Cook Inlet Risk Assessment

FINAL REPORT

January 27, 2015

Revision 1

Prepared by: **Nuka Research and Planning Group, LLC and Pearson Consulting, LLC**

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Executive Summary

The Cook Inlet Risk Assessment (CIRA) was initiated and led by the Alaska Department of Environmental Conservation, U.S. Coast Guard, and Cook Inlet Regional Citizens Advisory Council (Cook Inlet RCAC) from 2011-2014. These parties comprised the Management Team for the project. A multi-stakeholder Advisory Panel provided input throughout the process.

The risk assessment was conducted in two phases. The first phase involved collecting baseline information about the risks of marine accidents in Cook Inlet, including studies of vessel traffic, accident causality, and potential spill consequences. This information informed the Advisory Panel's consideration of potential risk reduction options. The second phase of the risk assessment included technical analyses to provide more information regarding selected risk reduction options. This report summarizes the technical analyses and describes the final recommendations of the Advisory Panel. All recommendations were developed based on group consensus.

The Advisory Panel considered 21 potential risk reduction options compiled through a public solicitation process as part of the CIRA, Advisory Panel members, and previous processes and forums related to navigational safety on Cook Inlet. This multi-stakeholder group ultimately recommended 13 risk reduction options to maintain and enhance the level of risk mitigation already achieved on Cook Inlet's waters. Where these efforts are already underway, they should be sustained and, in some cases, enhanced or expanded within the Inlet.

CIRA risk reduction options:

1. Construct subsea pipeline across Cook Inlet
2. Establish Harbor Safety Committee
3. Sustain/enhance training for pilots, captains, and crew
4. Harbormasters notify U.S. Coast Guard of unsafe vessels, and identify and communicate facility or equipment limits to all users
5. Maintain project depth at Knik Arm
6. Expand cellular and very high frequency (VHF) radio coverage
7. Use Automated Identification System (AIS) broadcasts to enhance situational awareness
8. Conduct third party inspections of workboats
9. Enhance emergency towing
10. Enhance vessel self-arrest
11. Promulgate federal non-tank vessel response planning regulations
12. Update and improve Subarea Contingency Plan
13. Continue to improve oil spill response equipment as proven options are developed

The State of Alaska secured initial funding for the CIRA through legislative appropriation, administered by the Kenai Peninsula Borough and Cook Inlet RCAC. The U.S. Coast Guard, National Fish & Wildlife Foundation, Tesoro Alaska, and Prince William Sound Regional Citizens' Advisory Council provided additional funding. The relatively modest budget of $870,000 limited the scope of analysis.

Acronyms

ADEC	Alaska Department of Environmental Conservation
AIS	Automated Identification System
AOOS	Alaska Ocean Observing System
ATON	Aid to navigation
AVTEC	Alaska Vocational Technical Center
AWOIS	Automated Wrecks and Obstructions Information System
CINC	Cook Inlet Navigation Channel
CIRA	Cook Inlet Risk Assessment
CISPRI	Cook Inlet Spill Prevention and Response, Inc.
Cook Inlet RCAC	Cook Inlet Regional Citizens Advisory Council
ETC	Eligible telecommunications carrier
ETS	Emergency towing system
HSC	Harbor Safety Committee
MXAK	Marine Exchange of Alaska
NOAA	National Oceanic and Atmospheric Administration
NVIC	Navigation and Vessel Inspection Circular
PWSRCAC	Prince William Sound Regional Citizens' Advisory Council
SMS	Safety Management System
TOO	Tug of opportunity
TRB	Transportation Research Board
USACE	U.S. Army Corps of Engineers
VHF	Very high frequency

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1. Introduction

The Cook Inlet Risk Assessment (CIRA) was a multi-year, multi-stakeholder project designed to assess the risks of oil spills to Cook Inlet from marine vessels and recommend risk reduction options. The project was launched in 2011 as a combined effort of the Cook Inlet Regional Citizens Advisory Council (RCAC), Alaska Department of Environmental Conservation (ADEC), and the U.S. Coast Guard.

1.1 CIRA Background

The safety of maritime transportation in Cook Inlet has been a heightened concern of the Cook Inlet RCAC, ADEC, and the U.S. Coast Guard since the grounding of the *T/V Seabulk Pride* in 2006 (ADEC, 2006). A series of efforts dating back 15 years laid the groundwork for the CIRA. In 2007, the Cook Inlet RCAC convened the Cook Inlet Navigational Safety Forum, which resulted in a consensus agreement that a more formal risk assessment should be conducted (Cook Inlet RCAC, 2007). Cook Inlet RCAC held another forum in 1999 (Cook Inlet RCAC, 1999). The U.S. Coast Guard had also convened a Ports and Waterways Safety Assessment of the region in 2000 (USCG, 2000a).

The State of Alaska secured initial funding for the CIRA through legislative appropriation, administered by the Kenai Peninsula Borough and Cook Inlet RCAC. The U.S. Coast Guard, National Fish & Wildlife Foundation, Tesoro Alaska, and Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) provided additional funding. The relatively modest budget of $870,000 limited the scope of analysis.

The risk assessment was conducted in two phases. The first phase was to collect baseline information about the risks of marine accidents in Cook Inlet. This information was used to guide the selection of potential risk reduction options. The second phase of the risk assessment was to conduct technical analysis for selected risk reduction options and provide final recommendations from the Advisory Panel.

1.2 Purpose and Scope

The purpose of this report is to summarize the technical studies and additional analysis conducted to inform the Advisory Panel's recommendations on risk reduction options. This report was completed by Nuka Research and Planning Group, LLC (Nuka Research) and Pearson Consulting, LLC as a final deliverable for the CIRA.

This report synthesizes the key analyses and findings from the interim studies completed during the CIRA. The Advisory Panel reviewed these studies and considered the results in developing the final recommendations presented in this report. These studies, listed below, are referenced throughout this report. Some are also included as appendices to this report, as noted below. The following technical studies were conducted for the CIRA:

1. Cook Inlet Vessel Traffic Study (2012), by Cape International
2. Spill Baseline and Accident Causality Study (2012), by Glosten Associates, Inc. in collaboration with Environmental Research Consulting
3. Consequence Analysis Report (2013), by Nuka Research and Planning Group, LLC
4. Reduced Risk of Oil Spill with a Cross Inlet Pipeline (2013), by The Glosten Associates *(included as Appendix A)*

5. Evaluation of 2012 Tugboat Response Times (2013), by The Glosten Associates *(included in Appendix B, along with comments)*
6. Evaluate Drifting Vessel's Ability to Self-arrest (2013), by The Glosten Associates *(included in Appendix B, along with comments)*
7. Benefit-Cost Analysis of the Trans-Foreland Pipeline as an Oil Spill Risk Reduction Option (2014), by Northern Economics, Inc. *(included as Appendix C)*

The authors updated the report in early 2015 by adding the comments received from during a public comment period in September and October 2014 as well as the Management Team's response to those comments. These can be found in Appendix D.

1.3 Organization of this Report

This report provides a high-level summary of the CIRA process and participants, as well as the technical studies completed during Phase A (Section 2). The report describes the Advisory Panel's recommendation of risk reduction options for further study (Section 3) and presents additional technical analyses to support the evaluation of risk reduction measures that eliminate or reduce root causes (Section 4), decrease frequency of immediate causes and exposure to hazardous situations (Section 5), prevent an accident if an incident occurs (Section 6), and reduce oil outflow and spill impacts if an accident occurs (Section 7). Based on these analyses, the Advisory Panel makes a series of recommendations for risk reduction options in Cook Inlet, which are described with each risk reduction option and summarized in Section 8.

2. Risk Assessment Process

Collaboration of all essential, decision-making parties was crucial to the success of the CIRA and critical to the future implementation and continuous improvement of risk reduction efforts. The CIRA engaged stakeholders in defining and analyzing risks and identifying risk reduction measures through a multi-stakeholder Advisory Panel and a Management Team comprised of representatives from Cook Inlet RCAC, ADEC, and the U.S Coast Guard. There were also opportunities for public comment at meetings and on draft documents.

2.1 Risk Assessment Approach

The CIRA focused on potential oil spills associated with large vessel traffic in Cook Inlet, Alaska. It followed a risk assessment process outlined by the Transportation Research Board (TRB) of the National Academies, with some modifications due to funding limits.

2.1.1 Transportation Research Board Process

The CIRA follows the TRB's recommendations from the 2008 Special Report 293, "Risk of Vessel Accidents and Spills in the Aleutian Islands: Designing a Comprehensive Risk Assessment." The TRB report recommends a two-phase process for conducting a maritime risk assessment and recommending risk reduction options based on both technical analysis and stakeholder input. Phase A included studying vessel traffic, analyzing spills and incidents to develop scenarios of likely future incidents, and considering the consequences of potential future spills. Phase B included identifying and evaluating potential risk reduction options, and recommending one or more priorities. The Aleutian Islands Risk Assessment, for which analyses and stakeholder meetings were completed in 2014, also followed the TRB process.[1] The CIRA followed a similar approach to the Aleutian Islands project, but was conducted with an abbreviated timeline and smaller budget.

The TRB's approach prescribed a management structure consisting of a Management Team, Advisory Panel, and Peer Review Panel. This structure was also used for the CIRA with the modification of having a single expert in marine risk assessment instead of the Peer Review Panel (Section 2.2).

2.1.2 Project Scope

The CIRA focused on the marine waters and coastal areas of Cook Inlet as defined in regulation[2] and shown in Figure 1. Cook Inlet has some of the most extreme tides in the world and is home to commercial and recreational fisheries; petroleum exploration, extraction, and transport; tourism; subsistence use; and both endemic and migratory birds and wildlife. More than 40% of Alaska's population lives in the Cook Inlet region and the vast majority of the state's commodities and goods are shipped through its ports. Conditions and activities vary across the Inlet's operating areas, which are defined as: Lower, Middle, and Upper. These are shown in Figure 1.

The CIRA considered potential impacts associated with oil spilled from marine vessels of more than 300 gross tons (excluding military and research vessels for which there are limited traffic data) and smaller vessels with a fuel capacity of at least 10,000 gallons. Tugboats and fuel barges were included regardless of their gross tonnage and fuel capacity. The CIRA considered the following major accident types: collisions, allisions, powered groundings, drift groundings, foundering, structural failures, mooring failures, and fires and explosions.

Operational and intentional discharges from ships were not considered, nor were releases associated with Cook Inlet's petroleum exploration and production operations.[3]

2.2 Participants

The CIRA was implemented by a Management Team, Advisory Panel, and Facilitation and Analysis Team, with input from technical analysts, the public, and a Subject Matter Expert in risk assessment.

2.2.1 Management Team

The Management Team was comprised of representatives from the U.S. Coast Guard, ADEC, and Cook Inlet RCAC as the relevant funding agencies (see Appendix E). The Management Team made

[1] www.aleutianislandsriskassment.com

[2] U.S. Coast Guard regulations at 46 CFR 7.165 define Cook Inlet's water boundaries as, "A line drawn from the southernmost extremity of Kenai Peninsula at longitude 151° 44.0 W to East Amatuli Island Light; thence to the northwestern extremity of Shuyak Island at Party Cape; thence to the eastern most extremity of Cape Douglas."

[3] Operational spills include spills that occur during cargo transfer or other routine operations. While spills from exploration and production infrastructure (drilling rigs and platforms) were excluded, spills from marine vessels associated with oil and gas production infrastructure were included in this study.

decisions for the project, reviewed and approved all project deliverables, and guided the expenditure of project resources. They also chartered and appointed members to the Advisory Panel.

2.2.2 Advisory Panel

The Advisory Panel was comprised of stakeholders and experts with local knowledge and expertise on issues critical to the success of the CIRA, including local infrastructure, relevant industries, waterways and their navigation, weather, subsistence use, and wildlife and habitat. The Advisory Panel consisted of a primary and alternate member for each stakeholder category (see Appendix E). The members represented their stakeholder groups generally, although many also work professionally in the area they represented. The recommendations described here represent the consensus of the Advisory Panel members.

Figure 1. Map of Cook Inlet, including study area boundaries and operating areas

2.2.3 Public

Public involvement occurred in two forms: (1) dissemination of ongoing project updates; and (2) public comment opportunities. All interested parties were invited to join a public email list for project updates, in addition to the information posted on the project website.[4] Input from the public has also been invited for specific project deliverables. These opportunities have included: recommending risk reduction options for consideration (via an online comment form), providing comments at meetings during comment periods on the agenda, and providing comments on studies or other deliverables. All key project deliverables, including this report, were released in draft form for public review (see Appendix D), and all public comments were posted on the project website. Comments were directly incorporated to the deliverables as appropriate and under the Management Team's guidance. In addition, materials provided by the public are often posted on the project website.

2.2.4 Facilitation and Analysis

Nuka Research and Planning Group, LLC and Pearson Consulting, LLC managed the project on behalf of the Management Team, facilitated the Advisory Panel, and procured sub-contract services necessary for some of the technical analyses. The Glosten Associates, Inc., Northern Economics, Inc., Cape International, Inc., and Environmental Research Consulting delivered analytical support in the form of key analyses conducted for the project (see Section 2.3).

The project also benefitted from the review and input of Dr. John Harrald as a subject matter expert on maritime risk assessments.

2.3 Initial Technical Studies (Phase A)

During Phase A, three initial technical studies were performed to explore marine vessel oil spill risks and inform the consideration of various risk reduction options. These included: a vessel traffic study estimated current and potential future vessel traffic patterns; a spill baseline study estimated the potential frequency, severity, and cause of spills from marine vessels; and a consequence analysis report compared the potential consequences of hypothetical spill scenarios based on stakeholder and expert input. The Advisory Panel considered these studies when developing their recommended risk reduction options.

2.3.1 Vessel Traffic Study

The *Cook Inlet Vessel Traffic Study* analyzed 2010 data on port calls and transits in Cook Inlet by vessels within the project scope (Cape International, 2012). Data were compared to a previous study of vessel traffic in 2005-2006 (Cape International and Nuka Research, 2006). Vessel traffic patterns and densities were not found to have changed substantially since this earlier study.

In 2010, 15 vessels made 80% of the estimated 480 transits of Cook Inlet by self-propelled vessels large enough to be included in the scope of this study. Most of these were state ferries or non-tank vessels. Most of the oil moving through Cook Inlet was transported via 102 oil barge transits and

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[4] www.cookinletriskassessment.com

tank ships calling at Nikiski and Drift River that year (Cape International, 2012). Figure 2 shows the routes taken by different types of vessels based on data collected for the study.

