Ship Simulation Modeling and Mariner Study of the Maritime Implications for Tank Vessels Utilizing Potential Places of Refuge, Prince William Sound, Alaska

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Purpose: The purpose of this research is to evaluate the safety of Potential Places of Refuge (PPOR) in Prince William Sound (PWS) for decision-making concerning oil tankers in distress. The Alaska Regional Response Team has identified PPOR for a vessel in distress throughout the state of Alaska. The Prince William Sound Subarea Contingency Plan (August 2018) identifies 21 PPOR as suitable for deep draft vessels including tank vessels (e.g., oil tankers). Six of these PPOR are too far west from the Traffic Separation Scheme in PWS to be utilized by an oil tanker. Seven of these PPOR are already utilized by oil tankers for anchoring or docking (e.g., Valdez Marine Terminal Berths, Knowles Head Anchorage) so there is sufficient information about their safety. However, there is a lack of empirical information about the safety of the eight remaining PPOR in PWS for oil tankers in distress.

Methods: The safety of these eight PPOR was evaluated using interviews with local subject matter experts and stakeholders (number of observations or n =16) and using ship simulated maneuvers (n=72). The simulated maneuvers were conducted by Southwest Alaska Pilots Association members using models representing Trans Alaska Pipeline System oil tankers in distress to varying degrees. The simulated maneuver began 0.5 miles from the prescribed latitude and longitude of the PPOR position. The oil tanker then proceeded based on its own headway (3 knots) and two tugboats assisting under extreme weather conditions. Determining whether the PPOR is safe for the oil tanker in distress is primarily a function of whether the tanker grounded or potentially could run aground and insufficient swing room when anchoring or mooring.

Results: The results found that none of prescribed latitude and longitude anchor or mooring positions at the eight PPOR are safe for an oil tanker in distress. However, alternative latitude and longitude anchor and mooring positions at several PPOR were also identified and analyzed. Alternative latitude and longitude anchor positions at Port Etches Anchorage and Zaikof Bay Anchorage were found to be safe for oil tankers in distress. In addition, McPherson Bay Anchorage and an alternative anchor location at North Smith Island Anchorage could also be used with caution as a PPOR for an oil tanker in distress.

Conclusions: Decisions about the use of PPOR come down to the best available information and best professional judgment. The empirical research in this report provides information about the safety of eight PPOR in Prince William Sound for oil tankers in distress and should be utilized to inform professional judgements about the identification and utilization of these PPOR.

Note: The opinions expressed in this PWSRCAC-commissioned report are not necessarily those of PWSRCAC.

Recommendations:

PPOR Decision-Making

1. An oil tanker in distress should seek a PPOR based on an incident-specific basis. Above all else, the best professional judgement should be used based on the best information available and understand that no PPOR is pre-approved.
2. Given that utilizing a PPOR should be incident-specific and none are pre-approved, an oil tanker in distress should seek to maneuver to the closest pre-identified PPOR. In northern PWS that means various locations in Port Valdez; in mid-PWS that is Knowles Head Anchorage; and in southern PWS either Port Etches Anchorage (60 19.91 N 146 36.05 W) or Zaikof Bay Anchorage (60 19.05 N 146 59.03 W).

Updating the Prince William Sound Subarea Contingency Plan (August 2018) and Charts

1. The Prince William Sound Subarea Contingency Plan (August 2018) should remove the following PPOR locations from those listed as safe for deep draft vessels: Outside Bay Anchorage (60 38.26 N 147 29.48 W), North Jack Bay Anchorage (61 02.41 N 146 37.30 W), South Jack Bay Anchorage (61 01.98 N 146 37.49 W), Port Etches Moorage depicted buoy position (60 20.39 N 146 33.20 W), as well as the Port Etches Moorage actual buoy position (60 20.52 N 146 33.50 W).
2. The Prince William Sound Subarea Contingency Plan (August 2018) should revise the latitude and longitude anchor locations for the following PPOR concerning deep draft vessels: North Smith Island Anchorage (60 31.31 N 147 24.22 W), Port Etches Anchorage (60 19.91 N 146 36.05 W), and Zaikof Bay Anchorage (60 19.05 N 146 59.03 W).
3. The Port Etches Moorage buoy position should be updated to the actual buoy position. Furthermore, the safe working load of the buoy ground tackle should be reported in the Prince William Sound Subarea Contingency Plan (August 2018).
4. PPOR should be identified on nautical charts with an associated symbol such as an anchor and the label "PPOR." This would assist pilots and shipmasters to quickly identify the closest PPOR in case of a vessel being disabled or otherwise in distress.

Additional Research

1. Additional research should evaluate the safety of deep draft vessels utilizing the remaining PPOR locations within PWS, in particular cruise ships using the following PPOR locations: Pigot Bay Anchorage, South College Fjord Anchorage, and North College Fjord Anchorage.
2. Additional research should evaluate the safety of various deep draft vessels such as oil tankers, LNG carriers, cruise ships, container ships and cargo ships utilizing pre-identified PPOR in the two remaining area contingency plans for Alaska that include coastal areas: Arctic and Western Alaska (includes Aleutians, Bristol Bay, Cook Inlet, Kodiak Island, North Slope, Northwest Arctic, Western Alaska) and Southeast.

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The PWSRCAC has demonstrated great support by giving mariners a voice in the evaluation of PPOR for oil tankers in PWS. The conclusions and recommendations from this report will inform pilots and shipmasters and assist them to better utilize PPOR, while also setting a precedent of consultation and cooperation between mariners and the PWSRCAC.

We would also like to thank the research assistants that provided critical support for this project: Nicole Schmitt, Katherine Hicks, and Hallie Bergwell.

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Questions, Comments, and Requests for More Information

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LIST OF ACRONYMS

ADEC: Alaska Department of Environmental Conservation
ADF&G: Alaska Department of Fish and Game
ARCP: Alaska Regional Contingency Plan
ARRT: Alaska Regional Response Team
ATC: Alaska Tanker Company
AIS: Automatic Identification System
BRM: Bridge Resource Management
COTP: Captain of the Port
CPA: Closest Point of Approach
CBM: Conventional Buoy Mooring
ECDIS: Electronic Chart Display Information Systems
GPS: Global Positioning System
LOA: Length Overall
(n=[number]): Number of Observations
NMFS: National Marine Fisheries Services
NOAA: National Oceanic and Atmospheric Administration
PPOR: Potential Place of Refuge
PWS: Prince William Sound
PWSRCAC: Prince William Sound Regional Citizens' Advisory Council
SERVS: Alyeska's Ship Escort/Response Vessel System
SGM: Safeguard Marine, LLC
SPM: Single Point Mooring
SWAPA: Southwest Alaska Pilots Association
TAPS: Trans Alaska Pipeline System
TSS: Traffic Separation Scheme
UC: Unified Command
UKC: Under Keel Clearance
USCG: U.S. Coast Guard
US DOI: United States Department of the Interior
VTS: Vessel Traffic Services

Directions
E: East
ENE: East northeast
N: North
NE: Northeast
S: South
SSE: South southeast
SW: Southwest
W: West

1. INTRODUCTION TO POTENTIAL PLACES OF REFUGE

The Alaska Regional Response Team (ARRT) provides federal, state, and local governmental agencies the means to participate in responding to pollution incidents. AART includes several federal and state government agencies including: U.S. Environmental Protection Agency, U.S. Coast Guard 17th District, U.S. Department of Agriculture (U.S. Forest Service), U.S. Department of Commerce (National Oceanic and Atmospheric Administration), U.S. Department of Defense (Alaskan Command), U.S. Department of Energy, U.S. Department of Health and Human Services, U.S. Department of Homeland Security (Federal Emergency Management Agency), U.S. Department of Interior, U.S. Department of Justice, U.S. Department of Labor (Occupational Safety and Health Administration), U.S. Department of State, U.S. Department of Transportation (Federal Aviation Administration), U.S. General Services Administration, and State of Alaska (Alaska Department of Environmental Conservation). The AART developed the Alaska Regional Contingency Plan (ARCP) (September 2018) to serve as guidance for a coordinated government effort to the threat or actual discharge of oil or other hazardous substances within Alaska. As part of this process, ARRT has identified potential places of refuge (PPOR) throughout the state for a vessel in distress.

According to the ARCP (September 2018), a PPOR "is defined as a location where a vessel needing assistance can be temporarily moved to and where actions can then be taken to stabilize the vessel, protect human life, reduce a hazard to navigation, and/or protect sensitive natural resources and/or other uses of the area (e.g., subsistence collection of mussels, commercial fishing, recreational boating). A place of refuge may include constructed harbors, ports, natural embayments, temporary grounding sites, or offshore waters. A vessel moved to a temporary grounding site must be removed after emergency actions are completed" (page 72).

Therefore, a PPOR is a temporary location where a vessel needing assistance can be stabilized for safety reasons. These temporary locations can be anchorages, docks, potential grounding sites, or moorings. Previous to 2018, Alaska was divided into 10 subareas for the purposes of contingency planning: Aleutians, Bristol Bay, Cook Inlet, Interior, Kodiak Island, North Slope, Northwest Arctic, Prince William Sound, Southeast Alaska, Western Alaska. In 2018, these were consolidated into four areas: Arctic and Western Alaska (includes Aleutians, Bristol Bay, Cook Inlet, Kodiak Island, North Slope, Northwest Arctic, Western Alaska), Prince William Sound, Southeast, and Inland zones. The Prince William Sound Area Contingency Plan (PWS Contingency Plan) (August 2018) defines deep draft vessels as those over 20,000 gross tons, drafts of 25 to 60 feet, and overall length of 450 to 1,000 feet. Each plan varies in the number of PPOR designated. The PWS Contingency Plan (August 2018) identifies a total of 68 PPOR including 21 that can be utilized by deep draft vessels.

The PWS Contingency Plan (August 2018) states that the list of PPOR were developed in 2004 by a work group of interested and knowledgeable stakeholders utilizing ARRT's "Guidelines for Places of Refuge Decision-Making." The following organizations participated in the work group: Alaska Department of Environmental Conservation, Alaska Department of Natural Resources, Alaska Department of Fish and Game, Alyeska Pipeline Service Company (Ship Escort/Response Vessel System), Chugach Alaska Corporation, Cook Inlet Regional Citizens Advisory Council, Prince William Sound Regional Citizens' Advisory Council, Prince William

Sound Response Planning Group, Southwest Alaska Pilots Association, U.S. Coast Guard (District 17), U.S. Coast Guard (Valdez Marine Safety Office), U.S. Department of Agriculture (Forest Service, Alaska Region, Chugach National Forest), U.S. Department of Commerce (National Oceanic and Atmospheric Administration), U.S. Department of Interior, and U.S. Environmental Protection Agency.

The work group took several steps to identify the PPOR as described by the PWS Contingency Plan (August 2018). The first step was identifying candidate sites based on risk and logistical information. These include: locations of bulk fuel facilities; primary traffic routes for State of Alaska ferries, cruise ships, and crude oil tankers; locations of frequent fishing vessel/tramper offload activities; locations of key nearshore fishing grounds, hatcheries, and remote release sites; locations of previous major marine spill events; locations of lingering oil from the 1989 Exxon Valdez oil spill; and locations of spill response hubs and equipment depots.

This led to the identification of 66 PPOR in PWS.[1] Then a site assessment matrix was developed for each PPOR with information about risk factors and site selection criteria. The information in the site matrix includes: PPOR identification number, map number, location name, location position by latitude and longitude, size of vessels, available swing room (feet) or dock face, bottom type, exposure to wind direction, conflicting location uses, ability to boom or geographic response strategy, sensitive resources, distances to population centers (nautical miles), and distance to alternative PPOR (nautical miles). The Site Assessment Matrix is on pages 263-264 of the PWS Contingency Plan (August 2018).

However, these locations are only *potential* places of refuge and are not pre-approved for utilization. According to ARRT's "Guidelines for Places of Refuge Decision-Making" (Guidelines) (September 2013), the organization "does not support the pre-approval of places of refuge in Alaska; therefore, there are no pre-approved places of refuge identified in the state. However, the ARRT does support the pre-incident identification of PPORs that would be evaluated on an incident-specific basis using the decision-making process outlined in Appendix 1 of these *Guidelines*. It is important to note that identifying a PPOR does not require that those locations be used as a place of refuge. PPORs have been identified in each of the nine subareas of the *Alaska Federal/State Preparedness Plan for Response to Oil and Hazardous Substance Discharges/Releases (Unified Plan)* that include portions of Alaska's coastline. Used in conjunction with these *Guidelines*, the [subarea contingency plan] for each of those nine subareas includes a PPOR section (Section H) with site-specific PPOR information" (page O-4). In other words, specific PPOR are not approved, but have been identified to be used on a case-by-case basis depending on the incident.

Responding to an emergency such as a fire, a vessel losing power, or structural damage to an oil tanker requires immediate action. According to ARRT's Guidelines (September 2013) the purpose of the guidelines is to assist U.S. Coast Guard (USCG) Captains of the Port (COTP) in deciding whether a vessel needs to be moved to a place of refuge and, if so, which place of refuge to use. Furthermore, the Guidelines (September 2013) provide a framework for

[1] The most current PWS Contingency Plan (August 2018) lists 68 PPOR including an incomplete list of five PPOR for shallow draft vessels and 12 potential grounding sites.

developing a pre-incident identification of PPOR for inclusion in the appropriate subarea contingency plan. These Guidelines (September 2013) are consistent with both the International Maritime Organization's "Guidelines on Places of Refuge for Ships in Need of Assistance" (December 2003) as well as the National Response Team's "Guidelines for Places of Refuge Decision-Making" (July 2007).

According to ARRT's Guidelines (September 2013), the best location for a PPOR is dependent on incident specific characteristics and real-time input from government actors, federally-recognized tribes, stakeholders, and other technical experts. When considering a PPOR the COTP has multiple interests to consider including the following: protecting human life, sensitive natural and cultural resources, historic properties, national defense, security, economic interests, critical infrastructure, and reducing or eliminating a hazard to navigation.

In addition to moving a ship in distress to a PPOR there are other options. Other options for the COTP are: (1) the vessel remaining in the same position; (2) the vessel continuing on its voyage; (3) the vessel moving farther from shore; (4) the vessel being intentionally grounded; (5) the vessel being intentionally scuttled in deep water; and (6) the vessel moving to a place of refuge (Guidelines, September 2013).

When a ship is in distress time is a crucial component. The Guidelines (September 2013) divide the amount of time available for the COTP to make decisions regarding PPOR into three categories: (1) immediate action is required not allowing time for consultation with any government actors, federally-recognized tribes, or stakeholders or any input from technical experts; (2) rapid action is required leaving only time to consult with appropriate government actors; and (3) there is time for consultation with appropriate government actors, federally-recognized tribes, and stakeholders and input from technical experts. Therefore, the Guidelines (September 2013) recommend that the COTP consult with stakeholders regarding the utilization of a PPOR based on the level of urgency that the incident requires.

An overview of the decision-making process prescribed by the ARRT's Guidelines (September 2013) is shown in Figure 1.

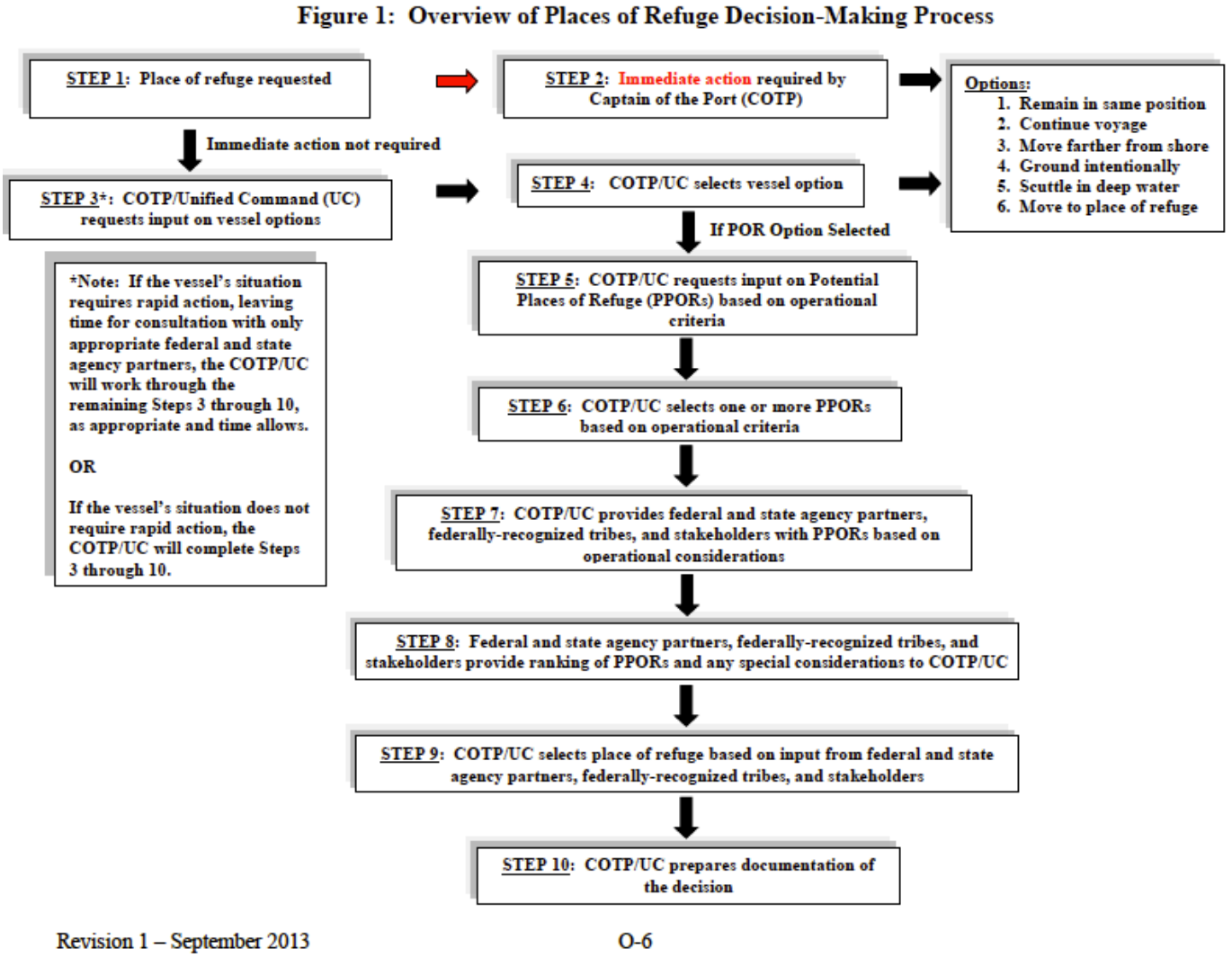

Figure 1. Overview of PPOR Decision-Making Process from ARRT's Guidelines (September 2013) page O-6

Ultimately, ARRT's Guidelines (September 2013) state that decisions come down to best available information and best professional judgment and the inclusion of other actors depends on the level of urgency that the incident requires. "Decisions to direct or permit a vessel to seek a place of refuge, as well as the decisions and actions implementing those decisions, will be based on best available information and best professional judgement. If time allows, the COTP will activate a Unified Command (UC) under the Incident Command System to assist with the decision-making process if the vessel is in state waters and/or the vessel may be intentionally grounded or moved to a place of refuge in state waters" (page O-5).

The objective of this study is to provide better information than is currently available about the PPOR in PWS for decision-making concerning oil tankers. To achieve this objective, this study

analyzes empirical data from a maritime perspective to evaluate the safety of various PPOR in PWS for oil tankers in distress.

2. BACKGROUND ON OIL TANKERS IN PRINCE WILLIAM SOUND

The Valdez Marine Terminal located in Port Valdez is the end of the Trans Alaska Pipeline System (TAPS). Tankers inbound to the terminal carry ballast water in order to stabilize the ship when it is not carrying crude oil. The marine terminals are designed for loading tankers with crude oil. Alyeska does not own the tankers, but rather the ships are owned by shipping companies contracted by the producers to carry the crude oil to market. Alyeska's Ship Escort/Response Vessel System (SERVS) provides an oil tanker escort system as well as the response equipment and personnel in the event of an oil spill. Loaded oil tankers are escorted by two large horsepower tugboats throughout their transit of PWS from the Valdez Marine Terminal to the sea. When transiting through PWS an oil tanker may become distressed (e.g., loss of power). In such cases, the oil tanker may proceed to a PPOR.

Safeguarding PWS from a maritime emergency, including an oil spill, is of the utmost importance to all public, private, and government stakeholders involved with TAPS and SERVS. Ship technology, design, operations, emergency response processes, and traffic control systems contribute to this effort. Multiple technological tanker movement safeguards have been implemented within PWS in the last 25 years, including electronic upgrades such as Global Positioning System (GPS) and Differential GPS that minimizes error within GPS receivers in PWS. The USCG's Vessel Traffic Service (VTS) monitoring capabilities have updated their radar and communications network and also utilized shore-based ice radar. Automatic Identification System (AIS) is an automatic tracking system used aboard ships and by VTS for identifying and locating vessels by electronically exchanging data with other nearby ships and VTS. Electronic Chart Display Information System (ECDIS) creates an electronic display of nautical charts, providing real time data of a ship's position, heading, and speed. Radar system upgrades including advanced collision avoidance systems and the ability to integrate ECDIS information into a radar system provide navigators a radar picture and nautical chart overlay with actual speed and course of ships over ground. Additionally, communication capabilities have improved and expanded to include cellular phone networks and satellite telephone systems. Ship construction has also improved to safeguard crew and cargo with double hull tank design, providing significant protection from penetration of oil tankers. Finally, ship operators have dramatically increased crew training and have implemented extensive bridge resource management (BRM) techniques among other safety training.

Tankers transiting PWS operate within a Traffic Separation Scheme (TSS), where traffic lanes are utilized to separate ships. Traffic lanes require all participating vessels to proceed in the same direction within their lane. When crossing lanes, vessels cross in an angle as close to 90 degrees as possible. TSS designated traffic lanes extend from Rocky Point to Bear Cape on Hinchinbrook Island. PWS traffic lanes are a significant distance from shore and other known hazards. Ships operating within the TSS designated traffic lane have an approximate closest point of approach (CPA) to dangers for outbound loaded tankers to shore are: abeam buoy 9 at 1 mile, Glacier Island 2.3 miles, Bligh Reef 3.5 miles, Naked Island and Smith Island 8.5 miles. Approximate CPA for inbound tankers are: Bear Cape 2.8 miles, Goose Island 6.0 miles, Bligh Reef 1.8 miles,

Rocky Point 0.9 miles. Ice from Columbia Glacier within TSS has significantly declined due to the distance it has to travel to enter the traffic lanes. Valdez VTS monitors the TSS and provides updates pertaining to one-way zones that may have been implemented due to ice in the area.

3. SCOPE OF THE RESEARCH

The waters of PWS are very deep, limiting the number and availability of safe anchorages for oil tankers which have deep drafts (National Oceanic and Atmospheric Administration, 2018). Anchorage locations for large tankers frequenting PWS require sufficient (1) water depth, (2) swing room for anchoring or mooring, (3) holding ground for an anchor or mooring line, and (4) protection from inclement weather. These criteria related to anchorage and mooring locations within PWS are difficult to identify because sufficient water depth is frequently not associated with sufficient swing room for an anchored oil tanker to not strike land or other obstacles.

The PWS Contingency Plan (August 2018) identifies 21 PPOR for deep draft vessels. It defines deep draft vessels as those over 20,000 gross tons, drafts of 25 to 60 feet, and overall length of 450 to 1,000 feet. The predominant type of deep draft vessels operating in PWS, which also pose the greatest risk to the environment, are oil tankers. Therefore, the scope of this research focuses on oil tankers that are greater than 20,000 gross tons, with drafts of 25 to 60 feet, and 450 to 1,000 feet length overall (LOA).

The 21 PPOR for deep draft vessels identified by the PWS Contingency Plan (August 2018) are shown in Table 1.

