Gateway Pacific Terminal (GPT)

Vessel Traffic and Risk Assessment Study

Prepared for
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Bellingham, Washington

In collaboration with
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Executive Summary

Project Background

In 1992, Pacific International Terminals (PIT) applied to Whatcom County for a permit to develop a multi-use marine terminal at Cherry Point, Washington. The proposed marine terminal was to be composed of a deep-water wharf with upland commodity storage and would be known as the Gateway Pacific Terminal (GPT). A terminal permit, known as the Shoreline Substantial Development permit, was issued by Whatcom County in 1997,[2] but was subsequently appealed by several agencies:

- The Washington State Department of Ecology.
- The Washington Department of Fish and Wildlife.
- North Cascades Audubon Society.
- People for Puget Sound.
- League of Women Voters of Bellingham/Whatcom County.
- The Washington Environmental Council.

A settlement agreement was reached in 1999 between the above parties that resolved the appeals to the 1997 permit. An agreement made during the 1999 settlement required that the Washington Department of Ecology oversee an analysis by PIT of the additional ship traffic brought by the proposed GPT.

In addition, during 2011 the Lummi Nation, which was not a party to the 1999 Settlement Agreement, identified additional topics that it wanted addressed as part of a vessel traffic analysis for the modified version of the GPT project proposed during 2011. Both Ecology and PIT agreed to include the topics identified by the Lummi Nation in the vessel traffic analysis.

Initially the vessel traffic analysis was to be performed by Jack Herrald, PhD. and Captain Jim Townley. During 2011, it was determined by the parties participating in the 1999 settlement agreement that it was no longer feasible for Messrs. Herrald and Townley to perform the vessel traffic analysis and it was agreed that the analysis would be performed by The Glosten Associates and their subcontractors (Glosten). In late June 2012, Glosten started the vessel traffic analysis for the proposed GPT.

PIT forecasts full capacity for the proposed GPT to be 487 total annual vessel calls. For the purposes of this study, GPT-calling vessels are assumed to export bulk commodities to Asia. PIT anticipates that these calls will be split between two vessel sizes: Panamax-sized bulkers and Capesize bulkers. This study defines vessels between 65,000 deadweight tons (DWT) and 80,000 DWT as Panamax bulkers. Vessels between 160,000 DWT and 180,000 DWT are considered to be Capesize bulkers. The proposed GPT will have capacity for vessels up to

[2] A multi-use marine terminal project of the type proposed by PIT also requires a number of other permits and/or authorizations, such as a Clean Water Act Section 404 permit and a Clean Water Act Section 401 water quality certification, a Rivers and Harbors Act Section 10 permit, an Air Operating Permit, and a WDFW Hydraulic Project Approval.

250,000 DWT (Reference 50), and smaller Handymax sized vessels may also call at the terminal. There are three berths along the wharf. Two Capesize and one smaller ship can be at berth concurrently. Of the total annual vessel calls, it is projected that there would be 318 Panamax and 169 Capesize vessels (Reference 44).

The number of annual calls at full capacity considers time for berthing, loading, and unberthing vessels, as well as a 70% utilization rate to account for down time. At full capacity, the proposed terminal would export 54 million metric tons, 48 million metric tons of it open storage commodities, such as coal, and six (6) million metric tons of it other dry bulk, closed storage commodities. PIT forecasts more than enough market demand for this level of throughput. "I*nitial operation of the Terminal is anticipated to occur in 2019 at full capacity*," (Reference 50).

The split between the Panamax and Capesize vessels is based on an internal business plan by PIT for total throughput. Their plan considers capacity at the proposed wharf, recent trends in vessel sizes, and a conservative approach. PIT's Alternatives Analysis reports, "*the average size of the bulk commodity fleet has grown steadily from an average of approximately 43,500 deadweight tons (dwt) in 1990, to an average of about 64,400 deadweight tons in 2012.*"[3] Larger vessels offer economies of scale. With larger loads, larger vessels can achieve greater fuel efficiency, and charter rates are competitive with smaller vessels (Reference 50). However, to take a conservative approach, a greater percentage of vessel calls are allocated to the smaller Panamax vessels (65%) than to the Capesize vessels (35%). In forecasting the risks associated with vessel traffic, it is conservative to forecast more vessel traffic.

Vessel Traffic and Risk Assessment Study

This Vessel Traffic and Risk Assessment Study (VTARAS) was conducted by Glosten on the proposed GPT, a multi-modal dry bulk commodities terminal. The purpose of the study is to assess potential risks posed by new traffic that the proposed terminal would bring to the northern part of Puget Sound. This new traffic falls into three main categories:

1) GPT-calling bulkers.
2) GPT-calling assist tugs.
3) Tugs and tank barges which support bunkering GPT vessels.

Existing and forecasted traffic levels are considered for the study area (Figure ES-2), which includes 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 tugs assisting GPT traffic. Figure ES- 3 shows the location and vicinity of the proposed terminal. This study addresses the following questions:

- What will be the demands on anchorages, bunkering volumes, ballast water management, vessel traffic management, and pilots in the study area?

[3] Institute of Shipping Economics and Logistics, Shipping Statistics and Market Review (2012).

- What is the incremental impact of the proposed GPT and of the proposed cumulative projects upon potential incidents and spills from marine traffic?
- What are some of the impacts of the GPT upon the Lummi Nations' fishing and cultural resources?

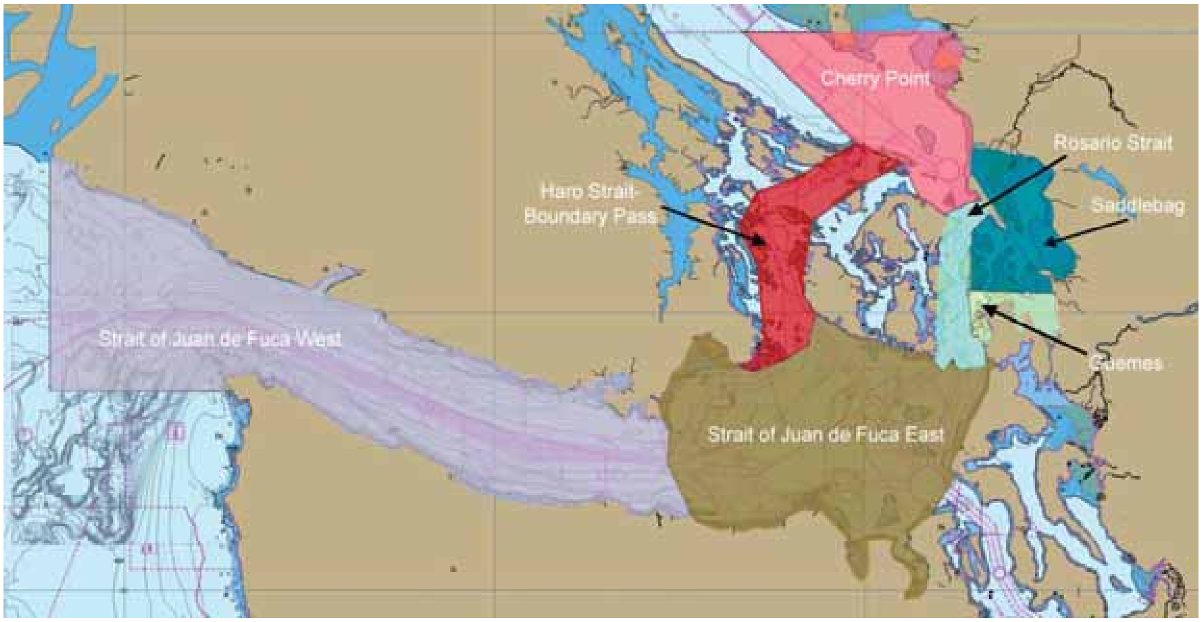

Figure ES-2 Project study area showing subareas (locations)