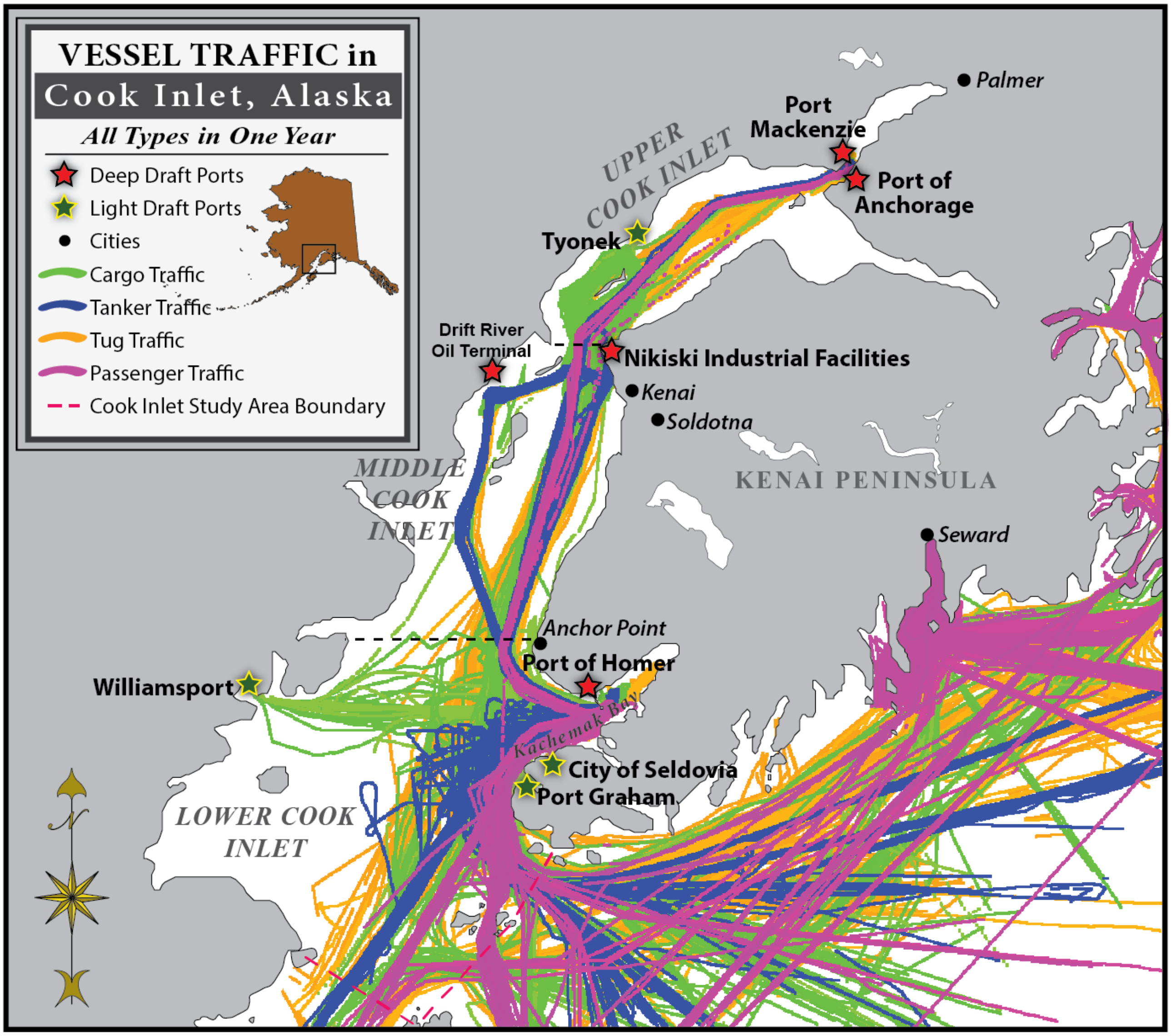

Figure 2. Vessel traffic in Cook Inlet by vessel type, 2010 (Cape International, 2012)

Several factors may impact future vessel activity in Cook Inlet, including planned and proposed changes to the Port of Anchorage and expansion opportunities at Port MacKenzie. The study also reviewed potential changes in import and export activities, including proposed coal projects, low sulfur diesel imports, the Alaska gas pipeline, and forest product and mineral extraction. Cook Inlet oil production forecasts included in the report indicate an overall downward trend in oil production volumes. However, oil movement by vessel through Cook Inlet may remain steady due to increased imports for Alaskan consumers and activity at the Nikiski refinery. Gas production is also trending downward, although recent exploratory drilling may increase available Cook Inlet gas reserves. Population and economic growth projections indicate only moderate potential impact on vessel activity. Over the next 10 years, it is reasonable to forecast that vessel traffic will remain flat or show only moderate increases (1.5-2.5% annually) due to population growth and post-recession improvements to the economy (Cape International, 2012).

2.3.2 Spill Baseline and Accident Causality Study

The *Spill Baseline and Accident Causality Study* established incident rates for tank ships, tank barges, non-tank/non-workboat vessels (ferries, cruise ships, container ships, bulk carriers, general cargo vessels, and gas carriers), and workboats (tugs, offshore supply vessels, and spill response vessels) (The Glosten Associates and ERC, 2012). Overall, the study estimated a historical spill rate of 3.4 spills (regardless of size) per year, with 3.9 spills per year forecasted for the years 2015 through 2020 across all vessel categories. Historical rates ranged from 0.7 spills per year for tank ships to 1.3 spills per year for non-tank/non-workboat vessels (The Glosten Associates and ERC, 2012). Table 1 shows the estimated 50th and 90th percentile spill volumes by vessel and incident type resulting from the study.

Table 1. 50th and 95th percentile spill volumes by vessel type and incident type (based on the The Glosten Associates and ERC, 2012)

Vessel Type	Incident Type	Oil Volume (gallons)	
		Moderate (50th percentile)	Large (95th percentile)
Tank Ship (Product Carrier)	Impact	5,000	4,000,000
	Non-impact	1,000	150,000
	Transfer Error	10	2,000
Tank Ship (Crude Carrier)	Impact	20,000	15,000,000
	Non-impact	2,000	8,000,000
	Transfer Error	10	2,000
Tank Barge	Impact	500	300,000
	Non-impact	200	300,000
	Transfer Error	10	2,000
Non-tank Vessel	Impact	1,000	300,000
	Non-impact	100	300,000
	Transfer Error	10	2,000
Workboat	Impact	100	20,000
	Non-impact	10	20,000
	Transfer Error	10	1,000

3.3.3 Consequence Analysis Workshop and Report

Subject matter experts, selected for their experience with Cook Inlet's environmental and socioeconomic resources, convened for a two-day workshop in Anchorage, AK on October 30-31, 2012. The results of this expert-led, qualitative analysis of potential spill consequences in Cook Inlet were described in the *Consequence Analysis Report* (Nuka Research, 2013). At the workshop, participating experts applied scores ranging from 1 (very low) to 5 (very high) to characterize the impacts of seven spill scenarios[5] on the following receptors:

[5] Spill scenarios were selected based on the Spill Baseline and Accident Causality Study (The Glosten Associates and ERC, 2012). The Spill Baseline and Accident Causality Study (2012) developed and categorized 2,112 scenarios based on historical and forecasted data for vessel traffic and reported incidents. The return period was calculated for each scenario based on historical spill rates. The return period of a spill describes how likely it is that a spill of equal or greater size will

- Cook Inlet habitat (pelagic, littoral, and benthic),
- Fish (shellfish and fin fish),
- Birds (waterfowl, shorebirds, and seabirds),
- Mammals (pinnipeds, whales and porpoises, and terrestrial),
- Commercial fishing,
- Subsistence uses,
- Recreation and tourism,
- General commerce, and
- Oil industry operations.

Participants considered the following factors known to influence the impacts of a spill: type of oil; spill size; and seasonality and environmental conditions that affect the movement of the spill (wind, temperature, currents or tides, and ice). The scenarios presented seven hypothetical spills with different locations, oil types, spill size, and season. Table 2 identifies the scenario parameters. The ranking of the scenarios based on subject matter expert input is shown in the middle column of Table 2. A preliminary analysis used oil spill volume as a single proxy for consequence, with the resulting rankings in the right-hand column.

Table 2. Comparison of rankings from subject matter experts and based on preliminary analysis (1 = Most Significant Impact)

Scenario					Ranking Based on Subject Matter Expert Input	Ranking based on Preliminary Analysis
Number	Location	Volume (bbl)	Product	Month		
1	Drift River	30,000	Crude oil	July	1	2
2	Nikiski	1,000	Diesel	November	6	5
3	Knik Shoal	48,000	Jet A	June	4	3
4	Anchorage	1,000	Heavy Fuel Oil (HFO)	February	7	6
5	Barrens	20,000	No. 2 Fuel Oil	May	2	1
6	Homer	100	Diesel	July	5	7
7	Anchor Point	1,000	Crude oil	September	3	4

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occur in a given year, but expresses this likelihood using an inverse probability; therefore, a 1000 year return period for a spill has a 0.001 or 0.1% chance of happening in any given year. Each scenario was also given a preliminary estimate of consequence (based solely on the type and amount of oil spilled). Six scenarios used in the Consequence Analysis Workshop were considered to be representative of possible events and resulting consequences by the Advisory Panel with input from the technical consultants who conducted the initial study. Workshop participants added a seventh scenario representing a low probability/high consequence event.

When considering the full range of potential direct impacts from an oil spill to Cook Inlet, it was clear that even relatively small spills of non-persistent fuel may have significant negative impact. For example, Scenario #6, a 100 bbl diesel spill, still had a mid-level impact score of three for Commercial Fishing and Recreation/Tourism. Each of the scenarios resulted in a significant (maximum score of three or above) impact to at least one of the receptors considered. Four of the seven scenarios resulted in a major impact (maximum score of five) to at least one of the receptors considered.

The conclusion of the workshop was that any of the spills considered would have significant impacts to the environment and socioeconomics of Cook Inlet. All areas of Cook Inlet are vulnerable to significant consequences from marine oil spills of any type in all seasons. Transferring risk from one area to another would have little or no benefits in terms of reducing consequences.

3. Risk Reduction Options (Phase B)

The Advisory Panel met in February 2013 to review and consider potential risk reduction options that served as the focus for Phase B. Potential risk reduction options were compiled through a public solicitation process as part of the CIRA (December 2012 – February 2013), options included in the Coast Guard Authorization Act of 2010, recommendations from the Cook Inlet Safety of Navigation Forum in 1999, and items identified through the Ports and Waterways Safety Assessment in 2000. During the meeting, four additional options were suggested by Advisory Panel members.

From the potential risk reduction options, the Advisory Panel and Management Team identified those that they agreed warranted immediate or sustained implementation, and those that warranted further consideration. Thirteen risk reduction measures were ultimately recommended and eight were eliminated.[6] In some cases, the activity or intervention is already underway and should be maintained, or the activity was already on track to be implemented and should be encouraged. In the case of items that were resource intensive or for which the qualitative balance of benefits and costs was unclear, further research and analysis were conducted.

Figure 3 shows each option in the context of a generic accident chain (Harrald et al., 1998), and Sections 4 through 7 describe these options. This presentation highlights the project's efforts to reduce risk throughout the accident chain, or to reduce risk *differently* even when two or more interventions focus on the same point in the accident chain. This avoids redundancy in risk reduction and ensures that efforts address not only accident and/or spill prevention but also acknowledge the potential for sufficient failures to require consequence mitigation. Overall, the greatest attention was paid to interventions that target the early stages of the accident chain.

[6] The following risk reduction options were eliminated at the February 2013 meeting: (1) traffic separation scheme, (2) establishing a Particularly Sensitive Sea Area through the International Maritime Organization, (3) satellite tracking of vessels, (4) use of long-range identification and tracking (LRIT), (5) improving aids to navigation, (6) removing out-of-service platforms and subsea pipelines, (7) placing quick-release mooring line hooks at the Port of Anchorage, and (8) positioning or pre-approving the use of the Oil Spill Eater Product.

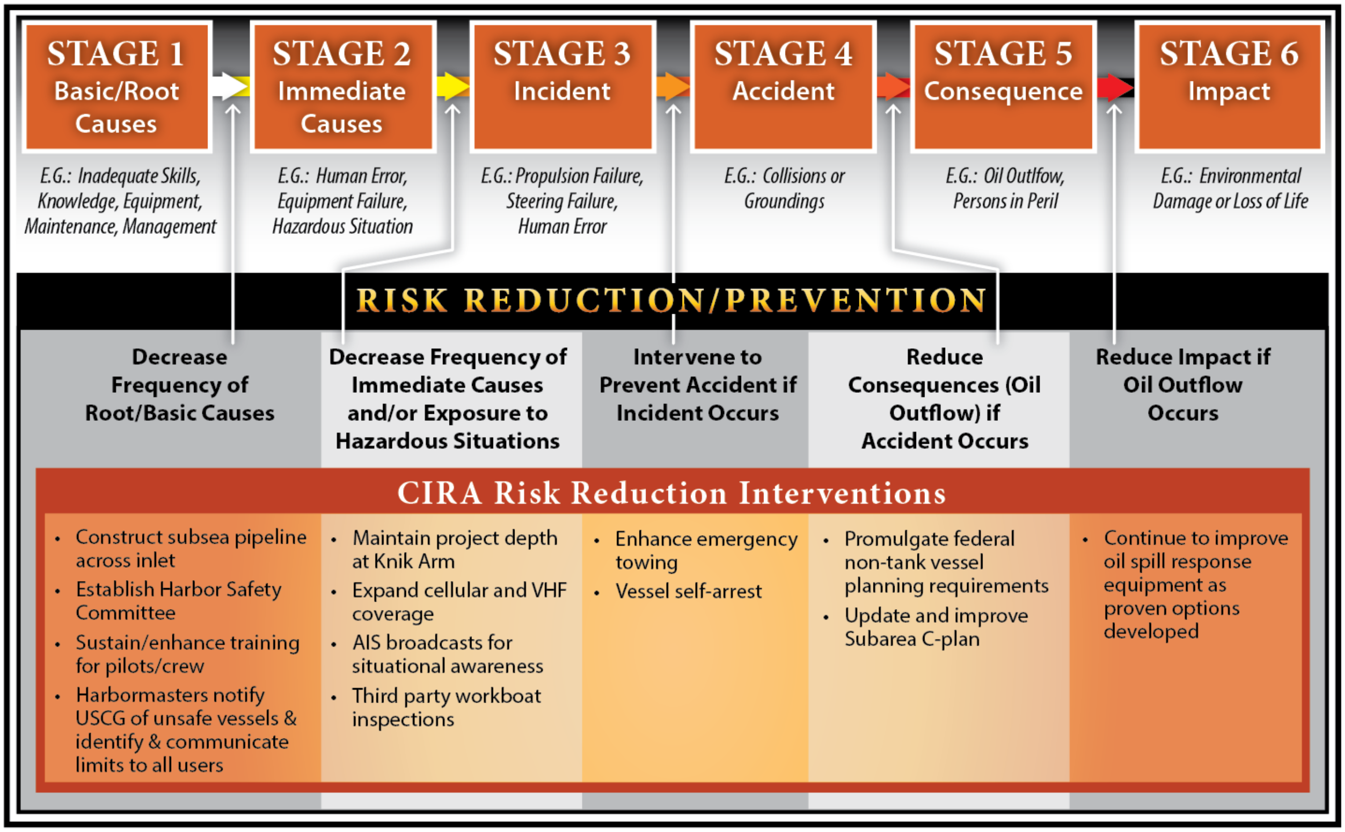

Figure 3. Risk reduction options considered in CIRA, in context of stages of accident chain (based on Harrald et al.,1998)

The recommendation to promulgate the final regulations regarding non-tank vessel response planning requirements was accomplished in July 2013 with new regulations released at 33 CFR 155. This item is not discussed further in the report.

4. Risk Reduction Options Related to Eliminating or Reducing Root Causes

The Advisory Panel supported either continuation or further consideration of several risk reduction options that relate to the elimination of root causes of accidents and spills. The displacement of cross-Inlet tanker traffic by constructing a subsea pipeline is the most resource-intensive of these options, and has the most readily quantified reduction of risk (see Section 4.1). Other risk reduction options in this category relate to reducing the potential risk by improving communication and coordination among the marine community by establishing a Harbor Safety Committee (Section 4.2) ; enhance maritime safety overall through rigorous training of captains, pilots, and crew to a high standard and in Cook Inlet-specific conditions (Section 4.3); and encouraging harbormasters to share certain information with the U.S. Coast Guard and harbor users (Section 4.4).

