Pacific Community
Communauté du Pacifique

Pacific Safety of Navigation Project

Risk assessment for Apia Harbour, Samoa

November 2019

PACIFIC SAFETY OF NAVIGATION PROJECT

IFAN

GEM
Geoscience, Energy and Maritime

Pacific Safety of Navigation Project: Risk assessment for Apia Harbour, Samoa

Salesh Kumar, Epeli Waqavonovono and Francesca Pradelli

Geoscience, Energy and Maritime Division, Pacific Community

Suva, Fiji, 2019

Original text: English

Pacific Community Cataloguing-in-publication data

Kumar, Salesh

Pacific safety of navigation project: risk assessment for Apia Harbour, Samoa / Salesh Kumar, Epeli Waqavonovono and Francesca Pradelli

1. Navigation – Samoa.
2. Navigation – Safety measures – Samoa.
3. Anchorage – Samoa.
4. Harbors – Anchorage – Samoa.
5. Harbors – Safety regulations – Samoa.
6. Harbors – Risk assessment – Samoa.
7. Transportation – Safety – Samoa.
8. Transportation – Law and legislation – Samoa.

I. Kumar, Salesh II. Waqavonovono, Epeli III. Pradelli, Francesca IV. Title V. Pacific Community

387.1099614 AACR2

ISBN: 978 982 00 1182 3

Prepared for publication at SPC's Suva Regional Office, Private Mail Bag, Suva, Fiji, 2019

www.spc.int

Contents

Executive summary

Samoa is a signatory to the International Convention for the Safety of Life at Sea (SOLAS), of which Chapter V Regulation 13.1 requires that contracting governments provide 'such Aids to Navigation (AtoN) as the volume of traffic justifies and the degree of risk requires.'

Samoa is one of the 13 targeted Pacific Island countries and territories of the Pacific Safety of Navigation Project implemented by the Pacific Community (SPC) and funded by the International Foundation for Aids to Navigation (IFAN), whose aim is to improve safety of navigation in the Pacific region through enhanced AtoN capacity and systems.

During Phase 1, in 2017, the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) and SPC developed the simplified IALA risk assessment tool (SIRA), a simple qualitative tool to enable smaller states to meet their international obligation of providing AtoN by conducting waterways risk assessments.

During Phase 2 of the project, in May 2019, Samoa identified Apia Harbour to be a priority area for SPC to conduct a risk assessment, using the SIRA tool, as the harbour is Samoa's major port. During the country mission, officials from the competent authority, the Ministry of Works, Transport and Infrastructure (MWTI), requested that the SPC technical team also review and advise on the AtoN at the two domestic ports on either side of Apolima Strait, Salelologa and Mulifanua. An extra field visit to look at the AtoN in Apolima Strait between the two domestic ports was, therefore, carried out. No detailed SIRA assessment was carried out for the two domestic ports, although recommendations were made following the field visit, in consultation with national officials.

This report details the risks identified, the estimated costs in the event of an incident, the risk control options suggested, and their costs associated with Apia Harbour. This report also contains the risks identified by national officials, the estimated costs in the event of an incident, the risk control options suggested, and their costs for the ports at Mulifanua and Salelologa.

Within Samoa, the regulatory aspect of AtoN falls within the MWTI, while the operational implementation and maintenance of AtoN comes under the jurisdiction of the Samoa Ports Authority for the Port of Apia, and the Samoa Shipping Corporation (SSC) for the domestic ports.

SSC is mandated to provide domestic shipping services within Samoa. SSC runs a daily ferry service between the two main islands, sailing from Salelologa, Savai'i to Mulifanua, Upolu. There a number of AtoN between these two ports that are managed by SSC.

Apia Harbour consists of an international wharf and a domestic wharf. There are currently a number of AtoN in and around the harbour that are managed by the Ports Authority.

Samoa's maritime stakeholders identified four scenarios for Apia Harbour: three groundings on the reef at the harbour entrance, and one grounding on the reef along the coast of Apia.

SSC and MWTI officials identified one grounding scenario for Salelologa and Mulifanua harbours after the field visit.

For each scenario in each area, the cost of the incident was estimated and a risk score was given, taking into account the probability of the incident happening and its potential impact on the country. Risk control options were then identified. The risk scores for the scenarios under the current situation were then compared with the new risk scores if the risk control options were put in place.

Apia Harbour

Scenario	Risk score	Risk control option	New risk score
Grounding of fishing vessels near the entrance on the west side	8	Ensure relevant training and awareness programmes are delivered for all fishermen.	4
Grounding of a container ship while being towed to anchorage area	6	Ensure that crew on the tugboat have relevant STCW training.	3
Grounding of vessels on reef at the harbour entrance	15	1) Cut the trees in front of the rear leading light. 2) Install dayboards at the front leading light. 3) Relocate rear leading light to higher. ground with dayboards if trees cannot be cut.	5
Grounding of ships on reef along the Apia coast	10	Replace two unlit lights at Faleula Village and Namu'a Island.	5

Salelologa and Mulifanua harbours

Scenario	Risk score	Risk control option	New risk score
Grounding of vessels while entering the ports of Mulifanua and Salelologa	6	1) Install four new leading lights on existing towers (two at each harbour). 2) Dredge the channel at Salelologa. 3) Send H-notes to the Primary Charting Authority (PCA)	3

The main outcome of the risk assessment process was four recommendations for Apia Harbour, and one recommendation for Salelologa and Mulifanua harbours. The aim of the recommendations is to reduce the risks to safety of navigation to an acceptable level for stakeholders. The recommendations and costs of their implementation are outlined below.

Apia recommendations

Recommendation 1 To reduce the risk of fishing vessels grounding on the west side of the entrance of Apia Harbour, it is recommended that relevant training and awareness programmes be delivered for all fishermen.	
Action	**Cost to implement (SAT)**
Deliver training and awareness programmes	20,000

Recommendation 2 To reduce the risk of a container ship grounding while being towed to the anchorage area, it is recommended that the crew on the tugboats have relevant STCW training.	
Action	**Cost to implement (SAT)**
Deliver relevant STCW training to tugboat crew members	12,000

Recommendation 3 To reduce the risk of vessels grounding at the entrance to Apia Harbour, it is recommended that: 1) the trees in front of the rear leading light are cut, and that 2) dayboards at the front leading light are installed. If recommendations 1 and 2 cannot be implemented, it is recommended that the rear leading light is relocated to higher ground and that it has dayboards.	
Action	**Cost to implement (SAT)**
Cut trees	500
Install day board	5000
Relocate rear leading light	TBD by MWTI
Maintenance cost[1]	250

Recommendation 4 To reduce the risk of ships grounding along the coast of Apia, it is recommended that the lights at Cape Faleula and Namu'a Island be replaced.	
Action	**Cost to implement (SAT)**
Purchase and install lights	10,000
Maintenance cost	500

[1] The maintenance cost of AtoN is estimated at 5% annual of the initial cost of purchase.

