Executive Summary

This report presents the findings from an analysis of the proposed design of the Seward Marine Industrial Center (SMIC), and provides recommendations to mitigate potential risks associated with the current proposed design. In order to determine the safe navigation of large shipping vessels in the SMIC a maritime simulator was utilized. The main factor examined using the maritime simulator was the potential risk associated with navigating large vessels into and around the harbor, and how to mitigate these potential risks by investigating alternatives for the proposed design of the SMIC. The findings indicate that the designed harbor is easily navigable for vessels less than 200’. However, revisions for the proposed design of the SMIC are needed to operate larger vessels such as those that are 340’ in length. In order to limit the potential risk to the navigation of these larger vessels, Safeguard Marine recommends an approach channel be created with a wider breakwater entrance including navigational markings. We also recommend that the docks within the harbor should be aligned north to south, and the turning dolphin at the ship lift dock utilize fenders for vessel docking.
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Introduction

R & M Consultants, Inc. is engineering the Seward Marine Industrial Center (SMIC) for the City of Seward. The preliminary design has been completed and Safeguard Marine was contracted by R & M Consultants to perform a navigational maritime analysis of this design utilizing the maritime simulator located at the Alaska Vocational Technical Education Center (AVTEC) Seward. During the operation of the AVTEC simulations, open dialogue between maritime experts and other stakeholders was encouraged so that the process of taking away valid data from the simulation information would benefit everyone and help create a facility that is successful and useable.
One of the primary objectives of this analysis was to bring stakeholders together to observe vessels being maneuvered utilizing the proposed design of SMIC. Vessel models were of comparable size and type of those that are projected to use the new harbor. Additionally, another objective was to determine the ability to safely navigate high profile vessels during wind conditions typical of Resurrection Bay and to assist with the determination of the placement of berths and docks compared to the channel navigation. Finally, we aimed to identify the potential risk to vessels attempting to maneuver, enter or leave the harbor.

The models utilized were designed to test the safe maneuverability of two vessel types: 1) the mega yacht: 302’ long, 42’ wide, 14’ deep (replicating the Tustumena and Trawler) and 2) a vessel 317’ long, 49’ wide, 18’ deep (replicating the Northern Hawk). In comparison, these vessels are as long as a football field, and their operation requires significant expertise and sufficient maneuvering room.

The simulation of harbors, waterways and other maritime assets prior to maritime construction is being used with increasing frequency in maritime development, and is recommended by The World Association for Waterborne Transport Infrastructure (PIANC) (Gray, Waters, Blume, & Landsburg, 2002). Simulations of channel alignment can provide substantial savings through design, evaluation, maintenance, or construction cost, or through avoidance of unforeseen expenses. The channel can be optimized for vessel size, which may conserve construction cost and provide the safest affordable channel to construct and maintain. The simulations were performed in accordance with professionally recognized procedures utilizing a sufficient number of mariners to validate the results of the analysis. Harbor design recommendations founded on both mariner expertise and advanced simulations have been recognized for over 20 years for their accuracy, as evidenced in part by the following statement from a 1992 Committee on Assessment of Shiphandling Simulation report:

A limited number of simulations using a less-than-perfect simulator, a few select (design) ship types, a few select environmental conditions over extreme ranges characteristic of the local area, and a few pilots with representative local expertise and shiphandling proficiency are sufficient to obtain a useful appraisal of waterway design. (Webster, 1992,
In addition to the aforementioned references, shiphandling simulations have also been used and promoted extensively by such bodies as the Army Corps of Engineers, who offer further support for the viability of simulator estimates on successful harbor design (Webb, 2007).

Two separate days of simulation were performed, on October 31 and November 1, 2013. The first day provided three expert mariners the opportunity to gain familiarity with the preliminary design of the harbor. Upon completion of the first simulation, we were able to ascertain the difficult situations that the harbor design presented and also comprehend what was going to be necessary for the operations the next day. On day two, four mariners arrived along with two observers from the City of Seward: Ron Long, assistant city manager, and Mack Funk, harbor master. Kim Nielsen, R & M’s primary engineer for the design, also attended. During the second day, at least two mariners were present when each simulator scenario was performed. This allowed for open dialogue concerning the navigation of the vessels during the simulations. Nearly twenty different scenarios were executed within these two days under various environmental conditions that are commonly known to exist within Resurrection Bay.