4.1 Construct Subsea Pipeline Across Cook Inlet

Currently, oil produced on the west side of Cook Inlet, either on land or from platforms in the Inlet, is transported via pipeline to the Drift River Terminal where it is loaded on to tank vessels and shipped across the Inlet to the Tesoro Refinery in Nikiski. There is a pending proposal submitted to state and federal regulators by Cook Inlet Energy to replace this tanker traffic with a subsea pipeline that would move oil produced from both onshore and offshore drilling sites on the western side of the Inlet to the Nikiski Industrial Facilities. This change would result in the removal of tank vessels from the system, thereby reducing the risk of vessel spill.

4.1.1 Overview of Proposed Project

In 2012, Cook Inlet Energy proposed the Trans-Foreland Pipeline Project that would consist of a 29-mile, subsea pipeline built to transport up to 90,000 barrels of crude oil per day along the bottom of Cook Inlet from Kustatan to Nikiski. At the federal level, the project qualifies for a nationwide permit from the U.S. Army Corps of Engineers, pending a review by other agencies. Permitting by the Alaska Department of Natural Resources is also required for the right-of-way. Figure 4 shows the proposed pipeline route, which was modified in 2012 after consultation with the Southwest Alaska Pilots Association to avoid the strong currents and deep areas in the immediate vicinity of the Forelands (Baker, 2013). The project is estimated to cost $50 million (Loy, 2012).

4.1.2 Potential for Subsea Pipeline to Reduce Overall Spill Risks

The construction of a subsea pipeline across Cook Inlet would reduce the number of tanker transits, and therefore would also reduce the potential for a tanker spill because the exposure, or total volume of oil transported by tanker, would be reduced. However, oil would still be transported across the Inlet by pipeline, so spill risk is not entirely eliminated. The probability of a spill and potential spill volume were compared for tankers and subsea pipelines.

The Glosten Associates estimated the extent to which the potential number and size of tanker spills would be reduced if tankers were no longer transporting oil across Cook Inlet (The Glosten Associates, 2013a). This estimate was developed based on the *Cook Inlet Vessel Traffic Study* (Cape International, 2012) and *Spill Baseline and Accident Causality Study* (The Glosten Associates and ERC, 2012). Assuming the pipeline displaced all cross-Inlet tanker traffic, 38 one-way crude tanker transits would be eliminated each year.[7] This translates to removing 35.1 traffic-days per year from the system, and would reduce spills by an estimated 0.105 per year (The Glosten Associates, 2013a).[8] The potential size of these spills does not change from the sizes estimated in the *Spill*

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[7] The vessel traffic study was conducted using 2010 data. At that time, activity at the Drift River Terminal had changed significantly due to the 2009 eruption of Mt. Redoubt. Because the Drift River oil storage tanks were not in service in 2010, actual numbers of tank vessels transits from the West to the East side of Cook Inlet are now lower though not quantified for the study. (Information provided by Jack Jensen, Tesoro Alaska and Advisory Panel member.)

[8] In addition to displacing tanker traffic, the pipeline would presumably eliminate the need to store oil at the Drift River Terminal prior to vessel loading. This would reduce the potential for spills from the storage terminal which is currently at a capacity of 1,080,000 bbl capacity per the operating company's state-approved oil spill contingency plan (CIPL, 2013). This risk reduction was not quantified as the terminal and associated storage are outside the scope of the CIRA.

Baseline and Causality Study (The Glosten Associates and ERC, 2012) because the tanker size and construction do not change.[9]

Based on leak frequencies found in the literature for subsea pipelines (IAOGP, 2010; Mott McDonald Ltd, 2003; Baker, 2013), the pipeline has the potential to add 0.0018 spills per year.[10] This results in a net reduction in spill risk of 0.103 spills per year, or 98%.

This comparison illustrates a clear reduction in the potential for oil spills by transferring the oil transportation from tankers to a subsea pipeline. However, the pipeline data is derived from U.S. statistics and not specific to Alaska or Cook Inlet, while the tanker spill return estimates are Cook Inlet-specific. There are currently no subsea pipelines in Cook Inlet from which to derive data. The Northstar pipeline on the North Slope of Alaska has been operating for 13 years without a spill, so this could not be used to corroborate the U.S. Outer Continental Shelf estimates. A query of the ADEC SPILL database shows during that same time, there were three crude oil spills from tankers operating in Cook Inlet.[11] This supports the general observation that tanker spills occur more frequently than subsea pipeline spills.

[9] See Appendix A for The Glosten Associates' estimated reduction in spill risk from tankers that are displaced by a subsea pipeline.

[10] The leak frequency for processed oil or gas, with a pipeline diameter of ≤ 24 inch, is 5.1×10^{-5} per km-year (IAOGP, 2010). This was used to calculate the return rate: 5.1e10-5 x 35.4 = 1.81E10-3 or .00181 spills per year, a return rate of 553.89 years.

[11] These were the *T/V Seabulk Arctic* (3/2/03), *T/V Seabulk Arctic* (3/14/04), and *T/V Seabulk Pride* (12/17/04) (ADEC, 2013).

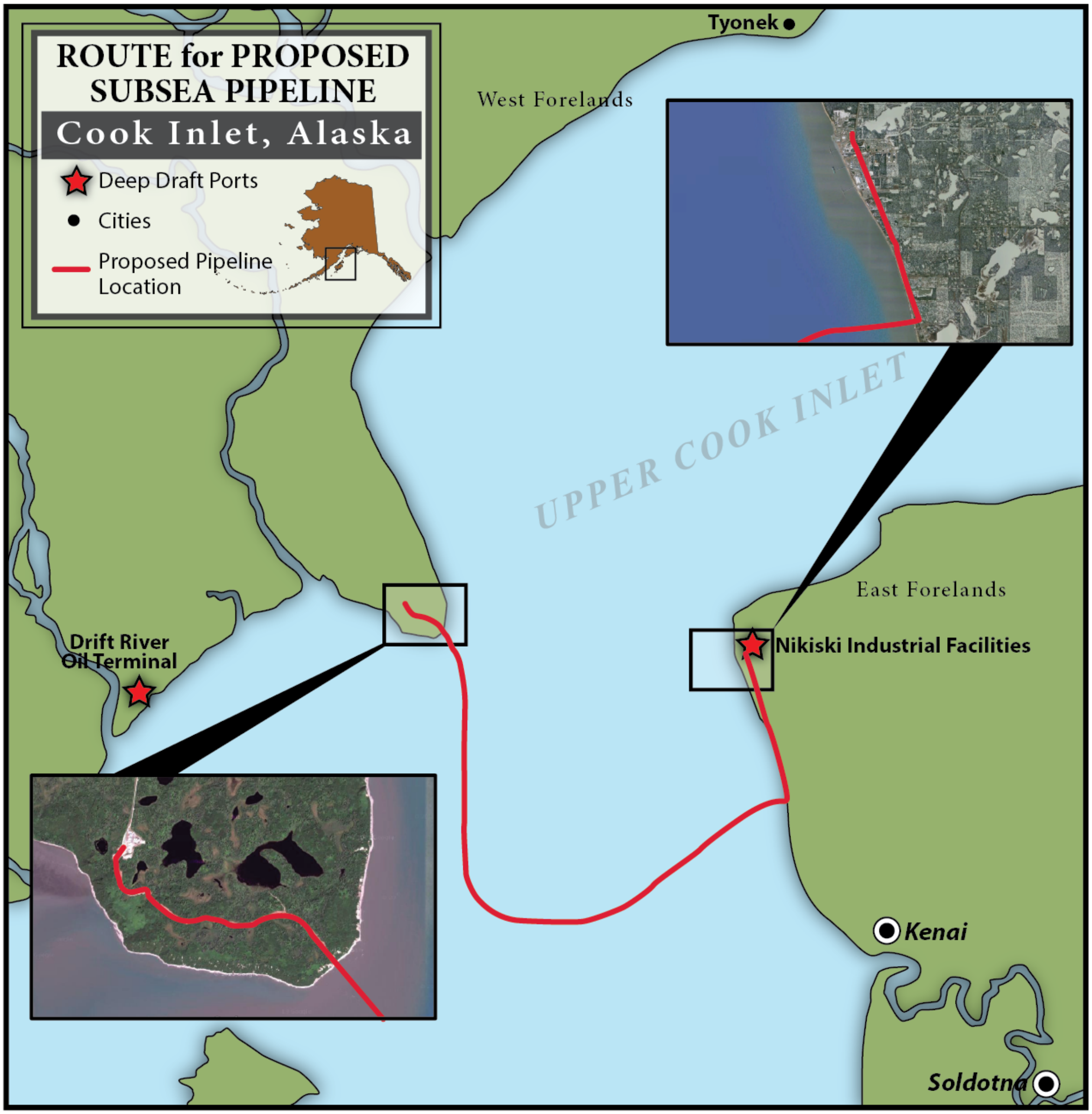

Figure 4. Map of proposed subsea pipeline route from Drift River to Nikiski (based on Baker, 2013)

Spills from pipelines also tend to be *smaller* than spills from tankers (Etkin, 2001). A study of U.S. Outer Continental Shelf pipeline spills from 1996 to 2010 indicates an average spill size of 928.2 gallons (Anderson et al., 2012). Data from this study were used to develop a spill size distribution for subsea pipelines similar in length and diameter to those described in the cross-Inlet pipeline project materials. These estimates are compared to the potential spill volume distribution from tankers developed in the CIRA Phase A study (The Glosten Associates and ERC, 2012). Table 3 compares the subsea pipeline and tanker spill size distributions. For all spill sizes, the subsea pipeline leak rates show a 99% reduction in potential spill volume when compared to tanker impact spills (spills from groundings, collisions, and allisions, which result in the highest potential spill volumes).

Table 3. Comparison of potential spill volumes from a double-hulled crude tanker and subsea pipeline

Spill Cause	Small 25th percentile (gallons)	Moderate 50th percentile (gallons)	Large 95th percentile (gallons)	Worst Case Discharge (gallons)
Tanker Spills				
Impact spill (resulting from allusion, collision, or grounding)	500	20,000	15,000,000	28,500,000
Non-impact spill (resulting from fire, equipment failure, or operator error)	100	2,000	8,000,000	28,500,000
Transfer error	1	10	2,000	75,000,000
Pipeline Spills				
Subsea pipeline	< 1	5	571	232,227[12]
Comparison of Spill Size Distribution				
%Reduction in spill rates: Tanker impact spills compared to subsea pipeline spills	>99%	>99%	>99%	99%

4.1.4 Benefit-cost Analysis of Cross-Inlet Pipeline

A benefit-cost analysis of the proposed pipeline was developed based on the information described in this section as well as other assumptions and inputs from the project description provided to the state and a review of published literature. The full report is included as Appendix C (Northern Economics, Inc., 2014).

A benefit-cost analysis results in a ratio of benefits (primarily representing avoided impacts by reducing the probability of a spill) to costs (primarily associated with the construction and operation of the subsea portion of the pipeline itself). In this case, the resulting ratio was relatively low (0.05) if only median size spills were considered, but rose to 5.8 if the potential for a large oil spill was considered. While smaller spills are more likely to occur, it is the desire to avoid larger or even worst-case spills that drives the recommendation to implement a significant infrastructure development as a risk reduction option. If a worst-case spill and its associated impacts and costs are considered, the benefit-cost ratio rises to 18.1 (Northern Economics, Inc., 2014)[13].

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[12] Worst Case Discharge for proposed subsea portion of pipeline is considered to be 100% of the total volume. Volume is calculated based on: 116,160 feet x 0.0476 bbl/ft (7" inside diameter) x 42 gal/bbl = 232,227 gallons.

[13] The Drift River Terminal is excluded from this analysis, both in terms of the potential size and frequency of spills and the consideration of benefits and costs. Thus, the operating costs, costs associated with a potential spill from the terminal's storage facilities, potential decommissioning costs, or other costs or benefits associated with the terminal was not included in this analysis. Northern Economics, Inc. also notes that the costs of using low sulfur fuel oil for tankers was incorporated into the analysis, but the cost of using marine gas oil for tanker generators is not included. If this information was included, the benefit-cost ratio would be expected to increase. (Northern Economics, Inc., 2014)

4.1.5 Recommendation

The Advisory Panel recommends that the subsea pipeline should be developed to reduce the potential for large spills from cross-Inlet tanker traffic between Drift River and Nikiski. The pipeline will have the ancillary benefit of reducing the need for storage of oil at the Drift River facility, though this benefit is not quantified here.

This recommendation is based on the Advisory Panel's charge to develop and recommend oil spill risk reduction options related to marine transport, and the Panel's consideration of analysis related to spill risks and a benefit-cost analysis focused on the same. The Panel acknowledges that there are economic factors and other considerations that fall outside its scope but warrant careful consideration by decision-makers in approving and developing this significant new infrastructure.

4.2 Establishing a Cook Inlet Harbor Safety Committee

The complexity of port areas and heavily used waterways means that there are multiple groups with different perspectives and information about risks and potential safety improvements in any given location. Harbor Safety Committees (HSC) provide a venue for groups with an interest in safe maritime operations to share information and develop and implement policy. They can also play a key role in ensuring that changes in risk resulting from changes in operations or conditions are identified and addressed. HSCs are widely implemented around the U.S., require no regulatory changes, and require minimal expenditures, assuming the key parties are willing to commit their participation. There are HSCs in many coastal and inland waterways around the country, although their level of activity varies widely.

Currently, there is an ad-hoc Safety and Navigation Committee that meets prior to the winter ice season to discuss operations pertaining to the Kenai Pipeline Dock, but not necessarily operations within the entire Inlet.

4.2.1 HSC Operations

HSCs typically operate at two levels:

- **Coordination.** An HSC can provide a basic forum for the exchange of information among people who rely on the resources of a waterway, whether for transport, resource extraction, or other activities. These groups can, if they choose, seek input from the public on certain issues. Keys to successful coordination include: (1) clear expectations for participation that includes representatives of the needed stakeholder groups; (2) regular means of communication, whether meetings (sometimes as often as once a month, but can be less frequent), website, email lists/listservs, and/or newsletter updates; and (3) high quality information that is understood and trusted by all key participants.

- **Policy development and implementation.** Even when operating outside of the regulatory process, HSCs may develop voluntary policies and procedures. These may include establishing standards of care or voluntary guidelines for certain operations, or identifying and clarifying important safety messages to waterway users (ranging from tanker operators to recreational boaters). HSCs often develop Harbor Safety Plans that encompass the practices that they develop to mitigate the potential for accidents or other unsafe operations. In addition to the items described for coordination, above, keys to successful policy development and coordination include: (1) establishing a clear and transparent process for prioritizing problems or policies to be addressed, and (2) establishing a method for gaining feedback on policy implementation and modifying the approach as needed for improvement.

4.2.2 HSC Organization

HSCs have many different structures. They may be housed within an existing organization, rely on staffing from an existing organization (essentially providing financial and administrative support), or be an independent organization. Funds may be raised through either required or voluntary annual dues or for support specific projects or needs.