Recommendation for Salelologa and Mulifanua harbours

Recommendation To reduce the risk of vessels grounding while entering Salelologa and Mulifanua harbours at night, it is recommended that: 1) new leading lights be installed at both the harbours, and that 2) the channel leading into Salelologa wharf be dredged, and 3) H-notes be sent to PCA informing it of any changes to the charts.	
Action	**Cost to implement (SAT)**
Purchase and install lights lights	14,000
Dredge	TBD by SSC
Draft H-Notes	0
Maintenance cost	700

1 Background

In early 2016, with support from the International Foundation for Aids to Navigation (IFAN), the Pacific Community (SPC) started the Pacific Safety of Navigation Project in 13 Pacific Island countries and territories (PICTs).[2] The project aims to improve safety of navigation in the Pacific region through enhanced aids to navigation (AtoN) capacity and systems, and hence supports economic development, shipping and trade in the Pacific region through safer maritime routes managed in accordance with international instruments and best practices.

During Phase 1, which ended in July 2018, SPC worked in close collaboration with the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) to conduct technical, legal and economic assessments in the 13 PICTs to identify needs and gaps in these areas. Another significant output of Phase 1 was the development of a new tool for risk assessment in small island developing states, the simplified IALA risk assessment tool (SIRA). In June 2018, IALA trained personnel in 12 of the 13 PICTs on the use of SIRA to conduct AtoN risk assessments in their countries.

Phase 2 of the project builds on the Phase 1 assessments and tools developed, to further assist in building capacity to develop and maintain AtoN in PICTs. Activities include conducting risk assessments (as required by Regulation 13 of the International Convention for the Safety of Life at Sea – SOLAS); developing safety of navigation policy and a legal framework; improving budgetary management; and supporting regional coordination related to safety of navigation in the Pacific.

In June 2019, Samoa's Ministry of Works, Transport and Infrastructure (MWTI) invited SPC to assist in conducting a risk assessment of Apia Harbour, which is the country's main port. A field visit was also organised by the Samoa Shipping Corporation (SSC) to look at AtoN in Apolima Strait between the harbour at Mulifanua harbour on Upolu Island and the harbour at Salelologa on Savai'i Island. No detailed SIRA assessment was carried out for these two ports, thus recommendations were made only from the field visit with officials from SSC and MWTI.

This report details the risk identified, the estimated costs in the event of an incident, the risk control options suggested, and the costs associated using the SIRA methodology for Apia Harbour. For Mulifanua and Salelologa harbours, the risk matrix was developed in consultation with officials from SSC and MWTI following the field visit.

Samoa is a maritime nation, with a large percentage of its citizens working in or around the maritime industry. Shipping is critical to the economic and social welfare of the people of Samoa, and safe navigation is vital to secure this welfare and to protect the environment.

Samoa is an independent state consisting of two main islands, Savai'i and Upolu, and four smaller islands. Samoa is a signatory to a number of conventions and protocols of the International Maritime Organization (IMO) including: the International Convention for the Safety of Life at Sea (SOLAS); the International Regulations for Preventing Collisions at Sea (COLREGS); Standards of Training, Certification and Watchkeeping (STCW); the International Convention for the Prevention of Pollution from Ships (MARPOL); and the Convention for the Suppression of Unlawful Acts (SUA) against the Safety of Maritime Navigation.

[1] Cook Islands, Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Niue, Palau, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu and Vanuatu.

Regulation 13 of Chapter V of the 1974 SOLAS Convention (as amended) states that 'each Contracting Government undertakes to provide, as it deems practical and necessary either individually or in co-operation with other Contracting Governments, such aids to navigation as the volume of traffic justifies and the degree of risk requires.'

The SIRA risk control process comprises five steps that follow a standardised management or systems analysis approach:

1. Identify hazards
2. Assess risks
3. Specify risk control options
4. Make a decision
5. Take action.

SIRA is intended as a basic tool to identify risk control options for potential undesirable incidents that Samoa should address as part of its obligation under SOLAS Chapter V Regulations 12 and 13. The assessment and management of risk is fundamental to the provision of effective AtoN services.

The assessment involved a stakeholder meeting as a first step, to gather the views on hazards and risks in Apia Harbour from those directly involved with or affected by AtoN service provision. Information provided by this step was then used by Samoa's IALA level-1 AtoN manager and SIRA-certified officer, Ms Makerita Atonio, and SPC to complete the full risk assessment matrixes based on four identified possible scenario for Apia Harbour. A possible scenario was also identified from the field visit of Mulifanua and Salelologa harbours, in consultation with the assistant Chief Executive Officer of SSC, Mr Pipi Loane Foma'i, and staff from MWTI.

2 Description of the waterway

Apia Harbour is the major port in Samoa and was, therefore, identified by MWTI as a priority for the risk assessment. Within Samoa, the regulatory aspect of AtoN appears to fall within MWTI, while the operational implementation and maintenance of AtoN comes under the jurisdiction of Samoa's Ports Authority for the port of Apia, and SSC for domestic ports.

SSC is mandated to provide domestic shipping services within Samoa, and has a fleet of vessels, including the MV *Lady Naomi* and MV *Lady Samoa III*. In addition, SSC owns and operates three landing craft: MV *SSC Fasefulu*, MV *Samoa Express* and MV *Fotu-o-Samoa II*. SSC runs a daily ferry service between the two main islands, sailing from Salelologa on Savai'i to Mulifanua on Upolu. There a number of AtoN between these two harbours, which are managed by SSC.

Apia Harbour consists of one international wharf and one domestic wharf. There are currently a number of AtoNs in and around the harbour that are managed by the Ports Authority.

The main entrance into Apia Harbour is through the east and west reefs, and is approximately 750 metres wide with a depth of around 30 metres.

The average predicted visibility is around 2.0 nautical miles but this can be reduced to 0.01 nautical miles in bad weather, which normally occurs between November and April. A maximum predicted swell of 7 metre is expected during cyclones, and a maximum tidal flow of 3 knots can be expected around the channel entrance during a new and full moon. There are several hazards in the harbour such as strong winds, currents, waves, all of which can pose problems for maritime traffic.

Chart NZ 8655 covers Apia Harbour at a scale of 1:7,500 (Fig. 1), while chart NZ864 covers Apolima Strait and chart NZ8645 covers Salelologa and Mulifanua harbours (Fig. 2).