Table 1. PPOR Identified by PWS Contingency Plan (August 2018) page 264 for Deep Draft Vessels

PPOR ID#	Map #	Location Name
A03	#1	1. Gold Creek Anchorage
D06	#1	2. Valdez Container Terminal
D08	#1	3. TAPS Dock at Berth 1
D09	#1	4. TAPS Dock at Berth 3
D10	#1	5. TAPS Dock at Berth 4
D11	#1	6. TAPS Dock at Berth 5
A13	#2	7. North Jack Bay Anchorage
A14	#2	8. South Jack Bay Anchorage
A21	#4	9. Knowles Head Anchorage
A28	#7	10. Port Etches Anchorage
A29	#7	11. Zaikof Bay Anchorage
M30	#7	12. Port Etches Moorage
A31	#8	13. MacLeod Harbor Anchorage
A36	#11	14. North Smith Island Anchorage
A37	#11	15. Outside Bay Anchorage
A38	#11	16. McPherson Bay Anchorage
A42	#12	17. Pigot Bay Anchorage
D43	#12	18. Whittier Cruise Ship Dock
D44	#12	19. Delong Pier
A47	#13	20. South College Fjord Anchorage
A48	#13	21. North College Fjord Anchorage

The map of PWS in Figure 2 depicts the approximate locations of the individual PPOR maps. The PPOR maps that include pre-identified PPOR for deep draft vessels are: 1, 2, 4, 7, 8, 11, 12, and 13. Therefore, PPOR identified at other locations are outside the scope of this research.

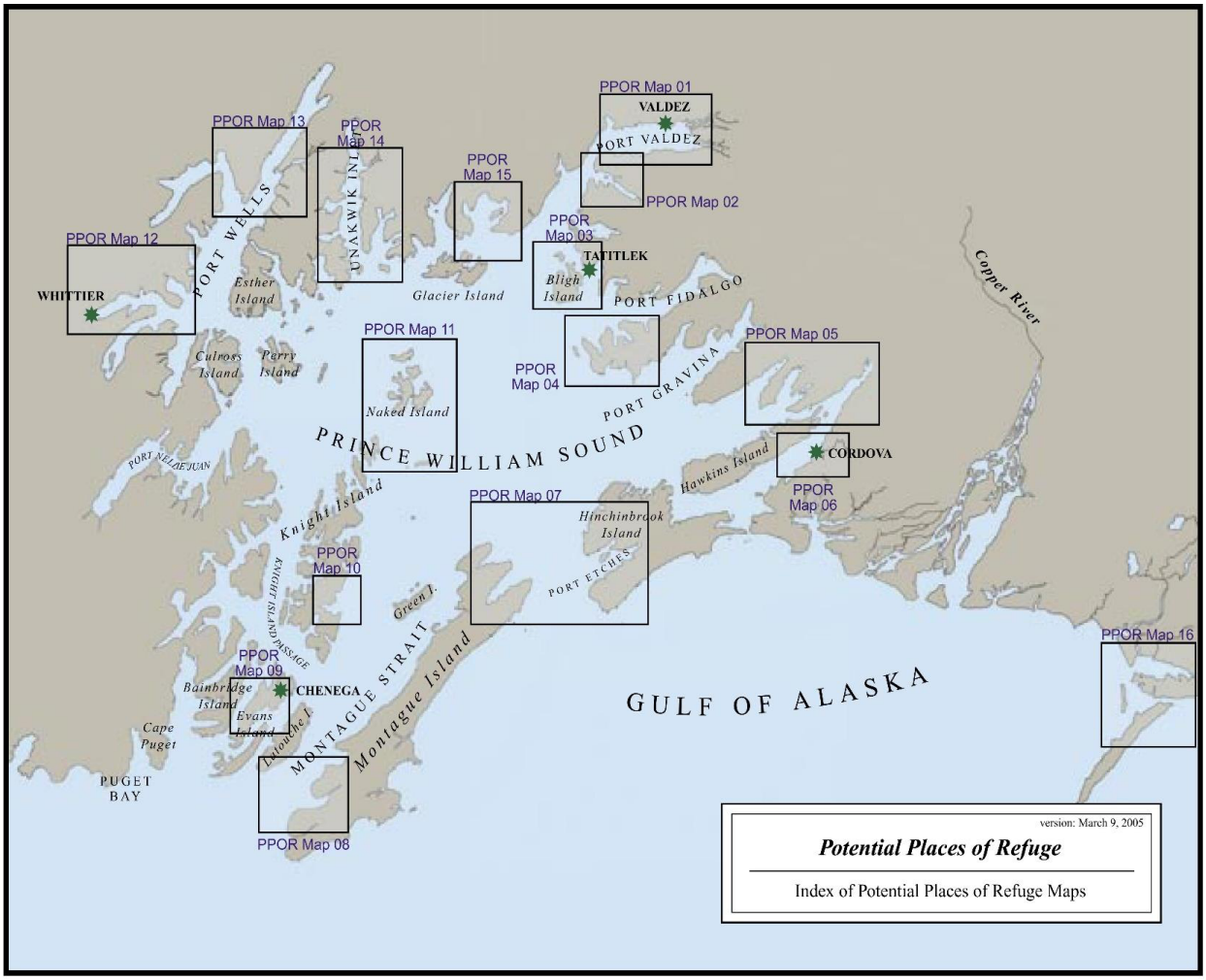

Figure 2. Index of PPOR Maps from PWS Contingency Plan (August 2018) page 263

Six of these PPOR pre-identified for deep draft vessels are outside the scope of this research because they are located in western PWS (PPOR Maps 8, 12, and 13) outside of the TSS traffic lanes for oil tankers. These are: Pigot Bay Anchorage, Whittier Cruise Ship Dock, Delong Pier, North College Fjord Anchorage, South College Fjord Anchorage, and MacLeod Harbor Anchorage. An additional six sites in PPOR Map 1 do not require research because they are already regularly utilized by oil tankers in Port Valdez and their limitations and capabilities are well known to pilots and shipmasters (Gold Creek Anchorage, Valdez Container Terminal, Valdez Marine Terminal Berths #1, #3, #4, and #5). In addition to these PPOR in Port Valdez, Knowles Head Anchorage in PPOR Map 4 is outside the scope of this research because it is currently used as an anchoring location for oil tankers. Knowles Head Anchorage and south of Knowles Head provide sufficient water depths of 15 to 26 fathoms, sufficient swing room for several ships at anchor, good holding ground with a mud bottom, and shelter from northerly weather. It is a safe location for oil tankers to use as a PPOR. Therefore, of the 21 pre-identified

PPOR, six are too far outside the traffic lanes for oil tankers and seven are known to be safe locations for oil tankers. The remaining eight PPOR that require research to evaluate whether they are safe for an oil tanker in distress are: North Smith Island, Outside Bay, McPherson Bay, North Jack Bay Anchorage, South Jack Bay Anchorage, Port Etches Anchorage, Port Etches Moorage, and Zaikof Bay Anchorage. These PPOR are described in Table 2.

Table 2. Description of PPOR by PWS Contingency Plan (August 2018)

PPOR ID Number	Map Number	PPOR Name	Latitude Longitude	Swing Room (feet)	Bottom Type	Wind Exposure
A 36	11	North Smith Island Anchorage	60 31.90 N 147 22.67 W	1,900	Mud	North
A 37	11	Outside Bay Anchorage	60 38.26 N 147 29.48 W	1,750	Mud	West
A 38	11	McPherson Bay Anchorage	60 40.65 N 147 21.79 W	1,750	Mud	Northwest
A 13	2	North Jack Bay Anchorage	61 02.41 N 146 37.30 W	1,200	Mud	East
A 14	2	South Jack Bay Anchorage	61 01.98 N 146 37.49 W	1,800	Mud	East
A 28	7	Port Etches Anchorage	60 20.59 N 146 33.84 W	2,300	Clay	East, West
M 30	7	Port Etches Moorage	60 20.39 N 146 33.20 W	2,300	NA	East, West
A 29	7	Zaikof Bay Anchorage	60 19.42 N 146 57.98 W	5,000	Mud	Northeast

For this research, these eight PPOR are divided into three geographic sections: Mid-Prince William Sound (Mid-PWS) including North Smith Island Anchorage, Outside Bay Anchorage, and McPherson Bay Anchorage; North-Prince William Sound (North-PWS) including North Jack Bay Anchorage and South Jack Bay Anchorage; and South-Prince William Sound (South-PWS) including Port Etches Anchorage, Port Etches Moorage, and Zaikof Bay Anchorage. Because of the large scope in number of PPOR, Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) and Safeguard Marine, LLC (SGM) agreed to divide the research into two studies. The first study evaluated PPOR in Mid-PWS (North Smith Island Anchorage, Outside Bay Anchorage, and McPherson Bay Anchorage) and was conducted in 2017. The second study evaluated PPOR in North-PWS (North Jack Bay Anchorage and South Jack Bay Anchorage) and South-PWS (Port Etches Anchorage, Port Etches Moorage, and Zaikof Bay Anchorage) and was conducted in 2019. This report includes both studies.

The 2017 study evaluating PPOR in Mid-PWS included 16 interviews with local subject matter experts and stakeholders as well as simulated maneuvers at the PPOR in Mid-PWS. The 2019 study evaluating PPOR in North-PWS and South-PWS consisted of only simulated maneuvers.

The 2019 study was informed by the interviews and simulated maneuver results from the first study.

The simulated maneuver methodology for the 2019 study is informed by the results of the 2017 study. This led to revising multiple factors to increase the explanatory power of the simulated maneuvers conducted in 2019. These revisions include reducing the number of variables such as vessel attributes and environmental conditions. The simulated maneuver research in the 2017 study was more exploratory compared to the 2019 study. The main revisions in the 2019 study were to only use loaded (rather than both ballast and loaded) vessel models representing oil tankers, as well as not varying visibility (compared to varying visibility based on distance, precipitation, and day/night conditions). Due to the number of variables, the 2017 study had more than 2,000 possible simulated maneuvers of which 34 were completed. In comparison by limiting the number of variables and categories of variables in the 2019 study, there were 40 possible simulated maneuvers and all 40 were completed.

The other main revisions in the 2019 study were to include recording additional information such as under keel clearance and difficulty of the maneuver, updating the available bollard pull on the tugboats assisting the vessels due to the 2018 change in tugboats (provided by SERVS), and increasing the listing on the vessels from 7 to 15 degrees. In the 2017 study the pilots were asked whether under keel clearance was sufficient, but in the 2019 study the distance was recorded in addition to asking the pilots whether it was sufficient. The listing of the vessel was also increased because it increases the visual resolution depicting a listing vessel in the simulator.

The results of both studies are valid and comparable. They are both used to draw conclusions and make recommendations about the PPOR in PWS. The program developed for how to carry out the simulated maneuvers were the same for both studies.

Simulated Maneuver Program

Simulated vessel maneuvers were conducted at the Alaska Maritime Training Center at AVTEC – Alaska's Institute of Technology in Seward, Alaska. Two Kongsberg Full Bridge Mission Maritime Simulators were utilized each with 300-degree visuals. These simulators have been certified by the USCG for instruction and training.

Simulated maneuvers were conducted in real time with the vessel starting approximately 0.5 miles from the latitude and longitude associated with each PPOR anchor or mooring location. The vessel's propulsion was disabled, its speed over the ground set to 3 knots, and two escort tugboats were attached at the bow and the stern of the vessel before the simulated maneuver began. The pilot utilized the forward momentum of the vessel and the two assist tugboats to pull and push the vessel to the previously identified PPOR. The pilot maneuvered the vessel as close as possible to the prescribed latitude and longitude position then when anchoring deployed an appropriate amount of anchor chain. The length of the anchor chain varied depending on multiple factors including the depth of the water and proximity to shallow waters or obstructions, as well as pilot discretion for the safety of the vessel.

The length of anchor chain deployed was measured in shots (1 shot = 90 feet) and ranged from 5 to 10 shots depending on various factors including the location and vessel. An important aspect of anchoring is scope. The scope of the anchor chain is the ratio of the amount of chain deployed at anchorage compared to the depth of water. Scope is determined by the following equation: scope = length of anchor chain / depth of water. Anchoring with appropriate scope for the specific location and situation is an important factor to maximize the holding power of the anchor gear. Anchor gear holds better when forces are horizontal because when strain increases, the anchor chain tends to lift off the bottom increasing the angle and reducing the holding power. Even a slight angle increase can result in significantly decreasing the holding power of an anchor. A 5-degree angle increase reduces holding power by 25 percent and a 15-degree angle increase reduces holding capability by 50 percent (Spencer, 2008). The optimum amount of scope is a function of several factors, including environmental conditions, length of time to remain at the anchor, bottom type, and swinging room for the vessel.

The length of anchor chain deployed, minus the depth of water, plus the length of the ship creates the swing room where the vessel may swing around the anchor depending upon environmental conditions. Oil tankers seeking refuge at a PPOR will deploy a significant amount of anchor chain to ensure that the vessel's anchor is secure and does not drag. Previous research suggests that the minimum scope required is 4:1 or 5:1, but the recommended scope ranges from 7:1 to as great as 10:1 (Burden, November 2018; Irons, 2013; McDowall, 2000; Spencer, 2008). SGM prescribed a scope of 5:1 or 6:1 for all simulated maneuvers involving anchoring. This was followed by the pilots, except for two maneuvers simulated at South Jack Bay Anchorage that used a 4:1 scope due to the prescribed anchor position being so close to the shoreline.

Once the pilot dropped the anchor or ordered for a mooring line to attach to a buoy and the pilot determined it was secure, the piloted part of the simulated maneuver was completed. This part of the simulated maneuver took approximately 15 minutes to complete. At this point, to better determine the ship position and swing room of the anchor or mooring line the simulation was sped up to 10 times normal speed for a total aggregate time of 60 minutes. This was done to help the pilot better understand the swing room at the PPOR, given the environmental conditions and vessel, after 60 minutes of time had expired. At this point the simulated maneuver was stopped and the pilot was debriefed using a screen captured image of the simulated maneuver.

4. INTERVIEW METHODOLOGY

The first step in the data collection to evaluate the PPOR for oil tankers in distress were 16 interviews with local subject matter experts as well as stakeholders during July and August 2016. The purpose of the interviews was to develop valid simulated maneuvers and to better understand the capabilities and concerns of pre-identified PPOR to provide refuge for oil tankers in distress. The focus of the interviews was on Mid-PWS including North Smith Island Anchorage, Outside Bay Anchorage, and McPherson Bay Anchorage, but some of the material also applies to the PPOR in the 2019 study. Interviews were conducted by SGM via the telephone and notes were taken by research assistants. The interview notes were then emailed to the interviewees to verify their accuracy and invite further comment. Individuals from the following organizations were interviewed: Southwest Alaska Pilots Association (SWAPA), Alaska Department of Environmental Conservation (ADEC), USCG, active and retired TAPS

industry members, active and retired TAPS ship captains, retired PWS assist tugboat operators, U.S. Department of Interior (US DOI), PWSRCAC members, previous PPOR work group facilitators, Alaska Department of Fish and Game (ADF&G), and National Oceanic and Atmospheric Administration (NOAA). These interviews are confidential as per human subjects' protocol, so identifiable information such as names or organizations are not associated with individual responses. Instead, responses are associated with a number such as "Respondent 1." This is the case except for the USCG, who requested that their written responses to interview questions explicitly be associated with the organization.

In addition to the formal interviews, five active and retired mariners involved with TAPS oil tanker shipping were also consulted in the development of the simulated maneuvers. These local subject matter experts provided feedback on the study and contributed important maritime perspective. This was not a formal interview, but rather provided background information.

5. INTERVIEW RESULTS

The key finding from the interviews was that the proposed simulated maneuvers were sufficient to determine the capability of oil tankers to utilize pre-identified PPOR in Mid-PWS (North Smith Island Anchorage, Outside Bay Anchorage, and McPherson Bay Anchorage). In addition, respondents agreed that members of SWAPA were appropriate experts for this research. Interviewees also provided important information about concerns and context regarding the PPOR that were assessed in the 2017 study. Interview responses are summarized in this section with interview questions in italics.

Question 1: Would you anticipate a stricken vessel to utilize the PPOR identified? If not, why?

Responses to this question were highly diverse. Five local subject matter experts as well as the TAPS individuals providing background information responded that they would *not* anticipate a stricken vessel to utilize North Smith Island Anchorage as a PPOR. The majority of respondents also responded "no" to using Outside Bay Anchorage and McPherson Bay Anchorage as a PPOR for an oil tanker in distress. Local subject matter experts gave various reasons for their rationale, including the concern that these locations provided minimal maneuvering room for an oil tanker, especially compared to the other designated anchorage sites in PWS in particular Knowles Head Anchorage (Respondents 1, 2, 5, 6, 8, and 13).

"Why would I risk my ship further by entering confined waters?" responded one interviewee, "the personnel aboard may be endangered if we were to flounder with restricted maneuverability in confined waters." Another interviewee stated that they did not anticipate vessels using any of the Mid-PWS PPOR (North Smith Island Anchorage, Outside Bay Anchorage, or McPherson Bay Anchorage) because they have "never been used before" and because Knowles Head Anchorage is "superior." Another respondent said they would "strive to make it to Knowles Head unless there is absolutely no chance of making it there. It's all [they] have ever known, and Knowles Head is the designated anchorage in PWS. Assist boat or no assist boat, [they] would avoid anchoring in bays of Naked Island or near Smith Island unless there is a pilot to assist. An anchorage area which is more open would be possible if there is no chance of getting to Knowles Head." Another respondent who answered "no" elaborated, "Outside Bay is the only one that

should be identified as a possible port of refuge for Mid-PWS." Finally, one respondent noted that they are "more in favor" of taking a vessel to Knowles Head Anchorage or further out into the ocean than a PPOR in order to avoid the spread of an oil spill; "unless a leak is severe, a PPOR should not be used."

In contrast, Respondents 9, 10, 11, 12, 14, 15, and 16 responded that they *did* expect the pre-identified PPOR to be used by an oil tanker in distress. The USCG summarized this sentiment by stating, **"**Yes, the PPOR list is the product of a significant amount of research and coordination with numerous involved agencies and stakeholders. There is a great deal of value in this information that mariners take very seriously and consult as a starting point for planning where to position a stricken vessel. Please bear in mind that there are a wide variety of factors (e.g., wind, seas, tide, currents, vessel condition, location, time of year, etc.) that the mariner would consider before deciding where and how to position a vessel, which might not be at a place identified as a PPOR."

Question 2: Can you recommend other PPOR that may be adequate for Mid-PWS that are not identified?

The majority of respondents stated that they did not have any alternative PPOR for Mid-PWS (Respondents 1, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, and 16). Knowles Head Anchorage was mentioned as a possibility; however, the site is already a PPOR and recognized as safe by mariners. Some respondents did mention alternative locations, such as the Two Arm Bay/Port Fidalgo, the area east of Goose Island in the old steam ship channel between Goose Island and Bligh Island, and a site south of Rocky Point. The USCG responded that, "At this time, [they] could not recommend a PPOR that isn't listed in the Prince William Sound Sub-Area Contingency Plan without discussing the decision with stakeholders and partner agencies…the PPOR identified in the [Contingency Plan] is a product of much research and stakeholder coordination. Additionally, the prevailing conditions (wind, seas, tide, currents, etc.) in the maritime environment are quite dynamic. Depending on the situation, the Coast Guard would coordinate with the same stakeholders/partner agencies to consider using a PPOR that is not listed in the [Contingency Plan]."

Question 3: Utilizing PPOR as portrayed within the attachment, do you foresee any difficulty maneuvering ships to any of the specific PPOR? If yes, please specify.

Three respondents did not foresee any difficulty maneuvering the ships into the PPOR (Respondents 1, 9, and 10), but most of the respondents stated that maneuverability would depend upon the circumstances of the specific situation, especially during high winds (Respondents 2, 3, 4, 5, 6, 7, 8, and 13). One respondent stated they "do not foresee difficulty at low wind speed, but [they] do see a variety of difficulty at high wind speed due to a variety of environmental factors. This all depends on the causality of the ship." Another respondent also noted that North Smith Island is "a little close for comfort" to jagged rocks. The USCG summarized the majority of respondent sentiment by stating that maneuverability depends on a number of factors including but not limited to the weather conditions at the time of the incident, and vessel propulsion and/or steering capabilities.

Question 4: If a ship required grounding to prevent sinking, which of the PPOR would be recommended?

The majority of respondents stated that North Smith Island Anchorage should not be recommended for possible grounding but did endorse the possibility of grounding at Outside Bay Anchorage or McPherson Bay Anchorage. One respondent noted that North Smith Island Anchorage would "not work" for this scenario. The other two sites were mentioned as possibilities for grounding, depending on the specific situation at the time. Utilizing Outside Bay Anchorage was recommended, as long as the vessel was moved "further to the south of the designated PPOR site" (Respondents 1, 3, 5, 9, and 10). One respondent wanted to know if the vessel would be loaded or ballast, but reflected that, either way, the vessel should likely "shoot for the south portion PPOR 2 (Outside Bay Anchorage)." This respondent also said that context, such as environmental conditions, could "effect their answer." Another respondent stated that Outside Bay Anchorage could be feasible, as long as the vessel is "pushed further in." Respondents 2, 3, 5, 6, 8, and 10 mentioned the possibility of grounding a stricken vessel in McPherson Bay Anchorage, particularly on the south end because it "provides the most shelter" and could most effectively contain an oil spill.

Overwhelmingly, respondents reflected that a grounding decision must consider an array of conditional factors and that a PPOR in "lee of the wind and weather" would be preferable. Put most comprehensively by the USCG, "wind, seas, current and tides would impact the decision. In addition, time of year, presence of protected or endangered species, and spawning, nesting, migratory patterns of mammals, fish, birds, and other wildlife would have to be considered when making this critical decision. It should be noted that information would be sought from US DOI/NOAA/ADF&G/NMFS [National Marine Fisheries Services] regarding all of the above concerns to assist with the PPOR decision."

Question 5: Which ship type or casualty type do you think simulations should be concentrated upon to best determine the capability of the selected PPOR to provide adequate refuge?

The majority of all the respondents desired that the simulations model anchoring a holed oil tanker or a disabled oil tanker in a variety of environmental conditions. Respondents particularly encouraged simulations of vessels "involved in a collision or holed in any way," vessels experiencing a "loss of power and loss of steering," and vessels with a "gash across the side or bottom of a ship in which a leak would be fast moving and destabilizing, thus forcing the ship to run aground." Respondents 4, 5, 6, 8, 9, 10, 11, and 13 all stated that the most common casualty type would be a disabled oil tanker and should thus be a focal point of the simulations. Respondents 3, 4, 5, 6, 7, 8, 9, 10, and 11 also stated that they would like to simulate a "total failure in which towing is required to get a ship into a PPOR."

Question 6: In the simulations at Mid-PWS, we will be comparing single propeller with twin propeller capabilities, what do you expect will be the results?

A vast majority of respondents stated that vessels with two propellers will have more maneuverability than single propeller because of redundancy and the availability of one propeller for maneuvering. One respondent expected "superior maneuvering capability" from twin

propellers, noting that redundancy is helpful if one propeller becomes dysfunctional. Other respondents echoed this sentiment stating, "with two propellers, losing one would still mean that one would be operational because of redundancy" and "twin propellers result in fewer issues because one is still useable in the event of the failure of the other." Respondents 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, and 13 all expected twin propeller capabilities to have a higher success rate of reaching the PPOR in simulations.

Question 7: Do you believe that more than two assist tugboats will be required to maneuver any of the stricken vessels being simulated into the identified PPOR? What about during high wind conditions?

The majority of all respondents believed that a third tugboat assist should be available, depending on mariner input, and that they would wait for sufficient tugboat assist prior to entering a PPOR. Many respondents believed that larger sized tankers were more likely to require three tugboats, just as they require three tugboats for maneuvering at the Valdez Marine Terminal. One interviewee responded that more than two tugboats would "not be required" for a ship of smaller size, but that three tugboats should be used for larger ships, especially for "higher winds or large laden ships." Another respondent stated that three tugboats should be used for "anything over 150,000 tons." Participants repeatedly stated that the mariners directly involved in the process should determine the number of tugboats. One interviewee noted that the power of the vessels is a big deciding factor, considering that "sometimes more tugboats can get in the way." Mariners also reflected that the need and number of tugboats assisting depends on whether the vessel is loaded or ballast. Regardless, one interviewee encouraged "a lot of sail" in either of these situations. Some respondents also considered currents and requested that the most extreme current situations be simulated. Respondents 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11 wished to see a simulation in which two tugboats are used until they fail, in order to see if a third is needed.

Question 8: Based upon the category of high wind direction and velocity would you recommend a stricken ship not use any of the identified PPOR to be simulated?

Multiple respondents recommended not using any of the identified PPOR during high winds (Respondents 1, 2, 6, 8, and 13). Among their comments, respondents stated that "none of the PPOR are to be used in high wind" and that "any ship not under tight control should stay in the traffic lane or head to Knowles Head Anchorage rather than use any of the three PPOR." North Smith Island Anchorage was specifically identified by respondents 3, 5, 7, and 13 as being problematic during high winds because of the site's close proximity to rocks and limited swinging room. Respondents described North Smith Island Anchorage as being "inadequate," "not recommended in high wind situations," and having high "general exposure to the elements."