Typically, HSCs operate in a manner that is complementary to but outside of the regulatory structure, so an HSC would not be housed in a state or federal agency. Instead, these agencies tend to serve in an advisory or observer capacity depending on the issues being discussed. The U.S. Coast Guard encouraged the creation of HSCs over the last decade with the issuance of a Navigation and Vessel Inspection Circular (NVIC) 1-00 and creation of a blog designed to encourage HSCs to exchange information, among other tools. However, as made clear in the NVIC, the Coast Guard neither mandates the establishment of HSCs nor does it take a direct management role within an HSC (USCG, 2000b).

4.2.3 Potential Priority Issues for HSC

Several mitigation measures emerged through the course of the CIRA, which are fitting near-term items for a new HSC. These mitigation measures deserve input from the maritime community, and also represent topics requiring ongoing attention:

- Consider enhanced ice monitoring to inform vessel operations
- Participate in the update to winter ice guidelines issued by the U.S. Coast Guard
- Update the National Oceanic and Atmospheric Administration's (NOAA) Automated Wreck and Obstruction Information System (AWOIS) for the area
- Update the Coast Pilot for the area, also maintained by NOAA
- Consider future needs related to vessel self-arrest and emergency towing (see Section 6)

Consider Enhanced Ice Monitoring to Inform Vessel Operations

Navigating the ice-infested waters of Cook Inlet has always been a challenge to mariners. Understanding and enhancing ice-monitoring capabilities has been a priority for agencies and operators with the goal of reducing accidents. The Cook Inlet RCAC has worked with the NOAA Ice Forecaster to organize observers operating in the Inlet to provide information about ice conditions. Ice observers provide daily observations to NOAA, sometimes including a digital photograph. Observations may include the extent of ice coverage, composition, pan dimensions, and thickness. Cook Inlet RCAC has also installed eight high-resolution digital cameras on platforms at key locations in Upper and Middle Cook Inlet (Loy, 2014). These sea ice web cameras are essential for NOAA's sea ice analysis on days when visual satellite imagery is not available due to cloud cover and greatly contribute to accurate ice advisory information for Cook Inlet.

In other locations in Alaska, radar imaging has been used for maritime navigational safety and environmental security including Prince William Sound and the U.S. Arctic Ocean.

- **Prince William Sound:** In 2002, PWSRCAC led a multi-stakeholder effort to install an ice detection radar system on Reef Island[14] to provide the USCG with real-time information regarding ice conditions in the shipping lanes near the Columbia Glacier and promote the research and development of new radar technologies. The Rutter Sigma S6 Ice Navigator radar system is used for iceberg detection (Arvidson and Jones, 2003). The radar signal is transmitted from Reef Island to Alyeska's Ship Escort Response System duty office, where the ice radar display is used to verify conditions received from tankers and tug escorts. The system continues to operate efficiently with minimal upkeep.

- **Arctic Ocean:** The University of Alaska Fairbanks' Sea Ice Group at the Geophysical Institute installed two coastal web camera/radar systems in Barrow and Wales. Both systems are land-based and consist of a webcam and marine band high frequency radar. The prototype system in Barrow was used to identify tactical and operational information needs for monitoring environmental hazards and effective emergency response in sea-ice environments (Eicken et al., 2011), gathering high-resolution data of ice distributions, movement and deformation, as well as ice characteristics and dynamics. Nearshore ice is monitored with commercially-available Furuno 10kW, X-band marine radars mounted on rooftops that can operate at ranges up to approximately seven miles (UAF, 2014). Data are transferred to Fairbanks at five minute intervals, geo-located, and archived by the Alaska Ocean Observing System (AOOS) (Druckenmiller et al., 2009). The radar and webcam images are recorded also available online for near-real time viewing.

Based on the existing operational radar systems, the Cook Inlet region would benefit from integrating the oil platform webcam ice observations with a marine band high frequency radar and satellite imagery to provide near-real time ice conditions to mariners. A multi-stakeholder effort involving entities such as the maritime industry, AOOS, Cook Inlet Spill Prevention and Response, Inc. (CISPRI), Cook Inlet RCAC, the Oil Spill Recovery Institute, University of Alaska Fairbanks, and government agencies could provide a cost-effective means for conducting a pilot project. The Cook Inlet ice radar pilot project could include the installation of one radar system on an oil platform located near the East and West Foreland. The estimated cost for establishing seasonal sea ice radar observing systems ranges from $41,000 to $122,000 (Rutter, Inc., 2013) depending on the type of radar and component add-ons.

Participate in Update to Winter Ice Guidelines as Needed

Ice conditions in Cook Inlet have long been identified as a navigational safety concern. The U.S. Coast Guarddeveloped the current guidelines in 2012 with input from the Southwest Alaska Pilots Association and Cook Inlet maritime operators. The "Operating Procedures for Ice Conditions in Cook Inlet" (November 20, 2012) establish procedures for the Upper Inlet (Phase I) and Lower Inlet (Phase II) based on the U.S. Coast Guard's determination that ice conditions warrant activation of the guidelines (USCG, 2012).

The U.S. Coast Guard also has the authority to stop cargo operations or close a terminal or port due to ice or other hazardous conditions under 33 CFR 160.111.

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[14] http://www.pwsrcac.org/programs/maritime/ice-detection/

Update NOAA's Automated Wreck and Obstruction Information System (AWOIS) Database
There are numerous subsea wells and pipelines in Cook Inlet, both those currently in use and those that are not being used at this time. There is the potential for vessels to hit underwater wellheads,[15] or to drop anchor onto a pipeline or other infrastructure. Some operators in the Inlet conduct their own subsea surveys prior to dropping anchor.

NOAA's Office of Coast Survey directs field programs for ship- and shore-based hydrographic survey units. The information gathered during NOAA surveys is entered into AWOIS and can be accessed online at: http://www.nauticalcharts.noaa.gov/hsd/hydrog.htm. The database identifies the locations of submerged wrecks or other obstructions. Mariners can also provide updated or additional information to NOAA.

Update NOAA Coast Pilot
NOAA's Coast Pilot, updated weekly, describes ports, harbors, and other waterway features, including information about potential hazards and recommended routing. Although these guidelines are non-regulatory, large vessels are required to have the Coast Pilot on board [33 CFR 164.33(a)(2)(i)]. If a vessel operator ignores the Coast Pilot recommendations, they are essentially violating a standard of care and increasing their liability if something goes wrong as a result of that choice. The Coast Pilot that includes Cook Inlet was most recently published August 17, 2014 (U.S. Coast Pilot 9, Chapter 4). NOAA's Office of Coast Survey welcomes information from mariners.[16] Pilots are required to memorize the relevant sections of the Coast Pilot for their pilotage areas, and frequently suggest updates to NOAA.

4.2.4 Recommendation

The Advisory Panel recommends that an HSC be established for Cook Inlet. A Cook Inlet HSC would provide a continuum started by the CIRA by gathering a group of individuals with diverse perspectives to identify potential problems, develop or recommend non-regulatory mitigation measures, and evaluate the success or areas of improvement. The Cook Inlet HSC would provide a means of prioritizing the consideration of relevant topics and mitigation measures. HSCs can also provide collective input on issues at both the Captain of the Port level and related regulations. While HSC participation will be determined as the group forms, the Advisory Panel recommends that participants should at minimum include representatives of maritime industry and Cook Inlet operators, tribes, and local communities.

The HSC should consider the following activities as part of its initial and ongoing efforts:

- Enhancing ice monitoring to inform vessel operations in Cook Inlet
- Participate in updating the winter ice guidelines as needed

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[15] Soon after the Advisory Panel met on February 22, 2013 a workboat collided with an inactive, subsea wellhead off the coast of Louisiana. See: http://abcnews.go.com/US/coast-guard-responds-oil-spill-off-louisiana-shore/story?id=18609482
[16] For the relevant section of the Coast Pilot, see: http://www.nauticalcharts.noaa.gov/nsd/coastpilot/files/cp9/CPB9_E30_C04_20130420_1212_WEB.pdf To suggest updates, see: http://ocsdata.ncd.noaa.gov/idrs/discrepancy.aspx

- Updating NOAA's Coast Pilot and Automated Wreck and Obstruction Information System (AWOIS)
- Additional study related to vessel self-arrest and emergency towing, as described under that risk reduction option (see Section 6).

4.3 Sustain and Enhance Training for Pilots, Captains, and Crew

Well-trained captains, pilots, and crew are critical to the operation of large vessels. U.S. Coast Guard and Alaska Department of Commerce, Community and Economic Development regulations establish the basic training and/or licensing requirements for marine pilots, deputy marine pilots, vessel masters, and crew. (International requirements are codified in the U.S. at the federal level.) These requirements vary depending on the role being played, but, for pilots, they include years of experience as a mariner, simulations, supervised operations on-water, and extensive oral and written tests.[17] At the state level, the Board of Marine Pilots establishes specific training requirements, including training related to the operating conditions in the region in which in the pilot will operate.

In addition to licensing and training mandated by the State or U.S. Coast Guard (which oversees adherence to international training standards in the U.S.), the pilots and shippers are conducting additional training together. This training, along with as much of the mandated training, is conducted at Alaska Vocational Technical Center (AVTEC) Maritime Training Facility in Seward where they have state-of-the-art simulators that allow personnel to safely practice anchoring, docking and other procedures in challenging conditions at specific docks or other areas of Cook Inlet. AVTEC offers a Coast Guard-approved ice navigation course based on 2010 updates to the International Maritime Organization's Standards for Training, Certification, and Watchkeeping, known as the Manila amendments, which include requirements for training in ice conditions.

4.3.1 Recommendation

The Advisory Panel recommends that Cook Inlet pilots, vessel officers and shoreside vessel managers engage in simulator training above and beyond normal qualifications specifically focused on the Cook Inlet operations and ice navigation. This recommendation does not imply a change in the required qualifications for vessel operators.

4.4 Harbormasters Notify U.S. Coast Guard of Unsafe Vessels and Identify and Communicate Limits to all Users

The Advisory Panel identified two items related to port and harbor operations as best practices for implementation at ports and harbors throughout the Inlet: (1) harbormasters should notify the U.S. Coast Guard if they turn away a vessel because it appears unsafe or unseaworthy, and (2)

[17] See "Statutes and Regulations: Marine Pilots" (June 2012) from the Alaska Department of Commerce, Community, and Economic Development.

harbormasters should ensure that they have the best possible understanding of the limits of their facilities and equipment, and clearly communicate these to vessels entering the port or harbor.

4.4.1 Notifying the U.S. Coast Guard if Unsafe Vessels are Turned Away

It is common practice for harbormasters and port directors to turn away vessels that they determine to be unsafe or unseaworthy.[18] When these vessels are denied moorage in a safe harbor, they may seek moorage or anchorage at a place that is less safe, more environmentally sensitive, and/or has less oversight from authorities. By promptly contacting the U.S. Coast Guard's Sector Anchorage Command Center or Marine Safety Detachment in Homer when they deny access to a "vessel of concern," harbormasters will facilitate the Coast Guard's ability to mitigate or address mechanical problems (such as poorly functioning radar or steering) or potential pollution. The U.S. Coast Guard would then proceed to contact the vessel owner and seek to address the situation.

A task force has been formed that is considering this and other issues related to abandoned and derelict vessels in Cook Inlet.

4.4.2 Understanding and Communicating Limits Associated with Safe Operations at their Facilities

Vessels casualties can occur when a vessel is at or approaching/departing a mooring or dock. In particular, attention has been paid to the impact of moving sea ice on mooring given the experience of the *T/V Seabulk Pride* in 2006. Ports and harbors throughout the Inlet should have a clear understanding of the potential hazards that vessels may face in terms of water depth, current, sea ice, high winds, or underwater facilities (pipelines, communication facilities, etc). These hazards can be translated into an understanding of the limits on vessel size, approach speed, mooring line requirements, and/or other equipment limitations. These limits, and desired or required procedures to be implemented if these limits are approached or exceeded, should be clearly communicated to vessels by port and harbor personnel.

4.4.3 Recommendation

The Advisory Panel recommends that Harbormasters and Port Directors in Cook Inlet establish procedures to help them identify unsafe and unseaworthy vessels, and to contact the U.S. Coast Guard when they turn such vessel away. This procedure should be included in port/harbor Standard Operating Procedures and/or included in the certification criteria for the Alaska Clean Harbors Program.

This recommendation does not involve additional regulations or costs, but simply encourages improved communications between harbormasters or port directors and the U.S. Coast Guard. This recommendation seeks to reduce accidents associated with vessels of concern by facilitating action from the U.S. Coast Guard based on harbormaster observations.

In addition, many ports and harbors in Cook Inlet already have achieved a strong understanding and communications plan regarding the limits of their equipment and facilities. Where these do not

[18] This risk reduction option focuses primarily on smaller vessels.

exist, they should be developed through a mooring study or other analysis and incorporated into the communications practices used by port and harbor personnel in their verbal and written interactions with vessels calling at their docks or moorings.

5. Risk Reduction Options Related to Decreasing Frequency of Immediate Causes and Decreasing Exposure to Hazardous Situations

Reducing the frequency of immediate causes or exposure to hazardous situations covers a wide range of risk reduction options. In the CIRA, related risk reduction measures include dredging Knik Arm Shoal (Section 5.1), near Anchorage, to reduce large vessel exposure to the hazard of grounding. The safety of workboat operations throughout the Inlet was considered, with the use of safety management systems, including third party inspections, as a key means of reducing potential immediate causes of incidents or accidents (Section 5.4).

Communications between vessels or between vessels and shore can be critical for sharing information about known or potential hazards, or for hastening a response to mitigate an incident or accident. In Cook Inlet, as elsewhere, vessels may rely on one or more of the following to share and receive information: satellite and cell phone (including Internet access) and very high frequency (VHF) radio (both discussed in Section 5.2), and Automated Identification System (AIS), discussed in Section 5.3. The supporting infrastructure for all of these modes of communication relies on equipment on the vessel itself, as well as a shore-based resources maintained by a combination of public and private entities. All three modes of communication can *also* be used to prevent an incident from occurring, if, for example, a vessel notifies rescue resources that it requires assistance (or if this is observed on the AIS, prompting a rescue).

5.1 Maintain Project Depth at Knik Arm

A substantial amount of glacial silt flows into Cook Inlet, including silt from the Knik Glacier and the Mat-Su river drainages. In addition, one of the highest tidal ranges in the world scours and re-deposits prodigious amounts of this silt every tide cycle. In recent years, Knik Arm Shoal and Port McKenzie Shoal have been growing much more quickly and have required increased dredging. The U.S. Army Corps of Engineers (USACE), which is responsible under Section 10 of the Rivers and Harbors Act of 1899 for maintaining vessel access to the Port of Anchorage,[19] has gone from dredging 300,000 cubic yards of material annually from the channel to nearly two million cubic yards. When first dredged in 2000, the area dredged was 1,017 feet wide, 38 feet deep and 6,500 feet long. Approximately 2.6 million metric tons of material was removed at a cost of $8.7 million U.S.

