STUDY BASIS FOR COLUMBIA RIVER VESSEL TRAFFIC NAVIGATION RISK ASSESSMENT

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I OVERVIEW

This study basis consists of the assumptions for conducting the Columbia River Vessel Traffic Risk Assessment.

The intent of this document is to clarify and confirm the assumptions made by DNV GL related to how the aspects of the marine transit route, including the marine traffic itself, have been collected, interpreted, and applied in the DNV GL marine traffic risk analysis.

These assumptions form the basis for the oil spill risk assessment. If any of these assumptions are altered, the results presented for the study are no longer valid. Consequently, alteration of any of these assumptions may generate a need for an update of the analysis.

I.1 Study Objectives

Category:	Analytical	**Item no.** 1
Relevant Analysis:	Navigation Incident Frequency Model	**Revision:** 1

Implication of Assumption:

The objectives defined here define the model inputs for the marine incident frequency assessment for vessels transiting the Columbia River. This assumption also determines the cases to be modeled as “existing conditions” as well as future cases for the risk calculations. This will also determine which year of AIS data DNV GL will use in the model.

The marine traffic incident frequency assessment will estimate the frequency of navigational incidents and cargo oil spill risk during transit for traffic from 5 miles offshore to the uppermost navigable portion of the Columbia River at the I-5 bridge. Results of this assessment will include incident frequencies for all traffic, with a primary focus on oil tanker related incidents and cargo oil spill risk.

In this study, the Marine Accident Risk Calculation System (MARCS) model, developed by DNV GL, will be used. MARCS combines three different types of data to predict incident frequencies.

- Shipping traffic data (e.g. ship types, routes, transit frequencies).
- Environmental data (e.g. visibility, wind sea state).
- Marine shipping operational data (e.g. pilotage, tugs, etc.).

The results included estimated frequencies of the following incident types:

- Collision
- Drift grounding
- Powered grounding
- Striking an object
- Fire / Explosion
- Structural failure

Two cases will be modelled for this study. The cases are defined in Table I-1.

Table I-1 Cases to be Modelled in MARCS

Scenario	Case A Existing Conditions	Case B Future Case (notional year 2028)	Case C Future Case (notional year 2028)
Vessel Traffic Considered	AIS baseline traffic	AIS modified by 25% of additional traffic from proposed future projects	AIS modified by 100% of the additional traffic from all proposed future projects

I.2 Navigational Input Data

This section describes the inputs that are required for the navigation risk assessment.

I.2.1 Vessel Route and Study Area

Category:	Data and Operational	**Item no.** 2
Relevant Analysis:	Navigation Incident Frequency Model	**Revision:** 1

Implication of Assumption:

The routes selected for the study influence the types of navigational hazards and mitigation measures imposed on the study vessels.

The route for inbound and outbound vessel travelling along the main channel of the Columbia River is presented in Figure I-1. The route was defined utilizing the local nautical charts (Ref. /A/, /B/, /C/, /D/). The route will extend from 5 miles seaward of the Columbia River bar to the I-5 bridge. The channel width for the route on the river is 800 feet (Ref. /E/). The navigable channel becomes wider when vessels travel in open water. Seaward of River Mile 0 will be modelled to have the measured width that deep draft vessel tracks show in the AIS data.