Four separate issues concerning the simulation of the preliminary design became apparent during the simulations. These were: 1) the approach channel to the harbor entrance, 2) harbor entrance between the breakwater and north dock, 3) inner harbor dock alignment and turning room within the harbor area, and 4) ship lift accessibility for large vessels within the harbor area. Each of these will be addressed in further detail with specific recommendations concerning this design later in the report.

In addition to these four areas, we identified other specific recommendations surrounding the design that, if included, may help facilitate a successful SMIC harbor. For example, we included in our analysis tug boat utilization of the design harbor. Tug boats will need to be used to assist other vessels in and around the harbor, and their inclusion is predicted to affect some aspects of the design. In particular, we conducted simulations that would allow a reduction in tug boat reliance, as tug boats are expensive to operate and would discourage harbor use if utilization was
Seward Simulator Information

Characteristics of Simulator and Harbor

AVTEC Marine Technical Center features the world class Kongsberg Maritime Simulator, which provides quality simulation. The simulators are frequently utilized by companies and state recognized pilot organizations. The simulators have been continuously upgraded to meet the latest standards within the maritime community.

Mike Angove is the maritime simulator technician who has been educated through Kongsberg approved classes to operate the facility. He is recognized as a highly competent technician with the capability to create simulations that provide informative, actual reality-based scenarios. His creation of the SMIC was a multiday project that focused on the specific characteristics and surroundings of the harbor area. This attention to detail was crucial to the success of the simulation. The accuracy, placement, and replication of the harbor were created to within a meter’s accuracy, which created an accurate and realistic depiction for the simulation of the vessels within the harbor. Figure 1 displays the actual bridge was used to conduct the simulations during our analyses.

Figure 1: Photograph, actual bridge utilized for the simulation
The bridge simulation has a 240 degree visual system with a stern view and a binocular view, which allows for a 360 degree viewing capability. Electronics on the bridge consist of dual radars equipped with automatic radar plotting aid (ARPA) capability. Electronic chart display and information system (ECDIS) are displayed on the port side of the bridge. We also employed VHF radios that communicate with the control room, depicting a normal bridge communication arrangement. A digital compass display is on the forward council indicating the course that is to be driven by the vessel. Wind indication is for relative direction with speed indicator in knots. A digital depth indicator represents the depth of water under the keel of the vessel. A speed log digital indicator with head or stern way made good over the ground. This display also provides the vessel speed over the ground made good in side axis or perpendicular to the vessel. When taken together, these advanced digital simulations provided accurate representations of various elements critical to successful navigation and, as a result, harbor design. Based on the aforementioned simulations, we developed specific recommendations. The preliminary design of the SMIC harbor is depicted below in Figure 2.
Figure 2: Design concept of the SMIC harbor and entrance channel

Approach Channel to Harbor Entrance
The original design of the dredged approach channel was a constant turn from the west that resulted in the vessel coming around the breakwater while executing the turn. The simulation indicated that with any wind from the north or south the vessel would be unable to create this constant turn and safely merge into the entrance channel without incident. Alignment of the vessel on a course to transit through the breakwater well north of the north dock was found in the simulations to be a crucial element in successfully navigating the channel. Therefore, we propose providing a vessel an opportunity to steady up on a southerly course at least two ship lengths prior to passing through the entrance. This would allow the vessels the capability necessary for navigating without contacting the breakwater or north dock.

The beach north of the harbor needs to be sounded to determine the depth of water within the proposed channel that is closer to the beach, as we are unaware of the depth. Dredging may be necessary in this area to create the depth that will allow the vessels to approach the east beach without grounding. We created a dredged channel north of the entrance on the simulator after multiple attempts to navigate into the harbor were unsuccessful. The channel we created was about 330’ long at 337 degrees true from a point abeam the south side of North Dock. (See Figure 3, below). The approach angle to the harbor entrance actually required only one ship length from the entrance between the breakwater and north dock, as this length proved to be adequate in the simulations to provide mariners the necessary sea room to align the vessel prior to passing the breakwater entrance.

