel, and, only when appropriate and only when vessel safety is assured, contain and clean up the spilled oil;

(j) Provide arrangements for the prepositioning of spill containment and cleanup equipment and trained personnel at strategic locations from which they can be deployed to the spill site to promptly and properly remove the spilled oil;

(k) Provide arrangements for enlisting the use of qualified and trained cleanup personnel to implement the plan;

(l) Provide for disposal of recovered spilled oil in accordance with local, state, and federal laws;

(m) Until a spill prevention plan has been submitted pursuant to RCW 88.46.040, state the measures that have been taken to reduce the likelihood that a spill will occur, including but not limited to, design and operation of a vessel, training of personnel, number of personnel, and backup systems designed to prevent a spill;

(n) State the amount and type of equipment available to respond to a spill, where the equipment is located, and the extent to which other contingency plans rely on the same equipment;

(o) If the department has adopted rules permitting the use of dispersants, the circumstances, if any, and the manner for the application of the dispersants in conformance with the department's rules;

(p) Compliance with RCW 88.46.230 if the contingency plan is submitted by an umbrella plan holder; and

(q) Include any additional elements of contingency plans as required by this chapter.

(2) The owner or operator of a covered vessel must submit any required contingency plan updates to the department within the timelines established by the department.

(3)(a) The owner or operator of a tank vessel or of the facilities at which the vessel will be unloading its cargo, or a nonprofit corporation established for the purpose of oil spill response and contingency plan coverage and of which the owner or operator is a member, shall submit the contingency plan for the tank vessel. Subject to conditions imposed by the department, the owner or operator of a facility may submit a single contingency plan for tank vessels of a particular class that will be unloading cargo at the facility.

(b) The contingency plan for a cargo vessel or passenger vessel may be submitted by the owner or operator of the cargo vessel or passenger vessel, by the agent for the vessel resident in this state, or by a nonprofit corporation established for the purpose of oil spill response and contingency plan coverage and of which the owner or operator is a member. Subject to conditions imposed by the department, the owner, operator, or agent may submit a single contingency plan for cargo vessels or passenger vessels of a particular class.

(c) A person who has contracted with a covered vessel to provide containment and cleanup services and who meets the standards established pursuant to RCW 90.56.240, may submit the plan for any covered vessel for which the person is contractually obligated to provide services. Subject to conditions imposed by the department, the person may submit a single plan for more than one covered vessel.

(4) A contingency plan prepared for an agency of the federal government or another state that satisfies the requirements of this section and rules adopted by the department may be accepted by

the department as a contingency plan under this section. The department shall ensure that to the greatest extent possible, requirements for contingency plans under this section are consistent with the requirements for contingency plans under federal law.

(5) In reviewing the contingency plans required by this section, the department shall consider at least the following factors:

(a) The adequacy of containment and cleanup equipment, personnel, communications equipment, notification procedures and call down lists, response time, and logistical arrangements for coordination and implementation of response efforts to remove oil spills promptly and properly and to protect the environment;

(b) The nature and amount of vessel traffic within the area covered by the plan;

(c) The volume and type of oil being transported within the area covered by the plan;

(d) The existence of navigational hazards within the area covered by the plan;

(e) The history and circumstances surrounding prior spills of oil within the area covered by the plan;

(f) The sensitivity of fisheries and wildlife, shellfish beds, and other natural resources within the area covered by the plan;

(g) Relevant information on previous spills contained in on-scene coordinator reports prepared by the director; and

(h) The extent to which reasonable, cost-effective measures to prevent a likelihood that a spill will occur have been incorporated into the plan.

(6)(a) The department shall approve a contingency plan only if it determines that the plan meets the requirements of this section and that, if implemented, the plan is capable, in terms of personnel, materials, and equipment, of removing oil promptly and properly and minimizing any damage to the environment.

(b) The department must notify the plan holder in writing within sixty-five days of an initial or amended plan's submittal to the department as to whether the plan is disapproved, approved, or conditionally approved. If a plan is conditionally approved, the department must clearly describe each condition and specify a schedule for plan holders to submit required updates.

(7) The approval of the contingency plan shall be valid for five years. Upon approval of a contingency plan, the department shall provide to the person submitting the plan a statement indicating that the plan has been approved, the vessels covered by the plan, and other information the department determines should be included.

(8) An owner or operator of a covered vessel shall notify the department in writing immediately of any significant change of which it is aware affecting its contingency plan, including changes in any factor set forth in this section or in rules adopted by the department. The department may require the owner or operator to update a contingency plan as a result of these changes.

(9) The department by rule shall require contingency plans to be reviewed, updated, if necessary, and resubmitted to the department at least once every five years.

(10) Approval of a contingency plan by the department does not constitute an express assurance regarding the adequacy of the plan nor constitute a defense to liability imposed under this chapter or other state law.

NEW SECTION. Sec. 202. A new section is added to chapter 88.46 RCW to read as follows:

By December 31, 2019, consistent with the authority under RCW 88.46.060, the department must update rules for contingency plans to require:

(1) Covered vessels to address situations where oils, depending on their qualities, weathering, environmental factors, and method of discharge, may submerge or sink in water; and (2) Standards for best achievable protection for situations involving the oils in subsection (1) of this section.

Sec. 203. RCW 88.46.220 and 2011 c 122 s 5 are each amended to read as follows:

(1) The department is responsible for requiring joint large scale, multiple plan equipment deployment drills of ((~~tank~~)) covered vessels to determine the adequacy of the owner's or operator's compliance with the contingency plan requirements of this chapter. The department must order at least one drill as outlined in this section every three years, which must address situations where oils, depending on their qualities, weathering, environmental factors, and method of discharge, may submerge or sink in water.

(2) Drills required under this section must focus on, at a minimum, the following:

(a) The functional ability for multiple contingency plans to be simultaneously activated with the purpose of testing the ability for dedicated equipment and trained personnel cited in multiple contingency plans to be activated in a large scale spill; and (b) The operational readiness during both the first six hours of a spill and, at the department's discretion, over multiple operational periods of response.

(3) Drills required under this section may be incorporated into other drill requirements under this chapter to avoid increasing the number of drills and equipment deployments otherwise required.

(4) Each successful drill conducted under this section may be considered by the department as a drill of the underlying contingency plan and credit may be awarded to the plan holder accordingly.

(5) The department shall, when practicable, coordinate with applicable federal agencies, the state of Oregon, and the province of British Columbia to establish a drill incident command and to help ensure that lessons learned from the drills are evaluated with the goal of improving the underlying contingency plans.

NEW SECTION. Sec. 204. A new section is added to chapter 88.46 RCW to read as follows:

(1) The department must establish the Salish Sea shared waters forum to address common issues in the cross-boundary waterways between Washington state and British Columbia such as:

Enhancing efforts to reduce oil spill risk; addressing navigational safety; and promoting data sharing.

(2) The department must:

(a) Coordinate with provincial and federal Canadian agencies when establishing the Salish Sea shared waters forum; and

(b) Seek participation from stakeholders that, at minimum, includes representatives of the following: State, provincial, and federal governmental entities, regulated entities, environmental organizations, tribes, and first nations.

(3) The Salish Sea shared waters forum must meet at least once per year to consider the following:

(a) Gaps and conflicts in oil spill policies, regulations, and laws;

(b) Opportunities to reduce oil spill risk, including requiring  tug escorts for oil tankers, articulated tug barges, and other waterborne vessels or barges;

(c) Enhancing oil spill prevention, preparedness, and response capacity; and

(d) Whether an emergency response system in Haro Strait, Boundary Pass, and Rosario Strait, similar to the system implemented by the maritime industry pursuant to RCW 88.46.130, will decrease oil spill risk and how to fund such a shared system.

(4) The definitions in this subsection apply throughout this section unless the context clearly requires otherwise.

(a) "Articulated tug barge" means a tank barge and a towing vessel joined by hinged or articulated fixed mechanical equipment affixed or connecting to the stern of the tank barge.

(b) "Waterborne vessel or barge" means any ship, barge, or other watercraft capable of traveling on the navigable waters of this state and capable of transporting any crude oil or petroleum product in quantities of ten thousand gallons or more for purposes other than providing fuel for its motor or engine.

(5) This section expires July 1, 2021.

Sec. 205. RCW 88.46.167 and 2006 c 316 s 2 are each amended to read as follows:

In addition to other inspection authority provided for in this chapter and chapter 90.56 RCW, the department may conduct inspections of oil transfer operations regulated under RCW 88.46.160 or 88.46.165. <u>The department must conduct specialized reviews and prioritize adding capacity for the inspection of oil transfer operations where oils, depending on their qualities, weathering, environmental factors, and method of discharge, may submerge or sink in water.</u>

<u>NEW SECTION.</u> Sec. 206. (1)(a) The department of ecology, in consultation with the Puget Sound partnership and the pilotage commission, must complete a report of vessel traffic and vessel traffic safety within the Strait of Juan de Fuca, Puget Sound area that includes the San Juan archipelago, its connected waterways, Haro Strait, Boundary Pass, Rosario Strait, and the waters south of Admiralty Inlet. A draft report, including recommendations, must be completed

and submitted, consistent with RCW 43.01.036, to the legislature by December 1, 2018. The final report must be completed and submitted to the legislature by June 30, 2019.

(b) In conducting the evaluation to produce the report, the department of ecology must rely only on existing current vessel traffic risk assessments and other available studies, consult with the United States coast guard, maritime experts, including representatives of covered vessels, onshore and offshore facilities, environmental organizations, tribes, commercial and noncommercial fishers, recreational resource users, provincial experts, representatives of the Salish Sea shared waters forum established in section 204 of this act, and other appropriate entities.

