Vancouver Energy
Appendix K, Safe and Effective Threshold Determination Report

Plan No. OP.05, Operations Facility Oil Handling Manual | Revision 00

Approved by:

Name, Title: Kelly Flint, Senior Vice President and Corporate Counsel, Savage Companies
Designated Agent for EFSEC Application No. 2013-01
Date: 26 June 2015

This page left blank intentionally.

Vancouver Energy

Appendix K, Safe and Effective Threshold Determination Report

EFSEC Application for Site Certification No. 2013-01
Docket No. EF131590
26 June 2015

Prepared for

Tesoro Savage Petroleum Terminal LLC
5501 NW Old Lower River Road
Vancouver, Washington 98660

Prepared by

BergerABAM
210 East 13th Street, Suite 300
Vancouver, Washington 98660

Job No. A13.0267.02

Revision Summary

No.	Date	Edits/Comments
00	26 June 2015	Submittal for Application Review

Vancouver Energy
Appendix K, Safe and Effective Threshold Determination Report

Table of Contents

Section

1. Summary 3
1.1 Safety and Environmental Conditions 4
1.1.1 Personnel Safety 4
1.1.2 Primary Environmental Conditions 4
1.1.3 Other Conditions 5
1.1.4 Efficacy of Oil Boom under Environmental Conditions 5
1.2 Safe and Effective Threshold Values 5
1.2.1 Personnel Safety Threshold Values 5
1.2.2 Environmental Conditions Threshold Values 5
2. Introduction 6
2.1 Purpose 6
2.2 Objectives 6
2.3 Location of Terminal Dock 6
2.4 Background 8
3. Site-Specific Safety and Environmental Conditions 8
3.1 Personnel Safety 8
3.2 Primary Environmental Conditions 8
3.2.1 Sea State (Wave Height and Period) 8
3.2.2 Water Currents 9
3.2.3 Weather (Wind and Precipitation) 12
3.2.4 Other Conditions that Influence Oil Transfer Operations 19
4. Safe and Effective Threshold Values 19
4.1 Priority of Safe and Effective Threshold Values 19
4.2 Personnel Safety 19
4.3 Efficacy of Oil Boom under Range of Environmental Conditions 20
4.4 Effective Threshold Conditions for Oil Boom 21
4.4.1 Surface Water Currents 21
4.4.2 Sea State (Wave Height and Period) 21
4.4.3 Wind 22

List of Tables

Table 1. Pre-Boom Decision Tool 3
Table 2. Summary of Environmental Data for Vancouver Energy Terminal Region. 10
Table 3. Thirty-year Average (1961-1990) Wind Speed and Predominant Direction 12
Table 4. Advisory for Oil Transfer Operation Actions Related to Wind Speed 20

List of Figures

Figure 1. Aerial View of Berths 13 and 14 7
Figure 2. Columbia River Current Velocity near Vancouver, Washington 11
Figure 3. PIA, Portland, Oregon: Historical monthly average winds (Jan and Feb 1961-1990) 13
Figure 4. PIA, Portland, Oregon: Historical monthly average winds (March and April 1961-1990) 14
Figure 5. PIA, Portland, Oregon: Historical monthly average winds (May and June 1961-1990) 15
Figure 6. PIA, Portland, Oregon: Historical monthly average winds (July and August 1961-1990) 16
Figure 7. PIA, Portland, Oregon: Historical monthly average winds (Sept and Oct 1961-1990) 17
Figure 8. PIA, Portland, Oregon: Historical monthly average winds (Nov and Dec 1961-1990) 18

1. Summary

This safe and effective threshold determination report has been prepared for Tesoro Savage Petroleum Terminal LLC's (Company) Vancouver Energy (Facility). The report provides the Facility's Terminal Person-In-Charge (TPIC) of pre-booming for oil transfer operations at the dock for the Facility terminals with the threshold values for environmental conditions that allow the safe and effective deployment of oil boom around vessels prior to and during oil transfer operations.

As of 26 October 2006, Washington State rules were adopted for Facility Oil Handling Standards (Washington Administrative Code [WAC] 173-180) and Vessel Oil Transfer Advance Notice and Containment Requirements (WAC 173-184). These rules require that Class 1 facilities, such as the Facility's terminals, develop guidance on criteria and threshold values for the safe and effective deployment of oil boom for pre-booming operations.

Table 1. Pre-Boom Decision Tool

Note: This table is the key decision-making tool for deploying or not deploying boom. It is part of the form that is filled out by the Boom Boat Captain. Keep the Shift Supervisor (Shift SUP) informed of weather changes that may trigger the use of this form. Note that the Shift Sup = TPIC.

Environmental Conditions		GREEN		ORANGE		RED	
		If ALL conditions are GREEN		If ONE condition is ORANGE		If ONE condition is RED	
		BOOM?	YES	BOOM?	Shift SUP	BOOM?	NO
		REMOVE BOOM?	NO	REMOVE BOOM?	Shift SUP	REMOVE BOOM?	NO
				NO GO or EARLY TERMINATION: Shift SUP submits DOE Boom Reporting Form.		EARLY TERMINATION: Shift SUP determines if safe for boom removal.	
1.	WINDS	0 - 10 knots		10 - 20 knots		> 20 knots	
2.	WAVE HEIGHT	0 -1 foot		1 - 3 feet		> 3 feet	
3.	WAVE TYPE	Low swells, ripples, or flat calm		Slight chop, steep swells, white caps		Steep choppy breaking waves	
4.	CURRENTS	0 - 0.5 knot		0.5 - 1.0 knot		>1.0 knot	
5.	VISIBILITY	Unlimited		< 2 miles		< 1,000 feet	

Shift Supervisor (Shift SUP) decision to boom or terminate booming early will be based on Operational Factors.

For any conditions within the ORANGE range, the Shift SUP, in consultation with the Boom Boat Captain, must make a case-by-case determination of whether conditions are safe and will promote effective booming. The Shift SUP and Boom Boat Captain will also consider whether conditions are forecast to degrade such that they decrease safety or boom effectiveness below acceptable thresholds based upon the following Operational Factors.

- Ability of boom boat to operate safely in present and forecast conditions; the new style is rated up to 5 knots whereas the older style is only rated to 2 to 3 knots and is part of the effective stance.
- If boom boat freeboard and present/forecasted wave conditions could put personnel at risk of pinch point or other injuries when making boom connection or operation over the side or stern.
- The ability of the boom to contain any potential oil.

1.1 Safety and Environmental Conditions

1.1.1 Personnel Safety

Safety of personnel is the first and overriding priority for the Facility's pre-booming and oil transfer operations at the Facility dock. The Facility TPIC at the dock has the ultimate responsibility and authority to determine if it is safe for personnel to deploy oil boom to meet the pre-booming requirement. That is, the TPIC may determine that, even though the environmental threshold values described later in this report are not exceeded, there are other factors that render the pre-booming operation unsafe for personnel and, therefore, the TPIC may terminate the pre-booming operation. In this situation and any other situation where the TPIC determines that pre-booming is not safe and/or effective, the TPIC will document the circumstances supporting the decision to not pre-boom.

Personnel safety during pre-booming may be compromised by one or more of the following conditions.

- High winds
- Waves, especially high, choppy (i.e., short period) waves
- Large floating/barely submerged debris carried by strong currents
- Icy conditions
- Heavy fog, rain, or other conditions that reduce visibility to unsafe levels
- Other conditions as determined and documented by the TPIC or contractor responsible for deploying the boom

1.1.2 Primary Environmental Conditions

1.1.2.1 Sea State (Wave Height and Period)

In the Port of Vancouver USA (Port) area, wave height and period (i.e., time between wave crests passing a fixed point) do not appear to have been continuously recorded. Under most wind and wave regimes, the location of the Facility dock is sheltered from significant wind-driven wave action. However, the Facility terminal manager reports that southeasterly and northwesterly winds exceeding 25 knots (~29 miles per hour [mph]) may occur and result in waves greater than 2 to 2.5 feet high that could affect pre-booming safety and effectiveness during the oil transfer operations.

Bow waves and wakes from large commercial and recreational vessels passing on the Columbia River occasionally may be large enough (e.g., >2 to 2.5 feet) to limit the effectiveness of the boom and affect the safety of the contractors deploying or maintaining it. This effect is temporary (e.g., on the order of a minute) but does require visual monitoring for safety reasons.

1.1.2.2 Water Currents

Continuous and long-term recorded current data for the surface currents in the Columbia River at the Port apparently are not available or do not exist. The Facility terminal manager and response contractor personnel note that, based on their experience, the estimated current speed in the vicinity of the Facility dock is usually on the order of 1 to 3 knots (~1.2 to 3.5 mph) and, in flood flows, may exceed 5 knots (~6 mph) at the dock face. Modeled current flow data for the project area from the National Oceanic and Atmosphere Administration (NOAA) Northwest River Forecast Center (Portland, Oregon) indicates that the monthly average current velocity ranged from 0.7 to 1.8 knots (~0.8 to 2 mph), with maximum currents occurring in May and June and ranging from 1.6 to 2.1 knots (~1.8 to 2.3 mph). In all months, maximum current speed exceeds 1 knot part of the time.