The dredged channel north of the entrance we utilized in the simulator was easily identifiable to the mariner on the electronic chart display. This channel will require some markings to indicate the north end termination for vessels that do not have the channel depicted such as we had in the simulator. This can be accomplished with several different options that are commonly utilized in Alaskan ports and waterways. One option would involve marking the northern terminus with a buoy placed at the northeastern edge of the channel. This can be a privately maintained buoy, or a navigational buoy implemented by United States Coast Guard. (See photos below comparing these two buoys; note the reflective tape on the buoy to allow the mariner to easily see the marker when navigating at night by the reflection from the spot light or own vessel lights.)
Figure 3: Vessel making an approach to the entrance channel
Alternatively, another option to mark the channel limits is to utilize a range line that would line up for the center of the channel. This could be placed on the beach and would be less likely to be disturbed, displaced or maliciously moved, any of which would create a problem for the mariner navigating the channel. Range lines such as these can be placed upon a piling on the shore side to eliminate the possibility of their being displaced. An example of privately maintained versus USCG operated range lines is displayed in the photographs below. These types of ranges can be reflective, which would allow the mariner to utilize a spot light or the vessel lights to illuminate the range line.
These types of markings also allow the mariner to instantaneously determine the set and drift of the vessel. Such determinations will be extremely beneficial for vessels approaching the proposed north dredged channel, as they will permit superior navigation capability within the SMIC harbor. When preparing to enter the harbor, the vessel will be east bound when entering the channel, which will expose the vessel broadside to the prevailing north or south winds, creating set and drift.

Mariners operating vessels of the size that were simulated (i.e., greater than 302’ long, 42’ wide, 14’ deep) will lose visual sight of the breakwater and north dock when entering the harbor if using a center window conning position due to their height of eye from the bridge. They will depend upon leading marks and electronic chart displays to navigate the vessel safely through the harbor entrance. Radar will be incapable of providing a clear picture that can be utilized for the maneuvering process into the harbor due to the confined aspects of the entrance and the range setting that would be employed for the transit.

Leading marks for mariners can be the simplest of land marks within the area. However, we recommend that a range line be created for the channel entrance. The dredged channel approach to
the entrance should also be indicated with similar markings or a buoy to expose the northern extreme of the dredged area. This would indicate to mariners the furthest north that they may proceed when coming from the west prior to turning onto the range for the channel entrance. These marks can be privately maintained or USCG markings.

**Harbor Entrance between the Breakwater and North Dock**

Two models were utilized in the simulations, a mega yacht model and a trawler model. The mega yacht model, which represents the state ferry Tustumena, is very maneuverable for vessels of her size (with twin propellers and bow thrusters) and does not utilize assist tug boats in the many dockings that are performed as a ferry. The trawler model represents the Northern Hawk factory ship, which is a possible future tenant with a high wind profile and single propeller with a small bow thruster compared for the wind surface area.

The original distance between the Breakwater and North Dock was utilized the first day of preliminary design simulations. The North Dock exists at the harbor entrance and is the confining side of the eastern entrance. In particular, our analyses focused on the North Dock as the object to be minimalized in order to create a wide channel. This decision was based on an older harbor design version that had the North Dock extending further into the harbor entrance or West toward the breakwater. In this simulation, we used the mega yacht model. Our simulations were executed with north and south winds of 20 knots and we kept running aground or striking the breakwater or the North Dock prior to entering the harbor area. After these accidents occurred we eliminated all winds and were able to navigate the vessel through the channel with twin screwing effect and utilizing the bow thruster.