(2) The report completed under subsection (1) of this section must include an assessment and evaluation of:

(a) Worldwide incident and spill data for articulated tug barges and other towed waterborne vessels or barges;

(b) Transport of bitumen and diluted bitumen;

(c) Emerging trends in vessel traffic;

(d) Tug escorts for oil tankers, articulated tug barges, and other towed waterborne vessels or barges, including a review of requirements in California and Alaska;

(e) Requirements for tug capabilities to ensure safe escort of vessels, including manning and pilotage needs;

(f) An emergency response system in Haro Strait, Boundary Pass, and Rosario Strait, similar to the system implemented by the maritime industry pursuant to RCW 88.46.130;

(g) The differences between locations and navigational requirements for vessels transporting petroleum;

(h) The economic impact of proposals for tug escorts and limitations on vessel size; and

(i) Situations, where oils, depending on their qualities, weathering, environmental factors, and method of discharge, may submerge or sink in water.

(3) The report required under subsection (1) of this section must include recommendations for:

(a) Vessel traffic management and vessel traffic safety; and

(b) The viability of the following in reducing oil spill risk:

(i) Tug escorts for oil tankers, articulated tug barges, and other towed waterborne vessels or barges. If tug escorts are determined in this assessment to reduce oil spill risk, the department of ecology must recommend specific requirements and capabilities for tug escorts;

(ii) An emergency response system in Haro Strait, Boundary Pass, and Rosario Strait, similar to the system implemented by the maritime industry pursuant to RCW 88.46.130. If the department of ecology determines such a system will decrease oil spill risk, it must also recommend an action plan to implement it.

(4) The definitions in this subsection apply throughout this section unless the context clearly requires otherwise.

(a) "Articulated tug barge" means a tank barge and a towing vessel joined by hinged or articulated fixed mechanical equipment affixed or connecting to the stern of the tank barge.

(b) "Waterborne vessel or barge" means any ship, barge, or other watercraft capable of traveling on the navigable waters of this state and capable of transporting any crude oil or petroleum product in quantities of ten thousand gallons or more for purposes other than providing fuel for its motor or engine.

(5) This section expires June 30, 2019.

PART 3

FACILITIES, GEOGRAPHIC RESPONSE PLANS, AND SPILL MANAGEMENT TEAMS

Sec. 301. RCW 90.56.210 and 2017 c 239 s 1 are each amended to read as follows:

(1) Each onshore and offshore facility shall have a contingency plan for the containment and cleanup of oil spills from the facility into the waters of the state and for the protection of fisheries and wildlife, shellfish beds, natural resources, and public and private property from such spills. The department shall by rule adopt and periodically revise standards for the preparation of contingency plans. The department shall require contingency plans, at a minimum, to meet the following standards:

(a) Include full details of the method of response to spills of various sizes from any facility which is covered by the plan;

(b) Be designed to be capable in terms of personnel, materials, and equipment, of promptly and properly, to the maximum extent practicable, as defined by the department removing oil and minimizing any damage to the environment resulting from a worst case spill;

(c) Provide a clear, precise, and detailed description of how the plan relates to and is integrated into relevant contingency plans which have been prepared by cooperatives, ports, regional entities, the state, and the federal government;

(d) Provide procedures for early detection of oil spills and timely notification of such spills to appropriate federal, state, and local authorities under applicable state and federal law;

(e) State the number, training preparedness, and fitness of all dedicated, prepositioned personnel assigned to direct and implement the plan;

(f) Incorporate periodic training and drill programs to evaluate whether personnel and equipment provided under the plan are in a state of operational readiness at all times;

(g) Describe important features of the surrounding environment, including fish ((~~and~~)) habitat, water column species and subsurface resources, wildlife habitat, shellfish beds, environmentally and archaeologically sensitive areas, and public facilities, that are: (i) Based on information documented in geographic response plans and area contingency plans, as required under RCW

90.56.210; or (ii) for areas without geographic response plans or area contingency plans, existing practices protecting these resources used for similar areas.

The departments of ecology, fish and wildlife, and natural resources, and the department of archaeology and historic preservation, upon request, shall provide information that they have available to assist in preparing this description. The description of archaeologically sensitive areas shall not be required to be included in a contingency plan until it is reviewed and updated pursuant to subsection (9) of this section;

(h) State the means of protecting and mitigating effects on the environment, including fish, shellfish, marine mammals, and other wildlife, and ensure that implementation of the plan does not pose unacceptable risks to the public or the environment;

(i) Provide arrangements for the prepositioning of oil spill containment and cleanup equipment and trained personnel at strategic locations from which they can be deployed to the spill site to promptly and properly remove the spilled oil;

(j) Provide arrangements for enlisting the use of qualified and trained cleanup personnel to implement the plan;

(k) Provide for disposal of recovered spilled oil in accordance with local, state, and federal laws;

(l) Until a spill prevention plan has been submitted pursuant to RCW 90.56.200, state the measures that have been taken to reduce the likelihood that a spill will occur, including but not limited to, design and operation of a facility, training of personnel, number of personnel, and backup systems designed to prevent a spill;

(m) State the amount and type of equipment available to respond to a spill, where the equipment is located, and the extent to which other contingency plans rely on the same equipment; and

(n) If the department has adopted rules permitting the use of dispersants, the circumstances, if any, and the manner for the application of the dispersants in conformance with the department's rules.

(2)(a) The following shall submit contingency plans to the department within six months after the department adopts rules establishing standards for contingency plans under subsection (1) of this section:

(i) Onshore facilities capable of storing one million gallons or more of oil; and

(ii) Offshore facilities.

(b) Contingency plans for all other onshore and offshore facilities shall be submitted to the department within eighteen months after the department has adopted rules under subsection (1) of this section. The department may adopt a schedule for submission of plans within the eighteen-month period.

(3)(a) The department by rule shall determine the contingency plan requirements for railroads transporting oil in bulk.

(b) For class III railroads transporting oil in bulk that is not crude oil in an amount of forty-nine or more tank car loads per year, the rules adopted under this subsection may not require contingency plans to include:

(i) Contracted access to oil spill response equipment; or

(ii) The completion of more than a total of one basic table-top drill every three years to test the contingency plans.

(c) For class III railroads transporting oil in bulk that is not crude oil in an amount less than forty-nine tank car loads per year, rules adopted under this subsection may only require railroads to submit a basic contingency plan to the department. A basic contingency plan filed under this subsection (3)(c) must be limited to requiring the class III railroads to:

(i) Keep documentation of the basic contingency plan on file with the department at the plan holder's principal place of business and at dispatcher field offices of the railroad;

(ii) Identify and include contact information for the chain of command and other personnel, including employees or spill response contractors, who will be involved in the railroad's response in the event of a spill;

(iii) Include information related to the relevant accident insurance carried by the railroad and provide a certificate of insurance upon request;

(iv) Develop a field document for use by personnel involved in oil handling operations that includes time-critical information regarding basic contingency plan procedures to be used in the initial response to a spill or a threatened spill; and

(v) Annually review the plan for accuracy.

(d) Federal oil spill response plans created pursuant to 33 U.S.C. Sec. 1321 may be submitted in lieu of contingency plans by a class III railroad transporting oil in bulk that is not crude oil.

(e) For the purposes of this section, "class III railroad" has the same meaning as defined by the United States surface transportation board as of January 1, 2017.

(4)(a) The owner or operator of a facility shall submit the contingency plan for the facility.

(b) A person who has contracted with a facility to provide containment and cleanup services and who meets the standards established pursuant to RCW 90.56.240, may submit the plan for any facility for which the person is contractually obligated to provide services. Subject to conditions imposed by the department, the person may submit a single plan for more than one facility.

(5) A contingency plan prepared for an agency of the federal government or another state that satisfies the requirements of this section and rules adopted by the department may be accepted by the department as a contingency plan under this section. The department shall ensure that to the greatest extent possible, requirements for contingency plans under this section are consistent with the requirements for contingency plans under federal law.

(6) In reviewing the contingency plans required by this section, the department shall consider at least the following factors:(a) The adequacy of containment and cleanup equipment, personnel,

communications equipment, notification procedures and call down lists, response time, and logistical arrangements for coordination and implementation of response efforts to remove oil spills promptly and properly and to protect the environment;

(b) The nature and amount of vessel traffic within the area covered by the plan;

(c) The volume and type of oil being transported within the area covered by the plan;

(d) The existence of navigational hazards within the area covered by the plan;

(e) The history and circumstances surrounding prior spills of oil within the area covered by the plan;

(f) The sensitivity of fisheries, shellfish beds, and wildlife and other natural resources within the area covered by the plan;

(g) Relevant information on previous spills contained in on-scene coordinator reports prepared by the department; and

(h) The extent to which reasonable, cost-effective measures to prevent a likelihood that a spill will occur have been incorporated into the plan.

(7) The department shall approve a contingency plan only if it determines that the plan meets the requirements of this section and that, if implemented, the plan is capable, in terms of personnel, materials, and equipment, of removing oil promptly and properly and minimizing any damage to the environment.

(8) The approval of the contingency plan shall be valid for five years. Upon approval of a contingency plan, the department shall provide to the person submitting the plan a statement indicating that the plan has been approved, the facilities or vessels covered by the plan, and other information the department determines should be included.

(9) An owner or operator of a facility shall notify the department in writing immediately of any significant change of which it is aware affecting its contingency plan, including changes in any factor set forth in this section or in rules adopted by the department. The department may require the owner or operator to update a contingency plan as a result of these changes.

(10) The department by rule shall require contingency plans to be reviewed, updated, if necessary, and resubmitted to the department at least once every five years.

(11) Approval of a contingency plan by the department does not constitute an express assurance regarding the adequacy of the plan nor constitute a defense to liability imposed under this chapter or other state law.

NEW SECTION. Sec. 302. A new section is added to chapter 90.56 RCW to read as follows:

By December 31, 2019, consistent with the authority under RCW 90.56.210, the department must update rules for contingency plans to require:

(1) Covered facilities to address situations where oils, depending on their qualities, weathering, environmental factors, and method of discharge, may submerge or sink in water; and

(2) Standards for best achievable protection for situations involving the oils in subsection (1) of this section.