1.1.2.3 Weather (Wind and Precipitation)

Wind velocity and precipitation data were available from the National Weather Service (NWS) for Pearson Field Airport (about 2 miles east of Vancouver, Washington). The wind direction data were obtained from a long-term dataset (30-year monthly averages) maintained on the U.S. Department of Agriculture (USDA) National Water and Climate Center website for the Portland International Airport (PIA). The PIA is

located across and about 5 miles upriver from the Port. Based on the PIA dataset, the wind in this area averages 8 to 11 mph (~7 to 10 knots) from the east-southeast during the months of October through March and approximately 8 mph from the northwest for April through September. The Vancouver NWS data, however, indicate that maximum sustained winds can occasionally exceed more than twice these averages and the Facility terminal manager's observations support this assessment. Rainfall is greatest from about late September through April but rain does occur in all months of the year. Rainfall is seldom heavy enough to, by itself, pose a safety hazard to the personnel involved in pre-booming.

1.1.3 Other Conditions

- According to the Facility terminal manager and dock personnel, other conditions that might affect pre-booming are
  - Large floating/barely submerged debris carried by strong currents.
  - Low visibility due to heavy fog, rainfall, or snowfall.
  - Freezing conditions from a combination of high winds, cold weather, and rain/sleet/snow fall may cause ice buildup on the dock and/or vessel used for deploying boom.
  - Other commercial vessel traffic in the immediate vicinity of the dock typically will not restrict pre-booming.
  - Recreational activities are very limited in the vicinity of the terminal dock and should not affect pre-booming.

1.1.4 Efficacy of Oil Boom under Environmental Conditions

Ideal performance conditions for booms used by the Facility are

- Surface current speeds < 1.0 knot perpendicular to the long axis of the boom
- Surface current speeds < 3 to 5 knots at increasingly acute angles to the long axis of the boom
- Wave heights < 1.5 to 2 feet
- Wind speeds < 20 knots (~23 mph)

Generally accepted rules among the response industry are:

- Current speeds > 0.8 to 1.0 knot perpendicular to the long axis of the boom begin to result in product loss
- Current speed > 1.5 knots perpendicular to the long axis of the boom will result in significant or complete product loss; i.e., boom efficacy approaches zero
- Waves > 18 to 24 inches high will result in splash-over of product reducing boom effectiveness by 10 to 20 percent
- Waves 24 to 30 inches in height will dramatically decrease the effectiveness of the boom
- Waves > 30 inches will render the boom essentially useless for retaining oil, even if the water current speeds are essentially zero
- Large debris entangled in the boom or lines will render the boom largely to completely ineffective

1.2 Safe and Effective Threshold Values

1.2.1 Personnel Safety Threshold Values

Because safety of personnel is the first and overriding priority for the Company pre-booming and oil transfer operations at the Facility dock, the TPIC may determine that, even though the environmental threshold values described following are not exceeded, there are other factors that render the pre-booming operation unsafe for personnel and, therefore, the TPIC may terminate the pre-booming operation.

1.2.2 Environmental Conditions Threshold Values

The following are threshold values for environmental conditions above which the TPIC will consider it not safe and/or effective to pre-boom.

- Water current speed > 1.5 knots will be the effective threshold value
- Wave heights > 2 to 2.5 feet will be the safe and effective threshold value

- Sustained wind speed greater than 30 knots (~35 mph) will be the safe and effective threshold value
- Low visibility resulting from fog, heavy precipitation, or snow at the dock and/or boom deployment vessel that, in the opinion of the TPIC, jeopardizes the safety of personnel involved in pre-booming
- Freezing and icy conditions that, in the opinion of the TPIC, jeopardize the safety of personnel involved in pre-booming
- Presence of large floating/barely submerged debris that, in the opinion of the TPIC, jeopardizes the safety of personnel involved in pre-booming

2. Introduction

2.1 Purpose

The purpose of this report is to provide the TPIC of oil transfer operations at the Facility terminal with the threshold values for environmental conditions that allow the safe and effective deployment of oil boom around vessels prior to and during oil transfer operations (also referred to as pre-booming).

2.2 Objectives

The objectives of the analysis and report are to

- Comply with the Safe and Effective Threshold Determination Report requirements of the Washington State Facility Oil Transfer Regulations (WAC 173-180-224)
- Identify personnel safety conditions and provide guidance on threshold criteria and values
- Identify oil boom oil-retention efficacy under a range of environmental conditions
- Provide guidance on criteria and threshold values for environmental conditions affecting personnel safety and oil-retention efficacy

2.3 Location of Terminal Dock

The Facility is located at the Port within the City of Vancouver in Clark County, Washington. The site is located on the Washington shore of the Columbia River. State Route 501 (Lower River Road) is located immediately to the north of the site and is available from the east. The site is located in the SE 1/4 of Section 18, NW 1/4 of Section 19, and the NW and NE 1/4 of Section 20, Township 2 North, Range 1 East W.M. Berths 13 and 14 are located at approximately Columbia River Mile 103.5.

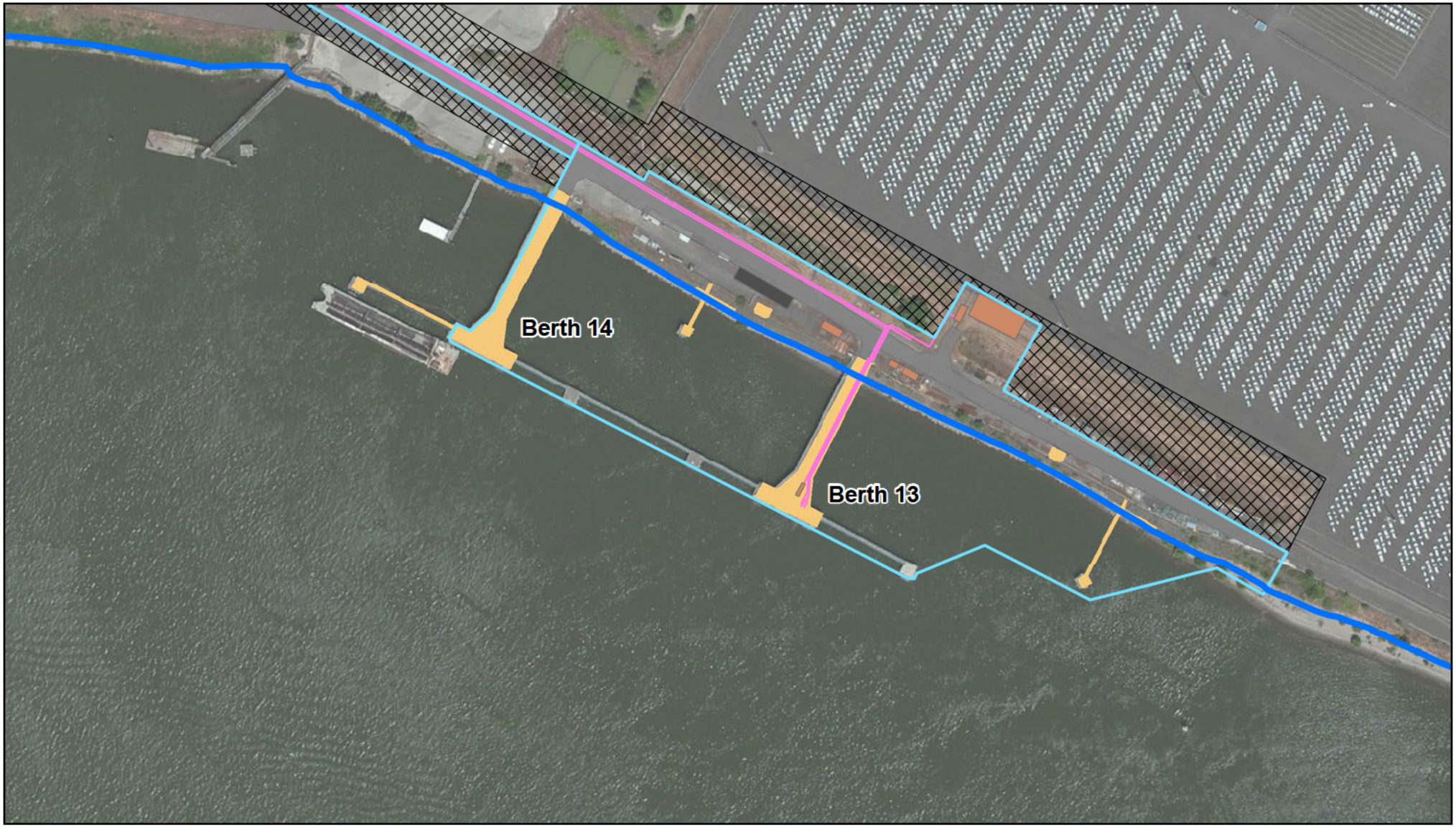


Figure 1 - Aerial View of Berths 13 and 14

VANCOUVER ENERGY

Tesoro Savage Petroleum Terminal LLC

LEGEND

Proposed Project Facilities

- Lease Boundary
- Construction Boundary
- Parking
- Building
- Roads
- Marine Terminal
- Transfer Pipeline
- Ordinary High Water

0 100 200 400 Feet

N

Date: May 2015

Map Notes: Aerail photo dated July 2010, courtesy of ESRI World Imagery service

2.4 Background

As of 26 October 2006, Washington State rules were adopted for Facility Oil Handling Standards (WAC 173-180) and Vessel Oil Transfer Advance Notice and Containment Requirements (WAC 173-184). These rules require that Class 1 facilities, such as the Facility, develop guidance on criteria and threshold values for the safe and effective deployment of oil boom around vessels during oil transfer operations.