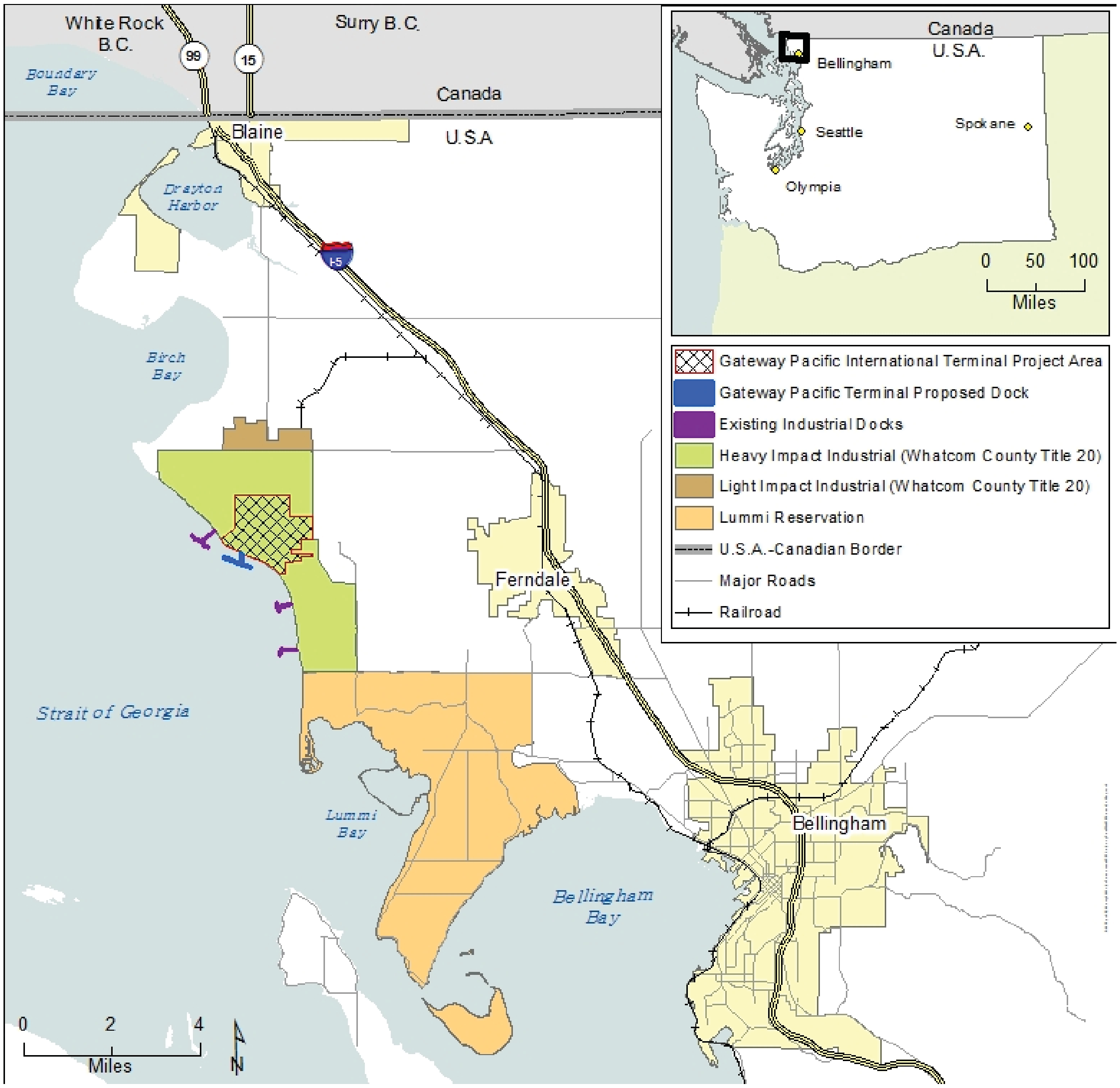

Figure ES- 3 Location of the proposed GPT, Reference 94

Note: Docks not shown to scale.

The final VTARAS report achieves compliance with the requirements of the settlement agreement, and it is expected that it will be used in preparation of an Environmental Impact Statement (EIS) by the third party contractor, CH2M Hill, for the proposed GPT project under the National Environmental Policy Act (NEPA) and State Environmental Policy Act (SEPA).

Peer Review Plan

A Peer Review Plan was developed with members of the GPT VTARAS Work Group concurrently with beginning this study. The GPT VTARAS Work Group was comprised of representatives from the Washington Department of Ecology, Pacific International Terminals, and the Lummi Nation. The peer review plan was developed to solicit feedback and obtain consensus from the GPT VTARAS Work Group. Glosten followed the peer review plan to receive comments on interim working documents and to then incorporate feedback into revisions. All interim working documents went through this peer review process with the GPT VTARAS Work Group.

Drafts of interim working documents were distributed to all members of the GPT VTARAS Work Group for review. Comments were then collected from each GPT VTARAS Work Group representatives, and consolidated. The GPT VTARAS Work Group convened four times – three times preceding a draft final and once preceding this final report. At these meetings, the GPT VTARAS Work Group members' comments were each reviewed within the context of the interim working document. Discussions were held to clarify issues, and generally consensus among the GPT VTARAS Work Group was reached. Comments were then included, excluded, or determined to require additional analysis. All comments from the GPT VTARAS Work Group have been addressed within this final report.

Report Organization

This Executive Summary reviews the study's scope, approach, and findings. Following a brief report Introduction and Peer Review Plan, the rest of the report is organized into three sections:

- Section 2, Vessel Traffic Infrastructure and Operations, which reviews the existing and expected traffic in the study area, with respect to traffic management, routing, anchorages, bunker demand, and ballast water discharge.
- Section 3, Vessel Traffic Analysis, which quantitatively analyzes the forecast traffic and risk statistics.
- Section 4, Select Vessel Traffic Impacts to the Lummi Nation, which assesses select GPT impacts through ballast water discharge volume, wake energy arriving at the shoreline, disruption to fishing activities, and collision risk with fishing vessels.

Additionally, a glossary of terms and acronyms is provided at the beginning, and the report closes with an exploration of potential risk mitigation measures.

Seven appendices provide additional data sources and analysis. The comprehensive vessel traffic study by Northern Economics, Inc. is contained in Appendix A Analysis Format and Vessel Traffic Data. Appendix B Small Vessel Memo addresses tugs (other than tugs with tank barges), commercial fishing vessels less than 60 feet in length, and recreational vessels. Appendices C, D, and E by Environmental Research Consulting, Inc. provides background data and input to the incident probability statistics and outflow model. Assembly of Questions for Lummi Fishers and Puget Sound Pilot Section – Questions for Pilots are Appendices F and G.

Approach

The bulk of this report is the quantitative, statistical analysis of three forecast vessel traffic cases:

- Case A – 2019 Baseline Vessel Traffic;
- Case B – 2019 Baseline traffic plus vessel traffic attributable to the GPT operating at full capacity in that year;
- Case C – 2019 Baseline plus GPT plus vessel traffic from other projects expected in the study area after 2019.

Representative risk statistics are calculated for each case for the purpose of finding the incremental, relative change between cases (Figure ES-4). The potential change in risk with the proposed GPT project is estimated by the change from Case A to Case B. The incremental impact of both the proposed GPT and other projects is estimated by the change from Case A to Case C.