Sec. 303. RCW 90.56.240 and 1990 c 116 s 4 are each amended to read as follows:

(1) The department shall by rule establish standards for persons who contract to provide spill management, cleanup, and containment services under contingency plans approved under RCW 90.56.210.

(2) For the purposes of this section, "spill management" means managing:

(a) Some or all aspects of a response, containment, and cleanup of a spill, and utilizing an incident command or unified command structure; or

(b) Wildlife rehabilitation and recovery services for a spill response.

Sec. 304. RCW 90.56.569 and 2015 c 274 s 25 are each amended to read as follows:

(1) The department must provide to the relevant policy and fiscal committees of the senate and house of representatives ((~~:~~

~~(a) A review of all state geographic response plans and any federal requirements as needed in contingency plans required under RCW 90.56.210 and 88.46.060 by December 31, 2015; and~~

~~(b)~~)) updates ((~~every two years, beginning~~)) by December 31, ((~~2017~~)) 2019, and ((~~ending~~)) December 31, 2021, consistent with the requirements of RCW 43.01.036, as to the progress made in completing state and federal geographic response plans as needed in contingency plans required under RCW 90.56.060, 90.56.210, and 88.46.060.

(2) ((~~The department must contract, if practicable, with eligible independent third parties to ensure completion by December 1, 2017, of at least fifty percent of the geographic response plans as needed in contingency plans required under RCW 90.56.210 and 88.46.060 for the state.~~)) In its updates of geographic response plans, the department must address situations where oils, depending on their qualities, weathering, environmental factors, and method of discharge, may submerge or sink in water.

(3) All requirements in this section are subject to the availability of amounts appropriated for the specific purposes described.

NEW SECTION. Sec. 305. A new section is added to chapter 90.56 RCW to read as follows:

(1) The department is responsible for requiring joint large scale, multiple plan equipment deployment drills of onshore and offshore facilities and covered vessels under chapter 88.46 RCW to determine the adequacy of the owner's or operator's compliance with the contingency plan requirements of this chapter and chapter 88.46 RCW. The department must order at least one drill as outlined in this section every three years, which must address situations where oils, depending on their qualities, weathering, environmental factors, and method of discharge, may submerge or sink in water.

(2) Drills required under this section must focus on, at a minimum, the following:

(a) The functional ability for multiple contingency plans to be simultaneously activated with the purpose of testing the ability for dedicated equipment and trained personnel cited in multiple contingency plans to be activated in a large-scale spill; and

(b) The operational readiness during both the first six hours of a spill and, at the department's discretion, over multiple operational periods of response.

(3) Drills required under this section may be incorporated into other drill requirements under this chapter to avoid increasing the number of drills and equipment deployments otherwise required.

(4) Each successful drill conducted under this section may be considered by the department as a drill of the underlying contingency plan and credit may be awarded to the plan holder accordingly.

(5) The department must prioritize drills for situations where oils, depending on their qualities, weathering, environmental factors, and method of discharge, may submerge or sink in water.

PART 4

SEVERABILITY AND EMERGENCY CLAUSE

NEW SECTION. Sec. 401. If any provision of this act or its application to any person or circumstance is held invalid, the remainder of the act or the application of the provision to other persons or circumstances is not affected.

NEW SECTION. Sec. 402. Sections 102, 103, and 206 of this act are necessary for the immediate preservation of the public peace, health, or safety, or support of the state government and its existing public institutions, and take effect April 1, 2018.

Passed by the Senate March 3, 2018.

Passed by the House March 7, 2018.

Approved by the Governor March 23, 2018.

Filed in Office of Secretary of State March 26, 2018.

--- END ---

# Appendix B. Participating tribes, First Nations, and stakeholders

Appendix B is a list of tribes, First Nations, and organizations who were invited to participate during development of this report.

## Tribes and First Nations

Beecher Bay First Nation

Confederated Tribes and Bands of the Yakama Nation

Council of the Haida Nation

Cowichan Tribes

Ditidaht First Nation

Duwamish Tribe

Esquimalt Nation

Hoh Indian Tribe

Homalco First Nation

Jamestown S’Klallam Tribe

Lower Elwha Klallam Tribe

Lummi Nation

Makah Tribe

Malahat Nation

Muckleshoot Tribe

Nisqually Indian Tribe

Nooksack Indian Tribe

Northwest Indian Fisheries Commission

Pacheedaht First Nation

Port Gamble S'Klallam Tribe

Puyallup Tribe

Quinault Indian Nation

Quileute Tribe

Samish Indian Nation

Sauk-Suiattle Indian Tribe

Skokomish Indian Tribe

Snoqualmie Indian Tribe

Squamish Nation

Squaxin Island Tribe

Stillaguamish Tribe of Indians

Stó:lō Nation

Suquamish Tribe

Swinomish Indian Tribal Community

Tulalip Tribes

Tsawout First Nation

Tsleil-Waututh First Nation

Upper Skagit Indian Tribe

## Organizations

American Waterways Operators

BC Coast Pilots

BC Ministry of Environment

Canadian Coast Guard

Canadian Consulate General

Friends of the Earth

Friends of the San Juans

Marine Exchange of Puget Sound/Puget Sound Harbor Safety Committee

Northwest Fisheries Association

Pacific Coast Shellfish Growers Association

Pacific Merchant Shipping Association

Pacific Pilotage Authority

Puget Sound Anglers

Puget Sound Pilots

Recreational Boating Association of Washington

Sierra Club

Transport Canada, Pacific Region

U.S. Coast Guard

Washington Environmental Council

Washington Public Ports Association

Western States Petroleum Association

# Appendix C. Accessible data tables for figures

This appendix provides accessible data for figures contained in the report that may not otherwise be accessible for readers using assistive technology.

## Data table for Figure 3

Tank ships entering from the Strait of Juan de Fuca to Washington ports, 2007–2017 (Washington State Department of Ecology, 2018a)

| Year | Tank ships to Washington ports Entering Transits (ET) | Tank ships to Washington ports Individual Vessels (IV) |
|---|---|---|
| **2007** | 589 | 112 |
| **2008** | 508 | 100 |
| **2009** | 607 | 107 |
| **2010** | 548 | 101 |
| **2011** | 448 | 131 |
| **2012** | 412 | 110 |
| **2013** | 391 | 122 |
| **2014** | 358 | 126 |
| **2015** | 310 | 117 |
| **2016** | 328 | 108 |
| **2017** | 339 | 106 |

## Data table for Figure 4

Tank ships entering from the Strait of Juan de Fuca to Canadian ports, 2006–2017 (Washington State Department of Ecology, 2018a)

| Year | Tank ships to Canadian ports Entering Transits (ET) | Tank ships to Canadian ports Individual Vessels (IV) |
|---|---|---|
| **2006** | 94 | 62 |
| **2007** | 231 | 111 |
| **2008** | 193 | 96 |
| **2009** | 204 | 120 |
| **2010** | 252 | 141 |
| **2011** | 197 | 106 |
| **2012** | 209 | 116 |
| **2013** | 200 | 103 |

| Year | Tank ships to Canadian ports Entering Transits (ET) | Tank ships to Canadian ports Individual Vessels (IV) |
|---|---|---|
| **2014** | 172 | 94 |
| **2015** | 206 | 116 |
| **2016** | 192 | 101 |
| **2017** | 195 | 96 |

## Data table for Figure 5

Tank barge entering transits to Washington ports, 2011–2017 (Washington State Department of Ecology, 2018a)

| Year | Tank barge to Washington ports Entering Transit Southbound (ET-S) | Tank barge to Washington ports Entering Transit Eastbound (ET-E) |
|---|---|---|
| **2011** | 295 | 49 |
| **2012** | 254 | 25 |
| **2013** | 226 | 40 |
| **2014** | 177 | 83 |
| **2015** | 131 | 49 |
| **2016** | 159 | 90 |
| **2017** | 192 | 42 |

## Data table for Figure 6

ATB entering transits to Washington ports, 2011–2017 (Washington State Department of Ecology, 2018a)

| Year | ATB to Washington ports Entering Transit Southbound (ET-S) | ATB to Washington ports Entering Transit Eastbound (ET-E) |
|---|---|---|
| **2011** | 159 | 65 |
| **2012** | 80 | 104 |
| **2013** | 142 | 221 |
| **2014** | 177 | 83 |
| **2015** | 113 | 189 |
| **2016** | 90 | 193 |
| **2017** | 96 | 178 |

## Data table for Figure 7

Cargo and passenger vessels (container, bulker, ro-ro and vehicle, and general) entering from the Strait of Juan de Fuca to Washington ports, 2007–2016 (Washington State Department of Ecology 2018a)

| Year | Cargo and passenger vessels to Washington ports Entering Transits (ET) | Cargo and passenger vessels to Washington ports Individual Vessels (IV) |
|---|---|---|
| **2007** | 1679 | 603 |
| **2008** | 1862 | 664 |
| **2009** | 1721 | 699 |
| **2010** | 1663 | 688 |
| **2011** | 1609 | 690 |
| **2012** | 1575 | 633 |
| **2013** | 1676 | 590 |
| **2014** | 1409 | 703 |
| **2015** | 1401 | 637 |
| **2016** | 1520 | 667 |
| **2017** | 1491 | 671 |