The rule requires pre-booming of: (a) any bulk oil transfer operation greater than 500 gallons per minute from a vessel to a non-recreational vessel or facility, or (b) oil transfer from a Class 1 facility to a vessel, "… when it is safe and effective to do so…." The rule provides guidance on the determination of when it is, and is not, safe and effective to pre-boom the oil transfer vessel and facility.

This report provides the personnel safety and environmental criteria and threshold values for determination of when it is safe and effective to pre-boom at the Facility's dock. The analyses are based on data available from a variety of sources, including NOAANWS; weather stations at the terminal; boom manufacturers' technical specifications for their products; experience of the oil spill response contractors retained by the Facility for the terminal; other contractors retained by the Facility to handle normal docking and oil transfer operations at the dock; and on-site observations and experience of the dock operators and other Facility personnel.

3. Site-Specific Safety and Environmental Conditions

3.1 Personnel Safety

Facility TPIC at the terminal dock has the ultimate responsibility and authority to determine if it is safe for personnel to deploy oil boom to meet the pre-booming requirement. That is, the TPIC may determine that, even though the threshold values described later in this report are not exceeded, there are other factors that render the pre-booming operation unsafe for personnel and, therefore, the TPIC may terminate the pre-booming operation. In this situation and any other situation where the TPIC determines that pre-booming is not safe and/or effective, the TPIC will document the circumstances supporting the decision to not pre-boom and to proceed with alternative measures as required in WAC 173-180-221 and WAC 173-180-222.

Personnel safety may be compromised by one or more of the following conditions.

- High winds that affect the docking of the vessel or maintaining its position at the dock during transfer operations, even if these winds do not result in large waves (e.g., sustained wind speeds greater than 30 knots).
- Waves, especially high, choppy (i.e., short period) waves that affect the stability and maneuverability of the vessels deploying the boom.
- Icy conditions that make the dock and/or boom deployment vessel slippery.
- Heavy fog, rain, or other conditions that reduce visibility to unsafe levels for the boom deployment crew.
- High river flow (e.g., flood conditions) carrying large debris, flotsam, and jetsam that could make small vessel operations unsafe (and likely render the boom ineffective if not completely inoperative).
- Other conditions as determined and documented by the TPIC or designee, or Facility response or other contractor responsible for deploying the boom.

3.2 Primary Environmental Conditions

3.2.1 Sea State (Wave Height and Period)

Under most wind and wave regimes, the location of the Facility dock is sheltered from significant wind-driven wave action. Except from southeasterly and northwesterly wind directions, the fetch (i.e., straight

line distance in a specified direction over water from the dock to land or large structure. such as the Interstate 5 bridge) is short and waves usually are not an environmental factor for oil transfer operations. Even from the southeasterly and northwesterly directions (which is approximately parallel to the Columbia River channel in this area), the dock location is partially sheltered from wind-generated waves. The upstream and downstream structures, such as bridges and shoreline structures, partially break up the wind-driven waves.

In the Port area, wave height and period (i.e., time between wave crests passing a fixed point) do not appear to have been continuously recorded or are not publicly available if they were. However, the Facility terminal manager reports that southeasterly and northwesterly winds exceeding 25 knots (~29 mph) [1] may occur and result in waves greater than 2 to 2.5 feet high that could affect pre-booming safety and effectiveness during the oil transfer operations.

Bow waves and wakes from large commercial and recreational vessels passing on the Columbia River occasionally may be large enough (e.g., > 2 to 2.5 feet) to limit the effectiveness of the boom and affect the safety of the contractors deploying or maintaining it. This effect is temporary (e.g., on the order of a minute) but does require visual monitoring for safety reasons.

3.2.2 Water Currents

Continuous and long-term recorded current data for the surface currents in the Columbia River at the Port were not identified despite Internet and literature searches, and contacts with the United States Geological Survey (USGS), NOAA, NWS, U.S. Army Corps of Engineers (USACE), Port, and cleanup contractors. Based on these efforts, it appears unlikely that long-term, continuous recorded data of current velocity data for the Port exist.

Based on experience at the nearby Tesoro Dock, the estimated current speed in the vicinity of the Facility dock is usually on the order of 1 to 3 knots (~1.2 to 3.5 mph) and, in flood flows, may exceed 5 knots (~6 mph) at the dock face. They reported that the current generally flows downriver (e.g., east to west) indicating that the tidal influence that reaches the Port has little effect on currents and does not impact booming operations or effectiveness.

Modeled current flow data (channel average) for the project area was obtained from the NOAA Northwest River Forecast Center (Portland, Oregon). The NOAA model uses certain “real-time” inputs (i.e., tide state and dam releases) to forecast flooding events. Given the apparent lack of recorded data, the modeled data represent a reasonable estimate of river channel current conditions at the Port over the period of 2003 to 2006 although it did not include the entire 2003 to 2006 time period. The results are summarized in Table 2 and Figure 2. Only the average, maximum, and minimum values for each month are included in Table 2 and Figure 2. Over the four-year period, the monthly average current velocity ranged from 0.7 to 1.8 knots (~0.8 to 2 mph), with maximum currents occurring in May and June and ranging from 1.6 to 2.1 knots (~1.8 to 2.3 mph). In all months, maximum current speed exceeds 1 knot part of the time. However, because of the structure of the dataset obtained, it was not practical to estimate the percentage of time over the four-year period that the current exceeded any specified value (e.g., 1 knot).

[1] Wind speed is typically reported in miles per hour by the weather service databases accessed for this report and the Facility. Weather station wind speed readout is in statute miles per hour. Marine operations typically report wind speed and water current speed in nautical miles per hour (knots). For this report, wind speed is presented in knots with speed in miles per hour provided in parentheses where appropriate. Also, for comparison, a statue mile is 5,280 feet and a nautical mile is 6,076 feet long.

Table 2. Summary of Environmental Data for Vancouver Energy Terminal Region

		Precipitation (in)[1]				Wind (mph)[1]			Current (kts)[2]		
YEAR	MONTH	Avg	Max	Min	Total	Avg	Max	Min	Avg	Max	Min
2003	Jan	0.26	2.15	0	8.16	4	26	0	na[3]	na	na
	Feb	0.11	0.81	0	2.24	3	23	0	na	na	na
	March	0.17	0.88	0	5.44	5	16	0	na	na	na
	April	0.16	0.73	0	4.89	4	17	0	na	na	na
	May	0.09	0.34	0	1.28	2	17	0	na	na	na
	June	0	0.1	0	0.25	3	18	0	na	na	na
	July	0	0	0	0	3	15	0	na	na	na
	Aug	0	0.03	0	0.04	3	15	0	na	na	na
	Sept	0.06	0.5	0	0.95	3	16	0	na	na	na
	Oct	0.11	0.88	0	2.88	4	18	0	na	na	na
	Nov	0.15	1.48	0	4.02	5	20	0	na	na	na
	Dec	0.25	1.59	0	8.02	5	31	0	0.9	1.4	0.1
2004	Jan	0.2	0.78	0	5.89	4	21	0	0.9	1.3	0.3
	Feb	0.13	0.61	0	4.16	4	22	0	0.9	1.3	0.4
	March	0.08	0.34	0	1.83	4	21	0	1.0	1.4	0.4
	April	0.05	0.31	0	0.83	4	23	0	1.1	1.6	0.5
	May	0.08	0.36	0	1.67	4	20	0	1.4	2.0	0.9
	June	0.07	0.36	0	0.93	5	24	0	1.4	1.9	0.7
	July	0	0.01	0	0.02	5	17	0	1.2	1.5	0.7
	Aug	0.13	0.84	0	2.68	5	18	0	1.0	1.2	0.7
	Sept	0.09	0.63	0	1.68	4	18	0	0.9	1.1	0.4
	Oct	0.13	0.69	0	3.54	4	23	0	na	na	na
	Nov	0.11	0.85	0	2.48	3	18	0	na	na	na
	Dec	0.14	0.59	0	4.3	5	30	0	na	na	na
2005	Jan	0.1	0.71	0	2.09	5	29	0	na	na	na
	Feb	0.07	0.66	0	1.24	4	23	0	na	na	na
	March	0.18	1.38	0	4.19	4	23	0	1.0	1.3	0.5
	April	0.13	0.58	0	3.59	5	29	0	0.9	1.5	0.4
	May	0.14	0.79	0	4.39	5	23	0	1.2	1.7	0.7
	June	0.09	0.45	0	2.12	5	17	0	1.2	1.6	0.6
	July	0.04	0.23	0	0.36	6	18	0	1.2	1.6	0.6
	Aug	0.03	0.8	0	0.81	6	17	0	0.9	1.2	0.4
	Sept	0.06	1.67	0	1.73	5	18	0	0.7	1.1	-0.1
	Oct	0.12	1.08	0	3.37	4	21	0	0.7	1.2	0.0
	Nov	0.18	1.23	0	5.23	4	24	0	0.8	1.2	0.2
	Dec	0.25	1.35	0	7.9	6	30	0	0.8	1.3	0.2