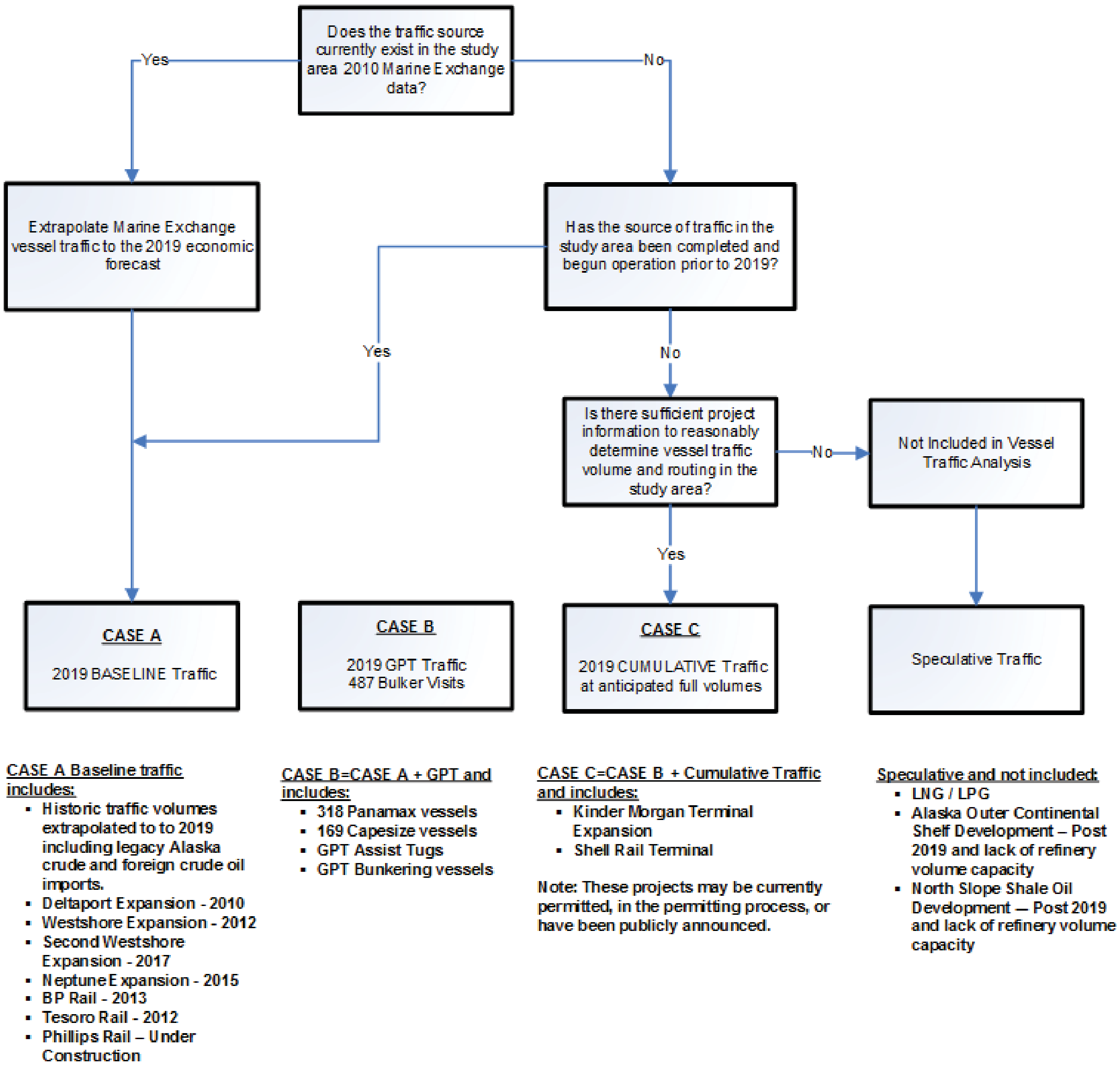

Figure ES-4 Logic flow to differentiate forecast cases

The approach used by Glosten to perform the analysis of the additional vessel traffic brought to the study area for the proposed GPT included:

- Procure, compare, check, and compile historical and current data for traffic volumes and routes and for incidents and spills to assemble a more complete, project-specific dataset from the assorted, available data sources.
- Establish a baseline of existing vessel traffic. Existing vessel traffic includes numbers of vessels, types and sizes of vessels, and typical vessel routing. Reasonable attempts

were made to identify vessels not included in the available vessel tracking data, and to confer with vessel owners/operators to estimate their vessel traffic and routes.

- Perform interviews with Puget Sound and Canadian Pilots to verify conclusions and assumptions regarding vessel traffic data.
- Submit questionnaires to the Lummi Nation to obtain information on the Lummi fishing fleet, fishing practices, and cultural resources.
- Forecast traffic volumes based on an underlying economic forecast of commodity throughput.
- Identify all reasonable future traffic sources, volumes and routing of vessel traffic based upon existing and proposed initiatives.
- Statistically analyze incident rates in the study area.
- Perform a statistical Monte-Carlo analysis to predict probability distributions for a potential range of the number of oil and bulk spills and spill volumes attributable to GPT vessel traffic in the study area.
- Compare predictions to historical data and to prior model predictions. Check that a change in output can be attributed to a change in input or in the calculation method. Check that outputs make sense given historical precedent.

Throughout the study, the GPT VTARAS Work Group used a conservative approach when processing data, making assumptions, and formulating calculations. A conservative approach is taken because of limited historical data and the inherent uncertainty in forecasting.

In the context of this study conservative means considering the worst possible circumstances or outcome of a given situation, and then basing our analysis upon it, and using it in our calculations.

Some examples of this conservative approach include:

- Despite no incidents during the 16-year historical baseline, we assumed an incident would happen in year 17.
- We predict cargo oil outflow from all tankers, not just oil tankers. By including liquid and chemical tankers, potential cargo oil outflow may be overestimated.
- In determining the energy of vessel wake reaching the shore, the study used a tug transiting at 14 knots, one-quarter mile offshore as the baseline. A slower tug, a bulker, or a further distance to shore would produce less wake energy arriving at the shoreline.

A result of the conservative approach used is that the study results may reflect higher potential risk than may actually occur because of the compounding effect of the conservative assumptions. While the study assesses a set of discrete, known risks, there is the additional potential for unknown risks. Unknown risks may be inconsequential or of great consequence; by definition, no unknown risk is included in this study.

Vessel Traffic Infrastructure and Operations

The Vessel Traffic Infrastructure and Operations section of the Vessel Traffic and Risk Assessment Study focuses on the operational parameters of GPT-calling vessels, for both existing and projected operations at full capacity in 2019. Study area routes, landmarks, and other operational considerations are presented. Vessel traffic management is discussed, including a list of vessel traffic management alternatives developed by Glosten and ranked by potential effectiveness. These alternatives were developed separately and are presented separately from the Risk Reduction Options discussed later in this Executive Summary. Additionally, the Vessel Traffic Infrastructure and Operations section uses a blend of qualitative and quantitative analysis to address anchorage capacity and usage, additional bunkering demand of GPT-calling vessels and assist tugboats, and ballast water management for GPT-calling vessels.

Alternative Vessel Traffic Management Schemes

This sub-section discusses alternative vessel traffic management schemes and ranks them in terms of their potential effectiveness. For the purposes of this section, effectiveness is defined as the inferred likelihood that a particular scheme could prevent a collision, allision, or grounding of any vessel traffic in the study area. Cost was not a consideration. This list and evaluation of effectiveness is purely qualitative, based on Glosten's own expertise, and is not intended to imply that systems currently in place for vessel traffic management are somehow deficient or ineffective. This list is offered for potential future discussion and consideration. The alternative management schemes are ranked as follows:

1. Mandatory Tug Escort
2. Voluntary Speed Reduction
3. Standby Rescue/Response Tugs
4. Area Transit Plans
5. Complements to the Existing Traffic Separation Scheme
6. Supplemental Aids to Navigation

Anchorage Capacity, Usage, and Demand

This section reviews existing USCG managed locations for vessels to anchor in the study area, compares their utilization, and then analyzes whether the existing anchorage areas have adequate capacity for GPT-calling traffic at anticipated levels. Anchorage data are published in the Puget Sound Harbor Safety Plan (Reference 102). The 28 anchorages in Puget Sound have never been filled to full capacity (Reference 66). The five primary anchorage areas used by shipping in the study area are located at Cherry Point, Bellingham Bay, Vendovi Island (East and South), Anacortes (West, Central, and East), and Port Angeles. Within the five study area anchorage areas, 20 vessels can be accommodated, Table ES- 1.