[19] Anchorage is by far the largest port in Alaska, with upwards of 85% of the cargo coming into the state. In August 2004, the Port of Anchorage became one of 19 ports in the U.S. designated a "Strategic Port" by the Dept. of Defense because of the extensive and strategically important military presence in the area that requires immense logistical support, much of which passes through the port.

dollars. The work area has increased since 2000: approximately 11 million cubic yards of material now has to be removed.[20]

The USACE identifies dredging projects that need funding under the Water Resources Development Act. The federal government cost shares with state and/or local governments in obtaining project funds. The annual cost for dredging the Port of Anchorage is now $15.4 million. The USACE plans to dredge 10 million cubic yards of sand, gravel, cobbles and silty sediment that have accumulated in the Knik Arm portion of the existing Cook Inlet Navigation Channel (CINC) between 2013 and 2017. Annual maintenance dredging of the existing channel to the specified project depth of 43 feet below mean low-low water, width of 1,100 feet, and length of 11,000 feet will consist of hydraulic and/or mechanical dredging. Figure 5 shows the CINC and proposed dredging area. Funding for maintenance dredging of the CINC beyond 2017 is uncertain,[21] yet it is critical to maintain minimum project depth for safe navigation of this waterway.

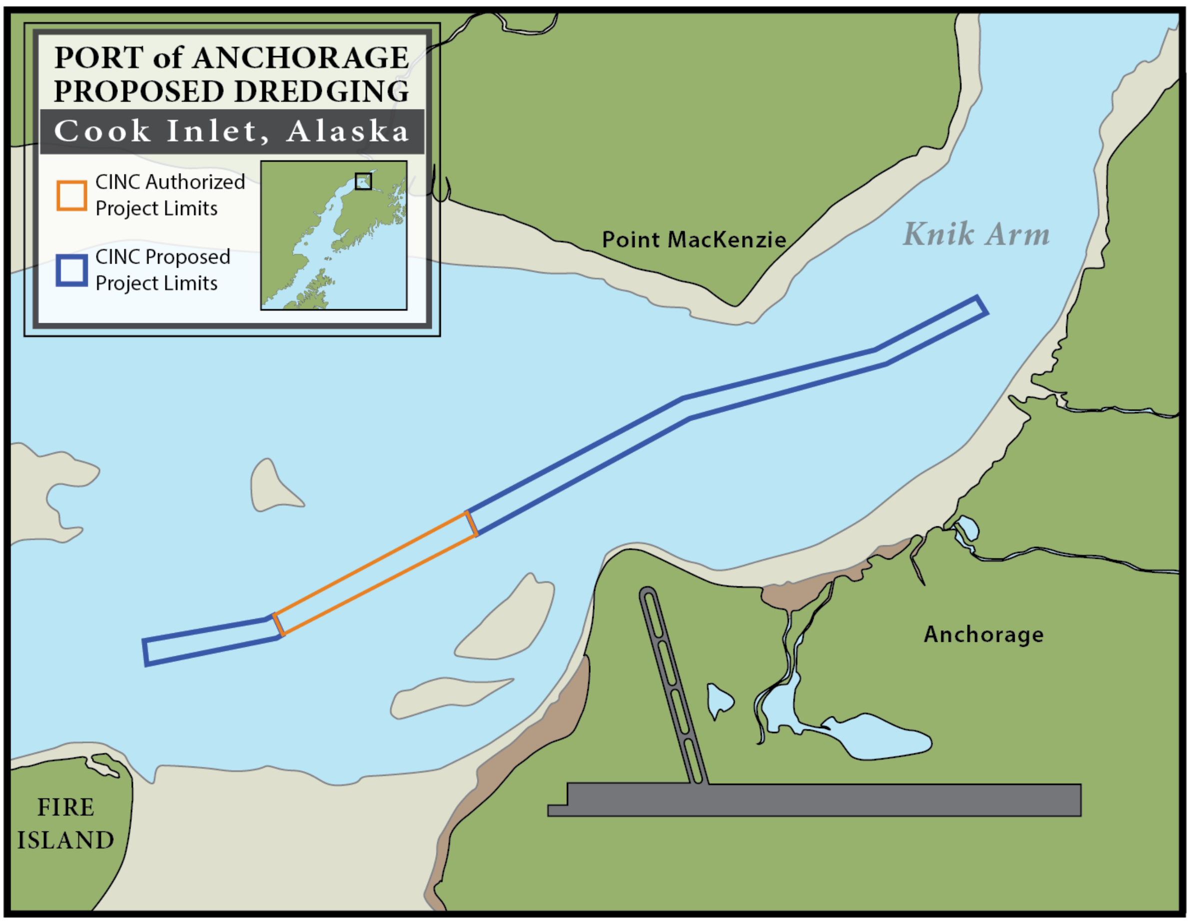

Figure 5. Cook Inlet Navigation Channel (CINC) as authorized by the Water Resources Development Act of 1996 (Based on USACE, 2013)

[20] Public Notice #ER-13-02 USACE AK. Dist.

[21] Obtaining annual funding from the federal government for dredging the critical navigation areas of Upper Cook Inlet has become a challenge. In 1986, Congress enacted the Harbor Maintenance Tax to recover the federal costs of dredging. The tax is paid by the shipper at a rate of 0.125% of the cargo value. Alaska's ports are exempt from this tax.

5.1.1 Recommendation

The Advisory Panel recommends that Knik Arm shoal be dredged as needed to maintain project depth, thereby reducing the potential for vessel grounding in this area.

5.2 Expand Cellular and VHF Coverage

Communications between vessels or between vessels and shore can be critical for sharing information about known or potential hazards, or for hastening a response to mitigate and incident or accident. This section discusses the gaps that currently exist in both cellular and VHF coverage; Section 5.4 describes the next step for enhancing situational awareness using AIS.

5.2.1 Cellular Coverage

When all towers are functioning, there is cell phone coverage in most of Cook Inlet north of Homer. However, there is a dead spot along shipping route from Middle Ground Shoal to Fire Island. The extent of cell coverage in this area is determined by the location and number of towers placed by the cellular service providers (as well as terrain, number of users, and other conditions that can limit coverage), and is essentially a corporate business decision made by the service provider (ACS, AT&T, GCI, or Verizon).[22]

[22] Service providers who want to access government funding that is intended to ease access for underserved populations must meet certain standards established by the Regulatory Commission of Alaska and the Federal Communications Commission. The Regulatory Commission of Alaska designates "eligible telecommunications carriers" (ETC) and sets the standards they must meet in order to receive this designation. The requirements include providing coverage maps, allowing a trial period, transparent costs and the presentation of charges on the billing statement, and customer service. They are currently set at 3 AAC 53.450, though may be changed in the near future to align with rule changes at the federal level. A telecommunications company will be a designated ETC in certain geographic areas; currently, there are not companies designated as ETCs between Anchorage and Homer. (Communication with John Paul Manaois, Regulatory Commission of Alaska, April 16, 2013.)

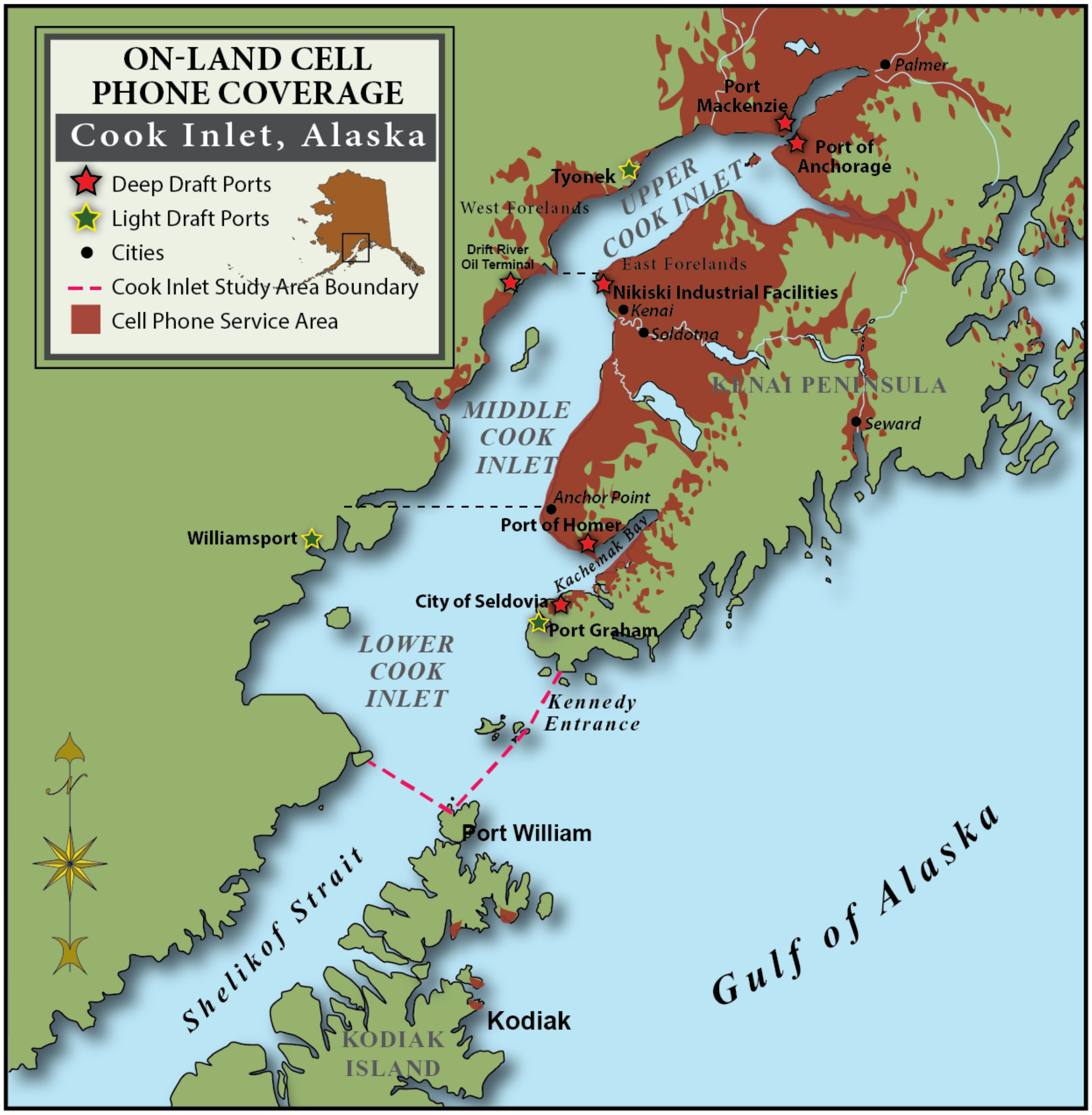

Figure 6. Generalized on-land cell coverage area, based on Verizon Wireless (Verizon, 2013)

The cellular providers decide to put in new towers or enhance existing towers if they believe it will expand their customer base. One option for expanding coverage is to use a repeater either on a vessel or (if coverage reaches far enough) a platform near the shipping route. Currently, vessels do not use repeaters as use of cellular phones is discouraged in safety management systems.

5.2.2 U.S. Coast Guard VHF Coverage

The U.S. Coast Guard maintains VHF stations on shore to facilitate communications between vessels and shore-based resources. Stations serving the Inlet provide coverage for much of the Upper and Lower Cook Inlet areas. However, there is a gap in coverage for vessels operating in the northern part of the Middle Cook Inlet area, up to and just past the Forelands. The gap, portrayed in Figure 7, will vary depending on the size and the power of the vessel's VHF radio.

Figure 7. U.S. Coast Guard VHF coverage in Cook Inlet based on a vessel with one watt (based on information provided by USCG Sector Anchorage)

5.2.3 Recommendation

The Advisory Panel recommends that communications infrastructure should be enhanced to fill gaps in cellular and VHF coverage for vessels operating on Cook Inlet waters.

While policies prohibiting the use of email or text messages for personal reasons are critical and must remain in place, having access to information (including visual information) via cellular coverage will help to enhance mariners' situational awareness and facilitate communications. All vessels using VHF should be able to communicate readily with both shore and other vessels to facilitate prompt assistance when needed.

5.3 Using AIS Broadcast to Enhance Situational Awareness

The International Maritime Organization and U.S. Coast Guard require most large, commercial vessels operating in Cook Inlet to be equipped with AIS equipment. [23] On vessels equipped with AIS, a VHF transponder transmits the vessel's location, size, type, course, speed, and destination to other AIS equipped vessels, shore-based receiving stations, and satellites equipped with AIS receivers. Vessel AIS equipment can also receive digital messages from other vessels and authorized shore stations if the software is appropriately configured.

The Marine Exchange of Alaska (MXAK) maintains and operates a network of more than 110 AIS stations in Alaska. These stations provide real-time vessel data to the U.S. Coast Guard, the State of Alaska, and various commercial operators and others in the maritime community authorized to have access for a fee. The five MXAK AIS receiving stations in Cook Inlet are located in Homer, Anchorage, Nikiski, and Anchor Point. These stations provide comprehensive vessel tracking coverage of the Inlet's navigable waters (see Figure 8).

The next step for the use of AIS to enhance situational awareness in Cook Inlet is to deliver weather information directly to the bridge of a vessel. The MXAK and AOOS have undertaken a project that provides the capability to transmit temperature, wind, and other environmental data via the AIS station on the Homer Spit. Homer is the first station in Cook Inlet to be upgraded to be able to transmit information via AIS in addition to receiving signals from vessels.

Information from the MXAK weather stations installed in Nikiski and Anchorage is also transmitted from the Homer site. An ATON (Aid to Navigation) AIS transmitter will be installed in Anchorage in 2014 and an additional weather station is planned for installation in Kenai in 2014. The broadcasts from Homer and other Alaska locations outside of Cook Inlet are now conducted under Cooperative Research and Development Agreement between MXAK and the U.S. Coast Guard's Research and Development Center that was announced to mariners in March 2014.[24] In the future, safety information including sea ice conditions could also be communicated via AIS as to vessels operating in the area.

While progress is being made to generate and transmit the weather data, not all vessels with AIS are able to receive it. For a vessel to *receive* weather (or other) information transmitted via AIS, the AIS software used onboard must receive and display the information. This requires a new capability, and one that most AIS software does not currently have. In the meantime, the weather sensors generating information for transmittal over AIS also transmit the data to the National Weather Service and AOOS, who disseminate the information over their websites. Additionally, MXAK posts the real time environmental data on the MXAK website[25] and has configured the data so that is also readily accessible on mobile devices. Thus, the weather information being translated currently is most accessible on handheld devices such as personal digital assistants, iPhones, or

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[23] U.S. Coast Guard regulations are at: http://www.uscg.mil/d11/vtssf/aisregs.asp. Additionally, smaller U.S. commercial vessels (i.e., tugs and cargo vessels) operating in a Vessel Traffic Service Area (e.g. Prince William Sound and Puget Sound) are also required to be equipped with AIS.

[24] http://www.navcen.uscg.gov/pdf/lnms/lnm17092014.pdf

[25] www.mxak.org

iPads. Due to gaps in cellular coverage in Cook Inlet and seaward approaches, information received on these types of devices will not always be accessible (see Section 5.2).

5.3.1 Recommendation

The Advisory Panel recommends that AIS software companies should upgrade software to allow vessel operators to receive information transmitted via AIS on board when requested. This upgrade should be widely disseminated to current users and included in new software sales.

Information transmitted from shore to vessels using AIS should relate to conditions in the immediate area only, so as to avoid providing irrelevant or distracting information. The AIS transmittals can also be used to contact individual vessels identified as being in the area in order to engage their assistance to another vessel and/or alert them of known or anticipated hazards.