Question 9: Depicted winds for specific PPOR result in windward shoreline anchoring. Is this appropriate or should alternative PPOR or leeward shoreline be utilized?

The majority of respondents stated that windward shoreline anchoring would be undesirable and recommend instead that the leeward shoreline should be utilized. Respondents described the windward shore as "inappropriate" and overwhelmingly recommended that leeward anchoring "always be used" (Respondents 1, 2, 5, 6, 7, 8, 9, 10, 11, and 13). One respondent elaborated to

say that shoreline anchoring depends on level of control, but that a windward shoreline is "not recommendable either way."

Other respondents answered that a specific PPOR, North Smith Island Anchorage, is inadequate. One respondent reflected, "a PPOR needs to be a place where a ship can be anchored safely with minimal damage. In light of this, North Smith Island Anchorage is unacceptable." One interviewee requested a survey of the bottom be completed to determine the anchoring capabilities of each PPOR.

Question 10: Do you have any specific simulations you wish to see performed based upon the specific three proposed PPOR?

Many of the respondents did not identify specific simulated maneuvers. Some respondents requested that the vessel conditions of sinking ships that require grounding be analyzed (Respondents 3, 6, and 8). One of these respondents reflected that, though they would like to see a sinking ship grounded in McPherson Bay Anchorage, they were skeptical that "any of the PPOR would be used in reality." That being stated, the respondent expressed a strong interest in knowing how and where to ground a ship if an emergency situation were to occur. The only specific recommendations were simulations in which the whole length of a ship's side is open, and a situation in which a rudder is jammed hard over.

Question 11: Based upon information provided, do you have any input concerning best practices to be performed during simulations?

Respondents answered with various recommendations, ranging from specific environmental conditions to the type of causality for ships and the number and types of tugboats utilized. Regarding environmental conditions, respondents requested "higher winds and reduced visibility as a result of conditions such as severe fog and other environmental factors" and grounding in a "variety of conditions." Many respondents also commented on casualty type for ships, with requests to simulate the "most extreme conditions" and a "variety of casualties" involving a sinking ship. One respondent suggested the possibility of a ship on fire or a vessel influenced by an act of terrorism that may cause marine casualties. The respondent reflected that these "out of the box situations" are exactly the situations in which a Contingency Plan is used. Finally, regarding tugboats, respondents reflected that if a vessel was truly stricken "all tugboats in the area not otherwise engaged would come to help anyway." Another interviewee requested that the study include "three yellow boats and no conventional tugboats."

Additional questions for regional stakeholders

Many of the questions previously noted focused on developing valid simulation maneuvers that could best be addressed by local subject manner experts. Therefore, in addition to these questions concerning simulation maneuvers, stakeholder organizations listed as participating in the development of the PWS Contingency Plan (August 2018) were asked the following additional questions. These groups included US DOI, NOAA, ADEC, ADF&G, and PWSRCAC.

What is the role of your agency in relation to PPOR?

All five respondents provided concise answers concerning their agency's involvement in determining PPOR for stricken vessels. Emphasis was placed upon the term "possible" places of refuge, stipulating that any place may be designated as a PPOR depending on the specific situation and pertinent circumstances. One respondent summarized this point by emphasizing, "the actual location of a PPOR is not limited to the pre-identified PPOR listed in the Contingency Plan. The pre-identified sites are *potential*, not predesignated, and the Unified Command is not bound to use a pre-identified location in the case of an emergency."

Each respondent stated that multiple agencies would be involved and consulted prior to the designated place of refuge being determined in the case of an oil tanker in distress. These agencies include ADF&G, NOAA, U.S. Forest Service, citizens' advisory councils, Native corporation(s), and federally recognized tribes in the area, as well as USCG and ADEC. ADEC works with the USCG COTP and resource trustees to "determine the sensitivity of a proposed PPOR location with regards to impacts on the environment, wildlife, local, cultural, and the economy." If a spill was to occur, the environmental unit of the unified planning command would "invite [resource trustees] to review PPOR closely, and comment/recommend sites for minimal environmental damage." In the event of an emergency, the state onsite coordinator works with the USCG COTP to "determine the specific needs of the incident, such as the safety of the crew, safety of the vessel, state of the vessel, and what activities will need to take place in the PPOR to address the problem." Another respondent seconded this sentiment noting, "the state onsite coordinator is very involved with the Captain of the Port to determine these needs and to weigh them against the environmental, cultural, and economic sensitivities of the area."

Ultimately, each respondent identified the Unified Command as the highest authority in determining a PPOR. "All PPOR are in state waters," states one respondent, "and ultimately the Unified Command has the final decision on where a vessel should go in the case of an emergency." Another respondent reflected that "under international maritime law, the Captain of the Port has the authority to direct a vessel operating in their area of responsibility to go anywhere in their jurisdiction…ultimately, the state onsite coordinator supports the Captain of the Port's decision to relocate a vessel to the determined location." While one respondent expressed interest in a process whereby marine mammal and habitat experts could conduct an in-depth review of various alternative PPOR prior to a spill event, the agency can only "logistically assess a handful of PPOR at a time." Therefore, agencies await consultation from the Unified Command in an emergency and provide information on the "many variables" impacting where a vessel should seek refuge.

In terms of research, what should SGM focus on from a maritime standpoint? What information would you like to see in SGM's final report?

One respondent provided specific maritime conditions they wished to be researched, which included loss of power, reduced maneuverability, and hull damage to a vessel that results in hull and/or cargo space flooding. Two respondents wished to see a focus on the environmental impacts of specific PPOR. One respondent stated, "the environmental implications are extremely important and, though they may not be simulated in this project, they should be considered in

assessing the PPOR." This respondent also suggested that environmental issues be considered by involving the various natural and cultural specialist organizations in research interviews. When determining PPOR, pre-identified or otherwise, one respondent noted that it is important to assess known consistent pinniped haul out and rookery haul outs for harbor seals and critical habitat and rookeries for stellar sea lions. Additionally, the agencies that oversee federal fisheries should be consulted to ensure they are protected.

Respondents also focused on the process for determining a PPOR in an emergency situation. One respondent stressed that the Alaska Unified Plan has "Places of Refuge Guidelines" that outline the process for determining where a vessel seeks refuge. There are pre-identified places, but depending on the vessel, product, time of year, operational needs, and other conditions, a vessel may consider a place that is not on the pre-identified list. The respondent acknowledged that this planning process may be outside the scope of this project, but that the process for identifying a place of refuge— pre-identified or not—should also be considered when discussing PPOR in PWS. This respondent offered to provide environmental information for the simulations and emphasized that it would be helpful to have a summary of the criteria for deciding a PPOR. In real events, the respondent noted that sometimes a place that is not listed on the pre-identified list of PPOR may be the most environmentally safe and reasonable PPOR. There are also different levels and priorities of critical habitat, which would be considered in-depth during the unified planning process.

Respondents varied in their opinions on the importance of vessel maneuverability and docking feasibility in determining a PPOR. For example, one respondent noted that "some PPOR are chosen almost exclusively for their protective environmental factors, such as natural wind shelter, etc." and another stated that "the original process for determining pre-identified PPOR started from a feasibility perspective and then expanded to consider environmental implications through the involvement of natural and cultural resource specialist agencies." This suggests that the vessel's maneuverability is thoroughly considered when determining a PPOR and was at the forefront of the process at its inception.

However, a different respondent noted, "though the simulations have various vessel configurations, redundant propulsion systems, redundant steering, etc., there is no discussion of how those variables would impact a PPOR in the PPOR guidelines." In this sense, the respondent indicated that the simulations evaluating maneuvering an oil tanker in distress may not be a valid way to evaluate a PPOR because the condition of the ship was not considered when the PPOR were first identified. However, the PPOR were identified specifically for vessels in distress. The majority of respondents, including the USCG, stated that using simulated maneuvers of an oil tanker in distress anchoring at a PPOR *is* an important factor for evaluating and determining a PPOR (see response to question three). This specific respondent also questioned why the simulated maneuvers were utilizing assist tugboats, because assist tugboats are only available in Cook Inlet and PWS. "The concept of an assist vessel is unique to PWS and the Cook Inlet," said the respondent. The scope of the research is limited to PWS and tugboats assist are available to oil tankers in PWS, so it is not clear what the respondent was referencing.

Do you have any additional context or information about the PPOR you would like to include? Do you have any additional comments or questions that we should be aware of?

Each respondent reflected on the process for determining PPOR under the Unified Plan and emphasized the importance of considering environmental implications in this process. Respondents consistently emphasized that, though the Unified Plan lists *potential* places of refuge, vessels are not limited to these specific locations. "The Alaska Unified Plan Places of Refuge is a process [stating that] a vessel may not use a pre-identified PPOR [unless] if circumstances warrant an exception." Ultimately, the Subarea Committee drives and determines the PPOR for a region. "The damage, timing, and accessibility of the situation all factor into the determination of where you should go to have a safe fix," concluded one respondent. Interviewees also consistently referenced the environmental implications of utilizing a PPOR. "The environmental impact should be a strong consideration when assessing PPOR in the region," stated one respondent and another was "happy to hear" that multiple agencies were consulted in this process, especially state and federal agencies operating in PWS. One respondent encouraged a "public and agency review of the PPOR determination process" to ensure that all relevant variables are considered when identifying PPOR.

6. SIMULATED MANEUVER METHODOLOGY FROM 2017 STUDY

The simulated maneuvers evaluating the PPOR at Mid-PWS (North Smith Island Anchorage, Outside Bay Anchorage, and McPherson Bay Anchorage) were conducted on October 14 – 15, 2016. They included the following variables: (1) three PPOR with corresponding prescribed anchor locations by latitude and longitude, bottom types, and prevailing wind directions with maximum sustained wind velocities; (2) six vessels representing a range of oil tankers currently operating at TAPS including both ballast and loaded; (3) vessels under various conditions of damage to the hull of the vessel as some were listing seven degrees to port and others were not; (4) day and night conditions; (5) variations in precipitation including none, rain, and snow; (6) variation in distance of visibility including 1, 3, 7, and 10 miles; (7) one knot ebb and flood currents; and (8) the three vessels with twin screw capability having one propeller and rudder available or not. All of these variables meant that there were over 2,000 possible maneuvers to simulate. This does not take into account the fact that two different SWAPA pilots took part in the study or that two different simulator operators were operating the vector tugboats. Therefore, due to the number of variables and categories the simulated research conducted was exploratory, but representative of the most difficult maneuvers in relation to oil tankers in distress at the three PPOR in Mid-PWS and verified by the interviews.

Potential Places of Refuge

The scope of the 2017 study are the Mid-PWS PPOR: (1) North Smith Island Anchorage, (2) Outside Bay Anchorage, and (3) McPherson Bay Anchorage. Each PPOR has a specific latitude and longitude in terms of anchoring position. However, during the study, the specific latitude and longitude position for North Smith Island Anchorage was immediately found to be insufficient for the safety of an oil tanker to anchor. Therefore, SGM identified an alternative latitude and longitude anchoring position at the PPOR. The PPOR latitude and longitude, SGM revised

latitude and longitude position, and the corresponding number of simulations completed at each PPOR are presented in Table 3.

Table 3. PPOR, Latitude and Longitude, and Number of Simulations Completed

PPOR Name	Latitude Longitude	Notes	#Simulations
North Smith Island	60 31.90 N 147 22.67 W		6
North Smith Island	60 31.31 N 147 24.22 W	SGM Revised	8
Outside Bay	60 38.26 N 147 29.48 W		10
McPherson Bay	60 40.65 N 147 21.79 W		10

Vessels Simulated

Vessel models utilized for the simulated maneuvers were representative of the tankers operating at TAPS in 2016. Approximately 14 tank vessels operated at TAPS in 2016, ranging in overall length from 600 to 941 feet with deadweight tonnage from 46,000 to more than 200,000 metric tons. Tankers were operated by four different companies, each with different class, size, and number of ships as represented in Table 4.

Table 4. TAPS Vessel Operators and approximate deadweight of oil tankers in 2016

Polar Tankers	Overseas Group	Alaska Tanker Company	SeaRiver
141,000 deadweight	60,000 deadweight	195,000 deadweight	115,000 deadweight
Adventurer	*Boston*	*Alaskan Explorer*	*Eagle Bay*
Endeavour	*Nikiski*	*Alaskan Navigator*	*Liberty Bay*
Resolution	*Martinez*	*Alaskan Legend*	
Enterprise		*Alaskan Frontier*	
Discovery			

Vessel models representing TAPS tankers were selected from the AVTEC library based upon having similar physical dimensions and block coefficients to the actual TAPS tankers. Ballast and loaded models were selected to represent SeaRiver and Polar oil tankers, while only a loaded model was used to Overseas Group and only a ballast model for Alaska Tanker Company (ATC). The interviews verified these as valid representations. Physical dimensions and characteristics of the actual vessels and models are listed in Table 5 along with the number of simulations conducted. The ATC vessel has dual propellers and rudders, but the tank vessel model available at AVTEC closest in physical dimensions only had one propeller and rudder. Therefore, to simulate the loss of one rudder and propeller on the ATC vessel, an LNG Carrier model was used (Q Flex GAS06L) that had similar LOA and the same draft and beam and also had two propellers and rudders.

Table 5. Description of Vessels, Vessel Models in Italics, and # of Simulations

Model / Ship	LOA (feet)	Beam (feet)	Draft (feet)	Displacement (tons)	# Props & Rudders	#Sims
Overseas Group Loaded	601	105	43	59,000	One	
PRODCo7L	*600*	*105*	*44*	*64,330*	*One*	3
Sea River Ballast	823	144	28	61,000	One	
VLCC14B	*820*	*144*	*28*	*61,320*	*One*	3
Sea River Loaded	823	144	49	134,352	One	
VLCC14L	*820*	*144*	*49*	*133,900*	*One*	8
Polar Tanker Ballast	892	151	30	68,000	Two	
VLCC15B	*859*	*138*	*27*	*60,000*	*Two*	3
Polar Tanker Loaded	892	151	50	160,000	Two	
VLCC15L	*859*	*138*	*49*	*153,100*	*Two*	7
ATC Ballast	941	164	36	90,000	Two	
Q FLEX GAS06L	*1,033*	*164*	*36*	*142,700*	*Two*	7
ATC Ballast	941	164	36	90,000	Two	
VLCC05B	960	143	*36*	92,960	*One*	3

Assist Tugboats

Each vessel had two tugboats assisting it that were simulated as vector tugboats meaning that they were operated by a simulator operator. The pilot would radio orders to the simulator operator to push and pull the vessel into position using the tugboats. The tugboat model includes an azimuth drive of approximately 10,000 horsepower with 150 tons of bollard pull. The dimensions of this model are: length 140 feet, beam 41 feet, and draft 16 feet. Tugboat models were representative of tugboats utilized by SERVS in 2016. The tonnage applied for vector tugboats was reduced by 15% to be more realistic as well as provide a safety factor.

Table 6. Horsepower for Vector Tugboats

Tug Order	150 Ton Assist Tugboat	15% Applied Power
Hang	15 tons	13 Tons
Dead Slow	22 Tons	19 Tons
Slow / Easy	38 Tons	32 Tons
Half	75 Tons	64 Tons
Two Third	100 Tons	85 Tons
Full	150 Tons	128 Tons

Wind Direction and Velocity

Multiple studies have assembled and analyzed the meteorological and oceanographic data in PWS, so that oil shipping corporations may "identify those environmental and operational conditions that limit the effectiveness of the chosen response tactics in the event of an oil spill in PWS" (Kumar and Gray, January 2007). PWSRCAC provided wind information to SGM to

conduct this research from the Alaska Experimental Forecast Facility. All simulated maneuvers were conducted using the highest sustained winds and predominant wind direction for the PPOR. A summary of the wind direction and velocity for each PPOR in Mid-PWS is shown in Table 7.

Table 7. Overview of Wind Direction and Velocity at Each PPOR

PPOR	Sustained Wind Direction	Sustained Wind Velocity
North Smith Island	East (105)	30 knots
Outside Bay	East (106)	34 knots
McPherson Bay	East (111)	36 knots

Note: These winds were used for all simulations except for one at Outside Bay that was conducted using a Low Wind. The Low Wind was at 4 knots from the Northeast (055). All wind information came from the Alaska Experimental Forecast Facility.

Current

PWS current is insignificant in comparison to other regions in Alaska. One knot of current was utilized for all simulations, either flooding or ebbing depending on the specific simulation. One knot of current would be considered an insignificant force for southcentral maritime operators, however this current vector resulted in creating a force which required compensation for deeply laden tankers.

Personnel

SGM coordinated with SWAPA to utilize two current pilots for this research. The two pilots were Captain Peter Garay, who was President of SWAPA in 2016, and Captain Jeff Pierce, who is President of SGM. Each pilot completed at least three simulated maneuvers at each PPOR. Captain Garay completed 18 simulated maneuvers while Captain Pierce completed 16 simulated maneuvers. SGM Vice President Jonathan Pierce, Ph.D., was in charge of designing and executing the simulation maneuver program as well as undertaking the assessment. SGM utilized a research assistant to help in executing the assessment. Furthermore, AVTEC provided two simulator operators to ensure the simulator ran properly and to operate the vector tugboats.

Table 8. Personnel Participating in Vessel Simulations

Name	Role	Organization Affiliation
Captain Peter Garay	Pilot	SWAPA
Captain Jeff Pierce	Pilot	SWAPA / SGM
Mike Angove	Simulator Engineer	AVTEC
Rob Chadwell	Simulator Operator	AVTEC
Jonathan Pierce, Ph.D.	Simulator Director	SGM
Katherine Hicks	Research Assistant	SGM

7. SIMULATED MANEUVER RESULTS FROM 2017 STUDY

Simulated maneuvers were conducted under various conditions including day or night, precipitation (none, snow, rain), visibility in miles (1, 3, 7, and 10), and 1-knot flood and ebb currents. However, the pilots reported that none of these conditions had a consistent significant effect on maneuvering the vessel. This is in large part because the simulated maneuver began 0.5 miles from the anchor location with the vessel under three knots headway when it lost power and had two assists tugboats already tethered. Therefore, a 1-knot current, limited visibility, or other variations in weather and daylight conditions did not have an effect on maneuvering the vessel to the prescribed latitude and longitude associated with each PPOR. In the 2019 study these variations in environmental conditions were either removed or held static.

After each simulation the pilots were asked a series of questions. These questions were used to determine the validity of the simulated maneuver; effects of tugboats, engine failure, and listing had on maneuvering the vessel; and most importantly evaluating the safety of the PPOR based on whether the anchor position provided safe refuge for the disabled oil tanker and whether there was adequate swing room to maintain the position.

On the question of the validity of the simulation, the pilots reported 100% yes (34/34), the simulated maneuver was realistic. On the question of whether the assist tugboats were adequate to maneuver the vessel, the pilots reported 100% yes (34/34), the tugboats were adequate. During 13 of 34 simulated maneuvers the vessel was listed by 7 degrees to simulate a damaged vessel. These ranged from a low of two maneuvers at the original North Smith Island Anchorage location to a high of four at both the Outside Bay Anchorage and McPherson Bay Anchorage. On the question of whether listing the ship effected the maneuverability of the vessel, the pilots reported 100% yes (13/13), the maneuverability of the vessel was impaired. For 17 of 34 simulated maneuvers the vessel model had twin rudders and propellers experience a starboard rudder and propeller failure meaning that the port side remained operational. When asked whether the availability of the port side rudder and propeller provided greater maneuverability the response was 94% yes (16/17). The responses were the same, 94% yes (16/17), for the similar question of whether having a rudder and engine available reduced the risk when maneuver a disabled ship. Therefore, we concluded that the simulated maneuvers were valid; that two 150-ton bollard pull tugboats were adequate; and that whether a vessel was listing and whether it had available an engine and rudder had an effect on the vessel's maneuverability.

The evaluation of the safety of each PPOR is organized by the specific PPOR in this section. Evaluating the safety of each PPOR depends on three observations made by the pilot. First, pilots were asked whether or not the prescribed anchor position provided safe refuge for the disabled vessel (yes/no). Second, whether there was sufficient swing room for the vessel once anchored (yes/no). Third, the level of concern for safety of the vessel reported by the pilot on a scale from 1 (not at all concerned) to 5 (extremely concerned).

North Smith Island Anchorage

North Smith Island is located 6 miles south of Naked Island, 10 miles west of the ship traffic lanes, and approximately 4 miles east of Knight Island. Montague Point is 11 miles south

southeast of Smith Island and provides minimal protection from North Pacific weather encroaching through Hinchinbrook Entrance. Smith Island is about 3 miles long, lays in an east northeast direction, and is surrounded by rocks close to the shore lines. Water depth drops off rapidly offshore from the island after a minimal width of shallow water contours close to the island. Shoal water extends from the eastern tip of the island in an easterly direction for about a mile. Small vessels may find adequate anchorage areas close to the shore lines.

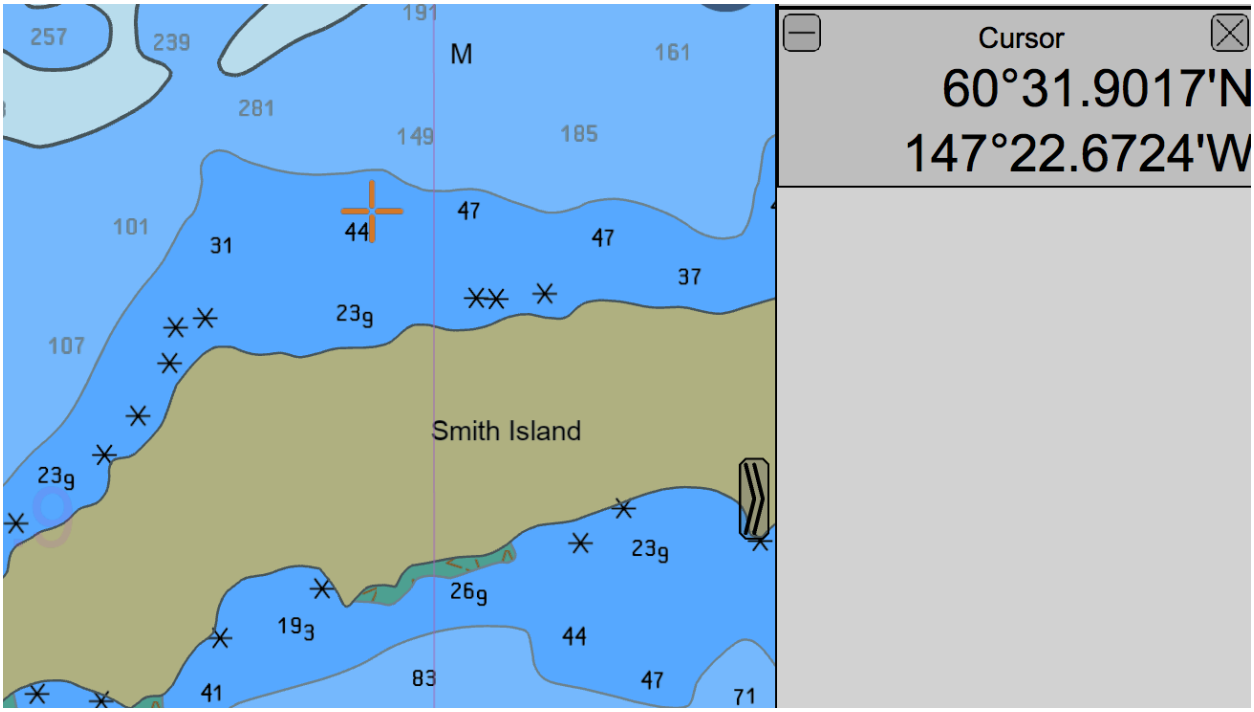

Figure 3. North Smith Island Anchorage, Anchor Position, 60 31.90 N 147 22.67 W

According to the PWS Contingency Plan (August 2018), North Smith Island Anchorage's anchor position is at 60 31.90 N 147 22.67 W. The simulation began with the vessel at heading 090 with a headway of 3 knots, 0.5 miles west of the anchor position. The wind was from the east (105 degrees) at 30 knots. The post simulation interviews concerning this specific location were very negative and unanimously had a high concern for safety of oil tankers utilizing the site as a PPOR. Participants noted that their vessels "went aground" when approaching the anchor position with a loaded ship. Another post simulation interview concluded that the anchoring maneuvers were "going fine" until the vessel ran aground because there was "not enough water at the location." Finally, the pilots stated in the post simulation interview that mariners should "not go near Smith Island" and that the site should not have been selected because there is "not enough water for these size ships."