		Precipitation (in)[1]				Wind (mph)[1]			Current (kts)[2]		
YEAR	MONTH	Avg	Max	Min	Total	Avg	Max	Min	Avg	Max	Min
2006	Jan	0.37	1.35	0	11.42	7	26	0	1.0	1.4	0.5
	Feb	0.1	0.63	0	2.33	6	31	0	1.1	1.5	0.6
	March	0.15	0.39	0	3.06	6	25	0	1.0	1.4	0.4
	April	0.1	0.48	0	2.38	5	22	0	1.6	2.0	0.5
	May	0.1	0.54	0	2.67	4	22	0	1.8	2.1	1.1
	June	0.08	0.45	0	1.18	5	18	0	1.8	2.1	1.1
	July	0.02	0.23	0	0.25	5	17	0	1.2	1.8	0.7
	Aug	0	0.11	0	0.12	5	17	0	1.0	1.4	0.4
	Sept	0.03	0.25	0	0.69	4	23	0	0.7	1.2	0.0
	Oct	0.08	0.42	0	1.41	3	22	0	0.7	1.1	-0.1
	Nov	0.55	2.9	0	13.31	6	29	0	0.8	1.3	-0.1
	Dec	0.1	0.64	0	7.16	5	23	0	0.9	1.5	0.2

1. Precipitation and Wind Data: taken from the Weather Underground website (www.wunderground.com), which archives NWS data.
2. Velocity Data: Calculated for Vancouver, WA by NOAA NW River Forecast Center
3. na = not available, usually because one or more of the input data were not available to NOAA

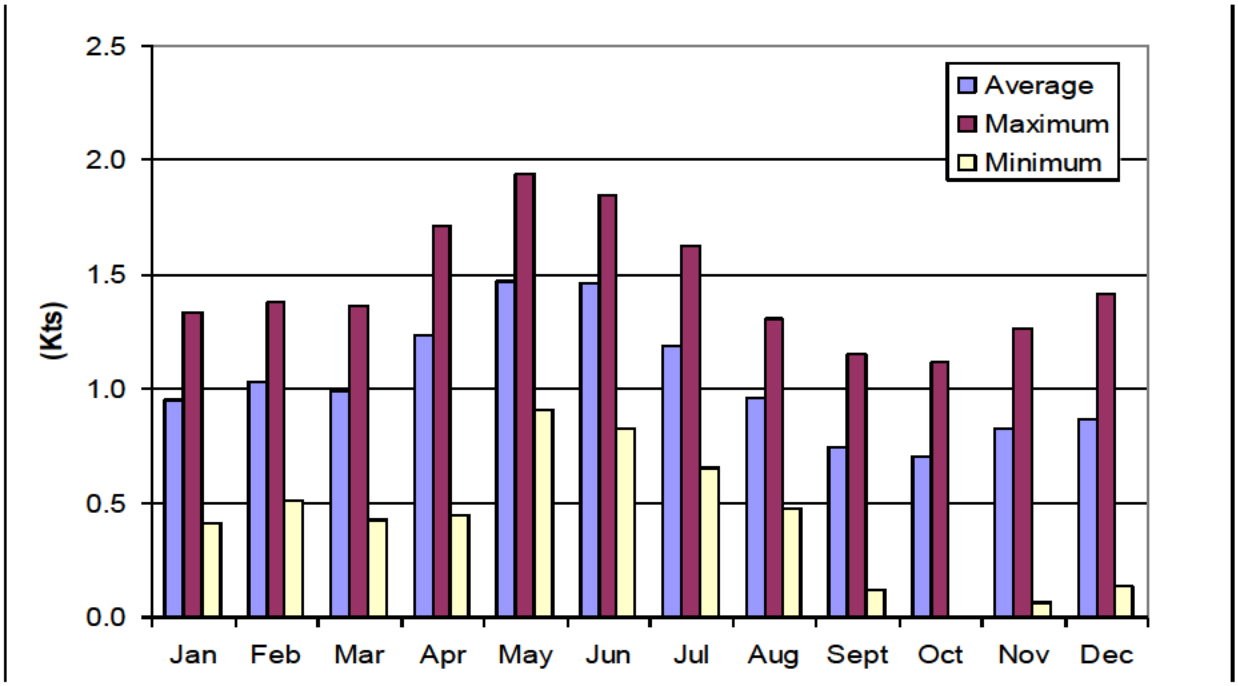


Figure 2. Columbia River Current Velocity near Vancouver, Washington (based on the 4 years of data provided in Table 2)

3.2.3 Weather (Wind and Precipitation)

The wind velocity and precipitation data presented in the summary Table 2 were collected at Pearson Field Airport (about 1.5 miles upriver of the dock and in southeast Vancouver, Washington) by NWS.

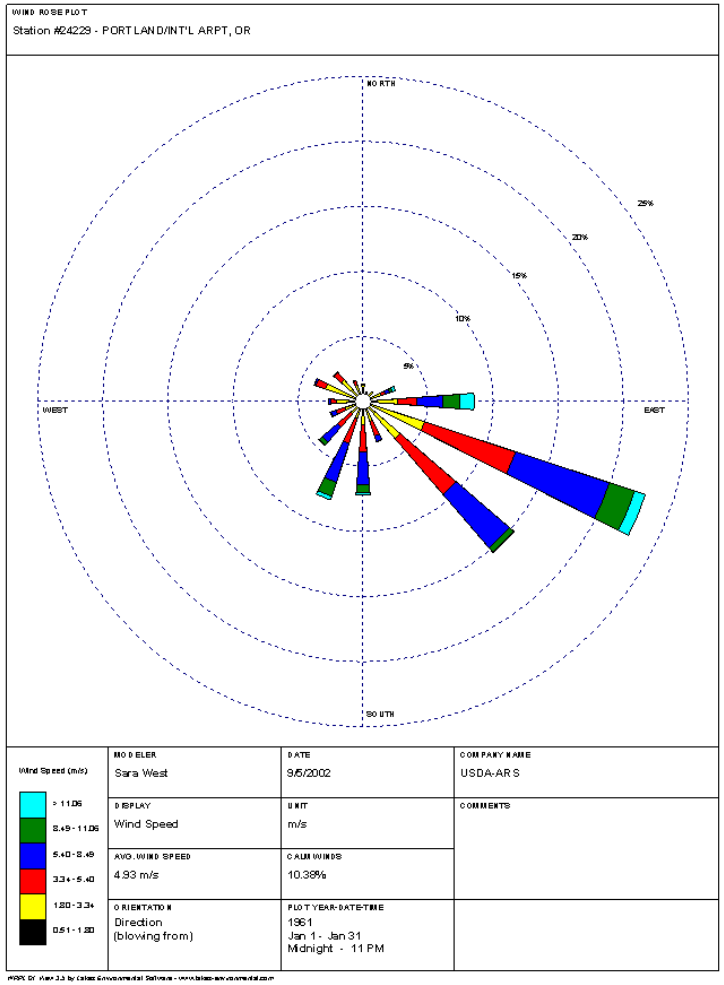
Because the wind direction information required was not available as a part of this dataset, these direction data were obtained from a long-term dataset (30-year monthly averages) maintained on the USDA National Water and Climate Center website for the PIA. The PIA is located across and about 5 miles upriver from the Port. The wind roses created by the USDA for this site are provided in Figures 3 to 8 and the information is summarized in Table 3. Based on the Portland USDA data, it appears that the wind in this area averages 8 to 11 mph (~7 to 10 knots) from the east-southeast during the months of October through March and approximately 8 mph from the northwest for April through September. The Vancouver NWS data (Table 2), however, indicate that maximum sustained winds can occasionally exceed more than twice these averages.

Most precipitation in the area is rainfall though occasional snowfall and rare hail or sleet storms occur in winter. Rain does occur in all months of the year and is greatest from about late September through April. Rainfall can be heavy but is usually not heavy enough for long enough duration to affect safety of the pre-booming operations.

Table 3. Thirty-year Average (1961-1990) Wind Speed and Predominant Direction Recorded at the Portland International Airport (Portland, Oregon)*

	Average Speed (MPH)	Primary Direction	Time From Primary Direction (%)
Jan	11	ESE	23
Feb	10.5	ESE	22
March	9.5	ESE	14
April	8.6	NW	11
May	8.1	NW	14
June	8.2	NW	17
July	8.3	NNW	23
Aug	7.9	NW	21
Sept	7.7	NW	14
Oct	7.9	ESE	11
Nov	10.1	ESE	19
Dec	10.6	ESE	24

* Long-term wind data obtained from the USDA National Water and Climate Center website http://www.wcc.nrcs.usda.gov/climate/windrose.html. Data are also presented in Figures 3 to 8 of this report.