## Data table for Figure 8

Cargo and passenger vessels (container, bulker, ro-ro and vehicle, and general) entering from the Strait of Juan de Fuca to Canadian ports, 2007–2017 (Washington State Department of Ecology 2018)

| Year | Cargo and passenger vessels to Canadian ports Entering Transits (ET) | Cargo and passenger vessels to Canadian ports Individual Vessels (IV) |
|---|---|---|
| **2007** | 1882 | 1025 |
| **2008** | 1937 | 1110 |
| **2009** | 1798 | 1041 |
| **2010** | 2040 | 1196 |
| **2011** | 2273 | 1271 |
| **2012** | 2811 | 1474 |
| **2013** | 2895 | 1459 |
| **2014** | 2719 | 1576 |
| **2015** | 2685 | 1507 |
| **2016** | 2732 | 1525 |
| **2017** | 2811 | 1616 |

## Data table for Figure 9

Worldwide tank barge spills by decade, 1970 – 2017 (International Tanker Owners Pollution Federation Limited, 2018a)

| Decade | >700 Tonnes | 7-700 Tonnes | Total |
|---|---|---|---|
| 1970s | 20 | 12 | 32 |
| 1980s | 4 | 21 | 25 |
| 1990s | 12 | 65 | 77 |
| 2000s | 5 | 29 | 34 |
| 2010s | | 8 | 8 |

## Data table for Figures 10 and 14

Number of tank barge oil spills in U.S. waters, 1973 – 2011 (U.S. Coast Guard, 2012); and number and volume of spills by source, 1991 - 2011, with interpretation (Excerpt from U.S. Coast Guard, 2012, Part I p.12)

| Year | Tank ship | Tank barge | All other vessels | Facilities | Pipelines | All other non-vessels | Unknown |
|---|---|---|---|---|---|---|---|
| **1973** | 694 | 603 | 1,527 | 3,317 | 511 | 301 | 2,061 |
| **1974** | 846 | 754 | 1,566 | 3,844 | 582 | 376 | 2,031 |
| **1975** | 595 | 767 | 1,499 | 3,139 | 667 | 390 | 2,235 |
| **1976** | 526 | 894 | 1,514 | 2,978 | 627 | 398 | 2,485 |
| **1977** | 533 | 993 | 1,760 | 2,671 | 461 | 426 | 2,615 |
| **1978** | 678 | 980 | 2,057 | 2,534 | 406 | 530 | 3,459 |
| **1979** | 647 | 862 | 1,833 | 2,358 | 583 | 506 | 3,045 |
| **1980** | 547 | 799 | 1,698 | 2,011 | 552 | 377 | 2,399 |
| **1981** | 419 | 718 | 1,584 | 2,007 | 561 | 324 | 2,198 |
| **1982** | 279 | 547 | 1,383 | 2,244 | 598 | 392 | 2,041 |
| **1983** | 258 | 523 | 1,444 | 2,443 | 582 | 444 | 2,222 |
| **1984** | 238 | 499 | 1,530 | 2,408 | 557 | 565 | 2,461 |
| **1985** | 164 | 385 | 1,113 | 2,032 | 385 | 385 | 1,705 |
| **1986** | 196 | 516 | 900 | 1,382 | 91 | 158 | 1,750 |
| **1987** | 158 | 413 | 1,208 | 1,160 | 95 | 142 | 1,665 |
| **1988** | 222 | 486 | 1,300 | 1,038 | 120 | 142 | 1,690 |
| **1989** | 200 | 504 | 1,564 | 1,688 | 110 | 138 | 2,409 |
| **1990** | 249 | 457 | 1,779 | 2,287 | 149 | 148 | 3,108 |
| **1991** | 220 | 428 | 1,780 | 2,389 | 105 | 117 | 3,530 |

| Year | Tank ship | Tank barge | All other vessels | Facilities | Pipelines | All other non-vessels | Unknown |
|---|---|---|---|---|---|---|---|
| **1992** | 193 | 322 | 4,795 | 2,045 | 36 | 815 | 1,285 |
| **1993** | 172 | 314 | 4,944 | 2,320 | 35 | 826 | 361 |
| **1994** | 172 | 393 | 4,681 | 2,258 | 55 | 796 | 605 |
| **1995** | 148 | 353 | 4,977 | 586 | 30 | 500 | 2,444 |
| **1996** | 122 | 313 | 5,151 | 509 | 17 | 552 | 2,671 |
| **1997** | 124 | 252 | 4,971 | 838 | 32 | 486 | 1,921 |
| **1998** | 104 | 220 | 4,848 | 937 | 45 | 571 | 1,590 |
| **1999** | 92 | 228 | 5,360 | 1,019 | 25 | 571 | 1,244 |
| **2000** | 111 | 229 | 5,220 | 1,054 | 25 | 566 | 1,149 |
| **2001** | 95 | 246 | 4,680 | 995 | 34 | 436 | 1,073 |
| **2002** | 55 | 126 | 1,635 | 1,219 | 0 | 67 | 1,395 |
| **2003** | 38 | 156 | 1,521 | 1,083 | 1 | 56 | 1,337 |
| **2004** | 35 | 143 | 1,527 | 1,099 | 1 | 37 | 1,055 |
| **2005** | 37 | 126 | 1,672 | 1,020 | 24 | 102 | 900 |
| **2006** | 38 | 134 | 1,821 | 1,136 | 21 | 101 | 933 |
| **2007** | 42 | 113 | 1,773 | 1,084 | 36 | 113 | 647 |
| **2008** | 34 | 106 | 1,504 | 1,007 | 36 | 105 | 608 |
| **2009** | 28 | 98 | 1,519 | 927 | 16 | 36 | 680 |
| **2010** | 23 | 73 | 1,412 | 869 | 34 | 105 | 492 |
| **2011** | 26 | 67 | 1,438 | 1,004 | 38 | 117 | 375 |

## Data table for Figure 11

Number of oil spills greater than 1,000 barrels from tank barges in U.S. waters compared to volume of oil moved by barge in billions of barrels, 1974 – 2013 (Excerpt from ABS Consulting, Inc., 2016, p.58)

| Year | All petroleum spills (Including crude oil) | Petroleum spills 1K-9.99K bbl | Petroleum spills 10K-24.99K bbl | Petroleum spills ≥25K bbl | Petroleum spills transported volume Bbbl | Petroleum spills per Bbbl | All crude oil spills only | Crude spills 1K-9.99K bbl | Crude spills 10K-24.99K bbl | Crude spills ≥25K bbl | Crude spills trans-ported volume Bbbl | Crude spills Per Bbbl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1974** | 13 | 10 | 0 | 3 | 1.616 | 8.045 | 5 | 4 | 0 | 1 | 0.321 | 15.576 |
| **1975** | 10 | 8 | 2 | 0 | 1.607 | 6.223 | 4 | 3 | 1 | 0 | 0.331 | 12.085 |
| **1976** | 9 | 9 | 0 | 0 | 1.746 | 5.155 | 3 | 3 | 0 | 0 | 0.339 | 8.850 |
| **1977** | 12 | 11 | 1 | 0 | 1.785 | 6.723 | 0 | 0 | 0 | 0 | 0.327 | 0.000 |

| Year | All petroleum spills (Including crude oil) | Petroleum spills 1K-9.99K bbl | Petroleum spills 10K-24.99K bbl | Petroleum spills ≥25K bbl | Petroleum spills transported volume Bbbl | Petroleum spills per Bbbl | All crude oil spills only | Crude spills 1K-9.99K bbl | Crude spills 10K-24.99K bbl | Crude spills ≥25K bbl | Crude spills trans-ported volume Bbbl | Crude spills Per Bbbl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1978** | 13 | 11 | 2 | 0 | 1.850 | 7.027 | 2 | 2 | 0 | 0 | 0.359 | 5.571 |
| **1979** | 10 | 10 | 0 | 0 | 1.707 | 5.858 | 1 | 1 | 0 | 0 | 0.319 | 3.135 |
| **1980** | 10 | 10 | 0 | 0 | 1.716 | 5.828 | 2 | 2 | 0 | 0 | 0.270 | 7.407 |
| **1981** | 5 | 3 | 0 | 2 | 1.675 | 2.985 | 0 | 0 | 0 | 0 | 0.219 | 0.000 |
| **1982** | 4 | 3 | 0 | 1 | 1.569 | 2.549 | 0 | 0 | 0 | 0 | 0.227 | 0.000 |
| **1983** | 5 | 1 | 3 | 1 | 1.537 | 3.253 | 1 | 0 | 1 | 0 | 0.251 | 3.984 |
| **1984** | 8 | 5 | 2 | 1 | 1.640 | 4.878 | 1 | 0 | 1 | 0 | 0.275 | 3.636 |
| **1985** | 9 | 7 | 2 | 0 | 1.580 | 5.696 | 2 | 2 | 0 | 0 | 0.300 | 6.667 |
| **1986** | 6 | 5 | 1 | 0 | 1.642 | 3.654 | 1 | 1 | 0 | 0 | 0.296 | 3.378 |
| **1987** | 4 | 4 | 0 | 0 | 1.666 | 2.401 | 0 | 0 | 0 | 0 | 0.270 | 0.000 |
| **1988** | 9 | 8 | 0 | 1 | 1.738 | 5.178 | 1 | 1 | 0 | 0 | 0.305 | 3.279 |
| **1989** | 7 | 7 | 0 | 0 | 1.715 | 4.082 | 0 | 0 | 0 | 0 | 0.283 | 0.000 |
| **1990** | 12 | 10 | 2 | 0 | 1.744 | 6.881 | 2 | 2 | 0 | 0 | 0.311 | 6.431 |
| **1991** | 3 | 3 | 0 | 0 | 1.649 | 1.819 | 0 | 0 | 0 | 0 | 0.282 | 0.000 |
| **1992** | 1 | 1 | 0 | 0 | 1.601 | 0.625 | 0 | 0 | 0 | 0 | 0.279 | 0.000 |
| **1993** | 2 | 2 | 0 | 0 | 1.638 | 1.221 | 0 | 0 | 0 | 0 | 0.284 | 0.000 |
| **1994** | 0 | 0 | 0 | 0 | 1.637 | 0.000 | 0 | 0 | 0 | 0 | 0.269 | 0.000 |
| **1995** | 2 | 1 | 1 | 0 | 1.600 | 1.250 | 0 | 0 | 0 | 0 | 0.257 | 0.000 |
| **1996** | 4 | 3 | 1 | 0 | 1.613 | 2.480 | 0 | 0 | 0 | 0 | 0.262 | 0.000 |
| **1997** | 2 | 2 | 0 | 0 | 1.734 | 1.153 | 0 | 0 | 0 | 0 | 0.262 | 0.000 |
| **1998** | 1 | 1 | 0 | 0 | 1.702 | 0.588 | 1 | 1 | 0 | 0 | 0.215 | 4.651 |
| **1999** | 2 | 2 | 0 | 0 | 1.649 | 1.213 | 0 | 0 | 0 | 0 | 0.202 | 0.000 |
| **2000** | 2 | 2 | 0 | 0 | 1.670 | 1.198 | 0 | 0 | 0 | 0 | 0.195 | 0.000 |
| **2001** | 2 | 2 | 0 | 0 | 1.684 | 1.188 | 0 | 0 | 0 | 0 | 0.183 | 0.000 |
| **2002** | 0 | 0 | 0 | 0 | 1.600 | 0.000 | 0 | 0 | 0 | 0 | 0.191 | 0.000 |
| **2003** | 1 | 0 | 0 | 1 | 1.634 | 0.612 | 0 | 0 | 0 | 0 | 0.209 | 0.000 |
| **2004** | 2 | 2 | 0 | 0 | 1.688 | 1.185 | 0 | 0 | 0 | 0 | 0.210 | 0.000 |
| **2005** | 2 | 1 | 0 | 1 | 1.709 | 1.170 | 1 | 1 | 0 | 0 | 0.205 | 4.878 |
| **2006** | 2 | 2 | 0 | 0 | 1.753 | 1.141 | 0 | 0 | 0 | 0 | 0.191 | 0.000 |
| **2007** | 0 | 0 | 0 | 0 | 1.795 | 0.000 | 0 | 0 | 0 | 0 | 0.187 | 0.000 |