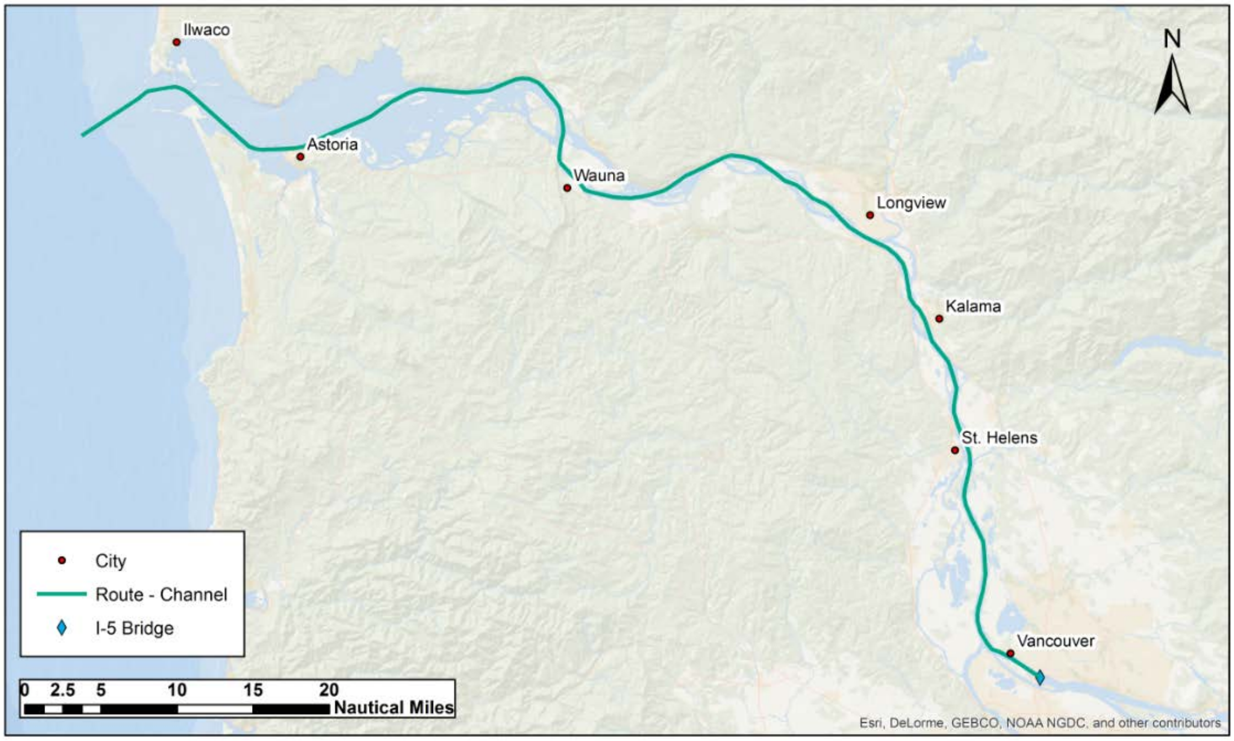

Figure I-1 Columbia River Route and Channel

References

A. U.S Department of Commerce. National Oceanic and Atmospheric Administration. *Columbia River – Pacific Ocean to Harrington Point.* 18521.

B. U.S Department of Commerce. National Oceanic and Atmospheric Administration. *Columbia River – Harrington Point to Crims Island*. 18523.

C. U.S Department of Commerce. National Oceanic and Atmospheric Administration. *Columbia River – Crims Island to Saint Helens*. 18524.

D. U.S Department of Commerce. National Oceanic and Atmospheric Administration. *Columbia River – Saint Helens to Vancouver*. 18525.

E. Meeting Minutes. CRVTSA and Columbia River Pilots, Oct 5, 2016.

I.2.2 AIS Data

Category:	Data	**Item no.** 3
Relevant Analysis:	Navigation Incident Frequency Model	**Revision:** 1

Implication of Assumption:

The AIS data will be used to characterize the baseline marine traffic along the shipping route in terms of ship types and number of transits, and will be used as an input to the MARCS model.

The MARCS model for this study requires Automatic Identification System (AIS) data for the area around the terminal and shipping routes. The AIS data are used to establish vessel traffic patterns and densities within the study area as well as vessel speeds.

AIS data will be obtained from Merchants Exchange in Portland, Oregon and will be utilized for the study area. The period of coverage for all of the AIS data will be the most recently available data covering one year: '2015-10-01 00:00' to '2016-09-30 23:59' (Ref. /A/). Figure I-2 presents AIS data from the year 2014 to provide a sample of how AIS data will appear.