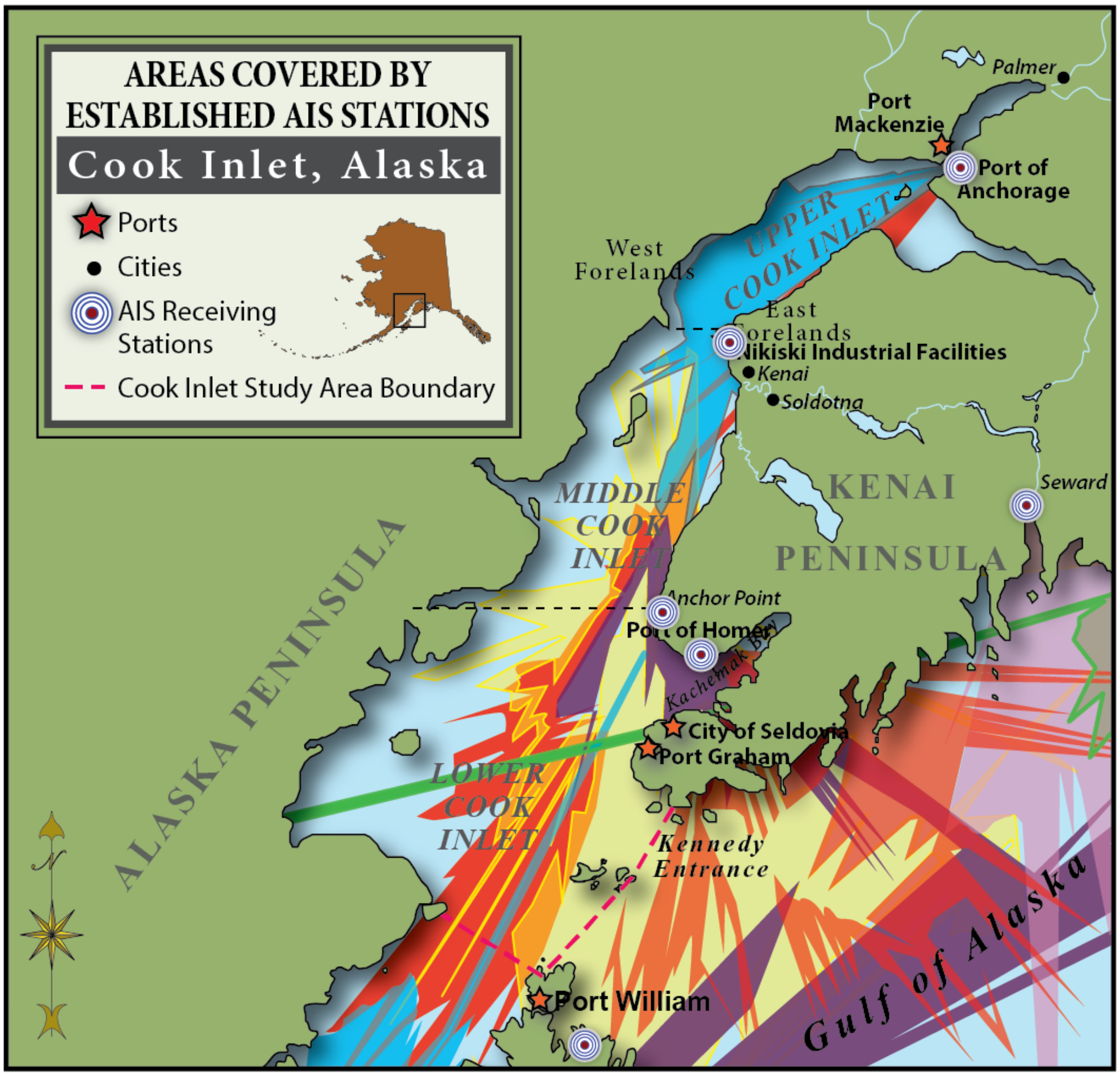

Figure 8. Cook Inlet areas covered by AIS shore stations (provided by the Marine Exchange of Alaska)

5.4 Third Party Workboat Inspections

After several maritime accidents were attributed to human error, the International Maritime Organization developed the International Safety Management Code "to provide an international standard for the safe management and operation of ships and for pollution prevention" (IMO, 2010). International Safety Management guidelines are functional management requirements for vessel operators, including assigning responsibilities for safety to the shore-side part of the company. The primary approach to meeting the standards is to establish a Safety Management System (SMS).[26]

Some vessels – typically large ones or those engaged in international trade or transport - are required to establish SMS, while others may choose to do so voluntarily.[27] The Cook Inlet resident vessel fleet includes a number of workboats, or resident commercial vessels such as offshore supply vessels, oil spill recovery vessels, and general freight vessels that service local communities, such a landing craft. Workboat operators may choose to meet the standard voluntarily through their own internal audits, which can highlight neglected practices, equipment, knowledge gaps and near misses in daily operations, or through audits by a recognized third party, such as a marine surveyor. Commitment to this or a similar program may result in fewer claims, lower premiums, and enhanced competitiveness.[28]

To learn more about the Cook Inlet workboat community's use of third party audits of their SMS, the CIRA project team developed a brief survey that was sent with an introductory letter to the workboat operators in Cook Inlet.[29] The seven survey questions and responses are summarized in Table 4. Questions were in multiple-choice format with prompts on several questions to explain their answers. Initial contact was made via email with follow up emails and phone calls to all possible respondents. Seven letters and surveys were sent out to the Cook Inlet workboat community members identified with input from the Management Team and Advisory Panel. Five of the seven surveys were completed and returned.

Survey results show that most current Cook Inlet workboat operators participate in voluntary third party inspections and audits. Many of the operators indicated that SMS inspections and audits were often "mandatory" within their company. These inspections and audits were found to contribute to improvements in safety and loss, better company-wide communication, and they have made operational changes as a result of such inspections and audits. Most importantly, the majority agreed that participation does make for a safer workplace.

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[26] The required components of a SMS can be found in 33 CFR section 96.250.

[27] Under 33 CFR 96.20, *mandatory* certification is required for all passenger vessels engaged on a foreign voyage, carrying more than 12 passengers; and tank vessels, bulk freight vessels, or high speed, freight vessels of at least 500 gross tons or more engaged on a foreign voyage. As of July 1, 2002, mandatory certification is required for all other freight vessels and self-propelled, mobile offshore drilling units of at least 500 gross tons or more engaged on a foreign voyage. The U.S. Coast Guard enforces this requirement.

[28] NVIC5-99 from the U.S. Coast Guard describes the voluntary approach to establishing SMS.

[29] CISPRI, Metson Blue Water Navigation, Sause Brothers Inc., Ocean Marine Services, Cook Inlet Tug and Barge, Alaskan Coastal Freight, Kirby Offshore Marine

Table 4. Survey questions and summary of responses related to SMS use by Cook Inlet workboat operators

Survey Questions	Summary of Responses
Do the operators use a CFR Part 96.250-compliant voluntary (SMS)?	Four respondents indicated that their company participates in a voluntary SMS. One respondent did not know for sure, but did say that they are subject to third party audits.
What factors encouraged the use of voluntary safety management systems?	Four respondents answered this question. All indicated that, "the system was mandatory" for certain vessels. One respondent did not answer this question.
What might inhibit participation?	Most respondents did not answer this question, likely due to the fact that many of them are participating in some sort of system. The one respondent who answered this question stated, " There is no expense to comply with our member's Offshore Vessel Inspection Database (OVID) inspection requirements, [as] this expense is borne by the member company."
Were they found to be helpful with safety and loss improvements?	Four of five respondents indicated that participating in a scheduled inspection/audit program has contributed to improvements in safety and loss. One respondent indicated it did not.
Did company-wide communication improve because of use?	All respondents agreed that participation in SMS audits and inspections has improved company-wide communication.
Did use contribute to an overall safer workplace?	All but one respondent agreed that the use of a SMS and third party audits/inspections make a safer workplace. That one respondent replied, "I would say yes if we're talking about an uninspected boat. I'd say no if the vessel is USCG and American Bureau of Shipping inspected already, which is what we have going."
Have these audits contributed to changes made in operations due to discoveries made during audits?	All respondents agreed that they have made changes in operations due to third party audits/inspections.

5.4.1 Recommendation

Both local and occasional workboat operators in Cook Inlet should continue to use third party audits/inspections of their vessels and procedures to promote safe operations. The workboat community should be represented in the HSC to facilitate identifying and addressing any future safety issues associated with workboat operations on Cook Inlet waters. New vessels working in Cook Inlet for the first time should have a way to check in with HSC to facilitate the identification of vessels with less experience operating in Cook Inlet conditions.

6. Risk Reduction Options Related to Preventing an Accident if an Incident Occurs

Some CIRA risk reduction options seek to prevent an accident if an incident occurs. This includes rescuing a distressed vessel to prior to its grounding or allision. A ship without power will drift with the wind and current until repairs are affected or a rescue vessel capable of securing a tow arrives. Much of the coastline of Cook Inlet is rocky, and the Upper Inlet is quite narrow, presenting a number of hazards for a disabled vessel. Whether a rescue prior to grounding is possible depends on the location of the distressed vessel, location and capability of rescue tug(s), and the wind, sea state, currents, and other conditions at the time of the incident.

Two types of risk reduction measures in this category are considered. First, the potential for emergency towing is considered by evaluating the availability, minimum capability requirements, and window of opportunity for tugs of opportunity to assist a distressed vessel in Cook Inlet (Section 6.1). In the event that emergency towing was not available, suitable, or able to reach a distressed vessel in time, the capability for a disabled deep draft vessel to self-arrest (deploy an anchor to secure its position) is considered (Section 6.2).

Emergency towing and vessel self-arrest are influenced by a wide range of factors, including, but not limited to, the exact conditions at the time (wind, tide, currents, or other complicating factors such as ice, temperature, and visibility); the size of the distressed vessel and nature of the problem; the location of potential rescue vessels and their location, speed, power, equipment, willingness to respond, and whether they have a tow underway; and the skills and abilities of personnel involved on both vessels as well as any shore support required. Because of the complexity and variability involved in these operations, it was not possible to develop general estimates for emergency towing or vessel self-arrest. Instead, these risk reduction options were explored through a series of representative scenarios, considering a range of environmental conditions, and relying heavily on the input of the subject matter expertise of the Advisory Panel. In some cases, the analysis points to the need for further study. Table 5 summarizes the tug scenario parameters.

Table 5. Tug scenario parameters

Locations	Vessel Types[30]	Environmental Conditions[31]
Upper Cook Inlet in the shipping lanes 13 nm north of the East Forelands Kachemak Bay in the shipping lanes along the route to the Homer Pilot Station Kennedy Entrance on the vessel route midway between the Barren Islands and Point Adams	338,000 bbl oil tanker similar to those calling at Nikiski 1,500 TEU containership similar to those calling at the Port of Anchorage	Median (common) wind, sea state, currents, and ice conditions 90th percentile (adverse) conditions for the same environmental factors

[30] Representative deep draft vessels based on Eley, 2012

[31] The Glosten Associates, 2013b

6.1 Potential for Tug of Opportunity Rescue

The potential need for additional emergency towing vessels to assist a disabled ship in Cook Inlet was highlighted by the 2006 grounding of the *T/V Seabulk Pride* and has been raised in the Cook Inlet Navigational Safety Forum in 2007 (Cook Inlet RCAC, 2007). Partly, because of this concern, and prior to the start of the CIRA, a docking assist tug was added at Nikiski in 2005.[32] Coincidentally, increasing oil and gas activity in the Inlet has brought more offshore supply vessels with secondary towing capability to the Inlet.

This section considers the potential for a tug or towing-capable vessel already present in Cook Inlet and surrounds to be able to rescue a drifting deep draft vessel.

6.1.1 Estimated Minimum Tug Size Required

The *Evaluation of 2012 Tugboat Response Times* (The Glosten Associates, 2013b) estimated the minimum bollard pull required to control a disabled vessel, assuming the rescue vessel arrests the drift of the disabled vessel and turns it into the direction of the prevailing drift (gain control and arrest its drift). The estimated minimum bollard pull is derived from the scenario conditions summarized in Table 6 and depicted in Figure 9.

When considering scenarios *without* sea ice present, the analysis calculated that the greatest required tug bollard pull at approximately 30 MT for both vessels in the Kennedy Entrance case during winter (90th percentile conditions). Tables 6 and 7 summarize the required tug bollard pull calculated in each load case for the containership and oil tanker, respectively. Some Advisory Panel members with experience operating towing vessels on Cook Inlet indicated that they believed that 30 MT would be inadequate in many conditions.

When considering the scenario with 70% ice coverage (the 90th percentile condition for sea ice) in Upper Cook Inlet, however, the analysis showed that it would not be feasible to turn and arrest a disabled vessel and instead calculated the maximum required tug bollard pull to arrest only (without turning) for the containership and oil tanker at 72 MT and 67 MT of bollard pull, respectively. Several members of the Advisory Panel noted the there might be other solutions available to rescue a disabled vessel in ice, such as turning and towing the vessel with the current. Thus, we use the 30 MT for no-ice conditions as the minimum required tug for the remaining analysis, and acknowledge that while the bollard pull required in ice conditions would likely be significantly higher, a firm estimate is not available for the months and locations of the Inlet when sea ice is present in high concentrations. Further study may be warranted to determine the range of bollard pull necessary during winter ice conditions.

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[32] In addition to the docking assist tug, following the *T/V Seabulk Pride* incident the U.S. Coast Guard modified the winter ice guidelines discussed in Section 4.2. Ice was involved in dislodging the vessel from its mooring.

Figure 9. Three scenario locations for Cook Inlet towing analysis

Table 6. Estimated required bollard pull for example containership (The Glosten Associates, 2013b)

Load Case	Environmental Condition					
	50th percentile			90th percentile		
Region	**Upper**	**Kachemak**	**Kennedy**	**Upper**	**Kachemak**	**Kennedy**
Turning and Arresting (MT)	70.60	3.20	20.70	-	11.90	47.50
Turning Load Only (MT)	0.80	0.80	2.60	-	4.30	7.70
Arresting Load Only (MT)	15.00	0.80	5.40	-	3.10	23.60
Tug Efficiency	0.80	0.80	0.80	-	0.80	0.78
Required Tug Bollard Pull (MT)	18.70	1.00	6.70	-	5.40	30.30

Table 7. Estimated required tug bollard pull for example tanker (The Glosten Associates, 2013b)

Load Case	Environmental Condition					
	50th percentile			90th percentile		
Region	**Upper**	**Kachemak**	**Kennedy**	**Upper**	**Kachemak**	**Kennedy**
Turning and Arresting (MT)	69.90	3.20	20.40	-	11.70	46.60
Turning Load Only (MT)	0.80	0.70	2.60	-	4.30	8.40
Arresting Load Only (MT)	14.80	0.80	5.20	-	3.00	21.30
Tug Efficiency	0.80	0.80	0.80	-	0.80	0.78
Required Tug Bollard Pull (MT)	18.50	1.00	6.50	-	5.40	27.30

6.1.2 Estimated Response Times for Potential Tugs of Opportunity

The same locations, ships, and environmental conditions that were used in the evaluation of tugboat response times were also used to estimate how long it would take tugs or other towing-capable vessels in Cook Inlet to reach a distressed vessel. For this analysis, the term, "tugs of opportunity" is used to refer to all tugs and towing-capable vessels, including offshore supply vessels, escort vessels in Prince William Sound, harbor tugs, and U.S. Coast Guard vessels.