| Year | All petroleum spills (Including crude oil) | Petroleum spills 1K-9.99K bbl | Petroleum spills 10K-24.99K bbl | Petroleum spills ≥25K bbl | Petroleum spills transported volume Bbbl | Petroleum spills per Bbbl | All crude oil spills only | Crude spills 1K-9.99K bbl | Crude spills 10K-24.99K bbl | Crude spills ≥25K bbl | Crude spills trans-ported volume Bbbl | Crude spills Per Bbbl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2008** | 1 | 1 | 0 | 0 | 1.636 | 0.611 | 0 | 0 | 0 | 0 | 0.169 | 0.000 |
| **2009** | 0 | 0 | 0 | 0 | 1.570 | 0.000 | 0 | 0 | 0 | 0 | 0.164 | 0.000 |
| **2010** | 0 | 0 | 0 | 0 | 1.575 | 0.000 | 0 | 0 | 0 | 0 | 0.171 | 0.000 |
| **2011** | 0 | 0 | 0 | 0 | 1.542 | 0.000 | 0 | 0 | 0 | 0 | 0.198 | 0.000 |
| **2012** | 2 | 1 | 1 | 0 | 1.678 | 1.192 | 1 | 1 | 0 | 0 | 0.326 | 3.067 |
| **2013** | 1 | 1 | 0 | 0 | 1.816 | 0.551 | 0 | 0 | 0 | 0 | 0.451 | 0.000 |
| **Total** | **178** | **149** | **18** | **11** | **66.706** | **2.668** | **28** | **24** | **3** | **1** | **10.365** | **2.701** |

## Data table for Figures 12 and 14

Volume of oil spilled from tank barges in U.S. waters, 1973–2011 (U.S. Coast Guard, 2012); and number and volume of spills by source, 1991–2011, with interpretation (Excerpt from U.S. Coast Guard, 2012, Part I p.12)

| Year | Tankship | Tankbarge | All other vessels | Facilities | Pipelines | All other non-vessels | Unknown |
|---|---|---|---|---|---|---|---|
| **1973** | 3,153,070 | 1,251,320 | 1,049,748 | 5,250,092 | 2,353,744 | 424,055 | 1,771,550 |
| **1974** | 1,177,851 | 2,331,302 | 317,939 | 3,834,292 | 6,833,402 | 588,091 | 615,854 |
| **1975** | 8,723,153 | 2,572,118 | 1,415,466 | 4,663,214 | 2,769,165 | 1,149,716 | 227,251 |
| **1976** | 9,315,761 | 1,702,772 | 281,032 | 2,046,062 | 4,283,495 | 647,656 | 241,170 |
| **1977** | 202,590 | 1,566,631 | 275,255 | 2,353,360 | 2,528,165 | 593,305 | 669,827 |
| **1978** | 329,699 | 3,239,284 | 474,151 | 4,391,595 | 1,220,486 | 501,074 | 707,819 |
| **1979** | 13,077,600 | 1,162,569 | 394,951 | 1,824,738 | 3,351,156 | 608,740 | 473,806 |
| **1980** | 1,597,088 | 1,738,003 | 290,976 | 2,926,797 | 3,067,276 | 382,505 | 2,594,326 |
| **1981** | 1,074,621 | 4,294,542 | 341,595 | 1,126,966 | 1,338,116 | 313,718 | 431,436 |
| **1982** | 1,219,922 | 2,146,576 | 412,484 | 1,660,560 | 4,213,862 | 368,696 | 322,696 |
| **1983** | 145,822 | 1,807,897 | 378,537 | 1,385,766 | 3,036,906 | 323,750 | 1,301,170 |
| **1984** | 4,663,952 | 2,484,481 | 1,863,435 | 1,193,770 | 1,212,702 | 381,704 | 6,205,834 |
| **1985** | 732,397 | 3,683,548 | 446,966 | 2,237,558 | 777,017 | 235,654 | 323,108 |
| **1986** | 1,164,962 | 1,510,064 | 160,890 | 902,917 | 230,785 | 28,596 | 283,764 |
| **1987** | 1,547,462 | 550,108 | 848,200 | 317,437 | 196,852 | 36,522 | 112,303 |
| **1988** | 852,287 | 3,164,017 | 369,985 | 1,368,898 | 704,719 | 39,383 | 86,715 |

| Year | Tankship | Tankbarge | All other vessels | Facilities | Pipelines | All other non-vessels | Unknown |
|---|---|---|---|---|---|---|---|
| **1989** | 11,272,320 | 746,833 | 674,660 | 448,792 | 214,920 | 33,030 | 88,137 |
| **1990** | 4,977,251 | 992,025 | 417,882 | 1,059,302 | 316,928 | 32,242 | 119,377 |
| **1991** | 92,334 | 241,346 | 362,809 | 445,986 | 49,382 | 10,068 | 674,027 |
| **1992** | 118,075 | 149,212 | 398,145 | 504,600 | 200,396 | 235,839 | 269,400 |
| **1993** | 69,541 | 697,653 | 409,963 | 350,141 | 362,399 | 145,796 | 31,895 |
| **1994** | 69,694 | 955,582 | 308,343 | 677,016 | 62,340 | 348,577 | 77,721 |
| **1995** | 125,491 | 1,101,938 | 396,724 | 868,900 | 11,894 | 77,428 | 55,854 |
| **1996** | 219,311 | 1,163,258 | 298,451 | 406,384 | 978,392 | 23,527 | 28,508 |
| **1997** | 22,429 | 165,649 | 192,801 | 204,935 | 224,122 | 72,208 | 60,430 |
| **1998** | 56,673 | 248,089 | 316,473 | 166,269 | 47,863 | 32,584 | 17,352 |
| **1999** | 8,414 | 210,383 | 357,678 | 367,537 | 36,140 | 147,704 | 44,593 |
| **2000** | 608,176 | 133,540 | 291,927 | 311,604 | 17,021 | 45,136 | 23,966 |
| **2001** | 125,217 | 212,298 | 232,341 | 201,025 | 13,577 | 55,921 | 14,141 |
| **2002** | 4,753 | 30,219 | 212,410 | 198,718 | 0 | 2,153 | 190,630 |
| **2003** | 4,450 | 102,874 | 103,481 | 78,202 | 14,952 | 361 | 96,819 |
| **2004** | 636,834 | 215,822 | 453,901 | 42,675 | 15,000 | 12,781 | 39,700 |
| **2005** | 2,976 | 2,006,774 | 115,058 | 7,633,248 | 136,465 | 1,934 | 30,126 |
| **2006** | 4,292 | 287,343 | 125,352 | 2,281,674 | 2,229 | 6,901 | 128,517 |
| **2007** | 46,731 | 4,516 | 184,093 | 141,857 | 295,165 | 2,701 | 30,279 |
| **2008** | 1,337 | 286,637 | 248,167 | 178,990 | 14,809 | 3,726 | 26,564 |
| **2009** | 14,417 | 4,424 | 107,816 | 51,703 | 1,657 | 916 | 30,667 |
| **2010** | 421,583 | 965 | 472,386 | 221,642 | 4,627 | 206,582,872 | 8,718 |
| **2011** | 1,702 | 15,852 | 90,109 | 89,467 | 1,687 | 3,605 | 7,849 |

## Data table for Figure 13

Volume of oil spilled from tank barges in U.S. waters, 1994 – 2016

The authors of this report created this table for accessibility purposes using the data shown in Figure 13. This table is not part of the source document from which the figure was obtained.

| Year | Gallons spilled |
|---|---|
| **1994** | 955,582 |
| **1995** | 1,101,938 |
| **1996** | 1,163,258 |
| **1997** | 165,649 |
| **1998** | 248,089 |

| Year | Gallons spilled |
|---|---|
| **1999** | 158,977 |
| **2000** | 133,540 |
| **2001** | 212,298 |
| **2002** | 136,688 |
| **2003** | 102,557 |
| **2004** | 213,043 |
| **2005*** | 1,942,144 |
| **2006** | 285,964 |
| **2007** | 4,527 |
| **2008** | 286,653 |
| **2009** | 4,347 |
| **2010** | 919 |
| **2011** | 15,871 |
| **2012** | 33,725 |
| **2013** | 17,529 |
| **2014** | 200,363 |
| **2015** | 147,070 |
| **2016** | 32,202 |

*Note: For 2005, if DBL-152 is *not* included, the spill volume is 96,618 gallons.