Utilizing the trawler model we were unable to navigate the entrance in the first few scenarios with wind at 20 knots out of the North. Wind was changed from the north to the south which allowed us to stem the wind and we were capable of navigating the channel after several more collisions occurred. The ship handling method we were utilizing to navigate the channel was short kicks ahead and stopping the engines to prevent head way from being created with hard over rudders. However, this method of ship handling is not common or acceptable in navigating a narrow channel.
because the vessel should be able to keep the engine running, even at minimum speeds, thus creating a constant flow of water over the rudder. The original designed harbor entrance was deemed insufficient for vessels of this size because it prohibited successful navigation in the presence of moderate winds common in this Alaska region.

The updated design was proposed and implemented on the simulator the evening of the first day. After the first day’s completed simulations, we received correspondence from Kim Nielsen of R & M Consultants requesting additional revisions. In particular, we were asked to further minimize the North Dock extension from the harbor entrance than we had determined in our first simulation. Mike Angove, our simulator technician, was capable of applying R&M’s updated version. The design created extra sea room by shortening the North Dock extension to the west. This change created less problematic scenarios for the second day of simulations, resulting in fewer collisions and groundings. It became apparent that the width of the channel entrance needed to be widened. After a group discussion it was decided to move the North Dock further to the east, thus creating a wider entrance between the breakwater and North Dock and allowing a larger margin of safety for vessels utilizing the harbor. This change was created on the simulator by moving the North Dock an additional distance to the east. After this was implemented, the estimated channel width between the Breakwater to the west and the North Dock to the east was changed to a dredged width of 170’ and total opening of 327’.

This channel alignment should include a “range” or navigational mark for larger vessels. Risk mitigation measures such as these are inexpensive and very helpful for mariners having to navigate a dredge channel. Navigational aids like these markings allow vessel operators to visually observe the set and drift that occurs due to the wind effect upon the larger, high profile vessels. Marks can be lighted so as to be easily visible if they are at a long distance from the vessel location. Such navigational aids can be privately operated or installed and maintained by the USCG. Our simulations indicated this tract line should be approximately 137 degrees. This line of direction can be easily obtained and will be confirmed more accurately if addressed in the design plans. A visual display of a vessel navigating the harbor entrance steering the recommended tract line is presented in Figure 4.
Figure 4: Vessel navigating the entrance channel between the North Dock and Breakwater

Harbor Accessibility

*Inner Harbor Dock Alignment and Turning Room*

Maneuvering room for vessels within the harbor will be defined by the existing breakwater south of the ship lift dock which extends in westerly direction perpendicular to the shore line. The new rock breakwater will extend from the end of this existing breakwater to the north with the northern terminus located due west of the present north dock. This breakwater is required to stop the
southerly swell that encroaches upon Resurrection Bay. The present breakwater south of the ship lift dock has not prevented this swell from bouncing into the minimally protected area, subsequently creating damage off shore. Safeguard Marine is not qualified to address this situation or the actual placement of the rock breakwater. The swell and wave effect within the harbor area, as designed, is not within this company’s capabilities or expertise to comment. Safeguard Marine created vessel simulations based upon the design that was presented, and has no knowledge if wave or swells will affect the harbor area. However, we feel it pertinent to indicate the presence of these possible effects, as they should be seriously considered during design construction.

These vessel simulations were created utilizing the design of the docks within the harbor. Great difficulty was encountered by the mariners in accomplishing a docking or undocking procedure at the dock that was aligned east west in the center of the harbor. The problem occurred due to the perpendicular wind directions; either north or south wind was utilized during these procedures. The wind velocity from the south was 17 to 20 knots and 20 knots from the north. These represent the common or average direction of the frequently occurring winds within Resurrection Bay.

Discussion occurred amongst all parties concerning the alignment of the dock during the second day of simulations. These discussions were based upon the ability to place the berth in a north south direction to allow the larger vessels an opportunity to stem the wind when docking with either a north or south wind. The simulations indicated that the high profile larger vessels would probably require tug boat assistance if the berths were in the east west direction. During one simulation, a mariner utilized an anchor (a poor man’s tug boat) in an attempt to get the vessel alongside during a south wind. However, this is not a practical solution for the dock alignment as many mariners are not adept at utilizing this procedure for docking.