Table 9. Simulated Maneuver Results for North Smith Island Anchorage, Anchor Position 60 31.90 N 147 22.67 W, (number of observations or n =6)

Vessel	Prop & Rudder Available	Listing	Safe Refuge	Swing Room	Concern for Safety
Overseas Group Loaded (PRODC07L)	No	No	No	No	5
SeaRiver Loaded (VLCC14L)	No	Yes	No	No	5
SeaRiver Loaded (VLCC14L)	No	No	No	No	5
SeaRiver Loaded (VLCC14L)	No	No	No	No	5
Polar Tanker Loaded (VLCC15L)	Yes	No	No	No	5
ATC Ballast (GAS06L)	Yes	No	No	No	5

Six simulated maneuvers were conducted at this location utilizing four different loaded vessel models. During two of the simulated maneuvers the vessel had a propeller and rudder available and for only one of the simulated maneuvers was the vessel listing. All six of the simulated maneuvers at this location resulted in the vessel grounding. Furthermore, for all six simulated maneuvers the swing room was not sufficient and the concern for safety was extremely concerned (5).

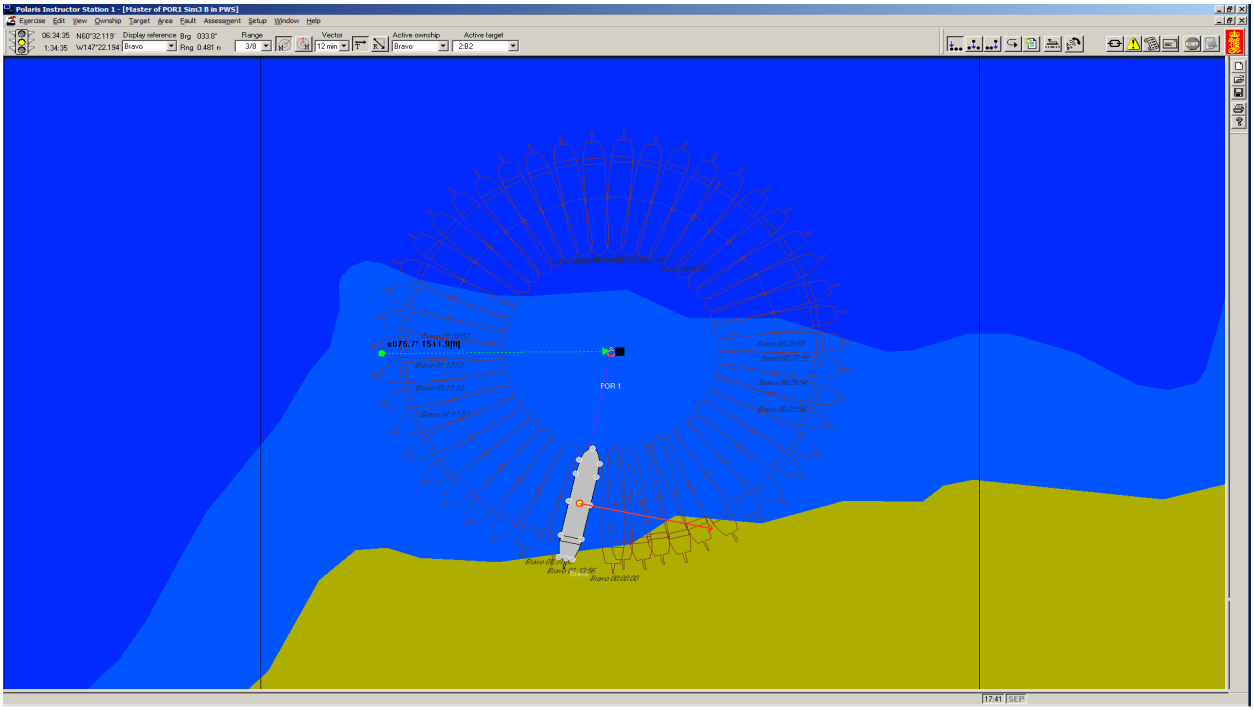

Figure 4. 360-Degree Anchor Swing at North Smith Island Anchorage, Anchor Position 60 31.90 N 147 22.67 W

To test the swing room of the PPOR, a 360-degree spin of a vessel at the anchor location was completed. This was done using the Overseas Group Loaded (PRODC07L) vessel model (LOA 600 feet, draft 43 feet) with 8 shots of anchor at a 5:1 scope. Figure 4 is a screenshot of the result. It indicates that the vessel ran aground. Therefore, the North Smith Island Anchorage at

the anchor position of 60 31.90 N 147 22.67 W is not a safe location for a deep draft disabled oil tanker to use as a PPOR.

Due to the repeated groundings of vessels at the North Smith Island Anchorage, SGM identified an alternative anchor location near North Smith Island to evaluate. This alternative location is at 60 32.31 N 147 24.22 W. This location provides about 150 feet of water depth and approximately 3,000 feet of swing room. The vessel heading was 090 with 3 knots headway. The wind was east (105 degrees) at 30 knots.

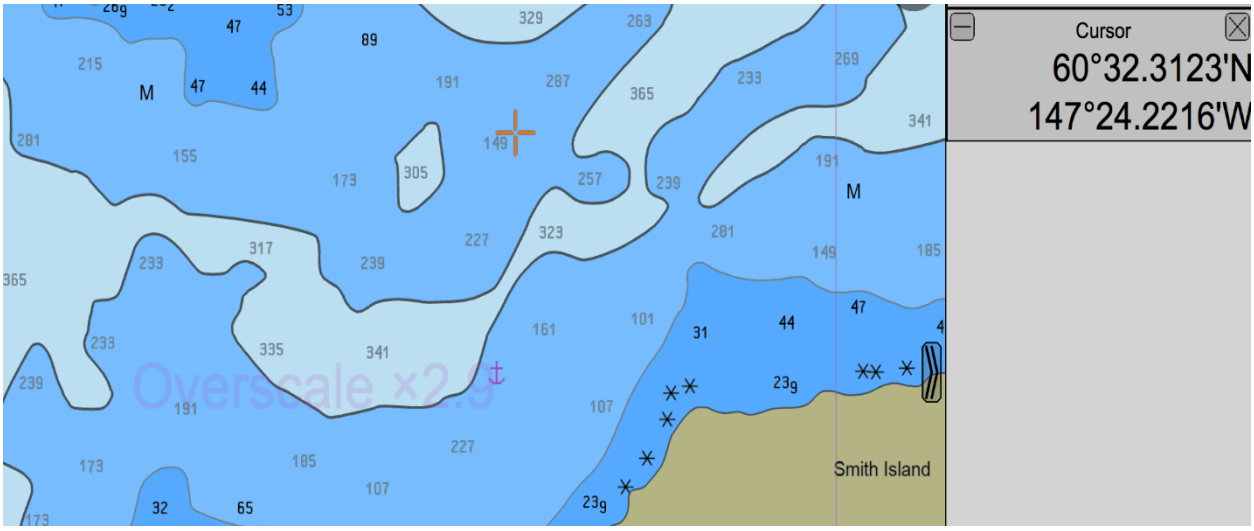

Figure 5. North Smith Island Anchorage, SGM Alternative Anchor Position, 60 32.31 N 147 24.22 W

Table 10. Simulated Maneuver Results for North Smith Island Anchorage, SGM Alternative Anchor Position 60 32.31 N 147 24.22 W, (n=8)

Vessel	Prop & Rudder Available	Listing	Safe Refuge	Swing Room	Concern for Safety
SeaRiver Ballast (VLCC14B)	No	Yes	Yes	Yes	1
SeaRiver Loaded (VLCC14L)	No	No	Yes	Yes	2
Polar Tanker Ballast (VLCC15B)	Yes	Yes	Yes	Yes	2
Polar Tanker Loaded (VLCC15L)	Yes	Yes	Yes	Yes	1
Polar Tanker Loaded (VLCC15L)	Yes	No	Yes	Yes	2
ATC Ballast (GAS06L)	Yes	No	Yes	Yes	2
ATC Ballast (GAS06L)	Yes	No	Yes	Yes	2
ATC Ballast (VLCC05B)	No	No	Yes	Yes	1

Eight simulated maneuvers were conducted at this alternative anchor location. These included testing both ballast and loaded SeaRiver and Polar tankers and the two ballast ATC models. Three of the vessel models were listing and five had a propeller and rudder available. Pilots reported that all of the simulated maneuvers resulted in a position that was a safe refuge. The pilots also reported that the swing room was sufficient for all eight simulated maneuvers. The

concern for the safety of the vessel ranged from 1 (not at all) to 2 (slightly concerned). However, while the anchor position may seem safe it was found to be problematic due to its potential exposure to environmental conditions and difficult anchor location.

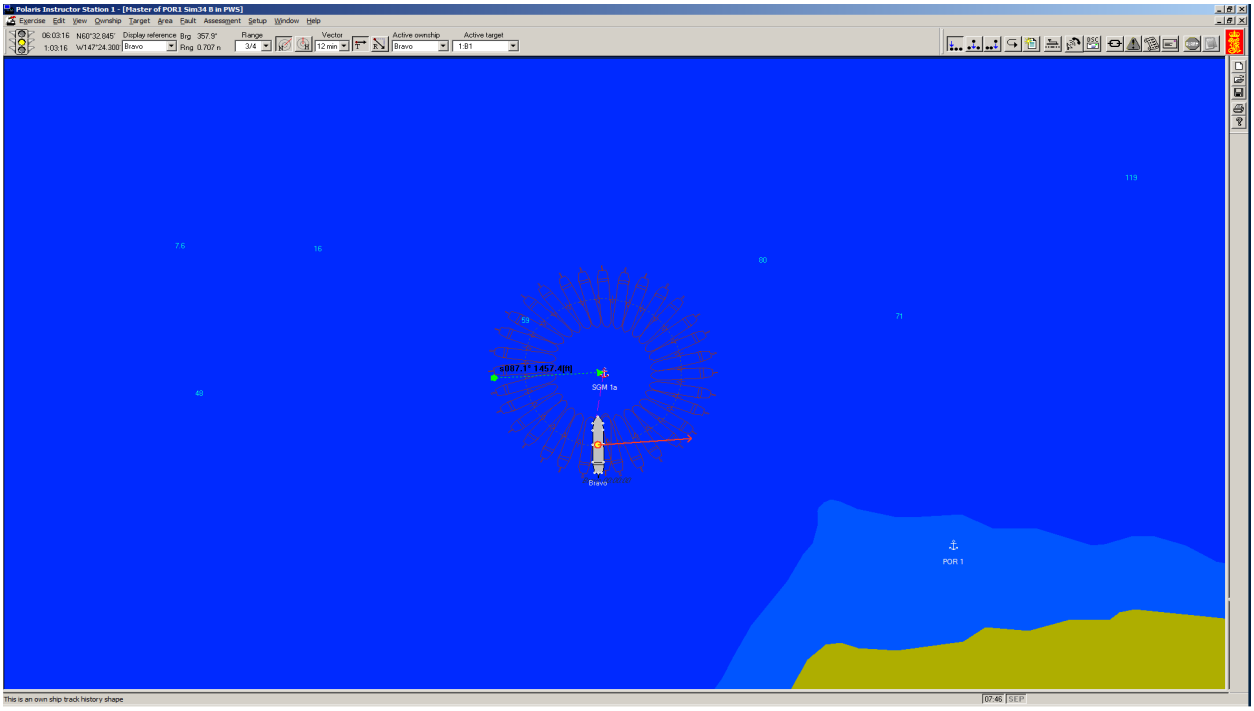

Figure 5. 360-Degree Anchor Swing at North Smith Island Anchorage, Anchor Position 60 32.31 N 147 24.22 W

To test the swing room of the PPOR, a 360-degree spin of a vessel at the anchor location was completed. This was done using the SeaRiver Ballast (VLCC14B) vessel model (LOA 820 feet, draft 28 feet) with 8 shots of anchor at a 5:1 scope. Figure 5 is a screenshot of the result. It indicates that the vessel did not run aground.

During the evaluation of this alternative anchor location, simulation results found the position may be safe, but it was found that the location lacked protection from hazardous environmental conditions. This location is exposed to wind and seas from all directions, except the southern quadrants. The anchor location found by SGM is a pinnacle, surrounded on three sides by significantly deeper water. If the vessel started to drag anchor, retaining this position is unlikely and would result in an unsafe anchor location. The only positive comment about this PPOR is that when environmental conditions are from the south, this location offers a leeward shore for anchoring. Therefore, this PPOR should be used with caution as it may not be an adequate position to hold an anchor due to possible exposure to inclement weather.

Outside Bay Anchorage

Outside Bay is located at the southwest end of Naked Island and lays in a southwesterly direction exposing it to southwest and westerly weather. The bay is approximately 1.5 miles long, with an entrance approximately 1 mile wide, and narrows down to approximately 0.5 miles wide three

quarters of a mile into the bay. Ships will enter the bay steering a northeast course and must remain center channel after approaching the bay from the southwest. A SERVS mooring buoy is located center channel approximately three quarters of a mile from the entrance of the bay. The bay provides good anchorage for small vessels.

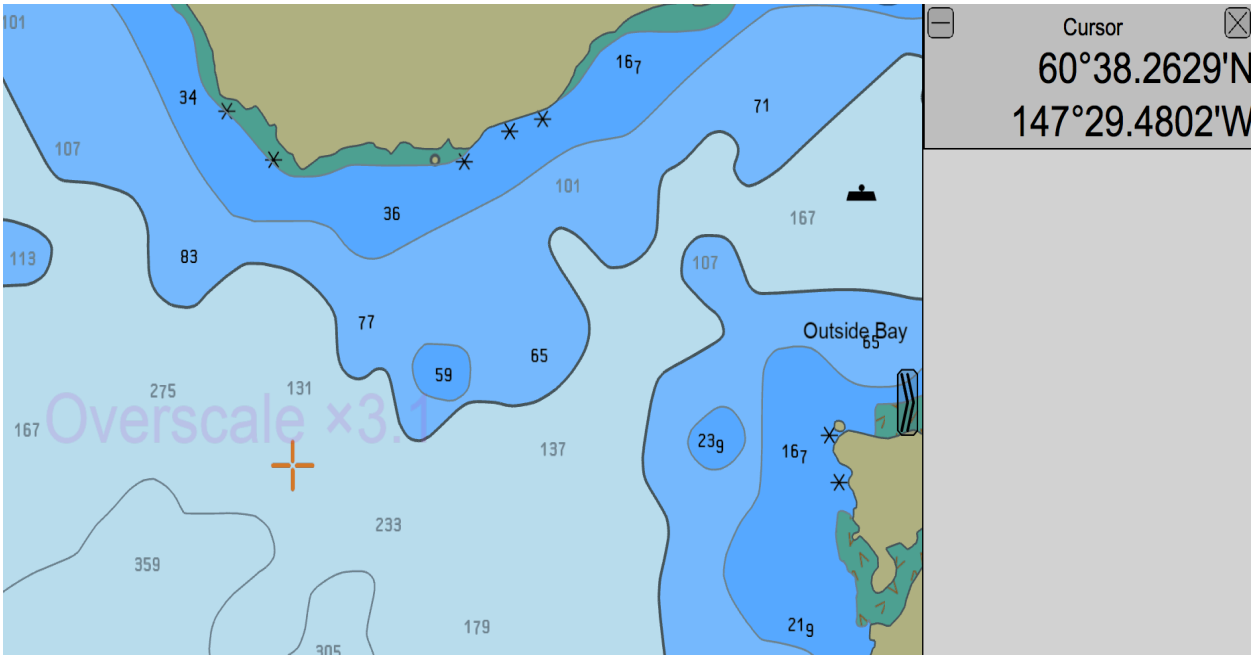

Figure 6. Outside Bay Anchorage, Anchor Position, 60 38.26 N 147 29.48 W

According to the PWS Contingency Plan (August 2018), Outside Bay Anchorage's anchor position is at 60 38.26 N 147 29.48 W. The simulation began with the vessel at heading 045 with a headway of 3 knots, 0.5 miles west of the anchor position. The wind was from the east (106 degrees) at 34 knots. Vessels approaching the anchor position came from the southwest on a course of 045 degrees with open water available for the vessel to maneuver. The pilots were most prominently concerned about the proximity of the anchor location to the 10-fathom curve. One pilot commented that he was able to drive the ship within a ship length of the anchorage without using tug boats, but that the anchor location was "too close" to the 10-fathom curve. Another reflected that he was able to use tug boats to maneuver the vessel into anchor position, but the anchor position is "too close to shallow water." In summation, the conditions at Outside Bay are "beyond the complexity of what a master is expected to deal with." If the ship were loaded, the tension on the chain would increase dramatically. Adding those factors to the disabilities of a stricken vessel, anchoring at this specific PPOR would be "even more complex." Therefore, this PPOR should not be used by oil tankers in distress.

Table 11. Simulated Maneuver Results for Outside Bay Anchorage, Anchor Position 60 38.26 N 147 29.48 W, (n=10)

Vessel	Prop & Rudder Available	Listing	Safe Refuge	Swing Room	Concern for Safety
Overseas Group Loaded (PRODC07L)	No	Yes	No	No	2
SeaRiver Ballast (VLCC14B)	No	Yes	No	No	3
SeaRiver Loaded (VLCC14L)	No	No	Yes	Yes	4
SeaRiver Loaded (VLCC14L)	No	No	No	No	4
Polar Tanker Ballast (VLCC15B)	Yes	Yes	No	No	4
Polar Tanker Loaded (VLCC15L)	Yes	Yes	No	No	2
Polar Tanker Loaded (VLCC15L)	Yes	No	No	No	4
ATC Ballast (GAS06L)	Yes	No	No	No	2
ATC Ballast (GAS06L)	Yes	No	No	No	4
ATC Ballast (VLCC05B)	No	No	Yes	Yes	1

Ten simulated maneuvers were conducted at Outside Bay Anchorage at anchor position 60 38.26 N 147 29.48 W. These included testing both ballast and loaded SeaRiver and Polar tankers and the loaded Overseas Group as well as the two ballast ATC models. Four of the vessel models were listing and five had a propeller and rudder available. The pilots reported that only two of the simulated maneuvers resulted in safe refuge for the disabled oil tanker. The pilots also reported that the swing room was only sufficient for the same two simulated maneuvers. The concern for the safety of the vessel ranged from 1 (not at all) to 4 (moderately concerned). The most frequent response (5/10) was a 4 indicating a moderate amount of concern for the safety of the vessel.

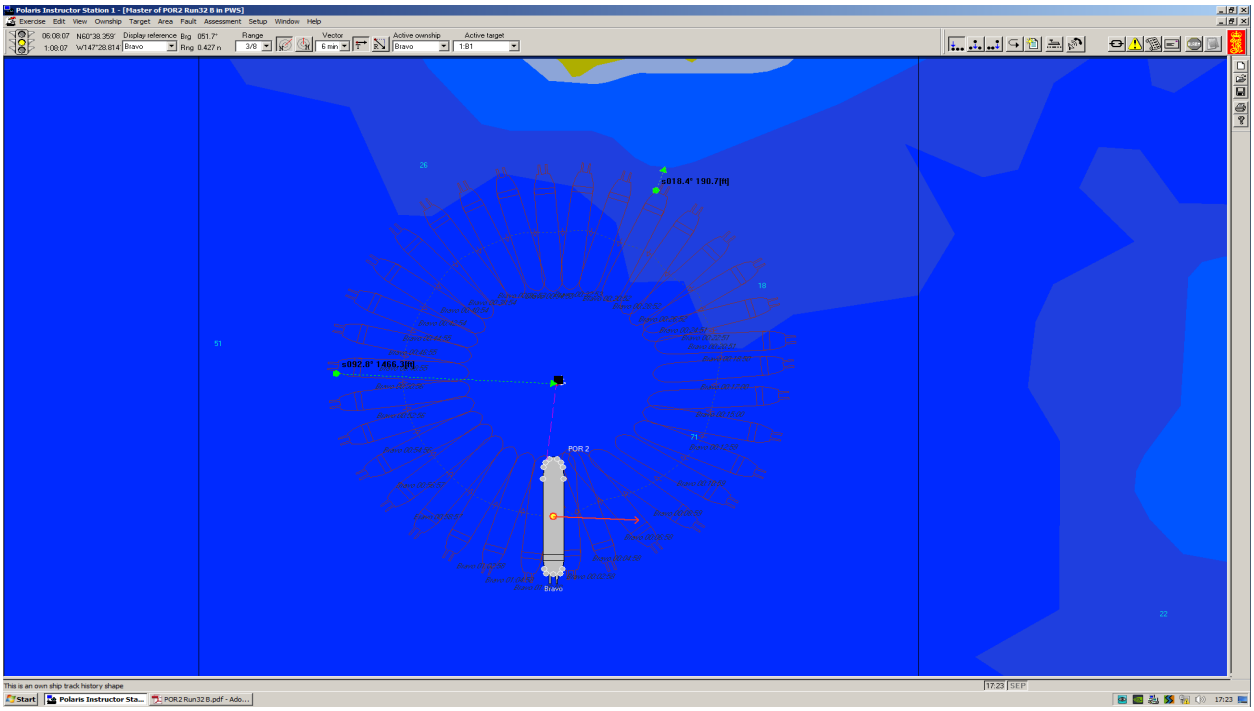

Figure 7. 360-Degree Anchor Swing at Outside Bay Anchorage, Anchor Position 60 38.26 N 147 29.48 W

To test the swing room of the PPOR, a 360-degree spin of a vessel at the anchor location was completed. This was done using the Polar Tanker Ballast (VLCC15B) vessel model (LOA 859 feet, draft 27 feet) with 8 shots of anchor at a 5:1 scope. Figure 7 is a screenshot of the result. It indicates that the vessel did not run aground. However, it is in close proximity to the 10-fathom curve, or 60-foot depth. This is not safe. Considering that a longer oil tanker may prefer 6:1 scope, which eliminates the sea room between an anchored vessel and the 10-fathom curve. Therefore, this PPOR should not be used by oil tankers in distress.

McPherson Bay Anchorage

McPherson Bay is located on the east side of Naked Island. The opening to the bay is from the northeast for larger vessels, between Peak Island and Naked Island. McPherson passage is a narrow waterway viable for smaller vessels accessing McPherson Bay from the northwest between Peak Island and Naked Island. The mid-channel of the bay is deep and has no obstructions, with Naked Island over a mile from Peak Island, and the entrance has over three quarters of a mile of deep water. Large vessels have adequate maneuvering room to reach the designated PPOR at the mouth of McPherson Bay. The location is approximately 10 miles west of the TSS lanes and provides protection from extreme weather for all directions except from the northerly quadrant.

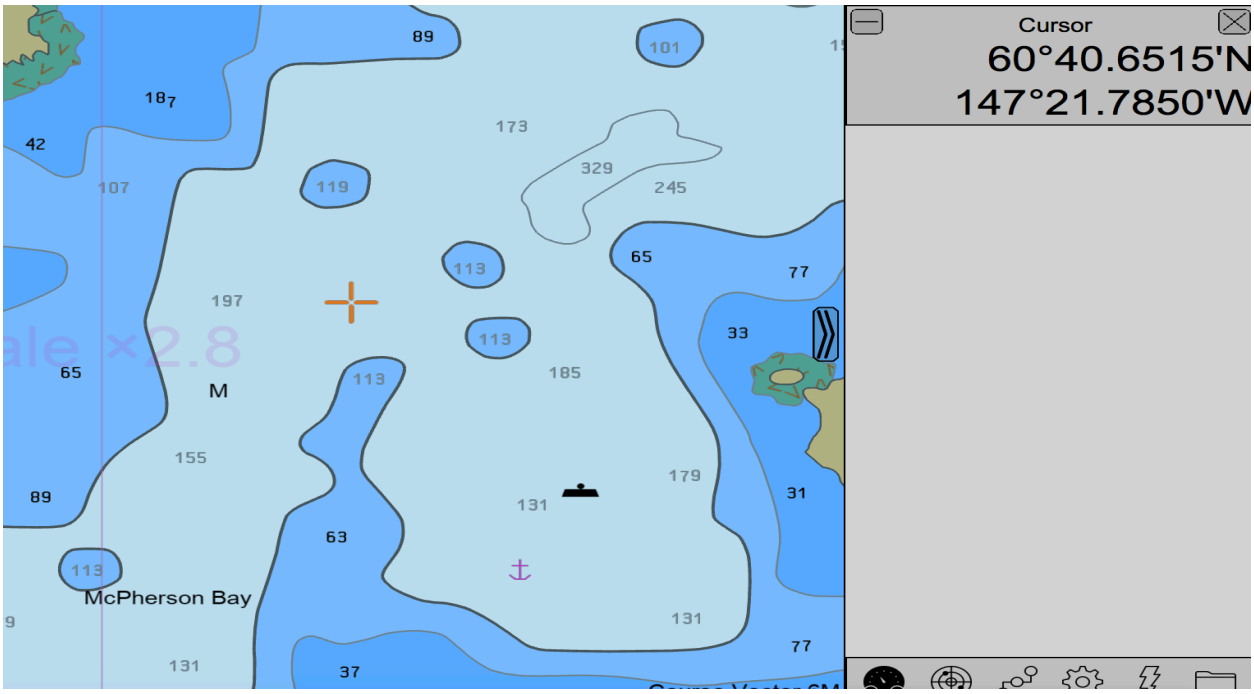

Figure 8. McPherson Bay Anchorage, Anchor Position, 60 40.65 N 147 21.79 W

According to the PWS Contingency Plan (August 2018), McPherson Bay Anchorage's anchor position is at 60 40.65 N 147 21.79 W. The simulation began with the vessel at heading 225 with a headway of 3 knots, 0.5 miles northeast of the anchor position. The wind was from the east (111 degrees) at 36 knots. The approach to the anchor point was executed from northeast on a course of 225 degrees, with open water available for the vessel to maneuver.