The source document for Figure 13, the U.S. Coast Guard–American Waterways Operators 2017 Annual Report, cites the original source of this information as: U.S. DOI/BSEE OCS Spill Database, December 2015 (Spills); U.S. Army Corps of Engineers, Waterborne Commerce of the United States, Part 5, National Summaries, 1975-2009 (Oil Handled).

## Data table for Figure 15

Number of tank barge oil spills reported to Ecology, 2008 – 2017 (Washington State Department of Ecology, 2018b)

| Year | Number of incidents |
|---|---|
| **2008** | 0 |
| **2009** | 4 |
| **2010** | 2 |
| **2011** | 3 |
| **2012** | 3 |
| **2013** | 1 |
| **2014** | 2 |

| Year | Number of incidents |
|---|---|
| **2015** | 3 |
| **2016** | 4 |
| **2017** | 4 |

## Data table for Figure 16

Number of tank barge non-spill incidents reported to Ecology, 2008 – 2017 (Washington State Department of Ecology, 2018b)

| Year | Number of incidents |
|---|---|
| **2008** | 5 |
| **2009** | 4 |
| **2010** | 2 |
| **2011** | 0 |
| **2012** | 4 |
| **2013** | 3 |
| **2014** | 0 |
| **2015** | 0 |
| **2016** | 0 |
| **2017** | 1 |

## Data tables for Figure 17

Causes of tank barge oil spill incidents for incidents reported to Ecology, 2008 – 2017 (Washington State Department of Ecology, 2018b)

| Cause | Number of incidents |
|---|---|
| **Equipment/material failure** | 12 |
| **Human error** | 11 |
| **Organizational/management failure** | 2 |
| **External conditions** | 1 |

Causes of tank barge non-spill incidents for incidents reported to Ecology, 2008 – 2017 (Washington State Department of Ecology, 2018b)

| Cause | Number of incidents |
|---|---|
| **Human error** | 10 |
| **Equipment/material failure** | 4 |
| **Unknown** | 3 |
| **External conditions** | 2 |

## Data table for Figure 18

ATB non-spill incidents reported to Ecology, 2008 – 2017 (Washington State Department of Ecology, 2018b)

| Year | Number of incidents |
|---|---|
| **2008** | 1 |
| **2009** | 2 |
| **2010** | 6 |
| **2011** | 1 |
| **2012** | 1 |
| **2013** | 0 |
| **2014** | 2 |
| **2015** | 1 |
| **2016** | 1 |
| **2017** | 1 |

## Data tables for Figure 19

Causes of ATB oil spill incidents reported to Ecology, 2008 – 2017 (Washington State Department of Ecology, 2018b)

| Cause | Number of incidents |
|---|---|
| **Equipment/material failure** | 2 |
| **Unknown** | 1 |
| **Organizational/management failure** | 1 |

Causes of ATB non-spill incidents reported to Ecology, 2008 – 2017 (Washington State Department of Ecology, 2018b)

| Cause | Number of incidents |
|---|---|
| **Equipment/material failure** | 7 |
| **Unknown** | 6 |
| **Human error** | 2 |
| **External conditions** | 1 |

## Data table for Figure 20

Tank barge incidents in the Canadian Pacific region, 2004 – 2017 (Transportation Safety Board of Canada, 2018)

| Year | Number of incidents |
|---|---|
| **2004** | 1 |
| **2005** | 1 |
| **2006** | 1 |
| **2007** | 0 |
| **2008** | 2 |
| **2009** | 3 |
| **2010** | 0 |
| **2011** | 1 |
| **2012** | 0 |
| **2013** | 1 |
| **2014** | 0 |
| **2015** | 2 |
| **2016** | 1 |
| **2017** | 3 |

## Data table for Figure 21

ATB incidents in the Canadian Pacific region, 2004 – 2017 (Transportation Safety Board Canada, 2018)

| Year | Number of incidents |
|---|---|
| **2004** | 0 |
| **2005** | 0 |
| **2006** | 1 |
| **2007** | 1 |
| **2008** | 3 |
| **2009** | 0 |
| **2010** | 3 |
| **2011** | 4 |
| **2012** | 4 |
| **2013** | 4 |
| **2014** | 2 |
| **2015** | 1 |
| **2016** | 3 |
| **2017** | 1 |

## Data table for Figure 22

Moving average, gallons of oil spilled by tank barges per million gallons transported (Excerpt from U.S. Coast Guard–American Waterways Operators, 2017, p.6)

| Year | Gallons of oil spilled per million gallons transported |
|---|---|
| **1994** | 13.9 |
| **1995** | 16.3 |
| **1996** | 16.9 |
| **1997** | 2.3 |
| **1998** | 3.5 |
| **1999** | 2.3 |
| **2000** | 1.9 |
| **2001** | 3.1 |
| **2002** | 2.1 |
| **2003** | 1.5 |
| **2004** | 3.1 |
| **2005** | 27.6 |
| **2006** | 4.0 |
| **2007** | 0.1 |
| **2008** | 4.3 |
| **2009** | 0.1 |
| **2010** | 0.01 |
| **2011** | 0.25 |
| **2012** | 0.49 |
| **2013** | 0.23 |
| **2014** | 2.62 |
| **2015** | 1.90 |
| **2016 (projected)** | 0.42 |

## Alternative (alt) text for Figure 24

Interaction of density, turbulence, and sedimentation in determining whether an oil will float, submerge, or sink (Excerpt from American Petroleum Institute, 2016, p.3 (Modeled after National Research Council, 1999)).

- Oil-to-Water Density Ratio less than 1.0: Floats initially.

1. High Sediment Interaction—Oil Can Sink:
    - After stranding onshore and mixing with sand.

- After mixing with sand suspended by wave action.
- Oil can refloat after separating from sand.

2. Low Sediment Interaction—Oil Floats, but Heavy Oils Can:
   - Quickly form tarballs.
   - Overwashing slows weathering.
   - Tarballs reconcentrate in convergence zones and on shorelines far from spill site.

- Oil-to-Water Density Ratio greater than 1.0: Majority does not float initially.

1. High Turbulence/Currents: Oil is submerged in water column.
   - High Sediment Interaction: Formulation of oil-particle aggregates that can sink quicker as turbulence decreases.
   - Low Sediment Interaction: Oil sinks slower as turbulence decreases and over larger areas.
2. Low Turbulence/Currents: Oil sinks to bottom.

## Data table for Figures 25, 26, and 27

The following data table shows:

- Locations of oil transfers by type of potentially non-floating oils
- Number of oil transfers of potentially non-floating oils
- Volume of oil transfers of potentially non-floating oils

| Location description | Transfer count | Transfer gallons | Non-floating oil types |
|---|---|---|---|
| **ANACORTES ANCHOR COVE MARINA** | 2 | 633174 | BUNKER OIL/HFO |
| **ANACORTES CURTIS WHARF** | 8 | 41000 | BUNKER OIL/HFO |
| **ANACORTES TESORO REFINERY** | 266 | 850396415 | Cat Feed/VGO; WASTE OIL; BUNKER OIL/HFO; CRUDE OIL; DECANT OIL |
| **Anchor - ANACORTES** | 13 | 3100090 | BUNKER OIL/HFO |
| **Anchor - MANCHESTER** | 33 | 8631214 | BUNKER OIL/HFO |
| **Anchor - MARCH POINT** | 1 | 131228 | BUNKER OIL/HFO |
| **Anchor - PORT ANGELES** | 178 | 44778640 | BUNKER OIL/HFO |

| Location description | Transfer count | Transfer gallons | Non-floating oil types |
|---|---|---|---|
| **Anchor - SEATTLE - EBE** | 11 | 3133065 | BUNKER OIL/HFO |
| **Anchor - SEATTLE - EBW** | 9 | 2387688 | BUNKER OIL/HFO |
| **Anchor - SEATTLE - SCE** | 29 | 7210969 | BUNKER OIL/HFO |
| **Anchor - SEATTLE - SCW** | 10 | 2344372 | BUNKER OIL/HFO |
| **Anchor - TACOMA** | 19 | 5441689 | BUNKER OIL/HFO |
| **Anchor - VENDOVI IS** | 18 | 3541837 | BUNKER OIL/HFO |
| **BANGOR NAVY DELTA PIER** | 1 | 4000 | BUNKER OIL/HFO |
| **BELLINGHAM FAIRHAVEN TERMINAL** | 1 | 115152 | BUNKER OIL/HFO |
| **CHERRY POINT BP** | 197 | 2715856535 | Cat Feed/VGO; WASTE OIL; BUNKER OIL/HFO; BAKKEN; CRUDE OIL |
| **EVERETT PACIFIC TERMINAL** | 1 | 126306 | BUNKER OIL/HFO |
| **EVERETT PIER 1 NORTH** | 1 | 109903 | BUNKER OIL/HFO |
| **EVERETT PIER 3 NORTH** | 1 | 6000 | BUNKER OIL/HFO |
| **FERNDALE PHILLIPS 66** | 285 | 1116936950 | Cat Feed/VGO; CRUDE OIL; BUNKER OIL/HFO |
| **MARCH POINT SHELL (FORMERLY EQUILON, TEXACO)** | 166 | 1585067651 | Cat Feed/VGO; BUNKER OIL/HFO; CRUDE OIL |
| **POINT WELLS ALON** | 321 | 268837241 | USED OIL; BUNKER OIL/HFO; DECANT OIL |
| **PORT ANGELES TERMINAL NO. 3 "T" PIER** | 1 | 504720 | WASTE OIL |
| **PORT ANGELES TESORO OIL DOCK (EX-BP)** | 143 | 59466065 | BUNKER OIL/HFO |
| **SEATTLE BALLARD FISHERMENS TERMINAL** | 4 | 630 | WASTE OIL |