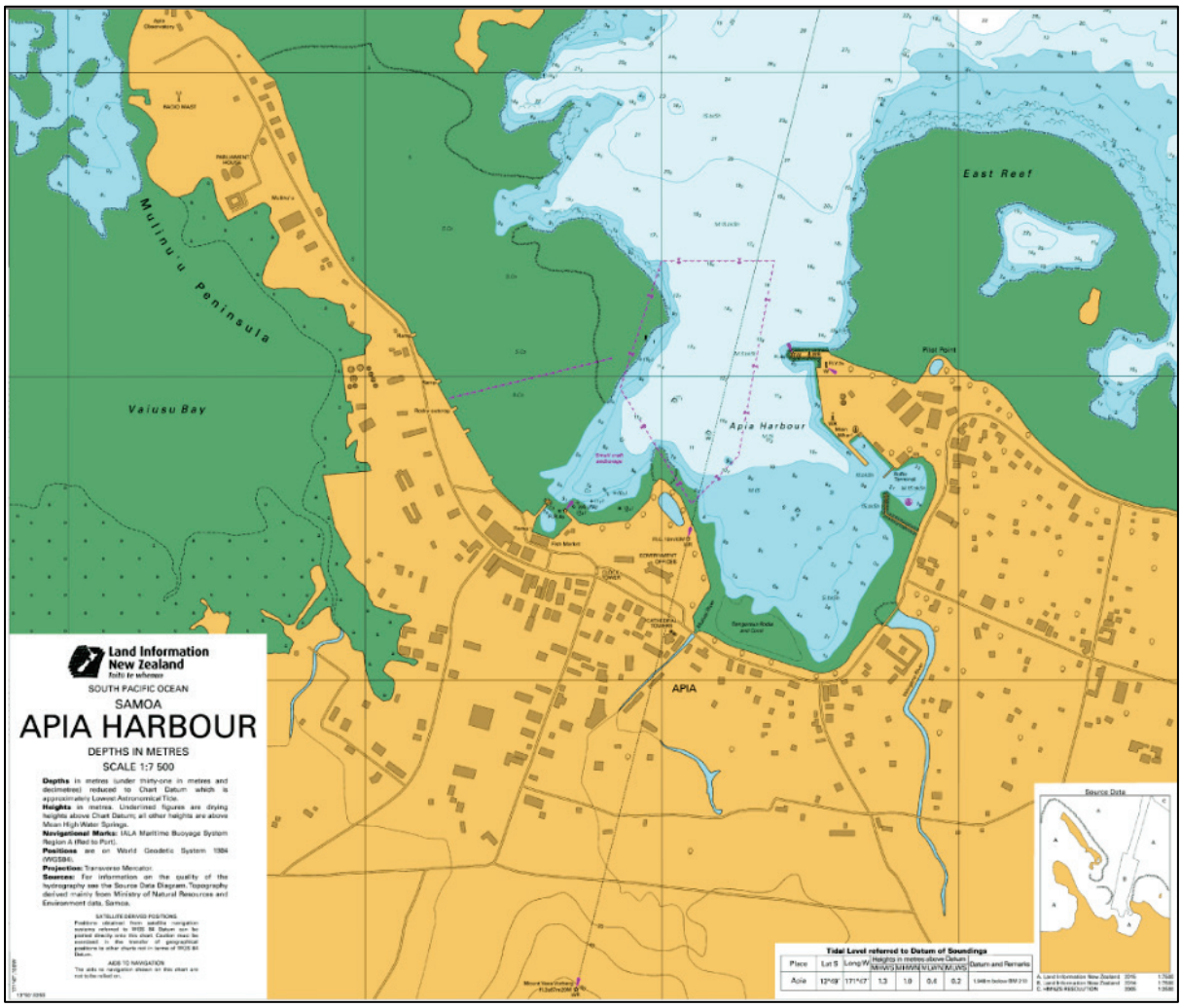


Figure 1. Chart NZ8655 of Apia Harbour at a scale of 1:7500.

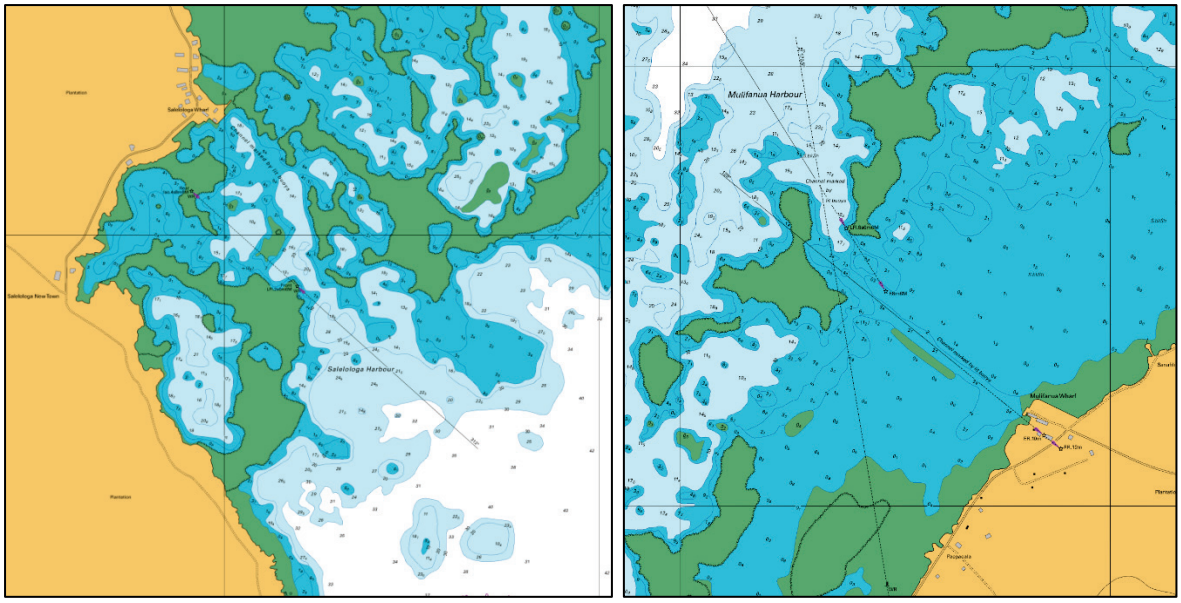


Figure 2. Chart NZ864501 and NZ864502 of Salelologa and Mulifanua harbours, respectively.

3 Stakeholder meeting

As the first step of the SIRA process, a stakeholder meeting was organised in Apia on 19 June 2019 at the Maritime Division by Ms Makerita Atonio, Principal Shipping Officer of the Maritime Division.

This meeting aimed to gather the points of view of individuals, groups and organisations involved with or affected by AtoN service provision in Apia Harbour. Stakeholders (Fig.3) included staff from Samoa's Ports Authority, SSC, the National University of Samoa (Maritime Institute), Maritime Police, Ministry of Agriculture and Fisheries, and MWTI (Annex A). During the meeting, participants were divided into two groups according to their experience and background. They then helped identify potential hazards and possible scenarios in Apia Harbour using the latest chart of the area and other tools such as Google Earth screen shots of the area, and their experience.

Figure 3. Stakeholders at the risk assessment meeting in Apia.

4 Hazards and risks

A hazard is something that may cause an undesirable incident. Risk is the chance of injury or loss as defined as a measure of 'probability or likelihood' and 'severity or impact'. Examples of injury or loss include an adverse effect on health, property, the environment or other areas of value.

The purpose of the stakeholder meeting was to generate a prioritised list of hazards specific to Apia Harbour. For the risk assessment, SPC and Samoa's Principal Shipping Officer (who is also a IALA level 1 AtoN certified manager) worked together to discuss the risks associated with the identified hazards and identified risk control options and recommendations.

The list of hazards identified for Apia Harbour is given in Annex B.

4.1 Types of hazard

Twenty-four hazards were identified for Apia Harbour, which were grouped into the following six categories:

- natural hazards, such as storms, earthquakes, safe minimum depth, proximity to danger, minimum visibility, low sun angle, and other natural phenomena;
- economic hazards such as insufficient AtoN funding;
- technical hazards such as system or equipment failure, quality and validity of charted information, substandard ships, and failure of communications systems;
- human factors such as crew competency, safety culture, influence of alcohol and/or drugs, and, linguistic challenges;
- operational hazards such as seasonal activities, poor promulgation of marine safety information (MSI), poor response to marking new dangers and ramp launching area; and
- maritime space hazards, such as crowded waterways and wrecks and missing lights.