A majority of comments concerning McPherson Bay Anchorage were favorable, however there is concern about the impact of wind. Anchoring a ship at McPherson Bay Anchorage is subject to wind forces due to velocity and direction because it is "empty and very large, so the wind sail area is enormous." The anchoring maneuvers generally went "very well" with "minimal problems" even when listing greatly affected steering. However, after the anchor was set, high winds put "too much strain on the anchor chain." Anchoring a large ship in the simulated high wind conditions at McPherson Bay Anchorage may not be an issue, but mariners may encounter problems holding it there due to the high winds and seas from the northerly quadrant. Therefore, McPherson Bay Anchorage could be utilized by oil tankers in distress, but only temporarily due to potential exposure to high winds and seas from the north.

Table 12. Simulated Maneuver Results for McPherson Bay Anchorage, Anchor Position 60 40.65 N 147 21.79 W, (n=10)

Vessel	Prop & Rudder Available	Listing	Safe Refuge	Swing Room	Concern for Safety
Overseas Group Loaded (PRODC07L)	No	Yes	Yes	Yes	2
SeaRiver Ballast (VLCC14B)	No	Yes	Yes	Yes	2
SeaRiver Loaded (VLCC14L)	No	No	Yes	Yes	1
SeaRiver Loaded (VLCC14L)	No	No	Yes	Yes	1
Polar Tanker Ballast (VLCC15B)	Yes	Yes	Yes	Yes	1
Polar Tanker Loaded (VLCC15L)	Yes	Yes	Yes	Yes	1
Polar Tanker Loaded (VLCC15L)	Yes	No	Yes	Yes	1
ATC Ballast (GAS06L)	Yes	No	Yes	Yes	1
ATC Ballast (GAS06L)	Yes	No	Yes	Yes	1
ATC Ballast (VLCC05B)	No	No	Yes	Yes	3

Ten simulated maneuvers were conducted at McPherson Bay Anchorage anchor location. These included testing both ballast and loaded for the SeaRiver and Polar tankers and the loaded Overseas Group as well as the two ballast ATC models. Four of the vessel models were listing and five had a propeller and rudder available. The pilots reported that all of the simulated maneuvers resulted in a safe refuge for the disabled oil tanker. The pilots also reported that the swing room was sufficient for all of the simulated maneuvers. The concern for the safety of the vessel ranged from 1 (not at all) to 3 (somewhat concerned) The most frequent response, accounting for 7 of 10 simulated maneuvers, was 1 (not at all concerned) for the safety of the vessel.

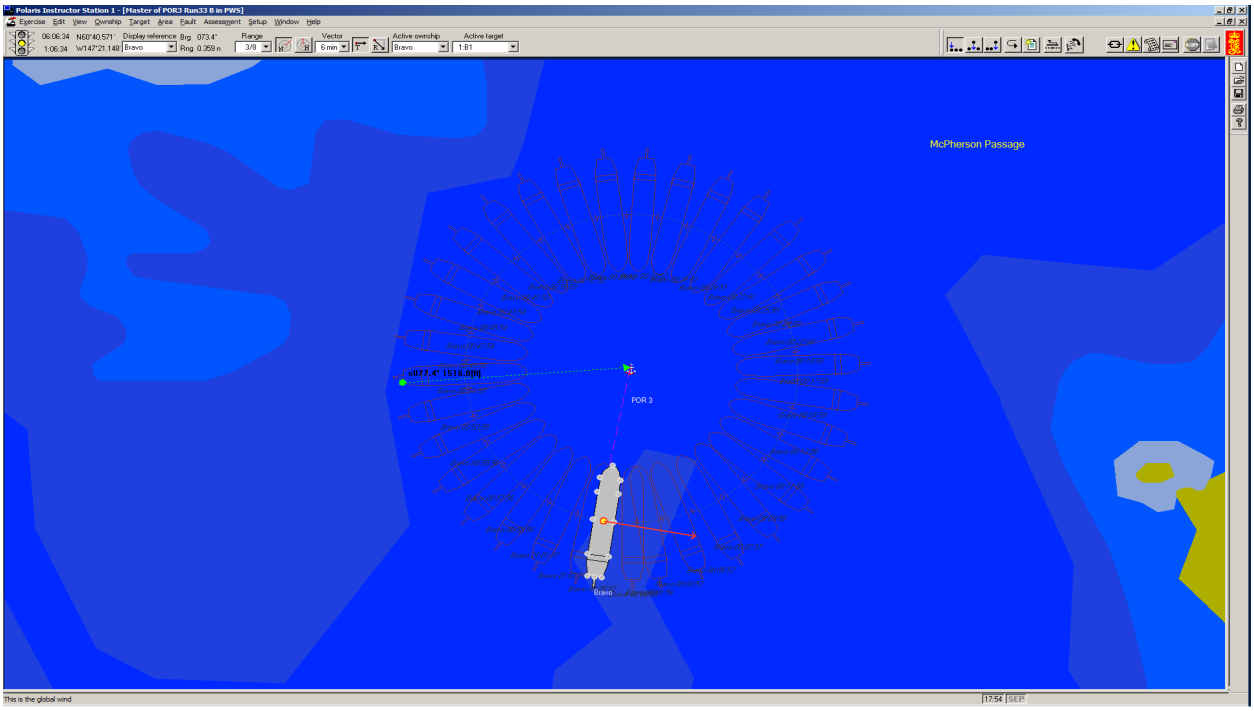

Figure 9. 360-Degree Anchor Swing at McPherson Bay Anchorage, Anchor Position 60 40.65 N 147 21.79 W

To test the swing room of the PPOR, a 360-degree spin of a vessel at the anchor location was completed. This was done using the Polar Tanker Ballast (VLCC15B) vessel model (LOA 859 feet, draft 27 feet) with 8 shots of anchor at a 5:1 scope. Figure 9 is a screenshot of the result. It indicates that the vessel did not run aground. This position allowed for an additional 2 shots of chain to be used (180 feet), increasing scope to 6:1 while still allowing for sufficient swing room. Overall, McPherson Bay Anchorage could be utilized by oil tankers in distress, but only temporarily due to potential exposure to high winds.

8. SIMULATED MANEUVER METHODOLOGY FROM 2019 STUDY

The simulated maneuvers evaluating the PPOR at North-PWS (North Jack Bay and South Jack Bay) and South-PWS (Port Etches Anchorage, Port Etches Moorage, and Zaikof Bay Anchorage) were conducted on March 26 – 28, 2019. They included the following variables: PPOR and anchor or moorage location by latitude and longitude, vessel characteristics, condition of the vessel under emergency conditions (listing 15 degrees or not), and various environmental conditions (wind and bottom type). These maneuvers were carried out by two experienced local maritime experts that are licensed State of Alaska marine pilots and active members of SWAPA: Captain Jeff Pierce and Captain Andy Wakefield.

Potential Places of Refuge

The scope of this study includes five PPOR previously identified PWS Contingency Plan (August 2018). These five PPOR are capable of providing for deep draft vessels – specifically crude oil tanker vessels in distress. They are: (1) North Jack Bay Anchorage, (2) South Jack Bay

Anchorage, (3) Port Etches Anchorage, (4) Port Etches Moorage, and (5) Zaikof Bay Anchorage. These five PPOR are identified in Figures 10 and 11.

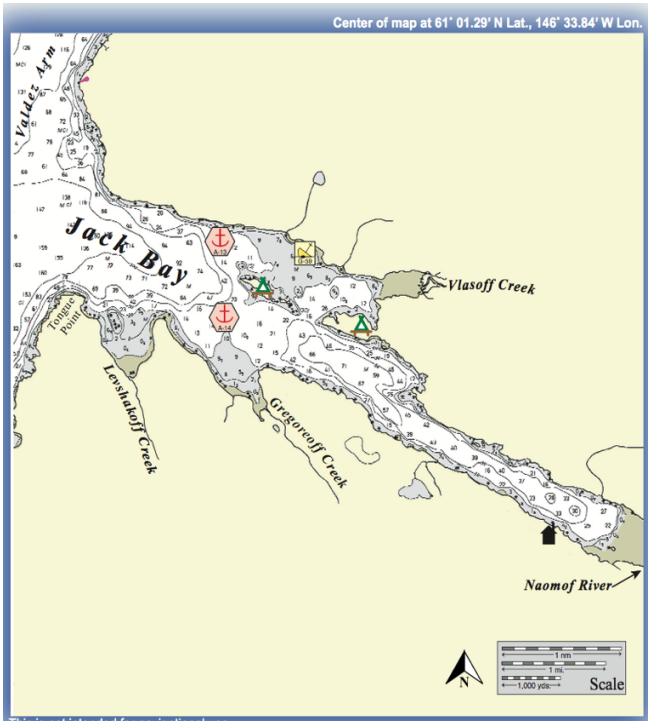

Figure 10. PPOR Map 2 Jack Bay

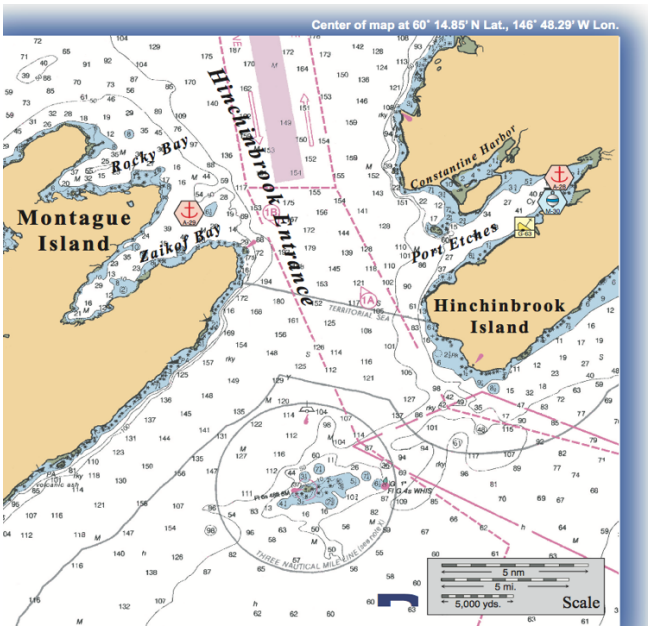

Figure 11. PPOR Map 7 Port Etches and Zaikof Bay

The PWS Contingency Plan (August 2018) on page 264 identifies the following information: PPOR ID #, Map #, PPOR location name, latitude and longitude, available swing room, bottom type, and exposure to wind direction. These are presented in Table 13.

Table 13. Description of PPOR by PWS Contingency Plan (August 2018)

PPOR ID#	Map#	PPOR Name	Latitude Longitude	Swing Room (feet)	Bottom Type	Wind Exposure
A 13	2	North Jack Bay Anchorage	61 02.41 N 146 37.30 W	1,200	Mud	East
A 14	2	South Jack Bay Anchorage	61 01.98 N 146 37.49 W	1,800	Mud	East
A 28	7	Port Etches Anchorage	60 20.59 N 146 33.84 W	2,300	Clay	East, West
M 30	7	Port Etches Moorage	60 20.39 N 146 33.20 W	2,300	NA	East, West
A 29	7	Zaikof Bay Anchorage	60 19.42 N 146 57.98 W	5,000	Mud	Northeast

Each PPOR has a specific latitude and longitude in terms of anchoring or mooring position. However, during the vessel simulation process, the specific latitude and longitude positions for all five of the PPOR were found to be insufficient to provide for the safety of a disabled vessel oil tanker. Therefore, for four of the PPOR, SGM identified alternative latitude and longitude anchoring or mooring positions. The PPOR (original and SGM revised latitude and longitude positions) and the corresponding number of simulations completed at each location are presented in Table 14.

Table 14. PPOR, Latitude and Longitude, and Number of Simulations Completed

PPOR Name	Latitude Longitude	Notes	#Simulations
North Jack Bay Anchorage	61 02.41 N 146 37.30 W		8
South Jack Bay Anchorage	61 01.98 N 146 37.49 W		7
South Jack Bay Anchorage	61 02.0 N 146 37.50 W	SGM Revised	1
Port Etches Anchorage	60 20.59 N 146 33.84 W		4
Port Etches Anchorage	60 19.91 N 146 36.05 W	SGM Revised	4
Port Etches Moorage	60 20.39 N 146 33.20 W	Depicted Buoy Position	2
Port Etches Moorage	60 20.52 N 146 33.50 W	Actual Buoy Position	6
Zaikof Bay Anchorage	60 19.42 N 146 57.98 W		2
Zaikof Bay Anchorage	60 19.05 N 146 59.03 W	SGM Revised	6

Vessels Simulated

According to the PWS Contingency Plan (August 2018), each of these PPOR should be able to accommodate deep draft vessels that exceed 20,000 gross tons, have drafts of 25 to 60 feet and range from 450 to 1,000 feet LOA (page 260). Therefore, this research utilized four vessel models representing loaded oil tankers all over 20,000 gross tons, with drafts of 25 to 60 feet and 450 to 1,000 feet LOA.

The four vessel models represent loaded oil tankers that are currently operating as part of TAPS shipping. Unlike the 2017 study all vessel models are loaded depicting outbound oil tankers that pose the greatest risk to causing an oil spill. All vessels were simulated with a full mechanical failure of propulsion. This meant that vessels with two propellers lost propulsion from both propellers. This is in contrast to the 2017 study that simulated maneuvers both with full and partial failure. Each vessel was simulated as both listing by 15 degrees and as not listing. This was done to simulate and determine whether an oil tanker with physical damage could maneuver to the PPOR location. A description of the vessels, corresponding representative model, and number of simulations completed with each model are described in Table 15. Two additional models were used in this study that were not in 2017. These models were used to represent loaded versions of the Polar and ATC vessels as the 2017 study only used ballast models representing these two vessels. The main limitation is that the ATC loaded vessel model only has one propeller and rudder compared to the actual ATC vessel that has two propellers and rudders. This is a limitation of this research, but all of the ATC vessel models were able to navigate to the prescribed PPOR anchor or mooring position.

Table 15. Description of Vessels, Vessel Models in Italics, and # of Simulations

Model/ Ship	LOA (feet)	Beam (feet)	Depth/Draft (feet)	Displacement (tons)	# Props Rudders	#Simulations
Crowley Shuttle Tanker Loaded	601	105	42	55,000	One	
PRODCo7L	*600*	*105*	*44*	*64,330*	*One*	10
Crowley Tanker Loaded	823	144	49	134,352	One	
VLCC14L	*820*	*144*	*49*	*133,900*	*One*	10
Polar Tanker Loaded	892	151	50	160,000	Two	
VLCC15L	*859*	*138*	*49*	*153,100*	*Two*	10
ATC Loaded	941	164	59	185,000	Two	
VLCC16L	*900*	*158*	*56*	*181,000*	*One*	10

Wind Direction and Velocity

Multiple studies have assembled and analyzed the meteorological and oceanographic data in PWS so that oil shipping corporations may "identify those environmental and operational conditions that limit the effectiveness of the chosen response tactics in the event of an oil spill in PWS" (Kumar and Gray, January 2007). PWSRCAC provided wind information to SGM to conduct this research from the Alaska Experimental Forecast Facility. All simulated maneuvers

were conducted using the highest sustained winds and predominant wind direction for the PPOR. A summary of the wind direction and velocity for each PPOR is shown in Table 16.

Table 16. Overview of Wind Direction and Velocity at Each PPOR

PPOR	Sustained Wind Direction	Sustained Wind Velocity (knots)
North Jack Bay Anchorage	Northeast (045)	31
South Jack Bay Anchorage	Northeast (045)	31
Port Etches Anchorage	East (090)	38
Port Etches Moorage	East (090)	38
Zaikof Bay Anchorage	East (090)	43

Assist Tugboats

For each simulated maneuver, the vessel was assisted by two vector escort tugboats controlled by a simulator operator. The two tugboats performed ship assist work at the pilots' direction maneuvering the stricken vessel to the PPOR for safe anchoring or mooring. The bollard pull tonnages provided by the two tugboats are in Table 17 and are based on a 10% reduction in power from the actual maximum bollard pull of the escort tugboats available at the Valdez Marine Terminal (136 tons) for greater realism and safety.

Table 17. Vector Escort Tugboat Commands

Tugboat Commands	%	Bollard Pull Tons
Dead slow	10	12
Easy	25	31
One third	33	40
Half	50	61
Three quarters	75	92
Full	100	122

Personnel

SGM coordinated with SWAPA to utilize two current pilots for this research. The two pilots are Captain Andy Wakefield, President of SWAPA, and Captain Jeff Pierce, President of SGM. Captain Wakefield completed 16 simulated maneuvers while Captain Pierce completed 24 simulated maneuvers. Each pilot completed at least three simulated maneuvers at each PPOR and at least two simulated maneuvers with each vessel. SGM Vice President Jonathan Pierce, Ph.D., was in charge of designing and executing the simulation maneuver program as well as undertaking the assessment. SGM utilized two research assistants, one in each simulator, to monitor and record the maneuver including the number of shots of anchor deployed, the tension on the anchor chain in tons to determine whether the anchor gear failed, and the minimum under keel clearance. Furthermore, AVTEC provided two simulator operators to ensure the simulator ran properly and to operate the vector tugboats.

Table 18. Personnel Participating in Vessel Simulations

Name	Role	Organization Affiliation
Captain Andy Wakefield	Pilot	SWAPA President
Captain Jeff Pierce	Pilot	SWAPA / SGM
Steve Fink	Simulator Operator	AVTEC
Rob Chadwell	Simulator Operator	AVTEC
Jonathan Pierce, Ph.D.	Simulator Director	SGM
Nicole Schmitt	Research Assistant	SGM
Hallie Bergwall	Research Assistant	SGM

Determining Whether a PPOR is Safe

Determining whether a PPOR is safe for a deep draft vessel, specifically an oil tanker, was a function of a triangulation of empirical observations and pilot judgment. Empirical observations made were whether the vessel ran aground and the under keel clearance (UKC) at the anchor position. Pilot judgement was gathered using structured interview questions after each simulation was completed. If the vessel runs aground or hits an obstruction the position is not safe. If the pilot determines that there is a high concern for the safety of the vessel, that there is insufficient swing room, or that the UKC is insufficient, then the position is not safe.

Upon completion of each simulated maneuver, a screen shot of the ship model's position at least every five minutes was taken. Along with the screenshot, whether the vessel ran aground and its minimum UKC were recorded. These screenshots depict what occurred during the simulated maneuver and were also utilized during the structured interviews with the pilots. Structured interviews were conducted with each individual pilot in reference to the screenshot of the simulated maneuver. The specific questions and associated scales are as follows.

What is your level of concern for the safety of the vessel based upon its current position?
1 = Not at all concerned, 2 = Slightly concerned, 3 = Somewhat concerned, 4 = Moderately concerned, and 5 = Extremely concerned

Does the anchor position provide enough swing room for the anchor so that the vessel can maintain its position? Yes/No

What was the level of difficulty for you to perform this maneuver?
1 = Very easy, 2 = Easy, 3 = Neutral, 4 = Difficult, 5 = Very difficult

Did the simulation represent realistic environmental conditions at the PPOR?
1 = Not at all, 2 = A little, 3 = A moderate amount, 4 = A lot, 5 = A great deal

Did the vessel model simulated represent realistic attributes and maneuverability of the vessel?
1 = Not at all, 2 = A little, 3 = A moderate amount, 4 = A lot, 5 = A great deal

In total, 40 maneuvers were simulated utilizing this process. These 40 maneuvers were equally distributed among the five PPOR and were completed using all four of the vessel models both listing and non-listing. In addition to these 40 piloted simulated maneuvers, eight vessel

simulations were conducted by having the simulator operator place a vessel model at the latitude and longitude designated for each PPOR with the appropriate amount of scope for the anchor or length of line from the mooring buoy. The scope at each location was either 5:1 or 6:1 and the moorage line was set at 100 feet. Then the simulator operator used various wind directions to spin the vessel 360 degrees around the latitude and longitude position, replicating wind direction changes, in order to determine whether the location provided sufficient swing room or if the vessel ran aground. The PPOR, specific latitude and longitude of the position, vessel model, and anchor scope for each 360-degree vessel spin simulations are described in Table 19.

Table 19. Describing 360-Degree Vessel Spin Simulation at Each PPOR

PPOR	Latitude Longitude	Vessel Model	LOA (feet)	Draft (feet)	Anchor Scope
North Jack Bay Anchorage	61 02.41 N 146 37.30 W	ATC	900	56	5:1
South Jack Bay Anchorage	61 01.98 N 146 37.49 W	ATC	900	56	6:1
Port Etches Anchorage	60 20.59 N 146 33.84 W	ATC	900	56	5:1
Port Etches Anchorage	SGM Revised 60 19.91 N 146 36.05 W	ATC	900	56	5:1
Port Etches Moorage	Depicted Buoy Position 60 20.39 N 146 33.20 W	Crowley Shuttle	600	44	100-foot Mooring Line
Port Etches Moorage	Actual Buoy Position 60 20.51 N 146 33.50 W	ATC	900	56	100-foot Mooring Line
Zaikof Bay Anchorage	60 19.42 N 146 58.0 W	ATC	900	56	6:1
Zaikof Bay Anchorage	SGM Alternative 60 19.05 N 146 59.03 W	ATC	900	56	6:1

One of the observations that the pilots used to determine the safety of a PPOR is whether UKC is sufficient. UKC refers to the distance between the lowest point on the ship's keel or hull and the highest point on the bottom beneath the ship. UKC is equal to the total water depth at the location of the ship minus the dynamic draft of the ship (the distance from the water's surface to the lowest point on the ship's keel while the ship is in motion). UKC minimums will vary by the specific waterway, port or harbor, and shipping company practices. PWS does not have a UKC minimum because of how deep it is within the normal shipping traffic lanes. Deep draft vessels should not travel near the shoreline or obstructions in PWS, so there is a lack of predetermined UKC minimums. Furthermore, charted depths of PWS, in particular near shorelines, do not have sufficient detail and information. NOAA's "United States Coast Pilot 9, Alaska: Cape Spencer to Beaufort Sea" (36th Edition) states, "It cannot be too strongly emphasized that even charts based

on modern surveys may not show all seabed obstructions or the shoalest depths … **Caution and common sense are continuing requirements for safe navigation**" (page 2, bold emphasis in original). Charts depicting the PPOR locations lack the number of soundings and detail necessary to determine a minimum UKC. Therefore, we agree with NOAA, that ship pilots and captains should use caution when navigating within close proximity to the shore lines and 10-fathom curves in PWS. Therefore, rather than being able to determine whether a UKC at a PPOR is greater than a predetermined minimum, we asked the pilots to judge the safety of the PPOR based in part on the minimum UKC observed.

9. SIMULATED MANEUVER RESULTS FROM 2019 STUDY

Pilots were asked after every maneuver how realistic on a scale of 1 (not at all) to 5 (a great deal) were the environmental conditions and the vessel model. For environmental conditions the pilots gave a response of 5 (a great deal) for all 40 simulations. For the vessel model the pilots gave a response of 5 (a great deal) for 37 of 40 simulations. The remaining three simulations were scored a 4 (a lot) across three different vessel models. Therefore, the environmental conditions as well as the vessel models were determined by the pilots as valid and accurate for every maneuver simulated.

The maximum anchor tension observed during all of the simulated maneuvers was approximately 150 tons on the ATC tanker vessel model. This is well below the approximately 700 tons of tension that is the safe working load for the ATC tanker. In all cases, the maximum tension on the anchor was less than the safe working load for all of the vessels. Therefore, there was no concern for anchor gear failure. The following results are organized by PPOR.