Table ES- 1 Anchorages in North Puget Sound, Reference 102

General Anchorages	Abbreviation	Number of Vessels / Anchorage Spaces	Maximum Stay	Radius*
Designated Anchorages				
Cherry Point	CP	1	30 Days	1,620 yds.
Bellingham Bay	BB	6	30 Days	2,000 yds.
Anacortes West	ANW	1	6 Days	600 yds.
Anacortes Central	ANC	1	10 Days	600 yds.
Anacortes East	ANW	1	10 Days	600 yds.
Non-Designated Anchorages				
Vendovi Island East	VIE	4	10 Days	1,660 yds.
Vendovi Island South	VIS	1	10 Days	648 yds.
Port Angeles Harbor	PA	5	10 Days	506 yds.

*Bellingham Bay anchorage is defined in 33 CFR §110.230 - 2(i). Port Angles anchorage is defined in 33 CFR §110.230 – 14. All anchorages are then divided into swing radii to fit the defined number of ships in the Harbor Safety Plan for each anchorage.

Within the five study area anchorage areas, there are 17 anchorage spaces available that could be used by GPT-calling vessels. Three anchorage spaces at the Bellingham Bay anchorage are subtracted from the 20 total anchorage spaces available, under the assumption that they are incompatible with GPT-calling vessels due to a combination of relatively shallow depth, poor holding ground, and exposure. This assumption is incorporated into the vessel traffic model. The Cherry Point anchorage space is included in the 17 anchorage spaces available, but it is only available for 274 days of the year due to adverse weather conditions in winter. After accounting for the subtracted anchorage spaces at Bellingham Bay and seasonal availability in Cherry Point, the 17 anchorage spaces have a capacity of 6,114 vessel days per year.

Past anchorage usage is compared to a capacity of 6,114 vessel days per year. The maximum utilization during the 2006-2010 was in 2007 with 1,444 vessel days, or 23.6% utilization. On average (2006-2010), there was 79.6% remaining availability. The daily average was 13.4 available anchorage spaces, and the forecasted daily average number of anchorage spaces available is also 13.4, assuming an even annual distribution of anchorage usage throughout the year. In practice, anchorage availability varies day to day.

The demand for anchorage from GPT vessels was estimated with a queuing analysis. GPT-calling bulkers are predicted to queue at-anchor while waiting for an available berth. Average wait time was 1.5 days per call. The probability that the number of vessels in the queue will exceed the number of available anchorage spaces (13) is less than 1%. This means that anchorage capacity may be fully utilized for about 3 days of the year. Therefore, the available anchorages are presumed to be adequate to meet the demand from GPT-calling bulkers for the majority of the time. The queuing analysis and USCG feedback both suggest that existing anchorages have sufficient capacity to accommodate increased traffic due to the proposed GPT project.

This queueing model is based on annual averages and does not take into account real-time operational management, which would reduce queuing time. Pilots, vessel agents, and the terminal are regularly in communication. This communication helps facilitate just-in-time arrivals at the berth. This means that both the cargo and the vessel arrive on schedule, so that neither is waiting for the other. For exports, the cargo is ready to be loaded onto the vessel and the berth is available when the vessel arrives. If a vessel has enough advance notice from the destination terminal that there is a delay, then the vessel may potentially reduce its speed earlier in the journey, before entering the study area, to manage arrival time and reduce cost and risk. There are costs associated with storing cargo at the terminal and with a vessel going to anchor. While at anchor, dragging anchor and other incidents are a risk. The cargo owner, terminal, and vessel are all incentivized to keep on schedule. In practice, delays occur. Even so, these operational practices could result in less queuing time than is predicted by the queuing model.

Bunker Demand

Additional vessel traffic of GPT-calling vessels will consume fuel oil. Fuel market trends indicate that GPT bulkers will meet at least part of this additional demand in the Pacific Northwest. Port Angeles is historically the most active bunkering site of the existing anchorage areas at Anacortes, Bellingham, Everett, Ferndale (Cherry Point), and Port Angeles. Due to variability and uncertainty in consumption rates and future bunkering locations, the projected increase in bunkering demand is given in a range. For the purposes of this study, we have assumed that between 50% and 100% of GPT–calling bulkers will bunker within the study area. This is a conservative estimate as non-GPT deep draft vessels calling in Puget Sound do not historically bunker at the high end of this range, nor do vessels transiting the study area and calling at Canadian ports (Reference 40). GPT-calling bulkers and assist tugs are forecast to bunker between 2,185,000 and 4,337,000 bbls within the study area per year that the terminal operates at full capacity, 487 vessel calls. Over the volume bunkered in 2011, this forecasted volume represents an increase of 122% to 243%.

Ballast Water Discharge

The primary risk of ballast water discharges to the environment is the introduction of non-indigenous species and pathogens. These risks can be reduced by decreasing the discharge frequency, the total quantity of viable organisms discharged, and the concentration density of viable organisms. However, there is a lack of data that can quantify the reduction in invasion risk due to control of these factors. In light of this lack of data, this study only projects the quantity of discharged ballast water and the standard to which that ballast water is required to be managed. GPT-calling bulkers are forecast to discharge 13,861,800 m^3 (3,661,410,000 gallons) of ballast water in 2019.

The 2019 GPT-calling bulkers nearly triple the volumes of ballast water discharged within the study area compared to 2013 volumes. Discharge from GPT-calling bulkers will occur almost exclusively within the Cherry Point subarea. Assuming they are adequately and reliably enforced, existing and evolving ballast water regulations are expected to mitigate the impact of the ballast water discharged at GPT. Existing vessels of high ballast water capacity, such as bulk carriers calling at GPT, will require refitting with ballast water treatment systems at their first drydocking after 1 January 2016. Assuming a five-year drydocking schedule, this fleet would complete its refitting by 31 December 2020.

Vessel Traffic Analysis

The Vessel Traffic Analysis section of the Vessel Traffic and Risk Assessment Study focuses on the potential change in risk with the proposed GPT upon potential incidents and spills from all marine traffic in the study subarea. This section comprises the bulk of the report and contains the quantitative, statistical analysis of the three forecast vessel traffic cases.

Vessel Traffic Analysis Statistical Approach

The objective of the Vessel Traffic Analysis Statistical Approach is to characterize the expected incremental number of potential incidents, the number of potential spills, and the combined volumes of dry bulk cargo, liquid cargo, or vessel fuel spilled in the study area. The predictions in this section are based on historical data from Puget Sound. Within the study area over a 16-year baseline, there were eight (8) collision, allision, or grounding incidents from deep draft vessels. Of the eight incidents, there was one spill; the spill volume recorded was one gallon. Due to the scarcity of events in Puget Sound, supplemental national and international data were also used to estimate outflow volumes in the event of a spill. The calculated risk prediction parameters for 2019 are shown in Table ES-2[4].