The above six types of hazards have the capability to generate seven different types of losses:

- health losses, including death and injury;
- property losses, including real and intellectual property;
- economic losses, leading to increased costs or reduction of revenues;
- liability loss, resulting when an organisation is sued for an alleged breach of legal duty; such cases must be defended even if no blame is assigned. Liability losses are capable of destroying or crippling an organisation;
- personnel loss, when services of a key employee are lost;
- environmental losses (negative impact on land, air, water, flora or fauna); and
- loss of reputation or status.

4.2 Risk factors

Any risk analysis needs to consider the range of factors that contribute to the overall risk exposure. Table 1 lists some of the factors that could be taken into consideration when identifying hazards for waterways and ports.

Table 1. Risk factors relating to marine navigation.

Ship traffic	Traffic volume	Navigational conditions	Waterway configuration	Short-term consequence	Long-term consequence
Quality of boats	Deep draught	Night/day operations	Depth/draft/under-keel clearance	Injuries to people	Health and safety impacts
Crew competency	Shallow draught	Sea state	Channel width	Oil spill	Lifestyle disruptions
Traffic mix	Commercial fishing boats	Wind conditions	Visibility obstructions	Hazardous material release	Fisheries impacts
Traffic density	Recreational boats	Currents (river, tidal, ocean)	Waterway complexity	Property damage	Impacts on endangered species
Nature of cargo	High speed craft	Visibility restrictions	Bottom type	Denial of use of waterway	Shoreline damage
Participation rate in routing systems, such as vessel traffic system (VTS)	Passenger ships		Stability (siltation)		Reef damage
		Background lighting	AtoN mix and configuration		Economic impacts
		Debris	Quality of hydrographical data		

Risk is evaluated to allow attention to be focused on high-risk areas, and to identify and evaluate factors that influence the level of risk. Once all of the risks have been assessed, they are then evaluated in terms of the documented needs, issues and concerns of the stakeholders, and the benefits and costs of the activity, to determine the acceptability of the risk.

Zero risk is not often realised, unless the activity generating the risk is abandoned. Rather than striving to reduce the risk to zero, authorities should reduce the risk to 'as low as reasonably practicable' (ALARP; Fig. 4).

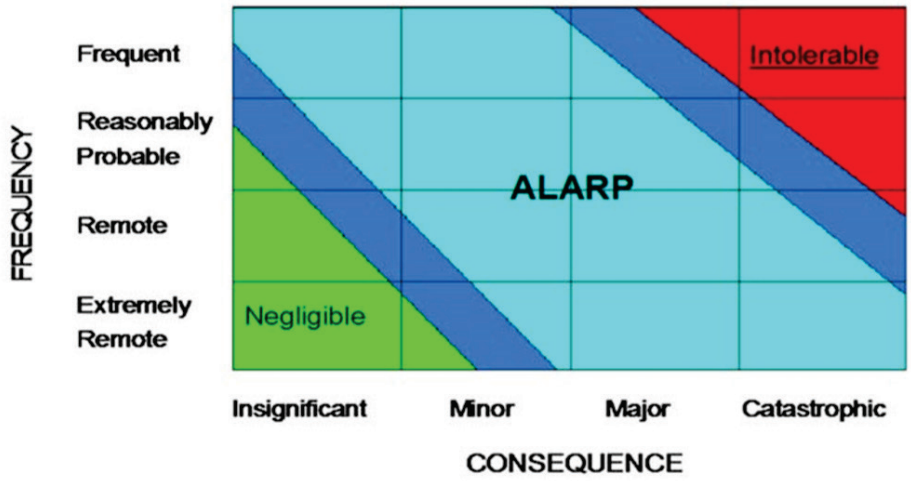


Figure 4. Graphical representation of the levels of risk. The risk level boundaries (negligible/ALARP/intolerable) are purely illustrative.

It is important to remember that when communicating with stakeholders about risk, perception is usually different from reality. People make judgements of the acceptability of a risk based on their perceptions, rather than on scientific factors such as probability. The public's perception of a risk may be influenced by many things, including their age, gender, level of education and previous exposure to information on the hazard. Public perceptions of risk may, therefore, differ from those of technical experts.

5 Scenarios

During the stakeholder meeting and discussions with Samoa's Principal Shipping Officer (who is also an IALA level 1 AtoN manager and SIRA-certified), various hazards were identified for Apia Harbour, which could lead to a number of different incidents or scenarios. Each hazard was considered carefully and the scenarios it could cause were identified and recorded.

The scenarios for Apia Harbour were classified into one category: grounding.

A grounding scenario was also developed from the field visit to Apolima Strait between Salelologa and Mulifanua domestic harbours. Annex C lists the identified scenarios for Apia Harbour and for Salelologa and Mulifanua harbours.

5.1 Grounding – Apia Harbour

Grounding is defined as a boat being aground by hitting or touching the shore, sea bottom or underwater object (e.g. a wreck). Four grounding scenarios were identified for Apia Harbour, all of which were on the reef at the harbour entrance, and were due to the following different hazards present in the area:

- fishing vessels running aground near the entrance at the west side due to misinterpretation of leading lights;
- container ships running aground while being towed out of the channel;
- vessels running aground near the entrance to the harbour due to the front and rear leading lights not being conspicuous because of the lack of dayboards and vegetation growth restricting the visibility of the front of the rear leading lights; and

- vessels running aground along the Apia coast due to unlit lights at Namu'a Island and Cape Faleula.

5.2 Grounding – Salelologa and Mulifanua harbours

Grounding is defined as a boat being aground by hitting or touching the shore, sea bottom or underwater object (e.g. a wreck). This scenario was identified after the field visit to Salelologa and Mulifanua harbours. The identified hazards were the unlit leading lights and shallow areas around these leading lights.

6 Probability and impact

SIRA specifies five levels of probability (Table 2) and five levels of impact that each type of scenario would create (Table 3). Each scenario is allocated a score for both probability and impact, and the risk value is calculated from the product of these scores. In this step of the process, the probability and consequences associated with each scenario were estimated and discussed with the Principal Shipping Officer in Samoa.

Table 2. Levels of probability specified for the simplified IALA risk assessment tool (SIRA).

Classification	Score	Probability
Very rare	1	Very rare or unlikely, will occur only in exceptional circumstances and not more than once in 20 years
Rare	2	Rare, may occur every 2–20 years
Occasional	3	Occasional, may occur every 2 months to 2 years
Frequent	4	Frequent, may occur once every weekly to every 2 months
Very frequent	5	Very frequent, may occur at least once every week

Table 3. Levels of impact specified for the simplified IALA risk assessment tool (SIRA).

Description	Score	Service disruption criteria	Human impact criteria	Financial criteria	Environ-mental criteria
Insignificant	1	No service disruption apart from some delays or nuisance	No injury to humans; possible significant nuisance	Loss, including third-party losses, of less than USD 1000	No damage
Minor	2	Some non-permanent loss of services such as closure of a port or waterway for up to 4 hours	Minor injury to one or more individuals, may require hospitalisation	Loss, including third-party losses, of USD 1000–50,000	Limited short-term damage to the environ-ment
Severe	3	Sustained disruption to services such as closure of a port or waterway for 4–24 hours	Injuries to several individuals requiring hospitalisation	Loss, including third-party losses, of USD 50,000–5,000,000	Short-term damage to the environme nt over a small area
Major	4	Sustained disruption to services such as	Severe injuries to many individuals or loss of life	Loss, including third-party losses, of USD	Long-term to irreversibl

		closure of a major port or waterway for 1–30 days or permanent or irreversible loss of services		5,000,000–50,000,000	e damage to the environment over a limited area
Catastrophic	5	Sustained disruption to services such as closure of a major port or waterway for months or years	Severe injuries to numerous individuals and/or loss of several lives	Loss, including third-party losses, of over USD 50,000,000	Irreversible damage to the environment over a large area

7 Acceptability of risk

Having determined probability and impact scores by consensus, the risk values are calculated by multiplying these scores, as shown in the matrix in Table 4. To determine whether the risks are acceptable or not, SIRA specifies four colour-banded levels of risk (Table 5). These colours are superimposed on the matrix in Table 4.