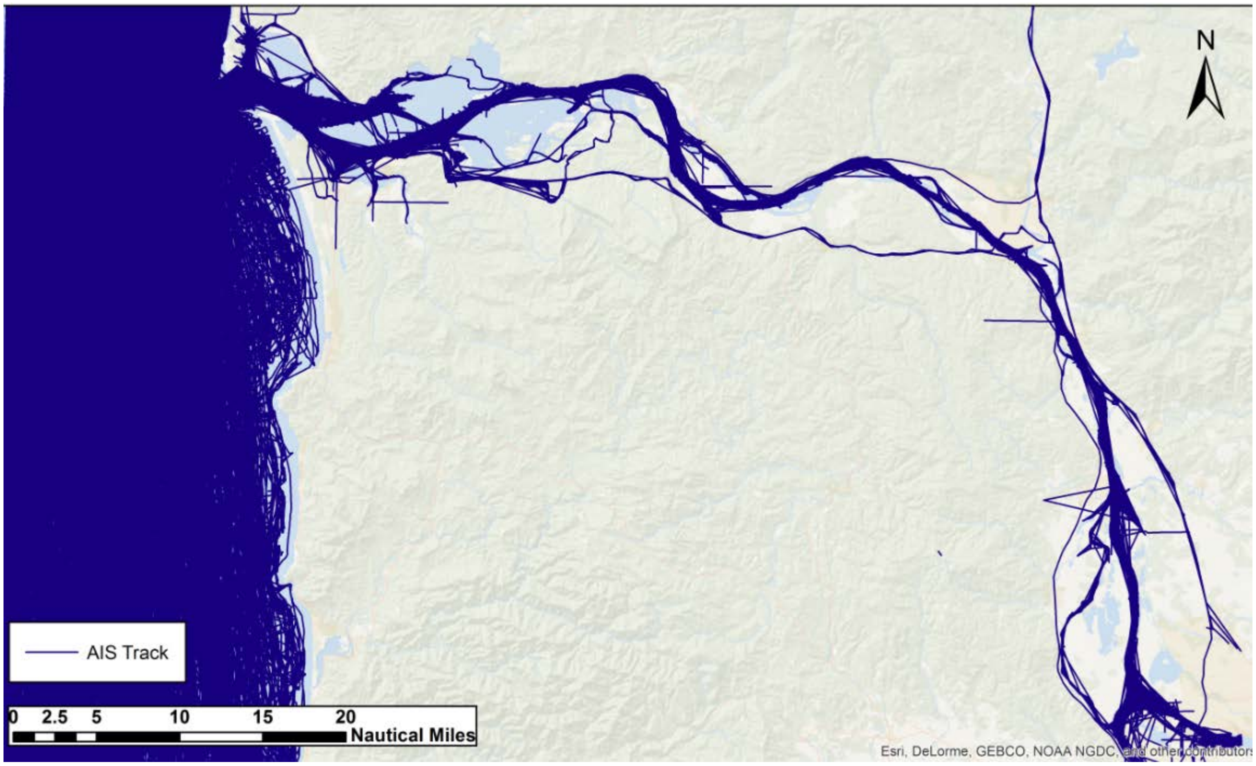

Figure I-2 Sample AIS Dataset of the Study Area

References

A. Merchants Exchange in Portland, Oregon (2015)

I.2.3 Environmental Data

Category:	Data	**Item no.** 4
Relevant Analysis:	Navigation Incident Frequency Model	**Revision:** 1

Implication of Assumption:

The environmental data will be a direct input into the MARCS model and will therefore affect the risk results.

This report will utilize met-ocean data that includes wind speed, wind direction, visibility statistics and seabed type for the study area. To ensure high levels of accuracy, this data should cover areas in close proximity to the navigable channel. The categories of data that will be implemented are as follows:

- Visibility data
- Wind data
- Seabed data

The wind data provide magnitude and corresponding probabilities for all relevant scenarios which will also be input into MARCS as factors that affect grounding frequencies. The wind data will be divided into four speed categories (0-20, 20-30, 30-45, 45+ knots).

The probability of occurrence for the wind speed categories applied in MARCS is presented below.