A total of 107 potential tugs of opportunity was identified using MXAK AIS data showing the location of self-identified tugs and offshore supply vessels in Cook Inlet, Kodiak, Seward and Prince William Sound at noon on Wednesdays in 2012. In total, there were 1,044 data points, or times when a tug was in the area at the designated time. It was assumed that tugs in tow would have to drop their tow at the closest port – either Port Graham, Seldovia, Homer, Drift River, Nikiski, or Anchorage - prior to going to the distressed vessel.

Using the same locations from the 2012 tug study and considering only tugs with at least 30 MT bollard pull operating in no ice, and based on the dataset from 2012, the average, worst, and best times for the first capable tug to arrive on scene are presented in Table 8.

Table 8. Average, worst, and best length of time (in hours) required for the first capable emergency tow vessel to reach the three scenario locations in Cook Inlet

Scenario Location	Average	Worst	Best
Upper Cook Inlet	3.6	7.1	2.2
Kachemak Bay	5.4	13.0	2.6
Kennedy Entrance	7.4	10.2	3.5

Figure 10 shows the breakdown of first response tugs to arrive at each location.

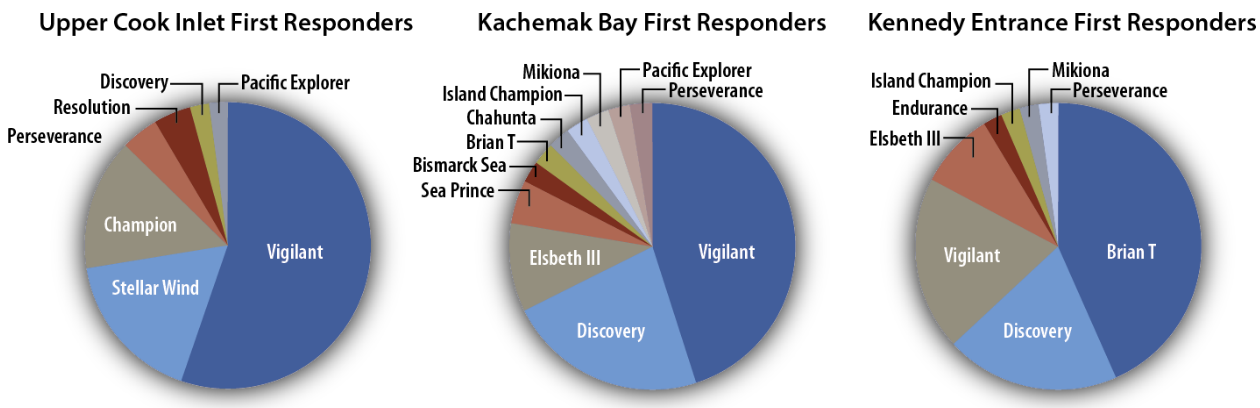

Figure 10. Tugs arriving first on scene at three scenario locations

The average time for the first capable towing vessel to reach the Upper Cook Inlet scenario location was 3.6 hours. Due to the uncertainty of tug travel times in ice, only the 50th percentile (common) weather conditions were considered for this scenario. The most frequent first responders include the Vigilant (a Nikiski based docking tug), the Stellar Wind (an Anchorage based docking tug), the Champion (a Nikiski based offshore supply vessel), and the Resolution and Perseverance (both oil spill response vessels based in Nikiski). The best response time was 2.2 hours when the Vigilant responded from her location in Upper Cook Inlet under favorable tides and 50th percentile (common) weather conditions. The worst response time was 7.1 hours when the Stellar Wind responded from the Port of Anchorage under adverse tides and common weather conditions.

The average time for the first capable towing vessel to reach the Kachemak Bay scenario location was 5.4 hours. Both the 50th percentile (common) and 95th (adverse) weather conditions were considered for this scenario. The most frequent first responders include the Vigilant (a Nikiski based docking tug), the Discovery (an offshore supply vessel present to attend to an exploration jack-up rig), and the Elsbeth III (a tug that was moored in Homer in 2012). The best response time was 2.6 hours when the Discovery responded from her location in Port Graham under favorable tides and common weather conditions. The worst response time was 13.0 hours when the Brian T responded from Kodiak under adverse tides and weather conditions.

The average time for the first capable towing vessel to reach the Kennedy Entrance scenario location was 7.4 hours. Both the 50th percentile (common) and 95th (adverse) weather conditions were considered for this scenario. The most frequent first responders include the Brian T (a Kodiak based docking tug), the Discovery (an offshore supply vessel present to attend to an exploration jack-up rig), and the Elsbeth III (a tug that was moored in Homer in 2012). The best response time was 3.5 hours when the Discovery responded from her location in Port Graham under favorable tides and common weather conditions. The worst response time was 10.2 hours when the Viligant responded from Nikiski under adverse tides and weather conditions.

The availability of potential rescue tugs was not consistent in every part of the Inlet or throughout the year studied. Generally, there were fewer potential rescue tugs in Lower Cook Inlet as compared to Middle and Upper Cook Inlet. There are times when transient tow vessels were in Homer, but in 40% of the weeks studied there were no tow vessels with a bollard pull >30 MT south of Anchor Point, including tugs towing barges. When considering only emergency towing vessels without barges this number increases to 64% of the weeks during which there was no first responder tow vessels available in Lower Cook Inlet.

These results are a snapshot of tugs available in 2012; the potential emergency tow vessels change over time, but the results are informative. The Vigilant[33], the Nikiski based docking tug, emerges as the most consistent first responder. The docking tugs stationed in Anchorage often are the first responders in Upper Cook Inlet. The Brian T, another docking assist tug based in Kodiak, appears the most common first responder in the Kennedy Entrance scenario. This tug is stationed 84 nm from the Kennedy Entrance scenario location, which is almost twice the distance from Homer. The fact that it is often the first responder speaks to the inconsistent availability of tugs of opportunity in Lower Cook Inlet. In this analysis it is assumed that docking tugs are always available to assist, which is not always true.

Offshore supply vessels and oil spill response vessels are also often the first responders. These vessels are usually in Central Cook Inlet, but in recent years offshore supply vessel activities associated with oil exploration in Lower Cook Inlet and drilling rig anchorage in Kachemak Bay or Port Graham have led to more offshore supply vessel activity in Lower Cook Inlet. The continued availability of these vessels in the Lower Inlet is uncertain.

Tugs with barges in tow were seldom first responders, due to the time necessary to secure their tow in a safe harbor or dock. Advisory Panel members have also pointed out that there are numerous contract, liability, and port requirement issues with assuming that a tug in tow can be counted on to drop its tow and assist a distressed vessel. Other than the Brian T, located in Kodiak, emergency tow vessels outside Cook Inlet were not able to reach the scenario locations before a capable tow vessel from within the Inlet. This indicates that vessels from Seward or Prince William Sound will likely not play a role in assisting disabled vessels in Cook Inlet.

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[33] The Vigilant has since been replaced by the Bob Franco, which was used in the Zone of No Save Analysis (see Section 6.1.3).

6.1.3 Estimating How Likely a Tug is to Reach a Distressed Vessel Before It Drifts Aground

Risk of a drift grounding varies dramatically as a ship transits Cook Inlet:

- As a ship traverses the route from Kennedy Entrance to the Port of Anchorage, the shipping lanes vary considerably in terms of sea room, shoreline hazards, wind, and currents. Kennedy Entrance at the south end of the Inlet is 13 nm wide and 300 feet deep, and experiences the worst sea and winds of the entire Inlet. The steep, rocky shorelines present extreme hazards should the ship become disabled. Results of the tug arrival time study indicate it will on average take more than seven hours for a rescue towing vessel to arrive at the Kennedy Entrance scenario location.

- Kachemak Bay is also wide and deep but with smaller seas. The prevailing northerly winter winds blow at right angles across the shipping lanes onto the southern rocky shoreline. Summer winds tend to blow along the length of the bay. On average it takes more than five hours for an emergency tow vessel to arrive at the Kachemak Bay scenario location.

- North of Anchor Point, the Central Inlet shoreline presents long tidal flats with a low sloping bottom and shoals that become more friendly to drift groundings, yet rock outcropping and boulder erratics still pose hazards. The channel gradually becomes narrower with depth restrictions and the tidal current begins to grow stronger. From this location on, the currents and prevailing winds are oriented in the same north-south direction as the channels. At the Forelands, the tidal current can exceed six knots. Low angle shorelines and high currents, with the additional drifting hazard of oil production platforms, also characterize Northern Cook Inlet. The average response time to the Northern Cook Inlet scenario is more than 3 hours. Near Anchorage, the channel becomes tidally restricted and ships can only proceed at high tide.

To compare the relative likelihood of a vessel incident, the amount of time required for a disabled to drift aground was analyzed for different locations. The first step was to estimate the length of time it would take for a disabled vessel at each scenario location to drift into shoal water. The drift rate for a given wind condition was taken from drift speed calculations for a typical containership (The Glosten Associates, 2012). The wind strength used was the 90th percentile wind in the direction of the hazard taken from the wind rose produced for the nearest wind station. Thus, 90% of time it will take *at least* the amount of time calculated for the vessel to drift to the hazard from the scenario location. Currents are not considered in this calculation. The distance drift time from each scenario location to the nearest grounding hazards is presented in Table 9, where the estimated time to grounding and estimated time for a response tug to arrive can be compared for different locations.

Table 9. Distance and estimated drift time to nearest hazard, and average response time for three scenario locations in Cook Inlet

Scenario Location *Hazard*	Wind speed (knots)	Distance to Hazard (NM)	Time to Grounding/ Impact (Hours)	Average Time for First Response Tug to Arrive (Hours)
Upper Cook Inlet				
Rocky shoal near Boulder Point	11	5.7	5.1	3.6
Granite Point Platform	7	5.7	6.3	3.6
Kachemak Bay				
Naskowhak Reef	14	2.3	1.3	5.4
Kennedy Entrance				
West Amatuli Island	16	7.2	3.3	7.4
Nord Island	17	8.5	3.6	7.4
Elizabeth Island	10	6.5	4.4	7.4

This approach can be generalized to the entire study area using the concept of a Zone of No Save (ZONS): an area in which a rescue tug might not arrive before a disable vessel could drift aground. The ZONS is contrived to show an area with a boundary. When a vessel is at the zone boundary there is a 90% chance that a rescue tug would arrive on-scene before a disabled vessel would be blown ashore by the winds that typically occur at that location. Inside this zone there is a proportionately lower chance that the tug arrives before grounding. Outside the zone there is a proportionately higher chance that the tug arrives before grounding. Note that the ZONS analysis does not consider the effect of currents, which might increase, decrease, or have no effect on the time to grounding. The assumptions made in this analysis represent favorable estimates of the time it will take for a tug to get underway. Actual response times are likely to be longer, and the ZONS is likely to be larger.

To conduct this analysis, hazards (rocky shorelines, isolated rocks, reefs, and oil platforms) were mapped along the entire coastline of Cook Inlet, and wind strength and direction data for each location were assembled from the nearest weather station. To create the ZONS, the 90th percentile wind conditions were calculated in every direction, at each hazard, and converted wind speed into drift speed for the example container ship. We then compared the time it would take the vessel to drift into a hazard to the time it would take a rescue tug to reach this hazard (Figure 11). Outside the zone, a tug could reach the ship before it impacted the hazard. Inside the zone, the ship could impact the hazard before a tug could reach it. The methods used to calculate the ZONS are included in Appendix F.

This analysis considers four tugs located in four different Cook Inlet ports: Anchorage, Nikiski, Homer, and Port Graham. The analysis was performed separately with each tug, and with all four together. Figure 11 presents two different ZONS cases--one assuming a tug is present in four ports and the nearest will respond and one assuming that the only available tug is at Nikiski.

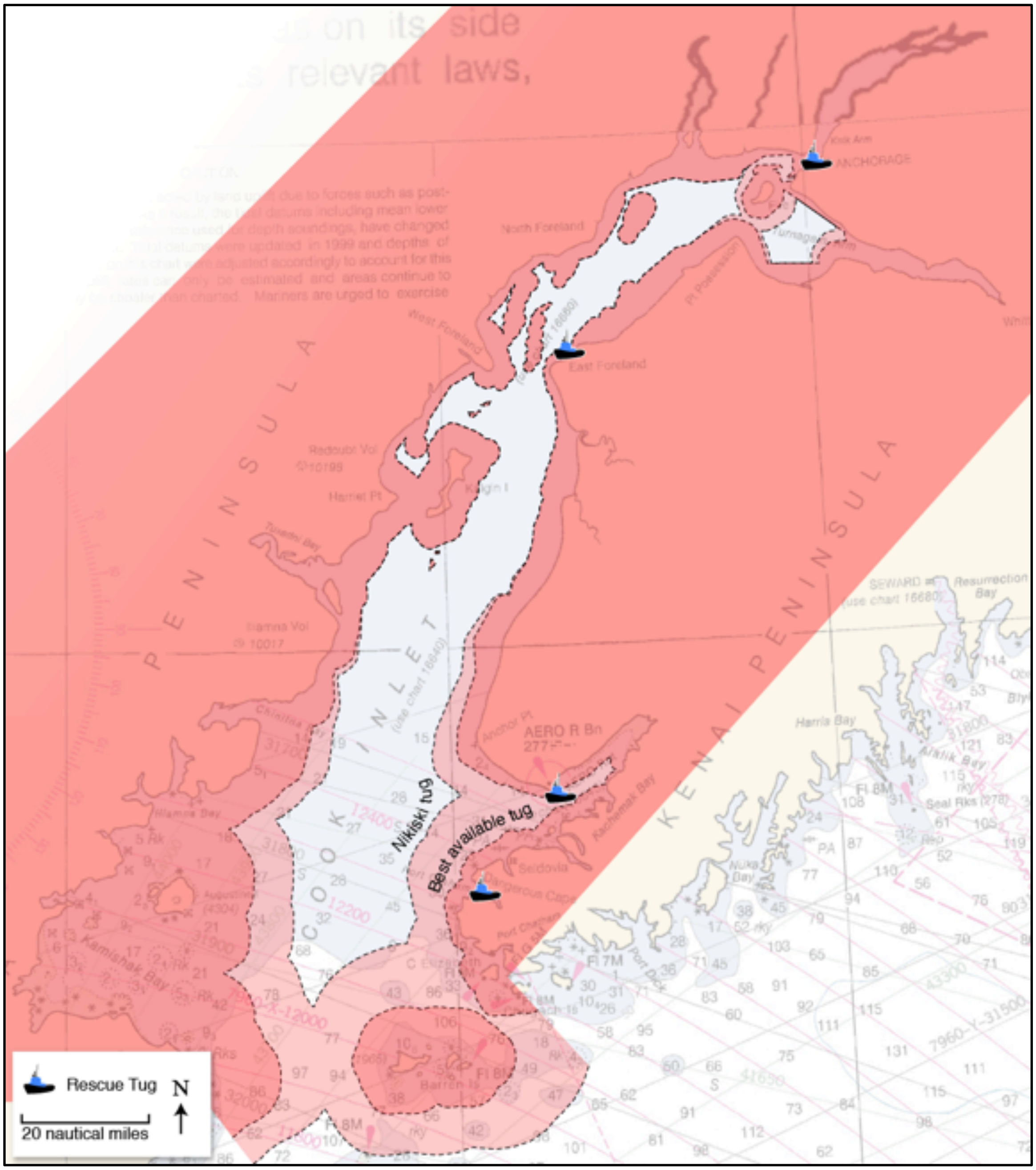

Figure 11. Zone of No Save analysis for Cook Inlet, considering two cases: tugs available in *four* ports, and a tug available *only* at Nikiski

The darker pink area over water is the ZONS for the best available tug, assuming a tug is present in each port in the study (noted as tug icons), and the lighter pink area assumes that only the Nikiski docking tug is available for response. Figure 12 focuses on Lower Cook Inlet including Kachemak Bay and Kennedy Entrance and depicts the ZONS for each tug location.