Table 4. Risk value matrix.

		PROBABILITY / (LIKELIHOOD)				
		Very Rare (1)	Rare (2)	Occasional (3)	Frequent (4)	Very frequent (5)
CONSEQUENCE (IMPACT)	Catastrophic (5)	5	10	15	20	25
	Major (4)	4	8	12	16	20
	Severe (3)	3	6	9	12	15
	Minor (2)	2	4	6	8	10
	Insignificant (1)	1	2	3	4	5

Table 5. Categories of risk, and action required.

Risk Value	Risk Category	Action Required
1 – 4	Green	Low risk not requiring additional risk control options unless they can be implemented at low cost in terms of time, money and effort.
5 – 8	Yellow	Moderate risk which must be reduced to the *"as low as reasonably practicable"* (ALARP) level by the implementation of additional control options which are likely to require additional funding.
9-12	Amber	High risk for which substantial and urgent efforts must be made to reduce it to "ALARP" levels within a defined time period. Significant funding is likely to be required and services may need to be suspended or restricted until risk control options have been actioned.
15-25	Red	Very high and unacceptable risk for which substantial and immediate improvements are necessary. Major funding may be required and ports and waterways are likely to be forced to close until the risk has been reduced to an acceptable level.

8 Risk control options

The objective of the risk assessment was to identify risk mitigation options for each undesirable incident that would, if implemented, reduce the risk to a level as low as reasonably practicable (ALARP), and which would be acceptable to stakeholders. Before any risk control decisions were made, they were communicated through the stakeholder consultation process. The risks were evaluated in terms of the overall needs, issues and concerns of the stakeholders. The mitigation options include:

- new, or enforcement of, existing rules and procedures;
- improved and charted hydrographical, meteorological and general navigation information;
- enhanced AtoN service provision;
- improved radio communications; and
- improved decision support systems.

Table 6 shows the risk scores for the scenarios for the current situation at Apia Harbour, while Table 7 shows the risk scores for the scenarios for the current situation at Salelologa and Mulifanua harbours, with new risk scores in case the risks are mitigated. The detailed risk control options for Apia Harbour and for Salelologa and Mulifanua harbours are shown in the risk control matrix in Annex D.

Table 6. Risk control options for Apia Harbour, and changes in risk score.

Scenario	Risk score	Risk control option	New risk score
Grounding of fishing vessels near the entrance on the west side	8	Ensure relevant training and continuous awareness programmes are delivered for all fishermen.	4
Grounding of a container ship while being towed to the anchorage area	6	Ensure that crew on the tugboat have relevant STCW training.	3

Grounding of vessels on the reef at the entrance to Apia Harbour	15	1) Cut the trees in front of rear leading light. 2) Install dayboards at the front leading light. 3) Relocate rear leading light to higher ground and install dayboards if trees cannot be cut.	5
Grounding of ships on the reef along the Apia coast	10	Replace two unlit lights at Faleula Village and Namu'a Island.	5

Table 7. Risk control options for Salelologa and Mulifanua harbours, and changes in risk score.

Scenario	Risk score	Risk control option	New risk score
Grounding of vessels while entering the harbour at either Mulifanua or Salelologa	6	1) Install four new leading lights on existing towers (two at each harbour). 2) Dredge the channel at Salelologa harbour. 3) Send a hydrographic note to PCA regarding changes to the chart.	3

9 Costing the risk control options

The outcomes of the risk assessment are essentially qualitative and subjective, based on the expert opinions of the stakeholders. The next step is to reach consensus on which risk control options to action. The risk control options are prioritised to facilitate the decision-making process.

Costing of the options is part of the decision-making process. Most of the control options identified require funding. Costs must cover capital, labour and other resources needed for planning and implementation, as well as costs of operation and maintenance throughout the life cycle under consideration. Maintenance is important to ensure that AtoN equipment and systems continue to perform at the levels required for mariners to safely navigate the waterways.

The control measures need to be both effective in reducing risk, but also cost-effective. The cost of the measures should not normally exceed the reduction in the expected value of the loss.

The cost of the options should be evaluated over a time frame equivalent to the economic or useful life of the facilities and assets associated with the option.

10 AtoN budgeting and resourcing

For countries to provide excellent AtoN services, it is important that an adequate level of resources be allocated towards AtoN installment, maintenance and management. During the visit, meetings were held with key stakeholders around the allocation and management of resources for AtoN.

Samoa's three main ports – Apia, which is an international port, and the two domestic ports at Mulifanua (Upolu Island) and Salelologa (Savaii Island) – are all operated by state-owned enterprises (SOEs). Samoa's Ports Authority (SPA) is responsible for the Port of Apia, while the two domestic ports are run by SSC.

MWTI's regulatory role ensures that port operations are compliant with Samoan laws and with international obligations that Samoa is party to. Meetings were held with officials from all three agencies to discuss the resourcing of AtoN maintenance and management.

SPA charges light dues to foreign vessels that call in at Apia Harbour. These dues are used for maintenance of the port's AtoN. SSC does not charge light dues as mostly their own vessels use their ports. However, SSC does have a well-resourced and functional maintenance section that has been consistent with AtoN upkeep. Further to this, both SOEs have the option to request for extra funding in the national budget process.

The meetings revealed that the SOEs delegated by the competent authority in Samoa to operate and maintain the ports have dedicated and adequate resources and processes in place for the continuous maintenance and management of AtoN.

11 Recommendations

A key outcome of the risk assessment undertaken at Apia Harbour is four recommendations that aim to reduce the risks to safety of navigation to an acceptable level for stakeholders. One recommendation was developed for Salelologa and Mulifanua harbours after the field visit.

11.1 Apia Harbour

Recommendation 1 (addressing grounding scenario)

This recommendation addresses the potential grounding of local fishing vessels near the entrance to the harbour on the west side due to the misinterpretation of leading lights. This is mainly due to the lack of crew competency.

It is recommended that all crew have relevant STCW training, and that more awareness programmes be delivered.

The above recommendations should potentially help to reduce the risk to as low as reasonably practicable.