The actual harbor size of the inner harbor area for maneuvering of the vessels was restricted by the east-west aligned dock in the middle of the harbor. Discussion occurred concerning the relocation of the dock to the northeast corner of the harbor in a north south direction. If the dock remained perpendicular to the prevailing winds, instead of being relocated or realigned, then wind forces upon a high profile vessel at this dock would need to be taken into account. The formula used for this calculation is: Wind Force = .004 x W x V (squared), where W= windage in
square feet and $V =$ wind speed in knots. Wind force is expressed in pounds. Consider the following example: the Northern Hawk is high profile vessel, assuming two thirds her length being four decks high and the other one third being two decks. Her windage in square feet for this simple example is assumed to be 11,000 square feet. Wind at 40 knots would result in 70,400 pounds of force, 35 short tons of force on the dock, and vessel moorings.

*Figure 5: Vessel approaching the east west berth middle of harbor*

*Ship Lift Dock Accessibility for Large Vessels*
Simulations were performed that required our team of mariners to bring vessels into the harbor and proceed as if they were bound for the ship lift to be lifted from the water. The wind was set at zero to portray what would be a calm day in Seward. This is realistic as a vessel this size would need to have no wind effect to dock between the two wing walls that exist for the lining up of the vessel prior to being lifted from the water.

The mega yacht was utilized with no tug boats to assist during the maneuver. It was a successful maneuver and the vessel had sufficient room to maneuver between the turning dolphin at the end of the north wing wall and the rock breakwater. Another simulation was conducted utilizing the trawler model with two tugs assisting with the same objective. It was carried out successfully and the vessel had adequate room to turn around the dolphin at the north end of the north wing wall and the rock breakwater. It was requested to freeze the simulation after the vessel port bow was inside or south of the north dolphin to analyze the distance from the stern of the vessel to the rock breakwater. It was agreed at the time that enough room existed within the harbor area for the vessel to reach the ship lift for lifting from the water.

The design had a steel section within the rock breakwater to allow more room for the turning of the vessels around the north dolphin and into the wing walls. These simulations depicted that enough room existed between the turning north dolphin off the north wing wall and the rock breakwater without utilizing the steel section within the breakwater. The steel section was replaced with a rock breakwater section on the simulator to replicate the rock instead of the steel section. The simulation indicated that this was feasible; however Safeguard Marine is not aware of the exact measurements of the rock breakwater base structure and how it may in actuality be different than what was portrayed in the simulation. The distance between the turning dolphin and the rock breakwater was estimated at 350 feet during the simulation.

For vessels maneuvering into the ship lift wing walls, the sea room distance from the north wall turning dolphin to the southern wing wall is useable space and would allow vessels greater than the 350 feet measurement utilization of the facility if the recommendations concerning the dolphin were implemented. This is visually viewable in the simulation snap shot that is included (Figure 6, below).
Figure 6: Vessel maneuvering into the wing walls at heavy ship lift dock

Tug Boat Utilization
Several different tug boats are available in Seward for vessels operating within the port. At this time, all these tugs are conventionally powered, which means they have maneuvering constraints that should be considered when using their assistance. They have different horse power capabilities and their actual sizes are dramatically different. Tug Junior is an 800 horse power boat, with minimal size, which allows it to maneuver within small and confined spaces. The operator of the tug is an excellent boat handler, and is very familiar with his boat’s capabilities, which makes its utilization within the inner harbor beneficial for all those requiring assistance. The other tugs presently available in Seward are 3,000 horse power, however they are significantly larger, and almost twice the length, which would make them more awkward within the inner harbor.

Tug assistance to dock and undock fishing vessels within the harbor may be necessary if the berth in the middle of the harbor remains perpendicular to the prevailing winds or in an east west direction. Normally fishing vessels do not utilize tug assistance, however as shown in the simulation Northern Hawk size vessels utilizing this berth would require this assistance during normal wind conditions experienced in Seward. Smaller vessels, less than 200 feet, would not require this assistance due to the sea room available within the inner harbor for them to maneuver.