Table I-2 Wind Speeds Applied in MARCS (Percentage of occurrence) (Ref. /A/,/B/,/C/,/D/,/E/,/F/,/G/)[1]

Weather Station	0-20 knots	20-30 knots	30-45 knots	>45 knots
Buoy 46029	0.871	0.116	0.013	-
Astoria Airport	0.982	0.017	0.001	<< 0.001
Astoria	0.994	0.006	< 0.001	-
Kelso/Longview Airport	0.999	0.001	-	-
Longview	0.998	0.002	-	<< 0.001
Pearson Field Airport	0.999	0.001	-	-
Portland	0.990	0.001	< 0.001	-

DNV GL received feedback that Buoy 46029 was ‘out of service’ for several periods of time included in the coverage period. The weather stations that were identified as possible replacements/supplements to the data were Buoy 46243 and Clatsop Spit land-based station. However, neither can be used for wind data. Buoy 46243 does not capture accurate wind data. The wind data archived at Buoy 46243 is archived as every entry having the wind speed of 99 m/s, which is a default value for indicating no value. The Clatsop Spit land-based station does not currently archive data, which has been confirmed by NOAA.

[1] When the data is gathered, the entry is the average over the measuring period as determined by the provider. For example, if a data point is reported every 2 minutes, the average wind speed over the 2 minutes would be calculated and recorded. If a gust of wind is over 45 knots, it will be weighted in the wind speed average over the time period.

Category:	Data	Item no. 4
Relevant Analysis:	Navigation Incident Frequency Model	Revision: 1

To verify that Buoy 46029 provided sufficient data to use in the model, the data was analyzed to identify potential patters of the periods in which data was not captured. Based on the analysis, there was not a strong pattern of gaps in data that would signify the data is not suitable to provide an overview of the realistic weather conditions. The noteworthy finding was a large amount of data was captured in 2015 compared to other years. Figure I-3 shows the trend of the volume of data collection for Buoy 46029. In the chart, month 1 corresponds to January of a given year.