Action	**Cost to implement (SAT)**
Deliver relevant training and awareness programmes	20,000

Recommendation 2 (addressing grounding scenario)

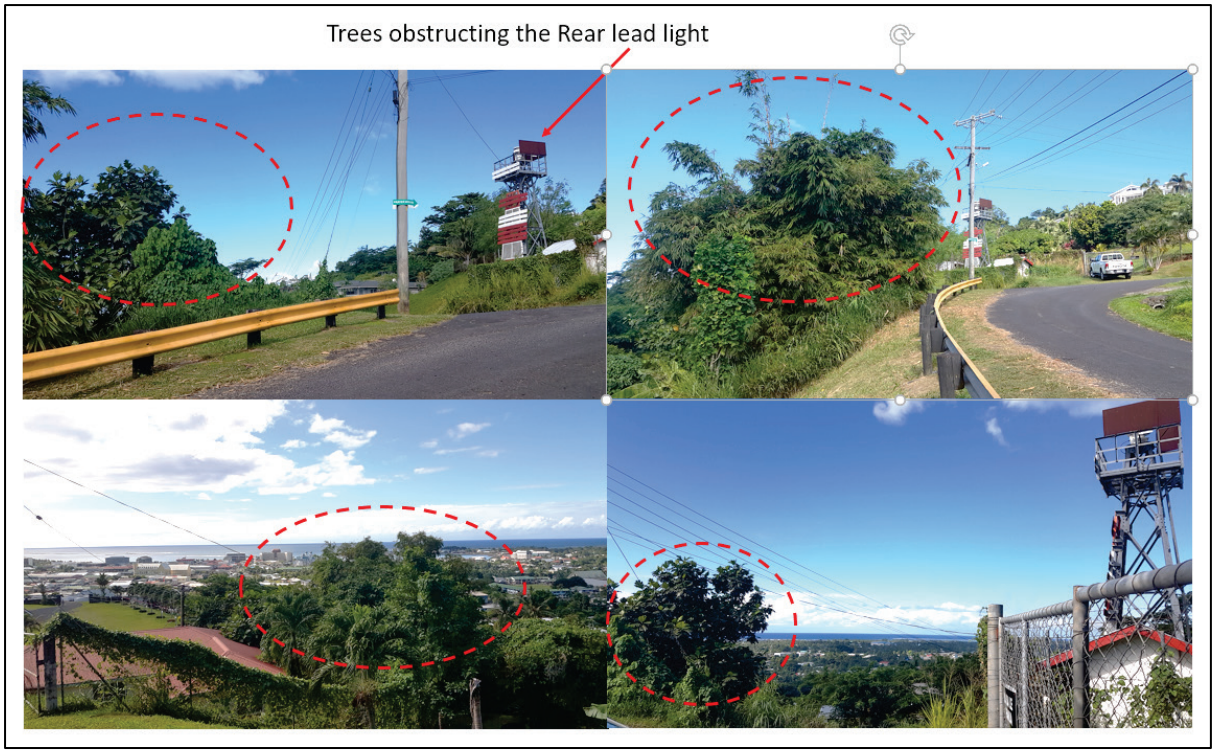
This recommendation addresses the potential grounding of a container ship while being towed out of the Apia channel for anchorage. This is mainly due to a lack of crew competency on the tugboat.

It is recommended that that crew on the tugboat have relevant STCW training.

Action	**Cost to implement (SAT)**
Deliver relevant STCW training to tugboat crew members	12,000

Recommendation 3 (addressing grounding scenario)

This recommendation addresses the potential grounding of vessels coming into port. This is mainly due to the leading lights and dayboard not being conspicuous. Tree in front of the rear leading light obstruct the leading light, and the front leading light is not conspicuous due to the lack of a dayboard.



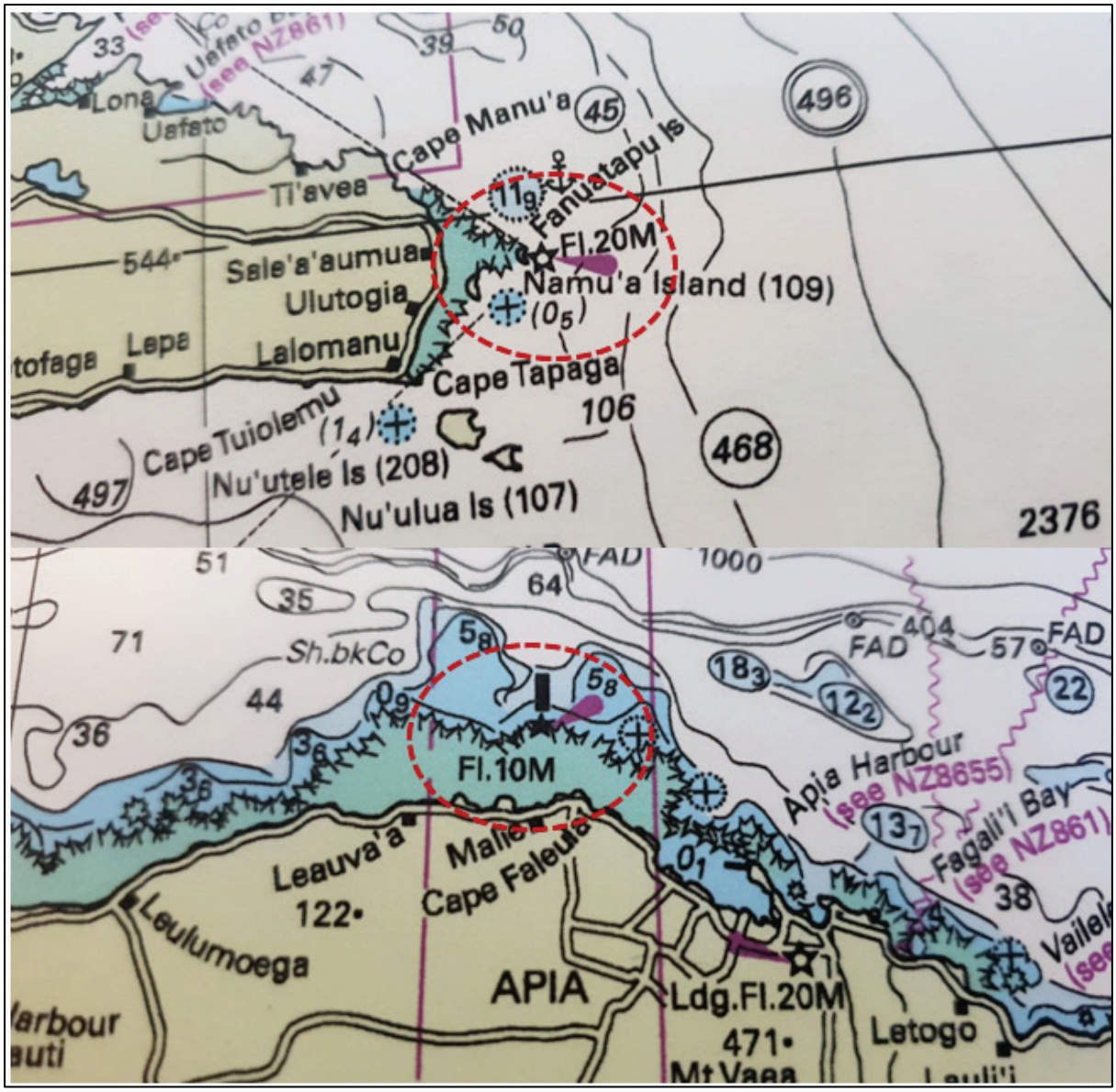
The following recommendations are made:

- Cut the trees in front of the rear leading light.
- Install a dayboard at the front leading light.
- Relocate the rear leading light to another position if the trees in front of it cannot be cut.

Action	Cost to implement (SAT)
Cut the trees in front of the rear leading light	500
Install a dayboard at the front leading light	5000
Relocate the rear leading light to another position if the trees in front cannot be cut	TBD by MWTI
Maintenance costs	250

Recommendation 4 (addressing grounding scenario)

This recommendation addresses the potential grounding of vessels along the coast of Apia, mainly due to unlit lights at Namu'a Island and Cape Faleula.