North Jack Bay Anchorage

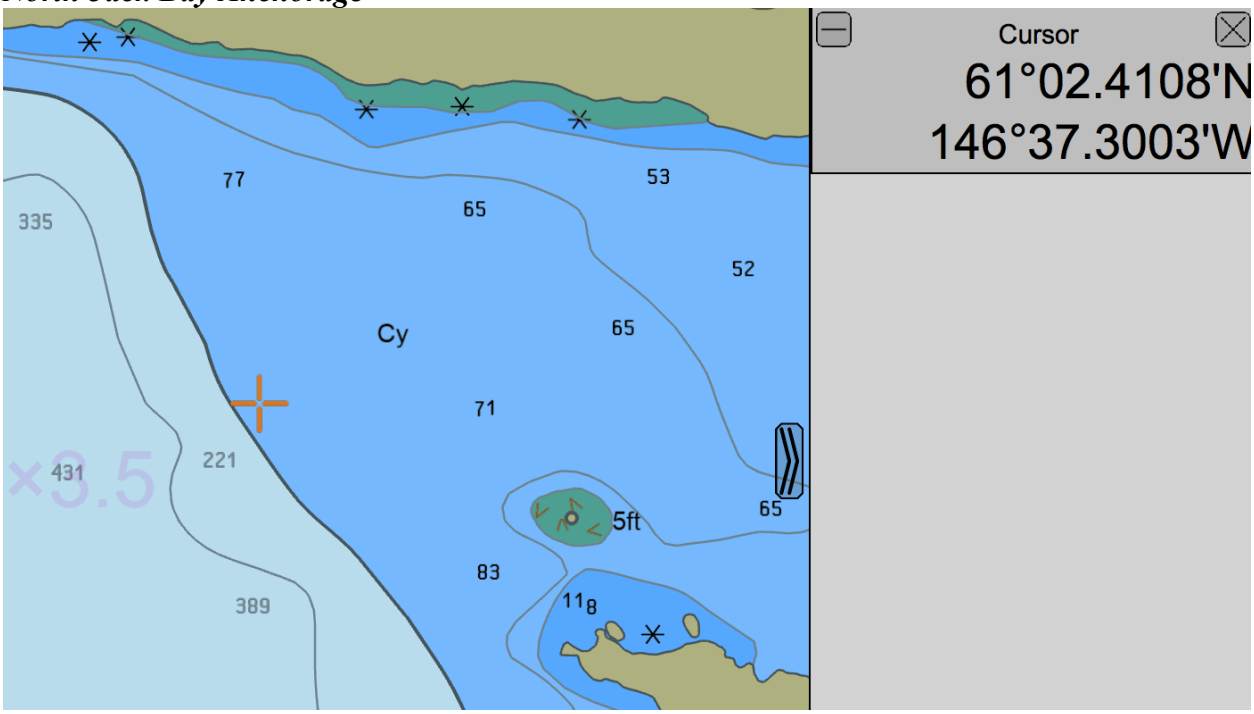

Figure 12. North Jack Bay Anchorage, Anchor Position, 61 02.41° N 146 37.3° W

According to the PWS Contingency Plan (August 2018), North Jack Bay Anchorage's prescribed anchor position is 61 02.41 N 146 37.30 W. This anchorage position is near the 30-fathom curve with decreasing depths shoreward, creating a deep anchorage site, approximately 30 fathoms deep. The 30-fathom depth is equal to 180 feet deep, requiring 2 shots of chain or 180 feet of anchor chain to reach the bottom. To create a 5:1 scope it requires 10 shots of chain or 900 feet of chain to be deployed.

Table 20. Simulated Maneuver Results for North Jack Bay Anchorage, Anchor Position 61 02.41 N 146 37.30 W, (n=8)

Vessel	Listing	Aground	UKC (feet)	Swing Room	Concern for Safety	Difficulty
Crowley Shuttle	Y	No	121	Yes	1	1
Crowley Shuttle	N	No	120	Yes	1	1
Crowley 115K	Y	No	280	Yes	1	1
Crowley 115K	N	No	194	Yes	2	1
Polar	Y	No	113	Yes	1	1
Polar	N	No	311	Yes	1	1
ATC	Y	No	255	Yes	1	1
ATC	N	No	112	Yes	1	2

At this anchor position, none of the vessels ran aground. The minimum UKC ranged from 112 to 311 feet. During the exit interviews, the pilots indicated that the swing room was sufficient for this position. The pilots indicated little concern for the safety of the vessel at this location and the maneuver was not difficult.

All of the maneuvers were simulated utilizing a northeast (045 degrees) wind at 31 knots. This meant that the ship stemmed the wind entering the bay and the anchor position was unobstructed from the west. The ships maintained a northeasterly heading after anchoring due to the strong winds, which is a good direction due to the location of the PPOR. However, the ship could not be allowed to turn around on its anchor at this location. The pilots stated that the concern for safety at this location is a function of the wind direction. "This works with northeast wind, but it will not work with another wind direction due to close proximity of shoal area." Furthermore, tugboats would have to stay with the ship at all times, due to the depth of the anchor location and to prevent the vessel from swinging around and getting too close to the 10-fathom curve or rocks. Pilot comments concerning this PPOR were: "Due to the depth of the anchor location tugboats would have to maintain the ship position, otherwise it would get too close to 10-fathom curve." Therefore, the depth is a benefit for UKC, but may also cause a problem if the anchor drags to deeper waters.

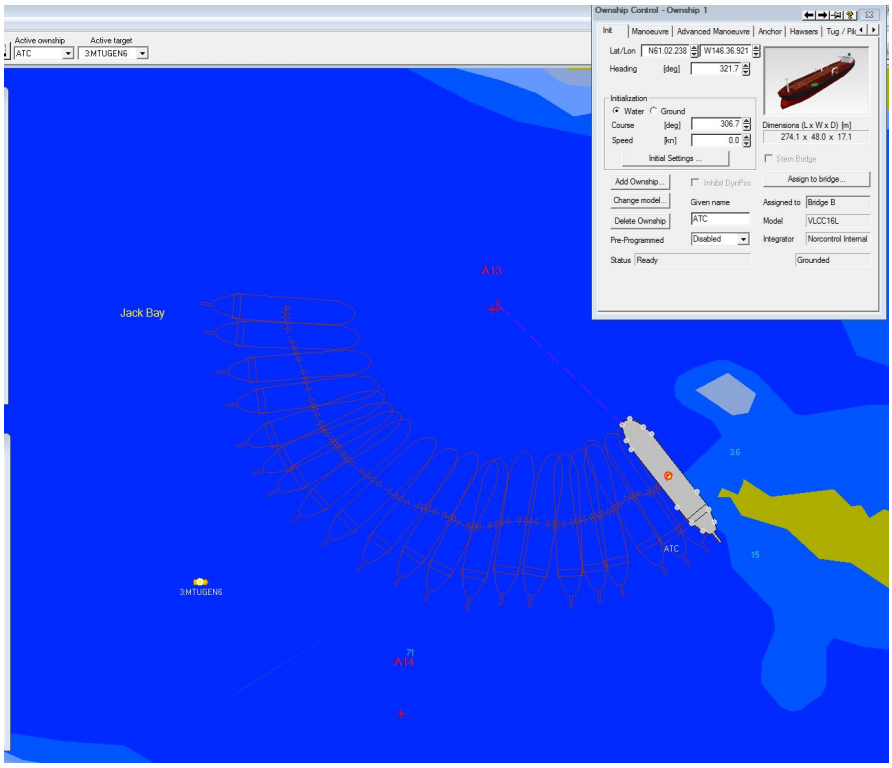

Figure 13. 360-Degree Anchor Swing at North Jack Bay Anchorage, Anchor Position, 61 02.41 N 146 37.3 W

To test the swing room of the PPOR, a 360-degree spin of a vessel at the anchor location was completed. This was done using the ATC tanker model (LOA 900 feet, draft 56 feet) with 10 shots of anchor at a 5:1 scope. Figure 13 is a screenshot of the result. It indicates that the vessel ran aground. Therefore, the North Jack Bay Anchorage at the anchor position of 61 02.41 N 146 37.30 W is not a safe location for a deep draft disabled oil tanker to use as a PPOR.

South Jack Bay Anchorage

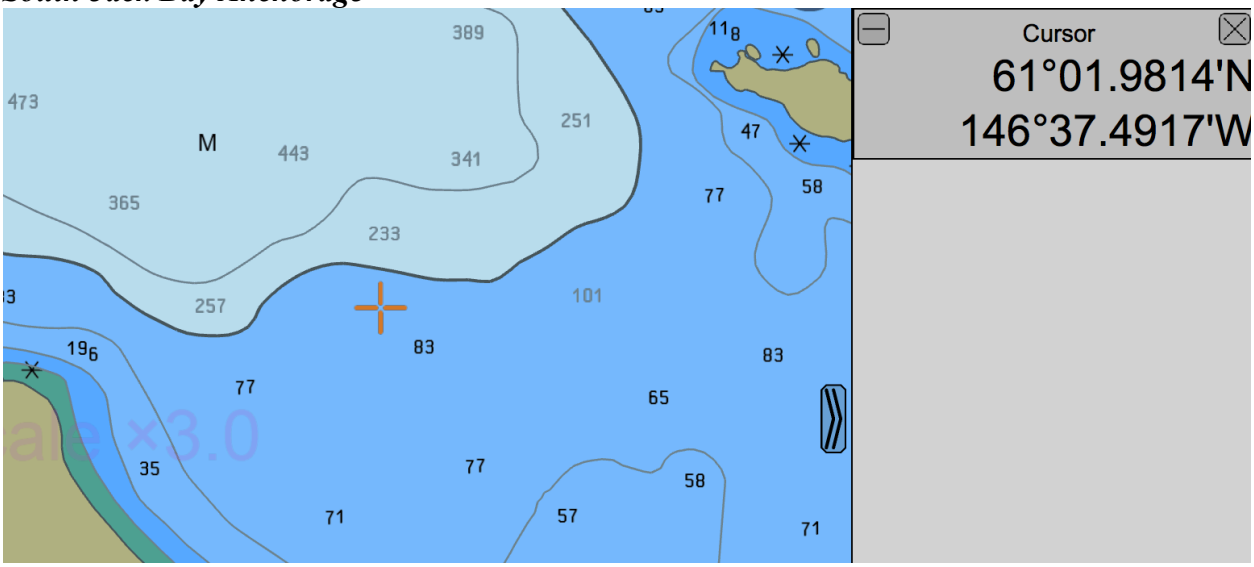

Figure 14. South Jack Bay Anchorage, Anchor Position, 61 01.98 N 146 37.49 W

According to the PWS Contingency Plan (August 2018), South Jack Bay Anchorage's prescribed anchor position is 61 01.98 N 146 37.49 W. Anchorage depth is approximately 90 feet of water, however 125 feet north of the location is the 30-fathom curve or 180 feet of water and dropping rapidly to 225 feet. Placing an anchor on this ledge may pose a risk for the anchor to hold the ship if it were to drag to the north. Recorded UKC during the simulations when maneuvering the vessels at this PPOR had a wide range. For example, one vessel observed 80 feet under the bow and 260 feet under the stern simultaneously. For the simulations, 8 shots of anchor were used creating a 6:1 scope for the Crowley Shuttle tanker, Crowley 115K tanker, and Polar tanker. Due to the length of the ATC tanker, we tried using a shorter length of anchor chain at 7 shots creating a 4:1 scope.

All of the maneuvers were simulated utilizing a northeast (045 degrees) wind at 31 knots. Multiple ships grounded because this wind direction pushes the ship towards and onto the shoreline. Ships at anchor swing into the wind and as soon as they stretch out their anchor chain multiple ships grounded in the shallow water west southwest of the anchor position.

Table 21. Simulated Maneuver Results for South Jack Bay Anchorage, Anchor Position 61 01.98 N 146 37.49 W, (n=7)

Vessel	Listing	Aground	UKC (feet)	Swing Room	Concern for Safety	Difficulty
Crowley Shuttle	Y	No	68	Yes	4	2
Crowley Shuttle	N	No	76	Yes	3	2
Crowley 115K	Y	No	91	Yes	1	1
Crowley 115K	N	Yes	NA	No	5	1
Polar	Y	No	13	No	5	2
ATC	N	No	11	No	5	2
ATC	Y	Yes	NA	No	5	2

Table 22. Simulated Maneuver Results for South Jack Bay Anchorage, SGM Anchor Position 61 02.00 N 146 37.50 W, (n=1)

Vessel	Listing	Aground	UKC	Swing Room	Concern for Safety	Difficulty
Polar	N	Yes	NA	No	5	2

Seven maneuvers were simulated at the prescribed anchor position at South Jack Bay Anchorage. Due to the ships running aground, an alternative anchor position was attempted. The simulated vessel ran aground at this alternative anchor position, so additional simulations were not attempted. Overall, 3 of 8 simulated maneuvers resulted in the ship running aground across three different vessel models. The UKC ranged from a low of none as the ship was aground to a high of 91 feet. When utilizing the smaller Crowley Shuttle tanker there was enough swing room for the vessel, as was also reported for the listing Crowley 115K tanker. However, the pilots reported that the other ships did not have enough swing room. The smallest ship, Crowley Shuttle tanker, was able to maintain its position and swing around its anchor without running aground due to their swing radius being less than larger vessels such as the ATC and Polar tankers. We

decreased the length of the anchor chain from 8 to 7 shots on the ATC tanker model because it is the longest vessel model at 900 feet, but it still ran aground.

The concern for safety of the vessel after the completed maneuver ranged widely from 1 (not at all concerned) to 5 (extremely concerned). Overall, 6 of 8 simulated maneuvers were associated with a moderate (4) or greater concern for safety of the vessel. Pilot comments concerning this PPOR reflected this high concern for the safety of the vessel at this anchor position. “Do not use it if the wind was blowing from this direction, which is what it usually does.” “Anchoring close to the windward beach isn’t prudent … due to the depth of water in Jack Bay, it will be difficult to find a PPOR in here.” Thus, indicating a high-risk situation at this anchor location. While the anchor position should be considered high-risk, the level of difficulty for completing the maneuver was generally considered easy (2).

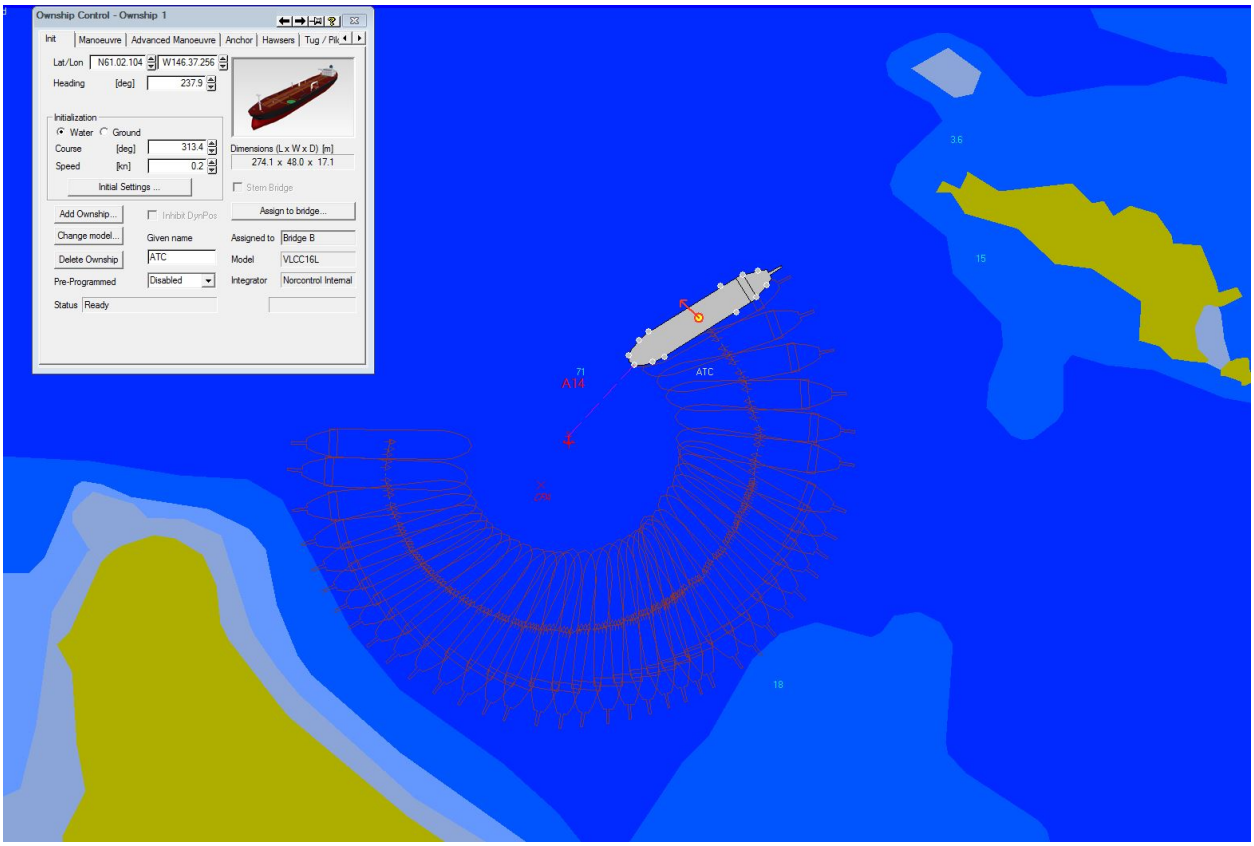

Figure 15. 360-Degree Anchor Swing at South Jack Bay Anchorage, Anchor Position, 61 01.98 N 146 37.49 W

To test the swing room of the PPOR, a 360-degree spin of a vessel at the anchor location was completed. This was conducted using the ATC tanker model (LOA 900 feet, draft 56 feet) using 8 shots of anchor at a 6:1 scope and utilizing varying wind directions. Figure 15 is a screenshot of the result. It indicates that while the vessel did not run aground, but it came in close proximity to the 10-fathom curve and shoreline. While the swing room is barely sufficient, multiple ships doing multiple simulated maneuvers ran aground at this location. Therefore, the South Jack Bay Anchorage at the anchor position of 61 01.98 N 146 37.49 W is not a safe location for a deep draft disabled oil tanker to use as a PPOR.

Port Etches Anchorage

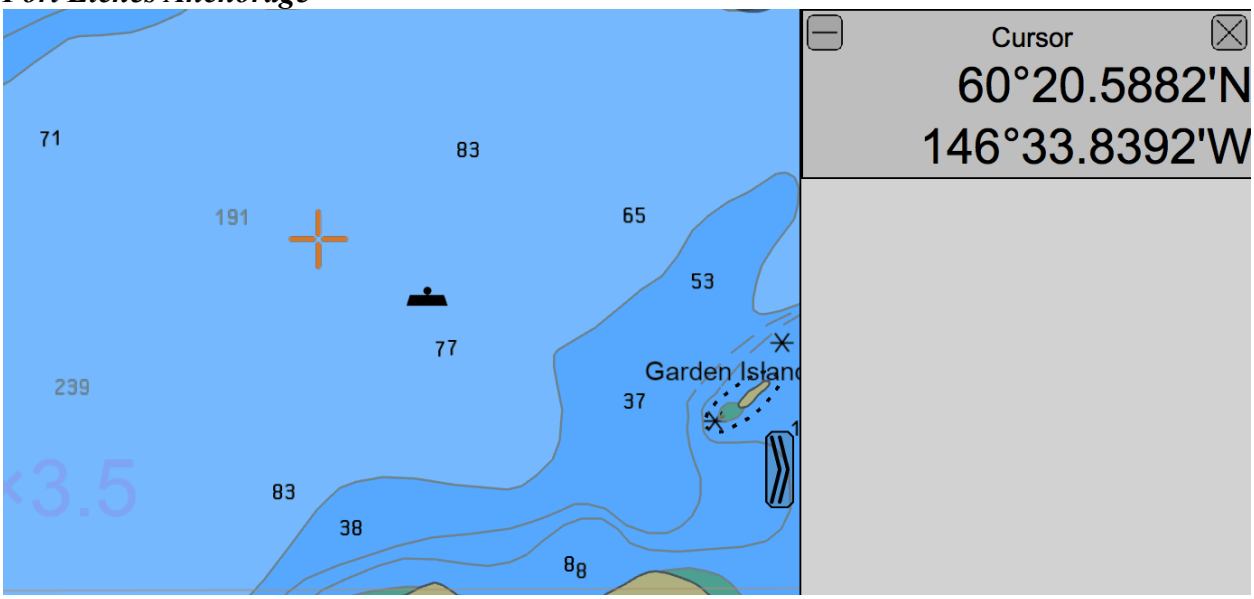

Figure 16. Port Etches Anchorage, Anchor Position, 60 20.59 N 146 33.84 W

According to the PWS Contingency Plan (August 2018), Port Etches Anchorage's prescribed anchor position is 60 20.59 N 146 33.84 W. This location depicts approximately 30 fathoms of water, or 180 feet deep and about 1,000 feet northwest of the charted location of a mooring buoy. Due to the depth of water, a significant amount of anchor chain will be required to create an appropriate amount of scope to hold a disabled oil tanker at this location. The minimum amount of scope to be considered would be 5:1 ratio meaning that a vessel would have to put out 10 shots of chain. The wind was simulated from the east (090 degrees) at 38 knots.

Table 23. Simulated Maneuver Results for Port Etches Anchorage, Anchor Position, 60 20.59 N 146 33.84 W, (n=4)

Vessel	Listing	Aground	UKC (feet)	Swing Room	Concern for Safety	Difficulty
Crowley 115K	Y	No	83	No	1	1
Crowley 115K	N	No	104	No	1	1
ATC	Y	No	91	No	1	1
ATC	N	No	94	No	1	1

Four maneuvers were simulated at the prescribed anchor position at Port Etches Anchorage. These were completed using the Crowley 115K tanker and the ATC tanker ship models. All four of the simulated maneuvers did not result in any ships running aground. The UKC ranged from 83 to 104 feet. Concern for the safety of the vessel for all four maneuvers simulated was rated a 1 (not at all concerned) based upon the wind direction from the east (090 degrees) and the maneuver was rated as not at all difficult. However, the pilots found that due to a mooring buoy being in close proximity to the anchor location, the swing room was insufficient for all four simulated maneuvers.

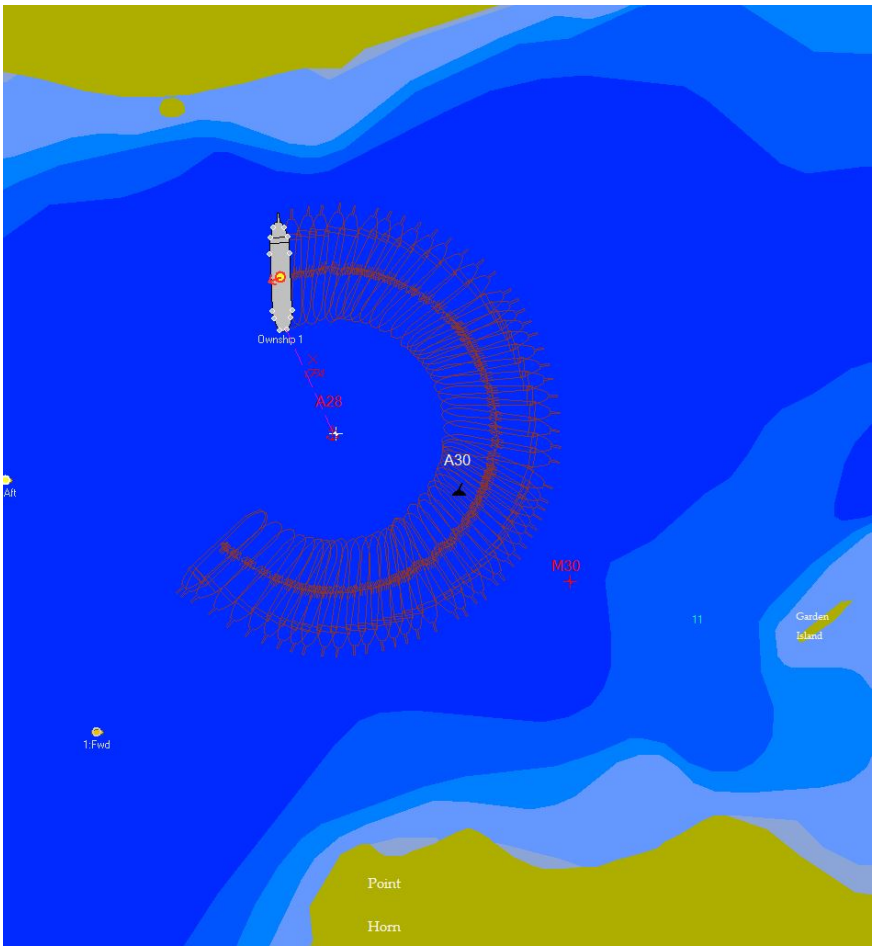

Figure 17. 360-Degree Anchor Swing at Port Etches Anchorage, Anchor Position, 60 20.59 N 146 33.84 W

To test the swing room of the PPOR, a 360-degree spin of a vessel at the anchor location was completed. This was conducted using the ATC tanker ship model (LOA 900 feet, draft 56 feet) using 10 shots of anchor at a 5:1 scope. Figure 17 is a screenshot of the result. It indicates that while the vessel did not run aground, it strikes the charted mooring buoy. The mooring buoy is an obstruction for this designated PPOR anchor location. Therefore, the Port Etches Anchorage at the anchor position of 60 20.59 N 146 33.84 W is not a safe location for a deep draft disabled oil tanker to use as a PPOR.