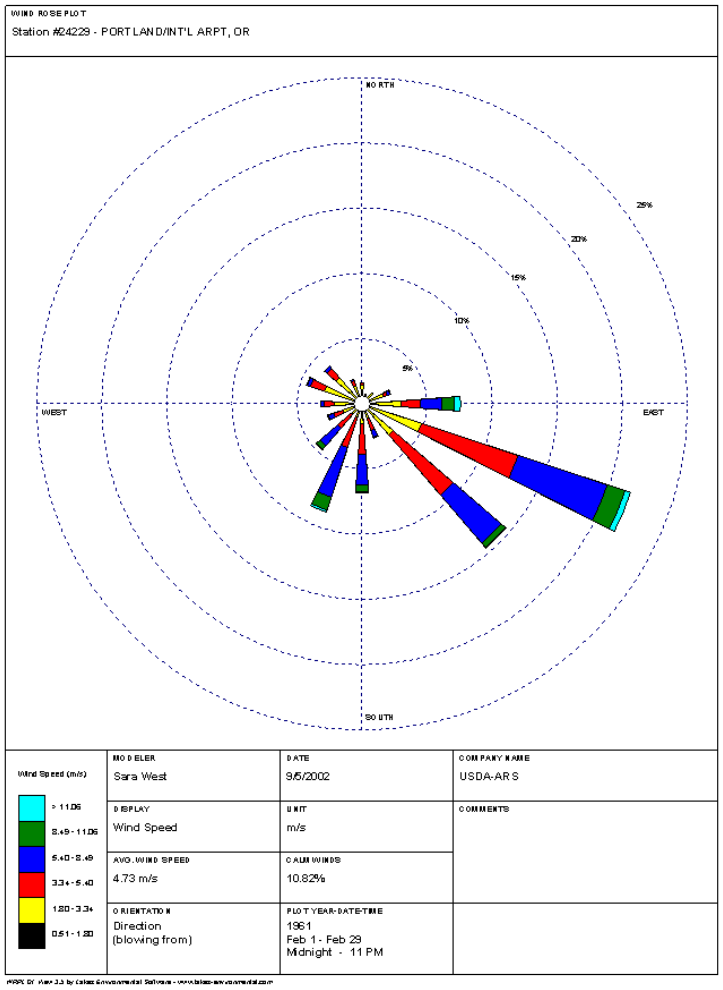
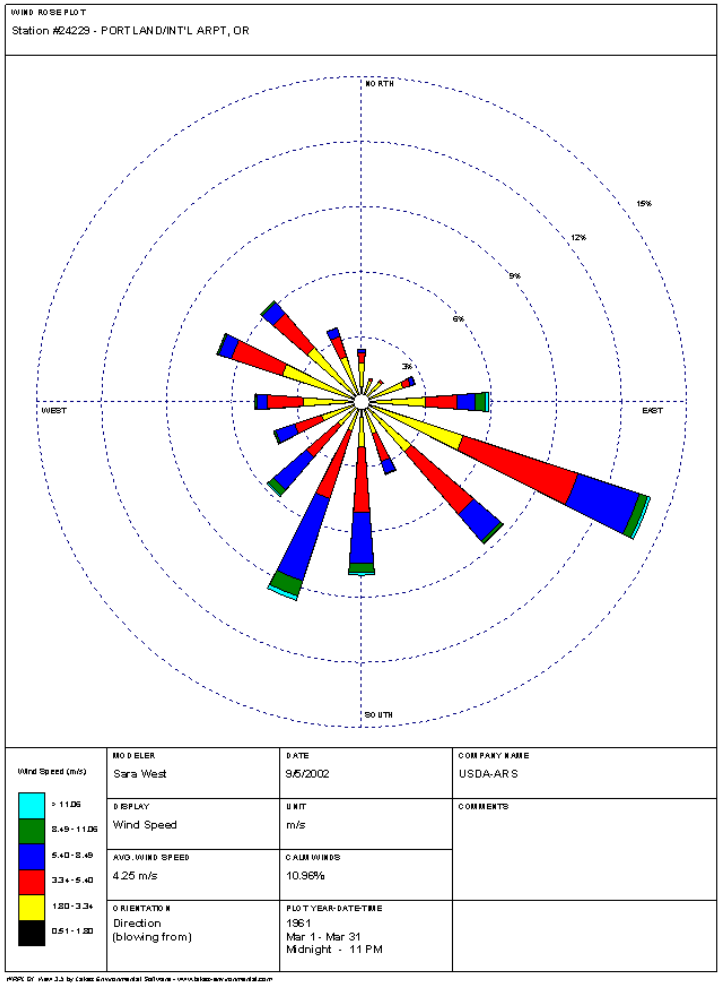


Figure 3. PIA, Portland, Oregon: Historical monthly average winds (Jan and Feb 1961-1990)



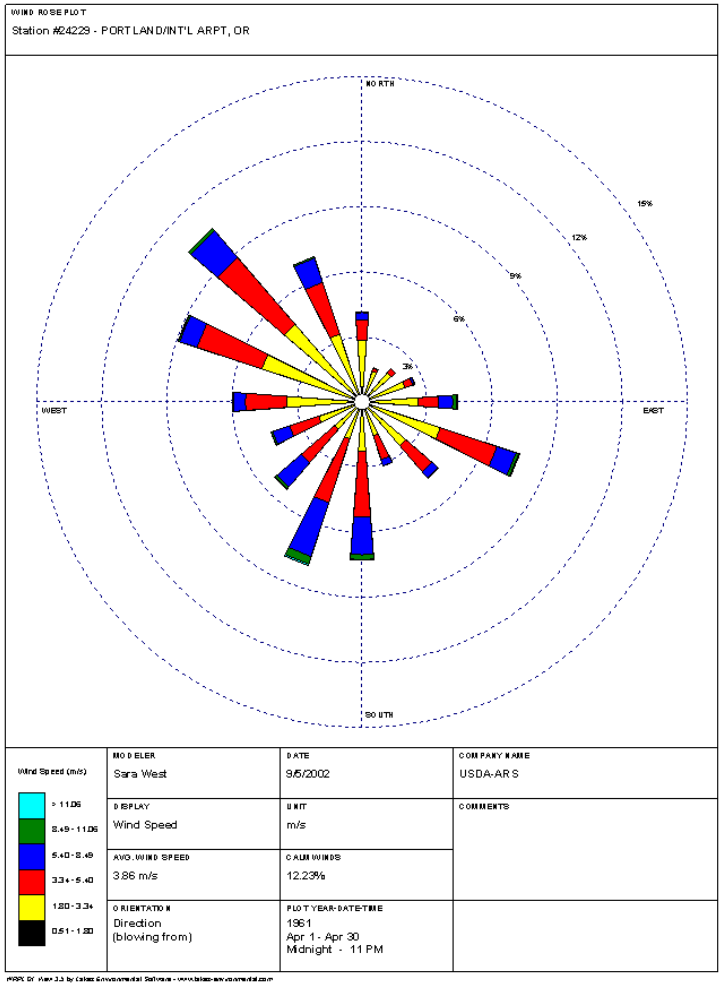
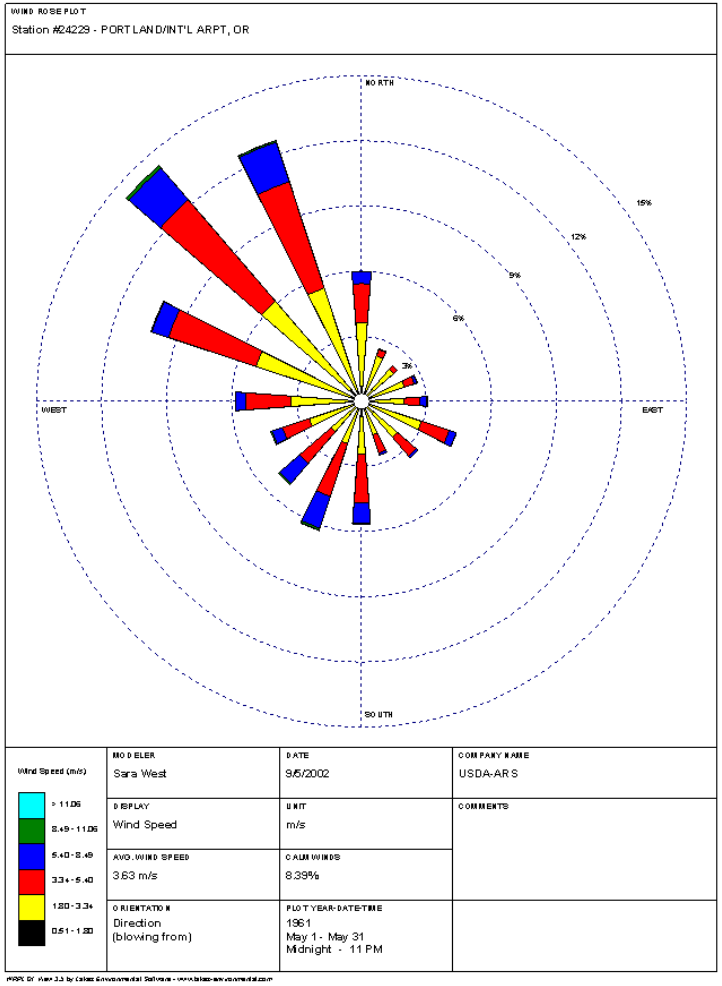