Table ES-2 Calculated risk prediction parameters

Risk Prediction Parameter	Analysis Performed
Annual vessel traffic days (24 hours of time in the study area)	By vessel type, activity, and geographic subarea
Incident Rates	By vessel type, activity, incident type, and geographic subarea
Probability of a spill when an incident occurs	By vessel type and incident type
Annual number of potential incidents	Total for study area By vessel type, activity, incident type, and geographic subarea
Annual number of potential spills	Total for study area By vessel type, activity, incident type, and geographic subarea
Annual volume of potential oil outflow	Total for study area By subarea, by vessel type, and incident type
Annual volume of potential bulk cargo outflow	Total for study area By subarea and incident type

The approach chosen in this comparative risk assessment is to use a Monte Carlo simulation to forecast a range of incident, spill, and volume predictions. The Monte Carlo simulation is an industry standard technique for combining probability distributions of the underlying input parameters. The simulation is repeated 10,000 times, each time randomly selecting inputs

[4] Risk is commonly defined as a combination of probability and consequence. The first five risk prediction parameters of Table ES-2 are a measure of probability. Analysis of these parameters gives an annual frequency or likelihood for certain events: traffic, incidents, and spills. Incidents and spills may also be interpreted as a consequence. Outflow volumes are a measure of consequence.

from the underlying input parameters. This generates 10,000 predictions. These predictions can then be sorted to determine a range and probability distribution for possible outcomes. Thus, instead of predicting singular incident, spill, and outflow values for the required comparisons, a probability distribution is calculated for each of these three risk parameters.

Predicted probability distributions are compared using representative statistics from the distribution. The statistics of the distributions are a measure of the probability of the predicted values and ranges of values. They are not a prediction of the statistics of what will occur in the forecast year. Each prediction has equal certainty. The reported distribution statistics are to be interpreted as a measure of risk. The selected statistics to characterize incremental risk are:

- The average (or "mean").
- The 50^{th} percentile.
- The 95^{th} percentile.

The average is simply the mean, or statistical average, of the 10,000 predictions. When all 10,000 predictions are sorted from smallest to largest, the 50^{th} percentile, or median, is the $5{,}000^{th}$ prediction. Half of the predictions are larger than the median, and half are smaller. Similarly, the 95^{th} percentile is the $9{,}500^{th}$ prediction out of 10,000. Only 5% of the predictions were larger, while 95% were the same size or smaller than the 95^{th} percentile. In other words, should any one prediction be sampled at random, there is a 95% likelihood, or a 95% chance, that the sampled value is the same size or smaller than the 95^{th} percentile. To compare the prediction for the number of potential incidents or for the number of potential spill between analysis cases, an appropriate statistic is the average. With respect to volume of outflow, it is appropriate to compare the median or some other percentile value (e.g., 95^{th}), rather than the average. The next subsection discusses why different statistics are used to represent different risk parameters in this VTARAS report.

Comparison of Risk Statistics:

The number of potential incidents and number of potential spills are integer numbers; i.e., there cannot be a fraction of an incident or a fractional number of spills. The average of 10,000 integers may not be an integer. For example, consider the case of 10,000 predictions, where three (3) incidents were predicted 2,500 times, and zero (0) incidents were predicted 7,500 times. The median of these 10,000 predictions is zero. The average of these 10,000 predictions, however, is 0.0003 incidents. By reporting the average for annual number of potential incidents and spills, predictions and differences between predictions of less than one are captured in the incremental risk analysis.

Conversely, oil outflow is best compared using the median (50^{th} percentile) and 95^{th} percentile, but *not* the average. The problem with averages when comparing oil outflow is that rare, extreme events can significantly skew the result and make it misleading.[5] Consider the example where each year for 9 years, there are 100 gallons of oil outflow. Then, in the 10^{th} year, a ship breaks up and spills 33 million gallons of oil. The average of the 10-year sample is 3.3 million gallons/year, whereas the median is 100 gallons and better reflects what

[5] Number of potential incidents and spills are resistant to the problem of skewed averages because they are not susceptible to maximum values that are orders of magnitude greater than their median values.

happened most (9 out of 10) years. Similarly, the 95th percentile oil outflow indicates an extreme scenario; in this example, the 95th percentile is 16.5 million gallons. The average is a poor indicator of both the "typical" year and the "extreme" year. For this reason, both the 50th and 95th percentiles are given for outflow volumes in place of the average.

It follows that care must be taken when choosing the statistics for measuring risk. The median (50th percentile) and 95th percentile are presented to highlight two scenarios ("typical" and "extreme") that are meant to give the reader a general understanding of risk. However, depending on how the data will be used, median and 95th percentile may not be the most appropriate percentiles. For this reason, the probability distributions for major results (e.g. predicted number of incidents)[6] are also presented graphically, allowing the reader to determine the incremental risk at *any* percentile.[7] This underscores the power of the probability distribution: every probability percentile is presented in a single illustration.

Analysis Cases

Potential risks posed by new traffic associated with the proposed terminal are studied by forecasting and comparing three vessel traffic cases (Figure ES-5). Firstly, traffic existing during and prior to 2010 was forecast to 2019. Secondly, additional sources of vessel traffic were identified. These additional sources of vessel traffic in 2019 were classified as either baseline or cumulative. Identified sources and the classification logic are captured in the flowchart, Figure ES-4. Representative risk statistics from cumulative probability distributions were generated for each case.

Case A (Baseline)	Case B (GPT)	Case C (Cumulative)
• Existing vessel traffic forecast to 2019 • Additional traffic from port expansions or new ports completed since 2010 or currently under construction and completed by 2019	• Case A traffic • Gateway Pacific Terminal vessel traffic	• Case B traffic • Projects expected to take place in the study area in the near future

Figure ES-5 Forecast analysis and traffic components

Analysis Scenarios

Total potential contaminant (oil and bulk cargo) outflow for a given year was determined by summing all the individual spills that occur in that year. Determination of the quantity and volume of individual spills was accomplished by breaking the system into scenarios that represented each potential occurrence of oil and bulk outflow, and sampling each scenario to

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[6] Highly specific results, such as predicted spill volume by incident type and subarea, are presented in tabular format only.

[7] It is suggested that when investigating rare results (e.g. the 95th percentile), conclusions should be made from differences in order of magnitude, rather than percentage differences. To emphasize this appropriate interpretation of results, spill volume outflow distributions in Glosten's incremental risk assessment report are plotted on a logarithmic scale.

determine if that scenario results in any spills of oil cargo, dry bulk cargo, bunker fuel, or some combination thereof. Scenarios are defined by six (6) vessel types, four (4) activity types, six (6) incident types, and seven (7) locations. Tugs pushing tank barges are included within the tug vessel type. The project scenarios taxonomy is summarized in Table ES-3 and yields 1,008 scenarios for each traffic volume case (6 vessel types x 4 activity types x 6 incident types x 7 locations = 1,008).

Table ES-3 Project scenario parameters

Vessel Type	Activity Type	Incident Type	Location
1. Tanker	1. Underway	1. Collision	1. Strait of Juan de Fuca West
2. Tank Barge	2. Maneuvering	2. Allision	2. Strait of Juan de Fuca East
3. Bulker	3. At dock	3. Grounding	3. Rosario Strait
4. General Cargo	4. At Anchor	4. Cargo Transfer Error	4. Haro Strait and Boundary Pass
5. Tug		5. Bunker Error	5. Cherry Point
6. Passenger or Fishing Vessel		6. Other Non-Impact	6. Saddlebag
			7. Guemes Channel and Fidalgo Bay

Total vessel time in the study area is captured by including four activity types. Twenty-four hours spent in the study area in one of the activity types is counted as a "vessel-traffic day." These twenty-four hours are not necessarily continuous hours by one vessel. Multiple vessels of a particular vessel type spending any length of time in a particular activity within a single subarea all contribute to the vessel traffic days by that particular vessel type, activity type, and location. In this report, traffic is defined in units of "vessel traffic day," and vessel traffic days are further defined with respect to vessel type, activity type, and location. Annual average vessel traffic days from 1995-2010 by subarea and vessel type, for all activity types, are shown in Table ES-4.

Table ES-4 Average annual vessel traffic days by subarea and vessel type, for all activity types, 1995–2010

Vessel Type	Strait of Juan de Fuca West	Strait of Juan de Fuca East	Haro Strait-Boundary Pass	Guemes Channel	Saddle-bag	Rosario Strait	Cherry Point	Total
Tankers	277	838	20	583	316	74	613	2,723
Bulkers	760	416	211	58	22	3	204	1,674
Cargo Ships	642	404	126	17	160	3	107	1,459
Tank Barges	88	295	29	383	99	62	409	1,364
Tugs	362	1,045	119	912	432	376	1,152	4,398
Passenger & Fishing	428	1,194	303	2,977	3,297	36	323	8,558
Total	2,556	4,193	808	4,930	4,326	555	2,808	20,175

Note: Data from 1995-2005 are historical estimates.