Due to the excellent location of Port Etches and the natural harbor protections provided for a PPOR, SGM identified an alternative location within Port Etches. This alternative location eliminates the problem of a ship swinging into a mooring buoy or other obstruction. The Port Etches Anchorage alternative SGM anchor position is 60 19.91 N 146 36.05 W and is depicted in Figure 9.

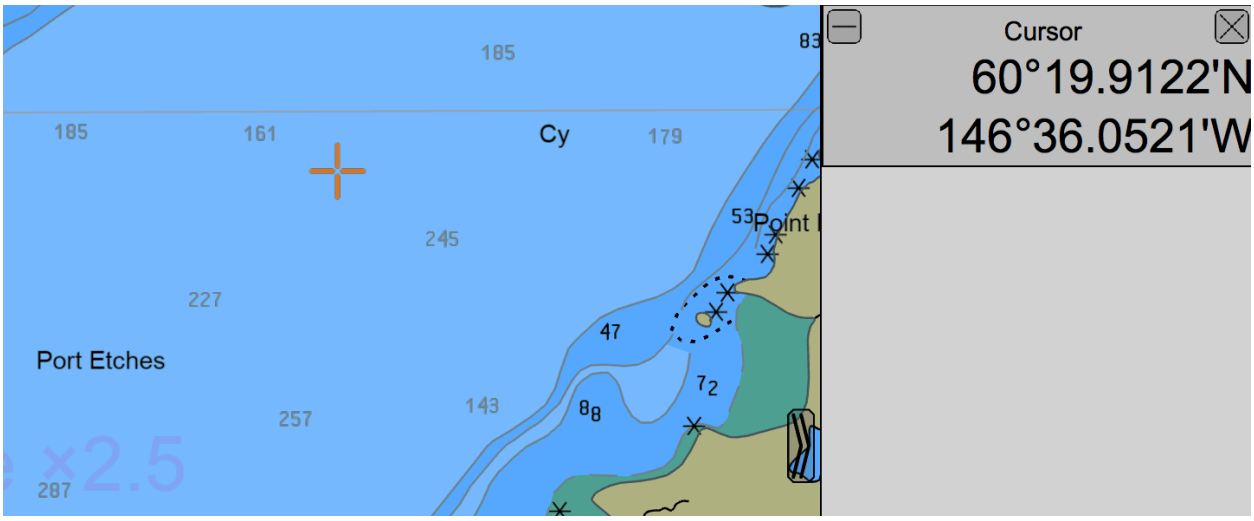

Figure 18. Port Etches Anchorage, SGM Anchor Position, 60 19.91 N 146 36.05 W

The SGM anchor position is approximately 1.3 miles bearing 230 degrees or west southwest of the prescribed anchor position. The SGM anchor position has over 3,000 feet of swing room and has a depth of 30 fathoms of water. This amount of swing room will allow a safe amount of anchor chain to be deployed by a disabled deep draft oil tanker. This location is approximately 3 miles from the entrance of Port Etches, providing essentially the same natural protection from any inclement weather that was provided by the original anchor position. The SGM anchor position also provides easier access for a ship captain to navigate a disabled oil tanker into Port Etches for anchoring than the original anchor position. Furthermore, the SGM anchor position would also provide a ship captain adequate maneuvering room to facilitate an unplanned departure from the anchorage in case of dragging the anchor during a strong easterly wind. Pilot comments concerning this alternative PPOR were: "This location for PPOR is one anyone could use, easy location for a captain to get to if a pilot is not on board." "Location made this an easy maneuver."

Table 24. Simulated Maneuver Results for Port Etches Anchorage, SGM Anchor Position, 60 19.91 N 146 36.05 W, (n=4)

Vessel	Listing	Aground	UKC (feet)	Swing Room	Concern for Safety	Difficulty
Crowley Shuttle	Y	No	147	Yes	1	1
Crowley Shuttle	N	No	138	Yes	1	1
Polar	Y	No	138	Yes	1	1
Polar	N	No	134	Yes	1	1

Four maneuvers were simulated at the Port Etches SGM anchor position at 60 19.91 N 146 36.05 W. These were completed using the Crowley Shuttle tanker and Polar tanker models. This location provides enough swing room for all of the ship models simulated. Overall, none of the ships ran aground and there was sufficient swing room for the vessels. The UKC ranged from 134 to 147 feet. The pilots were not concerned about the safety of the vessel or the difficulty of the maneuver.

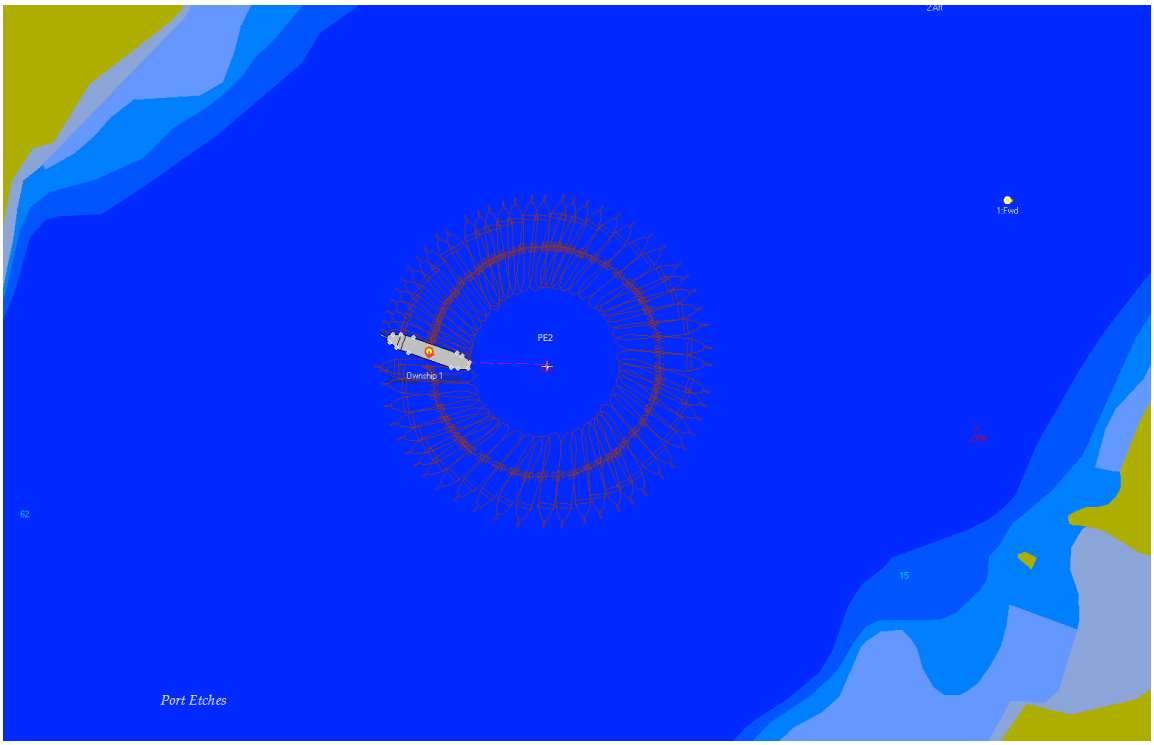

Figure 19. 360 Degree Anchor Swing Port Etches Anchorage, SGM Anchor Position, 60 19.91 N 146 36.05 W

To test the swing room of the PPOR, a 360-degree spin of a vessel at the SGM anchor location was completed. This was conducted using the ATC ship model (LOA 900 feet, draft 56 feet) using 10 shots of anchor at a 5:1 scope. Figure 19 is a screenshot of the result. It indicates the vessel is in a safe position away from the shoreline or other obstructions, such as the mooring buoy and sufficient room for the vessel to maneuver. Therefore, the Port Etches Anchorage, SGM anchor position of 60 19.91 N 146 36.05 W is a safe location for a deep draft disabled oil tanker to use as a PPOR.

Port Etches Moorage

According to the PWS Contingency Plan (August 2018) the Port Etches Moorage mooring buoy is located at 60 20.39 N 146 33.20 W. However, this location is incorrect. The charted location of the mooring buoy is at 60 20.51 N 146 33.496 W. These two locations are depicted in Figures 20 and 21. The charted mooring buoy location is about 1,000 feet northwest of the depicted mooring buoy position. The Port Etches Moorage depicted position of the mooring buoy is about 1,000 feet closer to the 10-fathom curve and Garden Island than the charted location of the mooring buoy. Therefore, two maneuvers were simulated at the Port Etches Moorage depicted mooring buoy position at 60 20.39 N 146 33.20 W and six maneuvers were simulated at the Port Etches Moorage charted mooring buoy position at 60 20.51 N 146 33.496 W.

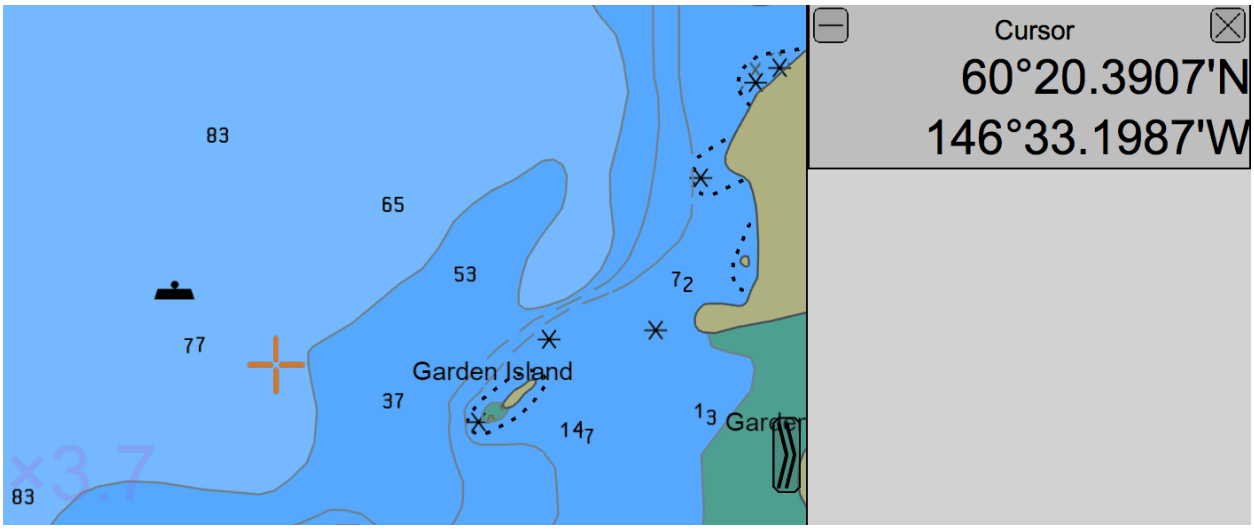

Figure 20. Port Etches Moorage, Depicted Position of Mooring Buoy, 60 20.39 N 146 33.20 W

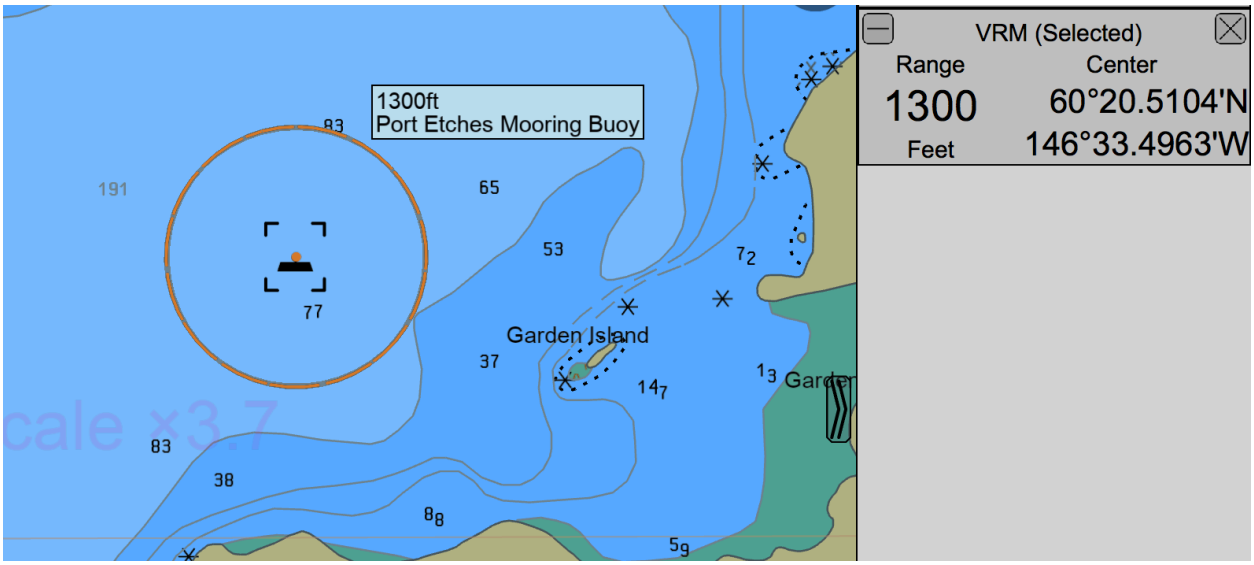

Figure 21. Port Etches Moorage, Charted Position of Mooring Buoy, 60 20.51 N 146 33.496 W

At the Port Etches Moorage, depicted buoy position of 60 20.39 N 146 33.20 W, the two maneuvers simulated utilized the Crowley Shuttle tanker. This model was selected as it is the smallest vessel with a LOA of 600 feet and draft of 44 feet with the intention of preventing it from running aground on the 10-fathom curve. Once the ship model was in range, a 100-foot mooring line was attached from the buoy to the bow of the ship by the simulator operator. The approach to the buoy required navigating close to the 10-fathom curve due to the east wind (090 degrees) at 38 knots. While neither simulated maneuver resulted the ship running aground, the UKC was 22 feet and deemed as insufficient by the pilots.

Table 25. Simulated Maneuver Results at Port Etches Moorage, Depicted Buoy Position, 60 20.39 N 146 33.20 W, (n=2)

Vessel	Listing	Aground	UKC (feet)	Swing Room	Concern for Safety	Difficulty
Crowley Shuttle	Y	No	22	No	1	2
Crowley Shuttle	N	No	22	No	1	2

To test the swing room of the PPOR, a 360-degree spin of a vessel at the depicted mooring buoy location was completed. This was conducted using the smallest vessel, the Crowley Shuttle tanker ship model with a LOA of 600 feet and draft of 44 feet using 100 feet of mooring line attached to the buoy. This was done with the intention of preventing the vessel from running aground on the 10-fathom curve. Figure 22 is a screenshot of the result. It indicates that the vessel ran aground. Therefore, the Port Etches Moorage, depicted buoy position of 60 20.39 N 146 33.20 W is not a safe location for a deep draft disabled oil tanker to use as a PPOR.

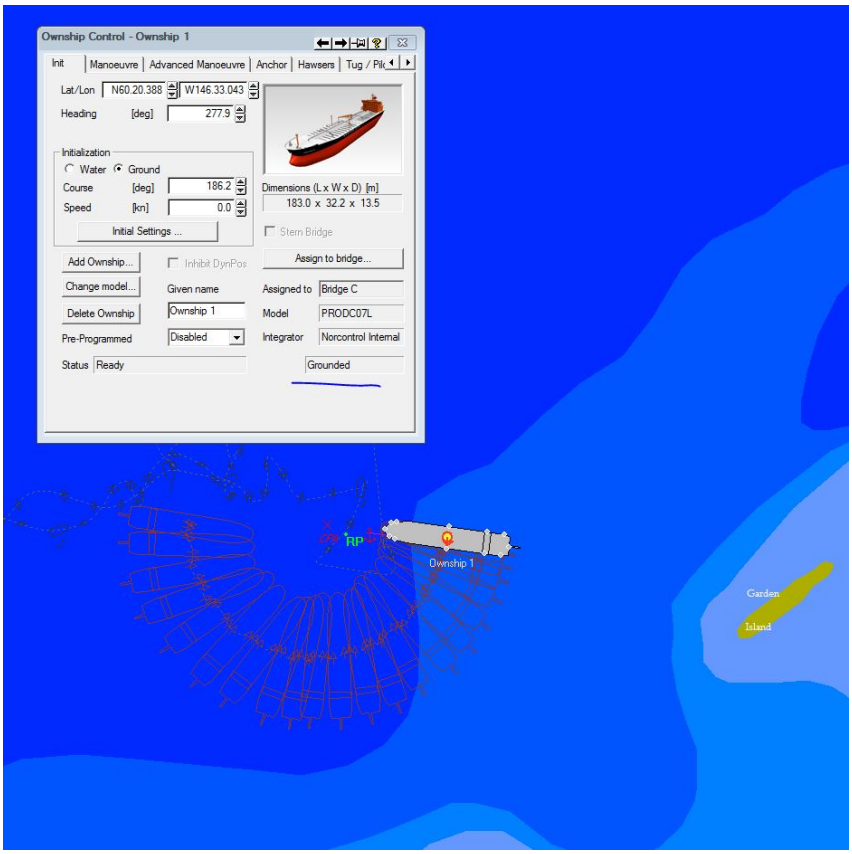

Figure 22. 360-Degree Anchor Swing at Port Etches Moorage, Depicted Position of Mooring Buoy, 60 20.39 N 146 33.20 W

The Port Etches Moorage charted mooring buoy position is at 60 20.51 N 146 33.496 W. It provides mooring capability for SERVS response barges and is not designed for deep draft oil tankers. SERVS was contacted but did not provide specific information about the mooring buoy such as its anchor gear and maximum line tension. Mooring buoys for ships are commonly utilized in the maritime industry as conventional buoy mooring (CBM) systems, single point

mooring (SPM) systems, or a combination of mooring buoy systems. All buoy mooring systems provide a secure mooring for vessels of specific sizes and prerequisites based upon the buoy anchoring system. The SERVS Port Etches mooring buoy is designed for SERVS barges and was not designed for deep draft oil tankers. Furthermore, in order to connect a deep draft oil tanker to the mooring buoy a third vessel would be required. This is because the two tugboats assisting the disabled oil tanker will have to maintain the vessel's position. Then a third vessel would take the mooring line from the disabled oil tanker to the mooring buoy. Therefore, the Port Etches Moorage at the charted mooring buoy position at 60 20.52 N 146 33.50 W is not a safe location for a TAPS disabled oil tanker to use as a PPOR. However, simulated maneuvers were still completed at this location.

Table 26. Simulated Maneuver Results for Port Etches Moorage, Charted Buoy Position 60 20.52 N 146 33.50 W, (n=6)

Vessel	Listing	Aground	UKC (feet)	Max Line Tension (tons)	Swing Room	Concern for Safety	Difficulty
Crowley 115K	Y	No	54	22	Yes	1	2
Crowley 115K	N	No	48	25	Yes	1	1
Polar	Y	No	46	48	Yes	1	2
Polar	N	No	48	45	Yes	1	2
ATC	Y	No	42	56	Yes	1	2
ATC	N	No	43	36	Yes	1	2

For the Port Etches Moorage at the charted mooring buoy position at 60 20.39 N 146 33.20 W, six maneuvers were simulated. Simulations resulted in the ship model being navigated within close proximity of the mooring buoy to facilitate a 100-foot mooring line being attached by the simulator operator to the buoy. The location of the charted mooring buoy did not require navigating as close to the 10-fathom curve as the previously depicted mooring buoy position. None of the simulated maneuvers resulted in the vessel running aground and all of them had sufficient swing room. The UKC ranged from 42 to 54 feet. The maximum line tension on the vessel ranged from 22 to 56 tons. Overall, concern for the safety of the vessel was low and the maneuver was not difficult to complete.

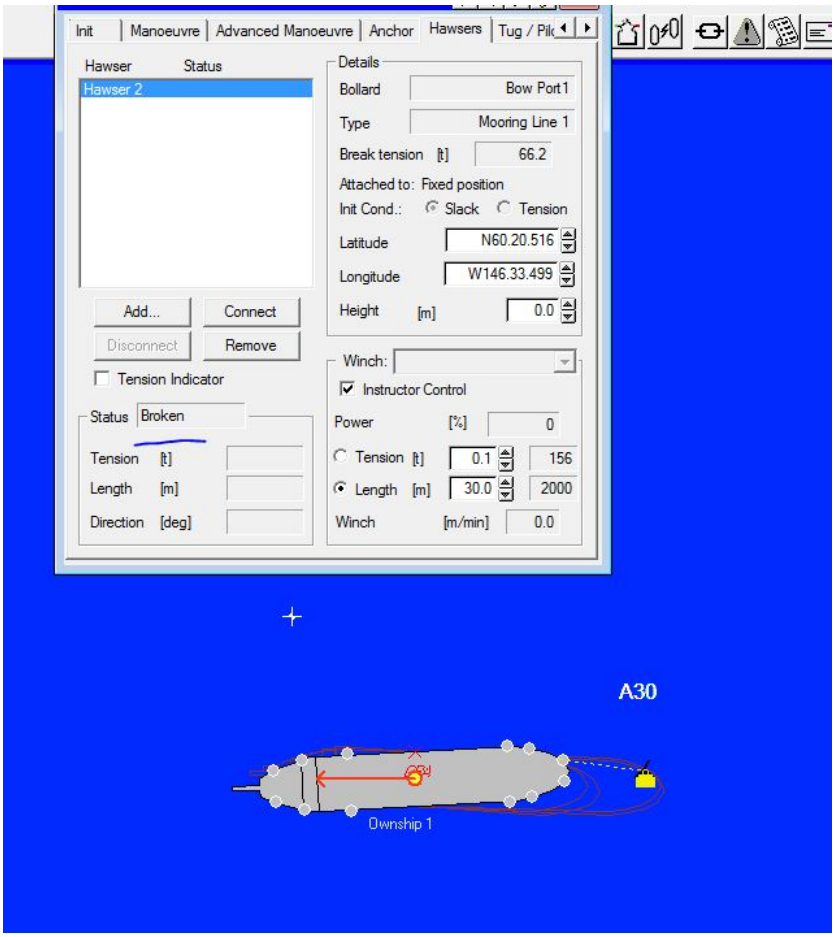

Figure 23. 360 Degree Anchor Swing at Port Etches Moorage, Charted Mooring Buoy, 60 20.52 N 146 33.50 W

To test the swing room of the PPOR, a 360-degree spin of a vessel at the charted mooring buoy location was completed. This was conducted using the ATC ship model (LOA 900 feet, draft 56 feet) using 100 feet of line tied to the mooring buoy. The mooring line was set to 60 tons of tension as the breaking point. Figure 23 shows a screenshot of the result. It indicates that the mooring line broke due to the tension being greater than 60 tons. This is a further indication about the mooring buoy being an insufficient PPOR for a deep draft disabled oil tanker.

Zaikof Bay Anchorage

Zaikof Bay is at the northeast end of Montague Island that is on the west side of Hinchinbrook Entrance. Zaikof Bay is situated in a northeasterly, southwesterly direction for approximately 5 miles. The entrance of Zaikof Bay is bordered by Middle Point to the north and Zaikof Point to the south. Schooner Rocks, located off Zaikof Point, are considered the southern boundary of Hinchinbrook Entrance and is a reporting location for VTS. The Zaikof Bay entrance is approximately 1 mile wide and open to the northeast. Midchannel at the entrance is a shoal that is only 6.5 fathoms, or about a 40 feet deep, and 1.4 miles northwest of Zaikof Point. This is depicted on the chart in Figure 24. This shoal is too shallow for the deep draft oil tankers to safely navigate over, so they are required to avoid this area. Therefore, this PPOR location

should not be considered safe due to it requiring a disabled deep draft oil tanker to maneuver in close proximity of the 40-foot shoal at the midchannel entrance.