Figure 4. PIA, Portland, Oregon: Historical monthly average winds (March and April 1961-1990)



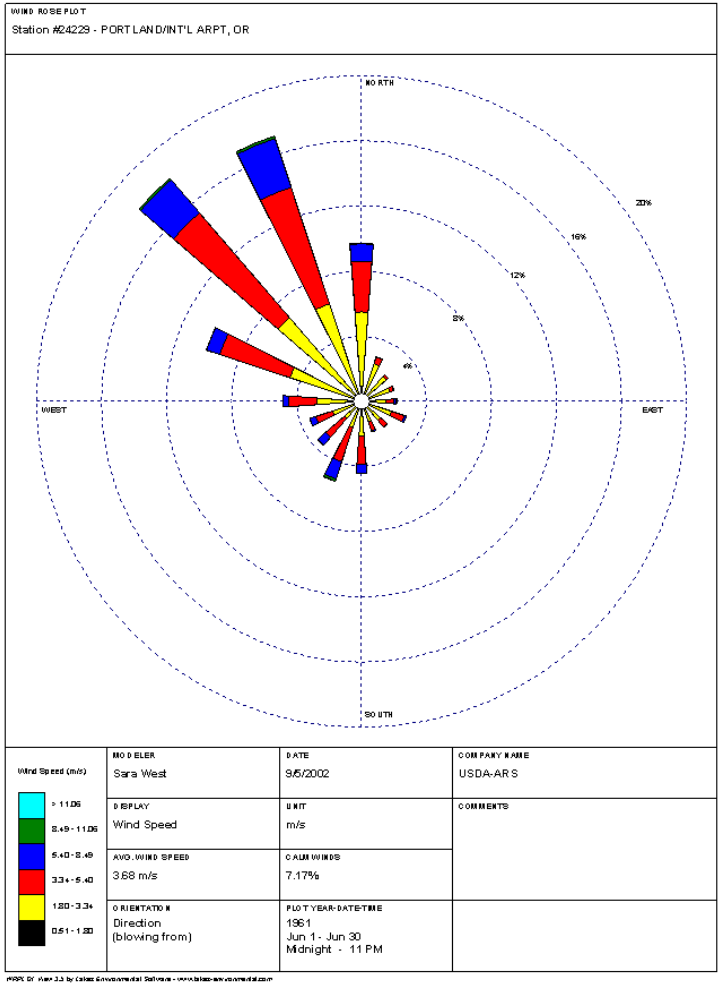
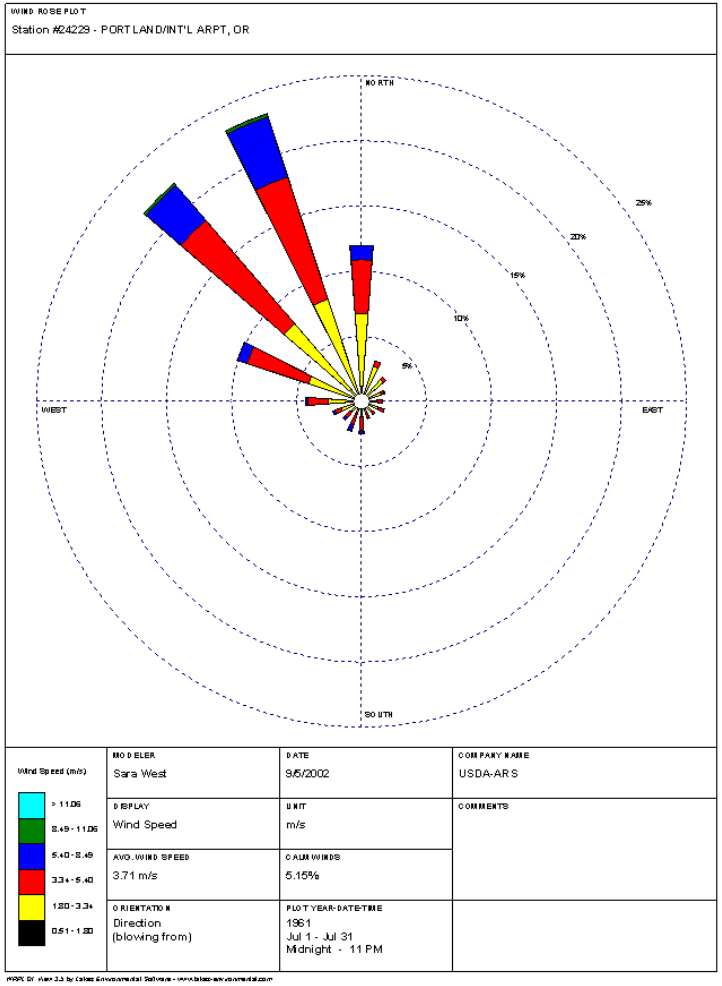


Figure 5. PIA, Portland, Oregon: Historical monthly average winds (May and June 1961-1990)



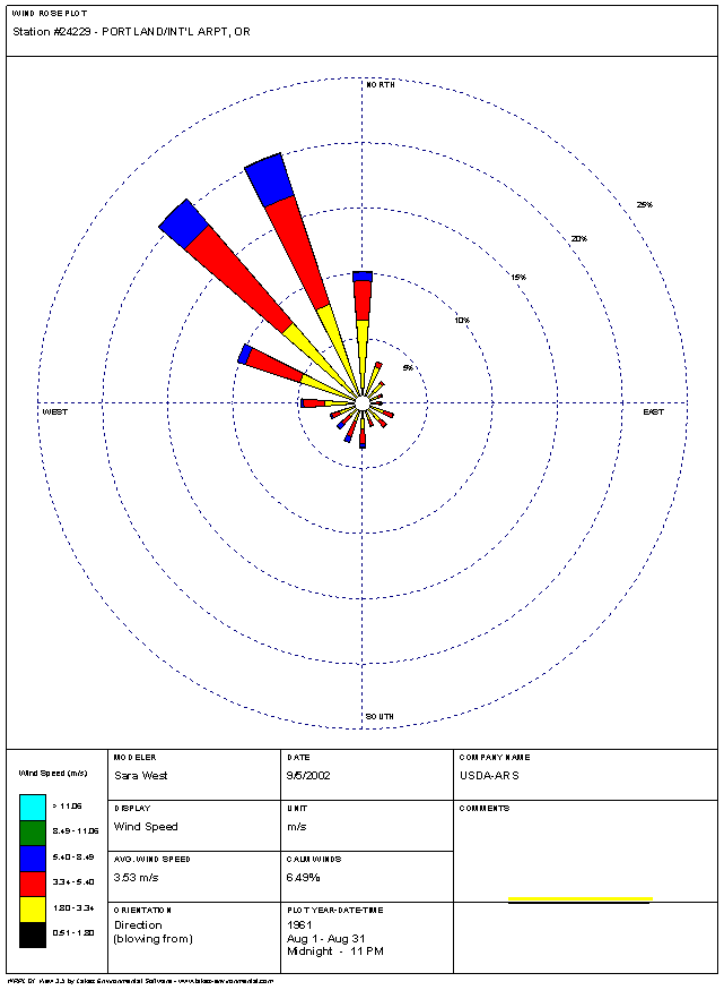
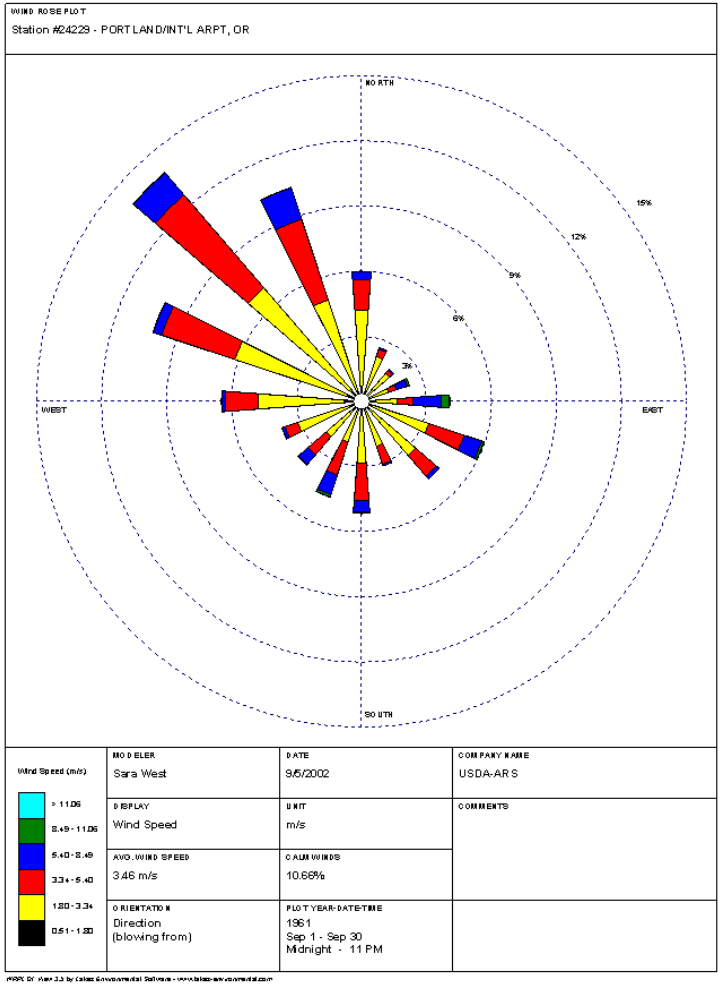