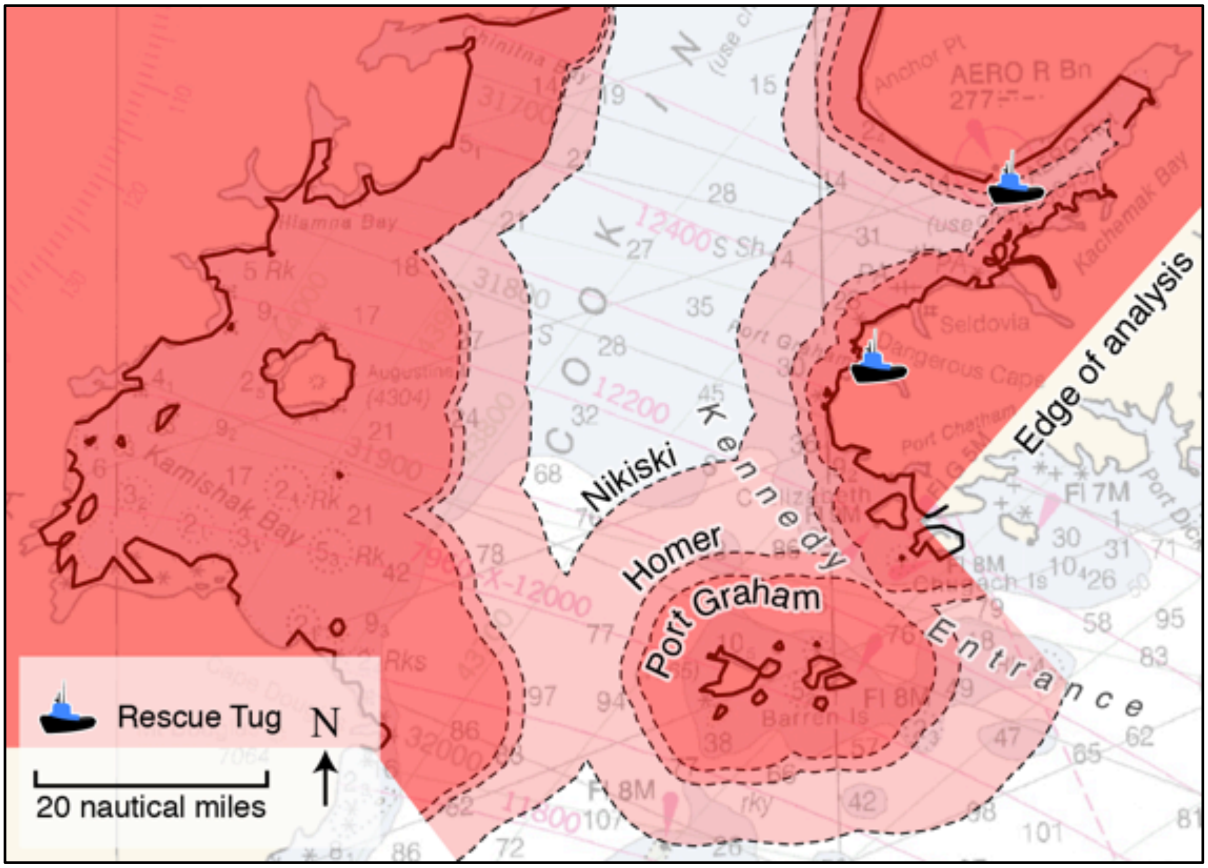

Figure 12. Zone of No Save analysis for Lower Cook Inlet and Kennedy Entrance for tugs stationed at Nikiski, Homer, and/or Port Graham

It is difficult to generalize the length of time a distressed vessel will have before drifting into a hazard because every incident has unique circumstances, but the ZONS analysis provides a standardized look at the vulnerability of a distressed vessel to drift grounding. The analysis shows that large portions of Cook Inlet are outside the ZONS and thus an emergency towing vessel would likely reach a distressed vessel prior to grounding, but there are areas where ships are vulnerable.

Areas where the ZONS encompasses much of the waterway include the Forelands, the area near Anchorage and Fire Island, Kamishak Bay, and Kennedy Entrance. If no tug is available in Lower Cook Inlet, Kachemak Bay is also completely within the ZONS. The waterway is very narrow and draft restricted near Anchorage and the ZONS around Fire Island covers most of the shipping route to Anchorage. This is true even when a response is mounted from Anchorage. If the Nikiski tug is the first responder, the zone encompasses all of Knik Arm and the entrance to Turnagain Arm.

In Central Cook Inlet the inlet is narrow, shallow, and contains both shoals and offshore oil platforms. Even with the Nikiski tug responding from very nearby, there is a significant chance that a ship would impact a hazard before it could be rescued.

In Kachemak Bay, the shipping lanes are generally outside the ZONS when a towing vessel is available in Homer or Port Graham, but if there is no rescue vessel in these ports, the entire bay is within the ZONS.

In Kennedy Entrance, the ZONS encompasses almost the entire waterway, even when a suitable emergency towing vessel is located in Port Graham. Any ship transiting Kennedy Entrance that becomes disabled, is vulnerable to a drift grounding before a rescue tug arrives.

6.2 Potential for Vessel Self-arrest

If a tug is not available, or in order to allow the tug more time to reach a distressed vessel, the distressed vessel may deploy its anchor or anchors to slow or stop its movement towards grounding or other hazards. In most of Cook Inlet, the water depth and bottom type are favorable for a ship's anchor to reach bottom with enough scope to set the anchor before grounding. A literature review was completed to inform the discussion about the feasibility of this option in an emergency (The Glosten Associates, 2013c; Appendix B). Advisory Panel members offered subject matter expertise to this qualitative assessment.

There are widely varying opinions on using a ship's anchor to perform a self-arrest. While a successful self-arrest could make the difference between an oil spill and a vessel simply waiting in place for further assistance, there are some potential consequences to attempting a self-arrest procedure. These include injury or death caused by the improper deployment of the anchor or faulty equipment, or rupturing a subsea pipeline or otherwise damaging subsea equipment (The Glosten Associates, 2013c).

Local mariners, including marine pilots, consider self-arrest practical and safe, and in Cook Inlet, dredging an anchor is a common docking maneuver.[34] Unlike this docking maneuver, which is performed under controlled conditions, using an anchor to self-arrest a vessel that has lost power can be more complex. Self-arrest was used during the 2006 grounding of the *T/V Seabulk Pride*, and although the tanker grounded, the use of the anchor allowed for a much more controlled grounding and likely minimized damage. A literature review revealed mixed results when this procedure was deployed in other waterways.

It was not within the scope of this analysis to quantify the circumstances where self-arrest anchoring will be successful. However, one approach to achieve this would be to conduct a more comprehensive study of the issue through simulations. More research into the efficacy of using an anchor to self-arrest in Cook Inlet is needed if this procedure is to be relied on as a risk reduction method for preventing grounding or similar incidents that could result in casualties or oil spills.

[34] In this situation, the Pilot sets the ship up into the current and takes way off of the vessel, at the appropriate time the anchor is realized and set as the ship drifts back with the current.

6.3 Recommendation

The Advisory Panel recommends that continued study is warranted in two areas related to self-arrest and emergency towing, and that the proposed HSC could coordinate the implementation of the following:

1) Demonstrate or otherwise qualitatively study the ability to arrest and control a large, deep-draft vessel in Upper Cook Inlet sea ice conditions, with input from large vessel mariners and local marine pilots, and, as needed, experts in materials, engineering, simulations, and ship dynamics.

2) Demonstrate or otherwise qualitatively study the ability of a large, deep-draft vessel to self-arrest in different parts of Cook Inlet, including identifying areas where this practice is more or less likely to be successful; identifying areas where this should *not* be conducted due to pipe, power, or communication lines located on the seabed floor; identifying best practices for implementation, and estimating the amount of time – and therefore associated vessel drift – that this would take. This effort should also involve large vessel mariners and local pilots, as well as experts in sea ice, ship and ice dynamics, and simulations.

While further information is needed to build a shared understanding related to the above topics, the Advisory Panel has identified the critical role that local, resident tugs can play in assisting a distressed vessel. Due to the number of tugs and the fact that many are believed to have sufficient power to be able to assist ships of the size typically traveling through Cook Inlet, while the estimated response times vary among different parts of the Inlet, a tug of opportunity (TOO) is likely to be available to assist in some way. To maximize the effectiveness of these potential tugs of opportunity, which include docking and assist tugs, tugs transporting barges, and oil spill response vessels, a program should be created that:

1) Identifies and works with the owners and operators of likely TOO to address procedures, potential obstacles, and legal arrangements associated with that vessel engaging on short notice in a rescue effort.

2) Monitors the availability and location of TOO and contacts them quickly when a rescue is needed. (This could be conducted in coordination with the monitoring of some deep draft, non-tank vessels already in place.)

3) Conducts training exercises or otherwise coordinates with potential TOO operators to ensure that tug/towing vessel crews are prepared to implement a vessel arrest mission if called upon to do so. This may include practicing the deployment of an emergency towing system (ETS) as described below, and should include training specific to the tow packages likely to be on vessels transiting the Inlet.

Finally, large, deep-draft vessels operating in Lower Cook Inlet outside the pilotage area require special attention as these vessels are operating in the most exposed waters with the longest response times, and will not have a marine pilot on board. The HSC should document and communicate best practices and standards of care for this area. An ETS should be located in Homer to further facilitate rescue in this area, especially as the initial deployment of the ETS by aircraft could start the process and save time until a TOO arrives on scene.

7. Risk Reduction Options Related to Reducing Oil Outflow and Spill Impacts if an Accident Occurs

Three risk reduction options relate to reducing the oil outflow and spill impacts if an accident occurs. One option was already addressed with the promulgation of the federal vessel response planning requirements for non-tank vessels greater than 400 gross tons. Both of the other options – updating and improving the Subarea Oil and Hazardous Substance Contingency Plan (Section 7.1), and ensuring use of the best possible response equipment for Cook Inlet conditions (Section 7.2) – were items that the Advisory Panel considered to be already planned or underway.

7.1 Update and Improve the Subarea Oil and Hazardous Substance Contingency Plan

The Cook Inlet Subarea Contingency Plan supplements the Alaska Federal/State Preparedness Plan for Response to Oil and Hazardous Substance Discharges/Releases (Unified Plan). The Subarea Contingency Plan, in conjunction with the Unified Plan, describes the strategy for a coordinated federal, state, and local response to a discharge or substantial threat of discharge of oil or a release of a hazardous substance from a vessel, offshore or onshore facility, or vehicle operating within the boundaries of the subarea. The Subarea Contingency Plan is used as a framework for response mechanisms and as a pre-incident guide to identify weaknesses and to evaluate shortfalls in the response structure before an incident. The plan also offers parameters for vessel and facility response plans under the Oil Pollution Act of 1990.

The Subarea Contingency Plan is slated for review and update beginning as soon as winter 2015 as a joint effort led by the U.S. Coast Guard and ADEC. The last update was completed in December 2010. The 2015 update should incorporate information and findings from the CIRA project reports. It will also identify any new section(s) to be developed, such as a prevention section that includes general ice rules and guidelines or nearshore operations response strategies. The Subarea Committee should also review the need for additional geographic response strategies, updates to infrastructure maps and hazard/vulnerability analysis, and the potential need to update Cook Inlet Environmental Sensitivity Index ESI maps.

7.1.1 Recommendation

The Advisory Panel recommends that the Cook Inlet Subarea Contingency Plan be reviewed and updated as needed. This will enhance response preparedness for the region, and is on track to begin in 2015. An update to the Subarea Contingency Plan provides the opportunity to ensure that the information in it regarding sensitive resources is widely shared and accessed by those operating port, docking, and other facilities whose localized planning could incorporate information about spill potential impacts and targeted mitigation measures.

7.2 Continuous Improvements in Spill Response Equipment for Cook Inlet Conditions

CISPRI and the Alaska Chadux Corporation are the two federally certified Oil Spill Response Organizations and State of Alaska Primary Response Action Contractors for the region. Both organizations are member-owned, non-profit corporations providing oil spill planning, training, and response services to facilities and vessels throughout the Cook Inlet region. CISPRI is certified to operate in the offshore, nearshore, ocean, inland and river/canal environments. Alaska Chadux is certified for the inland and river/canal environments. Each organization has mutual aid agreements in place with other Alaska OSROs to supplement response capabilities. Both CISPRI and Alaska Chadux maintain response resources strategically located in caches or warehouses throughout the Cook Inlet region, which they are ready to deploy on behalf of their member companies.

Both CISPRI and Alaska Chadux participate in ongoing activities aimed at exercising their existing capacity and investigating potential new technologies that will improve on-water oil spill containment and recovery.

7.2.1 Recommendation

The Advisory Panel recommends that response resources in Cook Inlet be continually tested and assessed to validate and improve on its effectiveness and to ensure that the best available, proven technology is being utilized in the Cook Inlet operating environment.

8. Conclusion

Cook Inlet benefits from an experienced maritime community with both a proven commitment to working together to improve safety and relatively ready access to response resources and infrastructure. Large, deep draft vessels operating on the Inlet are subject to both federal and state spill prevention and response requirements and are typically smaller than those vessels passing through U.S. waters off Alaska's shores to and from Asia. Cook Inlet also has two resident oil spill response organizations. Finally, Cook Inlet benefits from risk reduction measures that are already in place, including many of the items recommended by the Advisory Panel to continue or expand.

At the same time, there is widespread acknowledgement of the challenges that maritime operations in the Inlet can face, such as strong tidal currents and quickly changing sea ice coverage and thickness during winter. While there are many vessels and crew familiar with the Inlet, there is also a diverse array of vessel types and operations and occasional visits from vessels unfamiliar with local condition. Although less remote than other parts of Alaska, Cook Inlet has many areas that are inaccessible by road and hours or days from assistance or response services especially in unfavorable conditions. Cook Inlet also has valuable commercial, recreational, and subsistence fisheries and other harvests in addition to other ecological and wildlife resources that warrant protection.

The CIRA Advisory Panel recommended the risk reduction options discussed in this report to maintain and enhance the level of risk mitigation already achieved on Cook Inlet's waters. Where these efforts are already underway, they should be sustained and, in some cases, enhanced or expanded within the Inlet.

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Appendices

Appendix A – Reduced Risk of Oil Spill with a Cross Inlet Pipeline (2013), by The Glosten Associates

Appendix B – Evaluate Drifting Vessel's Ability to Self-arrest (2013), by The Glosten Associates and Evaluation of 2012 Tugboat Response Times (2013), by The Glosten Associates with Comments

Appendix C – Benefit-cost Analysis of the Trans-Foreland Pipeline as an Oil Spill Risk Reduction Option (2014), by Northern Economics, Inc.

Appendix D – Public Comments on Final Report and Response from Management Team

Appendix E – CIRA Management Team and Advisory Panel Members

Appendix F – Methodology for Zone of No Save Analysis