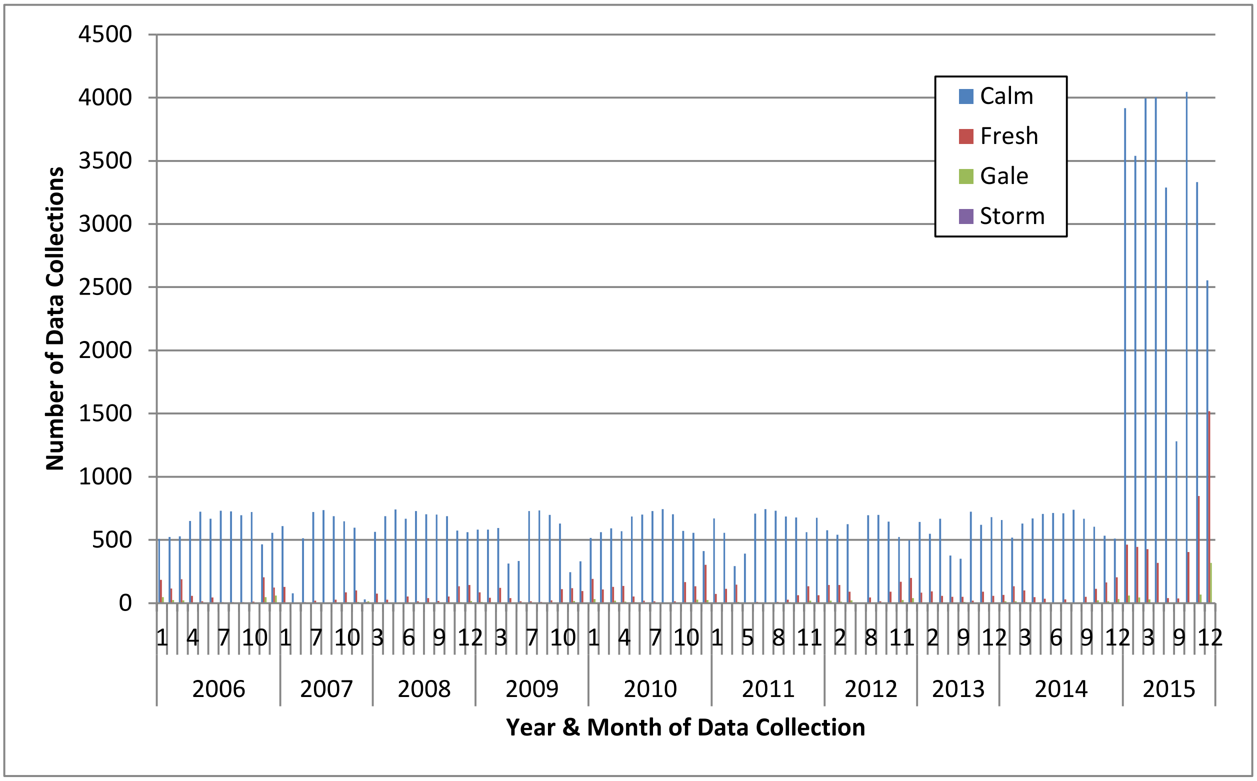

Figure I-3 Wind Data Collection of Buoy 46029

Due to lack of available sea state data, seastate is based directly on the wind speeds. The probability of occurrence for good and poor visibility applied in MARCS is presented below.

Table I-3 Visibility Data Applied in MARCS (Percentage of occurrence) (Ref. /B/,/D/,/F/,/G/)

Weather Station	Good (>2 nm)	Poor (<2 nm)
Astoria Airport	0.87	0.13
Kelso/Longview Airport	0.98	0.02
Pearson Field Airport	0.93	0.07
Portland	0.94	0.06

Category:	Data	Item no. 4
Relevant Analysis:	Navigation Incident Frequency Model	Revision: 1

Good visibility is defined as visibility over 2 nautical miles; poor visibility is defined as visibility less than 2 nautical miles.

The seabed bottom type is utilized to determine the probability of a cargo tank breach in the event of vessel grounding.

Table I-4 Locations of Rocky Bottom Type[1] (relevant to grounding consequences) (Ref. H/)

River Mile begin	River Mile end	Side of the Channel	Notes
27.25	+20 ft	Washington	Pillar Rock
30.5	33	Washington	Skamokaway
39	40.5	Oregon	Bugby Hole
52	54.5	Washington	Abernathy
55	56.5	Washington	Bunker Hill
72	73	Oregon	Coffin Rock
74	75.5	Washington	Kalama
78	79	Washington	Kalama
83.5	84	Oregon	Columbia City
87.25	88	Oregon	Warrior Rock

1. All other areas are assumed to be soft bottom, not able to penetrate the double hull of a tanker or barge.

References

A. NOAA Buoy Station: 46029. 01/01/2006 - 12/31/2015.
B. NOAA Weather Station: Astoria Airport - USAF 727910. 01/01/2006 - 12/31/2015.
C. NOAA Weather Station: Astoria - USAF 994011. 01/01/2006 - 12/31/2015.
D. NOAA Weather Station: Kelso/Longview Airport - USAF 727924. 01/01/2006 - 12/30/2015.
E. NOAA Weather Station: Longview - USAF 997801. 01/01/2007 - 12/31/2015.
F. NOAA Weather Station: Pearson Field Airport - USAF 727918. 01/01/2006 - 12/01/2015.
G. NOAA Weather Station: Portland - USAF 726980. 01/01/2006 - 12/31/2015.
H. Meeting Minutes. CRVTSA and Columbia River Pilots, Oct 5, 2016.

I.2.4 Vessel Categories

Category:	Data	**Item no.** 5
Relevant Analysis:	Navigation Incident Frequency Model	**Revision:** 1

Implication of Assumption:

The MARCS model will present results for each given vessel category and not for particular vessels.

The vessel categories will generally be used to group AIS descriptors together as a single category. Each category of vessels will have a specified average speed, average size (DWT, LOA, and B) and set of risk reductions applied to the vessel. The average speed and size of vessel categories will be derived from the AIS data (Ref. /A/).