A large majority of vessels maneuvering into the ship lift dock at the southern end of the harbor would require tug boat assistance due to the required maneuver around the turning dolphin to get between the wing walls. This is not that different than what has occurred in the past, however some vessels that may not have utilized a tug would probably need one due to the new rock break water. This is a tradeoff for the ship lift access, since it will now be protected from the southerly swell which has affected their establishment in the past.

Dead ship maneuvers into the harbor will be required to access the ship lift. These are typically executed utilizing a tug on the hip of the dead vessel to necessitate the least amount of difficulties in maneuvering. This will require the tug’s beam and also the vessel beam to be capable of transiting the SMIC breakwater entrance. This is a valid reason to open the entrance or make it wider than designed by reducing north dock extension. The larger vessels will require two tugs to navigate into the wing walls for hoisting from the ship lift. This will require additional planning,
including the total beam transiting the entrance of the harbor and minimal wind effect upon the vessels.

**Other Vessel Use of SMIC**

The economic analysis that was provided for the city of Seward had key economic factors required to create a sustainable SMIC development. The economic analysis highlights the need for other tenants to be capable of utilizing the facility for economic stability. Arctic development being implemented by international oil companies will ultimately involve multiple vessels that will be utilizing the ports of Alaska. Seward harbor was utilized extensively last year by Oil Supply Vessels (OSV) involved with this Arctic development. The SMIC provides sufficient maneuvering room within the dock facilities to allow OSV fleet easy access and utilization. The entrance to the harbor needs to be of sufficient width to allow the OSV vessels the ability to safely navigate into the harbor. As an example, one of the OSV vessels that utilized Seward last year was the arctic icebreaker Aiviq, which is 360 feet long and 80 feet wide. This vessel has an azimuth propulsion system with differential positioning capability. The vessel is highly maneuverable for its size; however it will still require enough room to enter through the breakwater.

**Recommendations**

Based on our simulations and analyses, we make the following recommendations. First, we recommend that the harbor should provide a range line with a heading of 137 degrees for transiting the breakwater entrance. A second range could be used to assist mariners with their initial approach for proper line up onto the main range. We suggest a heading of no more than a 20 degree difference between the two ranges to make the turn less acute. In addition to ranges, we suggest a buoy be placed on the North east side of the ranged channel near the confluence of the two range lines marking the eastern edge of the approach channel.

We also recommend that the North Dock extension into the harbor entrance be minimized as much as possible to allow the channel width to remain the same width that was utilized at the end of the simulations. This is estimated to be a dredged width of 170’ and a total opening of 327’.
The mooring dolphin at the end of the north wing wall that extends west into the harbor should be rounded and fendered so large vessels entering and departing the lift may come into contact with it and "roll" around the dolphin with no damage to either the dolphin or the vessel. Without the fendering a larger vessel would consider the dolphin an obstruction, and must avoid contact. Another option is the removal of the mooring dolphin and cat walk, also fendering west end of the present dock resulting in same capability as fendering the dolphin. This creates extensive room for the ship lift dock and increases its capabilities to facilitate even larger vessels.

We recommend a separate breakwater north of the harbor extending west from the beach to protect the harbor from north wind chop. Our understanding is that the preliminary design, which was utilized for this analysis, represents phase one of a multi phased project. This recommendation may be included within a different phase of the harbor construction. However, an inexpensive temporary solution which has been utilized in Captains Bay Alaska would be to anchor a floating breakwater in the vicinity of the planned break water. We are unable to determine the viability or success of the floating breakwater in Captains Bay or if utilized here.