It is recommended that these lights be replaced as soon as practical.

Action	Cost to implement (SAT)
Purchase and install two lights	10,000
Maintenance costs	500

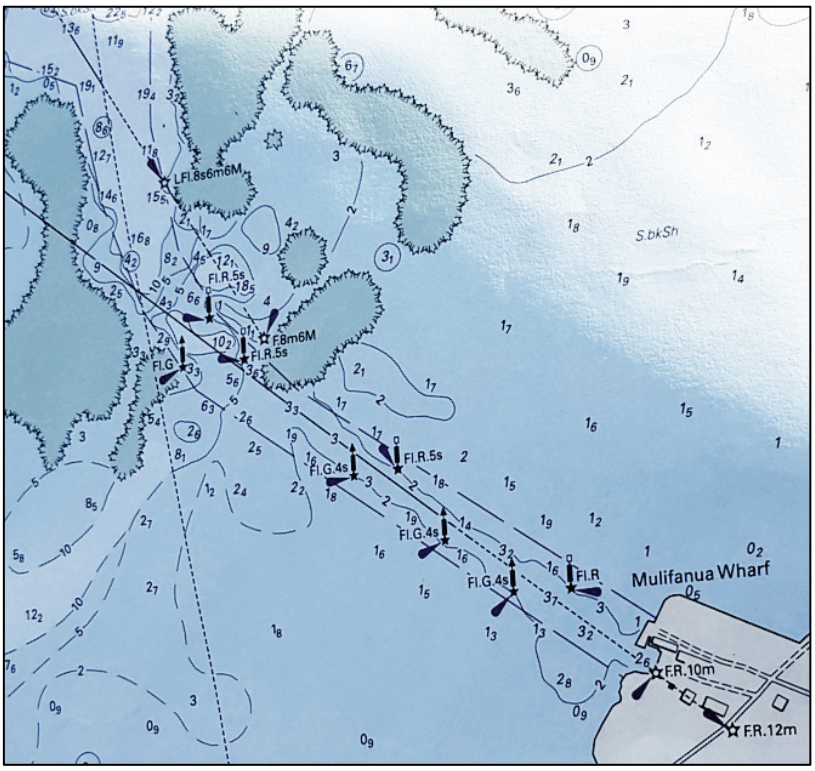
11.2 Salelologa and Mulifanua harbours

Recommendation 1 (addressing grounding scenario in Salelologa and Mulifanua harbours)

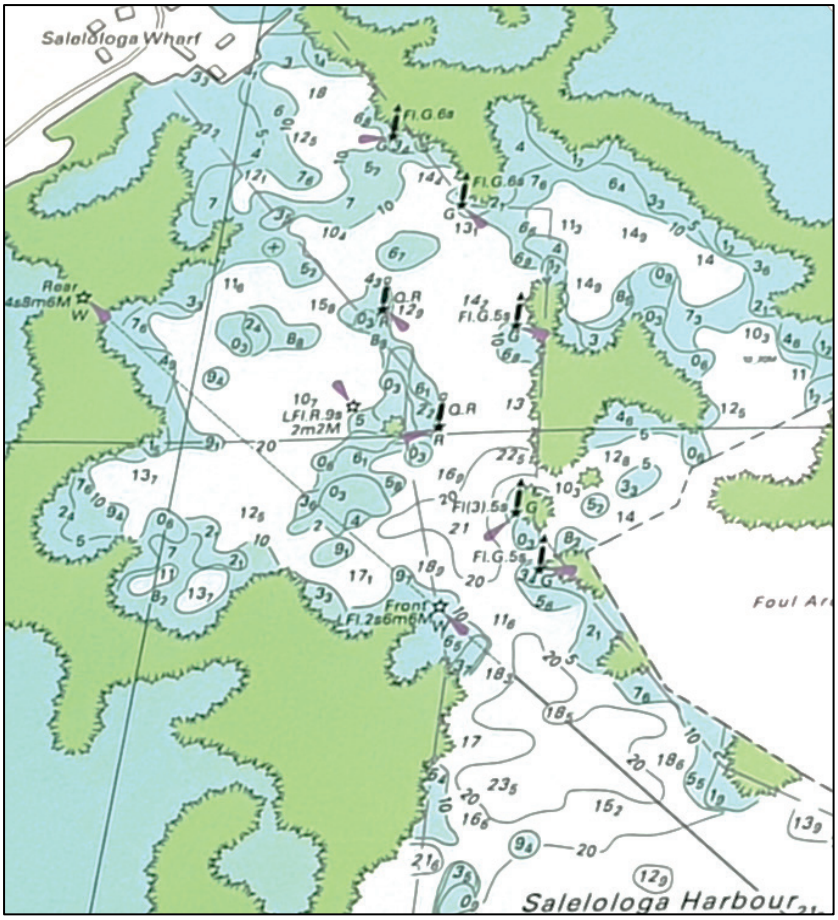
This recommendation addresses the potential grounding of vessels at both Salelologa and Mulifanua harbours.

There are currently eight lateral buoys and two sets of shore and channel leading lights marking the channel into Mulifanua harbour. The two leading lights in the channel, and buoys numbers 6 and 7,

have no lights, and the shore leading lights are completely destroyed. The lack of these AtoN can potentially cause the grounding of vessels accessing the harbour at night.



Salelologa harbour is marked by nine lateral buoys and two leading lights, with the latter being unlit. There are many shallow areas and coral along the channel entrance into Salelologa wharf. These hazards can cause the potential grounding of vessels entering the harbour.



The following recommendations are made:

1. Install two leading lights at Salelologa and two leading lights at Mulifanua harbours.
2. Dredge the channel into Salelologa harbour.
3. Update the current charts by sending a hydrographic note (H-note) to the PCA regarding the current situation of the AtoN.

Action	**Cost to implement (SAT)**
Purchase and install new leading lights	14,000
Dredge Salelologa channel	TBD (SSC)
Submit H-note	0
Maintenance costs (for AtoN)	700

12 Conclusion

This report completes the risk assessment process as required by Regulation 13 of the International Convention for the Safety of Life at Sea. It is also meant to guide MWTI, SSC and Samoa's Ports Authority in delivering compliant AtoN services in Apia Harbour and Salelologa and Mulifanua harbours.

SPC can provide further support in relation to capacity development, AtoN services and management, governance, and budget management to assist Samoa in offering safe maritime routes and meeting the county's international obligations.

It is suggested that a consistent and wider approach be taken by Samoa to include the delivery of hydrographic, marine meteorology, maritime safety information, and maritime search and rescue services in its governance processes.

Annex A. Stakeholders in the Apia Harbour risk assessment.