Traffic Forecast

A traffic analysis and forecast was performed in order to understand existing traffic, the change in traffic from other terminal developments, and the traffic associated with the proposed GPT. To paint a comprehensive picture of future traffic volumes, volumes of study area vessel traffic in 2019 were forecast for different traffic cases. This traffic analysis and forecast was critical to the VTARAS because the number of vessel traffic days is the only input that varies between the three forecast cases in Figure ES-5. All other inputs and algorithms are the same between the three forecast cases.

Table ES-5 Analysis cases' annual average vessel traffic days by analysis case and subarea, for all vessel types and activity types

	Juan de Fuca West	Juan de Fuca East	Haro Strait-Boundary Pass	Guemes Channel	Saddlebag	Rosario Strait	Cherry Point	Total
Case A	2,692	4,079	877	4,025	3,218	550	2,796	18,237
Case B	3,004	5,184	889	4,165	3,420	666	3,715	21,043
Case C	3,154	5,360	1,038	4,127	3,413	662	3,845	21,599

Vessel traffic days by subarea are given for the three analysis cases in Table ES-5 and Figure ES-6, for all vessel types and activity types: underway, maneuvering, at dock, and at anchor. The Strait of Juan de Fuca East, Guemes Channel, Saddlebag, and Cherry Point subareas include anchorages. The Case C traffic will add 566 total vessel traffic days or 2.6% over the Case B traffic in 2019. Case C adds 348 tanker vessel calls to the Kinder Morgan terminal at Port Metro Vancouver. These vessels only transit through the study area, adding vessel traffic days underway through the Strait of Juan de Fuca, Haro-Strait, Boundary Pass, and the Cherry Point subarea. GPT-based vessel traffic will add 2,805 vessel traffic days or 15% over the baseline forecast vessel traffic in 2019. The GPT-based vessel numbers include GPT bulkers, assist tugboats, and vessels to support the projected increase in bunkering. Vessel traffic days added by these vessel types and by subarea are given and compared to the baseline vessel traffic days in Table ES-6. The greatest increase in traffic is in the Cherry Point subarea where the proposed GPT project would be located (33%).

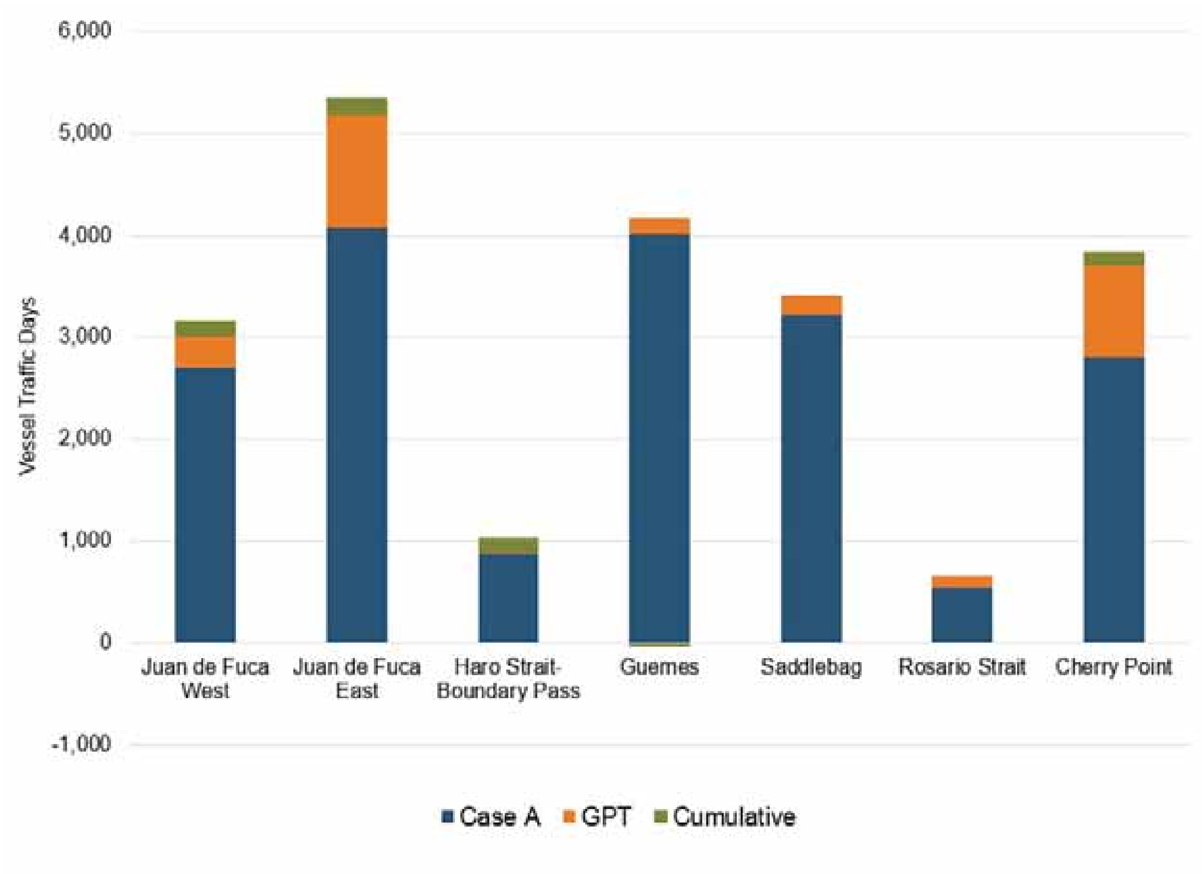

Figure ES-6 Analysis cases' vessel traffic days by analysis case and subarea, for all vessel types and activity types, 2019

Note: Case B = Case A + GPT
Case C = Case A + GPT + Cumulative
Activity types are underway, maneuvering, at dock, and at anchor.

Table ES-6 Baseline and GPT vessel traffic days by subarea, for all activity types, 2019

		Strait of Juan de Fuca West	Strait of Juan de Fuca East	Haro Strait-Boundary Pass	Guemes Channel	Saddle-bag	Rosario Strait	Cherry Point	Total
Case A	Total	2,692	4,079	877	4,025	3,218	550	2,796	18,237
GPT	Tank Barge	0	83	0	62	0	7	0	152
	Bulker	312	898	12	8	101	76	681	2,089
	Tug	0	123	0	70	101	33	238	565
	Total GPT	312	1,105	12	140	203	116	919	2,805
Change with GPT		12%	27%	1%	3%	6%	21%	33%	15%

Risk Forecast

Vessel traffic days are input to a Monte Carlo Analysis to predict a range and probability distribution for:

(1) Annual number of potential incidents.

(2) Annual number of potential spills.

(3) Annual potential oil outflow.

(4) Annual potential dry bulk outflow.

Total annual potential spills throughout the system for each traffic case are output as cumulative distribution functions, Figure ES-7. Average predictions are also reported for annual number of potential incidents and average number of potential spills. For the cumulative traffic case (Case C), the simulation predicts that there is a 95% likelihood that the number of total annual potential spills will be less than or equal to 21. It predicts that there is a 50% likelihood that the number of total annual potential spills will be less than or equal to 14. The average predicted number of total annual potential spills is 13.93. In Case A, the average predicted annual number of spills is 10.62, and in Case B, the average predicted annual number of spills is 13.37. The difference of 2.75 spills is a 26% increase, attributable to the additional GPT traffic. The subarea with the greatest increase in average predicted annual number of spills is Strait of Juan de Fuca East, which increases by 1.37 spills (60%). Increases in each subarea are given in Table ES-7. A majority of the 2.75 additional spills due to GPT are spills due to other non-impact incidents, which increase by 1.86 (33%). In terms of percentage increase, the greatest increase in spills is due to collisions, which increase by 0.33 spills (175%). Increases due to each incident type are given in Table ES-8.