| Location description | Transfer count | Transfer gallons | Non-floating oil types |
|---|---|---|---|
| **SEATTLE BALLARD OIL DOCK** | 71 | 12138 | WASTE OIL; USED OIL |
| **SEATTLE CALPORTLAND (ex-Glacier)** | 3 | 221446 | BUNKER OIL/HFO |
| **SEATTLE KINDER-MORGAN (NEW)** | 218 | 226087116 | Cat Feed/VGO; BUNKER OIL/HFO |
| **SEATTLE PIER 17** | 2 | 2132455 | BUNKER OIL/HFO |
| **SEATTLE PIER 48** | 2 | 721754 | BUNKER OIL/HFO |
| **SEATTLE PIER 66** | 41 | 9373702 | BUNKER OIL/HFO |
| **SEATTLE PIER 90** | 4 | 1622961 | BUNKER OIL/HFO |
| **SEATTLE PIER 91** | 115 | 26946778 | BUNKER OIL/HFO |
| **SEATTLE TERMINAL 18** | 151 | 96392884 | BUNKER OIL/HFO |
| **SEATTLE TERMINAL 20** | 4 | 1492718 | BUNKER OIL/HFO |
| **SEATTLE TERMINAL 25** | 4 | 1127437 | BUNKER OIL/HFO |
| **SEATTLE TERMINAL 30** | 5 | 333263 | BUNKER OIL/HFO |
| **SEATTLE TERMINAL 46** | 52 | 23952711 | BUNKER OIL/HFO |
| **SEATTLE TERMINAL 5** | 9 | 696963 | BUNKER OIL/HFO |
| **TACOMA A.P. Moller (ex-Maersk)** | 51 | 21744798 | BUNKER OIL/HFO |
| **TACOMA BLAIR TERMINAL** | 85 | 33770147 | BUNKER OIL/HFO |
| **TACOMA HUSKY TERMINAL** | 39 | 26754427 | BUNKER OIL/HFO |
| **TACOMA PCT A&B** | 111 | 104755045 | BUNKER OIL/HFO |
| **TACOMA PHILLIPS 66 (EX-TOSCO)** | 3 | 1913730 | BUNKER OIL/HFO |
| **TACOMA PIER 3** | 68 | 49282672 | BUNKER OIL/HFO |
| **TACOMA PIER 4 A & B** | 1 | 534754 | BUNKER OIL/HFO |
| **TACOMA SCHNITZER** | 1 | 164035 | BUNKER OIL/HFO |

| Location description | Transfer count | Transfer gallons | Non-floating oil types |
|---|---|---|---|
| **TACOMA TARGA SOUND TERMINAL** | 238 | 207111877 | Cat Feed/VGO; BUNKER OIL/HFO |
| **TACOMA TERMINAL 7** | 31 | 11666961 | BUNKER OIL/HFO |
| **TACOMA TERMINAL 7D** | 1 | 65614 | BUNKER OIL/HFO |
| **TACOMA TOTEM OCEAN TRAILER** | 10 | 2334330 | BUNKER OIL/HFO |
| **TACOMA U.S. OIL** | 106 | 283521402 | CRUDE OIL; DECANT OIL; BUNKER OIL/HFO; Cat Feed/VGO |
| **TACOMA WA UNITED** | 83 | 74180529 | BUNKER OIL/HFO |

## Data table for Figure 30

Diluted bitumen to Washington by pipeline, 2013–2017 (Washington State Department of Ecology, 2018e; Washington State Department of Ecology, 2018f)

| Year | Gallons |
|---|---|
| **2013** | 2,065,174,398 |
| **2014** | 2,186,156,742 |
| **2015** | 2,638,946,940 |
| **2016** | 2,895,146,814 |
| **2017** | 2,550,577,596 |

## Data table for Figure 32

Monthly volumes of crude oil by rail, in gallons, October 2016–April 2018 (Washington State Department of Ecology, 2018d)

| Month | All crude | Diluted bitumen |
|---|---|---|
| **Oct-16** | 214,314,996 | 15,217,776 |
| **Nov-16** | 200,385,486 | 12,893,202 |
| **Dec-16** | 200,062,128 | 10,209,024 |
| **Jan-17** | 193,940,838 | 10,156,188 |
| **Feb-17** | 161,503,524 | 7,779,660 |
| **Mar-17** | 193,540,998 | 16,841,412 |
| **Apr-17** | 206,854,662 | 15,412,152 |
| **May-17** | 203,642,922 | 10,919,076 |

| Month | All crude | Diluted bitumen |
|---|---|---|
| **Jun-17** | 188,054,622 | 7,751,730 |
| **Jul-17** | 192,927,588 | 12,829,698 |
| **Aug-17** | 181,562,136 | 18,155,802 |
| **Sep-17** | 194,556,432 | 25,028,598 |
| **Oct-17** | 191,274,720 | 29,115,030 |
| **Nov-17** | 170,448,936 | 23,543,604 |
| **Dec-17** | 188,752,158 | 25,506,768 |
| **Jan-18** | 201,700,968 | 24,805,032 |
| **Feb-18** | 150,190,866 | 10,962,168 |
| **Mar-18** | 211,830,948 | 17,745,336 |
| **Apr-18** | 176,462,202 | 17,523,030 |

## Alternative (alt) text for Figure 42

Definition of waterway zones in the 2015 VTRA (Van Dorp & Merrick, 2016, p. 3)

Map of Salish Sea area shows the fifteen VTRA 2015 waterway zones:

1. Buoy J.
2. ATBA (Area To Be Avoided off Washington coast).
3. Western Strait of Juan de Fuca.
4. Eastern Strait of Juan de Fuca.
5. Rosario Strait.
6. Guemes Channel area.
7. Saddlebag (Bellingham Bay area).
8. Georgia Strait.
9. Haro Strait and Boundary Pass.
10. North Puget Sound.
11. South Puget Sound.
12. Tacoma (area south of Tacoma Narrows).
13. Saratoga Passage and Skagit Bay.
14. San Juan Islands.
15. Southern Gulf of Georgia Islands (Canada).

## Data table for Figure 43

Relative comparison of potential oil loss by waterway zone in the 2015 VTRA (Van Dorp & Merrick, 2016, p. 128)

| Waterway Zone | Column A: Difference in potential oil loss between 2015 VTRA base case and the primary “what-if” case, in percentage of base case oil losses (Column C – Column D) | Column B: Multiplicative factor comparing potential oil losses in the primary “what-if” case to the 2015 VTRA base case (Column C ÷ Column D) | Column C: Potential oil loss by waterway zone in the primary “what-if” case, expressed as a percentage of base case potential oil loss (Output of 2015 VTRA model for the primary “what-if” case) | Column D: Potential oil loss by waterway zone for the 2015 VTRA base case (Output of 2015 VTRA model for the base case) |
|---|---|---|---|---|
| **Guemes** | +13.2% | x1.82 | 29.2% | 16.0% |
| **Haro/Boundary** | +35.8% | x3.53 | 50.0% | 14.2% |
| **Puget Sound South** | +0.0% | x1.00 | 11.6% | 11.5% |
| **Rosario** | +2.6% | x1.23 | 13.6% | 11.0% |
| **Saddlebag** | +6.7% | x1.62 | 17.5% | 10.8% |
| **Puget Sound North** | +0.3% | x1.03 | 10.9% | 10.6% |
| **Eastern Strait of Juan de Fuca** | +14.5% | x2.64 | 23.4% | 8.9% |
| **Southern Gulf Islands** | +1.2% | x1.19 | 7.5% | 6.3% |
| **Western Strait of Juan de Fuca** | +5.1% | x2.08 | 9.8% | 4.7% |
| **Georgia Strait** | +3.2% | x1.83 | 7.1% | 3.9% |
| **Buoy J** | +1.9% | x4.09 | 2.6% | 0.6% |
| **Tacoma South** | 0.0% | x0.97 | 0.6% | 0.6% |
| **San Juan Islands** | +0.0% | x1.02 | 0.6% | 0.6% |
| **Saratoga/Skagit** | +0.0% | x1.12 | 0.2% | 0.1% |
| **ATBA (Area To Be Avoided)** | +0.0% | x1.44 | 0.1% | 0.1% |

## Data table for Figure 44

Relative comparison of changes in potential oil loss for the 2015 VTRA primary “what-if” case with 5 potential risk reduction measures implemented and the primary “what-if” case without risk reduction measures, expressed as percentages of base case potential oil loss. Absolute changes in potential oil loss, and relative multipliers are provided for each waterway zone in the y-axis (Van Dorp & Merrick, 2016, p. 162).