Table I-5 Vessel Category Examples

Vessel Category	Examples of Included AIS Vessel Types
ATB (oil as cargo)	Oil carrying Articulated Tug/Barge
Tanker (oil as cargo)	Oil tankers
Tug, barge in tow with tag tug (oil as cargo)	Tug with barge in tow with tag tug
ATB (no oil as cargo)	Articulated Tug/Barge
Cargo/Carrier	Bulk carriers, container ships, general cargo ships, vehicles carrier, timber carriers
Fishing	Trawlers, all fishing vessels
Other	Dredgers, pollution control vessels
Passenger	Ro-Ro/Passenger ships, inland passenger ships, ferries
Pleasure	Pleasure crafts, yachts, sailing vessels
Service	Ice-breakers, military vessels
Tanker (no oil as cargo)	LPG tankers, chemical tankers
Tug	General tugs, towing vessels,
Undefined	Vessels missing AIS data for vessel type

In addition, the average speed of each vessel category will be estimated from the AIS data and used in the MARCS model as an input. Once AIS Data are obtained, a table will be produced containing representative Deadweight Tonnage (DWT), Length Overall (LOA), and Beam (B) for each vessel type.

References

A. Merchants Exchange in Portland, Oregon (2015)

I.2.5 Future Projects & Changes to Background Vessel Traffic Levels

Category: Operational		**Item no.** 6
Relevant Analysis: Navigation Incident Frequency Model		**Revision:** 1

Implication of Assumption:

There are several proposed projects on the river. This assumption determines which will be included in the model as well as the number and type of vessels are associated with each. Assumptions around changes to present-day traffic levels from 2015 into the future will affect the incident frequency estimates for vessels transiting the Columbia River.

No additional changes in traffic will be applied to the (Case A baseline) AIS traffic data. The number of vessels/transits from the new projects listed in Table I-5 will be added to Cases B and C.

Table I-6 Future Projects to be included in MARCS Model

Project	Location	Cargo	Vessels Per Yr
Millennium Bulk Terminal	Longview, WA	Coal	840 Panamax (Ref./A/)
Tesoro Savage Vancouver Energy Project	Vancouver, WA	Oil	365 Panamax (Ref. /B/)
Northwest Innovation Works LLC	Port of Kalama-Cowlitz County, WA	Methanol	72 Panamax (Ref. /C/)
Northwest Innovation Works LLC	Port Westward in Clatskanie, OR	Methanol	72 (63 assumed) Panamax (Ref. /D/)
Columbia River Carbonates Woodland Marine Terminal	Woodland, WA	Calcium Carbonate	30 barges (Ref. /E/)
NuStar Energy	Vancouver, WA	Oil	18 barges (Ref. /D/)

References

A. Millenium Bulk EIS. http://www.millenniumbulkeiswa.gov/assets/mbtl_technicalreport_vesseltransportation.pdf. Accessed May 2, 2016.

B. Tesoro Savage DEIS. http://www.efsec.wa.gov/Tesoro%20Savage/SEPA%20-%20DEIS/DEIS%20Chapters/DEIS%20Ch%205%20Cumulative%20Impacts.pdf. Accessed May 2, 2016.

C. Kalama Manufacturing & Marine Export Facility SEPA. Chapter 8. Port of Kalama and Cowlitz County. September 30, 2016. http://nwinnovationworks.com/projects/port-of-kalama. Accessed October 11, 2016.

D. Kalama Manufacturing & Marine Export Facility SEPA. Chapter 15. Port of Kalama and Cowlitz County. September 30, 2016. http://nwinnovationworks.com/projects/port-of-kalama. Accessed October 11, 2016.

E. Columbia River Carbonates SEPA (Cowlitz County. 2015. SEPA Revised MDNS Associated Permit #13-06-0570. Columbia River Carbonates Woodland Marine Terminal).

I.2.6 Existing Risk Controls

Category:	Operational	**Item no.** 7
Relevant Analysis:	Navigation Incident Frequency Model	**Revision:** 1

Implication of Assumption:

Any existing risk controls will be accounted for in the MARCS modeling process to provide a more accurate value for the frequency of incidents.

The explanation of risk controls should include all relevant information including the nature of measure (e.g. preventative, response, regulatory).

Potential mitigation measures will be evaluated in a separate process.