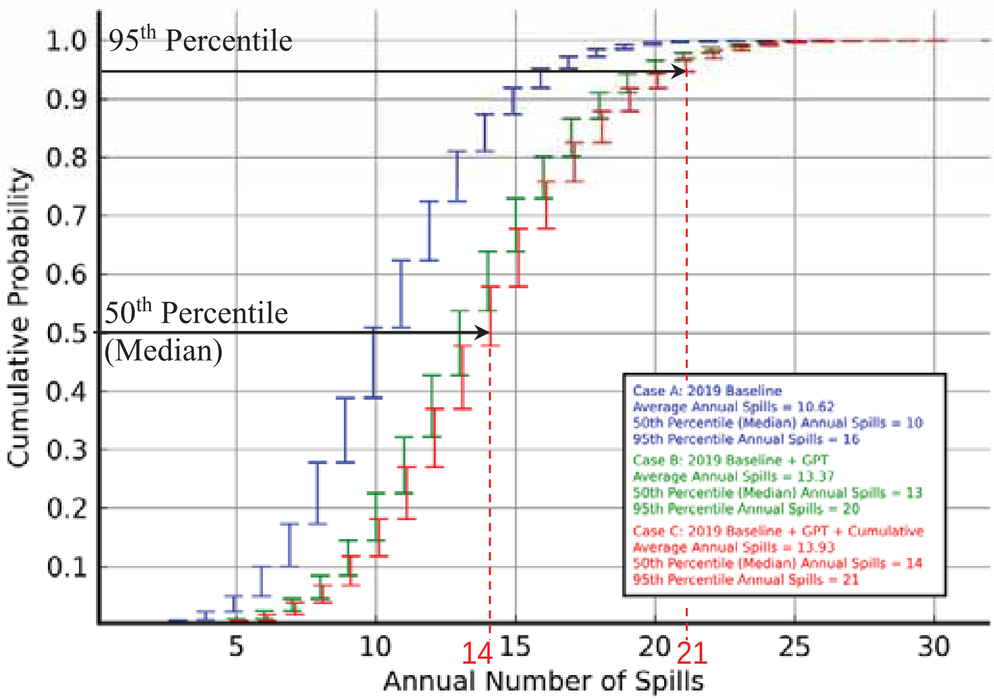

Figure ES-7 **Cumulative distribution function of total annual number of potential spills for all incident types in all subareas. Annual number of potential spills for Cases A and C offset by +/- 0.1 for visual purposes only. Averages presented in legend for comparison**

Table ES-7 Average annual number of potential spills per subarea for all incident types

Subarea	Case A Baseline	Case B Baseline +GPT	Case C Baseline +GPT +Cumulative	Incremental Change (B - A) / A	(C - A) / A
Strait of Juan de Fuca West	0.97	1.03	1.23	6%	27%
Strait of Juan de Fuca East	2.27	3.64	3.75	60%	65%
Haro Strait and Boundary Pass	0.17	0.17	0.20	0%	18%
Guemes Channel and Fidalgo Bay	2.70	2.84	2.84	5%	5%
Saddlebag	1.50	1.68	1.67	12%	11%
Rosario Strait	0.10	0.10	0.10	0%	0%
Cherry Point	2.92	3.91	4.14	34%	42%
All Subareas	10.62	13.37	13.93	26%	31%

Table ES-8 Average annual number of potential spills per incident type for all subareas

	Case A Baseline	Case B Baseline +GPT	Case C Baseline +GPT +Cumulative	Incremental Percent Change (B - A)/A	(C - A)/A
Collision	0.19	0.52	0.55	175%	188%
Grounding	0.13	0.22	0.23	76%	85%
Allision	0.23	0.56	0.56	147%	148%
Transfer Error	1.56	1.64	1.63	5%	5%
Bunker Error	2.91	2.95	2.92	2%	0%
Other Non-Impact	5.61	7.47	8.04	33%	43%
All Incident Types	10.62	13.37	13.93	26%	31%

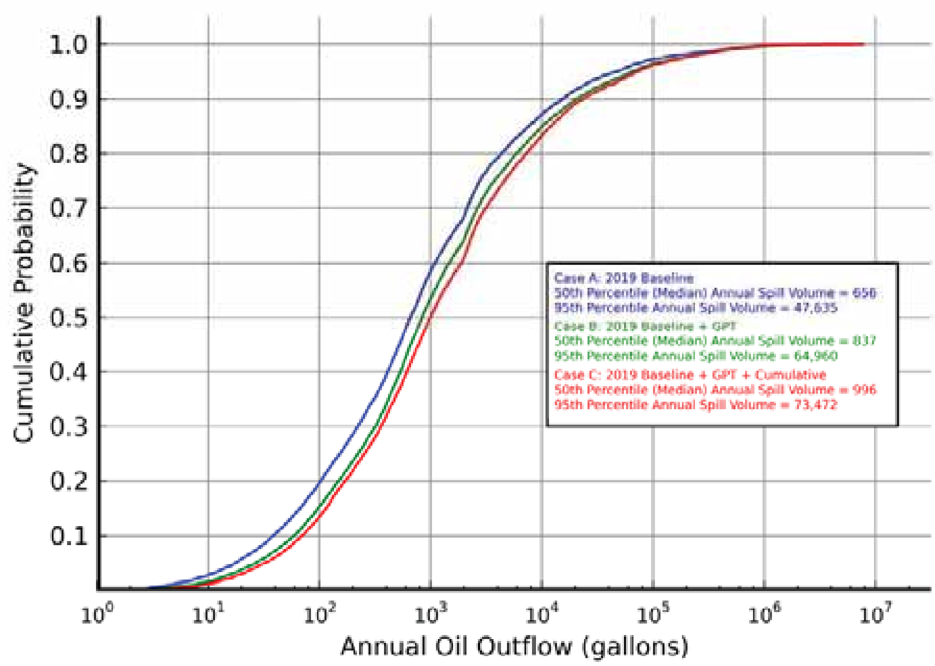

Figure ES-8 Predicted cumulative distribution function of total annual volume of potential oil outflow for all subareas

Total annual potential oil outflow throughout the system for each traffic case are output as cumulative distribution functions, Figure ES-**8**. The simulation results predict that in Case A, the median potential oil outflow is 656 gallons, and in Case B, the median potential oil outflow is 837 gallons. The difference of 181 gallons is a 28% increase, attributable to the additional traffic from GPT. The addition of cumulative traffic in Case C further increases the median total annual potential oil outflow by another 19% to 996 gallons.

Monte Carlo analysis results confirm that the magnitude of the increase in total annual potential oil and dry bulk outflow is predicted to be proportional to the quantity and size of the vessel traffic introduced into the system by GPT, which are Panamax and Capesize bulk carriers, assist tugboats and tank barge-towing tugboats, and tank barges. The contaminant outflow model predicts a 26% increase in the average number of potential spills and a 28% increase in the median potential oil outflow throughout the study area in 2019.

The outflow contaminant model predicts an increase in median total annual reported dry bulk cargo outflow from zero to 7,376 cubic feet with the addition of GPT. As discussed in Appendix E, dry bulk spills are rarely reported. Potential dry bulk outflow due to unreported spills and dry cargo sweeping will hypothetically result in a further increase in total annual potential dry bulk outflow proportional to the increase in the number and size of bulkers with the addition of GPT.