| Waterway zone | Column A: Difference in potential oil loss for the 2015 VTRA primary "what-if" case with 5 potential risk reduction measures implemented, and the primary "what-if" case without risk reduction measures. (Column C – Column D) | Column B: Multiplicative factor comparing potential oil loss for the 2015 VTRA primary "what-if" case with 5 potential risk reduction measures implemented, and the primary "what-if" case without risk reduction measures. (Column C ÷ Column D) | Column C: Potential oil loss by waterway zone for the primary "what-if" case with a portfolio of 5 potential risk reduction measures implemented, expressed as a percentage of base case potential oil loss (Output of 2015 VTRA model for the primary "what-if" case with 5 potential risk reduction measures implemented) | Column D: Potential oil loss by waterway zone for the primary "what-if" case without potential risk reduction measures, expressed as a percentage of base case potential oil loss (Output of 2015 VTRA model for the base case for the primary "what-if" case without potential risk reduction measures) |
|---|---|---|---|---|
| **Guemes** | -6.7% | x0.77 | 22.5% | 29.2% |
| **Haro/Boundary** | -19.5% | x0.61 | 30.5% | 50.0% |
| **Puget Sound South** | -4.7% | x0.59 | 6.9% | 11.6% |
| **Rosario** | -3.1% | x0.77 | 10.5% | 13.6% |
| **Saddlebag** | -6.4% | x0.64 | 11.1% | 17.5% |
| **Puget Sound North** | -3.8% | x0.65 | 7.1% | 10.9% |
| **Eastern Strait of Juan de Fuca** | -1.8% | x0.92 | 21.6% | 23.4% |
| **Southern Gulf Islands** | -3.3% | x0.56 | 4.2% | 7.5% |
| **Western Strait of Juan de Fuca** | -1.6% | x0.84 | 8.2% | 9.8% |
| **Georgia Strait** | -2.7% | x0.62 | 4.4% | 7.1% |
| **Buoy J** | -0.2% | x0.92 | 2.4% | 2.6% |
| **Tacoma South** | -0.2% | x0.72 | 0.4% | 0.6% |
| **San Juan Islands** | +1.1% | x2.85 | 1.7% | 0.6% |
| **Saratoga/Skagit** | -0.1% | x0.45 | 0.1% | 0.2% |
| **ATBA (Area To Be Avoided)** | 0.0% | x0.85 | 0.1% | 0.1% |

## Data table for Figure 45

Relative comparison of changes in potential oil loss for the 2015 VTRA primary "what-if" case and a risk reduction measure that modeled untethered tug escort of tank barges and ATBs east of Port Angeles, expressed as percentages of base case potential oil loss. Absolute changes in potential oil loss, and relative multipliers are provided for each waterway zone. (Van Dorp & Merrick, 2016, p. 185).

| Waterway zone | Column A: Difference in potential oil loss for the 2015 VTRA primary "what-if" case with a potential risk reduction measure implemented modeling untethered tug escorts for laden tank barges and ATBs east of Port Angeles, and the primary "what-if" case without risk reduction measures. (Column C – Column D) | Column B: Multiplicative factor comparing potential oil loss for the 2015 VTRA primary "what-if" case with a potential risk reduction measure modeling untethered tug escorts for laden tank barges and ATBs east of Port Angeles, and the primary "what-if" case without risk reduction measures. (Column C ÷ Column D) | Column C: Potential oil loss by waterway zone for the primary "what-if" case with a potential risk reduction measure modeling untethered tug escorts for laden tank barges and ATBs east of Port Angeles, expressed as a percentage of base case potential oil loss (Output of 2015 VTRA model for the primary "what-if" case with the potential risk reduction measure implemented) | Column D: Potential oil loss by waterway zone for the primary what-if case without potential risk reduction measures, expressed as a percentage of base case potential oil loss (Output of 2015 VTRA model for the base case for the primary "what-if" case without potential risk reduction measures) |
|---|---|---|---|---|
| **Guemes** | +2.7% | x1.09 | 31.9% | 29.2% |
| **Haro/Boundary** | +0.1% | x1.00 | 50.0% | 50.0% |
| **Puget Sound South** | -0.2% | x0.98 | 11.3% | 11.6% |
| **Rosario** | -1.9% | x0.86 | 11.7% | 13.6% |
| **Saddlebag** | -1.7% | x0.90 | 15.8% | 17.5% |
| **Puget Sound North** | -0.6% | x0.95 | 10.3% | 10.9% |
| **Eastern Strait of Juan de Fuca** | -0.4% | x0.98 | 23.0% | 23.4% |
| **Southern Gulf Islands** | -0.3% | x0.96 | 7.2% | 7.5% |
| **Western Strait of Juan de Fuca** | -0.3% | x0.97 | 9.5% | 9.8% |
| **Georgia Strait** | -0.9% | x0.88 | 6.3% | 7.1% |

| Waterway zone | Column A: Difference in potential oil loss for the 2015 VTRA primary “what-if” case with a potential risk reduction measure implemented modeling untethered tug escorts for laden tank barges and ATBs east of Port Angeles, and the primary “what-if” case without risk reduction measures. (Column C – Column D) | Column B: Multiplicative factor comparing potential oil loss for the 2015 VTRA primary “what-if” case with a potential risk reduction measure modeling untethered tug escorts for laden tank barges and ATBs east of Port Angeles, and the primary “what-if” case without risk reduction measures. (Column C ÷ Column D) | Column C: Potential oil loss by waterway zone for the primary “what-if” case with a potential risk reduction measure modeling untethered tug escorts for laden tank barges and ATBs east of Port Angeles, expressed as a percentage of base case potential oil loss (Output of 2015 VTRA model for the primary “what-if” case with the potential risk reduction measure implemented) | Column D: Potential oil loss by waterway zone for the primary what-if case without potential risk reduction measures, expressed as a percentage of base case potential oil loss (Output of 2015 VTRA model for the base case for the primary “what-if” case without potential risk reduction measures) |
|---|---|---|---|---|
| **Buoy J** | +0.2% | x1.09 | 2.8% | 2.6% |
| **Tacoma South** | 0.0% | x0.93 | 0.6% | 0.6% |
| **San Juan Islands** | +0.1% | x1.25 | 0.7% | 0.6% |
| **Saratoga/Skagit** | 0.0% | x0.85 | 0.1% | 0.2% |
| **ATBA (Area To Be Avoided)** | 0.0% | x0.98 | 0.1% | 0.1% |

## Data table for Figure 46

Relative comparison of changes in potential accident frequencies for the 2015 VTRA primary “what-if” case and a risk reduction measure that modeled untethered tug escort of tank barges and ATBs east of Port Angeles, expressed as percentages of base case potential accident frequency. Absolute changes in potential accident frequency, and relative multipliers are provided for each waterway zone. (Van Dorp & Merrick, 2016, p. 185).

| **Waterway zone** | **Column A: Difference in potential accident frequency for the 2015 VTRA primary "what-if" case with a potential risk reduction measure implemented modeling untethered tug escorts for laden tank barges and ATBs east of Port Angeles, and the primary "what-if" case without risk reduction measures.** <br> **(Column C – Column D)** | **Column B: Multiplicative factor comparing potential accident frequency for the 2015 VTRA primary "what-if" case with a potential risk reduction measure modeling untethered tug escorts for laden tank barges and ATBs east of Port Angeles, and the primary "what-if" case without risk reduction measures.** <br> **(Column C ÷ Column D)** | **Column C: Potential accident frequency by waterway zone for the primary "what-if" case with a potential risk reduction measure modeling untethered tug escorts for laden tank barges and ATBs east of Port Angeles, expressed as a percentage of base case potential oil loss** <br> **(Output of 2015 VTRA model for the primary "what-if" case with the potential risk reduction measure implemented)** | **Column D: Potential accident frequency by waterway zone for the primary what-if case without potential risk reduction measures, expressed as a percentage of base case potential oil loss** <br> **(Output of 2015 VTRA model for the base case for the primary "what-if" case without potential risk reduction measures)** |
|---|---|---|---|---|
| **Puget Sound South** | -7.4% | x0.84 | 38.4% | 45.9% |
| **Southern Gulf Islands** | -1.6% | x0.88 | 11.6% | 13.2% |
| **Guemes** | -3.2% | x0.74 | 9.0% | 12.2% |
| **Haro/Boundary** | -0.1% | x0.99 | 12.6% | 12.7% |
| **Puget Sound North** | -0.8% | x0.89 | 6.5% | 7.3% |
| **Western Strait of Juan de Fuca** | 0.0% | x0.99 | 4.7% | 4.8% |
| **Georgia Strait** | -0.3% | x0.91 | 3.6% | 3.9% |
| **Eastern Strait of Juan de Fuca** | -0.2% | x0.96 | 4.1% | 4.2% |
| **Tacoma South** | -0.5% | x0.78 | 1.8% | 2.3% |
| **Rosario** | -0.3% | x0.79 | 1.1% | 1.4% |
| **San Juan Islands** | -0.1% | x0.93 | 1.1% | 1.2% |
| **Saddlebag** | -0.2% | x0.79 | 0.8% | 1.0% |
| **Buoy J** | +0.0% | x1.03 | 0.7% | 0.7% |
| **Saratoga/Skagit** | +0.0% | x1.00 | 0.2% | 0.2% |
| **ATBA (Area To Be Avoided)** | 0.0% | x0.97 | 0.0% | 0.0% |

## Data table for Figure 47

Estimated economic impacts under modeled scenario.

| Year | Jobs | Economic output (in millions of dollars) |
|---|---|---|
| **2019** | 242 | $31 |
| **2020** | 235 | $27 |
| **2021** | 227 | $23 |
| **2022** | 212 | $19 |
| **2023** | 197 | $15 |
| **2024** | 183 | $11 |
| **2025** | 172 | $9 |
| **2026** | 164 | $7 |
| **2027** | 158 | $5 |
| **2028** | 154 | $4 |

## Data table for Figure 49

Economic impact of the difference between status quo and modeled scenarios.

| Year | Jobs | Economic output (in millions of dollars) |
|---|---|---|
| **2019** | 123 | $16 |
| **2020** | 120 | $14 |
| **2021** | 116 | $12 |
| **2022** | 108 | $10 |
| **2023** | 100 | $8 |
| **2024** | 93 | $6 |
| **2025** | 87.6 | $4 |
| **2026** | 83.5 | $3 |
| **2027** | 80.5 | $3 |
| **2028** | 78.3 | $2 |