Figure 6. PIA, Portland, Oregon: Historical monthly average winds (July and August 1961-1990)



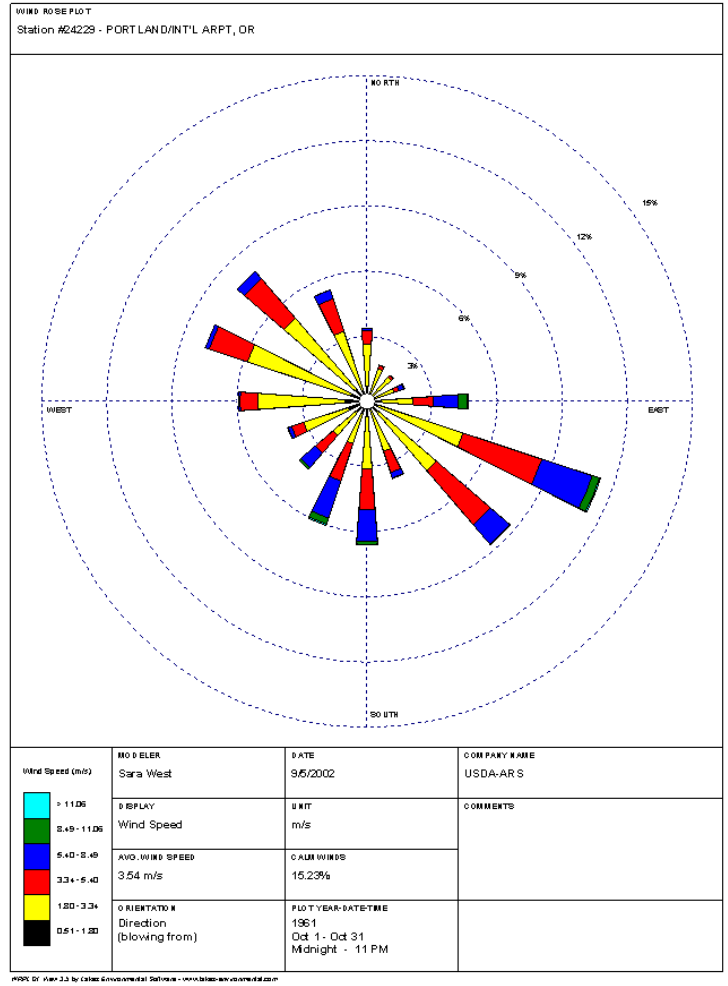
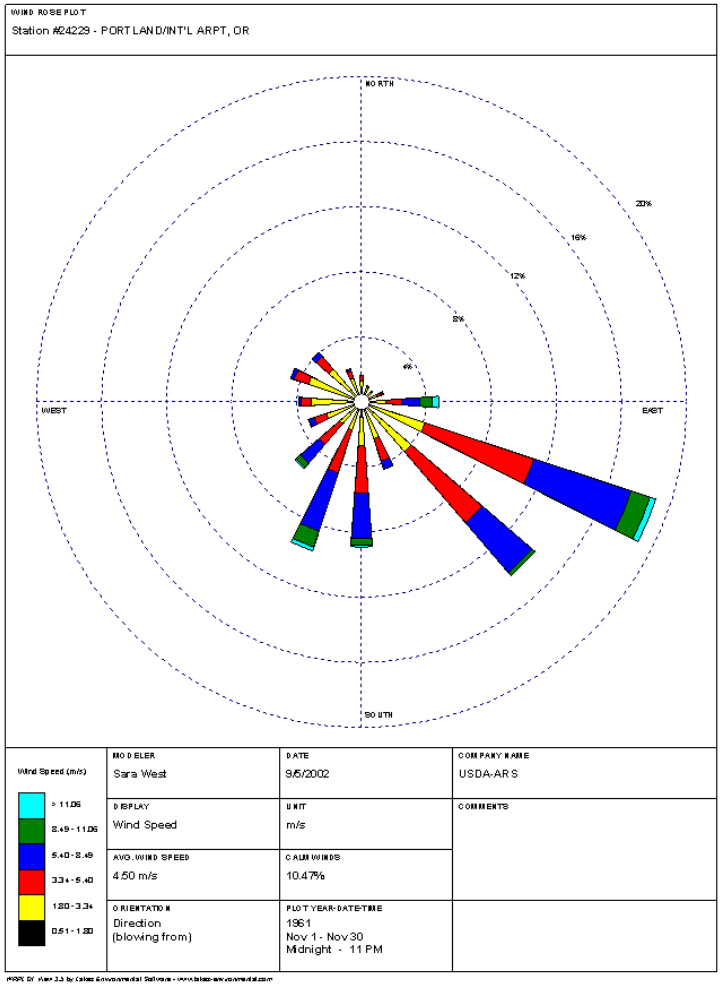


Figure 7. PIA, Portland, Oregon: Historical monthly average winds (Sept and Oct 1961-1990)



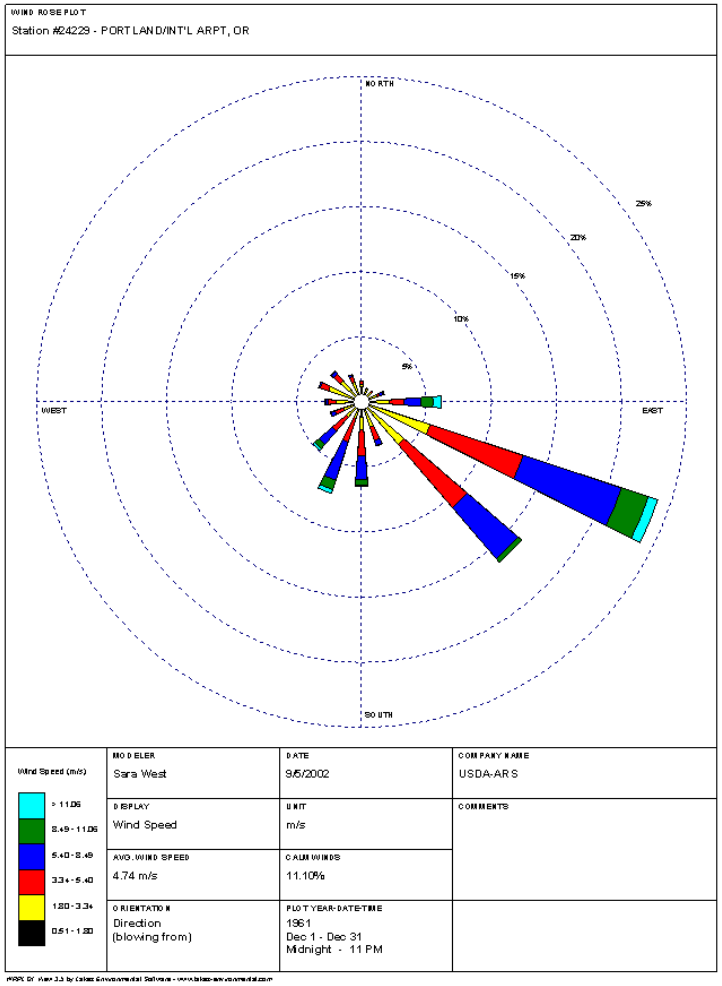


Figure 8. PIA, Portland, Oregon: Historical monthly average winds (Nov and Dec 1961-1990)

3.2.4 Other Conditions that Influence Oil Transfer Operations

Large floating or barely submerged debris (e.g., logs, tree stumps, pieces of buildings, lumber, etc.) carried by high river flow (e.g., spring flood conditions) is a relatively common occurrence according to personnel at the Port. The debris could make small boat operations unsafe and likely render the boom ineffective if not completely inoperative.

Low visibility due to fog or, rarely, heavy rainfall or snowfall may occur at the dock.

Freezing conditions from some combination of high winds, cold weather, and rain/sleet/snow fall may cause ice buildup on the dock and/or vessel used for deploying boom (as well as on the vessel being loaded or unloaded). This could result in unsafe operating conditions for the personnel.

Other commercial vessel traffic in the immediate vicinity of the dock during an oil transfer operation will typically not restrict the ability of the Facility contractor to deploy boom around the vessel. However, passing large vessels (e.g., freighters, tugs, and tug/barge combinations) may create a wake that briefly impacts the safety of pre-booming operations.

Recreational activities are limited in the immediate vicinity of the dock and should not present a limitation to oil transfer operations. Passing large recreational vessels may create wakes that briefly impacts the safety of pre-booming operations.