Select Vessel Traffic Impacts to the Lummi Nation

The section titled ‘Select Vessel Traffic Impacts to the Lummi Nation’ of the Vessel Traffic and Risk Assessment Study presents select additional impacts of the GPT on the Lummi Nation’s fishing and cultural resources. These select impacts include: ballast water discharges and the associated risk of introducing nonnative invasive species (discussed in Section 2, Vessel Traffic Infrastructure and Operations), increased vessel wake impacts on cultural resources, interference with tribal fishing sites and fishing gear, increased risk of collision with tribal fishing vessels, and increased risk of environmental damage due to oil and cargo spills (discussed in Section 3, Vessel Traffic Analysis). It is beyond the scope of this study to address all potential effects of the proposed GPT upon the Lummi Nations fishing and cultural resources.

Lummi fishers currently spend approximately one-third of their time in the Cherry Point subarea during various fishing activities.

In 2013, the Washington State Department of Fish and Wildlife (WDFW) estimated that 6,996,112 cubic meters of ballast water were released into Puget Sound by all marine vessels. Because nearly all of the vessels currently calling on the two existing petroleum oil refineries and the aluminum smelter in the Cherry Point subarea import either crude oil or raw materials for aluminum smelting, very little of the estimated ballast water discharges for all of Puget Sound currently occurs in the Cherry Point subarea. The ballast water discharges related to GPT calling vessels are projected to be 13,900,000 cubic meters (or nearly 3.7 billion gallons) per year that the terminal operates at full capacity, 487 vessel calls. This volume projected for 2019 will nearly triple the total 2013 ballast water discharges in all of Puget Sound. Nearly all ballast water discharges from GPT calling vessels will be within the Cherry Point subarea.

Historically, untreated ballast water discharges have been implicated as a vector for introducing non-indigenous and possibly invasive species. To meet the 2013 Coast Guard regulations (Reference 129), bulk carriers calling at the proposed GPT will require refitting with ballast water treatment systems at their first dry-docking after 1 January 2016. Assuming a five-year dry docking schedule, this fleet would complete its refitting by 31 December 2020.

In the interim period, regulations require all vessels without a ballast water treatment system to perform open-ocean ballast water exchange if the vessel captain determines that the exchange can be safely performed.

Ballast water treatment systems technology and implementation is developing rapidly and current data supporting its efficacy is limited. As the ballast water treatment industry matures, more data will become available supporting the best approach for ballast water treatment.

Additional studies, beyond the scope of the VTARAS, should be undertaken, if not already being done, to assess the impact of ballast water discharges on fishing activities.

Traffic Impact on Cultural Resources

An evaluation of the wake waves of GPT-calling vessels was used to assess the impacts of increased vessel traffic on traditional cultural properties and underwater archaeology. This analysis was focused on the shoreline at locations where traditional cultural properties and underwater archaeological artifacts exist. Vessel wakes were estimated for the two types of GPT-calling vessels that will operate in the vicinity of Lummi cultural resources: bulkers and tugs.

This analysis finds that tugboat wakes have a larger wave height and more energy flux than bulker wakes. Nevertheless, tugboat wakes are considerably smaller than an annual maximum storm wave as follows:

- Height: 13% of an annual maximum storm wave.
- Energy Density: 2% of an annual maximum storm wave.
- Energy Flux: 1% of an annual maximum storm wave.

This difference between small tugboat wakes and large annual storm waves is maintained even when aggregated over an entire year. When the total wave energy from a year of waves and storms and the total wake wave energy from GPT-bound vessels were estimated, it was found that the cumulative energy from the assist tugs and GPT-calling bulkers transiting past Lummi Island is equal to 24% of the cumulative energy from wind-generated waves. Total energy seen at the shoreline would increase by 24% with the additional vessel traffic attributable to the proposed GPT operating at full capacity in 2019.

Traffic Impact on Tribal Fishing

Siting of the wharf and trestle at the proposed GPT and the potential increased anchorage use by bulkers will interfere with Lummi access to fishing sites. A comparison of Lummi fishing times and locations with expected GPT vessel transits was used to quantify the potential disruption to Lummi fishing practices posed by GPT. The goal was to measure the time and area that Lummis fish (referred to as water-day-areas), measure the time and area that passing vessels disrupt this fishing activity (also formulated in vessel-day-areas), and compare the magnitude of the disruption with and without GPT-calling vessels. In general, the unit of vessel-day-area is the product of vessel days on the water and the area occupied. The analysis predicts that GPT would increase the Lummi fishing disruption by 76% in the Cherry Point subarea and 19% in the Saddlebag subarea, compared to baseline vessel traffic in 2019. The difference in vessel-day-area in Cherry Point increases from 26 to 45 between Cases A and B. The difference in vessel-day-area in Saddlebag increases from 130 to 155 between Cases A and B. The analysis shows that the Juan de Fuca East subarea will see the greatest relative increase in disruption of 83% over Case A due to the time and area occupied by GPT vessels at anchor and associated bunkering activity. However, the actual increase in disruption to Lummi fishing cannot be quantified as the Lummi U& A does not encompass all of this subarea.

A secondary aspect of disruption is the potential loss of Lummi fishing gear due to GPT vessel traffic. In 2008, the Lummi Natural Resources Department estimated that each Lummi fisher loses between 40 and 50 crab traps or pots each year. If gear loss changes proportionately with traffic changes, then in 2019 Baseline, fishers will expect to lose an additional three pots in either Juan de Fuca East or in Haro Strait-Boundary Pass. However, in Guemes Channel, Saddlebag, Rosario Strait, and Cherry Point—where rail projects are expected to lower the volume of vessel transits—fishers may actually see a decrease in gear loss. With the addition of GPT in 2019, gear loss per Lummi fisher is expected to increase between one and fifteen pots depending on which subarea the fisher is fishing in. The number of lost pots is predicted to increase by thirteen pots in Juan de Fuca East, one pot in Guemes Channel, nine pots in Rosario Strait, or nearly fifteen pots in Cherry Point. Impacts to gear such as long-lines and marker buoys are not included in this analysis, as historical loss volumes were unavailable. The variety of gear types and fishing practices used by the Lummi mean that the pot-loss estimate and the surface area disruption measured in this analysis does not fully capture GPT-related disruption.

Risk of Collision with Lummi Fishing Vessels

Incident records from collisions involving deep draft traffic, tugs, and fishing vessels from 1995 through 2010 (16 years) within the study area were studied in an attempt to quantify the potential likelihood of a collision between a GPT-calling vessel and a Lummi fishing vessel. Incidents were recorded by the United States Coast Guard (USCG) and/or the Washington State Department of Ecology. Only the larger of the vessels involved in a collision is usually recorded. The other vessel involved in the incident is not always recorded; however, none of the past collisions recorded were between deep draft vessels and fishing vessels.

Since there are no collision data from which to determine a collision incident rate, a conservative assumption is made that one (1) collision occurs every 17 years, or 0.1192 collisions per 10,000 vessel traffic days. At this rate, the GPT-based traffic is expected to add 0.0104 collisions in 2019, which amounts to a 16.7% increase over the baseline traffic without GPT. Consequences of a potential collision, such as cargo loss or fatality, are not studied in this assessment.

Risk Reduction Options

The VTARAS closed with an exploration of potential risk mitigation measures, termed Risk Reduction Options (RROs). The RROs were identified during a brainstorming session by a group of GPT study participants. The group considered the broader context of future risk in the study area beyond the potential risks posed by new traffic. Although the list of 49 RROs is neither prioritized nor exhaustive, it provides key points for discussion and consideration. This list is offered as a starting point for future efforts which may develop recommendations for risk mitigation. Just for illustration, the list of RROs includes:

- Near-miss reporting system.
- Vessel Traffic Management: Phase vessel arrivals.
- Manning: Add a 2nd officer on the bridge (west of Port Angeles).
- At-dock transfer: Limit other operations ongoing (e.g., bunker, internal fuel transfer).
- Offloading all untreated ballast water to onshore treatment facility.