**Conclusion**

Design of a harbor is as much an art as a science similar to ship handling. The design addresses many different factors affecting its cost and operability. This is balanced with the acceptable level of risk and the economic constraints available for the construction. Waterway and port configurations that can be characterized as achieving an acceptable level of risk are dependent upon the size of vessels utilizing the facilities. There are no guidelines about what the acceptable risk level should be; thus the determination is highly subjective. Ship pilots make these kinds of judgment decisions frequently, balancing between economics and safety utilizing the process of risk mitigation. Good seamanship requires the mariner to always endeavor to exercise a conservative risk management approach. For mariners, conservation risk management involves the following three principles: (1) the application of good seamanship; (2) the exercising of prudent and professional judgment; and (3) the reliance on, and interpretation of, all factual information germane to the measure(s) of risk being evaluated.
The two models employed in our simulations were representative of the larger vessels that would utilize the proposed harbor. Smaller vessels were not modeled because it was determined that they would be capable of operating without any complications if the larger vessels were proficient. Wind was factored in many of the simulations depicting the conditions that are commonly associated with Resurrection Bay. Wind velocities applied were northerly 20 or 25 knots and southerly winds at 17 to 20 knots. One meter swells were created in conjunction with the southerly winds.

The number of mariners involved in the project was a crucial and a necessary element for the justification of the results of the simulations. Ship handling, and being able to maneuver a vessel with accuracy and precision, can be described as the fundamental skill of professional seamanship. Each mariner provided a different interpretation and approach with the concept of completing the task successfully. These simulations put the mariners at the edge of their capabilities to ascertain the parameters of the SMIC harbor. The exchange of information and opinions were constantly occurring during the simulations, creating an environment of knowledgeable discourse.

Safeguard Marine and the mariners that were selected for this project are not capable of representing or having specific knowledge concerning the simulation of wave or swell analysis. This maritime simulation of the SMIC project was based upon vessel navigation principles only, and this report is based upon the information that was derived from this simulation.

We are comfortable in stating that the preliminary design of SMIC does not indicate any problem for vessels less than 200’ in length. For vessels from 200’ to 350’ we believe that our recommendations, if implemented, would create a harbor that would be safe and functional for these vessels, provided that good seamanship continues to be applied.

Safeguard Marine would like to thank R & M Consultants, Inc. and the City of Seward for recognizing the value of employing Safeguard Marine expertise. Our ability to provide such expertise and subject matter specialization, in conjunction with the ship simulator, resulted in the aforementioned recommendations. Based on these qualifications and our analyses, we are
confident that our recommendations will provide accurate guidelines for the proper design and construction of the SMIC harbor.
Acknowledgements

Mariners performed simulation of SMIC

Six different mariners executed the simulation of SMIC. This number of mariners operating the vessels provided a wide expanse of knowledge and experience, which assisted in validating the simulation process. Ship handling is an art which can be performed or executed with various methods of approach and skill. The mariners that performed the simulation had extensive backgrounds in developing their knowledge. Listed below are the mariners and a brief background that participated in the simulation of SMIC.

- Captain Jeff Pierce: Three years Captain 350’ fishing processors western Alaska, 29 years ship pilot with experience in western Alaska and South central Alaska including Port of Seward
- Captain Pete Garay: Multiple years captain 500’ fishing processor western Alaska, 22 years ship pilot with experience western Alaska and South central Alaska including Port of Seward
- Captain Scott Hamilton: Captain Alaska State Ferry system with over 20 years’ experience ferry system including Port of Seward experience
- Captain Brad Kroon: Over 20 years’ experience as tug operator Cook Inlet tug and barge, manager Cook Inlet tug and barge
- Captain Dan Butts: Extensive Port of Seward experience, Captain Kenai Fjord vessels, tugs for Cook Inlet tug and barge, simulator operator
- Captain Paul Merrill: Southeast Pilots lead pilot for training committee, with extensive Alaska maritime experience

Seward AVTEC personnel

Mike Angove is the simulator technician who designed the SMIC harbor on the simulator exhibiting his comprehensive knowledge of the simulation process.

Safeguard Marine would like to thank R & M Consultants, Inc. specifically Kimberly Nielsen, PE Group Manager--Waterfront Engineering for her participation and input during the simulations. We were able to modify the preliminary design during the simulations at her request, creating the
alterations instantaneously. Also, we extend our thanks to the City of Seward for recognizing the value of utilizing Safeguard Marine expertise in assisting with the SMIC project.

References