4. Safe and Effective Threshold Values

4.1 Priority of Safe and Effective Threshold Values

Safety of the personnel assigned to the pre-booming of barges or ships prior to oil transfer operations is the first and highest priority for the Facility TPIC. This priority, whatever the reason, will supersede all environmental threshold values (though it may be influenced by one or more of these environmental conditions).

Once the safety of the personnel is assured to the TPIC's satisfaction, the TPIC will then evaluate the environmental factors that affect the efficacy of oil-retention by the deployed boom. If these conditions, primarily surface water currents or sea state (e.g., wave height and period), exceed the threshold values provided here as guidance, the TPIC will make and document the decision to pre-boom or not.

Though other factors may affect the TPIC's determination to pre-boom or not, the environmental conditions that have the greatest potential to affect personnel safety are described in the following sections.

4.2 Personnel Safety

The primary environmental conditions that generally influence personnel safety at the Facility dock during oil transfer operations are high winds, sea state, and presence of large debris. Low visibility or ice formation is infrequent but possible limitations from a safety perspective.

High winds may be detrimental to the pre-booming and other oil transfer operations at the dock. For the safety of dock personnel and the contractor deploying the boom, the Facility PIC may use Small Craft Advisory (SCA) conditions as an initial guide in the PIC's determination to authorize the launch or use of company-owned and operated oil spill response equipment for pre-boom deployment. These SCA conditions may either be present or forecasted. By definition, the NWS SCA conditions reference sustained winds under 33 knots (~38 mph) that may pose a hazard for small vessel operators. The Facility recognizes that, even if the SCA is issued or SCA conditions are applicable for the region, certain local conditions or combinations thereof may occur that could allow the TPIC to proceed with pre-

booming. Pre-booming may occur only after conditions are documented and agreed to between TPIC and the contractor.

The following wind guidelines will be applied to all vessels at the Facility dock. The wind speeds are sustained as opposed to winds gusting up to these speeds. Sustained winds are determined when the speed is constant for more than 5 minutes. The following chart provides guidance as to the appropriate action to consider when wind speeds are high and sustained.

Table 4. Advisory for Oil Transfer Operation Actions Related to Wind Speed

Wind Speed (mph)	Wind Speed (knots)	Action Required
0-35	0-30	Monitor vessel tie-up lines and hose connections as normal.
35-40	30-35	Shutdown oil transfer operations and drain hoses.
Over 40	Over 35	Disconnect and stow hoses, if safe to do so.
Over 45	Over 39	Request vessel to prepare and sail if the vessel or dock is in jeopardy of sustaining damage. If safe to do so, sail the vessel.

Sea state (e.g., wave height and period) at the Facility dock are almost entirely a function of wind speed and direction, with southeasterly or northwesterly winds resulting in the highest waves. The vessel used to deploy the boom in the pre-booming operation is to be determined, but is likely to be a stable platform in most wave conditions expected at the dock. In the case when wave heights exceed about 2 to 2.5 feet in a “choppy” sea (i.e., short-period wind chop on top of the larger, longer-period swells), the PIC may consider it unsafe for personnel to deploy the boom, regardless of the potential efficacy of the boom to retain oil.

Low visibility resulting from fog, heavy precipitation, or snow at the dock and/or boom deployment vessel may jeopardize the safety of personnel involved in transfer operations. Close consultation between the TPIC and Vessel Person-In-Charge (VPIC) will be undertaken to determine if conditions are unsafe for personnel to pre-boom the vessel.

Freezing conditions that result in ice buildup on the dock and/or boom deployment vessel may jeopardize the safety of personnel involved in pre booming operations. Close consultation between the Facility TPIC and VICP will be undertaken to determine if conditions are unsafe for personnel to pre-boom the vessel.

Large floating/barely submerged debris is generally associated with high water flows and strong currents. The combination may pose a safety hazard to the pre-booming vessel, as well as to the boom and lines used to secure the boom. Close consultation between the TPIC and personnel on the contractor’s pre-booming boat will be undertaken to determine if conditions are unsafe for personnel to pre-boom the vessel.

4.3 Efficacy of Oil Boom under Range of Environmental Conditions

The Facility will deploy up to 1,600 feet of 18-inch fence boom, and 3,000 feet of 12- by 6-inch containment boom (1,000 feet with 36-inch floats and 2,000 feet with 72-inch floats). The fence boom is best suited for use in semi-protected environments. Having a high freeboard and a flat flotation device, fence booms are less effective in rough water, where wave and wind action can cause the boom to twist. Ideal performance conditions for the fence boom are

- Surface current speeds < 1.0 knot perpendicular to the boom and up to 5 knots depending upon the angle of the boom relative to the current direction
- Wave heights < 1.5 to 2 feet
- Wind speeds < 20 knots (~23 mph)

The containment booms have a more circular flotation device and a continuous skirt. They perform well in rough water, but are more difficult to clean and store than fence booms.

As currents pushing against the boom increase beyond ideal operating conditions, the boom becomes subject to hydraulic failure, commonly referred to as entrainment, and the oil product may begin to slip under the boom skirt. Entrainment is common to all types of booms regardless of size or design. Entrainment does not indicate a complete failure of the boom but does impact the efficacy of the boom.

It is difficult to establish exact limits of current speed to boom efficacy. A generally accepted rule among the response industry is that current speeds > 0.8 to 1.0 knot perpendicular to the long axis of the boom will begin to result in product loss, and current speed > 1.5 knots will result in significant or complete product loss. As the boom angle is adjusted toward parallel with the current direction, the entrainment is reduced for a given current speed. However, as current speed approaches 5 knots, boom effectiveness approaches zero regardless of boom configuration.

Modifying the boom configuration under different current regimes can have a dramatic impact on efficacy and in many cases can improve the capability to control product into a collection point. However, for oil transfer pre-booming where the boom needs to surround a vessel, the opportunity to develop alternative configurations is limited. In the pre-booming configuration, some portion of the downstream end of the boom will be at or near perpendicular to the current thereby reducing overall effectiveness of oil retention at high current velocity at that location.

Another generally accepted rule among the response industry is that waves > 18 to 24 inches high will result in splash over of water or product causing the boom effectiveness to be reduced by 10 to 20 percent. Waves > 24 inches in height will dramatically decrease the effectiveness of the boom through wash over, and waves > 30 inches high will render the boom essentially useless for retaining oil, even if the water current speeds are essentially zero.

Large debris that gets entangled in the boom or in the lines attaching boom to shore, other fixed points or vessels generally presents a large surface to the water currents. The resulting force drags the boom underwater or otherwise compromises the boom configuration to the extent the boom no longer retains oil. Large debris is typically present when current velocity is high, and the combination will almost always result in the boom efficacy being essentially zero.

4.4 Effective Threshold Conditions for Oil Boom

4.4.1 Surface Water Currents

Based on Tesoro's years of experience at their nearby dock and data presented in previous sections of this document, the Facility expects surface current speed to exceed 1.0 knot on a frequent basis all months of the year and occasionally to exceed 3 to 5 knots during spring flood flows of the Columbia River. The Facility anticipates that current speed will be a deterrent to effective pre-booming at this terminal for a substantial portion of the year. Therefore, the effective threshold value for current speed will be 1.5 knots at this terminal.

4.4.2 Sea State (Wave Height and Period)

Sea state will occasionally be a factor limiting pre-booming during oil transfer operations at this terminal, based on the long-term experience and observations of the terminal manager, dock operations personnel, and contractors supporting the Facility in oil transfer operations.

Wave action may be a factor on those occasions when sustained southeasterly or northwesterly winds exceed about 15 knots (~17 mph) and may cause waves from 1.5 to 2 feet high. Under these conditions, sea state will begin to exceed the capabilities of the boom to retain oil. At sustained easterly wind speeds

greater than about 20 to 25 knots (~23 to 29 mph), wave height may exceed 3 feet, which will render the oil boom almost completely ineffective in retaining oil. Therefore, wave heights greater than 2 to 2.5 feet will be the effective threshold value for waves at this terminal.

4.4.3 Wind

As noted in Section 3.2, if SCA conditions (i.e., sustained winds up to 33 knots [~38 mph]) that may pose a hazard for small vessel operators are posted or similar winds are measured at the Facility, the TPIC will evaluate potential for impacts to personnel safety and to effectiveness of boom deployment. The TPIC may make a real-time determination that, because of the wind direction and shelter at the dock, it is safe to pre-boom the vessel and continue with oil transfer operations.

Also, as noted in Section 3.2, wind speed > 30 knots (~35 mph) for longer than 5 minutes will exceed the personnel safe operating limit and booming, as well as oil transfer operations, will be terminated. Therefore, sustained wind speed greater than 30 knots (~35 mph) will be the effective wind at this terminal.

5. Acronyms and Abbreviations

Company: Tesoro Savage Petroleum Terminal LLC

Facility: Vancouver Energy

mph: miles per hour

NOAA: National Oceanic and Atmosphere Administration

NWS: National Weather Service

PIA: Portland International Airport

PIC: Person-in-Charge

Port: Port of Vancouver USA

SCA: Small Craft Advisory

Shift SUP: Shift Supervisor

USDA: U.S. Department of Agriculture

WAC: Washington Administrative Code