Table I-7 lists of the existing risk controls to be incorporated into the MARCS model.

Table I-7 Risk Controls Modeled in MARCS Base Case	**Bulker / Cruise Ship (incl comer-cial fishing > 250 GT)**	**Tanker / Carrier**	**Tugs, not ATB, under Coastwise Articles**	**Tug, not ATB, under Foreign Articles or Registry**	**ATB >10,000 GT**	**Fishing Vessel**	**ATB < 10,000 GT**	**All Other Vessels (note in report: small number)**
State Licensed, Independent Pilotage	Yes	Yes	No	Yes	Yes	No	No	No
Portable Pilotage Unit	Yes	Yes	No	Yes	Yes	No	No	No
Differential Global Positioning Satellite	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Conventional Aids to Navigation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Electronic Chart Display and Information System	Yes	Yes	Yes	Yes	Yes	No	Yes	No (exceptions will not be incorporated into the model)
Port State Control	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Under Keel Clearance Management	Yes	Yes	Yes	Yes	Yes	No	Yes	No
TV32 (PPU)	Yes	Yes	No	Yes	Yes	No	No	No
SeaIQ (PPU)	Yes	Yes	No	Yes	Yes	No	No	No
Cooperative Coordination (in specified areas)*	Yes	Yes	No	Yes	Yes	No	No	No

*Indicates that a discussion follows describing the estimated value of the risk reduction provided by a given risk control.

Transview 32 and SeaIQ

Transview 32 (TV32) and SeaIQ have not been quantified as risk mitigation measures; however, PPU has been studied. They are considered PPUs, a Vessel Traffic Information System (VTIS). In a VTIS, vessel location, course, and speed data is made available directly to vessels operating in the area and is seen as a benefit by marine pilots. Navigation decisions are agreed upon between the pilots using TV32 and SeaIQ.

Areas of Cooperative Coordination

In select areas along the navigation route pilots practice cooperative coordination between vessels. As a safety practice, pilots will avoid overtaking other deep draft vessels in these areas. The specific areas are listed in Table I-8. Because this is a widely used practice of collision avoidance, a 90% reduction in the number of vessel encounters is applied in the MARCS model to all study vessels and other tankers/carriers in the identified portions of the route.

Table I-8: Cooperative Coordination Areas Defined in MARCS Model (Ref. /A/)

Area Description	River Mile Range	Practice
Miller Sands	22-23	No overtaking or meeting
Brookfield	28-29	No overtaking or meeting
Skamokawa	30.5-33	No overtaking or meeting
Abernathy	35-37	No overtaking or meeting
Bugby Hole	39-40.5	No overtaking or meeting
Bunker Hill	55-57	No overtaking or meeting
Near Coffin Rock	72.5-73.5	No overtaking or meeting 50% of the time
Duck Club	88.5-90.5	No overtaking or meeting 50% of the time

Additional risk mitigations used in practice, but not quantifiable in the model at this time:

- Additional range lights
- Dredging & survey program
- SMS for tugs
- Vetting

References

A. Meeting Minutes. CRVTSA and Columbia River Pilots, Oct 5, 2016.

I.2.7 Oil Spill Risk Assessment

Category:	Data	**Item no.** 8
Relevant Analysis:	Navigation Accident Frequency Model	**Revision:** 0

Implication of Assumption:

The oil spill analysis will estimate the risk of an oil spill in barrels per year.

MARCS has the capability to estimate the oil spill risk for each vessel category. The oil spill risk results are presented in barrels of cargo oil spilled per year during transit (not transfer). The results incorporate the incident frequency results and estimated oil volume outflow to estimate the potential number of gallons of oil spilled per year from all vessel types.

MARCS utilizes curves of the frequency and amount of oil estimated to be spilled based on DNV GL's finite element analysis (FEA). The curves are derived from the FEA of a Handymax class oil tanker that is then adjusted based on average size of the vessel category in MARCS.

The results will be presented in the following format. This is a general format with example oil spill risk values.

Vessels Type with oil as cargo	Estimated volume of oil spilled per year
Oil Tanker	X,XXX gal/year
Barge	XXX gal/year