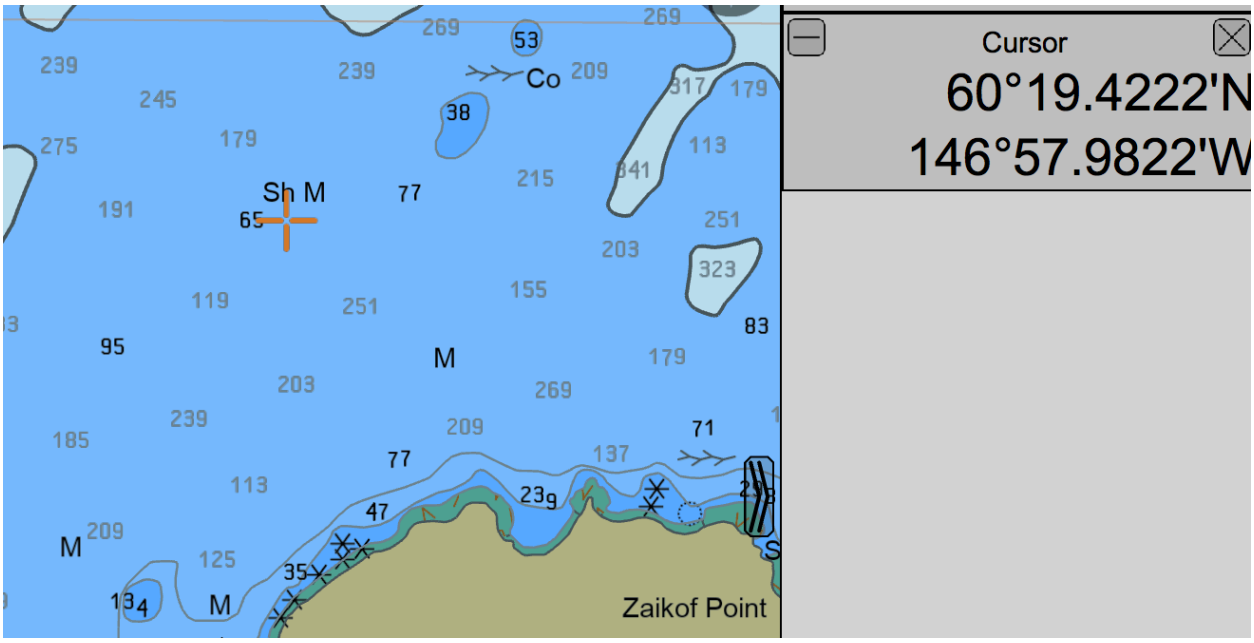

Figure 24. Zaikof Bay Anchorage, Anchor Position, 60 19.42 N 146 57.98 W

According to the PWS Contingency Plan (August 2018), Zaikof Bay Anchorage's anchor position is at 60 19.42 N 146 57.98 W. This requires the vessel to navigate with fair winds or wind from the stern as the prevailing wind is from the east (090 degrees). This wind direction makes it difficult to maintain control of a disabled ship. The close proximity of the grounding location at the shoal midchannel, 0.45 miles east northeast of the designated anchor location, requires the pilot or captain to navigate around the shallow area and maneuver the vessel up into the wind, or perform a round turn, within close quarters. The swing room at this PPOR location is sufficient, however it would cause concern for the safety of the ship if the wind blew from the west. A westerly wind would cause the stern to come close to grounding on the shallow shoal area. Pilot comments were: "I was somewhat concerned due to the depth of water only 17 feet UKC." "Downwind approach was complicated with shoal area too close to the anchor position." Therefore, two maneuvers were simulated at this location and SGM identified an alternative anchor position in Zaikof Bay.

Table 27. Simulated Maneuver Results for Zaikof Bay Anchorage, Anchor Position, 60 19.42 N 146 57.98 W, (n=2)

Vessel	Listing	Aground	UKC (feet)	Swing Room	Concern for Safety	Difficulty
Crowley 115K	Y	No	17	Yes	3	2
Crowley 115K	N	No	25	Yes	1	2

At the Zaikof Bay Anchorage anchor position at 60 19.42 N 146 57.98 W, two maneuvers were simulated utilizing the Crowley 115K tanker model. While neither simulated maneuver resulted

in running aground and there was sufficient room for swing room, the UKC ranges from 17 to 25 feet which was judged to be too shallow by the pilots.

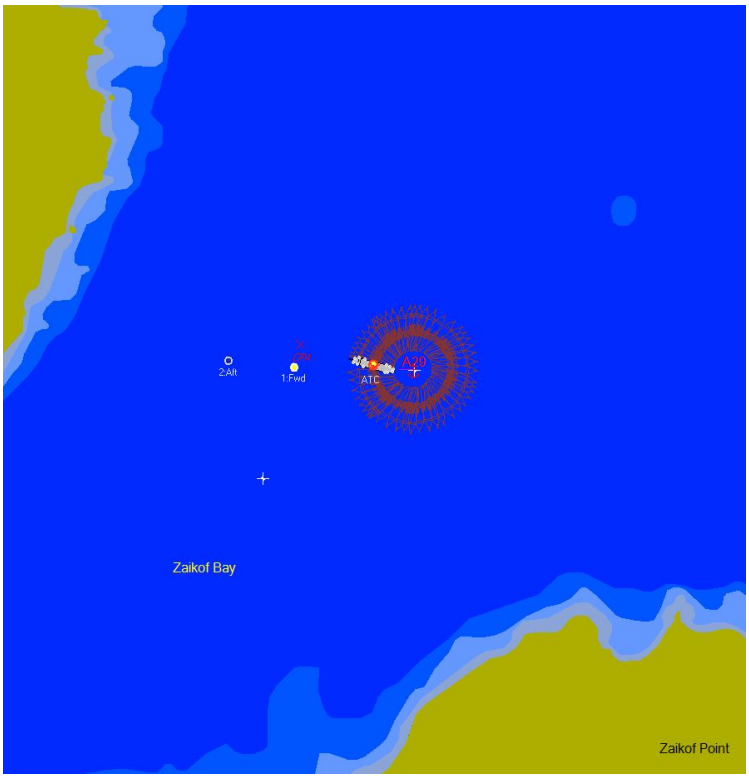

Figure 25. 360-Degree Anchor Swing at Zaikof Bay Anchorage, Anchor Position, 60 19.42 N 146 57.98 W

To test the swing room of the PPOR, a 360-degree spin of a vessel at the anchor location was completed. This was conducted using the ATC tanker model (LOA 900 feet, draft 56 feet) using 4.5 shots of anchor at 6:1 scope. Figure 25 is a screenshot of the result. It indicates that the vessel is in a safe position away from the shoreline. However, it is to close in proximity to the shallow shoal. Therefore, the Zaikof Bay Anchorage anchor position at 60 19.42 N 146 57.98 W is not a safe location for a deep draft disabled oil tanker to use as a PPOR.

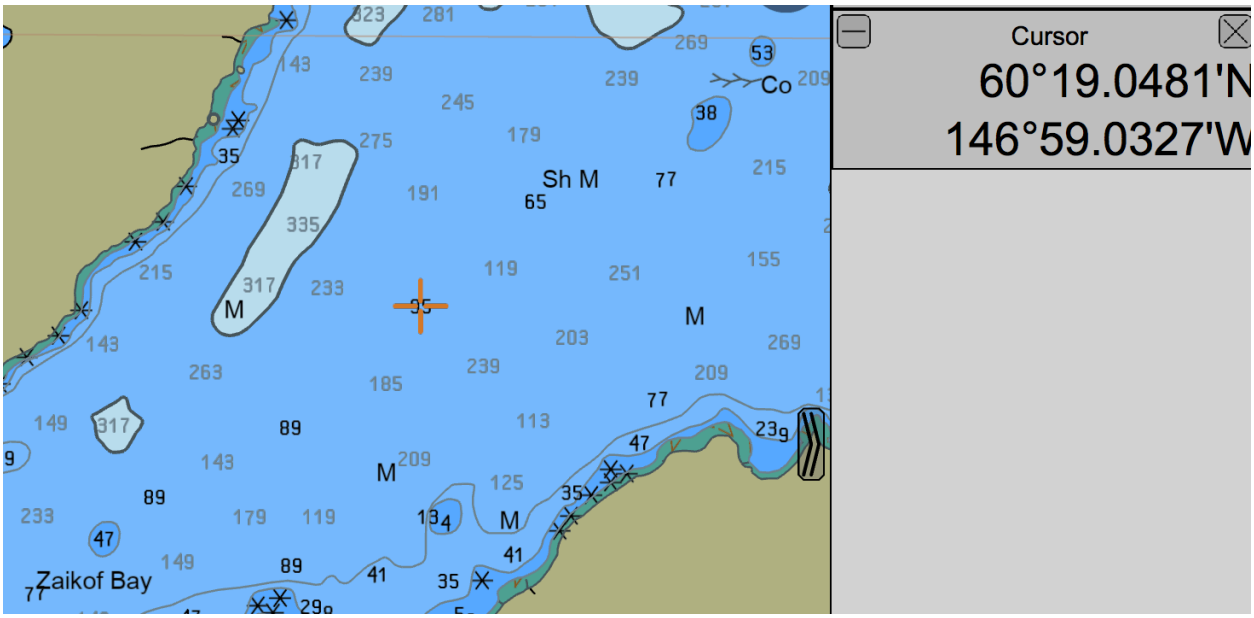

Figure 26. Zaikof Bay Anchorage, SGM Anchor Position, 60 19.05 N 146 59.03 W

SGM identified an alternative anchor position in Zaikof Bay due to the close proximity of a shallow shoal area (about 40 feet deep) near the original anchor position. Simulating the wind from the east (090 degrees) required the ship to navigate with a following wind. This approach is difficult in particular with a disabled vessel being towed into position. The SGM anchor position is at 60 19.05N 146 59.03W. That is 0.63 miles west southwest of the designated position with 95 feet of water for anchoring. This alternative location provides over a mile of maneuvering room for the disabled tanker away from the shallow shoal grounding position. Providing more maneuvering room for a disabled oil tanker under tow and approximately a 0.65-mile radius for swing room.

The previous anchor location was approximately 1.5 miles bearing 300 degrees from Schooner Rocks. This location could allow any wrap around southerly swells to affect an anchored vessel. Moving the designated position approximately 0.6 miles to the west, further into the bay, results in a position 2.1 miles bearing 284 degrees away from Schooner Rock. This provides better shelter for a deep draft oil tanker and reduces the possibility of wrap around swells affecting the anchor location. Pilot comments were: “more water, this was better, 50 feet UKC” and “more room to turn around into the wind prior to dropping the anchor.”

Table 28. Simulated Maneuver Results for Zaikof Bay Anchorage, SGM Anchor Position, 60 19.05 N 146 59.03 W, (n=6)

Vessel	Listing	Aground	UKC (feet)	Swing Room	Concern for Safety	Difficulty
Crowley Shuttle	Y	No	54	Yes	1	3
Crowley Shuttle	N	No	54	Yes	1	3
Polar	Y	No	49	Yes	1	3
Polar	N	No	56	Yes	1	3
ATC	Y	No	50	Yes	1	3
ATC	N	No	41	Yes	1	3

At the Zaikof Bay Anchorage, SGM anchor position of 60 19.05 N 146 59.03 W, six maneuvers were simulated. None of the maneuvers resulted in a grounding and the swing room was sufficient. The UKC ranged from 41 to 56 feet. There was little concern for the safety of the vessel and the maneuver was not too difficult to perform.

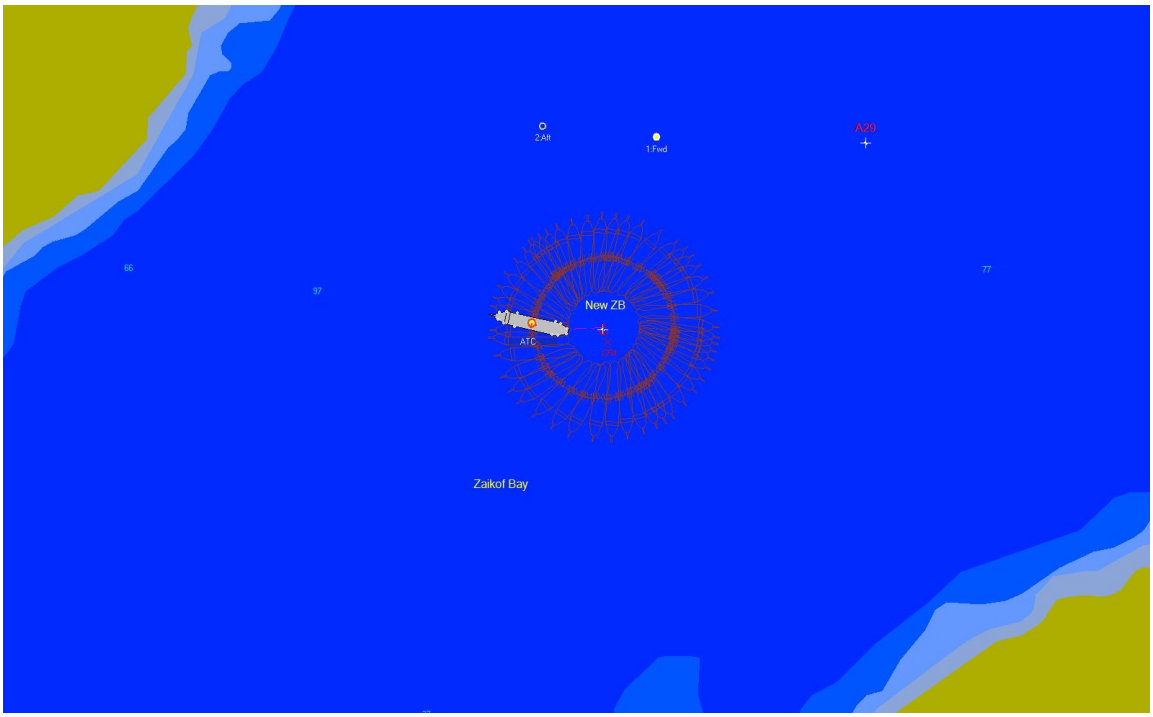

Figure 27. 360 Degree Anchor Swing at Zaikof Bay Anchorage, SGM Anchor Position, 60 19.05 N 146 59.03 W

To test the swing room of the PPOR, a 360-degree spin of a vessel at the anchor location was completed. This was conducted using the ATC ship model (LOA 900 feet, draft 56 feet) using 4.5 shots of anchor at 6:1 scope. Figure 17 is a screenshot of the result. It indicates that the vessel is in a safe position away from the shoreline or other obstructions. Therefore, the Zaikof Bay Anchorage at SGM anchor position of 60 19.05 N 146 59.03 W is a safe location for a deep draft disabled oil tanker to use as a PPOR.

10. CONCLUSIONS

In total, 74 ship maneuvers were simulated by three SWAPA pilots at the eight PPOR locations as well as alternative locations utilizing deep draft oil tanker models experiencing at least partial propulsion failure and either listing or not listing (i.e., in distress). The environmental conditions did not vary between simulated maneuvers at each PPOR and the highest sustained winds were utilized at each PPOR except for one simulated maneuver. This was done in part to test whether the vessel would run aground due to the prevailing wind direction. Furthermore, the pilots provided input after each simulated maneuver discussing their concern for the safety of the vessel, whether there was enough swing room, whether the UKC was sufficient, among other issues. Finally, 12 simulations were completed spinning a vessel model 360 degrees at the anchor or mooring location with sufficient anchor scope in order to better understand the swing room for the vessel from any wind direction. Based on these results we have come to the following conclusions evaluating the safety for deep draft oil tankers in distress utilizing the following PPOR locations.

Table 29. Results of Simulations of PPOR Risk Assessment for Deep Draft Vessels

PPOR Name	Latitude Longitude	Notes	Result
North Smith Island	60 31.90 N 147 22.67 W	Grounding of ships	Not Safe
North Smith Island	60 31.31 N 147 24.22 W	SGM revised	Caution
Outside Bay	60 38.26 N 147 29.48 W	Located close proximity to 10-fathom curve	Not Safe
McPherson Bay	60 40.65 N 147 21.79 W	Exposed to northerly quadrant wind and seas	Caution
North Jack Bay Anchorage	61 02.41 N 146 37.3 W	Insufficient swing room	Not Safe
South Jack Bay Anchorage	61 01.98 N 146 37.49 W	Grounding of ships	Not Safe
South Jack Bay Anchorage	61 02.0 N 146 37.50 W	SGM revised	Not Safe
Port Etches Anchorage	60 20.59 N 146 33.84 W	Insufficient swing room	Not Safe
Port Etches Anchorage	60 19.91 N 146 36.05 W	SGM revised	Safe
Port Etches Moorage	60 20.39 N 146 33.20 W	Depicted buoy position, insufficient swing room	Not Safe
Port Etches Moorage	60 20.52 N 146 33.50 W	Actual buoy position, mooring not adequate	Not Safe
Zaikof Bay Anchorage	60 19.42 N 146 57.98 W	Insufficient water depth	Not Safe
Zaikof Bay Anchorage	60 19.05 N 146 59.03 W	SGM revised	Safe

Table 29 summarizes the results of the simulated maneuvers conducted at each PPOR and SGM alternative latitude and longitude anchor or mooring position. The alternative anchor locations at Port Etches Anchorage and Zaikof Bay Anchorage are safe for a disabled deep draft oil tanker in distress to anchor. In addition, the revised anchor positions identified by SGM at North Smith Island Anchorage and the McPherson Bay Anchorage should be used with caution by oil tankers in distress.

This research has many limitations to both internal and external validity. Limitations to the internal validity include the PPOR analyzed. The PPOR in Port Valdez (Gold Creek Anchorage, Valdez Container Terminal, Valdez Marine Terminal Berths #1, #3, #4, and #5) as well as Knowles Head were beyond the scope of this research because their limitations and capabilities are already well known to pilots and shipmasters aboard oil tankers. Also, the PPOR in western PWS including Pigot Bay Anchorage, Whittier Cruise Ship Dock, Delong Pier, North College Fjord Anchorage, South College Fjord Anchorage, and MacLeod Harbor Anchorage are all west of the ship traffic lanes so were also outside the scope of this research. Also, west of Naked Island was utilized as a PPOR by the Exxon Valdez in 1989, however that location was not identified by the PWS Contingency Plan (August 2018) as a PPOR so it was also outside the scope of this research. Other locations within close proximity to the shipping lanes may also be utilized by oil tankers in distress as PPOR, but they were not previously identified by the PWS Contingency Plan (August 2018) and therefore are beyond the scope of this research.

This research only evaluates the maritime navigation of these PPOR. The PWS Contingency Plan (August 2018) took other factors into perspective when identifying these PPOR such as distance from population centers, proximity to environmentally sensitive areas, conflicting uses, response factors, and proximity to other PPOR. The depth and type of bottom used during simulated maneuvers was based on information provided by NOAA charts as well as the PWS Contingency Plan (August 2018). Soundings that may update or change the depth or type of bottom may lead to different results. The ship models used are only representative of the actual oil tankers that are a part of the TAPS fleet. Exact models of the tankers are not publicly available in the Kongsberg ship model library and are not available at AVTEC. Therefore, representative models similar in various attributes such as length, draft, displacement, block coefficient, and number of props and rudders are used. During the interviews with subject matter experts it was agreed that these models were representative of the types of ships that are in the TAPS fleet of oil tankers. Finally, the pilots taking part in this research knew the objective and conditions before the simulated maneuver began. In a real-life emergency, the response times and decision-making of all those involved may differ from these simulated maneuvers.

In terms of external validity this research has many limitations. These results only apply to the types of vessels modeled here which are deep draft oil tankers. The largest vessel model represents a loaded ATC tanker at 185,000 tons displacement, LOA of 941 feet, beam 164 feet, and draft of 59 feet. The safe evaluation of these PPOR does not apply to larger oil tankers or other deep draft vessels that may navigate PWS. Furthermore, this research only applies to oil tankers as deep draft vessels, so light draft vessels and smaller vessels may experience different results. It also does not apply to other deep draft vessels such as cruise ships, LNG carriers, or cargo ships that may also navigate PWS. These oil tankers in distress were maneuvered into position by three SWAPA pilots who all have multiple years of training and operations in Port

Valdez. The external validity of these results to other mariners including oil tanker captains and other SWAPA pilots may be limited. The decision to utilize any of these PPOR should be incident specific and based on the best judgement of the COTP as well as the ship's master. These tankers were maneuvered into position using two assist tugboats. The tugboats significantly improved the maneuvering capability of the oil tanker to reach the desired location. Therefore, these results only apply when at least two assist tugboats are able to tether to the disabled vessel to help it maneuver.

The results of the 2017 study also found that having only two assist tugboats with a bollard pull of at least 128 tons tethered to the vessel were sufficient to help navigate the distressed oil tanker to the PPOR. This was even in conditions of 7- and 15-degree listing of the vessel. However, this was also done within 0.5 miles of the PPOR location in all cases with the tugboats already tethered to the bow and stern and the vessel underway at 3 knots when it lost propulsion. Also, the 2017 study found that having dual rudders and propellers after one loses function is still superior for maneuvering a vessel compared to having a single rudder and propeller losing function.

What this research finds are that the specific anchor locations at Port Etches Anchorage and Zaikof Bay Anchorage could be safely used by an oil tanker in distress. However, this does not mean that these PPOR should be used by an oil tanker in distress. We agree with the ARRT, as stated in the Guidelines (September 2013), these PPOR are not pre-approved. Rather, this report provides information about these PPOR that should inform decision-making that is made on an incident-specific basis. In other words, in agreement with ARRT's Guidelines (September 2013) whether an oil tanker in distress should use a PPOR is incident-specific and based on the best available information and best professional judgement available.

This research concludes that the original anchor location at North Smith Island Anchorage, Outside Bay Anchorage, North Jack Bay Anchorage, original anchor location at South Jack Bay Anchorage, original anchor location at Port Etches Anchorage, the Port Etches Moorage (both the location depicted in the PWS Contingency Plan (August 2018) as well as the actual charted mooring buoy position), and the original anchor location at Zaikof Bay Anchorage all should not be used by an oil tanker in distress because they are not reliably safe.

11. RECOMMENDATIONS

Based on these conclusions we make the following recommendations:

PPOR Decision-Making

1. An oil tanker in distress should seek a PPOR based on an incident-specific basis. Above all else, the best professional judgement should be used based on the best information available and understand that no PPOR is pre-approved.
2. Given that utilizing a PPOR should be incident-specific and none are pre-approved, an oil tanker in distress should seek to maneuver to the closest pre-identified PPOR. In North-PWS that means various locations in Port Valdez, in Mid-PWS that is Knowles Head Anchorage, and in South-PWS either Port Etches Anchorage (60 19.91 N 146 36.05 W) or Zaikof Bay Anchorage (60 19.05 N 146 59.03 W).

Updating the Prince William Sound Subarea Contingency Plan (August 2018) and Charts

1. The Prince William Sound Subarea Contingency Plan (August 2018) should remove the following PPOR locations from those listed as safe for deep draft vessels: Outside Bay Anchorage (60 38.26 N 147 29.48 W), North Jack Bay Anchorage (61 02.41 N 146 37.30 W), South Jack Bay Anchorage (61 01.98 N 146 37.49 W), Port Etches Moorage Depicted Buoy Position (60 20.39 N 146 33.20 W), as well as the Port Etches Moorage Actual Buoy Position (60 20.52 N 146 33.50 W).
2. The Prince William Sound Subarea Contingency Plan (August 2018) should revise the latitude and longitude anchor locations for the following PPOR concerning deep draft vessels: North Smith Island Anchorage (60 31.31 N 147 24.22 W), Port Etches Anchorage (60 19.91 N 146 36.05 W), and Zaikof Bay Anchorage (60 19.05 N 146 59.03 W).
3. The Port Etches Moorage buoy position should be updated to the actual buoy position. Furthermore, the safe working load of the buoy ground tackle should be reported in the Prince William Sound Subarea Contingency Plan (August 2018).
4. PPOR should be identified on nautical charts with an associated symbol such as an anchor and the label “PPOR.” This would assist pilots and shipmasters to quickly identify the closest PPOR in case of a vessel being disabled or otherwise in distress.

Additional Research

1. Additional research should evaluate the safety of deep draft vessels utilizing the remaining PPOR locations within PWS, in particular cruise ships using the following PPOR locations: Pigot Bay Anchorage, South College Fjord Anchorage, and North College Fjord Anchorage.
2. Additional research should evaluate the safety of various deep draft vessels such as oil tankers, LNG carriers, cruise ships, container ships and cargo ships utilizing pre-identified PPOR in the two remaining area contingency plans for Alaska that include coastal areas: Arctic and Western Alaska (includes Aleutians, Bristol Bay, Cook Inlet, Kodiak Island, North Slope, Northwest Arctic, Western Alaska) and Southeast.

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