Safety of Navigation Risk Assessment Stakeholder Meeting (Phase II) - Apia, Samoa, 19 June 2019			
Name	**Job title**	**Organisation**	**Email address**
Anastasia Amoa-Stowers	Assistant CEO - Maritime Division	Ministry of Works, Transport and Infrastructure	anastacia.amoa@mwti.gov.ws
Pipi Ioane Foma'i	Assistant CEO	Samoa Shipping Corporation	pipi@samoashipping.com
Lealaiauloto Tafai Toilolo	Assistant CEO	Samoa Ports Authority	ttoilolo@spasamoa.ws
Seigafolava Tomane	Port Master	Samoa Ports Authority	portmaster@spasamoa.ws
Vaelua S. Brown	Head of School	National University of Samoa - Maritime Institute	s.brown@nus.edu.ws
Seumanu Iatua Pesetafa	Nautical lecturer	National University of Samoa - Maritime Institute	s.peseta@nus.edu.ws
Tasi Faatele	Police officer	Ministry of Police - Maritime Police	tasi.faatele@police.gov.ws
Ueta Faasili	Principal Offshore Fisheries Officer	Ministry of Agriculture and Fisheries	ueta.faasili@maf.gov.ws
Makerita Atonio	Principal Shipping Officer	Ministry of Works, Transport and Infrastructure	makerita.atonio@mwti.gov.ws
Tapaga Collins	Principal Surveyor	Ministry of Works, Transport and Infrastructure	tapaga.collins@mwti.gov.ws
Taligatuli Moala	Surveyor	Ministry of Works, Transport and Infrastructure	taligatuli.moala@mwti.ws
Etuate Tolo	Senior Safety Inspector	Ministry of Works, Transport and Infrastructure	etuate.tolo@mwti.gov.ws
Charlie Viane Sofe	Offshore and coastal engineer consultant	Ministry of Works, Transport and Infrastructure	charlie.sofe@mwti.gov.ws

Annex B. Hazards identified for Apia Harbour.

Hazards		Value	Remarks
Natural	Safe minimum depth (m)	15.1	Out of four groups of stakeholders, two mentioned that safe minimum depth is insufficient (both at the old jetty and the new jetty).
	Proximity of danger (nm)	0.01	Beacon # 3 at 0.01 nm, narrow passage, 8-m contours.
	Tide, wind, wave and tidal flow effect	7	Strong easterly wind combined with the tidal flow can have an effect on vessels entering and leaving the port.
	Low sun angle	Y	Low sun angle (in the morning and at sunset) reflecting off the water can be a problem when entering and leaving the channel.
	Background lighting	Y	Background lights from Samoa Ports Authority building can cause issues.
Economic	Insufficient AtoN funding	Y	Light dues are collected from all ships but they go to the government account and are not used for AtoN funding.
Technical	Shipborne NavAid failure	Y	Common issues with private and domestic vessels.
	Quality and validity of charted information	Y	Charts not updated.
	Loss of vessel control	Y	Loss of vessel control (steering).
	AtoN failure	Y	Lack of maintenance, vandalism, allisions and not enough AtoNs.
	Substandard ships	Y	Substandard ships
Human	Crew competency	Y	International vessels are not checked.
	Fatigue	Y	International vessels are not checked.
	Safety culture	Y	Boat operators not following standards and rules.
	Influence of alcohol and/or drugs	Y	Common issues with crew, and these have caused groundings previously.
	Political issues	Y	Control of vessel maintenance by government.
	Culture or language issues	Y	Foreign nationals serving as crew on international vessels are unable to communicate.
Operational	Impact of small vessels	Y	Vessels not compliant with Port Control procedures with regard to vessel movement.
	Fishing activities	Y	Can cause collisions
	Poor passage planning	Y	Vessels not complying with standard operating procedures.
	Poor promulgation of marine safety information	Y	Charts need to be updated.
	Poor response to marking new dangers	Y	Poor communication with shipping agencies.
Maritime Space	The existence of wrecks and new dangers	Y	Wrecks and missing navigation lights pose hazards.
	Crowded waterway issues	Y	Limited anchorage space for international vessels.

Annex C.1. Possible scenarios identified for Apia Harbour.

Scenarios		Remarks
Grounding	Grounding on reef	Fishing vessels running aground near the entrance at west side due to misinterpretation of leading lights.
	Grounding on reef	Container ship grounds while being towed out of the channel for anchorage
	Groundings on reef at entrance channel	Front and Rear leading lights not being conspicuous due to lack of day boards and vegetation growth
	Groundings on reef	Due to unlit lights at Namu'a Island light and Cape Faleula lights

Annex C.2. Possible scenario identified for Mulifauna and Salelologa harbours.

Scenario		Remarks
Grounding	Grounding on reef	Grounding of domestic vessels and yachts at Mulifanua harbour due to unlit transit lights and grounding of vessels at Salelologa harbour due to unlit leading lights and shallow areas along the leading lights.

Annex D.1. Risk assessment matrix for Apia Harbour.

	Scenario	Description of incident	Root Cause(s) (Hazards)	Description of Consequences (Short term and long term)	Existing Risk Control Measures	Probability Score	Consequence Score	Risk Score	Cost of Incident (SAT)	Further Risk Control Options	New Probability Score	New Consequence Score	New Risk Score	Cost of RCO (SAT)	Remarks
				1. GROUNDINGS											
1.1	Grounding on rock	Fishing vessels running aground near the entrance at west side due to misinterpretation of leading lights.	Misinterpretation and crew competency	Damage to the vessel and the marine environment	All vessels crew including fishing vessels must have nautical experience	2	4	8	2.88 M	Ensure relevant trainings are delivered for all fishermen and continuous awareness programs	1	4	4	20, 000	ALARP
1.2	Grounding on reef	Container ship grounds while being towed out of the channel for anchorage	Crew competency of tug boats	Damage to the hull of the vessel and minor environmental damages	Qualified crew	2	3	6	1.6 M	Ensure that the crew on the tug boats have relevant STCW training	1	3	3	12,000	STCW training to be delivered by Samoan Maritime Schools for local crew members.
1.3	Groundings on reef at entrance channel	Vessels runs aground while entering Apia port	No Day boards at front lead light and Rear lead lights and day board not conspicuous	Damage to the vessel and personnel as well as environment	Pilotage service	3	5	15	48.5 M	1.Cut the trees in front of rear lead light . 2. Install day boards at front lead light. 3. Relolate rear lead light to higher ground with day boards if trees cant be cut.	1	5	5	1. 500 2. 5,000 3.TBD (MWTI)	ALARP
1.4	Grounding on reef	Ships running aground while coming along the coast of Apia	Due to unlit lights at Namu'a island light and Cape Faleula lights	Damage to the vessel and personnel as well as environment	none	2	5	10	3.2 M	Replace those two un lit lights at Faleula village and Namua island	1	5	5	10,000	ALARP- SPA to replace these lights within the next two months

Annex D.2. Risk assessment matrix for Salelologa and Mulifanua harbours.

Scenario		Description of incident	Root Cause(s) (Hazards)	Description of Consequences (Short term and long term)	Existing Risk Control Measures	Probability Score	Consequence Score	Risk Score	Cost of Incident (SAT)	Further Risk Control Options	New Probability Score	New Consequence Score	New Risk Score	Cost of RCO (SAT)	Remarks
1. GROUNDINGS															
1.1	Grounding on reef around the harbour entrances	Vessels running aground while entering both ports of Mulifanua and Salelologa at night	Unlit leading lights and shallow areas along the channels	Damage to the ship side/hull and environment	No voyages at night time	3	3	6	24.3 M	1. Install 4 new lead lights on existing towers(2 at each harbour) 2. Dredge the channel at Salelologa harbour. 3. send H-Notes to PCA to update the charts	1	3	3	1. 14,000 2. TBD(SSC) 3. 0	New AtoNs and Dredging of harbours within the SCC workplan

ISBN 978-982-00-1182-3

Pacific Community | spc@spc.int | www.spc.int